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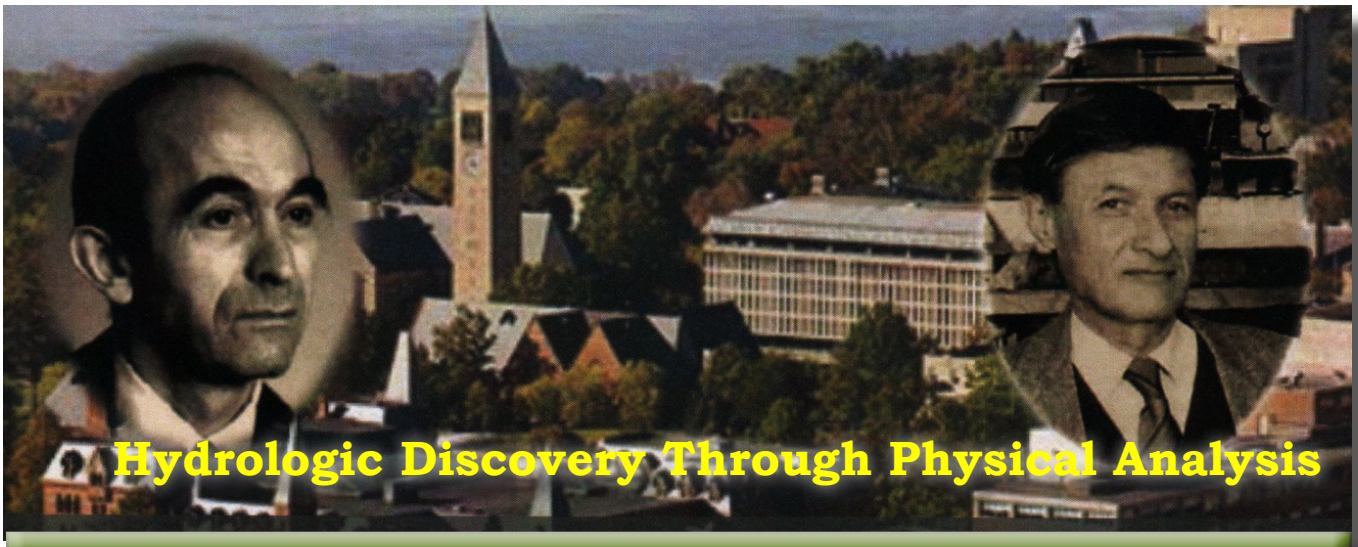

Poster Presentations

Abstracts with Links to the Posters

Honoring the Scientific Legacies of

Wilfred H. Brutsaert & Jean-Yves Parlange

May 14–15, 2012

Acknowledgments

The Symposium honoring Brutsaert and Parlange was organized by John Selker, Tammo Steenhuis,Todd Walter, Peggy R. Stevens, Andrew Barry and William Kustas, with special assistance from Marc Parlange,

Additional special assistance with the logistical support for the poster sessions was provided by Amy S. Collick. She also assembled and produced the booklet of abstracts for the oral presentations and the poster sessions. Steve Pacenka and Dan Fuka also provided valuable logistical support.

Peggy Stevens created the Symposium website and prepared the booklets and handouts for the Symposium. She also assembled and produced the booklet of abstracts for the oral presentations and the poster sessions. These Contents listings are a reformatted version of that document.

The videographers for the symposium were Peter Carroll and J. Robert Cooke, who also served as producer and editor for this online material. Mira Basara of the Cornell University Library posted these materials in eCommons in the Collection of Symposia as Hydrologic Discovery Through Physical Analysis Honoring the Scientific Legacies of Wilfried H. Brutsaert and Jean-Yves Parlange at **http://ecommons.library.cornell.edu/handle/1813/29545**

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EROSION

A1. Landslide Patterns as Fingerprints of Climate Change and Basin Scale Integrated Risk

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Abstract: Landslides are extremely important geomorphic events which sculpt river basin ecosystems by eroding hillslopes and providing sediments to coastal areas. However, at the same time landslides are hazardous events for socio-ecological systems causing enormous biodiversity, economic, and life losses in developed and in development countries. We propose a statistical spatially-explicit model based on a maximum entropy principle model (MaxEnt) for the prediction of precipitation-triggered landslides at the year-scale. The model is based on landslide occurrences, precipitation patterns, and environmental covariates at the basin-scale. The model predicts the size-distribution and location of over 27,500 historical landslides for the Arno basin in Italy which is considered as a case study of precipitation-controlled basins. Future landslide patterns are predicted for the A1B and A2 climate precipitation ensembles from 2010 to 2100. The spatial distribution of landslides, their size, and their potential hazard is calculated. The potential landslide-hazard is strongly correlated with the variation of the 12- and 48-hour precipitation with return time of 10 years. We assume a homogenous damage function in order to provide an average estimate of the potential hazard of landslides. The potential landslide-hazard is determined by 4-parameters of the double-Pareto landslide-size distribution: scaling exponents and truncation points of scaling regimes. Thus the landslide-size distribution is an indicator of the geomorphic effectiveness of precipitation. We observed an increase in potential landslide-hazard in the dry period 2040-2100 due to the activation of small landslides in remnant sites of past big landslides. On average, as the climate gets wetter the probability of large landslides gets higher. For a +20 and -15 mm variation of the 12-hour precipitation in 2020 and 2100 respectively the potential hazard of landslide is predicted 90 and 20 times higher than in 2011. For the Arno, the A1B and A2 emission scenarios do not produce relevant differences in the predicted landslide patterns, supposedly due to the small scale of the basin with respect to the scale of variability of precipitation. The model is proposed as a valuable risk-assessment tool under climate change scenarios. Further development is needed for calculating heterogeneous damage functions based on real exposure and vulnerability as a function of predictions of socio-ecological systems for the landscape analyzed. Our landslide modeling and assessment of landslide hazard is potentially applicable to any river basin worldwide in which precipitation plays a key role in landscape evolution.

URL: http://hdl.handle.net/1813/29610

A2. Effect of Rock Fragment Coverage on Soil Erosion

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Abstract: Rain splash soil erosion in the presence of rock fragments was tested in laboratory flume experiments under controlled conditions. The surface area exposed to rain splash erosion was adjusted by placing rock fragments onto the surface of differently prepared soil in laboratory flumes (surface initially dry and hand cultivated or sealed due to the pre-wetting). The laboratory results showed that the eroded cumulative mass depended on the cumulative runoff, and that soil erosion was proportional to the soil surface area exposed to raindrops, in situations where an initially dry, hand cultivated and smoothed soil surface were ensured. The results showed that this relationship was controlled to a smaller extent by the soil's initial moisture content, bulk density and soil surface characteristics. More in detail, it was observed that sediment concentrations during the first part of the erosion event were more sensitive to the initial state of the soil surface, whereas at steady state it was observed that the concentrations of eroded sediments were controlled mainly by the effective rainfall and area exposed to raindrops. Previously published field data on rain splash soil erosion were analyzed to ascertain whether the same behavior was evident under field conditions. It was found that rain splash erosion is in general not proportional to the area exposed. In contrast to the controlled laboratory experiments, the field experiments were characterized by non-uniform initial surface roughness, surface soil aging and heterogeneous rock fragment size and spatial distribution.

