
Dedicated to My Grandmother
Late Karuna Bala Bose
Whose Love and Blessings
I Believe will Forever Light
My Way

Statutory Declaration

I, the undersigned, hereby declare that the thesis entitled **"Urban Transport and Associated Vehicular Emissions in Siliguri City"** submitted for the degree of Doctor of Philosophy under the Department of Geography & Applied Geography, Faculty of Sciences, at the University of North Bengal, has been conducted in accordance with the Ph.D. rules and regulations of the University of North Bengal, bearing **Regn. No. Ph.D./Geog. (1316)/493/R-2021**.

This thesis has not been submitted for the award of any degree, diploma, or fellowship to any other university or institution, with the exception of certain parts that were submitted to peer-reviewed journals to partially fulfill the requirements for the Ph.D. Degree.

I affirm that the ideas, analyses, results, and conclusions presented in this Ph.D. thesis are entirely the product of my own efforts, except where otherwise acknowledged. I have duly recognized the work of other authors, organizations, or agencies wherever their contributions have been incorporated into this study, ensuring that proper acknowledgment is given at the relevant places with appropriate and feasible recognition. Published works, whether directly or indirectly utilized, have been employed with due respect. Any oversight in this regard is unintentional and will be corrected with proper acknowledgment to the concerned author(s), organization, or agency, although the likelihood of such an oversight is minimal.

In every aspect of this work, I have endeavored to establish originality and uniqueness with the aid of secondary data sources, published literary works, fieldwork, group discussions, interviews, etc.

Date: 27.02.2024
Place: University of North Bengal

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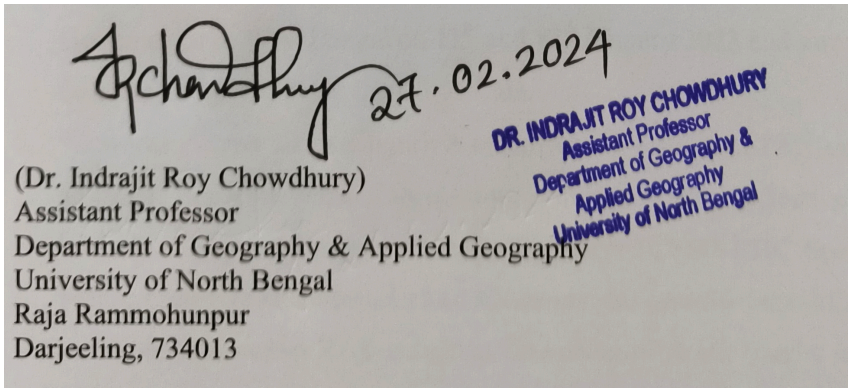
CERTIFICATE FROM THE SUPERVISOR

This is to certify that **Mr. Arghadeep Bose**, a UGC-JRF Research Scholar of the Department of Geography & Applied Geography, University of North Bengal, has carried out his Ph.D. research work entitled **"URBAN TRANSPORT AND ASSOCIATED VEHICULAR EMISSIONS IN SILIGURI CITY"** having Regn. No. Ph.D./Geog. (1316)/493/R-2021 under my supervision.

To the best of my knowledge and belief, it is his original research work based on extensive field surveys and secondary sources with the implementation of both quantitative as well as qualitative techniques to fulfil the objectives of the research work.

It may be further mentioned that Mr. Arghadeep Bose has fulfilled all the requisite criteria as per the Ph.D. rules and regulations of the University of North Bengal regarding the submission of the Ph.D. thesis. This thesis as a whole or any part of it has not been submitted to any other University/institution for any other degree.

I do hereby forward the said research work for the final submission and evaluation for the degree of Doctor of Philosophy (Ph.D.)



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Outcome of Ph.D. Thesis

This thesis has yielded two papers published in peer-reviewed journals indexed by SCOPUS and the Web of Science, following a rigorous peer-review process. Additionally, two seminar papers based on this research have been presented, demonstrating the work's scholarly impact.

