

**Theme 1 : Hydrological science and  
engineering for solving water  
problems**

# Macro-hydrology and watershed management in Southeast Asia

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**Abstract:** Models that can better simulate changing climate and hydrology are needed in Southeast Asia, as the rapid rate of land-use change may be having large scale impacts. Characterizing the climate and hydrological impacts of watershed change at the large scale necessitates characterization of the dominant modes of rainfall, transpiration, wet-canopy evaporation, surface wash, subsurface flow and channel behavior across landscapes divided into elements of at least 0.5° in area. Most of the variables mentioned (and their controlling land-atmosphere properties) are not measured in every 0.5° land area of tropical SE Asia; and where they are measured only a tiny fraction of each 0.5° area is sampled. Thus procedures to predict *ungauged* areas and *upscale* local measurements are needed to estimate the macro-hydrology dominating over a region divided into 0.5° areas, and how it changes with land-use impacts.

This study examines the typical measurement volumes, sample size and variabilities of the stated hydrological variables across the SE Asian region. It demonstrates why some variables (e.g., rainfall) can be mapped and explained at 0.5° integration scales, while the characteristics of others (e.g., rapid subsurface response) remain highly uncertain at this macro-scale. Next, we show how these variables might be affected by forest change in large watersheds, suggesting ways that uncertainties might be constrained in future research. Lastly, we present a radically new GCM Land Surface Scheme based on Data-Based-Mechanistic tools that illustrates both the upscaling issues and value of hydrological and meteorological time-series observations within tropical SE Asia.

# Study on Method for Comprehensive Assessment of Water Resources Reproducible Ability of the Yellow River

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**Abstract:** Using the theory and method of variable fuzzy set based on the difference function established by Chen Shouyu, we can obtain the effective solution to the recognition problem which assessment standard is interval pattern. In this paper, we develop the fuzzy variable set method for comprehensive assessment of water resources reproducible ability of the Yellow River and introduce its steps in detail. And finally this method is used to assess the water resources reproducible ability of the 9 administrative divisions along the Yellow River. The assessment result is better and shows that this method is available.

**Key words:** comprehensive assessment, water resource reproducible ability, the Yellow River, variable fuzzy set

# Simulating monthly streamflow changes for Upper Changjiang, China, under climatic change scenarios

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**Abstract:** Climatic change can exert pressure on future water supply of the Upper Changjiang (or Yangtze River) that may impact the water use of the populous Sichuan Basin and recharge of the reservoir impounded by the Three Gorges. The potential effect of climatic change on streamflow was simulated using the SLURP (Semi-distributed Land Use based Runoff Processes) model, and the ERA40 (European Re-analysis of Global Atmospheric) data from 1961 to 1990 was employed as the baseline dataset to represent the present climate. The simulated monthly discharge at Cuntan near Chongqing compares well with the long term monthly averages under the present climate. Scenario temperature and precipitation change as depicted by the Canadian Climate Model (CCCMA) were added to the baseline data, and the discharges under the corresponding scenario changes were simulated. Both the b2 scenario (moderate emission of greenhouse gases) and the a2 scenario (more intense emission) were considered, for the 2050 and 2100 time slices. In general, the projected changes in streamflow are more pronounced for the 2100 than the 2050 period. The Upper Changjiang basin is expected to have a relatively uniform temperature rise but the spatial pattern of precipitation change is quite varied. The Basin is expected to have a slight precipitation reduction in winter. In the spring, precipitation will likely increase in the east but decrease in the west. Late summer and autumn can experience a large increase in the southern sector, particularly in the southwest. While the annual total does not change substantially compared with the present climate, a redistribution of seasonal precipitation will give rise to a delayed arrival of high precipitation by two or more months. Streamflow responds to the precipitation regime with a flow reduction in the summer but enhanced runoff in the autumn, particularly for Jinsha River. Since this headwater catchment usually provides one-third of the total flow of Upper Changjiang, the regime shift of Jinsha is transmitted all the way downstream to Cuntan. Given the relatively uniform temperature rise but highly variable precipitation change across the basin, the simulation study suggests that runoff will be more sensitive to a shift in the precipitation regime than to the projected temperature rise.

# A Decomposed Approach to Optimal Planning and Operation of Water Supply Networks

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**Abstract:** Drinking water supply systems play a vital role in the people's daily life and for the stability of the society. To optimize the operations of such a system we have different goals to be achieved. First water resources should be optimally distributed concerning the water quantity and quality management and second the energy consumption for the water transportation should be minimized. At the same time the necessary supply to fulfil drinking water demands should be ensured. All these goals are not manageable in a complex water supply system with various plants and elements (tanks, reservoirs, pipes, pumps, valves etc.) as well as changing market conditions (supplies, demands, prices etc.) without an optimization solution strategy. However, due to the complexity of water supply systems the optimization problems are usually very complicated and large-scale.

A decomposed approach to solve such problems is proposed in this work. Based on its inherent characteristics, a water supply system is decomposed into three kinds of subsystems: water processing plants, pump stations and a pipeline network. Corresponding to these different subsystems, a nonlinear dynamic programming (NLDP) problem, a mixedinteger nonlinear programming (MINLP) problem and a large nonlinear programming (NLP) problem are formulated, respectively. The optimization software packet GAMS is used to solve the sub-problems, while simulated annealing (SA) is used to coordination the subsystems to ensure the minimum of total operation costs of a water supply system. Optimal operating policies for future 24 hours can be developed for water supply systems by the proposed approach.

These optimization studies were based on a validated process model obtained by rigorous modeling and simulation. As a result, a simulation and optimization program packet, HydroDyn, was developed. The packet runs under MS Windows with a user-friendly graphical interface. HydroDyn allows static and dynamic calculations of the water network including physical and qualitative parameters and rule-based control of the network elements. Optimization of long and short term water distribution as well as consumption are possible. Furthermore, HydroDyn can be used for tracking the water network status (design of networks, calculation of hydraulic and quality in networks within pressurized pipe networks and distribution system). It can exchange on-line data with several types of SCADA and process control systems. An interface for importing data from Smallworld GIS system is also available. This packet has been installed and successfully applied for the optimal operations of drinking water supply systems in several cities such as Mainz, Marburg and Hof in Germany.

# Hydrologic Analysis for Evaluations of Stream Grade Control Structures in Loess Soil Region

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**Abstract:** Grade control structures are used extensively to control river channel degradation for stream stabilization in loess covered areas of western Iowa, USA. Quantitative evaluations of these structures' performance, which include sheet pile, h-pile, rock sill and concrete block weirs, can aid to determine their durability and provide guidance for future design. Although local geology and groundwater can affect field performance, streamflow rate is one of the most important factors because it represents the external forces exerted on the structures. Structures that experiences different flows may perform differently, depending on the relationship between the stability of the structures and the external forces exerted, i.e., flow rate and velocity. An objective evaluation of the durability and performance of grade control structures requires information on the flow that has passed through each structure. A comparison of historical flows to design flows is needed to correlate measured external forces and structure performance observed in field.

In this study, a hydrologic analysis was conducted during the evaluations of stream grade control structures performance for drainage basins consisting of small rivers where no streamflow gauging stations are available. The reconstruction of streamflow history provided an estimate of the maximum discharge experienced by a structure, which was compared with the design flow rate. Historical flows and the maximum flow experienced by a structure were determined from precipitation data and drainage basin characteristics, using a computer simulation program (HEC-HMS, formerly HEC-1). The model was validated using field data from western Iowa and can be applied to ungauged sites in other regions. The ratio of maximum flow experienced by a structure to design flow reflects the maximum external force the structure had experienced, in relation to that the structure was designed to stand and overcome. Selected structures in the loess area of western Iowa were evaluated with a performance number system developed in the other component of the study. It was found that structures that experienced small flows performed relatively well, whereas those that carried large discharges had poor performance. In addition, the stability of riprap associated with a grade control structure decreases as the discharge ratio increases. This hydrologic analysis and evaluation method can be applied to loess soil regions worldwide such as the deep loess areas of Yellow River, China.

# Stormwater Reclamation—Assessment, Benefits and Feasibility

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**Abstract** As an alternative to direct discharge to surface waterbodies or high-cost treatment, urban stormwater could be collected and distributed for non-potable usage. Stormwater reuse is an innovative management practice and NPS control strategy. Environmental benefits and economic feasibility are essential to the adoption and implementation of a stormwater recalcation and management program in a urban area. The objective of this study is to paramterize and determine the benefits and feasibility of stormwater collection, storage, treatment and distribution for beneficial reuse in conjunction with flood control. Costs of various components of the system and economical and environmental benefits of stormwater reuse were parameterized and evaluated. A benefit-to-cost ratio was employed in the feasibility analysis for the stormwater reuse system. The performance of a future stormwater reuse system for meeting the non-potable water demand in the Easter Lake watershed in Des Moines, Iowa, USA, was evaluated by examining benefit-to-cost ratios under different reuse and design options. It is found that the use of a stormwater pond for aesthetic, recreational and flood control purpose would be economically attractive and feasible. However, the non-potable reuse of stormwater for irrigation and toilet flushing is less economically feasible due to low efficiency of the reuse pond from which a large amount of runoff is discharged instead of being reused.

**Keywords** Stormwater management, water quantity, water quality, beneficial reuse.

# **The Role of Hydrology in Managing Muda Irrigation Scheme**

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**Abstract:** The implementation of irrigation and drainage in the Muda Irrigation Scheme, the largest granary in Malaysia, hinge on the careful interpretation and management of hydrological data available in the network of hydro meteorological stations in the Muda plain as well as in the Catchments Area. This network the hydro meteorological stations was developed since the commencement of the project and its development and upgrading exercises had been carried out since. A total number of eighty four ( 84 ) hydro meteorological stations has been established in the plain and the catchments to efficiently managed water resources in the 'water stress' region of the country.

Networks of canal and drain in the scheme are equipped with water level recorders/stations which are useful in the monitoring of water supply during the irrigation season. The irrigation supplies in the canals are reflected in the 'water pattern diagram' monitored and produced for all the different irrigation blocks. In field water depths in the irrigation blocks are monitored weekly to optimize water usage in the water balance equation modeled for the scheme.

River flow from tributaries downstream of the dams forms 'uncontrolled flow' which supplement up to nearly an eighth of the water resources supply to the irrigation scheme. During the high river flow these networks of water level recorders/stations are useful in flood monitoring and flood routing exercise. These hydrological records form valuable information in the archives of water management and operation of the scheme.

The vital role of managing water resources for continuous double cropping of paddy in the scheme is made possible by the successful implementation of hydrological data management system and careful management intervention decision.

# Floods in Brahmaputra basin: causes and management

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**Abstract:** The Brahmaputra river basin extends to four northeastern states of India viz. Arunachal Pradesh, Assam, Meghalaya and Nagaland, with an area of  $1.94 \times 10^5 \text{ km}^2$ . The river has more than 100 tributaries, of which 15 in the north and 10 in the south are fairly large. The average annual runoff in the Brahmaputra river is  $537.2 \text{ km}^3$ , varying from  $3200 \text{ m}^3\text{sec}^{-1}$  to  $19,200 \text{ m}^3\text{sec}^{-1}$ . Floods are almost an annual feature in Brahmaputra basin with variable magnitudes and frequencies. Among natural factors, extremely high rainfall from June to September is responsible for flood events; while among anthropogenic factors, prevalence of shifting cultivation in  $2119 \text{ km}^2$  and affecting five times as high area at one time or the other, plays a key role in inducing floods. Floods are natural hazards capable of triggering disasters of great significance, affecting socio-economic fabric of a society. Floods are difficult to avoid but the damage can be minimized by appropriate and timely warning and, structural and non-structural approaches. The escalation of severe disaster events are among the most prevailing obstacles for sustainable socio-economic development and poverty reduction initiatives. The Brahmaputra basin receives heavy rainfall at an average of about 2450 mm, annually. The basin has a very steep gradient in the north and eastern sides but extremely gentle gradient in the south, falling at the rate of  $13 \text{ cm km}^{-1}$ . The basin is predominantly hilly and mismanagement of rain water causes heavy loss of soil in the hills and silting of river beds and floods in the plains. Though the rainfall is an important indicator to flood processes in the basin, the characteristics of the catchment also play a major role. The prevalence of shifting cultivation in the basin area also results in heavy soil erosion, deforestation and water resources degradation. Rapid population growth, urbanization, uncontrolled developmental works, encroachments and land use in the Brahmaputra basin have significantly contributed to flood events and risk enhancement. The combined effect of prolonged and intense rainfall, steep slope, well-developed drainage network and the fragile geology of the mountain make the land inundation an annual event. The annual rainfall variability index (RVI) varies from -1.77 (rainfall deficient years) to +1.85 (high rainfall years) in the Brahmaputra basin. The flood forecasting and warning system in place will be the most effective non-structural measure to mitigate flood effects. Construction of about 3647 km of embankments have, though, given some protection from floods in the basin, these have helped in adding to silt load in the river channel, which otherwise gets deposited in the flood plains around. There is urgent need to replace shifting cultivation with new eco-friendly and sustainable land use systems which may help in more *in-situ* retention of rainwater, particularly on hill slopes, to reduce runoff and soil loss through erosion. The extent of floods in the Brahmaputra basin, causes and management aspects have been discussed as the knowledge of flood generation processes is crucial for evaluating the vulnerability of a basin to floods.

# Hydrological Impacts of Land Use Change on Lam Phra Ploeng Reservoir Sedimentation in Northeastern Thailand.

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**Abstract:** In order to classify the hydrological impacts of land use change on reservoir sedimentation, the method for calibrating the siltation and sediment deposition in the reservoir to build up rates is needed. Effect of Land Use Change on Lam Phra Pleong dam were predicted by the comparison of 1970 original data and reservoir survey data from 1983 to 1991 with the catchment forest cover area ratios in each year (extended to 2000) that shows the capacity was reduced by sedimentation stored in the reservoir.

The annual sediment volume in the reservoir for the original from the year 1970 to 1983 is totally differed 2.230 mm. and the calculation of erosion rate is about 2.72 mm/km<sup>2</sup>/yr due to the forest area has been reduced 76.87 % . The annual sediment volume in the reservoir by the first reservoir survey from the year 1983 to 1991 has a total amount of 1.625 mm. and the calculation of erosion rate is about 1.98 mm/km<sup>2</sup>/yr due to the forest area has been reduced 1.30 % . And since 1991 to 2000, the forest area was maintain at the same rate. With this maintaining of the forest area can be used to assess the decreasing of the sedimentation rate and the annual sediment inflow was totally reduced to 0.36553 mm.. and the calculation of erosion rate is about 0.445 mm/km<sup>2</sup>/yr.

Most of the generated sediment was trapped by the meandering riverbed in both upstream and downstream of Lam Phra Phloeng Catchment, which reduced the water storage capacity of the reservoir. Distribution of the sediment deposition in the reservoir was estimated by using the Empirical Area Reduction method. In period 21 years the reservoir sedimentation that has reduced the 28 % of reservoir's utility. This result suggests that the lifespan of reservoir was predicted at 32 years due to its completion.

**Keywords:** Reservoir lifespan, sediment generation, sediment storage

# The importance of fluvial processes and local geomorphology to the fate of groundwater arsenic in Asian delta systems

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**Abstract:** One of the more pressing social and environmental issues of the day involves safe, clean water supplies for several of the world's most impoverished nations. In the Asian countries of Bangladesh, Burma, Thailand, and Vietnam, shallow water aquifers display complex patterns of natural arsenic contamination. While some arsenic heterogeneity in these areas has been explained by differences in large-scale, regional geomorphology, this is of little help at the village-scale where wells only meters apart and drilled to the same depth yield drastically different concentrations of dissolved arsenic (i.e., <10 - >300  $\mu\text{g/L}$  within 10m). It is on the order of this local heterogeneity that predictability for mitigation purposes still needs elucidation.

Results from field research on a largely abandoned floodplain of the Old Brahmaputra river (Araihazar, Bangladesh) indicate that much of the arsenic variability can be explainable by differences in local floodplain geomorphology. Villages aligning with coarse-grained, relict levee and bar features have lower concentrations of dissolved arsenic than villages overlying finer stratigraphies. In this way, the variation of dissolved arsenic in a 25km<sup>2</sup> area relates to the small-scale depositional patterns produced by the dissection, migration, and abandonment of a river. Given that many of Asian regions with arsenic enriched groundwater are themselves the products of large, dynamic rivers, it is possible that arsenic distributions there are also governed in part by fluvial geomorphology. Yet, the high-resolution groundwater datasets collected in areas other than Araihazar show a related but different correlation to local geomorphology, which presents a challenge for scientists and engineers contracted to predict the fate and speciation of arsenic in areas where surface morphology controls hydrology. Here, we discuss how understanding local morphology is an important factor for predicting trends in shallow aquifer chemistry, and also how existing geochemical studies from the other Asian locations can help clarify the role that geomorphology plays in arsenic availability on local scales.

# Potential evapotranspiration over humid and semi-arid regions: cases of Mekong River basin and Yellow River basin

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**Abstract** Potential evapotranspiration (PET) refers to the maximum meteorological evaporation on land surface. It is one key input in hydrological modeling, but difficult measured whereas depends on model estimation over large areas. As two extensions of the Penman equation, the Penman-Monteith (P-M) and the Shuttleworth-Wallace (S-W) models are widely employed. The P-M model treats the crop canopy as a single uniform cover, or “big-leaf”, and was standardized as FAO-24 and FAO-56 for the estimation of reference evapotranspiration on a hypothetical crop (RET). Then the RET is converted into PET by multiplying a crop coefficient for a special vegetation. With the global availability of land cover distribution and abundant cumulative satellite data on vegetation seasonal development, the PET can be estimated directly from the S-W model, thus the subjectively-determined crop coefficient is avoided. The S-W, however, is highly complex with many parameters and its application is not straightforward.

Based on the IGBP land cover classification, the threshold values of vegetation parameters are drawn from the literature. The temporal variation of vegetation LAI is derived from the NOAA-AVHRR NDVI using the SiB2 method. The CRU TS 2.0 database supplies with the required meteorological data sets. All these data inputs are publicly available. Neither experimental measurement nor calibration is introduced. The developed S-W model, therefore, is applicable at global scale, particularly to the data-poor large basins. The relationship between RET from FAO-56 and PET from S-W model is explored for different land cover at different climate region over Yellow and Mekong River basins.

The application of S-W model over Mekong and Yellow shows that the PET is not only controlled by climate patterns, but also changes with vegetation types and their development stages. From 1981 to 2000 when the monthly composite NOAA-AVHRR NDVI data are available, annual PET is estimated at 1373 mm with minimum 303 mm in north Tibet with the open shrubland and maximum 2067 mm in south Laos with the evergreen broadleaf forest over the Mekong, and at 679 mm with minimum 347 mm at the source of the river in eastern Tibet with the grassland and maximum 1596 mm nearby Tongchuan in Shanxi in the middle stream with the deciduous broadleaf forest over the Yellow. On the other hand, annual RET is estimated at 1253 mm with minimum 733 mm and maximum 1975 mm over the Mekong and 978 mm with minimum 751 mm and maximum 1548 mm over the Yellow. The PET can be directly applied to the hydrological model as an input, while the RET is a good indicator (probably need be combined with the precipitation) to describe the climate pattern and its change.

