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ORIGINAL PAPER

Considering disaster vulnerability and resiliency: the case of hurricane effects on tourism-based economies

Hyun Kim[1] · **David W. Marcouiller**[1]

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Abstract In this study, we examine the vulnerability and resiliency of 10 tourism-based regional economies which include US national parks or seashores (situated on the Gulf of Mexico or Atlantic Ocean coastline) affected by several hurricanes over a 26-year period. The vulnerability of each economy to natural disasters was estimated using a panel linear model, while resilience was estimated by employing a negative binomial panel regression and a difference-in-difference model. Natural disaster damage, related to physical damage and human loss, was shown to have a negative effect on regional economies. Regions with stronger economies prior to natural disasters have lower disaster losses than regions with weaker economic characteristics. More effort to improve regional economic conditions before natural disasters is necessary to minimize disaster loss. Lessons learned from the economic impacts of past natural disasters, in particular in tourism-based regions, can help regional planners and policy makers predict problems related to disasters and more effectively prepare for future events.

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✉ Hyun Kim
hkim525@wisc.edu

David W. Marcouiller
dwmarcou@wisc.edu

[1] Department of Urban and Regional Planning, University of Wisconsin-Madison, 925 Bascom Mall, Madison, WI 53706-1317, USA

1 Introduction

The disruptive aspects associated with natural events have ramifications for travel and tourism and can dramatically affect regional, national, and international economies. Examples that support this statement are increasingly prevalent. On April 14, 2010, the Eyjafjallajökull volcano erupted in southern Iceland impacting the world's climate, public health, and economy. In eight short days, the volcano had cancelled more than 107,000 flights in 23 European countries (affecting travel for 10 million individuals and accounting for approximately 48 % of air travel during the period), slowing the continent's economy (Bye 2011). According to the Airport Operators Association, during the week of the eruption, airports lost £80 million from such closures (Jamieson 2010). Many economic scholars have estimated that ashes and gases released by the volcano would have long-term socioeconomic consequences throughout Europe and beyond. Tourism-based economies along the coastal regions of the USA have likewise experienced severe effects from hurricanes and coastal storms (Woosnam and Kim 2014) during the recent past.

Climate change is expected to lead to more severe natural events including stronger hurricane and rainfall events, increased localized flooding, and rising sea levels (Alarslan 2008; Pine 2009). These impacts are particularly important for coastal communities which are densely populated and increasingly the focus of amenity-based migration. Indeed, these coastal areas now account for roughly 50 % of the US population (Brody 2012) and are popular travel and tourism destinations. Naturally occurring events that affect migration have both human and physical consequences that require proactive planning to reduce vulnerability and to improve resiliency (Berke and Smith 2010).

Natural disasters become crises when unambiguous failures of public and private decision making create outcomes that interrupt local activity (Schwab et al. 2007). Regional vulnerability reflects the frequency and intensity of naturally occurring large-scale materialized risks (Kim et al. 2015; Kusenbach and Christmann 2013), while natural disaster resiliency refers to the capacity of people and organizations to develop adaptive responses to perturbations that lead communities to avoid potential loss (Park et al. 2011). In the context of a changing climate, a central question involves the role of adaptation, or adaptive capacity, on the ability of communities to plan for disaster vulnerability and resiliency.

Even though vulnerability of tourism communities is often discussed in the context of natural or man-made disasters (Coffman and Noy 2012; Shareef and McAleer 2005; Woosnam and Kim 2014) and disaster management models for the tourism industry have been formulated (e.g., Faulkner and Vikulov 2001; Tsai and Chen 2011), few studies focus on the performance of tourism-based community economic vulnerability and resilience when faced with natural disasters (Belasen and Polachek 2008; Park et al. 2011). In addition, there is a dearth of empirical research that analyzes the vulnerability and resiliency attributes of tourism-based economies before and after natural disasters. Most studies on vulnerability or resiliency of tourism economies or community tourism planning to natural disasters relied on formulating theoretical framework for empirical applications (e.g., Biggs et al. 2012; Calgaro et al. 2014a, b; Lew 2014).

In this study, we develop a conceptual model of disaster loss factors that involve regional exposure, shock, and loss (both direct and indirect) within the context of inherent social system vulnerability and resiliency. Using panel data, we empirically examine vulnerability and resiliency of tourism-based economies to natural disasters in an effort to plan for sustainable tourism development and climate change adaptation. More specifically, our analysis examines the relationship between regional economic conditions and damage from hurricanes occurring in gateway communities proximate to 10 US national parks or seashores located in the Gulf of Mexico and the Atlantic Ocean during a recent 26-year period.

2 Literature review

2.1 Economies, tourism, and vulnerability to natural disasters

Whereas hazard is related to "… natural events that may affect different places singly or in combination at different times" (Wisner et al. 2004, p. 49), vulnerability to natural disasters relates to the ability to deal with the impact of natural hazards, withstand the potential negative consequences on an affected region/county, and cope with the resulting damage in a timely manner (Cutter et al. 2003). Vulnerability can be conceptually viewed as an outcome of the interaction between exogenous factors determined by the incidence and intensity of disasters as well as the ability of a region or community to deal with the resulting impacts (Sadowski and Sutter 2005). It should be noted that risk is not synonymous with vulnerability. Regarding differences between risk and vulnerability, Alexander (2000, 13) highlighted that while vulnerability "… refers to the potential for casualty, destruction, damage, disruption or other form of loss in a particular element, risk combines this [vulnerability] with the probable level of loss to be expected from a predictable magnitude of hazard."

In this regard, the relationship between vulnerability to natural disasters and economic situations includes both broad and specific damages at spatial levels involving a region or country. Broad regional damage can take the form of economic losses in diverse industry sectors sensitive to tourism demands; these include personal services, retail, construction, and transportation. Natural disaster damage, especially hurricanes, involves economic loss not only to personal property (e.g., homes and automobiles), but also to commercial and industrial businesses (e.g., those pertaining to tourism services, manufacturing, and agriculture), utilities, military installations, and other structures (Ewing et al. 2009). In addition, hurricane losses have been highly correlated with the occurrence, intensity, and costs of hurricanes identified by the property insurance industry. Similarly, the relationship between the intensity of a hurricane and the density of a population has been shown to be positively correlated so that a stronger hurricane striking a more densely populated coast would cause greater damage (Sadowski and Sutter 2005).

