International Symposium on Flood Forecasting and Water Resources Assessment for IAHS-PUB

September 28-30, 2006
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Themes of the Symposium

Varying from the cold to tropic and from the arid to humid regions, together with the differences in topographical, geological and land cover conditions, the hydrology shows very high variability over China. There is a great challenge in the forecasting in the Chinese ungauged or poor-gauged basins. On the other hand, under the pressure of an increasing population and fast economic development, China is facing many urgent water-related issues: flood, water shortage, water and soil loss, water pollution and degradation of ecosystem. There is an increasing demand on the PUB application for better management of water resources. For promoting the exchanges between China and IAHS and for showing the research progresses in China to the world, China PUB National Steering Committee suggested have International Symposium on IAHS-PUB for Flood Forecasting and Water Resources Assessment.

The main subjects of this symposium are:
1. Understanding of hydrologic processes and reduction of the uncertainties in their modeling;
2. The new theory and methodology for hydrological forecasting;
3. The new theory and methodology for water resources assessment and prediction;
4. Impacts of climate change and human activities on the hydrological cycle and regional water resources;
5. Hydroinformatics and its application to flood forecast and water resources assessment.
General Information & Services

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Symposium Secretariat:
   Tian Fuqiang: 13910200812
   Lv Huafang: 13466390099

Emergency services: +86-10-110
Scientific Agenda

September 27, 2006, Lobby of Jinchuanyun Hotel

Registration

September 28, 2006, Conference Hall of Jinchunyuan Hotel

9:00~10:00 AM: Opening ceremony, Chair: Prof. Zhang Jianyun

Welcome speech by Hu Heping, Vice President, Tsinghua University
Address by Hu Siyi, Vice Minister, Ministry of Water Resources of China
Speech by McDonnell, Chairman of IAHS-PUB SSG

10:00~10:30 AM: Coffee break

10:30~12:30 AM: Keynote Lectures, Chair: Prof. Yang Dawen

Prof. Jeffrey McDonnell, Isotope Hydrology in the Context of Improving Understanding of Hydrologic Processes and Reducing Uncertainty in Hydrological Modeling
Prof. Hu Heping, Runoff-Evaporation Hydrological Model for Arid Plain Oasis and its Application to the Tarim River Basin
Prof. Kuniyoshi Takeuchi, Water Hazards, Risk Management and PUB

12:30~14:00: Lunch

13:40~15:40 PM: Keynote Lectures, Chair: Xia Jun

Prof. Murugesu Sivapalan, Representative Elementary Area (REW) Approach to Distributed Hydrologic Modeling at the Catchment Scale: What Next!
Prof. Zhang Jianyun, Environmental Change and Hydrological Simulation and Prediction
Prof. Keith Beven, Flood Forecasting in the Framework of Models of Everywhere
Prof. O’Connell, Modelling the Impacts of Land Use Management Changes on Runoff Generation and Flooding

16:20~16:35 PM: Coffee break

16:35~18:35 PM: Keynote Lectures, Chair: Hu Heping

Prof. Ezio Todini, Distributed Hydrological Catchment Models for Extension to Ungauged Catchments
Prof. Xia Jun, Hydrological Modeling of Imperfect Gauged Basins: A New Challenge
Dr. Robert Moore, Flood Forecasting for Ungauged Basins: Perspective and Challenges

19:00~20:00 Reception
### Session 1

**Chair**: Prof. Jeffrey McDonnell, Dr. Ni Guangheng

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| 8:30-10:10 | Mo Xingguo: Estimation of evapotranspiration and gross primary production and their scale effects over a large basin in the Loess Plateau  
          Shen Chiang: Application of an uncertainty recognition methodology for assessment of TOPMODEL with a downscaled topographic index distribution  
          Chen Xing: Implementation of Subgrid-scale Spatial Variability of Parameters in a Regional Climate-Hydrology Coupled Model  
          Yang Tao: An approach for distributed runoff and sediment yield modeling of small watershed and parameter uncertainty analysis  
          Han Songjun: Evaluation of three complementary relationship approaches for evapotranspiration over the Akesu Plain Oasis in northwestern China |

**Chair**: Prof. Keith Beven, Prof. Mo Xingguo

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| 10:30-12:10 | Yang Dawen: Spatial and temporal variability of water-energy balance in non-humid catchments based on the Budyko hypothesis  
              Liu Fanggui: On some watershed hydrology problems based open-system  
              Guan Yiqing: Application of rainfall-runoff models in two small catchments  
              Cong Zhentao: Evaporation Paradox and its Response in Yellow River Basin, China  
              Yang Zhiyong: Modification of WEHY model and its application in Qinhe river basin |

### Session 2

**Chair**: Prof. O’Connell, Prof. Frederick N. Chou

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              Li Chong: Simulation of storm flood basing on deriving drainage networks from grid DEM and 2-D hybrid approach in Shalan River Basin  
              Li Shaohua: Real-time flood forecasting in a semiarid river basin of northwestern China  
              Ding Huakai: Research on the computing method of flood prevention in river estuary city  
              Xu Jijun: Regional floods forecast in the Three Gorges of the Yangtze River using rain-gauge data and weather-radar data |

**Chair**: Dr. Tachikawa, Prof. Ren Liliang

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| 16:40-18:00 | Liang Zhongmin: A statistically-based runoff-yield model considering spatial variation of rainfall  
               Murugesu Sivapalan: Impacts of climate variability on flood frequency: comparative study of catchments in Perth, Newcastle and Darwin, Australia  
               Li Guofang: Improvement in water level forecast for tidal reaches  
               Gao Cheng: A new method for the estimation of flood control benefit  
               Chen Yanping: Study on flood forecast’s runoff yield model for arid and semi-arid regions |
### September 29, 2006, No. 2 Meeting Room, Jinchunyuan West Building

**Session 3**

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**Chair** Dr. Robert Moore, Prof. Jia Yangwen

**Session 3**

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**Chair** Prof. Takeuchi, Prof. Xu Zongxue

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**Chair** Dr. S B Weerakoon, Prof. Ren Li

**Session 5**

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**Chair** Dr. Lu Zhang, Prof. Ao Tianqi
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Jeffrey J. McDonnell

Jeffrey J. McDonnell is the Richardson Chair in Watershed Science at the Department of Forest Engineering, Oregon State University. Professor McDonnell has received many awards and honors including: the Gordon Warwick Award, British Geomorphological Research Group; Fellow of the International Water Academy; Horton Research Grant, American Geophysical Union; Nystrom Award, Association of American Geographers. He is a registered professional hydrologist with the American Institute of Hydrology. Prof. McDonnell has been the STINT Fellow at the University of Stockholm, Gledden Fellow, University of Western Australia; Leverhulme Fellow at Bristol University; Hayward Fellow at Landcare New Zealand; STA Fellow at Japan Forest Products and Forest Research and USRA Fellow at NASA Marshall Space Flight Center. He is past President of the International Commission on Tracers and is the current Chair of the IAHS Decade on Prediction in Ungauged Basins. He has served as Associate Editor for the journals Water Resources Research, ASCE Journal of Hydrologic Engineering and Hydrological Processes and is now Associate Editor for Journal of Hydrology, Hydrological Sciences Journal, Hydrology and Earth Systems Science and Editorial Board Member for Hydrological Processes. He has authored or co-authored more than 150 journal articles. He has also edited several texts including the Elsevier textbook (together with Carol Kendall) “Isotope Tracers in Catchment Hydrology”. Recently he has served as Senior Advisory Editor of the Encyclopedia of Hydrological Sciences, published by John Wiley and Sons.

Isotope hydrology in the context of improving understanding of hydrologic processes and reducing uncertainty in hydrological modeling

Jeffrey J. McDonnell
Dept. of Forest Engineering, Oregon State University

Abstract: Stable isotope tracers have been in use in hydrology for more than 30 years. Nevertheless, their penetration into mainstream flood forecasting modeling and water resources assessment is still limited. Many of the major themes of IAHS-PUB initiative (watershed classification, conceptualization of processes, model uncertainty reduction, development of new hydrological theory, development of new techniques, topdown modeling, etc) can benefit from incorporation of isotope tracing approaches. This paper describes some of the basics of stable isotope tracers in the environment and the use of simple mixing relations that can be established in ungauged basins. It then provides some examples of where isotope hydrology can improve understanding of hydrologic processes and reduce uncertainty in hydrological modeling, based on recent studies in the USA.
Runoff-evaporation hydrological model for arid plain oasis and its application in Tarim River Basin

Hu Heping
Department of Hydraulic Engineering, Tsinghua University

Abstract: Recent advances in hydrological processes research make it widely accepted that runoff absorbing processes can considerably influence hydrological response. The redistribution of surface runoff by natural force or human activity becomes the dominating processes especially in arid plain oasis. Compared with traditional hydrological models focusing on rainfall-runoff processes, our model for arid plain oasis, namely runoff-evaporation hydrological model, is focusing on runoff-evaporation processes which is intended to represent water dispersion and consumption in river basin scale systematically. Runoff-evaporation processes are grouped into lateral and vertical processes. Lateral fluxes are related to water dispersive processes roughly parallel to the terrain surface such as river forks, river overruns, river water is diverted into irrigated area, and groundwater flowing. Vertical fluxes occur by redistribution processes of surface water such as evapotranspiration, infiltration and percolation during all the dispersive processes. Application of the model in Akesu, Kashi, Kezhou, Bazhou, and Hetian oasis in Tarim River Basin, located northwestern China, shows that simulated discharge and water table meet the observed value very well.
Kuniyoshi Takeuchi

Kuniyoshi Takeuchi is now a professor in Department of Civil and Environmental Engineering, University of Yamanashi, and the Director of International Center for Water Hazard and Risk Management. He received his Ph.D degree from University of Tokyo. He has received many awards including JSCE Research Award for "Optimal control of a large scale reservoir system", and JSHWR Distinguished Achievement Award. He served as President of International Association of Hydrological Sciences (IAHS) from 2001 to 2005, Vice President of International Water Resources Association (IWRA) from 1998 to 2000, Associate editor of Journal of Hydroscience and Hydraulic Engineering, and so on. He has also served as chairman of Japan National Committee for International Hydrological Program (IHP), UNESCO, and member of Japan National Commission of UNESCO.

Water Hazards, Risk Management and PUB

Kuniyoshi Takeuchi
Professor of Yamanashi University and Director of ICHARM

Abstract: The number of water-related disaster events is increasing and is expected to further increase in the century. Global warming, economic development and expansion of human habitat are responsible for increasing disaster risk that is the product of natural hazards and societal vulnerability. Early warning, preparedness and other risk management are the key to the reduction of disaster damages and they all are highly dependent on prediction capacity of society. Hydrologists are much responsible for its improvement and PUB is expected to play a central role in this direction. ICHARM founded last March will promote the advancement of flood forecasting capacity and disseminate the information helping the localities utilize it in their diverse situation.
**Murugesu Sivapalan**

Murugesu Sivapalan is now a full professor in department of Geography & Civil and Environmental Engineering, and the Director of Center for Water as a Complex Environment System, University of Illinois at Urbana-Champaign. He received his Ph.D degree from Princeton University. Professor Sivapalan has received many awards and honors including Centenary Medal by Commonwealth Government of Australia, John Dalton Medal by European Geophysical Society. He has been the fellow of American Geophysical Union, Australia Academy of Technological Sciences and Engineering, Modelling and Simulation Society of Australia and New Zealand, the International Water Academy, and so on. He has served as Executive Editor for Hydrology and Earth System Sciences Journal (European Geosciences Union), Chair of Science Steering Group, IAHS Decade on Predictions in Ungauged Basins. He has published nearly 100 journal articles and many other academic publications and presentations. His current major research themes include climate-soil-vegetation controls on hydrological variability, novel (upward and downward) approaches to hydrological modelling, hydro-climatology, human impacts on water quantity and water quality, biogeochemical cycling and riverine water quality, and threshold nonlinearities and risk assessment.

**Representative Elementary Area (REW) Approach to Distributed Hydrologic Modeling at the Catchment Scale: What Next!**

**Murugesu Sivapalan¹, Haksu Lee¹, and Erwin Zehe³**

¹School of Environmental System Engineering, University of Western Australia  
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**Abstract:** The development of the REW approach (Reggiani et al., 1998, 1999) has now completed its second phase. The first phase involved the derivation of the REW scale balance equations and constitutive theory. The second phase involved converting these balance equations into a working numerical model to serve as a new blueprint for distributed hydrological modelling at the catchment scale. The result is the numerical model named as the Cooperative Community Catchment model based on the Representative Elementary Watershed approach, or CREW, which is now available to anyone to use and advance. In the course of model development, four building blocks of a prototype model were worked on: 1) the development of reasonable closure relations for the mass exchange fluxes within and between various REW sub-regions that effectively parameterize the effects of sub-REW heterogeneity of climatic and landscape properties, 2) the construction of a numerical model to seek numerical solutions of the REW balance equations that are composed of a set of coupled ordinary differential and algebraic equations for the number of REWs and the sub-regions within them, 3) application of the resulting numerical model to real catchments to assess its performance in the prediction of any specified hydrological variables, and 4) the assessment of model reliability through estimation of model predictive uncertainty and parameter uncertainty using the Generalized Likelihood Uncertainty Estimator (GLUE). In this talk we will present a summary of the results of this developmental work, and then present a new vision into the next steps in further development of this modelling approach: development of more sophisticated closure relations, estimating parameters that are meaningful and measurable at the REW scale, alternative representations of transpiration based on ecological optimality and approaches to reduce equifinality and parameter identifiability, and extension of CREW (and the underlying theory) to deal with cold region processes etc.
Zhang Jianyun

Murugesu Sivapalan is now a full professor in department of Geography & Civil and Environmental Engineering, and the Director of Center for Water as a Complex Environment System, University of Illinois at Urbana-Champaign. He received his Ph.D degree from Princeton University. Professor Sivapalan has received many awards and honors including Centenary Medal by Commonwealth Government of Australia, John Dalton Medal by European Geophysical Society. He has been the fellow of American Geophysical Union, Australia Academy of Technological Sciences and Engineering, Modelling and Simulation Society of Australia and New Zealand, the International Water Academy, and so on. He has served as Executive Editor for Hydrology and Earth System Sciences Journal (European Geosciences Union), Chair of Science Steering Group, IAHS Decade on Predictions in Ungauged Basins. He has published nearly 100 journal articles and many other academic publications and presentations. His current major research themes include climate-soil-vegetation controls on hydrological variability, novel (upward and downward) approaches to hydrological modelling, hydro-climatology, human impacts on water quantity and water quality, biogeochemical cycling and riverine water quality, and threshold nonlinearities and risk assessment.

Isotope hydrology in the context of improving understanding of hydrologic processes and reducing uncertainty in hydrological modeling

Zhang Jianyun

Richardson Chair in Watershed Science, Dept. of Forest Engineering, Oregon State University

Abstract: Stable isotope tracers have been in use in hydrology for more than 30 years. Nevertheless, their penetration into mainstream flood forecasting modeling and water resources assessment is still limited. Many of the major themes of IAHS-PUB initiative (watershed classification, conceptualization of processes, model uncertainty reduction, development of new hydrological theory, development of new techniques, topdown modeling, etc) can benefit from incorporation of isotope tracing approaches. This paper describes some of the basics of stable isotope tracers in the environment and the use of simple mixing relations that can be established in ungauged basins. It then provides some examples of where isotope hydrology can improve understanding of hydrologic processes and reduce uncertainty in hydrological modeling, based on recent studies in the USA.
Keith Beven

Keith Beven is Professor of Hydrology and Fluid Dynamics at Lancaster University. He currently holds the King Carl XVI Gustaf Chair in Environmental Science for 2006/7 at Uppsala University in Sweden. He has published over 300 papers and 7 books, including a text on Rainfall-Runoff Modelling, and the first in the Benchmark Series of Hydrological Papers for IAHS on Streamflow Generation Processes. He is on the ISI Highly Cited list for both Environment/Ecology and Engineering. He has been awarded the John Dalton Medal of EGU and the Horton Award and Langbein Lecture Award and fellowship of AGU. He developed the original version TOPMODEL with Mike Kirkby, and is the originator of the Generalised Likelihood Uncertainty Estimation (GLUE) methodology.

