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NONLINEAR DYNAMICS OF THE DENGUE MOSQUITO PROPAGATION WITH RESPECT TO CLIMATE FORCES: A DISCRETE TIME DENSITY DEPENDENT FUZZY MODEL

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Dengue is one of the major public health problems particularly in the tropical and sub -tropical regions in the world and each year millions of people are vulnerable to this disease. Dengue disease is endemic in Sri Lanka now, since it was first identified in 1960s. Each year, thousands of people in Sri Lanka get infected with dengue which disturbs the national economy and the well-being of the society. Various mathematical models have been developed to understand the dynamic of the transmission of dengue disease. However the fixed parameter values have been used in these models so the real dynamics of the transmission is not explained completely. The mosquito density is an important parameter in these mathematical models which depends heavily on climate factors such as rainfall and temperature. The aim of this research is to construct a mathematical model to study the nonlinear behavior of mosquito density. This model consists of two additive components, namely the biological component and the climate force. In the biological component, we assume that the number of adult mosquitoes at time *t* depends on the number of adult mosquitoes at time *t*-1 plus the number of growing juveniles at time *t*-1. The Gompertz model is used to model the number of growing juveniles which is again a function of number of adult mosquitoes in the previous time. Fuzzy logic and fuzzy set theory is used to model the component of climate forces to grow mosquitoes. The fuzzy membership functions are constructed for each factor rainfall and temperature where the membership value in [0, 1] explains the degree of unfavorability to mosquitoes from each factor in different levels. The Modified Einstein Sum operator is used to compute the overall measure of unfavorability from climate factors. We simulated this model using climate data from year 2006-2011 and the results show a periodic behavior of mosquito density with an increasing trend.

Keywords: Mosquito density, Fuzzy logic, Climate forces, Gompertz model, Mathematical models