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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

National Parks[1]; t represents time; monthly data from January 2001 to December 2008 were used, for a total of 96 months; Q^i_{t-1} is the prior-year number of tourists, representing Taiwan residents' sightseeing habits across the five national parks (Croes & Vanegas, 2005; Garín Muñoz, 2007; Morley, 1998); Y is income, representing the population's purchasing power for tourism activities, expressed in real per-capita gross national income (Croes & Vanegas, 2005; Lise & Tol, 2002); P is the population in Taiwan, considering the national park tourism market potential scale (Lise & Tol, 2002); T^i is the temperature of the ith national park in degrees Celsius; and R^i is the rainfall of the ith national park in millimeters. These final two indicators are used to represent the impact of the climate (Bigano et al., 2005; Jones & Scott, 2006; Lise & Tol, 2002).

This study assumes that the national parks' tourism demand functions are independent of each other, yielding a total of five independently estimated demand functions. All data were drawn from the statistical database of the managing institution. The number of visitors to each national park was obtained from the Construction and Planning Statistical Annual Report of the Construction and Planning Agency, Ministry of the Interior; real per-capita national income and national population data were obtained from the statistics database of the Directorate-General of Budget, Accounting and Statistics (DGBAS); and temperature and rainfall data were obtained from the Central Weather Bureau climate statistics database. All data are monthly data from January 2001 to December 2008, for a total of 96 observation months. There are 96 observation values for each national park. The number of visitors, per-capita real income, and the country's population were log-transformed for analysis.

3. Results

The analysis showed that the climate variables significantly influence the number of national park visitors (see Table 1). The impact of rainfall is the most consistent and significant among those of the other variables; the temperature influence is also significant, but has an inconsistent direction. The economic and social variables also have significant influences, in line with theoretical expectations.

Rainfall has a negative impact on the number of tourists visiting all national parks. Except for Kenting National Park, for which the result is less significant, the influence of rainfall on national park attendance is significant at the 1% level. This phenomenon indicates that changes in rainfall are an important impact factor determining the number of tourists who visit Taiwan's national parks. Rainfall and the number of visitors are inversely related, which indicates that climate change may increase the difficulty of national park management. Increased rainfall may increase the washing out of roads and destruction of public facilities and ecological landscapes, thereby reducing tourists' incentive to visit and reducing visitor turnout. For instance, in 2004, Shei-Pa National Park experienced heavy rainfall, resulting in washed out roads in the fog-viewing recreation area; entire streams became buried in the Wuling Farm and Hoya Resort in the Wuling recreation area, which threatened the survival and procreation of endangered species such as the Formosan landlocked salmon and at the same time changed the population of the Xixi bird in Chichiawan. Reduced rainfall can also cause problems. Reduced rainfall often results in droughts in mountainous areas and increases the risk of forest fires. An increase in the number of tourists related to reduced rainfall will further increase the water usage pressure in national parks. If the water supply is inadequate, recreation quality will be lowered, and public health problems will arise.

Rainfall changes strongly affect three of the national parks: Taroko, Yushan, and Shei-pa. For each additional 100 cm of rainfall, these three national parks' visitor numbers were reduced by 5%, 4%, and 5%, respectively; rainfall had relatively less impact on Yangmingshan and Kenting National Parks. Taroko, Yushan, and Shei-Pa are located in the mountains, and their access roads are often impassable due to heavy rainfall; traffic to Yangmingshan and Kenting is less susceptible to the influences of weather. When comparing Yangmingshan and Kenting, the impact of rainfall on tourism in Yangmingshan becomes more evident. Because Yangmingshan National Park is located in the Taipei metropolitan area, which is home to over 1/3 of Taiwan's total population, residents of the metropolitan area can observe the real time local weather conditions and adjust their travel plans accordingly. On the contrary, Kenting National Park is located in southern Taiwan, and most tourists cannot observe the real-time local weather conditions, making their travel plans less flexible. Therefore, the impact of rainfall on the number of visitors in Kenting National Park is not significant.

