Hierarchical Bayesian ZI Model with Spatiotemporal Random Effects

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This study investigated the case reports and vaccination data of Measles across 38 Indonesian provinces from 2017-2025 (monthly) using a Zero-Inflated (ZI) model with spatiotemporal random effects [1]. Model performance was assessed using AIC/BIC comparison, DHARMa diagnostics [2], and correlation between observed and predicted values; the model demonstrated excellent fit, but revealed no significant vaccination effect. A significant downward time trend was detected, representing a reduction per standard deviation. Spatial effects [3] identified DKI Jakarta as the highest-risk province, and seasonal temporal [4] effects showed December-January peaks. The spatiotemporal interaction term [1, 5] revealed substantial variance, indicating that province-specific year-to-year fluctuations dominated disease dynamics. We extended this model based on the age group category for case reports.
Key words: spatiotemporal modeling, ZI model, Spatial Effect, Temporal Effect, Age-Group Category.

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[1] S. Z. Dadaneh, M. Zhou, and X. Qian, Bayesian negative binomial regression for differential expression with confounding factors, *Bioinformatics* **34(19)** (2018), 3349–3356.

[2] S. Khedhiri, Statistical modeling of covid-19 deaths with excess zero counts, *Epidemiologic Methods* **10(s1)** (2021) 10.1515/em-2021-0007.

[3] S. Banerjee, B. P. Carlin, and A. E. Gelfand, *Hierarchical modeling and analysis for spatial data*, Chapman and Hall/CRC, 2003.

[4] N. Cressie and C. K. Wikle, *Statistics for spatio-temporal data*, S. John Wiley & Sons, 2015.

[5] Sujit K. Sahu, *Bayesian Modeling of Spatio-Temporal Data with R*, Chapman & Hall, CRC Interdiciplinary Statistics, 2022.