

## Editorial: Assessment and adaptation to climate change impacts in cold regions

### INTRODUCTION

Global interest in water research has increased rapidly in recent years, with climate change being one of the key drivers. Many water issues have been prioritised on the political agenda. This research spans a wide spectrum of themes, including but not limited to climate change impacts on hydrology and hydraulic processes; lack of access to safe drinking water and sanitation; increase in water-related disasters such as floods and droughts.<sup>1,2</sup> Therefore, the discipline of *climate change-related water research* is more important than ever.

The cold regions, including polar and some parts of the temperate regions, have been emerging popular research areas in recent years. This is mainly motivated by significant climate changes and the unprecedentedly observed changes in different components of these regions (e.g. temperature, rainfall, snowfall, heat and moisture advection, freezing and thawing processes, surface and groundwater flow regimes, soil formation, water quality, ecological and biogeochemical processes) (Førland 2007; IPCC 2014; Hanssen-Bauer *et al.* 2017; Bui *et al.* 2020). With the rapid population and economic growth, and technological advancements in many countries located in these regions, assessing the responses of these regions to recent and future climate changes has become increasingly important in order to support adaptation strategies and plan and design more efficient and reliable sustainable mitigation measures.

### THIS SPECIAL ISSUE

Targeting the challenges in hydrology and hydraulics processes and the impacts of climate change on the total environment in cold regions, this special issue (SI) aims to present the latest research and innovation methods and findings in water-related disciplines, including climatology, hydrology, ecology and environmental sciences. These efforts are oriented towards assessing their impacts on hydrological processes, risk and vulnerability of natural disasters, water quantity and quality, and environmental effects under present and future climate changes, and testing and exploitation of sustainable and efficient solutions in cold regions, spanning different temporal and spatial scales (e.g. local, regional and global domains).

Selecting from the extended abstracts presented in a special session on Hydrology and Hydraulics in the Cold Regions, the 6th IAHR Europe Congress 2020<sup>3</sup> with the synergy of additional submissions, this Special Issue published seven scientific articles covering climate change impacts and mitigation effects in the cold regions.

First, Bui *et al.* (2021a) evaluated and demonstrated the potential of using high-resolution reanalysis weather data to replace the scattered ground-based weather data in the data-sparse Arctic region for accurate hydrological modelling, which supports climate change impact assessments in the Arctic river basin. Second, snow cover is highly sensitive to global climate change, and strongly influences the climate at global and regional scales. Zhang *et al.* (2021) presented their studies on the snow cover dynamics in the Nyang River basin of the South-eastern Tibetan Plateau in China. Five snow cover indices derived from observation and remote sensing data from 2000 to 2018 were used to investigate the spatial and temporal variation of snow cover in the Nyang River basin. Furthermore, Bui *et al.* (2021b) applied the Soil and Water Assessment Tool and the threshold drainage area (TDA) technique to evaluate the impacts of watershed subdivision on hydrological simulations in the Arctic conditions, which assists in the assessment of climate change impacts and risk management such as detecting vulnerable areas through high snowmelt runoff modelling, and flood risk analysis.

<sup>1</sup> UN-SDG: <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>.

<sup>2</sup> Water and SDGs: <https://www.thesourcemagazine.org/water-and-the-sdgs/>.

<sup>3</sup> 6th IAHR Europe Congress 2020 and Special sessions: <https://iahr2020.pl/approved-special-sessions/>.

Growth in rainfall can increase the amount of water contaminated with sulphate and toxic metals resulting from mining activities. Cold-tolerant sulphate-reducing bacteria were cultivated using low-cost carbon sources, i.e., whey, conditioned sewage sludge and peat, to find a cost-efficient biological method for treatment of mining effluents in cold conditions (Virpiranta *et al.* 2021). In their studies, an encouraging sulphate removal rate has been achieved even at 6 °C and the bacteria were able to utilise propionic acid present in the sludge.

Temperature change in a changing climate has an important impact on the efficiency of dry covers on the tailings. Lu *et al.* (2021a) introduced a laboratory column leaching experiment to investigate the impact of temperature on the leaching of sulphate, Co, Fe, Mn, Ni and Zn from Ballangen, Norway. The experiment was performed under four different temperatures of 5, 10, 14 and 18 °C. The results showed low oxidation of tailings and therefore high pH and low salinity, sulphate, Fe, Ni and Co in the leachates at 5 °C. In addition, the research team has studied the impact of temperature on the efficiency of sewage sludge cover on the tailings in preventing the oxidation of tailings and leaching of contaminants from tailings deposits (Lu *et al.* 2021b). At a leaching temperature higher than 10 °C, the sludge cover addition can reduce the leaching of elements significantly.

Finally, typical continental, cold climate conditions were applied to four large, laboratory columns to assess the seasonal effectiveness of bioretention application in cold climate regions, with temperatures ranging from –20 to +20 °C over summer, winter and spring runoff (Kratky *et al.* 2021).

Despite the relatively small number of papers included in this Special Issue, we hope that these papers can be used as spiritual examples to drive more research and outcomes of *Water and Climate Change* in the cold regions.

Many thanks to the authors for their particularly interesting papers, which we would like to believe have contributed to the understanding and strengthening of our scientific knowledge of climate change and its impacts in the cold regions. Furthermore, we would like to express our deepest thanks and gratitude to the reviewers, and to Dr Ahmed El-Kenawy, the Journal Editorial team and Emma Gulseven, Head of Editorial and Production, IWA Publishing for their full support and advice in the preparation of this Special Issue.

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