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## Breaking ice with explosive in Heilongjiang River

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**Abstract:** Breaking ice cover or ice jam is essential to prevent flooding in Alpine region. Field experiments have been conducted to study ice-breaking process with explosive in the upper reach of the Heilongjiang River(Amur River)for several years. It is observed that the water depth under the ice cover is a crucial factor affecting crater radius of the breaking ice cover after explosion. Based on the experimental results, a theoretical model is developed to correlate the crater radius and the water depth, the cover thickness, and the explosive charge weight. The application of the model in the Heilongjiang River in 2015–2016 showed good agreement between predicted and measured crater radius. This research provides the scientific basis for breaking ice with explosive to prevent ice disaster in the river of Alpine region.

**Keywords:** Heilongjiang(Amur)River; river ice; ice cover; thickness; flood; blast; explosive

**Assessment index system and decision-making model  
for load adjustment schemes of cascade hydropower stations**

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**Abstract:** The preference of cascade hydropower stations' load adjustment schemes directly impacts the benefits and risks of power generation sector. However, due to incompleteness of existing risk-benefit synergy assessment index system, it is unable to conduct a comprehensive and effective assessment on load adjustment schemes so far. This article aims to establish a systematic risk-benefit synergy assessment approach to improve the accuracy and effectiveness of load adjustment schemes assessment. In this article, authors proposed a comprehensive index system of risk-benefit synergy assessment based on the actual cascade hydropower stations operation process; defined generation risk rate, load fluctuation risk rate, and opportunity loss risk as new indexes then put forward their calculation formulas; besides, introduced the correlation coefficient matrix to replace the covariance matrix of Mahalanobis distance to address the deficiency of the traditional grey target decision-making model in terms of insensitivity of relative indexes; in addition, used the relative bull's-eye to calculate and sort the non-inferior sets. According to the case study of Jin-ping-guandi cascade hydropower stations of the Yalong River in which a comparison was performed between the traditional grey target model and the grey target model based on Mahalanobis distance, the methodology proposed by this article shows more reasonable results, which can be an important reference for future research on load adjustment of cascade hydropower stations.

**Keywords:** cascade hydropower stations; load adjustment schemes; risk-benefit synergy assessment; index system; an improved grey target decision-making model

**Study on dimension reduction for optimal operation  
of large-scale hydropower system II. Example for the method**

FENG Zhongkai, NIU Wenjing, CHENG Chuntian, WU Xinyu, SHEN Jianjian  
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**Abstract:** In order to solve the curse of dimensionality of joint optimal operation of large-scale hydropower system, orthogonal dimension reduction search algorithm (ODRSA) is presented on the basis of orthogonal experiment design. ODRSA solves the joint optimization scheduling problem of hydropower system by carrying out the orthogonal experimental design in the neighborhood of initial solution. During the iteration, some representative solutions are selected to calculate and the starting point will be replaced if the better solution is found. Analysis shows that the time complexity and space complexity of ODRSA are square. Simulation results of the cascade hydropower stations on the Wujiang River indicate that: ODRSA is a novel method for large-scale hydropower system with less calculation parameters, fast convergence speed and strong robustness.

**Keywords:** hydropower system; optimal operation; orthogonal experiment; dimensionality reduction; dimensional disaster; local search; computation complexity

## Study on the regulation line flow path equation of the sandy river

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**Abstract:** The design of the regulation line is an important content of river regulation. In this paper, a governing equation of the regulation line is established to describe the variation of the flow path in the natural state quantitatively. Based on the data of the Yellow River Model Test, it is found that the flow dynamic axis given by the maximum single width flow line of the cross section is in the form of a smooth curve with the change of curvature radius, so the sine generated curve was used to describe the flow path of the treatment planning. Through theoretical analysis, field and model data analysis, the mathematical expressions of parameters of the flow path have been established associating with the hydraulic factors of the river. The bending coefficient and bend amplitude are based on 61 groups of nature and experimental data; The starting angle considering the influence of the difference between the practical discharge and the regulation discharge; The bend span considering the changes of bend strength of circulation. The regulation line flow path equation is not only suitable to describe the stable form of the sandy and gravel bed rivers, but also can describe the special phenomena caused by the change of discharge in the river evolution. In addition, the method is validated by the typical braided reaches of the upper and lower reaches of the Yellow River and is applied to plan regulation line of the Inner Mongolia section of the Yellow River.