Flood Forecasting in the Framework of Models of Everywhere

Keith Beven, Peter Young, Renata Romanowicz, Florian Pappenberger, Paul Smith
Environmental Science/Lancaster Environment Centre, Lancaster University

Abstract: Increases in computer power and the speed and bandwidth of networking, and the needs of integrated catchment management will drive the development of hydrological models of everywhere. There is then an interesting issue about how such hydrological models of everywhere should be implemented to cope with the different time and space scales at which different types of information are available, the different scales and different purposes for which predictions are required, and the evolution of different model components as more process understanding is gained. Resolving these issues requires the problem of appropriate model complexity for different purposes to be addressed (including integrating top-down and bottom-up approaches to modelling) and the use of data assimilation (including the future possibilities of remote sensing and networks of cheap pervasive sensors) to learn about the characteristics of particular places and reduce the uncertainties associated with predictions in both real-time forecasting and simulation for long time scales. The requirements of flood forecasting provide an interesting example of some of these issues. Traditionally, different types of models have been used for (a) predictions to a point (often a gauging station), with calibration of model parameters on historical flood data and adaptive updating if observations are available in real time, and (b) for the distributed problem of mapping flood risk generally without much in the way of calibration because of lack of historical inundation data. There is, therefore, a classical issue of how best to use the information from gauged sites in conditioning the predictions at ungauged sites, whether for flood risk mapping or real time flood warning purposes. Past experience suggests that only simple top-down approaches are needed for forecasting to a point, facilitating adaptive data assimilation, while the distributed hydraulic models used for flood risk mapping are often highly uncertain in their predictions, even after conditioning on maps of inundation area from past events. This paper will discuss a methodology, based on the Models of Everywhere concepts, to combine these approaches in a way that is effective for both operational forecasting and flood risk assessment within an adaptive learning framework for applications to particular places.
Enda O’Connell

Enda O’Connell is Professor of Water Resources Engineering and Director of the Water Resource Systems Research Laboratory, which he established in 1984, at Newcastle University. He is also Director of the Earth Systems programme within the university’s Institute for Research on Environment and Sustainability. He is the founding past President of the Hydrological Sciences Section of the European Geosciences Union. He has contributed extensively to the literature in the areas of stochastic rainfall modelling, distributed physically-based modelling of river basins, climate change impact assessment, flood risk estimation, and water resources management. He was Principal Investigator in the DEFRA/EA Project FD2114 “Review of Impacts of Rural Land Use and Management on Flood Generation”, and was involved in launching the IAHS decade on “Prediction in Ungauged Basins”. He is coordinator of the NERC-funded CHASM (Catchment Hydrology And Sustainable Management) project, and is a member of the Editorial Boards of several leading international journals. He is a Fellow of the UK Royal Academy of Engineering.

Modelling the Impacts of Land Use Management Changes on Runoff Generation and Flooding

Enda O’Connell, John Ewen and Greg O’Donnell

Water Resource Systems Research Laboratory, School of Civil Engineering and Geosciences, Newcastle University, UK

Abstract: Over the past fifty years, much of the European landscape has been transformed as a result of changes in land use and management. The growth in intensive agriculture and associated farming practices have changed natural hydrological functioning at the field/hillslope scale, and as a consequence, flood generation mechanisms at the catchment scale may have been affected. In the UK, there is evidence that soil compaction/degradation has created local scale flooding problems, but it is not clear how flood generation at larger catchment scales may have been affected. A wide frange of interventions associated with farming and land use management (e.g. land drainage etc) complicate the overall picture. Similar problems have been observed ad documented in other European countries, and there is the added concern about how the catchments will respond to the more extreme rainfall regimes expected under climate change. There is also frequent controversy over the impacts of afforestation and deforestation in the uplands on lowland floods, particularly in Asia.

The current state of knowledge concerning the impacts of land use and management on flood generation will be reviewed, together with the current modelling and predictive capacity, and gaps in knowledge will be identified. Central to the prediction problem is the scale issue: how do local scale impacts on runoff generation propagate to larger catchment scales? A new modelling approach for tracking impacts from local to larger catchment scales will be described.
Abstract: The extension of hydrological catchment models to ungauged catchments is still a problem to be solved. Several approaches were advocated in the past, which used regionalisation techniques based on regression analyses of model parameters over the physiographical characteristics of the river basins. Unfortunately the results were never sufficiently accurate to allow for practical uses, particularly when dealing with floods. Most of the models to be regionalized were extremely simple models in order to limit the number of parameters to be regionalized, from basic rainfall-runoff lumped models (for instance the 1 or 2 parameters IUH), to simple conceptual models. Also the introduction of the GIS based models opened interesting perspectives, which were not fully met in practice. Scope of this presentation is to analyse the possibilities offered by the distributed physically meaningful models as opposed to lumped models. It appears in fact that not only the physical meaning of parameters can only be preserved at small scales (<1 km) but also that the lumping process hides two important phenomena such as a hysteretic saturation-desaturation effect which produces a loop-shaped saturated area–storage volume curve as well as an exfiltration process which is still active when rainfall stops. These two phenomena are implicitly described in a distributed model as a function of the catchment geomorphology and can thus be extended to ungauged catchments if the models are transferred in distributed form, while the relevant information is lost when lumping. This raises the idea of initially extending the distributed model to the ungauged catchment, in order to preserve the physical properties and the physical meaning of parameters and, if a lumped model is needed, obtain the relevant information by simulating the filling and depletion processes on the distributed model.
Xia Jun

Xia Jun is a Chair Professor on Hydrology & Water Resources, and Director, Key Lab. of Water Cycle & Related Land Surface Processes, Chinese Academy of Sciences (CAS) by the CAS Hundreds Talents Programming since 2000. He was the Dean(1998-2000), Faculty of Water Resources and Hydropower Engineering, Wuhan University. Since 2000, he was pointed as the 1st Vice President, United Research Center of China Water Problem, CAS, and Director General, Committee of Water Resources, China Society of Natural Resources (CSNR), Co-Director, China- Australia Center of Water Resources Research etc. He was awarded the National Labor Award on May 1st, 2001 by the Chinese Government. Since 2001, he was in charge of several key research projects, such as “Water Cycle & Water Resources Security in North China(2001-2005)” etc. He recently completed a series of publications in the Hydrological Sciences Journal, Water International, and Water Resources Management. In 2001, he also was pointed as an External Evaluating Member, IHP-V(1996-2001), UNESCO, and Member & Specialist, Theme Advisory Boards of International Hydrological Program 6th phase (IHP-VI, 2002-2007), UNESCO, and Asia Bank’s consult expert on Water Resources, National Strategies for Soil & Water Conservation (ADB TA 3548-PRC). He was elected as the Vice President of International Commission of Water Resources System (ICWRS), International Association of Hydrological Science (IAHS) in 1995; Director of Exclusive Board, International Water Resources Association (IWRA) in 2001; Vice President of International Water Resources Association (2003-2006) and Vice President of International Association of Hydrological Science (2003-2007).

Hydrological Modeling of Imperfect Gauged Basins: A New Challenge

Xia Jun
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Abstract: Many countries of the world have been facing increasing problems in managing their water resources. The imperative of the sustainable development puts several tasks on water management. China is an example of a country where water related problems are multifold and range from water shortage, eco-environment degradation to food safety, such as the courses drying up of low reaches of the Yellow River which almost became an annual events since 1972, and water crisis of the three river’s alluvial plain in last two decades in terms of shallow groundwater depletion. In order to manage water resources in a sustainable manner, it was emphasized to study hydrological processes associated with water problems to understand causes of existing vulnerability of water resources and provide more information of water resources change in basin/regional scale to try to increase water safety.

From the point of hydrological science research, we need to understand real behavior of water cycle in the world. On the other hand, we had to face many difficult problems on hydrological modeling of imperfect gauged basins, particular in the developing countries. For instance, a key project entitled the Northern China water resources safety problems research was granted recently by the Chinese Academy of Science. Main tasks can be identified as the time-space variation analysis of water cycle and the distribution of water resources at basin scale.

Water cycle at basin scale is the basis used to study the safety of water resources. In this part of research project, the focus will be on the Chaobei Basin in Northern China, which includes several important big cities such as Beijing and Tianjin. Through experimental studies involving the dynamics of small-scale water cycle and collection of remote sensing data, it will be commenced scientific research on problems of hydrological processes and responses. It will also be carried out research on downscaling issues linked with the interaction...
between atmosphere and land-surface in the water cycle process. Based on the geomorphology and other geographical information derived from digital elevation model (DEM), it was request to build a mathematical hydrological model to accurately describe the water cycle at basin scale. This model is required to integrate the mechanisms and processes in water cycle unit, and to simulate the hydrological impacts of land use/cover changes. It will also be used to perform simulation study to verify efficiency, to evaluate the impact of human activities on the changes of the time and space of water cycle, and to investigate the relationship between basin hydrology and biogeochemical cycle of carbon.

(1) Analysis of the time-space variation of the basin hydrological cycle: To identify the fundamental characteristics of hydrological changes by using the basic information obtained from the hydrological processes and the analysis data from the multiple features of the time-space field.

(2) Remote sensing information identification and parameterization of land-water interactions: To provide useful information for the construction of the hydrological model by making use of remote sensing data obtained from MODIS/TM combined with DEM and other GIS data layers, the mathematical model to be developed is required to capture the changes of types and coverage of vegetation, temperature in canopy layer and land surface, rate of reflection, soil water wetness, evapotranspiration capacity, and urbanization impact. Furthermore, through downscaling research, we aim to obtain the characteristic pattern of parameter variations of the basin-scale hydro-ecological model.

(3) Modeling and verification of the time-space variation of the basin hydrological cycle: This covers the study on how the information obtained from unit dynamic processes of water cycle can be used to extract required information at basin scale by using nonlinear parametric regression techniques in statistics. We aim to build a hydrological cycle model based on the specific characteristics of the land and environmental conditions of Northern China. This model will help us understand the interrelationship between the information obtained from the experimental site and the entire study region. It will integrate the physical processes of and interactions between surface water and ground water, the changes in land use/cover and the remote sensing information obtained. Simulation studies will be performed to examine the effectiveness of the model, and to evaluate the impact of human activities on the water carbon cycle.

Problem is “Can we do hydrological modeling & prediction in the imperfect gauged basin? How we can reduce uncertainty of hydrological modeling in large basin?” Hydrologists will have to face new challenges and opportunities that will be discussed in the Workshop.
Robert Moore

Robert Moore is the head of the CEH/Met Office Joint Centre for Hydrometeorological Research and head of the CEH Hydrological Modelling & Forecasting Group. CEH (Centre for Ecology & Hydrology) Wallingford was formerly the Institute of Hydrology. He leads a small modelling and forecasting team with specialist interests in lumped and distributed flood modelling and weather radar. Specialist developments include the PDM (Probability-Distributed Model) rainfall-runoff model, the Grid-to-Grid distributed model, the River Flow Forecasting System or RFFS (awarded the British Computer Society medal), HYRAD for processing and display of weather radar data, the Decision Support System for Drought Management (awarded the Tison Prize of the International Association of Scientific Hydrology) and CEH’s dynamic model of basin sediment yield.

Flood forecasting for ungauged basins: perspective and challenges

Robert Moore
Centre for Ecology and Hydrology

Abstract: A perspective is given on methods of flood forecasting for basins that are ungauged. Whilst rainfall-runoff models are the main focus of attention, discussion extends to hydrological and hydrodynamic approaches to river flow routing; simpler empirical models are also considered. Even for specific rainfall-runoff models it is rare that an ungauged modelling methodology is sufficiently well established for routine application to flood forecasting. The nature of the ungauged problem is considered, first at a generic level and then with reference to specific model types, and also in relation to real-time forecast updating. The growing need to forecast at any location where there is a risk of flood damage adds impetus to the development of improved methods. Simple extrapolation of forecasts and warnings from gauged sites, often based on lumped model formulations, may no longer suffice. New methods of grid-based area-wide forecasting – supported by digital datasets on terrain, land cover, soil and geology - show promise in providing an integrated approach to modelling for any location, whether gauged or ungauged. A framework for model development involving historical extreme storms, and amplified forms of them, is introduced to help understand flood genesis across an area as a function of storm characteristics, catchment form and antecedent moisture conditions. This provides fresh insights into the ungauged forecasting problem and provides support to a distributed area-wide modelling solution, especially in extreme and/or unusual storm to catchment situations. The framework allows locations not previously flooded to be identified as potentially vulnerable sites. Flood mitigation measures can then be planned and managed in an anticipatory rather than responsive manner.
Parallel Session – Abstract

Analysis of Surface Water Resources Evolving Regime Caused by Human Activities in Shandong Province

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Abstract: Surface water resources evolving regime refers to the temporal and spatial variations of surface water resources caused by changes of the underlying surface conditions due to human activities. This article analyzes the effect of human activities on surface water resources evolving regime in five concerned aspects, including the effect of multi-storage system, the effect of over-utilization of surface water and decline of groundwater table caused by over-extraction, the effect of water-soil conservation and urbanization, etc. It also analyzes the quantitative variation of surface water resources produced by the same amount of precipitation between present and natural underlying surface conditions by four subbasins, and gives a preliminary prediction on its evolving regime in the future.

Variable fuzzy sets assessment model and application on regional water resources assessment

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Abstract: The aim of regional water resources assessment is to assess the status and tendency of water resources in a region, and provide scientific basis for the development, utilization and protection of regional water resources, then according to the demand of the sustainable development of economic society, optimize the sustainable utilization plan of regional water resources. Therefore, it is important to conduct water resources assessment in an all-round way. Most of the existing assessment models for regional water resources only focus on water quantity assessment and water quality assessment. The assessment of hydroenergy resources is usually ignored. Furthermore, the assessment result is only compared with that of other models without analyzing its stability. Aiming at these problems, variable fuzzy sets assessment model of regional water resources assessment is established. The model considers three aspects: water quantity, water quality, and hydroenergy. And the stability of assessment results is analyzed by varying parameters of the model. A case study is given. The case shows that the model is of guiding significance to regional water resources assessment.

Chen Shouyu, Staff Professor, Research Fields is Hydrology and Water Resources; Hydropower Planning; Fuzzy Set Theory and Its Application; Major Research Projects Fuzzy Hydrology; Fuzzy Set Analysis for Water Resources System; Fuzzy Decision Making theory and Its Application. Email address: chensyccl@yahoo.com.cn
Implementation of Subgrid-scale Spatial Variability of Parameters in a Regional Climate-Hydrology Coupled Model

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Abstract: Climate variability has an important impact on various hydrologic processes. In order to represent small-scale hydrologic processes on the climate and hydrology interactions, it is necessary to couple the regional climate model with a fine-scale hydrologic model. In this paper, the parameterization of subgrid spatial variability is implemented in a coupled climate-hydrology model. The subgrid scale spatial variability in hydraulic conductivity and precipitation is considered in the simulation to represent the small scale hydrologic processes in the regional model. The results show that the simulated streamflow hydrograph at the basin outlet is consistent with the observed one. The incorporation of subgrid scale spatial variability in hydraulic conductivity and precipitation could improve the simulation greatly. It is necessary to incorporate these subgrid hydrologic processes to obtain the realistic and accurate simulations of hydrologic responses.

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Study on the runoff yield model of flood forecasting in the arid and semi-arid area

Chen Yanping

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Abstract: The mode of mixed runoff yield with runoff yield under saturated storage and under excess infiltration has been brought forward, according to great varieties of the precipitation distributed both in the time and space, flood level quick rise and fall in the arid and semi-arid area, that the characteristic is different with the wetness and semi-wetness area. The double excess runoff yield model which is runoff yield under excess infiltration and the soil moisture under excess saturated has been developed based on the models of both domestic and overseas. At the same time the paper has made suggestions to enhance the planning and constructing of the rain gauging station net, and establishing reasonable hydrological station net to meet the need of making flood forecasting project, parameters calculation and flood forecasting. The paper also has been suggested to increase the simulation unit of runoff yield and concentration flow in order to more rationality and veracity.

Chen Yanping, engineer, mainly is engaged in the hydrologic forecast work. BA, graduated from Hohai University in 1999, major in hydrology and use of water resource. E-mail address: cyp_sxswj@126.com.
Evaporation Paradox and its Response in Yellow River Basin, China

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Abstract: It is well known that the surface of Earth has warmed over the past 50 years. It is generally expected that the air will become drier and that evaporation from terrestrial water bodies will increase. However, lots of observations show that the rate of evaporation from open pans of water has been steadily decreasing all over the world over the past 50 years. The contract between expectation and observation is called the evaporation paradox. Using climate data from 1951 to 1998 at 140 weather stations and hydrological data at 71 stations, it is found that most potential evaporations, the pan evaporations or the reference evaporations, show significant decreasing trend, which indicates the evaporation paradox does exist in Yellow River Basin. At the same time, the actual evaporation estimated by water balance decreased in the past 50 years with the decrease in precipitation and the decrease in runoff in most sub-basins. With the increase of the precipitation, the potential evaporation and the actual evaporation have a complementary relationship; while year by year, the potential evaporation and the actual evaporation have a proportional relationship.

