บทความที่น่าสนใจประจำเดือนพฤศจิกายน 2555

1. Influence of biofouling on pharmaceuticals rejection in NF membrane filtration

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สาระสังเขป: The effects of biomass attachment and growth on the surface characteristics and organic micropollutants rejection performance of nanofiltration membranes were investigated in a pilot installation. Biomass growth was induced by dosing of a readily biodegradable carbon source resulting in the formation of a biofouling in the investigated membrane elements. Surface properties and rejection behaviour of a biofouled and virgin membrane were investigated and compared in terms of surface charge, surface energy and hydrophobicity. The last two were accomplished by performing contact angle measurements on fully hydrated membrane surfaces, in order to mimic the operating conditions of a membrane in contact with water. Compared to a virgin membrane, deposition and growth of biofilm did slightly alter the surface charge, which became more negative, and resulted in a higher hydrophilicity of the membrane surface. In addition, the presence of the negatively charged biofilm induced accumulation of positively charged pharmaceuticals within the biomass layer, which probably also hindered back diffusion. This caused a reduction in rejection efficiency of positively charged solutes but did not alter rejection of neutral and negatively charged pharmaceuticals. Pharmaceuticals rejection was found to positively correlate with the specific free energy of interaction between virgin or biofouled membranes and pharmaceuticals dissolved in the water phase. The rejection values obtained with both virgin and biofouled membranes were compared and found in good agreement with the predictions calculated with a solute transport model earlier developed for high pressure filtration processes.

2. Solar disinfection of wastewater to reduce contamination of lettuce crops by Escherichia coli in reclaimed water irrigation

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สาระสังเขป: Low-cost disinfection methods to allow safe use of recycled wastewater for irrigation can have important beneficial implications in the developing world. This study aims to assess the efficiency of solar disinfection to reduce microbial contamination of lettuce crops when solar-treated wastewater effluents are used for irrigation. The irrigation study was designed as a complete experimental loop, including (i) the production of irrigation water through solar disinfection of real municipal wastewater treatment plant effluents (WWTPE), (ii) the watering of cultivated lettuce crops at the end of solar treatment, and (iii) the detection of microbial contamination on the irrigated crops 24 h after irrigation. Solar disinfection was performed using two types of reactors: (i) 20-L batch borosilicate glass reactors equipped with CPC to optimize solar irradiation, and (ii) 1.5-L PET bottles, i.e. the traditional SODIS recipients commonly used for disinfection of drinking water in developing communities. Both solar and H_2O_2-aided solar disinfection processes were tested during ≤5 h exposure of WWTPE, and *Escherichia coli* inactivation was analysed. A presence/absence detection method was developed to analyse lettuce leaves sampled 24 h after watering for the detection of *E. coli*. Results of inactivation assays show that solar disinfection processes can bring down bacterial concentrations of $>10^3$–10^4 *E. coli* CFU mL^{-1} in real WWTPE to <2 CFU/mL (detection limit). The absence of *E. coli* on most lettuce samples after irrigation with solar-disinfected effluents (26 negative samples/28) confirmed an improved safety of irrigation practices due to solar treatment, while crops irrigated with raw WWTPE showed contamination.

3. Modeling complexity in simulating pesticide fate in a rice paddy

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สาระสังเขป: Modeling approaches for pesticide regulation are required to provide generic and conservative evaluations on pesticide fate and exposure based on limited data. This study investigates the modeling approach for pesticide simulation in a rice paddy, by developing a component-based modeling system and characterizing the dependence of pesticide concentrations on individual fate processes. The developed system covers the modeling complexity from a “base model” which considers only the essential processes of water management, water–sediment exchange, and aquatic dissipation, to a “full model” for all commonly simulated processes. Model capability and performance were demonstrated by case studies with 5 pesticides in 13 rice fields of the California's Sacramento Valley. With registrant-submitted dissipation half-lives, the base model conservatively estimated dissolved pesticide concentrations within one order of magnitude of measured data. The full model simulations were calibrated to characterize the key model parameters and processes varying with chemical properties and field conditions. Metabolism in water was identified as an important process in predicting pesticide fate in all tested rice fields. Relative contributions of metabolism, hydrolysis, direct aquatic photolysis, and volatilization to the overall pesticide dissipation were significantly correlated to the model sensitivities to the corresponding physicochemical properties and half-lives. While modeling results were sensitive to metabolism half-lives in water for all fields, significances of metabolism in sediment and water–sediment exchange were only observed for pesticides with pre-flooding applications or with rapid dissipation in sediment. Results suggest that, in addition to the development of regional modeling scenarios for rice production, the registrant-submitted maximum values for the aquatic dissipation half-lives could be used for evaluating pesticide for regulatory purposes.

