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# Dynamic monitoring of Dongting Lake wetland using time-series MODIS imagery

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**Abstract**: The popular method of wetland mapping, which is usually based on single-date satellite imagery, cannot meet the requirements of wetlands monitoring because of the highly dynamic features of wetlands. Using multi-temporal or time series satellite imagery is a good choice to monitor wetlands at large scale, and time series MODIS products with highly temporal revisiting frequency have been employed in many cases of land use/land cover mapping. Different phonological characteristics of various land cover types laid a foundation for wetlands classification using time series MODIS Enhanced Vegetation Index (EVI) products. The standard phonological curves of various wetlands categories were developed firstly on the base of training samples selected from MODIS images and Google Earth. And then, Spectral Matching of Minimum Distance (SMMD) was employed by taking temporal EVI curve of each pixel as substitute of spectral curve to classify the time series MODIS images from 2001 to 2014 in the Dongting Lake. The results show that: (1) the overall classification accuracy and Kappa coefficient of the study area was 87.87 % and 0.85 respectively in 2014, and the accuracy of the seasonal wetlands was 84.85 %. The good performance of SMMD approach indicates that time series MODIS imagery can be used to monitor the dynamic characteristics of wetland ecosystem. (2) There is a declining trend for those natural wetlands in the Dongting Lake using 2001-2014 MODIS imageries, including waters, seasonal wetlands and permanent marshes. Among them, Permanent water decreased by 11 %, permanent marshes by 22 % and seasonal wetlands by 13 %, while forest land increased continually by 29 %. (3) The decreased amount of water input and altered date of drying and wetting in the Dongting Lake has affected the spatio-temporal landscape patterns of Dongting wetlands ecosystem, such as the shrinkage of permanent waters, spatial transformation of seasonal wetlands and increasing forest land, which undoubtedly will give rise to changes of wetlands functions and services. Those new phenomenon should be paid more attention in future to protect biodiversities and agriculture in this region.

**Key words**: Dongting Lake; MODIS; time series; spectral matching; phenological character

# A briefly review of functional indicators of river ecosystem and its application

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**Abstract**: River health indicators are the measures to reflect the river ecosystem health condition and river ecosystem integrity, which are very important for exact and comprehensive assessment of river health. However, previous studies on river health indicators in our country were mostly focused on the structural aspects of river ecosystem, and functional indicators were rarely reported. This study reviewed the most used functional indicators briefly and introduced the application and criteria of two typical structural and functional indicators. Meanwhile, a case study of Ohyama River environmental flow restoration was introduced to illustrate the application of metabolism in Japan. The results show that the functional indicators can well response to the new environmental flow. The study may be helpful for enriching the indicator system for river health assessment in our country.

**Key words**: river health assessment; functional indicators; organic mass decomposition rate; river ecosystem metabolism rate

# Quantification and evaluation of water footprint of major grain crops in China

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**Abstract**: Guaranteeing water resources and food security are the main challenge that China faces today. To explore the diversity of nutrient supply of different crops in the case of consuming the same volume of water will contribute to establishing the water saving diet pattern and cropping structure. Based on the water footprint(WF) theory, the multidimensional water footprint of five major grain crops are analyzed by assessing the WF per unit weight, per unit energy, and per unit protein of those crops. Through scenario analysis, the water saving benefits of adjustments to the dietary consumption structure is evaluated. The results show that Northeastern and Huang-Huai-Hai Region have a relatively low WF which indicates that those regions have high weight water use efficiency. Among the five grain crops, wheat and maize have relative small energy water footprint. Soybean has a relative small protein water footprint. It indicates that wheat and maize will consume less water than other crops when provide the same energy. Soybean will consume less water than other crops when provide the same protein. Scenario analysis of adjustments to the grain crops structure proves that it is feasible to reach the objective of water saving benefit in agriculture through changing crop consumption structure. The conclusion will act as a reference for a water-conserving dietary pattern, and provide a potential solution for future water resource crises faced by grain production.

