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Quantifying the carbon footprint of religious tourism: the case of Hajj

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ABSTRACT

Travel and tourism is one of the largest industries in the world and is a large contributor of greenhouse gas (GHG) emissions. Religious tourism is a fast growing sector within the tourism industry. Pilgrimage to Mecca, Hajj, is one of the oldest and largest religious tourism events in the world drawing 2.79 million participants from all around the world in 2011. Managing an event at such scale poses many challenges on multiple fronts, not the least are the environmental management of its impacts. Quantifying the environmental impacts of the event is a key element in setting up proper and effective environmental management programs. This article uses life cycle methodology to assess the Global Warming Potential (GWP) from the main activities of the Hajj event. On average each pilgrim contributes 60.5 kg $CO_{2\text{-eq}}$ per day as a result of transportation, hotel stay, meals and waste management. Long haul air travel is the largest contributor of greenhouse gases, followed by lodging then food with each accounting to 60%, 18% and 13%, respectively. Infrastructure provision, upstream emissions and aviation higher altitude emission effects account to more than 50% of the total GWP of the event. The potential of applying the concept of carbon neutrality by extending preservation principles built-in the traditional Hajj rituals is also discussed.

1. Introduction

1.1. Overview

Travel and tourism is one of the largest industries in the world accounting for 9% of the world's gross domestic product (GDP) and 8% of the world's total employment in 2010 (MercoPress, 2011). Travel and tourism is also blamed for being the fifth largest pollution source in the world responsible for nearly 14% of the global greenhouse gas (GHG) emissions (UNEP, 2006). Religious tourism is a form of tourism where people of a particular faith travel to visit places of religious significance in their faith. The World Religious Tourism Association (WRTA) estimates that 300 million people from around the world participate in religious tourism every year (Saltzman, 2010). Hajj, the pilgrimage to Mecca, is one of the oldest and largest annual religious tourism events outside the Christian world. In 2011, the event attracted 2.79 million people (CDSI, 2011). According to the Islamic faith teachings, every able bodied Muslim who can afford the journey to Mecca is required to attend Hajj at least once in his/her life time. The actual event lasts 5 days during which devotees visit 4 designated sites to perform certain rituals called the acts of Hajj (Ministry of Hajj, 2011). Fig. 1 is a schematic diagram of the Hajj ritual sites.

Pilgrims usually arrive 1–3 weeks earlier and many stay behind after the completion of the acts of Hajj to visit other significant places such as the city of Madinah, the second holiest city in the Islamic faith, nearly 540 km north of Mecca by road. Pilgrims participate in what is known as zeyarah (visit to sites of religious significance). The following diagram (Fig. 2) is a schematic illustration of the most commonly visited places by pilgrims in Mecca and Madinah.

The number of pilgrims has been increasing at a steady rate over the past decades. For example during the period between 2000 and 2010, the total number of pilgrims grew by 46% with the numbers of international pilgrims arrivals growing by 34% in the same period. There are many factors that contributed to this growth such as natural population growth, increased religious awareness and economic prosperity in the source countries. Nevertheless, advancement in transport plays a significant role because it reduces the overall duration needed to perform the Hajj. As a result, the overall cost and commitment (financial cost, being away from family, exposure to risk during the journey, loss of income, impact on career progress etc.) are reduced; consequently, more people are willing to make the journey. Inspecting the countries where pilgrims originate from and their mode of transport provide an interesting insight. In 1972, 37% of the pilgrims came from the

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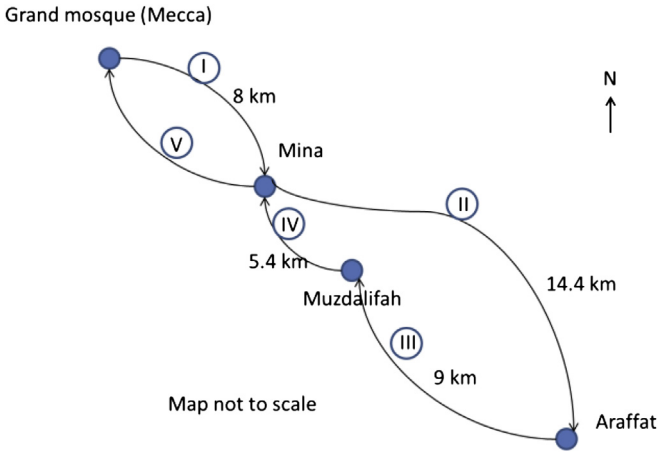

Fig. 1. Diagram of Hajj rituals (not to scale).

immediate neighbouring Arab countries, however, in 2011 this percentage has fallen to less than 9%, a clear indication that people are travelling longer distances to attend the Hajj event. This would have been extremely difficult without the advancements in transport technology. For example, the number of pilgrims who arrived by air in 1972 were 141,658 people representing approximately 29% of the international pilgrims this number increased to 1.5 million representing approximately 83% of international arrivals in 2011.

