

## **COPING WITH CLIMATE CHANGE IN THE TOURISM INDUSTRY: A REVIEW AND AGENDA FOR FUTURE RESEARCH**

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### **Abstract**

The two-way relationship between tourism and Climate Change has important economic and developmental implications for numerous regions worldwide. Purpose: The purpose of this paper is to present an overview of the existing literature on the relationship between tourism and climate change in order to establish the current state of corporate and institutional responses in the tourism industry and to set out an agenda for research. Methodology: As this is a literature review paper, a comprehensive review was undertaken of the management journals and related topics. Findings: The global or overall impact of tourism on climate has received little attention by researchers. In general, the majority of companies are still in a preliminary phase in terms of implementing adaptation and mitigation measures. There is a requirement to examine the determinants of these strategies in organisations, as well as their associated outcomes. There is a need to examine tourist preferences in terms of activities and destinations, the impacts of climate change, and whether and how this affects tourist-consumer decision making. Academic research has focused mostly on specific and individual solutions to address the impact of climate change on tourism. The analysis of the interplay of these measures and their possible synergies constitute an important topic for future research. Originality: The timeliness of the review is evident given the recent surge in popular debate on climate change, its effects on tourism and the appearance of a broad and disparate array of studies on this topic.

**Keywords** Climate Change, Tourism Industry, Literature Review

### **INTRODUCTION**

The tourism industry is a major contributor to global economic development, especially as an employer in developing economies and regions where tourism commonly represents the main source of national income (Bigano et al., 2007; Hall and Higham, 2005). However, tourism is clearly and closely dependent on and susceptible to climatic conditions (Giles and Perry, 1998; Agnew and Viner, 2001, Gössling and Hall, 2006a, 2006b). The Stern Report on the Economics of Climate Change (2006) concluded that although small rises in temperature may initially benefit the economy, but if left unchecked, this could result in a 20% reduction in per capita consumption by the end of the century (Stern, 2006).

The link between climate change and tourism implies complex interactions and can be described as a two-way relationship. On the one hand, tourism activity contributes to climate change (Nicholls, 2006). The UNWTO (2008) estimates that emissions from

global tourism, including transport, accommodation and tourism activities subsectors make up 5% of total CO<sub>2</sub> emissions. The major contributor is the private automobile and air transport (Chapman, 2007), followed some way off by other forms of transport and the accommodation subsector (UNWTO, 2008). In 2005, CO<sub>2</sub> emissions originating from transport accounted for 75% of tourism-based emissions, with the most of this attributed to air transport. This means that air transport is responsible for between 2.5% and 3.5% of total anthropogenic emissions causing global warming (Scheelhaase and Grimme, 2007; Mendes and Santos, 2008).

On the other hand, climate change also significantly affects the tourism industry, most importantly due to its effect on the attractiveness of tourism destinations and tourist flows (Lise and Tol, 2002; Amelung et al., 2007). Tourism depends on natural resources, such as water, coastlines, landscapes, biodiversity, etc. These influence the potential attraction of destinations. However, climate change threatens the loss of some of these relevant natural resources (Gössling and Hall, 2006a).

Therefore, these two facts, the contribution of tourism to economic growth and the complex two-way relationship between tourism and climate change, suggest that research on the implications of climate change on the tourism industry and vice versa is of significant interest and relevance.

The objective of this manuscript is to present an overview of the existing literature on the relationship between tourism and climate change in order to establish the current state of corporate and institutional responses of the tourism industry and to set out an agenda for research. The timeliness of the manuscript is evident given the recent surge in popular debate on climate change, its effects on tourism and the appearance of a broad and disparate array of studies on this topic. Hence, at this point in time, it is necessary to take stock of the situation and to identify future research priorities. The manuscript is structured as follows; firstly, the relevant literature on climate change and tourism is identified and reviewed. Secondly, the principal mitigation and adaptation measures employed by companies and institutions in the tourism industry are identified and considered. Thirdly, conclusions and an agenda for future research are outlined.

## **1. CLIMATE CHANGE AND TOURISM**

There is no doubt that climate change has a significant influence on the tourism sector (De Freitas, 2005; Hall and Higham, 2005; Gössling and Hall, 2006a). Climate change has been a major factor in research in sectors such as agriculture, water supplies, construction and insurance for many years (Smit and Skinner, 2002; Danielopol et al., 2003; Hertin et al., 2003; Arnell and Delaney, 2006; Linnerooth-Bayer and Mechler, 2006). However, there has been significantly less research on climate change in the tourism industry and the research that has been carried out has been done much later (Maddison, 2001; Lise and Tol, 2002; Scott et al., 2003; 2005a; Becken, 2005).

