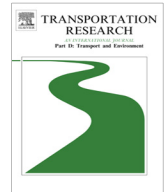




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Accessibility, vulnerability, and resilience in a stochastic model of sustainable ecotourism [☆]



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ABSTRACT

We show how the notions of *accessibility*, *vulnerability*, and *resilience* can be used to shed light on the sustainable management of a natural area that is used for ecotourism. To this end, we construct and analyze two queuing-theoretic models that approach the problem of sustainable management in different ways. In the first model, there is a capacity constraint on the number of ecotourists that are permitted to visit the natural area and the optimal *rate* at which an ecotourist agency manager provides service to the ecotourists is endogenously determined. In the second model, there is *no* capacity constraint but the manager endogenously ascertains the optimal *number* of ecotourists who are allowed into the natural area before he provides service to these ecotourists. The sustainability aspect of the management problem is addressed in two ways. First, the conceptualizations of accessibility, vulnerability, and resilience depend on certain *long run* metrics. Second, the objective functions in the two models that the manager optimizes are formulated using these long run metrics.

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Introduction

Definitions of accessibility, vulnerability, and resilience

Consider the notions of *accessibility*, *vulnerability*, and *resilience*. The first two of these three notions originated in the transportation literature but the third originated in the ecology literature. Even so, all three of these notions have now been widely used to study a whole host of different problems in the burgeoning transportation literature. Since these three notions also comprise a key part of the main question that we analyze in this paper, let us first understand the meanings of these three notions and the main ways in which they have been used in the extant transportation literature.

The most general and useful definition of the notion of accessibility was proposed by [Morris et al. \(1979, p. 91\)](#). According to these researchers, accessibility “denotes the ease with which activities may be reached from a given location using a

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particular transportation system.” Using a somewhat different perspective, Weibull (1980, p. 54) has noted that accessibility is concerned with the “properties of the configuration of opportunities for spatial interaction.” Researchers now recognize that accessibility is a function of both land use patterns and the performance of a given transport system. Therefore, this notion is well suited to evaluate the service that a particular transport system provides to different groups of users. Taking all this into consideration, Reggiani et al. (2011, p. 621) point out that “accessibility may be considered as a general concept which tries to encapsulate all the potential benefits that transport investments produce. . .”

According to Berdica (2002, p. 117, *emphasis added*), the relatively new notion of vulnerability is “a problem of reduced accessibility that occurs because of various reasons.” From this definition, it is clear that the notions of accessibility and vulnerability are related. Even so, not all researchers have drawn such a clear link between these two concepts. For instance, Taylor and Susilawati (2012, p. 761) contend that “network vulnerability deals with the socio-economic impacts and transport systems performance of degraded transport networks.” Transportation researchers now agree that however specifically one might define vulnerability, this concept has everything to do with disruptions to transport and the risk of such disruptions. Echoing this point, Cats and Jenelius (2014, p. 436) point out that the “research field concerned with the risk of severe transport network disruptions for the society is commonly called vulnerability analysis. . .”

The notion of resilience originated in the ecology literature and it was first proposed by Holling (1973). In this view, resilience “is the magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behaviour” (Holling et al., 1995, p. 50).¹ This “far from equilibrium” notion of resilience is to be distinguished from an alternate “near equilibrium” definition proposed by Pimm (1984). In this latter view, resilience “refers to stability near an equilibrium steady-state, where resistance to disturbance and speed of return to equilibrium is emphasised. . .” (Holling et al., 1995, p. 50).² Even though both these notions of resilience originated in the ecology literature, Cox et al. (2011) and Reggiani (2013) note that with some context related modifications, these two notions have found wide applicability in the transportation literature.³ What is particularly salient for our purpose is the observation by Reggiani (2013, p. 67) that the notions of vulnerability and resilience are the “converse” of each other. Put differently, this means that a system that is vulnerable to one or more shocks is not very resilient and, conversely, a resilient system is not very vulnerable to these same types of shocks.

With these definitions of accessibility, vulnerability, and resilience out of the way, we are now in a position to state the main topic of this paper. This topic is the study of the connections between the above three concepts and the sustainable management of a natural area that is used for the purpose of ecotourism.

Sustainable ecotourism

As more and more people have become concerned about the environment and, at the same time, have looked for distinctive vacation experiences, ecotourism has become one of the fastest growing segments within the travel and tourism industry. As such, it is no surprise that the United Nations declared 2002 to be the “International Year of Ecotourism.”

Lockwood (2003) has noted that an ecotourist is a person with a strong environmental conscience and a philosophy of environmental protection. He goes on to point out that an ecotourist destination is a site or location with three noteworthy features. First, this location frequently includes an on-site hotel or resort along with an unspoiled or reclaimed environment of native flora and fauna. Second, this site often educates tourists about the local environment and it minimizes the impact that tourists have on the local environment with measures such as the placement of a limit on the number of visitors allowed into the site during a particular time period. Finally, the ecotourist site is usually protected by a local or a national government.

There now exists a fairly substantial literature on ecotourism in general and on sustainable ecotourism in particular. For instance, Lee and Mjelde (2007) have used the contingent valuation technique to value ecosystem resources in the context of the demilitarized zone in Korea. Similarly, Baral et al. (2008) have also used the contingent valuation technique to determine the willingness to pay for entry into the Annapurna conservation area in Nepal by foreign ecotourists. Focusing on two categories of fisheries co-management in Brazil, Lopes et al. (2011) contend that ecotourism in coastal fishery reserves can be a useful management tool because this kind of tourism can help reduce local fishing pressure.

Can ecotourism be used to promote green development strategies? Shen and Redclift (2012) answer this question affirmatively by studying the Hong Kong wetland park. These researchers claim that what they call “ecological modernization” along with effective management and planning strategies can be used generally to contribute to the greening of industry in China as a whole. Liu et al. (2013) study ways in which ecotourism might be promoted in Taiwan. Their analysis of the behavior of ecotourists shows that ecotourism can be promoted by means of experiential marketing and superior service quality. Finally, Franco and Quintela (2013) use a case study approach and make the point that public–private partnerships can be a very useful way to promote ecotourism in Portugal.

The studies discussed in the preceding two paragraphs have certainly advanced our understanding of alternate ways in which we can make ecotourism a sustainable undertaking. Even so, three points are now worth emphasizing. First, the extant literature on sustainable ecotourism is based largely on case studies or on empirical analysis. Second, there are

¹ This Holling inspired notion of resilience is also known as ecological resilience and as resilience of the second kind.

² This Pimm motivated notion of resilience is also known as engineering resilience and as resilience of the first kind.

³ Batabyal (1998) and others have noted that the Holling notion of resilience is applicable to socioeconomic systems in general.

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