



Remote Sensing and Deep Learning for Dam Inflow Prediction in Semi-Arid Regions: Assessing the Contributions of Rainfall and Snowmelt in Moroccan Catchments

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Abstract

Accurate prediction of dam inflow is critical for improving water resource management in arid and semi-arid regions, where hydrological processes are strongly influenced by climatic variability. This study combines remote sensing observations and data-driven modeling to analyze and predict inflow dynamics in key Moroccan catchments, with particular attention to the respective roles of rainfall and snowmelt. In situ-based inflow and rainfall measurements are integrated with remotely sensed MODIS snow cover data and temperature data to characterize the hydro-climatic controls on inflow variability across multiple temporal scales.

To model these processes, we apply Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), and Linear Regression (LR) models. A full-dataset analysis approach is conducted to better distinguish the contributions of rainfall and snowmelt during hydrologically active periods.

The results reveal marked spatial and temporal differences among dams, reflecting the complexity of inflow generation in semi-arid mountain-fed systems. They also show that combining remote sensing observations with deep learning models improves inflow prediction and provides a more refined understanding of the relative influence of rainfall and snowmelt on dam inflows. This study demonstrates the potential of integrated observation-modeling frameworks to advance understanding of hydrological processes and support water management in data-scarce regions.

Keywords: dam inflow prediction; hydrological processes, remote sensing; Deep learning; rainfall and snow melt contribution.