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Research on the Computing Method of Flood Prevention in River Estuary City

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Abstract: In this paper, the characteristics and forming mechanism of flood and waterlogging disaster in urbanized river estuary areas is analyzed and the tasks and existing problems of flood prevention that the cities face is summarized. Different methods of runoff calculation are adopted according to the diversities of the underlying surfaces, and the river net's unsteady flow computing method is adopted to calculate the hydrological factors of river channel cross-sections. Xinanjiang Model is introduced for runoff calculation in moisture fields, and urban rainfall runoff model is established to substitute traditional runoff computation methods in urban areas. As for the confluence calculation of river network, the 4-point Preissmann implicit scheme is adopted to solve the Saint-venant Equations. By coupling the above methods, the model of flood prevention computing for river estuary cities with complicated hydrologic conditions is established, the model is suitable for many land using conditions and can accurately simulate the influence of various water projects, such as floodgates, water pumps and weirs and so on.

After calibration with several heavy flood events, the model is put into practical use in flood prevention computations for urban flood control plan in NingBo, an important estuary city in east China, and it applies well. The model is also applicable to other cities with similar hydrological characteristics in river estuary area.
Estimation of the expected Yield during Drought Season of the Feitsui Reservoir

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Abstract: Reservoirs are operated mostly based on annual cycle in Taiwan. It is very likely to suffer water shortage in the following dry season if the rainfall is less than usual in the wet season. When the storage of a reservoir is assessed not capable to meet the water demand of future months in the dry season, the authority should plan the reduction policy of water supply in advance to alleviate the impact of probable water shortage on the civil life and economic development.

This research applied simulation approach to estimate the probable water supply, deficit and its risk under the conditions of different levels of predetermined demands in the near future. The probabilities of discretized reservoir storages of each month in dry season were simulated with streamflows of the last month, the storage of current month and streamflow transitional probabilities. The probable water shortages and their occurrence probabilities provided useful information in the decision-making of discounted water supply policies.

The Feitsui Reservoir was taken as a case study. A multivariate autoregressive moving average (ARMA) model was established for historical monthly streamflows of Peishih Creek and Nanshih Creek by accounting the cross correlation between the two creeks. This ARMA model generated 2,000 sets of 47-year synthetic streamflow series. Twelve transitional probability matrices with 125x125 elements were built for every month with the above synthetic streamflows. Twenty scenarios of four reduction ratios and five initial storages were simulated for expected water supply, shortages and their probabilities during drought season. The discounts of water supply were set as 0%, 10%, 20% and 30% of project demand. The averaged daily water supply was estimated for every reduction ratio and initial storages.

Fredeick N.-F Chou received his Ph.D degree from Department of Civil Engineering, Colorado State University. He is now an associate Professor of Department of Hydraulic and Ocean Engineering. His major research interests include Water Resources Planning and Management, Water Resources Engineering, Irrigation and Drainage, Watershed Management. The corresponding email address is hyd4691@mail.ncku.edu.tw.
A New Method for the Estimation of Flood Control Benefit

Gao Cheng, Liu Jun
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Abstract: Multiform disaster resulting from flood is one of the most frequent and hazardous nature disasters to mankind in the nowadays world. Under the existing technology level and economic condition, to eliminate flood disaster completely is not realistic, but to adopt measures and build various projects to alleviate or avoid the loss resulting from flood disaster will produce prominent flood control benefit.

Flood control and disaster decrease is a complicated and systemic project, whereas to estimate the benefit of the flood control and disaster decrease accurately can offer a scientific basis for improving flood control standard and developing flood control projects.

In this paper, by establishing the relationship between flooded area and hydrological properties under particular project conditions, and determining assets of unit area and the comprehensive loss rate of flood disaster reasonably, a new method to estimate flood control benefit is put forward and used in Lixia River Basin where the flood disaster is the severest in Jiangsu Province. The result shows the method is both simple and feasible, and also convenient for popularizing application.
Application of rainfall-runoff models in two small catchments

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Abstract: The comparative study of two rainfall-runoff models is conducted by using two different catchments. The objective of the study is to examine the model capabilities. Two rainfall runoff modules are employed. One is the Xinanjiang Model (XAJM) developed by Hohai University of China in 1970s, another is the Wageningen Model (WAGMOD) developed by Wageningen University of the Netherlands in 1980s. Both are continually lumped concept rainfall runoff models and have similar structure but with different characteristics for treating the soil moisture and evapotranspiration. They have been successfully applied in many catchments with different characteristics. WAGMOD is successfully applied for the Dutch flat river basins and XAJM was successfully used in the humid and semi-humid mountainous basins either in China or in other countries. The comparative study was carried out by using two different catchments. One is a flat plain region in the south of Netherlands, which is of highly permeable characteristics and the main component of runoff is usually the slow flow from groundwater in the study region. Another is the mountainous basin in southeast China, which is of large basin slope and with more quick flows. In addition, the land use and topography are significantly different. Both models are intended to develop for calculating the runoff of basin scale, and they examined the complex interaction between rainfall, evaporation, soil moisture, groundwater storage and runoff. Models results demonstrate that both can produce relatively satisfactory agreement between the calculated and recorded volumes of runoff as well as the hydrographs. Comparative study indicates that XAJM is much more robust and may be better suited for simulating the rainfall-runoff relationship of the humid mountainous region and WAGMOD is more capable for the small flat and permeable basin.

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Evaluation of three complementary relationship approaches for evapotranspiration over the Akesu Oasis in Northwest China

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Abstract: Evapotranspiration is a dominant process in arid oasis, where river water disperses and is evaporated during dispersion. However, reliable estimates of regional evapotranspiration are very difficult in arid plain oasis because of extreme climate and disturbance of human activities. In this study, three evapotranspiration models using the complementary relationship approach, which are the CRAE model of Morton, the advection-arid (AA) model of Brutsaert and Stricker, and the GG model proposed by Granger and Gray, are evaluated and compared with the water balance method over Aksu plain oasis in Tarim River Basin, Northwest China during 1981-2000. The calculation was made on a daily basis and the comparison was made on monthly and annual bases. The results showed that using the original parameters, the CRAE model produces the closest values with the water balance model. While using the calibrated parameters, all the three models can reflect the annual increasing trends of evapotranspiration, with the mean annual errors less than 10% and the Nash coefficient ($R^2$) about 0.64, 0.78 and 0.84 respectively. But the CRAE model is not better than the AA model, which is contrary to the results in other climate regions. The reason is analyzed according to the comparison of the different estimation of potential evapotranspiration and wet environment evapotranspiration by the two models.

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Study of Ecological Water Resources Requirement of Ningxia Natural Oasis based on “Ground Water Level Variation Amplitude Method”

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Abstract: This paper presents “ground water level variation amplitude” method which is proper to calculate Ningxia ecological water resource requirement. The information of annual ground water level variation from observation well is used to search for the yearly variation value of closed ground water flow field. The ecological water resources requirement of Ningxia natural oasis is estimated on the base of superposition of the yearly variation value of closed ground water flow field, remote sensing vegetation data and hydrogeological data. This overcomes the insufficient quantum for ecological water demand in a certain degree and provide a new concept for the calculation of ecological water resources requirement and for ecological protection and recovery in northwest arid and semi-arid areas.

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Dynamic Assessment of Water Resources in the Yellow River Basin Using WEP-L Distributed Hydrological Model

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Abstract: A distributed hydrological model, WEP-L, which couples simulations of natural hydrological processes and water use processes, is developed for dynamic assessment of water resources in large basins under impacts of climate change and human activities. Concepts of special water resources (i.e., surface water resources plus groundwater resources) and general water resources (i.e., the special water resources plus the precipitation directly utilized by ecosystem) are proposed, and an approach for dynamic assessment of water resources is suggested. It proposes computation formulas, explains how to compute various components of general water resources by taking the distributed watershed hydrological cycle model WEP-L as an example, and distinguishes the utilization efficiencies of various components of general water resources according to whether they play key functions during cycling processes. Basin subdivision, classification of land covers, and deduction of water use spatial/temporal distributions in the Yellow River basin are carried out with the aid of RS data and GIS techniques. The basin is subdivided into 8485 sub-watersheds and 38720 contour bands, and the WEP-L model is verified by comparing simulated and observed discharges at main gage stations. Continuous simulations of 45 years (1956-2000) in the variable time steps from 1 hour to 1 day are performed for various land cover and water use conditions, and water resources assessment results under present condition of land cover and water use are compared with those under historical condition of land cover and water use. The study results reveal that: (1) the surface water resources reduced, but the groundwater resources non-overlapped with the surface water resources increased under the impact of human activities in the Yellow River basin; (2) the special water resources reduced, but the general water resources increased accompanied with increase of the precipitation directly utilized by ecosystem in the basin; and (3) the high-efficiently utilized rainfalls increased much more than the decreased runoffs-typed special water resources.

(Note: contribute to “Theme (3) the new theory and methodology for water resources assessment and prediction”)

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Simulation of “6.10” Storm Flood using a 2-D Hybrid Approach in Shalan watershed in Heilongjiang Province

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Abstract: Digital data on the position and characteristics of river networks and catchment are important for understanding of local river basin, and necessary for the input of simulating hydraulic or hydrology model. Based on the 2004 (3) Arc Second SRTM Elevation, a digital elevation data with 90-m resolution, published by Global Land Cover Facility (GLCF), USGS, which is available at: http://glcf.umiacs.umd.edu/data/srtm/, a software on extracting drainage networks from raster DEM has been developed to extract river network of Shalan river basin, which drainage area is 114.3 km². Good visual consistence was obtained to compare the extracted river networks information with field observation in other references, as well as the inter-basins boundary and drainage area. Using supposed rainfall process of “6.10” storm in Shalan catchment and extracted drainage network, a hybrid approach which combining simplified hydrology process with 2-D hydraulic model was developed and used to simulate the storm flash flood in Shalan river basin in Heilongjiang Province. The result shows, the maximum flood discharge in outlet is $415 \, \text{m}^3/\text{s}$, the maximum water depth nearby the Shalan town is 1.3m, flash flood lasting period is 5~6 hr, and 1~2 hr for water depth over 1 m at the same location. The flood zone mainly locates along the Shalan River with the width of 500m. Though default of flood observation and remote sensing data, the simulation shows reasonable agreement with real situation. The results imply that the proposed software and approach are apt to simulate storm flash flood with reliable resolution in mountainous area or valleys, based on river networks extracted automatically from grid DEM and the hybrid approach which combining simplified hydrology process with 2-D hydraulic model, which can served as a new tool for analysis of national storm flash flood in mountainous area or valleys.

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Improvement in water level forecast for tidal reaches

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Abstract: The water level in tidal reaches is difficult to be forecasted because it is influenced by both the upstream flood wave and the downstream tidal wave. With Tianshenggang, Xuliujing and Yanglin tide stations in the lower reach of the Yangtze River taken as examples, and Datong hydrologic station taken as the representative station of upstream inflow, the relationships between mean daily set-up of each tide station and discharge increment of Datong station were established based on large samples. With the relationships, the tidal levels of past several years calculated by the tidal prediction model were corrected according to the discharge of Datong station. With 20cm selected as error limit, the qualification ratios of calculated tidal level were raised to 92.1% from 77.3% at Tianshenggang station, to 88.7% from 76.3% at Xuliujing station, and to 89.2% from 83.8% at Yanglin station, therefore, the calculation accuracy was evidently improved. The present method is applicable to tidal level forecast for other tidal reaches.

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Study on Contributing Area Threshold of Digital River Network Extracted from DEM

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Abstract: Contributing area threshold is an important parameter of extracting digital channel networks from digital elevation models. Its effects on runoff routing, determining-method and spatial distributing were studied in the article. The study about effects of it on runoff routing showed that basin mean concentration time became longer and the discharge of flood peak was decreasing with the increasing of area threshold, while the change of flood peak time was unapparent. It could also be found that routing characteristics and basin area would affect the sensitivity of runoff routing to the parameter at the same time. However, these studies showed that it was necessary to estimate right threshold for extracting better digital river network for its sensitivity. Several methods of estimating the threshold in common use were analyzed and a new method was proposed here. In the new method, electric water system was looked as data source of right river network. Drainage density of digital river networks extracted with different threshold was calculated firstly. Then compare them with that of right river network, select the one with which the drainage density of digital channel network is best adjacent to that of right channel network as the right threshold. Furthermore, the fractal dimension of right and digital water system were also calculated and compared to test the result in order to make the digital channel network be consistent with the right at channel density, morphology and the growth. Finally, 60 basins were studied with the new method and their thresholds were analyzed. It was found that contributing area threshold distributed in some rule, for example, it changed approximately with power function of upslope gradient under the same plant. It would benefit to consider the unevenness of contributing area threshold in catchment properties extraction and hydrologic simulation.

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Time Variable Instantaneous Unit Hydrograph Watershed Concentration Model Based on Entropy-Weighted Multi-Objective Decision Method

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Abstract: Based on Nash instantaneous unit hydrograph (IUH), a new model of time variable instantaneous unit hydrograph (TVIUH) was established in the paper. In this model, nonlinear factors including net rainfall intensity and spatial nonuniform distribution have been taken into consideration. And, as for the multi-objective decision-making (MODM) problem that requiring flood peak discharge, time to peak and deterministic coefficient meet the requirements simultaneously, a MODM method based on entropy-weighted was introduced into the model. And taking floods of Guanyinge-Shenwo cascade reservoir for example, flood forecast computation has been investigated and the comparison between results of TVIUH model and that of IUH model has been done in details. The results shown that TVIUH model based on entropy-weighted MODM method could take good account of the nonlinear factors of the runoff-flow and multi-objective problem. The whole precision of flood forecast was improved compared with the results obtained from IUH.

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Real-time flood forecasting: A model based on Volterra series and its application in semiarid area

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Abstract: Mechanism identification and model selection for hydrological modeling in semiarid river basin are of great importance and urgency, especially in ungauged basins. On the basis of the present models with systematic approach, a total runoff non-linear response model based on Volterra series (Volterra-TNLR model) is proposed, and its expressions in matrix are deduced, together with its solving process. A 3-layer artificial neutral network (ANN) model is introduced to simulate the self-relative relationships of error series between observed and computed runoff, then the forecasted runoff can be corrected dynamically by ANN model in the course of real-time flood forecasting. Both the Volterra-TNLR and ANN model have clear structure and high ability of non-linear mapping, and they are easy to be programmed and integrated into a real-time flood forecasting system. It takes Qian river basin, a semiarid area of northwestern China, as an example to verify the Volterra-TNLR model, and the results show that the model have a high precision, together with a potential applicability in semiarid river basin.

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Weighted summation of wavelet coefficients model to hydrology time series prediction

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Abstract: A kind of hydrology time series prediction model is proposed using weighted summation of major period’s wavelet coefficients to predict period component. According to the relativity between wavelet coefficients of wavelet transformation and time series, the method is based on the qualitative prediction of continuous wavelet transformation and wavelet variance, and it effectively takes advantage of multi-resolution characteristic of wavelet analysis. The annual runoff data of Huayuankou gauging station in Yellow River is used to build up the model and examine it, meanwhile the prediction result indicates that the prediction method proposed in the paper can receive more ideal results, and can be used to predict hydrology time series.

A statistically-based runoff-yield model considering spatial variation of rainfall

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Abstract: The process of runoff-yield is much complicated as it is controlled by hydrological and meteorological conditions such as rainfall and evaporation, and also influenced by underlying surface including geology, topography, soil type and structure etc. Among which, the spatial variation of rainfall is a pivot influencing factor for runoff generation. However, it is usually neglected and taken as a uniformly value for a certain divided computing unit (sub-basin), especially in some of conceptual rainfall-runoff models. This in one hand largely simplifies the computation of runoff, but on the other hand it could not be the exact realization of runoff-yield process, thus in turn decreases the computation accuracy. In this paper, a statistically based runoff-yield model considering the spatial variation of rainfall and soil infiltration capacity over a basin is presented. The spatial variation of a rainfall event is described by introducing a new probability density function (pdf) which is constructed by combining a simple linear function with a negative exponential function. Meanwhile, the soil infiltration capacity over a basin is simulated by using a parabolic type pdf. Horton mechanism was adopted to compute the surface runoff and soil infiltration. According to the joint probability distribution of rainfall and soil infiltration capacity, the probability distribution of the surface runoff can be derived, thus obtain the average or total surface runoff. Part of the infiltration supplements to the soil moisture, and the rest recharges to ground water through using a water storage capacity curve of soil moisture. The total runoff is composed of both rainfall excess runoff and saturated runoff, so that the model, from another point of view, is initially applicable to basins with both rainfall-excess and saturated runoff yield mechanisms. Because of the exponential and parabolic type pdfs of rainfall and soil infiltration used in this model, explicit expression of formulas for runoff calculation are available, which results in the convenience for model application.

As an example, the model was used to simulate flood runoff for the basin above Lushi cross-section of Luohe River, a branch of Yellow River. Comparisons were also made between results of this model and other models. It shows that the accuracy of the simulation of the model is acceptable, especially for those continuous rainfall-runoff events. The simplicity in determining the model parameters brings the possibility for the model to be applicable to un-gauged basins.

