

Climate, Weather and Tourism: Bridging Science and Practice



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A person in a yellow kayak is paddling down a narrow, calm river. The river is flanked by dense green trees and vegetation. The water is still, reflecting the surrounding greenery. The person is wearing a blue life vest and a white cap. The overall scene is peaceful and scenic.

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Executive Summary

In November, 2008, approximately 100 scientists, academics, public policy officials, non-profit leaders and business owners, met on the campus of East Carolina University (ECU) for a Climate, Weather and Tourism Workshop sponsored by ECU's Center for Sustainable Tourism. One of the objectives of the workshop was to identify common themes that emerged and to communicate these themes to immediately improve business practices and help direct long-range research and policy goals.

In this publication the tourism industry's relationship with weather and climate is defined and recent tourism trends and preferences are explored. Next, types of weather information and ways to disseminate them are presented. Adaptation and mitigation strategies to climate variability and change are then offered and, finally, climate is placed in the context of sustainable tourism.

Tourists are choosing outdoor and nature based activities now more than ever before. At the same time, their decision timelines and length of vacations are shortening. Thus, weather becomes an increasingly important factor in choosing where to travel as well as the overall satisfaction level with the vacation experience. Throughout this document, North Carolina is used as a model for exploring the issues and opportunities of weather and climate, because the state has a broad range and variety of tourism sectors – agritourism, golfing, whitewater rafting, skiing, biking and coastal-related recreational activities to name a few – which are all uniquely affected by adverse weather conditions and climate change.

The aforementioned trends in tourism are beginning to influence marketing strategies. Maintaining a sustainable business in the face of climate change and weather variability begins with an understanding of the weather preferences of the tourist and then matching these preferences with reliable

weather and climate information for efficient and effective marketing. Thus, it is essential that tourism businesses and destination communities have access to short and long-term weather and climate data in a form that is easy to interpret. The Geographic Information System-based web portal (GIS) is one way that multiple layers of data can be easily accessed and overlain for addressing specific questions. However, it often takes extension and outreach specialists or atmospheric scientists with training in applications, to effectively communicate information from the masses of data available. FAQ sheets, blogs, and community meetings are all ways scientists can help support tourism operations.

Finally, tourism businesses from each sector must assess what they can do to adapt to and mitigate the effects of climate change. Climate change generally entails higher temperatures globally, an increase in extreme weather events, changes in frequency of extreme events, sea-level rise, and substantial warming at higher latitudes and altitudes. Many of these changes will bring unknown effects, whether positive or negative, to the tourism industry. However, tourism cannot face these 21st century challenges in isolation. A fundamental challenge to addressing climate change is the lack of an "institution" devoted to bringing various stakeholders, scientists, managers, business operators, and political leadership, together on the question of adaptation. Mitigation is also important as the "tourism industry" is responsible for a large portion of anthropogenic greenhouse gas emission. Many tourism businesses are going green, including the use of energy efficient light bulbs, thermostat turn-backs, waste and water management practices and even small scale solar energy. A final piece is the education of the tourist. The "quadruple bottom line" of environmental, social, economic, and climate responsiveness will only be achieved by instilling in guests the connection between climate change and the long-term sustainability of their favorite vacation destination.

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The tourism industry and weather and climate.

Each and every day there are vacationers making decisions about where to travel in order to pursue their favorite recreational activity. Tourism destinations and their individual tourism businesses are all vying for the expenditures and vitality these tourists bring to their respective locations. But, in making travel choices, these vacationers have many considerations besides distance and cost. They are taking into consideration the weather of the day or week as well as other factors induced by climate in determining both where to go and ultimately the extent to which they enjoy their travel experience. Wind, humidity, temperature, drought or storm conditions, snow conditions, water temperature, and degree of sunshine are a few of the factors that affect the visitor's decision, satisfaction and the extent of spending—that important economic “bottom line” for tourism businesses and tourism destinations.

Tourism is considered to be a socio-economic activity dependant on the characteristics of a destination. It is a phenomenon designed to satisfy the needs and expectations of visitors who wish to participate in pleasurable and fulfilling experiences away from their normal home environment. Tourism is also viewed as a multi-faceted activity consisting of tasks and functions both directly and indirectly related to customer or visitor services and satisfactions. Tourism is considered a major industry in almost every U.S. state and territory and historically has been an important contributor to our nation's balance of trade.

Within North Carolina, as with most states, tourism is a major economic driver. Consequently there is substantial public and private investment in attractions and supporting infrastructure. Tourists come for business purposes, for conventions and conferences, for government business and educational travel, for leisure and holidays, and to visit family and friends. Their travel expenditures are tracked through the North American Industrial Classification System within five expenditure categories, those being 1) Performing Arts, Spectator Sports and Related Industries, 2) Museums, Historical Sites, and Similar Institutions, 3) Amusement, Gambling, and Recreation Industries, 4) Accommodations, and 5) Food Services and Drinking Places.

Tourism in North Carolina is one of the State's largest industries accounting for \$16.9 billion in travel expenditures, \$4.2 billion in payroll, \$1.3 billion in state and local tax receipts and employing roughly 190,000 state residents (2008 figures). Visitor spending reduces the tax burden of each North Carolina household by \$374. As a domestic destination, North Carolina ranks sixth behind California, Florida, Texas, New York and Pennsylvania and receives about 358,000 international visitors annually. Among the 20 coastal counties there are roughly 4,000 businesses between the Arts, Entertainment, and Recreation Sector of tourism and the Accommodation and Food Service Sector¹. Across all of North Carolina there are approximately 27,300 tourism-related businesses most of which are influenced daily and seasonally in some fashion by weather and climate-induced factors.