**Keywords:** river regime; regulation line; sine generated curve; flow path equation



**Study on the interception effects of ecological pond  
on Nitrogen and Phosphorus in the rainfall runoff of rice field**

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**Abstract:** The ecological pond has double effects on drainage and ecological wetland. With huge loss of farmland nutrient becoming one of the main sources of agricultural non-point source pollution, it is significant to study the interception effects of ecological pond on nitrogen and phosphorus in the rainfall runoff of rice field and the removal effect on nitrogen and phosphorus in static water. In this paper, the ecological pond was built based on the transformation of natural pond, and the interception effects of ecological pond on nitrogen and phosphorus in the three rainfall runoff events happened in rice growth periods was studied. What's more, the removal effects of ecological pond on nitrogen and phosphorus under stationary state of the ecological pond water was also studied. The results show that: (1) in the process of three different rainfall events, the average removal rate of total nitrogen (TN) and total phosphorus (TP) by ecological ditch are 34.7% and 34.8% respectively; (2) the sort order of nitrogen and phosphorus removal rate by ecological ditch is ammonia nitrogen ( $\text{NH}_4^+\text{-N}$ ) > grain nitrogen (PN) > nitrate nitrogen ( $\text{NO}_3^-\text{-N}$ ) and particles phosphorus (PP) > dissolved phosphorus (DP), and the concentration of nitrogen and phosphorus in different water body vertical stratifications are varied during rainfall runoff, but the concentration of nitrogen and phosphorus in the underlying water body is mostly greater than that in the surface water body; (3) after the rainfall runoff, the removal rate of TN and TP in ecological pond are 50.4% and 52.3% respectively, and the removal rate of pond 2 on TN and TP is greater than pond 1 and pond 3, indicating that the ecological pond has a strong self-repairing ability.

**Keywords:** paddy field; ecological pond; nitrogen and phosphorus; rainfall runoff; stratified vertically; interception effect

## Numerical simulation of dynamic flow around wicket gate in hydro turbine with guide vane closure

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**Abstract:** The strong fluid transient induced by the hydraulic transient process is an unsteady turbulent flow, which has an important influence on the stable operation of hydro unit. In order to explore the hydro-turbine dynamic regulating action induced by strong fluid transient effect on the transient characteristics of the unit, the immersed boundary method and large eddy simulation for simulating fluid-structure interaction were applied to deal with the strong nonlinear dynamic boundary problem of fluid dynamics. The distribution of pressure and wake structure was finely simulated in linear cascades in a channel. The flow field of the downstream is very complicated due to the unsteady flow characteristics of staying vanes and moving guide vanes. The dynamic flow around wicket gate in hydro-turbine with guide vane closure was simulated. The change of corresponding flow topology is more complicated. The real simulation of the closing process of guide vanes in wicket gate was performed. The method can be used for the fine simulation of flow around multi-cascade in hydro-turbine, and provides reference for studying the transient performance influenced by the oscillation in the hydro-turbine adjusted process. The research was instructive to the hydraulic transient of the upstream pressure conduit and the three dimensional hydraulic transient effect of hydro-turbine.

