Downscaling AWRA PET data for hydrological applications

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1.0 Introduction and Objective

The R2O Water Models team is leading the development of catchment hydrologic models and tools through the NextGen Flood and Streamflow (NGFS) forecasting project to upgrade the national flood and 7-day streamflow forecasting services. The models will produce hourly probabilistic streamflow forecasts.

Currently, monthly and daily potential evapotranspiration (PET) data downscaled to hourly timestep using uniform weights are used as input to the models. To reduce the uncertainty in the hourly data, we present a simple methodology to temporally downscale daily PET data to hourly using weights derived from a global hourly dataset, hPET (Singer et. al., 2021).

2.0 Data and Methodology

The study area is Hawkesbury Nepean Valley (HNV) catchment located in New South Wales (Fig. 1). The catchment is delineated into 343 sub-areas, and the hydrologic model is applied to each sub-area using areal average input data.

Daily PET estimates from the Australian Water Resources Assessment model (AWRA) downscaled to hourly timestep will be used for the operational service.

In this study, we:

1. compare the temporal and spatial correlations of the AWRA PET outputs derived from Penman (1948) equation (e0) and Morton (1983) equation (ma_wet), Australian Water Assessment Program (AWAP) PET dataset, and hPET dataset,
2. calculate the hourly weights (ratio between hourly and daily data per each hour) using the hPET dataset for the entire spatiotemporal period (1981-2022),
3. check the usability of average hourly weights to generate hourly PET for the operational service.

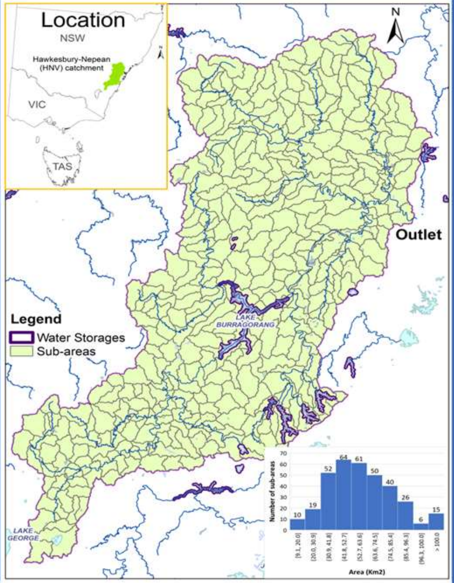

Figure 1. Study location.

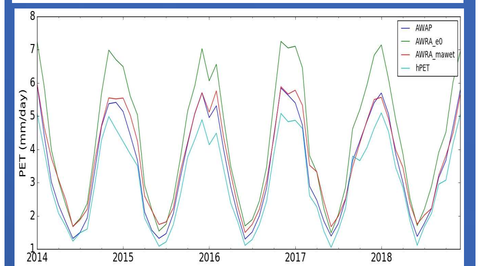

Figure 2. Comparison of different PET products.

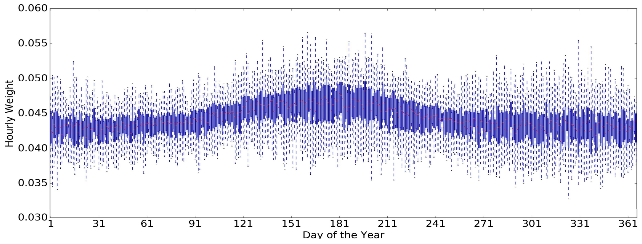

Figure 3. Hourly weights for each day of a year.

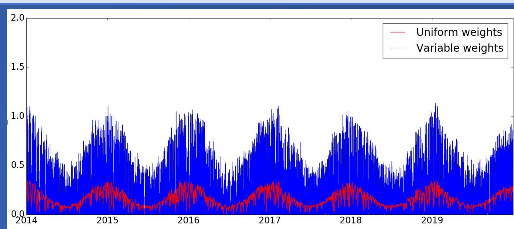

Figure 4. Comparison of PET estimated using hourly uniform and variable weights.

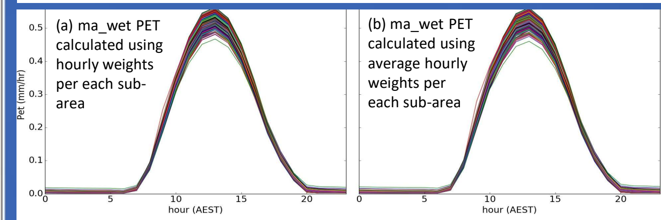

Figure 5. Spatial variability of hourly PET estimated using hourly weights and average hourly weights.

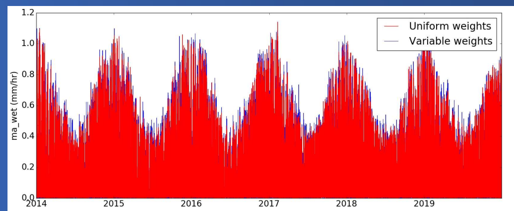

Figure 6. Comparison of PET estimated using hourly weights and average hourly weights.

3.0 Findings

1. AWRA ma_wet PET correlates better to AWAP and hPET data than AWRA e0 (Fig. 2). e0 is generally higher than the other three products.
2. Hourly weights calculated using 41 years of hPET data for the whole HNV catchment mainly vary between 0.035 and 0.055 (Fig. 3). Large weights are observed from June to August.
3. Hourly PET calculated using uniform weights underestimated 67% (average) at peak hours (i.e., 10 am to 3 pm) compared to the PET calculated using variable weights (Fig. 4).
4. The PET derived from hourly weights and average hourly weights (1981-2022) are spatially consistent (Fig. 5). The datasets have a good correlation (Fig. 6), and the error is insignificant (RMSE=0.07; MAE=0.02; NSE=0.92).
5. The simple methodology presented here can be successfully used for downscaling daily PET data to hourly while maintaining the general variation of PET throughout a day.
6. Further analysis is recommended to evaluate the impact of PET estimated using hourly weights and average hourly weights on streamflow forecasts.

References

Singer, M.B., Asfaw, D.T., Rosolem, R. *et al.* Hourly potential evapotranspiration at 0.1° resolution for the global land surface from 1981-present. *Sci Data* **8**, 224 (2021). https://doi.org/10.1038/s41597-021-01003-9

Penman, H.L.,. Natural evaporation from open water, bare soil and grass. Proceedings of the Royal Society of London, A193: 120–146 (1948).

Morton, F.I. Operational estimates of areal evapotranspiration and their significance to the science and practice of hydrology. Journal of Hydrology, 66, 1-76 (1983).