An area-based modification of the Hairsine and Rose (H-R) soil erosion model was employed to analyze the experimental data. The H-R model predictions agreed well with the measured sediment concentrations when high rainfall intensity and low rock fragment cover were used. Predictions were instead less accurate with low rainfall intensity and high rock fragment cover

URL: http://hdl.handle.net/1813/29579

A3. Effect of Antecedent Conditions on Soil Erosion Dynamics in a Laboratory Flume

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Abstract: The effect of antecedent conditions on precipitation-driven soil erosion dynamics through multiple rainfall events was investigated using a pair of 6-m × 1-m flumes with 2.2% slope. Three experiments denoted H6, H7-E2 and H7-E3, involved the same precipitation rate of 74 mm h-1, but using the different initial conditions. In each experiment, one flume was bare while the other had 40% rock fragment coverage. The soil was hand cultivated and smoothed before the first event (H6) only. However, the initial bulk density and moisture content were increased before the two others events using different pre-wetting followed by 22h of air-drying. Sediment concentrations at the flume exit reach steady-state conditions over time scales that increase with sediment size, and experiments were designed such that both steady and non-steady effluent concentrations were reached in H7-E1. Results showed that short-time soil erosion was sensitive to whether steady-state erosion was achieved during the preceding event, although consistent steady-state effluent concentrations were reached for each sediment class. Steady state concentrations were, however, dependent on the rainfall intensity. If steady-state concentrations were reached for a particular size class, that class's effluent concentration peaked rapidly in the next rainfall event, then declined gradually to its steady-state value. When steady concentrations were not reached, the subsequent event produced effluent concentrations that increased gradually to steady state. The results showed that the presence of rock fragments on the topsoil reduced the time needed to reach steady state compared with bare soil.

Digital terrain models (DTMs) were generated before and after one of the experiments. The results revealed that the rock fragments protected the soils from raindrop detachment and retarded the overland flow, therefore decreasing its sediment transport capacity. The DTM results showed that the presence of rock fragments on the soil surface led to increased soil compaction, perhaps due to higher soil moisture content (from greater infiltration) within the rock fragment-covered flumes.

URL: http://hdl.handle.net/1813/29580

A4. A Web-Based BMP Selection Tool to Minimize Pesticide Transport

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Abstract: Farmers rely on best management practices to reduce pesticide transport to surface waters and groundwater. There are a variety of tools available to help soil and water conservation managers optimize agricultural best management practices (BMPs), but many require a considerable amount of time to calibrate and/or advanced training to use. More often than not, these same BMP tools also fail to accurately identify dominant hydrological processes, and thus, the location of runoff generating areas. More specifically, commonly used BMP selection tools are capable of predicting either infiltration excess runoff or saturation excess runoff but not both. Many studies have shown that saturated areas in the landscape are more likely to contribute dissolved and sediment bound contaminates. Therefore, an easy-to-use tool that can accurately characterize local hydrology is needed to assist soil and water managers as they work to target management practices and reduce pesticides transport. In this study we present a simple online BMP selection tool and compare simulated versus observed atrazine loads under different tillage conditions in the Goodwater Creek Watershed of northeastern Missouri. Results indicate a reasonable fit for runoff and dissolved atrazine concentrations but more research is needed to improve the accuracy and usability of this tool.

URL: http://hdl.handle.net/1813/29581

A5. Identifying Susceptible Areas for Gully Erosion Using a Geospatial Analysis

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Abstract: Many studies have noted that gully erosion, the severe stage of soil erosion, has become one of the most challenging environmental problems restricting the long term productivity agriculture and water quality in developing countries. Even though several soil and water conservation practices have been implemented, the effects are far below expectations mainly due to lack of information to identify vulnerable areas for gully erosion. In this study, we specifically tested reliability of the topographic wetness index (TWI) to predict areas sensitive to gully erosion where saturation excess overland flow controls the erosion process. We used Debre Mewi watershed 30 km south of Lake Tana in the head waters of the Blue Nile where upland erosion takes place and gullies are actively forming in downhill locations. Wells were installed to measure groundwater table depths in the gully and in surrounding areas to assess the influence of subsurface flow on gully formation. Using geospatial analysis, TWI was correlated with ground water table depths during rainy months and can be used to estimate gully susceptibility in the studied region when data availability is limited.

URL: http://hdl.handle.net/1813/29582

A6. A Simple Hillslope Erosion Model for Saturation Excess Runoff Tested in the Ethiopian Highlands

Seifu A. Tilahun[1,2], Christian D. Guzman[1], Tegenu A. Engda[3], Assefa D. Zegeye[3,5], Amy S. Collick[1,2], A. Rimmer[4], and T. S. Steenhuis[1,2]

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Abstract: A simple hillslope erosion model is developed and tested for watersheds ranging from 100 ha to 180,000 km2 in Ethiopian Highland. The erosion model is a simplification of Hairsine and Rose (1992) in which sediment concentration is a linear function of velocity and it has only two parameters to be calibrated. The model is coupled with a saturation excess water balance model that divides the watershed into three regions: two runoff producing areas (saturated and degraded) and a hillslope region with shallower soils where water infiltrates and is the source of the baseflow and interflow. The hydrology model has nine parameters consisting of the relative portion in the watershed and the water holding capacity for each of the regions and three subsurface flow parameters. Only surface flow generates sediment. Baseflow and interflow dilutes the concentration in the surface flow. This model was simulated in two upland watersheds (Anjeni and Debre Mawi with a size of 1Km2) in Blue Nile Basin dominated by agricultural activity and the Blue Nile Basin (180,000km2). The daily sediment concentration simulation for the two upland watersheds and the 10-day model simulation for Blue Nile basin compares well with the measured data with Nash Sutcliffe efficiency in the range of 0.64 to 0.8 while the hydrology model was in the range of 0.7 to 0.9. The result suggested that sediment producing areas are only 20% and the higher parameter parameters in Debre Mawi and Anjeni might be because of agricultural activities, higer slope and gullies. The analysis also suggests that identifying the runoff source areas and predicting the surface runoff correctly is an important step in predicting the sediment concentration.

URL: http://hdl.handle.net/1813/29583

A7. Decision Making and Analysis Tools for Biosurveillance and Sustainable Watershed Management

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Abstract: The biggest challenges in mitigating water contamination with chemical and biological agents are (1) identification of their sources, and (2) lack of real- or near-real time assessment of environmental processes. This problem is exacerbated by the heterogeneous distribution of contaminants in time and space. Any watershed management decisions must therefore be made under conditions of uncertainty. This is the focus of the ongoing work at UC's Multi-Scale Environmental Modeling Lab, which brings into a common, systems-based framework several aspects of watershed management. In this framework, strategic and optimized biosurveillance yields multi-scale data that include environmental information coupled with microbial concentrations, genetic sequences and host-specific information from environmental samples. These data are used in stochastic models of microbial dynamics and nutrient transport that capture their interactions with sediment transport in watersheds. Results embedded into GIS are employed to develop risk and vulnerability maps, which in turn are used to inform decisions on surveillance strategies and watershed management.