Disaster vulnerability has been linked to business type and location (Zhang et al. 2008), indicating that some industries are far more vulnerable to hurricanes than others. For instance, the insurance, service, and retail sectors are quite familiar with hurricanes and must deal with such disasters regularly (Ewing et al. 2009). Some locations (e.g., surrounding the Gulf of Mexico) rich in oil and natural gas deposits are extremely vulnerable to natural disasters due to the concentration of offshore drilling and refining operations (Richardson et al. 2008). For instance, following Hurricane Katrina (September 2005), the US oil production decreased substantially leading to significant oil price increases (Gordon et al. 2010). It was not long after this that Richardson et al. (2008) indicated that research concerning tourism impacts and oil and gas losses in the region were currently underway, showing the link between the industries and the resulting consequences of the natural disaster. Further, Hystad and Keller (2008) examined the negative influence of long-term forest fire disasters on local tourism-sensitive sectors in Canada. With respect to tourists' vulnerability, Burby and Wagner (1996) claimed that, in general, most tourists who are not familiar with the travel destination's natural disaster risk are more vulnerable than the local residents.

In terms of broad damage influencing economic losses globally, hurricane exposure has been found to be negatively correlated with initial per capita GDP (Kahn 2005). Intuitively, richer nations seem to have sustained greater economic losses than poorer nations in the face of natural disasters (Sutter and Simmons 2010). However, in the case of an equal quantity and intensity of disaster shocks, people in wealthier nations suffer less death from natural disasters than those in poorer nations, which is likely a function of established infrastructure and higher construction standards. Kellenberg and Mobarak (2008) have shown that developed countries experience fewer and weaker disaster damages than many developing countries. These disasters can have major implications for various industries throughout the world, including tourism. As Hall (2010, 401) pointed out, the effect of natural disasters on international tourism "… are likely to increase in both size and frequency as tourism becomes increasingly hypermobile and the global economy even more interconnected." In terms of international tourism-based economies in Taiwan, Huang et al. (2007) investigated how the hospitality sector is negatively affected by earthquakes, typhoons, and floods.

Specific regional natural disaster damage has also been examined in the context of vulnerability or risk. Specific economic damages in affected communities involve losses to tourism-sensitive business receipts, labor market disruptions, stock price fluctuations, and damage to real estate and other properties (Carbone et al. 2006; Ewing and Kruse 2002; Huang et al. 2007; Tsai and Chen 2011). Stock prices of insurance companies are prone to fluctuate in response to disasters based on regional exposure. For instance, Hurricane Andrew reduced the stock prices of property–casualty insurers in Florida and Louisiana by 7 %, compared to those that did not experience loss from the hurricane (Lamb 1998). In this sense, vulnerability is somewhat a subjective term, indicating the hypothetical relative likelihood of suffering negative consequences if exposed to a disaster event of a specific strength or duration.

Vulnerabilities are those characteristics that determine the ability to absorb the shock of an event. Vulnerability is spatially mutable and region specific; coastal zones (e.g., small islands) are more vulnerable to tsunamis. The economy of a region might have vulnerabilities that make it more likely to suffer significantly higher losses when compared to other adjacent regions. For this reason, we can conclude that conditions leading to a slow recovery (e.g., lack of preparedness and planning, and natural hazards awareness strategy, poor economic condition, and isolation) can contribute to a community's vulnerability to natural disasters (Calgaro and Lloyd 2008; Faulkner and

Vikulov 2001; Prideaux 2004; Ritchie 2008). In tourism disaster management, Huang et al. (2007) emphasized that a crisis management plan can help to restore tourism-sensitive businesses from natural disasters. Cioccio and Michael (2007) addressed the vulnerability of tourism sectors due to the lack of disaster preparedness and insurance inadequacy based upon investigating small tourism-sensitive firms displaced by the 2003 bushfires in northeast Victoria in Australia. Furthermore, reducing vulnerability should reduce the potential damage and enable a more rapid recovery. In this regard, identifying disaster vulnerability can be useful to disaster management, in particular in both coastal tourism-dependent communities and other disaster-prone areas.

2.2 Economies, tourism, and resiliency to natural disasters

Resilience, with an emphasis on disaster risk, refers to the capacity of people and systems involved to return to a state prior to the occurrence of significant disturbances (e.g., natural disasters, oil spills, and terrorism events) (Garmestani et al. 2006; Park et al. 2011). Walker et al. (2004, 3) described resilience as "… the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks." Likewise, Ersing (2012, 103) pointed out that "… resiliency is described as the ability to 'bounce back' or to return to a state of functioning that was in place prior to exposure to a significant stressor such as a natural hazard. " If something is resilient, it will require less time to return to normality or regular operation (Hamzah and Hampton 2013). A region can enhance its resilience particularly through planning and mitigation of vulnerabilities. As a consequence, the adaptive capacity is dependent on individuals and resources as well as competencies to manage the demands, challenges, and changes encountered (Adger 2006; Garmestani et al. 2006; Smit and Wandel 2006). In addition, regarding differences between capacity of response and adaptive capacity, Gallopin (2006) pointed out that adaptive capacity is the more appropriate concept in the longer-term or more sustainable adjustment. Previous studies suggest a diverse definition of resilience to natural disaster at the level of the individual firm, market, and regional economy (Cutter et al. 2008; Park et al. 2011; Rose 2007). Tierney and Bruneau (2007) offer that economic resilience to disasters refers to the inherent and adaptive responses to disasters that lead individuals and communities to avoid potential losses.

Existing regional economic conditions can have either positive or negative effects on disaster risk or damage. For example, income has been shown to be negatively correlated with degree of natural disaster damages (Sadowski and Sutter 2005). However, such regional economies have proven to be quite resilient as long as the exogenous baseline assumptions are maintained in disaster damage (Ellson et al. 1984). Since wealthier residents seem to take more precautions to mitigate hurricane losses, the value of real and personal property is higher in areas with higher incomes (Sadowski and Sutter 2005).

More specifically, economic resilience on a regional level describes the capacity of firms in key industrial sectors to function in spite of adverse disturbance to normally occurring activities (Paton and Hill 2006). Any disturbance, especially natural disasters, becomes a crisis when it reveals an unambiguous failure of management actions and policy with an emphasis on capacity to adapt to interruptions in business activity (Paton and Hill 2006). Resilience of an industrial sector will depend on the coping strategies of firms and diversity of firms in any environment. Likewise, referring to resilience as the "… ability to dampen the maximum potential economic output loss," Park et al. (2011, 163) underscore that resilience in business is the ability to reschedule or recapture lost product after a natural disaster has occurred.