**Keywords:** Potential evapotranspiration; Physically-based distributed model; Land cover; NOAA-AVHRR NDVI; Mekong River; Yellow River

# Coastal tsunami geomorphological impacts and sedimentation processes: case studies of modern and prehistorical events

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**Abstract:** The study of coastal flood risk is of considerable interest to engineers, planners and politicians. Tsunami represents one of the most potentially serious forms of coastal flood risk. This paper reviews recent advances in research into geomorphological impacts and sedimentation processes associated with tsunami inundation. Detailed geomorphological and sedimentological investigations made in the cases of the Flores Tsunami generated by 1992 Indonesian earthquake, the 1998 Papua New Guinea tsunami and the Holocene Storegga Tsunami caused by a catastrophic submarine landslide off Storegga, Norway at circa 8,000 yrs B.P. are selected here. Although much is known on occurrence of this type of catastrophic coastal flooding which may cause loss of life, widespread destruction of property, and of infrastructure and industrial installations, it is not widely known, as these case studies show that the extent of flooding and geomorphological impact vary significantly along a coastline. Estimating the impact of tsunami and the vulnerability of coastlines to these phenomena may assist in coastal zone planning and management decisions. This paper also presents a conceptual model of coastal tsunami sedimentation processes deduced from the case studies and outlines diagnostic features of tsunami deposits.

**Key words:** Tsunami, stratigraphy, Geomorphology, Sedimentation, Particle size distribution, Conceptual model

# Problems & Challenges of Water Cycle Change & Water Security in China

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**Abstract:** China is a developing country with a variety of climate & much stress from its population & economic development in the world. Water problem, namely floods, droughts and water environment pollution, becomes a major limited factor to sustainable development in China. This paper will address the issues of water cycle change to change environment & challenges of water security in present and future of China. Discussions will focus on two major impact aspects, namely climate change and human activity. Three emergency & conflict areas from North China, West China and Yangtze River basin are selected as examples to show water stress and challenges of water security. North China is the center area of politic, economic & cultural in China. The water security problem in both water shortage and water pollution is a big challenge very serious. In West China, water is the key issue for ecosystem and sustainability. How to balance water demands for social & economic development and eco-system requirements will be a long terms task. Yangtze River basin is the biggest river in China. Several big water projects, such as Three Gorges Projects were built up. How to maintain health Yangtze will be a big challenges in the future. All these aspects would be thought in whole picture. Thus, several perspectives and suggestions are given for the goal of water sustainable use in the emergency & conflict areas to support the sustainable development of China in the future.

**Key World:** water crisis, water security, climate change, human activity, countermeasures

# Discussion and demonstration of good area water circulation

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**Abstract:** Good area water circulation is the research forward of international geology and water resources in the present. Its main content is integrated application about water saving technology, rainwater using and grey water re-using (including waste water disposal) by combining resources development with water saving and water circulation application to improve the efficiency of water using so as to reach the aim of no drain. On the basis of theory research of good area water circulation, we had demonstration in the emergent water resources area of Huai rou in Beijing. Those include integration of water saving, rainwater collecting and using system in buildings and roads, grey water disposal and re-using system and green land irrigation system. It gives a model of good area water circulation to realize efficient using of water resources and no drain. In the demonstration area, there is no collective rainwater on the road when it is raining and all life wastewater is disposed and used. The disposed water is used for green land irrigation and plant growth is very good which sufficiently show good water circulation in the small area. This model could be a reference and demonstration for setting up good water circulation in large area in Beijing.

**Key words:** good area water circulation; water saving; rainwater using; grey water re-using

# COPULA METHOD FOR DERIVING JOINT DISTRIBUTIONS in WATER RESOURCES EnGINEERING

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

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

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

# Conflicting Philosophies for Training the Wandering reach of the Lower Yellow River

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**Abstract:** There are various philosophies for training the wandering reach of the Lower Yellow River. Among others, twos are given below for comparison and contrast.

The current one, which also is the mainstream one for the training, follows the principle that the river will wind its way ahead. According to the philosophy, a typical stream course that the wandering reach follows most for medium sized floods will be selected as the model the wandering will follow after the training. The stabilization of the stream course would be realized by constructing the training structures at the concaved sides of stream bends.

Another philosophy for the training the wandering reach, which is so-called conjugate-training- structure philosophy for easy wording, is by constructing two training structures, spur dikes, on the both sides of the main channel at a site. With such training philosophy, the broad main stream will be made go through a relatively narrow channel, which will create high capacities for floods and sediment transport, so developing gradually into a deepening river and its course will be stabilized.

The twos conflict under the current principle for the operation of Xiaolangdi reservoir. Based on the experiment on a physical scale bed movable model for the wandering reach of the Lower yellow River, the paper is intended to produce a philosophy for the training by analyzing the strong points of each philosophy and the critical problems with it and exploring the way of taking the best of two philosophies.

# Application of artificial neural network to predict river stages in ice covered rivers

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**Abstract:** In winter, ice covers or jams often occur in northern regions, which reduce the flow cross section and increase the flow resistance and rise the stage in upstream. Ice induced flooding has multiple impacts on the economy and ecosystem. the presence of ice cover or jam causes many problems, such as: effecting on the operation of reservoir, dams and locks, hydropower plants and water intakes. break up ice jams can lead to sudden and catastrophic flooding without any warning and evolve river bed rapidly. For these changes are related to variation of ice-related stage, it is important to study and predict stages of river in ice-period.

Numerical river ice models have become useful tools for prediction ice jam stages, but the accuracy of results leaves much to be desired. Some forecasting methods of stages, from classical empirical threshold-type analyses to statistical methods, are limited to highly site-specific. A method used in ice jam stages prediction in a river may be highly variable from site to site for the complexity of river ice process.

Based on the analyses factors impacting on river stages in ice covered river, The artificial neural network prediction proves to be more accurate by training BP neural network with the data observed at Hequ section of the Yellow River.

**Key words:** Ice cover, ice jam, prediction, stages, BP neural network

# Analysis of the law of density current evolution in Xiao Langdi Reservoir

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## 1. Brief account

Xiao Langdi Reservoir is situated at the point of 130km of lower reaches of Sanmen Gorge reservoir on the Yellow River. The sandy water current drained from Sanmen Gorge reservoir enters into Xiao Langdi reservoir and forms density current starting from immersion point. Near the immersion point, the sandy water current immerses to the bottom of reservoir and move forward to form density current. The site observation shall be made from 2001.

## 2. The evolution of density current within reservoir

### 2.1 The change in thickness

During the procedure of movement and transmission of density current in Xiao Langdi Reservoir, the change in thickness is greatly influenced by topography. In the section above Bali lane, the section is a little wide and the thickness is a little small; in the section of Bali lane (the field in the distance of 26-30), the section is a little narrow and thickness of the density current increase. After flowing out of Bali lane, the thickness is decreased; before and after arriving the front section of the dam, under the state of close aerial drainage valve it will form turbid water reservoir firstly filled in the deepest position in front of dam, then develop toward upper reaches so the interface of clean and turbid water tends to be horizontal; in the state of opening the valve, the turbid water shall be expelled from the dam and the thickness of density current will become thin.

### 2.2 Change of velocity of flow

The velocity of flow near the immerse point is big, and will be increased when the width of the section is smaller or in the narrow section or will be decreased when the section is wider or enlarged. In the river section of Bali alley, the section is relatively narrow, the velocity in the density current layer is bigger; the velocity at the front of the dam is the lest.

### 2.3 The transmission of the flood peak in the reservoir region

Analysis of the transmission of the flood peak of the density current in the reservoir region has important meaning for the management and application and drainage and sediment ejection of Xiao Langdi Reservoir. After analysis of the field data of density current of Xiao Langdi Reservoir from 2001 to 2003, the empirical relationship between the emission time and the main elements to influence the emission velocity is found to be :

$$T = \frac{130 - L}{V} + \frac{1.21L}{(Q_m \cdot \rho_m \cdot J)^{\frac{1}{3}}} + 10.91$$

### 2.4 The sediment concentration and the D<sub>50</sub> change along the process

During the evolution of the density current in Xiao Langdi Reservoir, the average sediment concentration of the maximum vertical line in every inspected section along the process and

the change of average  $D_{50}$  of the maximum main flow and is decreasing step by step along the process and increased in the narrow river section of Bali Lane.

### **3. The exchange of water and sand between the density current and mush layer**

Seen from the change procedure of the thickness of the mush layer, in the river section above the front section of the dam and Bali Lane, it is generally thin in the former period and becomes thick in the latter period. In the river section of Bali Lane, due to the narrow and deep of the river course, when the velocity in former period is smaller, the mush layer will occur; the velocity in former period will increase, the mush layer will be blended into the density current layer to make progress to the lower reaches and becomes a part of density current.

### **4. Conclusion**

It is concluded through analysis of the change in the thickness, flow velocity, sediment concentration and  $D_{50}$  in the evolution of the density current that the water sand amount of the flood entering into the dam and the topographic in the reservoir region exerts much bigger influence on the evolution of the density current. The mathematics empirical correlation of the evolution of the flood peak of the density current has important value for confirming the occasion of sediment ejection of density current.

# The Influence of Taixi Colliery Exploiting Groundwater on Water Uses Environment in Dongping Lake Area

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## 1. Brief Account

Dongping Lake area is an important laying-up and flood retarding basin of Huanghe lower reaches with area 627 square kilometers. The water resources within the region are rich but the economic development level is backward. Taixi Colliery to be built is situated in the juncture of Dongping County and Liangshan County within the flood retarding basin of Dongping Lake. Mine exploiting groundwater and the waste water effluent in mine area have big influence on the resources environment in Dongping Lake area and geologic environment.

## 2. The state quo of water resources environment of Dongping Lake area

This area belongs to warm temperate zone seasonal subhumid climate with clear season and average rainfall at 604.74mm for many years. The river network within the boundary is developed and the perennial storage area of Dongping is 119 square kilometers; Huanghe is the northern boundary of mine field, the average runoff for many years of Sunkou hydrologic station is 36.2366 billion m<sup>3</sup>. The shallow ground water within the area is rich and the ground water is generally about 40 and mineralization of water is between 0.33—1.25g/L, and hydrochemistry type HCO<sub>3</sub>~Ca •Na has HCO<sub>3</sub> •SO<sub>4</sub> •Cl~ Ca •Mg •Na type.

## 3. The exploitation of groundwater and the condition of waste water effluent

The mine to be built needs normal water used in production and in the life of employees during the construction and production period. The exploitation position of water resource of water used in production and inrush of mine water are in the water stratum with elevation of 450-480m (base level of Huanghai) with depth about 495-525m away from the ground;

The productive reservoir of water used in life is Quaternary System groundwater with elevation 61.45—102.6m (the base level of Huanghai) and the depth away from the ground is about 100.95—142.1m. The drainage scheme of Taixi mining area adopts under well drainage of mine (except returned remnant) mixed with the production and life sewage in industry field after treatment by sewage disposal station and drained into Daima River along the original agriculture irrigate ditch of the southern side of industrial plaza to supply for the surrounding area to use in agriculture irrigation, and stored inside the river course between the Daima River brakes up to the canal of Beijing and Huangzhou. The water body having

not been drained into Jinghuang Canal, Dongping Lake and Huanghe is 4689 m<sup>3</sup>/d in waste water effluent amount in the mining area.

#### **4. The influence that exploration of groundwater makes on the water resources environment in Dong Ping Lake area**

##### **4. 1 The influence on water resource amount**

Long-term exploration of ground water will make the Yellow River's hydraulic slope for supplying groundwater and increase the lateral seepage recharge capacity. The average water level of many years of Dongping Lake is lower than groundwater level, with less effect on water resource amount of Dongping Lake. The total water-storing capacity of excavate coal layer of Taixi mine in integral geologic element is 1.911 billion m<sup>3</sup>, and the total hydraulic discharge of the mine during the mining period accounts for 3.6% of total water-storing capacity; water yield of living well is 0.3015 million m<sup>3</sup>/a accounting for 17.6% of the exploitable water amount in the aquifer, and the maximum drawdown of the groundwater level in a small scale is 3.74m.

##### **4. 2 The influence on the geology of the periphery environment**

Due to pouring out of abundant groundwater in the mining layer, the rock body in the aquifer will be pressed gradually causing the deformation and sedimentation of the ground; at the same time, with the exploitation of coal mine, sedimentation of different extent will be caused and the horizontal distance between the boundary of exploitation and the o point line of the sphere of influence is 800m, the sedimentation field of the ground is about 11.57 km<sup>2</sup>.

#### **5. The influence that effluent discharge made on the water resources environment in Dongping Lake area**

Taixi mine drainage has mainly coal fines and rock dust pollution. After coagulating sedimentation, filtration, disinfect, the strip rate of COD, BOD, SS is respectively 82.5%, 66.7%, 92.5%, the mine drainage can be used as water used in production under the well of mining well, ground and afforest in the factory area, and the excess parts shall be drained into Daima River after mixed with domestic sewage. After domestic sewage and little production sewage in industry site was treated with technics of billogy contact oxygenation, the strip rate of COD, BOD<sub>5</sub>, SS is respectively 53.3%, 71.0%, 50.0%, TDS on the high side of drainage of mining well may affect surrounding environment. Mine drainage can not pollute water body of Dongping lake, Yellow River and the Project of Water Diversion from the South to the North.

#### **6. Conclusion**

The element of high mineralization of water of mine drainage at the beginning of exploiting coal mine shall be fully considered. The water drainage at the beginning of exploiting coal cannot be used in irrigation of agricultural land as much as possible and used in irrigation of agricultural land until the mineralization of water of mine drainage was decreased at the standard of agricultural irrigation. Before then it shall be stored in the river channel after treatment of anti seepage to decrease the influence on the water quality of shallow groundwater near water storage river and salification of the land.

# Catastrophe Criterion Research of Soil Temperature involved the Effect of Groundwater Table

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**Abstract:** Based on the field experimentation data of the representative region in North China, the effect of groundwater table to the corresponded land surface temperature is analyzed. The statistic model of land surface temperature is built considering the influence of groundwater, climate, precipitation and time, etc. Based on the above, the catastrophe criterion of soil temperature involved the effect of groundwater table is built, with which the developing depth of the groundwater can be decided logically.

**Key words:** groundwater, statistic model, time series, catastrophe theory

# NUMERICAL SIMULATION OF FLOWS IN CHANNEL BENDS

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**Abstract:** The research and application of two-dimensional horizontal shallow water model has been a long history, and many research results about it have been applied to actual engineering, such as hydraulic engineering, environmental engineering, flood defense, and etc; and play an important guidance role in the organization, development and utilizations of water resources (De Vriend, 1981; Wei Wen-Li,2001; Liu Zhe,2004). Because the natural streams are serpentine, narrow and long, the commonly used two-dimensional depth-averaged model can't accurately predict bend flows with obvious 3D properties. So some researchers have investigated the influences of transverse momentum exchange caused by the secondary flows on the distributions of water depths and velocities across the section in channel bends, and obtained some useful results. The purpose of this paper is to modify the two-dimensional horizontal depth-averaged shallow water model in a curvilinear coordinate system considering the transverse momentum exchanges caused by the secondary flows in channel bends according to past research results (De Vriend, 1981), and the adopted curvilinear coordinate system has been generated by using the proposed boundary-fitted coordinate technology in the Ref. (Liu Zhe, Wei Wen-li, Guo Yong-Tao,2004), with which a curvilinear grid being orthogonal near the boundaries can be obtained. By using the modified shallow water mathematical model, the behaviors of the flows through the sequent bends have been computed; And the computational results of the two examples coincide well with the measured data. The study has provided a good basis for research of sediment and water quality in rivers with complex boundaries.

**Keywords:** boundary-fitted coordinates; transverse momentum exchange; secondary flow.

# RESEARCH ON THREE-DIMENSIONAL FINITE DIFFERENCE MODEL FOR WATER QUALITY

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**Abstract:** A three-dimensional finite difference transport model appropriate for the coastal environment is developed for the solution of the three-dimensional convection–diffusion equation. A higher order upwind scheme is used for the convective terms of the convection–diffusion equation, to minimize the numerical diffusion. The validity of the numerical model is verified through some test problems, whose exact solutions are known.

**Keywords:** convection–diffusion equation; a higher order upwind scheme; finite difference method

# COMPUTATION OF ONE-DIMENSIONAL DAM-BREAK FLOW USING ENO SCHEME

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**Abstract:** Since the 1980s, FVM (finite volume methods), one powerful numerical method for solving the fluid dynamic problems, has a rapid development and extensive application. With the development of adaptable grid, structured and unstructured grid, FVM make a great and rapid progress, which not only can solve big distortion, shock wave and complex fluid dynamic problem, but also make great progress in method, resolution and convergence theory. In recent years, more and more high-resolution schemes, such as TVD, ENO and WENO schemes are applied into dam-break numerical simulation when solving discontinuous problem such as the shock wave. Although TVD scheme can keep the total variation diminishing, it cause the accuracy drop to one-order at the local extreme point of smooth region. To overcome this weakness, ENO (Essentially no-oscillatory) scheme is proposed, which amplify the restrict of total variation diminishing and also allowing a tiny increase of total variation, then the scheme was kept uniform high resolution and essentially no-oscillatory. What the character of ENO scheme is that it eliminate the monotonicity limit, and can adaptively choose the best interpolating point in the interpolating functions reconstructions.

In this paper, the ENO scheme is applied to shallow water equations, and the TVD Runge-Kutta method is also used in it. At last, the numerical solution is compared with the exact solution of one-dimensional dam-break equation, and they are in good agreement.

**Keywords:** ENO scheme; FVM (finite volume method); dam-break numerical simulation

# HIGH- RESOLUTION NUMERICAL MODEL FOR SHALLOW WATER FLOWS AND WATER QUALITY

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**Abstract:** The research and application of two-dimensional shallow water model has been a long history, and many research results about it have been applied to actual engineering, such as hydraulic engineering, environmental engineering, flood defense, and etc; and play an important guidance role in the organization, development and utilizations of water resources.

The natural streams are usually serpentine, narrow and long; therefore, they require the computational models having a flexibility to treat the complex topology of boundaries, and require more effective scheme to simulate them than the conventional method. Recently an arbitrary quadrilateral finite-volume method is being applied extensively to the shallow water equations for its advantages of flexibility of geometry, simplicity of a finite-difference method and less computational effort than the finite-element method; and the total variation-diminishing (TVD) scheme is used very widely in aerodynamics because of its numerical performance of high accuracy, good shock- capturing ability and strong stability. In this paper, a high-resolution numerical model for coupling the shallow water flows and pollutant diffusions was presented based the two-step component-wise TVD scheme and arbitrary quadrilateral finite-volume method, by which second-order accuracy in both time and space is achieved. The computational results of the example coincide well with the measured data. The open channel flow and pollutant dispersion were implemented and compared with experimental data. The validation of this method shows that it can not only deal with the problem involving discontinuities and unsteady flows, but also solve the general shallow water flows and pollutant diffusions.

**Keywords:** shallow water flow; pollutant diffusion; TVD scheme; finite-volume method; numerical simulation

# RESEARCH ON NUMERICAL SOLUTION OF UNSTEADY 2-D OPEN CHANNEL FLOWS

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**Abstract:** There are two key problems in the numerical solution of unsteady two-dimensional flows. One is how to deal with the complicated shape of natural river boundaries; and the other is how to solve the water governing equations (Wei Wen-Li, 2001). The two key problems have been well solved in this paper.

