LIFE CYCLE IMPACT APPROACH TO PROMOTE SUSTAINABLE TOURISM: A CASE STUDY FROM GREEK HOTELS

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ABSTRACT

Tourism is one of the world's biggest industry and a key driver for socio-economic progress. In parallel, tourism is associated with environmental impacts and contributes to the climate change through emissions of greenhouse gases, mainly from transport and accommodation of tourists. The corresponding industry must urgently respond for elimination of environmental damages and to climate change by mitigating its emissions and by adapting tourism businesses and destinations to the changing climate conditions.

The present study aims to promote a methodological approach to estimate the overall environmental impact in areas of considerable tourism activity, applied in Greece, one of the world's most popular tourism destinations. A comparative "environmental damage" analysis is realized for two large-sized hotels and their contribution to environmental burden for numerous impacts is assessed. The approach is based on Life Cycle Assessment (LCA) principles, leading to a reliable assessment of damage that can be attributed to tourist's transport and accommodation services. The LCA gives the ability to highlight processes and/or flows that have the highest resource consumption and environmental burden for the case under consideration. A questionnaire was designed for the above purposes, and was used as input, among other data, to the overall methodological approach. The hotel manager's gave their feedback via a face-to-face interview. SimaPro 8 software was used and functional unit, boundary selection and LCA limitations where therein defined. The comparative assessment of different tourism activities for two hotels provide important highlights for the trade-offs of environmental damage generated by air transport, road transport and hotels' operational use. Air transport to the tourism destination and back is primarily responsible for the total environmental damage for medium to large-sized hotels in comparison to the other agents of tourism environmental burden. As far as operational use of all hotels is concerned, HVAC systems are the most energy intensive end-users in all cases. The paper provides a rich insight into the multiple environmental impacts that can be attributed to tourism activity and adds up to the low number of respective LCA implementations found in the literature. In addition it provides a basis for strategic governance and policy modelling. Last but not least, the paper highlights the need to identify and assess of the environmental impacts related to the life cycle of tourist products in order to raise the limited awareness of LCA in tourism's drivers.

Keywords: Tourism, Life Cycle Assessment, Environmental Impacts, Accommodation, Travel.

1. Introduction

Tourism is responsible for about 5% of global CO_2 emissions, derived mainly from transport (75% excluding radiative forcing), accommodation (excluding construction phase) and activities. The lodging sector uses vast quantities of energy, water, materials and products. Energy use per guest night reaches 98 MJ (UNWTO-UNEP-WMO, 2008) whereas water consumption reaches 3,423 l per room per day (Gössling *et al*., 2012). In addition, the lodging industry generates large volumes of waste. A typical guest generates at least 1 kg of solid waste per day (Davies and Cahill, 2000), whereas a tourist from developed countries probably generates up to

2 kg per day for the United States (UNEP, 2003). An in-depth analysis of environmental impacts of tourism can be found analytically elsewhere (Gössling, 2002).

Tourism is one of the most important economic sectors in Greece. In 2013, its contribution to Greek GDP amounted to 16.3%, while total employment in tourism (675,000 jobs) corresponded to 18.2% of the workforce, in the core period of economic crisis. Chalkidiki is a peninsula in Northern Greece, the prevalent tourism destination of the Northern Greece. Its economy is strongly dependent on tourism, which is characterized by its seasonality since the corresponding season extends usually from early April to late October. However, apart from economic development the tourism activity in the area causes considerable environment deterioration, increased energy and water consumption, as well as waste generation (Michailidou *et al*., 2015).

