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Environmental Flow Assessment of the Old Brahmaputra River Under Climate Change Scenarios Using HEC-HMS

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INTRODUCTION & AIM

The Old Brahmaputra River is a vital water resource in Bangladesh, but it faces numerous challenges due to natural variability, human activity, and climate change. This study uses the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) to evaluate the environmental flow requirements (EFR) of the Old Brahmaputra River under historical and future climate change scenarios [1]. Three hydrological techniques are used in the study to assess the EFR for both low-flow and high-flow seasons: the Tennant Method, the Flow Duration Curve (FDC) Method, and the Constant Yield Method (CYM). Using CMIP6 climate models (ACCESS-ESM1-5, BCC-CSM2-MR, and MRI-ESM2-0) under the SSP5-8.5 scenario, future projections were made for the 2030s, 2050s, and 2080s based on historical data from 1994 to 2024. To address the challenges posed by climate change, the study highlights the importance of adaptive water resource management strategies, such as preserving minimum flows during the low-flow season. The results highlight the necessity of integrated water resource management to maintain the Old Brahmaputra River's ecological sustainability and sustain the livelihoods of the communities that depend on it.

METHOD

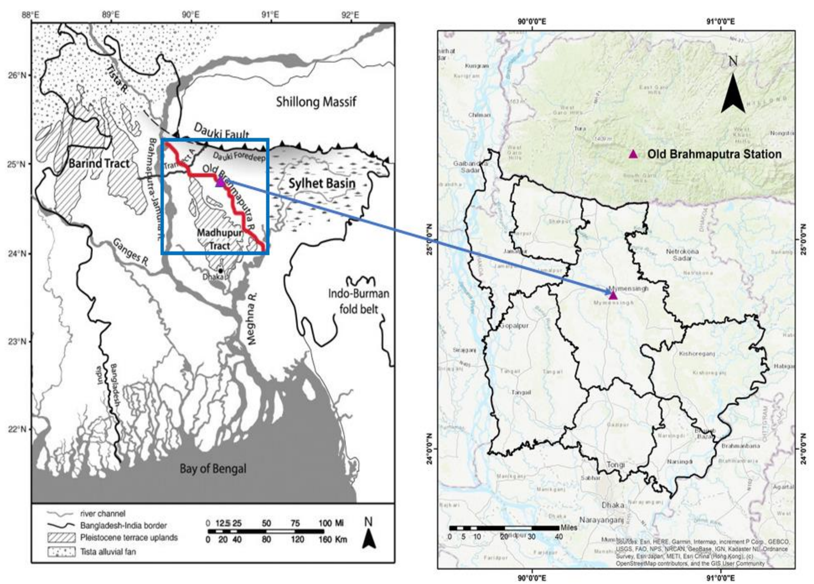

Figure 1. Study Area.

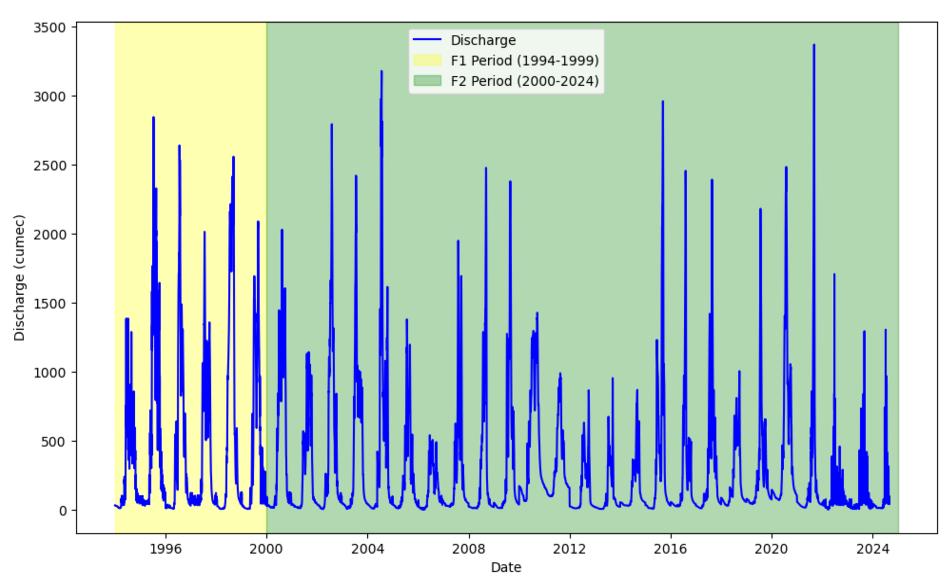

Figure 2. Hydrological analysis period.

