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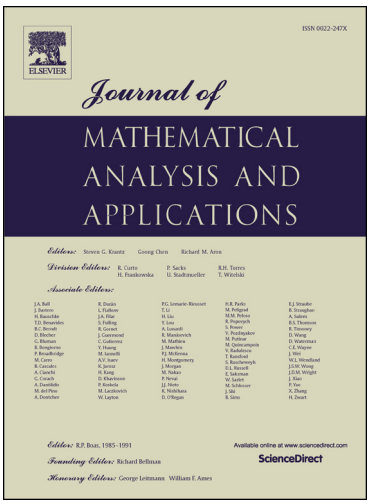

A cholera epidemic model in a spatiotemporally heterogeneous environment

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A cholera epidemic model in a spatiotemporally heterogeneous environment☆

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Abstract

The transmission of cholera, a water- and food-borne intestinal infection, involves complex interactions among human hosts, pathogens, and the environment, and is impacted by the spatial variation and seasonal fluctuation. In this paper, we propose a new deterministic model to investigate the spatiotemporal dynamics of cholera transmission. The model employs a reaction-convection-diffusion system to represent the spatial movement of the hosts and pathogens, and incorporates time-periodic parameters to describe the seasonality of the disease transmission and bacterial growth rates. Using the theory of principle eigenvalues, we define and analyze the basic reproduction number of this model, based on which we establish the threshold type results for cholera transmission in a spatiotemporally heterogeneous environment.

Keywords: Cholera model, spatiotemporally, heterogeneous environments, threshold dynamics

1. Introduction

Cholera is a severe water- and food-borne infectious disease. The causing agent for human cholera is the bacterium *Vibrio cholerae*, which can be transmitted both from the contaminated aquatic environment (i.e., through indirect environment-to-human transmission route), and from person-to-person contacts such as shaking hands or eating food prepared by infected individuals (i.e., through direct human-to-human transmission route) [14, 21]. Thus, the dynamics of cholera involve multiple interactions among the human hosts, the pathogens, and the environment [22]. Although tremendous efforts have been made in the prevention, intervention and control of the disease, cholera remains a significant public health threat in underdeveloped countries and regions. The persistence of the disease has been highlighted by recent outbreaks in South Sudan (2014), Haiti (2010-2012), Zimbabwe (2008-2009), Angola (2006), South

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