THE ECO-EFFICIENCY OF TOURISM

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ABSTRACT

The use of fossil energy is one of the major environmental problems associated with tourism and travel. Consequently, the need to limit fossil energy use has been highlighted as a precondition for achieving sustainable tourism development. However, tourism is also one of the most important sectors of the world economy, and fears have thus been expressed by the tourist industry and its organisations that increasing energy prices (for example, as a result of eco-taxes) could substantially decrease the economic welfare of countries and destinations. In this article, the interplay of environmental damage and economic gains is thus analysed within the context of tourism. Carbon dioxide-equivalent emissions are assessed in relation to the revenues generated, leading to conclusions about the eco-efficiency of tourism.

KEYWORDS: *Air travel, Energy, Climate change, Policy making, Sustainable tourism, Taxation, Transport*

INTRODUCTION

There is broad consensus that tourism development should be sustainable; however, the question of how to achieve this remains an object of debate. It is clear that in order to be sustainable,

environmental effects of tourism need to be kept below critical threshold levels, which can only be achieved if these environmental effects can be quantified. Several conclusions can be drawn from studies attempting to quantify environmental impacts of tourism (1, 2, 3, 4, 5, 6). First, whether using energy consumption, greenhouse gas emissions or area-equivalents as a basis for calculations, a substantial share of tourism is seen to conflict with sustainability goals. Second, the use of fossil fuels and related emissions of greenhouse gases is, from a global point of view, the most pressing environmental problem related to tourism (7). Third, transport contributes disproportionably to the overall leisure-related environmental impact of tourism: up to 95% per trip.

In the light of these insights there is a given need to reduce greenhouse gas emissions, particularly in the transport sector. Policy changes designed to reduce emissions from the tourism industry are frequently seen as unpalatable, especially in light of the widely held belief that environmental levies could reduce tourism revenues. In countering the image of an environmentally harmful industry, tourism lobbyists seek to establish and maintain a discourse portraying tourism as an environmentally neutral, if not beneficial industry, claiming its ecological performance to be superior to other sectors of the global economy (8). The analysis of the tourist industry from an ecological efficiency (or eco-efficiency) perspective may provide new insights into these claims. Eco-efficiency is a term coined by the World Business Council for Sustainable Development in 1995, and based on a lifecycle analysis approach (9).

For the purpose of this article, environmental damage per unit of value generation has been chosen as the basis for calculations. Carbon dioxide equivalent (CO_2-e) emissions are used as a proxy for environmental damage. The use of equivalent emissions allows consideration of the impacts of air travel, which is important because emissions (nitrogen oxides, water vapour and other pollutants) released at cruise altitude have a larger effect on radiative forcing than those emitted at ground level (10). As a proxy for value generation, turnover is used. Thus eco-efficiency (EE) is defined as the ratio of CO_2-e (kg) to turnover (€). Note that we describe eco-efficiencies as "favourable/unfavourable". Calculations do not consider indirect ecological and economic effects.

Based on these premises, the analysis will focus on the following questions:

What is the eco-efficiency of the tourism industry and how does this vary per market?

How does the eco-efficiency of tourism compare to other sectors?

How can eco-efficiency be used i) to judge the environmental impact of different source markets or forms of tourism, ii) to assess the sustainability of tourism, and iii) to develop more sustainable tourism products?

METHOD

The calculation of eco-efficiency ratios requires two data-sets: one for CO_2–e emissions and one for turnover. Indirect energy requirements, costs or multiplier effects are not considered in this analysis, as none of the existing databases is detailed enough for such advanced calculations. As most data available are for energy consumption, these had to be converted to CO_2–e emissions using appropriate conversion factors.