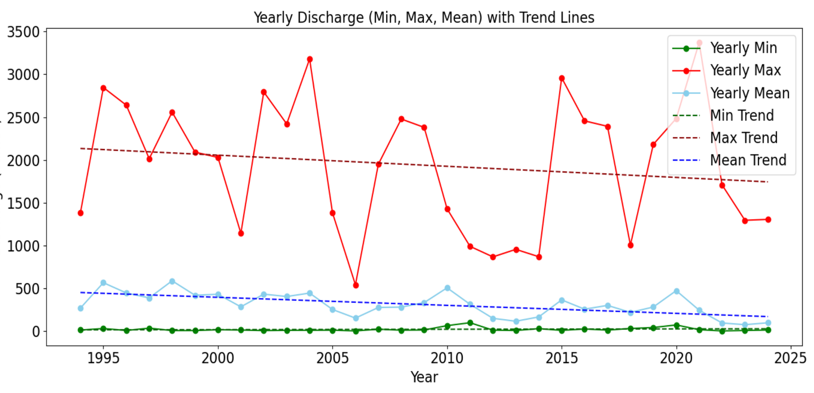

Figure 3. Discharge variation at Mymensingh Station (Station ID: SW228.5) for the time duration of 1994 to 2024.

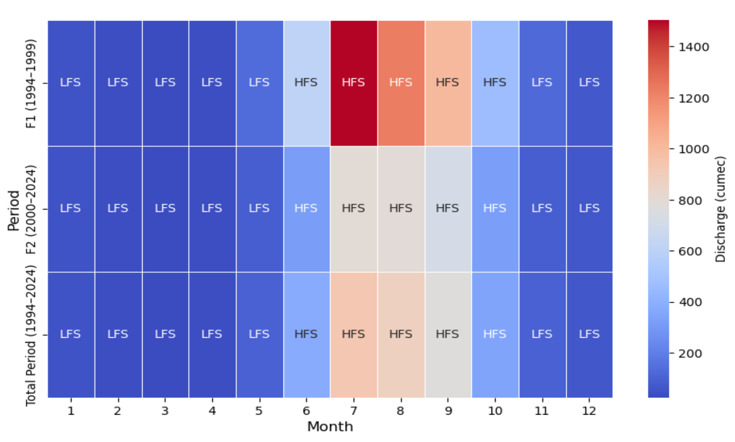

Figure 4. Seasonal Flow Classification of the Old Brahmaputra River Using the Tessmann Method Across Three Time Periods.