The literature may be divided into two main research streams based around the cause-effect relationship between climate change and tourism. Hence, one stream examines the contribution of tourism to climate change while the other examines how climate change affects the development of tourism.

### **HOW TOURISM CONTRIBUTES TO CLIMATE CHANGE**

In general there are fewer studies on how tourism contributes to climate change (Becken, 2005) (than vice-versa). This may be as a result of the relatively moderate contribution of the tourism industry to CO<sub>2</sub> emissions and other greenhouse gases when compared to other economic sectors such as energy and manufacturing. The affect of tourism activities is often viewed from a more general perspective of its environmental impacts. For example, Becken et al. (2003) analyse how transport, accommodation and activities affect energy consumption. Other authors such as Danielopol et al. (2003) describe how coastal tourism can seriously damage water supplies. Martens and Rotmans (2005) describe the implications of global tourism on a set of natural resources such as water and biodiversity, among other factors. Both Lordkipanidze et al. (2005) and Williams and Ponsford (2009) employ the case study method to illustrate how collective action in the tourism sector, or specific subsectors such as rural tourism, can achieve sustainability and successfully manage the relationship between tourism and the environment.

There is a significant focus on the contribution of transport, as part of the tourism industry, to CO<sub>2</sub> and other greenhouse gases emissions (Gössling et al., 2005; Scheelhaase and Grimme, 2007; Mendes and Santos, 2008; Gössling and Hall, 2008). Although transport activities, and especially aviation, make a positive contribution to economic development, the growth of this sector leads to adverse environmental impacts (Daley, 2009; Walker and Cook, 2009). Most of the previous studies discuss measures and policies to reduce the impacts of transport on climate change and analyse the suitability of these in terms of tourism demand and economic gains.

The general conclusion of this line of research is that although the effect of the tourism industry on climate change is moderate in comparison with other industrial sectors, actions must be undertaken in order to manage the impacts and to guarantee the sustainability of the tourism activity in the long term. Also, it is broadly held that there are no generic solutions useful for all activities, sectors and regions involved in tourism, so specific studies are required to minimise the contribution of tourism to climate change in specific tourism contexts.

### **HOW CLIMATE CHANGE AFFECTS TOURISM**

The main focus of this line of research is based on discovering and evaluating the effects of climate change on tourism demand and flows (Hamilton et al., 2005; Scott et al., 2007a; 2007b). This includes a large number of studies based on the construction of models of arrivals and departures of tourists in terms of climatic variables (such as precipitation and temperature), environmental variables (coastal length, biodiversity),

and socio-economic variables (population, population density, tourism costs and GDP), among others. Agnew and Palutikof (2006) and Hamilton and Tol (2007), examine the impact of climate change on international tourist arrivals and departures, as well as domestic tourist flows. Hamilton and Tol based their analysis on three regions, the UK, Germany and Ireland while Agnew and Palutikof centered their study in the UK. Scott et al. (2007a) develop a statistical model of monthly visitation and climate to examine direct and indirect impact of climate change on visitation to a national park in Canada. Furthermore, a number of studies consider the effect on tourist flows of more specific variables related to (but not part of) climate change, such as the air transport eco-tax (Tol, 2007; Gössling et al., 2008).

The majority of these studies analyse the consequences of climate change on a number of future scenarios, normally adopting the scenarios suggested by the Intergovernmental Panel on Climate Change (IPCC) (Hamilton et al., 2005; Hamilton and Tol, 2007; IPCC, 2007). These publications conclude that climate is an important consideration for tourists' destination decisions and that climatic variables can explain tourists' flows. For example, for a large number of tourism activities and for the majority of international tourists, warm temperatures are the ideal independent of the tourist's origin (Lise and Tol, 2002). The main value of this research is that it tries to explain how tourism demand and tourists' choices can change in certain regions as a result of climate variables and climate change. However, these models tend to be limited in that they cannot consider all the relevant variables that affect the behaviour of tourists in light of climate change. Moreover, models rarely include the capacity of countries and regions to react to climate change or to establish measures to meet demand (Hamilton and Tol, 2007).

