

# **METAHEURISTIC ALGORITHMS AND NEURAL NETWORKS IN HYDROLOGY**

Edited by  
**Kuok King Kuok and  
Md Rezaur Rahman**

# Metaheuristic Algorithms and Neural Networks in Hydrology

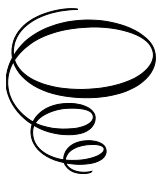


# Metaheuristic Algorithms and Neural Networks in Hydrology

Edited by

Kuok King Kuok and Md Rezaur Rahman

**Cambridge  
Scholars  
Publishing**



Metaheuristic Algorithms and Neural Networks in Hydrology

Edited by Kuok King Kuok and Md Rezaur Rahman

This book first published 2024

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

Copyright © 2024 by Kuok King Kuok, Md Rezaur Rahman  
and contributors

All rights for this book reserved. No part of this book may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the copyright owner.

ISBN: 978-1-0364-0804-6

ISBN (Ebook): 978-1-0364-0805-3

# TABLE OF CONTENTS

Chapter 1 .....	1
Neural Network – A Black Box Model Kuok King Kuok, Chiu Po Chan, Md Rezaur Rahman, Khairul Anwar Mohamad Said, Chin Mei Yun	
Chapter 2 .....	35
Particle Swarm Optimization in Feedforward Neural Networks for Rainfall-Runoff Simulation Kuok King Kuok, Chiu Po Chan, Md Rezaur Rahman, Chin Mei Yun, Mohd Elfy Mersal	
Chapter 3 .....	63
Bat Optimisation Neural Networks for Rainfall Forecasting: Case Study for Kuching City Kuok King Kuok, Chiu Po Chan, Md Rezaur Rahman, Chin Mei Yun, Mohd Elfy Mersal	
Chapter 4 .....	83
Cuckoo Search Optimization Neural Network Models for Forecasting Long-Term Precipitation Kuok King Kuok, Chiu Po Chan, Md Rezaur Rahman, Khairul Anwar Mohamad Said	
Chapter 5 .....	105
Whale Optimization Neural Network for Daily Water Level Forecasting Considering the Changing Climate Kuok King Kuok, Chiu Po Chan, Md Rezaur Rahman, Teng Yeow Haur	
Chapter 6 .....	129
Salp Swarm Optimization Neural Network for Daily Water Level Forecasting with the Impacts of Climate Change Kuok King Kuok, Teng Yeow Haur, Chiu Po Chan, Md Rezaur Rahman, Muhammad Khusairy Bakri	

Chapter 7 .....	147
Missing Daily Rainfall Prediction using Grey Wolf Optimizer-based Neural Network Lai Wai Yan, Kuok King Kuok, Chiu Po Chan, Md Rezaur Rahman, Muhammad Khusairy Bakri	
Chapter 8 .....	170
Development of Multi-Verse Optimizer in Artificial Neural Network for Enhancing the Imputation Accuracy of Daily Rainfall Observations Lai Wai Yan, Kuok King Kuok, Chiu Po Chan, Md Rezaur Rahman, Muhammad Khusairy Bakri	
Chapter 9 .....	194
Sine Cosine Algorithm based Neural Network for Rainfall Data Imputation Po Chan Chiu, Ali Selamat, Kuok King Kuok	
Chapter 10 .....	208
Hybrid Sine Cosine and Fitness Dependent Optimizer for Incomplete Dataset Po Chan Chiu, Ali Selamat, Kuok King Kuok	

## 5. Book's contents

### CHAPTER 6

#### SALP SWARM OPTIMIZATION NEURAL NETWORK FOR DAILY WATER LEVEL FORECASTING WITH THE IMPACTS OF CLIMATE CHANGE

KUOK KING KUOK<sup>1</sup>, TENG YEOW HAUR<sup>1</sup>,  
CHIU PO CHAN<sup>2</sup>, MD REZAUR RAHMAN<sup>3</sup>,  
MUHAMMAD KHUSAIRY BAKRI<sup>4</sup>

<sup>1</sup>Faculty of Engineering, Computing and Science, Swinburne University of Technology, Sarawak Campus, Jalan Simpang Tiga, 93400, Kuching, Sarawak, Malaysia.

<sup>2</sup>Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak, Jalan Datuk Mohammad Musa, 94300, Kota Samarahan, Sarawak, Malaysia

<sup>3</sup>Faculty of Engineering, Universiti Malaysia Sarawak, Jalan Datuk Mohammad Musa, 94300, Kota Samarahan, Sarawak, Malaysia

<sup>4</sup>Composites Materials and Engineering Center, Washington State University, Pullman, WA, United States

#### **Abstract**

*Forecasted daily water level data is essential in water resource planning and management. Proper water resource planning and management based on accurate water level forecasting considering climate change's impact can help minimize flooding damage and achieve optimum use of water resources. Thus, this paper proposed applying the Salp Swarm Optimization Neural Network (SSONN) model to forecast daily water levels at Batu Kitang River with the impact of climate change. This study was conducted using seven years of rainfall and water level data from Batu Kitang Station and*



*Global Climate Model (GCM) predictors from Institut Pierre Simon Laplace – Climate Model 5A – Medium Resolution (IPSL-CM5A-MR) under the scenario of Representative Concentration Pathway (RCP) 4.5. The performance of the SSONN model on daily water level forecasting was evaluated for Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Coefficient of Correlation ( $r$ ). The SSONN model's reliability was compared with the performance of the Levenberg-Marquardt Neural Network (LMNN) and Scale Conjugate Gradient Neural Network (SCGNN). Results obtained from this study indicate that the performance of SSONN was superior to LMNN and SCGNN.*

**Keywords:** Salp Swarm Optimization Neural Network (SSONN), daily water level, forecasting, Climate Change, IPSL-CM5A-MR, Global Climate Model (GCM)

## 1. Introduction

Daily water level forecasting is vital to water resources planning and management due to uncertainty from climate change. Accurate daily water level forecasting considering climate change impacts can be adopted as guidelines to facilitate the management of water resources, which allows early flood mitigation, enhancing dam operation, optimizing water supply, optimizing hydropower generation, and decision support systems. Early water resource planning management with accurate daily water level forecasting can help minimize property damage and loss of lives due to unforeseen floods.

Over the past decades, professional experience, advanced knowledge, and large amounts of historical complete time series data have often been required to predict water levels using conventional hydrological models. However, a lot of historical data obtained from gauging stations is missing due to equipment malfunctions or delayed maintenance of the broken equipment.

This discontinuation of historical local data could limit the efficiency of conventional forecasting models. Therefore, Artificial Neural Network (ANN) models are more favored to overcome the limitations of conventional forecasting models due to their flexibility in performing various tasks.

An ANN, inspired by the function of the human brain and nervous system, offers a relatively fast and flexible means of hydrologic model and the capability to forecast water levels accurately. ANNs have been applied by scientists in various fields for various prediction modeling, especially