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The influence of climate change on tourism demand in Taiwan national parks

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ABSTRACT

This study investigated the impact of climate change on tourism demand in the national parks of Taiwan. The results show that the climate has a significant influence on the number of tourists, with rainfall having a more significant influence than temperature. Therefore, managers of the national parks should monitor rainfall variation caused by climate change. The economy overall also has a clear influence over the number of visitors to national parks, but attendance at different national parks responds very differently to the overall economic environment. To accurately predict the number of visitors and assess their impact on park facilities and ecological environments, the influence of climate change on the number of visitors and the influence of the overall economy on park tourism activities must be understood. Changes in management in response to economic changes will increase the flexibility of the national park system in responding to climate change.

1. Introduction

National parks are established to preserve a unique natural environment, cultural heritage, and biodiversity and to provide recreation areas for citizens using explicit management and conservation measures. In short, the main functions of national parks are to protect the natural environment, to save endangered species from extinction and preserve their genes, to provide space for recreation and bring prosperity to the local economy, and to promote academic research and environmental education. National parks perform most of these functions effectively. In particular, the effects of national parks on conservation and environmental education have repeatedly been acknowledged (Bagarinao, 1998; Bruner, Gullison, Rice, & da Fonseca, 2001; Rodrigues et al., 2004; Yahnke, de Fox, & Colman, 1998). However, these important assets are gradually being eroded by climate change.

Significant changes in temperature and rainfall caused by climate change have seriously affected various functions of the national parks. Temperature increases have caused melting of glaciers (Brugman, Raistrick, & Pietroniro, 1997; Hall & Fagre, 2003), vegetation changes, reduction of natural habitat areas, and even extinction of species (Cumming & Burton, 1996; Hall & Fagre, 2003; Halpin, 1994; Scott, Malcolm, & Lemieux, 2002). For example, Glacier National Park has already lost 115 glaciers, and the remaining 35 glaciers are expected to melt within the next 30 years (Hall & Fagre, 2003). Kilimanjaro National Park only has 40% of its glacier landscape remaining. In addition, the U.S. Rocky Mountains trout habitat may decrease in size by 62% (Keleher & Rahel, 1996). Bartlein, Whitlock, and Shafer (1997) have also predicted that Yellowstone National Park will lose a portion of its tree species.

Extreme rainfall variations or changes in rainfall patterns will increase the frequencies of floods, droughts, and forest fires. Chamaillé-Jammes, Fritz, and Murindagomo (2007) used component regression to show the relationship between climate change and both floods and droughts in the Zimbabwe Hwange National Park. The forest fires in Yellowstone National Park in 1988 have also been confirmed to be related to the severe drought that was experienced that year (Beniston et al., 2003). A severe drought in 2002 resulted in numerous forest fires in Colorado, USA, and caused large-scale damage to the forest (Scott, 2003).

In addition to threatening the ecosystem and landscape, climate change is a serious threat to cultural assets. Venice has suffered flooding for many years, and a flood in 2010 seriously damaged the important Inca site of Machu Picchu. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) has noted that the Chan Chan ruins and Timbuktu, two World Heritage sites, have suffered the impact of floods and desertification, respectively (Colette, 2007).

Famous features of many national parks that used to attract tourists have suffered from climate change, with the number of tourists changing correspondingly. Australia's Great Barrier Reef suffered severe bleaching due to abnormal temperatures in 1998, 2002, and 2006; according to a survey, 35% of tourists would not visit the Great Barrier Reef while it was affected by severe coral bleaching (Prideaux, 2006). The 2002 drought in Colorado, USA, decreased the number of tourists in the state by 40% (Scott, 2003). Studies of Waterton Glacier International Peace Park and Banff National Park reported that 19% and 31%

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of visitors, respectively, would not want to visit these parks if climate change affected the scenery, and furthermore, 36% to 38% of visitors would reduce their number of visits to the two national parks.

Climate change does not just have a negative impact on national park tourism. As a result of temperature increases, some areas may experience more comfortable weather, more diverse environments, and a longer tourist season, which will increase the number of visitors. For example, approximately 10% of visitors to Waterton Glacier International Peace Park and Banff National Park agreed that they would visit more frequently if the weather conditions were more comfortable. A study of Rocky Mountain National Park found an approximately 10–14% increase in the number of visitors during warmer weather (Scott, Jones, & Konopek, 2007). National parks in Alaska have also received increased tourism due to climate change.

A reduction of the number of visitors to a national park is detrimental to its goal of environmental education; an increase in the number of visitors, on the other hand, will exert pressures on managers of the parks. For example, a substantial increase in the number of visitors will increase the ecological pressure on the tourist areas and the need for public facilities to meet the needs of tourists. Therefore, more sophisticated tourism management strategies and more public environmental education information are needed to sustain tourism in the national parks (UNWTO-UNEP-WMO, 2008).

