Road transport´s footprint: An approach to natural resources preservation - Lanzarote

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Objectives | After air transport, road transport represents one of the main contributors of environmental impact and climate change. As it conforms one of the elements that threaten natural heritage of mankind and life quality of people in the world, sustainable development of road transport in tourism destinations should be considered as a main key to preserve natural resources, reduce the sector´s footprint and global warming.

Natural value and wealth of the Canary islands is undeniable. Timanfaya in Lanzarote, Teide in Tenerife, Garajonay in La Gomera and Caldera de Taburiente in La Palma represent four of Spain´s national parks located in this archipelago. Large segments of its territory have been considered as protected areas; in the case of Lanzarote this represents 41% of the island´s territory.

Economy in this archipelago is not diversified and it depends mainly on tourism, sector that represents 29.9% of its GDP. Tourism industry in general, and in the islands, depend on the attractiveness of its natural capital, but so far it has been self-degraded. Transportation habits influence this degradation and as in many tourist destinations around the world, car prevails as the most polluting and preferred mode of transport while visiting Lanzarote and the rest of the Canary Islands.

This study analyses environmental impact from road transport and paths used by tourists to get to the main sites in Lanzarote. As quality and frequency of public transport in Lanzarote island is currently deficient, this study will not only allow us to determine approximate environmental impact generated by cars and road transport, it will as well provide the proper scenery to propose several policies and possible sustainable transport alternatives serving as model for other islands in similar conditions.

Development planning of tourist destinations should follow a sustainable approach, and it must consider the structure of a touristic mobility model that identifies and implements effective measures to reduce car use and encourage visitors to choose eco-efficient alternatives. This will help to preserve natural resources and will offer environmental quality.

Regulations that promote competitiveness and sustainability by prohibiting construction in touristic areas and motivating rehabilitation of existing rural settlements exist in the archipelago, but until now, despite its importance, no priority has been given to the unsustainability of current tourist mobility.

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Methodology | The chosen methodology is the ecological footprint (ef). Over time, ef has become a useful indicator of environmental impacts and its application has approached, so far, cases in over 134 countries. Understanding the level, effectiveness, benefits and opportunity offered by this tool have emerged despite literature debates. Some authors say that the tool is still young and its potential has not been exposed to its maximum level, others insist in continuing discussions to avoid wrong arguments linked to current sustainability.

Ef has proven itself to be a useful methodology when comparing the environmental impact of the different components of tourism products, it is also appropriate to provide a global perspective for management policy decisions. This methodology's approach helps us to understand environmental impacts of tourism mobility and it rejuvenates as well theoretical aspects of sustainable tourism.

It is possible to estimate road transport´s ef (Chi & Stone, 2005), for this, we need to use road network data like traffic volume, vehicle types, vehicle fuel efficiencies and physical dimensions of the road network (length and width of a determined path). The road network´s ecological footprint (tef) is determined by the following expression and its result is represented as the equivalent of land area (ha) required to sequester carbon dioxide emitted by motor vehicles on determined road networks:

tef = fef + eef = [width (km) x lenght (km)] + [vehicle - km/year) x (liters/km) x (0.0035 ha/l**)]

*tef: total ecological footprint.
*fef: physical footprint of road network.
*eef: energy footprint of paved road.
** this value is the result of the land/sea factor estimation conversion. On average onle litter of fuel produces about .035 gigajoule (gj)/l: [1 (l) x 0.0035 gj/l] / [100 gj/ha/year] = 0.0035 ha/year.

In order to estimate Lanzarote´s tef related to vehicle use and touristic ends we first identified the island´s main sites of interest: Timanfaya National Park, Jardin de Cactus, Jameos del Agua, Cueva de los Verdes and Mirador del Rio. We then located where accommodation infrastructure is mainly focused: Playa Blanca, Yaiza, Puerto del Carmen and Costa Teguise. By determining this, according to Lew & Mckercher (2005) and their model of tourist movements, we can determine possible day trip movement patterns within a local destination area. Despite the complexity of movement patterns, literature confirms that they can be easily predicted in small and compact destinations with few attractions and a limited transportation network. This description could refer in every sense to Lanzarote or many other island destinations, and for this reason, we decided to include a movement matrix in our calculation, this way our tef results would be directly related to tourism road mobility.