The complicated shape of natural river boundaries are represented accurately in the finite-difference formulation by the use of numerically generated boundary-fitted coordinate system (Thompson, J.F., 1980). This procedure eliminates the shape of the boundaries as a complicating factor and allows the flows about arbitrary boundaries to be treated essentially as easily as that about simple boundaries. All computations can be done on a rectangular transformed field with a square mesh regardless of the shape or configuration of boundaries in the physical field. Therefore the technique of boundary-fitted coordinate system is used to overcome the difficulties resulting from the complicated shape of natural river boundaries.

The water governing equations have been well solved by the method of physical fractional steps (Wei Wen-Li, 1998; Wei Wen-Li, 2001). The basic idea of this method is that according to the behavior of each differential operator, the water governing equations can be separated into three parts. The first is a convective problem; the second is a diffusive problem; and the third is a source term. The advantage of this method is that in the convective-diffusion equation a more reasonable scheme for the convective and diffusive operator is adopted respectively. In the convective problem, since the equations are hyperbolic, the use of the method of characteristics will reduce numerical viscosity and liquidate spurious oscillations. Therefore, we use the method of characteristics for the convective problem calculation; and in the diffusive problem, since the equations are elliptic, ADI method is effective for the diffusive problem calculation.

The technique of moving boundary is used to deal with the riverbed exposed to water surface due to unsteady flows. By using this method, the computed results are in good agreement with the experimental data for a steady flow.

**Key words:** Boundary-fitted coordinate systems; Orthogonal curvilinear meshes; Technique of moving boundary

# NUMERICAL SIMULATION OF 2D DAM-BREAK FLOOD WAVES

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**Abstract:** Mathematically, the dam-break problem is commonly described by the shallow water equations (also named the Saint Venant equations for the 1D case). One feature of hyperbolic equations of this type is the formation of bores (i.e., the rapidly varying discontinuous flow). It is an important basis for validating the numerical method whether the scheme can capture the dam-break bore waves accurately or not. Many researchers have done much work to solve such a problem. Therefore, several finite difference schemes that handle discontinuities effectively were used to compute open-channel flows, such as the approximate Riemann solver (Glaister 1988), the modified Lax-Friedrich scheme (Nujic 1995). In recent studies, the finite-volume method based on a high-resolution scheme, such as the Godunov method, approximate Riemann solver, etc. (Mingham and Causon 1998), was used to a natural channel. During the last decade another type of shock-capturing scheme, the so-called total variation-diminishing (TVD) scheme, which was proposed by Harten (1983) and developed Yee (1987) and others, was applied widely in gas dynamics. The main advantage of this TVD scheme is that it has second-order accuracy, is oscillation-free across discontinuities, and does not require additional artificial viscosity. So it was introduced to solve hydrodynamics for free-surface flows, in particular, for recent complex dam-break flows. Delis and Skeels (1998) made a comparison with several different TVD schemes (i.e., symmetric, upwind, TVD-MacCormack, and MUSCL scheme) to predict 1D dam-break flows.

The technique is able to simulate satisfactory discontinuous flows such as those associated with the dam break problem or real hydrodynamic flows. However, the TVD schemes with different limiters have different features. Some are more dissipative and some are more compressive (Yang and Przekwas 1992; Jeng and Payne 1995). Based on the above research results, this paper is concerned with a High- Resolution mathematical model for 2D shallow water equations; and the 2D shallow water equations were split into two systems of equations in x and y directions by using the Strang type operator splitting method; and were solved with the one-dimensional upwind total variation diminishing (TVD) schemes and finite volume method (FVM). And this model is used to predict the flood evolution process caused by the instantaneous partial dam-break, and the simulating results are analyzed qualitatively. The analysis indicates that this model is fairly effective for simulating dam-break flood waves.

**Key words:** Shallow water equations; Difference splitting; FVM method ; TVD scheme; Dam break waves

# The spatial and temporal variability of soil moisture on grasslands on the Loess Plateau of China

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**Abstract:** Soil moisture is one of the most important factors to limit the plant growth on the Loess Plateau of China. Soil water content of 300 cm-depth at 20 cm intervals on three different grasslands were determined respectively on forage grass beginning growth stage (on May) and on stopping growing stage (on November) during the period from 1987 to 1999 to evaluate its spatial and temporal variability. The results showed that the soil water content at 0~20 cm and 160~300 cm were significantly higher than those at 40~140 cm. The soil water content of corresponding soil layers at 0~200 cm were higher on May than on October, especially on 0~80 cm. However, the 200~300 cm soil layer on October contained more water than on May. These results indicate that during the grass growth period (May to October), the topsoil water was further consumed, and the soil water in deep-seated soil layer was supplied. During 1987~1999, the variation coefficients of soil water content on each soil layer on May was significantly ( $p < 0.05$ ) higher than those on October. This may be attributed to the factor that most rainfall (accounts for 80% of annual precipitation) occurred in the period. In addition, the variation coefficients at 200~300 cm soil layer were higher than those at 0~200 on both May and October. The water storage of 0~300 cm (WS) had a significant linear relationship with rainfall during May to October (RR) ( $WS = 1.7483 RR + 34.804$ ,  $*r=0.554$ ), rather than annual precipitation.

**Key words:** Soil moisture; grassland; rainfall; long-term field experiments; Loess Plateau of China

# Determination on variation point of annual runoff sequence of Shiyang River by R/S analysis

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**Abstract:** The Shiyang River basin is one of the areas with the earliest irrigation agriculture development in inland river basins in Northwest China. In recent decades, due to the fast development of production and the great increase in water consumption in the upper and middle reaches, the runoff into the downstream Minqin has decreased sharply. The disturbance of human activities has made the runoff sequence not answer for the demand of “consistency”. In order to exactly determine the disturbance point of human activities to the runoff of the Shiyang River, this paper analyzed the sequence of runoff into the Hongyashan Reservoir in lower reaches from 1956 to 2000 by R/S analysis (Rescaled Range Analysis). The results showed that, the variation year of the sequence of runoff was 1977. There was a significant difference between the two regressed lines ( $y = -0.1015x + 5.3612$ ,  $R^2 = 0.4929$  for 1956~1977 and  $y = -0.0677x + 2.7293$ ,  $R^2 = 0.8047$  for 1978~2000). This approximately accorded with the historical status of exploitation and use of water resources in the Shiyang River basin, which showed that the analyses result of the variation point agreed to the fact. Thus it can be seen that since later 1970s, natural conditions have not been the main factor that influences the runoff of lower reaches of the Shiyang River, and human activities of upper reaches have maybe had a more important effect on the runoff.

**Key words:** Annual runoff; Human activities; R/S analysis; Shiyang River

# The simulation of different options of saline water irrigation in Hetao irrigation District, Inner Mongolia, China

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**Abstract:** The Hetao Irrigation District is one of the key agricultural bases in the Yellow River (YR) Basin. It is located in the upstream part of the YR in the Inner Mongolia, north of China and covers about 1,200,000 hm<sup>2</sup> with the annual precipitation 150-200mm and evaporation 2050mm, which is a typical arid area. Recently, the irrigation water drawn from the YR is allocated by the central government for the sake of YR depletion. The irrigation demand for the groundwater is increasing, while in most area the salt content in the groundwater is more than 2 g/l. The purpose of this study was to reveal the effect of saline water irrigation on crop yield and on water and salinity components both in the saturated and unsaturated soil, and to decide the sustainable saline water irrigation way.

The agro-hydrological model SWAP and the ground water and salinity model Modflow were used to analyse the crop yield, water flow and salinity transport for different saline water irrigation scenarios. The required parameters of the two models were calibrated and validated based on the saline water irrigation experiments in 2001-2002. 18 scenarios derived from 2-irrigation ways (irrigating with fresh water and saline water alternatively or mixed), 3-irrigation amount (100%, 75%, 50% of sufficient irrigation amount of 3750m<sup>3</sup>/hm<sup>2</sup>), 3-types of irrigation times (2, 3, 4 times respectively) for both sunflower and maize. The results show that, if the maximum yield of crops, the minimum salinity simulation in the unsaturated zone of soil profile and the water table control are put into considerations, the best choice is that the irrigation amount is 3750m<sup>3</sup>/hm<sup>2</sup> with 4 times irrigation of fresh water and saline water alternatively in 2001 when the precipitation is 260.1mm.

**Keywords:** saline water irrigation; Modflow; SWAP; water-saving irrigation; water management

# Water Level Control at the End of Year of Longyangxia Reservoir Based on BP

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**Abstract:** Long yangxia reservoir is a yearly regulation reservoir in the upstream Yellow River in China. The water level of Long yangxia reservoir is low for a long time, which has affected the benefits of Long yangxia and comprehensive benefits of the cascade reservoirs. So, it is very important to rationally control water level of Longyangxia reservoir. In this paper, the main factors related to water level at the end of year of Longyangxia reservoir are discussed by using regress method, on the basis of which, the BP model is introduced for deriving the water level rules at the end of year. The training of the neural network is done using a supervised learning approach with the back propagation algorithm. This paper presents the usefulness of the neural network in deriving general water level policies for a yearly regulation reservoir.

# THE RESEARCH OF THE RIVER WATER CONFIGURATION

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**Abstract:** In terms of the satisfaction on different function of the river water and from the protection of environment as well as the utilization's points of view, this article puts forward a research model of river water configuration (RWC) from the microcosmic point of view. This model divides the river water into four segments: ecological water volume(EWV), safe water volume(SWV), risk water volume(RWV) and disaster water volume(DWV). The EWV is the fundamental segments of the river, which is mainly used to maintain the ecological environment of the river. The SWV serves as the major economical consumptive use of water, which takes the most part of the total river water. The RWV is determined based on the economic losses and dike safety. The DWV is the part river water out flowing the river embankment, which can bring flood disaster in the flood years.

The ranges between the different water volumes can be determined by the special river flow. In addition, a case study illustrates the real application of the model to the Songhuajiang River in the North of China, which is frequently affected by floods and droughts. this paper quantitatively analyzes the quantity of each of the water volume and then discusses the fluctuation characteristics of the four kinds of water. The last conclusion indicates that the analytic model of this article provides with very important significance to optimize distribution of the river water resources.

**Key words:** The river water configuration (RWC); The ecological water volume(EWV); The safe water volume(SWV); The risk water volume(RWV); The disaster water volume(DWV)

# A water balance analysis of Zhalong Wetland 1956-2000

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**Abstract:** The evolution of wetlands mainly depends on the Hydrological state of them. An understanding of hydrological situation is a prerequisite for the successful management, conservation and restoration of wetland environments. As a result, the hydrological restoration is the first step of wetland restoration. Flood plain Wetlands usually have a wide flat surface and deep soil layers. The special geographic condition and geological structure form a water detention area and the essential condition of water plants as well as biodiversity. Furthermore, in the long-term evolution of wetlands, departed water plants and sediment create some special kinds of wetland soils, which are soft in structure, thin in granule and of remarkable water retention property. A typical one is the peat soil layer in peat wetlands. These geographical and geological conditions make wetland have a special function in hydrological cycle system.

Zhalong Wetland is a floodplain wetland with 2100km<sup>2</sup> area. The mainly source rivers are Wuyu'er River on right hand and Shuangyang River on left. The surface of the wetland is very flat except some small ridges. It processes a wide central area covered with flush reeds and some lakes spread around outside. A root and humus layer of reed with the depth of 1m to 2m covers a deeply embedded clay layer in the wetland. The maximum depth of water in the central area of the wetland is about 2m. The area of water surface may account for 70% of the area of the nature reserve in an average hydrological year. Water balance for the Zhalong wetland was calculated for the period of 1956-2000. The main hydrological processes including inflow, precipitation, evapotranspiration, infiltration and outflow are considered, Results indicate that the main water source of Zhalong wetland are from precipitation, which count for 58.4% compared to 39.0% from upstream discharge and 18.7% from other sources such as runoff from upland, returned flow from agricultural irrigation areas. Evapotranspiration accounted for 67.8% of overall outgo, and outgo from downstream outflow and seepage were 20.5% and 11.7%, respectively. An area-volume relationship, which was achieved by the associated application of 17 Landsat TM5 imageries from November 1986 to October 2002 and 1:50,000 DEM digital map, was used to model the variety of area covered by water within Zhalong wetland. The results show that in 1950s, the area covered by water was about 700km<sup>2</sup>, however, it declined to less than 200km<sup>2</sup> in 1970s due to the arid climate condition, after that, the area expanded gradually to about 500 km<sup>2</sup> in 1990s, This was partially due to the water diversion from the Nen River to Zhalong wetland from 1971-1987.

**Keywords:** Water Balance, Zhalong wetland, Wetland restoration.

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**Key words:** The river water configuration (RWC); The ecological water volume(EWV); The safe water volume(SWV); The risk water volume(RWV); The disaster water volume(DWV)

# Evaluation on renewable resources and development situation of the porous confined water

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**Abstract:** Evaluation on the development situation is one of important basic tasks to groundwater administration, and the renewable groundwater resources is an important index for evaluating the development situation. In a porous confined water filed, taken the analysis on recharge source recharge way of the exploitation aquifer as base, combining with the hydrogeology-environmental problems caused by groundwater exploitation, property of recharge is judged for determining the component of renewable water resources. According to the component judgement, the renewable volume and the development situation of the groundwater field can be evaluated. In the porous confined water basin located in Huaibei Plain, Anhui Province, P. R. China, replenishment condition of porous confined water is poor, and several land subsidence has formed due to groundwater development. This confined water basin is taken as an example to demonstrate the proposed method for determining the component of renewable groundwater resources. Then, the renewable volume and the exploiting situation of the basin are calculated by numerical simulation.

**Key words:** porous confined water; recharge way; property of recharge; renewable ability; development situation

# One-dimensional Water Quality Model of River Subjected to Water Exchange between Surface and Ground Water

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**Abstract:** Subjected to water exchange between groundwater and river water, taken the hypothesis of the classical one-dimensional surface-water quality model as base, a new one-dimensional model on river-water quality is constructed and its analytical solution is proposed. Based on the physical implication of above models and the mathematical characteristics of the new model's solution, it is demonstrated that variation of river water-quality caused by groundwater-surface water exchange can't be implicated by the synthetic coefficient of decay. Based on the new model's solution, the rule of river water-quality varying with river reach responds to water exchange is analyzed quantitatively, and the suitable conditions for the two model are discussed. The successive monitoring data of several years in Yinghe River, Anhui Province, P. R. China, is taken as an example to show the contrasting research on the two models. From above research, groundwater discharge can't be neglected during the normal low-water periods.

**Key words:** groundwater; water exchange; water quality of river; one-dimension model; analytical solution

# APPLICATION OF REEDBED IN GREY WATER RECYCLING – THE UK EXPERIENCE

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**Abstract:** Sustainable development has raised much attention in general public in recent years. A common topic in this field is to consume water in a sustainable manner. Compared with the water from toilet, which is commonly called “back water”, the waste waters from washing machine, bath, shower, hand basin and kitchen are lightly polluted and termed as “grey water”. It has been argued that grey water could be reclaimed for non-potable use, for example, toilet flushing in terms of sustainable development. Investigation in the UK showed that about 30% of water consumed in a household is for toilet flushing, while 70% for other purposes. This implies that water demand could be reduced by one third potentially by using reclaimed grey water. In recent years, many on-site grey water reclaim technologies have been developed and applied. However, most of them are very expensive and not economic sustainable, especially for developing country. Reedbed, as recognized as low-tech and low cost method, has been broadly used for industrial waste water treatment. Its application in grey water treatment is rarely reported. As part of the Water Cycle Management for New Developments (WAND) project [[www.wand.uk.net](http://www.wand.uk.net)], reedbed has been chosen as one of the contenders to investigate the most acceptable on-site grey water treatment technologies. For comparison purpose, vertical, horizontal and roof based reedbeds were constructed in this project. The capabilities of these three systems on grey water treatment are compared and discussed in this paper. Their feasibilities in developed country (such as UK) and developing country (such as China) are also discussed.

# A Bayesian probabilistic hydrologic model based on BP Artificial Neural Network

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**Abstract:** The Bayesian forecasting system (BFS) has been developed as a general theoretical framework for short-term probabilistic forecasting, which leads to more rational decision making, via any deterministic hydrologic model. Within the BFS framework, the total uncertainty about a predictand (such as river stage, reservoir inflow, or antecedent soil moisture) is quantified in terms of a probability distribution and decomposed into input uncertainty (precipitation uncertainty) and hydrologic uncertainty (arising from sources other than precipitation input, such as model, parameter uncertainties and measurement errors). As no probabilistic quantitative precipitation forecast is available in China, only hydrologic uncertainty is considered in this study. According to Bayesian revision theorem, the hydrologic uncertainty is integrated into a final posterior predictive distribution by incorporating prior available information and knowledge through prior distribution with observed data expressed in likelihood function. In this paper, a new prior density and likelihood function model is developed with BP artificial neural network (ANN) to study the hydrologic uncertainty of short-term reservoir stage forecasts based on the BFS framework. Markov chain Monte Carlo (MCMC) method is employed to solve the posterior distribution and statistics of reservoir stage. A case study is presented to investigate and illustrate these approaches applied on Shuangpai Reservoir with historic floods. The results show that Bayesian probabilistic forecasting model based on BP ANN not only increases forecasting precision greatly but also offers more information for flood control, which makes it possible for decision makers consider the uncertainty of hydrologic forecasting during decision-making and estimate risks of different decisions quantitatively.

**Key words:** Bayesian probabilistic forecast; hydrologic uncertainty; ANN; MCMC

# Modeling and measurement of rainfall interception loss from a subtropical conifer - deciduous mixed forest, China

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**Abstract:** Three versions of Gash analytical models (the original, the revised and the sparse Gash models) have been applied to simulate rainfall interception loss from canopies in a subtropical mixed Shaoshan forest in central-south China during the year of 2002. The modeling results suggest that the sparse Gash model provides the most accurate estimated values and overestimates the measured interception loss by < 0.1 % relative to a 5.7 % overestimation by the revised Gash model and a 9.3 % overestimation by the original version. The original, the revised and the sparse Gash models suggest that 77%-81% of total estimated interception loss are in the form of evaporation from the canopy during the storms, with a further 5.2%-5.9% of total estimated interception loss evaporated from the canopy after storms and an additional 5.4%-7.2% evaporated from canopy + trunks.

# The effect of controlled drainage on outflow reduction, salt and nitrogen balances in YinNan Irrigation District, China

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**Abstract:** The YinNan Irrigation District (YNID) is located in the upper reaches of the Yellow River in NingXia Hui Autonomous Region, China. Due to easy access to water source and the traditional Irrigation practice in the area, farmers tend to over-irrigate their fields and consequently discharge a large amount of drainage water to the downstream of the Yellow River. Such practice is not only a waste of the valuable water resources, but also a threat to water quality of the Yellow River. In order to improve the current situation, we conducted a field study of adopting controlled drainage technique in 2004-2005 based on the current irrigation practice. The results showed that by raising the field ditch outlet from 1m to 0.6m, a 50% subsurface flow reduction was achieved; controlled drainage had little or no effect on surface runoff, and the contribution of surface runoff to total drainage volume over shadowed the flow reduction benefit of controlled drainage. The effects of controlled drainage on salt and nitrogen balances were relatively minor in such an over-irrigated area. In the controlled fields, observed salinity from both of field ditches and monitoring wells showed slight increases. Nitrogen loss was mainly controlled by slow release of N fertilizer applied at the beginning of the growing season. The study results also indicate that without changing current irrigation practice, with controlled drainage alone is not enough to achieve water quality goals and improve water use efficiency.

