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PREFACE - SPECIAL ISSUE

The impacts of changes in climate and land use on hydrological processes

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The contributions selected for this Topical Issue are follow-ups from the EGU2016 session HS2.4.3 under the title "Impacts of climate and land use change on hydrological processes". Here we focus on the impact of environmental changes on hydrological processes that were studied under a number of international projects, including CHIHE, CHASE-PL and the FLORIST.

This Issue deals with changes in hydrological extremes related to climatic and human-induced changes in catchments. A number of studies have been published on the influence of climate changes on floods and droughts (Osuch et al. 2016; Romanowicz et al. 2016; Meresa et al. 2016; Kundzewicz et al. 2017a). However, the picture of future changes is far from clear. There are too many unknowns, including future climate model projections, hydrological modelling errors and land-use development that may influence river flows in future. That is why we do not write about flow predictions but instead the term "projections" is used in the literature related to climate change impact on flows. Among many studies on future flow extremes, high flows are of particular interest due to the necessity of flood risk management taking into account future climate changes (Alfieri et al. 2016). The latter study argues that adaptation to floods should aim at reducing the impacts of floods rather than avoiding them. Following that path of reasoning, the development of infrastructure and urbanization may be the main drivers for the increased perception (and number) of catastrophic flood events observed recently.

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The papers published under this Topical Issue can be classified into those describing observed changes in flow patterns in catchments (Kundzewicz et al. 2017b; Somorowska 2017), papers presenting changes in the trends of future flow projections (Meresa et al. 2017; Piniewski et al. 2017). The paper by Doroszkiewicz and Romanowicz (2017) presents issues related to adaptation to floods under future climatic conditions. The last two papers by Debele et al. (2017a, b) present an application of new statistical tools able to deal with the nonstationarity of future flow projections.

Research on the impact of climate change on hydrological processes, and in particular, on floods and droughts usually starts from an assessment of observed extreme events in the area of interest. There are two papers in this issue that directly deal with the observed flow patterns (those by Somorowska 2017; Kundzewicz et al. 2017b).

Somorowska (2017) describes the trends in flow regime in a low-land catchment, Lasica. The 65-year long flow and groundwater level records were analysed. The observations show a step-like change in the flow regime, which the author explains by increased evapotranspiration due to the temperature rise. That conclusion supports the idea of a nonlinear relationship between the flow and water losses in the catchment. The catchment is nearly natural, forested and processes there may be influenced by a strong ecological feedback related to changes in forest water demands.

Kundzewicz et al. (2017b) present a study of flood risk in the northern foothills of the Tatra Mountains. The research was performed in the FLORIST project (Kundzewicz et al. 2014). The main project goals included creating an information database on past floods in the area, estimating changes in flood risk generated by in-channel wood on mountain streams and rivers, detection of change

in observed precipitation, atmospheric circulation patterns and high flows, analysing projections of future flow changes and simulation modelling of past events. The results give evidence of strong inter-decadal variability of intense precipitation and flow events. The work also involved an application of dendro-geomorphology to study floods in a mountain environment.

Piniewski et al. (2017) compared projected future changes of flow in eight Polish catchments obtained using two hydrological models based on different assumptions. The catchment-scale projections obtained from a semi-distributed, large scale SWAT model calibrated for the Vistula and Odra basins were compared with conceptual HBV model results calibrated on individual catchment observations. The models were driven by the same EURO-CORDEX meteorological projections, which differed due to the different bias-correction methods applied. The comparison showed large differences in projected changes, which questions their value to practitioners. One immediate point that comes to mind is the uncertainty related to those projected changes.

That problem is discussed in more detail by Meresa et al. (2017) who present a comparison of projections of high flow trends based on varying time horizon. The GR4J conceptual, lumped precipitation-flow model (Perrin et al. 2003) was used to derive flood estimates for ten Polish and eight Norwegian catchments in the 21st century. The results showed that the relative changes of high flow projections based on 30-year periods are not consistent with the trends estimated using a 130 year-long time horizon. The reason might be the inter-decadal variability that affects 30-year records.

Doroszkiewicz and Romanowicz (2017) present the guidelines on the adaptation to future floods. The paper shows the feedback between the choice of adaptation strategy and its legal feasibility to be implemented. It also points out that the climate and society changes strongly influence the choice of the adaptation scenario and raises the uncertainty issues. The paper advocates the application of simulation approach to support the decision making processes.

Debele et al. (2017a, b) present two inter-related papers. The first paper compares three different approaches to flood frequency analysis in non-stationary conditions involving also the application of the novel statistical tool GAMLSS. The second paper is a philosophical discourse of the pros and cons regarding the application of tools which are sophisticated and not easy to apply properly.

In a summary, the papers included in this Topical Issue present very wide and also novel view-points to modelling hydrological processes influenced by climatic and environmental change. Papers stress the need for adequate lengths of periods for the evaluation of climate change impact on the extreme flow indices and also the need for extending the spectrum of observation inputs. The use of novel/cutting-edge statistical methods and taking into account the uncertainty issues to support the decision making process are also strongly recommended.

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