

## ABSTRACT

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This thesis emerges from a profound engagement with the challenges at the nexus of development and climate change. Addressing how climate change impacts development is a crucial and multifaceted issue that demands both theoretical investigation and practical solutions. The research presented in this thesis comprises two distinct but interrelated studies, each exploring different aspects of this challenge. Specifically, it examines the repercussions of climate change on rural livelihoods and development programs, as well as how adaptation strategies can be seamlessly integrated into broader development efforts to foster sustainable progress.

The rapid trend towards urbanization is a defining feature of our times, with projections indicating that over half of the world's population will be urban dwellers in the coming years. Concurrently, the stress on water resources is mounting, driven by both population growth and climate change. In India, these pressures are intensified, endangering vital water resources and exacerbating existing challenges. As an engineer committed to the sustainable management of essential resources, it is crucial to develop models that support the effective use of water and understand the trends influencing these resources.

Focusing on the eastern part of India, particularly the Damodar River Basin—a key segment of the Ganges River system—this thesis utilizes daily rainfall data spanning from 1923 to 2022. The research employs MATLAB for advanced programming and ArcGIS 10.5 for the creation of spatiotemporal maps. Analytical methods include non-parametric approaches such as the Mann-Kendall test, Modified Mann-Kendall test, Sen's slope method, and drought detection techniques. Prior to applying these methods, the time series data were rigorously analyzed to understand trend behaviors, followed by the application of Variable Size Cluster Analysis (VSCA) to identify trends and change points in climatic extremes.

VSCA was employed to uncover multiple change points and delineate the patterns of climatic extremes over a century-long period. Unlike the traditional Mann-Kendall (M-K) test, which provides a single monotonic trend, VSCA offers a nuanced

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view by detecting several change points and illustrating the complex behavior of climatic extremes. The modified Pettitt Mann Whitney (PMW) test was used to graphically represent these change points, further validating the VSCA results. The resulting 3-D visualizations from this analysis reveal intricate patterns of climatic variability, with data clusters of variable sizes leading to a triangular graphical representation due to the repeated application of the M-K test.

In the concluding stages of the research, the impacts of climate change were assessed, and strategies to mitigate anthropogenic effects were proposed. Key findings from this work have been published and accepted in SCI-indexed journals, including Sustainable Water Resources Management, CLEAN Soil, Air, Water (published), and Theoretical and Applied Climatology (under review), reflecting the significant contributions of this thesis to the field.