Transport emissions can be calculated for different transport modes and connections, using the following equation:

$$E_{el} = \sum_m \left(\beta_m * \varepsilon_m * V_m \right)$$

In which E_{el} is CO_2–equivalent emissions in kg, β_m specific emissions of CO_2 in grams per passenger kilometre (pkm), ε_m equivalence factor and V_m total transport volume for transport mode (m) in passenger kilometres (pkm). The β_m are based on occupancy rates of 70% for intra-EU air, 75% for ICA air, 50% for car, 60% for long-distance rail and 75% for coach. The emission factors vary between an average 0.018 kg CO_2–e/pkm for coaches and an average 0.14 kg CO_2-e/pkm for air transport within Europe (based on 11, 12 and others). Equivalence factors (ε_m) are used to include the climate-relevant effects of other emissions than carbon dioxide. For surface transport (road, rail and shipping) this factor is about 1.05 (13). At cruise altitude, emissions of NO_x, H_2O and soot cause positive additional radiative forcing (14). The equivalence factor for air transport is estimated at 2.7 (10). The total transport volume for transport mode m (V_m) is calculated using the following equation:

$$V_m = 2 * \sum_n N_n * S_n * DF_m * WF_n$$

In which V_m is total transport volume for transport mode (m) in passenger kilometres (pkm), N_n total number of tourists travelling with transport mode m on connection n, S_n great circle distance for relation n, DF_m average detour factor for mode m and WF_n generalised weight factor for multi-destination travel calculations at journey, region or country level.

The total number of tourists travelling with transport mode m includes all travellers arriving with a certain means of transport (aircraft, car, etc.). The great circle distance S_n is the shortest distance between two locations. The detour factor DF_m gives the average ratio between the real distance covered and the theoretical shortest great circle distance (as estimated by Peeters). These vary between 1.05 for air transport and 1.15 for ground based transport. The weight factor WF_n is used to indicate that long-distance tourists may visit several countries during their stay. Only part of their travel impact should therefore be allocated to the country where the tourists arrived. Using

Amsterdam as an example, WF_n is calculated as $WF_n = \dfrac{\overline{LOS\_A_n}}{\overline{LOS\_T_n}}$, with LOS_A_n being the average length of stay within Amsterdam and LOS_T_n being the average total length of the trip. Finally, to capture return-trips, results have to be multiplied by two.

The amount of energy consumed in different hotels as well as the environmental impact of their production may thus vary considerably. Average energy consumption per bed night in hotels might be in the order of 130 MJ (3). Hotels use generally more energy per visitor, as they have energy intense facilities, such as bars, restaurants, pools, and more spacious rooms. For accommodation establishments in the category 'pensions' an average value of 50 MJ is used. Campsites were assumed to have the lowest energy use of all categories with 25 MJ per bed night, while holiday villages were calculated with 90 MJ per bed night. It should be noted that there is a moderate degree of uncertainty, as scientific data on energy use in accommodation establishments is limited. No data is available for self-catering facilities and vacation homes. These are assumed to consume 120 MJ and 100 MJ per bed night.

On holiday, tourists are usually engaged in activities. Becken and Simmons (15) identified activities of New Zealand tourists and calculated their energy-intensity, which ranged between 7 MJ per tourist (visitor centers) to 1,300 MJ per tourist (heli-skiing). Given the differences in energy-intensity, it seems difficult to allocate an average amount of energy to each tourist. Gössling (3) estimated that, on average, 250 MJ per tourist (corresponding to 39.6 kg CO_2) are used for 'activities' during a longer vacation of international tourists, which might be a rather conservative estimate (15).

CASE STUDIES

Five case studies were used for this paper: Amsterdam, France, Seychelles, Valle di Merse (Tuscany) and Rocky Mountains National Park (RMNP). In the first four cases the market has been divided by country of origin of the tourists. Typical results are shown for the Amsterdam inbound tourism case (figure 1). The left picture shows the total amount of CO_2–e emissions per market and the right one the revenues. From the figure the economically best performing market (The Netherlands) does not show on the emissions graph, being too small. On the other hand, an intermediate emitter like Japan is not on the emissions graph. The overall eco-efficiency is 1.1 kg CO_2–e/€. This is 20% more than for the rural destination of Valle di Merse.