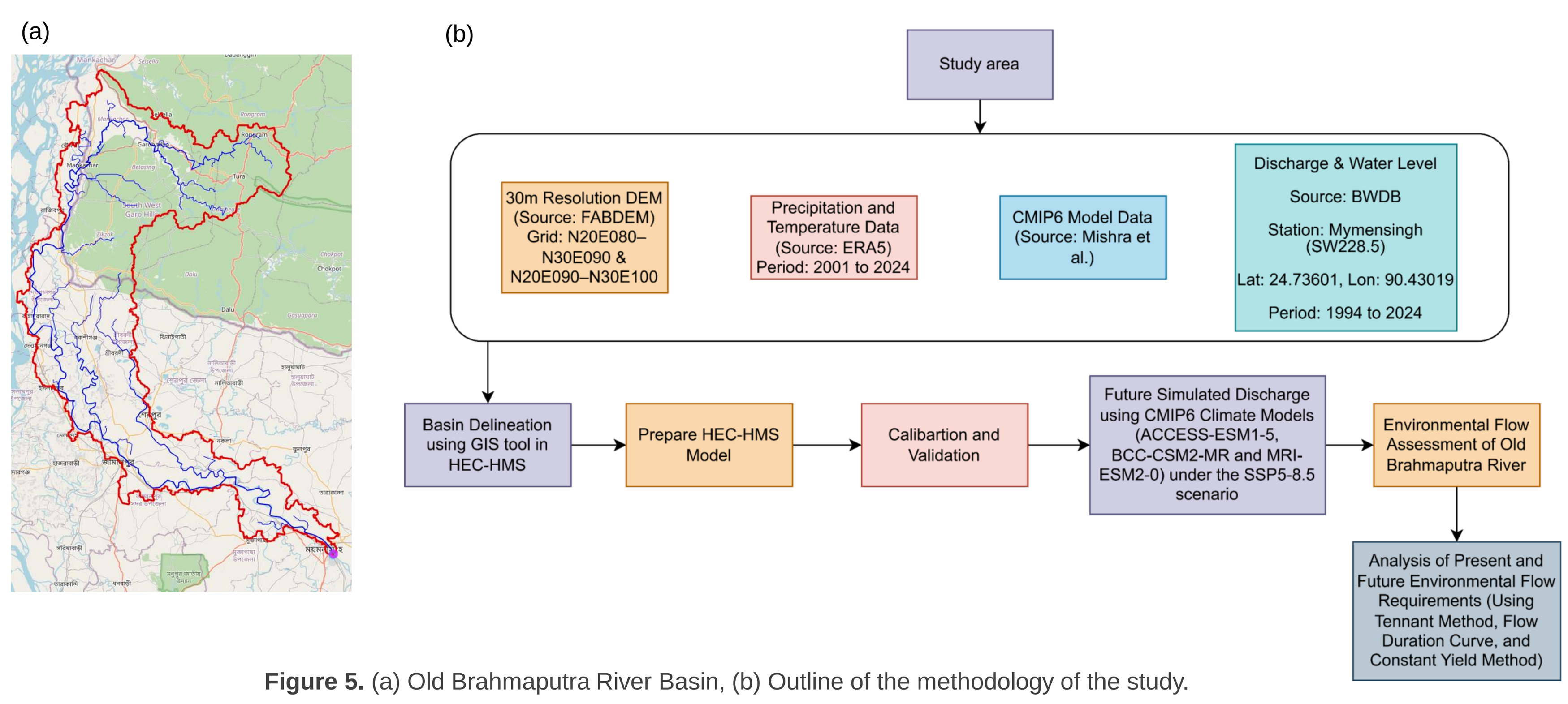

Figure 5. (a) Old Brahmaputra River Basin, (b) Outline of the methodology of the study.

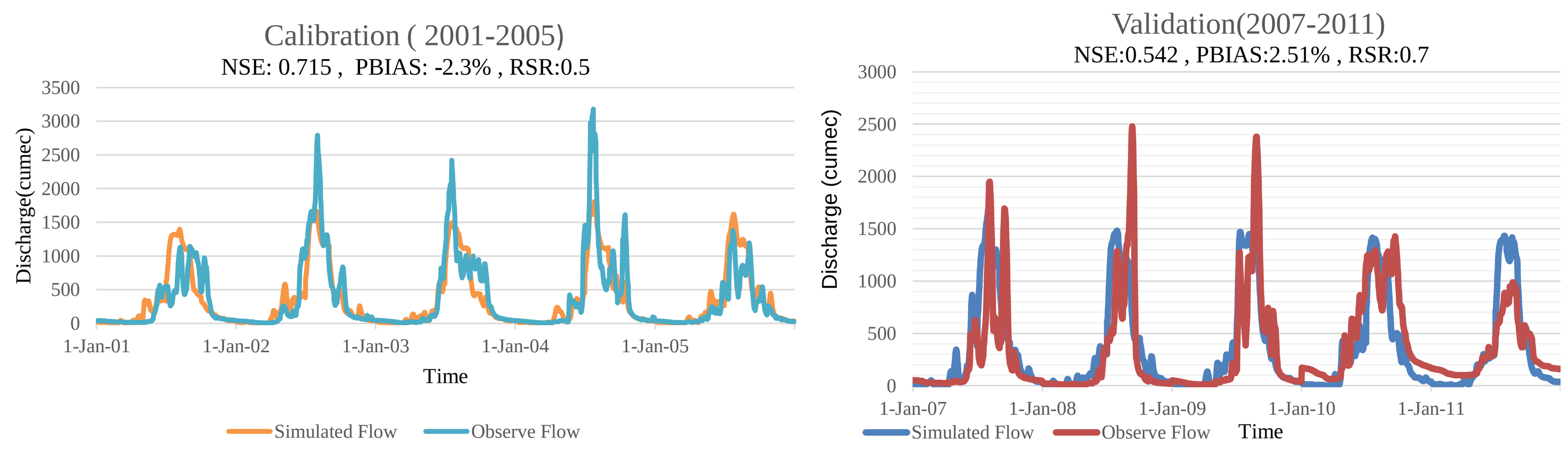

Figure 6. (a) Calibration of the HEC-HMS model for the years 2001 to 2005, (b) Validation of the HEC-HMS model for 2007 to 2011.