Weather and the influences of climate frequently emerge as important criteria for choosing a tourism destination as they help in determining the appeal of a location in absolute or relative terms. The tourism industry is particularly sensitive to weather conditions and climate variability; it can compel businesses to shorten traditional profit-making seasons, force them to raise prices to help cover economic losses, and can challenge them in retaining stable business activity and year-round permanent residents². (Fig. 1) Weather fluctuations and climate variability affect tourism planning in addition to the tourists' destination decisions³ keeping in mind that weather and climate can serve as an opportunity for tourism as well as a potential threat. When travelers choose alternative destinations, the economic effects can

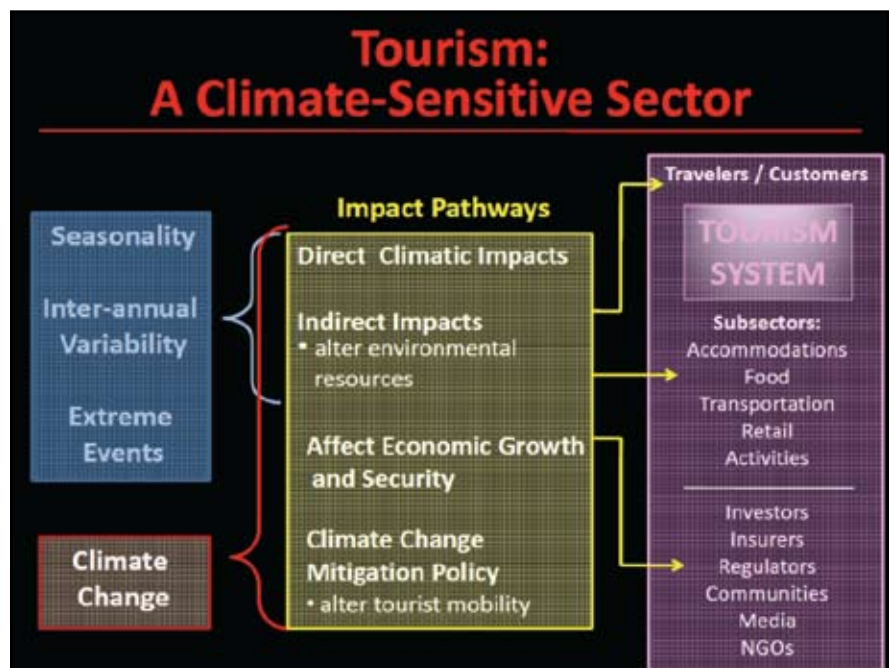


Figure 1. Linkages between climate and tourism.

"Weather can ruin a holiday, but climate can ruin a destination."

Daniel Scott
Chairperson, WMO Commission on Climatology
Expert Team on Climate and Tourism

is uniquely vulnerable to these conditions because of the range and variety of tourism sectors represented in the state – golfing, whitewater rafting, skiing, biking and coastal-related recreational activities are only a few examples. The mountain, Piedmont and coastal tourism economies of North Carolina are all structured to support the tourist orientation and demand and thus weather and ultimately climate change can dramatically impact economic success. Specifically, four sectors show this orientation⁵:

- Construction, where more homes and businesses are being built to meet the needs of the ever-growing visitor and retiree population;
- Retail trade, ranging from souvenir shops to clothing and grocery stores;
- Real estate, renting, leasing, and selling of mountain and beach houses and second homes; and,
- Leisure and hospitality, meeting the recreation, accommodation, and food service needs of visitors.

Policy makers, government officials, business operators, scientists and academic researchers are all turning their attention to the important linkages of weather, climate and tourism. The World Meteorological Organization, NATO, the International Society of Biometeorology, the World Tourism Organization, and UNEP are a few of the groups addressing this relationship. Additionally, the authors of this publication have been involved with the planning of two regional workshops on climate and tourism here in the US, one at the University of Colorado in Boulder, Colorado, and a second at East Carolina University in Greenville, North Carolina. The weather and climate issues facing businesses across the country, whether those businesses are involved directly and indirectly in the tourism industry, require immediate attention from many different disciplines or institutions.

Preferences and trends of tourists and how their decisions are shaped by weather and climate.

Tourism is similar to agriculture, transportation and the insurance industries in that it is a highly climate-sensitive economic sector. Perceptions that tourists have about weather conditions and climate can be as strong a factor in making travel decisions as the actual conditions that are present. And the public reporting of weather conditions and events can often determine the ultimate level of visitation and resulting tourist expenditures.

Despite the fundamental influence that climate has on a state's tourism industry, there is limited understanding of the relationship between tourism business operations, the weather, and a changing climate, particularly with respect to longer term sustainability⁶. Climate change generally entails higher temperatures globally, an increase in extreme weather events, changes in frequency of extreme events, sea-level rise, and substantial warming at higher latitudes and altitudes. One of the observed impacts of this warming has been an increase in the number of frost-free days across the west and southwest (Fig. 2). The implications of fewer frost free days are evident in the loss of snow on the shoulder seasons of ski areas. This phenomenon, combined with more precipitation falling as rain as opposed to snow, is leading to a decrease in the snow season affecting management of resources and the level of visitor revenues.

⁴(UNWTO, 2007) ⁵(Kleckley, 2008) ⁶(Nicholls, 2004)

be devastating to local economies and alter the patterns of tourism for long periods of time.

The effects of weather and climate over the long term can reverberate through businesses and host communities which rely heavily on tourism to generate income. They can also affect other industries and sectors that supply these communities and the tourism sector indirectly⁴. North Carolina

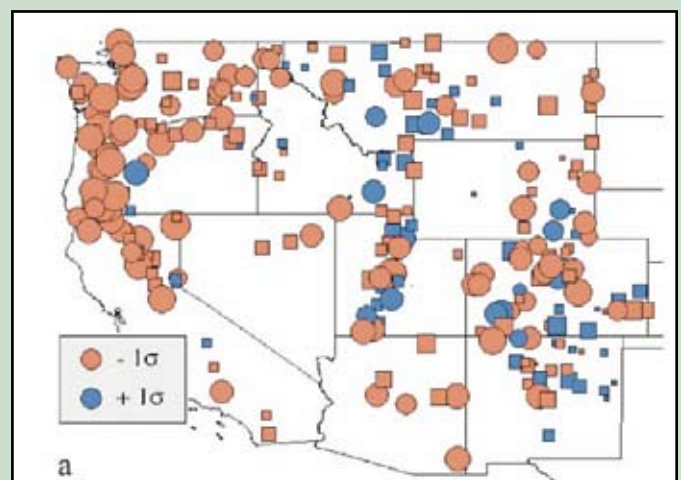


Figure 2. Trends in fraction of winter precipitation falling as snow (blue symbols) versus rain (red symbols) from 1949 to 2004. Circles denote high trend significance. Figure is a reproduction of Figure 1a in Knowles et al. (2006).

