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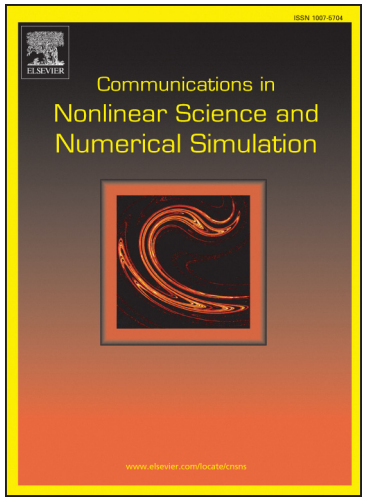

A mathematical model of dengue transmission with memory

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PII: S1007-5704(14)00392-X
DOI: http://dx.doi.org/10.1016/j.cnsns.2014.08.009
Reference: CNSNS 3308

To appear in: *Communications in Nonlinear Science and Numerical Simulation*

Please cite this article as: Sardar, T., Rana, S., Chattopadhyay, J., A mathematical model of dengue transmission with memory, *Communications in Nonlinear Science and Numerical Simulation* (2014), doi: http://dx.doi.org/10.1016/j.cnsns.2014.08.009

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ACCEPTED MANUSCRIPT

A mathematical model of dengue transmission with memory

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Abstract

We propose and analyze a new compartmental model of dengue transmission with memory between human-to-mosquito and mosquito-to-human. The memory is incorporated in the model by using a fractional differential operator. A threshold quantity R_0, similar to the basic reproduction number, is worked out. We determine the stability condition of the disease-free equilibrium (DFE) E_0 with respect to the order of the fractional derivative α and R_0. We determine α dependent threshold values for R_0, below which DFE (E_0) is always stable, above which DFE is always unstable, and at which the system exhibits a Hopf-type bifurcation. It is shown that even though R_0 is less than unity, the DFE may not be always stable, and the system exhibits a Hopf-type bifurcation. Thus, making $R_0 < 1$ for controlling the disease is no longer a sufficient condition. This result is synergistic with the concept of backward bifurcation in dengue ODE models. It is also shown that $R_0 > 1$ may not be a sufficient condition for the persistence of the disease. For a special case, when $\alpha = \frac{1}{2}$, we analytically verify our findings and determine the critical value of R_0 in terms of some important model parameters. Finally, we discuss about some dengue control strategies in light of the threshold quantity R_0.

Keywords: Dengue transmission, Mathematical model, Fractional order differential equations

1. Introduction

Dengue is a viral disease transmitted by the bite of an *Aedes* mosquito infected with one of the four dengue virus serotypes (DEN-1, DEN-2, DEN-3 and DEN-4) (World Health Organization, 2013a,b). Dengue can affect almost all age groups (infant to adult), and symptoms appear 3-14 days after the infected mosquito bite (World Health Organization, 2013b). A person recovers from one

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