**Key words**: water footprint; grain crop; crop consumption pattern; scenario analysis; water saving benefit

# Experimental study on the variation of permeability of medium-fine feldspar-quartz sandstone low-permeability reservoir under the circulatory increasing or reducing conditions of confining pressure

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**Abstract**: Long-term $CO_2$ geological storages are mostly injected in a process with the characteristics of discontinuity in multiple injection stages. Intermittent injections cause reservoir stress to accumulate and dissipate repeatedly, and horizontal effective stress in the reservoir also appears repeated loading and unloading effect. Through experiment, the permeability of two rock samples with similar petrological features were analyzed under the circulatory loading and unloading conditions of confining pressure, and in consideration of stress dissipation during injection gap period. The experimental results show that the permeability are declined significantly with the declines ranging in 20% ~ 40%, under the repeated loading and unloading condition of confining pressure. The change of permeability is smaller in high confining pressure area, while bigger in low confining pressure area. The stress dissipation in injection gap period has much effect on the rock permeability, and full attention should be given to the numerical simulation of actual injection engineering. Based on the experimental data, the permeability quantitative equations in different loading and unloading stage of confining pressure have been built for the medium-fine-grained feldspar-quartz sandstone with about 10% clay mineral content. The result is helpful to evaluate the potential of reservoir storage and to interpret the monitoring data of $CO_2$ geological storage project with multi-period injection.

**Key words**: permeability; reservoir; sandstone; confining pressure; cyclic loading and unloading

## Reservoir stochastic optimization scheduling research based on Bayesian statistics and MCMC

WANG Liping, WANG Boquan, LI Chuangang, LIU Minghao, ZHANG Yanke
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**Abstract**: In order to solve the dimension disaster problem in the theory of Markov stochastic dynamic programming, the paper proposed an improved Markov stochastic dynamic programming. Based on Bayesian statistical principle, the paper used the Markov Chain Monte Carlo method to establish the actual flow probability matrix related to the forecast values according the actual inflow probability density function. The uncertainty optimal scheduling result of the method was compared to the result of Markov stochastic dynamic programming of combination of prediction and non-prediction period. The results show that the results by the improved Markov stochastic dynamic programming are more close to the actual average annual generation, and the computation complexity is reduced effectively and the computing time by the improved method is less than the time by the Markov stochastic optimization scheduling. The method solves the dimensionality problem to some extent and it can provide an important theoretical reference for the optimal scheduling of uncertainty.

**Key words**: Bayesian statistics; optimal scheduling; Markov Chain Monte Carlo; uncertainty

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## Assessment on the hazard of flash flood disasters in China

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**Abstract**: The hazard area of flash flood disaster in China was identified, and the assessment index was proposed on the basis of the characteristics of flash flood disasters in this study. The variable fuzzy set model was used to evaluate the hazard of flash flood disaster with 1km × 1km of resolution in China, and the spatial variation of hazard was analyzed. The results showed that hazard areas accounted for two thirds of the land area in China, in which the high-hazard areas of flash flood disasters accounted for 19.95%, and the extremely high hazard areas accounted for 3.92%. The top five provinces with great ratios of high-hazard areas among the 33 provinces (cities, autonomous regions) in China are Hong Kong, Fujian, Guangxi, Guizhou and Chongqing, which are all flash flood disaster-prone areas; Zhejiang, Hubei, Sichuan and other areas are vulnerable to the impact of small-scale flood disasters. The result objectively reflected the spatial variation of flash flood in China and could provide scientific support for quantitative assessment of flash flood disasters and disasters regionalization.

**Key words**: Flash flood disaster; hazard; China

# Effects of hydrodynamic pressure on dynamic stress of slab of high concrete faced rock fill dam under excitation of different directions

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**Abstract:** There is little study on dynamic interaction of concrete face rockfill dam (CFRD) and reservoir. Existing research generally didn't account for the hydrodynamic pressure component which is caused by vibration of river valley. That means it is impossible to exactly calculate dynamic water pressure on face slab, which go against the reasonable safety evaluation of 300m-level CFRD. In this paper, the 3D finite element dynamic analysis of a 300m high CFRD is adopted to investigate the distribution rule of dynamic water pressure and how much hydrodynamic pressure effects the stress of face slab under excitation of different directions considering hydrodynamic pressure by scaled boundary finite element method (SBFEM). The research results show that the maximum of hydrodynamic pressure caused by longitudinal and axial earthquake has little difference, while it is relatively larger for vertical excitation. On dynamic stress of face slab, hydrodynamic pressure has obvious influence under longitudinal earthquake, some effect under axial seismic load and a big impact under vertical vibration when neglecting dynamic water pressure can substantially undervalue the maximum and high amplitude region of stress along slope direction of face slabs.

