

Research Probe

This Department has been specifically created to include findings of special significance and problem areas of subtle nuances in tourism research. Insightful contributions presenting the state-of-the-art, preferably from the developing societies, will be appreciated. It will also encourage scholars and authors to think against the grain, probing the consistency of theoretical notions and research trends whose heuristic value is all too often taken for granted. For details, contact Editor-in-Chief, Tourism Recreation Research, A-965/6 Indira Nagar, Lucknow, India. e-mail: tvsingh@sancharnet.in

Tourism and Climate Change: Knowledge Gaps and Issues

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Introduction

The role of climate on tourism has been the subject of considerable interest for many years. However, the relationship between tourism and climate change is a much more recent concern (Scott et al. 2005) which has witnessed a dramatic increase in the publication of articles, book chapters and monographs (e.g., Hall and Higham 2005; Becken and Hay 2007), including a valuable background report prepared for the UNWTO's second conference on climate change and tourism (Scott et al. 2007a). The reasons for such growth are several folds. First, because climate has a number of direct and indirect influences on tourist decision-making and destination attractiveness, tourism is a potentially sensitive economic sector with respect to climate change. Second, policy discussions with respect to mitigating climate change, e.g. through the imposition of 'green taxes' on aviation and/or tourists, but even including appeals to avoid forms of holidays that impact on the climate system, clearly have implications for tourism flows and tourist behaviour. Third, tourism has itself become a more significant component of the reporting of the Intergovernmental Panel on Climate Change (IPCC) that was formed in 1988 under UN auspices to inform policy-makers and society with respect to knowledge on the causes and impacts of climate change. For example, the first IPCC assessment report did not even mention tourism, whereas the fourth assessment report published in 2007 has substantial reference to tourism and related subject areas. Finally, and connected to all the above, there is far greater public and media debate, and arguably concern with respect to the potential affects of climate change to which the academic community is responding and contributing to, particularly those who are engaged within the environmental and impacts research tradition of tourism.

The purpose of this probe is to provide an overview of some of the key issues that emerge out of recent research on tourism and climate change as well as the policy context in which it is situated. The paper is divided into several sections. First, a brief account of the policy context for tourism and climate change research. Second, the place of tourism within IPCC assessments and the influential Stern (2006) review on the economics of climate change. Third, an overview of the major current research themes in tourism and climate change. Fourth, an account of research on a regional basis. Finally, the paper seeks to draw some conclusions with respect to the current state of knowledge on tourism and climate change.

The Policy Context

The results of academic research are not value free, perhaps nowhere more so in the case of such a politically charged area as climate change where research is an important element of policy determination. The reasons for the highly charged policy environment primarily relate to the implications of the costs of any mitigation and adaptation strategies (Monbiot 2006; Randerson 2006). For example, application of the 'polluter pays' principle to an area such as aviation would have significant impacts on costs of airline passenger and freight costs and therefore levels of demand. Furthermore, climate change is now part of wider political debates and appears to be a factor in electoral campaigns. For example, Australia's non-ratification of the Kyoto agreement under the conservative coalition government of Prime Minister John Howard was an issue that emerged a number of times during Australia's 2007 federal election (e.g., BBC News 2007). Similarly, political parties in the UK were seeking to position themselves with respect to climate change in the run-up to the next election, with the Labour government announcing an amended

climate change bill including adding emissions from the aviation and shipping industry in the UK's greenhouse gas (GHG) emissions targets (Ryan and Stewart 2007). The bill built on the British governments announcement in October 2007 that as from 2009 air taxes would be levied on the flight, rather than directly on the passenger, a measure that is regarded as better targeted at cutting carbon emissions (Wintour and Elliott 2007), and which was also a policy of the conservative opposition. The policy is supported by budget airline EasyJet who argued that air passenger duty should be dropped in favour of a scheme that grades aircraft according to their emissions and length of journey (Milmo 2007). However, given the potential lifespan of aircraft this may also have the effect of moving older aircraft with higher emissions to regions with weaker emissions rules such as Africa, Asia or Latin America.

Also of great significance in policy terms has been the awarding of the Nobel Peace Prize to former US Vice-President Al Gore and to the IPCC in October 2007. In awarding the prize the Nobel committee signalled its view that climate change is now a global security issue which therefore means its policy importance is reinforced beyond an economic or environmental interpretation (Black 2007). However, it is important to recognize the extent to which such an award lends credibility to the science of climate change despite attempts by various interests to discredit scientific findings and recommendations (Monbiot 2006). Nevertheless, it is often the coincidence of weather related natural disasters combined with awareness of climate change that arguably leads to the most volatile policy environments such as in the case of the impacts of Hurricane Katrina in the United States; wildfires in Greece, the Iberian Peninsula and the United States; drought in Australia and the United States; and flooding in Africa and Mexico. In such cases, which involve major temporary and in the case of Hurricane Katrina and the Australian drought potentially permanent displacement of people, it is perhaps not surprising that the spectre of environmental refugees (Myers 2002) wrought by climate change is regarded as occurring in the present rather than just being in the future.

Tourism Within Climate Change Reports

The global climate change political and public debate has been strongly influenced by the contents and media reporting of a number of climate change reports in which tourism is noted. In policy terms the 2006 review on the economics of climate change commissioned by the UK government from Sir Nicholas Stern, a former chief economist with the World Bank, was extremely important. In media terms, it generated substantial interest (e.g., Hinsliff 2006a, b; Randerson 2006). For example, the UK's Observer

newspaper ran a headline in covering the review: 'Ten years to save the planet from mankind' (Hinsliff 2006a).

The Stern review arguably did not bring anything new to the understanding of climate change in a scientific or environmental sense. But it did have the important function of 'independently' affirming scientific argument from the respectability of a conservative economic position rather than one that may be perceived as solely 'academic'. Just as significantly for economic thinking it placed a price on the cost of failing to act on climate change unless it is tackled immediately – a figure of £3.68 trillion. Stern (2006) forecast that the world needed to spend 1% of global GDP - equivalent to about £184 billion per year – in dealing with climate change, or face a bill between five and twenty times higher for damage caused by letting it continue. According to Hinsliff (2006b) unchecked climate change could therefore cost as much as £566 for every man, woman and child on the planet – roughly 6.5 billion people – in 2006 terms.

The debate surrounding the review's release focussed on a number of areas of interest to tourism, particularly with respect to the potential imposition of green taxes on aviation (e.g., Hinsliff 2006b). Yet the review itself gave only minor consideration to tourism. Table 1 note that there were only 19 references to tourism, tourist and recreation and cognate terms in the review with most of these being brief mentions. The most substantive discussion of tourism was in relation to some of the positive effects that climate change will bring for a few developed countries for moderate amounts of warming, although it is also noted that they will become very damaging at the higher temperatures expected in the second half of this century. On page 126 it is stated that 'tourism may shift northwards, as cooler regions enjoy warmer summers, while warmer regions like southern Europe suffer increased heat wave frequency and reduce water availability. One study projected that Canada and Russia would both see a 30% increase in tourists with only 1°C of warming' (Stern 2006: 126; referring to Hamilton et al. 2005). Although the discussion then goes on to note the potentially harmful affects of climate change to alpine and winter tourism and to tourism resources such as the Great Barrier Reef. Tourism is thus only superficially considered in the Stern Review, and represented by a selective, non-comprehensive choice of references.