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Analysis of Groundwater Balance in the Cretaceous Groundwater Basin of the Ordos

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Abstract: The Cretaceous Groundwater Basin (CAB) of the Ordos Basin locates in the east of northwestern China. Based on the analysis of groundwater balance, conceptual model was established and 3-D numerical groundwater model of steady state was developed and calibrated. Using the model, the analysis of groundwater balance is validated. Numerical modeling has provided basis for groundwater resources assessment.

On some watershed hydrology problems based open-system

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Abstract: The watershed in nature can be viewed as a complex open-system. The watershed topography and geomorphology is shaped by the long-range interaction between watershed and environment. Many aforementioned researches show that soil, hillslope and river network have self-organized characteristics in different level, which is called multiscale hierarchical structure. Most of hydrological elements, rainfall intensity, soil moisture and hydraulic conductivity etc., bear double characteristics, i.e., variability and scale-invariant. The climate, vegetation and soil show wonderful catenary relations. These researches shed light on the expectation towards the formation of hydrologic model whose physical mechanism is more reasonable. At last, the progress about hydrologic models based on an open-system is reviewed. The hydrology scholars take more and more interests in some important, difficult problems: spatial and temporal patterns, multiscale effect and soil hysteresis effect etc. The problems above are sufficiently important to the future study of hydrological model.

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A Spatial Distribution Model for Surface Air Temperature based on Remote Sensing

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Abstract: To describe the spatial variability of surface air temperature, spatial interpolation and geostatistics based on Geographic Information System (GIS) are widely applied, but they need enough and representative meteorological stations. By analyzing the observation data, a good linear relation was found between surface air temperature and surface temperature. On the basis of this linear relation and incorporating the aerodynamic theory, a spatial distribution Remote Sensing (RS) model for surface air temperature was proposed, which mainly depends on the remote sensing information with only few non-remote sensing factors. Additionally, a method for simulating the diurnal variation of air temperature was developed based on the observed data at the point scale, and then the values of the instantaneous air temperature estimated by this method were compared with those from the Remote Sensing model. Indicated by the results, the Remote Sensing model can capture the primary spatial variability characteristics of air temperature, and it is valuable for the predictions in ungauged or poorly-gauged regions.

A Cell-Based Distributed Hydrologic Model and Its Predictability in Chinese Ungauged Basins

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Abstract: This paper presents an application study of a cell-based physical rainfall-runoff model, the TOPKAPI model, to three case-study Chinese catchments for flood simulation, which are flood-prone basins with different basin characters and climate conditions, for the sake of investigating the applicability of the TOPKAPI model. Application of the TOPKAPI model was conducted with a grid size of 1 km x 1 km, at a time step varying from 1-hour to daily based on the basin character and data availability. Model calibration did not use a curve fitting process, but was chiefly based upon moderate variations of parameter values from the ones estimated on physical grounds. The application of the TOPKAPI model to the three case-study catchments demonstrated that the model performed well for flood simulation. The TOPKAPI model represents such a comprehensive process-based model, which can offer wide-ranging applicability for flood forecasting application, and has the clear potential for the Prediction of Ungauged Basins (PUB).

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**Estimation of evapotranspiration and gross primary production and their scale effects over a large basin in the Loess Plateau**

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**Abstract:** A distributed eco-hydrological model based on soil-vegetation-atmosphere transfer processes is applied to estimate actual evapotranspiration (ET) and gross primary production (GPP) over the Wuding River basin, the Loess Plateau, China, from 2000 to 2003, based on Terra-Modis 16-day maximum composite NDVI. The spatial patterns of annual ET and GPP amounts vary in years, due to the precipitation variability and land management conditions. By comparing the simulated results of three spatial resolutions (250m, 1km and 8km), it is found that the scaling up effects of both ET and GPP are significant, especially while extending to 8 km grid. The GPP is more sensitive to the grid size. Geo-statistic analysis shows that the scaling effect is positively correlated with the spatial variability of precipitation. However, both daily ET and GPP values seem to be insensitive to the grid size at basin scale.

**Impacts of climate variability on flood frequency: comparative study of catchments in Perth, Newcastle and Darwin, Australia**

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**Abstract:** Traditional flood frequency analysis assumes stationarity, and thus cannot account for non-stationarity caused by long-term climate variability and changes. In this study, we demonstrate that the probability distribution of annual maximum floods is a function of multi-annual, multi-decadal trends in climate. Three locations in Australia, namely Perth, Newcastle and Darwin are selected and compared to explore the impact of multi-annual and multi-decadal climate variability on flood frequency. Analysis is performed using a stochastic rainfall model coupled with a continuous rainfall-runoff model that captures the water balance variability at a multiplicity of time scales ranging from event to seasonal, inter-annual and inter-decadal time scales. Climate variability is incorporated using different parameterizations of the rainfall model, based upon analysis of observed rainfall data and selected climate scenarios. We present six climate scenarios linked between ENSO (El Nino Southern Oscillation) and IPO (Inter-decadal Pacific Oscillation) in Newcastle, and six different climate scenarios for Perth and Darwin that are related to ENSO and an apparent shift in climate, identified by statistical analysis, occurring from 1970. The results show that La Nina (ENSO negative) years cause higher annual maximum floods compared to El Nino (ENSO positive) and ENSO neutral years during both IPO (+) and IPO(-) in Newcastle and pre- and post-1970 in Darwin and Perth. The impact of ENSO on annual maximum floods in Newcastle is enhanced when the IPO is negative. For Perth, the impact of ENSO weakens post-1970, while it strengthens in Darwin. This research shows that non-stationarity in climate associated with ENSO and long term climate shifts has a significant impact upon flood frequency and need to be considered in the estimation of extreme floods.
Effects of Silt-trapping dam on hydrological cycle in the Loess Plateau

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Abstract: Controlling soil erosion in the Loess Plateau is considered to be a fundamental way to improve the Yellow River condition. Now the top three measures which are expected to be more rational and effective include hillside terracing, silt-trapping dam and afforestation, of which the silt-trapping dam is selected by the Ministry of Water Resources as one of the three key projects to promote.

The Chabagou watershed, which is situated in the severe soil erosion region of the Loess Plateau and of a draining area of 187 square km, is chosen as the study area for detailed data as topography, land use of both present and historic conditions are available, as well as long term meteorological and hydrologic data. Experimental data of soil hydraulic properties are also collected for determining model parameters.

To evaluate the impacts of soil erosion controls on sediment and runoff production and provide useful information for decision making, a physically based distributed model is established by making some refinements and adding some new modules to an exiting cell-based distributed hydrological model. The established model is then applied to the study watershed by using the data of 1960s to illustrate the model performances. Long term simulations for 1961 to 1981 are carried out to compare the effective of different erosion controls in terms of runoff and sediment load. It is found that silt-trapping dams play important role in flood peak reduction, while their effects on infiltration and evapotranspiration are relatively small.

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Water Resources Assessment Based on Distributed Hydrology Model: a Case study of Hai River Basin, China

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Abstract: Water resources system includes natural hydrological process cycle and socio-economic process cycle two sub-systems. It’s very important issue for water resources assessment to effectively integrate the two sub-systems. Despite numerous efforts to develop methods for water resources assessment, no assessment methods for larges scale river basin are based on distributed hydrology model yet. A whole basin distributed hydrological model based on SWAT (Soil and Water Assessment Tool) for Hai River basin’s water resources assessment is presented.

Firstly, Hai River Basin’s SWAT model has been set-up for the water resources system according lots of spatial and attributed data of Hai River basin and carry on the optimization and sensitivity analysis on the model parameters, and select many typical stations to carry on the verification and analysis to the simulation results by using hydrometeorology series’ data and surface conditions’ spatial data from 1995 to 2002. Secondly, the spatial distributed SWAT sub-basins’ hydrological regime has been transferred into different water resources districts’ regime by using transform matrix. Lastly, some scenarios of Hai River basin’s water resources assessment are discussed. The study results show that water resources assessment method based on distributed hydrology model is leading to more credible results.

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DIRECT RUNOFF MODELLING IN UNGAUGED BASINS USING A CELL BASED MODEL

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Abstract: Sri Lanka heavily depends on her surface water for irrigated agriculture, power generation, municipal and industrial water supply and other environmental needs. Though, the island receives an average annual rainfall of about 1850mm, significant spatial and temporal variation in rainfall is significant. There are 103 river basins ranging from 10km2 to 10450km2 in size with most of the large basins originating in the central mountains and extending to plain coastal areas. The land cover in the basins continues to change with the increase in population, urbanization and developments in agricultural and industrial sectors.

The country is covered by over 600 rainfall gauging stations there are only about 40 stream flow gauging stations in operation at present. Thus, some basins are totally ungauged, and even in others, many sub basins remain ungauged. Even the existing records are sometimes of little use for predicting the flows due to the changes in land use in the basins. With respect to hydropower generation, many potential sites for mini-hydropower developments exist in the mountain streams that abound the central hills and most of these streams are ungauged and there is little or no information on the reliability and the quantity of stream flow. The present practices for generating stream flow in such ungauged basins have been by a) derivation of flow duration curves from that of a hydrologically similar gauged basin, b) use a hydrological model developed for a similar or nearest basin, c) use of synthetic unit hydrographs using regionized parameters, d) estimation of only the low flow by the use of empirical formulae with little or no reference to topographic, land use characteristics of the basin.

The present study is aimed at the development of a model that simulate direct runoff on the basis of meteorological data and parameters that can be readily derived from basin maps, geophysical information systems and remote sensing. The Kotmale River basin in the central hills, which is the upper most sub basin of the Mahaweli River of Sri Lanka where the stream flows have been monitored for years was selected as the experimental basin for the study by installation of high resolution rainfall recording stations and more stream gauging stations. The area of the basin is 304 km2 and the elevation varies from 1200 m to 2500 m above mean sea level. The basin is situated in the wet zone of the country and the average annual rainfall varies from 2200 mm to 2600 mm. The basin is under varying land use and land cover types comprise of tea (44%), forest (36%), build up land (7%), grass (5%), water bodies (1%) and other crops.

In the model developed, the basin is divided into several grid cells and the physical properties are derived for each cell using GIS data. Flow paths to the basin outlet and the stream network are derived from the DEM of the basin. Overland flow is generated from each grid cell of the basin by the application of continuous effective rainfall of 1mm/hr to the basin. The flow velocity through each grid cell is calculated using the kinematic wave approach and travel time of flow through each cell is obtained considering flow travel distance in the flow direction of the cell. The collated overland flow at a cell with a flow accumulation number above a specified value is considered to flow as a canal flow. The travel times for direct runoff from each grid cell to the basin outlet are calculated by using the flow direction grid and the flow travel time through each cell. The S-curve for the basin so obtained is then used to derive the unit hydrograph of a given duration for the basin. Direct runoff hydrograph for a given rainfall hyetograph is obtained by using the basin unit hydrograph with a flow travel time based constant rate loss model. The model is tested using hourly data collected from the basin. The direct runoff hydrographs for rainfall events obtained by the application of the model reasonably agree with the observed hydrographs. The unit hydrograph obtained from the model was compared with the conventional
Snyder’s synthetic unit hydrograph obtained using regionalized parameters assuming the basin as an ungauged basin. It is found that the new model predictions are more accurate than the Snyder’s unit hydrograph predictions and thus, the developed model is a useful tool to derive the direct runoff hydrograph for ungauged basins.

**Simulation of water flow for some soils of northwest China by using agro-hydrological model, Remote Sensing and GIS Techniques**

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**Abstract:** To optimize the water use in irrigated agriculture a complete knowledge of all water balance components is essential. However, most water balance components are very difficult to measure either in terms of the required time interval or due to the complexity of the processes. For this, unsaturated zone model is a useful tool in predicting effects of measures and can be used to optimize agricultural practices in the view of minimizing the agricultural water use. For the irrigated areas in the Minqin county of northwest China, the physically based one-dimensional agro-hydrological model SWAP (Soil Water Atmosphere and Plant) for water transport and crop growth was applied in a distributed manner to reveal all the terms of the water balance. This model has a varying degree of abstraction level referring to simulated processes in time and space. A combination of field data and aerial data was used as input for the model. Inverse modeling of ETa fluxes was followed to calibrate the soil hydraulic functions by using parameter estimation package PEST. Surface Energy Balance System (SEBS) was used to measure actual ET fluxes from NOAA AVHRR satellite images. Simulations were carried out for fifteen different sites of the Minqin County by taking wheat (Triticum aestivum L.) as a test crop. However, only three sites were selected for model calibration and evaluation. The duration of simulation was from 1st April 2004 to 19th August 2004 i.e., for whole-wheat growing season and detailed analyses were performed for all sites. SWAP results exhibited that the model gives sufficient adaptation for soil water dynamics and it was concluded that the use of the SWAP model in a distributed way is a useful tool to analyze all water balance components. Kriging interpolation technique was used to obtain the soil hydraulic parameters and subsequently surface soil water content at different stages of crop for entire arable lands of Minqin county.
The Xinanjiang model towards the perspective of PUB

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Abstract: The progress of the Xinanjiang model, a semi-distributed conceptual hydrological model for use in humid or semihumid regions, including model inputs, model structure and model parameters, will be reported towards the perspective of PUB science and implementation plan. This presentation comprises five parts: introduction, model inputs, model structure, model parameters, and future research. Model inputs are of great importance in a hydrological forecasting system because their distributions both in space and in time make a notable impact on computed results. Model inputs rank first in reducing hydrological uncertainty in the context of PUB. Novel data can be from space-borne, air-borne and on-ground measurement, as well as from computed models, such as GCM (General Circulation Model), QPE (Quantitative Precipitation Estimates, Vieux et al., 2003) or HEP (Hydrological Ensemble Prediction, Schaake, 2004). Model inputs need interdisciplinary development. The focus of this presentation is on the structure and parameters of the Xinanjiang model. The Xinanjiang model has four superiorities: (a) to compute runoff depth over partitioned spatial units in horizontal direction; (b) to estimate evapotranspiration using a three-layer method in vertical direction; (c) to separate runoff components into surface, subsurface and groundwater flows according to flow velocity; and (d) to conveniently transfer partial model parameters across temporal scales by means of relations between those parameters on different time scales, e.g. to derive the outflow coefficients of the free-water storage to groundwater and subsurface flow in an hourly mode from those in a daily mode, based on the fact that daily hydrological data are more available than hourly data in the real situation.

Soil moisture is a key component in describing the transfer and distribution of mass and energy between the land and the atmosphere. It is a state fundamental variable in biosphere–atmosphere transfers, biogeochemistry, ecosystem processes, and the rainfall–runoff process itself. Based upon the assumption that the use of an inadequate model structure may be more problematic than the use of sub-optimal parameter values, the experience and progress in the Huaihe River Basin Experiment (HUBEX) during the intensified observation period from 1998 to 1999, as a component of the GEWEX Asian Monsoon Experiment (GAME) Project, is reported here. The focus is on the realism of the Xinanjiang model structure, which is evaluated not only by discharge hydrographs observed upstream (Huangnizhuang station) and downstream (Jiangji station), but also by volumetric soil moisture data gauged at three sites, Meishan, Nianyushan, and Jiangji.

In addition, some research progresses will be introduced, such as the relation amongst sensitive parameters and catchment characteristics, biological (mainly refer to vegetation) aspects taken into consideration especially in the estimation of evapotranspiration using energy conservation principle, which provides a scientific basis for balancing water for humans and nature, a new approach in ecohydrology. The Xinanjiang model considering vegetation could be used to evaluate green flow and blue flow, and to transform from measured basins to ungauged ones, which is very significant content of the decadal PUB science plan.

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Application of Correlation Analytical Method into Basin Runoff Forecast with Single-gauge Rainfall

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Abstract: The basin-wide average rainfall is very important for flood forecast. However, rainfall of some gauges in the basin is often insufficient. The problem is how to calculate basin-wide average rainfall according to single-gauge rainfall. Firstly, bivariate correlation analysis and partial correlation analysis were introduced. Secondly, taking Hunhe basin in Liaoning Province as an example, the correlativity and extent of correlation between single-gauge rainfall and basin-wide average rainfall were studied, and the significance level of correlation coefficient was verified. The result proved that both the average of Person simple correlative coefficients and the mean of partial correlative coefficients are bigger than 0.8 with the significance level p<0.05, so the single-gauge rainfall has high positive correlation with the basin-wide average rainfall. Thirdly, the correlograms were established to estimate basin-wide average rainfall even if there is only single-gauge rainfall in the whole basin. With the correlograms historic floods were manipulated according to single-gauge rainfall, and the precision is supernal. The correlation analytical method can be used to forecast runoff for the basins where basin-wide average rainfall is imperfectly gauged. The application shows that this method is simple and feasible.

