Catchment Science Symposium

AGU Fall Meeting

December 12, 2018

Washington Grand Hyatt, Constitution Ballroom AB

Modeled after an annual pre-AGU symposium traditionally held at Berkeley, this session features four invited seminar-length talks presenting in-depth explorations of key topics in catchment science.

8:20 – 8:40 Introduction
8:40 **Ilja van Meerveld (University of Zürich)**
Effects of tropical land use change on hydrological processes and streamflow responses

10:00 – 10:20 Coffee Break

10:20 **Ciaran Harman (Johns Hopkins University)**
Co-evolution, bedrock weathering, and lateral flow in hillslopes

11:40 Pop-up presentations

12:20 – 13:40 Lunch (on your own)

13:40 **Irena F. Creed (University of Saskatchewan)**
Enhancing protection for vulnerable waters

15:00 – 15:20 Coffee Break

15:20 **Martyn Clark (National Center for Atmospheric Research)**
Advances in continental-domain hydrologic modeling and prediction

16:40 Pop-up presentations and discussion

Pop-up presentations

There will also be time for pop-up presentations from at least two dozen attendees. Pop-ups are short (2 minutes or less!) presentations that may, for example, present a concise new result, show intriguing new data, present a new question, comment on an issue, announce an upcoming meeting or job opening, and so forth. Attendees wishing to be considered for a pop-up presentation slot should send any slides (PowerPoint show .pps or Adobe Acrobat .pdf files preferred), along with a short note explaining the main point, to **catchment_symposium@usys.ethz.ch** by 5PM (East Coast time) Monday, December 10th. Presenters who can be accommodated in the schedule will be notified by return e-mail by 5PM Tuesday, December 11th.

Registration

The Catchment Science Symposium is being held as part of AGU this year. Attendance is included in your AGU registration and ***no separate registration is needed*** (or possible). So just come. And bring a friend – the room holds about 250.

Effects of tropical land use change on hydrological processes and streamflow responses
Ilja van Meerveld, Department of Geography, University of Zurich

Large areas of the agricultural-forest frontier in tropical countries are dominated by swidden cultivation (also known as shifting cultivation or slash-and-burn agriculture). In many of these areas, the increased population pressure has led to a dramatic shortening of fallow periods, resulting in extensive degradation and unproductive fire-climax grasslands that are prone to soil erosion. Reforestation of these degraded grasslands is promoted for a wide range of benefits, including biodiversity, carbon sequestration and streamflow regulation. However, the impacts of reforestation of these degraded lands on water resources remain understudied and are largely undocumented. There are strong perceptions about the effects of forests on streamflow. Forest management has been blamed for both floods and droughts. Water losses (transpiration and interception losses) likely increase after reforestation of degraded land, while infiltration rates may increase and overland flow may decrease as a result of the increase in the hydraulic conductivity of the soil with time since reforestation. The net results of these two opposing effects on total water yield and peak flows remain unknown and are likely site specific.

In this presentation, I will use data from projects in Madagascar and the Philippines to describe how tropical land use change, and in particular reforestation of degraded land, affects hydrological processes at the soil core, plot and catchment scales. The work includes detailed soil hydrological investigations, plot scale measurements of surface runoff, interception and transpiration losses, and streamflow and stream chemistry responses to rainfall events. The results show that land use significantly affects the dominant hydrological processes and that reforestation results in more macropore flow, faster and deeper infiltration, less overland flow and much smaller event water contributions to streamflow. These changes affect streamflow responses during all events, including extreme events, and show that reforestation can restore the hydrological functioning of degraded land if the forest and soils are allowed to develop over a sufficiently long period.

Co-evolution, bedrock weathering, and lateral flow in hillslopes
Ciaran Harman, Dept. of Geography and Environmental Engineering, Johns Hopkins University

The landscape properties that control the storage and release of meteoric water are the integrated result of myriad processes acting over time, and across space. Those properties are often extremely difficult to measure, particularly in the subsurface, where they control the recharge of groundwater and the release of base flow discharge.

Perhaps it would be useful to ask: how do landscapes develop the hydrologic properties they have? Here I will present an attempt to understand how the internal structure of hillslopes could both control and be controlled by the lateral flow of meteoric water towards adjacent streams. Unlike landscape evolution models that focus on surface topography, the focus here will be on the subsurface topography -- the relief of unweathered bedrock, and the development of porosity and permeability profiles. I will present a model that couples a Boussinesq approximation for the advection-diffusion-reaction equation with a parsimonious model of geochemical weathering and its effect on porosity and permeability. The resulting approximate analytical solutions yield realistic hillslope architectures when supplied with realistic geochemical and hydrologic parameter values derived from literature.

Enhancing protection for vulnerable waters
Irena F. Creed, School of Environment & Sustainability, University of Saskatchewan

Governments worldwide do not adequately protect freshwater ecosystems and therefore place freshwater functions and attendant ecosystem services at risk. Particularly vulnerable are small streams and wetlands, which form a large majority of the world's freshwater ecosystems and are being lost or degraded more quickly than any other type of ecosystem on the planet. Scientific evidence of the importance of these vulnerable waters to downstream ecosystem functions and associated services is needed to support policies that promote their protection and restoration. New mapping methods to detect vulnerable waters are combined with new surface-subsurface models that estimate their surface and subsurface hydrological connections (i.e., transit length and transit time) to neighboring wetlands and to downstream waters. The role of this portfolio of hydrological connections in regulating biogeochemical functions (e.g., nitrogen removal and phosphorus retention) and biodiversity functions are then explored. The scientific findings provide clear evidence of the interdependence of hydrologic connectivity on biogeochemistry and biodiversity and that the entire portfolio is needed to maintain ecological services and functions upon which society depends. Policy makers need to develop management strategies that recognize and protect the complexity of hydrologic connections that vulnerable waters provide and consider the portfolio, not the nominal management approach.

Advances in continental-domain hydrologic modeling and prediction
Martyn Clark (National Center for Atmospheric Research)

The last two decades are characterized by remarkable scientific and technical advances in many areas supporting hydrologic modeling and prediction. Major science advances are evident in the areas of remote sensing, in physically-oriented, distributed watershed process modeling, in parameter estimation, data assimilation, diagnostic model evaluation, multi-model synthesis, and uncertainty estimation. Our technical capacity for hydrologic modeling is rapidly evolving due to advances in super-computing, data storage, standardization (e.g., data protocols), connectivity, and society's shift to open data and open models. This expansion of knowledge, resources, and activity is revolutionizing our capabilities for continental-domain hydrologic modeling and prediction.

In this presentation I will summarize recent science advances in continental-domain hydrologic modeling and prediction. Key topics include developing continental-domain probabilistic forcing datasets, advances in the physical realism of continental-domain hydrologic model simulations, and advances in spatial downscaling, hydrologic data assimilation, and diagnostic approaches to model evaluation. I will summarize historical modeling challenges, provide examples of modeling advances that address these challenges, and define outstanding research needs.