Tourism's relationship to climate change is complex but direct, and generally there are two effects:⁷ 1) making the destination more or less attractive, and 2) making the origin of departure more or less attractive. Researchers⁸ have presented a climate change model where in general countries with cooler climates (e.g. Canada) are expected to gain more tourists (arrivals) than lose tourists (departures) to other destinations as compared to countries with warmer climates⁹ (Fig. 3).

Tourism businesses and travel destinations are turning more to weather and climate information to aid in focusing traveler marketing efforts during periods when climate conditions are favorable. Climate variability and changing weather patterns over the short term can affect tourism planning, as well as affecting tourists' destination decisions¹⁰. These short term effects can be more detrimental to businesses if such effects create increasingly changed patterns of tourist demand and tourist flow. Over the long term this reverberates through businesses and host communities that rely heavily on the tourism sector to generate income¹¹. There have already been significant attempts in North Carolina to use weather information and tourists' environmental perceptions for decision-making and marketing. Authorities at Pinehurst¹² Golf Resort report that when the weather is favorable, locally direct e-mail marketing is used to advertise excellent golf conditions to surrounding areas in North Carolina, Virginia and South Carolina, that may be experiencing poor weather conditions in their own location. Rafting companies¹³ have reported the use of the Personal Digital Assistant (PDA) to communicate when river levels are most conducive to a great rafting experience.

A primary research tool for assessing the trends in recreation and tourism in the United States is the National Survey on Recreation and the Environment (since 1960) which focuses on demographic trends across a range of outdoor recreation activities¹⁴. Between 2000 and 2007, the total number of people participating in outdoor and nature-based activities grew (Fig. 4) and the number of days spent participating in these activities also increased (Fig. 5). One emerging factor in this growth has been the increasing role of women in outdoor recreation. Some traditional activities such as mountain biking, downhill skiing, and rafting have seen a decline in participants and participant days¹⁵ and the mix of activities has been changing over time most specifically an increase in visitation to public lands. But, while leisure has been increasing, time devoted to outdoor recreation has in fact decreased as people are taking more frequent but shorter duration trips (Fig. 6). This trend has been attributed in many ways to a changing economy as household discretionary income is being further stretched. Additionally, as gas prices rise, tourists increasingly are seeking more inexpensive local destinations (e.g. walking trails) for recreation and leisure, rather than long-distance trips (e.g. skiing vacations) that tend to be more costly. These changing recreational decisions are impacting local areas and forcing them to adjust to changing tourist flows and new demands on local resources.

The development of climate indices, matching climate and weather factors with tourism choice and destination preference, is shedding light on factors that influence vacation decisions and

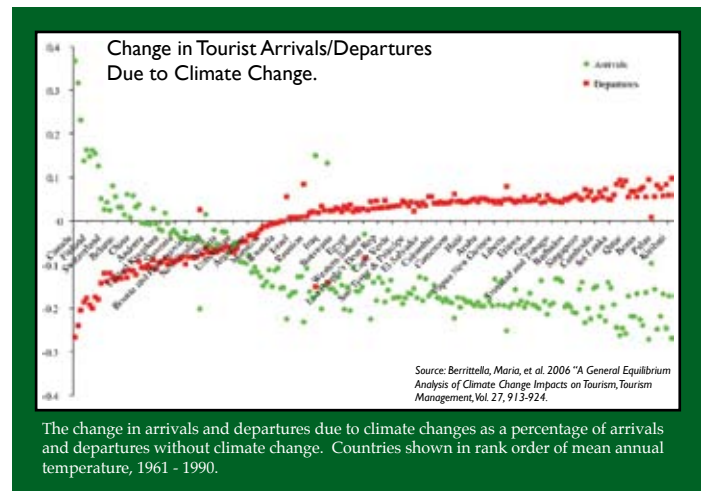


Figure 3. Change in tourist arrivals/departures because of climate change. A reproduction of figure 1 from Berrittella et al. (2006).

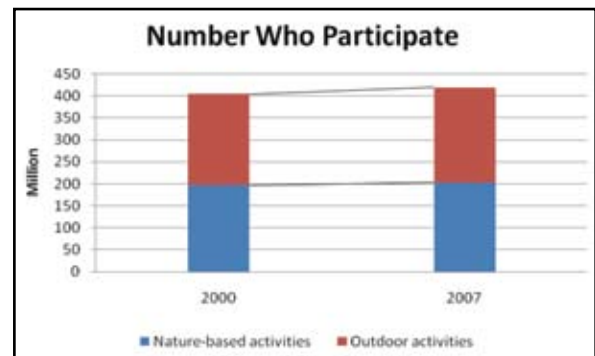


Figure 4. Changes in the number of people participating in outdoor and nature-based activities.

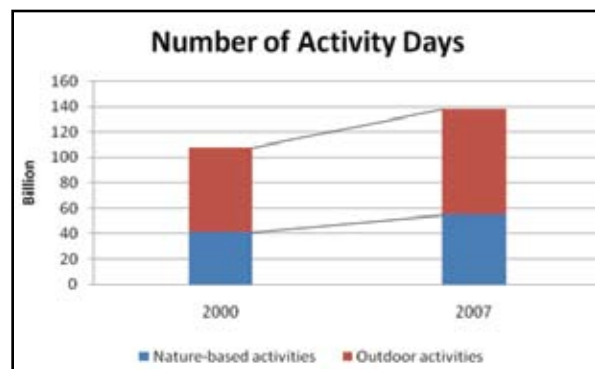


Figure 5. Changes in the number of days people participate in outdoor and nature-based activities.

