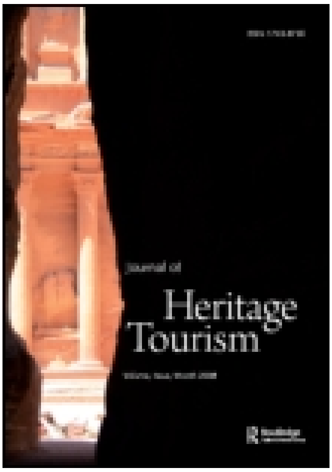

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Forests, climate change and tourism

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Forests, climate change and tourism

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Forests are an important store of carbon within the global carbon cycle and increasingly play a role in climate change adaptation and mitigation. The review illustrates that the cultural, economic and environmental services of forests that are utilized for tourism and recreation are being affected by climate change. In addition to the changes to the distribution and composition of forests as a result of climate change, forest tourism is also affected by changes in frequency and intensity of fires, storm damage and the introduction of alien species. On examining the relevant literature on forests, tourism and climate change, the review identifies the need for a greater understanding of tourist perception of forest change as a major research task. There is also a need for better understanding of systemic effects of tourism-related climate change adaptation and mitigation policies on forest conservation and deforestation. The need for further research of urban forests and woodlands for climate change adaptation and mitigation and their potential implications for tourism and leisure is also highlighted.

Keywords: sustainable tourism; tourism policy; biodiversity; landscape change; environmental change; environmental image

Introduction

Forests are among the most productive terrestrial ecosystems and cover 31% of the total global land area with the world's total forest area in 2010 estimated to be just over 4 billion hectares (Food and Agricultural Organization of the United Nations [FAO], 2010), with 42% in the tropics, 25% in the temperate and 33% in the boreal zone (Fischlin et al., 2007). The FAO (2010, p. 299) defines a forest as, 'Land spanning more than 0.5 ha with trees higher than 5 m and a canopy cover of more than 10%, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use'. They also have an associated category of 'other wooded land' that refers to 'Land not classified as "Forest", spanning more than 0.5 ha; with trees higher than 5 m and a canopy cover of 5–10%, or trees able to reach these thresholds *in situ* or with a combined cover of shrubs, bushes and trees above 10%. It does not include land that is predominantly under agricultural or urban land use' (FAO, 2010, p. 299). Forests are increasingly being affected by climate and environmental change (Dale et al., 2001; Gössling & Hickler,

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2006; Hall, 2011a). This is significant as not only do forests have a significant role in the global carbon cycle, but are also increasingly important for climate change adaptation and mitigation. In addition forests are also direct, e.g. as an attraction and indirect, e.g. erosion prevention, tourism resources (Hall, 2011a). This research note aims to provide a brief overview of some of the relationships between forests and climate change from a tourism context.

The impact of climate change on forests

The Intergovernmental Panel on Climate Change [IPCC] (2007) reported with very high confidence that forests world-wide were already being affected by recent climate changes (the last 30–50 years), including earlier spring and summer phenology, longer growing seasons in mid- and higher latitudes, range expansions at higher elevations and latitudes, population declines at lower elevational or latitudinal limits to species ranges, and vulnerability of species with restricted ranges, leading to local extinctions. IPCC projections are that major changes in forest and woodland ecosystem cover are likely to occur at temperature rises over 3°C. They mostly predict significant loss of forest towards 2100, particularly in boreal, mountain and tropical regions, but some climate-limited forests are expected to expand, particularly where water is not limited (Fischlin et al., 2007; Lenton et al., 2008). They also note that recent moderate climate changes have been linked to improved forest productivity, but these gains are likely to be offset by the effects of increasing drought, fire and insect outbreaks. Estimates of the ability of tree species to migrate are uncertain, but high latitude and altitude shifts appear likely. Losses of species diversity have been projected, particularly in tropical forest diversity hotspots. Mountain forests appear particularly vulnerable (Campbell et al., 2009; Fischlin et al., 2007).

Changes in forest and woodland ecosystems as a result of climate change may further exacerbate abiotic impacts on forest health (FAO, 2010), including deforestation, urbanization, introduction of exotic species and land-use change. While all of these types of ongoing and future forest change have implications for tourism aesthetics and safety, little specific information is available to understand what the impact could be at the destination scale and the affect on tourist perceptions of the landscape (Gössling & Hickler, 2006; Hall, 2008, 2011a).

