Tourism Management 42 (2014) 334–340

Contents lists available at ScienceDirect

Tourism Management

journal homepage: www.elsevier.com/locate/tourman

How to evaluate the effects of climate change on tourism

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HIGHLIGHTS

- Statistical models evaluating the effect of climate change on tourism are investigated.
- Climate change would lead to a gradual shift of tourists' towards higher latitudes.
- Global warming would increase domestic trips, especially in colder countries.
- Global warming is good news for seasonality.
- Different perspectives show a non-linear relationship between tourism and temperature.

ARTICLE INFO

Article history:
Received 22 March 2013
Accepted 11 November 2013

Keywords:
Climate change
Effects of climate change
Climate indexes
Tourism demand

ABSTRACT

The aim of this study is to assess the most relevant quantitative approaches to evaluating the effects of climate change on tourism. In recent years, numerous empirical studies have conducted evaluations of this kind, based on different methodologies and perspectives. This review shows that the effects of climate change can first be assessed through changes in physical conditions essential to tourism; secondly, by using climate indexes to measure the attractiveness of tourist destinations; and, thirdly, by modelling tourism demand with the inclusion of climate determinants. The review suggests that, although some methodologies are in the early stages of development, different approaches result in a similar map of those areas mainly affected by the problem.

1. Introduction

Climate science shows that, in the 21st century, changes in the Earth's climate will take place at an unprecedented rate (Solomon et al., 2007). The spatial and temporal pattern of tourism demand can be expected to adjust to this, either as a result of the direct effects of climate change, such as rising temperatures, or due to secondary effects, such as rising sea levels, a loss of snow cover or impacts on the landscape. Despite the economic significance of the Travel and Tourism Industry, estimated as accounting for 9.1% of the Gross Domestic Product worldwide (WTTC, 2012), and tourism's apparent overwhelming dependence on climatic factors, literature on the economic implications of climate change has been dominated by other sectors such as agriculture – with a lower weight in economic terms, estimated as representing 6.1% of the Gross Domestic Product (CIA, 2012) –, while tourism has been pushed into the background. This is reflected in successive reports by the *Intergovernmental Panel on Climate Change,* in which tourism only featured more prominently in the last AR4 Report (IPCC, 2007).

The relative extent to which tourism has been overlooked in literature on climate change could be explained by the uncertainty and complexity of expected tourism demand reactions. In a recent study, Gössling, Scott, Hall, Ceron, and Dubois (2012) highlight the complexity of understanding tourist perceptions and reactions to the impacts of climate change as a means of anticipating the decline or increase of specific tourism markets and seasonal shifts in tourism demand. They argue that tourism stands out for its substantial adaptive capacity, which must be combined with other uncertainties concerning the implementation of future mitigation policies and their impacts on transportation systems, together with the wide range of climate change impacts on destinations and broader impacts on society and economic development.

However, the tourism industry today needs to anticipate the consequences of climate change on future demand. Despite controversies regarding the weaknesses of statistical models in predicting tourist flows under scenarios of climate change (Bigano, Hamilton, Maddison & Tol, 2006; Gössling & Hall, 2006), strategic planning is now needed by the tourism industry in terms of new infrastructures and the detection of mid and long-run business opportunities. The results of literature on tourism and climate change should be contextualized, implying that all the determinants of tourism demand – except for climate, whose

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0261-5177/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.tourman.2013.11.006

influence is being analysed – should be held constant. Consequently it must be assumed that a high level of uncertainty will remain, given the difficulties involved in forecasting social phenomena in the medium and long run. For instance, with the winter tourism market segment, although it is almost impossible to provide information on the changing preferences of potential tourists visiting mountain resorts during the next 50 years, it is feasible to evaluate the physical consequences of a loss of snow cover brought about by climate change. An idea of future snow cover can then be forecast by quantifying expected snowfalls, which in turn will implicitly determine the availability of winter tourism conditions.

Similarly, optimal tourism conditions can also be evaluated by assuming that some tourism activities require a certain level of favourable climate conditions. For instance, visits to nature reserves, cycling, golf tourism, beach tourism, nautical tourism or city tourism can require certain weather conditions. In this case, an assessment is needed of what tourists perceive to be optimal conditions, and a subsequent evaluation of future climate conditions will then determine a destination's diminished or improved attractiveness for tourists. Evidently, changes in climatic preferences are hard to anticipate and only optimal climate conditions can be projected.

Although the inclusion of climatic determinants in modelling exercises in the field of tourism demand has traditionally been disregarded, since the turn of the century the incorporation of climatic variables (such as temperature, precipitation and wind) in tourism demand models has become more common (Goh, 2012). The effect of climate on tourism demand is taken as a short-run determinant in the context of time series and as a push and pull structural determinant when both discrete choice models and aggregate tourism models are considered. Since estimation techniques usually entail the isolation of each of the determinants, it is possible to evaluate the marginal contribution of climatic factors to tourism demand while the rest of the variables are held constant.