In contrast tourism is given much greater emphasis in the IPCC climate change reports. The IPCC's role is to 'assess on a comprehensive, objective, open and transparent basis the best available scientific, technical and socio-economic information on climate change from around the world. The assessments are based on information contained in peer-reviewed literature and, where appropriately documented,

Table 1. References to Tourism, Tourist and Recreation and Cognate Terms in Stern Review

Part	chapters	Focus	citations in text*
1	1-2, technical annex to 2	The nature of the scientific evidence for climate change, and the nature of the economic analysis required by the structure of the problem which follows from the science	0
2	3- 6	How climate change will affect people's lives, the environment and the prospects for growth and development in different parts of the world.	10
3	7-13	The economic challenges of achieving stabilisation of greenhouse gases in the atmosphere	4
4	14-17	Policy responses to mitigation	0
5	18-20	Policy responses for adaptation	5
6	21-27	International collective action	0

* does not include citations in references

in industry literature and traditional practices' (IPCC 2004: 1). The First Assessment Report was released in 1990 and outlined the scientific basis for concern about climate change. The Second Assessment Report was released in 1995. The Third Assessment Report, released in 2001 consisted of three working group reports on The Scientific Basis; Impacts, Adaptation and Vulnerability; and Mitigation, and a Synthesis Report primarily aimed at policy makers. The Fourth Assessment Report in 2007 was released with a similar structure with three working group reports on The Physical Science Basis; Impacts, Adaptation and Vulnerability; Mitigation of Climate Change and a Synthesis Report.

Although tourism has not been cited in reports on the scientific basis for climate change and only marginally with respect to mitigation, it has become increasingly recognized in the reports of the IPCC Working Group on Impacts, Adaptation and Vulnerability (Wall 1998; see also Amelung et al., forthcoming). Table 2 compares reference to tourism and cognate terms in comparable chapters of the 2001 (McCarthy et al. 2001) and 2007 (Parry et al. 2007) reports of the Working Group. It is noticeable that although there are similar total numbers of references to tourism, tourist, recreation and cognate terms in the regional chapters of the two reports, there is a substantial variation between chapters. In particular there are notable increases (greater than 10%) in citations in the chapters on Africa, Australia and New Zealand, Europe and Small Island states. There are decreases in citations with respect to Asia and the polar regions although these only have a small overall number of citations. The most significant decrease in citations of tourism related

Table 2. References to Tourism, Tourist and Recreation and Cognate Terms in Regional Chapters of IPCC Working Group II 2001 and 2007 Reports on Impacts, Adaptation and Vulnerability

Regional Chapter	3 rd report (2001) citations	4 th report (2007) citations
Africa	3	28
Asia	9	7
Australia and New Zealand	22	31
Europe	34	40
Latin America	10	10
North America	86	27
Polar regions	11	7
Small island states	26	47
Regional chapter totals	201	197

Note: citations refer to references in text, figures, tables and headings with respect to tourism, tourist, recreation and cognate terms. References to terms in bibliographic information at the end of each chapter are not included in tallies of key words.

words occurring in the chapter on North America, down from 86 in 2001 to 27 in 2007.

Changes in word counts are important as it can be argued that they reflect aspects of the issue ecology of content in IPCC reports and are therefore a crude surrogate measure of importance and levels of knowledge on particular subjects. Of course, this is also partly a reflection of the authors of the various chapters as well with respect to their levels of knowledge of tourism and the selection of references they cite with the range of academic publications and approaches to tourism and climate change (Scott et al. 2005; Gössling and Hall 2006a; Scott et al. 2007a) being far greater than those actually utilized. Nevertheless, the relative emphasis of subjects covered by the report may broadly correspond to the relative research emphasis on tourism and climate change in general. Table 3 outlines the substantive comments on tourism issues (a sentence or more) in Parry et al. (2007). Although not the sole source, the identification of particular topics is used in the next section to provide an overview of the major current research foci on tourism and climate change.

Research Issues and Topics

The aim of this section is not to restate the IPCC's conclusions and forecasts with respect to the effects of climate change on the global environment and the role of anthropogenic warming (see Solomon et al. 2007). Instead, it seeks to identify some of the key topics and issues addressed by research on tourism and climate change.

Table 3. Dimensions of the Tourism and Climate Change Relationships Covered in the IPCC Working Group II 2007 Reports on Impacts, Adaptation and Vulnerability

Dimension	Specified locations	Chapter source
Sensitivity to climate change	Africa, Asia, Australia and New Zealand, Europe, North America, Tropical destinations, Small islands	Alcamo et al. 2007: 543-4; Boko et al. 2007: 450, 459; Cruz et al. 2007: 489; Hennessy et al. 2007: 523; Mimura et al. 2007: 689, 697; Schneider et al. 2007: 790; Wilbanks et al. 2007: 363, 368, 375, 380.
Issues in adaptation to climate change	Small islands	Alcamo et al. 2007: 561; Anisimov et al. 2007: 673, 676; Mimura et al. 2007: 705; Wilbanks et al. 2007: 380.
Effects on coastal tourism	Africa, Americas, Caribbean, Mediterranean, Florida, Thailand, Maldives, small islands	Alcamo et al. 2007: 543-4; Boko et al. 2007: 440, 449; Field et al. 2007: 634; Magrin et al. 2007: 584, 599, 600; Mimura et al. 2007: 689, 696, 698, 701, 703; Nicholls et al. 2007: 335-6, 337.
Degradation of coral reef, coral bleaching	Africa, Australia, small islands	Boko et al. 2007: 439; Fischlin et al. 2007: 235; Hennessy et al. 2007: 523; IPCC 2007: 13, 15; Mimura et al. 2007: 689, 696; Nicholls et al. 2007: 320.
Effects on summer tourism	Europe, especially Mediterranean	Alcamo et al. 2007: 565.
Effects on winter tourism	Asia, Europe, Bolivia	Adger et al. 2007: 721, 722, 734; Alcamo et al. 2007: 543-4, 561, 565; Cruz et al. 2007: 489; Field et al. 2007: 634; Hennessy et al. 2007: 523; IPCC 2007: 14, 18; Magrin et al. 2007: 589; Rosenzweig et al. 2007: 117; Wilbanks et al. 2007: 363.
Skiing	Asia, Australia and New Zealand, Europe	Adger et al. 2007: 721, 722, 734; Alcamo et al. 2007: 557, 561; Field et al. 2007: 634; Hennessy et al. 2007: 523; Magrin et al. 2007: 589; Rosenzweig et al. 2007: 89, 111.
Effects on mountain tourism	Europe	Fischlin et al. 2007: 223; Rosenzweig et al. 2007: 88, 89.
Effect on wild faunal diversity/nature-based tourism	Marine ecosystems, Mediterranean-type ecosystems, Small islands, Southern Africa, Tropical savanna systems	Boko et al. 2007: 435, 459; Field et al. 2007: 634; Fischlin et al. 2007: 225, 226, 234; Mimura et al. 2007: 696.
Reservation economies	North America	Field et al. 2007: 625.
Effect of extreme events	Mexico, North America, small islands	Field et al. 2007: 626; Magrin et al. 2007: 585; Mimura et al. 2007: 693, 702.

The relationship between GHG emissions and the nature of economic development is regarded as extremely important to climate change mitigation in the longer term

with a number of factors influencing the amount of emissions:

- Structural changes in the production system in relation to the role of high or low energy-intensive industries and services.
- Technological patterns in sectors such as energy, transportation, building, waste, agriculture and forestry.
- Geographical distribution of activities encompassing both human settlements and urban structures in a given territory, and its two-fold impact on the evolution of land use, and on mobility needs and transportation requirements.
- Consumption patterns – for a given income per person, parameters such as housing patterns, leisure styles, or the durability and rate of obsolescence of consumption goods will have a critical influence on long-run emission profiles.
- Trade patterns – which may influence access to the best available technologies and to finance may limit the building of infrastructure (Fisher et al. 2007: 177).

Surprisingly, even though mobility, transport and leisure consumption were noted as long-term determinants of emissions there was very little discussion in the IPCC reports on the role of tourism in mitigation, even with respect to tourism transport. In contrast several studies (Gössling 2002; Gössling and Hall 2006b; Peeters et al. 2006) have noted the rapid growth of tourism as a contributor to emissions. Scott et al. (2007a) estimated that 5% of the global share of CO₂ emissions are attributable to tourism within a range of 4-6%. Measured in radiative forcing, a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system that is an index of the importance of the factor as a potential climate change mechanism, the contribution of tourism to global warming may be up to 14%, even though there is great uncertainty with regard to the contribution of cirrus-related effects. The majority of tourist trips create only small amounts of emissions. However, air travel, and especially long-haul travel are major contributors. For example, long haul travel between the five world regions accounts for only 2.7% of all tourist trips, but contributes 23% to global tourist transport emissions. Furthermore, given current predictions for travel growth under a 'business as usual' scenario it is estimated that tourist attributable CO₂ emissions will grow by 152% and radiative forcing by 171% by 2035 (Scott et al. 2007a). Therefore, given such forecasts it is perhaps not surprising that reducing the effects of air travel through technological,

regulatory and/or behavioural mechanisms has become a significant focus for tourism and climate change research (e.g. Peeters et al. 2006, 2007; Peeters 2007; Gössling et al. 2007 a, b), although other parts of the tourism system are also of importance (e.g. Chan and Lam 2003; Gössling et al. 2005).