Forest and woodland ecosystem migration

Forest ecosystems often require long timeframes to observe changes in distribution. However, evidence is already starting to mount that such changes are already happening (Campbell et al., 2009). Some tree species already exhibit movement towards higher latitudes and higher altitudes (Beckage et al., 2008). Uphill migration of treelines in Scandinavia has been observed on the order of 150–200 m (Kullman, 2007). The upward advance of the alpine treeline has also been seen in the encroachment of woody vegetation into alpine meadows in Yunan, China (Baker & Moseley, 2007).

Tropical areas are expected to experience substantial changes in ecosystem distribution with savannah ecosystems moving into equatorial regions now occupied by forests as a result of drier conditions (Salazar, Nobre, & Oyama, 2007). Substantial uncertainty remains over the extent of climate-related loss of the Amazon forest with projections ranging from 18% (Salazar et al., 2007) to 70% (Cook & Vizy, 2008), with the upper end extent of loss being a potential major 'tipping point' in climate change impacts (Lenton et al., 2008). Some ecosystems that have either an extremely limited distribution, as at the top of mountain ranges, or are potentially subject to extremely rapid change, such as some coastal ecosystems, are likely to have extremely limited or no capacity to move. This may be significant for niche nature-based tourism products based on vulnerable environments. In the case of Australia, for example, this would include such significant tourism areas as the tropical and temperate rainforests, as well as the relatively low lying alpine areas in south-east Australia and the Stirling and Porongup Ranges in Western Australia (Hughes, 2003).

The rainforests of the North Queensland Wet Tropics are a World Heritage Site that is under substantial threat from climate change (Steffen et al., 2009). The region is dominated by mountain ranges varying from sea level to 1600 m with altitude being the strongest environmental gradient-affecting species composition and patterns of biodiversity (Williams, 2009). Tropical mountain systems, such as those in North Queensland, are extremely vulnerable to climate change due to their fragmentary nature, small area, high rates of endemism and species specialization (often as the result as acting as a long-term refugia (Hilbert, Graham, & Hopkins, 2007), and the compression of climatic zones over the elevation gradient (Williams, Bolitho, & Fox, 2003). Such montane forests contain the highest numbers of endemic species in the Wet Tropics and are the most threatened by climate change. Bioclimatic modelling of the distributions of regionally endemic rainforests vertebrates in the Wet Tropics by Williams et al. (2003) predicted that with a greater than 2°C temperature increase, most species will undergo dramatic declines in distribution, with some completely losing their current climatic environment. Cloud forests and other highland rainforests types are predicted to become greatly reduced in area and more fragmented across the Wet Tropics, even under a conservative scenario of 1°C temperature increase and a small reduction in rainfall (Hilbert, Ostendorf, & Hopkins, 2001).

Forests and increased storm intensity

In European forests, heavy storms can create significant economic, ecological and social problems and together with fire are likely to be the most important, large-scale disturbance to stands of both natural and managed forests. According to Gardiner et al. (2010) storms are responsible for more than 50% of all primary abiotic and biotic damage by volume to European forests from catastrophic events. Historically, catastrophic storms have tended to occur every 5–10 years in Europe (FAO, 2010), with more than 130 separate windstorms identified as causing noticeable damage to European forests from 1950 to 2010. However, due to the effects of climate change, change in wind patterns and/or oceanic currents and general increased variability in meteorological events, the period between destructive storms is expected to change in the coming years and decades (FAO, 2010).

According to Gardiner et al. (2010), there is some evidence that storm intensity is already increasing and that storm tracks are penetrating further into mainland Europe and along a wider swathe, therefore also increasing the risk to forests in Eastern Europe. With climate change, higher temperatures will lead to longer periods of unfrozen soils during European winters, leading to a potential increase in forest damage and particularly in the Nordic countries. Storms will also tend to be accompanied by heavier rainfall leading to more saturated soils and increased risk of wind damage. Gardiner et al. (2010) also conclude that if the current expansion of growing stock continues together with predicted changes to the climate, damage levels are then expected to at least double, and possibly quadruple, by the end of the century. Such a situation will also affect the capacity of forests to store carbon, with current estimates suggesting that storm damage to European forests will result in an annual reduction of 2% in the carbon sequestration by forests with his figure potentially exceeding 5% by the end of the century if the current build-up of growing stock continues (Gardiner et al., 2010).