Considering regional economies, businesses of varying degrees must fulfill different needs in order to be resilient and deliver the products and services on which individuals have come to depend. According to Rose (2007), businesses can exhibit two forms of resilience following a natural disaster. The first form of resilience is referred to as "static," which reflects the ability of an entity or system to maintain function when experiencing shock. The second form of resilience is considered "dynamic" and encompasses "… the speed at which an entity or system recovers from a severe shock to achieve a desired state" (384). In terms of sustainable tourism management, it is noteworthy to examine the relationship between disaster resilience and the activities of tourism-sensitive firms (Biggs et al. 2012).

Globally, the degree of economic development has been found to be correlated with disaster risk, which is similar to what has been found at the regional level (Kellenberg and Mobarak 2008; Toya and Skidmore 2007). For instance, in metropolitan areas, disaster risk may be mitigated by larger numbers of people having access to more adequate economic and social institutions that include well-designed infrastructure and competent urban planning (Kellenberg and Mobarak 2008).

Likewise, regions (and countries) with higher levels of key economic indicators, higher educational attainment, greater public participation or social network and social responsibility, and more complete financial systems experience fewer disaster losses (Mullins and Soetanto 2012; Murphy 2012) due to well-established emergency disaster plans. As supported by Huang et al. (2007), Kelman et al. (2008), Ritchie (2009), and Orchiston (2013), while regions with higher output levels are able to respond to disaster risks by employing additional costly precautionary measures such as tourism disaster preparedness, disaster warning systems, and a tourism disaster plan, regions with lower output levels have difficulty responding to disaster losses due to the lack of a disaster recovery plan. Likewise, disaster losses can also be associated with the quality of infrastructure and social pressures that put more people in hazardous locations and life-saving services placed in inequitable places.

3 Research design and method

3.1 Conceptual framework and testable hypotheses

Based on the literature review, a conceptual framework was formulated. The framework serves to provide a theoretical basis for the statistical model in describing (1) the effects of natural disasters on tourism-based regional economies (disaster vulnerability, *Scenario I*) and (2) the response of tourism-based economies to natural disaster losses (disaster resiliency, *Scenario II*). In *Scenario I,* the natural disaster factors were examined to determine which factors contributed to the increase or decrease in disaster losses (Raddatz 2007). The endogenous shocks, including conflicts, political instability, and economic mismanagement, were put forth by Raddatz (2007). The degree of the response to a disaster depends on the intensity of the disaster and degree of previous disasters in the area (Sadowski and Sutter 2005). Vulnerability to disaster, as a potential for loss, refers to the likelihood of exposure to disaster damage.

The disaster losses factor following an event can involve human losses and physical damage. Disaster losses contribute to the decrease or increase in regional economic conditions before a natural disaster. In addition, as shown by Zhou et al. (2010), prior to a disaster, regional economic vulnerability involving social, natural systems, and the built environment exists in relation to inherent vulnerability and resiliency. In the empirical analysis, the regional economic factor includes direct effects (e.g., per capita income, gas prices, employment, and percentage of service industry) and indirect effects (e.g., inflation, per capita income in the USA, and percentage of the population between the ages of 15 and 44). In this context, we can hypothesize that more human losses and physical damage from natural disasters will have a negative association with regional income levels (*Hypothesis 1*).

Scenario II examines the resiliency of economies to natural disasters in tourism-based regions. The resiliency of surrounding areas before the disaster damage includes the two properties of inherent resiliency and adaptive resiliency as suggested by Rose (2004). At the same time, regional economic conditions before disasters will be affected by natural disasters. This regional economic factor includes direct effects and indirect effects. In the context of resilience to disaster damage, Rivera and Settembrino (2013) claimed that wealth enables a region to absorb and recover from disaster losses more quickly owing to insurance, social safety nets, social networks, and entitlement programs. The natural disasters factor contributes to the increase or decrease in tourism-based regional economic characteristics. New regional economic status damaged by natural disasters will show a considerable number of disaster responses in human losses and physical damage. Regions with high levels of economic characteristics before the disaster can be useful to determine whether or not they experience fewer disaster losses and require a shorter amount of time to recover from disasters. Based on this *Scenario II* and with respect to disaster resiliency of regional tourism-based economies, we hypothesize that greater (or less) economic development from direct or indirect economic effects will result in lower (or higher) disaster losses (*Hypothesis 2*).

3.2 Data collection and study area

To better understand vulnerability and resiliency of regional economies, especially those based on tourism in disaster-prone areas, panel data on the regional economies and disaster damages or losses during the hurricane season (i.e., June to November) in the Gulf of Mexico and Atlantic Ocean were examined. Data were collected from 1979 through 2004 for each hurricane season, which overlapped with the peak tourism season in the southeast USA. The study period was chosen due to the ability of obtaining reports from a variety of databases as well as the prevalence of hurricanes and accompanying damage from disasters in and around national park sites during these years. As described in Table 1, 19 coastal shoreline counties with regional economies focused on tourism were selected for analysis that included six national parks and four national seashores.

According to coastal economic data for these study areas, approximately 30 to 99 % of the total economic gains of industries adjacent to the park sites were linked with tourism-sensitive sectors of the economy. These data were derived from the National Ocean Economic Program on the Web site of the Center for the Blue Economy (1990–2000). Based upon the Standard Industrial Classification system, it considered construction, living resources, minerals, ship & boat building, tourism & recreation, and transportation. For example, in 2000, in Accomack County (Virginia) and Worcester County (Maryland), which includes *Assateague* National Seashore, each employee working in the tourism industry earned approximately US $13,000 in annual wages (i.e., more than 55 % relative to all economic sectors in these counties) (see Table 2). This indicates that these county economies were relatively dependent on tourism. Such figures reflect the fact that tourism-sensitive sectors can play a significant role in local economies (Milne and Ateljevic 2001; Telfer and Wall 2000).

The increasing frequency and severity of storms along the Atlantic and Gulf of Mexico coasts have put a large number of people and resources at risk. The 10 selected national park territories were deemed ideal for examining the impact of hurricanes on regional economies (highly focused on tourism) given their comparatively large areas, large numbers of visitors, and their history of hurricanes during the time period. General information on these national parks and seashores in the disaster-prone areas was collected from the National Park Service Public Use Statistics Office. Information on historical tracking, intensity, duration, frequency, and speed of the hurricanes during the study period was collected from the National Oceanic and Atmospheric Administration. In addition, data on disaster damage or losses, such as fatalities, injuries, property damage, and crop damage, were collected from the Spatial Hazard Events and Losses Database for the USA (SHELDUS) at the Hazard Research Laboratory at the University of South Carolina. SHELDUS was compiled from US government sources such as the US Geological Survey and the National Climatic Data Center. Given these SHELDUS data were only available at the county level, mean values pertaining to damage were used for county (or counties) in which each national park or seashore was located.