We show two applications in Little Miami River's East Fork Watershed in Southeast Ohio. The first application couples a stochastic microbial transport model with an erosion model (the Water Erosion Prediction Project – WEPP) to better understand transport and partitioning of fecal contaminants in overland and stream flow. The second develops spatial probability maps that indicate probabilities of exceeding the nitrogen standard in various hydrologic regimes. This effort is based on load-resistance models borrowed from structural engineering, which provide methodology to estimate failure in complex structures. Both models are implemented in ArcGIS's Schematic Processor, a suite of geoprocessing tools expanded to accommodate for complexities of microbial and nutrient transport in watersheds.

URL: http://hdl.handle.net/1813/29584

BOUSSINESQ AND RUNOFF RELATIONSHIPS

B1. Recession Slope Analysis Coefficients, Low Flows, Groundwater and Precipitation Responses for Climate Change Studies

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Abstract: Recession slope analysis has often been used to estimate aquifer thickness, i.e. groundwater depth. Here we look at long term trends in the coefficients of this analysis for several large watersheds in areas potentially free of human influences in Pennsylvania, and compare them with trends in groundwater depths and low flows. We also look at long term precipitation trends in these areas, making the effort to compare the trends according to different hydrological units such as individual watersheds and Atlantic/non-Atlantic interferences drainage areas. In general total annual precipitation has tended to increase. These increases are matched by an increase in low flows. Intriguingly, the coefficients of the recession slope analysis show trends that do not match the trends in groundwater depths or low flows. These comparisons show that the choice of analysis may have important implications on the conclusions drawn from studies that attempt to assess the effects of climate change on the hydrological cycle.

URL: http://hdl.handle.net/1813/29585

B2. Modelling (Flash) Floods in a Dutch Lowland Catchment

Claudia Brauer[1], Ryan Teuling1, Aart Overeem[1,2], Ype van der Velde[3], Pieter Hazenberg[1], Piet Warmerdam[1], Peter Kloosterman[1], Remko Uijlenhoet[1]*

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Abstract: On 26 August 2010 the eastern part of The Netherlands and the bordering part of Germany were struck by a series of heavy rainfall events. We investigated the unprecedented flash flood triggered by this exceptionally heavy rainfall event (return period > 1000 years) in the 6.5 km2 Hupsel Brook catchment, which has been the experimental watershed employed by Wageningen University since the 1960s. This study improved our understanding of the dynamics of such lowland flash floods and the results have been published in HESS (Brauer et al., 2011). During this extreme event some thresholds became apparent that do not play a role during average conditions and are not incorporated in rainfall-runoff models.

We present a detailed analysis of this extreme event, focusing on (1) the measured soil moisture, groundwater and discharge response of the catchment, (2) the thresholds we found, (3) the manner in which these processes and thresholds are incorporated in some well-known conceptual hydrological models and (4) how well these models are able to simulate the rainfall-runoff processes during the 2010 flash flood.

Reference

Brauer, C.C., Teuling, A.J., Overeem, A., van der Velde, Y., Hazenberg, P., Warmerdam, P.M.M and Uijlenhoet, R.: Anatomy of extraordinary rainfall and flash flood in a Dutch lowland catchment, Hydrol. Earth Syst. Sci., 15, 1991–2005, 2011.

URL: http://hdl.handle.net/1813/29586

B3. Approximate Solution to the Generalized Boussinesq Equation

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Abstract: The Boussinesq equation describes water flows in unconfined groundwater aquifers under the Dupuit assumption that the equipotential lines are vertical, making the flow essentially horizontal. It is a nonlinear diffusion equation with diffusivity depending linearly on water head. The generalized Boussinesq equation or the porous medium equation is a diffusion equation where the diffusivity is a power law function of water head. Solutions to the generalized porous medium equation will propagate with a finite speed in case of initially dry aquifer, unlike the solutions to the linear diffusion equation that propagate with infinite speed. For certain types of initial and boundary conditions similarity reductions are possible; and the original initial-boundary value problem for the partial differential equation is reduced to a boundary value problem for a nonlinear ordinary differential equation. We construct approximate analytical solutions to the generalized Boussinesq equation that respect the scaling properties of the equations.

URL: http://hdl.handle.net/1813/29587

B4. Improving Risk Estimates of Runoff Producing Areas: Formulating Variable Source Areas as a Bivariate Process

Xiaoya Cheng[*1], *Helen E. Dahlke*[2], *Stephen B. Shaw*[3], *Rebecca D. Marjerison*[1], *Chris Yearick*[4], *Stephen D. DeGloria*[5], *M. Todd Walter*[1]

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Abstract: Predicting runoff producing areas and their corresponding risks is important for developing watershed management strategies for protecting water quality from nonpoint source pollution. However, the currently proposed engineering methods to do this do not account for antecedent soil wetness status, which may substantially impact risk estimates, especially where variable source area (VSA) hydrology is a dominate storm runoff process. The objective of this study is to develop a simple approach to estimate spatially-distributed risks of runoff production. By considering the development of overland flow as a bivariate process, we incorporated both rainfall and antecedent soil moisture conditions into a method for predicting VSAs based on the Natural Resource Conservation Service-Curve Number equation. We used base flow immediately preceding storm events as an index of antecedent soil wetness status. Using the data from a study hillslope near Ithaca, NY, we demonstrated that our estimates agreed with independent field-observations. We further applied the proposed approach to the Upper Susquehanna River Basin and mapped predicted saturated areas in a Geographic Information System (GIS) using a Soil Topographic Index to demonstrate large-scale applicability and identify potential issues of the approach. The proposed methodology provides a new tool to watershed planners for quantifying runoff risks across watersheds, which can be used to target water quality protection strategies.

URL: http://hdl.handle.net/1813/29588

B5. Determining Waste Load Allocations for Water Bodies by Coupling an In-Stream Macroinvertebrate Model with SWAT

Casey A Garland[*1]*; Steven M Gladding*[2]*; Brian T Duffy*[2]*; and Tammo S Steenhuis*[1]

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Abstract: The Clean Water Act requires states to identify water bodies that do not meet water quality criteria for their designated use (human consumption, aquatic life support, recreational use, etc.) and develop total daily maximums loads (TMDLs) as a way to control pollutant influx to receiving bodies. Watershed scale models that tie anthropogenic, geochemical, and hydrologic activity to changes in chemical water quality are widely used to develop TMDLs and policy mechanisms to restore water quality. Current trends in water quality monitoring of streams and lakes have moved from chemical sampling (total nitrogen, total phosphorus, dissolved oxygen) to biological sampling due to the low resource requirement and the ability to capture long-term water quality of biological sampling. Many state agencies have integrated statewide biological monitoring programs as a way of monitoring water quality and aid in setting TMDLs. Our goal is develop an in-stream model that links best management practices to changes in biological profiles to help decision makers set numerical criteria for TMDLs and develop programs to improve water quality in impaired streams. In order to account for a range of water body impairments, three different watersheds will be modeled: non-impacted, slightly impacted, and severely impacted. The Soil and Water Assessment Tool (SWAT) will be used for hydrologic simulations and determining impacts of best management practices on water quality. It will be coupled with an in-stream macroinvertebrate model that will produce the population's response to SWAT simulated constituents.

