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Identification of regional ocean-atmospheric controls for seasonal streamflow forecasting in the Ganges-Brahmaputra-Meghna basin

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This study describes the development of a statistical forecasting approach using atmospheric and oceanic predictor variables to produce seasonal streamflow volumes for the large eastern Himalayan Rivers. The Ganges, Brahmaputra and Meghna (GBM) river system is the fourth largest freshwater discharge regime in the world and collectively drain more than 1.5 million square kilometers. More than eighty percent of the total annual rainfall occurs in four months of the monsoon season. The region faces severe water shortages during the prolonged dry season, followed by intense monsoon precipitation and rapid rise in streamflow volumes. Bangladesh, the lowest riparian in the GBM system, experiences disastrous droughts and floods almost every year causing immense suffering to its population. Existing deterministic streamflow forecasts with short lead-times (2-4 days) are insufficient for adequate planning. With increasing climate variability, rising population and agricultural demand, the impacts of these hydrologic calamities are expected to become more extreme in the coming decades.

Streamflow forecasts with monthly to seasonal lead-times can improve the situation by providing the necessary time for flood preparation, crop plantation planning and river navigation practices. We focus on understanding the large-scale ocean-atmospheric processes affecting the monsoon precipitation and streamflow patterns of the region and identifying the control variables that has significant memory on a seasonal scale. The roles of ocean phenomena such as El-Nino Southern Oscillation (ENSO) and the Indian Ocean Dipole, and other regional oceanic and atmospheric variables are investigated. The analysis is performed using 50 years of streamflow and NCEP/NCAR Reanalysis data (1958-2007). Our findings suggest that the rivers in this eastern Himalayan system are controlled by separate moisture transport regimes. A step-wise multiple linear regression approach incorporating the individual ocean-atmospheric predictors for each river is explained. Streamflow forecasts from such a combined probabilistic forecasting system along with an effective disseminating network could become exceptionally valuable for disaster mitigation planning and water resources management in Bangladesh.