As a result, over the last fifteen years numerous quantitative studies have attempted to evaluate the consequences of climate change on tourism. So far, however, no attempt has been made to compile these findings to any great extent in order to try and identify a regular pattern as means of building up knowledge and establishing certain general principles. Due to the recent emergence of multiple quantitative methodologies for assessing the consequences of climate change on tourism, this paper aims to evaluate these different alternatives, demonstrating that despite the different approaches used to tackle the problem, the results show a significant consistency. What is more, because a pioneering joint analysis is made of the different alternatives, it is possible to highlight some of the main advantages and limitations of each one.

2. Evaluations through physical changes

A change in the depth of snow cover is the most direct consequence of climate change, and winter tourism is heavily dependent on the reliability of snow cover at mountain resorts. As a result, the financial viability of winter tourism depends on favourable snow conditions. However, reliable snow cover will rise to higher altitudes over the coming years if climate change occurs (Elsasser & Bürki, 2002). Adaptational strategies play an important role in the winter tourism segment (e.g. artificial snow production), and anticipating the consequences of climate change on the depth of snow cover has become a key factor in management and strategic decision-making. Breiling and Charamza (1999) analysed the impact of a 2 °C temperature change on seasonal snow cover depth for all areas of Austria, finding that it leads to a reduction in the length of the ski season and usability of ski facilities. Warming will have a strong impact on low altitude resorts, which are expected to disappear first by the authors, while the remaining resorts will become more expensive due to the reduced supply. Further studies have been made of winter sports tourism in Scotland (Harrison, Winterbottom, & Shephard, 1999), Switzerland (Elsasser & Messerli, 2001), Canada (Scott, McBoyle, Minogue, & Mills, 2006), the Alps (Rixen et al., 2011; Soboll & Dingeldey, 2012) and Australia (Pickering, 2011).

Methodologically, all these studies seek to estimate the amount of precipitation that falls as snow and rain, snow accumulation, and snowmelt. Historical precipitation data can be analysed for each mountain resort in order to determine the temperatures that best predict historical snowfall amounts. Then, by using projected temperature and precipitation data for different climate change scenarios (or by assuming the existence of a certain trend in temperatures and precipitation), it is possible to estimate the amount of snow precipitation that determines snow accumulation. Breiling and Charamza (1999), Harrison et al. (1999) Elsasser and Messerli (2001), Scott et al. (2006), Rixen et al. (2011) and Soboll and Dingeldey (2012) and other similar studies find a general decline in natural skiing conditions, although this will be less of a problem at high altitude sites. At this point it is important to note that the use of snowmaking machines should be taken into consideration in the final evaluation, even though this partial solution is also temperature dependent.

Despite winter tourism's special interest appeal, the importance of sun and sand tourism cannot be ignored because it is also affected by climate change. Just as winter tourism depends on snow, summer tourism at some destinations relies on other physical conditions that are required for tourism activities. Although the development of models for this broad area (sun and sand tourism) is in the initial stage, the rise in sea level and its consequences on beach coverage (Nicholls et al., 2011), coral reef health (Hoegh-Guldberg et al., 2007), the proliferation of jellyfish (Purcell, 2012) and algal blooms (Englebert, McDermott, & Kleinheinz, 2008) should be on the agenda of future quantification of the effects of climate change on tourism. These quantified assessments could be considered at both a global and regional level. It should be possible to characterize the extension of beaches, coral reef coverage, jellyfish and other tourism-related environmental attributes sensitive to climate change at a global level. If all these characteristics are projected in the context of climate change, then the link with tourism can be established. On the other hand, at a local level, if a particular region is popular because of its natural environment, the role of each of the natural characteristics in attracting tourism can be estimated. Consequently, future tourism demand can be projected once the environmental attributes altered by climate change have been pinpointed.

In this context, it is important to note that although some exploratory studies have demonstrated the relative irrelevance of tourism opinions when faced with a marginal loss of environmental quality (Gössling, Bredberg, Randow, Sandström, & Svensson, 2006), a certain threshold level – defined sometimes by visibility, the abundance and variety of different species, the occurrence of algae or the physical disappearance of beaches – seems to exist (Gössling, Lindén, Helmersson, Liljenberg, & Quarm, 2007), showing that tourists might respond to climate changes in a non-linear way. Although a slight change in environmental quality cannot be detected through simple techniques, it is suggested that ecosystem responses to pressures are characterized by discontinuities and threshold effects, hindering accurate estimations of the consequences on tourism.

3. Climate indexes

A climate index is a set of climate variables combined through a mathematical formula to capture human comfort preferences. The potential changes in human comfort levels suggested by a