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Editorial

Special Issue: Assessing Climate Change's Impact On Hydrological Responses.

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Abstract

Examining the diverse effects of climate change on hydrology is the goal of this Special Issue of the journal Water, "The Evaluation of Hydrologic Response to Climate Change." Using a variety of methods, such as field observations and hydrological modeling; investigations, such as shifting habitats and organismal influences; modeling of water supply and landscape impacts; and the response of various hydrological cycle components, the issue has published nine articles from multi-institution, frequently multi-country collaborations that evaluate these changes in places all over the world, including China, Korea, Russia, Pakistan, Cambodia, the United Kingdom, and Brazil.

Keywords : *hydrology, watersheds, water balance, coastal fog, evapotranspiration, baseflows, ecosystems, recharge, streamflow, snowfall, and climate change.*

INTRODUCTION

The impact of climate change on water balance and hydrological processes worldwide is among its most evident effects, and hydrological responses to climatic fluctuations are particularly well-known [1]. Globally, the effects are diverse. For example, recent changes in the climate have affected the ecological conditions in Russia's Small Aral Sea [2], Pakistan is experiencing some of the worst water shortages in the world [3], which further affect ecosystem services [4], and Brazil's semi-arid northeastern region, home to some of the nation's poorest rural communities, has seen an increase in droughts [5]. Due to its distinct geographical features, Pakistan's Tibetan Plateau—known as the "Water Tower of Asia"—plays a significant role in East Asian and global atmospheric circulation patterns. It is also warming, which has a significant impact on snowmelt and the sustainable water supplies for Asia's largest rivers [6]. The Tonle Sap Lake basin in Cambodia, the most fertile and diverse freshwater ecosystem in Southeast Asia [7], and the chalk streams of England, which have a notably high level of biodiversity because of their unusual predominance of groundwater seeps [8], are two difficult places to find threats to freshwater ecological systems and biodiversity.

Tools to describe the current hydrological and climatic conditions as well as possible future changes are necessary for assessing hazards.

A number of issues make it difficult to determine changes to watershed hydrology by using current hydrologic modeling methods, which accurately reflect historical conditions, and then forcing them using future climate data. First, past calibrations that are changing in terms of trends and extremes are more challenging to depict in a model, let alone project into the future, because climatic circumstances are no longer static. Second, in order to construct a correspondence of the historical runs by the global climate models (GCMs) and ensure that future simulations are not skewed about relative change from historical circumstances, the GCMs must be adjusted for bias in the historical record. circumstances at the moment. Lastly, in order to more accurately depict the conditions and processes inside a watershed, GCMs must be downscaled to more local spatial scales. The collection of papers in this Special Issue has examined these challenges.

These studies examined the performance of hydrological models and GCMs, projected ecological and hydrological changes to basins [1, 2, 4–8], and used a suite of analytical and numerical tools to improve both historical calibration/ validation capabilities [2,8] and future climate modeling performance [4,5,9]. These studies addressed various aspects of the water balance, ranging from precipitation [6] and evapotranspiration [9] to runoff [1–3,7,8] and impacts to water resources [2–5,7,8].

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SUMMARY OF PAPERS

Ayzel And Ishitskiy's 2019 Assessment Of The Effects Of Climate Change On Freshwater Inflow Into The Small Aral Sea

The scientific community views the recent decades-long fast separation of Russia's Small Aral Sea from the official Aral Sea as a glaring example of an ecological catastrophe caused by human activity, as the water balance has changed in tandem with climatic shifts. In order to assess the effects of future climate forecasts, Ayzel and Ishitskiy set out to create and validate a hybrid watershed model for the Syr Darya River basin, which serves as the main source of freshwater inflows to the Small Aral Sea. They integrated machine learning with the Hydrologiska Byrans Vattenbalansavdelning (HBV) model to carry out thorough calibrations and validations for the historical era with trustworthy outcomes. Four global climate models and three representative concentration pathway scenarios were used to evaluate the influence of future climate change. The results of the models showed conflicting findings; more aggressive scenarios are projected to result in more noticeable changes in relative runoff.

Climate Change-Related Long-Term Variation In Runoff Coefficient During Dry And Wet Seasons By Ha Et Al. (2019)

This study used 13 future climate models for two representative concentration pathway scenarios in order to assess the future long-term variation in the runoff coefficient computed by the model utilizing the Soil and Water Assessment Tool (SWAT) on five main river basins in South Korea. When comparing the trends for the wet and dry seasons, the estimates indicate that the runoff coefficient will grow over time in both RCPs during the twenty-first century. The trend and uncertainty in the dry season are predicted to be larger than those in the wet season, and they also show a significant contrast to each other. Although the relationship is anticipated to alter with variations in temperature and precipitation during both seasons in all future climate periods, a geographical relationship between the variation in the future runoff coefficient and land cover/ land use type has also been established.