Regional economic data were obtained from the US Census Bureau and contained detailed economic information for counties located in the 10 study areas and for the overall USA during the study period. Such data collection strategies were based on the following basic assumption regarding the economic synergistic effect of tourism on sustainability and community resilience (Calgaro et al. 2014a, b). Economic data pertaining to income, employment, and percentage of related industries were also utilized in analysis following the work of Belasen and Polachek (2008). It should be noted that the inflated value based on the consumer price index in 2004 was selected as an indirect effect to represent the most accurate value for the study period.

Table 1 Selected national parks or seashores and counties landfall US major hurricanes during study period

National seashores				National parks					
Padre Island[a]	**Gulf Island**[b,c]	**Canaveral**[c]	**Assateague**[f,g]	**Everglades**[c]	**Dry Tortugas**[c]	**Biscayne**[c]	**Cumberland Island**[d]	**Cape Lookout**[e]	**Cape Hatteras**[e]
Kleberg	***Jackson***	***Brevard***	*Worcester*	***Collier***	*Monroe*	***Miami-Dade***	*Camden*	*Carteret*	*Dare*
Kenedy	*Harrison*	***Volusia***	*Accomack*	***Miami-Dade***					*Hyde*
Willacy	***Escambia***			*Monroe*					
	Okaloosa								
	Santa Rosa								
Hurricane Allen (1980)	Hurricane Elena (1985)	Hurricane Hugo (1989)	Hurricane Emily (1993)	Hurricane Andrew (1992)			Hurricane Charley (2004)	Hurricane Gloria (1985)	Hurricane Emily (1993)
	Hurricane Andrew (1992)								

Bold letters indicate the selected study areas, bold italic letters metro-counties, and Italic letters counties hosting the selected study areas
[a] Texas
[b] Mississippi
[c] Florida
[d] Georgia
[e] North Carolina
[f] Maryland
[g] Virginia, Year hurricane occurred in parentheses

Table 2 Economic characteristics for each county (1990 and 2000)

State, county	1990*			2000**					
	Employment (person)	Wage per employee (US$)	GDP per capita (US$)	Employment (person)		Wage per employee (US$)		GDP per capita (US$)	
	C	C	C	C	A	C	A	C	A
Texas									
Kleberg	591	13,007.04	825.27	996	10,391	19,994.77	25,673.45	2199.28	20,245.37
				(9.58)		(77.88)		(10.86)	
Kenedy	–	–	–	–	295	–	22,662.99	–	507.36
Willacy	155	15,678.98	395.26	172	3656	10,476.55	23,703.59	207.31	10,331.96
				(4.70)		(44.19)		(2.00)	
Mississippi									
Jackson	16,707	32,921.44	59,944.84	17,510	50,571	34,310.87	34,704.95	5773.06	33,201.21
				(34.62)		(98.86)		(17.38)	
Harrison	7326	14,934.38	1111.20	16,929	89,759	20,145.51	28,793.36	3436.99	33,888.49
				(18.86)		(69.96)		(10.14)	
Florida									
Escambia	4983	11,935.03	427.69	7505	125,208	10,831.75	30,206.54	571.74	30,048.66
				(5.99)		(35.85)		(1.90)	
Okaloosa	6236	13,301.02	1045.16	7643	72,629	15,534.26	28,754.23	1330.47	28,650.83
				(10.52)		(54.02)		(4.64)	
Santa Rosa	696	11,243.88	178.88	1570	24,979	12,606.36	27,453.15	332.91	13,623.12
				(6.28)		(45.91)		(2.44)	
Brevard	15,446	18,650.54	1162.71	18,587	180,459	20,394.38	36,371.58	1306.58	32,238.03
				(10.29)		(56.07)		(4.05)	

Table 2 continued

State, county	1990*			2000**					
	Employment (person)	Wage per employee (US$)	GDP per capita (US$)	Employment (person)		Wage per employee (US$)		GDP per capita (US$)	
	C	C	C	C	A	C	A	C	A
Volusia	13,004	13,434.48	855.21	13,030	141,619	15,629.63	25,116.61	913.73	18,642.08
				(9.20)		(62.22)		(4.90)	
Collier	1083	16,213.36	222.61	2948	103,093	18,064.62	33,980.04	453.79	32,596.58
				(2.85)		(53.16)		(1.39)	
Miami-Dade	36,050	21,279.26	750.78	45,914	978,174	24,073.29	38,387.25	1020.21	38,977.74
				(4.69)		(62.71)		(2.61)	
Monroe	8727	17,230.40	3907.56	9841	36,645	19,537.72	30,414.68	5230.95	32,755.90
				(26.85)		(64.23)		(15.96)	
Georgia									
Camden	410	12,562.84	383.84	567	13,703	9201.79	31,503.77	264.64	22,441.22
				(4.13)		(29.20)		(1.17)	
Maryland									
Worcester	668	13,787.40	587.38	1055	23,394	13,404.76	23,733.34	664.39	26,022.09
				(4.50)		(56.48)		(2.55)	
Virginia									
Accomack	767	12,188.99	643.77	787	13,706	13,009.75	23,681.52	646.26	19,083.94
				(5.74)		(54.93)		(3.38)	

Table 2 continued

State, county	1990*			2000**					
	Employment (person)	Wage per employee (US$)	GDP per capita (US$)	Employment (person)		Wage per employee (US$)		GDP per capita (US$)	
	C	C	C	C	A	C	A	C	A
North Carolina									
Carteret	2034	13,926.16	1772.07	4240	21,931	14,221.80	23,762.37	1939.69	20,779.93
				(19.33)		(59.85)		(9.33)	
Dare	1832	13,826.67	3608.53	3915	20,950	15,750.98	22,510.54	4062.22	37,270.17
				(18.68)		(69.97)		(10.89)	
Hyde	280	11,147.55	1789.95	581	2095	14,282.96	22,515.46	3029.83	19,171.34
				(27.73)		(63.43)		(15.80)	