For tourism industry and its mobility patterns, trip generating areas are mostly represented by accommodation infrastructures. In our movement matrix calculation, we considered Playa Blanca, Yaiza, Puerto del Carmen and Costa Tegise as Lanzarote´s trip generating points. After examining inter-destination patterns and geometry of tourist´s movements we have decided to integrate as an additional attribute 2 types of movement patterns to it: a point to point mobility pattern and a circular loop mobility pattern, this way, movement behaviours of both individual and collective transportation are represented.

*movement matrix:

Movement pattern a (trip generating points - Timanfaya National Park - trip generating points)
- Point to point or individual movement pattern -
Movement pattern b (trip generating points - Jardin de Cactus, Jameos del Agua, Cueva de los Verdes, Mirador del Rio)
- Point to point or individual movement pattern -
Movement pattern b1 (trip generating points - northeast destinations - trip generating points)
- Circular loop or collective transport mobility pattern -

Information regarding environmental impact generated by the volume of busses and passenger vehicles used to access the main sites of interest would be very valuable. So, in order to gather all the necessary data and to begin our calculation, it was obtained the approximate volume of vehicles used to access them with their representative percentage in Lanzarote´s vehicle fleet and the number of visits each recorded by each touristic site:

*buses = [number of visits / 50 passengers] x .05
*passenger vehicles = [number of visits/ 4 passengers] x .723

Once our movement matrix was set and the number of busses and passenger vehicles used to access the main sites of interest in Lanzarote were determined, we proceeded with our movement pattern (a, b and b1) tef estimation.
By combining the chosen ef methodology with a movement matrix it was provided an innovative and valuable alternative to quantify and compare environmental damage between many modes of road transport. When including approximate or accurate movement patterns (point to point, circular loop or others) this can as well highlight a determined sustainability level in paths to access touristic sites

Main results and contributions | Ecological footprint analysis performed in 2009 by Rendeiro and Ramirez for Lanzarote´s road transport was based on projections of a trip matrix estimated for Lanzarote island and its territory. It reflects as well, additional information regarding saturation level of its roads. The study indicates that most of Lanzarote´s road network shows saturation level equal or higher than 80%, particularly in roads in tourist areas in the centre and south of the island. As the island´s economy depends on tourism it is assumed that a substantial part of traffic is due to the sector´s actual dynamic. Congestion loads in the access to Lanzarote´s tourist area gives visitors a negative perception of the island as a tourist product (decrease of a 9% in tourist flow and increased emissions were attributed to this). Rendeiro and Ramirez (2009) determined that environmental impact of car use in the island would increase strongly through the years, but its estimation of physical footprint was not focused on the paths usually followed by tourists to get to the main sites of interest, this suggests that calculation and data sources for vehicle travel ef in Lanzarote can be improved to give more accurate results regarding real tourist ef and road transport use.
Ef predicted for emissions linked to road transport in 2010 represented 43% of Lanzarote´s territory. This study updates and compares this prediction to a real estimation allowing us to specify areas that policy makers could approach. As part of its main contributions, it proposes as well an upgrade of ef calculation as a tool to assess road transport sustainability in tourism destinations. In addition it could become a model to implement in other islands.
Tourist mobility in Lanzarote relies on excessive private transport use and this represents high environmental impacts. It has been said that the absence of policies and new technology to reduce vehicle emissions may increase tourism negative environmental share in the island. We begin a sustainable transport initiative identifying opportunities to promote transport alternatives to the visitors. A successful implementation of public transport improved services will help solving saturation levels, reduce emissions and preserve natural environment.

Limitations | As occurs with other methodologies that calculate environmental impacts, we were limited by the availability of updated data, but it is proven that if the methodology is applied in the right way, the resultant indicator can be used to compare segments of an economic sector. This is important for tourism since it is a diversified sector and in this case we measure the impact of its transport segment providing a quantitative source of one of the most worrying emission contributors.

Conclusions | Results confirm unsustainability of road transport´s use and generated emissions. Enabling a sustainable connection and integrating touristic sites with the rest of the territory may make a positive impact on sustainability, natural resources preservation and regional development, building a sustainable relationship between environment, residents and tourists. This will contribute to Lanzarote becoming a competitive destination offering environmental quality and uniqueness in its preserved resources.

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