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Application of an uncertainty recognition methodology for assessment of TOPMODEL with a downscaled topographic index distribution

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Abstract: It is widely realized that the value of the parameters of hydrologic models is highly related to the temporal and spatial scale of the hydrologic simulation. The reason is: a hydrologic model is a simplification of the sophisticated natural reality, no matter how physically-based the model is, the scale information is implicitly implanted in the parameters in terms of its value through the model calibration/validation processes. Consequently, if the scale of the hydrologic simulation changed, the identified model parameters will be different. This always confuses the model user when they try to relate the fluctuation of the model parameters to the watershed behavior. The temporal scale of the simulation is determined by the time scale of the observed forcing time series (i.e.: rainfall, discharge, temperature… etc.). The spatial scale of the simulation is determined by the resolution of the watershed topographic information. In most of the cases, this is related to the resolution of the watershed DEM data. In this study, a downscaled topographic index distribution is applied to eliminate the spatial scale effect and making the specification of the parameter value easier. The downscaled topographic index distribution is obtained through the methodology proposed by Pradhan et al.1) The methodology is composed of two ideas: One involves introducing a resolution factor to account for the scale effect in upslope catchment area per unit contour length in the topographic index; the other utilizes a fractal method through steepest slope scaling to account for the scale effect on slopes. This method successfully derived a topographic index distribution of a fine-resolution DEM by using only a coarse-resolution DEM. In this study, Mae Chaem basin (Thailand) is selected as the study area. The original resolution of the topographic index distribution is approximate 1 km (30 arc seconds), while the resolution of the downscaled topographic index distribution is 50 meters. The assessment of the adequacy of TOPMODEL with different topographic index distributions is done through the methodology proposed by Chiang et al.2) Firstly, Monte Carlo simulation method is applied to add bias item in model input data series (rainfall series), and then rainfall realizations, parameter space, and model outcomes (outflow discharge) under different bias level are acquired. Here, daily observation data are applied as forcing input for model outflow calculation. Then, by examining the counter relationship between model simulation outcomes, calibration outcomes and observed watershed response series (discharge), an uncertainty structure can be recognized. Finally, parameter uncertainty, calibration uncertainty, and model structure uncertainty caused by input data uncertainty are recognized, separated, and quantified through the methodology. The quantified model prediction uncertainty by applying different topographic index distributions are interpreted by an index which originated from Nash-Sutcliffe efficiency named Model Structure Indicating Index (MSII).
A method to calculate grid storage capacity from topographic index

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Abstract: The research of distributed hydrological model has been a hotspot in recent years. An important problem in conceptual distributed hydrological model is how to determine the storage capacity at every grid. Considering the similarity between the maximum of grid soil moisture deficiency and the grid topographic index, the fact that a logarithmic Weibull function relation exists between them was discovered. And then a method to calculate the grid storage capacity from the grid topographic index was put forward. The method was applied in a grid distributed hydrological model with incompact structure, the results was satisfactory.

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Effects of Boundary Uncertainty on Water Supply Safety

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Abstract: There are many factors that influence the groundwater evaluation results, including boundary conditions of numerical model, specific yield of aquifer (Sy), hydraulic conductivity (K), precipitation infiltration coefficient (α) and other hydrogeological parameters. The hydrogeological parameters can be relatively objective determined by some hydrogeologic tests, but the boundary conditions is often subjectively determined, especially there is no natural boundaries, such as river, fault, impervious layer, etc.. Boundary condition plays an important role in the evaluation of groundwater allowable withdrawal. In other words, how large the area and what kind of boundary type are the best?

In this paper, a well field of the Beipiao City in LiaoNing Province was chosen as a case study. Groundwater exploitation at present is 2.5×104m3/d, which is used for domestic, industrial and agricultural purposes. The objective of the paper is to study the influence of the change in boundary of model domain on groundwater availability, which will affect on water supply safety.
Experimental and modeling study on groundwater pollution from agricultural fertilization

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Abstract: Agricultural non-point source pollution from farm land is an important source of water pollution. The portion of excessive fertilizer and pesticide not only cause eutrophication when being washed into water body by rainfall-runoff, but also pollute groundwater by leaching through soil. The pollutant into groundwater can be divided into two sources: from soil or from fertilizer. Only the part from fertilizer can be controlled by human. In this way, distinguishing these two sources is important for groundwater pollution control. In this paper, a tracing experiment of isotope $^{15}N$ in potted wheat is carried out. By testing the abundance of $^{15}N$ in soil and solution leaching from soil, the movement of nitrogen in soil profile can be depicted, and the contribution of pollutant from fertilizer can be determined. Using LEACHM model, the cases of different fertilizing patterns, times and quantities are respectively simulated, and effects of dominant factors on groundwater pollution are analyzed. These research results can provide some useful information for groundwater protection from agricultural non-point pollution.

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Extension of Representative Elementary Watershed approach and its application in Chabagou River Basin

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Abstract: The paper extends the Representative Elementary Watershed (REW) theory for cold regions through explicit treatment of energy balance equations to include associated processes and process descriptions. A new definition of REW is presented which subdivides the REW into six surface sub-regions and two subsurface sub-regions. The final system of 24 ordinary differential equations (ODEs) can meet the requirements of most hydrological modeling applications, and the formulation procedure is re-arranged so that further inclusion of sub-regions and substances could be done more easily. The new statistical method for constitutive relationship development based on Monte Carlo simulation is presented, which upscale the point or REV scale physical equations into REW scale by incorporating spatial and temporal heterogeneity and requires less data than the methods previously proposed. By adopting the Backward Differentiation Formulas, Newtonian Iteration, and preconditioned GMRES algorithm, the numerical theme for the final coupled ODE system is developed with higher efficiency, stability, and robustness. The new equations and numerical model was applied to the Chabagou Watershed typically with semi-arid climate. The calibration and validation results show the proposed constitutive relationships can represent the essential characteristics of the corresponding hydrological processes, and the model can simulate and forecast the stream flow soundly.

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Genetic Algorithm Based Combinational Evaluation Model for Regional Water Security Evaluation: A Case Study

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Abstract: Water Security crisis is one of the most cut-throat challenges to sustainable socio-economic development in the world. In this paper, considering the pros and cons of both the subjective and objective weighting evaluation methods, a new Combinational Evaluation Model based on Genetic Algorithm (CEM-GA), integrating four single evaluation methods with the Minimizing Difference Degree Model based on Nash Equilibrium in Game Theory and Genetic Algorithm as the coordinated objective, was developed for regional water security evaluation. The case study of North River basin in Guangdong Province in China illustrated the methodology. The results suggests that CEM-GA combines information on both subjective and objective weights, hence objective evaluation information and the requirements of the decision-maker can be well balanced. As a practical method, it can be widely used for the quantitative evaluation and comparison of water security states in different regions.

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Modelling univariate streamflow processes with long-memory ARFIMA model

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Abstract: When modeling streamflow processes in ungauged basins, we may have to deal with univariate streamflow processes sometimes. The most commonly used model for modeling univariate hydrological time series is the autoregressive moving average (ARMA) model. The ARMA model is a short-memory model, whose autocorrelation function (ACF) decays exponentially. However, it has been confirmed by many researchers that daily streamflow processes exhibit long-memory, that is, there is not negligible serial dependence among observed streamflows at long temporal distance. Therefore, it is worthwhile to investigate the applicability of long-memory fractionally integrated ARMA model, i.e., ARFIMA model, to modeling daily streamflow processes. In the present study, the ARFIMA model is applied to three daily streamflow series of the headwaters of three rivers in cold mountainous areas, i.e., the Yellow River in China, the Columbia River and the Fraser River in Canada. The results show that the ARFIMA model, built on the basis of deseasonalized daily streamflow processes, outperforms the ARMA model consistently. In addition, the ARFIMA model also outperforms the multi-layer perceptron (MLP) artificial neural network (ANN) models for making daily streamflow forecasts. The use of the ARFIMA model is therefore recommended for modeling univariate daily streamflow processes.

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Assessing the Effects of Different Cropping Patterns on Drainage Capability of the Southern Riverine Basin

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Abstract: Compared with natural watersheds, only a few studies have been conducted to take the specific characteristics of farmed watersheds into account in hydrological modeling. The purpose of this paper is to develop a conceptual rainfall-runoff model with which both the impact of human activities, especially the existence of drainage practices and ditch network, on flood events and the effects of different cropping patterns on drainage capability of the southern riverine basin could be assessed. The model uses the monolayer soil-structure Tank model with surface water layer and the QualHYMO model to calculate the runoff of paddy fields and dry lands respectively. The Saint-Venant equations are used for flow routing through the main drainage system, and the special technique is employed to simulate the discharges of sluices and pumps. Applications of the model are demonstrated for Luoshan drainage basin, which is located in Hubei Province. To analyze the role of cropping patterns, six hypothetical scenarios are discussed. Results show that the drainage system of Luoshan drainage basin can dispose of the excess water from 3-day rainfall totals with return periods of 6.9 years in five days and with the area of paddy fields being increased, the drainage capability would be strengthened.

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Study on environmental risk assessment at a groundwater contaminated area

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Abstract: Since common utilization of organic compounds in industries, more and more sites have been reported contaminated by those hazardous compounds. However, practice in those developed countries for many years has showed that, it is usually unsuccessful to remediate contaminants in soil and groundwater based on environment standards. To solve this problem more smoothly, risk conception and health risk assessment are introduced into traditional remediation of subsurface contamination, and several remediation modes based on health risk have been developed.

Among many risk sub-modes, RBCA mode developed by American Society for Testing and Materials is most successful and famous. RBCA mode is adopted in this research to frame health risk analysis theory system on remediation of contaminant in soil and groundwater. This theory system includes many mathematical models: health risk assessment, contaminant transporting and fating in environment, calculation of remediation and monitoring target based on health risk, existing judgment and analysis of NAPL. These models not only come from ASTM E2081-00 which defines RBCA mode, but also introduced the latest achievements in this domain. In order to make theory guide practice better, a software toolkit have been developed based on the theory system.

A health assessment of carbon tetrachloride in a water-bearing basin has been executed by using the developed software toolkit. This water-bearing basin is a main source of water supply in one north city in China. However, karst water in the basin has been contaminated by carbon tetrachloride, which roots in a pesticide plant located at hill slope in recharge area of the karst aquifer. Carbon tetrachloride in groundwater hazards human health through drinking groundwater, volatilization into indoor air and outdoor air. The health risk caused by these three exposure pathway has been assessed to thirteen serious contaminated wells. The results show that, drinking groundwater is the critical exposure pathway, and the risk caused by volatilization into indoor air also exceeds the target health risk limit. The health risk caused by volatilization into ambient air from probable leakage point of carbon tetrachloride within pesticide plant has also been assessed. The results show that, the possible maximum impact distance is 1280 meters. Moreover, a risk map has been plotted to indicate relative risk level in the affected area. In order to meet the target risk limit, the concentration of carbon tetrachloride in groundwater must be decreased to lower than 3.3 ug/L.

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The Design and Realization of the Parallel Computing Platform for Digital Watershed Management

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Abstract: A large-scale watershed system has the following two features: 1) the amount of data and computing is so massive that traditional computing method has difficulty in finishing even a simple task; and 2) the requirement for the computing speed is particularly high, such as in the application of flood forecast. To meet the requirement for a high computing capability brought up by these features, a simple way is to raise the computing capability of current hardware, however, it costs much while the extent to which the computing speed can be elevated is limited. Therefore, parallel computing method, which is effective and cheap, is adopted into our watershed management system, and a Parallel Operation Unified Platform (POUP) is built up to control the computing process.

POUP has a hierarchical structure with four layers. The bottom layer is Modeling Layer, which aims to develop the runoff yield and confluence model, sediment yield model, pollutant dispersion model and other hydraulic, hydrology and environmental models. The second layer is Computing Layer, which aims to define a coding method for river network, assign and reassign tasks to maintain the Workload Balance, and use adaptive control to optimize the computing efficiency. The third layer is Control Layer, which aims to synchronize configurations and data in computing nodes, supervise the computing processes, and provide reports for analysis and optimization. The top layer is Application Layer, which shows an interface to a GIS platform. Through this interface, the tributaries that have been computed in a certain node are dynamically displayed in the current map. The interface also provides a way to find out real-time information, such as the runoff yield and sediment yield process, on a certain tributary.

For the convenience of parallel programming, we develop a Binary Tree River Encoding Method (BTREM), which transfers all streams in a watershed into a binary tree and use non-fixed-length binary code to indicate them. In this way, the value and the length of the code also make sense to the stream orders and the shape of main stream.

POUP is implemented with MPICH2 in the master-slave pattern, and the massive data are stored in a single database on the server. The result of our experiments on the simulation of Cha Ba Gou River, a child watershed of the Yellow River, shows that POUP facilitates the control of parallel computing process, raises the computing speed and gives good results that coincides with the actual data. However, because of the restriction in the read-write capability of our database, the parallel efficiency of POUP falls when the number of computing nodes grows beyond a certain threshold.

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Effects of physical basin features on hydrological responses of the Mekong River

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Abstract: In hydrological modeling, one of the challenges is how to reflect the effects of physical basin features on hydrological responses. This paper focuses on investigating the effects of natural and human-made basin changes on hydrological responses for the Mekong River. Effects of land-use changes on hydrological responses of the whole basin are explored. Simulation is carried out by a physically based distributed hydrological model: block-wise use of the TOPMODEL with the Muskingum-Cunge routing method (BTOPMC). Model parameters are identified for each grid by soil type, land-cover and land-use. The whole basin is subdivided into 737 natural sub-basins. Rainfall and discharge datasets of 1980-1982 are used for optimization by the SCE-UA algorithm; datasets of 1985 are used for validation. The results indicate that hydrological responses depend highly on land-use.

Regional Parameter Estimation of the VIC Land Surface Model: Methodology and Application to River Basins in China

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Abstract: This paper presents a methodology for regional parameter estimation of the VIC-3L land surface model with the goal of improving the streamflow simulation for river basins in China. This methodology is designed to obtain model parameter estimates from a limited number of calibrated basins and then regionalize them to uncalibrated basins based on climate characteristics and large river basin domains, and ultimately to continental China. Fourteen basins from different climatic zones and large river basins were chosen for model calibration. For each of these basins, seven runoff-related model parameters were calibrated using a systematic manual calibration approach. These calibrated parameters were then transferred within the climate and large river basin zones or climatic zones to the uncalibrated basins. To test the efficiency of the parameter regionalization method, a verification study was conducted on nineteen independent river basins in China. Overall, the regionalized parameters, when evaluated against the a priori parameter estimates, were able to reduce the model bias by 0.4-249.8 % and relative root mean squared error (RRMSE) by 0.2-119.1 % and increase the Nash-Sutcliffe efficiency of the streamflow simulation by 1.9-31.7 % for most of the tested basins. The transferred parameters were then used to perform hydrological simulation over the entire China to test the applicability of the regionalized parameters on a continental scale. The continental simulation results agree well with the observations at regional scales, indicating that the tested regionalization method is a promising scheme for parameter estimation for ungauged basins in China.
Regional floods forecast in the Three Gorges of the Yangtze River using rain-gauge data and weather-radar data

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Abstract: The major uncertainty in the flood forecast is from the rainfall input to the flood prediction model, due to insufficient information of rainfall in spatial distribution. The rainfall which observed directly at rain-gauge is point quantitative measure, not enough to describe spatial variability, particularly in poor-gauge catchment. However, the new generation weather-radar is good at capturing the spatial distribution of rainfall, but poor in quantitatively measure. At present, the assimilation of rain-gauge data and weather-radar data is a better method to achieve the purpose of reducing uncertainty of forecast. In the Three Gorges region which is a concentration zone of rainstorm, the regional floods have the most important effect on the safety and operation of the Three Gorges Reservoir. The floods from this region will flow directly into the reservoir, and it will be a key issue after the construction of the Three Gorges Project. Toward forecast of the regional floods for the real time reservoir operation, a distributed hydrological model has been developed, which can describe the spatial variability of rainfall and land use. The present sparse rain-gauge network in this region brings a great uncertainty into the flood prediction. In this paper, the sensitivities of flood response to the spatial variation of rainfall are addressed, using rain-gauge data combining with the weather-radar data.
Large-Scale Simulations of Surface Water and Ground Water with a Coupled Hydrologic Model

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Abstract: Research on Predictions in Ungauged Basins (PUB) is a fundamental problem and challenge in hydrology. Coupled atmospheric-hydrologic model can provide a promising tool for us on the hydrologic predictions in ungauged or less-gauged basins. A newly coupled atmospheric-hydrologic model system is used to simulate the ten-year (1984-1993) water balance in the gauged and hypothetically ungauged Mississippi River basin in term of precipitation. Simulated river discharges and groundwater tables at different sub-basins are compared at daily and monthly time scales. The river discharges simulated with site precipitation data are consistent with the observed, while the results simulated without site precipitation data can also capture the general trend of flood hydrograph. The spatial patterns of variables simulated with the two cases are both reasonable. Research indicates that the coupled model system has the capability for hydrologic simulations as well for flood forecasting and water resources assessment on PUB at a certain extent.