Jia Et Al.'S (2019) Evaluation Of The Effectiveness Of Cmip5 Global Climate Models For Forecasting Future Precipitation Change In The Tibetan Plateau

In this study, the ability of 33 global climate models to replicate historical precipitation across China's Tibetan Plateau was evaluated. A submultiple model ensemble was also used to forecast future precipitation variations for two representative concentration pathway (RCP) scenarios.

They demonstrated that while the majority of models were able to replicate the pattern of an annual precipitation cycle, they all overestimated precipitation, particularly during the spring and summer, and struggled to replicate its geographical distributions.

According to RCP4.5 and RCP8.5 scenarios, the future annual precipitation was expected to rise by roughly 6% in the near future and by 17% and 12%, respectively, over the final half of the century. Future variations in precipitation showed that the majority of increases took place on the northern Tibetan Plateau and maintained comparable spatial distributions under both scenarios. The findings should give managers of agricultural and water resources important information for addressing the effects of climate change.

Using The Soil And Water Assessment Tool, Nauman Et Al. (2019) Evaluated The Effects Of Future Climate Change On Streamflows Upstream Of Khanpur Dam In Pakistan.

The purpose of this study was to assess the long-term variations in climatic factors and measure the effects they have on the water resources of the Pakistani watershed of the Haro River upstream of the Khanpur Dam.

The model was calibrated to historical streamflow and meteorological data using the Soil and Water Assessment Tool (SWAT). Future streamflow variations for two representative concentration pathway scenarios were evaluated using the MIROC-ESM global climate model, which had been bias-corrected to the historical time period.

According to this model, streamflows for the basin were expected to grow from 8.7 m3/s to 9.3 m3/s, while air temperature and precipitation were predicted to rise as well. Many major cities rely on this watershed for their freshwater and irrigation needs, and knowing how future streamflows will fluctuate can help with the development of future regulations and Khanpur Dam management strategies.

Evaluating How Climate Change Affects River Flows In Cambodia's Tonle Sap Lake Basin By Oeurng Et Al. (2019)

In this research, a different multi-country team from Cambodia, New Zealand, the US, France, and Thailand aimed to examine how climate change is affecting Cambodia's Tonle Sap Lake basin, which is home to the most diversified and productive freshwater environment in Southeast Asia. Climate change poses a challenge to the natural flow patterns that maintain the basin's diversity in addition to its rapid expansion. Eleven sub-basins that drain to the lake have their flows calibrated and verified to historical levels using the Soil and Water Assessment Tool (SWAT). The possible extent of future hydrological changes in the basin was then estimated using three global climate models for a medium representative concentration route over three future time horizons. All models predicted that river flows will likely decline during both the wet and dry seasons, with mean annual flow reductions ranging from 7 to 41% by the end of the century. Furthermore, a drop in extreme river flows suggested that larger drought events and smaller floods should be anticipated. These findings offer guidance for planning water resources and river ecosystem adaption plans, especially during the dry season when the greatest decline in water flows is anticipated.

Saifullah Et Al. (2019) Developed A Climate-Sensitive Model And Threshold Levels For The Hydrological Regime Of The High-Altitude Catchment Of The Western Himalayas In Pakistan.

The water shortages in Pakistan, which are regarded as some of the worst in the world because of continuous fluctuations in the hydro-meteorological conditions, were assessed by this multi-country team comprising China, Pakistan, the United States, and Australia. The scientists examined past patterns in streamflow and climate in the high altitude Kunhar River basin, which empties into the Indus River in the western Himalayas. For the basin, they created a nonparametric climate-sensitivity model using threshold values of hydrological variables. Although the temperature rose and the precipitation greatly increased, the runoff in the high elevation area reduced. In the basin's lower elevation section, flow and temperature rose as precipitation fell. Extreme drought occurrences were depicted using a two-dimensional Pardé coefficient visualization to explain these trends, which showed that the hydrological regime was more sensitive to temperature than to precipitation. A modified climate-elasticity model further demonstrated how temperature affects the hydrological regime, which in turn affects the snowmelt process. In order for policymakers and water managers to make sustainable decisions about the management of water resources, it was thought to be crucial to characterize and comprehend the hydrological sensitivity to climate of the entire basin.

Santos Et Al. (2019) Used A Hydrologic Model To Evaluate The Performance Of Regional Climate Models In A Semi-Arid Watershed In Brazil

This study evaluated how the hydrological regime of the Paraguaçu River basin in northern Brazil's semi-arid region is affected by climate change. The economy, community, and agricultural practices in this impoverished rural area have all been impacted by the recent drought, and climate change estimates indicate that temperatures will rise, rainfall will decrease, and there will be further droughts. In order to use this model with two Regional Climate Models and two representative concentration pathway (RCP) scenarios that they bias-corrected to the historical climate, the authors first calibrated and validated a Soil and Water Assessment Tool (SWAT) in this watershed. By contrasting the maximum, average, and reference (Q90) flows of the simulated and real streamflow data, the effect of climate change on streamflow was examined. The mean monthly streamflow was reduced for all time periods under both RCPs, according to climate projections from both models, however the magnitude of the drop varied. The study's findings offer guidance for managing the Paraguaçu River Basin's water resources in the future.

