

**MATHEMATICAL MODELLING OF DENGUE  
DYNAMICS AND CLIMATE VARIABILITY  
IN SRI LANKA**

Thiyanga Shamini Talagala



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Degree of Master of Science

Department of Mathematics


University of Moratuwa  
Sri Lanka

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DYNAMICS AND CLIMATE VARIABILITY  
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 University of Moratuwa, Sri Lanka.  
Dissertation submitted in partial fulfillment of the requirements for the degree Master  
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of Science in Financial Mathematics  
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Department of Mathematics

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Sri Lanka

August 2015

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University of Sri Jayewardenepura

## Dedication

This thesis is dedicated to my mother and father who have supported me throughout my studies.



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It is my parents who are always behind with me, caring about me in every second of my life, whose heartiest love, encouragement, guidance and motivation enables me to build better foundation for my life. Hence certainly my deep appreciation is expressed to my parents for their endless love and caring.

## Abstract

Dengue fever (DF) is a life threatening infectious mosquito borne disease that places a heavy burden on public health system in Sri Lanka as well as on most of the tropical countries around the world. Currently, there is no antiviral drug for treatment of DF. The objective of this study is twofold, first is to analyze the epidemic outbreak patterns of dengue cases in 25 districts in Sri Lanka, second is to identify the association between climatic variables and dengue counts in Colombo district where dengue is predominant. Weekly data on dengue cases were obtained between January, 2009 – September, 2014. Temperature (maximum, minimum, mean), precipitation, visibility, humidity, and wind speed were also recorded as weekly averages. Wavelet analyses were used to explore the periodicity of dengue cases. Wavelet coherence was performed to identify the association between dengue and climatic factors. Further, a Poisson regression combined with distributed lag nonlinear model (dlm) was used to quantify the impact of climatic factors on dengue counts while taking the lag time into account. Change point analysis was performed as a complementary analytic method to identify changes in variance of dengue and climate time series. Dengue dynamics showed multiple periodic patterns (1-8 weeks, 26 weeks and 52 weeks) across twenty five districts which can be divided into two groups based on wavelet cluster analysis. Wavelet coherency revealed a significant non-stationary association between climatic variables and dengue incidence in annual and semi-annual scale. Results of dlm revealed mean temperature around 25°C – 26°C prior to 5 weeks, high precipitation (>30mm), humidity 65% - 75% prior to lag of 10-15 weeks, and high visibility have an harmful impact on increasing relative risk of dengue incidence. These findings can aid the targeting of vector control interventions and planning for dengue vaccine implementation.

 **Keywords:** Dengue, Wavelet Analysis, Climate, Distributed lag nonlinear model, Change point analysis

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## LIST of ABBREVIATIONS

CWT – Continuous Wavelet Transformation

DF – Dengue Fever

DHF – Dengue Hemorrhagic Fever

DLNM – Distributed Lag Nonlinear Models

DSS – Dengue Shock Syndrome

GAM – Generalized Additive Models

GAMAR – GAM with Autoregressive terms

GLM – Generalized Linear Models

PELT – Pruned Exact Linear Time

RR – Relative Risk

SARIMA – Seasonal Autoregressive Integrated Moving Average

WER – Weekly Epidemiological Reports

WHO – World Health Organization



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