Editorial: Hydrology and water resources management in a changing world

The XXX Nordic Hydrological Conference (NHC) was held in Bergen with 145 participants. The conference was organized by the Norwegian Hydrological Council in cooperation with the Nordic Hydrological Association (NHF). A total of 114 contributions were submitted from 24 countries, of which 30 were given by master or PhD students. In addition, the five invited speakers gave presentations at the conference. Most of the contributions came from Nordic and Baltic countries which constitute the NHF's area of activity. The main theme of the conference was 'Hydrology and water resources management in a changing world'. This theme reflects important challenges for both researchers and practitioners in the public and private sectors. Sub-topics were: water in urban areas; groundwater; floods; climate services; hydrological processes and models; hydropower; water consumption; environmental impact and water quality.

As part of the conference, we had a tour of 'Bryggen', which gave us insight into how blue-green solutions were used to save this UNESCO world heritage site. Rory Dunlop from NIKU, Guri Venvik from NGU and Floris Boogaard from Tauw have worked for several years preserving 'Bryggen', and gave insightful scientific guidance to the challenges and solutions.

After the conference, authors were given the opportunity to submit their original contributions for publication in a special issue of *Hydrology Research*. After a rigorous peer-review process, 15 papers were accepted for publication in this special issue covering a range of the conference themes outlined above.

Six of the papers address advanced methods and technology in hydrological modelling. Hydrological modelling is instrumental both for scientific application and for providing public services, and the papers present algorithms, tools, platforms and systems used within modelling different aspects of the hydrological cycle. To better simulate peak flows with short time resolution, Tsegaw *et al.* (2020) extend the DDD-model (Skaugen & Onof 2014) by introducing a dynamic river network that depends on the catchment saturation.

Correct classification of precipitation phase is important for hydrological modelling in Nordic and high altitude areas. Both Grigg *et al.* (2020) and Feiccabrino (2020) investigate approaches for this classification. Grigg *et al.* (2020) present three methods for utilising physiographic catchment descriptors in precipitation phase determination for 169 meteorological stations in Norway and Sweden. Feiccabrino (2020) estimates uncertainty in precipitation phase models using thresholds of air temperature, dew-point temperature and wet-bulb temperature. The analysis was done for time of observations and averaged data for readings of different time intervals. It is shown that the best option is to use wet-bulb temperature or reduce the time-step from 24 hours to 3 or 1 hours.

The availability of input data is often a limitation for precipitation-runoff modelling. Both the density and representativity of the gauging stations is challenging in mountainous areas with large precipitation gradients and most of the gauges located at low altitudes. Sivasubramaniam *et al.* (2020) compare the use of temperature and precipitation from observations and from meteorological models for several catchments located in mid-Norway. It is shown that using input data from meteorological models is almost as good as, and in some cases better than, using gauge data. Bhattarai *et al.* (2020) compare different global forcing datasets for hydrological modelling of the Narayani catchment in Nepal. The paper evaluates the variability and uncertainty of discharge in the catchment for the different forcing datasets. The results also show that the global datasets could be highly useful as input for modelling in areas with sparse observations.

Snow is an important component in hydrology in cold climate areas, and observations of snow can be used for improving hydrological forecasts by data assimilation. In Magnusson *et al.* (2020) snow observations are used to update the snow water equivalent, an important state

doi: 10.2166/nh.2020.000

variable for correct prediction of runoff during the snowmelt period. The method is tested in a streamflow forecasting framework.

Hydrologic indicators are often used to describe changes to the hydrological regime due to changes in anthropogenic or climatic factors, and in the case of a lack of data indicators are estimated based on hydrological models. Massmann (2020) investigates how good models will simulate changes in hydrological indicators based on calibration strategies, catchment properties and properties of the hydrological indicator itself. The studies show that indicators of magnitude are estimated reasonably well, but indicators related to dynamics of the flow regime are problematic.

Climate change is impacting the high latitudes more rapidly and significantly than any other region of the Earth, and two of the papers address climate change impact on streamflow. Akstinas *et al.* (2020b) combine three climate models with different emission scenarios with a statistical downscaling approach to estimate uncertainty in runoff projections in Lithuanian rivers. It is shown that the global climate models (GCMs) are the dominant uncertainty source in the runoff projections.

Zhang *et al.* (2020) use the VIC-glacier model to study the contribution of melt water and rain water to streamflow of two basins on the Tibetan Plateau. The model is calibrated using streamflow, glacier mass balance data and MODIS snow, and used to study changes in streamflow between the baseline period (1964–1990) and the 1990s and 2000s. An increasing trend in runoff during the past 50 years is shown, mainly explained by increasing rainfall, but also some increase in glacier melt.

Floods are a major issue in hydrological analysis, and are the main topic of two of the papers. The papers present contrasting flood types, covering both a rainfall driven flood in a small catchment and flood in a large basin driven by rainfall and snow melt. Extreme localized precipitation with short duration is expected to become more frequent in the future, and Bruland (2020) estimates extreme unit discharge in a small catchment after such a flood event in Storelva in Utvik, Norway. A common problem for many analyses like this is lack of data, and the paper presents several different approaches to estimate the flood magnitude using hydrological and hydraulic analysis. Akstinas *et al.* (2020a) analyze the causes and effects of two large flood episodes in the Nemunas river basin using data analysis and hydrological modelling. The findings show that snow accumulation was the main factor of the formation of large floods and it also identifies the subcatchments with the largest contributions to the flood volume.

