Sampling NARCliM factored stochastic data for infrastructure risk assessment

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Abstract: Investments in infrastructure to improve water availability and water security are significant both for the potential benefits they provide and for the cost of building and operating this infrastructure. The performance of proposed infrastructure for meeting its water availability and security objectives depends on prevailing climate and on demand and water management. These types of infrastructure are expected to be effective for several decades, and climatic conditions for that future period must be considered in a risk assessment of the proposed infrastructure. Decision makers need to have some degree of confidence that the proposed infrastructure will perform well for plausible future climate conditions.

The climate water infrastructure will operate in is highly uncertain with characteristics of both natural variability and change. Drought sequences as well as storage filling events are important, as is potential structural change in seasonality and extreme climate conditions. The New South Wales (NSW) government has developed climate risk data sets that combine historical observed climate and paleo-informed climate in a stochastic framework to provide for a comprehensive representation of natural variability. This 10,000-year data set has also been factored by percent changes in monthly rainfall from the driest NARCliM 1.0 data set with the intent of stress-testing water security performance in NSW river systems.

The stochastic data alone as an expression of natural climate variability identifies water security vulnerabilities during extreme droughts in those sequences. When combined with dry modelled climate projections, failures in water security indicators are typically so frequent and extreme in the assessments, that improvements in the design of the data sets were needed to constrain uncertainty in overall changes to a more plausible range as represented within the distribution of contemporary CMIP models. As well as the scale of change, for cognitive purposes decision makers required assessments for shorter periods than the full 10,000-year stochastic data,

To meet these changed requirements for infrastructure assessment, we developed a method that sub-sampled multiple 100^{+}-year replicates of the NARCliM factored paleo-stochastic data set, based on changes in mean rainfall for that period as sampled from the CMIP5 distributions. The multiple replicates allowed for climate variability to be considered as well as changes to seasonal and total rainfall on water availability.

The method has been used in recent infrastructure assessments of climate risk on water availability and security, and important environmental outcomes. One such assessment that has been publicly reported is the proposed new Dungowan Dam in the Peel Regulated River water source in north-west NSW. This storage was proposed to improve water security for water supply for the city of Tamworth, which experienced severe water security issues during the 2017–2020 drought. Improved water security was needed for the existing population as well as for projected significant increases in population.

The sampled climate sequences were used as inputs to the Peel Source model, which can simulate water availability on a daily time step for extended and variable climate sequences. The Peel Source model represents the water sharing arrangements that determine water availability and demand of the urban, environmental, and agricultural sectors. The results showed improvements in water security for these sectors from the proposed new Dungowan Dam as expected, however, it also demonstrated residual vulnerabilities.

The sampling method is being further developed and proposed to be made generally available.

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