4. Valuing hydrological alteration in multi-objective water resources management

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วารสาร: Journal of Hydrology, Volumes 472–473, 23 November 2012, Pages 277–286

Summary: The management of water through the impoundment of rivers by dams and reservoirs is necessary to support key human activities such as hydropower production, agriculture and flood risk mitigation. Advances in multi-objective optimization techniques and ever growing computing power make it possible to design reservoir operating policies that represent Pareto-optimal tradeoffs between multiple interests. On the one hand, such optimization methods can enhance performances of commonly targeted objectives (such as hydropower production or water supply), on the other hand they risk strongly penalizing all the interests not directly (i.e. mathematically) included in the optimization algorithm. The alteration of the downstream hydrological regime is a well established cause of ecological degradation and its evaluation and rehabilitation is commonly required by recent legislation (as the Water Framework Directive in Europe). However, it is rarely embedded in reservoir optimization routines and, even when explicitly considered, the criteria adopted for its evaluation are doubted and not commonly trusted, undermining the possibility of real implementation of environmentally friendly policies. The main challenges in defining and assessing hydrological alterations are: how to define a reference state (referencing); how to define criteria upon which to build mathematical indicators of alteration (measuring); and finally how to aggregate the indicators in a single evaluation index (valuing) that can serve as objective function in the optimization problem. This paper aims to address these issues by: (i) discussing the benefits and constrains of different approaches to referencing, measuring and valuing hydrological alteration; (ii) testing two alternative indices of hydrological alteration, one based on the established framework of Indicators of

Hydrological Alteration (Richter et al., 1996), and one satisfying the mathematical properties required by widely used optimization methods based on dynamic programming; (iii) demonstrating and discussing these indices by application River Ticino, in Italy; (iv) providing a framework to effectively include hydrological alteration within reservoir operation optimization.

5. Effect of connecting rain barrels on the storage size reduction

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วารสาร: Hydrological Processes, Volume 26, Issue 23, November 2012, pages 3538–3551

สาระสังเขป: In this article, the possibility of sharing rain barrels and the potential benefit of reducing storage size through physical and non-physical connections of rain barrels in a community are investigated. Using the concepts of homogeneous/heterogeneous users in rainwater harvesting systems (RWHS), two simple cases of a community composed of four prospective users are examined. The first is performed with the users who have the same mean and variance in water demands (homogeneous users), and the second is with the users with different means and variances (heterogeneous users). To take account for the rainfall characteristics in different places, historical records from six cities in the USA are used for storage–reliability–yield analysis. The result indicates that required total storage can be reduced by connecting multiple rain barrels. In addition, a significant difference is found between homogeneous and heterogeneous user groups. Homogeneous users do not achieve a substantial benefit from connecting their rain barrels; these users may even be disadvantaged by sharing. In contrast, heterogeneous users receive benefit by reducing the total required storage. Most benefit is expected between users with maximum difference in mean water demands. The reduction in storage size was as considerable as 37% in this study. The quantity of storage reduction depends on locations and target reliabilities. Knowledge of the benefits and limitations of rain barrel connections can improve RWHS performance through ability to customize a network plan for individual users.

6. Flood changes during the past 50 years in Wujiang River, South China

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วารสาร: Hydrological Processes, Volume 26, Issue 23, November 2012, pages 3561–3569

สาระสังเขป: Changing trends of peak flood and flood duration in the Wujiang River Basin are detected with the help of the Mann–Kendall test and the Pettitt analysis during the past 50 years. Results indicate that the peak flood and the flood duration at Lishi Station have different changing features. The peak flood showed only marginally increasing trend, whereas the flood duration exhibited decreasing trend at the significance level of 90%. The result shows a weak positive correlation between the peak flood and the flood duration. The changes of flood duration are influenced by the total rainfall duration, which is in downward trend at significance level 90%. In addition, the changing trends of peak flood are similar to the total rainfall amount. In the change-point analysis, it was found that the change points for the peak flood and flood duration series were in the years 1993 and 1966, respectively. Human activities such as the construction of reservoirs were the main driving forces causing the change of flood duration. The periodicity of the peak flood during the period 1955–2007 at Lishi Station is detected by using the wavelet analysis. The result indicates that the peak flood at Lishi Station displayed alternation between big floods and small floods on the 25- to 26-year period. At the same timescale, the peak flood of Wujiang River showed an evidence of change between big floods and small floods. It was essential to be prepared and aware of the consequences of climate changes and human influences affecting the water resources in the Wujiang River Basin. This result is expected to draw more attention from the local governments in its decision making and water resource management.