URL: http://hdl.handle.net/1813/29589

B6. Suitability of Using Groundwater Temperature and Geology to Predict Arsenic Contamination in Drinking Water – A Case Study in Central Mexico

Anouk I. Gevaert[1,2], Jaime D. Hoogesteger1, Cathelijne R. Stoof [2]*

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Abstract: Arsenic in drinking water poses a risk to people's health and can cause skin disorders, irritation of the respiratory and digestive systems and increased risk of cancer. In parts of Irapuato, central Mexico, arsenic levels in groundwater used for drinking water exceed Mexican and World Health Organization drinking level norms, but a cheap and simple method to identify areas at risk of exceeding these norms is lacking. Since previous research suggests a relationship between water temperature and arsenic concentration, and geology may also play a role in elevated levels of arsenic, water managers can possibly use local knowledge on well temperatures with available geological data to identify high-risk areas. To evaluate the suitability of such an approach, data was collected for 111 wells, using well samples collected in the field and government data collected by JAPAMI. Results show that water in 24% of the sampled wells exceeded the Mexican norm of 0.025 mg/l arsenic, while a disturbing 51% exceeded the stricter WHO norm of 0.010 mg/l. There was a fairly good (R2=0.54) positive linear correlation between temperature and arsenic concentration. On average, groundwater >27.4°C exceeded the Mexican arsenic norm, and >25.9°C exceeded the WHO norm, with false negative rates of 7 and 20%, respectively (i.e. cooler water exceeding arsenic norms). Surface geology in Irapuato is dominated by alluvial sediments, volcanic rock, limestone, sandstone and conglomerate. Results show that surface geology has a significant effect on arsenic concentrations, with limestone, and to a lesser degree sandstone and conglomerate, having significantly higher arsenic levels than alluvial sediment and volcanic rock areas. However, the sampled wells were predominately located in alluvial sediment areas, with only 2% of measurements in limestone and 9% in sandstone and conglomerate areas. This research shows that in Irapuato, groundwater temperature can be used to evaluate which areas are likely to exceed arsenic drinking water norms, though additional factors could lower the false negative rate. Wells in consolidated sedimentary rock, particularly limestone, were particularly vulnerable for arsenic contamination. Water managers can use this information to target high-risk areas and for the development of water management and treatment plans.

URL: http://hdl.handle.net/1813/29590

INSTABILITY AND FLUID MECHANICS

C1. Dynamic Contact Angles for Slug flow in Rectangular Capillary Tubes

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Abstract: Wetting front instability has been related to the dynamic contact angle. Although gravity is the driving force for instabilities in soils, little is known theoretically and experimentally how gravity affects the dynamic contact angle. The objective of this study was, therefore, examining the relationship of contact angle and gravity in moving a liquid slug though a tube. Experiments were carried out in using four different capillary tubes, five different liquids of different viscosities. Capillary tubes were inclined to vary the strength of gravity. We observed the moving contact line at the air-liquid-solid interface at the wetting front (dynamic contact angle) as the slug traveled down the capillary tube using a Hirox Bright Field Microscope. The results show as the capillary tube circumference increases, the velocity increased and as the viscosity increased, the velocity decreased. The contact angle results were compared to Hoffman's (1975) results. He observed in the absence of gravity that as the capillary number ($Ca = \mu V/\gamma$, where μ is the viscosity, V is the velocity and γ is the surface tension) increased, the dynamic contact angle increased. In addition to including gravity we found a linear relationship between the capillary number and Bond number ($Bo = \rho gr2/\gamma$, where ρ is the density, g is gravitational force, r is the radius and γ is surface tension) with a correlation coefficient (R2) of .91. The Bond number was between .1 and 10, indicating that gravitational forces were comparable to capillary forces within the tube. These relationships will ultimately lead to a better understanding of the role of dynamic contact angle in the formation of unstable preferential flow paths in soils.

URL: Not Available

C2. Modeling Solute Transport in Structured, Heterogeneous Porous Media

Bin Gao and Lei Wu

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Abstract: Knowledge of solute transport in heterogeneous porous media is crucial to monitor contaminant fate and transport in the vadose zone and groundwater systems. In this work, saturated and unsaturated soil columns packed with coarse-grained cores embedded within a fine sand matrix were used to examine the transport behaviors of bromide in heterogeneous porous media. A two-domain model considering solute exchange between zones was developed to describe bromide transport in structured, heterogeneous porous media. Simulations from this two-domain transport/exchange model matched experimental breakthrough concentrations very well for both water-saturated and unsaturated conditions. Experimental and model results show that under saturated conditions, both fast-flow and slow-flow domains affect solute transport in heterogeneous media. Under unsaturated conditions, however, our results indicate that flows in the fast flow domain dominate the solute transport and retention processes.

URL: http://hdl.handle.net/1813/29591

C3. Wildfire Effects on Spatio-temporal Soil Moisture Dynamics in the Portuguese Schist Region

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Abstract: Increasing fire occurrence in the Mediterranean is causing alarming degradation of soils and vegetation shifts from native shrubs to invasive and highly flammable degradation-loving species. Fast reestablishment of burned native vegetation can mitigate soil degradation and associated vegetation shifts, and is enhanced by the availability of soil water after fire. We studied the spatio-temporal dynamics of soil moisture distribution in five Portuguese soils affected by wildfire in summer 2008. Burned and adjacent unburned soils were sampled in transects 2-11 days and 6 months post-fire. Samples were taken using 50 cm3 soil cores in transects (8x3 samples) and analyzed for soil moisture, water repellency, organic matter content and bulk density. Additional sampling 3, 4 and 14 months post-fire assessed the longevity of fire effects on topsoil moisture, repellency, and temperature. Results show that burned soils were consistently drier and warmer than unburned soils, which was particularly true for the top 0-2.5 cm. In addition, contrary to common belief that soil water repellency is only induced by fire, both burned and unburned soils exhibited soil water repellency, particularly in summer. Preferential flow paths, expressed as zones with higher soil moisture and lower repellency in a dry and repellent matrix, were likewise present in both burned and unburned soil. The drier and warmer soils after the fire can likely be explained by increased post-fire soil evaporation due to the decreased canopy cover, which was possibly enhanced by a reduced water holding capacity due to observed decrease in soil organic matter content and increase in dry bulk density. Given the abundance in the occurrence of preferential flow in unburned environments around the world, the existence of preferential flow patterns in this highly fire prone region is not surprising. However, it does suggest that plant (re)growth on these soils may be strongly affected by the resulting uneven distribution of soil water. Combined with the drier topsoils, this may negatively affect post-fire plant regeneration and reestablishment of canopy cover, which is important for the mitigation of post-fire land degradation.

URL: http://hdl.handle.net/1813/29592

C4. Spatiotemporal Analysis of Aquifers: Salinity around Coastal Area of Yunlin, Taiwan

Yih-Chi Tan and Chu-Hui Chen

Abstract: The groundwater resource in Choushui River alluvial Fan is an important water resource in Taiwan. In the past, time and space characteristics often discussed separately. This study adopts regionalized variables theory, and describes the water quality in terms of its structure in time and space to assess the situation of Yunlin. This study applied the Quantum Bayesian Maximum Entropy Toolbox (QtBME), which is a spatiotemporal statistics function, can be applied to estimate and map a non-stationary and non-homogeneous spatiotemporal process under the platform of Quantum GIS (QGIS) software. Kernel smoothing method is used to divide the original process into a deterministic trend and a stationary and homogeneous spatiotemporal process, assuming that a spatiotemporal process can be divided into high and low frequency. The covariance model of the process of high frequency is selected objectively by particle swarm optimization (PSO) method and Akaike's information criterion (AIC). Bayesian maximum entropy method is then applied to spatiotemporal mapping of the variable of interest. In this study, QtBME estimated the situation of aquifers salinity at Yunlin coastal area in 1992 to 2010. Finally, one investigated the rainfall and aquifers salinity on the degree of impact.