➢ Published Article

1. Bose, A., & Roy Chowdhury, I. (2023). Investigating the association between air pollutants' concentration and meteorological parameters in a rapidly growing urban center of West Bengal, India: a statistical modeling-based approach. ***Modeling Earth Systems and Environment***, *9*(2), 2877-2892. (Impact Factor-**3.0** as of 2022, **Springer**)
2. Bose, A., & Chowdhury, I. R. (2024). Towards cleaner air in Siliguri: A comprehensive study of $PM_{2.5}$ and PM_{10} through advance computational forecasting models for effective environmental interventions. ***Atmospheric Pollution Research***, *15*(2), 101976. (Impact Factor-**4.5** as of 2022, **Elsevier**)

➢ Seminar Presentation

1. "Finding the association between air pollutants' concentration and meteorological parameters in a rapidly growing urban center of West Bengal, India: a statistical modeling-based approach", paper presented at the **5th Regional Science and Technology Congress, 2022-23** organized jointly by University of Gour Banga, Malda, West Bengal and Department of Science and Technology and Biotechnology, Government of West Bengal on 11th and 12th January 2023 and awarded among the 5 best papers by achieving the 4th position.
2. "Towards cleaner air in Siliguri: A comprehensive study of $PM_{2.5}$ and PM_{10} through advance computational forecasting models for effective environmental interventions", paper presented at the Two days **ICSSR-ERC Sponsored National Seminar on Urbanization, Urban Environment and Sustainability in Himalayan and Sub-Himalayan Region** held at University of North Bengal on 1st and 2nd July, 2023.

Preface

The nexus between rapid urbanization and its ensuing environmental challenges, particularly traffic congestion and air pollution, is a global concern that has increasingly come to the fore in developing countries. Siliguri, a vibrant city in West Bengal, India, stands at the crossroads of this phenomenon, showcasing both the opportunities and adversities brought about by its strategic position as a commercial and transportation hub. Nestled in the foothills of the Himalayas, Siliguri's transformation from a quaint village to a bustling metropolis mirrors the broader narrative of urban expansion in the region. This growth, while remarkable, has not been without its pitfalls. The city's burgeoning population and increasing vehicular density have exerted considerable pressure on its infrastructure, leading to persistent traffic congestion and escalating levels of vehicular emissions. These issues not only compromise the urban environment but also pose significant risks to public health, making it imperative to address them through comprehensive research and strategic planning. This thesis is motivated by a deep-seated concern for the sustainable development of urban spaces, with a focus on mitigating the adverse effects of vehicular pollution and enhancing the quality of life for urban residents.

This thesis unfolds across eight meticulously crafted chapters, each pivotal in weaving the narrative of this research. The introductory chapter sets the thematic and conceptual groundwork, framing the study within the broader context of urban pollution and its ramifications. Chapter II offers a vivid portrayal of Siliguri, delineating its physical, demographic, and socio-economic tapestry, while also spotlighting the city's pressing traffic and pollution challenges. In Chapter III, the focus narrows to the spatial dynamics of traffic flows and pollution, employing GIS and spatial analysis to map and interpret the data. Chapter IV examines the interconnections between air pollutant levels and meteorological variables, leveraging statistical models to uncover patterns and insights. The narrative then shifts in Chapter V, which probes the vexing issue of traffic congestion, employing both quantitative and qualitative analyses to unravel its causes and effects. Chapter VI delves into the public health implications of vehicular emissions, integrating time series forecasting and SEM to predict air quality trends and assess health impacts. Chapter VII is dedicated to exploring potential solutions and discussing transport action strategies and legislative frameworks aimed at mitigating pollution. Finally, Chapter VIII encapsulates the study's findings and recommendations, offering a concise yet comprehensive synthesis aimed at guiding policy and planning initiatives. Together,

these chapters embody a rigorous inquiry into the environmental and health challenges posed by urban transport, presenting a cohesive blueprint for navigating the path towards sustainable urban development in Siliguri and beyond.

