

## Abstract

This study aimed to monitor surface water changes in the Ganga River Basin using Hydroweb satellite altimetry data, WRF-Hydro discharge data, and WaterGAP historical discharge data. The comprehensive methodology involved integrating these datasets to create rating curves linking water levels to discharge rates, validating anticipated discharge values with observed data, and conducting long-term trend analysis. Data from 228 Hydroweb virtual stations within the basin provided a robust foundation for assessing temporal water level variations. The Mann-Kendall trend analysis revealed significant trends in 53 stations, with 28 locations showing increasing trends and 25 exhibiting decreasing trends, while 210 locations displayed no significant trends, indicating relative stability in water levels.

Detailed examination at key sites showed Haridwar with a significant increasing trend (0.0022 meters per year) and Lucknow with a significant decreasing trend (-0.0251 meters per year). The developed rating curves demonstrated varying correlations between water levels and discharge rates, with the exponential method showing higher accuracy. Long-term discharge analysis from 1901 to 2016 indicated a general decline in discharge levels, reflecting the impacts of climate change, reduced rainfall, and increased water extraction. Seasonal analysis highlighted consistent decreasing trends during the monsoon season across the basin, emphasizing the need for adaptive water management strategies. At the outlet of the Ganga Basin, the maximum discharge was observed during the monsoon season, with 2021 recording the highest peak at approximately 175,000 cubic meters per second, underscoring the significant impact of monsoon rains on river flow.

The study's findings are crucial for effective water resource management, flood forecasting, and sustainable development planning in the Ganga River Basin. The integration of diverse datasets underscores the importance of comprehensive hydrological assessments, highlighting the need for targeted and adaptive strategies to mitigate climate change impacts, ensure water security, and promote sustainable development in the region.