Wilbanks et al.'s (2007) chapter on industry, settlement and society probably provided the most substantial assessment of the impact of climate change on tourism within the IPCC context. Tourism was identified as a 'climate-sensitive human activity' with the chapter concluding that vulnerabilities of industries to climate change are 'generally greater in certain high-risk locations, particularly coastal and riverine areas, and areas whose economies are closely linked with climate sensitive resources, such as ... tourism; these vulnerabilities tend to be localized but are often large and growing' (Wilbanks et al. 2007: 359). However, one of the greatest problems with assessing the impacts of climate change on tourism is that both direct and indirect effects will vary greatly with location (Gössling and Hall 2006b). Direct effects include the role climate variables, such as temperature, sunshine hours, precipitation, humidity and storm frequency and intensity play with respect to tourist decision-making, including activity and destination choice (Scott et al. 2007d). Another effect is the extent to which particular environments, such as tropical or alpine resorts, gain some of their appeal from climatic variables. Finally, indirect effects of climate change such as heat waves, fires, disease outbreaks, landscape change, and biodiversity change can also have substantial affects on tourism activities, perceptions of a location, and the capacity of firms to do business. However, as Rosenzweig et al. (2007: 111) identified, 'as a result of the complex nature of the interactions that exist between tourism, the climate system, the environment and society, it is difficult to isolate the direct observed impacts of climate change upon tourism activity. There is sparse literature about this relationship at any scale'.

Climate change is likely to have a long term effect on domestic and international tourist flows. Higher temperatures are potentially likely to change summer and winter destination preferences in the longer term, either through direct affects on a tourism resource such as snow availability, or in terms of making competing destinations more or less attractive climatically. However, the capacity of potential tourists to accurately judge the implications of changes in average temperatures or climate conditions for a destination is quite debatable (Gössling et al. 2006) with the exception of tourism resource loss, such as snow. Deterministic models such as the Tourism Comfort Index (Amelung and Viner 2006) indicated improved conditions

for tourism in northern Europe, while econometric modelling by Hamilton et al. (2005) indicated that an arbitrary climate change scenario of 1°C would also lead to a gradual shift of tourist destinations further north and up mountains thereby affecting the preferences of European summer tourists (Alcamo et al. 2007). Nevertheless, Gössling and Hall (2006b, c, d) have noted that there are a number of major weaknesses with respect to current models in predicting travel flows under conditions of climate change (Table 4) and have urged substantial caution in utilizing the results of deterministic approaches to climate change adaptation given high levels of behavioural uncertainty.

Table 4. Major Weaknesses of Current Models in Predicting Travel Flows

• Validity and structure of statistical databases
• Temperature assumed to be the most important weather parameter
• Importance of other weather parameters largely unknown (rain, storms, humidity, hours of sunshine, air pollution)
• Role of weather extremes unknown
• Role of information in decision-making unclear
• Role of non-climatic parameters unclear (e.g., social unrest, political instability, risk perceptions, destination perception)
• Existence of fuzzy-variables problematic (terrorism, war, epidemics, natural disasters)
• Assumed linearity of change in behaviour unrealistic
• Future costs of transport and availability of tourism infrastructure uncertain
• Future levels of personal disposable income (economic budget) and availability of leisure time (time budget) that are allocated to travel uncertain

Source: Gössling and Hall, 2006b, c, d.

In light of concern with the role of higher temperatures on tourist flows it is perhaps not surprising that the environments that have attracted the most research attention are those of coastal, including those of small islands, and alpine areas. Arguably, these are the same environments that have attracted tourism research on environmental impacts in general (Hall and Page 2006). Coasts and small islands are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea-level rise (IPCC 2007). In addition, the impact of climate change on tourism dependent coastal economies may be exacerbated because of the increased human-induced pressures tourism brings to coastal areas (Hall 2006a; Nicholls et al. 2007). Nicholls et al. (2007: 331) summary of climate-related impacts in relation to recreation and tourism in coastal areas argued that temperature rise (air and seawater), extreme events (storms, waves), erosion (sea level, storms, waves) and biological effects will have strong impacts; floods (sea level, runoff) will have a weak impact; and rising water tables (sea

level) and saltwater intrusion (sea level, runoff) will have a negligible impact or that an impact is not established. However, such relative impacts will not be the same in all locations (Uyarra et al. 2005).

Extreme events, such as cyclones and hurricanes, for example, are regarded as significant because of both their physical impact on environment and infrastructure (Nurse and Moore 2005) as well as the potential negative contribution to destination image. Under climatic change more frequent high-magnitude events may mean there is less time for physical and human systems to recover, meaning that recovery may never be complete and thereby resulting in long-term environmental deterioration. Such effects are already observed in coral reef ecosystems, even though the consequences for tourism remain unclear (Gössling et al. 2007b).

With respect to small islands Mimura et al. (2007) concluded that there was a high degree of confidence that the effects of climate change on tourism are likely to be direct and indirect, and largely negative.

Tourism is the major contributor to GDP and employment in many small islands. Sea-level rise and increased sea water temperature will cause accelerated beach erosion, degradation of coral reefs, and bleaching. In addition, a loss of cultural heritage from inundation and flooding reduces the amenity value for coastal users. Whereas a warmer climate could reduce the number of people visiting small islands in low latitudes, it could have the reverse effect in mid- and high-latitude islands. However, water shortages and increased incidence of vectorborne diseases may also deter tourists' (Mimura et al. 2007: 689).

In the western Indian Ocean region, a 30% loss of corals resulted in reduced tourism in Mombasa and Zanzibar, and caused financial losses of about US\$ 12-18 million (Payet and Obura 2004). Australia's Great Barrier Reef has experienced eight mass bleaching events since 1979 (1980, 1982, 1987, 1992, 1994, 1998, 2002 and 2006). The most widespread and intense events occurred in 1998 and 2002, with about 42% and 54% of reefs affected, respectively (Berkelmans et al. 2004). Climate change related effects such as rising sea temperatures and ocean acidification being exacerbated by coral reefs exposure to local anthropogenic impacts, including sedimentation, pollution and reduction of fish stocks (Hoegh-Guldberg 1999, 2004). However, in addition to marine environments climate change related biodiversity loss is also significant for nature-based tourism in terrestrial environments (Hall 2006b; Scott et al. 2007a).

The potential impact of climate change on alpine and winter tourism has been a major focus of research in Europe (e.g. Burki et al. 2005; Harrison et al. 2005) and North America (e.g. Scott et al. 2003; Scott et al. 2006; Scott et al. 2007a, b, c).

Declines in mountain snowpack in western North America and in the Swiss Alps are largest at lower, warmer elevations with corresponding impacts on skiing, ice climbing and scenic activities in areas affected (Rosenzweig et al. 2007: 89). Over the past century snow cover has decreased in most regions, especially in Spring. Northern Hemisphere snow cover over the 1966 to 2005 period decreased in every month except November and December (Solomon et al. 2007).