Yang Chuanguo, PhD in hydrology and water resources of Hohai University, also study in the Institute of Atmospheric Physics, Chinese Academy Science as a jointly educated doctor. The major study regions are large scale hydrology simulations and its response to the climate change and human activities. Now I am introducing a coupled hydrologic model described in this paper into Asia/China regions, to do large scale simulations for various hydrological processes. Email address: ychg@mail.iap.ac.cn
Spatial and temporal variability of water-energy balance in non-humid catchments of China based on the Budyko hypothesis

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Abstract: Through the analysis of the long-term water balance, coupled water-energy balances relations have been established for 108 non-humid catchments, scattered in the Yellow River basin, Haihe River basin, and inland river basins of China, based on the Budyko hypothesis. The characteristics of the coupled water-energy balances are tested in these catchments (the areas are from 272 to 94800 km2). In particular, the unique parameter (ϖ) representing the integrated effect of catchment characteristics in the coupled water-energy balances model is calibrated in each catchment, and then using the calibrated parameter, the model is applied to estimate the annual water balance. The results show that the model can be applied in these study areas well. The parameter (ϖ) is shown to have a significant regional pattern. It has been ascertained that this parameter represents the land surface conditions of the catchments, such as vegetation cover, soil properties, and topography, etc. An operational formula is proposed for estimating this parameter from average slope and the average plant extractable water capacity of each catchment, which is proved valid in the study areas. The quality and coarse resolution of the land cover and soil data are responsible for the poor performance of the formula in some catchments. Finally as demonstrated in this study, when the catchment areas are on the order of 100 km2 or larger, the parameter (ϖ) and model accuracy are by and large independent of the spatial scale, as indicated by catchment area.

An approach for sediment yield modeling in the hilly loess region and parameter uncertainty analysis

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Abstract: A DEM-based distributed sediment yield model was developed and applied in a small watershed of hilly loess region by using GIS technique. Theories of runoff excess and kinematic wave for describing surface runoff generation and movement in the hilly slope and the finite-difference method were adopted in the model development. Quantitative estimation of the soil erosion amount was based on topography characteristics of loess slope, gully slope and groove. The Chabagou catchment, located in the middle stream of Yellow River and with an extremely high soil loss rate in China, were selected for model application. The uncertainty of model parameters was analyzed using generalized likelihood uncertainty estimation (GLUE) method. Analysis results show that the model is capable to simulate runoff process and soil erosion in hilly loess region.

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Improvement of WEHY model and its application in Qin River Basin

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Abstract: Heterogeneity of landscape greatly affects hydrological response of watershed to atmospheric forcing. Kavvas proposed WEHY model (Watershed Environment Hydrology Model) to incorporate nonlinearity of processes and heterogeneity of landscape directly into the conservation equations in hydrological model. As a first attempt, current WEHY model suffers from limitation of discretization scheme, arbitrary selection of flow depth profile of interrill area, and its over-complexity of groundwater and evaporation modeling. To push WEHY model into water resources assessment practice, this paper redefines the model computation units, replaces origin flow depth profile by power function, and simplifies groundwater and evapotranspiration estimation approach.

We also applied the improved WEHY model, which is currently validated by several flood events in Shiobra-Dam watershed, to Qin River Basin for long time streamflow modeling with semi-arid climate. The results show that the model runoff predictions match the observed counterparts well, and validate the model ability of long time streamflow modeling in semi-arid watersheds.

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A study for the appropriate size of model-building unit for rainfall-runoff modeling

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Abstract: Development of a hydrologic modeling framework with appropriately sized topographic representation and model building unit (MBU) is the starting point for constructing a reliable and sound rainfall–runoff model. This research investigates the appropriate size of MBU for rainfall–runoff modeling with numerical simulations.

The definition of MBU is the catchment size within which the explicit spatial distributions of hydrological variables are not necessary to construct a hydrologic model. A lumped representation or a distribution function approach is enough to describe rainfall–runoff processes within the size of MBU. The size of MBU needs to satisfy the condition that explicit spatial distributions of topography, model parameter values, and rainfall do not affect the simulated discharge at the outlet of that unit. This size may be the maximum value of the representative elementary area, REA (Wood et al., 1988) that plays a significant role in hydrologic modeling.

To investigate the size, the influence of explicit spatial distributions of model parameters and rainfall on runoff response is examined through numerical simulations. A distributed rainfall-runoff model with a kinematic wave approximation is used, which routes the slope runoff along the steepest flow lines and channel flow to the catchment outlet. The distributed model is constructed at two catchments with 210km² and 6,600km² using a 50m grid based DEM and 250m grid based DEM respectively.

The simulation results show that the absolute size of MBU exists regardless of catchment scale when the size of catchment is between 150km² to 1,500km². Within the range of the catchment size, the size of MBU is 200 km² if we allow the 5 % difference of relative peak discharge among the river discharges simulated with different spatial distributions of hydrologic conditions keeping mean and variance of hydrologic variables. We find the size of MBU is basically defined by the existence of channel network. If the catchment size is larger than 1,500km², the size of MBU is larger than 200 km² and the size of MBU depends on the size of catchment scale, which results from the attenuation caused by river flow routing.

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Assessing crop water stress using MODIS data during winter wheat growing period along downstream of the Yellow River, China

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Abstract: Water resource is considered to be a major limiting parameter for local crop growth in northern China, where irrigation as an indispensable method to insure a stable agricultural yield. Therefore, how to quantify the crop water use and realize a high efficient irrigation pattern is urgent to relieve the pressure on the scarce water resource. Weishan Irrigation District along the downstream of Yellow River, with a designed irrigated area of 360,000 hm², has an average annual rainfall of 500-600 mm, where 60-70 percent of local rainfall has been accumulated in summer and less than 15 percent in spring. Water stress in spring brings a big problem for local winter wheat growth from middle March to early June, which is a major growth period closely related to the wheat production. Remote sensing has provided an efficient guide for local irrigation agriculture through modeling the actual crop evaporation repeatedly and simultaneously combined with meteorological data to map the water stress in the region. In this paper, about twenty MODIS datasets including visible, near infrared and thermal infrared bands from March to June in 2006 have been collected and the Surface Energy Balance System (SEBS) model, derived by Bob Su, has been applied to monitor the daily energy flux changes. The drought index map based on the evaporation fraction (EF) has been made to estimate the soil water deficit and crop drought status, and is compared with daily in-situ measurements of the volumetric soil moisture, and vegetation water content (VWC) data during this period. The result shows that the drought index is useful as an indicator of the wheat water stress in the semiarid and subhumid zone.
Global projection of floods and droughts under global warming by CCSR/NIES/FRCGC GCM

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Abstract: Future projection of changing risks of floods and droughts is one of the important topics of PUB study. Recent global warming simulation becomes much smaller horizontal resolution than previous ones, which may be applied to investigations of future projection of hydrological cycle on global river basin scale. This study explains projections on floods and droughts under global warming simulation by relatively high-resolution (T106) coupled general circulation model (GCM) using the Earth Simulator. The present-day GCM simulation reproduced the magnitude of discharge in 100-year return periods and the global distribution of the flood parameter, even though the absolute value of that parameter was underestimated. The simulated increase in floods and droughts between 2071 and 2100 significantly exceeds the natural change between 1941-2000 and 1971-2000. The frequency of very large floods was projected to increase over many regions, except for continental North America and middle to western Eurasia. Globally, the drought frequency was shown to increase in most regions except over the northern high latitudes, eastern Australia, and eastern Eurasia. Changes in flood and drought are not simply explained by changes in annual precipitation, heavy annual precipitation, annual evapotranspiration, or differences between annual precipitation and annual evapotranspiration. Several regions were projected to have increase in both flood frequency and drought frequency in the future. Such regions include basins in the northern high latitudes, where the timing of snowmelt would be earlier in warmer climates, and basins where precipitation patterns may change so as to decrease precipitation days but increase days with heavy rain. Because the predicted future changes in floods and droughts varied among rivers and sub-basins, projections of disastrous extremes in discharge using high-resolution GCMs will become important for local risk assessment.
Sensitivity analysis of XinAnJiang Model parameters

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Abstract: XinAnJiang rainfall-runoff model is a widely used rainfall-runoff model in China. The model has been successfully applied to many humid and semi-humid areas. One advantage of the model is that most of its 15 parameters have a physical meaning. However, usually not all parameters have measurements in the studied catchment. Some parameters were experientially assigned a value. In this study, XinAnJiang model was applied to Baishuikeng catchment, Zhejiang Province with the precipitation and evaporation data from 1980 to 1988. For the daily modeling, a good fit between the simulated and observed values and a good water balance were obtained in the basin. The sensitivity analysis of the model parameters was made. The results were compared with many previous researches on XinAnJiang model. The results show that the parameters on evapotranspiration and free water reservoir (K, SM) are the most sensitive parameters influencing the model performance. Therefore the results can help us to understand in the ungauged area, some parameters can use the data of the neighboring area or be assigned a value experientially because they are not sensitive, and those sensitive parameters should be calibrated carefully to get a good modeling.

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The monthly discharge simulation/construction in upper Yangtze River with absent or poor data coverage

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Abstract: Advancing the ability to predict the fluxes of water and associated constituents from ungauged basins, along with estimates of the uncertainty of predictions is one of objectives of the IAHS Decade. The water supplying region of the First Phase of the South-to-North Water Transfer Project (Western Route) is geographically located at the southeast of the Qinghai-Tibetan Plateau, China, where the altitude is high and observed hydrological data coverage is poor. A monthly-scale, spatial-distributed hydrological model with consideration of snow cover and permafrost were developed on the basis of GIS analyses. Some of parameters of the model were determined by observed meteorological data and Remote Sensing data, others were calibrated and validated using the observed discharge data of 4 downstream gauges, which have more than 40 years observed hydrological data, the results demonstrated that the Nash-Sutcliffe coefficient exceeded 0.77 either during the calibrated or validated period. Comparisons of simulated results with the short-term observations at the 5 auxiliary stations suggest that the model simulations are successful. By comparing mean annual discharge with that calculated by custom engineering hydrological method, it indicates that the calculated mean annual discharge may be reasonable.

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Space-time Self-organizations of soil moisture and overland flow generation in small catchment

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Abstract: Soil Moisture is a key component and has a major influence on the generation of overland flow. The space-time self-organizations of soil moisture and overland flow generation in Tarrawarra experimental catchment in Australian are analyzed here. The A-K Network, which is the combination of ART neural network and Kohonen neural network, was used to identify the spatial pattern of soil moisture. The semivariograms were calculated for the clustering center of each identified pattern in order to find the structures of variance. The variety of overland flow generating area in catchment was analyzed by using a cellular automata model which models the self-organizing incorporation in soil water balance including infiltration, rainfall and evaporation. In this paper, our goal is to find the possible occurrence of self-organization in hydrological process. Some initial results tend to approve the hypothesis.

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Application of Gray-self-memory-neural Network Model to Prediction of the Annual Runoff

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Abstract: Runoff time series is a non-linear, weakly dependent and complicated dynamic system. The key of improving the accuracy of runoff prediction is to digging the information included in the limited sample sufficiently. Gray system modeling uncovers the dynamic laws inside the system via processing gray information in order to transform the desultory data into ordered series for establishing model based on differential equations. Self-memory theory on base of physical motion irreversibility, emphasizes relation of system status, which urges upon evolutional rules of system itself, and then differential equations of dynamic system could be set up for the self-memory models. Combination of gray, self-memory could effectively responds ultra data, but with some phase lag. Neural network has advantage of paralleling distributed processing. On account the thought of integrative prediction, three modeling are combined to forecast annual runoff. It is shown that gray self-memory neural network model has higher prediction accuracy and may be fit for annual runoff prediction.

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Impact of Climate Change on the Streamflow in a PUB Region: Headwater of the Yellow River Basin

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Abstract: A coupled system integrating GCMs output data, downscaling model and distributed hydrologic model is proposed in this study. First, the Statistical DownScaling (SDS) model for the simulation of historic climate (1961-1990) and three future scenarios (2020s, 2050s and 2080s) are calibrated and applied. Furthermore, a hydrologic model, Soil and Water Analysis Tool (SWAT), has been successfully applied to simulate streamflow for headwater of the Yellow River basin. Finally, the coupled system is applied to investigate the hydrologic response to climate change in the future. The results show: (1) SDS model is successful in reproducing the main features of the observed hydrometeorology from the baseline climate simulation, when it is used to HadCM3 GCM output. (2) The monthly flow simulated by SWAT corresponded very well with the measured ones, and the model captures the seasonal tendency very well. (3) The hydrologic processes in headwater of the Yellow River basin are very sensitive to future climate changes. The streamflow of HYRB will decrease greatly for future scenarios investigated in this study.
Assessment of hydrologic model structures based on of parameter identifiability
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Abstract: The uncertainty on structures of hydrologic models results in uncertainties on estimation of parameter values and simulation or prediction results of models. One of the most direct ways to reduce uncertainty is to improve model structure. This improvement has been done traditionally depended on hydrologists’ intuitions and experiments, there are not quantitative indexes describing it. Parameters are always set to correspond to model components. The identifiability of parameters is related intimately to reasonability of model structure. Based on the relationship between them, this paper presents an index of parameters identifiability as a measurement of model structure uncertainty. The measurement can be used for assessment of model structure reasonability and give guiding information to model structure adjustment. GRJ model is selected in assessment case study. Parameters identifiabilities of two versions of GRJ are calculated as measurements of evaluating structures. Some suggestions on improving the model are presented based on the analysis result.

Study on box-counting dimension of fractal river networks
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Abstract: Fractal dimension of river networks has become a significant geomorphologic parameter for identifying hydrologic patterns. Several definitions for fractal dimension are used in hydrological literatures, of which the box-counting dimension via Digital Elevation Model (DEM) is widely applied. To explore the mathematical nature of box-counting method, three factors, i.e., confluence area for river networks extracting from DEM, and range and interval of calculated box sizes, were selected for identifying their influence on the value of box-dimension. We also select one real watershed, Chabagou Watershed, and one ideal watershed generated by iterative algorithm for numerical experiments. The results suggest the following properties of box-dimension of river networks: it shows a power law asymptotic behavior for large confluence area; it has a logarithmic dependence for smaller confluence area; it is monotone to the range of calculated box size while insensitive to the interval of calculated box size. These relationships reveal the complexity of box-dimension of fractal river networks.
Development of A Moving Average Model for Predicting Monthly Runoff In the Heihe River

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Abstract: The Heihe River, located in the central part of the Hexi Corridor in northwest China, originates from the Qilian Mountains, flows through the Hexi Corridor plain area and enters into the Juyanhai Lakes in Ejina Basin. Yinluoxia Station at the mountain outlet controls a runoff production area of 10,009 km² in the upstream catchment, with a total annual runoff of 1,602 M m³. Estimating monthly runoff from monthly rainfall is very important for water resources management in the inland river basin. In this study firstly, the monthly rainfall data from 12 stations was processed and completed for a long time monthly series of 40 years. Based on the statistical analysis and double mass analysis, the tests on homogeneity and consistency show that none of the annual rainfall and runoff series has a linear trend and the mean of the series appear to be stable at 95 % confidence level. Secondly, the monthly series of area rainfall over the study catchment area was calculated through Thiessen Polygon method by using the annual rainfall at 11 stations. Thirdly, the moving average model for predicting monthly runoff using threshold losses was developed with a multiple linear regression method. The model was calibrated with the first 20 years’ monthly data series with a high coefficient of efficiency (CE) of 0.91 and validated with second 20 years’ data series with a better CE of 0.85. Finally, the results of model performance show that the relation between the monthly area rainfall and the runoff is better and that the correlation substantially improves by taking into account the threshold rainfall losses of 20 mm. Model results improved most significantly by including the first month back.