Climate change has significantly influenced the management of the national parks; moreover, there is a high degree of uncertainty regarding its impact on tourism activities. To effectively increase national parks' ability to respond to climate change, the second Climate Change and Tourism Global Conference, hosted by the United Nations Environment Programme Department and the World Tourism Organization, made the following proposals: improve communication between experts and management authorities; increase the availability of hardware to improve management effectiveness of protected areas; develop risk assessment and prevention strategies; implement contingency plans for early stage warning systems; develop water supply planning for drought-sensitive areas; improve water-saving technologies and efficiency of water use through rainwater storage, use of water-saving equipment, or waste water recycling; manage drainage and soil and water conservation to reduce the risk of flooding and erosion; reduce or eliminate external pressures, such as agricultural runoff; ensure that the residents of communities in the protected areas actively participate in the policy-making and management process; and consider local traditional and cultural knowledge when determining development strategy (UNWTO-UNEP-WMO, 2008).

Other important management and adaptation measures include the following: integrating climate change factors into the context of tourism development and management, for example, by assessing the impact of climate change on tourism infrastructure; applying carrying capacity assessment technology that considers economic, environmental, sociocultural, and managerial factors in planning tourism for protected regions; improving parks' management of visitors and carrying capacity to prevent the excessive use of land and monitor tourism's actual impact; redesigning or restoring protected areas; promoting tourism products, including seasonal tourism product diversification to reduce the dependence of the travel behavior on climate and the gap between low and peak seasons caused by seasonal activities; creating new tourism sites in or near visitors' favorite national parks and natural heritage attraction sites; and promoting eco-tourism to increase environmental awareness (UNWTO-UNEP-WMO, 2008).

In addition to these management measures, national park management institutions should perform detailed analyses on the influence of climate change on visitor turnout. This analysis will allow managers of national parks to adjust the types of tourism and recreation, marketing promotions, and education methods offered and to identify suitable sites for recreation activities (Jones & Scott, 2006; UNWTO-UNEP-WMO, 2008). Although climate change is a very important contributor to visitor turnout estimates and an important consideration in national park management, the research literature on this topic remains very limited. Thus far, the published studies all focus on exploring the status of temperate regions (Jones & Scott, 2006). Very few studies have focused on tropical regions, subtropical regions, islands, or other geographic areas.

To compensate for the inadequacies of existing research and to understand the impact of climate change on subtropical island national park tourism and recreation activities, this study investigated tourism in Taiwan's national parks. This study analyzed the impact of climatic factors on tourism turnout at five national parks, Kenting, Yangmingshan, Yushan, Taroko, and Shei-Pa, to understand the possible impact of climate change on these parks. The results can be compared with results of other studies to understand differences regarding the impact of climate change between temperate and tropical regions, between continental and island regions, and between other different eco-geographical regions. The results can also be used as a reference for Taiwan's national park management institutions for adjusting management strategies in response to climate change.

2. Research method

This study aimed to assess the impact of climate variables on the number of visitors to the national parks of Taiwan to determine the impact of climate change on the tourist demand potential of national parks. Assessment of tourism demand, first and foremost, requires an established tourism demand function. Past relevant studies have often used a single function to assess the impacts of certain variables on tourism demand (Croes & Vanegas, 2005; Divisekera, 2003; Garín Muñoz, 2007; Song, Li, Witt, & Fei, 2010; Song, Witt, & Jensen, 2003). This function can be expressed as:

$$Q = f(x_1, x_2, \ldots, x_n),$$

where Q is the tourism demand, expressed as a function of explanatory variables from x_1 to x_n. Frequently used explanatory variables include income and price index. Although weather conditions also affect tourism and recreational activities, very few studies attempt to quantify the impact of climate on tourism demand (Jones & Scott, 2006; Lise & Tol, 2002).

To understand the impact of climate on tourism demand, climate factors need to be added to the function above. Lise and Tol (2002) and Jones and Scott (2006) directly added measurements of rainfall and temperature, respectively, to the tourism demand function and demonstrated the significant influences of these two factors on tourism activities. The climate change research project of the European Union (EU) Weather Impacts on Natural, Social and Economic Systems (WISE) project used the same method (Bigano, Goria, Hamilton, & Tol, 2005). The conclusion from the WISE project also indicates that the climate factors are important explanatory variables for tourism demand. Therefore, adding climate variables not only increases the effectiveness of analysis of tourism demand measurements to prevent biased estimation results but also quantifies the impact of climate on tourism activities to test the possible impact of climate change on the tourism industry, allowing the tourism industry to draft corresponding strategies.

Under the aforementioned settings of the tourism demand function and with reference to the methods in Lise and Tol (2002) and Jones and Scott (2006), and the WISE project (Bigano et al., 2005), this study modifies the tourism demand function into the following formula:

$$Q_t^i = f\left(Q_{t-1}^i, Y_t^i, P_t^i, T_t^i, R_t^i\right),$$

where Q^i is the number of visitors to the ith national park. This study includes the Kenting, Yangmingshan, Yushan, Taroko, and Shei-Pa