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Preface: HS02 – Hydrologic Non-Stationarity and Extrapolating Models to Predict the Future

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The phrase "hydrologic non-stationarity" is increasingly used to describe many things, ranging from climate and streamflow variability evident in different periods within a long hydroclimate time series to changes in climate-runoff relationships and dominant hydrological processes over time, or simply to explain why hydrological model assumptions and conceptualisation fails in some modelling applications. Hydrologists have excelled in developing models for numerous applications, through analysing and interpreting climate and hydrologic data to understand hydrologic processes, conceptualising the processes in hydrological models, and calibrating and testing models against observations. These models are particularly good at predicting the streamflow response to changes in the climate inputs (as long as the prediction period climate is not too different to the climatic conditions in the calibration period) and catchment characteristics. However, extrapolating hydrological models to predict further into the future is more challenging as streamflow will be increasingly influenced by higher temperatures and changed ecohydrological processes under higher CO2. Reliably modelling these is difficult because of the complex interactions and feedbacks between many variables and processes in a future environment that have not been seen in the past (i.e., hydrologic non-stationarity that has not been observed).

The paper by Milly et al. (2008) initiated significant discussions and an increased focus towards research on hydrologic non-stationarity. Although this paper presented a philosophical and thought provoking commentary on hydrological non-stationarity, it worked as a catalyst and led to more practical investigations where the ability of hydrological models to simulate streamflow under non-stationary conditions are tested using large observation datasets and approaches proposed and developed to overcome the model extrapolation problem (Vaze et al., 2010; Merz et al., 2011; Coron et al., 2012). This is an active and increasingly important field of research as extrapolating hydrological models to predict the future under higher temperatures and CO2 concentrations is complex and a challenge for the research community.

This IAHS symposium on "hydrologic non-stationarity and extrapolating models to predict the future" in the 2015 IUGG General Assembly (in Prague, Czech Republic, 22 June to 2 July 2015) directly addresses a key issue in the IAHS Panta Rhei Decade (Change in Hydrology and Society, Montanari et al., 2013) and builds on previous forums on this topic. These include the Colorado State University (2010) workshop on "hydrologic non-stationarity", special session H093 at the 2012 AGU Fall Meeting (San Francisco, USA) on "Hydrological modelling under non-stationarity" and the special session at the 2013 IAHS Scientific Assembly (Göteborg, Sweden) on "Modelling temporally variable catchments" (Thirel et al., 2015 and other papers in the special issue in Hydrological Sciences Journal on "Modelling temporally variable catchments").

The presentations (oral and poster) and dedicated discussions in the 2015 Prague HS02 Symposium are focussed on recent advances in hydrologic non-stationarity research and implications for hydrologic predictions. This PIAHS volume presents the 35 full papers accepted for publication from the Symposium. The papers can be broadly grouped into four categories: (i) papers that characterise hydroclimate trend and non-stationarity and discuss their implications on hydrologic predictions, (ii) papers that largely model climate change impact on water; (iii) papers that explore approaches to take into account hydrologic non-stationarity in predicting the future (through process conceptualisation and/or smart parameterisation of existing models); and (iv) papers that address anthropogenic non-stationarity from catchment development, river regulation and environmental disturbances.

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