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Assessment of Physical Carrying Capacity for Managing Sustainability at Religious Tourist Destinations

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Increased interest in the sustainability of tourism development has initiated concerns about the capability of tourist destinations. This concept implies a threshold or a number of assumptions that are supported by destinations and due to uncontrolled tourism activity it is essential to regulate and manage visitors as well as destinations. In the recent past, many miss-haps have occurred at famous destinations because such large numbers of visitors are unsupported by the destinations. This study aims to provide an examination of visitor thresholds. It tries to estimate the carrying capacity of Brahm Sarovar, a very famous Hindu religious destination in Kurukshetra, Haryana using methodology suggested by IUCN and IRC. Data were collected through field surveys of Pilgrims and beside that, a GIS approach is used to establish a framework for assessment of the study area. The study results that the destination provides a good carrying capacity and basic facilities are sufficient at this place for normal days but there needs to be additional facilities on certain specific occasions.

Key Words: physical carrying capacity, international union of conservation of nature and natural resources, parking capacity, toilet & bathrooms capacity, drinking tap water capacity and land use/land cover.

Introduction

The growing interest in sustainable tourism has been accelerating concern about the effects of tourism (McCool and Lime, 2001) and the assessment of carrying capacity is an important component, one of the mechanisms for establishing standards for sustainability in this sector, for the planning of spatial development. Carrying capacity can be defined as a maximum number of tourists that sojourn in a specific area (Jovicic and Dragan, 2008). In fact, it is a paradigm for addressing and limiting the amount of tourism development. In India, tourism is a big industry, particularly when one includes activity related to religious and spiritual values. It offers a great opportunity for diversification and can also be a vehicle for additional earning (Kruk et al., 2007). However, the unplanned exploitation of resources is destroying the basic functionalities of eco-systems and creates a risk of losing destinations’ recovery capacities (Hassan et al., 2014). These issues are associated with the possibility of identifying the ‘magic number’ of tourists that can sustainably visit certain destination. The concept is most important for tourism planning (Nghi et al., 2007) and it gives an idea of a threshold volume that can be accepted at a destination (Pazienza, 2004). In the recent past, this concept has received significant attention since the world has faced many tragedies at renowned religious destinations such as Nainadevi (2008) and Kedarnath (2013) in India and Mecca (2015) in Saudi Arabia.

Considering these observations, the present study focuses on the evaluation of sustainability in the tourism sector with the aim to develop a method for assessing the physical carrying capacity of a tourism destination, Brahm Sarovar, a religious lake in Kurukshetra, Haryana, where about half a million people visit on specific occasions - such as during a Sun-eclipse. To bathe in this holy lake, is believed by the people of Hindu religious faith, to make a person free from all sins.

Objective

Tourism can generate both positive and negative effects on destinations where visiting and leisure activities take place, hence planning in the tourism sector has become more important; it assures a good level of conservation of natural resources and mitigates the impacts. Keeping tourism planning and sustainable
tourism development in mind the main objective of this study is to evaluate the physical carrying capacity of the Braham Sarovar, a holy artificial lake in Kurukshetra and try to develop a strategy to initiate a tourism surveillance system.

**Methods**

This study area is very rich in pilgrim tourism both in terms of destinations and types. The detailed analysis of the area is done by using both primary and secondary data sources.

**Survey schedule and instrument**

Data such as comfortable space and time spent at usage zones by pilgrims were collected through field survey and interviews with 50 pilgrims through simple random sampling in November, 2014. This research was conducted during the occasion of Geeta Jyanti (Table 1) to fulfill the requirements of the formula given by the IUCN for calculating physical carrying capacity.

The use of the covered zone for bathing (ladies only) needs more time due to the congestion of entry/exit points and space. The average time to take drinking water from a public tap point is considered as 30 seconds per person, which is based on the average time taken by the individual tourists at the destination and is also verified in a dummy / test exercise conducted by the authors. Tourists’ views of diverse age groups were elicited through Focused Group Discussion (FGD) during the big event field research conducted in 2014.