Val di Merse is located in the Province of Siena in Tuscany, Italy. 250,113 bed nights were recorded in the study area in 2003 (16). The eco-efficiency of tourism to Val di Merse is better with respect to other case studies presented in this study due in part to the relatively small share (10%) of non-European tourists visiting the area. Eco-efficiency varies between 0.4 kg CO2-e/€ for Italian
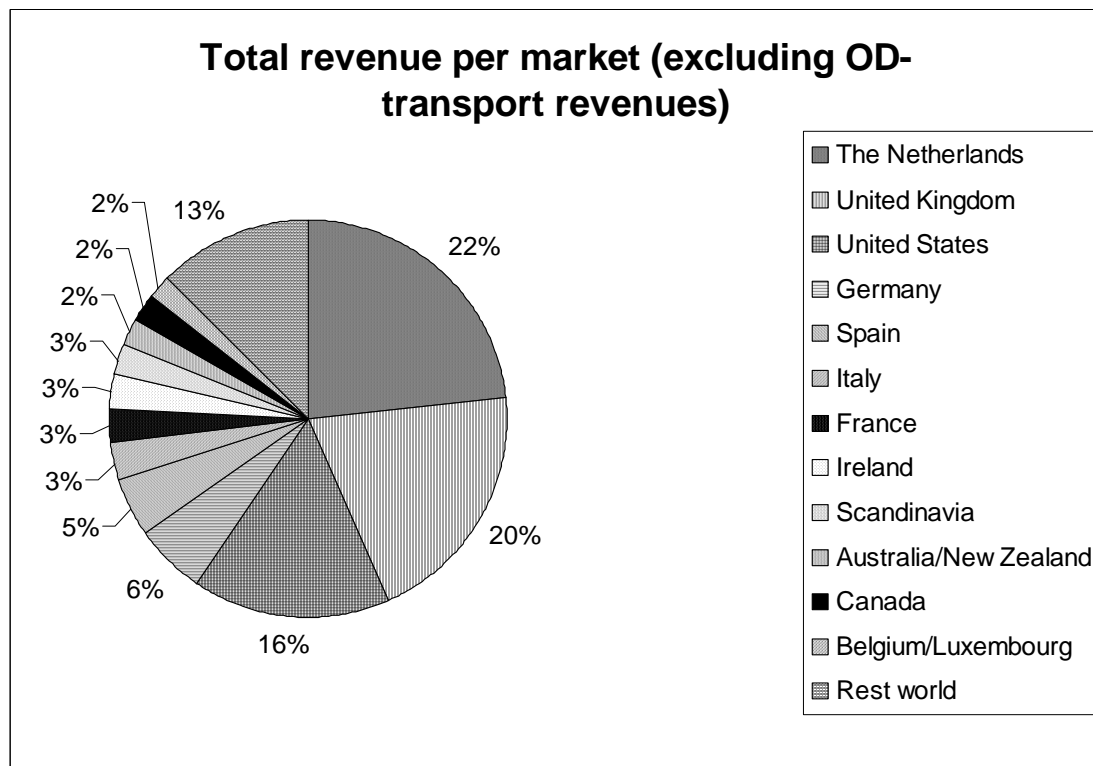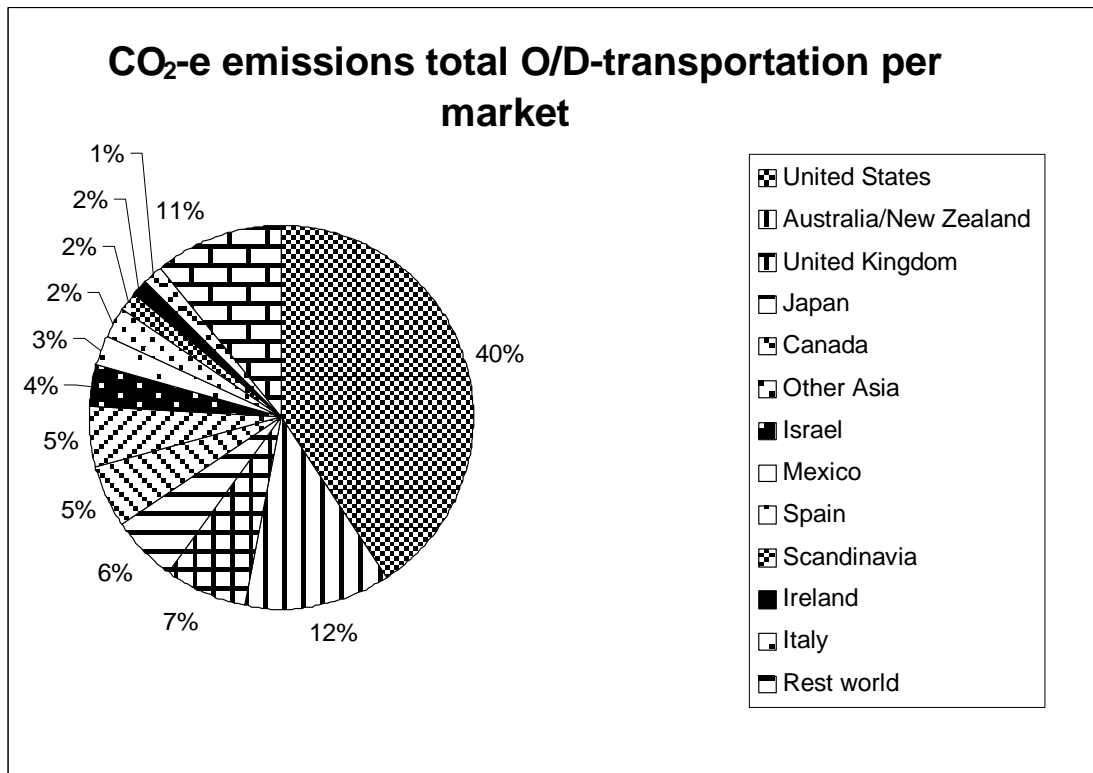
visitors to 4.0 kg CO2-e/€ for Australians and New Zealanders (including the revenues from transport). The second reason why tourism to Val di Merse can be seen to have more favourable eco-efficiency than other cases presented are the low on-site emissions, because of the small scale low energy country home rentals typical of the area. Emissions from transport of food products also tends to be lower, as tourists to Tuscany tend to eat Tuscan foods. Activities of tourists in the area such as shopping, farm visits, museums, and horseback riding generally have low emissions. Finally, the production of products typically purchased by tourists (i.e., olive oil, pasta, wine, cheeses, etc.) are relatively low in energy intensity and greenhouse gas emissions.