The impact of temperature on the number of visitors is more varied than the impact of rainfall. Temperature had a negative impact on tourism at Yushan, Shei-Pa, and Yangmingshan National Parks and a positive impact on tourism at Taroko and Kenting National Parks. This influence was significant for Yushan, Yangmingshan, and Kenting National Parks and insignificant for Taroko and Shei-Pa National Parks. Temperature had the most significant positive change in Kenting National Park, where for every increase in temperature of 1 °C, the number of visitors increases by 6%. Because Kenting National Park is located on a plain, its temperature is more consistent with that of the metropolitan area of Taipei; in addition, Kenting National Park includes many seaside recreation areas, so many visitors come to swim when the temperature is high. An increase in temperature had a significant negative impact on the number of visitors in Yushan and Yangmingshan National Parks. The monthly data on visitor turnout in these two national parks provide more insight. The number of visitors to Yangmingshan National Park increases substantially every March and is relatively stable in other months (see Fig. 1). The month of March is characterized by low temperature, so the increase in visitor turnout during that month indicates an inverse relation between temperature and tourism in Yangmingshan National Park. Yushan National Park, in addition to showing a substantial increase in winter visitors, also demonstrates a significant reduction in the number of visitors in summer, therefore showing a more pronounced negative effect of temperature on tourism. For each additional degree Celsius in temperature, the number of visitors in Yushan National Park will be reduced by 4%.

Population and income impacts on tourism in national parks are mostly in line with expectations, except for the effect of population on the number of visitors in Shei-Pa and Kenting National Parks and the effect of income on the number of visitors in Yangmingshan National Park. If other conditions remain unchanged, the number of tourists should increase as the total population increases. The respective influences of population growth on tourism in Yangmingshan, Taroko, and Yushan National Parks are all positive, with each additional 1% increase in the total population corresponding to increases of 18.49%, 12.13%, and 3.99%, respectively, in visitor turnout. Because Yangmingshan National Park is located in Taiwan's largest metropolitan area and is easy to access, tourism trips increase most significantly there when the population increases. Taroko National Park, despite being located in eastern Taiwan, is conveniently accessible by rail, road, and air transport and is therefore sensitive to population growth. Tourism in Yushan National Park relies only on road transport, which is less convenient; thus, this park's tourism is less influenced by nationwide population increases in Taiwan.

The impacts of demographic variables on Shei-Pa and Kenting National Parks run contrary to expectations. Shei-Pa's problem can be analyzed based on the monthly number of visitors (see Fig. 2). Before 2004, the number of tourists in Shei-Pa National Park exhibited an upward trend, but it dropped significantly in August 2004. Although the number of tourists recovered slowly thereafter, the number of tourists reached 2001 levels again only in 2008. This phenomenon shows the

[1] These five parks were selected because of data availability. Nowadays, there are nine national parks in Taiwan. The selected parks were established before 2000. Among the other four national parks, one was based majorly on it being the site of historic battles and three were established after 2007. Parks appropriate for the topic are all selected.

Table 1
Estimated results.

Variable	Taroko	Yushan	Shei-Pa	Yangmingshan	Kenting
Intercept	−197.84***	−62.95	140.99***	−270.49***	436.87***
	(8.10)	(76.66)	(13.97)	(12.19)	(3.57)
Temperature	0.01	−0.04**	−0.001	−0.02*	0.06***
	(0.01)	(0.02)	(0.004)	(0.01)	(0.01)
Rainfall	−0.0005***	−0.0004***	−0.0005***	−0.0003**	−0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
LN(population)	12.13***	3.99	−11.02***	18.49***	−27.22***
	(0.49)	(4.78)	(0.83)	(0.72)	(0.21)
LN(GDP percapita)	0.53	0.72	4.62***	−2.47***	2.95***
	(0.49)	(0.98)	(0.62)	(0.78)	(0.35)
LN(tourist arrivals in t-1 period)	0.40***	0.50***	0.33***	0.24**	0.22**
	(0.10)	(0.09)	(0.11)	(0.11)	(0.11)
AIC	13.11	101.11	69.00	131.65	44.75
R squared	0.62	0.50	0.51	0.24	0.35