⁷Berrittella et al. (2006) ⁸Berrittella et al. (2006) ⁹(e.g. Qatar) ¹⁰(de Freitas, 2003) ¹¹(Martin, 2004; UNWTO, 2007) ¹²Bob Farren, Director of Grounds and Golf Course Management, Pinehurst Resort and Country Club ¹³Jeff Greiner, Vice President for Marketing, Wildwater LTD ¹⁴(Cordell, 2008) ¹⁵(Cordell, 2008)

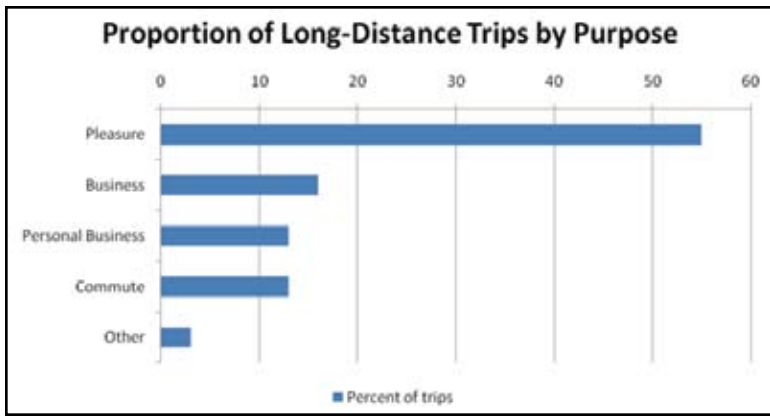


Figure 6. Proportion of long distance trips by purpose. Source is the 2001 National Household Travel Survey, preliminary long distance file, U.S. Department of Transportation.

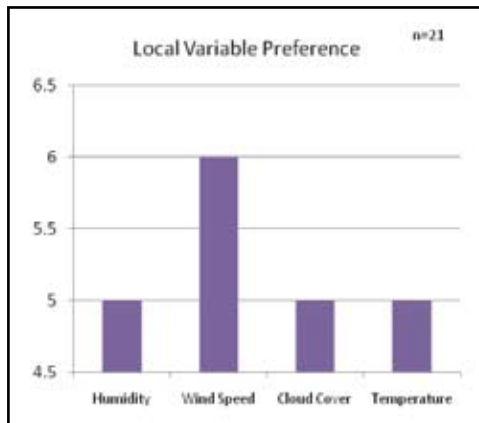
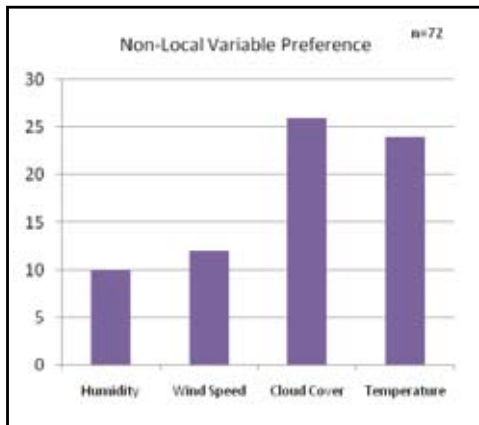


Figure 7. Number of Outer Banks tourists and locals selecting variable that has the strongest influence on their decision to come to the beach.

participant enjoyment. East Carolina University researchers¹⁶ are developing a climate index specific to the beach experience, using threshold values for heat, humidity, and environmental aestheticism (e.g. cloudiness). Data collected from beachgoers indicates that coastal tourists are more influenced by factors such as wind and cloud cover than by heat or humidity (Fig. 7). This finding challenges a commonly held notion that temperature is the primary driver of beach tourism and suggests there may be some alternative ways for businesses to creatively market to beach tourists when conditions are less than ideal.

This research also found significant differences between the “ideal” conditions as perceived by locals and non-locals with wind being a key variable for locals in deciding whether or not to go to the beach. Incorporation of this “locals’ behavior” could be utilized by tourism businesses to more effectively market to tourist populations, both on site and potential visitors, by better communicating wind conditions. This finding of course is contrary to the unique needs of kite boarders who depend upon higher winds in order to participate in their preferred beach activity. Tourism businesses, by understanding key variables which factor into the tourist decision-making process, can potentially better market and advertise to their respective tourist populations.

“Collectively and individually the tourism industry can no longer afford to ignore climate change...”

Fiona Jeffery
Chairperson of World Travel Market 2007

¹⁶ (Curtis, Arrigo and Covington, 2008)

Climate scientists and tourism professionals each understand variability and trends within their respective fields but lack a clear way to communicate their knowledge and information needs to each other. Part of the explanation of this communications disconnect may stem from each community talking in a different language. Another problem may be finding a common platform to exchange ideas and integrate information. There are also non-climate tourism drivers that need to be accounted for, such as the state of the economy and competing tourist destinations. Thus, a systems approach is critical where information can be better delivered to decision makers for sustainable tourism planning and policy.

Weather and climate information needs of tourism businesses, planners, investors and policy makers.



Figure 8. Kiteboarding on the Outer Banks of North Carolina. Photo courtesy of Kitty Hawk Kites, Nags Head, NC.

Many tourism businesses either do not know exactly what their needs are or have weather and climate information needs that are specific to the unique activities they provide. Key meteorological variables might include temperature, wind, precipitation amounts and types, and sunshine. Sometimes tourism businesses in the same geographical location can have conflicting requirements regarding the same variable. For example, in coastal areas, a vacation/golf resort may prefer light wind, while a sailboat rental shop would desire a stronger wind (Fig. 8). Other businesses, especially agritourism and wine tourism, are secondarily impacted by seasonal climate variability – for example the length and quality of leaf color or wine quality depends on a number of complex atmospheric conditions occurring over many weeks to months, even years.

