CHAPTER 1

INTRODUCTION

Fine timescale rainfall data are required for environmental modelling particularly where erosion is an issue. However, fine timescale rainfall data is scarce and costly to gather. Therefore, disaggregation of daily data, which is readily available, is a necessity. The Australian SILO Data Drill facility (http://www.nrm.qld.gov.au/silo/datadrill/) generates continuous daily rainfall data from 1889 to the current date for any set of coordinates on the Australian continent. To make the daily rainfall data useful to users, such as farmers and environmental modellers, a robust disaggregation model that generates sub-daily time series fully consistent with the daily totals while preserving multiple sub-daily time scale stochastic structure is required (Gyasi-Agyei, 2005). A Stochastic Disaggregation model (Gyasi-Agyei and Willgoose, 1997), which incorporates repetition techniques and a proportional adjusting procedure (Koutsoyiannis and Onof, 2001) into a regionalised hybrid model (Gyasi-Agyei, 1999), has been demonstrated to have such capability. The model is structured such that clusters of consecutive wet days can be disaggregated during the generation of the binary wet and dry sequence and/or intensity phases. This model is a product of the binary nonrandomised Bartlett–Lewis rectangular pulse model (Rodriguez-Iturbe et al. 1987) and a lognormal autoregressive model used as a jitter (Gyasi-Agyei, 2005). In this research, the model has been applied to simulate fine timescale rainfall data at stations around Queensland, Australia. Enhancement of the model for a better performance of the stochastic rainfall disaggregation in Queensland has also been investigated. Sufficient confidence in model prediction was sought in order to make the model a valuable tool for stochastic rainfall disaggregation in Queensland.

1.1 Aims and Objectives

Gyasi-Agyei (2005) has demonstrated the use of the Stochastic Disaggregation Model to capture sub-daily statistics with excellent results. Our goal is to explore the capability of the same model, and where relevant extend the model for application to a broader region such as the whole of Queensland. To accomplish this task, it is essential to ensure that the data are of good quality with minimal error. The research will also focus on incorporating any recent developments made in the area.

The specific features of this research work are as follows:

- Literature Survey to update with latest developments.
- Check the fine time scale data from Bureau of Meteorology for Queensland.
- Develop regional model parameters for Rainfall Disaggregation for the broader Queensland region.
- Disaggregate daily rainfall into fine timescale for Queensland.
- Simulation of Intensity-Frequency-Duration (IFD) curves and compare with the existing Australian Rainfall and Runoff (ARR) approaches for Queensland.
- Linking the model with synthetic data for Queensland.

1.2 Scope and Limitations

The focus of the research is the applicability of a rainfall disaggregation model for the greater Queensland region. This exercise may lead us to the modification and generalisation of the existing Stochastic Rainfall Disaggregation Model. The primary data source for this research is anticipated to be the Bureau of Meteorology fine time scale (6 minutes) rainfall data. The Global optimisation technique for calibration of the model parameters is within the scope of this research. Compatibility of the existing Stochastic Disaggregation model for Queensland and other states can be investigated though this work. COMPAQ FORTRAN 95 will be used for data manipulation and programming purposes.

In the short term, we will depend solely on the Bureau of Meteorology rainfall data for the analyses. This rainfall data may be corrupt for various reasons including system malfunctioning and human error. This research will not explore the data improvement prospects but rather will be confined only to checking of these data. The original Bartlett-Lewis Model specifies five parameters relating to Storm Arrival, Cell Arrival, Cell Cessations, Rainfall Intensity and Cell Duration. This research does not anticipate the introduction of any new parameter beyond those specified in the original Bartlett-Lewis Model. Furthermore, the research will be confined to the parametric analyses of Rainfall Disaggregation. Non-parametric analyses of Rainfall Disaggregation are beyond the scope of this research.

The remainder of the thesis is arranged in the following order:

Chapter 2 describes the up to date literature surveys on the topic of rainfall disaggregation.

Chapter 3 presents the data source for rainfall disaggregation and also the rainfall statistics analysed in this thesis.

Chapter 4 presents the stochastic disaggregation model used in this research with descriptions of each component of the model. The seasonality into the variance relationship and a robust approach of capping the maximum intensity have been introduced as model components in this chapter.

Chapter 5 discusses the parameter estimations for each component of the model. First, the parameters have been identified and then estimated for the selected regions.

Chapter 6 describes the disaggregation of the daily rainfall by the stochastic model and its implication over the selected regions. This chapter also investigates the improvement of the model by incorporating seasonality into the variance relationship.

Chapter 7 presents the derivation of the Intensity-Frequency-Duration (IFD) curves using the disaggregation technique. This chapter investigates the uncertainty in the rainfall depth simulation and uses capping as a proposed remedy. A technique of using the model for sites with little or no rainfall data is also presented in this chapter.

Chapter 8 links the disaggregation model to SILO Data Drill synthetic data and validates the use of the model at any location in Queensland.

Chapter 9 draws conclusions based on the parameterisation, application and enhancements of the model.