7. Numerical experiments on breaking waves on contrasting beaches using a two-phase flow approach

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สาระสังเขป: A mechanistic understanding of beach environments needs to account for interactions of oceanic forcing and beach materials, in particular the role of waves on the evolution of the beach profile. A fully coupled two-phase flow model was used to simulate nearshore fluid-sediment turbulent flow in the cross-shore direction. It includes the Reynolds-Averaged Navier–Stokes equations and turbulent stress closures for each phase, and accounts for inter-granular stresses. The model has previously been validated using laboratory-scale data, so the results are likely more reliable for that scale. It was used to simulate wave breaking and the ensuing hydrodynamics and sediment transport processes in the surf/swash zones. Numerical experiments were conducted to investigate the effects of varying beach and wave characteristics (e.g., beach slope, sediment grain size, wave periods and heights) on the foreshore profile changes. Spilling and plunging breakers occur on dissipative and intermediate beaches, respectively. The impact of these wave/beach types on nearshore zone hydrodynamics and beach morphology was determined. The numerical results showed that turbulent kinetic energy, sediment concentrations and transport rate are greater on intermediate than on dissipative beaches. The results confirmed that wave energy, beach grain size and bed slope are main factors for sediment transport and beach morphodynamics. The location of the maximum sediment transport is near the breaking point for both beach types. Coarse- and fine-sand beaches differ significantly in their erosive characteristics (e.g., foreshore profile evolutions are erosive and accretionary on the fine and coarse sand beaches, respectively). In addition, a new parameter (based on main driving factors) is proposed that can characterize the sediment transport in the surf and swash zones. The results are consistent with existing physical observations, suggesting that the two-phase flow model is suitable for the simulation of hyper-concentrated mixed water-sediment flows in the nearshore. The model thus has potential as a useful tool for investigating interactions between nearshore hydrodynamics and beach morphology.

8. Viscoplastic dambreak waves: Review of simple computational approaches and comparison with experiments

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วารสาร: Advances in Water Resources, Volume 48, November 2012, Pages 79–91

สาระสังเขป: We investigated the dam-break problem for Herschel–Bulkley fluids: a fixed volume of a viscoplastic material (a polymeric gel called Carbopol ultrez 10) was released and flowed down an inclined flume. Using Particle Image Velocimetry techniques, we measured the velocity profiles far from the sidewalls, the front position as a function of time, and the flow depth evolution at a given place. The experimental data were compared to three models of increasing complexity: the kinematic wave model, an advection diffusion model (lubrication theory), and the one-layer Saint-Venant equations. Surprisingly, the best agreement was obtained with the simplest model (kinematic wave model) even though it could not capture the details of the head profile (regarded as a shock wave, i.e., a discontinuity). Lubrication theory (the advection diffusion model) performed well from a qualitative viewpoint. Computed velocity profiles and depth evolution were in reasonably good agreement with data, but this model overestimated initial acceleration, which resulted in a systematic difference between theoretical and experimental curves of the front position over time. This shortcoming was not fixed when using a more elaborate model (Saint-Venant equations), rather it was exacerbated. The relatively modest performance of the more elaborate models was intriguing (for Newtonian liquids, the best agreement was obtained with the most sophisticated model).

9. Velocity distribution for open channel flows with suspended vegetation

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วารสาร: Advances in Water Resources, Volume 49, December 2012, Pages 56–61

สาระสังเขป: Suspended vegetation in open channels retards flow, which, as a result the vertical distribution of streamwise velocities, will deviate from the classic logarithmic law. To clearly understand the hydraulic properties of turbulent flow in an open channel with suspended vegetation, we analyzed hydraulic mechanisms by vertically dividing the flow region into three parts extending from the channel bed to the water surface: a basal non-vegetated layer, an internal vegetation layer and an upper vegetation layer. For each layer, the streamwise velocity was obtained by mathematically solving the momentum equations. Mixing length theory was adopted to determine the shear stress in the internal and non-vegetation layers, and some parameters were determined using published data from Plew's detailed laboratory measurements. The good agreement between the analytically and experimentally predicted vertical distributions of streamwise velocity indicated that the three-layer model is both applicable and reliable.

10. Product-Units neural networks for catchment runoff forecasting

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สาระสังเขป: In this paper Product-Units neural networks (PUNNs), which probably have never been used within the field of hydrology, are introduced and applied for catchment runoff forecasting in cold climate zones. This type of neural networks, a subclass of higher order neural networks uses product nodes with inputs raised to exponential weights in one layer and well-known summation nodes in another layer. The present paper empirically shows that PUNNs with unbounded weights are difficult to train and do not perform well for catchment runoff forecasting. However, a very good predictive performance may be achieved when the weights are bounded within [−1, 1] interval. Several variants of optimization methods, mostly Differential Evolution-based algorithms, and a few approaches enabling good generalization capabilities of neural networks are compared in order to select the appropriate technique for PUNNs training. PUNNs with parameters bounded within [−1, 1] interval are shown to outperform Multi-Layer Perceptron neural networks and HBV conceptual model for runoff forecasting case study at Annapolis River, Nova Scotia, Canada. Gradient-based Levenberg–Marquardt algorithm and Evolutionary Computation-based Differential Evolution with Global and Local Neighborhood method turn out to be the most successful among the tested training algorithms. Surprisingly, in the case of Product-Units neural networks with weights bounded within [−1, 1] interval using noise injection or early stopping do not improve the results obtained when no method to avoid overfitting is used.