There are also a number of studies in this second research stream, which develop indices (TCI "Tourism Climate Index") based on climatic and environmental variables. The main aim of this research is to develop indices in order to explain and predict tourist flows. Matzarakis (2002) uses an index of thermal comfort to identify regions of Greece with high likelihood of heat stress. Scott and McBoyle (2001) apply a climatic index to evaluate the impact of climate change on city tourism. They analyse the tourism demand and flows, as well as changes in tourists' preferences for specific North-American cities. Scott et al. (2004) use a tourism climate index to evaluate the spatial and temporal distribution of climate resources for tourism in North America in two different climate change scenarios. Gómez-Martín (2006) uses seven climatic variables and comfort indices to demonstrate the level of comfort of tourists in specific destinations and how this can help to explain the geographic and temporal distribution of tourism in Catalonia, Spain. Amelung et al. (2007) examine how the TCI explains seasonality. They indicate the most suitable regions for tourism in specific seasons in the years 2020, 2050 and 2080. Overall, these scenario studies suggest that conditions will vary significantly according to the scenario and the specific location in question, and that this will determine the choice of destinations, the season and the length of the stay.

This research stream also examines further effects of climate change such as the direct economic effects on the tourism industry, such as tourism prices (Shih et al., 2009), and tourist opinions (Schmitz et al., 2007). For example, Uyarra et al. (2005) studied how

various environmental factors may explain tourist preferences and tourists' opinions on how they enjoyed their holidays in Bonaire and Barbados.

The main conclusion to emerge from research on the complex relationship between climate change and tourism is that both the causes and the consequences of this relationship are of significant importance, that they have a significant economic impact (Berritella et al., 2006), and that both require attention. However, it is important to emphasise that the economic consequences are not the same for all activities, regions or destinations (Shaw and Loomis, 2008). Indeed, it is generally agreed that there will be a redistribution of the income generated by the tourism sector. Hamilton et al. (2005) present a simulation model of changes in international tourist flows because of changes in population, per capita income and climate change. This study suggests a general and global increase in the growth of international tourism in the medium term; however it shows that the most favoured regions will be those situated at higher altitudes and latitudes. In fact, the regions in which climate change leads to moderate temperatures, and which do not incur extreme weather conditions, which are normally not the traditional tourist destinations, will experience a double positive effect. On the one hand, the locals will no longer travel to foreign holiday destinations. On the other hand, there will be an influx of tourists from what are currently the most popular destinations (Hamilton et al., 2005)

Given the importance of acting in the face of climate change, existing studies often outline a series of recommendations that governments, institutions, companies and individual tourists should undertake in order to reduce emissions and to adapt to the new scenarios, which involves avoiding the risks and taking advantages of opportunities of the changing climate (Gómez-Martín, 2006; Schmitz et al., 2007; Gössling and Hall, 2008). The following section examines these measures.

## **2. MITIGATION AND ADAPTATION STRATEGIES IN THE TOURISM INDUSTRY**

There is widespread agreement in the literature regarding the two basic measures to be undertaken in order to combat climate change in the tourism sector: adaptation and mitigation (Bode et al., 2003; Barnett; 2005; UNWTO, 2008). On the one hand, adaptation involves responses on the part of corporations, institutions and governments by taking advantages of the benefits of climate change for tourism and looking for solutions to minimise the problems it causes. On the other hand, mitigation refers to undertaking actions in order to minimise the contribution of tourism activities to global warming. According to the UNWTO (2008) both policy-makers and business managers in the tourism industry must become involved in decision-making on adaptation and mitigation strategies for tourism.

## MITIGATION

In terms of mitigation, the literature contains a large number of studies dedicated to transport. Although road transport is the biggest producer of greenhouse gases in the transport sector, the major contributor is road freight (Chapman, 2007), unrelated to tourism activities. Indeed, air transport is the largest transport-related polluter in the tourism industry. Moreover, the environmental damage of aviation is larger because greenhouse gases are released directly into the upper atmosphere and this increases their negative effects (Chapman, 2007; UNWTO, 2008).

There are various mitigation measures designed to limit the contribution of air transport to greenhouse gases emissions and a number of studies consider the beneficial effects of the inclusion of air transport in emission trade systems (Chapman, 2007; Scheelhaase and Grimme, 2007; Mendes and Santos, 2008). Other mitigation instruments imply a behavioural change by replacing air transport with other modes of mobility, such as inter-city rail travel instead of short haul flights (Chapman, 2007). Aviation will also benefit from improvements in technology and changes in operational procedures. Some examples include changes in the design of aircraft to reduce fuel consumption, the use of alternative fuels, modification in the operational procedures for landing and taking off, etc. (Chapman, 2007; Interavia, 2008). These studies conclude that the reduction of emissions addressed by these mitigation measures is unclear, and in any case a single type of measure is not sufficient for the target of sustainable aviation. What is required is a combination of technological, behavioural and management changes (Chapman, 2007).

