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Editorial

Hydrolink

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EDITORIAL

Every day there are stories in the news directly or indirectly related to climate change. Even though it is not possible to attribute specific extreme events just to climate change, their increasing frequency and intensity suggest a trend in several meteorological and hydrological variables which is becoming evident even to the most ardent climate change skeptics. Recent examples are the devasting flooding in Pakistan and the catastrophic impact of hurricane Ian in Florida. Besides the almost daily news reports on the negative impacts of climate change, a number of scientific publications warn us about the potentially irreversible effects of a changing climate. For example, a recent paper discussed several climate tipping points, which "occur when change in a part of the climate system becomes self-perpetuating beyond a warming threshold"[1]. They include the collapse of the Greenland Ice Sheet, the West Antarctic Ice Sheet, the boreal permafrost, the Atlantic Circulation, the Arctic Winter Ice Sheet and the East Antarctic Ice Sheet, as well as the Amazon rainforest dieback and low latitude coral reef die-offs. Some of these tipping points are likely even if the Paris Agreement range of 1.5 to less than 2°C warming is met[1].

Water is at the center of many of the consequences of climate change. As the planet is warming evapotranspiration rates increase raising the amount of moisture in the atmosphere leading to more intense precipitation. This in combination with changes in the global atmospheric circulation affecting the distribution of precipitation both in space and in time, results in some areas experiencing extended droughts while other are subjected to extreme flooding. The warming of the oceans on the one hand causes more stronger cyclones with higher wind speeds and carrying more moisture, and on the other contributes to sea-level rise due to thermal expansion which adds to sea-level rise due to the melting of land-based ice, such as continental glaciers and the Greenland and Antarctica ice sheets.

Valuable assessments of expected changes in temperatures, precipitation and sea-level rise are provided periodically by the Intergovernmental Panel on Climate Change (IPCC) which synthesizes information from thousands of scientific papers and presents conclusions that represent the consensus of climate scientists. These assessments are based on the analysis of historic data and projections based on the results of Global Circulation Models (GCMs) and Regional Circulation Models (RCMs). The article by Roberto Ranzi in this issue summarizes key points of the most recent, the sixth, IPCC Assessment Report (AR6).

The hydrologic and hydraulic engineering and research community faces the challenge of accounting for climate change in the design of new infrastructure and the development of mitigation measures. What is of most interest to this community is estimates of future average and extreme precipitation for the design of water supply, hydropower and flood protection projects, and projection of sea level rise, storm surges and cyclone intensity for the design of coastal infrastructure.

Accounting for extreme precipitation in the design of new infrastructure and water resources management has always been a challenge. The design criteria for various facilities and structures are typically expressed in terms of the return period, or the annual recurrence interval (ARI), of the precipitation event that the design should be based on. The magnitude of events of a given ARI is obtained by fitting a distribution to historic data and using it to extrapolate to longer periods than that of the historic records, which in most cases are too short to allow the estimation of extreme events with confidence. A common rule of thumb is to restrict extrapolation to return periods equal to about twice the period of record. This limitation can be to some extent overcome through regional frequency analysis, but there is still significant uncertainty in the estimation of the magnitude of large ARI events. This leads to often confusing reports in the press, such as for example that a 500-year event occurred multiple times within few years. Considering that it is difficult estimate the intensity of events with a given probability of occurrence under the assumption of stationarity, i.e., that the future will look like the past, it is no surprise that it is even more difficult to do so when we face a future with a changing climate.

Projections of changes in precipitation from GCMs and RCMs are at global and regional level scales, and they cannot be used as such to assess climate change impacts on the hydrologic regime at small spatial and short time scales. It is up to the practicing hydrologic engineers working on specific projects to translate them to the local scale of interest. Different methods have been developed for downscaling the results of GCMs and RCMs to a specific locality. These methods vary in complexity and in the computer resources needed for their application. It is also noted that the results of all atmospheric models are subject to uncertainty, and it is often recommended working with the ensemble average of several models. A critical review of the feasibility and adequacy of various downscaling techniques aimed at helping identify the most suitable procedure for evaluating the impacts of global climate changes on the hydrologic processes at a given location is presented in the article by Van-Thanh-Van Nguyen and Filippo Giorgi in this issue.

Besides the two articles mentioned above, the current issue of Hydrolink includes four more articles on different aspects of the work of the hydraulic community on climate change issues. Another recent contribution of IAHR to the subject is the recent lecture by Peter Goodwin on climate change adaptation which is available at the IAHR website[2].

1 | Armstrong McKay, D.I., A Staal, J.F. Abrams, R. Winkelmann, B. Sakschewski, S. Loriani, X. Fetzer, S.E. Cornell, J. Rockström, T.M. Lenton: "Exceeding 1.5°C global warming could trigger multiple climate tipping points", Science, Vol 377, No. 6611, September 9, 2022

2 | Goodwin, P., 2002: "Climate change adaptation", lecture at the IAHR Africa Summer School, October 3, 2022, https://www.iahr.org/index/detail/590#/