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Local consequences of climate change: State park visitations on the north Shore of Minnesota

Mark Kanazawa [a,*], Bruce Wilson [b], Kerry Holmberg [b]

[a] Department of Economics, Carleton College, United States
[b] Department of Bioproducts and Biosystems Engineering, University of Minnesota, United States

1. Introduction

Ongoing climate change is one of the major environmental challenges of our time, and economists have been actively engaged in trying to project its economic impacts. Economists are in broad consensus that these impacts are potentially quite large, but also that they are likely to vary significantly over different sectors of the economy. Agriculture, for example, is one sector that is likely to be disproportionately affected because of the likely impact of changing climate on the length of growing seasons, precipitation patterns, and so forth [1–7].

The tourism industry is another sector likely to be heavily affected, especially those forms of tourism that are based on outdoor amenities likely to be impacted by climate change. A large recent scholarly literature examines likely impacts of climate change on outdoor recreational activities.[1] The economic impact could be quite large: outdoor recreation currently accounts for nearly $650 billion in consumer spending in the United States alone, according to the main industry trade association.[2] Nevertheless, the scholarly study of climate change impacts on tourism remains underdeveloped compared to the study of impacts on other sectors [8–11].

Researchers have taken a variety of empirical approaches to determining the likely impact of climate change on recreational tourism. Most of these studies use a revealed-preference approach, based on some actual measure of tourism activity, such as destination choice, fishing activity, visits to national parks, or even rounds of golf.[3] Such studies model their chosen measure of tourism activity as determined by a set of variables, including some variables that measure climate change. In economic terms, the typical assumption, implicit or otherwise, is that climate change has the potential to shift the demand for the recreational activity by altering the quality of the recreational experience [12–14]. Recent studies have commonly found climate variables to have a systematic effect on tourism activity, while the magnitude and direction of the effect differs with regard to various factors, including the type of activity, time of year, and geographic location.[4]

An interpretive concern with many previous findings in the recreational tourism literature is that they fail to control for, nor to provide insight into, the impact of extreme climate events on tourism activity. As students of climate change know, a clear finding of the scientific literature is that ongoing climate change is likely to lead to increased incidence of extreme events, such as drought, floods, fires or heat waves (see, for example, Refs. [5,15–18]). In terms of affecting recreational tourism, the increased incidence of extreme events may well swamp the impact of marginal changes in the levels of climate variables such as temperatures.

* Corresponding author.
E-mail address: mkanazaw@carleton.edu (M. Kanazawa).

[1] The recent literature is voluminous. For a few representative studies, see Refs. [9,10,12–14,31–35.42].

[2] Outdoor Industry Association, https://outdoorindustry.org/research-tools/outdoor-recreation-economy/; accessed 2/29/2016. See also Ref. [10]; p. 259.

[3] Destination choice: Refs. [9,13]; Fishing activity: Ref. [36]; Visits to national parks: Refs. [31,32,37]; Rounds of golf: Ref. [33]. The other main alternative is the stated-preference approach, based on survey data. See Ref. [14].

[4] Refs. [10,37].

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It is not surprising that existing studies are unable to convincingly investigate the impact of extreme climate events, because the data used have typically been aggregated at the monthly, quarterly, or even annual level.[5] Data aggregated at these levels are unable to capture many extreme events such as fires, floods, and short-term heat waves, which either last a few days or may extend across calendar periods. In these cases, the data fail to capture the actual climate phenomena that may have significant effects on tourism behavior.

In this paper, we exploit a new data set consisting of daily observations on visitations to state parks in northern Minnesota over a period of thirteen years, along with daily observations on various climate variables. These data are used to derive estimates of impacts on tourism activities of increased incidence of extreme climate events likely to occur under ongoing climate change. Using daily visitation activity permits estimation of visitation responses to extreme events – such as short term heat waves – that are typically masked in existing studies that rely on data that are aggregated over longer periods of time.[6] We then use projections of climate models to assess the magnitude of the impacts of extreme climate events on local tourism.