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

negative impact of population growth on tourism. However, based on a review of information from August 2004, Shei-Pa's fog-viewing areas and external roads had been severely damaged in August 1993 due to heavy rainfall. During the reconstruction period, to ensure the safety of tourists, the park was closed from February 1, 2005, to December 31, 2005, and entry was forbidden. The Dalu forest road to Dabajian closed to automobile traffic at this time and became accessible only on foot. Heavy rains in 2004 seriously damaged the Wuling Recreation Area access roads. Traffic infrastructure damage caused a decline in the number of visitors, substantially offsetting the increase in the number of visitors during the same period as the population increased. For Kenting National Park, the number of visitors in the park during the studied period exhibits a declining trend (see Fig. 3). The clear inverse relationship between the population and the number of tourists is not unexpected, but our data are insufficient to explore the causes of the trend.

The impact of income on the national parks is mostly in line with expectations, with the exception of Yangmingshan National Park. With an increase in income, Taroko, Yusan, Shei-Pa, and Kenting National Parks all showed positive elasticity of income, demonstrating that tourism activity in these national parks is a normal good. Among these four parks, Taroko and Yushan National Parks had income elasticities under 1, demonstrating that sightseeing there is considered a necessity for Taiwan's residents. Shei-Pa and Kenting National Parks had income elasticities greater than 1, indicating that tourism in these parks is seen as a luxury activity for the people of Taiwan. The ways in which national parks should plan tourism and conservation strategies to enhance social welfare based on these differences is a worthy topic for future in-depth exploration. For Yangmingshan National Park, the income elasticity of −2.47 shows that tourism increases as income decreases and vice versa. This phenomenon has social implications. For most residents of the Taipei metropolitan area, the cost of traveling to other national parks is higher than the cost of traveling to Yangmingshan National Park; therefore, only increased income would increase their likelihood of visiting other parks. If their income decreases, they are unable to afford long-distance travel and are left with no choice but to visit Yangmingshan if they wish to visit a national park. Therefore, Yangmingshan National Park shows characteristics of an inferior good.

4. Conclusion

This study found a significant effect of climate on national park visitor turnout, with rainfall having a more obvious influence than temperature. The results also showed that the national parks show characteristics of different types of goods. The overall economic environment significantly affects national park turnout, but the national parks react very differently to the overall economic environment.

The two phenomena have increased the complexity of national park management under climate change, but this situation also provides an opportunity to innovate national park management methods and to improve conservation and social benefits.

The momentum of climate change mainly comes from global warming. Due to the term "warming", studies on the impact of climate change on national parks have largely focused on problems caused by

