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Risk assessment of precipitation and the tourism climate index

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HIGHLIGHTS

- A mathematical approach is proposed for risk assessment of the TCI.
- The TCI coupled with the IDM to calculate probability of precipitation.
- Spatial analysis of the TCI risk provided end result that is easy to understand.

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ABSTRACT

This study proposes a mathematical approach to a risk analysis of potential changes in the tourism climate nexus. The Information Diffusion Model (IDM) and Geographical Information Systems (GIS) were applied to the spatial risk analysis of excessive rainfall based on the Tourism Climate Index (TCI) for North Cyprus. The probability of excessive rainfall was calculated using the IDM. The data were then inserted into the TCI formula to estimate the risk analysis of tourism climate for each station on the island. The spatial pattern of climate-related risks to tourism prepared using geo-statistical techniques with GIS software, revealed that the northern borders of the island are exposed to a high levels of precipitation, with resulting adverse effects on tourism. Risk assessments of the tourism climate, spatial–temporal analyses using the TCI, and climate insurance are suggested as adaptive strategies to address seasonality issues.

1. Introduction

The main socioeconomic impacts of tourism worldwide are job creation (101 million employed), financial enlargement (turnover of US$1075 billion in international tourism receipts), and reciprocity among countries through interactions (1035 million international arrivals) (UNWTO, 2013). According to UNWTO's (2013) statistics, by 2030, there will be 1.8 billion international travelers annually.

Martin and Belén (2005) defined a “tourism climate” as the convergence of two branches of geography, namely the geographies of tourism and climatology, to demonstrate how tourist activities are shaped by climate. According to this definition, tourists have a propensity to visit/settle in places that provide the highest level of comfort and well-being with regard to the climate and weather. Climate has been frequently reported to be one of the most valuable natural resources in tourism development (Saarinen, 2014), as it affects a tourist's selection of a destination (Mieczkowski, 1985; Ridderstaat, Oduber, Croes, Nijkamp, & Martens, 2014). In addition to playing a role in the suitability of a destination, the climate has a significant influence on the natural resources of a region. Such resources can be considered unique tourist assets (Amengual, Homar, Romero, Ramis, & Alonso, 2014). From the perspective of the supply side (i.e., planners, decision makers, stakeholders, etc.), variations in climate across time and space need to be matched with patterns of tourist activity and tourism planning projects. Climatic conditions affect several factors, such as the temporal patterns of the arrival/departure of visitors, tourists' experiences, the degree of tourist satisfaction, loyalty, word-of-mouth recommendations, types of tourists' activities, locations of facilities, the use and efficiency of infrastructure, and the return on an investment (Becker, 2000; De Freitas, 2003; Hernández-Lobato, Solis-Radilla, Moliner-Tena, & Sánchez-García, 2006). It is important to note that climate is a unique, free, non-transportable, and nonstorable resource that varies in space and time (Martin & Belén, 2005). Climate can have a positive or

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negative influence on most tourists' enjoyment, presenting a challenge for tourism planners in the future in an era of climatic uncertainty (Hartman & Spit, 2014).

Risk assessments of the tourism climate not only evaluate potential advantages of the climate but also provides practical approaches to mitigate possible excesses of destructive weather patterns (e.g., rainfall) (UNEP, 2008). The use of such assessments to identify favorable/unfavorable tourism climates can provide useful information, which can be used to ensure that the expectations of tourists are met. The resulting data will also be of use in destination marketing (De Freitas, 2014; Martin & Belén, 2005). In this context, Rutty, Scott, Steiger, and Johnson (2014) indicated that weather risk management has become increasingly important over time, especially in sport tourism (e.g., the Olympic Winter Games), which has commercial and financial ramifications. According to Becken, Zammit, and Hendrikx (2014), mapping the tourism climate and changes raises the awareness of tourists and helps stakeholders plan properly for tourism development and management, as well as providing a realistic image of a destination's weather for tourists (Assaker, 2014; Denstadli, Jacobsen, & Lohmann, 2011; Matzarakis, 2006). In addition to having a positive impact on the selection of a tourist destination, a favorable climate can boost tourist loyalty (i.e., increase the number of revisits) (Martin & Belén, 2005). Empirical evidence from Scandinavia revealed that disinformation about the weather influenced the relationship between a tourist's perception and intention to return (Denstadli et al., 2011). Mitigating probable gaps between tourists' expectations and experiences is extremely important. This issue, in common with several complex perspectives of the tourism and climate nexus, remains an under-researched topic (De Freitas, Matzarakis, & Scott, 2007; Lohmann & Kaim, 1999; Scott & Lemieux, 2010). The present study integrated a mathematical model with a tourism-climate index to estimate the risk of precipitation as an adverse climatic factor affecting tourism activities.