Source Authors' calculation based on National Ocean Economic Program on the Web site of the Center for the Blue Economy
* Dollar values are converted to year 2005; ** Dollar values are converted to year 2000 equivalent, "C" refers to coastal economic sector, "A" refers to total economic sector, the ratio of coastal economic sector to total sector in parentheses, Units in brackets

3.3 Model specification

According to Baltagi (2008), panel data analysis has the merit of utilizing cross-sectional region-specific data collected across multiple periods for appropriate time series analyses. It can also take into account the heterogeneity of cross-sectional data by allowing for individual-specific effects, all the while, providing more variance, less collinearity among variables, a larger degree of freedom, and more efficiency (Baltagi 2008; Wooldridge 2002). To take full advantage of the available data and to allow for testing whether or not a natural disaster has any effect on a regional economy like this study, it was advantageous to pool the time series data over the study areas. When pooling cross-sectional and time series data, it is useful to take advantage of the fact that the data are really several blocks (panels) of related data. More specifically, fixed-effect versus random-effect estimators in panel data are as follows:

$$\begin{aligned} y_{it} &= \alpha + X_{it}\beta + v_i + \varepsilon_{it}, \quad i = 1, \ldots, N; t = 1, \ldots, T \\ \varepsilon_{it} &= v_t + \omega_{it} \end{aligned} \tag{1}$$

where i denotes various spatial units (counties in this study) and cross-sectional dimensions, t denotes time and time series dimensions (June to November from 1979 through 2004 in this study). α is a scalar, β is K^*1, and X_{it} is it the observation of K explanatory variables. v_i is the unit-specific residual and differs between units. But for any particular unit, its value is constant. ε_{it} is the "usual" residual with the usual properties (i.e., mean 0, uncorrelated with itself, uncorrelated with X, uncorrelated with v, and homoskedastic) (Baltagi 2008; Wooldridge 2002).

On the logical basis of linear static panel data analysis, a difference-in-difference (DD) model is appropriate to employ in comparing the influence of an unexpected event in a distinct area (i.e., a treatment group) to other areas (i.e., a control group) analogue to the experimental group in all aspects except for the event occurrence itself (Belasen and Polachek 2008). We used such a DD technique to compare the areas affected by hurricanes with those not affected. More specifically, the DD model compares outcome O (in this study, per capita income in the study areas denoted as *COINCOME*) between treatment group (T) and control group (T'). For event H (in this case Hurricane Andrew), there are two possible outcomes: O_T if a hurricane occurred and $O_{T'}$ if it does not.

Thus, whereas $E[O_{c,t}|T']$ indicates the predicted result of O if a hurricane does not make landfall in the study areas c at time t, $E[O_{c,t}|T]$ represents the expected finding of O if the event does occur in area c at time t. In this regard, the empirical specification can be characterized by the following equation:

$$E[O_{c,t}|T'] = \alpha_c + \alpha_t, \; E[O_{c,t}|T] = E[O_{c,t}|T'] + \gamma \tag{2}$$

The coefficient γ measures the exogenous shock in case the above two equations are different:

$$E[O_{c,t}|T] - E[O_{c,t}|T'] = \gamma = \gamma_c + \gamma_t \tag{3}$$

This γ difference can be time- and event-averaged exogenous shocks resulting from the events H in accordance with attributes of the affected areas. In accordance with the attributes of the dependent variable and in an effort to compare the influence of an unexpected event in a distinct area to other areas, a panel linear static model, a negative binomial panel regression, and difference-in-difference method were employed in *Scenarios I* and *II*.

4 Empirical results

4.1 Natural disaster damage and tourism-based regional economic trends

The case study regions containing the 10 national parks or seashores have both important tourism resources and have experienced significant natural disasters over the recent past. As shown in Table 3 during the study period (between 1979 and 2004), regions containing the national parks directly or indirectly experienced seven hurricanes including Allen, Diana, Elena, Emily, Charley, Gloria, Hugo, and Andrew. It should be noted that even though the 10 parks are located in disaster-prone areas, overall average income of counties where each park is located continued to increase during the period between 1979 and 2004. Apart from the impact of the US economic decline during the study period, over that same time frame, however, a decline in average per capita income (US \$), compared to average per capita income (US\$) for the five years prior to the disaster (between 1985 and 1990 and between 1990 and 1995), is apparent. The income decline in this period is consistent with the aftermath of hurricane occurrences such as Diana (1984), Elena (1985), and Hugo (1989). In view of natural disaster damage (human losses), especially hurricane duration (day) and intensity (hurricane category measured by the Saffir–Simpson hurricane scale in National Oceanic and Atmospheric Administration) during the study period, income would intuitively decrease.

4.2 Descriptive statistics

To assess the regional economic impact of a natural disaster and the response of the regional economy to the natural disaster in more detail, a panel linear model (for *Scenario I*) and a negative binomial panel regression model (for *Scenario II*) based on the panel data for the 10 national park sites were then conducted. Table 4 displays concept measurement for the variables used in these analyses. The first panel indicates that as a form of natural disaster damage, the average number of fatalities (*FATALITY*) and injuries (*INJURY*) from the hurricanes during the study period was 0.016 and 0.03, respectively. Hurricane physical damage variables such as property and crop damage show the average amount of damage inflicted by various hurricanes. The average of property and crop damage ranged from US \$0 to 40.2 million and 12.5 million, respectively.

With regard to regional economic status, the second and third panels state that eight variables, measured on continuous scales, describe the extent of community capacity and US capacity. These variables represent economic conditions which contribute

Table 3 Natural disaster damage and county income trends (1980–2004)

Year	Natural disaster damage			Income		Hurricane occurrence
	Duration (day)	Intensity (category)[a]	Damage (fatality)	Average (US$)	Change from 5 years ago (%)	
1980	0.03	0	0.0005	8431.19	–	Allen (1980), Gloria (1982)
1985	0.47	0.37	0.0007	12,590.16	49.33	Diana (1984), Elena (1985), Hugo (1989)
1990	0.05	0.13	0	16,585.75	31.74	Andrew (1992), Emily (1993)
1995	0.20	0.41	0.03	19,699.34	18.77	
2000	0.12	0.02	0	25,147.18	27.65	
2004	0.48	0.65	0	28,825.60	14.63	Charley (2004)

Units in brackets. Year hurricane occurred in parentheses. This trend has no reflection on US economic decline impacts

[a] Measured by the Saffir–Simpson Hurricane Scale (NOAA)

to regional economic activities and lessen natural disaster damage in the county as well as the nation. In addition, average per capita income, one of the selected regional economic attributes, was about US $17,658. This *COINCOME*, measured on a continuous scale, represents the economic status of the county containing each national park site. More specifically, in accordance with the capacity scope, variables by direct effect include the gas price index, population, and percentage of service industry in the entire county industry, whereas overall US variables, such as a neighboring economic effect, include inflation index in 2004, per capita income in US dollars, the unemployment rate, and the percent of 15–44 year olds in the overall population regarded as main age population with active economic efforts. During the study period, the effect of tourism-dependent economic factors on disaster damage and the influence of disaster damage on regional economic status were estimated.