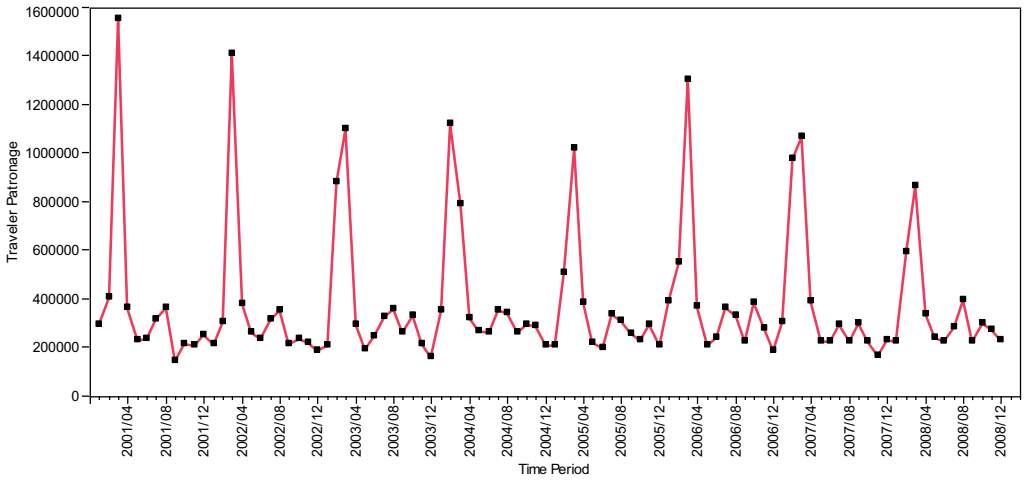

Fig. 1. Monthly tourist arrivals in Yangmingshan National Park.

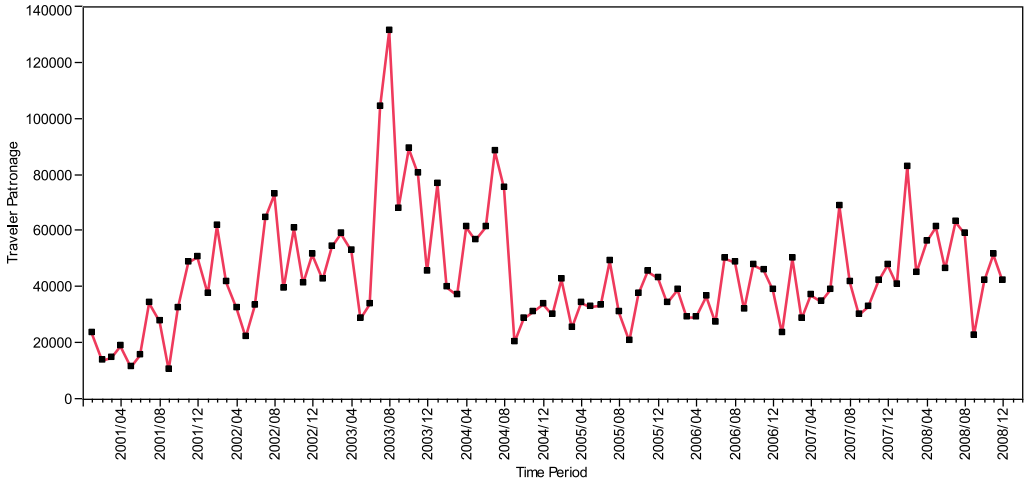

Fig. 2. Monthly tourist arrivals in Shei-Pa National Park.

temperature increases. The temperature increase has indeed altered the ecology and tourism trends of national parks around the world, such as through the melting of polar glaciers and the bleaching of tropical coral reef, and tourism may increase or decrease depending on the region. The study also found that the influence of temperature on national park tourism is not consistent. A negative impact was found for Yushan, Shei-Pa, and Yangmingshan National Parks, whereas a positive impact was found for Taroko and Kenting National Parks. Temperature is one of the explanatory factors in tourism activities, so if the impact of temperature is not understood, it will be difficult to predict the number of tourists correctly in the future. Therefore, the managers of each national park cannot rely on a single mode of analysis when determining their strategies but should discuss the impact of temperature specific to that park to draw up and implement appropriate strategies corresponding to climate change.

Compared to the effects of temperature, the impact of rainfall on the tourist turnout of the national parks of Taiwan is more consistent and significant. This result demonstrates that variations in rainfall caused by climate change are a concern for national park management. Increased rainfall damages important tourist facilities and seriously disrupts ecosystems. The repair process of tourist facilities further increases the pressure on the ecological environment. Reduced rainfall is not beneficial in the national park environment either. Shei-Pa National Park's environmental changes in recent years provide an important reference case. Heavy rainfall damaged public facilities at Shei-Pa National Park and caused the ecological environment to deteriorate; on the other hand, low rainfall caused water shortages, and the ecological environmental pressure increased. The drought caused the Momoyama North River to dry up over more than half of its length; tourists attracted by low rainfall worsened the water shortage problem in the Wuling recreation area. To improve water supply issues, it is important to reinforce the protection zone already designated for the Formosan landlocked salmon.