**Keywords:** hydro-turbine vane cascades; immersed boundary method; large eddy simulation; wake; numerical simulation

## Study on the calculation model of river water environment capacity considering water intake and tributary

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**Abstract:** In order to provide technical support for total amount control of pollutants and for defining red lines of received-pollutant limits in water function areas, a stepwise summation model is built to calculate water environment capacity, which considers water intake and tributary based on one-dimensional water quality model. The water function area was divided into several reaches to calculate water environment capacity by the control section with sewage outlet, water intake or entrance of tributary. Comparing to the traditional model, this model could control the function area of water quality target neatly, and avoid water environment capacity too strict or too loose. The model was adopted to Shaanxi section of the Weihe River. The calculated results of water environment capacity by the new model, segment first control model and the section-end control model were 73814.43, 36159.96 and 85365.49t/a, respectively. The results show that the new model is more modest and it could calculate water environment capacity between any two control sections. Because of considered intake, tributary and sectional velocity, water environment capacity is also more accurate and reasonable. The new model could provide technical support for the total amount control of pollutants and for defining the red lines of water functional areas.

**Keywords:** river; water environment capacity; water intake; tributary

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## A method for flood forecasting based the operation chart of aggregated reservoir

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**Abstract:** Hydraulic constructions can dramatically alter the hydrological characteristics of the basin, especially the process and volume of the flood, which make it more difficult to accurately forecast flood. In the present study, we propose a new method for flood forecasting, which can effectively account for the hydraulic constructions. In this method, the hydraulic constructions is firstly aggregated as the equivalent reservoir, whose operation chart of holding and discharging is obtained according to the rule of the single hydraulic construction. Then, the new flood forecasting method is formed by combing the operation chart with the original TOPMODEL calibrated with the natural flood. The proposed method has been applied for forecasting flood in Subarea II of the Fengman basin in Northeast China and results show that the precision is significantly improved with an advance of the qualified ratio of forecasting runoff yield. The situation that the value at beginning of flood season and after a long drought is usually underestimated has also been modified. Three types of typical flood process simulated by the new method are more suitable to observed process. All the results indicate that the method developed can effectively account for the impacts of hydraulic constructions on flood process.

**Keywords:** flood forecasting; hydraulic constructions; aggregated reservoir; operation chart of holding and discharging; TOPMODEL

## Preparation of biochar ball with agricultural ditch sediment and rice straw by pyrolysis and adsorption of ammonium

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**Abstract:** Agricultural ditch sediments were mixed with rice straw according to their ratios of mass, five treatments including no rice straw addition, and mass ratios of agricultural ditch sediment and rice straw were 20:1, 10:1, 20:3, 5:1, then all the samples were made into particle balls, of which the size was 5 mm, finally, they were prepared at 600°C by anaerobic pyrolysis 4h into biochar balls, and respectively marked as SS-0, SS-50, SS-100, SS-150, SS-200. Elemental analysis, BET-N<sub>2</sub> surface area (SA) and porosity analysis, scanning electron microscope, FTIR spectra analysis and Boehm titration were used to characterized their physicochemical properties. Sequencing batch experiments were conducted to investigate ammonium adsorption performance of biochar balls, to build the kinetics models and adsorption isotherm models, and also to research the effects of water temperature on ammonium adsorption. The results revealed that rice straw addition was beneficial to increase the permeability and hydrophilic of biochar balls, and enhanced their mass transfer performance, which were 14%, 52%, 26%, 33% and 38% for SS-0, SS-50, SS-100, SS-150 and SS-200 samples, respectively; while the amounts of acidic functional groups were 2.74, 2.88, 3.71, 3.36 and 3.03 mmol·L<sup>-1</sup>, respectively. The results for fitting experimental data of adsorption process with kinetics models show that SS-0 biochar ball is more aligned with pseudo-first-order kinetic equation, however, the adsorption of ammonium on SS-50, SS-100, SS-150 and SS-200 biochar balls follows pseudo-second-order kinetic equation well, in addition to the intra-particle diffusion, there are other common controlling ammonium adsorption rates of biochar balls. Moreover, Langmuir equation could accurately describe the adsorption isotherms of ammonium on biochar balls. The indexes of Freundlich isotherms equation are all less than 1, which show that the absorptions are endothermic processes, and high temperature is beneficial to the adsorption of ammonium.