Another widely researched mitigation strategy in this context is the eco-tax, despite the absence of an international agreement to impose a tax on aviation. For example, Brouwer et al. (2008) consider the extent to which air passengers will accept such a tax, highlighting factors such as passengers' knowledge and awareness of the impacts of flying on the environment and the links with climate change, the contribution of air transport to the problem and knowledge about the Kyoto Protocol. Tol (2007) examines how an eco-tax may affect emissions and the impact of the tax on tourist flows. These studies conclude that the willingness to invest in climate change mitigation and to pay for its consequences is higher than is generally assumed. This is due to the recognition of responsibility for climate change and its effects on the quality of life of future generations (Brouwer et al., 2008). However, there are some important differences in terms of the context of research and the tourist cultures. Europeans are most aware and willing to pay, whereas North Americans and Asians are less informed and less willing to act (Brouwer et al., 2008). Other relevant conclusions refer to the small effect of the carbon tax, especially in the case of medium distance flights. This could produce a positive effect on air mobility within the same region, such as the European Union (Gössling et al., 2005; Tol, 2007).

Besides air transport, some authors have attempted to consider other sources of tourism-related greenhouse emissions. Bode et al. (2003, p. 258) state that "two kind of sources have to be distinguished: emissions due to the journey, but the tourism companies' influence to lower them is more or less limited [...], and emissions at the destination area due to energy supply to meet the customers' demand for electricity,

water and other commodities". In this sense, reductions in emissions may be achieved by reducing energy consumption by promoting energy consciousness and energy saving behaviour on the part of the tourist and tourism industry employees. Lee (2000) suggests that a key factor in the success of these strategies is the capacity of companies to innovate, adopt renewable energies and incorporate new energy saving technologies. Further proponents of energy saving technologies such as Bode et al. (2003) and Becken (2005) propose the use of solar panels, low energy lighting, room keys to operate lights, light sensors and the simultaneous education and consciousness of tourists and employees in the problem of climate change and in the use of these technologies as the key to reducing the carbon print of tourism and especially of the accommodation subsector.

## **ADAPTATION**

The focus of much of the attention of research on tourism and climate change is on the measures undertaken to adapt to the new scenarios. Nevertheless, there is general agreement that the tourism industry is approximately five to seven years behind in research terms on climate change when compared with other economic sectors. As Becken (2005, p. 381) states, "while the wider climate change debate has until recently mainly focused on mitigation [...], the sparse research specifically dealing with tourism and climate change has largely concentrated on tourism's vulnerability and adaptation to climate change".

There are important differences in the adaptation measures undertaken in the tourism industry, in terms of the various subsectors, activities and destinations. For example, in the case of beach tourism and the protection of the coastline, research suggests that institutions play a key role in adaptation measures. It is suggested that institutional policies are required to go beyond the adaptation policies of private tourism companies. As Adger et al. (2005, p. 79) state "a broad distinction can be drawn between action that often involves creating policies or regulations to build adaptive capacity and actions that implement operational adaptation decisions. The latter will often be constrained and influenced by a higher-level adaptation framework". In this respect, various studies analyse institutional responses for beach tourism. These include hard engineering solutions, such as the construction of dykes and wave breakers, and soft engineering measures such as the beach nourishment (Phillips and Jones, 2006; Hamilton, 2007). Hamilton (2007) analyses what adaptation strategies would be more appropriate from an economic point of view for companies involved in beach tourism. He suggests that soft measures may be more beneficial than hard solutions, as hard measures cause a relevant environmental impact which could reduce the price that tourists would be willing to pay for accommodation, and this would mean a financial loss for companies.