The challenge for many alpine resorts is that mountain snow can be especially sensitive to only small changes in temperature, particularly in temperate regions where the transition from rain to snow is generally closely associated with the freezing level altitude. According to Agrawala (2007) under present climate conditions, 609 out of the 666 (or 91%) Alpine ski areas in Austria, France, Germany, Italy, and Switzerland can be considered as naturally snow-reliable with the remaining 9% already operating under marginal conditions. Agrawala (2007) estimated that the number of naturally snow-reliable areas would drop to 500 under a 1 °C increase, to 404 under 2 °C, and to 202 under a 4 °C warming of climate. Responses to climate change in alpine and winter tourism destinations include artificial snow-making and associated structures such as high altitude water reservoirs; grooming of ski slopes; moving ski areas to higher altitudes and glaciers; use of white plastic sheets as protection against glacier melt; market, economic and regional diversification; and the use of market-based instruments such as weather derivatives and insurance (Scott 2006, 2007a, b, c; Agrawala 2007).

Ecotourism has been seen as a potential substitute for the ski industry in Asia (Fukushima et al. 2002; Cruz et al. 2007). However, as Scott et al. (2007c) point out climate and associated environmental change will also affect the viability of nature-based tourism in alpine areas. Similar concerns exist in the Arctic. For example, Anisimov et al. (2007) noted the potential significance of ecotourism as an opportunity for adaptation of indigenous peoples, even though the biodiversity and landscape of the region is experiencing some of the most rapid climate related environmental changes on the planet today, with average Arctic temperatures having increased at almost twice the rate of the rest of the world in the past 100 years (ACIA 2005; Solomon et al. 2007).

Even one of the most high-profile dimensions of climate change in 2007 – the opening of the Northwest Passage as the result of the loss of Summer ice – is seen as potentially beneficial for tourism. Anisimov et al. (2007: 676) state 'the Northern Sea Route will create new opportunities for cruise shipping. Projections suggest that by 2050, the Northern Sea Route will have 125 days/yr with less than 75% sea-ice cover,' Similarly, Instanes et al. (2005) noted that increased

possibilities for marine navigation and the extension of the warm-weather season will improve conditions for tourism.

The fact that there are potentially ‘winners’, at least in the short term, as well as ‘losers’ from climate change also reflects on the adaptation capacities of different regions, sectors, actors or firms. ‘Adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behaviour and in resources and technologies’ (Adger et al. 2007: 727). Because of their explicit focus on real-world behaviour, assessments of adaptation practices differ from the more theoretical assessments of potential response. However, at this stage an understanding of the adaptive capacities and practices of the various elements of tourism in relation to climate change are quite limited (Becken 2005; Gössling and Hall 2006a; Scott et al. 2007a). In one sense this situation reflects the large knowledge gaps that surround a number of areas of tourism and climate change research.

Knowledge Gaps at a Regional Level

The level of knowledge with respect to tourism and climate change can be assessed regionally as well as thematically. Indeed, a number of knowledge gaps have been highlighted in the various IPCC reports. Table 5 provides a summary of the relative levels of knowledge for a region in relation to the estimated impact of climate change on tourism.

Table 5. Relative Level of Tourism-Specific Climate Change Knowledge and Estimated Impact of Climate Change on Tourism by Region

Region	Estimated impact of climate change on tourism	Relative level of tourism specific climate change knowledge
Africa	Moderately-strongly negative	Extremely poor
Asia	Weakly-moderately negative	Extremely poor
Australia and New Zealand	Moderately-strongly negative	Poor-Moderate (high in Great Barrier Reef)
Europe	Weakly-moderately negative	Moderate (high in alpine areas)
Latin America	Weakly-moderately negative	Poor
North America	Weakly negative	Moderate (high in coastal and ski areas)
Polar regions	Weakly negative – weakly positive	Poor
Small islands	Strongly negative	Moderate

Sources: Derived from Gössling and Hall 2006a; Parry et al. 2007; see also Scott 2007a.

In the case of Africa, Boko et al. (2007: 450) stresses that ‘very few assessments of projected impacts on tourism and climate change are available’ and later notes:

There is a need to enhance practical research regarding the vulnerability and impacts of climate change on tourism, as tourism is one of the most important and highly promising economic activities in Africa. Large gaps appear to exist in research on the impacts of climate variability and change on tourism and related matters, such as the impacts of climate change on coral reefs and how these impacts might affect ecotourism (Boko et al. 2007: 459).

Tourism is similarly recognized by the IPCC as one of the most important industries in Asia, although the lack of research is bemoaned. ‘Nature-based tourism is one of the booming industries in Asia, especially ski resorts, beach resorts and ecotourist destinations which are likely vulnerable to climate change; yet only a few assessment studies are on hand for this review’ (Cruz et al. 2007: 489).

Even in North America, which is one of the better studied regions, substantial knowledge gaps exist. For example, Field et al. (2007: 634) note that, although ‘coastal zones are among the most important recreation resources in North America, the vulnerability of key tourism areas to sea-level rise has not been comprehensively assessed.’ Such assessment is extremely significant for policy makers and industry stakeholders as it can provide increased understanding of the relative vulnerabilities of destinations and attractions to climate change. For example, Scott et al. (2007b), highlights that early studies of climate change impact on the ski industry did not account for snowmaking capacity, which substantially lowers the vulnerability of some ski resorts to climate change.

In the case of Australia and New Zealand, Hennessy et al. (2007) note that few regional studies have assessed potential impacts of tourism, although it is still argued that ‘Some tourist destinations may benefit from drier and warmer conditions, e.g., beach activities, viewing wildlife and geothermal activity, trekking, camping, climbing, wine tasting and fishing’ (Hennessy et al. 2007: 523) but that there is likely to be greater risks to tourism as a result of increased hazards. Similarly, positive change with respect to summer and winter tourism is parts of Europe (Alcamo et al. 2007: 565), even though, as noted above, understanding of many of the behavioural and adaptive capacities with respect to tourism is currently relatively weak.

Conclusions

This review has sought to outline some of the key issues that have emerged in recent studies and debate on tourism and climate change. Although, it has noted some of the

Table 6. Adequacy of Tourism Knowledge with Respect to Climate Change Adaptation, Mitigation and Impacts

Factor	Very inadequate	Inadequate	Adequate	Very adequate
Generic				
Understanding of tourism system at various scales		X		
Understanding of tourism within human, environmental and innovation systems at various scales		X		
Understanding of human behaviour with respect to destination and activity choice		X		
Impact of climate change on different environments in which tourism occurs				
Alpine environments			X	
Arid environments		X		
Coastal environments			X	
Coral reef environments				X
Polar environments	X			
Small islands (warm-water)			X	
Small islands (cold-water)		X		
Temperate forests		X		
Temperate grasslands		X		
Tropical forests	X			
Tundra	X			
Urban	X			
Impact of climate change on different tourism activities				
Adventure	X			
Cycling	X			
Eating out/restaurants	X			
Farm tourism	X			
Food and wine	X			
Fishing	X			
Garden tourism	X			
Health and spa	X			
Historic buildings	X			
Indigenous	X			
Museums and art galleries	X			
National parks		X		
Nightlife	X			
Scenic drives	X			
Shopping	X			
Sightseeing (urban and non-urban)	X			
Snow-based activities (e.g. skiing)				X
Sports tourism (e.g. golf)	X			
Theme Parks	X			
Water-based (lakes and rivers)	X			
Water-based (ocean)		X		
Wildlife viewing		X		
Adaptive capacities				
Airlines		X		
Attractions	X			
Coach and Bus		X		
Cruise ships	X			
Destination communities	X			
Hotels/resorts		X		