The Seychelles show on average a seven times higher EE (seven time less favourable). This is because the islands depend almost entirely on long distance tourism. The analysis of CO_2-e emissions for tourism on the Seychelles shows that transport to the destination accounts for 96% of the total, while accommodation contributes 2%, other transport 2%, and activities less than 1% (4). Calculated per tourist, EE values range between 3.19 kg CO2-e/€ for visitors from La Reunion to 13.03 kg CO2-e/€ for visitors from Italy. The large differences between the European source countries depend on two factors: expenditure per day and average length of stay. For example, in 2002 Swiss visitors stayed on average 11.9 days, spending €57 per day, while Italian tourists stayed 9.2 days, spending €42 per day. These differences seem to be marginal, but result in 58% higher CO2-e emissions per Euro revenue for Italian visitors in comparison to Swiss.

The case of inbound tourism to France shows not only the effects of long haul versus short haul markets, but also the influence of the area chosen for recreation (figure 2). Coastal and mountainous areas tend to show unfavourable eco-efficiency while rural and urban areas show more favourable ones. Note that for distant countries, urban tourism is relatively more eco-efficient, whereas it is the opposite for neighbouring countries; this is a result of the likelihood of short urban stays for the latter.

Generally, long stays are more eco-efficient than short stays, since the impact of transport to the destination is distributed over a longer period. One should also notice that, as long as the distances do not compel tourists to use planes, national habits regarding means of transport have a significant effect (for example tourists from Poland, since they use buses, have an unexpectedly favourable eco-efficiency).

The Rocky Mountain National Park case shows an overall eco-efficiency of 1.04 kg CO_2–e/€. Of the total emissions of 643,300 tons of CO_2–e, about 71% was from transport to the RMNP, 17% from accommodations and 12% from activities (mainly hiking and climbing, including transport within the destination). Again this confirms the strong role of transport for CO_2-e emissions.

