# Teaching and Learning Components in an MPhil Research: Literature Review on Regional Flood Frequency Analysis

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*Abstract*

*Literature review is an important component of the learning and teaching associated with a higher degree research (HDR) study. As a Master of Philosophy (MPhil) student in civil engineering at Western Sydney University, the first important task by the first author was conducting a literature review on her research topic - Regional Flood Frequency Analysis (RFFA) under the guidance of her supervisors. Accordingly, this paper presents challenges and opportunities in the literature review on RFFA faced by the first author. A literature review in RFFA field covers relevant scholarly journal articles, book chapters, conference papers and other relevant online sources and provides an overview, summary, analysis and interpretation of each source. Furthermore, a successful literature review interprets old researches and identifies critical knowledge gaps to create a path for a new research and outcomes. It has been found that publishing a literature review in an international journal needs significant knowledge, writing skills and commitment from the research student and his/her supervisors to make it comprehensive, complete and innovative.*

*Keywords:* Regional flood frequency analysis, floods, probability distributions, RFFE model, MPhil.

## 1. INTRODUCTION

Literature review is a critical examination of previously published studies in a particular area of research. It generally covers review of relevant scholarly journal articles, research books, conference papers and many other online sources and provides an overview, summary, analysis and evaluation of knowledge that has been previously established on a research topic. Moreover, a successful literature review interprets old and recent researches and proposes questions for future research. It helps to develop a research idea and gain adequate knowledge and deep understanding of the research area. In addition, conducting a literature review helps to learn key concepts, different techniques and methods used in a specific field of research. Kordrostami et al. (2016) stated that new research students often struggle in carrying out a meaningful literature review. Furthermore, Rahman et al. (2016) examined the problem of technical writing for engineering students in Australia and found that critical literature review skills are generally poor among many engineering students. This paper focuses on literature review in flood risk assessment as a part of Master of Philosophy research of the first author.

Water is one of the most important resources on planet earth. It has played vital roles in human history and building of civilisation. But despite their benefits to humans, water also has brought numerous deaths and destruction to many communities due to lack of sustainable water resources management. For example, too much water causes flood, which is one of the worst catastrophic natural events causing deaths of human beings and animals and bringing disruptions to services and damages to infrastructure, agricultural lands and properties. Thus, it results in severe economic downturn, e.g. floods in 2010-11 in Australia caused over $30 billion damage to Australian economy. Flooding is one of Australia's costliest natural disasters, for example, in Australia, about 1.3 million homes have a flood risk rating and the estimated average annual flood damage is worth over $314 million (Australian Bureau of Statistics, 2008).

To reduce flood damage, the planers need to know flood risk at a given location. Design flood is often used for this purpose, which is a flood having a specified exceedance probability. At-site flood frequency analysis is the best method of design flood estimation which needs a long period of recorded flood data to generate meaningful outcomes. However, Australia is a large continent where many catchments have poor/no streamflow data. In such cases, Regional Flood Frequency Analysis (RFFA) is adopted, which is a data-driven procedure that allows estimating design floods at sites with short or no recorded flood data by transferring flood information from gauged to ungauged catchments on the basis of regional homogeneity (Cunnane, 1989). In RFFA, flood characteristics information is transferred from gauged to ungauged catchments. RFFA uses data from nearby sites in a defined homogeneous region to analyse flood frequency estimation at ungauged sites of interest and estimate flood quantiles at any site within this region.

Over the years, a large number of RFFA techniques have been developed around the world, with different assumptions, data requirements, and limitations. Currently, there is no universal RFFA approach that has been adopted across the world and most of them are associated with a high degree of error (Haddad and Rahman, 2012a; Haddad et al., 2012b). Therefore, the development of new and more accurate RFFA approaches are desirable to design more flood-safe infrastructures that will reduce flood damage by allowing passage of flood water safely.

As a Master of Philosophy student in civil engineering at Western Sydney University (WSU), the first author presents her experiences in conducting a critical literature review on RFFA. This aims to prepare a critical literature review to investigate both the past and recent studies on RFFA to assess the most relevant and up-to-date RFFA procedures, to explore their advantages and disadvantages, to investigate their assumptions and limitations, and finally to identify gaps and limitations with the current RFFA techniques and to propose further research in RFFA.

Recently, Rahman et al. (2015) upgraded the Regional Flood Frequency Estimation (RFFE) method in Australian Rainfall and Runoff (ARR) (the national guide) as a part of ARR Project 5 Regional Flood Methods. Therefore, based on the knowledge gained from the previous studies, the proposed research aims to propose additional recommendations to enhance the accuracy of RFFE in Australia.

The objective of this paper is to focus on the importance of the literature review as a learning and teaching component related with a Higher Degree Research (HDR), and to present the difficulties and opportunities in carrying out literature review on RFFA and in particular how this literature review has enhanced the first author's learning skills of an MPhil degree in WSU.

