African Probability and Statistics (Pure Science)

Stability Analysis and Convergence Proofs of Nonlinear Differential Equations for Epidemic Spread Modelling in Uganda: A Mathematical Study

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Abstract

Uganda has faced significant challenges in managing epidemic spread due to both natural and human-induced factors. This study aims to develop a mathematical model that accurately predicts these dynamics, contributing to public health strategies. Nonlinear differential equations are formulated based on epidemiological data from Uganda, incorporating key factors such as infection rates, recovery rates, and transmission dynamics. Stability analysis is performed using Lyapunov function theory, ensuring robustness against perturbations in model parameters. A novel stability theorem has been established for the proposed model, confirming that under certain conditions, the system's equilibrium state remains stable regardless of initial conditions. The findings validate the utility of nonlinear differential equations in epidemiology, providing a robust framework for predicting and mitigating epidemic spread within Uganda. Future research could explore more complex scenarios and incorporate additional variables. Public health authorities should consider implementing interventions based on these models to enhance preparedness and response strategies against future epidemics. Uganda, Epidemic Spread, Nonlinear Differential Equations, Stability Analysis The analytical core is $\hat{\{y\}}t = mathcal\{F\}(xt;\theta)$ with $\hat{\{\theta\}} = argmin_{\theta} L(\theta)$, and convergence is established under standard smoothness conditions.

Keywords: *Sub-Saharan, Nonlinear, Stability, Convergence, Differential, Equations, Modelling*