URL: http://hdl.handle.net/1813/29593

C5. Transport and Retention of Fullerene Nanoparticles in Saturated and Unsaturated Porous Media

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Abstract: Increasing production and use of fullerene-based nanomaterials is likely to result in their environmental dispersal and subsequent human and ecosystem exposures. A thorough understanding of fullerene transport in the subsurface is essential to assessing environmental fate of fullerenes. To date, few transport studies have used actual environmental media or fullerene derivatives. In this study, the transport of two fullerene nanoparticles (i.e., aqueous colloidal suspensions of C60 [aqu/C60] and more water-soluble C60 derivative [C60 pyrrolidine tris-acid]) was studied in columns packed with model porous media (Iota quartz and Ottawa sand) and a sediment from Call's creek under saturated and unsaturated steady-state flows. Fullerene retention was correlated with the degree of grain surface chemical heterogeneity manifested in amorphous Al hydroxide concentrations of the three media. Surface roughness was also responsible for the greatest fullerene retention in the sediment. As explained by the XDLVO theory, water soluble C60 PTA was more transported than aqu/C60 at near neutral pH, as results of its greater hydrophilicity and smaller particle sizes. Fullerene retention was dependent on solution pH and soil water saturation degree, and underlying mechanisms were discussed.

URL: http://hdl.handle.net/1813/29594

ATMOSPHERIC RADIATION

D1. A-Posteriori Analysis of Surface Energy Budget Closure to Determine Missed Energy Pathways

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Abstract: The residual of the surface energy budget is represented as the linearized sum of energy losses due to storage, advection and flux underestimation. Individual contributions to the residual can be quantified through constrained multiple linear regression which identifies the site specific processes that are responsible for the lack of energy budget closure. This residual decomposition approach is applied to energy balance data from the Surface Layer Turbulence and Environmental Science Test (SLTEST) site at the Dugway Proving Grounds in the Utah Salt Flats. In this case, energy storage in the soil and underestimation of the soil heat flux accounted for 89% of the residual variance. Underestimation of the sensible and latent heat fluxes had no apparent contribution to the residual, and the contribution of advection to the residual was not statistically significant.

URL: Not Available

D2. Near Coastal Spatiotemporal Variation of Temperature Response to Insolation

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Abstract: Fine-resolved temperature variability is ecologically important, regulating the distribution and expansion/restriction of species in a landscape. This study develops and uses GIS-based modeling of incoming solar radiation to investigate fine-resolved spatiotemporal responses of monthly average temperature, and diurnal temperature variation at different times (within the growing season) and locations within a field study area, located on the eastern coast of Sweden. For this field study site, we derive insolation maps with 50 m resolution and analyze subsequent responses of local temperature. Surface and near surface temperatures are then measured by a dense network of temperature sensors during the spring and summer of 2011 and are used for comparison with modeled temperature maps.

The modeling is based on topography, distance from the sea, and observed variations in atmospheric conditions, accounting for site latitude, elevation, surface orientation, daily and seasonal shifts in sun angle, and the effect of shadows from the surrounding topography. We develop a methodology for use on a coastal site, where surface temperature and its response to temporal insolation variability is influenced by the presence of the sea. The appropriate time between insolation and subsequent temperature response follows an exponential decay from the coastal to the inland measurement sites. We use the insolation data with this appropriate time lag, which in turn depends on distance to the sea, in a linear regression model. That model is developed to estimate the spatiotemporal temperature distribution in the studied landscape and between different months in the growing season. The results are encouraging for the potential and usefulness of the developed modeling approach, for instance in downscaling coarse-scale climate model results and/or historic data to finer-resolved variability of local temperature in heterogeneous landscapes.

URL: Not Available

TURBULENCE IN ABL

E1. Large-Eddy Simulation of Stable ABLs to Develop Better Turbulence Closures for Climate and Weather Models

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Abstract: A disconnect remains between our improved physical understanding of boundary layers stabilized by buoyancy and how we parameterize them in coarse atmospheric models. Most operational climate models require excessive turbulence mixing in such conditions to prevent decoupling of the atmospheric component from the land component, but the performance of such a model is unlikely to be satisfactory under weakly and moderately stable conditions.

Using large-eddy simulation, we revisit some of the basic challenges in parameterizing stable atmospheric boundary layers: eddy-viscosity closure is found to be more reliable under stable conditions due to an improved alignment of vertical Reynolds stresses and mean strains under stable conditions, but the dependence of the magnitude of the eddy viscosity on stability is not well represented by several models tested here. Thus, we propose a new closure that reproduces the different stability regimes better. Subsequently, tests of this model in the Geophysical Fluid Dynamics Laboratory's (GFDL) single-column model (SCM) are found to yield good agreement with LES results in idealized cases with steady state weak and strong stabilities, as well as in cases with gradual and sharp changes in stability with time.

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E2. Interactions between the Atmospheric Boundary Layer and Wind Farms

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Abstract: Accurate prediction of atmospheric boundary layer flow and its interactions with wind turbines is of great importance for optimizing the design (layout) and efficiency of wind farms. It can also be used to assess the impact of wind farms on land-atmosphere exchanges of momentum, heat and moisture. This presentation focuses on recent efforts to develop and validate a large-eddy simulation (LES) framework for wind-energy applications. The subgrid-scale turbulent fluxes of momentum and heat are parameterized using tuning-free Lagrangian scale-dependent dynamic models. The turbine-induced forces are parameterized using two types of models: an actuator disk model that allows for non-uniform force distribution and includes rotational effects, and an actuator line model. The LES code is validated against wind-tunnel measurements collected inside and above a large model wind farm. Overall, the characteristics of the wind-farm wakes simulated with the proposed LES framework are in good agreement with the measurements. Moreover, LES is also found to provide reasonable predictions of turbine power output in simulations of flow through an operational wind farm. Both LES results and wind-tunnel measurements show that, in the presence of wind farms, the boundary layer height increases, while the magnitudes of the surface momentum and scalar fluxes decrease.

URL: Not Available

E3. Stability and Properties of Near-Surface Turbulent Shear Flows: Enhancing Our Understanding of Passive Scalar Fields

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Abstract: We analyse two field experiments of near-surface atmospheric turbulence, particularly the applicability of the concept of the stability parameter (Brutsaert, 1999) in the context of intermittency. The first field experiment consisted of a single mast located in Corsica, France. Three sonic anemometers were installed on the mast at 22, 23 and 43m; measuring three-dimensional wind velocity data at 10Hz. Complex terrain and buoyancy forces were observed to have influenced the measurements.

The second (GROWIAN) field experiment took place in Germany. It consisted of an array of propeller anemometers measuring wind speed inflow data at 2.5Hz over flat terrain. The propeller anemometers were positioned vertically at 10, 50, 75, 100, 125 and 150m with four horizontal measurements taken at 75, 100 and 125m. The spatial measurements meant we could calculate the horizontal and vertical shear structure functions of the horizontal wind allowing us to test Taylor's hypothesis over a wide range of scales.