**Physical Carrying Capacity**

Physical Carrying Capacity (PCC) is defined as maximum number of tourists who can physically fit into a specific area over a given time. To estimate physical carrying capacities, mathematical formulas suggested by the International Union of Conservation of Nature and Natural Resources (IUCN) were used (Cifuentes, 1992; Ceballos, 1996; Ngh et al., 2007; Lagmoj et al., 2013 and Queirozet et al., 2014). Quickbird imagery from Google earth pro for the year 2014 was used to calculate the land uses at the destination and their identification was confirmed by ‘ground truthing’.

A total of five indicators were analyzed to assess the physical carrying capacity for Braham Sarovar. These indicators include adequate space and other necessary basic services:

- Land use land cover
- Parking capacity
- Toilet and bathroom capacity
- Drinking water capacity
- Footpath capacity

The elements used to calculate PCC are as follows:

\[
PCC = A \times V/a \times Rf
\]

Where;

PCC = Physical carrying capacity
A = Area suitable for tourism (m²)
V/a = Appropriate space for displacement of tourists/tourist density (tourists/ m²)
Rf = Rotation factor (number of visits per day)

**Area Suitable for Tourism (A):** A is determined by particular conditions of the considered area. In any conservation area, the available area can be estimated from the total area where tourists can do camping or other activities.

**Appropriate space for displacement of tourists (V/a):**

The area needed for a tourist who can undertake an activity comfortably.

**Rotation Ractor (Rf):** The number of permissible visits over a specified time (Usually calculated by daily

<table>
<thead>
<tr>
<th>Zones</th>
<th>Usage</th>
<th>Average Space (m²)</th>
<th>Average Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow water zone</td>
<td>Bathing</td>
<td>2.5</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Covered shallow water zone</td>
<td>Bathing for Females</td>
<td>2</td>
<td>40 minutes</td>
</tr>
<tr>
<td>Pedestrian movement zone</td>
<td>Walking</td>
<td>2</td>
<td>2 hours</td>
</tr>
<tr>
<td>Covered zone</td>
<td>Staying</td>
<td>4</td>
<td>2 hours</td>
</tr>
<tr>
<td>Parks zone</td>
<td>Relaxation</td>
<td>10</td>
<td>3 hours</td>
</tr>
</tbody>
</table>

Source: Field survey, 2014
opening hours) and calculated through dividing the amount time usable in day for visitors by the mean number of visits. Thus, this is a combination of:

**Duration of usability:** The number of visit-hours per day (opening hours) at the tourist destination.

**Visit duration:** The average time required by tourists for touring and visiting various attractions of the region and it is expressed by;

The Present study considers the open period as 11 hours per day. This is the average annual time between sunrise and sunset. This is most important on No Moon day, which is the peak time according to the pastor, this is the main timing of bathing in the sacred tank.

Standards given by the Indian Road Congress (IRC) were used to calculate the parking and footpath capacity. Since very large number of people travel to such destinations to satisfy their appetite for obeisance or submission to god, sometimes the congregation of such people creates chaos. In extreme situations this can result in tragedy, hence the need arises for the need to evaluate the capacity of such religious destinations.

The guidelines specified by the Ministry of Urban Affairs and Employment, in the Government of India were used to estimate the toilet, bathroom and urinal capacity for the safety and convenience of pilgrims. The time required for one person at the destination to safely and comfortably drink water from public tap points was collected through field survey as discussed above.

**Area of study: Braham Sarovar**

Kurukshetra is a land of pilgrimage and is revered all over India for its great historical and religious importance. People from various parts of the world come here for salvation on various festive occasions.

