Institut
Grand-Ducal
Section des Sciences

Conference series

on

Water resources in a changing world

January – April 2019

Musée National d'Histoire Naturelle – Luxembourg-City

All lectures will start at 6.30 pm (18h30) in the lecture hall of the "Musée National d'Histoire Naturelle" 25, rue Münster, Luxembourg-City (free access and free seating)

Co-organizers

Section Historique de l'Institut Grand-ducal
Section des Sciences médicales de l'Institut Grand-ducal
Section de Linguistique, d'Éthnologie et d'Onomastique
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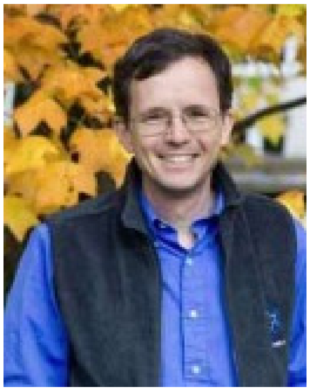
Prof. James Kirchner (ETHZ, Switzerland) - 29. January 2019



James W. Kirchner
Professor of the Physics of Environmental Systems
Department of Environmental System Science
Swiss Federal Institute of Technology (ETH)
Universitätstrasse 16, CH-8092 Zurich, Switzerland

Senior Scientist and Ex-Director
Swiss Federal Institute for Forest, Snow, and Landscape Research (WSL)
Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland

Goldman Distinguished Professor for the Physical Sciences, Emeritus
Department of Earth and Planetary Science
University of California, Berkeley, CA 94720-4767

Exploring landscapes and ecosystems by studying their streams

Streams integrate the water, solutes, and sediments from their drainages, and thus they act as mirrors of the surrounding landscape. Patterns of streamflow, chemistry, and sediment flux can therefore shed light on physical, chemical, and biological processes at the scale of whole ecosystems. However, landscapes are complex and heterogeneous on all scales, and therefore store waters over a wide spectrum of time scales, complicating efforts to interpret hydrological and chemical signals in streamwaters.

Prof. Kirchner will review current and recent research linking landscapes to the streams that drain them. Groundwater levels and stream flows exhibit diurnal cycles in response to snowmelt in springtime and plant water use during the growing season. These cycles vividly illustrate how aquifers and streams mirror ecological processes in their surrounding landscapes.

Stream flow and water quality vary dynamically across multiple scales. Stream networks extend and retract, both seasonally and in response to individual rainfall events, dynamically mapping out variations in subsurface transport and in the balance between precipitation and transpiration. Water quality time series spanning the periodic table, from H+ to U, exhibit universal fractal scaling on time scales from hours to decades, complicating efforts to identify water quality trends. Isotope tracers such as ^{18}O, ^{2}H, ^{3}H, and ^{14}C can be used to quantify water ages over seven orders of magnitude, from hours to thousands of years. These tracers show that streamflow is often much younger than the groundwater that feeds it.

Examples such as these will be presented to illustrate the close coupling between landscapes and the waters that drain them, and to demonstrate how streams can be used as windows into landscape processes.

Prof. Günter Blöschl (TU Vienna, Austria) - 19. February 2019

Prof. Blöschl is Head of the Institute of Hydraulic Engineering and Water Resources Management, Director of the Centre for Water Resource Systems of the Vienna University of Technology as well as Chair of the Vienna Doctoral Programme on Water Resource Systems. He is currently teaching courses on Engineering Hydrology, Risk Assessment, Modelling and Simulation, Integrated Water Resources Analyses, and Water Resources Management and Planning.

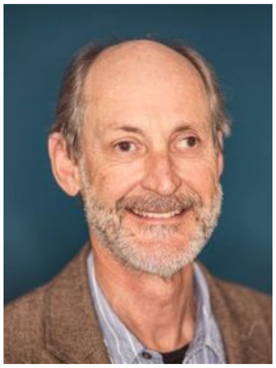
Prof. Blöschl received the Robert E. Horton Medal from the American Geophysical Union (AGU) in 2015, the Helmholtz International Fellow Award of the Helmholtz Association (Germany) in 2014 and the International Hydrology Prize from the IAHS in 2013. He also is an ERC Advanced Grant Laureate and he received the Creativity Prize of the Prince Sultan Bin Abdulaziz International Prize for Water in 2018. He will be awarded the Dalton Medal from the European Geophysical Union in 2019.

Understanding flood regime changes in Europe

There has been a surprisingly large number of major floods in the last years around the world, which suggests that floods may have increased and will continue to increase in the next decades. However, the realism of such changes is still widely discussed in the literature. This presentation examines whether floods have changed in the past and explores the driving processes of such changes in the atmosphere, the catchments and the river system based on examples from Europe. Methods are reviewed for assessing whether floods may increase in the future.