RESULTS & DISCUSSION

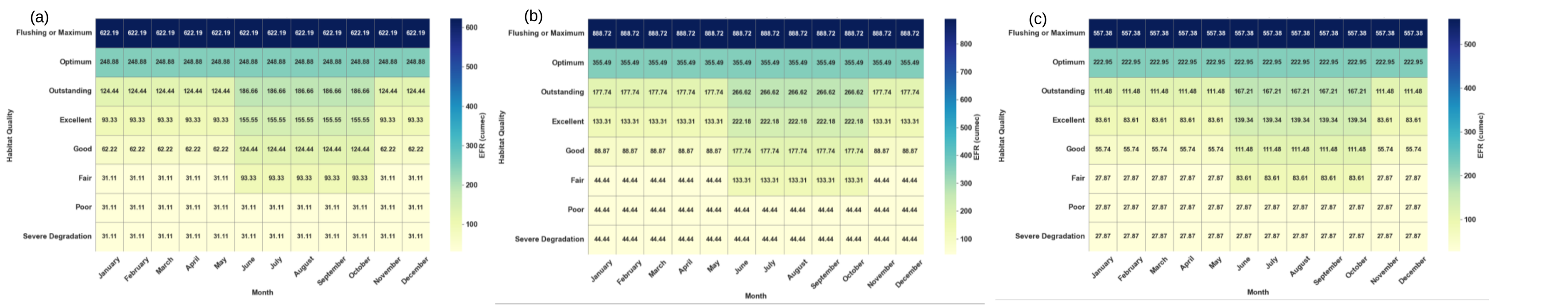

Figure 7. Monthly environmental flow requirement for the (a) total period, (b) F1, and (c) F2 period using the Tennant approach.

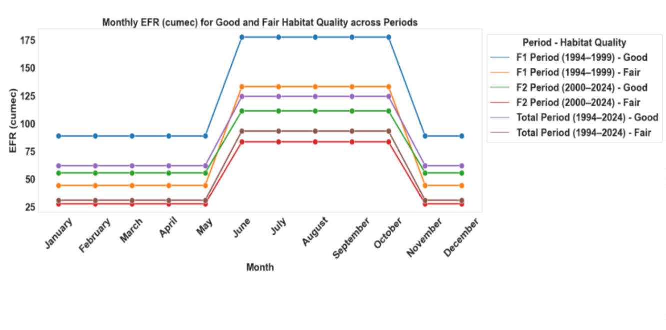

Figure 8. Monthly environmental flow requirement (Discharge in m³/s) for Good and Fair habitat quality across F1 (1994–1999), F2 (2000–2024), and the total Period (1994–2024).