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Optimal and Real-Time Water Management for the Yellow River, China

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Abstract: Based on the characteristics of water dispatch of the Yellow River, the dispatch system is divided in viewpoint of control, and mathematical models are put forward for water demand forecast, water allocation, reservoir dispatch, river channel evolution, and so on. Through the simulation -- optimization coupling method and non-linear planning, the integrity of the sub-models and optimistic control of the dispatch system are realized, and a model system is structured for the water dispatch of the river basin. Online identification and feedback ensure system operation stable. The system, combining with model storehouse and database, was applied to develop a plan management system for the water dispatch of the Yellow River Basin, which has been used in the dispatch work since 2003. The result of operation in 2004 – 2005 shows that the average deviation of reservoir dispatch is controlled within 10% while nearly 80% of cross-section flow deviation is less than 20% with an average deviation of 16%.
Monthly Precipitation and Runoff Forecasting for the Heihe River Basin in North-west China

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Abstract: One step ahead monthly forecasts of precipitation and streamflow in the Heihe River Basin in North-west China have been greatly improved by considering meteorological teleconnections. Enhanced values of explained variance for streamflows were obtained by incorporating antecedent values of the sea surface temperatures along the Pacific coast of China and the phase of the Southern Oscillation in addition to antecedent monthly precipitation, air temperature and runoff into the forecast procedure. Although correlation analysis was employed to make the initial choice of independent variables, the forecast model was developed in the form of an Artificial Neural Network. Such networks have the property of being universal approximators, and are therefore capable of capturing features of the data set unconstrained by assumptions of linearity of the relationship between the dependent and independent variables or their transforms inherent in multiple linear regression analysis. The forecast model obtained was found to be capable of reproducing the behaviour of low and medium sized flows to a high degree of accuracy. Peak flow months, which were not as well represented in the data set, were not simulated as well. Nevertheless, the levels of explained variance achieved in this study by considering teleconnections were found to be higher than those reported for similar studies on other large river basins, such as the Nile, Ganges and Murray-Darling. This enhanced performance can be partly attributed to the regularity of the flow regime in the Heihe River Basin, for which the snowmelt in spring and the frequent interchanges between surface water and groundwater are particular features.
The Research of the Feasibility of Data Scarce Macro-Scale Hydrologic Simulation

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Abstract: Hydrologic predictions of Macro-scale, data scarce basins are now a hotspot in hydrology researches. Hydrological models are important tools in hydrological prediction, and physical based hydrological models have been widely applied in water cycle researches, watershed water resources planning and management. Whether a specific hydrologic model could precisely describe the hydrologic processes of a specific region at a specific time scale depends on the structure of the model and the quality of input data, including hydro-climate data and surface ground data. Macro and meso-scale hydrologic predictions in data-scarce basin are even more relies on input data. In this research a physical based distributed hydrological model VIC-3L was selected to study its adaptability in the source regions of the Yellow River. The total area of the study area is 122,000 Km² and there are only 8 meteorological stations. The study regions were gridded into 218 square-cell of 0.25 0.25. Forcing data of each cell including daily precipitation, minimum and maximum temperature were gridded from climate data of the 8 meteorological stations using inverse distance weighted(IDW) method. Runoff of each cell was routed to the regions’ outlet with a coupled routing model. Simulated and observed runoff of 3 different time scales (yearly, monthly and daily) of the basins’ outlet were referred to investigate the feasibility of hydrologic simulation of VIC-3L in this regions. As to yearly-time-scale, the maximum water balance error of calibration and validation periods were both below 10%, which showed the performance of VIC-3L on this time scale in this study regions was well. Nash–Sutcliffe coefficient and flow duration curve error index(EI) of monthly runoff series could both satisfy a certain criterion showed VIC-3L could reproduce month hydrology process. Although the shape of modeled daily runoff fitted well with observed, Nash–Sutcliffe coefficient and flow duration curve error index(EI) couldn’t pass the standards discovered that VIC-3L model in this regions couldn’t precisely describe the daily runoff with the given daily forcing data. Many resources could contribute to this phenomenon, such as model structure, cell numbers and input data quantity. In the study regions it could be mainly contributed to the sparse meteorological station which couldn’t describe daily rainfall spatial distribution enough. These results showed that VIC-3L model could used as water resource planning or management tools in this regions on yearly or monthly time scale but if want to describe the daily hydrologic processes other data source should be made. So more meteorological stations should be constructed or others modern monitoring technique as remote sensing of micro-wave techniques should be applied in these regions.
Elman network model for comprehensive assessment of regional water resource carrying capacity

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Abstract: It is difficult to establish the mathematics model and to control the precision of the assessment models for comprehensive assessment of regional water resource carrying capacity. In order to solve the nonuniformity indexes problem and to raise the model precision of regional water resource carrying capacity assessment, the method, structure, design, simulation and figure output of Elman network for comprehensive assessment of regional water resource carrying capacity are given. As an example, regional water resource carrying capacity is assessed for 18 cities in Henan province by Elman network model. The result shows that the model has the features of direct, credibility and good application. The precision of assessment result of this Elman network model is higher than that of fuzzy analysis model and RBF network model. Not only the precision is high for the Elman network model, but also it has high stability.

Elementary Application of the BP Neural Network Model In Computing Annual Natural Runoff at Huaibin Station

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Abstract: In this paper, a method is provided for computing natural annual runoff by a neural network BP model. As a case, the model is satisfactorily structured and effectively used in computation of annual natural runoff on the basis of precipitation and evaporation at Huaibin Station on the upper reach of Huai River. The results show that the BP model not only has a certain simulation accuracy and but also gives a new approach on researching the computation of runoff quantity.
Impacts of Climate Change on Hydrological Processes and Water Resources in Headwater Area of the Yellow River

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Abstract: The headwater area upstream the Tang-Nai-Hai hydrological gauge station is one of main runoff generation areas of the Yellow River Basin. Climate change is one of main reasons of water resources decrease and ecological deterioration in the headwater area in recent years, and analyzing of future further change impact is important to water resources planning and management in the basin. In this article, we simulated the changes of both annual runoffs and monthly ones in headstream of the Yellow River under air temperature and precipitation change using the WEP model. WEP is a physically-based distributed model and impacts of air temperature change on water resources can be reflected through evapotranspiration change, snow storage and melting change and infiltration capability change in the frozen soil layer. The model was validated using the observed daily discharge data from 1956 to 2000 at the Tangnaihai station. After validating the model, we assumed 8 different schemes with temperature change by 1, 2 and precipitation change by 10%, 20% on the basis of historical observed meteorological data. The result indicated that air temperature change have different impacts on annual runoffs and monthly ones. The temperature increase causes annual runoff decrease, obvious monthly runoff decreases from May to October because of evapotranspiration increase and increases from November to next April because of snow storage and melting and frozen soil infiltration capability change impacts. The maximum increase is 63.7% in March, 1989 when assuming the air temperature increase of 2. Precipitation increase or decrease causes runoff increase or decrease to different extents, and runoff has a change rate larger than precipitation.

Note: contribute to “Theme (4) Impacts of climate change and human activities on the hydrological cycle and regional water resources”

Study On Flood Forecasting Based On Kalman Filter Learning Algorithm & Artificial Neural Network

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Abstract: With the rapid development of Artificial Neural Network (ANN), ANN is gradually applied to the study of flood forecasting. Back Propagation (BP) algorithm is the most important part of ANN, and it has powerful learning ability and simple structure that are very attractive properties for a wide range of application. Since BP algorithm is defective in rapidity of convergence and apt to trap into local extreme value, and it also has too many parameters to be adjusted when it is applied to nonlinear objects, a BP algorithm based on Kalman filter algorithm that used for training ANN is presented in this paper. The Kalman filter learning BP algorithm (KBP) regards all the weight values and threshold values as the state equations for Kalman filter, and the outputs of the network as the observing values for the kalman filter in the feedforward networks. Finally, this paper applied the KBP algorithm to the flood forecasting process, it has shown that the KBP algorithm is evidently superior to the standard BP algorithm in the rapidity of convergence, the ability of resisting noise and the ability of generalization.
A system for drainage and flood simulation in the urban areas of Shanghai

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Abstract: A rainfall runoff model suitable for city flood simulation is established for Shanghai based on the hydrological and hydraulic characteristics of the urban drainage system. With the compact combination of the model and a visual interface using GIS and MAPBASIC language which can be easily operated, a system for drainage and flood simulation in the urban areas of Shanghai is developed. In both real time and planning situations, this system can be used to not only dynamically simulate the whole flooding process of all city blocks, but also inquire both the depth and position of a random hydrops point. It satisfies the need of flood forecast, flow condition analysis, and engineering planning and management of the city and is adopted by The Information Center of Flood Prevention of Shanghai. Rationality analysis of simulation results and practical investigation of processes of extraordinary rainstorms in history indicate that this research result is basically reliable and satisfactory.

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Water Quality of Urban Runoff from Different Rainwater Harvesting Surfaces

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Abstract: Water shortage and water environment pollution were serious problems in Beijing, China. Thus, it is necessary to study the quality of the annual runoff in Beijing. In this paper, we investigated the water quality of runoff from different rain harvesting surfaces (i.e. roofs, streets and sunken-lawn). Results indicated that the main contaminants in the runoff were organic compounds and suspended solids. NH$_3$-N, Permanganate Index and volatile phenol of the runoff from roofs were all beneath the criteria of class V. The quality of the runoff from the sunken-lawn was quite good except that the content of NH$_3$-N was higher than the criterion of class III; The COD from the road surface was more than 493.5ml/L at the initial stage of the runoff, and it deceased to a lower and stable level with the time increasing of the rainfall. In a conclusion, the runoff from the roofs could be used for life and municipality except that from the initial stage of the runoff, while the runoff from the road surface could not be reused directly.
Trends and Variability analysis of streamflow time series in the Tarim river basin

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Abstract: Tarim River lies in the southern Xinjiang, which is the longest continental river in China and is also a famous continental river in the world. It plays an important role of shutting out the sand deserts and protecting the oases. Trends and Variability of streamflow time series in the Tarim river have important significant for agricultural irrigation and water supply in southern Xinjiang. Hydrological process is conventionally regarded as stationary processes. However, there is growing evidence of trends and long term variability, which may be related to anthropogenic influences and the natural features of the climate system. Hydrology signal fluctuations are highly unstationary and physical processes often operate under a large range of scales varying from one day to several decades. The trends are detected by Mann-kendall non-parametric test and t parametric test methods. Long term variability of streamflow at multi-time scales is detected by Wavelet analysis methods. In this paper the following issues are investigated: (1) Trends of annual runoff from 1957 to 2000 year over Tarim River in China are analyzed by using the Mann-kendall test and t test methods. (2) The reasons of trends are analyzed in the mainstream of Tarim River. (3) Morlet form wavelet transformation is used to investigate the 1957-2000 year data of annual runoff in Tarim River at multi-time scale. The results indicate that (1) Tarim river runoff exhibits increase trend in the headstream of Akesu river and Yerqiang river, no trend in the headstream of Hotan river, decrease trend in the mainstream of Tarim river, at the 0.05 significant level. The same conclusions about trends were drawn by Mann-kendall test and t test. (2) The reason of decrease trend in the mainstream of Tarim River was human being activity because runoff in the headstreams had increase trends or no trend. (3) The main periods of the streamflow variability in Tarim River are found except for Yingbazha station and Kala station. Streamflow exhibits different High-water period and low-water period variability at different time scales, indicating that wavelet transformation is a powerful tool in the study of streamflow long term variability.

Comprehensive assessment method of groundwater resources carrying capacity based on variable fuzzy sets theory

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Abstract: Many factors affect carrying capacity of groundwater resources, and the relationship between these factors is quite complicate, which makes it difficult to assess groundwater resources carrying capacity. Variable fuzzy sets assessment method is a newly proposed method for comprehensive assessment of groundwater resources carrying capacity. The method can scientifically determine relative difference functions and relative membership functions of disquisitive indexes at level intervals relating to carrying capacity of groundwater resources, and can reliably determine the assessment level of each sample by varying model and its parameters. Variable fuzzy sets assessment method and corresponding model are applied to assessing groundwater resources carrying capacity in Guanzhong plain in Shanxi province. The case study suggests that the method and corresponding model are reliable and practicable. They are good method and model for comprehensive assessment of various problems in water resources system.
Mapping the average annual runoff depth in Huangshui watershed using DEM

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Abstract: We found that precipitation and the surface water flows generally increase with elevation as does the vegetation cover in Huangshui watershed. So we assume that runoff depth increase with elevation and the vegetation cover. Based on this assumption, we revised the runoff depth contour manually created by using Spline interpolation. The runoff depth contour fitted much better after revised. This determined that the geographical variables, such as elevation and vegetation cover, can be used to improve the precision of mapping of runoff depth. To carry it further, we focus on discovering an automatic approach for mapping runoff using geographical variables. Using multiple linear regression technique, we create a regression equation that relates runoff depth to altitude and relative distance from the source of water vapor. Data used for this study include runoff data measured at 13 stations, Landsat TM data and DEM data. We used the runoff data of 13 stations for validation. Comparing with the empirical model used by local water resource survey institutions, the regression approach appears to give more precise results. And it can achieve a similar precision as that from the normal interpolation methods.

The Hydrological characteristics of runoff and its response to climatic change in Tarim

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Abstract: The Tarim River is the typical continental river in China, which runoff-forming regions has located upper mountain reaches. This paper has studies the change characteristics of river runoff and the impact of climatic change conditions on regional hydrological cycle in the headwater of the Tarim River. The paper demonstrates that the headwaters of Tarim river basin show great change of runoff under impact of climate change without regard to human activity. There is a very abundance of glacial water resource in mountain areas so that glacial snowmelt water is the main source for river feeding. Multi-variances Mann Kendall non-parameters has been applied to distinguish impacts of temperature, precipitation and evaporation on runoff. The results have shown that the impact of temperature and evaporation change on runoff is greater than that of precipitation; what’s more, the change differs from region to region in terms of geographic difference. A consistent correlation is highlighted between regional monthly temperature and runoff, suggesting the notable exponent increasing trend of runoff against temperature rising. It is clear that the global warming and glacial retreat in the 1990s has caused increases of rainfall, evaporation and surface water resource amount, especially, an increase of 6.5% in mean annual runoff in upper reaches of the Tarim River basin. In conclusion, this contribution describes the link between the global warming and the intensification of the regional hydrological cycle. This corresponds to more increase temperature couple to glacier retreating and attenuating acceleration, which finally leads to an increase of the surface runoff.
An Inversion Method to Estimate Parameters of Canal Water Transport Model based on Uniform Experiment

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Abstract: Based on the uniform experimental design theory, an inversion method for estimation of infiltration and roughness parameters of long distance canal unsteady flow model is presented. In order to exactly simulate the regime of the unsteady flow transport stage in a canal, changes of percolation rate along with water transport time and roughness coefficient along with canal flow depth are taken into account. In the case of many canal subsections, too many parameters need to be estimated. According to the practical considerations of the Emergency Dispatching Project of Yellow River water diversion to Tianjin and uniform experiment theory, we designed a uniform experiment for estimation of 19 parameters in 6 canal subsections. We set 10 levels for each parameter, and an unsteady flow calculation approach and observed data are used for parameter estimation. The results show that the proposed method can reduce calculation complexity and obtain acceptable parameter estimates.

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The Method of the Time-Varying Geomorphologic Unit Hydrograph Applied to Flood Forecasting of Small Catchments

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Abstract: The runoff yield and component deviding parts of the Xinanjiang model with three components of runoff absorbed in this paper, combined with the time-varying geomorphologic unit hydrograph configure flood forecast mode of small catchments, and it is called a method of the time-varying geomorphologic unit hydrograph of small catchments. This is a new pathway of the flood forecasting of small catchments.
Prediction of chaotic monthly runoff series using Volterra adaptive method

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Abstract: It is important to understand the dynamic features of runoff in hydrology and water resources research fields. An attempt is made in this study to characterize and predict runoff dynamics using nonlinear dynamical methods. The proposed procedure for this is: (a) detect the possible presence of chaos in monthly runoff series using correlation integral analysis and Lyapunov exponent method; (b) design a second-order Volterra adaptive model to meet the need of chaotic series prediction; (c) predict monthly runoff series using Volterra adaptive method. Monthly runoff series from the Second-Songhua River Basin in the northeast of China is studied as an example. The low correlation dimension (about 4.9) and the plus maximal Lyapunov exponent (about 0.111) provide convincing evidence for the presence of low-dimensional chaotic behavior. Predictions of noise-reduced runoff time series show promising results. The Volterra adaptive method (correlation coefficient about 0.98) is proved to be superior to the local approximation technique (about 0.95) for prediction, indicating the Volterra adaptive method a more effective approach for runoff prediction.

