CHAPTER 9

CONCLUSIONS

This research has evaluated the use of a stochastic rainfall disaggregation model to disaggregate daily rainfall into any desired fine timescale down to 6-minute timescale for the State of Queensland in Australia. The total work has been organised into five correlated phases: Model Structure, Parameter Estimation, Disaggregation of Daily Rainfall, Simulation of Rainfall IFD Curves and Linking of the Model to Synthetic Data. During the execution of each phase some new and exciting findings were observed and incorporated into the stochastic model. The following sections will discuss each of these phases separately.

9.1 Model Structure

The stochastic disaggregation model in this research is based on the hybrid regionalised stochastic model (Gyasi-Agyei, 1999) that incorporated the non-randomised Bartlett-Lewis Rectangular Pulse point process rainfall. This model is structured in the following order in this research:

- The Binary (wet and dry sequence) process
- The Jitter (intensity) process
- The Repetition Technique and Proportional Adjusting process
- The Capping process and
- The Seasonality into Simulated Variance Relationship process

9.2 Parameter Estimation

The original model had five parameters to calibrate regardless of the location. During the parameter calibration for Queensland rainfall regions, it was observed in this research that three parameters only were enough to calibrate for the binary process without loss of accuracy. Hence the number of calibrating parameters were reduced for Queensland and incorporated into the disaggregation model. The parameter estimation process also revealed that the model parameters had to be regionalised. Scaling relationships could be established between different model parameters. But if the model is to be used in regions other than Queensland, regionalised parameter values need to be established first. The seasonal parameters for fine timescale variance and regionalised autocorrelation were also estimated and incorporated into the model in this phase for Queensland regions. Site specific capping parameters for each selected stations in Queensland regions were also determined in this phase.

9.3 Stochastic Disaggregation of Daily Rainfall

For the disaggregation process, 6-minute fine timescale rainfall data were collected from the Bureau of Meteorology (BOM) Australia for the selected Queensland regions. These fine scale data were aggregated to several higher aggregation levels up to 24-hour. Then the disaggregation model was used to disaggregate the aggregated observed daily data into the fine timescales of any desired level down to 6-minute timescale. During the disaggregation it was observed that a single downscaling relationship for variance could not satisfactorily reproduce the fine scale variances (especially for winter months from April to November) in Queensland. Therefore, seasonality was introduced into the downscaling relationship to improve the model performance for both summer and winter months for Queensland.

An analysis of extent of improvement in the variance relationship showed that the likelihood of any station-month falling close to the predicted seasonal variance relationship equation was increased with the incorporation of the new technique and the data lengths of different months did not affect this relationship. However, it cannot guarantee improved model simulation for each and every station- month but certainly most of them for both summer and winter seasons were improved. The 6-minute autocorrelation statistics were also found to assume a slightly different regional constant value for the Queensland region. It was observed that a regionalised value improved the model prediction of autocorrelations at finer timescales better than using an Australia wide autocorrelation value for Queensland. No seasonality effect was observed for autocorrelation. The dry probabilities for both summer and winter months mostly remained unchanged with or without the introduction of seasonality at all aggregation levels. This was due to the fact that the binary component of the model remained unaffected after the introduction of seasonality. Further investigations can be done on the regional seasonal pattern of fine timescale variances throughout Australia. Improvements of other statistics such as the intensities will be investigated in the next section.

9.4 Simulation of Intensity-Frequency-Duration (IFD) Curves

This research has evaluated the stochastic disaggregation of daily rainfall into fine timescale as a measure for deriving the rainfall IFD curves. The current ARR defined practice of deriving IFD curves for any Australian location is also investigated and compared with the proposed stochastic disggregation technique. A novel approach of capping, i.e. placing an upper limit on the simulated fine timescale rainfall depths, is incorporated into the model. This new approach has eliminated the need for assuming different probability distribution functions for the annual maximum intensities. Also, interpolations through the different ARR maps, as required to derive the ARR IFDs, to work out the basic intensities are not required in this new approach. The maximum recurrence intervals of this new approach will depend on the data lengths of the observed sites. Simulation of higher ARIs can be studied further to enhance the model capability.

The model has been applied at several selected sites in Queensland, Australia. It was found that the ARR approach has been slightly underestimating the intensities at higher ARIs at these sites although both approaches produced results within the simulation range. The advantage of this new approach over the ARR approach is that it produces the storm profile at any desired fine timescale. Different durations were considered from 6-minute to 24-hour. Durations beyond this range can be further studied and incorporated into the model. The model is also applied to an experimental station in Queensland where fine timescale rainfall data are available for only 9 years. Calibrating parameters from the nearest BOM stations with significant fine timescale rainfall data were used for this experimental site. This approach produced good predictions of IFDs as well as variances, dry probabilities and autocorrelations for all selected sites including the experimental station. The technique of using the parameters of the nearest BOM station for the experimental site can be further established by applying it to some other stations where little or no fine timescale data are available.

9.5 Linking the Disaggregation Model with Synthetic Data

Synthetically produced data can provide uniform data lengths throughout the stations in a region. This research has used such a source of synthetic data called the SILO Data Drill maintained by the Queensland Department of Natural Resources and Water. This facility generates long term (from 1889 to date) daily rainfall data at any location in Australia. With the confidence that the model predictions of intensities are not worse at higher ARIs than the ARR method and that the model predictions of other statistics (mean, variances etc.) are improved to a certain extent with the introduction of seasonality, the model is used to disaggregate SILO data at selected Queensland stations. The intention behind the linking of the model to the synthetic SILO data is to provide a disaggregation framework for stations in Queensland which do not have either BOM fine timescale data or any experimental data. The calibrating parameters for such stations can be drawn from the nearest BOM stations with significant fine timescale rainfall data. As SILO generated 118 years of synthetic daily rainfall data for the selected Queensland stations, IFDs of up to 100 years were simulated by the stochastic disaggregation model. It was observed that the ARR method slightly underestimated the intensities at higher ARIs compared with the disaggregation approach for up to 3 hour durations of rainfall. Other statistics such as variances, dry probabilities and autocorrelations for all selected sites including the experimental station were also simulated at all aggregation levels for the synthetic data.

It has been established through this research that the enhanced hybrid stochastic disaggregation model based on the non-randomised Bartlett-Lewis rectangular pulse point process rainfall is able to reproduce the rainfall properties at fine timescale down to 6 minute for Queensland, Australia. Hence it can be recommended for use in Queensland.