There have been attempts by some researchers and tourism operators to use weather as a “performance” index. For example, wind surfers have an informal hundred degree rule, where acceptable weather conditions occur when the water temperature plus the air temperature are greater than 100 degrees Fahrenheit¹⁷. Most North Carolina tourism businesses also have a keen sensitivity to drought. Thus, precipitation data is often sought and knowing the regional distribution of rainfall and its forecasted probabilities can be used in marketing efforts. It is also important that tourism businesses and destination communities have access to short and long-term weather and climate data in a form that is easy to interpret. Researchers report¹⁸ that climate data is useful for consumers in determining the destination, timing of travel, and activity of choice;

weather forecasts are important for last minute holiday destination choices and activity choices; and the actual weather on the trip is related to activity choice, holiday satisfaction, and spending (Fig. 9).

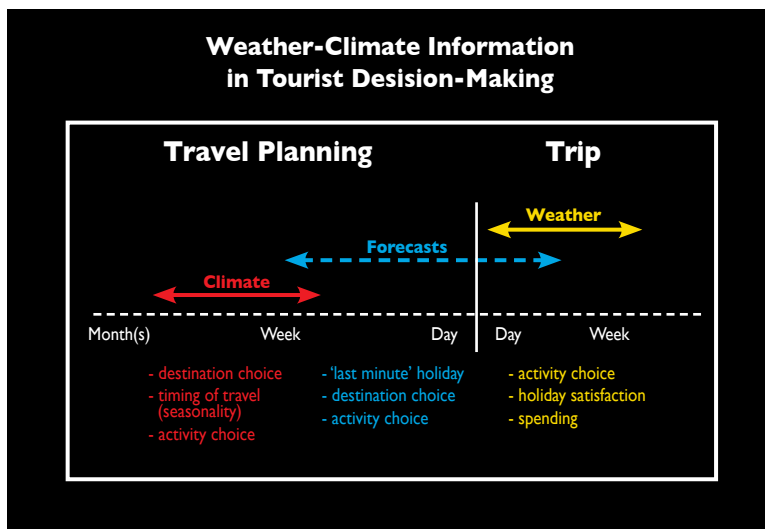


Figure 9. Tourist decision time line.

Policy makers and planners are looking increasingly to the emerging field of climate-tourism for direction. The Davos Declaration states there is “a need to urgently adopt a range of policies which encourages truly sustainable tourism which reflects a quadruple bottom line of environment, social, economic and climate responsiveness”¹⁹. There is now an international call for concerted government, industry, and consumer action around the commonly agreed Kyoto (and post-Kyoto) framework on climate change being led by the United Nations.

Combining climate and economic data into useable information for tourism businesses and destinations.

In North Carolina there is an interrelationship between tourism and other major industries that are primarily controlled by local leadership and a local decision-making process²⁰, hence the need for a systems approach. Select business data such as occupancy tax receipts or transportation data such as traffic flow, should be compared with climate-tourism indices to help determine the relative influence of weather on the tourist's decision-making process and the resultant tourist expenditures.

The interface of tourism and economics in North Carolina was explored in a recent study²¹ showing the impact of lost beach areas from 18 inches of sea level rise projected by 2080 to be as high as \$60 billion. Lost recreation value to local anglers was estimated to be \$15 million by 2030 and \$17 million by 2080. The transportation infrastructure was also determined to be at risk due to sea level rise. It should be noted that tourism travel is a substantial emitter of greenhouse gases, 5th highest if equated to country level emissions²², and is thus an important component in the discussion of global warming mitigation.

Unfortunately, transportation is less efficient now than three decades ago due to the increases in miles traveled, which can be traced to the increase in global wealth (Fig. 10). In the case of Rocky Mountain National Park in Colorado, it has been determined that transportation accounts for 84% of a tourist's total emissions, compared with lesser amounts attributable to accommodations and recreational activities. This imbalance is highlighted by the fact that long holidays tend to reduce a person's travel carbon footprint compared to what would be generated if the person stayed home²³.

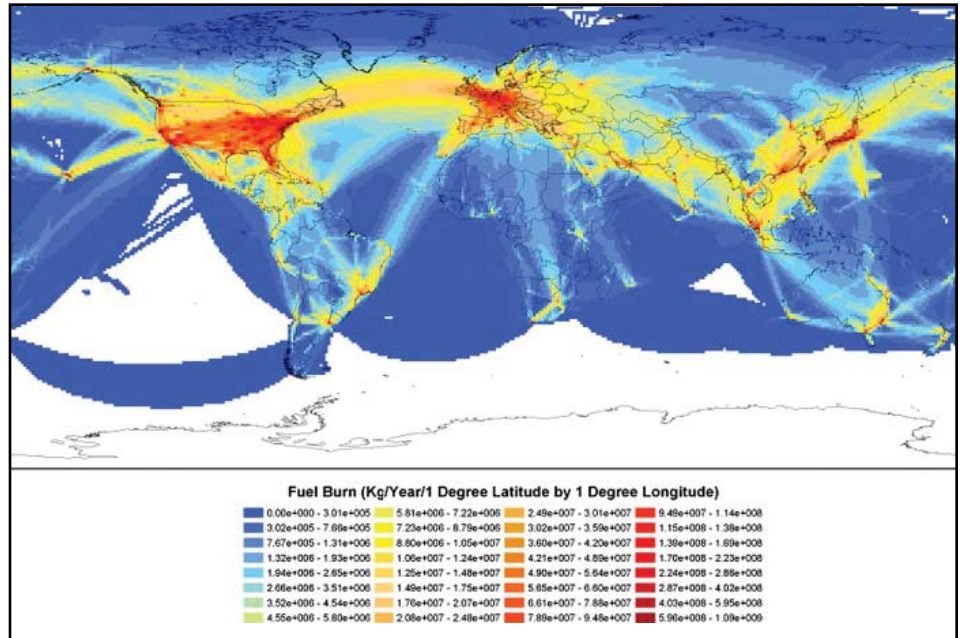


Figure 10. Fuel burn due to air travel. A reproduction of figure 8 from Kim et al. (2007).