4.3 Effects of natural disasters on tourism-based regional economies

Income of the study areas influenced by direct and indirect tourism-dependent economic effects (such as regional and national economic conditions and hurricane damage) was predicted using a panel linear static model with stationary panel data. That is to say, in an attempt to investigate the determinants of tourism-based regional economies through time, a panel linear model was employed, with the dependent variable defined as the log of average per capita income in each county.

Before making estimations, it was necessary to test the panel unit root and co-integration for the panel data in this study to investigate whether or not the data were stationary (Dickey and Fuller 1979; Johansen 1994; Hsiao and Hsiao 2004). First, except for the *FATALITY*, *INJURY*, *PROPERTY*, and *CROP*, all the variables shown in

Table 4 Concept measurement

Variable name	Definition	Units	Obs	Data source	Mean	SD	Range
Disaster damage effect characteristics							
FATALITY*	Average fatalities	Person	1560[a]	SHELDUS at Hazard Research Laboratory at the University of South Carolina	0.016	0.191	0–3.75
INJURY*	Average injuries	Person	1560		0.03	0.65	0–20.07
PROPERTY*	Average property damage	US$	1560		1,033,346	1.34e+07	0–4.02e+08
CROP	Average crop damage	US$	1560		436,671	6368,299	0–1.25e+08
Direct economic effect characteristics							
GAS	Gas price	Cents per gallon	1560	U.S. Census Bureau	97.606	41.341	49.2–286.3
COPOP	Population	Person	1560		351,178.7	594,322	9326–2358,714
SERVICE	Service industry	%	1560		33.998	8.294	12.85–56.89
COINCOME*	Per capita income	US$	1560		17,657.72	6914.81	5850.74–40,203.37

Table 4 continued

Variable name	Definition	Units	Obs	Data source	Mean	S.D	Range
Indirect economic effect characteristics							
INFLATION	Inflated value[b]	Index	1560	U.S. Census Bureau	23,962.60	4892.076	14,766.3–40,597.82
USINCOME	Per capita income	US$	1560		20,697.90	7098.201	9146–33,090
UNEMP	Unemployment rate	%	1560		6.230	1.409	4–9.7
ECONPOP	15–44-year-old population	%	1560		46.033	1.597	42.74–47.97

∗ Dependent variables used in this study
[a] 26 years (1979–2004, study period) × 6 months (June to November, disaster-prone period) × 10 study areas (national parks or seashores)
[b] Consumer price index in 2004,

Table 4 are not stationary (i.e., panel unit root) at least at the 10 % level of significance in terms of intercept, intercept, and trend, and none in the first and second difference. The co-integration test for the eight non-stationary variables (*COINCOME*, *GAS*, *COPOP*, *SERVICE*, *INFLATION*, *USINCOME*, *UNEMP*, and *ECONPOP*) suggests that the variables are strongly co-integrated at the 5 % level of significance, are stationary in the panel data, and there is no spurious regression problem. In addition, because the Durbin-Watson is 1.80, we can be reasonably confident that autocorrelation is not a problem in panels. Therefore, we can use all the variables in both a panel linear model and a negative binomial panel regression model.

The three models in Table 5 are statistically significant at the 0.05 and 0.01 alpha levels. Initial OLS estimates of the models in linear form were investigated for non-spherical disturbance and multi-collinearity. As a result of this examination, a problem with heteroscedasticity was discovered. The dependent variable, *COINCOME*, was transformed to log *COINCOME* using OLS in semi-log form. The regressors are meant to capture various hurricane damages and regional or national economic status. In addition, this estimation reveals the determinants of the tourism-based economies affected by natural disasters. Since the second level has the characteristics of random selection from all regions, we address all three models to suggest the empirical findings in more detail.

More specifically, the pooled OLS results suggest that the explanatory variables were significant with the expected signs. The coefficient estimate of *USINCOME* was 0.001, while the coefficient estimate of *ECONPOP* was 0.081. Both coefficients were significant at the 0.05 alpha level. Therefore, the pooled OLS results supported the positive effect of employment as a direct economic effect, and income and population of economic activity as an indirect effect on regional performance. Such a result is in line with findings presented in Kellenberg and Mobarak (2008).

Model 1 focused on regional economic attributes related to direct or indirect economic conditions in both the county and throughout the nation. The findings of the empirical model in both fixed effects and random effects indicated that *GAS* and *SERVICE* are related negatively and significantly to the dependent variable, log *COINCOME*. Unexpectedly, this result indicated that a higher gas price index, extent of employment, and percent of service industry in the county all lead to lower county income. Consistent with *Hypothesis 1* and the findings of Woosnam and Kim (2014), this result implies that more human losses in disasters lead to lower regional growth.

In addition, results for *Model 2*, focused on natural disaster damage related to physical and human losses, suggested that the significant coefficient of the interaction variable between *PROPERTY* and *CROP* (*PROPERTY*×*CROP*) was negative for the log *COINCOME*, supporting *Hypothesis 1* and the result of Coffman and Noy (2012). The negative sign indicated that more disaster losses, especially physical damage, were not helpful in increasing regional economic conditions. This result is in keeping with findings presented in Kellenberg and Mobarak (2008). On the other hand, *Model 3* was a fully specified model incorporating important variables from the three panels. In particular, the coefficient of human losses by natural disaster, *FATALITY*, on the regional economy was, as expected, negative and significant at a 1 % level of significance. In terms of the relationship between statistically significant variables graphically, impulse and response functions show that the regional economic status

Table 5 Nested model estimating the effect of disaster damage on regional economies (1979–2004)