Date: 27.02.2024

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Acknowledgments

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Furthermore, I am profoundly indebted to my respected teachers, Prof. Deepak Kumar Mondal, Prof. Ranjan Roy, Dr. Indira Lepcha (nee) Lama, Dr. Arindam Basak, Dr. Snehasish Saha, Dr. Rupak Kumar Paul, and Dr. Riti Moktan. Their valuable suggestions during the synopsis preparation and their continuous guidance, motivation, and encouragement from my post-graduation have been a beacon of light in my academic journey.

Special thanks are due to Prof. Subir Sarkar (Retired), Prof. Sushma Rohatgi (Retired), Dr. Sudip Kumar Bhattacharya (Retired), and the late Dr. Surjapada Paul for their invaluable guidance and encouragement. Their insights have been a cornerstone in the development of my research. Additionally, my heartfelt appreciation goes to all the non-teaching staff of the Department of Geography and Applied Geography, particularly Mr. Bhanu Basak, for his unwavering moral support and encouragement.

I sincerely thank my college teachers, Dr. Bipul Chandra Sarkar, Mr. Manas Paul, Mr. Prosenjit Karmakar, and Mr. Mousona Moitra, whose guidance was pivotal in my academic progression.

Special thanks are reserved for Mr. Subham Roy, Mr. Suranjan Majumder, and Mr. Debanjan Basak for their invaluable support and insights throughout my research. Their assistance was crucial in both the survey and subsequent work.

I extend my heartfelt gratitude to the University Grants Commission (UGC) for awarding me the UGC NET JRF with an All-India Rank of 52. This recognition has not only provided me with continuous financial support throughout my Ph.D. journey but has also laid a prestigious foundation for my research work.

I am thankful to Shri S.W. Bhutia, Commissioner of Siliguri Municipal Corporation, and Mr. Souhardo Chakraborty of ICLEI-South Asia, for their assistance in providing necessary data. Special appreciation is extended to Mr. Subir Kumar Dutta, I.C. of Junction Traffic Guard, for his insights into Siliguri's traffic challenges and assistance in my study. Gratitude is also owed to Purelogic Labs India, New Delhi, for training in data collection tools and to the Siliguri Police Commissionerate for granting permission for the Drone Survey across selected traffic intersections. My gratitude extends to each traffic police personnel and respondent whose cooperation made the primary survey possible.

I extend my heartfelt gratitude to Dr. Kalyan Rudra, Chairman of the West Bengal Pollution Control Board, for his invaluable insights on air pollution and its correlation with meteorological parameters, as showcased in his various works and lectures. His profound knowledge and expert perspective have significantly enriched my understanding of this complex subject, adding depth and clarity to my research.

I extend my sincere appreciation to the Central Pollution Control Board (CPCB), Government of India, and the West Bengal Pollution Control Board (WBPCB), Government of West Bengal. Their provision of crucial secondary data has greatly enriched my work, offering valuable insights and a robust foundation for my research. Additionally, I am grateful to the Siliguri Regional Transport Office (R.T.O) and the Siliguri Jalpaiguri Development Authority (SJDA) office for their indispensable contributions. Their cooperation and assistance in providing essential data have been pivotal in the successful completion of my study.

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I am eternally indebted to my late grandmother, Karuna Bala Bose, and my uncle, Mr. Anup Kumar Bose, for their unwavering support and financial assistance. Their faith in my abilities has been the foundation of my educational journey, enabling me to pursue my aspirations from school to this pivotal moment in my academic career. My heartfelt appreciation extends to my parents, Mr. Ashis Kumar Bose and Smt. Ratna Bose, for their infinite love and encouragement. I would also like to express my gratitude to my maternal grandmother, Mrs. Tripti Rani Sarkar, and acknowledge Puja Das for her encouragement and support. My cousins, Sudipta Chowdhury, Shubhadeep Chowdhury, Aritra Bose,

Pragati Bose, Aditi Bose; and other family members, particularly my uncle Ashim Kumar Bose, Samar Chowdhury, and my aunts Tandra Bose, Swati De Bose, Dipti Chowdhury, and Moumita Chowdhury Sarkar, have been pillars of emotional support. Their encouragement has been invaluable to my academic success, providing me with the strength and motivation to excel.

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