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Tourism travel under climate change mitigation constraints

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ABSTRACT

The paper first describes an inventory for 2005 giving the tourism related CO_2 emission caused by global tourism, and presents a 30-year projection and a 45-year simulation. The study found that tourists cause 4.4% of global CO_2 emissions. Also these emissions are projected to grow at an average rate of 3.2% per year up to 2035. This increase is problematic as globally a reduction of emissions by 3–6% is required to avoid 'dangerous' climate change. Using contemporary scenario techniques it appeared difficult to find a future tourist travel system consistent with CO_2 emission reductions of up to 70% by 2050 with respect to 2005. Based on the model underlying the 30-year projection, 70 scenarios are presented in a 'landscape' graph exploring the effect of opportunities to reduce the emissions, but this attempt did not reach the large reductions envisaged. We therefore explored automated scenario generation as a way to define backcasting scenarios that both reach the emission reduction target and retain the highest possible economic value for the sector. The main contributions made by this study are (1) in comparing the value of different ways to approach a (desired) future and (2) giving insight into the kind of structural changes required within tourism and tourism transport in case very strong emission reductions are required. Finally the model showed signs of 'complex' behaviour.

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1. Introduction

The fourth Assessment report of the Intergovernmental Panel on Climate Change (IPCC) forecasts that a post-industrial temperature rise is very unlikely to stay below 1.5 °C and likely to rise above 2 °C (IPCC, 2007c). A change in temperature of over 2 °C is considered to be at a 'dangerous' level, meaning it may destabilise the climate system (Hansen et al., 2006; Schellnhuber et al., 2006). Temperature rise projections for 2100 range from 1.5 °C to as much as 6.4 °C. To avoid 'dangerous' climate change, current emissions will have to be reduced by between 3% (Hansen et al., 2006; Parry et al., 2008b) and 6% per year from 2015 onwards (Parry et al., 2008a). In our paper we will show that current tourism development is unsustainable with respect to climate change as its emissions are projected to grow at over 3% per year, and, if unrestricted, may even become larger than the global emission allowance within four decades. Both the sector and governments need to assess the risks and opportunities associated with future climate change and climate policies. So there is a clear need for thorough examination of the future of tourism and tourism transport.

Scenario development is one of the major tools to inform the policy building process (Bradfield et al., 2005). This is especially true in IPCC reports, heavily dependent on scenario studies (IPCC, 2000) to deliver data on global greenhouse gas emissions or on climate change impacts. Global tourism scenarios are scarce, with only four studies found (Bosshardt et al., 2006; Nordin, 2005; TUI UK, 2004; WTO, 2000). Only Bosshart and Frick (2006) and Nordin (2005) mention climate change, but their studies are limited to the impacts of climate change on tourism. On a regional level, very few studies deal with tourism's contribution to climate change (e.g. for the EU by Peeters et al., 2007 and for France by Dubois and Ceron, 2007). Scenarios for global transport and climate change are more common (e.g. Åkerman, 2005; Azar et al., 2003; Boeing, 2007; Hawksworth, 2006; Kelly et al., 2007; Moriarty and Honnery, 2004; Olsthoorn, 2001; Schafer, 1998; Schäfer and Jacoby, 2005, 2006; Schafer and Victor, 2000; Vedantham and Oppenheimer, 1998; Wiederkehr, 1999), but none of these studies deal specifically with tourism transport. Global emission inventories are published by the IPCC (IPCC, 2000, 2007b, 2007c). These inventories are unsuitable to extract the impact of tourism as these inventories

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are based on contemporary economic sectors, while tourism is not such a sector in itself but a composite of parts of other sectors (e.g. transport, leisure industry, hospitality, ITC). This clearly illustrates the need for both specific emission inventories and scenarios for tourism.

In 2007 the UN World Tourism Organisation (UNWTO), UNEP and the World Meteorological Organisation (WMO) issued a report about tourism and climate (UNWTO-UNEP-WMO, 2008). For this report the authors developed an emission inventory and 2005–2035 emission scenario (published in Chapter 11 and Section 2.5). In this paper we describe this inventory and these scenarios. However, scenarios, being narrative or model-based (Raskin et al., 2005), often are problematic as they are subject to bias towards the ordinary (MacKay and McKiernan, 2004). Scenario builders reject the more remote scenarios or those perceived to be unlikely and generally have difficulties in introducing discontinuities, which hampers the ability to assess risks (van Notten et al., 2005). A specific way out of these problems is to develop systematic sets of 'landscapes' of scenarios reaching all extremes regardless of probability (see e.g. Lempert et al., 2003). A more general solution is to use automated techniques of scenario building, avoiding the many arbitrary or subjective choices to be made when developing just a small number of scenarios.