	Pooled OLS	*Model 1*		*Model 2*		*Model 3*	
		Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect
Intercept	4.5497**	4.8500 **	4.8348**	9.6946**	9.6950**	4.7595**	4.7622**
Direct economic effect characteristics							
GAS	−0.0001	−0.0001*	−0.0001*			−0.0001*	−0.00001*
SERVICE		−0.0042**	−0.0411**				
Indirect economic effect characteristics							
INFLATION						0.00003**	0.00003**
USINCOME	0.0001**	0.0001**	0.0001**			0.00005**	0.00005**
ECONPOP	0.0810**	0.0788**	0.0789**			0.0681**	0.0665**
Disaster damage effect characteristics							
INJURY	0.0042			0.0435	0.0448		
FATALITY	0.0057			0.1120	0.1145	−0.0225*	−0.0235*
PROPERTY	2.64e−10			1.06e−09	1.06e−09	1.15e−10	1.07e−10
PROPERTY*CROP	−8.46e−18			−1.41e−16*	−1.41e−16*	−4.31e−18*	−4.56e−18*
Number of observations	1560	1560		1560		1560	
Number of groups[a]	10	10		10		10	
R^2 within		0.9739		0.4066		0.9726	
R^2 between		0.1670		0.3998		0.1394	
R^2 overall	0.8540	0.4407		0.4092		0.4706	

* $P < 0.1$; ** $P < 0.05$

[a] The number of natural parks and seashores, the symbol "*" in a variable name indicates interaction term, Dependent variable: log COINCOME

Table 6 Impact of disaster damage on regional economy between affected and non-affected area by Hurricane Andrew (1984–1995)

	Affected areas[a]	Non-affected areas[b]
Intercept	0.736*	−0.539**
SERVICE	0.002**	0.009***
USINCOME (log)	0.729***	1.110**
UNEMP	0.003	0.004
PROPERTY *CROP	−2.23e−17*	9.58e−16
Number of observations	264	396
Number of groups	4	6
Wald Chi^2	364.86***	1217.94***
R^2 within	0.934	0.963
R^2 between	0.953	0.553
R^2 overall	0.772	0.462

* $P < 0.1$; ** $P < 0.05$; *** $P < 0.01$

[a] Gulf Island, Everglades, Dry Tortugas, Biscayne

[b] Padre Island, Canaveral, Cumberland Island, Cape Lookout, Cape Hatteras, Assateague, Dependent variable : log COINCOME

(log *COINCOME*) usually decreased as a result of disaster impact (*FATALITY* and *PROPERTY*×*CROP*). This suggests that a regional economy may try to compensate for the negative impact of disaster damage. In addition, negative exogenous shocks, such as natural disasters, were directly linked to a more significant decrease in the level of tourism-based regional economic characteristics. This result implies that more human disaster losses lead to lower regional economic growth.

In order to compare the economic effects of a natural disaster in a distinct area (i.e., a treatment group) to other areas (i.e., a control group), a DD model was utilized. In accordance with the basic condition of the DD model, data on the regional economies and disaster damages or losses during 1984 to 1995 were reselected to investigate the impacts before and after Hurricane Andrew (1992). Each study area was designated as either affected by Andrew: (1) *Gulf Island*, *Everglades*, *Dry Tortugas*, *Biscayne* or not (2) *Padre Island*, *Canaveral*, *Cumberland Island*, *Cape Lookout*, *Cape Hatteras*, *Assateague*.

As described in Table 6, the DD model was employed with random-effect GLS regression in line with the dependent variable described as the log *COINCOME* in each county. As predicted, regional economic attributes, *USINCOME* and*SERVICE,* related to indirect economic conditions in both the affected and non-affected counties, were associated positively with the dependent variable, log *COINCOME* at a 5 % level of significance. However, in terms of the extent of economic impact, counties not affected by Andrew had a better regional economy than those counties that were affected. More importantly, in the affected areas, the economic impact of natural disaster damage related to physical losses (*PROPERTY*×*CROP*) indicated that the coefficient was negative for the log *COINCOME*. Supporting *Hypothesis 1*, the negative relationship between the two suggests that disaster losses in the damaged areas decrease regional economic performance.

Table 7 Response of regional economy to disaster losses (1979–2004)

	Model 4		*Model 5*		*Model 6*	
	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect
Intercept	−32.7343	−23.6448	6.6651	2.8600	6.6575	0.1392
Direct economic effect characteristics						
GAS	−0.0017	−0.0014	−0.0034	−0.0033	−0.0310	−0.0165
POP	−1.37e-06*	−7.07e-07	1.77e-07	1.88e-07	3.79e-07	6.01e-07
SERVICE	−0.1754*	−0.1132	−0.5814*	−0.4005**	−0.6626*	−0.3371*
Indirect economic effect characteristics						
INFLATION	−0.0009*	−0.0007*	−0.0017*	−0.0014*	−0.0019*	−0.0015*
USINCOME	−8.53e-06	−0.0001	−0.0006*	−0.0006*	−0.0007	−0.0007*
ECONPOP	0.8253	0.5619	0.5626	0.4626	0.6198	0.4737
UNEMP	−0.0167	−0.1069	−0.6508	−0.6387	−0.1485	−0.4566
Number of observations	1404	1560	1404	1560	1404	1560
Number of groups[a]	9	10	9	10	9	10
Log-likelihood	−82.34	−110.29	−59.43	−97.25	−29.01	−73.94
Wald Chi^2	14.19*	10.66*	19.76**	22.83**	10.92*	20.52**

* $P < 0.1$; ** $P < 0.05$, Dependent variables : *Model 4* (FATALITY), *Model 5* (INJURY), and *Model 6* (PROPERTY)

[a] The number of natural parks and seashores

4.4 Response to natural disaster damage of tourism-dependent economies

In addition to examining the effects of natural disasters on tourism-based economies, a negative binomial panel regression model (NBPR) was employed to predict the response of natural disaster losses to income in the study areas focused on tourism. NBPR was employed with the dependent variable *FATALITY* and *INJURY*. The reason that an NBPR was chosen was that the mean and standard deviation of *FATALITY* was 0.016 and 0.191, and that of *INJURY* was 0.03 and 0.65, respectively (see Table 4). This result indicated the rejection of Poisson's assumption that the mean and standard deviation should be identical and suggests that a large number of the variables are zero or smaller (Hilbe 2007). Similar to Table 5, the explanatory variables included in the analysis were gas price index, county population, percent of service industry, inflation in 2004, per capita income in the USA, the percentage of the population 15–44 years of age and the unemployment rate.

