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Updated climate inputs for rainfall-runoff modelling in northern Victoria

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Abstract: This paper presents an evaluation of rainfall–runoff models and associated climate inputs for Northern Victoria. The aim is to improve hydrological modelling for current applications such as extending streamflow datasets and assessing model suitability for potential climate projection work. Key advancements include correction to rainfall and evaporation datasets, model performance assessments, and analysis of updated climate input impacts. These improvements lay the groundwork for consistent and reliable model application across Northern Victoria. By correcting data artefacts and improving model reliability, this work reduces the risk of biased inflow estimates and strengthens the evidence base for both current water planning and future climate scenario assessments.

Keywords: *Rainfall-runoff modelling, climate data, streamflow simulation*

1. INTRODUCTION

Reliable rainfall runoff models are essential for informed water resource planning. In Victoria, rainfall–runoff models support inflow estimation to assess historic and projected water availability. However, their reliability is often constrained by input data quality and model calibration practices. Non-climatic artefacts—such as gauge relocations, changes in instrumentation, and historical limitations in solar radiation estimation—have introduced biases into rainfall and evaporation datasets.

This paper enhances rainfall–runoff model reliability for Northern Victoria by updating and standardising climate inputs, applying consistent modelling framework and evaluating model responses. While the primary focus is on current application (e.g., infilling and extending streamflow datasets), the improved models and data also provides a foundation for future climate-related applications.

2. METHODS

2.1. Climate Data Updates

2.1.1. Rainfall Correction

Patched point rainfall data were corrected using a double-mass curve method, referencing annual district rainfall averages to detect and remove non-climatic trends. These adjustments were applied based on breakpoint ayalysis using DEECA's Climate DeTrending Automation Tool, with manual correction for anomalous gauges (DELWP 2020). Natural climatic trends were retained.

2.1.2. Evaporation Correction

Historical evaporation datasets were trend-adjusted using double-mass analysis against an independent climatic proxy—the sum of maximum monthly temperatures from ACORN-SAT (extended pre-1910 using SEARCH data). Pre-1956 evaporation data were adjusted to match stable conditions observed from 1956–1975 in DELWP (2020), retaining the climatic signal while removing spurious shifts.

For post-1990, the updated SILO evaporation dataset (released in November 2023) was directly adopted. This addressed previously identified biases associated by reduced reliability in solar radiation estimates in earlier SILO products, largely due to declining station coverage (Austin & Szabo 2019). These biases had led to systematic understimation of evaporation, compromising model accuracy. DEECA's analysis had previously highlighted these issues, which have now been addressed in the updated SILO dataset. This underscores the importance of critically evaluating processed climate data, as corrections significantly enhance hydrological model reliability.

2.2. Rainfall-Runoff Model Evaluation

A total of 106 rainfall–runoff models (primarily Sacramento and GR4J) across the GBCCL, Ovens, Kiewa, and Wimmera–Glenelg catchments were reviewed. These models were originally developed using site-specific calibration. Model performance was evaluated using performance metrics such as Nash–Sutcliffe Efficiency

(NSE), volumetric bias, and low-flow representation. Simulated flows generated using updated climate inputs were compared to previous outputs to assess sensitivity and guide recalibration needs.

2.3. Hydrological Response Analysis

Hydrological responses were analysed over two timeframes—1891–2020 and 1990–2020—to assess long-term and recent-period impacts. Inflows to major storages (e.g. Lake Eildon, Rocklands Reservoir) were also examined following updated climate data to test the need for rederiving water balance inputs.

3. RESULTS AND DISCUSSION

3.1. Model Performance

The use of updated climate data had minimal impact on NSE values, but notable effects were observed in low-flow periods and seasonal volumes. Some models displayed persistent volume bias or weak low-flow simulation, supporting the need for recalibration.

3.2. Climate Input Impacts on Flows

- For 1891–2020, updated climate inputs led to increased annual inflows for GBCCL (+4.1% or +147 GL/year), ranging from +2.9% (Campaspe) to +11% (Broken).
- For 1990–2020, overall inflows slightly decreased for GBCCL (approximately 2%) due to the updated climate inputs, although some catchments (e.g., Ovens, Kiewa) showed slight increases.

3.3. Seasonality Effects

Seasonal evaporation patterns can significantly influence modelled flows. For example, during the Millennium Drought, reduced winter evaporation led to higher flows despite higher overall annual evaporation. This highlights the importance of accounting for seasonal variability and non-stationarity in climate impact assessments

3.4. Storage Inflow Impacts

Updated climate data notably impacted on storages with large surface areas. For example, inflow estimates to Lake Eildon shifted enough to justify recalibration of its inflow derivation model to maintain mass balance integrity.

4. CONCLUSIONS AND RECOMMENDATIONS

This study highlights several key findings and offers critical lessons for the broader hydrological modelling community:

- **Input data quality matters**: Non-climatic artefacts significantly affect model reliability and should be corrected using robust and standardised methods.
- **Automated detrending enhances consistency**: DEECA's Climate DeTrending Automation Tool enable efficient, consistent updates across large datasets.
- **Seasonality significantly influences model outputs:** Incorporating seasonal variations is critical for modelling and future climate assessments.
- Validation and caution are crucial when adopting externally processed data, such as corrected evaporation datasets provided by SILO, highlighting the value of independent analysis and verification.

While the rainfall runoff models are not yet used for climate projection investigation, this work strengthens their foundation for ongoing applications and future scenario analysis.

Next Steps:

- Recalibrate models with notable performance issues.
- Continue stakeholder engagement to communicate findings and implications.
- Explore expanded use of models for strategic planning and climate assessments..

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REFERENCES

Austin, K.A. and Szabo, K.E. (2019). Non-climatic in gridded climate data. In Elsawah, S. (ed.) MODSIM2019, 23rd International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December 2019, pp. 619.

DELWP (2020) Guidelines for rainfall and evaporation trend correction for long-term water modelling, Department of Environment, Land, Water and Planning, Victoria.