Existing studies have found that climate change impacts are likely to vary dramatically across different times of the year, with the biggest difference being between winter activities (such as alpine and Nordic skiing, snowmobiling and ice fishing) and summer activities (such as hiking, canoeing, swimming, and boating). The impact of climate change will differ significantly across these two tourist seasons, because of the different nature of the activities. In this study, we focus on tourism activities during the warmer months of the year from late spring into early autumn, which is the peak season for tourists in the study area (Ref. [19]; p. 12). This seasonal emphasis strategy is consistent with a number of other studies that have examined climate change impacts on outdoor tourism activities.[7]

2. Water-based recreation on the North Shore

For a number of years, the north shore of Lake Superior in northern Minnesota has been an important destination for recreational tourism in the upper Midwest. The area supports a variety of recreational activities year-round. Summer activities, which are the focus of this study, include hiking, hunting, fishing, sightseeing, swimming, boating, canoeing, biking, and golfing [20]. These activities are affected in various ways by extreme events associated with climate change, such as heat waves, increased fire incidence, changing patterns of precipitation, and increased flooding [21].

Intense heat waves, where temperatures rise to uncomfortable levels, may discourage certain activities such as hiking, hunting, fishing, biking, and sightseeing, while possibly encouraging other activities such as swimming and boating. Fires resulting from extremely dry conditions may destroy structures, property, and habitat, and may pose threats to public health and safety [21,22]. Floods may also destroy structures and property, as well as pose public safety risks. For example, massive flooding hit the southern North Shore area in June of 2012, damaging roads and inundating residential houses, leading to the evacuation of 250 local residents and over $100 million in damages [23,24].

3. Study area

The eight state parks that are the subject of this study are located at various points on the North Shore (see Fig. 1) and receive between 1.6 and 1.9 million visitors per year. Fig. 2 graphs annual visitation data for each of these parks from 1996 through 2013. These data reveal an overall steady, perhaps slightly upward trend of visitors over time, which is subject to short-term fluctuations. They also reveal a hierarchy of visitation traffic among the parks, with Gooseberry Falls State Park, the southernmost and therefore most easily accessible to visitors from the south, receiving by far the most visitors.[8]

4. Data and econometric model

The analysis is based upon daily visitation data during the late-spring to summer months for all eight state parks on the North Shore, from May 2002 through September 2014.[9] This comprises 15,914 total observations, though some observations were discarded because of brief periods of time when various parks were closed for renovation or other reasons, and during early July of 2011, when a government shutdown temporarily closed all of the parks. Omitting these observations leaves us with 15,669 usable observations. Table 1 reports park-level summary statistics for this visitation variable and reveals major differences in visitation levels across the parks. Gooseberry Falls is by far the most-visited park, whereas the smallest parks – Crosby-Manitou and Grand Portage – receive a fraction of the visitors that Gooseberry does. This park-level variation in visitation numbers will pose statistical issues that will need to be accounted for in the econometric analysis.

It will be recognized that ours is a panel data set: a pooled time-series cross-section sample of eight parks over thirteen years of daily data, which permits us to exploit both cross-sectional and temporal variation. The model thus uses a standard panel data framework, as presented in equation (1):

$$Y_{it} = X_{it}\beta + \alpha_i + \varepsilon_{it} \quad (1)$$

[5] For example, see Refs. [31–33,37].

[6] See, for example, Refs. [13,31–33,35]. Ref. [14] is one of the few studies that have focused on extreme events by modeling variability, but they use aggregated monthly visitation data.

[7] See, for example, Ref. [14,36].

[8] Most visitors to the North Shore are from Minnesota, and they tend to be relatively young, white, and have above-average income (Ref. [20]; p. 7).

[9] The year 2002 is the earliest year for which daily records are available from the Parks and Trails Division of the Minnesota Department of Natural Resources [44].