Factor	Very inadequate	Inadequate	Adequate	Very adequate
Industry associations	X			
Intermediaries	X			
Railways			X	
Small operators	X			
Tourists	X			
Transnationals		X		
Mitigation capacities				
Airlines			X	
Attractions		X		
Coach and Bus				X
Cruise ships				X
Destination communities	X			
Hotels/resorts				X
Industry associations	X			
Intermediaries		X		
Railways				X
Small operators		X		
Tourists		X		
Transnationals			X	
Adaptation and mitigation innovations and strategies				
Adoption of innovations and strategies	X			
Behavioural change	X			
Education and information		X		
Energy conservation (designed)				X
Energy conservation (behavioural)		X		
Energy-efficient building construction				X
Extreme event risk insurance				X
Demarketing	X			
Diversification of market (destination)	X			
Diversification of market (firm)	X			
Diversification of product (destination)		X		
Diversification of product (firm)	X			
Finance and insurance			X	
GHG emission offset programmes		X		
Government assistance programmes		X		
Health risk			X	
Impact management planning		X		
Monitoring and evaluation			X	
Policy formulation		X		
Pricing/'Green' taxes		X		
Recycling				X
Site location			X	
Snowmaking				X
Transport technology improvements			X	
Water conservation and recycling (designed)				X
Water conservation and recycling (behavioural)		X		

findings with respect to the potential impacts of climate change on tourism it has indicated that the lack of knowledge in many areas, including primary tourism processes and systems, is severely constraining capacity to better understand the relationship between tourism and climate change (Table 6). In particular, it reinforces the need to improve understanding 'as to how direct and indirect impacts of climate change affect human behaviour with respect to recreation patterns and holiday destination choice (Henessy et al. 2007: 530). Undoubtedly, tourism will see changes in travel flows and patterns in the short, e.g. reduction in ski season, and long term, e.g., changed competitiveness of destinations because of changes in climate and high-magnitude events (Hamilton et al. 2005; Schneider et al. 2007; Scott et al. 2007a). However, it is extremely important that the research based advice available to policy makers and stakeholders in tourism moves beyond deterministic modelling and is based on a deeper understanding of tourism behaviours and flows.

It is also important that a better understanding of the adaptive capacities of destinations, environments and firms is developed and, where possible, that adaptations are charted over time so as to better transfer innovations from one location or firm to another as well gain a more accurate account of such capacities. For example, research on small tourism firms by Hall (2006c) in New Zealand and Finland (Saarinen and Tervo 2006) indicates that although firms may be seeking to both adapt and mitigate with respect to climate change other immediate and more pressing business needs mean that climate change cannot be a primary focus of business activity. Thereby potentially hindering firm and destination innovation with respect to climate change (Hall 2007).

As well as being subject to climate change tourism is

also seen as a non-climatic stress. For example, with respect to Latin America the IPCC comments 'The rapidly expanding tourism industry is driving much of the transformation of natural coastal areas, paving the way for resorts, marinas and golf courses' (Magrin et al. 2007: 587). Similarly, tourism is also regarded as a competitor in a number of locations for potentially scarce water resources (Gössling et al. 2002; Mimura et al. 2007). Increasingly, demands for biofuels for transport, including for leisure travel, may also be placing pressure on food production leading to competition between mobility for the world's rich and food for the world's poor (Vidal 2007). Therefore, a better understanding of tourism and its role in sustainability also needs to be generated with respect to its place in wider human and physical systems (Hall 2008).

This review has identified a number of significant knowledge gaps with respect to understanding tourism and climate change relationships. These gaps are important not only in terms of the sustainability of the tourism industry but also with respect to destination communities and the physical environment. Stern (2006) noted that climate change adaptation policies and measures, if implemented in a timely and efficient manner, can generate valuable co-benefits such as enhanced energy security and environmental protection. It is to be hoped that if the present review was to be repeated following the next IPCC assessment report then not only would a greater range of research have been conducted and acknowledged in scientific and policy terms, but that concrete steps will have been taken to address climate change and security concerns.

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Research Probe

Climate Change – Beyond the Hype

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In the last 12 months we have been literally bombarded with media reports on climate change. As a result, the awareness of climate change by the general public – including tourists – has increased dramatically. This is desirable, of course, as climate change is a serious issue and we are likely to already lag behind with what should be achieved in terms of greenhouse gas (GHG) reductions. Similarly, there is a great urgency to develop and implement cost-effective adaptation measures to assist those destinations that are mostly affected by climate change impacts, for example small island states. In the following, however, I will largely focus on GHG emissions and mitigation.

C.M. Hall in this probe rightly mentioned the Stern Report and IPCC's Fourth Assessment Report as key drivers in the media frenzy. However, he also noted that tourism is only marginally covered or at best treated as part of more generic sections, such as mitigation for transport (e.g., aviation) in the IPCC's Working Group III Report.

There is probably a reason for tourism being slightly 'underreported' in these major publications. First, one could say that tourism is only one particular application or manifestation of a bigger problem. For example, aviation relates to freight, non-tourist travel and tourism travel. In the end, all of them use the same kinds of aircraft and rely on the same technological improvements for GHG reductions. Similar arguments could be made for road transport technologies and building design. Moreover, tourism researchers very rarely hold expertise in energy efficiency technology and are more concerned with the more geographic or humanistic discussions of travel as a modern world phenomenon.

However, tourism as a field of study and policy cannot be so easily dismissed, especially not in relation to such an important issue as climate change, which has the potential to substantially change the way people will travel in the future (Becken and Hay 2007). After all, tourists are not the same as a few boxes of fresh food transported by plane, hotels are not the same as office blocks and road transport is part of

the experience rather than a means to move from A to B. Thus, not only do technological innovations have to take into account some of these tourism-specific features, but policies that aim at changing behaviour need to delve into the tourist's psyche to understand what is possible and what is desirable.

In the last few years, tourism research has made some progress in finding ways to reduce tourism's contribution to climate change. First of all, there has been an increasing volume of 'measure to manage' research. Such research seeks to assess tourism's contribution to climate change by measuring energy use and (largely) Co₂ emissions. In the latest synthesis of knowledge in this area, Scott et al. (2007) report that tourism contributes about 5% to global GHG emissions. Figures can be manipulated, of course, and interpreted according to the user's perspective, as has happened with the well-quoted 3% contribution of aviation reported by the IPCC in 1999 (Penner et al. 1999). Measuring, however, does help to focus on reduction efforts in those areas that provide the largest potential for gains. Typically, this is in the tourism transport sector. The research strand of quantitative emission analyses is often extended to modelling of future emissions (e.g., Peeters et al. 2004). This research is highly relevant for developing policies such as those relating to emission trading schemes or carbon taxes. If aviation is not included in any climate policies, for example, it is likely to dominate a country's carbon budget by the middle of this century (Bows et al. 2005).

Most recently, research has investigated carbon offsetting as a means of 'neutralising' tourism's emissions, with a focus on those from flying. Researchers have studied tourists' perceptions of offsetting (Becken 2007), the awareness of travel agents (Dodds 2007), and the credibility of offsetting schemes (Gössling et al. 2007). Such research follows the line of earlier work undertaken in the areas of voluntary initiatives, ecolabelling and certification.

In addition to tourism-specific research – largely published in tourism journals – there is a substantial number

of highly relevant publications from research fields relating to energy, transport and buildings. For example, the Energy Policy Journal published a study by Meyer et al. (2007) about growth rates and climate change impact of international passenger transport between 2000 and 2050. Renewable Energy Reports on a feasibility study of stand-alone renewable energy supply options for a large hotel (Dalton et al. 2008). Often, tourism professionals remain unaware of papers published in such journals.

The heightened research interest and action by governments and other organizations resembles the awakening of the sleeping beauty: task forces and working groups are established, workshops organized, high level meetings held, and strategies developed. Organizations such as the United Nations World Tourism Organization, the Pacific Asia Tourism Association and Southpacific Travel (former SPTO) made climate change one of their priority topics. While this 'burst of activity' is likely to be helpful to the cause, it may raise some suspicions about climate change and tourism becoming a new academic and political battlefield with possibly more opportunism than altruism. In some way this reminds one of the hype around ecotourism in the early 1990s, where ecotourism was seen as the panacea for almost everything, and mostly of course to sustainable development in local communities.

Interestingly, there is also an important North-South element in this present climate debate. Not only are developing countries most likely to be affected by the negative impacts of climate change, but they are also likely to suffer the most from climate policies imposed on aviation. So the argument goes... In my view this is one of the most serious research gaps needing to be addressed. Key questions that come to mind are (a) what benefits do developing countries really receive from tourism (given that tourism often adds to the destinations' vulnerability to climate change, e.g., pressure on water resources and coastal zones), (b) what forms of tourism would provide the greatest net benefit, (c) how price sensitive are the types of tourists that visit developing destinations, and (d) are there substitution possibilities between markets so that the overall numbers of arrivals does not change but market composition does (with tourists coming from closer countries of origin), or at least spending power?