In addition to the direct impacts of climate change on trees and forest ecosystems, such changes can have devastating effects and can increase forests' susceptibility to other disturbances (FAO, 2010). For example, a major storm in January 2005, and again in 2007, caused severe windthrow in southern Sweden, especially in middle-aged and old spruce stands. This resulted in an increase in the populations of insects, notably the European spruce bark beetle, *Ips typographus*. Severe storms were also experienced in several other countries in Europe including Germany and Slovakia, where the storm of 2004/2005 affected forest in national parks, resulting in a severe bark beetle outbreak. Such interactions clearly make the prediction of future impacts of climate change on forest disturbances and their subsequent affects on recreation and tourism more difficult (Müller & Job, 2009).

Extreme weather events can also destroy ecosystems, such as mangrove forests or coral reefs that provide protection against sea-level rise (SLR) and further high-magnitude events, which will in turn have direct consequences to the ecosystem and for the buffering of associated ecosystems. A review of mangrove threats by Alongi (2008) suggested that climate change may lead to a global loss of 10–15% of mangrove forest, and SLR is an important component of that threat because sediment accretion is not keeping pace with it. This is extremely significant for some tropical and sub-tropical coastal systems in which tourism resorts are located, e.g. Florida and the Gulf of Mexico, south-east Asia, Pacific Islands, where mangroves are an important coastal protection, as well as delivering other ecological services, such as a fish nursery (Hall, 2010b).

In a tropical mountain rainforest landscape in Queensland, Australia, Prideaux, Coghlan, and McKercher (2009) used the substantial damage from a recent category five tropical cyclone as a proxy to explore tourist perceptions of landscape change under climate change. In the survey of three months after the cyclone, 54% of tourists reported noticing substantial damage to the landscape, but by 15 months, only 6% reported noticing impacts. They concluded that to most tourists (largely from urban areas), the scenic value would not change greatly, once obvious physical damage to the forest is obscured by new growth and the impression of a vibrant forest is restored. Therefore, the impact of cyclones, and by extension climate change, on tourist demand was anticipated to be minimal in terms of direct landscape perceptions. The use of similar climate change analogues, as long as the impacts are similar to what is anticipated under climate change, deserve greater attention by researchers in other mountain regions of the world (Scott, Gössling, & Hall, 2012).

Forest fires

Increased fuel loads, longer fire seasons and the occurrence of more extreme weather conditions as a consequence of a changing climate are expected to result in increased forest fire activity (Mortsch, 2006), with Goetz, Mack, Gurney, Randerson, and Houghton (2007), suggesting that the frequency and extent of wildfires has already increased in Canada, Russia and the USA as a result of recent climate changes. Wildfires have impacted tourism destinations in the USA, Greece, Spain, Portugal, Australia, Russia and Canada since the 1990s (Hall, 2010a; Hystad & Keller, 2006; Lynch, 2004; Ritchie, 2008). Forest fires may have different affects on tourist perception of environmental values than other climate-related change (Staple & Wall, 1996). In parts of Greece, after the devastating fires of summer 2000, more than 50% of all bookings from tourists for 2001 were cancelled (International Union for Conservation of Nature [IUCN], 2007). Dangerous wildfire conditions in parts of the western USA in the summer of 2002 and the media coverage of major fires, including a mis-statement by a senior government official who stated that ‘it felt like the whole state was on fire’, also had a significant impact on tourism, including reservation cancellations and reduced visitation to parks in the region (even those unaffected by the fires) (Butler, 2002; Scott & Lemieux, 2010). Sanders, Laing, and Houghton (2008) analysis of the impact of the 2006–2007 wildfires on tourism in and near the national parks of south-eastern Australia revealed similar findings with respect to the importance of media reporting of the fires and statements by public officials, the generalization of impacts from specific locations to the entire tourism region. Wildfires may deter tourists out of concerns for safety, health effects of air pollution, loss of recreation opportunities (access to certain areas, ban on open fires, damaged infrastructure) and the loss of attractions (landscape and wildlife) (Brown, Rosenberger, Kline, Hall, & Needham, 2008; Hesseln, Loomis, González-Cabán, & Alexander, 2003).