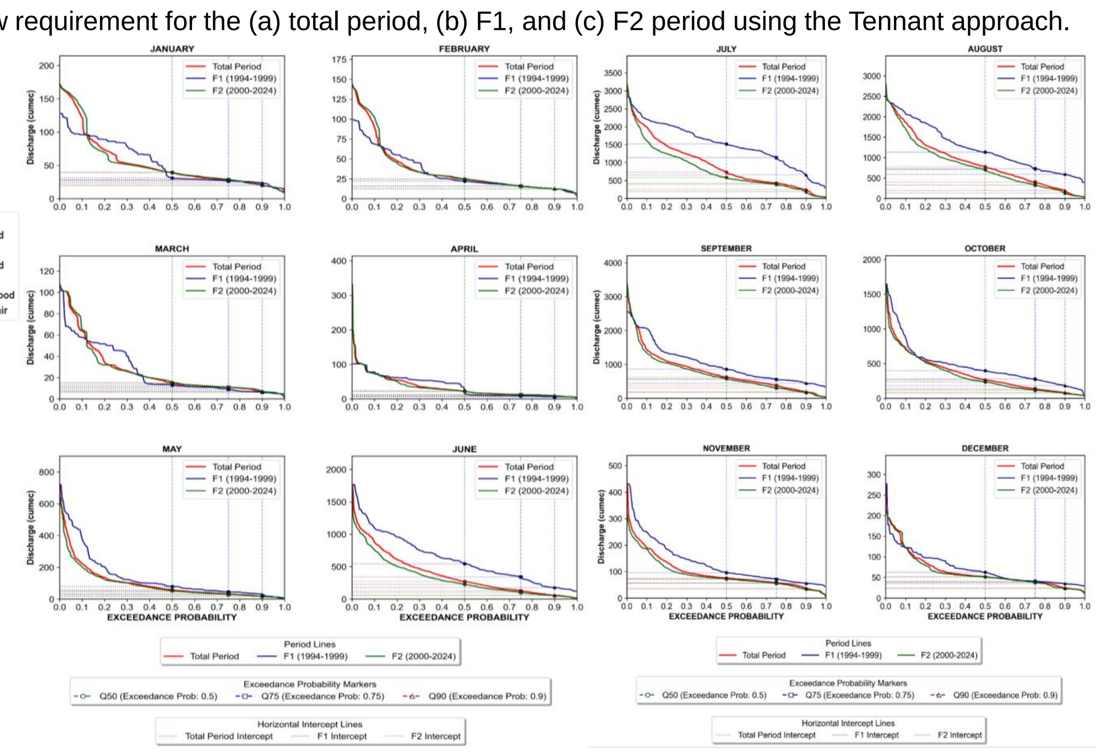

Figure 9. Monthly flow duration analysis: January to December discharge patterns with Q_{50}, Q_{75}, and Q_{90} thresholds across three time periods.

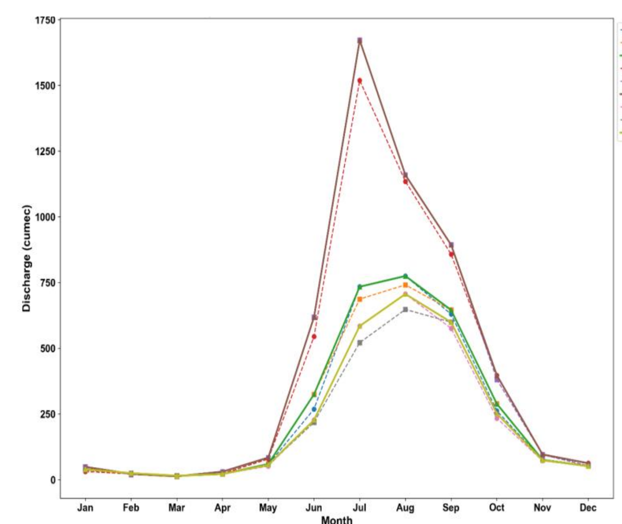

Figure 10. Comparison of monthly median flows, median of monthly medians, and proposed final environmental flow requirements (EFR) across total, F1, and F2 periods.

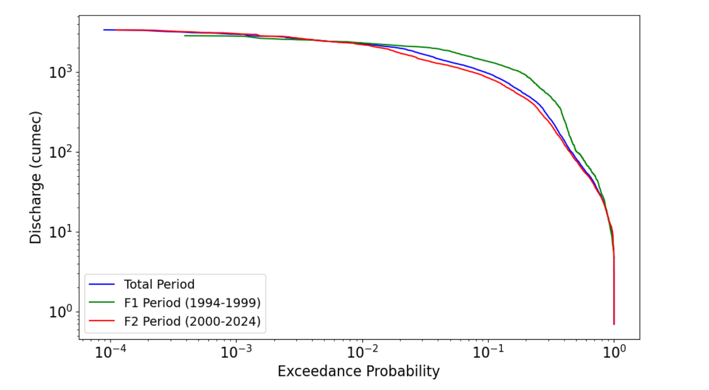

Figure 11. Flow duration curves for the Old Brahmaputra River during F1 (1994–1999), F2 (2000–2024), and the total period (1994–2024).

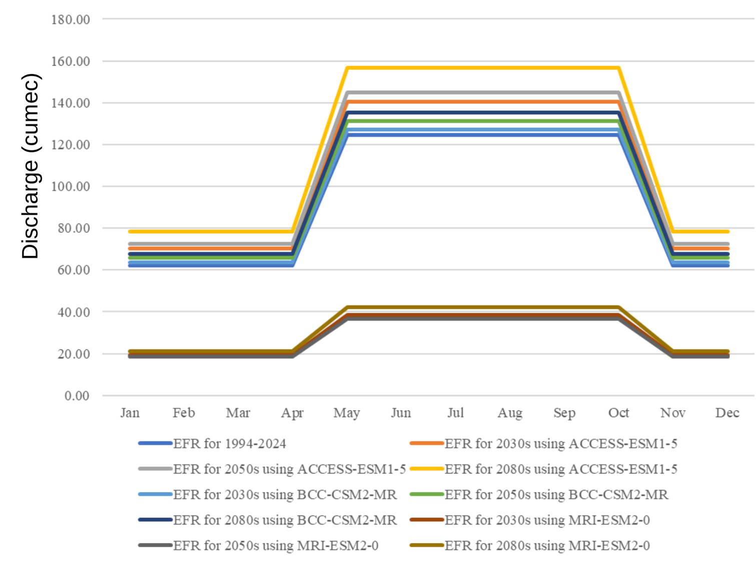

Figure 12. Comparison of present and future EFR for the Old Brahmaputra River by the Tennant method.