## 2. LITERATURE REVIEW

### 2.1. Types of Literature Review

It is important to identify the most common types of literature reviews. Uman (2011) defines the following types of literature review:
- The narrative review gives a critical summary of the literature about a particular topic. It is mainly descriptive. It describes how knowledge fits within the topic area and what relevant research has already been established.
- The systematic review identifies and synthesises all relevant studies on a particular field and it tends to reduce bias in research knowledge.
- The meta- analysis review includes statistical analysis to combine and interpret data from different studies.
- The scoping review identifies gaps in the literature and describes the necessity for further research.

## 2.2. Method of Writing an Effective Literature Review in RFFA

To carry out an effective literature review, the first author adopted the following methodology:

- Identify the keywords in RFFA (such as Flood, Index Flood, Homogeneity, Parameter Regression Technique and RFFA)
- Search for these keywords in the scientific databases such as Google Scholar, Science Direct and WSU library.
- Gather relevant sources to read (such as journal articles, conference papers and research books).
- Scan article title and abstract to shortlist the reading materials based on relevance.
- Understand the key concepts in RFFA, different assumptions (such as advantages and limitations for each procedure) and methodologies providing a comprehensive and deep coverage of the topic.
- Read critically, evaluate and synthesise the information in order to develop analytic arguments that lead to the research questions to be examined in the MPhil research.
- Compare similarities and differences between studies.
- Summarise findings of the relevant articles.
- Identify gaps in the literature review.
- Suggest investigations for further research need.
- Organise and structure the literature review to convey the findings of the literature review effectively.
- Prepare citations and references of each information included in the report in the required format.

Figure 1 presents a chart consisting of the main stages completed by the first author to carry out an effective literature review.
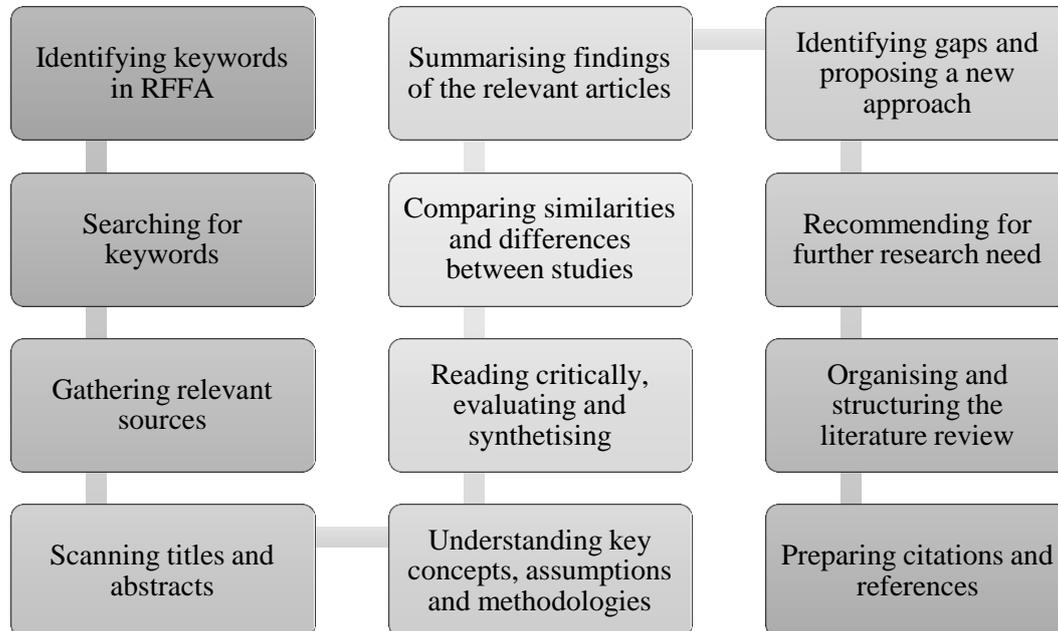


**Figure 1. Stages in the literature review adopted in this study**

## 2.3. Advantages of Literature Review in RFFA

Conducting a literature review has brought numerous benefits to the first author of this paper. It enhanced learning skills and provided significant knowledge and deep understanding of the RFFA

techniques. Moreover, it gave a clear idea of the studies that have already been undertaken and created a robust foundation for advancing knowledge in RFFA. It improved critical thinking and analytical skills through identifying the similarities and differences between previous studies on RFFA. In addition, it identified gaps in the existing literature and suggested new research investigations to be undertaken in the MPhil research of the first author.