**Keywords:** controlled drainage, irrigation, salt balance, nitrogen loss, Yellow River

# The influence of micro-topographic properties and relative locations on riverine wetland hydrology and water balance

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**Abstract:** Wetlands often exhibit great heterogeneity in their overall wetness and plant distribution. Such characteristics are desired in preserving the ecological value of a wetland. Aside from the factors such as undulating topography, a riverine wetland is also affected by its relative location to the river channel that serves as its drainage outlet during the dry season and recharge source during the flooding season. Based on topographic data of a wetland near Xi'an, China, this paper presents results from a modeling study that simulated the process that affects the wetland hydrology of a riverine wetland under different physical conditions, such as relative location to the main channel, surface storage capacity, soil property, as well as the frequency and duration of flooding. The simulation results showed that, when the width of floodplain exceeds certain value, the effects of drainage and recharge of the river channel on the wetland become negligible, the major source and sink for water balance of the wetland are precipitation and evapotranspiration; changes of water level in the river channel affect wetness of the wetland only when the duration is long enough. These findings indicate that in the water deficit area like Xi'an, local drainage conditions play an important role in determining the wetness of a riverine wetland.

**Keywords:** Wetland, riverine wetland, micro-topography, wetness, evapotranspiration

# **Spatio-temporal changes of NDVI and their relations with climatological parameters and runoff in the Poyang Lake Basin**

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**Abstract:** NDVI is an important index denoting a region's vegetation cover. In this paper, the Poyang Lake Basin is divided into 6 sub-regions and their NDVI series of 1982~2000 are obtained from 8 km resolution multi-temporal NOAA AVHRR/NDVI data of Pathfinder. The Spatial distribution and dynamic change of vegetation cover in the regions of the Poyang Lake basin are analyzed in recent 19 years. The results show that: (1) In general, NDVI in all sub-regions reaches peak value in July or August within a year in the Poyang Lake Basin. In average in the 19 years, the NDVI values of most sub-regions show the increasing trends in July, August and annual average except for Rao river basin which shows the tiny downward trend in August and annual average. These imply that the coverage percentage of the vegetation presents a rising trend and the ecological quality is being improved on the whole in the Poyang Lake Basin, but also there is some deteriorating trend in some sub-region. (2) There is no obvious difference in the 6 sub-regions, the higher annual value of NDVI occurs in the Rao river basin, while the lower in the region that encircles Poyang Lake. The temporal changes of NDVI are unanimous with precipitation in most part of the Poyang Lake Basin and the spatial changes of NDVI have not affected obviously by precipitation. The average changing rates of NDVI in different sub-regions are different. Finally, the relations of NDVI between climatological parameters (precipitation and temperature) and natural runoff in Five Rivers' (Gan river, Fu river, Xin river, Xiu river and Rao river) basins are researched. The results show that NDVI has some apparent positive correlations with precipitation and temperature within a year. But it has complex relations with natural runoff variability and there is no, if any, obscure correlations between them. Furthermore, NDVI has some time lags behind precipitation, and the temperature affects vegetation more than precipitation in Poyang Lake Basin. From the perspective of inter-annual changes, NDVI has some positive correlations with precipitation, temperature and natural runoff.

# Evaluation of Micrometeorological Models for Estimating Evapotranspiration from a Wheat Field in the Hetao Irrigation District of Yellow River Basin

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**Abstract:** Hetao irrigation district, located in the Yellow River basin, is one of the most important centers of agricultural production in China. With the rapid regional development in the last decades, shortage of water resources has become a big concern affecting sustainable crop production. The whole area of Hetao irrigation district is about 1.2 million ha and the cultivated land area is about 0.514 million ha in which 93% is irrigated from the Yellow River. The large amount of the discharge has been regarded as the cause of the lower course of the river. To cope with these problems, the Chinese Ministry of Water Resources has decided to diminish 20% of the present diversion in Hetao district. The assessment of water consumption of typical crops in typical irrigation districts of the Yellow River at present is very important to improve agricultural water productivity in the Yellow River basin. Thus in this article, in order to elucidate the water balance in Hetao irrigation district, evapotranspiration (ET) from an irrigated field of wheat, which is one of the main crops in the district, was estimated and three micrometeorological models of ET were developed. Micrometeorological conditions in the wheat field were measured to evaluate the radiation balance and energy balance in the field from 6 May to 3 July 2005. Daily ET was estimated by Bowen ratio energy balance method by integrating hourly ET. Three ET models; ET ratio, Penman Monteith (PM) and the Bulk equation methods were assessed. ET ratio and canopy resistances of PM and the bulk methods were calculated by  $ET_B$  and measured micrometeorological conditions. The plant heights of the wheat and leaf area index (LAI) were also measured during this period. From the measurement and meteorological data analysis, the applicability of three simple ET models was assessed. The results showed that the canopy resistances of the PM method ( $r_{c1}$ ) and the bulk method ( $r_{c2}$ ) had high correlations with SR and also with soil water content, which are supported by the physiological notion. The total ET from 6 May to 3 July (60 days) was estimate as 301.3mm, while the irrigated water was roughly 289 mm and rainfall was 3.9 mm during the measure period. Almost all the irrigated water and rainfall was used for the growth of the wheat. This shows a typical water balance in an irrigated field in an arid region.

**Key words:** Evapotranspiration, Canopy resistance, Irrigated wheat, Water balance

# **River morphology and bank erosion: A case study in the Kaligandaki river valley, Nepal**

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**Abstract:** Kaligandaki river valley is located in Mustang district north of the Himalayan range. Under condition of harsh high-altitude, people in the valley live mostly between 2000 and 4000 m asl, in extreme condition even up to 5000m asl. The geology consists of Tibetan-Tethys sedimentary rocks. Major rocks are limestone, sandstone, black shale, quartzite etc. A wide variety of Quaternary sediments of various origin such as lacustrine, glaciofluvial, glaciolacustrine, fluvial and debris flow develop along the Kaligandaki valley. In addition, thick glacial moraine deposits of Recent age occur locally. Many tiny settlements in the basin suffer from various ecological handicaps for human life due to high altitude, including a dry climate and an extremely stormy weather. Hence, a combination of natural hazards persists in the valley ranging from rockfalls, landslides, bank cutting by river flood, wind erosion to discharges of moraine and glacier-dammed lakes. However, the study focuses only on the riverbank erosion problems and discusses on the changes in river morphology and associated consequences in the settlement area. A case study of Tukuhe village is described which is situated in the altitude of about 2600m asl, about 13 km south from the district headquarter- Jomsom.

Following points will be described in the full paper:

1. Type of natural hazards and their association with geology, topography, landuse and climate. (Wind erosion, hillslope erosion, rockfalls, landslides, debris flow, river bank cutting)
2. Morphological characteristics of the Kaligandai river (Jomsom-Tukuhe Section)
3. Consequences of river course shifting and bank erosion problems.
4. Case study of Tukuhe village: How people cope with the natural hazards (settlement pattern, landuse and sustainable livelihood environment), landslides induced by bank erosion, structural countermeasures and their effectiveness)

# **The study of drought trend with utilization of standard precipitation index (spi) in Anzali wetland basin.**

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**Abstract:** Anzali wetland is one of the most important global recorded ecosystems that affects local climate, bird life, aquatics and etc. Drought phenomena can affect this complexity and combined role. We have done this experiment for recognition of conditional drought in the Anzali wetland region by utilization of two index: 1-Percent Normal Precipitation Index (PNPI). 2-Standard Precipitation Index (SPI).

First index can not be the best selection to distinguish drought circumstances, but the second index with moving mean control chart (5 years) can be used. Result of research showed that coastal area to be susceptible for drought, semi highland is normal and, the highland area is conditional in wet years. Some plans should be used for prevention the natural hazards so that this problem does not convert into natural disaster.

**Key words:** Anzali Wetland, Drought, Moving Mean Control Chart, Standard Precipitation Index

# Rainfall-effective runoff modeling

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**Abstract:** Effective rainfall is one of the process of the hydrologic cycle that has been studied very extensively. The various models proposed for description of this process are usually applicable to small plots, subjected to rainfall intensities that are higher than the infiltration capacity of the plots. In this paper, a model which was presented by Diskin and Nazimov (1991), was used for computing effective runoff. The model presented herein is not restricted to capacity infiltration only. It can be used for computing the variations in the infiltration capacity rate and the production of rainfall excess for any given rainfall hyetograph and a specified value of the initial moisture content of the upper soil layer. The model comprises two elements, a linear reservoir and a regulating element. The definition of the two elements require three parameters: minimum and maximum rate of infiltration capacity ( $f_c, f_o$ ) and the maximum value of moisture storage in upper soil layer. The reservoir element represent the soil moisture, in excess of field capacity, in the upper soil zone and the inlet regulating element is assumed to represent the soil surface. Computing the infiltration and rainfall excess requires the knowledge of the model parameters and the initial state of the storage state variable. and it is also necessary to adopt a computation time interval and to express the input in the form of hyetograph with the same time interval. In order to calculate the amount of rainfall excess, the model used in Kechic watershed, Golestan province in Iran. The hyetograph of the rainfall with the time interval of 10 minutes is available and the total depth of rainfall is 85.48 mm. The model parameters estimated from field survey data and the following set of model parameters were adopted for the calculation:  $f_o=210$  mm/h,  $f_c=3.3$  mm/h,  $s_m=30.5$  mm. Two sets of computations were done, for two assumed value of the initial soil moisture content. The results show that the depth of the rainfall excess during that rainfall was about 59.30 mm, when the initial moisture content of the upper soil layer is 10 mm and 49.83 mm, when it is 0.

# Theoretical Analyses of the In-Phase and Out-of-Phase Relations between Seasonal Precipitation and Water Vapor and Their Applications in Monsoon Onset and Retreat

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**Abstract:** Water vapor can be converted into precipitation (P) under certain dynamic and thermodynamic conditions. The relation between P and the total water vapor of the atmospheric column, i.e., precipitable water (W), especially at seasonal scale, is of a great concern to the hydroclimate community. It is found from observed data that over monsoon regions, P and W have an in-phase relation, both increasing from winter to summer. However, over some of the nonmonsoon regions (e.g., the northwestern coast of the U.S.), they have an out-of-phase relation. When W is the least of the year in winter, P is the largest, while when W is the largest in summer, little P forms. In this study, the formations of these in-phase and out-of-phase relations between seasonal P and W are understood through a theoretical analysis of the water vapor and temperature fields.

Our analysis shows that the seasonal change of W has a strong dependence on temperature. Due to the large annual range of temperature in mid-high latitudes, W always increases from winter to summer in both the monsoon and nonmonsoon regions. The seasonal P can be well represented by relative humidity, thus varies with water vapor and temperature. In monsoon regions, the change of water vapor is much greater than the change of temperature. So, the seasonal P mainly changes with water vapor, and hence has an in-phase relation with W. In those nonmonsoon regions, although water vapor increases from winter to summer, the increase in temperature is much greater. So, the seasonal P is mainly conversely affected by temperature, leading to a decrease of P from winter to summer. Therefore, the seasonal P and W have an out-of-phase relation.

In our previous study, a unified method is proposed by using W to determine the global monsoon onset and retreat dates. Since P is conventionally used to determine the monsoon onset and retreat, the above in-phase relation between seasonal P and W, and the in-phase relation between synoptic P and W as well, demonstrate that both the means and the interannual variations of the monsoon onset and retreat can be reflected from W.

# Effects of Astronomical Factors on Flood of Songhua River

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**Abstract:** From the periods of the solar activity, lunar and earth motion, the correlation between the astronomical factors and the flood of Songhua River are studied. The periodic forcing resulting from the motion of the moon can lead to remarkable climatic responses in certain regions on the earth. Results of correlation analysis between the series of the flood and syzygial periods show that the flow variability over the North China is highly related to the moon. Moreover, It is also found that the date of perihelion, aphelion and spring begins are approximately the same every year in solar calendar, but much different in lunar calendar. This change of the moon phases leaves room to research the inherent relation between them and the flood. The author has also turned the date of perihelion, aphelion and spring begins into one index, and built the long term prediction model for the flood of Songhua River. The method effectively and fully utilizes astronomical factors so it can predict the first great flood ahead long time and the precision is satisfying.

**Key words:** astronomical factors; flood; moon; prediction

# The Flow field calculation and analysis of *Acipenser Sinensis*' spawning sites in Gezhouba Dam downstream

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**Abstract:** The Chinese sturgeon (*Acipenser sinensis*) is one of China's unique and important fishery resources. Since the construction of Gezhouba Dam, the sturgeon's traditional migration route has been blocked reducing the length of natural spawning sites from 800 km in the past to less than 5 km at present. An endangered species, the Chinese sturgeon has become a first-rank protected animal from what was considered a general aquatic resource. In this article, we simulate and analyze the flow field of Chinese sturgeons' spawning states in the downstream of Gezhouba Dam, using N-S equations and  $k-\varepsilon$  turbulent flow numerical model in hydraulic dynamics. We also use the volume of fluid (VOF) method to simulate the water-air two-phase flow. Based on the ecological-hydraulic characteristics of the Chinese sturgeon, we analyze the features of the flow field at the fish's spawning sites in order to provide theoretical support and technical parameters for optimizing the management of the Three Gorges Reservoir.

**Keywords:** Chinese sturgeon, volume of fluid (VOF), natural spawning site, three-dimensional river channel

# **Preliminary Study on Hydrological Effect of Agriculture Activities in Hetao Region of Inner Mongolia**

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**Abstract:** With Hetao region of Inner Mongolia as study area, this paper analyzed the quantitatively influence of agriculture activities on hydrological factors and water resources including surface water, groundwater, soil water and total quantity of water resources based on hydrology cycle and the WEP-L distributed hydrological model to study the hydrological effects of agriculture activities. Moreover, the variation trend of hydrological effect of agricultural activities was discussed. Two simulated cases was described. The results show that the agricultural activities as an important part of artificial ecological system affect the vertical and horizontal course of watershed hydrological cycle, and influence the surface water, groundwater, soil water increase, total quantity of water resources and ecological water use.

**Key words:** agriculture, hydrological effects, WEP-L

# Comparison of Several Reference Evapotranspiration Methods for Itoshima Peninsula Area, Fukuoka, Japan

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**Abstract:** Six reference evapotranspiration (ET<sub>o</sub>) methods are compared, based on their daily and monthly performances under the given climatic condition in the western region of Fukuoka City, Japan, where a new campus of the Kyushu University is under construction. The Penman-Monteith equation standardized by the Food and Agriculture Organization (FAO) (FAO56-PM) is used to compare with Thornthwaite, Hargreaves, Hamon methods, the FAO56-PM method has also been used as an index for two equations for estimating ET<sub>o</sub>: the solar radiation (R<sub>s</sub>) based and net radiation (R<sub>n</sub>) based equations, which are the simplified versions of FAO56-PM. Performance analysis for the calculated values using meteorological data for 7 years (Jan 1996 – Dec 2002) was made. The standard error of estimates (SEE) was calculated on monthly basis. The annual ET<sub>o</sub> by these methods were higher in the solar radiation (R<sub>s</sub>)-based equation with values ranged from 957 mm yr<sup>-1</sup> in 1999 to 1042 mm yr<sup>-1</sup> in 2000. On the other hand, the net radiation (R<sub>n</sub>)-based equation gave 1084 mm yr<sup>-1</sup> in 1999 to - 1143 mm yr<sup>-1</sup> 2001. The estimated values by the Thornthwaite, Hargreaves, Hamon, and the R<sub>s</sub>-based and R<sub>n</sub>-based radiation methods were all correlated with FAO56-PM having correlation (r<sup>2</sup>) values calculated by Pearson's correlation of 0.80, 0.69, 0.48, 0.71 and 0.45 and their standard error estimates SEE were 0.25, 0.25, 0.25, 0.28 and 0.24 mm mon<sup>-1</sup>, respectively. Proximity in ET<sub>o</sub> estimates by the Hargreaves and the R<sub>s</sub>-based methods showed that the solar radiation as input variable was important as the FAO56-PM method. Also, the Thornthwaite method, which uses only temperature as input variable, has been found to have highly correlated with the FAO56-PM method. Thus, when considering the availability and reliability of the input data, the use of these methods are suggested as practical methods for estimating ET<sub>o</sub> if the standard FAO56-PM equation is not applicable due to the complexity of its input parameters.

**Keywords:** reference evapotranspiration by FAO56-PM, crop evapotranspiration, water budget estimation, crop coefficient, Automated Meteorological Data Acquisition System (AMeDAS).

# Characterization of Rainwater Harvesting from Rooftop in Urban Area, Xi'an, China

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**Abstract:** Nowadays, in many countries of the world, rainwater collected from small catchments such as roof tops has become a viable alternative source of water in regions where other sources have proved too difficult to obtain or where the quality has been very poor. Generally, rainwater collected from roof catchments has been regarded as a source of safe water for drinking purposes, but recent studies have shown that its quality is affected when the roof is contaminated by diffuse sources of pollution from the atmosphere and with the feces of birds and other creatures, as well as from deterioration of the roofing material itself.

In this paper the characteristics of rainwater runoff from rooftops on storm events, and the first flush effect in urban areas is studied. Four kinds of roofage in the city of Xi'an, China were selected for sampling and study with different characteristics during the period from October 2002 to November 2004. The quality parameters of rainwater and rooftop runoff such as pH, COD, N-NH<sub>4</sub><sup>+</sup>, Pb, SS, TH, Turbidity, EC were analyzed for the relationships between rooftop runoff and water quality.

The study indicated that pollutants of rooftop runoff have close relationships with the roofing material and the duration of dry weather between storm events, and concluded that the pollutants can be mostly removed by pre-sedimentation.

**Key Words:** urban rainwater, first flush, rooftop

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# Analysis of the hydrological response of Zhalong wetland to changes in climate and human activities

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**Abstract:** A wetland hydrology model is developed and used to investigate the response of a marsh wetland, Zhalong wetland to climate variability and water use practices in its upstream catchments. The hydrological model is used to investigate the response of the wetland area and wetland water storage to different climate and human activities scenarios in upstream basin. Wetland area–volume relationships were established from wetland DEM and Landsat TM images. Missing data in the time series are filled using statistical regression techniques. Based on mean monthly data, the wetland water balance model produced a good agreement ( $r^2=0.91$ ) between the simulated and observed wetland outflow for the period 1970–87 when the outflow data is available and wetland area for 9 specific dates derived from Landsat TM images. Using the proposed wetland hydrological model, a comparison of the simulation with and without human consumption is conducted and the result indicates that climate variability controls the interannual fluctuations and that the human water use affects the equilibrium of the system by strongly reducing wetland area in dry year such as 1968, 1979 and 1990. This study shows wetland area of Zhalong wetland is more sensitive to climate changes than human activities.

