**Spatial shift in monsoon**

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During the long hot summer, monsoon rains are no less than a blessing for South Asian countries. It would not be an exaggeration to call monsoon the much-awaited season, especially at a time when temperatures soar to record-breaking levels. Pakistan benefits significantly as 70 to 80 percent of the annual rainfall is received during the monsoon season that stretches from end June to September.

This rainfall plays a vital role in replenishing the country’s water resources, gives a new life to the desert regions, adds to agricultural productivity and ultimately contributes to economic growth. Due to these reasons, monsoon has become a focus of attention among climate researchers over the past few decades. Also, like all other natural phenomena, monsoon is subject to variability due to the impacts of climate change which has also invoked the scientific community to investigate multiple dimensions of this phenomenon in detail.

Pakistan occupies the western edge of the South Asian Summer Monsoon (SASM) system where moisture-laden winds from the Bay of Bengal and the Arabian Sea cause downpours in the upper half and coastal belt of the country. The major area receiving monsoon rainfalls during the season is referred to as the monsoon core region (MCR) and includes parts of northern Punjab, Azad Jammu and Kashmir (AJK), Khyber Pakhtunkhwa (KP) and a small part of the northern areas located at lower elevation.

While the research has shown variability in monsoon in terms of the amount of precipitation and the onset time due to climate change impacts during the last couple of years, a new discussion on spatial shifts in monsoon area is also undergoing among researchers. Although there are plenty of studies that indicate the changes in intensity and the onset of monsoon rains in Pakistan at present as well as in the near future, no investigation was made until the recent study, which assesses spatial shifts in monsoon area, was conducted.

The study has been conducted under the APN-funded project led by Dr Shaukat Ali (GCISC); the project aims to provide “robust projections of climate extremes and adaptation plans over South Asia”. The study exclusively investigates the likelihood of spatial shifts in monsoon area in future over Pakistan under the influence of changing climate. The study, which is titled ‘21st Century Precipitation and Monsoonal Shift over Pakistan and Upper Indus Basin (UIB) using High-Resolution Projections’ and is published in an internationally reputed science journal ‘Science of the Total Environment’, reports future shifts in Pakistan’s monsoon area using fine resolution regional climate models (RCMs).

A northward shift in monsoon precipitation has been observed, which shows the expansion of around 80-100 kilometres of the future monsoon system over Upper Indus Basin (including cities like Gilgit, Gupis and Astore) with more penetration under higher warming scenario RCP8.5. Also, the retreat of around 100-150 kilometres from the lower boundary of MCR (including cities like Faisalabad, Sargodha and Lahore) is also projected in future, which will result in less rainfall in these parts of Punjab, during the monsoon season. For instance, a significant increase of 975 percent is projected in monsoon area over UIB with the slight retreat of 2.38 percent in MCR by the end century under RCP8.5. The retreat is projected to be the highest in 2040 – 24.6 percent from MCR under high emission scenario. This expansion towards north indicates wetter conditions in high elevation regions of Pakistan and Upper Indus Basin in future.

Changes and spatial shifts in monsoon area are found to be associated with changes in atmospheric wind circulation at the lower and upper levels. The spatial shift in monsoon area can have severe implications with respect to agricultural productivity and water availability in the region and needs to be addressed in a timely manner to avoid any negative consequences on the economy. As indicated by the research, monsoon precipitation is projected to increase in the country’s northern part. In UIB, the precipitation is likely to decrease over the southern side (Sindh and lower Punjab) under high emission scenario RCP8.5 (by 2050s or 2080s)

Given the agro-economic dominance of central and southern Punjab and parts of Sindh, the spatial northward shift of monsoon could have a devastating effect on agriculture and food security since the key economic crops are grown in these areas. This alarming situation demands a concerted long-term planning and action in ensuring the country’s food security. On the one hand, the increase in rainfalls in northern parts can intensify flash floods and landslides that are already being frequently experienced. On the other, it, if properly managed, can be helpful in bringing more area under cultivation, increasing agricultural productivity and vegetative cover on the mountains.

The increasing frequency of intense rainfalls occurring every year in the monsoon season in northern areas, in recent times validates these research findings and calls for special interventions to avoid the possible devastating effects on agriculture, infrastructure and humans. Apart from advancement in the early warning system, infrastructure development and upgrade are also pertinent in flood prone areas with special attention to vulnerable communities in the north, where monsoon is likely to penetrate in future. With timely management and interventions, this blessing can be avoided from transforming into a curse.

Given the importance of monsoon rains for the South Asian region, a capacity-building training workshop for students and early career researchers under the title ‘Monsoon variability and extremes in changing climate’ is being organised by the GCISC with the support of APN in Islamabad, Pakistan, from October 12-14, 2021, as part of the APN-funded project.

Early career scientists and students from Pakistan will participate in the workshop, along with equal participation of female students to ensure gender balance. Renowned experts from Pakistan, Canada, the US, Korea, China, Nepal, and Bangladesh will provide hands-on training on cutting edge scientific techniques and tools to analyse the dynamics of monsoon extremes.

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