## 3.  CHALLENGES AND OPPORTUNITIES IN LITERATURE REVIEW

Reviewing literature is an important component of academic writing and research and aims to gain an understanding of the current state of knowledge on a research topic (Davies, 2011). According to Kordrostami et al. (2016), students have found the preparation of a critical literature review as the most difficult task in their Master of Engineering degree at WSU. Therefore, it is important to highlight the challenges and opportunities that the first author has faced in carrying out the literature review in RFFA (see Figure 2).
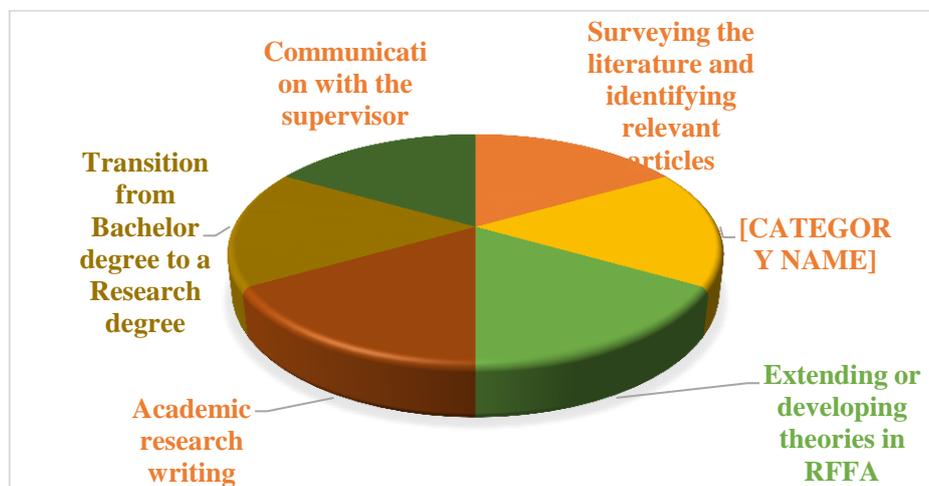


**Figure 2. Aspects of literature review on RFFA**

### 3.1. Surveying the Literature and Identifying Relevant Articles

There were too many past studies on RFFA that took significant time to screen and analyse. The first important step was finding the relevant keywords, searching for titles and abstracts containing these keywords and collecting relevant sources e.g. book chapters, journal articles and conference papers. Few issues were found to be important at this stage: relevance (selecting articles that have contributed to the main concepts of RFFA (e.g., what is generally accepted, what is developing, what is the current trends); authority (type of publication, qualification of the authors, importance and reputation of the publisher); and currency (the influence of the paper on the topic and date of publication); and grouping the collected information on headings of interests/relevance.

### 3.2. Understanding Main Concepts in RFFA

As RFFA was a new research area for the first author, an essential and difficult task was to deeply understand the broad concepts of the RFFA as a high-quality literature review should focus on concepts and benchmark the existing knowledge in this area. Thus, it was necessary to become familiar with the key principles of RFFA in the literature, such as Probability Distributions, Regional Homogeneity, Station Year Approach, Index Flood Method, Probabilistic Rational Method, Quantile Regression Techniques and Parameter Regression Techniques.

A summary table (Table 1) is prepared explaining the key concepts with relevant key references and important notes.

**Table 1: Summarised Findings for Literature Review in RFFA**

| Topic | Highlight | References | Comments |
|---|---|---|---|
| Homogeneity Test | L-moments ratio<br>H statistics<br>Z statistics | Hosking and Wallis (1993) | Strict homogeneity could not be established for any of the Australian states. |
| Formation of Regions | Fixed regions<br>ROI | Burn (1990a, 1990b)<br>Haddad and Rahman (2012a) | ROI improves flood quantile estimates and offers more flexibility in RFFA. |
| Outlier Identification | Low - high outlier<br>GB test<br>MGB test | Grubbs (1969)<br>Grubbs and Beck (1972)<br>Rosner (1975, 1983)<br>Cohn at al. (2013) | GB detects one outlier at a time<br>MGB identifies multiple potentially influential low flows in a flood series. |
| Goodness of Fit Tests | CS, KS and AD tests<br>L-moment ratio diagram | Chowdhury et al. (1991)<br>Hosking and Wallis (1993) | Examine the fitness of the candidate regional frequency distributions. |
| Parameter Estimation | MOM<br>L-moments<br>MLE | Hosking (1990)<br>Hosking and Wallis (1997)<br>Martins and Stedinger (2000) | MLE and L moments have been considered as robust methods and preferable in most studies. |
| Flood Frequency Distribution | LP3<br>GEV | Cunnane (1989) | LP3 and GEV are the most preferred distributions in FFA in Australia. |
| PRT | Parameters of a probability distribution regressed against catchment characteristics<br>GEV - LP3<br>OLS, WLS, GLS, BGLS | Tasker and Stedinger (1989)<br>Madsen et al. (2002)<br>Haddad and Rahman (2012a) | PRT is more appropriate than QRT. GLS and BGLS are the most used and preferred regression technique in Australia. BGLS model is preferable method of PRT. ARR (2016) has adopted PRT-LP3-ROI as RFFE Model 2016. PRT - GEV has not been tested in RFFA |
| QRT | Flood quantiles regressed against catchment characteristics<br>OLS, WLS, GLS, BGLS | Benson (1962)<br>Thomas and Benson (1970)<br>Rahman (2005) | |
| IFM | Assumption of strict homogenous regions<br>Scaling factor<br>Coefficient of variation<br>PWMs or L-moments | Dalrymple (1960)<br>Ishak et al. (2011) | Large heterogeneity among Australian catchments.<br>Results may be subject to substantial error. |