To meet the demand of the increasingly sophisticated pilgrims, tour operators are now offering a wide range of packages ranging from basic economy travel to five star accommodation packages. As a result, the current trends combined with the large number of pilgrims, pose significant environmental challenges. The Hajj authorities have put tremendous efforts to enhance Hajj services and experiences of pilgrims, in particular in areas of safety and transport planning. In the recent years, environmental management of the Hajj impacts have received special attention, for example, air quality monitoring, the introduction of pilot projects for waste minimisation and recycling etc.

In the Davos declaration, the United Nations World Tourism Organisation (UNWTO) acknowledged the importance of mitigating the environmental impacts in order to maintain sustainable growth in the tourism sector (UNWTO, 2007). Several methodologies are applied to account for the environmental impacts of tourism such as the Ecological Footprint, e.g. (Gössling et al., 2002; Hunter, 2002), Pollution Cost Assessment (Carić, 2010), Life Cycle Assessment, e.g. (Kuo et al., 2011).

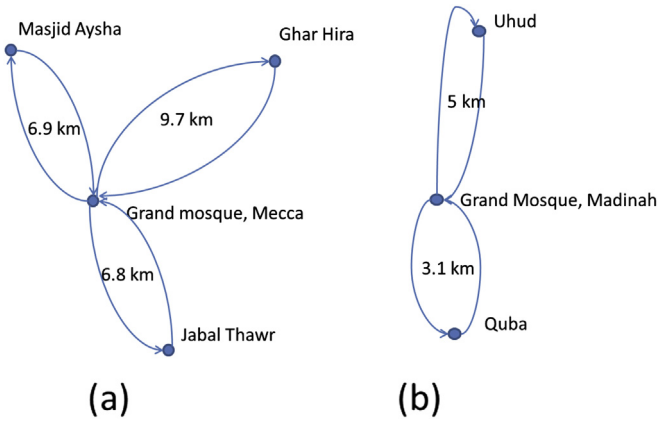

Fig. 2. Most commonly visited places by pilgrims in Mecca (a) and Madinah (b) (not to scale).

The aim of this study is to provide an estimate of the carbon footprint of the annual Hajj event using life cycle methodology to identify areas for potential improvement.

2. Methodology

2.1. Life cycle assessment

The scope of this study quantifies carbon footprint from all aspects directly associated with Hajj including transport, meals, hotel stay and waste management but excludes the impacts of internal travel within the country of origin to the port of embarkation. It also excludes gifts and souvenirs. The functional unit chosen for this study is 1 pilgrim day.

The International Civil Aviation Organisation (ICAO) carbon calculator is used to determine the most direct route between the source and destination and the amount of fuel used throughout the flight (ICAO, 2012). The ICAO calculator has the most updated database of the routes and planes that fly between the city pairs. The tier-2 (landing take off (LTO) and cruise cycle method) is used to estimate the amount of fuel used in the LTO using the international average fleet emission factors as described by Rypdal (1996). Google maps™ are used to determine the most direct passable route for road travel. Bus fuel consumption is calculated using the model presented by Jia et al. (2010).

The Intergovernmental Panel on Climate Change (IPCC) 2007 Life cycle impact assessment method is used to assess the Global Warming Potential (GWP) for all emissions (IPCC, 2007). To account for the impacts of aviation emissions at higher altitudes, a multiplying factor of 1.30 is applied to greenhouse gas emissions from the combustion of aviation fuel during the cruise cycle only. This was selected based on the findings of Lee et al. (2010) who suggested a value of between 1.3–1.4. Due to the high levels of uncertainty, aviation induced cloudiness (AIC) is not considered.

SWIMS; a life cycle inventory, spread sheet based, integrated solid waste management model (El Hanandeh and El-Zein, 2010), is used to estimate the emissions from waste management activities. Emissions from meal provision are based on an average omnivorous diet (Berners-Lee et al., 2012). Hotel stay emissions are based on an average 3 star hotel as described by (Filimonau et al., 2011). An MS Excel™ spread sheet is built to calculate the emissions. This study is directed to audience from academia, LCA practitioners and policy makers.

2.2. Hajj statistics

Hajj attracts people from almost every country in the world. To prevent over-crowding, the number of pilgrims is controlled through a quota allocation system. The current quota set by the Saudi Arabian Authorities allows for 0.1% of the Muslim population of each country to travel to Hajj each year. In the 2011 season, it is estimated that 2.79 million (1.79 million international and 0.99 million local) people attended the event (CDSI, 2011). In this paper, it is assumed that quotas for each country are filled. Appendix A shows the estimated number of pilgrims from each country and their mode of transport. Table 1 summarises the number of pilgrims arriving by each mode of transport based on the quota assigned by the Saudi authorities for each country in 2011.

2.3. Life cycle inventory (LCI)

Life cycle inventory data were collected from different sources in the literature and presented in Tables 2–7. The ICAO carbon calculator is used to determine the most direct air travel routes between the capital city in the country of origin and Jeddah