Reservoir Inflow Forecast System for Major Indian Dams

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1. Introduction

- India experiences frequent and intense flooding during the Indian summer monsoon, leading to major disruptions despite the presence of thousands of large dams.
- Dams play a key role in mitigating downstream floods, but their effectiveness is often compromised when reservoirs are already near full capacity before peak inflow events—highlighting the importance of anticipatory action.
- Current dam operations in India lack a unified inflow forecasting system, especially one that integrates real-time meteorological forecasts with hydrological and hydrodynamic modeling across all major reservoirs.
- Without timely inflow forecasts, reservoir operators face challenges in maintaining optimal storage levels, increasing the likelihood of emergency releases or dam overflow that worsen downstream flooding.
- This study addresses a critical gap by developing a national-scale reservoir inflow forecast system, which is essential for data-informed reservoir management and improving flood resilience in a changing climate.

2. Objectives

- To setup a model framework to simulated the reservoir dynamics across India
- To develop a real-time reservoir inflow and storage forecast system using meteorological forecast products for major Indian dams

3. Datasets Used

Data (Source/Reference)	Resolution
Climate data	
- Precipitation (IMD/Pai et al., 2014)	0.25° (~25km x 25km)
- Temperature (IMD/Srivastava et al., 2009)	1.0°
- Wind Speed (ERA5/Copernicus Climate Change Service (C3S) Climate Data Store (CDS))	0.1° x 0.1°
- GEFS meteorological forecast (IITM)	0.125° (~13km x 13km)
- ERFS meteorological forecast (IITM)	
Observed Streamflow (CWC, India-WRIS)	Daily
Reservoir Storage (CWC, India-WRIS)	Daily

4. Methodology

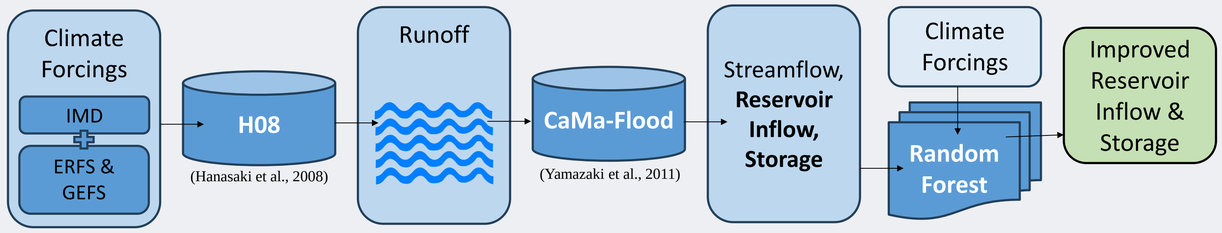

Fig 1: Methodology

5. Results

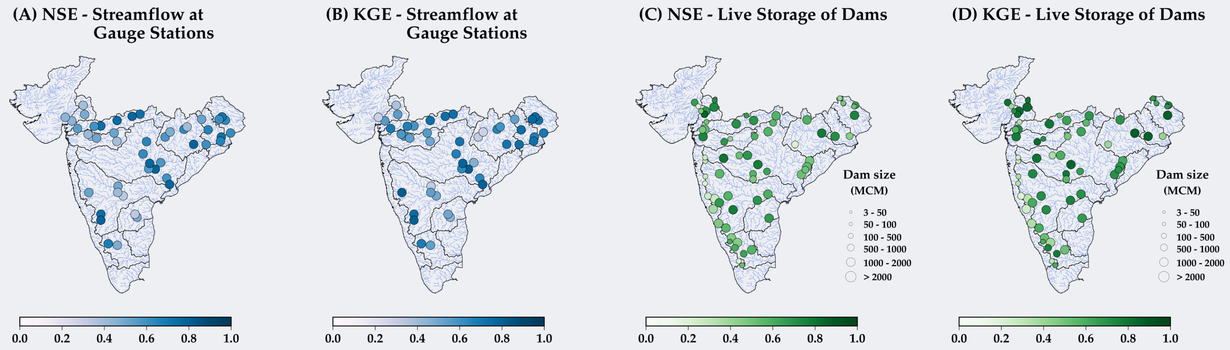

Fig 2: Model calibration for streamflow showing (A) NSE and (B) KGE at the selected gauge stations against daily observed streamflow. Model calibration results showing (C) NSE and (D) KGE for live dam storage against the observations