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# **Hydrometeorological and hydrological characterization of Zhalong wetland**

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**Abstract:** The objective of this work is to analyze at a regional scale the hydrometeorological and hydrological characteristics (precipitation, evapotranspiration, discharge, surface water area ) of the Zhalong wetland , a vast freshwater marsh wetland located in Northeast China. Since water is the main driving force in the inland wetlands and variations in surface water area impose conditions on the behavior of vegetation and animal populations, the knowledge of the main hydrometeorological variables that affect the hydrology is essential. Data correlation analysis makes it possible to evaluate the observed changes in the wetland and to infer its response to regional climatic change. As a first approach, the construction of a topo-bathymetric map provides a basic tool for developing a digital elevation model (DEM) using a geographic information system (GIS) and models that are based on a spatial scale. A water balance of Zhalong wetland is calculated for the period 1956-2003. The result of the paper will be useful to understand the hydrological characterization of Zhalong wetland and provide supports to wetland hydrological restoration.

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The research is a part work of key research project (50139020): Study on the use of floodwater resources and the management of wetland ecological environment on Songnen Plain, which is supported by National Natural Science Foundation of China and Songliao Water Resources Commission of the supports, are appreciated.

# Utilization and Protection of Stream Natural Functions

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**Abstract:** Stream natural resources and functions are critically important to human lives, regional socio-economic development, and maintenance of biodiversity. This paper analyzed stream natural functions and roles in detail, and identified the human demands for stream natural resources and functions. The results provide a window for human beings to best understand stream natural resources and functions. Since stream hydrological regime have been significantly altered by human activities with economic growth and population increase, stream natural functions have been greatly affected. Therefore, it is necessary to assess the impacts of human activities on stream natural functions. To do so, this paper evaluated the development and utilization patterns of stream water resources at different stages of watershed economic development, investigated the flooding, water resources and ecological problems induced by human activities. According to the current socio-economic development trend of stream watersheds, the future changing trend of stream natural functions and roles were projected. The necessity in the restoration and protection of stream natural functions were stressed and the corresponding measures were proposed.

**Key words:** stream systems; stream natural functions; restoration measures

# IMPACTS OF HUMAN ACTIVITIES ON HYDROLOGICAL REGIME OF THE YELLOW RIVER

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**Abstract:** The Yellow River is the second biggest river in China in term of its drainage area and length. However, its natural runoff is only  $5.8 \times 10^{10} \text{m}^3$ , accounting for 2% of China's total stream runoff. Belonging to arid and semi-arid regions with less but greatly varying precipitation, flowing through the biggest loess plateau in the world, and having a very fragile ecological environment, the Yellow River is suffering severely from deficient water resources, serious soil and water erosion, which has led to high sediment load, frequent basin-wide droughts and tremendous flood disasters in the lower reaches. With economic growth and population increase, the hydrological regime of the Yellow River, particularly the lower reach of the Yellow River, has been significantly alerted by human activities including runoff impoundment (dam construction), soil and water conservation, excessive water withdrawals from the Yellow River, etc. This paper selected the Yellow River as a case study site, on the basis of the past 50 years of flow and sediment data, examined the changing trends of the incoming runoff and sediment load of the Yellow River's lower reach, explored the driving forces of hydrological alteration, evaluated the impacts of human activities on the runoff, sediment load and sediment deposition of the Yellow River's lower reach, and statistically analyzed the drying-up durations in different decades. The results revealed that impacts of human activities on hydrological regime are becoming more significant as time goes by. This paper provides a step toward the assessment of the impacts of human activities on water cycle and substances transport of the Yellow River basin and their ecological effects.

**Key words:** The Yellow River; human activities; hydrological regime; runoff; sediment

# Rainfall and Droughts in Arid and Semi-Arid regions of Rajasthan, India

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**Abstract:** Drought can occur in virtually all rainfall regimes, but it is more damaging in low rainfall regions. India's lowest rainfall area is said to be the state of Rajasthan (342239 KM<sup>2</sup>) which lies in northwest part of the country. The cause of low rainfall is the existence of an inversion at about 1.5 km above sea level. This causes the suppression of large-scale ascent of moist monsoon currents to a point of saturation. The area of Rajasthan has broadly been divided into two climatic subdivisions, namely West Rajasthan and East Rajasthan. The climate of West Rajasthan is arid and that of East Rajasthan is semi-arid.

Rainfall from the southwest monsoon is the main source of water supply in these two areas. On the basis of rainfall data for 120 years (1871 – 1990), the average annual rainfall in West Rajasthan is about 294 mm with a standard deviation of 110 mm and in East Rajasthan is about 694 mm with a standard deviation of 174 mm. Per capita water availability from the surface and ground water resource in West Rajasthan and East Rajasthan is about 2994 m<sup>3</sup>/year and 1612 m<sup>3</sup>/year respectively. Because of inherent variable character of the Southwest monsoon, there are often occasions when the actual rainfall in a year over these two regions falls appreciably below their respective normal rainfalls. This causes acute shortage of water and consequently drought, which is manifested in terms of crop failure and unreplenishment of ground and surface waters. Such instances of low rainfall are of particular interest in the context of the arid and semi-arid zone hydrology for a better management of their water problems.

Droughts in the Indian region are mainly caused due to failure of monsoon rain. As such in this paper, the occurrence of droughts during the 120 years (1871-1990) in West Rajasthan and East Rajasthan has been evaluated on the basis of rainfall deficiency. Two categories of droughts are defined on the basis of India Meteorological Department (IMD) classification. A rainfall deficiency of 26-50% from the normal over an area is considered as a moderate drought and a deficiency in excess of 50% as a severe drought. Statistics summarizing the rainfall and droughts are presented in a tabular form.

Parameter	West Rajasthan	East Rajasthan	Parameter	West Rajasthan	East Rajasthan
Land Area (km <sup>2</sup> )	195091	147148	Surface & ground water (MCM)	34414	61272
Climate	Arid	Semi-Arid	Per Capita Water (m <sup>3</sup> /yr)	2994	1612
Population (million)	15	38	Lowest Annual Rainfall (mm)	37	276
Population Density	78	258	Highest Annual Rainfall (mm)	723	1328
Average rainfall (mm)	294	694	Moderate Droughts	22	14
SD (mm)	110	174	Severe Droughts	8	3

Table shows that compared to East Rajasthan, the areal rainfall of West Rajasthan is highly variable. The annual rainfall totals vary from 37 to 723 mm in West Rajasthan and from 276-1328 mm in East Rajasthan. The ratio between the lowest and highest rainfall is 1:20 in the arid region of West Rajasthan and 1:5 in the Semi-Arid region of East Rajasthan. In the past 120 years, West Rajasthan and East Rajasthan experienced 30 and 14 droughts respectively giving an annual probability of 25% and of 14% respectively.

There is an impression that low rainfall years over India generally coincide with the El-Nino – Southern Oscillation (ENSO) phenomena. Investigation will be made to find whether or not an ENSO phenomena exercises any significant influence on the amount of rain occurring in the arid and semi-arid regions of Rajasthan.

# **Regional Analysis of Mean Annual Flood in Nangro Aceh Darusalam (NAD) Province, Indonesia**

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**Abstract:** The annual maximum flood series with a short period of record gives difficulties in analysis to estimate design flood with high return period. To solve this problem, L-moment regional analysis was applied in NAD province. This method is employed at three steps, namely: at site frequency analysis, identification of homogeneous region and developing regional relationship of flood parameters. This analysis was done by generating 500 series data using Gamma random and simulated them to get 100 artificial regions. In this study, annual maximum flood series data from 24 locations of water level recorders were used. The result showed that homogeneous region based on specific discharge was selected from other parameters, the Pearson Type III distribution was chosen and the index floods performed by the average annual maximum flood and L-Kurtosis. This result can be used to estimate design flood in the location that only has a short record of flood series data.

**Key words:** index flood, specific discharge, homogeneous region.

# DROUGHT ANALYSIS AND FORECASTING FOR AGRICULTURAL WATER MANAGEMENT IN AWASH RIVER BASIN, ETHIOPIA

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**Abstract:** Drought is one of the recurring natural hazards in Ethiopia. Understanding the characteristics of drought is crucial to establishing an effective and comprehensive monitoring and early warning system for an effective drought management plan. The objective of this study is to describe and forecast droughts in the Awash River Basin, Ethiopia, based on meteorological and hydrological variables on the basis of which appropriate agricultural water management strategies are proposed for a large irrigation estate in the basin.

Droughts in the basin are described using two methods: Standardized Precipitation Index (SPI), a measure of meteorological drought, and the theory of runs, a measure of hydrological droughts. The SPI method is used to generate monthly spatial patterns of various categories of drought on a basin level at different temporal scales (3, 6, and 12 month). The study reveals that Middle and Lower Awash Basins are the most vulnerable areas to drought conditions. Similarly, the feasibility of rainfed agriculture in the basin for some selected crops is assessed based on the available meteorological data with the aid of ArcView/GIS. It is found that growing cotton crop in the basin should be considered only under irrigated condition for optimum yield. The second method of drought characterization, the theory of runs, is used to monitor and measure drought events in terms of streamflow in the Awash River system. Based on their intensity, it is found that the severest drought events occurred at Melka Sedi stream gauging station during the periods May/1988 to June/1988 and April/1998 to May/1998.

A non-linear streamflow forecasting model is developed using Artificial Neural Network (ANN) modeling technique for the Melka Sedi stream gauging station with adequate lead times. This gauging station is located above a weir that diverts water to a large estate irrigation scheme, Middle Awash Agricultural Development Enterprise (MAADE), for which water management strategies are proposed. On the basis of the model-forecasted streamflow time series and irrigation water and minimum flow requirements, the study proposed appropriate agricultural water management strategies for the irrigation scheme. These proposed strategies are evaluated based on different scenarios of abstraction demand which are formulated based on a range of possibilities of developing agricultural fields in the MAADE. An appropriate scenario of agricultural development is decided on the basis of the residual flows in the river vis-à-vis the trigger/threshold value established for Melka Sedi stream gauging station. It is found that for a reliable supply of water to the scheme throughout the growing season, a 1-24% reduction (depending on the scenarios considered) in the cultivated area of the scheme is necessary.

# Effects of the Operation of Chao Phraya Dam upon the Upstream Flood Hydraulics

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**Abstract:** In the past, one measure of flood mitigation in the Lower Chao Phraya river basin was the operation of Chao Phraya dam in controlling the release of discharge to downstream which caused the level of water upstream higher. Then the Chao Phraya dam diverted the discharge to irrigation canals. This measure was the cause of flood inundation in Chao Phraya Yai irrigation project as well as in the area of Chai-nat, Uthai-thani, and Nakhonsawan in comparison to the great flood in the Year 1995, equivalent to the flood 25 years returned period. The purposes of this research were to study the effects of the operation of Chao Phraya dam upon the upstream flood hydraulics in the Year 1995 and to study the harmony of the operation of Chao Phraya dam and the operation of discharge water from upstream reservoirs to handle with the flood situation in Upper Chao Phraya river basin by using mathematic models in hydrology and hydraulics, simulation techniques for flood inundation areas and gate operation and parameters optimization. Study results mentioned that the operation of Chao Phraya dam was deviated from the operation plan and was caused greater upstream flood inundation. In addition, the upstream flood inundation was increased due to the operation of Chao Phraya dam significantly compared with the situation without the Chao Phraya dam project. The flood effects not only the area of Muang district, Nakhon Sawan province, but also inside Sakaekrang river up to Muang district, Uthai-thani province. Moreover the operation of Chao Phraya dam was not related to discharge releasing of upstream reservoirs that increased the flood inundation in Upper Chao Phraya river basin. The effective approaches of flood mitigation for Upper Chao Phraya river basin, that will not effect flood inundation in Lower Chao Phraya river basin, is to adjust the plan of releasing discharge from upstream reservoirs, Chao Phraya dam and irrigation canals, improvement of river course and increasing of water retarding area in Upper Chao Phraya river basin.

**KEYWORDS:** Flood Risk Map, Hydrologic Routing, Hydraulics Routing, Back Water Effects, Gate Operation Rules

# **Study on the Impact of Urbanization to the Flood Prevention & Storm Drainage of Tianjin**

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**Abstract:** Tianjin is a big city lies in plain river net area, and Haihe River runs across the city. In recent years, with the process of urbanization, the city develops rapidly which results in serious flood and drainage problems. In this paper, the impact of urbanization on hydrological properties, the features and forming mechanism of flood disaster in Tianjin is analyzed. The Basin of Haihe River in Tianjin is divided into suburb and urban drainage areas according to different runoff and confluence characteristics of different underlying surface, and suitable model to simulate runoff process of suburb and urban drainage area is established respectively according to corresponding hydrologic property. By coupling urban storm-runoff model, the model of runoff and confluence of suburb and the hydrodynamics model of Haihe River net, an integrated hydraulic model of Haihe River basin is established. On this basis, calculation of design water level of river network under different conditions of water inflow and regulations is made, and the results can be used as the scientific guidance for the plan of flood prevention and storm drainage in Tianjin. The methods suggested in this paper are also applicable to other cities having similar hydrological problems in plain river net area.

**Key Words:** flood prevention; urbanization; runoff and confluence; integrated hydraulic model

# THE FLOOD CHARACTERISTIC OF HANJIANG RIVER AND ENSURING COUNTERMEASURES

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**Abstract:** Hanjiang River is the largest branch of Changjiang River, and its runoff is supplied mainly by precipitation, so the volume of water is quite abundant, and the flood occurs quite easily. Danjiangkou hydro-junction, which is the vital hydraulic engineering of flood control in Hanjiang River, has been completed and run for 37 years. What influence does the hydro-junction exert to the runoff and the flood in the middle reaches of Hanjiang River? What about its rule? Does the threatening flood still exist in the middle and lower reaches of Hanjiang River? If it exists, what countermeasures should we take to ensure the engineering measures and control measures which are paid equal attention to, and promote the flood of Hanjiang River to getting along with human harmoniously, make it become the available resources by humanity, and then the economic society and ecological environment will develop with sustainable coordination? This is the special issue people concern about. So we have made a study of these matters, and obtain some answers for reference.

**Conclusions:** The runoff of Hanjiang River is mainly produced in the upper reaches. The common flood in the upper reaches is regulated by the hydro-junction, specially the adjustment and the control of the Danjiangkou reservoir, which is not pose the large threat to the middle and lower reaches of Hanjiang River. Although the Danjiangkou reservoir has the certain flood prevention function to the middle and lower reaches of Hanjiang River, and after dam of the second phased projects in Danjiangkou reservoir is raised, which will reduce the flood prevention pressure greatly, as for nearly 50,000 km<sup>2</sup> catchment area without yearly adjustment hydraulic engineering in the middle and lower reaches sector, it still possibly produces the Flood, in addition, it is operated in the low water section for a long time in the river course of the middle and lower reaches in Hanjiang River, which caused the ability of releasing flows reduced, the same class magnitude flood water level is raised, the embankment pressure in middle and lower reaches of Hanjiang River will be able to increase. Therefore, besides catastrophic flood in the upper reaches, which constitutes a true threat to the middle and lower reaches of Hanjiang River and Wuhan city is mainly produced in the middle reaches, especially the rare flood in the middle reaches, must be given highly attention to. Resist the rare flood, besides the hydraulic engineering construction, the ecological environment construction and the information network construction, we must strengthen the leadership and the management, correctly dispatch the

existing hydraulic engineering (including the flood diversion, flood basin project) to cause its full display function. Only strengthens the construction of infrastructural facilities, the ecological environment construction, carries on the management legally, dispatch in scientific and comprehensive, and utilize the existing hydraulic engineering, enables it to play the most major role, achieves the flood-control works union utilization to each levels of reservoirs and the flood diversion area and flood basin of downriver Dujiatai and so on, pays equal attention to defends and emergency protects, achieves controlling the flood, eliminate or the reduced flooding disaster, gets along with the flood of Hanjiang River harmoniously, economic society and ecological environment expand coordinately.

# **The analysis of regime of water resources in the source region of Yellow River**

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**Abstract:** Because of the influence of the varied weather and human activities, the runoff-producing factors in the source region of Yellow River have varied seriously such as rainfall、infiltration、underlying surface etc. The water resources condition and the mode of water circulation are different from the past. The varied regime of water resources and it's development situation in the source region of Yellow River affect the water safety very biggest, and relate to directly the accuracy about the management and development and the decision of Yellow River. Aiming at the flow went down sharply and ecosystem environment became worse seriously in the current source region of Yellow River, the research about varied regime of water resources has seemed to be urgent. Through the variety of precipitation、air temperature 、flow and human activities analyze the variety trend of water resources in the source region of Yellow River, finding out the reason about the flow went down sharply, providing the science reference for the program and decision in the source region of Yellow River.

**Key words:** water resources, variety, analysis of regime, source region of river, Yellow River

# Hydrological Risk Assessment for the Existing Earth Dam

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**Abstract:** Overflow-based risk is one of the leading risks on the existing earth dam. After operating for some years, it is indispensable to evaluate its hydrological risk. The currently adopted rainfall-based design flood estimation techniques, for example the Design Event Approach, do not explain the probabilistic nature of the key variables, along with the limitation of this method itself and the storage of its observed data. That results in the error of its design values. Therefore it is improvement in applying the principle of maximum entropy to develop a minimally prejudiced conditional probability distribution model to estimate runoff on weekly or monthly basis for the catchment of the Zhelin dam in Jiangxi. For estimation of the hydrological risk it follows three steps: The first step adopts Monte Carlo Technique for singling out flood seasonality. The second step uses maximum entropy-based conditional probability model to establish flood function. The third step takes advantage of a Bayesian setting to estimate the hydrological risk.

# METHOD TO REAL-TIME CORRECT IN TIDAL LEVEL FORECASTING OF AN ESTUARY

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**Abstract:** The sea tidal level under normal weather situation would be forecasted by tidal forecasting model when the tidal harmonic constant have been analyzed according to the historical data of tidal level, and the accuracy of forecasting is usually satisfying. At present, the method is also used to forecast the tidal level of an estuary. But the level of an estuary is affected by both tidal power from the sea and the freshwater inflow from its upstream, because the total volume and temporal distribution of the upstream inflow vary from year to year, the tidal harmonic constant determined according to the historical data of tidal level only reflected the historical inflow from its upstream, when the tidal forecasting model is used to forecast future process of tidal level, it is necessary to correct the forecasted tidal level according to the real-time inflow from its upstream, this is very important to improve the accuracy of forecasting. Taking Tianshenggang, Xuliujing and Yanglin stations of the lower reach of the Yangtze River as examples, the paper proposed a method to correct the tidal level calculated by tidal forecasting model according to the corresponding increment of upstream discharge. The correlation equations between daily mean forecast error of tidal level and increment of upstream discharge were derived respectively based on the historical sample data. As a verification, these equations were used to correct the past several years of tidal levels calculated by tidal forecasting model according to the corresponding inflow, After an error limit of  $\pm 20$ cm being set, the frequencies of the error of predicted tidal levels less then the error limit increased to 92.1% from 77.3% for the Tianshenggang station, 88.7% from 76.3% for the Xuliujing station, 89.2% from 83.8% for the Yanglin station, the forecast accuracy was improved significantly. The research results of the paper have been applied in the hydrological forecasting system serving the construction period of the Suzhou-Nantong Yangtze River Bridge, which is only 2km away from the Xuliujing station, and will provide reference for other similar estuaries.