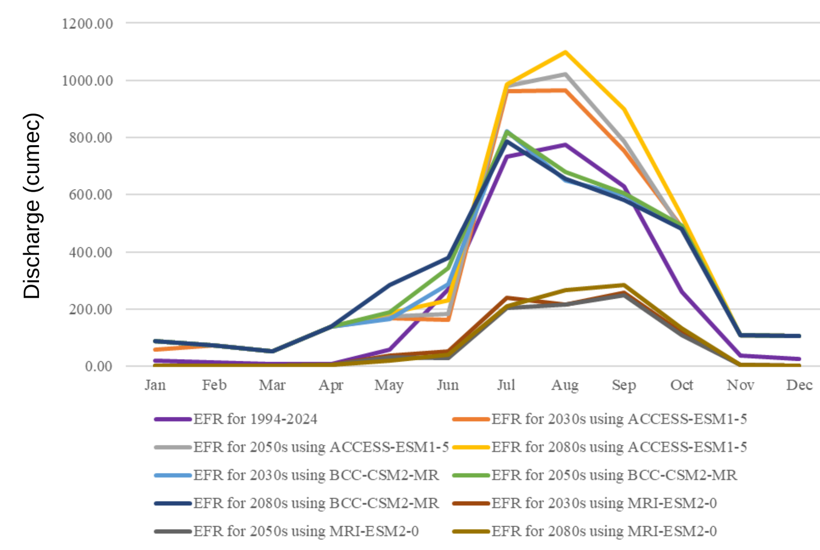

Figure 13. Comparison of present and future EFR for the Old Brahmaputra River by the FDC method.

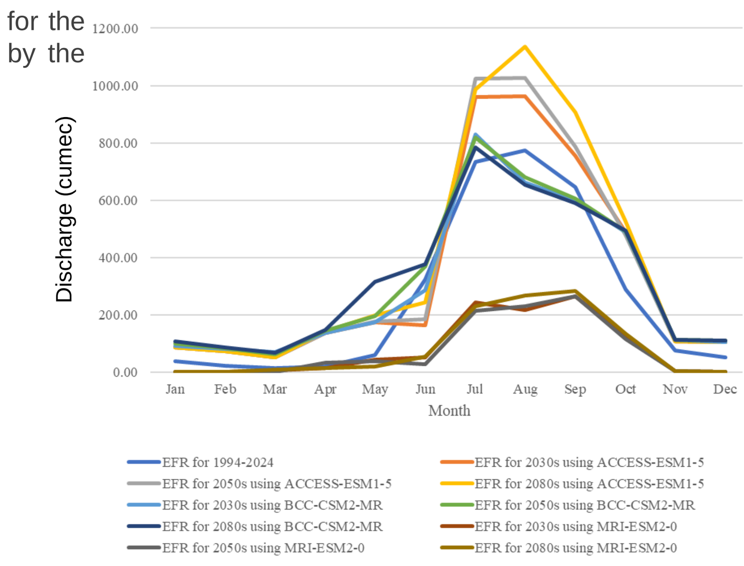

Figure 14. Comparison of present and future EFR for the Old Brahmaputra River by the CYM method.

CONCLUSIONS

The ACCESS-ESM1-5 model predicts considerable increases in monsoon flows in the future, which could result in more frequent and severe flooding. Future projections show growing flow variability. On the other hand, the MRI-ESM2-0 model projects lower future flows, indicating potential water scarcity.

REFERENCES

[1] Gain, A. K., Immerzeel, W. W., Sperna Weiland, F. C., & Bierkens, M. F. P. (2011). Impact of climate change on the stream flow of the lower Brahmaputra: Trends in high and low flows based on discharge-weighted ensemble modelling. Hydrology and Earth System Sciences, 15(5), 1537–1545. https://doi.org/10.5194/hess-15-1537-2011