26th International Congress on Modelling and Simulation, Adelaide, SA, Australia, 30 Nov–4 Dec 2025
mssanz.org.au/modsim2025

Using rainfall characteristics to evaluate sizing of rainwater tanks under climate change

Desmond P Manuelpillai [a], Brandon Winfrey [a] and Anna Lintern [a]

[a] *Department of Civil & Environmental Engineering, Monash University, Clayton, VIC 3800, Australia*
Email: desmond.manuelpillai1@monash.edu.au

Abstract: A popular Water Sensitive Urban Design (WSUD) technique is rainwater harvesting in which stormwater runoff is collected and stored in a physical tank for later use as part of irrigation, toilet flushing and other non-potable applications. Over the years, various modelling tools have been developed to efficiently size these rainwater tanks so that they are big enough to ensure adequate reliability, but not excessively oversized such that capital costs and age of stored water become an issue. Current design methods, however, assume stationary climate conditions in the future and use historical rainfall data as inputs. This is despite growing research which shows that climate change is expected to impact future rainfall patterns and variability leading to more extreme intensities and longer dry periods (e.g. Deb et al., 2019).

In response to this concern, researchers have begun to investigate the impact of climate change on rainwater tanks. However, rainwater tank designs can offer numerous optimal solutions according to different combinations of geographical characteristics (i.e. spatial variability of rainfall amounts, frequencies and intensities) and modelled site conditions (i.e. scale of tank sizes, roof area and demand). Conclusions drawn from literature developed to-date are therefore typically varied or limited in breadth (i.e. only applicable at a catchment scale level), sometimes resulting in contradictory findings. Moreover, futureproofing of rainwater tanks has limited consideration in building regulations and legislation to-date.

In this study, we explore the use of dimensionless analysis, as described by Khastagir & Jayasuriya (2010), to isolate the impact of changes in rainfall from the other system characteristics which influence tank sizing. Victoria (Australia) is used as the case study for this investigation with an ensemble of six different downscaled General Circulation Models (GCMs) sourced from the Victoria Climate Projections 2019 Project (VCP19). These models have been deemed by the VCP19 to represent most of the range of projected possible future climates for the region. Statistical analyses show that the simulated near future projections (2016–2045) predict a drier future with less annual rainfall and higher seasonality when compared to the baseline historical period (1981–2010). Storage-behavioural simulation has been undertaken to calculate reliabilities across a range of tank configurations. This includes sizes between 1-20 kL, roof areas between 50-300 m^2 and daily demands between 0.02-0.6 kL/day. Comparison via dimensionless analysis shows that changes in future performance are minimal in response to decreases in rainfall amount. High variabilities, however, were observed in response to increased seasonality, indicating that harvesting reliability (and tank sizing under the current design paradigm) in Victoria is most vulnerable to increases in intra-annual variability (i.e. more seasonal climates).

The capacity of a Victorian consumer to use readily available local rainfall data to quickly assess resilience either to identify if design using historical data is sufficient (i.e. if intra-annual variability remains significantly unchanged) or if more intensive means of futureproofing should be investigated (i.e. if intra-annual variability has significant changed over the last few years) is a significant advancement to current tank design methodology. This will enable a much broader audience of users to be able to gauge the need to consider climate change in their design, at the least cost and disruption, and well in advance of anticipated changes.

REFERENCES

Deb P, Kiem AS and Willgoose G (2019) 'Mechanisms influencing non-stationarity in rainfall-runoff relationships in southeast Australia', Journal of Hydrology, 571:749–764, doi:10.1016/j.jhydrol.2019.02.025.

Jing X, Zhang S, Zhang J, Wang Yujie and Wang Yunqi (2017) 'Assessing efficiency and economic viability of rainwater harvesting systems for meeting non-potable water demands in four climatic zones of China', *Resources, Conservation and Recycling*, 126:74–85, doi:10.1016/j.resconrec.2017.07.027.

Khastagir A and Jayasuriya N (2010) 'Optimal sizing of rain water tanks for domestic water conservation', Journal of Hydrology, 381(3–4):181–188, doi:10.1016/j.jhydrol.2009.11.040.

Keywords: *WSUD, rainwater tanks, climate change, Victoria (Australia)*