**Key words:** hydrodynamic pressure; SBFEM; CFRD; FEM; dynamic stress of face slab

# Mechanism of erosion resistance and vegetation promotion by W-OH in Pisha sandstone

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**Abstract**: Pisha sandstone area is one of the main coarse source areas in the middle reach of the Yellow River, while Chemical-Vegetation measures have a significant effect on protecting Pisha sandstone from rainfall and wind. Based on the experimental study of Pisha sandstone erosion mechanism, surface wettability, corrosion resistance, microstructure, Infrared spectrum (IR), water retention and plant raw, mechanism of erosion resistance and vegetation promotion by a kind of novel hydrophilic polyurethane (W-OH) used in solidifying Pisha sandstone was studied. The results show that the reason why Pisha sandstone susceptible to erosion is mainly due to its compositions and internal structure. However, when certain concentration of W-OH solution is sprayed on the weathering Pisha sandstone surface, it would penetrate into Pisha sandstone particles quickly and wrap them well, and then a certain consolidation layer is formed. As a result, the adhesion force between particles is increased and further erosion would be prevented. Moreover, as a hydrophilic polymer material, W-OH could react with water to form an elastic gel with network. The elastic gel has the effect of water and fertilizer retention, and it could slowly absorb and release water repeatedly in several times to provide the water for vegetation growth and to extend its growth period in dry or semidry areas. Therefore, these all would provide a references and supports in controlling Pisha sandstone area comprehensively.

**Key words**: Pisha sandstone; W-OH composite material; mechanism of erosion resistance; vegetation promotion

# Bond behavior between rebar and geopolymer concrete

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**Abstract**: Geopolymer concrete is a new type of low carbon building material which possesses features such as outstanding high-temperature resistance, high early-strength, low reaction heat, etc. Due to those advantages, geopolymer concrete has been extensively concerned by international academic and engineering world widely in last decade. In comparison to ordinary concrete, the bonding behavior between geopolymer concrete and rebar was studied through pull-out experiment. The influence of different parameters on the bond behavior of reinforcement in geopolymer concrete was discussed. Test data indicate that to transfer the same level of stress, the thickness of concrete cover and developing length of rebar in geopolymer concrete are much smaller than that in ordinary concrete; and the bond performance of rebar in geopolymer concrete is influenced by the loading rate. With increase of loading rate, an improvement in bond strength and energy consumption is achieved; however, the improvement becomes weak with the increase of developing length. Based on test data, empirical formulas were proposed to estimate the bond strength of rebar in geopolymer concrete. According to these formulas, some suggestions were recommended for the design of reinforced geopolymer concrete structures.

**Key words**: geopolymer concrete; developing length; bond strength; pull-out experiment; mechanism of failure

# Research on conservation strategy of water heritages based on investigation of the Grand Canal in China

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**Abstract**: The Grand Canal of China is the largest canal system located on the most complex landform with longest history for application listed in The World Culture Heritage group, with water projects as main-body and core components. Based on investigation of canal and related rivers, all kinds of water projects and heritages along, existing functions, management system and related planning on the canal, this paper analyzes prominent problems on water projects heritages conservation and development, discusses strategy in the future and gives proposal on macroscopic view. Research finds that the Grand Canal with double attributes of a culture heritage and active water works continues to evolve as its essential characteristic, and the isolation of relevant departments and inadequate legal system are the primary causes of existed problems. It is pointed out that the water functions of the Grand Canal should be equally accounted in canal heritage protection, and its utilization such as culture heritage, perfect and united law system and technical standard system should be formed for in-use heritage conservation. Overall planning, distinct treatment, emphasizing the key points and step-by-step actions should be the principle to conserve and develop the water heritages of the Grand Canal, and basic and applied research, demonstration and spreading of water technology and culture in canal history should be reinforced in the same time.