According to Hindu mythology, it is believed that Braham Sarovar was created by the creator of this universe lord Brahma and it is mentioned in the eleventh century AD memoirs of AL-Beruni, called Kitab-ul-Hind. Braham Sarovar covers a geographical area of 1,141,054.74 m² and is located on coordinates 29°56’N and 76°83’E (Fig. 1). People come to take a holy bath at Braham Sarovar on the occasion of ‘Somavati Amavasya’ (the Sacred No-Moon day that only happens on a Monday) and on the occasion of a Sun-eclipse - it is believed that to bathe in the waters of Holy Sarovar makes one free from all sin and the cycle of birth-death. Over half a million pilgrims come here on such occasions and create pressure on the management of the destination. Furthermore, big concentrations of local, national and international tourists are also observed on the most auspicious
Table 2 Braham Sarovar: Land use/land cover, 2014

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Land use</th>
<th>Area (m²)</th>
<th>Sr. no.</th>
<th>Land use</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deep water zone</td>
<td>411,766.23</td>
<td>14</td>
<td>Multi art culture center</td>
<td>21,434.66</td>
</tr>
<tr>
<td>2</td>
<td>Shallow water zone</td>
<td>3,686.58</td>
<td>15</td>
<td>Parks</td>
<td>11,304.07</td>
</tr>
<tr>
<td>3</td>
<td>Covered shallow water zone</td>
<td>5,373.75</td>
<td>16</td>
<td>Police station</td>
<td>1,637.60</td>
</tr>
<tr>
<td>4</td>
<td>Pedestrian movement zone</td>
<td>47,360.77</td>
<td>17</td>
<td>Restaurant</td>
<td>160.61</td>
</tr>
<tr>
<td>5</td>
<td>Covered zone</td>
<td>19,986.72</td>
<td>18</td>
<td>Road</td>
<td>7,838.96</td>
</tr>
<tr>
<td>5.1</td>
<td>Cell size under covered zone</td>
<td>3.1 × 5</td>
<td>18.1</td>
<td>Dividing Road of Braham Sarovar</td>
<td>3,975.35</td>
</tr>
<tr>
<td>6</td>
<td>Main gates</td>
<td>275.25</td>
<td>18.2</td>
<td>Circular road</td>
<td>7,440.61</td>
</tr>
<tr>
<td>7</td>
<td>Entry points</td>
<td>2,803.37</td>
<td>19</td>
<td>Stage</td>
<td>279.72</td>
</tr>
<tr>
<td>8</td>
<td>Auditorium</td>
<td>2,863.61</td>
<td>20</td>
<td>Religious points</td>
<td>3,305.21</td>
</tr>
<tr>
<td>9</td>
<td>Chariot</td>
<td>936.96</td>
<td>20.1</td>
<td>Temples in Braham Sarovar</td>
<td>2,936.64</td>
</tr>
<tr>
<td>10</td>
<td>Footpath</td>
<td>2,829.07</td>
<td>20.2</td>
<td>Temples in outer periphery</td>
<td>30,122.57</td>
</tr>
<tr>
<td>11</td>
<td>National flag premises</td>
<td>268.26</td>
<td>21</td>
<td>Toilets and bathrooms</td>
<td>26,750.74</td>
</tr>
<tr>
<td>12</td>
<td>Parking</td>
<td>36,513.47</td>
<td>22</td>
<td>Vacant land</td>
<td>22,071.49</td>
</tr>
<tr>
<td>12.1</td>
<td>Attached parking</td>
<td>5,286.71</td>
<td>23</td>
<td>Vegetation cover</td>
<td>37,123.94</td>
</tr>
<tr>
<td>12.2</td>
<td>Road cross parking</td>
<td>31,226.76</td>
<td>24</td>
<td>Museum and library</td>
<td>16,356.69</td>
</tr>
<tr>
<td>13</td>
<td>Forest office</td>
<td>538.72</td>
<td>25</td>
<td>Water works</td>
<td>23,742.78</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>1,141,054.74</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Based on Quickbird satellite imagery, 2014
occasionally for short periods of time. There are nine gates for entry and exit of pilgrim crowds and at the north-west corner, a police station is established for the safekeeping of visitors and to maintain order. Similarly, a circular road is constructed around the Sarovar to manage traffic congestion during events.

