

## ESTIMATING DESIGN FLOODS FOR GAUGED URBAN CATCHMENTS UNDER CLIMATE CHANGE CONDITIONS

### Case Study: Cooks River

The project involved extending a flood study to include a catchment sensitivity analysis for climate change using regionally downscaled rainfall. The focus was to compare how presently applied methods of IFD (Intensity Frequency Duration) scaling compared to rainfall and flow results derived from continuous simulation approaches from various Global Climate Models (GCMs). The outcomes of the project were based on adopting a regional downscaling model to directly downscale GCM rainfall sequences from a selection of the AR4 GCMs and then applying a non parametric disaggregation model to derive a stochastic series of fine scale rainfall data by the application of a statistical bootstrap. The project also looked at the non linear relationship between rainfall, flow and flood extents and a method with which continuous sequences of rainfall at fine time some ch T4bcanda

simulation approaches compared to design rainfall (IFD) scaling for the Cooks River catchment (Cooks River, Sydney).

#### MAJOR FINDINGS AND OUTCOMES:

The hydrological model results identified that it is unreasonable to adopt simple scaling approaches to account for climate change variations due to all the uncertainties that underpin its examination. The continuous simulations showed large variability in terms of catchment flows, where IFD scaling methods of up to 30% only marginally captured the median values of the predicted flow ranges derived from the continuous simulations. This result highlights the limitations associated with the IFD scaling approaches and their assumptions about the exceedance probability of floods being directly relatable to the exceedance probability of the rainfall. The results from the hydraulic analysis of the Cooks River illustrated that the variability in the catchment flow is not reflected in the inundation of the catchment to the same order of magnitude. The results illuminate the inherent non-linear relationships between rainfall and flow, and, flow and flood inundation.

The study was subject to a cascade of uncertainties, which must be explored in future studies. There is a great deal of uncertainty entailed with the future climate and as there are no ways to certify the emission scenario or the ability of the model to simulate future climatic system, the model outputs should be taken as comparative rather than predictive outcomes until these issues are better addressed. The simple downscaling methodology used assumed that the complex weather-generating mechanisms, which produce rainfall in the future, operate in the same manner as the current climate paradigm. Linear scaling methods assume that the rain-producing mechanisms behave in the same way between the climate epochs and carry over the different meteorological regimes of the past. Even though looking at the trends in the relative changes (over direct and uncorrected GCM outputs) compensates for a part of the statistical biases of the GCMs, the length and statistical properties of the modified daily weather series are constrained by the variability of the historic weather sequences. The sensitivity of the re-se current magnitudes of rainfall before adoptin

his ns, the adequacy of the model is contingent on the different sub-daily temporal pattern. When in conjunction with linear statistical downscaling methods, the input data fed into the MOF model is a sequence which is related to the historic rainfall sequence. This implies that the rainfall sequence in the model, maintains the order of the rainfall and class structure as exactly those observed at the catchment gauge. This is a major drawback since the window of rain adopted from the disaggregation method (to feed into the hydrological model) will reflect the window observed in the historic sequence of days with rain or no rain, thereby providing a biased and unlikely stochastic sequence.

The results from the study indicated a strong non-linear relationship however, the number of runs conducted for each GCM to produce the stochastic series, were not sufficient to make conclusions about the extent of uncertainty. Further applications of the method can be used to produce more convergent results for this relationship and make statistical inferences about the extent and nature of the non-linear relationship.

## **PROJECT SIGNIFICANCE TO ADAPTING AND PROTECTING AUSTRALIA'S SETTLEMENTS AND INFRASTRUCTURE:**

Climate change has raised many questions about the reliability of design rainfall estimates based on historical records, and as such, provided the impetus for greater understanding of hydro-climatic systems such that the changes can be modeled given our understanding of the rain producing mechanisms. Most engineering applications of hydrology have opted to consider conservative, arbitrary values to account for