Snow tourism has been one of the most researched of tourism activities, possibly due to the more immediate impact of climate change on the sector. Indeed, the major focus of this research has been on the adaptation strategy of artificial snowmaking. These studies tend to examine various future scenarios in snow tourism in terms of snow precipitation in specific regions, in the years 2020, 2050 and 2080 (Scott et al., 2007b;

2008). The main objective of these studies is to determine if snowmaking is a suitable strategy for ski resorts, how artificial snow could contribute to lengthening the snow sports season, the probable effect on tourist flows, and the economic effects of this measure (Scott et al., 2007a, 2007b). The principal findings confirm the positive effect of snowmaking both in economic terms and in lengthening the tourist season. However, the costs of snowmaking must be taken into account. In the case of the warmest scenarios, this measure can become prohibitive for some ski operators, and can hardly solve the problem of a shortening ski season, especially in lower elevation regions. Further measures should be considered by the ski industry, such as diversification, contracting insurance policies (Scott et al., 2003), and new marketing strategies aimed at attracting new segments and retaining existing clients, which could emphasize the opportunities that climate change offers to create advantage in this sector (Scott et al., 2007b; Hill et al., 2010).

### **3. CONCLUSIONS AND AGENDA FOR FUTURE RESEARCH**

Increasingly governments, institutions and businesses are taking a greater role in achieving the goals of sustainable development, in developing responses to mitigate and adapt to the threats and opportunities of climate change (IPCC, 2007). However, much work remains to do because there is a serious disconnection between the messages of public policy makers and the actions undertaken by companies regarding how to address the influences of climate change (Sullivan, 2010). This explains the significant increase in recent times of research in the management literature dedicated to analysing the impacts of climate change in tourism. Nevertheless, this literature is still in its infancy and much research remains to be undertaken. Overall, compared to other economic activities, there is a lack of research on the management of tourism and climate change, and the overriding focus of existing research is on specific tourism activities (such as beach and ski tourism) and on specific regions (northern Europe, UK and USA). The main conclusions and the agenda for research are outlined below.

Firstly, greater effort is required in order to clearly identify a broad range of measures for tourism companies. Most research has not examined the totality of the impact of tourism on climate, which requires the consideration of effects at the origin, travel, and destination of tourists (Gössling and Hall, 2006a). In addition, only a limited set of responses have been examined, both in terms of limiting emissions and the impact on global warming, as well as in terms of adapting businesses to the new scenarios presented by climate change (Elsasser and Bürki, 2002). In this sense, there is a general call for a greater research focus in order to identify the entire array of measures and to avoid the increasing focus on very narrow solutions and a limited range of destinations. Indeed, efforts have already recently begun on this front on the part of international institutions (UNWTO, 2008).

Secondly, in general the majority of companies are still in a preliminary phase in terms of implementing adaptation and mitigation measures (Kolk and Pinkse, 2005; Pinkse, 2007), and tourism companies are no exception. Hence, the process companies undergo in terms of considering and taking on adaptation and mitigation measures should receive increased attention as an emerging issue in tourism management research.



Thirdly, there is a need to go beyond simply diagnosing the current situation, in terms of describing the scenarios faced by companies and what is being done to confront climate change. There is a requirement to examine the determinants of these strategies in organisations, such as the knowledge, motivation and awareness of managers in the tourism sector, as well as the effectiveness and results of these strategies (Blennow and Persson, 2009; Hoffmann et al., 2009; Arnell and Delaney, 2006). Likewise, there is a need to examine the tools used by companies in order to determine what specific measures are required in each case (Arnell and Delaney, 2006).

Fourthly, there is a need for more research on the specific impact of climate change on tourism activities (Shaw and Loomis, 2008), in comparison with the effort focused on examining specific tourism regions or destinations. This is especially important given the contribution of specific activities to diversification strategies which are being recommended to tourism companies in order to combat the effects of climate change on their businesses.

Fifthly, there has been very little research from the viewpoint of the consumer, in this case, the tourist. There is a need to examine tourist preferences in terms of activities and destinations, the impacts of climate change, and whether and how this affects tourist-consumer decision making (Uyarra et al., 2005; Schmitz et al. 2007). Indeed, the little research that has been carried out has focused on analysing changes in tourist flows based on arrivals and departures data, rather than consulting directly with consumer on the reasons or motivations for changes in their behaviour.

Finally, academic research has focused mostly on specific and individual solutions to address climate change impacts on tourism. Nevertheless, as previous research states, various mitigation and adaptation strategies should be applied simultaneously in tourism sub-sectors and activities (Chapman, 2007). The analysis of the interplay of these measures and their possible synergies constitute an interesting topic for future research.

These limitations in the current state of knowledge on climate change and the tourism industry suggest that the coming years will see increased emphasis placed on examining the issues identified, with the overall objective of better managing the tourism industry as it enters a world characterised by a changing climate.