These questions take me to another major research gap. Tourism is very rarely seen in the context of the wider economy. I recall interesting debates about a decade ago around the difference between 'sustainable tourism development' and 'sustainable development'. The latter does not necessarily rely on tourism. The former focuses on developing tourism (in a sustainable way, of course);

however, isolating tourism from wider economic dynamics runs the risk of misjudging its significance and overall impacts, and also devising policies that may be sub-optimal in the wider scheme of things. Policy analyses specific to tourism and climate change are notably absent from the current research effort, yet it is here where most research is required to achieve significant GHG reductions. Such policy analysis would, for example, examine the wider implications of measures such as carbon taxes, business incentives for energy efficiency, and biofuel targets. Detailed-yet-comprehensive and place-specific analyses in these areas would enhance the discussion, inform decision making and counteract simplistic and scare-mongering statements such as those made by the author of the discussion paper in relation to biofuel and food crises.

Clearly, research on climate change and tourism requires a wide set of expertise and rather than just relying on 'tourism researchers' who pick up the 'flavour of the month'. Future research programmes need to integrate tourism with established disciplines such as engineering, planning, sociology, and psychology. Tourism researchers are good at identifying high-level messages and communicating them to the tourism sector (e.g., the need for more energy efficient transport). However, very few are actually trained to understand how a combustion engine works and why certain biofuels are not suitable at high altitudes. Also, not all tourism researchers will be equipped to understand the major changes in Western lifestyles that might be required in the future to address climate change. Analyses of societal trends, tipping points and behavioural changes are more likely to be the domain of sociologists and psychologists (some of whom may well work in the field of tourism).

Having said all this, I believe that tourism studies have come a long way in their endeavour to delineate the relevance of climate change to tourism. What is needed now is a quantum leap towards research that provides solutions rather than descriptions, that integrates across disciplines and that works in partnership with tourism organizations.

The challenge of climate change is also an opportunity for tourism to become more systematic, smart, strategic and sustainable. At a research level there is a risk, however, that climate change research becomes fragmented with a myriad of case studies emerging, just like we experienced for ecotourism (Becken and Schellhorn 2007). Hall (2008) unfortunately steers us in this direction by providing a (rather arbitrary) assessment of climate change knowledge in relation to the many facets of tourism, such as cycling, fishing, theme parks etc., rather than providing a systematic

framework for analysis. At a policy level, there is a risk that climate change overpowers other issues of importance to tourism, such as growing concerns about global oil production, water resources and biodiversity. While some of these are clearly related to climate change, it would be foolish to view them in isolation, through the climate change lens. Rather than adding climate change as a separate task for a decision-maker to consider, it should be 'mainstreamed' into every-day management and planning, for example in the form of risk management, resource efficiency and sustainability (see also the discussion paper author's comment about the lack of interest by small businesses).

I strongly believe that there is an important place for research and policy in the area of tourism and climate change. High-quality research and sound policies will help to increase the 'voice of tourism' and, as a result, lead to greater support for the tourism sector. Clearly, there are some areas where tourism has the potential to show leadership and excellence (e.g., research on human-environment coupled systems), and there are other areas where tourism is likely to be a taker (rather than provider), for example, in specific technology. For all these activities, partnerships and collaborations will be crucial, both for the goal of reducing GHG emissions and for the future of tourism research.

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Research Probe

Climate Change: Tourism Destination Dynamics

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The increasing attention given to the tourism sector within international negotiations on climate change is documented by Hall (2008); and the industry's potential role in mitigation is explored by Becken in her probe on Climate Change. Here, therefore, I shall outline the ways in which tourist destinations of various types are likely to be affected by climate change, the ways in which they may respond, and the research they will need to inform those responses. In particular, Table 3 of Hall's probe lists much of the relevant literature currently available, and Table 6 in that review compares the relative frequencies with which more detailed subtopics have been referred to. Further information is available in Hall and Higham (2005); Becken and Hay (2007). As noted by Becken (2008) in her response, however, this does not in itself provide a framework for further analysis; nor does that commentary itself adopt such an aim. Here, therefore, I attempt to provide such a framework, make some predictions, and identify research priorities.

Analytical Framework

There are four main links between tourism and climate change:

- contributions of tourism to climate change, and ways to mitigate or offset them
- increased travel costs because of mitigation measures, and consequences for travel patterns
- changing climates in countries of origin, and effects on outbound and domestic tourism
- changing climates at destinations, and effects on their attractiveness, safety and comfort.

My focus here is on the last of these. It can be considered in three sub-categories: artificial climates, climatic variability, and climatic means. Artificial climates provide a buffer against climate change, particularly in urban destinations, simply through changing, heating and air-conditioning. If the natural attractions at a tourism destination are affected

by climate change, the simplest response is to substitute artificial attractions: swimming pools instead of beaches, shops instead of ski slopes. Changes to climatic variability include, e.g., more storms and floods, and more droughts and heatwaves leading to wildfires and coral bleaching. Most of these effects are temporary, and various protective measures are available, either through engineering or insurance approaches (Buckley 2007). The tourism industry too can actively adopt such protective measures, either independently or in conjunction with government and other landholders. The main approaches include upgrading buildings and infrastructure, and improving emergency provisions. Changes to climatic means may affect, e.g., skiable snow, beach configurations, river flows and lake levels, icon wildlife species, and so on. The principal response is to change the tourism products on offer, re-position the destination accordingly, and target new markets.

Regional Patterns

The ski industry is particularly vulnerable to warming and to reduced precipitation, since these changes reduce both natural snow cover, and opportunities for snow-making. Ski resorts in North America and Europe, Australia and New Zealand are much more vulnerable than those of Hokkaido in Japan, or those of northern Canada and Alaska. The industry's response to-date has been to increase snow-making, snow grooming and terrain modification; to re-position resorts from winter to four-season; and to increase financial reliance on property and retail rather than lift tickets.

The coastal resort industry has responded to climate change much more slowly than ski resorts (Buckley 2008). Possible reasons include: lags in oceanic as compared to atmospheric changes; more distributed ownership of land and infrastructure in coastal settlements; controversy over liabilities and responsibilities; and misperceptions of likely climatic impacts (Buckley 2008). Tropical coral reefs are susceptible to bleaching from warm ocean temperatures, but to date this seems to have had relatively little effect on tourism.

Most of the world's reef tourism destinations have experienced bleaching events, but the only serious effect on visitation seems to have been a 9% drop at Palau (Glantz 2000, cited in Becken and Hay (2007). Experienced divers descend below the impacts of bleaching, and snorkellers seem unconcerned as long as they can still see fish. Future effects may be more severe if the ocean becomes increasingly acidic (Hoegh-Guldberg et al. 2007).

In forests, the main risks of climate change are from increased wildfires, which damage infrastructure and affect both access and attractiveness for tourism. In grasslands and deserts, droughts will affect populations and migrations of icon watchable wildlife species, as well as grazing pressure from domestic livestock, cultural landscapes, and the availability of water.

Research Priorities

The framework outlined above, as well as Hall's Probe suggest three major research themes at the destination scale. In urban tourist destinations, the key is the degree to which market share can be maintained by modifying the mix of activities and attractions. This is essentially a question of tourist behaviour, and there is already a considerable body of academic literature on tourism economics and geography, marketing and market research, and destination life-cycles which could be adapted to examine this question.

The second major theme is that of extreme weather events: their immediate impacts on tourist safety, attractions and infrastructure; and their longer term effects on competition between destinations. There is already a significant academic literature on disaster response and crisis management in tourism, which can be applied here.

The third and perhaps the most complex research theme is in predicting how natural attractions for tourism

may be modified by climate change, and how tourists may change their travel patterns accordingly. This theme covers not only direct impacts of climate change on parks and beaches, water and wildlife; but also the indirect impacts on tourism as the social frameworks for access to these attractions change in response to changing climates (Buckley 2007).