Visser Et Al.'S 2019 Study, The Effect Of Climate Change On Hydroecological Response In Chalk Streams

The quality of England's chalk streams, which typically supply nutrient-rich, clear water from primarily baseflows to sustain high biodiversity, is poor, and there are serious worries about how resilient they will be to climate change. The purpose of this study was to measure how climate change is affecting the hydroecological response of the River Nar in southeast England. Using the UK Probabilistic Climate Projections 2009 (UKCP09) weather generator as input (CMIP3 A1B high emissions scenario, 2021 to the end of the century), the authors implemented a coupled hydrological and hydroecological modeling methodology to achieve this conclusion. The findings show that the long-term mean hydroecological response throughout this time period changed very little under this high emissions scenario. While lower likelihood extremes are almost guaranteed to become more homogeneous, the median hydroecological reaction is more unpredictable in terms of interannual variability. Key categories are underrepresented in harsh conditions, according to a functional matrix that links species-level macroinvertebrate functional flow preferences to functional food groups. Because of interannual variety, the River Nar has so far been able to adapt to harsh events despite its small range. This variance will significantly decrease in the future, which raises serious questions about how resilient the river ecosystem—and chalk ecosystems in general—will be to climate change.

Wang Et Al. (2020) Improve Meteorological Input For Surface Energy Balance System By Estimating Daily Actual Evapotranspiration Using Mesoscale Weather Research And Forecasting Model

This study concentrated on creating methods to enhance the Surface Energy Balance System's (SEBS) estimation of actual evapotranspiration by taking into account the heterogeneity of underlying surfaces used in the Weather Research and Forecasting (WRF) model simulations, which are frequently employed to dynamically downscale future climate projections. WRF significantly outperformed commonly used mathematical interpolation techniques in simulating the climatic conditions of the Hotan Oasis in China, and it supplied more accurate input for SEBS modeling of actual evapotranspiration.

REFERENCES

1. Ha, D.T.T.; Ghafouri-Azar, M.; Bae, D.-H. Long-Term Variation of Runoff Coefficient during Dry and Wet Seasons Due to Climate Change. Water 2019, 11, 2411. [CrossRef]

2. Ayzel, G.; Izhitskiy, A. Climate Change Impact Assessment on Freshwater Inflow into the Small Aral Sea. Water 2019, 11, 2377. [CrossRef]

3. Saifullah, M.; Liu, S.; Tahir, A.A.; Zaman, M.; Ahmad, S.; Adnan, M.; Chen, D.; Ashraf, M.; Mehmood, A. Development of Threshold Levels and a Climate-Sensitivity Model of the Hydrological Regime of the High-Altitude Catchment of the Western Himalayas, Pakistan. Water 2019, 11, 1454. [CrossRef]

4. Nauman, S.; Zulkafli, Z.; Bin Ghazali, A.H.; Yusuf, B. Impact Assessment of Future Climate Change on Streamflows Upstream of Khanpur Dam, Pakistan using Soil and Water Assessment Tool. Water 2019, 11, 1090. [CrossRef]

5. Santos, C.A.S.; Rocha, F.A.; Ramos, T.A.; Alves, L.M.; Mateus, M.; de Oliveira, R.P.; Neves, R. Using a Hydrologic Model to Assess the Performance of Regional Climate Models in a Semi-Arid Watershed in Brazil. Water 2019, 11, 170. [CrossRef]

6. Jia, K.; Ruan, Y.; Yang, Y.; Zhang, C. Assessing the Performance of CMIP5 Global Climate Models for Simulating Future Precipitation Change in the Tibetan Plateau. Water 2019, 11, 1771. [CrossRef]

7. Oeurng, C.; Cochrane, T.A.; Chung, S.; Kondolf, M.G.; Piman, T.; Arias, M.E. Assessing Climate Change Impacts on River Flows in the Tonle Sap Lake Basin, Cambodia. Water 2019, 11, 618. [CrossRef]

8. Visser, A.; Beevers, L.; Patidar, S. The Impact of Climate Change on Hydroecological Response in Chalk Streams. Water 2019, 11, 596. [CrossRef]

9. Wang, D.; Zhan, Y.; Yu, T.; Liu, Y.; Jin, X.; Ren, X.; Chen, X.; Liu, Q. Improving Meteorological Input for Surface Energy Balance System Utilizing Mesoscale Weather Research and Forecasting Model for Estimating Daily Actual Evapotranspiration. Water 2020, 12, 9. [CrossRef]