## REFERENCES

- Adger, W.N., Arnell, N.W. and Tompkins, E.L. (2005), Successful Adaptation to Climate Change across Scales, *Global Environmental Change* 15, 77-86.
- Agnew, M.D. and Palutikof, J.P. (2006), Impacts of Short-Term Climate Variability in the UK on Demand for Domestic and International Tourism, *Climate Research* 31, 109-120.
- Agnew, M.D. and Viner, D. (2001), Potential Impacts of Climate Change on International Tourism, *Tourism and Hospitality Research* 3, 37-60.
- Amelung, B., Nicholls, S. and Viner, D. (2007), Implications of Global Climate Change for Tourism Flows and Seasonality, *Journal of Travel Research* 45, 285-296.
- Arnell, N.W. and Delaney, E.K. (2006), Adapting to climate change: Public water supply in England and Wales, *Climatic Change* 78, 227-255.
- Barnett, J. (2005), Titanic States? Impacts and Responses to Climate Change in the Pacific Islands, *Journal of International Affairs* 59, 203-219.

- Becken, S. (2005), Harmonising Climate Change Adaptation and Mitigation: The Case of Tourist Resorts in Fiji, *Global Environmental Change* 15, 381-393.
- Becken, S., Simmons, D.G. and Frampton, C. (2003), Energy Use Associated with Different Travel Choices, *Tourism Management* 24, 267-277.
- Berritella, M., Bigano, A., Roson, R. and Tol, R.S.J. (2006), A General Equilibrium Analysis of Climate Change Impacts on Tourism, *Tourism Management* 27, 913-924.
- Bigano, A., Hamilton, J.M. and Tol, R.S.J. (2007), The Impact of Climate Change on Domestic and International Tourism: A Simulation Study, *The Integrated Assessment Journal* 7, 25-49.
- Blennow, K. and Persson, J. (2009), Climate Change: Motivation for Taking Measure to Adapt, *Global Environmental Change* 19, 100-104.
- Bode, S., Hapke, J. and Zisler, S. (2003), Need and Options for a Regenerative Energy Supply in Holiday Facilities, *Tourism Management* 24, 257-266.
- Brouwer, R., Brander, L. and Van Beukering, P. (2008), A Convenient Truth: Air Travel Passengers' Willingness to Pay to Offset their CO<sub>2</sub> Emissions, *Climatic Change* 90, 299-313.
- Chapman, L. (2007), Transport and Climate Change: A Review, *Journal of Transport Geography* 15, 354-367.
- Daley, B. (2009), Is Air Transport an Effective Tool for Sustainable Development? *Sustainable Development* 17, 210-219.
- Danielopol, D.L., Griebler, C., Gunatilaka, A. and Notenboom, J. (2003), Present State and Future Prospect for Groundwater Ecosystems, *Environmental Conservation* 30, 104-130.
- De Freitas, C.R. (2005), The Climate-Tourism Relationship and its Relevance to Climate Change Impact Assessment, in: Hall, M.C. and Higham, J. (eds.) *Tourism, Recreation and Climate Change*, Channel View Publications, Clevedon, 29-43.
- Elsasser, H. and Bürki, R. (2002), Climate Change as a Threat to Tourism in the Alps, *Climate Research* 20, 253-257.
- Giles, A.R. and Perry, A.H. (1998), The Use of a Temporal Analogue to Investigate the Possible Impact of Projected Global Warming on the UK Tourist Industry, *Tourism Management* 19, 75-80.
- Gómez-Martín, M.B. (2006), Climate Potential and Tourism Demand in Catalonia (Spain) during the Summer Season, *Climate Research* 32, 75-87.
- Gössling, S. and Hall, M. (2006a), *Tourism and Global Environmental Change: Ecological, Social, Economic and Political Interrelationships*, Routledge, New York.
- Gössling, S. and Hall, M. (2006b), Uncertainties in Predicting Tourism Flows under Scenarios of Climate Change, *Climate Change* 79, 163-173.
- Gössling, S. and Hall, M. (2008), Swedish Tourism and Climate Change Mitigation: An Emerging Conflict? *Scandinavian Journal of Hospitality and Tourism* 8, 141-158.
- Gössling, S., Peeters, P., Ceeron J.P., Dubois, G., Patterson, T. and Richardson, R.B. (2005), The Eco-Efficiency of Tourism, *Ecological Economics* 54, 417-434.
- Gössling, S., Peeters, P. and Scott, D. (2008), Consequences of Climate Policy for International Tourism Arrivals in Developing Countries, *Third World Quarterly* 29, 873-901.
- Grubb, M., Vrolijk, C., and Brack, D. (1999), *The Kyoto Protocol: A Guide and Assessment*, RIIA/Earthscan, London.
- Hall, M.C. and Higham, J. (2005), *Tourism, Recreation and Climate Change*, in: Hall, M.C. and Higham, J. (eds.) *Tourism, Recreation and Climate Change*, Channel View Publications, Clevedon, 3-28.
- Hamilton, J.M. (2007), Coastal Landscape and the Hedonic Price of Accommodation, *Ecological Economics* 62, 594-602.
- Hamilton, J.M., Maddison, D.J. and Tol, R.S.J. (2005), Effects of Climate Change on International Tourism, *Climate Research* 29, 245-254.
- Hamilton, J.M. and Tol, R.S.J. (2007), The Impact of Climate Change on Tourism in Germany, the UK and Ireland: A Simulation Study, *Regional Environmental Change* 7, 161-172.
- Hertin, J., Berkhout, F., Gann, D. and Barlow, J. (2003), Climate Change and the UK House Building Sector: Perceptions, Impacts and Adaptative Capacity, *Building Research and Information* 31, 278-290.
- Hill, M., Wallner, A. and Furtado, J. (2010), Reducing Vulnerability to Climate Change in the Swiss Alps: A Study of Adaptative Planning, *Climate Policy* 10, 70-86.
- Hoffmann, V.H., Sprengel, D.C., Ziegler, A., Kolb, M. and Abegg, B. (2009), Determinants of Corporate Adaptation to Climate Change in Winter Tourism: An Econometric Analysis, *Global Environmental Change* 19, 256-264.
- Interavia (2008), *The Quest for Sustainable Aviation*, Interavia Business and Technology 691, 1-5.
- IPCC (2007), *Climate Change 2007*, Intergovernmental Panel on Climate Change, Geneva.
- Kolk, A. and Levy, D. (2001), Winds of Change: Corporate Strategy, Climate Change and Oil Multinationals, *European Management Journal* 19, 501-509.