Four of the papers address surface water, groundwater and blue-green solutions in urban areas. Handling surface water in cities is a challenge. With increasing intensity of rainfall for short periods, the challenges will also increase. Events in Copenhagen and elsewhere in Northern Europe in early June 2013 are examples of challenges with headlines like 'Rain showers in the cities cost far more than floods' (*Aftenposten*, June 2, 2013). Oslo and other major cities have similar events. Surface water and groundwater must be handled in a comprehensive and not separate manner in order to handle the climate change of the future in a cost-effective and sustainable manner. The drainage and piping of today is not designed for the rainfall of the future, and it is also expensive to clean rainwater that is taken along with graywater. Alternative solutions for surface water management, tailored to future precipitation forecasts and 'in harmony' with groundwater, will provide solutions that can withstand heavy rainfall episodes and save society the high costs. For coastal towns and cities, both increasing precipitation and rise of sea level is a potential threat to society. Venvik *et al.* (2020) present a study from the city of Bergen where effects of subsidence and floods are studied to establish risk hazard maps for the city. Through these maps subsidence mitigation and flood water management can be planned. Green roofs are one of the common green strategies for stormwater management. Schärer *et al.* (2020) investigate the suitability of using runoff coefficients for designing green roofs. Based on laboratory and field studies, the applicability and magnitude of runoff coefficients for different types of detention based roofs are assessed. Bian *et al.* (2020) study the flood responses related to changes in precipitation and urbanisation for the Qinhuai basin in China. The catchment has seen a marked development in urbanisation since the start of the 2000s. Based on trend tests on flood data, the impact of urbanization is evaluated by studying periods before and after urbanisation of the catchment. Modelling urban flooding to estimate inundation depths is important in planning urban infrastructure. Li *et al.* (2020) use the SIMWE model to model overland flood for different design rainfall events and spatial resolutions over Oslo to estimate the overland flood. The paper presents the effect the rainfall input and spatial resolution have on flooded areas and the predicted water depths.

ACKNOWLEDGEMENTS

We would like to thank all authors for their interest in *Hydrology Research*, and the reviewers for their help in the review process, which significantly improved the quality of the papers. We are also grateful for the support and patience of Chong-Yu Xu and Bjørn Kløve, *Hydrology Research* Editors, in the preparation of this issue.

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REFERENCES

Akstinas, V., Meilutytė -Lukauskienė, D., Kriauciunienė, J. & Šarauskienė, D. 2020a Features and causes of catastrophic floods in the Nemunas River basin. *Hydrology Research* **51** (2), 308–321.

Akstinas, V., Jakimavicius, D., Meilutytė -Lukauskienė, D., Kriauciunienė, J. & Šarauskienė, D. 2020b Uncertainty of annual runoff projections in Lithuanian rivers under a future climate. *Hydrology Research* **51** (2), 257–271.

Bhattarai, B. C., Burkhart, J. F., Tallaksen, L. M., Xu, C.-Y. & Matt, F. N. 2020 Evaluation of global forcing datasets for hydropower inflow simulation in Nepal. *Hydrology Research* **51** (2), 202–225.

Bian, G., Du, J., Song, M., Xueliang, Z., Xingqi, Z., Li, R., Wu, S., Duan, Z. & Xu, C.-Y. 2020 Detection and attribution of flood responses to precipitation change and urbanization: a case study in Qinhuai River Basin, Southeast China. *Hydrology Research* **51** (2), 351–365.

Bruland, O. 2020 How extreme can unit discharge become in steep Norwegian catchments? *Hydrology Research* **51** (2), 290–307.

Feiccabrino, J. M. 2020 Precipitation phase uncertainty in cold region conceptual models resulting from meteorological forcing time-step intervals. *Hydrology Research* **51** (2), 180–187.

Grigg, L. D., Feiccabrino, J. & Sherenco, F. 2020 Testing the applicability of physiographic classification methods toward improving precipitation phase determination in conceptual models. *Hydrology Research* **51** (2), 169–179.

Li, H., Gao, H., Zhou, Y., Xu, C.-Y., Ortega, R. Z. & Sælthun, N. R. 2020 Usage of SIMWE model to model urban overland flood: a case study in Oslo. *Hydrology Research* **51** (2), 366–380.

Magnusson, J., Nævdal, G., Matt, F., Burkhart, J. F. & Winstral, A. 2020 Improving hydropower inflow forecasts by assimilating snow data. *Hydrology Research* **51** (2), 226–237.

Massmann, C. 2020 Reproducing different types of changes in hydrological indicators with rainfall-runoff models. *Hydrology Research* **51** (2), 238–256.

Schärer, L. A., Busklein, J. O., Sivertsen, E. & Muthanna, T. M. 2020 The limitations in using runoff coefficients for green and gray roof design. *Hydrology Research* **51** (2), 339–350.

Sivasubramaniam, K., Alfredsen, K., Rinde, T. & Sæther, B. 2020 Can model-based data products replace gauge data as input to the hydrological model? *Hydrology Research* **51** (2), 188–201.

Skaugen, T. & Onof, C. 2014 A rainfall-runoff model parameterized from GIS and runoff data. *Hydrological Processes* **28** (15), 4529–4542. doi:10.1002/hyp.9968.

Tsegaw, A. T., Skaugen, T., Alfredsen, K. & Muthanna, T. M. 2020 A dynamic river network method for the prediction of floods using a parsimonious rainfall-runoff model. *Hydrology Research* **51** (2), 146–168.

Venvik, G., Bang-Kittilsen, A. B. & Boogard, F. C. 2020 Risk assessment for areas prone to flooding and subsidence: a case study from Bergen, Western Norway. *Hydrology Research* **51** (2), 322–338.

Zhang, Y., Hao, Z., Xu, C.-Y. & Lai, X. 2020 Response of melt water and rainfall runoff to climate change and their roles in controlling streamflow changes of the two upstream basins over the Tibetan Plateau. *Hydrology Research* **51** (2), 272–289.