Assessment of physical carrying capacity

The carrying capacity of Braham Sarovar would be determined as the maximum capacity of visitors at a single point in time. Limiting and regulating the number of visitors, and not exceeding this number should be helpful in the management of important events. The total areas of the destination accessible by pilgrims is 665,040.25 m$^2$ (Table 2). Statistics regarding comfortable space is stated in Table 1 and to evaluate the physical carrying capacity of the zones which are used by pilgrims for their religious purposes during the celebratory occasions were considered.

Area in the deep water zone is around 411,766.23 m$^2$ which is 36.08 percent of the total destination area. During the occasion of No-Moon, the shallow water zone of 36,846.58 m$^2$ provides an ideal place to pilgrim’s for bathing. There are also 20 separate covered bathing zones, constructed for women pilgrims - these covered areas comprise 5,373.75 m$^2$ and thereby account for 14.58 percent of the total shallow zone. The roofed zone covers 19,986.72 m$^2$ which is divided into cells. Each of these cells is covered on three sides and the front remains open facing the Sarovar (lake). The size of each cell is 3.1×5 m and is mainly used by Babas / Saints during their stay. A large area of 113,047.07 m$^2$ is parkland which is built around the roofed zone, forming the outer periphery of the destination (Table 2). This zone is primarily used for recreation and comfort by pilgrims and they take rest here for short periods of time. There are nine gates for entry and exit of pilgrim crowds and at the north-west corner, a police station is established for the safekeeping of visitors and to maintain order. Similarly, a circular road is constructed around the Sarovar to manage traffic congestion during events.

### Result and Discussion

#### Land use / land cover

Extrapolating from Quickbird satellite imagery (2014), the total area of Braham Sarovar is 1,141,054.74 m$^2$ (Fig. 2). For the estimation of physical carrying capacity, different categories of land use were identified and only those zones which are used by pilgrims for their religious purposes during the celebratory occasions were considered.

The carrying capacity of Braham Sarovar can physically deal with is about 567,534 persons on any single day. Comparatively, Kurukshetra Development Board (KDB) estimate the upper limit of pilgrims to be around 4.5 lakh (lakh = 100,000 - see Glossary of Terms in Issue 4(vi) ) during a big fair - this is within the carrying capacity of the destination as calculated.

<table>
<thead>
<tr>
<th>Zones</th>
<th>Derived PCC(A × V/a × Rf)</th>
<th>Carrying capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow water zone</td>
<td>$36046.58 \times \frac{1}{2.5} \times \frac{11}{30} = 324,249$</td>
<td></td>
</tr>
<tr>
<td>Covered shallow water zone</td>
<td>$5373.75 \times \frac{1}{2} \times \frac{11}{40} = 44,112$</td>
<td></td>
</tr>
<tr>
<td>Pedestrian movement zone</td>
<td>$47360.77 \times \frac{1}{2} \times \frac{11}{2} = 130,242$</td>
<td></td>
</tr>
<tr>
<td>Covered zone</td>
<td>$19986.72 \times \frac{1}{4} \times \frac{11}{2} = 27,481$</td>
<td></td>
</tr>
<tr>
<td>Parks</td>
<td>$113047.07 \times \frac{1}{10} \times \frac{11}{3} = 41,450$</td>
<td>567,534</td>
</tr>
</tbody>
</table>

Source: Calculated by the authors
Parking capacity

Large gatherings of tourists during specific auspicious occasions usually creates traffic chaos in the city. The Hisar-Yamunanagar road is the life-line of the city and most of the traffic plying between these two cities passes through this route. However, construction of the flyover on Braham Sarovar by-pass road has relieved some of this load. Moreover, an increase in the number of vehicles at important events creates additional demand for parking. Therefore, parking space is one of the major problems for religious spots such as this. The standard size of a car parking by IRC norms is approximately 5 meters by 2.5 meters with suitable clearances all round (Fig. 4).

