SPATIAL AND TEMPORAL ANALYSIS OF RAINFALL AND DROUGHT AND DEVELOPMENT OF A DROUGHT PREDICTION MODEL BY USING MULTI-MODEL ENSEMBLED APPROACH

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Degree of Master of Science

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Spatial and Temporal Analysis of Rainfall and Drought and Development of a Drought Prediction Model by using Multi-model Ensembled Approach

Abstract

Drought is one of the major catastrophes faced by most of the countries in recent times. Studies have been carried out to find underlying patterns and to implement forecasting systems specified for a particular region. Finding common patterns among diverse regions and implementing forecasting systems have become challenging due to climatological differences. Climatologists have divided drought into several categories for the ease of interpretation and analysis which make analysis and forecasting more complex. Sri Lanka is a climatologically diverse country, where people can experience the climate differences within a hundred kilometres.

This study contains three major components named spatial and temporal analysis, analysis of drought and development of a drought prediction model with drought risk assessment. Spatial and temporal analysis has been carried out for five selected basins in Sri Lanka namely Malwathu Oya, Kirindi Oya, Kanakarayan Aru, Gin Ganga, and Kala Oya by using selected five different drought indices. The results show that the best suited drought index to identify occurrence of drought is Standard Precipitation Index (SPI), while a significant variation is observed within Kirindi Oya basin which spans over several climatological regions.

The development of the drought prediction model has been accomplished for Malwathu Oya basin by using recurrent neural networks with Long Short-Term Memory Networks and Artificial Neural Networks. The model has achieved an accuracy up to 86% in drought prediction in sub basin scale. Different models with different parameters were tested to arrive at the best suited model.

A drought risk assessment has been conducted for Anuradhapura district and comparative risk in each Divisional Secretariat Division (DSD) was identified. The identified risk has been compared with the relief payments and drought affected population data in order to ensure the applicability in Anuradhapura district.

The multi-model ensembled approach developed can be effectively used in drought risk identification and to obtain relative indication of socio-economic implications of drought for similar regions in Sri Lanka and elsewhere and thus can be employed as a decision support system in drought prediction and relief management.

Keywords: Drought Prediction Model, Drought Risk Assessment, Malwathu Oya Basin, Spatial and Temporal Analysis of Drought

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LIST OF ABBREVIATIONS

Abbreviation	Description
ANN	Artificial Neural Networks
DHI	Drought Hazard Index
DI	Deciles Index
DRI	Drought Risk Index
DSD	Divisional Secretariat Divisions
DVI	Drought Vulnerability Index
GLG	Lower Gin Ganga
GMD	Maha Dola
GTE	Terun Ela
GUG	Upper Gin Ganga
GUM	Upper Middle Gin Ganga
KAI	Iranamadu
KAL	Lower Kanakarayan Aru
KAU	Upper Kanakarayan Aru
KIK	Kuda Oya
KIL	Lunugamwehera
KIM	Maha Ara
KIU	Upper Kirindi Oya
KIW	Lower Kirindi Oya
KO	Kuda Oya
KOH	Hewanhella
KOM	Mirisgoni Oya
KOR	Upper Rajanganaya
KOS	Siyambalangamuwa Oya
KOU	Upper Uttumadu Aru
LK	Lower Kirindi Oya
LSTM	Long-Short Term Memory

LU	Lunugamwehera
MA	Maha Ara
MOA	Kal Aru
MOK	Kudahathu Oya
MOL	Lower Malwathu Oya
MOM	Upper Malwathu Oya
MOU	Upper Kanadara Oya
MOY	Maminiya Oya
MRF	Mean Rainfall
PN	Percent of Normal
RAI	Rainfall Anomaly Index
RNN	Recurrent Neural Networks
SPI	Standard Precipitation Index
UK	Upper Kirindi Oya