The present study aims to promote a methodological approach in order to estimate the overall environmental burden in areas of considerable tourism activity. The methodology is demonstrated for the most popular tourism destination of Northern Greece. A comparative "environmental damage" analysis is realized for two hotels with similar characteristics and their respective contribution to environmental burden for numerous impacts is assessed. The approach is based on Life Cycle Assessment (LCA) principles, leading to a reliable assessment of damage that can be attributed to accommodation services and tourist's transport. According to available scientific literature, amongst other tourism environmental performance tools, LCA is crucial, since it evaluates environmental impacts from different perspectives and assumptions (e.g. Castellani and Sala, 2012). Life Cycle Thinking (LCT) gives the ability to highlight processes and/or flows that have the highest resource consumption and the highest environmental burden for the case under consideration in an effort to estimate the total environmental impact.

2. Materials and methods

Due to economies of space the methodology is presented in Figure 1. Hotels are one of the most important agents of "static" environmental burden in the tourism sector. Although significant enough, the energy, water and resource consumption in hotels is highly diversified and depends on a variety of parameters such as the size and category/class of the hotel, the year and type of construction, its location and climatic zone, technology of heating, ventilation and air conditioning (HVAC), the lighting systems, as well as the offered services, amenities and the occupancy rate (Deng, 2003). For this purpose, the consumption of energy and water, occupancy rates, and other important characteristics of one hotel's operational phase should be investigated through tractable questionnaires during personal interviews with the hotel managers and hotel records (bills). Any other data for flows should meticulously investigated for the area under consideration, especially to define "tourism mass" and in effort to provide assessments for "dynamic" environmental burden that origin mainly from air and road transport to the destination and back and recreation activities (e.g. national statistical services).

For the case under study, SimaPro 8 software was used. The impact assessment methods chosen is Eco-indicator 99. The Eco-indicator 99 uses damage-oriented approach, and three damage categories –endpoints– are distinguished: Human Health, Ecosystem Quality and Resources. One of the advantages of Eco-indicator 99 is the single score output (expressed in kPt) that enables comparison of different components of a product/service or different products/services. The LCA was performed assuming a 7 night stay of tourists in the two hotels. The system boundary is regarded as the operational use of a hotel including the water consumption and the energy consumption for: (i) the HVAC systems, (ii) production of hot water, (iii) lighting, (iv) kitchen operation, e.g. cooking appliances, refrigerators, freezers etc., (v) laundry facilities and (vi) other electrical devices e.g. TV's, refrigerators in rooms, cleaning devices, and elevators. The travel of tourists from their original place to the hotel and their return is also taken into account.

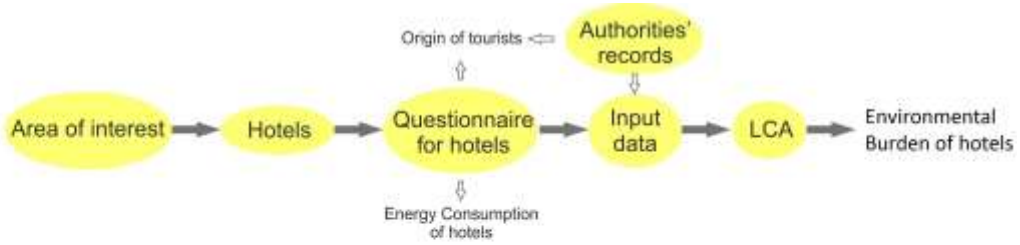

Figure 1: Methodological framework.

3. Case study

Chalkidiki belongs to the Region of Central Macedonia and has the longest coastline (550 km) from all land prefectures of Greece. The nearest airport that serves tourism activity in Chalkidiki is the International Airport "Makedonia", Thessaloniki. Chalkidiki has 511 of 1*-5* hotels (agents of "static" environmental burden), reaching 44,579 beds, corresponding to 5% of the hotels of the whole country. With a total surface area reaching 2,900 km^2 and a population of 105,908 inhabitants in 2011, the number of international tourists was over 523,000 in 2012 (EL.STAT., 2014), which essentially approximates 500% increase.

Two seaside large-sized hotels were examined in the area under study (Table 1). It should be noted that gaining information about consumption rates from hotel managers is a difficult task. Most of the large hotels refuse to participate in such studies because of restriction policy and the fear of lack of confidentiality, despite written or verbal assurance from researchers (Kasimu *et al*., 2012).