Accounting for feedbacks within the human-water system is important when assessing flood changes over lead times of decades or centuries. It is argued that an integrated flood risk management approach is needed for dealing with future flood risk with a focus on reducing the vulnerability of the societal system.

Prof. Hubert Savenije (TU Delft, The Netherlands) - 26. February 2019



Since 1999, Hubert Savenije is Professor of Hydrology at the Delft University of Technology, where he is the head of the Water Resources Section. As a young graduate hydrologist he worked for six years in Mozambique where he developed a theory on salt water intrusion in estuaries and studied the hydrology of international rivers. From 1985-1990 he worked as an international consultant mostly in Asia and Africa. He joined academia in 1990 to complete his PhD in 1992. In 1994 he was appointed Professor of Water Resources Management at the IHE (now UNESCO-IHE, Institute for Water Education) in Delft, the Netherlands.

He is President of IAHS (the International Association for Hydrological Sciences) and editor in chief of Physics and Chemistry of the Earth. He is Past-President of Hydrological Sciences of the European Geosciences Union (EGU), and Past-President of the International Commission on Water Resources Systems of IAHS.

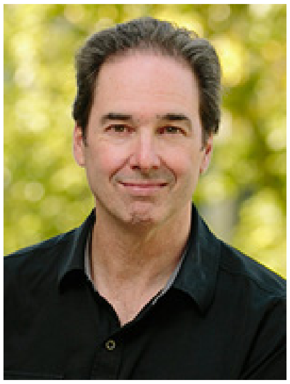
Modelling catchments as living organisms

Hydrological models often miss essential characteristics of hydrological functioning. The most important active agent in catchments is the ecosystem. It manipulates and partitions moisture in a way that it supports the essential functions of survival and productivity: infiltration of water, retention and storage of moisture, mobilization and retention of nutrients, and drainage of excess water. Ecosystems do this in the most efficient way, establishing a continuous, ever-evolving feedback with the landscape and climatic drivers. In brief, hydrological systems are alive and have a strong capacity to adjust themselves to prevailing and changing environmental conditions. Although most models take Newtonian theory at heart, they generally disregard Darwinian theory on how ecosystems evolve, manipulating their environment to maintain and optimize crucial hydrological functions.

In addition, catchments, such as many other natural systems, develop emergent patterns of spatial organization, including surface and subsurface drainage patterns. This all sounds extremely complex, but – surprisingly – accounting for such patterns makes models simpler, even in highly heterogeneous environments. Models that fail to account for these patterns, miss a critical element of how systems function at the interface of atmosphere, biosphere and geosphere. Moreover, such models are generally far too complex, require a myriad of distributed parameters, a lot of computational power, and suffer from equifinality. But, more importantly, they miss the essential physics of self-organisation, even though claiming to be "physically based".

In contrast to what is widely believed, relatively simple, semi-distributed conceptual models have the potential to accommodate patterns and their temporal evolution in an efficient way. The reason being that – because their parameters are effective at the modelling scale and integrate over natural heterogeneity – they may be directly inferred from observations at the same scale, thereby reducing the need for calibration. In particular, the emergence of new and more detailed observation systems from space will further permit the development of relatively simple time-dynamic functional relationships that can represent spatial patterns and their evolution over time, even in poorly gauged environments.

Prof. Jeffrey McDonnell (Uni. of Saskatchewan, Canada) - 12. March 2019



Jeffrey J. McDonnell was born in Toronto, Canada and has a BSc (Hon) from the University of Toronto, MSc from Trent University and PhD and Dr Sc from the University of Canterbury, where he was a Commonwealth Scholar. He has taught at Utah State University, SUNY College of Environmental Science and Forestry and Oregon State University, where he was Richardson Chair in Watershed Science and University Distinguished Professor. Since 2012, he has been Professor of Hydrology and Associate Director of the Global Institute for Water Security at the University of Saskatchewan. His work focuses on new ways to measure, understand and model streamflow generation processes. He has co-authored >300 articles on watershed hydrology and co-edited the Elsevier textbook "Isotope Tracers in Catchment Hydrology". He was the founding Editor of HPToday and sits currently on a dozen journal editorial boards. He is an elected Fellow of the Royal Society of Canada (Canada's National Academy of Science), and an elected Fellow of the Geological Society of America and the American Geophysical Union. He is the 2016 winner of the International Hydrology Prize (Dooge Medal) from the International Association of Hydrological, UNESCO and World Meteorological Organization. Previously, he has received the Dalton Medal from the European Geophysical Union and the Birdsall-Dreiss Distinguished Lecturer Award from the Geological Society of America. Jeff is currently President of the AGU Hydrology Section and Visiting Distinguished Professor at Tsinghua University.