Because the impact of rainfall is the most consistent and significant and because either an increase or a decrease in rainfall affects the national parks, the climate change adaptation measures taken by Taiwan's national parks should focus on changes in rainfall rather than on changes in temperature, as recommended in other studies. Climate change adaptation and water usage are directly related. Water supply plans should be developed for drought-sensitive regions and should include improved water-saving technology and efficient water resource usage, such as saving rainwater or recycling waste water. Meanwhile, drainage and soil and water conservation should be managed to reduce flood and erosion risk. External pressure, such as agricultural runoff, should be reduced or eliminated (UNWTO-UNEP-WMO, 2008). Indirect measures may include the redesigning or restoration of the protected areas. In addition, promotion of tourism products and seasonal tourism may reduce the dependence of travel behavior on climate and reduce the gap between the low and peak seasons caused by seasonal activities. Creating new tourism sites near or in visitors' favorite national parks and natural

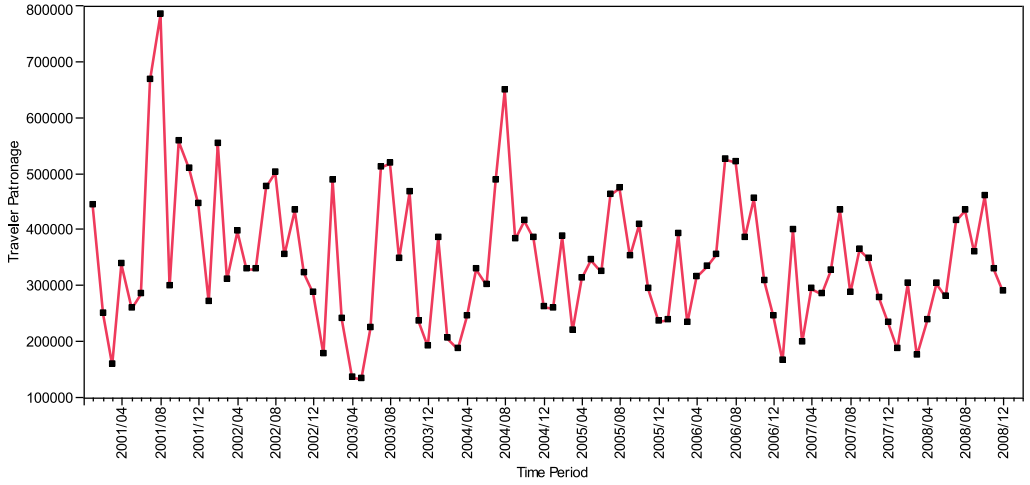

Fig. 3. Monthly tourist arrivals in Kenting National Park.

heritage sites should be helpful as well. Eco-tourism should be promoted to increase environmental awareness and ensure that local residents actively participate in policy-making and management. Local and traditional and cultural knowledge should be considered when determining the development strategy (UNWTO-UNEP-WMO, 2008).

In addition to the facilities, the most important recommendation of these coping strategies is to upgrade the management of national parks from partial to overall management. National parks are managed differently based on ecological characteristics. General landscape areas and recreation areas are the main tourist areas, and historic preservation areas, special landscape areas, and protected ecological areas limit the entry of tourists. Ecosystems in different partitions influence one another; environment changes outside of a park also affect the ecological integrity of the areas inside the park. To reduce effectively the pressure on the environment caused by climate change, it is necessary to redesign or restore the protected areas.