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FONNF model and its application to medium and long-term runoff forecast

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Abstract: Medium and long-term runoff forecast is the key issue, since its significance to water resources although it is complex and difficult to study. Based on the fuzzy neural networks model, fuzzy optimization neural network forecast (FONNF) model is developed, integrated the correlation analysis between forecast factors and object. The FONNF model is applied to annual runoff forecast of Huanren reservoir, Liaoning province. The results show that the FONNF model can solve the intricate correlation problem better of medium and long-term runoff forecast, compared with the nearest neighbor bootstrapping regressive model. Analyses on annual runoff forecast are also present.
Temporal and spatial variations of $\delta^{18}O$ along the main stem of Yangtze River, China
--Based on the 1st isotopic water campaign (2003) and 1-yr regular monitoring at 4-station

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Abstract: Yangtze River is the largest river in China, and the third longest around the world. The isotope compositions of $\delta^D$ and $\delta^{18}O$ in river water are very useful tools for interpreting hydrological processes and hydrological cycle related to climate changes and anthropic activities in large-scale river basin. Since 2003, 170 water samples recovered from the 1st water campaign and 1-year regular sampling at 4-station are analyzed for $\delta^D$ and $\delta^{18}O$ composition. From upstream to downstream, isotopic compositions $\delta^D$ and $\delta^{18}O$ are gradually increased. The trend line of the first campaign is just situated in the medium of LMWL and the trend line of 1-year river water sampled at 4 regular stations. The relationship of isotopic $\delta^D$ and $\delta^{18}O$ at the 4-station is in good accordance with the LMWL. New water body from the tributaries coming to the main stem of Yangtze River is one of the main reasons of spatial isotopic variations in river waters. The results revealed that temporal and spatial variations in the oxygen- and hydrogen-isotope of water samples along the main stem of the Yangtze River strongly relies on the isotope pattern of the regional precipitation. Furthermore, signatures derived from influx of evaporatively enriched waters through the several reservoirs or lakes along the system will be resulted in $\delta$-excess values increasing. From the beginning to the end of the low water standing period, isotopic compositions ($\delta^D$ and $\delta^{18}O$) are expressed as progressively increasing. The peak of the river water isotopic temporal variations is good corresponding to the boundary point of the beginning or ending for annual flooding period at site. The peak and valley of the river water temporal isotopic variations is a good indicator to split flooding period or low water standing period at a given location for a water year.

Lu Baohong is the associate professor of Hohai University. His specialty is hydrology and water resource and his present study are isotope hydrology, water resource planning and management, flood preventing design, reliability and risk of water conservancy. Now he is in charge of the NSFC project of “Isotope Composition of the main stem of Yangtze River”, and of the isotope investigation of the water quality and quantity of Huangpu River after the release of Taipu River, etc. He has published above 30 papers including 8 international conference papers. E-mail: lubaohong@126.com.
Estimate the Available Surface Water Resources in Xinjiang Changji Prefecture

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Abstract: Through the statistics and analysis of the actual utilization and characteristics of water resources in 38 rivers in Changji prefecture, Xinjiang, PR. China, this paper estimated the volume of sustainable utilization of surface runoff in 38 rivers, based on keeping the baseflow within a certain river length in large river basins, ensuring local economic sustainable development in middle river basins and the water environment in small river basins will not continue to deteriorate, then the results of the available volume of the surface water resources in Xinjiang Changji Prefecture is 24.82×10^8 m^3 preliminarily. All what we do are the groundworks for the development of the national economy, and the reasonable development, utilization and saving protection of the water resources, also the initial division of water rights and the normative of water market in Xinjiang Changji Prefecture.

The flood forecasting practice in the case of lacking datum

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Abstract: It is very difficult to forecast flood exactly in the case of lacking datum, because the form of flood is influenced by various factor. But in practice we usually have to make a predication to flood under the situation that we are lacking in the water & rain information, so it is requisite to find a kind of simple and convenient method by which the flood can be forecasted or estimated. Base on predecessor’s experience, the author tried to find out two kinds of methods of forecasting flood, the Flood Shape Simulation and the Flood Peak Flux Estimate. The Flood Shape Simulation’s water line or flux project is assessed to attain the precision of the first grade or the second grade, and the Flood Peak Flux Estimate is assessed to obtain the precision of the third grade, so the two kinds of methods can be used to forecast or estimate flood peak water or flood peak flux.
Review on the isotopic hydrograph separation methods

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Abstract: The objective of this study is to introduce briefly the basic concept and expression of isotope and the theory of isotopic hydrograph separation, to review the advantages and disadvantages of serious hydrograph separation methods which is applied all over the world and to introduce two-component isotopic hydrograph separation model and three-component isotopic hydrograph separation model in details. Deficiency of the domestic study about isotopic hydrograph separation is pointed out and research direction and the state-of-the-art of its application are viewed.

Some thought on modern urban flood control in China

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Abstract: Higher demand is put forward with the process of city construction and rapid development of urban economy as well as increased flood loss occurred in cities, which also embodies the importance of urban flood control. In this paper, what connotation does modern urban flood control should possess and what advanced techniques should be adopted is discussed.

Application of GA Method and SCE-UA method for calibrating the Xinanjiang model

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Abstract: This paper presents the research work on application of GA method and SCE-UA method for calibrating Xinanjiang watershed model’s concentration parameters, compare the results of using the two methods in calibrating the Xinanjiang watershed model. using the hydrology data of Xiuhe watershed Jiangxi province. as the deterministic coefficient of simulate history flood as the index. Results show that SCE-UA method in calibrating the Xinanjiang watershed model’s concentration parameters is be superior to GA method in some sort.
Study of Long-term Runoff Forecast Model Based on Association Rules Mining

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Abstract: Association rule is an important method of data mining techniques. There are a mass of hydrological and forecasting data in the region of long-term runoff forecast. How to fully analyze and mine those data via various intelligent algorithms to formulate accordingly hydrological forecast for precise forecast is of crucial importance. Considering the characteristics of hydrological forecast, association rules mining method is applied to the long-term runoff forecast. The hydrological and meteorological data from 1956 to 2005 are selected to constitute the runoff forecast database of Jiangqiao hydrologic station at Nenjiang River. So as to find the strong association rules which accord with the min-support and min-confidence, we discretize the values of the attributes by the standards. In the practical example of Jiangqiao station, three strong association rules are mined and these rules reveal the effects of the north pacific sea surface temperature (SST) on the flood season runoff at Jiangqiao hydrologic station. The results of test show that the qualified rate of the model comes to 80%, and the model is highly effective for the flood prediction of Jiangqiao station in flood season. Furthermore, association rules mining may be one of effective tools for the long-term hydrological forecast.

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Impacts of climate change and human activities on runoff in Sanchuanhe River basin

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Abstract: Runoffs in many rivers in China have been decreasing over the last decades. How to identify the contributions of human activities and climate change to runoff variation is a hot topic, as well as a difficulty problems. A method to solve the problem was put forward. SIMHYD rainfall runoff model was firstly calibrated with natural recorded hydro-meteorological data in Sanchuanhe River basin. And then, the model was used to extrapolate natural runoff in human activities affected period. Finally, causes of runoff variation in Sanchuanhe River basin were analyzed with hydrological simulation method. And results show that SIMHYD rainfall runoff model performs well for monthly discharge simulation at Houdacheng hydrometric station. Absolute runoff reductions caused by human activities and climate change have both generally presented increasing trends. On average, 70.1% and 29.9% of total runoff reduction were caused by human activities and climate change. Human activities are main reasons of runoff reduction in Sanchuanhe River basin.

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Impacts of climate changes and human activities on runoff in the Jialing River

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Abstract: In order to analyze the impacts of climate changes and human activities on the runoff, the Jialing River in the upper Yangtze River was chosen as a case study and a distributed monthly water balance model---Distributed Time Variant Gain Model (DTVGM) was developed and applied in the Jialing River. The application results indicated that the model could simulate monthly runoff well. Then the proposed model was used for assessing the effects of climate changes and human activities on runoff changes. The runoff after 1984 decreased 17.99% than that before 1984. Among them, about 2/3 was caused by human activities and 1/3 by climate changes. So the decreasing trend in the Jialing River discharge is mainly attributed to human activities. The increased water consumption and reservoirs construction are the main influencing factor.

A Study of Tide Level Prediction Approach for Shangtang Station

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Abstract: Shangtang station is located in tidal current boundary. Water flow variation is a complicated unstable variability system owing to the combination affects by upriver flood and downriver tidewater. This paper put forward a simple and practical approach for tide level forecast according to water current change characteristics. By analyzing the associated influences between upriver Shizhu station flood and downriver Wenzhou station tide, it studied a new separated water level model to Shangtang tidal prediction by disjoining two kinds influence, using unattached figure method and combined congruence. Comparing the tidal levels between predicted and practical values in 20 historical floods, the qualification ratios of predicted tidal level reached second class. It indicated that the approach was effective and the model blue print could be applied in task prediction.
**Dynamic model of water usufruct transfer in arid area**

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**Abstract:** In arid area, the economic development tries to reallocate the water resources for water resources restrict the development of economy and society; thus the water resources are reallocated and the system of water resources, economy and society upsets its balance. Since the main reason of system imbalance is the water resources reallocation, it is important that we should study the dynamic mechanism of water resources reallocation in arid area. Water resources potential energy is defined by analogy with the geo-potential and electric potential energy. Based on the first law of thermodynamics and the second law of thermodynamics, the formulas of water resources potential energy and water resources reallocation are deduced to analyze the dynamic mechanism of water resources reallocation. After the society, economy and ecology system is depicted using system dynamics (SD), the dynamic model of water resources reallocation is established and Shiyang River Basin as an example is taken to calculate the population, arable area, GDP and to analyze the system development mode.

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**Bayesian processor of hydrologic probabilistic forecasting**

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**Abstract:** Rational decision making requires that the total uncertainty about hydrologic predictand be quantified in terms of a probability distribution, conditional on all available information and knowledge. Hydrology knowledge is embodied in a deterministic catchment model. It is presented that a Bayesian Forecasting System (BFS) for producing a probabilistic forecast of a hydrologic predictand via any deterministic catchment model. The BFS decomposed the total uncertainty into input uncertainty and hydrologic uncertainty, which were quantified independently and then integrated into a predictive distribution. A deterministic equivalence principle was put forward in input uncertainty processor, and a Meta-Gaussian model whose heart is Normal Quantile Transform (NQT) was used in hydrologic uncertainty processor. Each component of BFS was detailed.

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Simulation of stromwater flooding processes in cities

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Abstract: The hydrologic and hydraulic characteristics in an urban basin are far more complex than that in a natural watershed which involve gravity flow, pressure flow, circumfluence, backwater, flow backwards and flooding. The methods used to design urban drainage system do not suit to analyses of surcharge systems or simulation of flooding processes in the cities. A mathematical model was established based on hydrologic and hydraulic methods which is mainly used to simulate cover area, depth, and duration of flooding during a storm period, and dynamically to demonstrate the flooding processes with the aid of GIS. The simulation results provides flood information for the decision of measures of flood prevention and disaster reduction for the cities.

Impacts of climate change on the variability of water resources in Yerqiang River Basin

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Abstract: The variability of water resources impacted by climate change was investigated in Yerqiang River Basin. The long-term trend of the hydro-meteorological time-series was detected by using non-parametric Mann-Kendall test, while the impacts of climate change on stream flow were assessed by correlation analysis and stepwise regression. The results show that during the last 50 years the basin became warmer with an increase tendency of 0.3°C per decade in the mountains area, and the stream flow had a slight increase by 2% per decade. The correlation coefficient of temperature with runoff was larger than 0.6 in June-September flood period, as a result of the runoff fed by glacier melt water in the high mountain area. At daily scale, a good linear multiple correlation of runoff with the last three days temperature is found by using stepwise regression, with R2 value of 0.55; as well as R2 value between runoff and temperature two days ago is 0.42.

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Assessing Chinese Sturgeon Spawning Ground by Using Acoustic Doppler Current Profiler to Measure River Velocities

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Abstract: The prior research has demonstrated the feasibility of employing the variable based on spatial velocity gradients to characterize and describe stream habitat. The higher gradients generally indicate the higher levels of physical heterogeneity and the better habitat quality. In the practice, acoustic Doppler current profiler (ADCP) is used to obtain the detailed velocity data, except for the 2D hydraulic model. Herein we demonstrate the use of ADCP to obtain ecologically relevant data of the Chinese sturgeon spawning ground and compute the associated variable. The data were collected from the downstream of Gezhouba Dam in Yangtze River, which is the last spawning ground of Chinese sturgeon. The habitat variable based on spatial velocity gradients is proved to be available in the scope of the sample cross-sections. Three of the twelve sample cross-sections are greater than the others in terms of the habitat variable computed upon the measured velocity. Moreover, the locations of the three sample cross-sections are just the mating field of Chinese sturgeon, which has been proved by relevant Chinese ecologists by proper ecological means.
Study on Countermeasures for Water Resources shortage and Changes of Ecological Environment in Shiyang River Basin

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Abstract: The Shiyang River basin is a special inland river basin in china, of which the population density is the biggest, per capital GDP is higher and the average per person water resources possession is the least. As a result, the contradiction between supply and demand of water resources is prominent, and the ecological environment deteriorates seriously in this region. Moreover the urbanized advancement development also gave the Shiyang River water resources and the ecological environment research the new challenge. This paper shows that the basin water resources has already been seriously overloaded, and the basin comprehensive governing program ought to be urgent, through analyzing the present water supply volume, ground water equilibrium, the present water consumption level, the water used efficiency and the present supply and demand balance of Shiyang River basin. The prominent question of this basin is the scarce water resources, the contradiction of supply and demand, the suddenly dropping groundwater table, the intensifying of ecological environment degraded trend, degeneration of the Qilian mountainous area ecology, the weakness of water source self-control function, the irrationality of economic structure, low efficiency of the water used, the distemperedness of the management system, the weak water resources unification management. After analyzing the origin of these questions, It is suggested advancing water saving, establishing saving water society, adjusting economic structure reasonably, optimizing disposition of water resources, developing the ecology construction vigorously, improving the ecological environment diligently, actualizing water resources unification management and attemper, enlarging water pollution preventing and controlling, enhancing the water environment quality unceasingly. By countermeasures to reserve source in south part of basin, develop oasis of middle part, control north part sandstorm, with the measure of protecting upper river, reforming middle river, rescuing down stream to prevent the trends of ecological environment degrading, improving the efficiency of water resources utilization, realizing integrate administration and sustainable utilization of water resources of basin, it will support the sustainable development of society, promote harmonic relationship between human and nature.
**A Fuzzy-pattern approach to flood classifying and predicting**

Zhang Gaihong, Zhou Huicheng

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**Abstract:** Scientific flood management is essential to predict and master some flood characteristics in real-time flood control dispatching. Previously, statistic analysis and neural networks were used in quantitative flood forecast, which is insufficient for real-time flood control operation. The objective of this study is to apply systematically fuzzy theory to flood classifying and predicting according to certain flood features. Based on fuzzy cluster iteration algorithm, history floods are classified into several specified groups, and by cluster validity evaluating, the optimal partition number and corresponding cluster centers may be obtained. Then taking the optimal cluster centers as the criterion of recognizing flood type and importing fuzzy pattern recognition theory, the real-time flood type may be predicted. Finally, the approach is applied to flood classifying and recognizing of Huanren reservoir basin and the results demonstrate the feasibility and practicability of this method.

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**Derivation of unit hydrograph model considering spatial-temporal variation of rainfall by using artificial neural network**

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**Abstract:** For decades, the impactions of watershed morphologic and topographic structure and spatial-temporal variation of rainfall on unit hydrograph (UH) has been the key questions in the study of watershed flow routing. In this paper, a new method is proposed to derive UH considering the spatial-temporal variation of rainfall. The method is termed the S-curve function. S-curve is the cumulative curve of UH. A non-linear function with two parameters was used to fit the S-curve. The relationships between the parameters of the new S-curve equation and the barycenter of storm and the intensity of rainfall were built by using artificial neural network. So the unit hydrograph with changing position of storm barycenter and intensity of rainfall can be built by using this method, which has the characteristics of Sherman unit hydrograph and also consider the temporal-spatial variation. A case study in Juhe catchment shows that the suggested method is effective.
The determination of natural desert plant root-zone soil water storage by surface soil moisture content

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Abstract: In soil-plant-atmosphere continuum, plant root-zone water storage is an important water source. The study on plant root-zone water storage is an important part in the study on the continuum. The accurate estimation of the plant root-zone water storage will provide scientific basis for estimating irrigated water amount, ecological water-need amount and for the regional sustainable development in arid inland river basins of China. In the lower reaches of arid inland river basins of China, because of water recharge reducing, the water storage in plant root-zone reduces and plant withers, then a series of ecological and environmental problems produce. So, it is imperative to study how to estimate plant root-zone water storage. Based on two-layers soil moisture balance model, root-zone water storage of a familiar natural undershrub Sophora alopecuroides in Ejina basin, which is the lower reaches of Heihe river basins, the second largest inland river basin in the arid region of northwest China, is determined by the soil moisture content of the surface layers 0-10cm obtained by remote-sensing method in desert areas of China, and therefore, the feasibility study on determining natural plant root-zone soil water storage by using remote-sensing data in western China is done. This also will provide scientific basis for simulating plant root-zone water storage at regional scale.
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