Hydrology's great mystery: The unpredictability of streamflow response to forest harvesting

Countries around the globe are striving to meet the UN's 17 Sustainable Development Goals of the 2030 Agenda for Sustainable Development. Goal 15 is focused on 'sustainable forest management'. With about 30% of the world land surface covered by forests, this goal is vitally needed against a backdrop of stunning change. Most of this is occurring in the headwaters of larger watersheds. These headwaters are where partitioning occurs between water used by vegetation and the water that leaves the watershed via streamflow. At risk are the forested headwaters that support the water supply for billions of people worldwide.

Paired watershed studies—where one watershed serves as a reference, while the adjacent watersheds are harvested—have been the standard approach for over 100 years for quantifying the effects of forest cover change on streamflow in the headwaters. But even with >150 paired watersheds to date around the world, we're still unable to predict streamflow response to harvesting. Paired watershed studies have revealed increases, decreases or no change in annual streamflow in response to harvesting: some studies with 100% forest removal show no response of annual streamflow, whereas some watersheds with < 20% forest removal show an observable response. All this illustrates the difficulty in predicting, a priori, the outcome of forest cover change on streamflow. This is problematic for Goal 15 because variable outcomes of paired watershed experiments contribute to uncertainty about how forests should be managed for water sustainability.

This talk outlines the current situation and presents new analysis that suggests a way forward. The talk builds on recent commentary (McDonnell et al., 2018, Nature-Sustainability) and focuses on a hitherto largely unexplored factor in paired watershed analysis: below ground storage. The talk will show how storage may be one of the most critical factors for understanding hydrological change and presents a vision for future work in forest hydrology to quantify storage in paired watershed studies to inform how to manage water sustainably in forested landscapes.

Prof. Stefan Uhlenbrook (United Nations World Water Assessment Programme) - 3. April 2019

Professor Uhlenbrook is the Coordinator of the UNESCO World Water Assessment Programme (WWAP) and the Director of the UNESCO Programme Office on Global Water Assessment in Perugia, Italy, since 2015. He coordinates the UN World Water Development Report that the WWAP produces annually (on behalf of UN-Water and jointly with many UN-Water Members and Partners) to inform policy and decision makers on key water challenges and solutions. He has proven records of building and coordinating strategic partnerships with a large variety of stakeholders and is committed to support achieving the Sustainable Development Goals (SDG), including through the coordination of the UN-Water SDG 6 Synthesis Report on Water and Sanitation 2018.

Prof. Uhlenbrook previously worked at the UNESCO Institute for Water Education (UNESCO-IHE), as Professor of Hydrology (since 2005), Deputy Director (Vice-Rector) for Academic and Student Affairs (2000-2014) and Director a.i. (acting Rector; 2014-2015). Dr. Uhlenbrook obtained his PhD (1999) and habilitation (2003) in Hydrology at the University of Freiburg, Germany and is a professor for experimental hydrology at the Delft University of Technology, The Netherlands (since 2009).

Water – The critical element to achieve the Agenda 2030 and the Sustainable Development Goals (SDGs)

Climate change, land use change, urbanisation, demographic development and migration, conflicts and peace, food demand and change of diets, industry 4.0, globalisation etc. are among the challenges that integrated sciences as well as development programmes need to address to serve societal needs. Business as usual in policymaking and project developments is no option. However, exciting developments have been taking place as the global community agreed on the ambitious Agenda 2030 for Sustainable Development, which aims to be comprehensive and include the participation of all stakeholders in one integrated framework. Water – in all its facets including water supply, sanitation, wastewater, water quality, IWRM, ecosystem requirements etc. - plays a central role in the Agenda 2030, as it is not only central in Sustainable Development Goal (SDG) 6, but it is fundamental for the realization of other SDGs related to, for instance, poverty reduction, sustainable growth, health, food security, education, gender equality, climate change, ecosystems (land and sea), etc.

An integrated analysis and synthesis of data, information and related policy linkages will be presented for the Water Goal (SDG 6) in light of achieving the whole 2030 Agenda. The presentation will summarise 'the big picture' on progress made in achieving SDG 6 with some links to the current R&D agenda of knowledge economies like Luxemburg, and policy perspectives of how to accelerate achieving this fundamental goal in a rapidly changing environment will be discussed. The presentation will draw upon the UN-Water SDG 6 Synthesis Report 1) that informed the High-level Political Forum on Sustainable Development (HLPF) in its in-depth examination of SDG 6 2018 about the state of affairs re SDG 6, the interlinkages to other SDGs and related policy perspectives.

1) The Synthesis Report was prepared by a UN-Water Task Force including CEO Water Mandate, FAO, ILO, UNDP, UNECE, UN-Environment, UNESCO WWAP (coordinator), UN-HABITAT, UNICEF, UN-Water TAU, UNU, WHO, WMO and World Bank. MANY colleagues have contributed to the results presented.