For example, in Shei-Pa National Park, climate variables affect both ecology and tourism. To reduce necessary maintenance of the Dalu Forest Road and reduce the environmental stress on the Dabajian Shan protected ecological area, the Dalu Forest Road was closed after it became damaged, and the recreational activities in the Dabajian Shan area were reduced. If tourists who originally wanted to visit the Dalu Forest Road or fog-viewing recreation area all visit the Wuling recreation area instead, the tourism pressure on this area will increase significantly, and the existing water supply problem will worsen. It will be harder to understand the environmental problems caused by climate change in the Wuling recreation area. Based on the recommendation of the UNWTO-UNEP-WMO (2008), national parks should offer a variety of attractions to avoid excessive concentrations of tourists. Although controlled ecological zones are important for ecological preservation, appropriate increases of tourism opportunities and an increased proportion of ecological touring will prevent excessive concentrations of tourists at a specific time and place and improve the capacity of the ecosystem as a whole to buffer the negative impact of climate change.

In addition to increasing the tourist attractions offered within the park, national parks can extend their sightseeing routes to neighboring tribal areas. This policy can stimulate the local economy and reduce the tourism load in the park. In addition, residents may increase their approval of the national park and their cooperation with relevant national park management measures when they observe that the park improves their quality of life, which makes the management goals of national parks more achievable.

National parks should integrate economic, environmental, social, cultural, and management factors when assessing the impact of climate change on tourism infrastructure and tourism development management. They should then adjust their tourism and recreation offerings, marketing and promotions, education methods, and possible recreation locations accordingly. This approach should provide an important adaptation strategy for national parks in response to climate change. The five national parks studied in this paper showed different reactions to income changes. The status of national parks as inferior, necessary, or luxury goods should be taken into consideration in planning tourism and preservation strategies. For instance, the income elasticities of Shei-Pa and Kenting National Parks are each much larger than 1, which is characteristic of luxury goods, so the numbers of tourists visiting these two places will change several times more than the corresponding change in income. When the overall economy is poor, the number of tourists visiting the Shei-Pa and Kenting National Parks will drop significantly, so such periods can be used to construct and maintain park infrastructures that will be necessary at busier times; when the overall economy improves, tourist turnout will increase significantly, so recreation routes must be actively planned and managed. Yangmingshan National Park has a negative income elasticity, which is characteristic of inferior goods. Therefore, during an economic downturn, the number of tourists entering Yangmingshan National Park will increase, and more diverse tourism activities should be planned during this period to absorb the increase in tourists. However, during an overall economic recovery, Yangmingshan National Park will experience a reduction in tourist visits, and this period of low tourism pressure can be used to let the ecosystem rest and recuperate. Taroko and Yushan National Parks have income elasticities of less than 1, meaning that tourism at these two sites is a necessity for Taiwan residents. The number of visitors fluctuates less than does income. Necessity tourism sites such as these require even more detailed and precise management plans to ensure that attention is paid to both preservation and recreation.

This paper suggests that the management of Taiwan's national parks must consider not just climate change but also the economy. The impact of climate change on the number of visitors has to be understood to predict the number of visitors accurately, but the pressure on the facilities and ecological environment of the parks must also be understood. In addition, the overall economic impact of park tourism activities should be studied. Because tourism at each park reacts differently to an overall economic change, there must be parks with comparatively few visitors during every period. During such periods, parks should actively engage in ecological recovery and/or public infrastructure construction and maintenance. Making necessary management decisions and taking measures to adjust the offerings of national parks in accordance with overall economic changes will increase the elasticity of Taiwan's national park system in response to climate change.

The analyses of the paper are highly limited by availability of data. We cannot include some important factors affecting individual's travel decision. For example, visitation patterns can influence tourist's psyche of nature based travel but there is no time series data for exploring the visitation patterns of national park guests. Emerging new alternatives for recreational activities and means of escape may also change the demand for tourism in national parks but there is no systematic analysis of the relation between them across the time span of the study. It is important to control these factors to keep the estimation from being biased.

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