Impact of climate change on urban water security in SEQ

The Urban Water Security Research Alliance (the Alliance) is working to assess and quantify the impact of climate variability and climate change on water supply in South East Queensland (SEQ). In order to undertake an assessment of impact from climate change, regional and catchment-scale future climate information models have been developed for the Wivenhoe and Somerset catchments. This research is highly relevant to the SEQ Water Strategy as it will improve forecasting and projections, and provide valuable information for the development of long-term water supply strategies and infrastructure investment decisions.

Australia's SEQ region faces increasing pressures on its present water resources from a growing population. These pressures are compounded by the impact of climate variability and human-induced climate change.

It is now well recognised that the impacts of climate change must be taken into account in regional planning and water strategies.

Climate change and variability pose a risk to water supplies through:

- Increased rainfall variability and intensity with an increased risk of flooding, decreased and less frequent rainfall, and changes in the intensity, frequency and duration of drought; and

- Warmer temperatures, which increase evaporation from catchments and reservoirs as well as water demand on hot days, exacerbating the impact of prolonged drought.

The overall focus of the Alliance's climate research is to investigate and quantify the impact of climate variability and change on water supply over the SEQ region.

There is also a need for research on how the intensity, frequency and duration of drought and floods in SEQ may alter due to climate change and natural climate variability.

Alliance research will provide the information needed to develop hydrological models so that potential climate change impacts can be estimated and incorporated into the SEQ Water Strategy.

The project team found that climate change is leading to rising average temperatures and potential evaporation, which would make future droughts last longer and be more severe.

One example of rainfall trends with downscaled information using the IPPC Model CSIRO Mk3.0 and emission scenario A1B, highlighting the substantive increase in information using this technique.
Research outcomes to date

Downscaling of global climate models

In the past, water management strategy in SEQ was informed by data from large-scale global climate models (GCMs). These models have a resolution of several hundred kilometres, which does not provide enough topographic detail, such as coastal ranges, to accurately project the impact of climatic influences at the local scale.

However, Alliance research has resulted in significant progress in analysing what impact climate change will have on SEQ water supplies after researchers completed a series of regional downscaling experiments.

Downscaling is the method of obtaining high-resolution climate change information from relatively coarse-resolution GCMs. The downscaling of the GCMs undertaken as part of this project reduced the resolution of information to approximately 15 kilometres square. Work completed on this project so far includes 12,130-year downscaling experiments, covering the period 1970–2100. These new data have been used in the Queensland Department of Environment and Resource Management’s (DERM’s) hydrological model, the Integrated Quantity and Quality Model (IQQM), and this has greatly refined what scientists are able to obtain from global climate models.

Climate change and its impact on rainfall in SEQ

SEQ summer rainfall has been declining since around the 1980s. However, the reason for this decline remains unclear. To gain insight into this decline, the project team completed several downscaling experiments and showed that the observed reduction in rainfall in SEQ is not simulated by the majority of current climate models.

The team then investigated whether the decline could be a consequence of natural climate variability and found that multi-decadal variability alone could potentially be responsible for the recent SEQ rainfall decline.

However, while the observed rainfall reduction since the 1980s may not be due to climate change, other factors such as increased temperature and evaporation, together with reduced runoff, could result from future climate change. Rainfall events may also become more intense under future climate change, bringing an increased risk of flooding.

Climate change and its impact on temperature and evaporation

A key finding following the research on the downscaled climate models has been that human-induced climate change will raise temperatures, causing an increase in evaporation, which will have a big influence on runoff from rainfall events. This will affect inflows into water storages in SEQ when it does rain and so there will be longer periods between major filling events.

A key finding has been that human-induced climate change will raise temperatures, causing an increase in evaporation, which will have a big influence on inflows to dams in SEQ.
Experiments using the high-resolution downscaled climate models suggest that the frequency and duration of drought events will increase dramatically over the next century compared to the late twentieth century. There is significant variability between models, however, most of the models show consistent increases in drought duration in the future. The longer duration of droughts is expected to have significant implications for the period of time taken to refill water storages.

**Climate change and its impact on the Moreton catchment**

Recent drought and flood in SEQ has prompted further consideration of climate variability and climate change when assessing the security of urban water supplies.

The downscaled data indicate a likely reduction in rainfall during the wet season months in spring and summer. The research also shows a likely increase in evaporation rates.

Assessments of climate change impacts on the overall water availability within the Moreton catchment in SEQ have been undertaken by DERM using the IQQM calibrated for SEQ catchments.

The modelling shows reduced inflows into water storages when it rains and longer periods between major storage filling events. This will mean a decrease in water availability in SEQ.

For the first time, Alliance researchers have been able to provide DERM with climate information at a resolution of 15 kilometres square across SEQ to run its hydrological model and make more accurate projections of water storage inflows.

The majority of downscaled GCMs show significantly lower inflow than the original GCM projection and indicate that climate change assessments for water supply planning purposes in SEQ using the GCMs may underestimate the impact on available water resources.

Although climate change is projected to result in longer periods of drought, rainfall may also become more intense, with an increased risk of flooding. Both drought and flood may place pressures on water resources and the environment.

*High resolution downscaling climate model output is showing a further reduction in water availability in a future climate.*
Future research opportunities

To date, this body of research has resulted in more detailed projections of climate change impacts at sub-catchment scales, which are being used in models to improve forecasting of system yields. However, further research is required to continue to improve the accuracy of the model projections and increase our understanding of the effects of climate on water supply.

- Increasing accuracy of projections – So far, Alliance researchers have used five global models but plans are in place to increase this to eight models to help remove the variability between the models and increase the accuracy of future projections.

- Increasing model resolution – The team will complete a super-high resolution downscaling experiment with a resolution of approximately eight kilometres square to see if an even higher level of resolution makes a difference to model projections.

- Understanding droughts – Future work will examine whether droughts will become more intense, more frequent or last longer because of the impact of climate change and multi-decadal climate variability.

- Impact of evaporation on inflows – They will also examine the impact of increased evaporation on inflows assuming rainfall remains constant.

- Understanding floods – New areas of research have developed as a result of this work, in particular, the study of floods. The recent flooding experience in SEQ has highlighted the need to not only have an understanding of climate on drought and water supply, but also to better understand whether future climate will increase flooding frequency and intensity.

- Regional comparisons – To date, research has focused on SEQ and the Wivenhoe Dam catchment in particular. Future research could expand this focus to other catchments in SEQ and in other regions of Queensland and undertake a comparison of the differences between catchments.

This research is highly relevant to the SEQ Water Strategy, as it will improve forecasting of system yields due to climate change, assist in developing drought response plans, provide valuable information in the development of long-term water supply strategies and help inform future infrastructure investment decisions.

While the Queensland Government has made significant progress preparing Queensland’s water supplies for the impacts of climate change, additional issues to be addressed include further diversification of water sources and dealing with post-flood community perceptions of water availability.

Further information

More detail on the above research can be found in a number of publications on the Alliance web site at www.urbanwateralliance.org.au/publications.html

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