To statistically characterise the stability, we used the probability distributions of the gradient Richardson number — large negative values indicate unstable conditions, large positive values indicate stable conditions and values close to zero are indicative of neutral conditions — this implies therefore anti-symmetric distributions correspond to either stable or unstable conditions.

Since the empirical probability distributions follow power law behaviour the departure from neutral to (un)stable conditions is quantified with the ratio of the corresponding power law exponents.

Finally, under the universal multifractal (UM) framework, we study and compare the scaling properties of near-surface atmospheric turbulence. We found in both experiments the multifractality parameter, $\alpha \approx 1.5$, and the intermittency parameter, $C1 \approx 0.2$. The scaling non-conservativeness parameter, H, of the vertical shears of the horizontal wind varied from Kolmogorov to Bolgiano-Obukhov depending on the condition of stability. These results give new insights into the 23/5-dimensional model of stratified turbulence (Schertzer and Lovejoy, 1985, Lilley et al., 2006, Fitton et al. 2011) thus greatly enhancing our understanding of the multifractal properties of passive scalar fields, e.g., water vapour.

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E4. Why Does Turbulence Transport Momentum and Scalars Differently?

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Abstract: The exchanges of momentum, water vapor, and heat between the earth surface and the atmosphere play a critical role in meteorology, hydrology, ecology, and other fields. To model these exchanges, which are dominated by turbulent transport, it is often assumed that momentum and all scalars are transported similarly; this is known as the Reynolds analogy. This study examines the breakdown of this analogy and the dissimilarity between turbulent transports of momentum and scalars (i.e., temperature and water vapor) in the atmospheric surface layer. Frist, observations indicate the dissimilarity mainly appears under unstable conditions and concurs with a change in the turbulence structure topology. The increase in the transport efficiencies of scalar fluxes under unstable conditions is then shown to be caused by a 'scale-resonance' between the turnover mixing eddy and the vertical temperature profiles. Based on this evidence, a recently-proposed phenomenological theory that explains the observed scaling laws in the stability correction function for momentum is modified to include the dissimilarity between momentum and scalar transfer, and extended to explain the behavior of the stability correction function for temperature across a wide range of atmospheric stability conditions.

URL: http://hdl.handle.net/1813/29597

E5. Evaluation of Local Similarity Scaling Over a Steep Alpine Slope

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Abstract: In this work, we investigate the applicability of similarity scaling over a steep mountain slope (30°- 41°). The results are based on eddy correlation measurements collected in Val Ferret, a narrow valley of the Swiss Alps, in summer 2010. The turbulent fluxes of heat and momentum are found to vary significantly with height in the first few meters above the inclined surface. These variations exceed by an order of magnitude the well-accepted maximum 10% required for the validity of Monin-Obukhov similarity in the surface-layer, possibly as a result of advective fluxes. In these cases when surface-layer theory breaks down, we show that local scaling can be a useful tool. Under convective conditions and after removing the effects of self-correlation, the normalized standard deviations of vertical velocity, temperature and humidity scale relatively well with z/L, where z is the measurement height and Λ the local Obukhov length. However, the horizontal velocity fluctuations are not correlated with z/Λ, and that under all stability conditions. The non-dimensional gradients of temperature and wind velocity are also investigated. For those the local scaling appear inappropriate, particularly at night when shallow drainage flows are found and lead to negative wind speed gradients near the surface.

URL: Not Available

E6. Influence of Urban Morphology on Surface Energy Budget

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Abstract: Our study combines eddy flux measurements from four different sites with distinct land cover characteristics with an urban canopy model to understand the influence of urban materials and morphology on the surface energy budget. Turbulent fluxes of heat and water vapor and other micrometeorological variables were continuously sampled from four different sites (UMBC, Cubhill, Princeton and Broadmead) located in the North Eastern United States. Of the four sites, UMBC and Princeton were located in dense urban areas, while their counterparts Cubhill and Broadmead were located in a suburban and a rural environment, respectively. Our preliminary analysis has shown that while the latent heat flux dominates at the rural and suburban sites, the more urbanized UMBC and Princeton sites were dominated by sensible heat flux. This is expected and could directly be attributed to the vegetative cover fraction surrounding the respective sites. A more interesting finding is that, over the more urbanized surfaces, a considerable shift in peak flux times can be noted due to the heat retaining capacity of urban materials, especially concrete. To quantitatively assess these effects, the Princeton Urban Canyon Model (PUCM) was used. PUCM combines basic meteorological data with aerodynamic and geometric properties of built environment and thermal properties of built and vegetated surfaces to estimate the surface energy budget for urban canopies. The model was able to reproduce the shift in peaks observed in the eddy flux data at the densely urban site (UMBC). The sector-averaged fluxes produced by the model show relatively high sensible heat fluxes from sectors filled with asphalt and concrete. Moreover a significant phase shift was observed in sensible heat fluxes emitted by different urban surfaces.

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EVAPORATION

F1. Using Temperature-Based Estimations of Radiation to approximate Potential Evapotranspiration

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Abstract: It is well established that potential evapotranspiration (PET) can be reliably estimated using the energy budget at the canopy or land surface. However, in most cases the necessary measurements are not available. Because of this, many mostly-empirical temperature-based models have been developed and are widely used. Here we test whether a radiation based model (Priestley-Taylor) can reliably predict PET using air temperature to estimate the radiation fluxes. We used data from the AmeriFlux network to approximate net radiation from daily minimum and maximum temperature measurements, day of the year, and geographic location of the sites; i.e., readily available data in most places. We found good agreement between Priestley-Taylor PET calculated from measured radiation fluxes and Priestley-Taylor PET determined primarily via air temperature. The most difficult parameter to estimate was the atmospheric transmissivity to in-coming solar radiation. Overall the results suggest that radiation-based PET estimates can be made even when direct measurements of the radiation fluxes are unavailable.

URL: http://hdl.handle.net/1813/29599

F2. A Method to Determine Long-Term Watershed-Scale ET Trend

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Abstract: Beyond temperature and precipitation, evapotranspiration (ET) is sensitive to climate change and its long-term trend can serve as an indicator of climate change. However, there are very few long-term ET data, mainly because it is difficult to directly measure ET, especially at watershed-scale. But, long-term precipitation and river discharge have been directly measured in many major watersheds. A simple and robust method was developed to use long-term precipitation and river discharge data to indirectly estimate watershed-scale ET trend. This method is applicable to those watersheds underlain by impermeable bedrocks where groundwater discharges into a river, whose flow rate has been being monitored. Results based on this method showed that the ET along the entire western Great Lakes within the US side has increased since late 1990's. The watershed with the highest ET increase is the Northern Wisconsin River above Merrill, WI.

URL: Not Available

F3. Hydrology in a Dutch Polder Catchment: Natural Processes in a Man-Made Landscape

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Abstract: Experimental catchments are traditionally located in areas with limited human influence, but the societal and financial losses due to hydrological extremes are often larger in more densely populated areas. In The Netherlands and other delta areas around the world, intensive drainage and water level regulation have made patches of originally swampy land between cities suitable for agriculture. The question is how the rainfall-runoff processes in these artificial catchments compare to those occurring in more natural catchments and whether conceptual hydrological models, which have been developed for natural landscapes, contain the appropriate hydrological processes for application to artificial catchments.