**Keywords:** tidal level forecasting, real-time correction, correlation analysis, accuracy of forecasting

# The multiple factor riverway current progress research of numerical circulation

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**Abstract:** In the area of lacking water resource, the riverway current progress numerical circulation has an important effect on the project designing of the upriver water source supplying water and the downriver area using water. There are many factors affecting the numerical circulation of the riverway current progress in the water lacking area. These factors include the progress of current in the discontinuous flow riverway, the appearance of discontinuous flow alternate interval aroused by changing flow, the changing of flow aroused by the downriver area using water ,the riverway seepage and so on. In this article, the intelligent methods is adopted to distinguish the discontinuous flow riverway, the more accurate roughness choosing model is adopted for the shallow water depth district. And the methods can avoid none stabilization and distortion which arise frequently in the similar problems circulation in the past. And it is also considered that the flow output corresponds to the various depth of the downriver places using water. In addition, according to different geological information, by the early stage of seepage and the stable stage of seepage, it is adequately considered the water loss aroused by the seepage. So , this method supplied by this article could have more reliability and accuracy .

# Distribution of the Resistance to the Yellow River Bed

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**Abstract:** The resistance distribution to the Yellow River is analyzed based on the observation data and flume experiment data. The results can be referred to hydraulic calculation.

**Key words:** Flow with high concentration of suspended load, Resistance to river bed, Roughness, Reynolds Number, Yellow River

**Preface:** Base on observation data, the maximum proportion of annual bed load to annual suspended load is 1.31% in heishi station of Yiluo River in 1963. So the suspended load is the main of the Yellow River, the concentration is normally ranged from 0~20kg/m<sup>3</sup>. In the upstream of the Yellow River, the maximum is 329 kg/m<sup>3</sup> (Lan Zhou, 1959). In middle stream, the concentration is high, and normally about 600kg/m<sup>3</sup> for flood. It can reach 1000~1500kg/m<sup>3</sup> for some branches in subbasin between shanxi and shanxi, for example, the observer data was 1700kg/m<sup>3</sup> in Wen Jiachuan station, Kuye River on Jul.10, 1958 (Based on expert analysis, it is corrected to 1600kg/m<sup>3</sup>). The concentration is under 546kg/m<sup>3</sup> in down stream. The range for high concentration definition is being argued now, and the range from 200~400kg/m<sup>3</sup> used in this paper can be verified. The flow for Natural River is normally in turbulent zone. The flow for test case is normally in larger, or transition zone (the test data used in this paper includes data from turbulent zone). It is helpful with the understanding to the resistance characteristics of river bed for combination use data from natural river and flume experiment.

# Research on GRID-based Dynamic Water Balance Model of Jin River Basin

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**Abstract:** Research on water balance is the basis on water resources assessment, planning and management. Most of the former water balance model is basis on the river basin or sub-basin. In this paper, GRID-based dynamic water balance model was developed using the GIS tools in order to model the process of water balance in the GRID unit. The space scale of the model is  $1\text{km}\times 1\text{km}$  GRID, and the time scale is month. The model was calibrated by the runoff data on-the-spot survey month by month from 1995 to 1997. The model calibration result revealed that trend of the simulation runoff line was inosculated with the observation runoff line, its medium absolute error is  $6.72\text{ m}^3/\text{s}$ , and the correlation coefficient is 0.932. At the end, the model was used in simulation of the progress of hydrological cycle on Jin river basin, and obtained the precipitation, evaporation, soil water and groundwater of every grids month by month. The simulation results revealed that the runoff of Jin river basin is focused on the south and middle of the river basin, the runoff on the north of the river basin is lower oppositely. This distribution is related with the precipitation distribution. The soil water and groundwater has the similar distribution with the runoff. This represents that the soil water and groundwater distribution has some correlation. All of this represent that the model fitted the observed data quite well, and could satisfy the needs of the water resources assessment, planning and management in the main.

**Keywords:** Dynamic water balance; GIS; Jin river basin; GRID

# Natural Renewability Assessment of Water Resources of Jin River Basin based on GRID Hydrological Cell

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**Abstract:** First of all, start with the basic concept of the natural renewability of water resources, a concept of renew rate of water resources based on the GRID hydrological cell was proposed in order to represent the natural renewability of water resources of the GRID hydrological cell. On the basis of this, a completely new method of natural water renewability assessment was developed. In the next place, on the basis of dynamic water balance simulation of Jin river basin based on the GRID, the natural water renewability of the river basin in 1996 was assessed by calculating the renew rate of water resources of the river basin grid by grid in 1996. The assessment results indicate there are quasi cycle motion law of natural water resources renewability of Jin river basin in the time scale in years. The natural renew rate of water resources of Jin river basin is between -1.5 and 1.5, and the lowest in the April and the largest in the June. The entire trend is influenced by precipitation very much, and there is obvious different between the high water period and low water period. At same time, there is a obvious law of distribution of natural water renewability of Jin river basin in space. It represent concretely that natural water resources renewability is highest in the middle and the west of the Jin river basin, and the lowest in the north. This kind of space distribution of natural water resources renewability is depended on the space distribution law of the precipitation, evaporation and underlying surface of Jin river basin, such as soil and vegetation in the river basin.

**Keywords:** Water resources renewability; GRID; Jin river basin; Renew rate of water resources

# Discussion on method of analyzing hydrological spatial difference

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**Abstract:** By referring to the difference theory and geo-statistics theory, this article bring out a way which can describe the spatial difference of hydrology series quantitatively. This method is used to analyze vary years' precipitation difference in Chaobai valley, the results show that this method is just a good choice when studying into multi-dimension difference of hydrological series.

**Key words:** Theory of difference information; Theory of geo-statistics; Geographical information system, Chaobai Valley

# Semi-Active Control for Flow-induced Vibration of Hydraulic Arch Sluice

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**Abstract:** Hydraulic arch sluice is one of popular types of gates applied in hydraulic projects. One of the key problems in designing arch sluice is how to diminish flow-induced vibration, especially for submerged outlet arch sluice. In the case of small opening and submerged discharge, if rubber seal system of arch sluice damaged (the usual type of damage for arch sluice), the interaction between water and sluice may cause intensive structural vibration so as to result in arch sluice damage at last. Improving hydraulic boundary condition and optimizing arch sluice structure are very important measures to reduce the vibration, but these measures which can only be taken before construction are not enough for reduction of the vibration. Employing structure control method is a further way to solve the problem. This method is significant for vibration mitigation of already existing arch sluice. In this paper, an arch sluice of a diversion bottom outlet in certain large hydro junction is taken into account. Based on simplified structural model and simulated time-history fluctuant pressure, “on-off energy dissipation” semi-active control strategy is applied to reduce the vibration of the arch sluice installed with MR dampers. The simulated result shows that MR dampers installed on the arch sluice can diminish flow-induced vibration of the sluice effectively and MR damper is a simple, convenient and effective intelligent control device.

**Key words:** Semi-active control, MR damper, Arch sluice.

# **Analysis of influence factors on normal water circulation in the basin**

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**Abstract:** In many districts where human activities are very intensive, the influence of human activities to water circulation even exceeds the one of natural process. To solve the problems of the water resources shortage and water environment degradation existing in many basins of China at present, this paper discussed the meanings of normal hydrological cycle in basin. Normal Water circulation is the foundation of water resources' sustainable utilization of basin. At first, this paper analyzed the nature-artificial dual complex characters of water circulation. Then taking Taizi River basin as a case study, the paper built the primary water circulation model of Taizi River basin. After calculating hydrological data of long records, the paper finally gives the trend of future water circulation of Taizi River. The key factors affecting the normal hydrological cycle of Taizi River are industrial water supply, agricultural water supply and domestic water supply.

**Key Words:** normal hydrological cycle, Taizi River basin

# The Effects of ENSO Events on the Summer Precipitation in Song Hua River Basin

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**Abstract:** It is well known that ENSO event is a sea surface temperature anomaly phenomenon of the big yardstick and it is mainly due to the interaction of the big yardstick of ocean meteorology. ENSO event doesn't only influence the weather climate of the tropical area, but also influence the atmospheric circulation of the high latitude area obviously at the same time, and lead to the anomaly of short-term climate.

Since the 1990s, ENSO events have taken place in succession and their influences are more noticeable. The strongest ENSO event during the 20<sup>th</sup> century happened in 1997-1998, which had a serious influence on the weather climate in the whole world and even may attribute to the inundation in China in 1998. So it is feasible to predict change of the long-term climate in our country based on ENSO information.

Song Hua River is one of the seven major rivers of China. There are 86 rivers which area of the whole basin is larger than 1000 km<sup>2</sup> and 16 rivers' larger than 10000 km<sup>2</sup>. The annual mean precipitation is 525 mm in the Song Hua River basin and 681 mm in Second Song Hua River basin, which is relatively larger. Precipitation is concentrated in summer (June - August) and accounts for 80% of the precipitation in the whole year. In this situation, preventing flood is important in flood season.

The paper looks for the reasons that influence the precipitation from the sea surface temperature (SST) anomaly phenomenon. The relations between the ENSO events and the summer precipitation in Song Hua River basin are studied based on the north Pacific sea surface temperature monthly mean data, the summer precipitation in Song Hua River basin and the ENSO events researched by Wang Shaowu from the period 1951 to 2000.

The results are summarized as follows: (1) The relations between the summer precipitation in Song Hua River basin and the north Pacific SST anomaly in preceding seasons are very close, and is rather significant after the year of ENSO events. The correlation coefficients of the modes also far exceed 95% significance level. (2) El Nino is characterized by unusually warm ocean temperatures in the Equatorial Pacific, compared to La Nina, which is characterized by unusually cold ocean temperatures in the Equatorial Pacific. Song Hua River basin tends to be more (or less) precipitation than its normal in summer in El Nino (or La Nina). (3) There isn't a simple one-to-one correspondence of the summer precipitation in Song Hua River basin and ENSO event. Thus the summer precipitation in Song Hua River basin in each month is of obvious difference.

The paper reaches a conclusion that the method taking the SST distribution of north Pacific especially ENSO event as the precursor signal to predict the summer precipitation tendency in Song Hua River basin has the good reliability and definite indicative significance to a certain extent.

**Key words:** ENSO; precipitation; correlation; interdecadal variations; Song Hua River basin

# Emergy assessment of water resources value of China's main rivers

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**Abstract:** Water is one of the most precious resources. The value of water resources occupies an important place in water resources management and sustainable utilization. In this paper, the emergy analysis is introduced into the assessment of water resources value. Emergy analysis is a methodology of quantitative analysis based on thermodynamics which determines the values of natural resources, services and commodities in common units of the solar emergy. Based on ecological economics theory, the emergy value concept of natural resources was discussed. According to the rules of water cycle and emergy concept, the connotation and extent of water resources value was analyzed. Different aspects of emergy value of water were compared and summarized. Taking China's main rivers as a case study, the value of water resources was investigated using the chemical potential energy of water. Several indices of the different rivers from the emergy assessment were figured out. Several indices of average total rivers are close to those of the average global river water. The main data of average total rivers of China are the emergy transformity ( $4.17 \times 10^4 \text{ sej/J}$ ), the emergy per volume ( $2.05 \times 10^{11} \text{ sej/m}^3$ ) and the emdollar per volume ( $0.068 \text{ \$/m}^3$ ). The value of water resources of Haihe-Luanhe River ( $11.39 \times 10^4 \text{ sej/J}$ ) is highest, followed by Yellow River ( $10.27 \times 10^4 \text{ sej/J}$ ), the lowest is the Rivers in Southwestern China ( $2.92 \times 10^4 \text{ sej/J}$ ). The results show that using the traditional methods (e.g. market price) to appraise water resources value possibly underestimates its real value and that emergy analysis is a scientific, equitable and effective method. However, the application of emergy analysis method in the research field of water resources value remained to be further studied.

**Key words:** emergy; assessment; water resources; value; rivers

# The Flow Characteristic of Culvert and Sluice And its Influence on the Oncomelania Diffusion

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**Abstract:** Schistosomiasis is the harmful verminoses along the Yangtze River<sup>[1]</sup>. Oncomelania is middle-parasitized of Schistosomes. So controlling oncomelania diffusion is the most important and effective way to prevent the spread of schistosomiasis. Irrigation canal, culvert and sluice between agricultural fields are important water conservancy facilities of agricultural irrigation; They are also main channels which oncomelania can diffuse through. The article mainly introduces the measurement of the velocity distribution by ADV, standard k-epsilon and hybrid finite analytic method (HFAM) numerical modeling. Lastly demonstrating the cause why the purpose of holding oncomelania back cannot be achieved only by culvert and sluice, and on the contrary, a little part of oncomelania may breed and diffusion locally by two ways of experiment and numerical stimulating.

**Keywords:** Oncomelania Culvert and Sluice ADV HFAM Flow field

# Study on the Mutation Regularity of the Main Crop's Sensitive Index $\lambda_i$ in Semi-arid Region

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**Abstract:** The function model of the main crop's stage water consumption and yield is the theory base when we carry out the water-saving irrigation decision and irrigation management. The irrigation experimentation data of the main crop in the Yudong plain, was applied to analyze and study the yearly mutation regularity of the sensitive index  $\lambda_i$  in the main crop's model Jensen, aiming at the situation of the few growth stages and disunion of the main crop, the forecasting model of the sensitive index  $\lambda_i$  of main crop in different hydrologic year was analyzed and studied ,the accumulative function of the sensitive index is established, and the transform and calculation problem of the sensitive index in different stage is solved, the result makes the applying of water-saving irrigation in semi-arid region have more practical sense.

# Numerical Simulation of High-concentration Solid-liquid Turbulent Flow in a Centrifugal Pump

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**Abstract:** Slurry pumps are widely applied to irrigation, dredging, mining and hydropower engineering, transferring liquids together with solid materials such as ash, sand, rocks and gravel. Among these slurry pumps, centrifugal type pump is the most predominant. In China, for instance, centrifugal pumps are near 80% of the slurry pumps in use. With the increase of industrial demand, centrifugal slurry pumps are required aiming at high efficiency, high solid concentration ( $C_w > 60\%$ ), long-distance transferring and long life maintenance. These targets demand more sophisticated analysis and concepts on the solid-liquid two-phase flow mechanism of the centrifugal slurry pumps. However, so far the corresponding works are limited either on the performance of slurry pump or the flow analysis of dilute solid-phase in the pumps ( $C_w < 5\%$ ). In this study, by using FLUENT code, author numerically simulates the three-dimensional high solid-concentration ( $C_w = 40\%$ ) solid-liquid turbulent flow through a centrifugal pump, in order to understand the nature of high concentration solid-liquid flow in pump and finally improve the performance of slurry pump.

Compared with the single-phase flow in the impeller, it is found in the study the main stream of solid-liquid mixture tends to pass by the impeller shroud and the pressure sides of impeller blades. The solid-phase velocity is higher than that of liquid-phase in the rotating impeller due to the stronger centrifugal force. In the volute, however, the solid particles move more slowly than those of the liquid-phase owing to their heavier drag. Furthermore, the solid particles cumulate near the suction sides of blades and hub of the impeller, resulting in higher solid-concentration distributions and potentially more serious abrasion in the zones. The predicted pump performance in the current simulation is verified by measurement data from pump supplier.

# Study on Zhalong wetland distribution and its hydrographical genesis

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**Abstract:** Zhalong Wetland is located at the downriver of Wuyuer River in Songhua River-Nenjiang River Plain in western Heilongjiang Province, China, between 123°47'~124°37'E and 46°52'~47°32'N, the total area is 2100 km<sup>2</sup>, the local topography is dominated by low-lying and flat marshland, the mean sea level is 144.0 m, the trend of the region is the northeast- southwest, and the gradient ratio is 9/1000. The wetland is a typical riparian wetland, reeds and marshland distribute widely. The wetland ecosystem is an ecosystem with diversified environmental functions and extremely affluent biodiversity because of the unique geographical coordinate and the typical ecosystem. The wetland is the largest state wetland nature reserve for rare species of birds composed mainly of such big waterfowl as crane. The state-level nature reserve is assented in 1987, and is listed in the directory of international important wetlands in 1992.

Nevertheless, during the latest two decades, significant degradation has occurred in the wetland, mainly due to the notable change of eco-hydrological regime resulted in regional climate change and human irrational activities, which has critically threatened the habitat of some precious wildlives, for example, the red-crowned crane. Moreover, during to the lack of water resources, the larger two fires caught at August 2002 and March 2005, respectively, the ecological environment has been seriously destroyed. Therefore, the subjects of wetland management, restoration and creation are more focused on than before, there is therefore significant potential to study the wetland distribution, hydrographic genetic analysis and the mechanism of wetland evolutionary and ecological processes with the hydrography for study on reasonably manage, restore and create the wetland by optimal manage schema and concordant relationship between human and nature.

In this paper, based on the perennial local observation and check tests data, the wetland distribution, type characteristics and spatiotemporal dynamics are described in spatiotemporal scale, the wetland hydrographic genesis, occurrence and evolution are analyzed with geology, geomorphology, climate, seasonally frozen soil, and so on. On the bases of that, the varying rule, evolution trend and expulsion mechanism of the wetland and environmental elements, as well as, the mechanism and environmental effects of wetland evolutionary and ecological processes with the hydrography are disclosed. The results point out that the wetland hydrographic genesis is mainly including: (a) monsoon climate resulting in centered precipitation during Jun ~Sep and considerable surface water compiling and detaining in the wetland, (b) low and flat landform causing only one flood outlet and slow drainage, as well as the river swing and rechannel, (c) seasonally frozen soil

and lam reducing infiltration water and forming frozen backwater, and (d) perennial tectonic sinking forming stable gathering ground and the continuous transition of rivers or lakes resulted in sinking center transmigration creating some bottomlands.

**Key words** wetland; hydrographic genesis; monsoon climate; geological structure; seasonally frozen soil

<sup>1</sup>Supported by Project 50139020 of the National Natural Science Foundation of China (Study on the use of floodwater resources and the management of wetland ecological environment on Songnen Plain)

# The freeze- thawing rule of seasonal frozen soil and its hydrological function in Zhalong Wetland

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**Abstract:** Zhalong wetland lies in the west of Songnei plain in China, the geographic coordinate is as follows: 123°47'~124°37'of the east longitude and 46°52'~47°32'of the northern latitudes, which is a typical riparian wetland with the total area of 21×104 hm<sup>2</sup>. In this area, the seasonal frozen soil distributes extensively, which changing the physical appearance of soil moisture delivers, resulting in the instability of runoff generation and accordant junction which making it difficult to simulate the runoff.

This paper, analyzes the freezing and thawing processes on the bases of location observation of the air temperature, soil temperature, and so on, from the first automatic monitoring station of our country constructed on the wetland for the weather- ecosystem- hydrology system observation. Meanwhile, the authors open out the freezing and thawing rule and the influence of the processes on soil moisture delivers and runoff of the catchments, as well as, the influence of the backwater of soil freezing on the wetland ecosystem.