In each destination, governments and the tourism industry have invested additional resources in tourism marketing strategies, specifically to counteract negative publicity generated by the fire events. Interestingly, while the immediate impact of wildfires on tourism is highly negative (reduced visitation and damage to tourism assets and infrastructure), in some high-profile nature-based tourism destinations (e.g. Yellowstone National Park in the USA), severe wildfires have been observed, to increase tourism in the years following fires, as visitors come to see the devastation and nature’s rebirth and tourism operators develop new products, such as ‘fire recovery’ tours (Lichtman, 1998). The impact on tourism of wildfires may be particularly acute for parks and recreation areas, where fires may be perceived as degrading their social value, and where the public perception is often of a healthy environment that is protected in perpetuity (Hesseln et al., 2003; Scott, 2003; Starbuck, Berrens, & McKee, 2006). However, long-term rebound in any forest area affected by wildfire is likely to be dependent on the rate of fire event recurrence, media reporting, promotion and marketing, and the quality of interpretation. In addition, from a climate change impact perspective, the effects of these recent wildfires provide a useful analogue of potential future relationships between environmental change and tourism and deserve further analysis.

Changed species composition

The increased frequency of such fires can change the usual fire regime, thereby favouring some species over others, and potentially enabling the spread of fire-adapted exotic species. For example, in parts of Europe, and especially the Iberian Peninsula, increased wildfires is potentially helping spread acacia and eucalyptus species thereby radically changing the woodland landscapes (Lorenzo, González, & Reigosa, 2010), while also assisting in the expansion of Mediterranean heath species. Changes in fire regimes may also go hand-in-hand with other ecosystem changes, including species change (Flint, McFarlane, & Müller, 2009).

In British Columbia, Canada, the largest recorded outbreak of mountain pine beetle has affected an estimated 130,000 km^2, or close to the total area of England, between 1993 and 2006 (Canadian Broadcasting Corporation, 2008). The infestation is partly related to the lack of cold winters over this time period, which normally curbs the populations of the beetle. The infestation has resulted in widespread mortality of the lodgepole pine, one of the area’s most abundant tree species, with the dead trees rendering the forest in entire valleys a rust-red colour. Many forest values are put at risk, including the value of the forest landscape for tourism (McFarlane, Stumpf-Allen, & Watson, 2006). The British

Columbia Council of Tourism Associations (Tourism Industry Association of British Columbia, 2009) has begun to develop a tourism action plan to respond to the mountain pine beetle damage, which may provide lessons for other destinations facing similar challenges and the need to identify strategic opportunities for investment in response to the negative impacts of climate change.

Although in most cases, gradual changes in species composition will be innocuous for tourism, in some destinations, impacts will occur. In parts of the north-eastern USA (mainly the New England region) and parts of south-eastern Canada, there is a US$400 million tourism industry that draws visitors from around the region and North America to see the varied mosaic of fall foliage (leaf colours) (Rathke, 2008). Vegetation modelling has projected that the maple-beech-birch forest type that currently dominates the region would be replaced by the oak-hickory forest type under climate change conditions (Frumhoff, McCarthy, Melillo, Moser, & Wuebbles, 2007), replacing species that provide the colour essential to spectacular fall landscapes with a greater abundance of less colourful tree species. How tourists would respond to such changes in the palette of fall forest landscapes remains uncertain, but no such tourism industry exists in less colourful forest landscapes to the south and west.

Climate change will also have an affect on the composition of alpine ecosystems and associated aesthetic response. Cultural alpine landscapes have developed over centuries and are significant heritage and tourism commodities. However, alpine agriculture is in transition raising concerns about landscape aesthetics as abandoned farmlands revert back to forest (Höchtl, Lehringer, & Konold, 2005; Soliva, Bolliger, & Hunziker, 2010). Furthermore, abandoned low-altitude ski fields may also be allowed to revert to forest. Using photo manipulations of an alpine region depicting different land-use conditions, Soliva et al. (2010) found Swiss respondents who visually preferred low-intensity land use over reforested landscapes and that spontaneous (natural) reforestation was less liked at higher elevations. Research on alpine landscape aesthetics and land-use change has revealed differing perceptions among nationalities and generations (Höchtl et al., 2005; Kianicka, Buchecker, Hunziker, & Müller-Böker, 2006; Soliva et al., 2010), although further research is required to better understand the implications of landscape change on tourist perceptions or intentions to visit.