Our experimental "catchment" of 0.5 km2 is part of a polder area located near the town of Cabauw in The Netherlands. This polder is completely flat and at an "elevation" of one meter below mean sea level. The catchment is drained by many small, man-made channels of which the water levels are regulated. Water is supplied upstream into the catchment by the local water authority.

The catchment is part of the Cabauw Experimental Site for Atmospheric Research (CESAR), which is well-known in the international meteorological community. In addition to the large amount of meteorlogical measurements, including precipitation and actual evapotranspiration, we measure discharge (both into and out of the catchment), ground water levels and soil moisture contents.

We will present a detailed development of the water balance terms over several years, an overview of the main hydrological processes during wet and dry conditions and differences between natural and polder catchments.

URL: http://hdl.handle.net/1813/29600

F4. Country-Wide Rainfall Maps from a Commercial Cellular Telephone Network

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Abstract: Accurate rainfall observations with high spatial and temporal resolutions are needed for many applications, for instance, as input for hydrological models. Weather radars often provide data with sufficient spatial and temporal resolution, but usually need adjustment. In general, only few rain gauge measurements are available to adjust the radar data in real-time, for example, each hour. Physically based methods, such as a Vertical Profile of Reflectivity (VPR) correction, can be valuable and hold a promise. However, they are not always performed in real-time yet and can be difficult to implement.

The estimation of rainfall using microwave links from commercial cellular telephone networks is a new and potentially valuable source of information. Such networks cover large parts of the land surface of the earth and have a high density. The data produced by the microwave links in such networks is essentially a by-product of the communication between mobile telephones. Rainfall attenuates the electromagnetic signals transmitted from one telephone tower to another. By measuring the received power at one end of a microwave link as a function of time, the path-integrated attenuation due to rainfall can be calculated. Previous studies have shown that average rainfall intensities over the length of a link can be derived from the path-integrated attenuation. A recent study of us shows that urban rainfall can be estimated from commercial microwave link data for the Rotterdam region, a densely-populated delta city in the Netherlands.

A data set from a commercial microwave link network over the Netherlands is analyzed, containing approximately 1500 links covering the land surface of the Netherlands (35500 km2). This data set consists of several days with extreme rainfall in June, July and August 2011. A methodology is presented to derive rainfall intensities and daily rainfall depths from the microwave link data, which have a temporal resolution of 15 min. The magnitude and dynamics of these rainfall intensities is compared with those obtained from weather radar. Rainfall maps are derived from the microwave link data and are verified against rainfall maps based on gauge-adjusted weather radar data. Although much more work needs to be done, the first results look promising. Since cellular telephone networks are used worldwide, data from such networks could also become a valuable source of rainfall information in countries which do not have continuously operating weather radars, and no or few rain gauges.

Apart from rainfall maps which are solely based on microwave link data, a preliminary analysis will be presented to assess whether commercial microwave link data can be used to adjust radar rainfall accumulations.

URL: http://hdl.handle.net/1813/29601

INFILTRATION

G1. Can Stream Baseflow be Augmented Through Stormwater Infiltration? The Case of Minnehaha Creek Watershed

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Abstract: Coursing nearly 21 miles from its origin at Lake Minnetonka to its confluence with the Mississippi River, Minnehaha Creek is among the most valued surface water features of the Twin Cities area and attracts roughly half a million visitors annually. Flow in Minnehaha Creek is heavily dependent on discharge from Lake Minnetonka, the outlet of which is controlled to manage water elevations in the lake. The recent streamflow record indicates that groundwater-fed baseflow is not consistently sufficient to sustain flow in Minnehaha Creek during periods when Lake Minnetonka's outlet is closed, as the creek has experience dry periods in 8 of the last 12 years. Expedient stormwater drainage networks throughout the creek's urbanized watershed exacerbate extremes in flow conditions and contribute to the creek's impaired status for biotic integrity.

Local interest in enhancing ecosystem service provision by Minnehaha Creek is driving stormwater management decisions in the watershed. We have posed the hypothesis that baseflow in Minnehaha Creek can be augmented through strategic infiltration and storage of stormwater runoff in the shallow aquifer system. As an initial step in understanding surface/ shallow groundwater interactions and current low-flow conditions in Minnehaha Creek, several methods have been investigated to estimate groundwater recharge within the watershed, water balance calculations have been conducted, and the method of Brutsaert and Nieber (1977) has been applied to streamflow data to infer physical characteristics of the shallow aquifer. Combined with surficial geologic datasets, initial results indicate that sustained baseflow during drought periods in Minnehaha Creek is likely limited by rapid vertical transit of groundwater through the shallow aquifer to underlying bedrock units, the median travel time of which is on the order of 0.5 years. As such, it is likely that only a small portion of the shallow aquifer (< 1%) contributes baseflow to the creek. Field measurements of stream and porewater temperatures, groundwater seepage, and O-18 and deuterium isotopes will be used to provide further insight to the Minnehaha Creek aquifer system and the potential to augment flow during drought periods through stormwater management.

URL: http://hdl.handle.net/1813/29602

OPEN CHANNELS

H1. A Surface PIV Approach for the Remote Monitoring of Mean and Turbulent Flow: Properties in an Open Channel

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Abstract: In an effort to develop a reliable, continuous and efficient method of remotely monitoring mean velocities, water column turbulence levels and bathymetry, a surface PIV (particle image velocimetry) experiment is conducted in a wide open channel (B/h >12) for a range of flow conditions. Mean and turbulent velocities, longitudinal power spectra and the longitudinal integral length scale have been calculated at the free-surface from the PIV data. The results reveal the presence of secondary flow within the channel, which leads to heterogeneous turbulence metrics on the surface; for example, the streamwise turbulent velocities and the Reynolds stress vary strongly as a result of the secondary motion. The results also indicate two methods by which the flow depth can be determined: 1.) the longitudinal integral length scale which varies predictably with the flow depth ($L_{22,1} \approx 0.3h$) and 2.) the normalized longitudinal spatial spectra which exhibit a slight bump at the wave number corresponding to the flow depth. These results suggest that it is possible to determine volumetric flow rate solely from measurements of the free- surface water flow. These findings have important implications for developing new technologies for stream gauging, near-shore and estuarine monitoring.

URL: http://hdl.handle.net/1813/29603

SATELLITE IMAGERY

I1. Inferring Species-Richness and Species-turnover by Statistical Multiresolution Texture Analysis of Satellite Imagery

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Abstract: The quantification of species-richness and turnover is one of the most important tasks in monitoring ecosystems. This is both for guaranteeing ecosystem function, and to understand the linkages between natural and human stressors with species patterns. Wetland ecosystems, particularly water-controlled subtropical wetlands, are extremely sensitive to external changes, for example in rainfall and water management. The effect of these changes at the metacommunity level in space and time are still not well understood. We analyze interseasonal and interannual average species-richness and turnover of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (\Water Conservation Area 1») in the Greater Everglades Ecosystem) in South Florida as a case-study for the application of a novel multispectral image analysis technique. We use a texture augmented procedure to analyze high resolution satellite images (Landsat) in order to detect texture changes of vegetation, soil, and water components. α- and β-diversity, which are observed to be independent, are estimated for the green-band by the Shannon entropy and by the Kullback-Leibler divergence respectively. Validation with observations about the evolution of vegetation patterns shows that the analysis predicts 73 % and 100 % of species-richness and turnover within the study-area from 1984 to 2011. The KL divergence is a better metric than the difference of Shannon entropy which captures 85 % of the species-turnover. This is because the KL divergence takes in account the pairwise interactions between vegetation communities in time. α- and β-diversity are positively correlated, and _-diversity is strongly correlated to the average annual rainfall. We found that changes in vegetation, soil and water are positively correlated and that the fluctuations of the Shannon entropy for each component in the wet-season are smaller than in the dry-season. However, the KL divergence better predicts the species-turnover in the wet-season. The Gaussian density function in texture characterization and the use of the KL divergence constitute a promising technique for monitoring spatiotemporal ecohydrological patterns with particular focus on species-richness and turnover. We envision relevant applications of the KL divergence to infer species-dissimilarity, which is the diversity in space. This is particularly important when historical data or continuous monitoring data are not available in order to detect and potentially anticipate the effects of natural and anthropic changes on ecosystem structure.