In the context of car parking, Braham Sarovar, has adequate provision (see Figure 3). Figures 4 gives an estimation of space required for one specific vehicle type, to calculate the carrying capacity of the destination. The extant parking space (see Table 4) at the destination would allow for 2920 cars and taxis / 1489 light goods vehicles / 948 medium or heavy goods vehicles / 651 containers / 868 coaches and buses or 1521 light buses) per day at a time.

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladies toilets</td>
<td>350</td>
</tr>
<tr>
<td>Ladies bathrooms</td>
<td>172</td>
</tr>
<tr>
<td>Gents toilets</td>
<td>270</td>
</tr>
<tr>
<td>Gents bathrooms</td>
<td>172</td>
</tr>
<tr>
<td>Urinal</td>
<td>100</td>
</tr>
<tr>
<td>Drinking tap water point</td>
<td>35</td>
</tr>
<tr>
<td>Water cooler</td>
<td>7</td>
</tr>
<tr>
<td>Numbers of workers(sweepers)</td>
<td>67</td>
</tr>
<tr>
<td>Pump house</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Kurukshetra Development Board (KDB), 2014.
Toilet and bathrooms capacity

Toilets are the most essential basic facilities to serve the needs of every visitor. There is a large transient population for any religious occasion at the destination. The details of public utilities and facilities at the destination are given in table 5. Around 23 blocks of toilets and bathrooms are provided for pilgrims, separated for ladies and gents. Twenty two of these blocks are located along the covered zone / cell and 1 at the center of the destination for the visitor’s convenience. The present study has reviewed community toilets guidelines given by the Ministry of Urban Affairs and Employment for the calculation of requirement of toilet seats, bathrooms and urinals (Table 6). Presently, the destination has fairly large numbers of permanent toilet facilities both for males and females separately (Table 5). These are 270 and 350 respectively. Further, there are 172 bathrooms for males and females separately and 100 urinal points. Many temporary toilets are also installed nearby, in open spaces to the east of Braham Sarovar. According to the carrying capacity, the destination should have 5675 toilets (permanent or temporary combined), 8107 bathrooms and 1135-1891 urinals to fulfill the demand of pilgrims at peak events. Thus, it requires an additional 5055 toilets, 7763 bathrooms and 1035-1791 urinals of a temporary nature on the occasion of any major event like solar eclipse or Somvati Amavassaya.

Table 4 Braham Sarovar: Carrying capacity estimation of parking

Table 6 : Availability and requirements of toilets and bathrooms according to Government of India norms

Source: Calculated as per guidelines for community toilets, 1995, ministry of urban affairs & employment, Government of India.
Footpath capacity

Braham Sarovar is divided into two equal parts by a road which runs through the centre of the destination (Fig. 2). This road has around 2.5 metres of footpath on either side. The guidelines given by IRC:86-1983 are considered for calculating the carrying capacity of this footpath. Since there is are no restrictions on the movement of pilgrims in the destination, pilgrims move freely in any direction. Therefore, 2400 persons can move per hour in both directions per 2.5 metre width of footpath.

Drinking tap water capacity

Pure, safe and stress-free access to drinking water is a vital necessity at any destination. In the absence of government guidelines, the authors have devised the norms on the basis of experience of the visitors at the destination through Focused Group Discussion (FGD) and by conducting dummy exercise as to how long it takes to fill one litre of water bottle comfortably. Considering the average stay of the visitor of one hour (as suggested by the visitors), it is assumed that each person requires drinking water at least once during their stay at the destination. The existing number of water taps is highly insufficient and needs improvement. On any big occasion, the administration, namely KDB makes makeshift arrangements, providing additional tankers at different locations. However, as depicted in Table 7 the number of such points needs to be many times the existing provision on any big occasion.