- Kolk, A. and Pinkse, J. (2004), Market Strategies for Climate Change, *European Management Journal* 22, 304-314.
- Kolk, A. and Pinkse, J. (2005), Business Responses to Climate Change: Identifying Emergent Strategies, *California Management Review* 47, 6-20.
- Lee, H. (2000), Climate Change Policy and the Sustainable Future, *International Review for Environmental Strategies* 1, 17-23.
- Linnerooth-Bayer, J. and Mechler, R. (2006), Insurance for Assisting Adaptation to Climate Change in Developing Countries: A Proposed Strategy, *Climate Policy* 6, 621-636.
- Lise, W. and Tol, R.S.J. (2002), Impact of Climate on Tourist Demand, *Climate Change* 55, 429-449.
- Lordkipanidze, M., Brezet, H. and Backman, M. (2005), The Entrepreneurship Factor in Sustainable Tourism Development, *Journal of Cleaner Production* 13, 787-798.
- Maddison, D. (2001), In Search of a Warmer Climate? The Impact of Climate Change on Flows of British Tourists, *Climatic Change* 49, 193-208.
- Martens, P. and Rotmans, J. (2005), Transitions in a Globalising World, *Futures* 37, 1133-1144.
- Matzarakis, A. (2002), Examples of Climate and Tourism Research for Tourism Demands, Proceedings of the 15th Conference on Biometeorology and Aerobiology joint with the International Congress on Biometeorology, Kansas City 2002, 391-392.
- Mendes, L.M.Z. and Santos, G. (2008), Using Economic Instruments to Address Emissions from Air Transport in the European Union, *Environment and Planning A* 40, 189-209.
- Nicholls, S. (2006), Climate Change, Tourism and Outdoor Recreation in Europe, *Managing Leisure* 11, 151-163.
- Phillips, M.R. and Jones, A.L. (2006), Erosion and Tourism Infrastructure in the Coastal Zone: Problems, Consequences and Management, *Tourism Management* 27, 517-524.
- Pinkse, J. (2007), Corporate Intentions to Participate in Emission Trading, *Business Strategy and the Environment* 16, 12-25.
- Scheelhaase, J.D. and Grimme, W.G. (2007), Emissions Trading for International Aviation – An Estimation of the Economic Impact on Selected European Airlines, *Journal of Air Transport Management* 13, 253-263.
- Schmitz, M.F., de Aranzabal, I. and Pineda, F.D. (2007), Spatial Analysis of Visitor Preferences in the Outdoor Recreational Niche of Mediterranean Cultural Landscapes, *Environmental Conservation* 34, 300-312.
- Scott, D. (2003), Climate Change and Sustainable Tourism in the 21st Century, in: Cukier, J. (eds.) *Tourism Research: Policy, Planning, and Prospects*, Department of Geography Publication Series, University of Waterloo, Waterloo.
- Scott, D., Dawson, J. and Jones, B. (2008), Climate Change Vulnerability of the US Northeast Winter Recreation-Tourism Sector, *Mitigation Adaptation Global Change* 13, 577-596.
- Scott, D., Jones, B. and Konopek, J. (2007a), Implications of Climate and Environmental Change for Nature-Based Tourism in the Canadian Rocky Mountains: A Case Study of Waterton Lakes National Park, *Tourism Management* 28, 570-579.
- Scott, D., Jones, B. and McBoyle, G. (2005b), *Climate, Tourism and Recreation: A Bibliography – 1936 to 2005*, University of Waterloo, Waterloo.
- Scott, D. and McBoyle, G. (2001), Using a “Tourism Climate Index” to Examine the Implications of Climate Change for Climate as a Tourism Resource, in: Matzarakis, A. and Freitas, C.R. (eds.), *Proceedings of the First International Workshop on Climate, Tourism and Recreation, Porto Carras 2001*, 69-89.
- Scott, D., McBoyle, G. and Mills, B. (2003), Climate Change and the Skiing Industry in Southern Ontario (Canada): Exploring the Importance of Snowmaking as a Technical Adaptation, *Climate Research* 23, 171-181.
- Scott, D., McBoyle, G. and Minogue, A. (2007b), Climate Change and Quebec’s Ski Industry, *Global Environmental Change* 17, 181-190.
- Scott, D., McBoyle, G. and Schwartzentruber, M. (2004), Climate Change and the Distribution of Climatic Resources for Tourism in North America, *Climate Research* 27, 105-117.
- Scott, D., Wall, G. and McBoyle, G. (2005a), The Evolution of the Climate Change Issue in the Tourism Sector, in: Hall, M.C. and Higham, J. (eds.) *Tourism, Recreation and Climate Change*, Channel View Publications, Clevedon, 44-62.
- Shaw, W.D. and Loomis, J.B. (2008), Frameworks for Analyzing the Economic Effects of Climate Change on Outdoor Recreation, *Climate Research* 36, 259-269.
- Shih, C., Nicholls, S. and Holecek, D.F. (2009), Impact of Weather on Downhill Ski Lift Tickets Sales, *Journal of Travel Research* 47, 359-372.