The results show that the soil begins to freeze around October 20, and finishes melting around June 20 of the next year; that altitude, slope side, vegetation, condition of the land and temperature are the factors influencing the depth and the time of the soil frozen; that the frozen stagnant water generally increases the amount of water by 8-25%, the maximum water content is about 40%, which is indispensable, even is unique resources of water for the live through the winter and multiplying in springtime of the natural and artificial plants, and is the predominant factor that keeps the ecosystem balance; as well as, that the relationship between frozen soil depth and catchment's runoff is inverse ratio.

This research may also be useful to have insights on other processes closely related to soil moisture dynamics, such as soil-atmosphere interaction, plant water uptake, and eco-hydrology.

**Key words:** Zhalong Wetland; freezing - thawing rule; hydrological function; seasonal frozen soil

<sup>1</sup>Supported by Project 50139020 of the National Natural Science Foundation of China (Study on the use of floodwater resources and the management of wetland ecological environment on Songnen Plain)

# Dynamic study of algae in source water based on wavelet

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**Abstract:** With the rising of a large quantitative water quality and health matters caused by the algae in raw water, the measurements of algae in source water was heightened by water unities, so lots of data about algae in raw water could be collected for many years. The time series data which are daily chlorophyll measurement on raw water of Tianjin was transformed by use of wavelet techniques. Then the original time series would be decomposed as 5 low- and lower-frequency period components and 3 high-frequency 'noise' components. Based on the analysis, these messages from the 5 period compounds were mostly caused by seasons, predominant algae kinds switch, and algae growth dynamic equilibrium under given conditions, and so on; however high-frequency detail message might come from rain, wind direction and the depth of sample raw water, also from the measurement error. At last, the meaning of these components and conclusions of wavelet techniques were validated by collecting and analyzing the data of air temperature, radiant intensity and rain in the source water basin during the same periods.

**Keywords:** wavelet; source water; algae; dynamic change; weather

**Note:** The research work, as a main part of the National High-tech Programming of China (863 Project, No. 2002AA601140)

# Analysis on water-sediment evolvement in river basin hydrological cycle in multi-time scales

——A case study in QingJian river basin

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**Abstract:** In Yellow River of China, mass sediment originates from the middle reach region of the river. This area is in a typical aridity and semi-aridity climate, with a total 500mm rainfall or so around the year, and the rainstorms share the features of short duration, high intensity and un-uniform distribution. The change of water and sediment factors practically measured in basin in year scale is overlapped by the affects of climate fluctuating and human evolutionary activities. In natural conditions, water resource exists in a balanced system of rainfall, runoff, evapotranspiration and infiltration. However, human activities will change the underlying surface conditions of the basin, conducting the hydrological cycle process adjust to a new environment, which can be called a comprehension of natural water resource cycle and the artificial water cycle. Admittedly, in any basin, rainfall-runoff characteristic are in a close relation with the precipitation course. The surface runoff will change the period of infiltration, thus make the subsurface and underground flow fluctuating greatly, and finally affect the hydrological cycle in the atmosphere. After continuous steps of weathering, erosion, spatter and degradation, the parent rock and soil are disintegrated into fragmental material, then transported into river by the current. Ordinarily, the amount of river sediment is harmoniously companied with volume of runoff. That is the very reason why the river sediment concentrates in flood reason extremely when the runoff discharge varies dramatically in loess-hill-gully region of North Shanxi Province in China.

It is obvious that climate undulating in cycle leaves various impacts on the water-sediment factors. Qingjian river basin can be taken for an example. In terms of a long series of practical-observed records of 36 years, the rainfall reduced a lot, from 516.1mm in 1960s to 462.0mm in 1980s. At the same time, depending on an integrated maintenance method of water resource and soil, which has got a larger scope, a higher level and a faster rate recently, transported sediment of that river has been cut back in abundance. The historical records show that the average transported sediment falls from 42.936 million tons in 1960s to 14.482 million tons in 1980s, reducing by 66.3%. On the basis of understanding this principle completely, it is acceptable that, in order to solve the complex basin water resource problem, we should improve the former mold control our human being's activities and exploit the limited water resources appropriately. In views of climate's variety in different regions along the river, this paper analyzes the inherent reasons and the fundamental principle of water and sediment alteration performance in temporal and spatial perspectives. First for the sake of finding out the principal components in large scales, factor analysis is carried out about the water-sediment cycle evolvement, taking years as time pace, leading to an estimation of decade affections. Then the mathematical statistical

software, namely SPSS (Statistical Package for the Social Science), is utilized to analyze the separate variable factors in a small scale, by virtue of the Principal Components Analysis Module in the soft. In this step, year's item is taken as a time-effect, and three separate variables, precipitation, sediment transported and runoff are selected to ascertain the contribution of different ingredients to the whole water-sediment evolvement in different kinds of time-effect scales. The ultimate outcome is to clarify the impacts the climate and human activities exert on basin hydrological cycle evolvement.

# **The evaluation of debris flow's influence on water resource distributing project and mitigation countermeasures**

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**Abstract:** The characteristic of water resource in China is that the south is rich, while the north is poor, and the spatial distribution is unbalanced. The water distributing project is a strategic policy used to carry out large-scale cross-basin water transfer, optimize rational allocation of water resource and solve the problem of lack in water in the north of China. The region of the distributing project usually has a lot of high mountains and valleys, violent Neotectonic activities, complicated geological conditions and frequent seismic activities. Influenced by the natural factors and human activities, debris flows are well developed near the dam site, in the reservoir area, entrance highway and tunnel passageway. If scientific mitigation countermeasures are not adopted, the debris flow will have threat and danger to the construction and running safety of the distributing project; On the other hand, the construction of main project (dam, tunnel) and the accessorial project (highway, staff site, waste stack site, living region and so on), the rapid increase of human activities, slope excavation and reservoir sluice will change regional natural geographic conditions and influence regional engineering geological environment and hydrogeological environment. If effective mitigation countermeasures are not adopted, new debris flows will be happened and threaten project itself and the expecting benefits.

Through field survey, topography map implement, GPS fixed-point, aerial photos and TM, SPOT satellite image interpretation, the characteristic (type, density, frequency) ,distribution rules and status of debris flow are found out in the area of water resource distributing project. On the basis of this, the paper analyzes and predicts the bursting scales of debris flow (the maximal discharge, the total amount of a debris flow). Then the blockage of the main river by debris flow is analyzed. The possible height and the backwater length of the blockage are calculated and the quantitative analysis of the second possible hazards derived from debris flow is discussed. Based on the location relationship between debris flow ,backwater region and the distributing project(dam site, tunnel passageway, entrance highway and so on), the evaluation of debris flow's influence on water resource distributing project and mitigation countermeasures are presented.

# The Annual Precipitation and Land Use Changes in Recent 20 Years in Chengdu city, Sichuan province, China

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**Abstract:** This paper utilizes remote sense images landsat-7 TM in 1986, 1995, 2000 and SPOT in 2003 to extract the land use and land cover (LUCC) information. Applying the spatial data analyzing function of GIS, it analyses the rules of LUCC changes of Chengdu city in recent 20 years. After analyzing the data of precipitation, it reveals the rules of the precipitation changes. Combining the rules of LUCC changes with the rules of precipitation changes, the relations are revealed. The results indicate that LUCC taken place intensity changes in Chengdu city in recent 20 years. The area of farmland and construction land is dominant in Chengdu city. The pattern of land use and land cover in study area has gone through a great change. The pattern of farmland domination has changed to the pattern of construction land domination. Paddy field is domination in farmland, and dry land only occupies little proportion. The area of farmland has experienced a process of quick decrease from 1986-2003. Compared the previous time separately, farmland reduced 21.3%, 8.94%, 40.96% in 1995, in 2000 and in 2003, and paddy field reduction 19.67%, 10.74%, 41.48%. The construction land has experienced the fast increase process from 1986 to 2002 year; Compared the previous time separately, construction land increased 43.04%, 8.86% and 38.57% in 1995, in 2000 and in 2003, and urban construction land increased separately 50.46%, 7.98%, 31.51%. The lawn and the forestland change range were quite great, but their total quantity of changing area was little. Change of annual precipitation of Chengdu city has taken place too. The precipitation has kept overall reducing in Chengdu city for 23 years. And the precipitation in 1990 was the most, reached 1246mm. Then the precipitation in 1991 was the least, reached 5937 mm. It was the turning point that the annual precipitation changed in 1990. In 1980-1990, the annual average precipitation was 9208mm, while in 1991-2003 the annual average precipitation was 7824mm, which has reduced by 15% compared with the previous period. It could find that the Chengdu urban city has experienced the process that the precipitation decreased gradually from 1980 to 2003, and which made Chengdu city become more drought. The correlation coefficient between the city area and the total quantity of precipitation each year was -0.892. It indicated that the total amount of precipitation was sensitive to the enlargement of urban area. The value of the correlation coefficients was negative and the changing directions were opposite. It indicated that the increase of urban area caused the reduction of the amount of annual precipitation. This has proved the urbanization caused the effect of the "Dry Island" of city, not the "Rain Island".

# Application of EFDC-WASP modeling system in water pollution control: A case study in the Nansha River

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**Abstract:** Water pollution is serious in the Nansha River of Haidian District, Beijing, which is owing to domestic and industrial wastewater discharges. In order to control pollution and rehabilitate water environment of the river system, 4 water pollution control scenarios of planning year 2020 were proposed for decision-makers to finalize the control scheme. Using integrated EFDC-WASP modelling system, water quality scenarios of the Nansha River were simulated and compared under different pollution control scenarios. Thereinto, EFDC was applied to simulated hydrodynamics of the river system, and simulated hydrodynamic data was used as input of WASP to simulate water quality variation in the river. Observed water level and water quality datasets were applied to calibrate hydrodynamic and water quality parameters of the EFDC-WASP modelling system through trial and error method. The water quality items of dissolved oxygen (DO), chemical oxygen demand (COD), ammonia nitrogen (NH<sub>3</sub>-N), total nitrogen (TN) and total phosphorus (TP) were simulated and water quality effects of different scenarios were compared, the better water-environment-friendly pollution control scheme was recommended. In the meanwhile, water environmental capacity of pollutants COD, TN and TP loadings were estimated for the river depending on recommended scheme. The simulations indicate that COD concentrations of all scenarios can meet national surface water quality standards of level 4 under predicted COD loadings. However, TN concentrations of all scenarios cannot meet the standards for more than 10 months in a year, which indicates that the TN loadings into the river is too large. TP concentrations of all scenarios also cannot meet the standards from December to May in a year, because it is in drought in Beijing during that period and the low stream flow of the river does less help to the decomposition of pollutants. The results of water environmental capacity showed that capacities of TN and TP are smaller than their predicted pollutant loadings in 2020 respectively. It is impossible to achieve current water quality objective of level 4 for TN and TP, and function zoning adjustment of water environmental quality was suggested for the Nansha River system.

**Key words:** environmental fluid dynamics computer code(EFDC); water quality analysis simulation program (WASP); water environmental capacity; water pollution control

# Characteristics of Phreatic Evaporation From the Layered Soil and Calculation Methods

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**Abstract:** Considering the fact that most soil profile assumes layered structure in the field on northwestern area in China, a laboratory investigation was conducted for phreatic evaporation from the layered soil-sand columns in the presence of shallow water table. The results show that the sand-layered soil had an important effect on phreatic evaporation as compared to the uniform soil column. The evaporation can be not only restrained but speeded as well. The phreatic evaporation rate from the layered soils decreased with the increase of the sand layer position and the average sand particle size when the relative distance (i.e. the ratio of the distance between the low boundary of the sand layer and the water table to the buried depth of the groundwater) is more than 0.1. The mechanism of those changes was studied through the hydraulic conductivity of the two soils in the profile. The effect of the sand layer position and texture on the phreatic evaporation were behaved by parameters including its relative position and its relative effective particle size (i. e. the ratio of particle diameter with 10% of the sand to that of uniform soil) respectively. Based on the parameters and the empirical equation by Lei at el, the improved equation was developed, which was to be suitable for calculating the phreatic evaporation rate for the layered soil. Those achievements will be very important for calculating water circulation amount of the groundwater in the layered soil profile.

**Key words:** The layered soil; the phreatic evaporation; the improved equation

# In-situ Determination Methods of Streambed Hydraulic Conductivity in Lower Reaches of the Yellow River, China

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**Abstract:** On the basis of the practice of the integrated water dispatch in the Yellow River and corresponding statistical data in recent years, the water imbalance value of the reach between the Xiaolangdi site and the Lijin site from 1999 to 2002 is found to exceed 4 billion m<sup>3</sup>. Since the Yellow River in the lower reaches is “River above Ground”, the leakage loss from the stream water to groundwater is significant. In quantitative study of the interaction between the Yellow River water and groundwater, streambed hydraulic conductivity is a very important parameter. How to exactly determine values of streambed hydraulic conductivity is an urgent problem for hydrogeologists. The traditional methods, such as laboratory analysis, numerical modeling, etc., can not provide values of hydraulic conductivity that represent in-situ streambed conditions. The standpipe test and the permeameter test can be used to determine the values of hydraulic conductivity in situ. In this study, a series of in-situ standpipe tests and permeameter tests were conducted at the Huayuankou site, located near Zhengzhou city in the lower reaches of the Yellow River. In the in-situ standpipe tests, the artificial gradient method and the natural gradient method were both used for determining the value of streambed vertical hydraulic conductivity. Based on the measured data and by using Chen’s formula, the average value of streambed vertical hydraulic conductivity at the Huayuankou site has been found to be 0.48 m/d. The permeameter tests were conducted in situ at the same time as the in-situ standpipe tests. Considering the grain size characteristics in the lower reaches of the Yellow River, the falling-head permeameter tests were selected for measuring the value of streambed hydraulic conductivity. Five undisturbed streambed sediment samples at different spots of the Huayuankou site were respectively collected and tested. The value of streambed hydraulic conductivity of the Huayuankou site has been found to be 0.51 m/d by averaging the five values obtained in each falling-head permeameter test. Consequently, the slight difference between the results of standpipe tests and falling-head permeameter tests shows that both methods can give reliable values of hydraulic conductivity at the Huayuankou site. Due to the similar streambed characteristics and in-situ conditions, this study provides practical methods for determining values of streambed vertical hydraulic conductivity of other sites in lower reaches of the Yellow River.

**Key Words:** Hydraulic Conductivity, Streambed, In-situ Standpipe Tests, Permeameter Tests, Lower Reaches of the Yellow River.

# Appraisalment on Methods of Hydrological Trend Analysis

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**Abstract:** This article researches on the power of the method of multi-resolution of wavelet when it used in analyzing trend of hydrologic time series. Through Monte-Carlo simulating approach, it is found that the capability of the method varies with sample size, coefficient of variation and extends of the trend. When the trend degree, sample size become larger, the resolution capability of the method increases and decreases with coefficient of variation of a sample series getting larger. Besides, this paper compared the performances of the each methods of wavelet analysis, liner regression and polynomial fit in resolving the trend of an assumed hydrologic time series which distributed as normal and person types with different parameters and investigated the conditions under which the methods can work well.

# **Study of Urban Water Supply Cost Computation and Meterage in Guangdong Province**

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**Abstract:** It has been continuous droughty in fall, winter and spring for the latest four years in Guangdong Province, which results in some problems such as short municipal water supply. However, nowadays water-rate is on the low side and water resources go to waste, due to inconsequence computation and meterage in price of municipal water supply. In order to release urban water supply and live up to water saving, in this paper it is suggested to establish a price system of urban water supply by the advanced whole water price mode in Guangdong Province, including cascade water price, two-part water price and seasonal water price in order to keep the economic and social sustainable development in Guangdong Province supported by sustaining use of water resources.

**Key words:** Urban water supply, Whole water price, Cascade water price, Two-part water price, Seasonal water price

# A Fast Iterative Tidal Harmonious Analysis Method base on Continuous Functions Least-square Method

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**Abstract:** The theory of the tidal harmonious analysis method based on continuous function least-square method was discussed. With regard to the calculation of the harmonious analysis equations, by studying character of the coefficient matrix, the minimum time length of known measured data with various general used 11,63,128,306 components were given, they are 12days,202 days,252 days,345 days respectively. A iterative tidal harmonious analysis method when data incomplete or existing significant error was offered, and a fast calculating scheme for the iterative method was provided, the iterative results can be get by calculating the fast calculating schemes only once, the result show that the computational efforts are cut down greatly of the same precision.

**Keywords:** harmonious analysis; continuous function least-square method; computational efforts

# The Comparative Application of SIMHYD in Chinese Northern and Southern Zone

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**Abstract:** This paper introduces the structure of a rainfall-runoff model-SIMHYD model and the application of SIMHYD model to Chao River basin in northern China and Hangjiang basin in southern China. The results show that SIMHYD model can perform a good simulation of monthly runoff to Chao River basin but it is not so good to Hanjiang basin. The study also indicates that certain parameters of SIMHYD model are related to the catchment physical and climatic characteristics. However, it is not yet to develop the quantitative relationship between them.

**Keywords:** SIMHYD model; monthly runoff simulation; Chao River basin; Hanjiang basin

# A study of urban dew in Guangzhou, China

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**Abstract:** Urban dew, a potential source of water, was not well known like other ecological factors. However, urban dew is important for plants and animals, as well as the urban ecosystem, especially in arid season. Most researches into dew were focused on rural area, while urban dew data rarely reported. In order to study the quantity of urban dew and the relationship between urban dew and the ecological factors, Guangzhou was chosen as a representative city in a delta of low sub-tropic. Results showed that urban dew amounts were less than those that in its countryside. The dew amounts were different from different areas in the city. Some correlations were suggested between urban dew and the ecological factors. Further researches of the dew amounts in other cities and the relationship between urban dew and latitude, longitude and the landscapes would be valuable.

**Keywords:** Guangzhou, urban dew, areas, ecological factors

# Flood forecasting model of BP network based on adaptive genetic algorithm

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**Abstract** The paper builds a flood forecasting model which can search the best fleetly based on advanced genetic algorithms and BP network. The model can forecast downstream flood water level after several times by making water level datum of upstream station and downstream demand forecasting as input data of artificial neural network, and by training historic datum fleetly for the best with adaptive genetic algorithms. The model has been tested with the datum of Qingyun and Lubao water level station, which locate on Beijiang River in Zhujiang Delta, with Qingyun water level station as the upstream and Lubao as the forecasting station of downstream. The test results show that the forecasting model can obtain the good forecasting datum with the reasonable parameters and forecasting period.

**Keywords** BP artificial neural network; genetic algorithms; adaptive; forecasting model; flood

# Flood Frequencies Analysis Transformed Model for Small Sample

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**Abstract:** This thesis is aimed to integrate the theory of nonparametric statistics and that of transference, establish nonparametric statistical transference models, explore their applicability in analyzing floods frequency, the present model improves the precision in small sample estimation, and provide an alternate method to floods frequency analysis. Firstly , the thesis reviews the condition of the application of nonparametric statistics in hydrology and water resources and points out the difference of nonparametric statistics and parameter statistics in calculation method as well as their advantages and disadvantages. Secondly, it suggests integrating the theory of transference and that of nonparametric statistics as its research focus. Thirdly, it establishes nonparametric density transference model, transference regression model, and floods frequency-analyzing model, which are all applicable to floods frequency analysis. Theoretically, it discusses the consistency and asymptotic behavior of nonparametric transference model, introduces the idea and methods of model building in detail and testifies the stability of the models by means of statistical experimentation. The main factor influencing nonparametric kernel estimation accuracy lies in the choice of kernel function and bandwidth especially bandwidth has an enormous influence on the result of kernel estimation. Adopting the method of transformed kernel estimate helps overcome the contradiction of non bias and minimum mean square error requirement and avoid the difficulty in choosing bandwidth. With the help of transference method, a new sample can be made available. For its corresponding function curve is smoother and the gap of the true value of the statistical points is smaller, using more smooth points can avoid making big errors/deviations. And what's more, optimal function is more even and bias is small, as a result, mean square error diminishes by choosing bigger bandwidth Finally, based on curve-fitting method and non-parameter model, analyses and calculations are conducted on the floods frequency of yearly maximum floods peak flow in Yichang Station, Xiaolangdi Station and Qinhe-based Wulongkou Hydrometric Station, the results of which proves the feasibility of the method. In particular, non-parameter transference model has better stability in contrast to the less ideal hydrological data of curve-fitting method.

