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Existence and nonexistence of periodic solution and Hopf bifurcation of a tourism-based social-ecological system

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Abstract

This paper is devoted to analyze dynamical behavior of a four-dimensional nonlinear tourism-based social-ecological system by using the Hopf bifurcation theory. Our purpose is using a criterion based on the Routh-Hurwitz criterion for existence of a region for Hopf bifurcation. Because existence of Hopf bifurcation and therefore bifurcated periodic solutions helps us to show an interesting type of coexistence between mass-tourists and eco-tourists through a periodic pattern, although they have different effects on environmental quality. Furthermore, numerical simulations are carried out to support our theoretical results and show sustainability of tourism. In fact by simulation we indicate a coexistence between mass-tourists and eco-tourists, the existence of chaotic behavior and sustainability of tourism industry.

Moreover another criterion, Bendixson's negative criterion, which is based on the connection between compound matrices and ordinary differential equations is applied to prove the nonexistence of periodic orbits and then nonexistence of Hopf bifurcation.

Keywords: periodic solutions, Hopf bifurcation, Routh-Hurwitz criterion, Sustainability, Bendixson's negative criterion.

2010 MSC: 34C25, 34C23

1. Introduction

Tourism is an activity which has a direct effect on the national income of all touristic countries. Indeed, it can create work opportunities and several investments that cause to promote social and economic developments and also raise nations cultures. As well as it can distribute nations history, civilization, and traditions. Therefore, tourism activities are considered to be one of the most important sources of economic growth and recently many countries rely on it as one of the fastest growing economic development. On the other hand, tourism industry can also have negative effects.

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