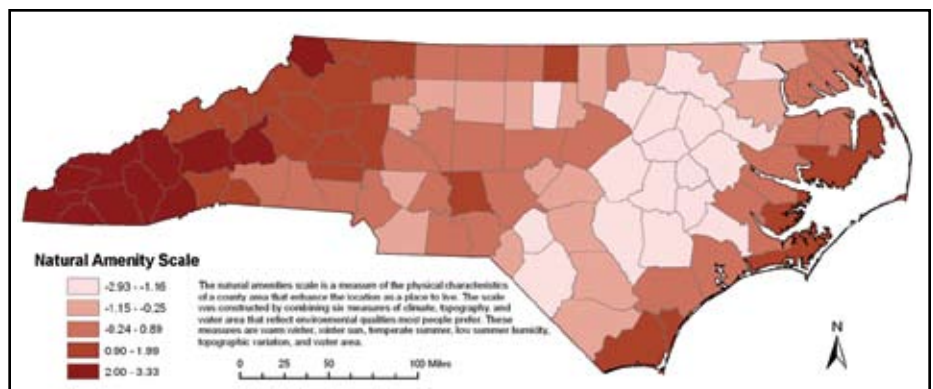


Figure 11. Natural amenities index for North Carolina.

There is a growing consensus that GIS holds a key to effectively combining the various economic and weather data sets. GIS has been used to map such variables as climate, transportation infrastructure, tourism amenities (Fig. 11), hotel receipts, foliage color, and corridors and trails. These variables can then be integrated for the tailored needs of the tourism operator. Some climate sensitive tourism activities already have GIS-based informational resources housed on the Internet (www.obxsurfinfo.com). GIS is being used to explore potential impacts of environmental change on tourism and vice versa; for example, the potential affect of wind energy development (Fig. 12) and pollution sources on the quality of coastal tourism²⁴. GIS is also useful for natural hazard risk visualization and assessments.



Figure 12. Wind farm design on the Outer Banks of North Carolina, courtesy of RENCI@ECU.

²⁰ (Kleckley, 2008) ²¹ (Bin et al. 2007) ²² (Scott, 2008) ²³ (Hunter and Shaw 2007) ²⁴ (Allen, 2008)

GIS could be an effective way to automate the emerging weather-based marketing approach of many tourism sectors. Forecasts from the National Digital Forecast Database of the National Weather Service are available on a 3 mile (5 km) grid. This information could be overlaid with a digital road map and combined with a decision model to strategically target electronic advertisements at lead times of one to 48 hours.

Strategies to communicate weather information accurately and timely.

One problem encountered by many tourism businesses is the way media portrays the impact of weather and climate on tourism operations (Fig. 13). Tourism perceptions are critical to the choices consumers make and an inaccurate or unnecessarily negative presentation can be devastating. Difficulties in providing consistency in weather reporting is one reason that tourism businesses are turning to scientific data for realistic information and promotion strategies. The National Climatic Data Center (NCDC), North Carolina Climate Office (NCCO), Southeast Regional Climate Center (SERCC), and North Carolina Sea Grant are all developing ways to interface with tourists and tourism businesses to communicate climate data most effectively. These centers are taking on the challenge of creating information from vast data resources²⁵ (Fig. 14).



Figure 13. Meteorologist for the Weather Center, The Weather Channel.



Figure 14. Linking data resources and user needs through information creation.

NCDC's data is currently being used only in limited ways for tourism support²⁶. One of NCDC's most popular services, the NOAA Virtual Data System, is an online service presented within a GIS framework (Fig. 15). The GIS-based access portal provides



Figure 15. National Climate Data Center, Hourly Global Surface Data Web Page.

data that is Google Earth compatible and allows for the overlay of various layers of information. The NCDC also produces "climatological normals" or averages as well as extreme statistics, which can be helpful in deciding the location of new tourism businesses. Multivariate summaries are another option. For example, some businesses would benefit from knowing the local frequencies of wind speed and direction. The SERCC serves as a clearinghouse or secondary provider of data²⁷ for a six-state region that includes North Carolina as well as Puerto Rico. The SERCC also synthesizes and monitors climate change such as drought and fall foliage to help answer common questions across the region.

Weather and climate education is part of the solution to communication problems as there is a good deal of weather and climate awareness, but very little weather and climate education²⁸. Often the NCCO must correct common weather and climate misconceptions, which are sometimes promulgated by the media. In addition to education, the NCCO has a focus on data collection and storage, applications, and collaborations with scientists and end users. Finally, North Carolina Sea Grant provides climate extension services to

Great Wolf Resorts, Inc.

www.greatwolf.com

www.projectgreenwolf.com

Great Wolf Resorts is North America's largest family of indoor waterpark resorts, and, through its subsidiaries and affiliates, owns and operates its family resorts under the Great Wolf Lodge and Blue Harbor Resort brands. The company's resorts are family-oriented destination facilities that generally feature 300 - 600 rooms and a large indoor entertainment area measuring 40,000 - 100,000 square feet. Through Great Wolf Resorts' environmental sustainability program, Project Green Wolf, the company is the first and only national hotel chain to have all US properties Green Seal Certified at the Silver Level.

Great Wolf Resorts addresses the issues of climate and weather in their business model in two ways. First, they provide a family friendly controlled indoor waterpark experience unaffected by weather except under extreme outdoor weather conditions which may prohibit travel. Second, Great Wolf Resorts has taken aggressive actions to lessen its carbon footprint and thus Greenhouse Gas Emissions of all of its properties. At Great Wolf Lodge in the Pocono Mountains, PA, for example, the company saved nearly nine million gallons of water in one year by changing plumbing fixtures to low-flow units. This water, and resulting cost savings, represents only one property in the company's portfolio of 12 resorts. Across the board, the company is using less electricity and gas, which saves natural resources reducing both the footprint and company expenses in these areas. Both the hotel and waterpark portions of the business are part of Project Green Wolf which includes an inventive educational program for the resorts' youngest guests created in partnership with National Geographic Kids.