Conclusions

Climate change is indeed a highly significant issue for the global tourism industry: less acute than wars and terrorism, but larger scale and longer lasting. The subsectors of the tourism industry most affected by climate change will be smaller fixed-site operators or destinations which rely heavily on a single natural attraction – such as snow, reefs or wildlife – that happens to be particularly susceptible to climate change. Even in these cases, however, there are opportunities to re-position either the product or the target market segment so as to maintain revenue. The key in these cases will be forethought and innovation, to maintain a competitive position as corresponding adjustments occur worldwide.

As suggested by Becken in her further probe, climate change is likely to become so pervasive that it should be mainstreamed into all aspects of tourism research. Already, many analyses in tourism economics refer routinely to various climate change scenarios in much the same way as they routinely specify discount rates. Future research in tourism planning, policy and geography will no doubt refer to regional climate change patterns and predictions in a similar way.

In the short term, however, it would seem that if we were to pick a single top priority for research, it would be the social and environmental consequences of extreme weather events at destinations, and the flow-on effects for tourism.

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Research Probe

Climate Change and Tourism: Time for Critical Reflection

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The New Realities of Tourism in an Era of Global Climate Change

In 2007, the Intergovernmental Panel on Climate Change (IPCC) issued its Fourth Assessment Report (4AR), which made the most definitive statement on the anthropogenic causes of observed global climate change, stating that human interference with the global climate system was 'unequivocal.' In the words of Achim Steiner (Head of United Nations Environment Programme), 'this year may be remembered as the day the question mark was removed from whether human activity has anything to do with climate change' (Giles 2007: 579). The environmental and economic risks associated with climate change in the 21st century featured prominently in international policy debates that culminated at the 13th Conference of the Parties (COP) in Bali, Indonesia. While the 'Bali Road Map' did not produce new greenhouse gas emission targets to succeed the Kyoto Protocol, many are now convinced that the climate change science has progressed sufficiently that it will engender a serious response from global policymakers.

The year 2007 was also a witness to a flourish of high-level activities related to tourism and climate change. The United Nations World Tourism Organization (UNWTO) organized the Second International Conference on Climate Change and Tourism (Davos, Switzerland). The Davos Declaration that emerged was strongly endorsed by the Ministers' Summit which met during the World Travel Market (London, UK) and later at the UNWTO 2007 General Assembly (Cartagena, Colombia), and became a core component of the UNWTO submission to COP-13 in Bali. It is also not a coincidence that the title of one of the main sessions at the CEO Challenge: Confronting Climate Change conference, organized by Pacific Asia Travel Association in April 2008, was titled 'Environmental Regulations: Preparing for the Inevitable.' This and other sentiments expressed as part of the CEO Challenge (e.g., 'unless we take positive action to reduce our carbon footprint – and seen to be doing it – others will act for us), are highly revealing of industry concerns about how governments are preparing new climate

policies and regulations that may have a considerable affect on the tourism sector.

What substance will emerge from these high-profile events remains to be seen. Regardless of whether rhetorical discussion is replaced by meaningful (and binding) emission reduction targets or adaptation plans with necessary financial and human resources, the nature of the climate change dialogue within the tourism sector in 2007 represents a significant advance in only a few short years. Not very long ago, Butler and Jones (2001: 300), in their concluding summary of the International Tourism and Hospitality in the 21st Century conference, forthrightly stated, "(Climate change) could have greater effect on tomorrow's world and tourism and hospitality in particular than anything else we've discussed (at this conference)... The most worrying aspect is that ... to all intents and purposes the tourism and hospitality industries ... seem intent on ignoring what could be the major problem of the century (original emphasis)."

The Research Probe led by Hall (2008) has offered a discussion of the place of tourism in the IPCC Fourth Assessment Report (4AR) and the Stern Review, which have featured prominently in recent international climate policy discussions and outlined major knowledge gaps and research priorities to guide this rapidly developing field of tourism studies. Each of these topics is further considered below; however I shall restrict my remarks to the themes of impacts and adaptation.

The Place of Tourism in the IPCC-4AR

As indicated in Hall's Research Probe, word counts serve only as a crude metric of importance or level of knowledge and we must be careful not to place too much concern or optimism in relative changes from IPCC assessment to assessment.

While the tourism sector has been coming to terms with the new realities posed by an increasingly carbon-constrained global economy, environmentally conscious and carbon-wise consumers, and observable destination level

impacts, climate change is also a rapidly developing area of tourism research. Contributions from multiple disciplines have doubled the number of scientific publications that examine the interactions of tourism and climate change between 1996–2000 and 2001–2005 (Scott et al. 2005). With more information available, might we not have expected more tourism content than in the IPCC 4AR? Similar growth patterns in climate change research in other sectors have occurred as well, which has put Coordinating Lead Authors in the unenviable position of setting extremely tight word limits for all sectors and cross-cutting issues in order to achieve the hard page limits set by the IPCC. As the author of the tourism section in the North American chapter of both Third Assessment Report (TAR) and 4AR, this is the explanation for why the length of the tourism section was cut in half. Conversely, while the tourism content is noted to have increased substantially in the African chapter (Boko et al. 2007), a review of the tourism section and other references to tourism throughout the chapter reveals a tremendous knowledge gap, as there is not a single tourism specific study cited from the continent and the entire discussion of tourism related impacts is based on conjecture and extrapolation of studies from other continents.

The place of tourism in IPCC assessments has also had much to do with people involved in past assessments. In the TAR and 4AR no Coordinating Lead Author has had a tourism background and it was not until the 4AR that a Chapter Lead Author (in the Industry, Settlement and Society Chapter) had the requisite knowledge of the tourism sector and related literature to champion further discussion of the tourism sector. Jean-Paul Ceron (France) deserves credit for advancing the place of tourism in the 4AR, as does UNWTO for recommending a panel of experts to the IPCC for consideration as Contributing Authors or Expert Reviewers.

An equally important question from my perspective is how far has climate change discourse penetrated the ranks of the tourism research community? While there are encouraging signs of progress here as well, including three recent books (Gössling and Hall 2006a, Becken and Hay 2007), a science review for UNWTO (Scott et al. 2008a), conference proceedings (Peeters 2007) and many journal articles, my impression from discussions with colleagues from the tourism community is that much remains to be done to integrate climate change considerations into mainstream tourism literature and professional practice. At the same time, those researching the interface of climate change and tourism have much to gain from collaborating with the tourism research community, particularly to deepen our understanding of the response of tourists to climate change impacts and climate policies.

'Mind the Gaps'

In the same way we are advised not to ignore the 'gap' on the subway, the tourism sector should not ignore the important gaps in knowledge about the implications of climate change, for future regulatory changes or climate-induced impacts may have equally unpleasant consequences. If the climate change issue is not adequately considered, many of the other sustainability initiatives in tourism may become wasted efforts. I concur with the assessment of regional knowledge on climate change in Table 5 of Hall's (2008) Research probe, and believe that addressing the major regional gaps in our knowledge of how climate change will affect the natural and cultural resources critical for tourism in Africa, the Caribbean, South America, and large parts of East Asia must be a priority considering the relative importance of tourism to the economies of some nations in these regions.

While I also applaud the effort that has gone into the evaluation of tourism knowledge in Table 6 of Hall's Research Probe, it must be considered a starting point for such a dialogue; which is surely the spirit in which it was intended. Given the contested nature of anthropogenic climate change itself, it should be no surprise that experts will hold differing views about what climate change might mean for the tourism sector and that ratings of the adequacy of knowledge by other leading experts would probably yield differing results. With this in mind, there are two important terms in Table 5 ('relative') and 6 ('adequacy') that deserve elaboration in my opinion. While alpine areas and snow-based/ski tourism are identified as having high or very adequate levels of knowledge, I would contend that our knowledge of the implications of climate change on these tourism markets remains very limited in many respects and is not yet 'adequate' for use in decision-making regarding climate change adaptation. For example, while the ski industry in the European Alps is probably the most frequently studied tourist activity, large uncertainties remain as to what the vulnerability of this industry is and what the response of national governments and destination communities should be. The most comprehensive analysis conducted for the Organization for Economic Cooperation and Development (OECD) pronounced that the number of ski areas that were considered 'snow reliable' dropped from 609 to 404 under a +2°C warming scenario and further declined to 202 under a +4°C warming scenario (Agrawala 2007).