### 3.3. Extending or Developing Theories in RFFA

Proposing new research in RFFA was challenging because writing a good literature review does not only require an investigation of the past and current theories but also should show directions for future research and recommendations. In addition, the knowledge gained from the literature review helps to propose a new approach in RFFA and to compare it with the previous procedures.

### 3.4. Academic Writing

Academic/research writing was a difficult and challenging task for the first author. It requires confidence and ability to write from an expert point of view. It is a challenge for most native English speakers and a common difficulty for non-native speakers of English (such as in the first author's case as a French language graduate student), due to weakness of knowledge in certain skills which are necessary for academic writing such as struggling to express thoughts and ideas smoothly, outlining, summarising, avoiding plagiarism and using the correct format of citation and referencing. According to Steiner (2011), civil engineers have a lack in effective writing skills, although they are required to write project proposals and research reports. Moreover, another study by Rahman et al. (2016) showed that many engineering students faced a significant problem in technical writing as they are unable to express their ideas in an explicit and complete fashion.

### 3.5. Transition from Bachelor to a Research Study

Generally, a student with a Bachelor degree has a knowledge base within a specific range. However, the transition from bachelor to research study was challenging and exciting. It is quite like an evolution from teacher-centered education to student-centered education in order to improve in-depth knowledge and significant learning experiences. There were changes in tasks and student's responsibilities. The first author believed that research student should be fully responsible for their learning, design his own learning environment and enhance new professional skills such as: deeply understanding the topic of the research, a high level of independence, critical thinking, time and project management skills, problem-solving, excellent organisation and communication skills. Moreover, the student should enhance his/her self-learning of programming skills (such as MATLAB, FLIKE software). Accordingly, Noor and Rahman (2016) discussed the necessity of practical knowledge achieved through virtual laboratories such as MATLAB software. In RFFA research, learning of programming skills are essential as this needs modelling, uncertainty analysis, data generation and Monte Carlo simulation

### 3.6. Communication with the Supervisor

A positive relationship between a student and his/her higher degree supervisor is a very important factor for student success. The first author argues that student should manage well his/her supervisor, develop and maintain a supportive and positive relationship in order to produce a good quality thesis. Moreover, the English language can be considered as an important factor affecting research degree. As non-native English speaker, the explored challenges were those caused by different accented English and it has been found that the main difficulty that might be faced is miscommunication between student and supervisors which is due to the struggling communication, the ability to express ideas adequately and the difference in foreign-sounding English accents. In fact, incorrect or poor sound production may lead to more comprehension problems than speech with lexical errors (Gilakjani, 2012).

Both the supervisors (second and third authors) are knowledgeable, expert and professional and are very helpful and supportive in carrying out the literature review. We met regularly even though the supervisors were busy, and we prepared a research plan and timeline for the research degree.

Furthermore, it has been learned that responsibilities must be taken during the research such as meeting deadlines, following rules, completing work with the maximum standard of moral and scientific practice and taking in seriously supervisor's advices and constructive criticisms. In addition, as an MPhil student, it is not expected to have detailed guidance for daily research, independent work is the desirable norm.

# 4. PUBLISHING A LITERATURE REVIEW AS A JOURNAL PAPER

During this research, it has been discovered that writing a good review is really challenging. It is not just a summary; it needs to be critical to judge whether the published results are logical and should give pathways for future research in RFFA. It should be known what has been done as well, as what could be done to make progress in RFFA. Therefore, publishing a good review paper requires a deep knowledge and a higher level of understanding plus an excellent organisation and experience than just reading and summarising. Moreover, high standard requirements should be met to be able to publish a review paper in an international journal.

# 5. CONCLUSION

This paper examines the importance of the literature review as a main component of the learning and teaching in a Higher Degree Research. It presents the preparation of the literature review on RFFA highlighting challenges and opportunities that have been faced by the first author and how it enhanced learning skills of his MPhil study in WSU. It has been noted that a successful literature review requires critical examinations of the previous and recent studies in a specific topic area including learning about important concepts, design methods, and techniques. In addition, it has been found that publishing a good literature review in an international journal requires significant knowledge and commitment from the research student and his/her supervisors.

# 6. ACKNOWLEDGMENT

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