1.1. Theoretical background

This study employed the IDM and Tourism Climate Index (TCI) in a in a risk analysis of an adverse climate (i.e., increased rainfall) on the comfort and well-being of tourists in North Cyprus. These models were deployed to justify the process theoretically and zoom in on the risk assessment of the weather and tourism nexus, which is further elaborated in the following sections.

1.1.1. Information diffusion model (IDM)

The IDM is one of several methods used for risk analysis of phenomena proposed by Huang (1997). It employs fuzzy set methodology to improve the probability estimation in disaster risk assessments. Feng, Mao, and Zhao (2010) previously descried information diffusion theory in detail.

> "The information diffusion theory will then help to extract as much as possible underlying useful data and thus improves the accuracy of system recognition. Therefore, the technology can also be called the fuzzy information optimized processing technology. Information diffusion is a process of fuzzy mathematics that deals with the samples using the set numerical method. A single-valued sample can be transformed into a set numerical-valued sample through this technology" (Feng et al., 2010, p 214).

This theory has been utilized in various disciplines, such as natural, social, and medical sciences (Feng & Luo, 2008; Liu, Siu, Mitchell, & Xu, 2013; Shang, Lu, Jin, & Zhang, 2004). In a study on the projected loss of life caused by natural hazards in China, Liu et al. (2013) employed the IDM to estimate the risk of multiple hazards to human life and the probability distribution of such risks. Another study used the IDM to investigate the linkage between prevalence rates of coronary heart disease and relevant risk factors (Shang et al., 2004). Researchers also reported that the IDM was a practical tool for risk assessments of environmental issues, such as pollution caused by the chemical industry (Meng et al., 2014) and the grassland biological disaster (Hao, Yang, & Gao, 2014). Furthermore, researchers have frequently applied this approach to risk analysis of natural hazards and disasters, such as floods (Feng & Luo, 2008; Mouri et al., 2013), meteorological droughts (Zhang, Hou, & Wang, 2008), agricultural droughts (Kocheva, Georgiev, & Kochev, 2014), earthquakes (Chen & Hawkins, 2009), grassland fires (Liu, Zhang, Cai, & Tong, 2010), and water crises (Feng & Huang, 2008; Feng, Zhang, & Luo, 2009), in addition to agricultural insurance (Lou & Sun, 2013).

1.1.2. Tourism climate index (TCI)

Two main approaches to estimating the favorability of climate for tourism activities are expert-based index in relation to the TCI proposed by Mieczkowski (1985) and user-based indices in relation to Climate Index for Tourism developed by De Freitas, Scott, and McBoyle (2008). Furthermore, Beach-users Climate Index proposed by Morgan et al. (2000), functions based on tourist's response. In the context of the TCI, Mieczkowski (1985) weighted five meteorological parameters, namely, temperature, relative humidity, precipitation, wind speed, and hours of sunshine, to categorize climate in the TCI as ranging from unfavorable (−20) to excellent (100). The TCI has several drawbacks, such as ignoring nonthermal aspects of weather and climate (Moreno & Amelung, 2009), over-riding the effect of precipitation and wind (De Freitas et al., 2008), and a lack of empirical validation due to the expert-based approach (Perch-Nielsen, 2010). Nevertheless, many researchers have used it to estimate the favorability of climate and climate changes on tourism activities (Amelung & Nicholls, 2014; Deniz, 2011; Mailly, Abi-Zeid, & Pepin, 2013; Rosselló-Nadal, 2014; Scott, McBoyle, & Schwartzentruber, 2004).

Although some researchers have used only meteorological parameters, there is a multifarious association between weather and tourism, as exemplified below:

> "… The impacts of the weather on tourism were complex. Rain, for example, was directly detrimental to tourism as some activities or events are unable to proceed in the case of rain. Rain also resulted in issues of access (e.g., because of flooded rivers), higher operational costs (e.g., leakage in buildings), structural damage to infrastructure (e.g., bridges and tracks), and increased snowmelt. At the same time, rain increased the business of indoor attractions and resulted in a shift of guests from campgrounds to other accommodation" (Becken et al., 2014, p 4).

In a way, meteorological factors can function as a double-edged sword, with one edge promoting tourism activities and the other hindering them. In the study by Becken et al. (2014), some tour operators attributed the disappearance of river-based activities to a lack of precipitation. In contrast, the empirical results of Førland et al.'s (2013) study indicated that tourists do not like frequent rain or the resulting low visibility during recreation and leisure activities.

Increased rainfall is regarded as one of the negative consequences of global warming (Heltberg, Siegel, & Jorgensen, 2009). Regardless of the impact of climate change, most studies found that precipitation was considered a destructive factor in the tourism and climate nexus (Day, Chin, Sydnor, & Cherkauer, 2013; De Freitas,