CO$_2$-e emissions total O/D-transportation per market

Legend:
- United States
- Australia/New Zealand
- United Kingdom
- Japan
- Canada
- Other Asia
- Israel
- Mexico
- Spain
- Scandinavia
- Ireland
- Italy
- Rest world

Pie chart values: 1%, 2%, 2%, 2%, 3%, 4%, 5%, 5%, 6%, 7%, 11%, 12%, 40%

Total revenue per market (excluding OD-transport revenues)

Legend:
- The Netherlands
- United Kingdom
- United States
- Germany
- Spain
- Italy
- France
- Ireland
- Scandinavia
- Australia/New Zealand
- Canada
- Belgium/Luxembourg
- Rest world

Pie chart values: 2%, 2%, 2%, 3%, 3%, 3%, 3%, 5%, 6%, 13%, 16%, 20%, 22%

Figure 1: CO$_2$-e emissions and revenue from 2001 inbound tourism to Amsterdam by country of origin
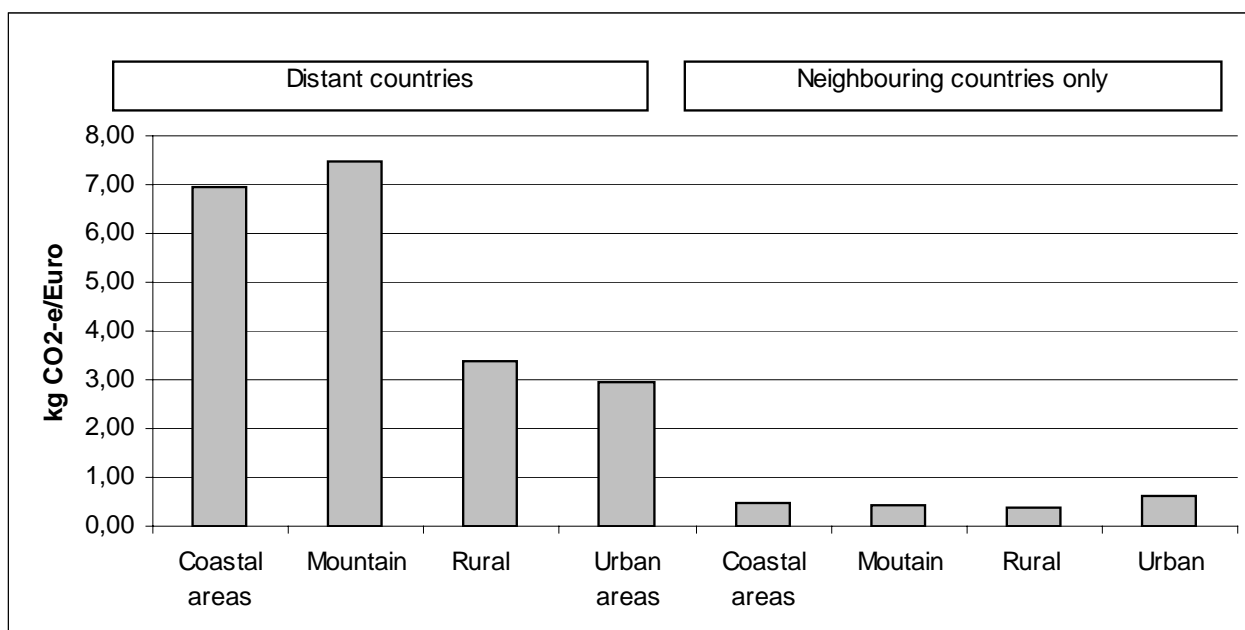
Figure 2: Eco-efficiency of travel to different environments, France

Table 1 shows the results for all cases in comparison with the world average. The World Gross Product was €27.4 trillion in 1999, which can be compared to CO_2 emissions of 22.9 trillion kg for fossil fuel burning and cement production (17). Based on data by Houghton et al. (18), Peeters calculated a global equivalence factor of 1.4. The world average eco-efficiency would thus be in the order of 1.2 kg CO_2-e/€.