While some specifics vary by property, key areas of the Project Green Wolf program include:

- **Management of Fresh Water Resources:** Water conservation programs include guest linen recycling; laundry facilities that recycle most of the consumed water; low-flow showers, toilets, and faucets; and waterless urinals. Additionally, by using the latest in pool filtration technology, most of the water in the waterparks can be recycled.
- **Waste Minimization: Recycling and Reuse:** Recycling bins are available in all public areas, guest rooms and employee areas. When possible, Great Wolf Lodge works with local waste specialists to compost food waste and donate unused food items to local charities.
- **Energy Efficiency:** Throughout the resorts, Great Wolf Lodge uses energy-efficient bulbs, highly efficient heating and ventilation equipment, and Energy Star appliances.
- **Environmentally and Socially Sensitive Purchasing:** Great Wolf Lodge's purchasing partners are held accountable to ensure that every item ordered is environmentally sensitive. All paper products are post-consumer recycled, dishwashing and laundry detergents are biodegradable, and paint is low VOC.

"We believe green tourism is the most important travel trend of our lifetime, and we wanted to do the right thing by taking a leadership position on this," said Kim Schaefer, chief executive officer of Great Wolf Resorts. "It's nice to be recognized as the first national hotel chain to achieve Green Seal Certification, yet more importantly, it's gratifying to know we're doing our part to create a sustainable tourism product for lots of families and generations to come."

The natural systems that support North Carolina’s tourism economy will most certainly be increasingly under stress from natural and anthropogenic forces. The need for information about these changing forces is only part of an all important research and management agenda. As tourists’ expectations and activities change in conjunction with climate, weather



Figure 16. Birding in Carolina Beach State Park. Photo courtesy of the North Carolina Division of Tourism.

conditions and a changing environment, there will be competing demands on the natural resource base relied upon by the tourist industry from the mountains to the coast. Quantifying the vulnerability of specific environments, locales and sectors of the tourism industry can and should inform adaptation and business management strategies. Across the state variations in the demands on the natural resource base and in the capacity of tourism business to adapt to changing economic, environmental and social conditions will necessitate the creation of new institutions to support adaptation and sustainable practices in the industry. Approaching adaptation in a reasoned and informed way will be a key to successfully navigating the changing landscape of climate and tourism (Fig. 16).

Vulnerability and the adaptive and management capacities of North Carolina tourism businesses to climate change.



Figure 17. Serendipity at the Outer Banks.

Assessing the current adaptive capacity of North Carolina tourist businesses is a necessary first step in understanding future vulnerability and adaptation strategies. This is, however, not a straightforward task. All tourism sectors face distinct and unique vulnerabilities due to changing climate and environmental conditions, and individual businesses vary in their current adaptation planning and capabilities.

The broad patterns of vulnerability are known. For example, sea level rise from climate change will increase coastal erosion and habitat loss related to saltwater intrusion³⁰ and this phenomenon is a major focus of coastal agencies. The National Sea Grant College Program of North Carolina Sea Grant, has identified a number of risks and strategies related to this specific issue. It has been argued that a fundamental challenge to addressing climate change is the lack of an “institution” devoted to bringing the various stakeholders, scientists, managers, business operators, and political leadership together on the question of adaptation³¹. Work done by North Carolina Sea Grant, particularly on coastal vulnerabilities due to sea level rise, shows the possibility of bridging the gap of federal priorities and interest to local level information and research needs that assist businesses and local governments.

Although the broad vulnerability is sea level rise, federal or large scale attention cannot answer some of the fundamental questions of adaptation of a specific region or local destination. For example, the impact of sea level rise will be felt through changing insurance costs and property values but will play out based on a case by case basis driven by other local factors and individual events (Fig. 17). One house may be at risk because of the particular orientation of a coastline or the track of a specific storm, while others

seemingly under the same risk will be spared. The challenge is to devise federal or region wide adaptation regimes and institutions that can effectively provide support to what will necessarily be local decisions.

Thus, the current adaptive capacity of North Carolina's tourism businesses is best examined in a systematic way that includes a holistic view of adaptation. The first step should be to identify regional or sector vulnerabilities. For the coastal environment, these will be sea level rise and its associated affects, and such things as increased "storminess". For the mountains, these will be such things as the predicted warming winter temperatures and changes in precipitation. It is from these regional or sector vulnerabilities that adaptive capacity can be estimated and assessed.

A central question is whether business operators are overestimating their adaptive capacity, and what their long term planning and management strategies have been thus far. Tackling the assessment of current adaptive capacity through a more decentralized approach will address this question. Estimating future adaptive capacity to climate change by measuring and assessing current practices related to climate variability can only be done by engaging the current business operators and other involved members of the tourism industry.

One general prediction of regional climate change is that the incidence of drought will increase. Under such circumstances the adaptive capacities of tourism businesses will surely be tested. One need only look to the recent past – severe droughts from 1999 – 2002 and from 2006 to the present that have affected tourist sensitive regions to note adaptive capacities. For

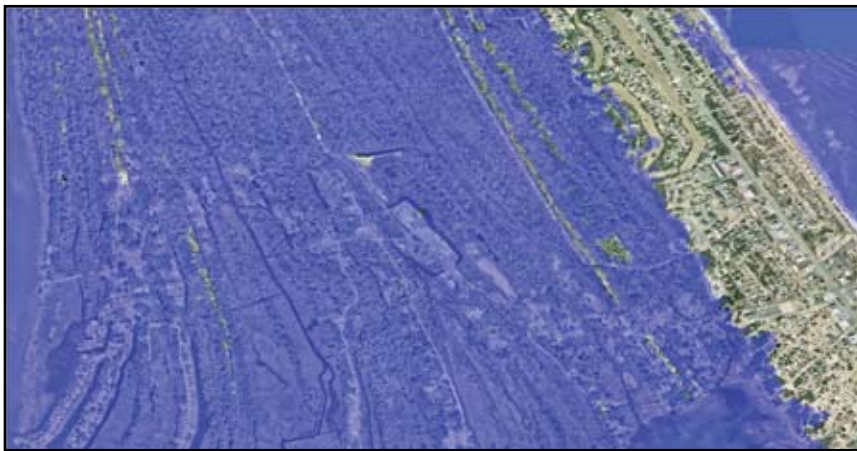


Figure 18. 100-year coastal flood simulation, Kitty Hawk, NC courtesy of RENCI@ECU.

