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Spatio-temporal modelling of Dengue Cases in Caraga Region, Philippines

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Abstract: Dengue fever remains a public health concern in tropical countries such as the Philippines. Identifying and monitoring high-risk areas is essential for creating early-warning strategies to reduce transmission and prevent future outbreaks. This paper focuses on spatio-temporal analysis of weekly dengue case counts in the Caraga region of Mindanao, Philippines, from 2009 to 2024. Count data is typically characterized by overdispersion, spatial dependency, and temporal autocorrelation, which classic time series methods cannot fully address. We present the Negative Binomial INGARCHX model, which improves classic Poisson models by addressing overdispersion and including exogenous factors with delayed effects. The method uses a Bayesian hierarchical framework with predefined prior distributions for key parameters. To improve efficiency and convergence, parameters are estimated using an adaptive Markov Chain Monte Carlo algorithm. Results show that the proposed model produces in-sample predictions closely aligned with the observed data and the diagnostic analysis does not show significant residual autocorrelation. The analysis shows clear geographic variation, with nearby places showing the highest spatial influence, while geographically isolated areas have much weaker effects. We conclude that the proposed model sufficiently and effectively captures the temporal and spatial patterns in the data. It offers an interpretable and flexible tool for modeling infectious diseases where both space and time are relevant.

Key Words: Spatio-Temporal analysis, Negative Binomial, INGARCH, MCMC method

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