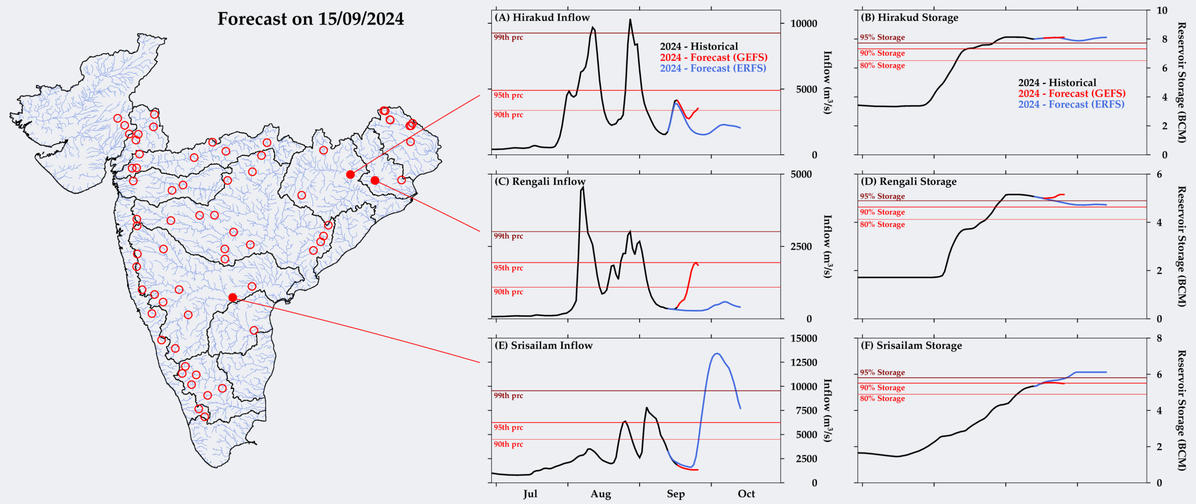

Fig 3: Short to medium range (1-10 days; GEFS – red line) and extended range (1-32 days; ERFS – blue line) reservoir inflow and storage forecast projections for three selected dams: (A-B) Hirakud dam (Mahanadi river basin), (C-D) Rengali dam (Brahmani river basin), (E-F) Srisailam dam (Krishna river basin). Black line represents the simulated inflow/storage till the day of forecast

6. Results

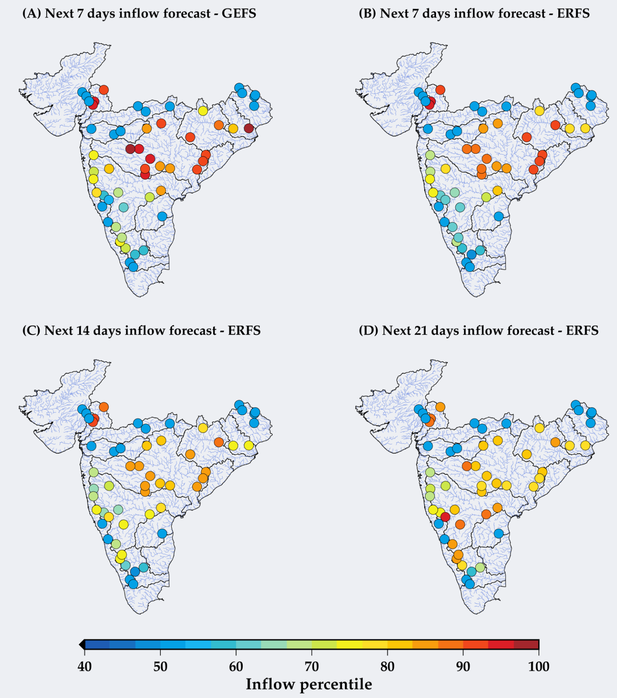

Fig 4: Reservoir inflow outlook for (A) next one week based on GEFS forecast and for next (B) one, (C) two, and (D) three weeks based on ERFS forecast products

7. Future Work

- Post-process the forecast simulations using a random forest algorithm for improved forecasts of inflow and storage in the reservoirs.
- Deploy the real-time portal with daily forecast updates of inflow and storage for major Indian dams.

References

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