**Keywords:** agricultural ditch sediment; rice straw; biochar ball; ammonium; adsorption

## Runoff and sediment yield process and characteristics research on litter slopes in simulated rainfall

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Beijing Forestry University, Beijing 100083, China)

**Abstract:** Litter is a key factor for determining erosion rates, to provide quantitative information for hydrological soil processes in litter covered slopes, different rainfall intensities(30, 60, 90 mm/h)were conducted under different litter coverage(0, 50, 100, 150, 200, 250 g/m<sup>2</sup>)with the method of artificial rainfall in laboratory. The results show that runoff and sediment yield rates increase with increasing rainfall intensity and decrease with increasing litter coverage, the correlation relationships are exponential function; relatively stable runoff in runoff–duration curve is mainly affected by rainfall intensity; relatively stable sediment in sediment–duration curve are affected by rainfall intensity, litter and other factors; litter has significant influence on runoff dynamic characteristics, compared with the bare land, runoff velocity of slopes covered with 50, 100, 150 and 200 g/m<sup>2</sup> litter decreased by 17.7%, 26.8%, 37.9% and 26.8%, respectively, decrement of Reynolds number are 11.2%, 18.7%, 26.3% and 18.7%, and decrement of Froude number are 21.3%, 30.3%, 42.9% and 30.3%, respectively. Darcy–Weisbach resistance coefficient increase by 0.5–5.6 times; there is a logarithmic relationship between Darcy–Weisbach resistance coefficient and sediment yield rate, a linear relationship between runoff shear stress, runoff power and sediment yield rate. The correlation coefficients between sediment yield rate and hydrodynamic parameters decrease in the following order:  $Re > w > V > P > Fr > f > t$ .

**Keywords:** litter; simulated rainfall; runoff; sediment; hydrodynamic

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## Vibration fault diagnosis of hydroelectric generating unit by using stochastic resonance and Empirical Mode Decomposition

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3. Gansu Province Electric Power Research Institute, Lanzhou 730050, China)

**Abstract:** Aiming at the low accuracy problems caused by the difficulty of weak signals detection in fault diagnosis for actual hydroelectric generating unit, this paper presents a weak signal detection method based on stochastic resonance (SR) and Empirical Mode Decomposition (EMD). This method first reduces noise signal of a vibration signal using stochastic resonance to enhance its stochastic resonance, then uses EMD to decompose its output signal and energy method to extract its feature vectors. Taking the feature vectors as input, a genetic algorithm optimization and support vector machine model is able to achieve identification and diagnosis of the signal faults. The simulation results show that this method can accurately identify the unit's abnormal situation with high accuracy in fault diagnosis.

**Keywords:** stochastic resonance; EMD; support vector machines; fault diagnosis; hydroelectric generating unit

## Processes of river ice and ice–jam formation in Shensifenzi Bend of the Yellow River

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(College of Water Conservancy and Civil Engineering, Inner Mongolia Agricultural University, Hohhot 010018, China)

**Abstract:** Because of the special channel morphology and geographical location, the initial ice jam is easily formed in the Shensifenzi bend of the Yellow River in Inner Mongolia. According to the field observation and hydrological, meteorological data collection during the winter of 2014–2015, and combining Landsat8 remote sensing image data, the processes of river ice evolution and ice jam formation in Shensifenzi Bend were analyzed. The results show that field observation combined with remote sensing image interpretation can accurately describe the spatio–temporal characteristics of river ice. The growth of dynamic border ice in concave bank and static border ice in convex bank decreased the river width obviously, and reduced the ice transport capacity, which caused ice jamming firstly formed in this bend. Further, ice cover developed upstream from this site. Due to the reduction of ice discharge and increase of the hydraulic slope, the lead form at the downstream of river bend. Under the effect of spiral flow, the frazil ice accumulated under ice cover around the junction of main channel and shoals; during the freeze–up period, changes of air temperature lead ice cover surface solidification and melting, decreasing the roughness and increasing area of smooth ice cover.