**Key words**: the Grand Canal; water heritage; investigation; conservation; strategy

# Multi-objective optimization method for irrigation scheduling of crop rotation system and its application in North China

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**Abstract**: For rotation cropping system of winter wheat and summer corn in North China, a multi-objective simulation based optimization model was proposed to determine the optimal irrigation scheduling on annual basis based on irrigation experiment data. For simulation models, a cropland water balance model was used to simulate field evapotranspiration processes at different irrigation scheduling, and crop water production functions of winter wheat and summer corn were used to estimate crop yield at different irrigation scheduling. For the optimization model, the date and quota of irrigation applications for two rotation crops were taken as decision variables, and the crop yield of winter wheat and summer corn were taken as two objectives. By introducing dynamic penalty function for the constraint of irrigation quota, the non-dominated sorting genetic algorithm-II was used to solve the multi-objective simulation based optimization model to get the Pareto solution set. According to the principles of the ideal point method, an appropriate irrigation scheduling was recommended from the Pareto solution set for each given irrigation quota. The multi-objective optimization results of irrigation scheduling for winter wheat-summer corn rotation field in Beijing show that the key irrigation periods for winter wheat are heading and filling stages, which is in agreement with the periods with higher water sensitivity. The key irrigation periods for summer corn are shooting and filling stages, which is before the periods with higher water sensitivity caused by lower initial water content and precipitation process in the growing period. With the increase of irrigation quota, the yield of two crops increases, the production value increases in parabolic manner with decreasing marginal benefit, the crop evapotranspiration increases logarithmically, and the amount of soil water use decreases in parabolic manner.

**Key words**: irrigation scheduling; crop rotation; cropland water balance; crop water production function; multi-objective optimization

# A calculation method for the capillarity force of the liquid bridge between coarse particles considering the effect of solid-liquid contact angle

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**Abstract**: The investigation of the capillary force of water in the form of liquid bridge between soil particles is increasingly concerned by soil mechanics researchers. To investigate the effect of solid-liquid contact angle on the capillary force of liquid bridge between coarse particles, these particles can be simplified as a pair of uneven-sized sphere particles. The gravity and buoyancy of particles will be neglected with a toroidal approximation of the liquid bridge geometry. Based on Young-Laplace equation, governing equations were first derived to calculate capillary fore for the liquid bridge. The combined iterative procedure was then proposed on the cases of perfectly and non-perfectly wetting coarse particles, so as to study the influence of solid-liquid contact angle, liquid bridge volume, and ratio of particle radius on the normalized relations between capillary force and particle separation. Finally, the combined iterative procedure was validated against the test data of capillary force versus particle separation for uneven-sized particles in the past literature. The results of RMSE between predicted and measured values of capillary force of liquid bridge show that this procedure is superior to other one in previous work for describing the evolution of capillary force with particle separation.

**Key words**: unsaturated soil; coarse particle; capillary force; liquid bridge; solid-liquid contact angle; the combined iterative procedure

# Experimental research on permeability of undisturbed loess during the freeze-thaw process

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**Abstract**: Based on the electron microscope scanning and triaxial permeability test of $Q_3$ undisturbed loess from Xi'an, the permeability of undisturbed loess during the freeze-thaw process was studied. Experiment results show that during the freeze-thaw process, the growth of ice crystal and formation of cryogenic structure result in obvious change of microstructure about undisturbed loess, and the permeability of loess is enhanced. Using the image processing software, it is concluded that the void area ratio exponentially increases with the increase of freezing-thawing cycle number, representing that the structural strength of loess can be destroyed by freezing-thawing. However, the strength and permeability of loess tend to be stable after repeated freezing and thawing. Freezing-thawing makes the irregular cracks produced on the surface of the sample, and has a bigger influence with the increase of water content, which is the main reason for the enhancement of permeability. The permeability coefficient decreases exponentially with the increase of confining pressure, and the permeability coefficient difference under high confining pressure is small. The permeability coefficient approximately follows the parabola rule with the increase of moisture content, and the rule is not obvious under high confining pressure. The permeability coefficient exponentially increases with the increment of freezing-thawing number, and the permeability coefficient of sample with low water content has a small change. Based on the regularity of test data, a multivariate prediction model was developed by considering the influence of moisture content, freezing-thawing number and confining pressure.

**Key words**: undisturbed loess; freeze-thaw action; SEM; permeability