Forests and tourism-related climate change adaptation and mitigation

Because of their role in carbon storage as well as the important ecosystem services they provide, forests and woodlands have become significant components of climate change adaptation and mitigation. Point four of the World Travel and Tourism Council's (WTTC) 10 Point Action Agenda on Climate Change states:

> We will support the effort to develop a funding mechanism to reduce emissions from deforestation and forest degradation in developing countries through initiatives such as REDD. As an industry we will work with the Prince of Wales Rainforest Project and others to reduce tropical deforestation by supporting the sustainable livelihoods of forest communities and by protecting their ecosystems (World Travel and Tourism Council [WTTC], 2009, p. 15).

Moreover, in a later publication, the WTTC comment: 'travel and tourism could be one of the most coherent, non-extractive, economic activities for forest communities and can act as a major tool for Reducing Emissions from De-forestation and Degradation (REDD)' (World Travel and Tourism Council [WTTC], 2010, p. 9). In this regard, it proposes various actions. For governments, these include integrating mitigation and adaptation policies in tourism planning, considering tourism in national climate vulnerability assessments, promoting collaboration between national and local governments and the private sector to communicate the benefits of adapting to a low-carbon economy, considering poverty reduction as a tourism development goal, and combining reducing emissions from deforestation and degradation (REDD) actions with small-scale, high-value nature-based tourism in forest communities to provide alternative sources of income.

However, a number of problems have emerged in REDD and other carbon offset schemes with respect to their implementation, equity and effectiveness (Hirsch et al., 2011; Isenberg & Potvin, 2010; Levin, McDermott, & Cashore, 2008). In a review of the voluntary carbon market for aviation, Gössling et al. (2007) found that most organizations focused partially or entirely on forestry projects. While it is clear that afforestation and halting deforestation need to be part of strategies to address climate change (Palmer & Engel, 2009), the role of afforestation/deforestation projects as offsets is more difficult to assess, for instance because of the need to guarantee that carbon stored in biomass can be maintained over decades and centuries (Broderick, 2009; Gössling et al., 2007). It should also be noted that there is no political consensus yet regarding the role of, and mechanisms for, 'REDD' in a global emission reduction framework, even though proposals continue to emerge and implementation of REDD+ activities have been affirmed under COP-16 (Scott et al., 2012).

Trees play an important role in the creation of attractive urban and cultural landscapes. Although perhaps not seen in the context of climate change by the wider public, urban forests and tree plantings can be extremely significant in reducing the temperatures of urban environments (Larsson, 2003). Urban forests and woodland can have a role in carbon dioxide sequestration and thus in climate change mitigation as well as providing recreational opportunities and environmental services (Niemelä et al., 2010; Rosenzweig, Solecki, Hammer, & Mehrotra, 2011). Kitha and Lyth (2011) argue that urban green landscapes act as a 'soft engineering' climate change response strategy, and calls for management practices that preserve and promote the use of these urban spaces. In a study of Mombasa, Kenya, they find that a well-managed system of green landscapes in resource-poor urban areas can generate net social benefits under a range of future scenarios. Organizations, such as the US Mayors Climate Protection Center (2008), have argued for the maintenance of healthy urban forests and the promotion of tree planting to increase shading and to absorb CO_2 as an integral component of local government response to climate change. However, there is need for further research on the interplay between urban tourism and recreation and urban forests as part of tourism-related climate change strategies.

Conclusions

This review has briefly noted some of the main relationships between forests and climate change from a tourism context. Climate change has the potential to dramatically affect both the distribution, as well as the composition of forests. In some circumstances, such as the role of autumn/fall forest colours as tourist attractions, this may have significant economic implications for some destinations. However, some of the most substantial effects are likely to be from high-magnitude events such as storms and forest fires that may alter forest appearance and composition. A critical issue in many forest-based tourism attractions and destinations is the extent to which forest and landscape change is perceived by tourists to be significant and this will likely be a major research focus in the future, particularly for national parks and forest reserves that generate income via tourism.

The tourism industry has also been supporting forest conservation and reforestation projects via carbon offset programmes. However, some concerns have been expressed as to the actual benefits of these, especially in light of their long-term effectiveness as well as the continued expansion of tourism mobility (Gössling et al., 2007; Hall, 2011b). In addition, the tourism transport sector's interest in promoting biofuel as an alternative energy source may have significant implications for the loss of forest resources unless carefully monitored. Such a situation reflects the importance of assessments of the interrelationships between tourism, climate change and forests being conducted on a system-wide basis and at multiple scales.

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