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GLOBAL STABILITY OF A NETWORKED CONNECTIVITY MODEL OF DISEASE EPIDEMICS

Jorge Rebaza

Department of Mathematics
Missouri State University, Springfield, Missouri, U.S.A.
jrebaza@missouristate.edu

Abstract. The dynamics of a networked connectivity model of disease epidemics on a site of n communities is studied. Besides existence and local stability analysis for both the disease-free equilibrium and the endemic equilibrium, a detailed global stability analysis of both equilibria is provided. Lyapunov functions are constructed using either matrix-theoretic or graph-theoretic methods and combinatorial identities. .

Keywords. Networked connectivity models, dynamical systems, Lyapunov function, epidemics.

AMS (MOS) subject classification: 37B25, 92D30, 92D25.

1. Introduction

Several mathematical models have been studied with the goal of explaining the dynamics of epidemic diseases. Special attention has been given to establishing conditions on the stability properties of disease-free and endemic equilibrium points. Such conditions help explain when a disease outbreak occurs and whether the epidemics will eventually die out or persist. Studying the dynamics of epidemic diseases is helpful in understanding and preventing the initiation and spread of the disease, establishing and expanding emergency management of the disease, and creating new health-care resources.

Typically, disease models consider only one given community or location (e.g. [3, 10, 16]). Among other important results, it has been shown that for those models the so called *basic reproduction number* R_0, needs to be greater than one in order for an outbreak to take place. The model studied here, which is a variation of that originally proposed by Gatto et al. [6] to study waterborne diseases like cholera, considers a number n of communities connected by a human mobility network, and the dynamics of the bacteria is explicitly included in the system. The condition that one or more of the corresponding basic reproduction numbers R_{0i}, $i = 1, \dots, n$ cross the value one, is in this case not sufficient nor necessary for an outbreak in the metacommunity to occur. Some results on the local and global stability properties of an disease-free equilibrium of general networked connectivity