The model was estimated on three different types of natural disaster damages including fatality, injury, and property damage as residential damage. Each model summarized in Table 7 was statistically significant at the 0.05 and 0.01 alpha levels. This estimation revealed the response to human damages such as fatality and injury. *Model 4* focused on fatality attributes with regard to natural disaster losses in counties damaged by hurricanes. Except for the *POP* and *SERVICE* variables, all fixed effects were negatively correlated with *FATALITY*, the dependent variable. As expected, this result indicates that larger populations and a larger percent of the service industry in a county lead to lower human losses in natural disasters. Based on this finding, we failed to reject *Hypothesis 2* that greater economic development leads to less disaster loss. This result supports the research of Kellenberg and Mobarak (2008), who document that disaster deaths decrease with higher regional economic levels. Additionally, this finding is supported by the work of Toya and Skidmore (2007), who claim higher income is inversely correlated with deaths caused by natural disasters.

Ultimately, counties having better economic conditions are expected to experience fewer disaster losses. The region having fewer losses from natural disasters is more resilient than those that have greater losses. However, the significant coefficient, *INFLATION*, is negatively related to *FATALITY*. This implies that lower economic condition results in less disaster losses. *Models 5* and *6*, focusing on human disaster losses, *INJURY* and *PROPERTY* show that, in fixed effects and random effects, the coefficient of *SERVICE* was negative and significant at the 0.05 and 0.01 alpha levels. In addition, the *USINCOME* had a negative effect on *INJURY*. As predicted, this result shows that better economic conditions lead to minimized disaster losses within a region, consistent with the results of Zhou et al. (2010).

5 Conclusions and discussion

Using the premise that coastal tourism often is considered to be susceptible to natural disasters (Aswani et al. 2015; Woosnam and Kim 2014), we investigated the vulnerability and resiliency of regional economies affected by natural disasters in tourism-based and disaster-prone areas. This work differs from previous studies in two aspects. First, this research focuses on a conceptual framework which provides the theoretical basis for the overall process of disaster vulnerability and resiliency in tourism-based regional economies not specifically described in existing studies. Second, we examine the constructs of disaster vulnerability and resiliency utilizing empirical analysis of panel data, which complements the conceptual and descriptive approaches in the extant literature.

Through empirical analysis, two overarching results were found as related to the vulnerability and resiliency of tourism-based economies before and after a natural disaster. First, as expected, natural disaster damage related to physical damage and human loss had an influence on regional economies. This negative relationship between the two suggests that more disaster losses lead to lower regional economic levels. Second, greater economic development before the disaster occurs contributed to lower disaster losses. This finding indicates that if a region has a stronger economic condition without taking into account natural disaster insurance before a disaster, it will experience less disaster losses than a region with a weaker economic condition. Smaller economies with less industry diversity (i.e., primarily or largely dependent on tourism) are more deeply impacted by disaster events than larger and more economically robust economies.

5.1 Study limitations and future research

In light of such findings, the current study has limitations. Measurements of regional economies and natural disasters in this study were primarily focused on panel data from official Web sites. In utilizing such secondary data, estimates such as those provided by SHELDUS may be slightly over or under true losses experienced in counties under consideration. As Babbie (2012) claims, such potential for error exists when using data collected and compiled by others. Additionally, such data are limited in that individual-level perceptions of local economic status (e.g., quality of life, or degree of satisfaction about government assistance programs) altered by natural disasters are not considered. Therefore, in addition to utilizing secondary data, as suggested by Park and Reisinger (2010), Kelman et al. (2008), and Méheux and Parker (2006), future research should include primary data measuring local resident, tourism-dependent business interests, and tourist perceptions of natural hazards at multiple points in time as in longitudinal data collected through questionnaires and interviews.

Furthermore, since this study included only 10 national parks or seashores damaged by natural disasters during the study period (and considered such sites to be homogeneous), there is a limitation in generalizing the empirical results. For example, the economic losses from Hurricane Katrina in 2005 were among the largest the world has ever seen, and some areas were impacted more than others, most notably the Lower Ninth Ward of New Orleans (Rich 2012). The data used in this study treated all areas impacted by a disaster as equally impacted. To remedy this, future studies should involve additional study areas impacted by natural disasters and compare them with non-damaged areas in the context of longitudinal spatial econometric analysis (e.g., quasi-experimental control group methodology, spatial regression, and regression discontinuity design). In addition to this, once secondary data are available from necessary sources, subsequent research should be undertaken that encompasses more recent years of hurricanes making landfall adjacent to national park sites.

Finally, like other studies using panel data, this study has limitations for discovering the determinants of economic vulnerability and resiliency to natural disasters within a distinct study area and time period. For this reason, future studies should employ other empirical methods (e.g., intervention analysis in a time series and dynamic panel analysis). Despite these limitations, in keeping with the concept of sustainable tourism management including disaster vulnerability and resilience of tourism-based economies, this study provides an extensive empirical effort analyzing the vulnerability and resiliency of tourism-based regional economies impacted by natural disasters.

5.2 From vulnerability and resiliency to sustainable tourism

As discussed earlier, our findings suggest that better economic performance prior to the occurrence of natural disasters leads to minimized disaster losses. More effort to improve regional economic conditions before natural disasters is necessary to minimize damage (Toya and Skidmore 2007). To mitigate economic vulnerability, disaster-prone regions should set aside resources to make residents safer. For this, policy makers and planners at the city or regional level along with residents need to work together, based on planning for disaster mitigation or resiliency activities related to economic development and social justice, thus "achieving the multiple objectives needed for a resilient system" (Godschalk 2003, 140). In particular, to mitigate the economic vulnerability in disaster-prone tourism-dependent areas, effective and proactive tourism disaster planning and management and community-based sustainable approaches can help minimize disaster loss while helping to make disaster-prone and tourism-based communities more resilient to future events (Aswani et al. 2015; Faulkner 2001; Hall 2008; Prideaux 2004; Ritchie 2008, 2009). Initial results of this modeling effort suggest that disaster damage has a negative association with regional economic structure and that engaged social capital, more equitable distributional characteristics, and local proactive planning in place before the disaster results in lower disaster losses.

Ultimately, economic resiliency to natural disasters leads to sustainable economic development at the regional or community level (Campanella 2006). Furthermore, the importance of sustainable economic development in decreasing vulnerability is recognized, especially as it increases the opportunity for achieving disaster resiliency in tourism-dependent regions (Liu et al. 2011). For this reason, lessons learned from the economic impacts of past natural disasters, in particular in tourism-based regions, can help regional planners or policy makers predict problems related to disasters and prepare before the next disaster occurs.

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