- Smit, B. and Skinner, M.W. (2002), Adaptation Options in Agriculture to Climate Change: A Typology, Mitigation and Adaptation Strategies for Global Change 7, 85-114.
- Stern, N. (2006), The Economics of Climate Change: The Stern Review, Cambridge University Press, Cambridge.
- Sullivan, R. (2010), An Assessment of the Climate Change Policies and Performance of Large European Companies, Climate Policy 10, 38-50.
- Tol, R.S.J. (2007), The Impact of Carbon Tax on International Tourism, Transportation Research Part D 12, 129-142.
- Uyarra, M.C., Côté, I.M., Gill, J.A., Tinch, R.R.T., Viner, D. and Watkinson, A.R. (2005), Island-Specific Preferences of Tourists for Environmental Features: Implications of Climate Change for Tourism-Dependent States, Environmental Conservation 32, 11-19.
- Walker, S. and Cook, M. (2009), The Contested Concept of Sustainable Aviation, Sustainable Development 17, 378-390.
- Williams, P.W. and Ponsford, I.F. (2009), Confronting Tourism's Environmental Paradox: Transitioning for Sustainable Tourism, Futures 41, 396-404.
- UNWTO (2003), Djerba Declaration on Tourism and Climate Change, World Tourism Organization, Madrid, Available through the internet:  
<http://www.unwto.org/sustainable/climate/decdjerba-eng.pdf> [accessed: 29/04/2008].
- UNWTO (2007), Second International Conference on Climate Change and Tourism – Davos Declaration, World Tourism Organization, Madrid, Available through the internet:  
<http://www.unwto.org/pdf/pr071046.pdf> [accessed: 29/04/2008].
- UNWTO (2008), Climate Change and Tourism – Responding to Global Challenges, World Tourism Organization, Madrid.

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