The first objective of this paper is to fill gaps in knowledge about current and future greenhouse gas emissions caused by global tourism. The second objective is to show what tourism could look like in the case of very strong emission reduction goals. The third objective is to explore methods beyond the classical scenario method using automated backcasting. For the 2035 projection and landscapes, the Global Tourism and Travel Model, basic version ($GTTM^{bas}$) was developed. This model assumes constant annual growth of its input variables projecting tourism and transport volumes and CO_2 emissions. For automated backcasting scenario generation, this model has been re-programmed using Powersim Studio 7 system dynamic modelling software into the advanced $GTTM^{adv}$.

Section two briefly discusses the scenario method and the position of our global scenarios within this theory. It also describes the assumptions and methods used for the inventories and the model versions. Section three presents the results of the 2005 emissions inventory, the projections and the backcasting scenarios. Finally, section four discusses the limitations of the methods presented to explore the future and presents some conclusions.

2. Methods

2.1. The scenario method

The scientific literature gives a wide range of definitions of scenarios (Bradfield et al., 2005; Schwartz, 1996). We have adopted the definition given by the IPCC for climate scenarios: "A scenario is a coherent, internally consistent and plausible description of a possible future state of the world. Scenarios are not predictions or forecasts but are alternative images without ascribed likelihoods of how the future might unfold" (IPCC, 2007a, p. 145).

The range of scenario types is broad, and scenarios are often divided into different groups. One commonly used division distinguishes four groups by dividing scenarios into combinations of exploratory ↔ normative and quantitative ↔ qualitative projections (Gordon, 1992; Prideaux et al., 2003 and, in other terms, van Notten et al., 2003). Exploratory (plausible) scenarios generally extrapolate trends or are forms of forecasting, while normative (desirable) scenarios first define a desired future and use backcasting to find a way to get to this future (Prideaux et al., 2003, p. 476). The technique of backcasting is useful for studies exploring sustainable development of complex systems, where a specific future situation is desired that deviates strongly from continuation of current trends (e.g. Dreborg, 1996). Quantitative scenarios use a range of methods (e.g. models, simulations) to describe the future and determine underlying relationships, while qualitative scenarios depend on expert judgement (e.g. the Delphi method, brainstorms, narratives). Our 2035 tourism and tourism transport projection is quantitative and explorative and uses the exponential growth $GTTM^{bas}$ model. The 2050 backcasting simulation with the $GTTM^{adv}$ is quantitative and normative as it uses a well-defined future target for tourism and tourism transport CO_2 emissions. Furthermore the backcasting exercise differs from the landscape method as we used wider ranges for the input variables, we tested the model against four different economic and demographic background scenarios and we extended the scenario period by 15 years to 2050.

Future studies are empirical and output-oriented comprising a multitude of techniques, the choice of which depends on the objectives of the study. In the field of transport quantitative results are often required (Ceron and Dubois, 2007), for example to plan new infrastructure, while in tourism qualitative results are indispensable, such as the type of societal change. Ideally, a scenario exercise should try to integrate both needs (Raskin et al., 2005): coherent and plausible quantitative results embedded within qualitative storylines and policy pathways. A challenge for our backcasting exercise is to define a tool allowing a transparent and rigorous exploration of a future situation satisfying several targets (e.g. a certain GHG emission reduction, while maximising tourism revenues), for a complex set of variables and factors of change (e.g. technology, infrastructure, the tourism markets, demographics, international context). Contemporary scenarios are often developed in working groups, but present severe limitations:

- At best, if at all, they allow for quantification through laborious manual iterations with simple models, consuming large amounts of time.
- The complex interactions and feedbacks within many systems hamper experts to fully comprehend/control which is a source of inconsistency and plain errors.
- More importantly, for such long term scenarios (2050, or even 2100, frequently used in the field of climate change), experts and scientists tend to ignore strong discontinuities or trends perceived to be unlikely, thus censoring themselves while venturing at 'terra incognita'.
- Finally, the experts may introduce some moral limitations in the process blurring the broader picture (e.g. reducing growth of domestic travel in developing countries as a possible solution, but dismissed on grounds of equity when done manually).

Therefore, instead of first exploring narratives and qualitative pathways of change for tourism and then quantifying the most promising ones, we chose to explore first quantitative automated backcasting optimisation. We run this optimisation model thousands of times to find the set of input parameters (growth of markets, technological development) that satisfies the goal (a certain reduction of CO_2 emissions) and objective (maximum total tourist revenues). In this way we may inform policy makers about structural changes of the tourism sector required to reach the emission goal. The next step – to be developed in a follow-up to this paper – will go back to explore and describe the qualitative pathways and policies to reach this desired future.

2.2. The 2005 emissions inventory

Tourism is defined as 'the activities of persons travelling to and staying in places outside their usual environment for not more

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