URL: http://hdl.handle.net/1813/29611

I2. Early Results of the Soil Moisture Active Passive Marena Oklahoma In Situ Sensor Testbed (SMAP-MOISST)

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Abstract: The Soil Moisture Active Passive Mission (SMAP) is an upcoming NASA mission to monitor surface soil moisture. Key to the success of this mission is the calibration and validation of the resulting product. As part of the calibration and validation program for SMAP, an ambitious intercomparison study was initiated to determine how soil moisture sensors vary with respect to measuring a long term in situ time series. The Marena Oklahoma In Situ Sensor Testbed (MOISST) was installed in May of 2010, with other instrumentation added more recently. There are more than 200 sensors installed over an approximately 64 hectare pasture in Central Oklahoma. There are 4 main stations with multiple sensors installed in a profile. Sensors located at the site include a COSMOS system, GPS reflectometers, and a passive DTS system. Additional sensor systems are also installed which represent the Oklahoma Mesonet and the NOAA Climate Reference Network stations. This diverse set of sensors will provide guidance on the aggregation of soil moisture networks worldwide into a single soil moisture data record. In support of the time series, regular sampling of gravimetric soil moisture and vegetation water content were conducted to determine an absolute ground truth. A full year of data is available for study which has yielded several conclusions regarding how different sensors perform in space and time. Early conclusions will be presented, including accuracy, calibration, reliability, and scalability.

URL: http://hdl.handle.net/1813/29604

I3. Hydrological Modeling Where No Meteorological Stations Exist

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Abstract: An important characteristic of hydrological is the need for accurate forcing data, such as precipitation and temperature. Acquiring precipitation and temperature gauge data poses a variety of challenges, not least the fact that gauges are often located outside of target watersheds and may not accurately represent local conditions. Over the last decade, there has been a drive to archive global atmospheric data from which our daily and hourly weather forecasts originate, primarily for the purpose of weather forecast improvement. We are investigating ways to utilize these products for hydrological modeling purposes and to address some of the inherent problems associated with the use conventional gauge data.

In this study, we compare calibrations of a watershed model using derived statistical representations of precipitation forecasts from a "poor-man's" ensemble of raw gridded atmospheric models interpolated to the center of the model subbasin, versus, calibration to the closest precipitation gauge measurement. In addition, we investigate at what scale and radii the use of direct gridded model outputs may introduce less or equal error to watershed modeling projects using the closest gauge station.

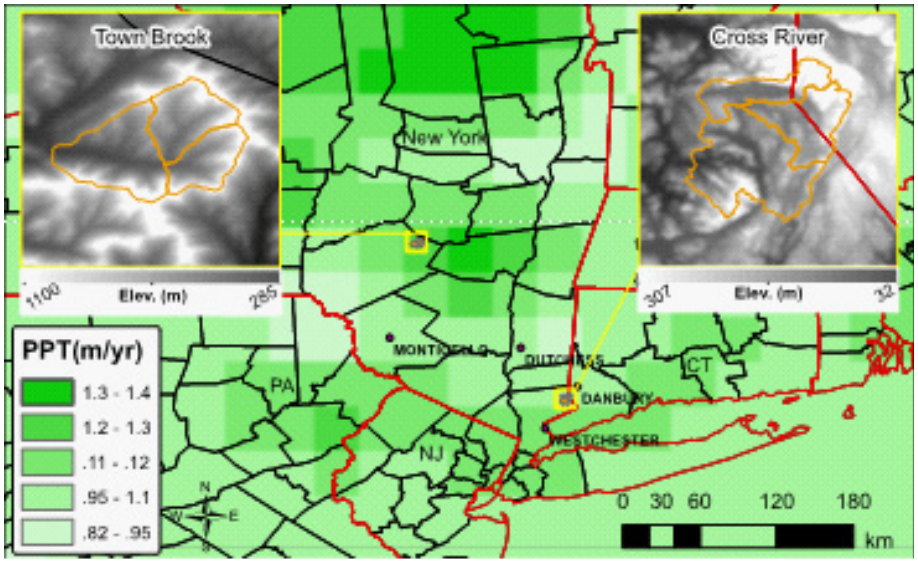

Illustration of study locations along with native forecast data resolution.

URL: http://hdl.handle.net/1813/29605

I4. Irrigation Area Suitability Mapping by Multi-criteria Evaluation Technique for the Case of Lake Tana Basin, Upper Blue Nile, Ethiopia

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Abstract: The study was carried out in the Lake Tana Basin, the upper portion of the Blue Nile Basin in Ethiopia. It has a total catchment area of around 15,000 km2, of which the lake covers approximately 3,060 km2 at an average altitude of 1786 m amsl. Although the lake has developmental potential, until recently, there has been only one water resource development situated at the mouth of the lake to control the outflow for harnessing hydroelectricity down stream on the Blue Nile River.

Besides hydroelectric power, expansion of surface irrigation is of great interest to the basin farmers whose livelihoods are heavily dependent on cereal and other rainfed crop production. Therefore, in this study, the suitability of surface irrigation within the lake basin was evaluated by employing a GIS-based Multi Criteria Evaluation (MCE) analysis of available spatial data. The main objective was to identify suitable medium scale (between 200 and 3000ha) and large scale (greater than 3000ha) irrigation areas in the basin by considering factors, such as meteorological information (temperature, humidity, rainfall etc), river proximity, soil type, land cover, topography/slope and market outlets.

Using the daily metrological data from 1992 to 2006, the long-term average rainfall and potential evapotranspiration raster map was computed through interpolation based on Thiessen polygons. The monthly rainfall deficit map (rainfall-evaporation) was aggregated to the annual rainfall deficit map. The major perennial river network segment map and slope raster map was derived from an SRTM DEM of the basin, and then the drainage network map was interpolated using the Euclidian distance tool in ArcGIS. Major potential marketing towns and the main paved road were digitized manually from Google Earth and interpolated. The interpolated maps were reclassified into four groups of suitability by an equal interval ranging technique. The soil and land use map collected from the Ethiopian Ministry of Water and Energy (EMWE) was reclassified to four major classes of FAO land suitability.

Weighting of the decision factors was accomplished by comparing three approaches: ranking technique, pairwise comparison and equal weighting. Approximately 10%, 7% and 5% of the basin was suitable for surface irrigation according to the pairwise, equal weighting and ranking technique, respectively.

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