Furthermore, not all visitors use tap water as a source of drinking water. 47 percent of visitors (based on authors’ research) prefer bottled water. Considering that only 53 percent of the visitors depend on public taps for drinking water, a comparative requirement for taps in both situations (i.e. wherein all use public taps or when only 53 percent rely on them) is presented in Table 7.

| Table 7 : Norms of drinking water tap point requirements according to pilgrim numbers |
|-------------------------------------------------|-------------------------------------------------|
| **Norms/time necessity for drinking water tap according to the primary survey of pilgrims** | Average time = 30 seconds/person (120 persons / hour) = 1320 persons/open time for visit (11 hours) / tap point |
| **Presently available tap points in the premises of Braham Sarovar** | 55 |
| **Carrying capacity of permanently available drinking water tap points** | \(55 \times 1320 = 72,600\) persons |
| **Requirement according to pilgrim numbers on an occasion** |  |
| **Number of pilgrims** | **When all visitors use public taps** | **When 53 percent visitors use public taps** |
| 100,000 | 75 | 40 |
| 200,000 | 151 | 80 |
| 300,000 | 227 | 120 |
| 400,000 | 303 | 160 |
| 500,000 | 378 | 200 |
| 600,000 | 454 | 240 |

Source: Computed by the authors.
There is need for extra public vehicle parking spaces (mainly buses), located away from the destination, to avoid congestion in the city on big occasions. The study proposes different locations to relieve the traffic congestion, shown by green colour: on Kaithal road and Pehowa road to the west; the nearby vegetable market (sabji mandi), Haryana Urban Development Authority (HUDA) sectors and along national highway 1, all located to the east.

**Conclusion**

Due to its unique mythological background, Braham Sarovar is one of the most attractive destinations and a huge number of pilgrims visit this destination during each sun-eclipse. In the light of the many tragedies at pilgrim destinations in India on certain religious occasions in the recent past, the importance of assessing the carrying capacity of Braham Sarovar for more scientific sustainable tourism management and development is essential. The suggestions for the makeshift provision of basic services during big events are in particular useful to the local administration for improvement and monitoring of this site. The destination’s physical carrying capacity which is around 567,534 persons and 2,920 cars parking on any single day is very good, but every destination has its limiting factors - in this case, basic facilities like toilets, water, accommodation, security and the like are sufficient for normal days but more such facilities of a temporary nature are needed to fulfil peak demand.

Efforts from the KDB and local people are seeking to include the site in the Krishna circuit by extending the scope of Mathura-Varindavan (Uttar Pradesh state) to Kurukshetra (Haryana state). In line with that, the present study tries to define thresholds for the destination to ensure tourism sustainability. To achieve that, the surrounding vacant lands have an important role to play for better management and to avoid mishappenings; to ensure smooth movement and comfort of stay by pilgrim at the destination. The study tries to identify suitable sites which can be used for the various identified purposes (as depicted in Fig. 5).

To the north, a big space of 58,140.3m$^2$ (named as theme park - shown with yellow colour) can be used for temporary provision of medical facilities, installation of huts and free community lunch facilities, locally called as bandaras.

To accommodate pilgrims, temporary settlements i.e. tents and temporary toilets should be developed near to the destination and this study proposes the adjoining open space of 109,672m$^2$ to east of the destination. This is also an appropriate location for parking ambulance and fire brigade vehicles (shown with orange colour in Fig. 5).

Parking for important guests (VIP) should be to the south which provides a sufficient segregated space of 72,875.1m$^2$. 

Fig. 5 Braham Sarovar: Suggested sites for multi-purposes
during important events like sun eclipses. The aforesaid suggestions mentioned in the paper can help the administration to design and implement a viable strategy to deal with the peak rush of tourists on specific occasions like solar eclipse and Somvati Amavasya.

References