North Carolina's golf industry, increased drought puts additional pressure on water use, use of fertilizers and course management. For the restaurant sector, installing water saving spray heads in dishwashers and the practice of serving water to patrons only upon request, will be expanded to other water saving techniques. Experiences of current businesses can give insight into adaptive capacity and strategies of how to strengthen it. Similarly, when assessing the coastal capacity to successfully mitigate and adapt to hazards posed by increased storminess, the experiences of current tourism operators with recent storms and how they assess their vulnerability changing in the future, will be most critical (Fig. 18).

While looking for recent analogs is a valid approach, one must also recognize that some aspects of climate change will create vulnerabilities that tourism destinations have not faced before, or such vulnerabilities may occur on a much larger scale. One such possibility is the expanding range of diseases and invasive species that threaten the health of both North Carolina's ecosystems as well as its population. Several coastal organisms responsible for varied phenomena such as red tides, beach asthma attacks, and shellfish poisoning are all expected to increase and to expand their range along our coasts³². Additionally, the coast is expected to see large increases in storm water and the consequences of storm water runoff, already the top pollution source, due to projected population increases³³. The impacts of increased population and the possibility of a changing storm or precipitation regime loom large as a potentially disastrous challenge to storm water management practices. Work done at the multi-campus UNC Coastal Studies Institute champions a holistic approach of managing the entire water budget; this should result in improved water quality in addition to isolating or tracking specific sources. This approach is a large departure from current practice and is a major question mark in the region's ability to adapt in the future.

Implications of climate change for sustainable tourism and future tourism development.

Adaptation is clearly necessary--climate change is and will affect tourism. On the flip side, however, tourism activity and resource use affects climate and the natural environment. Thus, planning criteria for tourism businesses should recognize the bi-directionality of climate change and tourism. There has been an increasing trend toward green and sustainable practices in the tourism industry. These practices need to be maintained and expanded even with the increasing pressure for mitigation and adaptation.

Similar to assessing adaptive capacity, the future of sustainable tourism in North Carolina can be viewed through the lens of present analogs. What are businesses already doing to promote sustainability? How and why are they successful or not? To

³² (Swinker, 2008) ³³ (White, 2008)



Figure 19. Green Fudge Shop at Grandfather Mountain.

what extent are such practices economically viable? How can new tourism development be addressed to account for both factors of adapting to changing climate conditions and promoting sustainability?

Many North Carolina tourism businesses are already engaging in green practices, and from these we can explore the accounting that goes into adopting sustainable practices. Two such entities are Grandfather Mountain and Bald Head Island Conservancy. Grandfather Mountain has placed sustainability as a top priority implementing a number of small but significant changes, including the use of energy efficient light bulbs, thermostat turn backs and small scale solar (Fig. 19). These actions allow Grandfather Mountain to become more sustainable and more profitable. Additionally, these types of actions, both economically and environmentally sound, can be promoted in the larger tourism community and have the potential of becoming even more cost effective in the future. In the bigger picture of overall greenhouse gas emissions what may be sacrificed is the intermittent view from Grandfather Mountain of the City of Charlotte (150 miles away) due to variations in air quality (Fig. 20).



Figure 20. View of Charlotte, NC from Grandfather Mountain.

Bald Head Island (BHI), a barrier island 35 miles SW of Wilmington, NC, has made education of its visitors an integral part of its mission. This unique destination engages in a strategy of low impact development and erosion control along its beaches, but because it is part of a system of barrier islands it still experiences significant erosion and is vulnerable to sea level rise (Fig. 21).

With climate change, a new accounting must be done. Larger projects such as solar and wind power have economic or logistical barriers and opportunities in certain locations yet investing in green building technology will be necessary in order to address emerging problems such as energy use, waste and water management, as well as storm water³⁴. In a changing climate, the development of successful tourism expansion is dependant in large part on the ability to successfully leverage and protect the environment. Sea level rise is a potential outcome of climate change, but also serves as an indicator that the changing environment will lead to the development of new tourism opportunities in other places. Adding climate change to the long term business planning perspective will guide more sustainable practices and, in the long run, more profitable business development. Finally, instilling in guests the direct connection to climate change and sustainability to their future travel experiences and satisfaction is an important factor in keeping sustainability at the forefront of business and tourism.



Figure 21. Addressing beach erosion on Bald Head Island.

Concluding Thoughts

Weather and climate affect every aspect of the natural environment and society, which in turn contributes to the ebb and flow of tourism dollars. Despite the fundamental influence that weather and climate have on tourism destinations - operation, aesthetics, and comfort level - there is limited understanding of the relationship between tourism sustainability and climate variability. First, it is important that each tourism business understands the impacts of weather on the tourist experience. Second, pertinent weather data should be used to construct site specific climate and tourism indices. Such indices should then be combined, using GIS for example, with economic data to quantify the impact weather has on sector specific activities. This information will allow businesses to adjust their current practices, recognize their vulnerabilities to future climate change, and develop adaptation strategies as necessary. Further, mitigation of climate change is everyone's responsibility and policies should be adopted to reduce the carbon footprint of the tourism industry. There is a pressing need for further discussion among tourism industry leaders and scientists, planners, investors and policy makers. In closing, the IPCC states that vulnerabilities of industries, infrastructures, settlements, and society to climate change are generally greater in certain high-risk areas. Tourism is included in this category because of its close link between economic vitality and climate-sensitive resources.

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