Yet, in the same report it is noted that over 50% of skiable terrain in Austria, and somewhat lesser proportions in other nations, have snowmaking capacity that is not incorporated in the impact assessment. Thus, these widely cited impacts do not represent the operating realities of many

ski areas today let alone 25 years from now, when Wolfsegger et al. (2008) showed most ski area managers plan to have enhanced snowmaking capabilities. If snowmaking capacity were factored into the OECD assessment, how would vulnerability change and for which locations? If available water supply were also considered, the relative vulnerabilities of communities with ski tourism would be further refined, perhaps in favour of ski areas further away from cities/towns that are major competitors for winter water supply. Even if we overlook the omission of snowmaking as a key adaptation to climate change, the OECD report indicates that approximately one-third of existing ski areas would remain snow reliable with natural snowfall even under a +4°C scenario. The implication is that the ski tourism industry would contract to a smaller number of destinations. Communities that are at risk of losing ski operators and those where ski operations are likely to persist will need to adapt to climate change, though for very different reasons. The former will need to adjust to reduced winter tourism spending, lost employment, and potentially declining real estate prices, while the latter will need to plan for increased visitation, congestion, and perhaps greater development pressures. How will consumers respond to this supply-side contraction? How will factors like proximity to major markets or destination loyalty influence the vulnerability of destinations? Tourism studies have much to say on these issues. A comprehensive assessment of supply- and demand-side responses to climate change and how they will interact to affect the competitiveness of destinations and the restructuring of tourism markets is what is required by decision-makers. We are not there yet.

This single example highlights three other key knowledge gaps that I deem critical and were also identified by Hall (2008) in his Probe. The IPCC (2007) has indicated that the need for societies and economic sectors like tourism to adapt to further climate change in the decades ahead is inevitable. Adaptation has figured less prominently in climate change research on tourism than in some other economic sectors (e.g., agriculture) and remains an important knowledge gap, particularly with respect to destinations (Scott et al. 2008b). The dynamic nature of the tourism industry and its ability to cope with a range of recent shocks, including SARS, terrorism attacks, or the Asian tsunami, suggests a relatively high climate change adaptive capacity within the tourism industry overall (Scott et al. 2008a), however knowledge of the capacity of current climate adaptations to cope successfully with future climate regimes remains rudimentary.

The cavalier representation of adaptation by Buckley (2008) is therefore to some extent disconcerting. First, we must be careful not to confuse adaptation to past-current

climate variability with anticipatory adaptation to future climate change, as studies that have examined climate change risk appraisal among tourism operators have consistently found low awareness of climate change and little evidence of strategic planning in anticipation of future changes in climate (see Scott et al. 2008a for a summary). There is also some evidence that tourism operators are overestimating their capacity to adapt to future climate change, especially if high emission scenarios are realized (Wolfsegger et al. 2008).

Second, we should not assume that climate change adaptation will be simple or even successful. Adaptation will be a long-term process that must be anticipated and carefully planned. The information requirements, policy changes and investments required for effective adaptation by tourism destinations will require decades in some cases, and therefore the process of adaptation needs to commence in the very near future for destinations anticipated to be among those impacted by mid-century (Scott et al. 2008a). In the words of the UNWTO Secretary-General (2007):

... it is not easy to see (adaptation) through successfully, because it entails, all at the same time, modifying economic circuits, introducing new technologies, carrying out intensive training, investing in the creation of new products, ... changing the minds of public authorities, entrepreneurs, host communities and tourists.

Using the ski tourism example above to illustrate this point, it is ill-considered to simply suggest that ski destinations can be rebranded through market diversification. There is only so much room for more conference centres and spas and if a market existed for these attractions, resorts would fill them now and not wait for climate change. Furthermore, from a revenue replacement perspective, golf courses and spas which can only put hundreds of people through in a day, are not substitutes for ski slopes that can accommodate thousands of visitors a day.

I concur with Probe authors (Hall 2008; Becken 2008), that with their capacity to adapt to the effects of climate change by substituting the place, timing and type of holidays in their travel decision, tourists will play a pivotal role in the eventual impacts of climate change on the tourism industry and destinations. Information on tourist climate preferences and tourist perceptions of the environmental impacts of global climate change at destinations (i.e., perceptions of coral bleaching, diminished or lost glaciers, degraded coastlines, reduced biodiversity or wildlife prevalence, insect harassment) remain important knowledge gaps that must be addressed if potential long-range shifts in tourism demand are to be more accurately projected. All models of

what happens to tourism flows from regional to international scales ultimately depend on understanding what individuals will do – these causal mechanisms remain poorly understood. There is also limited understanding of how climate change impacts will interact with other long-term social and market trends influencing tourism demand, including: ageing populations in industrialized countries, increasing travel safety and health concerns, increased environmental and cultural awareness, advances in information and transportation technology, and shifts toward shorter and more frequent holidays. Here a vexing conceptual challenge exists that has been largely overlooked in climate change impact assessments. Can the potential behavioural response of tourists a generation or two into the future be inferred from responses from contemporary visitors? Can behavioural transference between adjoining generational cohorts be considered reliable?

The call for the development of a more comprehensive framework for understanding the potential implications of climate change for the tourism sector are echoed here. Analyses of potential impacts at destinations have focused on a narrow range of impacts (e.g., natural snow cover for skiing), but to understand the implications of climate change for a destination requires the development of a systems approach that holistically considers four-season supply and demand-side impacts and adaptation options, as well as the fate of key marketplace competitors and interactions with other major influencing variables in the tourism sector (e.g., fuel prices, ageing populations, increasing travel safety and health concerns (Gössling and Scott 2008). Multi-disciplinary collaborations will be increasingly needed to develop such a comprehensive framework and closer co-ordination with governments and the private sector will be needed to ensure that possible effects of climate change are effectively factored into relevant tourism policies and development and management plans (i.e., ‘mainstreaming climate change in decision making’).

Finally, the climate change and tourism research community must not overstate the case of climate change

impacts, since the real problems of climate change will be serious enough if we remain on the current emissions trajectory for much longer. A number of media stories have foretold the major threat that increased future summer temperatures poses for tourism in the Mediterranean. Indeed some stated that ‘The likelihood [is] that Mediterranean summers may be too hot for tourists after 2020’ (Guardian 2006) and that ‘by 2030, the traditional British package holiday to a Mediterranean beach resort may be consigned to the ‘scrap-heap of history’ (Halifax Travel Insurance 2006). As Scott et al. (2008a) demonstrate empirically, such pronouncements are scientifically unfounded and diminish the credibility of all other climate change studies.

Time for Critical Reflection

As with all maturing fields of scholarly work, there comes a time when a sufficient critical mass of research exists to warrant critical reflection on what has been done, its limitations, major knowledge gaps, and new pathways forward. With the earliest scholarly publications on climate change and tourism now 20 years old and rapid increase in the volume of research over the past 10 years, this time has come. I believe there is a strong need for critical reflection on this collective body of work to enable the emergence of a new generation of climate change and tourism assessments that deliver far more rigorous insight than some of the past pedestrian pronouncements about the possible impacts of climate change that lack information on the magnitude and timing of impacts and under what climate change scenarios or adaptation initiatives that destination communities or tourism operators are vulnerable.

This Research Probe, particularly the constructive exchange on the limitations of models used to predict travel demand patterns under climate change (summarized in Table 4, but see also – Gössling and Hall 2006b), and other recent synthesis works (Gössling and Hall 2006a, Becken and Hay 2007, Scott et al. 2008a) represent a starting point for such a critical dialogue, but more is required. I would hope that a future conference or series of review papers would take on this much needed task.

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