

INFLUENCE OF CLIMATE CHANGE ON MALARIA TRANSMISSION THROUGH STOCHASTIC MODELLING

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Abstract. Malaria remains a significant public health burden on many African governments, with no effective vaccine available yet. We propose a stochastic model to investigate the influence of climate conditions on malaria occurrences in Sudan. We prove the existence and uniqueness of the positive solution of the stochastic seasonal epidemic model. Through qualitative properties, we also study the asymptotic behavior of the solution to the stochastic model around the disease-free equilibrium of the underlying deterministic model. Under conditions that allow for a disease-free equilibrium point, we demonstrate the almost sure exponential stability and exponentially p -stable of the disease-free equilibrium for $\mathcal{R}_0 < 1$. We discuss the steps and challenges in assigning numerical values by calibrating model parameters using data. Theoretical results are illustrated by numerical simulations with parameters applied to Sudan in Gezira State. The results, with respect to confirmed climatic conditions, are becoming increasingly important in light of their potential to alter the rate of evolution of malaria vectors, shift their geographic distribution, and control malaria transmission dynamics.

Keywords. Malaria; Climate change; Stability analysis; Stochastic model.

AMS (MOS) subject classification: 60H10; 92D25; 92D30; 65C30.

1 Introduction

The global impact of malaria as a widespread and lethal human disease caused by Plasmodium parasites spread by mosquitoes cannot be understated. The disease poses a significant threat to human health, particularly in Sub-Saharan Africa, affecting more people than any other region in the world [9, 10]. Over 80% of all malaria cases and 90% of all malaria deaths occur in Sub-Saharan Africa [30]. For example, Sudan faces significant challenges with malaria, making it one of the hardest-hit African countries by this disease [2]. The literature on malaria in Sudan [3, 25] highlights its substantial impact on public health, leading to high morbidity and mortality rates. Malaria disproportionately affects children under five years of age and pregnant women during the rainy season [13]. Critical interventions such as indoor residual spraying, long-lasting