**Keywords:** the Yellow River; remote sensing; Shensifenzi River Bend; river ice process; ice jam

## Design and experiment of erosion reduction engineering technology on the wave type slope farmland

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**Abstract:** According to the wave type slope farmland morphological features and its characteristics of soil and water loss, a wave type slope interception-precipitation-drainage technology was designed to solve the soil erosion problems of the wave type slope farmland, and a method was put forward to calculate the relative parameters. Two plots (contrast plot and measure plot) were deployed in a small watershed, named Northeast Gully, in PingQuan County of Hebei Province, and then the runoff and sand output were observed. Observation results during 3 years showed that the soil erosions of wave type slope farmland were mainly caused by several heavy rains, the average erosion reduction rate could still reach 98.37% in the case of heavy rains as a result of using wave type slope interception-precipitation-drainage technology. Additionally, it is found that sub rainfall is an important factor affecting on the soil erosion in wave type slope farmland through the analysis of rainfall data, and by the regulation of the wave type slope interception-precipitation-drainage measures, the runoff of the measure plot has been significantly reduced, and the correlation coefficient between the measure plot runoff and sub rainfall decreased. Finally, the cost of the wave type slope interception-precipitation-drainage technology is estimated at 30,075 yuan per hectare based on the actual cost of building the runoff plots, only account for 49.60% of the rock mountain area stone dike terrace cost, which has a good economic applicability. Therefore, the wave type slope interception-precipitation-drainage technology can effectively prevent the soil and water loss in wave type slope farmland, which can be used as a new technology for slope farmland erosion control.

**Keywords:** wave type slope; soil erosion; engineering technology; rate of cutting flow; rate of erosion reduction

## Application of PyrLK “corner-mass center” method for surface flow field calculation in the complex flow field

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**Abstract:** The method of particles matching is the key to obtain surface flow field value accurately. This paper expounds in detail on principle and realization course of the newly proposed PyrLK “corner-mass center” method based on the optical flow algorithm. Using the PyrLK “corner-mass center” method, the complex surface flow field in the bend channel is calculated, and compared with the advanced method at present called matching probability method. The results indicate that, for the complex flow field shown in this paper, the calculation results of the matching probability method rely on the parameters selected to a large extent such as motion vector permissible variations, and generate the error matching which occurs in implementation process of previous PTV technology owing to mass centers of some non-tracer particles are extracted and used to calculation, because there will be extracted to the center of mass and make them participate in the calculation of tracer particles and the error matching. While the PyrLK “corner-mass center” method only related to image information features and does not rely on the assumption of tracer particle match rule, it can be better in realizing the tracking and matching of tracer particles in the complex flow. Compared with the matching probability method, this method has a better adaptability in the calculation of complex flow field where the tracer particles have large differences in the displacement vector.

**Keywords:** surface flow field; complex flow field; Pyramid LK optical flow method; the matching probability method; PTV



## Numerical model for vertical distribution of dissolved oxygen in cold and icy lake ice

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**Abstract:** According to the observation data of dissolved oxygen (DO) during January to April of 2011 under ice of Valken-Kotinen Lake in Finnish, the vertical distribution patterns of DO are examined by analyzing these data. A new normal distribution model that can describe the spatial and temporal distribution of the DO is also given. The DO concentration in the numerical model is determined by the depth and the frozen duration of the lake. Compared with the results obtained by using wavelet analysis and Gaussian fitting time series methods, the DO concentration under ice attained by the proposed model is more agreed with the experimental data. The drawn surface and contour line of DO concentration are smoother. Finally, some considerations are discussed to improve the proposed model in future. This study can be applied to describe the dissolved oxygen of other cold regions such as icy lake, mariculture ponds, and so on.

**Keywords:** dissolved oxygen; icy lake; data analysis; numerical model