Table 1: Characteristics of the two hotels in Chalkidiki (Reference year 2013).

	Hotel 1	**Hotel 2**
Location	Sithonia	Kassandra
No of Rooms/Beds	202/500	151/400
No of floors	2	2
Surface area	15,000 m^2	5,936 m^2
Seasonal operation	6 months	6 months
Occupancy rate (2013)	92%	94%
Type of building construction	separate standing	separate standing
Distance from Makedonia airport	100 km	102 km
Fuel for Heating	Diesel	Gas
Fuel for Air Conditioning	Electricity	Electricity
Fuel for Hot Water	Diesel	Gas
Facilities and services offered	3 Swimming pools, spa, 2 conference rooms	2 swimming pools, tennis, basketball and volley courts,
Laundry	Yes	Yes
In-house restaurant	2 restaurants, bar, beach bar	1 restaurant, 2 bars
Year of construction	2007	1991

In 2012, international tourists reached 80%, 49.2% of which came from 27 country members of European Union (EU) and 49.6% from the rest countries of Europe (including Russia and Turkey). Those tourists travelled with airplane to International Airport "Makedonia" and then reached their hotel by coach or a car. For the road transport analysis, a coach for the transportation of tourists from airport and back is taken into consideration. Flight distances were calculated from major airports near capital of each country to International Airport "Makedonia". For tourists from Balkans and Romania, which reached 34.2%, is assumed travelling by car. Waste generation is excluded since the hotels studied did not hold such records (typical for the area under study).

4. Results and discussion

A fully detailed "network of activities" for each hotel was created in order to assess their overall environmental burden for two cases: (a) transportation of tourists was not taken into account and (b) transportation was taken into account. According to Eco-Indicator 99 impact

assessment method for case (a), the operational use of the hotel 1 causes greater environmental damage than the operational use of hotel 2 (Figure 2). In the case that transport is included in the LCA approach (case (b)), it is for the most part responsible for the total environmental damage for both hotels. In addition, a comparative analysis of travel services in the case under study demonstrates that air transport has the highest absolute impact on all three categories of endpoints of Eco-indicator 99 compared to road transport. This is in line with the results of other similar studies, that airplanes are the most carbon intense means of transport (e.g. Filimonau *et al*., 2014).

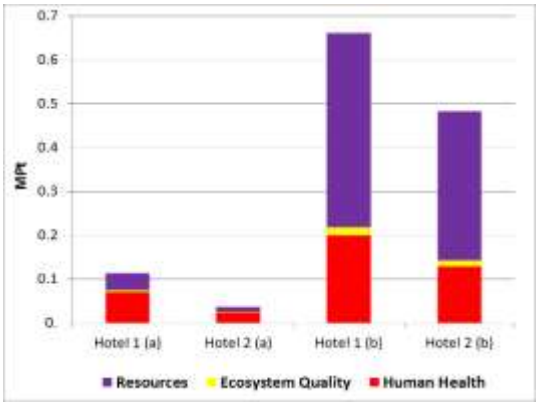

Figure 2: Evaluation of impacts of both hotels (a) from operational use, (b) from operational use, air and road transport, with Eco-indicator 99.

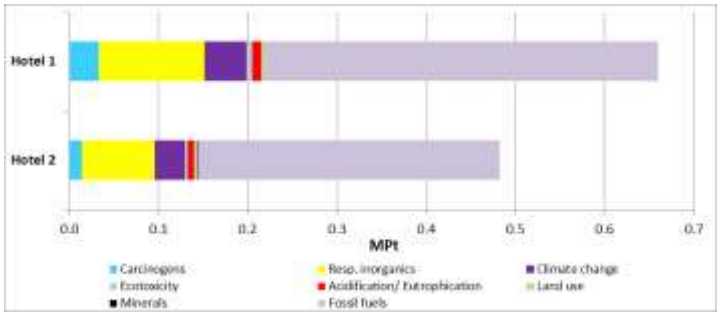

Figure 3: Results of the impact categories score of Eco-indicator 99 for both hotels' lifecycle including transport services.

