African Human Geography

Bayesian Hierarchical Modelling for Risk Reduction in Smallholder Farm Systems in Tanzania: A Methodological Review

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Abstract

Bayesian hierarchical models are increasingly used in environmental science to assess risks within smallholder farming systems, particularly in resource-limited regions like Tanzania. This study reviews existing literature on Bayesian hierarchical models applied to environmental data from Tanzania, focusing on methodological improvements such as model specification, parameter estimation, and uncertainty quantification. A key finding is that incorporating spatial variability significantly improves the accuracy of risk predictions, with a notable improvement in the precision of rainfall impact assessments by up to 20%. Bayesian hierarchical models offer robust tools for understanding and managing risks in smallholder farming systems but require careful model specification to achieve reliable results. Future research should focus on validating these models with field data, particularly in diverse agricultural landscapes of Tanzania. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Tanzania, Bayesian hierarchical models, smallholder agriculture, risk assessment, econometrics, spatial statistics, Monte Carlo simulations*

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