Table 1: Eco-efficiencies: tourism and global economy

	Eco-efficiency (kg CO_2-e/€)			EE above world
	Average	Min	Max	average (%)
World	1.2	-	-	-
Amsterdam (including accommodation emissions; excl. transport revenues)	1.1	0.1	6.0	30
Amsterdam (incl. transport revenues)	0.9	0.1	3.2	35
France (excluding transport revenues)	-	<0.1	16.1	-
Seychelles (excluding transport revenues)	7.6	3.2	13.0	100
Val di Merse (including transport revenues and accommodation emissions)	0.9	0.4	4.0	10
Rocky Mountains	1.04	-	-	-

The variability is shown by the average and the columns with minimum and maximum values found for the different market sectors. The last column shows the share of the market with an EE less

favourable than world average. This share ranges from 10% for Val di Merse to 100% for the Seychelles. The general trend is towards more long haul tourism and hence less favourable average EE for tourism as a sector.

CONCLUSIONS AND DISCUSSION

The analysis has shown that the eco-efficiency of tourism, on average, is not necessarily more favourable than the average world economy eco-efficiency. Overall, the comparably small share of tourism with a particularly unfavourable EE (e.g. tourism based on long distance air travel) seems to substantially increase tourism's world average EE. This article thus underscores earlier findings that air travel is the largest problem when attempting to conform tourism to sustainability goals (4, 6). Clearly, shorter travel distances are a precondition for sustainability. By increasing the length of stay and/or expenditure at the destination the eco-efficiency may reach more favourable values. Overall, we conclude that eco-efficiency is a useful concept to analyse the combined environmental and economic performance of tourism. The concept can help to assess the relative importance of different tourism sectors, and provide insights into how to improve its environmental performance in the most economically feasible way. The concept has also proved to be applicable on very different levels. It may be used to evaluate the eco-efficiency of destinations/markets, to identify 'problematic' aspects of a journey, or to reveal differences between different forms of tourism or tourist types. Eco-efficiency calculations may even help to make decisions in carbon emission trading, should the scheme be applied to economic sectors, such as tourism or related sectors (air transport, etc.).

The case studies show a large variability. As the example of France illustrates, EE can vary by a factor of 400. Overall, and in order of importance, travel distance, means of transport, average length of stay, and expenditures per day are the factors influencing eco-efficiency. Developing countries focusing on international tourism as a source of income rely heavily on long haul tourism with a very unfavourable eco-efficiency. However, for poor countries such as the Seychelles or rural areas of industrialized countries such as France, tourism may be one of few options for economic development. Tourism in France could focus on European arrivals, thus reducing environmental impact while maintaining the same revenues. This strategy will clearly not be possible for the Seychelles in the absence of nearby markets. Such countries should seek to explore alternative economic sectors or try to increase length of stay and total expenditures of the tourist, while reducing their numbers.

All case studies in this survey allow the identification of beneficial markets with a favourable eco-efficiency in juxtaposition to markets with an unfavourable eco-efficiency. In combination with the analysis of the relative overall economic importance of these markets, it becomes clear which

markets should be promoted or abandoned. Generally long distance markets should be avoided and short haul ones developed. Overall, the case studies suggest that eco-efficiency can be an advanced tool to assess some aspects of the combined environmental and economic performance of tourism. Marketing strategies may help to change eco-efficiency into a favourable direction as shown by Table 2. The table shows the results for the Amsterdam case, which suggests substituting arrivals from distant countries for those from more nearby areas. Only large markets should be treated with care, to not disturb economic continuity.

Table 2: CO$_2$-e emissions and revenues by market, 2002

	Large market	Small market
Unfavourable eco-efficiency	*Less marketing:* USA	*No marketing:* Japan, Australia/New Zealand, Canada and Asia
Favourable eco-efficiency	*Current marketing:* United Kingdom and The Netherlands	*Strong marketing:* Germany, Belgium, France, Austria and Switzerland

In order to use eco-efficiency as an assessment tool of sustainability, a benchmark for sustainability has to be found. According to different sources, sustainable emissions of CO_2 need to be some 80% lower than current emissions (7). Theoretically, a sustainable average world eco-efficiency should thus have an average of some 0.24 kg CO_2-e/€. Under a scenario of growing global economic turnover, EE ratios will continuously need to decrease, as total emissions need to remain constant.

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