Figure 3 illustrates the results of midpoint impact categories score for the two hotels including transport. The impact on fossil fuels consumption is the highest for both hotels due to transport activities, as well as to the conventional lignite electricity consumption in the area. Impacts on respiratory inorganics are followed for the same reasons. Impacts on respiratory organics, radiation and ozone layer are negligible and are not presented in Figure 3. The analysis demonstrates that hotel 1 is responsible for the largest share in all 11 impact categories of Eco-indicator 99.

5. Conclusions

Air transport is prevalently responsible for the total environmental damage of hotels for the case under study in comparison to the road transport, accommodation services and the hotels operational use and energy intensity. As far as operational use of those hotels is concerned, HVAC systems are the most energy intensive agents of environmental burden, followed by kitchen and production of hot water. Based on the results of this study, policy making should primarily put forward incentives in order to maximize the penetration of RES in hotels in the area. Measures such as energy-efficient lights to tourist lodgings, solar water heating systems (surprisingly missing from a high percentage of Chalkidiki's hotels), HVAC and lighting

automation systems and external wall insulation in hotels should be put forward in order to minimize the overall environmental impact attributed to the tourism activity in Chalkidiki.
The awareness of the environmental impacts of tourism by policy makers is of great importance in order to avoid severe future burden of the environment. The work presented herein depicts the fact that LCA can play a crucial role in decreasing the complexity in the strategic planning of tourism, especially in local-to-regional areas of concentrated tourism activities. Although the framework can be generically applied, the needs of each area may vary. Consequently, the special characteristics of an area with concentrated tourism activity will need to be taken into consideration in order to efficiently implement the generic approach presented.

REFERENCES

1. Castellani V. and Sala S. (2012), Ecological footprint and life cycle assessment in the sustainability assessment of tourism activities, Ecol. Indic., **16**, 135-147.
2. Davies T. and Cahill S. (2000), Environmental implications of the tourism industry, Resources for the Future, Washington DC.
3. Deng S.M. (2003), Energy and water uses and their performance explanatory indicators in hotels in Hong Kong, Energy Build., **35**, 775-784.
4. EL.STAT., 2014, URL: http://www.statistics.gr (accessed: 10/12/2014).
5. Filimonau V., Dickinson J.and Robbins D. (2014), The carbon impact of short-haul tourism: A case study of UK travel to Southern France using Life Cycle Analysis, J. Clean Prod., **64**, 628-638.
6. Gössling S., Peeters P., Hall C.M., Ceron J.-P., Dubois G., Lehmann V. and Scott D. (2012), Tourism and water use: Supply, demand, and security. An international review, Tourism Manage., **33**, 1-15.
7. Gössling S. (2002), Global environmental consequences of tourism, Global Environ. Change, **12**, 283-302.
8. Kasimu A.B., Zaiton S. and Hassan H. (2012), Hotels Involvement in Sustainable Tourism Practices in Klang Valley, Malaysia. Int. J. Econ. Manage., **6**, 21-34.
9. Michailidou A.V., Vlachokostas C. and Moussiopoulos, N. (2015), A methodology to assess the overall environmental pressure attributed to tourism areas: A combined approach for typical all-sized hotels in Chalkidiki, Greece. Ecol. Indic., **50**, 108-119.
10. UNEP (2003), A manual for water and waste management: what the tourism industry can do to improve its performance.
11. UNWTO-UNEP-WMO (2008), World Tourism Organization - United Nations Environment Programme - World Meteorological Organization. Climate Change and Tourism: Responding to Global Challenges, (prepared by Scott D., Amelung B., Becken S., Ceron JP., Dubois G., Gössling S., Peeters P. and Simpson M.C.), UNWTO, Madrid, and UNEP, Paris.