**Key words:** non-parameter statistics, kernel estimation, density estimation, bandwidth, kernel function transference, nonparametric regression, historical floods, frequency analysis.

# The Analysis of Taoer River Flood Season Evaluative Fuzzy Statistics

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**Abstract:** The analysis of flood season evaluative fuzzy statistics is an important part of risk analysis of floodwater. The analysis can distinguish high risk and low risk and is an important reference of the reservoir operation. The Moon-Lake Reservoir mainly stores the flood water from Taoer River under the dynamic reservoir flood limit water level operation. The paper makes a fuzzy statistics according to the daily flow process of the Taoer River, and calculates the experimental membership function and the fitting function which show the feasibility of flood, as well as the extent that a certain day belongs to flood season. Suppose that the flood season begins with a signal that membership function equals to 0.8, and then the flood season of Taoer River is From July 20<sup>th</sup> to September 3<sup>rd</sup>. Therefore, from July 20<sup>th</sup>, the bigger membership function is, the more likely the flood occurs. From August 2<sup>nd</sup> to August 8<sup>th</sup>, the membership function equals to maximum 1.0, thus the chance that flood occurs is greatest. After August 8<sup>th</sup>, the chance decreases since the membership function decreases. Hardly any floods will occur after October. Furthermore, combining flood predict and flood pre-discharge, the reservoir's flood limit water level can be risen gradually, as well as obtain considerable economical benefit.

**Key words:** Taoer River, flood season, fuzzy statistics, membership function

# The Research of Nenjiang River Flood Prediction of Dalai Area

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**Abstract:** The flood utilization plays a vital role in the development of Baicheng City. In order to find out the objective flood and determine the utilizing amount and the opportunity of flood water, the exact Short-term flood prediction is very important. Moon-lake Reservoir in Baicheng City locates near Dalai hydrology station. According to the flood information of Jiangqiao station, the paper predicts the flood characteristics of Dalai area, namely flood peak flow and daily flow process, which provide a foundation of the flood control of the Moon-Lake Reservoir. The flood peak flow of Dalai area is calculated by up-low stream flow correlation analysis. The daily flow process of Dalai area is calculated by Genetic Algorithm. At last, the paper gives the fitting test and the predict test, which prove the accuracy of the Nanjiang River flood prediction of Dalai area.

**Keywords:** flood prediction, flood peak flow, daily flow, Genetic Algorithm fitting test.

# **A new method for rainfall spatio-temporal variability analysis based on information entropy**

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**Abstract** The Chaobai River Basin lies in the upper reaches of the Hai River Basin and also the upstream of Miyun reservoir which is the Beijing municipal tap water main source. The precipitation is one of the most important hydrological factors and its variability analysis is crucial for further understanding hydrological process and hydrological modelling. Traditional spatial variability was quantitatively described using Average Error (AE), Relative Error (RE), Standard Error (SE), and Coefficient of Variation (CV) based on statistics. In this paper, we combined information entropy theory with GIS spatial analysis technology to analyze the spatio-temporal variability of annual precipitation. A new spatio-temporal variability analysis method which is based on the differential information entropy relatively estimates is also presented. This study was conducted using 58 gauge stations rainfall data of Chaobai River Basin during the period from 1973 to 2002. Results of this study show that the new spatio-temporal variability analysis method is feasible and effective.

**Key Words** spatio-temporal variability; information entropy; Chaobai River Basin; Coefficient of Variation; Rainfall

**Downstream effects on peak-floods of urban  
flood-detention release rates: Blackberry Creek  
Watershed, Kane County, Illinois, USA.**

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**ABSTRACT** Effects of release rates specified for detention basins were examined on the watershed scale with a continuous simulation model HSPF (Hydrologic Simulation Program-FORTRAN). The detention basins were sized according to the specified release rate and the flow routing was built into the model. The results showed that a release rate of 0.0056 cms/ha is needed for areas expecting high development, and a release rate of 0.007 cms/ha, in general, can attain the goal of maintaining post development 100-year peak-flood discharge to the similar magnitude of that of pre-development at the farthest downstream point before entering another county.

**KEYWORDS** detention basin, orifice, release rate, flood mitigation, watershed management, hydrological modeling, continuous simulation.

# U.S. EPA Research on Urban Stormwater Pollution Control

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**ABSTRACT** The U.S. EPA's Urban Watershed Management Branch is responsible for developing and demonstrating technologies and methods required to manage the risk to public health, property and the environment from wet weather flows (WWF) in urban watersheds. The activities are primarily aimed at restoring surface waters in the context of water quality uses intended for aquatic life and recreation.

WWFs include combined sewer overflow (CSO), sanitary sewer overflow (SSO) and urban storm water. The primary goals of the research are development of: (1) watershed management strategies and associated models integrating area-wide WWF control for groundwater and surface water protection; (2) multi-purpose WWF methods, practices, and technologies including new and retrofit designs for drainage, flood, pollution, erosion and sedimentation control, for management of contaminated sediments in sewers; (3) pretreatment requirements for adequate WWF disinfection; and, (4) protocols for measuring WWF control program effectiveness. The overall direction of the program is geared to developing novel approaches for controlling WWFs and the integration of watershed based urban wet weather controls in mixed land-use watersheds for resolving water quality impairments as well as integration with drinking water source water protection. This paper addresses select projects and products related to these activities, especially the ongoing research activities related to best management control technologies for urban stormwater generated pollution control.

# Changes of Pan Evaporation in the recent Years in China

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**Abstract:** Based on observational data of 664 meteorological stations in China from 1960 to 2000 and combined with the Geographic Information System (GIS) of ArcGIS, the spatial and temporal distributions and their trends for pan evaporation in China are investigated in this study. The results indicate that, from 1960 to 2000, the rate of pan evaporation has steadily decreased in China. Compared with the period of 1960s to 1970s, the rate of annual pan evaporation during 1980s to 1990s has decreased 99.8mm or 5.8%. Seasonal analyses show that the decrease of pan evaporation is mainly in spring, summer and winter. Spatial distribution of the rate of change show that the decrease of pan evaporation is mainly occurred in East and Central South of China. Further analysis show that the decrease of pan evaporation is mainly related to reductions in solar irradiance resulting from sun-shine percentage decrease.

**Keywords:** Climate change, GIS, Pan evaporation

# Variable Fuzzy Recognition Methodology for Groundwater Vulnerability Assessment

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**Abstract:** More and more problems with groundwater come from the increasing industrialization and the growing waste problem. The DRASTIC model has been used as a valuable tool in many parts of the world for assessing the vulnerability of groundwater. In the DRASTIC system, however, factors that influence groundwater must be divided into ranges and then be given ratings according to whether or not their values can be directly measured. The system may give the same range and rating to those having obviously different values. As a result, DRASTIC may be unable to actually reflect the difference between factors and hydrogeological setting. A DRASTIC-based fuzzy pattern recognition model overcame this defect. But the DRASTIC-based fuzzy pattern recognition method takes assessment standard as points, while standard of a level type is an interval in practice. In this paper, variable fuzzy recognition model is established as a newly proposed method for assessing the pollution potential of groundwater, which can identify the difference degree between factor of sample and interval of level standard. Finally, a case study is presented, which shows the proposed methodology is straightforward and its result is reasonable.

**Key words:** variable fuzzy recognition; groundwater vulnerability; assessment

# The Build-up of Green-blue Water System

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**Abstract:** The conception of green water and blue water has been accepted widely in the world so far, but no real system on green-blue water have come into being. To promote the development of the catchment water resources management, this paper puts forward the system of green-blue water including the indices of system, the relations between green-blue water system and the normal conceptions in water resources research area etc. for the first time. We hope the build-up of the system can shed light on catchment water resources researchers and managers and advance the development of water resources management methods.

**Key words:** green-blue water system; water resources management, system indices

# **The Regional Hydrology of Extreme Floods in Urbanizing Drainage Basin**

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T . S SCIENCE AND TECHNOLOGY. SERREKUNDA- GAMBIA

The Basse, North Bank Division area has experienced extensive urban and Suburban growth since 1975 three of the largest floods peaks in the 25yr discharge record of little sugar creek ,which drains the main urban Basse, have occurred since May of 2002.

A main objective of this study is to explain how these three observations are linked .To achieve this goal, a series of hypotheses of broad importance to the hydrology and hydrometeorology behaviour of extreme floods will be examined .These hypotheses concern the roles of 1]space -time variability of rainfall,2] attractions of the drainage network for extreme floods in urbanizing drainage basins. The methodology used to examine these hypotheses centers on studies of flood response for the three major flood events that have occurred since May ,2002. Diagnostic studies exploit the diverse range of extreme precipitation forcing for the three events and heterogeneity of land surface properties for catchments with stream gauging records .The observational resources for studying floods in the Basse North Bank Division are exceptional. They include two National Weather Service WSR- 99D radars were deployed in 2002, a dense network of rain gauges and stream gauges installed by the W. A. Geological Survey in 2002, and extensive land use response ,as elements of the constructed environment of particular interest are the hydrologic ,hydraulic, and hydrometeorological controls of extreme flood response at basin scales ranging from 1 to 400k sq. miles.

# Historical temporal trends of hydro-climatic variables and runoff response to climate change and their relevance in water resource management in the Hanjiang basin

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**Abstract:** The Danjiangkou reservoir lies in the upper Hanjiang basin and is the source of water for the middle route of the South-to-North Water Diversion Project (SNWDP) in China. Any significant change in the magnitude or timing of runoff from the Danjiangkou reservoir induced by changes in climatic variables would have significant implications for the economic prosperity of the area in the Hanjiang basin as well as for the South-to-North Water Diversion Project. In this paper the following issues are investigated: (1) Temporal trends of annual and seasonal precipitation and temperature from 1951 to 2003 in the Hanjiang basin are analyzed by using the Mann-Kendall and the linear regression methods; their spatial distributions are interpolated by the inverse distance weighted interpolation method. (2) Temporal trends of runoff, precipitation and temperature from 1951 to 2003 in the Danjiangkou reservoir, an upper stream basin of the Hanjiang River, are further tested. (3) To assess the impact of climate change on water resources and predict the future runoff change in the Danjiangkou reservoir basin, a two-parameter water balance model is used to simulate the hydrological response for the climate change predicted by the GCMs for the region for the period of 2021 to 2050.

The results indicate that (1) at the  $\alpha = 0.05$  significance level precipitation in the Hanjiang basin has no trend, but the temperature in the same region has significant upward trends in most parts of the Hanjiang basin. (2) The mean annual, spring, and winter runoffs in the Danjiangkou reservoir basin have a decreasing trend. (3) The results simulated for the period 2021 to 2050 show that runoff of the Danjiangkou reservoir would increase in all the seasons, mainly in response to the predicted precipitation increase in the region. Sensitivity analysis shows that a 1°C and 2°C increase in temperature would reduce the mean annual runoff to about 3.5 and 7%, respectively. A decrease/increase of the mean monthly precipitation of 20 and 10% would decrease/increase the mean annual runoff to about 30 and 15%, respectively. The results of this study provide a scientific reference not only for assessing the impact of the climate change on water resources and the flood prevention in the Hanjiang basin, but also for dimensioning the Middle Route of the SNWDP in China.

**Key words:** trends analysis; linear regression; Mann-Kendall; climate change; Hanjiang basin

# Application and review of some methods for identifying of hydrologically homogeneous regions

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**Abstract** The demarcation of hydrological homogeneous regions is the key procedure for regional flood frequency analysis and network analysis for regional information. The main objective of this study is to systematically review and compare various methods for identifying groups (or regions) of hydrologically homogeneous catchments with special emphasis on data from the Jiangxi province of China. Four methods for delineating homogeneous regions, included the single variant method, the Ward's cluster method, the fuzzy c-means method and artificial neural network, were investigated and these methods are described here. Application of examples of these techniques to flood data for the Jiangxi province has demonstrated that classes are hydrologically more appealing than those imparted merely by geographical proximity. The results indicate the feasibility of employing these methodologies on Jiangxi province.

**Key words:** Hydrologic classification, the single variant method, the Ward's cluster method, the fuzzy c-means method, SOFM

# Inter-provincial Water Disputes and Countermeasures in the Changjiang River Basin

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**Abstract:** With the rapid development of national economy, the inter-provincial water disputes have been rising all the way, due to water resources development project constructions, water allocations, water resources management, water disaster management, water environment protection and so on. The causes can be varied and complicated. Many disputes are long unsettled ones, resurfaced now and then. The conflicts caused by water disputes can be harsh, which cannot be easily mediated. If water disputes cannot be settled in time, they would endanger not only the regional water resources safety but also cause social unrest and disrupt the sustainable development of economy. The types, characteristics and the developing trend of inter-provincial water disputes have been explored taking the Changjiang River basin as an example. The existing problems in river basin management have been discussed. Countermeasures for solving water disputes have been proposed, including integrated river basin management, enhancement of legal and regulatory system building, introduction of market mechanism and formulating new theories about water right and water market to guide water disputes solving.

**Key words:** Inter-provincial rivers, water dispute, water right and water market, river basin management, countermeasure

# Integrated Urban Watershed Management

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**Abstract** Now more than 1,800,000 people live in the Greater Kansas City Metropolitan Area. The area straddles the border between the states of Kansas and Missouri. Moreover, the area consumes part or all of eight counties and all or part of one hundred sixteen incorporated municipalities. By far the largest municipality is Kansas City, Missouri (KCMO) with a population exceeding 450,000. Spread out over 320 square miles, KCMO now includes parts of four counties and continues to grow in both population and area as new territory is annexed. Roughly half of KCMO lies north of the Missouri River and half south. The area south of the river generally is older and much of it is served by combined sewers. KCMO extends from the old downtown and industrial areas along the river southward some 18 miles characterized by newer and newer developments. The Northland generally is much younger in character and continues to undergo rapid urbanization.

The effort to develop a comprehensive watershed management program has been dubbed KC-One and will clarify responsibilities within the City and will include recommendations in policy and regulation, administration, watershed master planning, capital improvement programming, public education and outreach, funding, and implementation. To address the regulatory requirements as well as maintain natural resources, the comprehensive program is based upon “Green Infrastructure” concepts, an amalgam of non-structural BMPs, low impact development, and smart growth concepts. It protects existing natural resources and waterways by minimizing adverse impacts from new developments. It also enhances existing natural resources and waterways by retrofitting existing developments with appropriate “Green” solutions. Emphasis will be placed on avoiding adverse impacts first, then minimizing adverse impacts where unavoidable.

The entire work effort for KC-One was broken into two Phases. The purpose of Phase I was to establish the vision, principles, and priorities for the new program. These key elements guided the development of the scope of work, budget, and schedule for Phase II. Phase I culminated in a consensus of what the vision, guiding principles, and priorities for stormwater management should be. Phase II focuses on reducing flooding, protecting natural resources, and improving water quality. Innovative approaches are identified that combine local, state, and federal funding. A big picture view is taken that incorporates “Green Infrastructure” into multi-objective and multi-use solutions. Public education and outreach is the key to building support and implementing effective programs.

# **Spatio-temporal Change Characteristics of Precipitation in the Pearl River Basin during 1961-2000**

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**Abstract:** In order to research spatio-temporal change characteristics of precipitation in the Pearl River Basin, surfaces of monthly mean precipitation are fitted with data from 80 precipitation observation stations of recent 40 years (during 1961-2000), using Kriging interpolation method supported by Spatial Analyst model of ArcGIS 9.0). We perform the interpolation of precipitation of 8km×8km resolution grids using ArcMap to generate output maps on which we further analyze the spatial distribution of monthly and yearly precipitation. The Mann-Kendall (M-K) test is applied to examine trends in monthly, seasonal, yearly and flood-season precipitation in recent 40 years and also detect the abruption which is further confirmed by Moving T Test. Analysis of variance (ANOVA) is used to analyze precipitation change characteristics on temporal and frequency field.

The main conclusions follow below: ①There is a weak positive trend for yearly precipitation ( $M=0.21$ ), with a speed of 5.5 mm/a. From the trend changing maps, it can be seen that the decreasing area focuses on the southwest of the Pearl River Basin, and the increasing area focuses on the northeast of it. ②In autumn, the rainfall presents an apparent decline trend ( $M=-1$ ); But in spring, summer and winter, there exists an increasing trend in the recent 40 years. ③In flood season (from Apr to Sep), the precipitation presents an insignificant decline trend; But in main flood season (from May to Jul) and non-flood season (from Oct to Mar of the second year), there exists an increasing trend in the recent 40 years. ④In Jan, Feb, Mar and Jul, precipitation shows an insignificantly increasing trend, and in other months precipitation reveals an insignificant decline trend. ⑤Due to different changing trends in the distributions of precipitation in each month, precipitation becomes more imbalanced, with less rainfall in low-water months (from Aug to Dec) while more rainfall in July. So this might cause to an increase of flood or drought probability of the whole basin. The research results in this paper may be meaningful for future climatic changes of the basin and social mitigation of climatic disasters.

**Key words:** spatio-temporal change; precipitation; Kriging; Mann-Kendall; the Pearl River Basin

# **A Primary Discuss to the Influence of Human Activities on the Variability of Runoff Series of the BeiJiang River**

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**Abstract:** With the development of society and more intensive human activities, especially after the large-scale economic building in recent decades, some new characteristics appeared beyond the intrinsic laws in water resource. Recognizing the new laws of runoff evolvement under the changing environment seemed very necessary. The paper analyzed the characteristics of the precipitation and the runoff of BeiJiang River in the past 45 years (1956-2000) based on the measured data of precipitation and the hydrological data at ShiJiao station which is the main controlling station on the river. The research found that the runoff series shows a rising tendency while the precipitation is even. This said that the rising trend of runoff is caused by human activities. We analyzed the runoff coefficient series. Result showed the coefficient had changed around 1973. So we assumed that the runoff is under the natural conditions before 1973. We obtained a regression equation based on the data of precipitation and runoff in 1956-1972. Using this equation the human activities' influence on runoff can be quantified. The calculated results showed human activities increase the runoff as 3.81、 2.54、  $4.13 \times 10^8 \text{m}^3$  at the three periods of 1973-1980、 1981-1990 and 1991-2000 respectively. At the last, we analyzed the water lose and soil erosion and vegetation changing of the basin in recent two decades, and these further proved it is the underlying surface changing caused by human activities result to the runoff increasing.

**Key words:** BeiJinag River; human activities; runoff; underlying surface