



Beach Carrying Capacity Analysis for Sustainable Tourism Development in the South West Coast of India

Brilliant Rajan¹, Vincy Mary Varghese² and Anakkathil Purushothaman Pradeepkumar³

¹Assistant Professor, PG Department of Environmental Science, St. John's College, Anchal

²School of Environmental Sciences, Mahatma Gandhi University, Kottayam

³Reader, Department of Geology, University of Kerala, Kariavattom

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The rapid growth of coastal tourism that has been seen in the last 10 years is frequently described as one of the major reasons for the development of these areas and also is responsible for many current coastal problems. The beaches perform, in this context, a fundamental role, where the issues related to planning and management are increasingly more important when it comes to an implementation of a sustainable development philosophy. In Kerala, where coastal tourism plays a major part of the state's economy, the management of beaches is crucial for maintaining their quality and therefore continuing to attract tourists. Since the 1990s, with the application of Coastal Zone Management Plans to the whole Kerala coast, beach plans are now required. The concept of capacity has received considerable attention as a result of increasing anthropogenic pressure in certain natural environments. Much consideration has recently been given to an increase in coastal population, with the implication that the carrying capacity of the world's coast is finite, and such consideration forms part of several coastal management initiatives. Tourism is the world's largest industry, which accounts for more than 10% of total employment, 11% of global GDP, and total tourist trips are predicted to increase to 1.6 billion by 2020. The ecosystems, typically stressed by development activity along the Indian coastal areas, are particularly vulnerable to socio-economic driving forces. The planning and management of coastal tourism can be improved through more careful understanding of social and ecological systems and their linkages, with a view to ensure a development that lasts, not only for tourism but also for the host destination. The present study gives a comprehensive idea on both sustainability of coastal areas and a prerequisite for the carrying capacity based development in tourism destinations.

Keywords: *coastal tourism; beach carrying capacity; coastal management; sustainable development.*

1. Introduction

'Sustainable tourism development meets the needs of present tourists and host regions while protecting and enhancing opportunity for the future. It is envisaged as leading to management of all resources in such a way that economic, social and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes and biological diversity and life support systems' (WTO 2004).

Environmental management involves the management of all components of the bio-physical environment for sustainable development; the

carrying capacity assessment is considered as an effective management tool to reduce negative environmental impacts. Unsustainable management of natural resources is now considered as a global issue rather than a regional one. The concept of tourism carrying capacity is based on the general statement that any form of development within the carrying capacity of ecosystem means sustainable utilization of tourist resources and development of ecosystem. When an area is used beyond its capacity, the quality of natural resources changes and gets destroyed. The increased inflow of either local or foreign tourists

beyond the carrying capacity of the area may deteriorate the area due to increase in luxury hotels, shopping centres and fun plaza in ecotourism regions (Lindberg et al. 1997). Ecotourism has every threat to wipe out the plant and wildlife species, and further it may lead to replace the entire ecosystem into an artificial landscape (Gosling 1999). There is a need to preserve and protect the fragile natural sites, wildlife and ecosystem, and at the same time there is a need to educate people and to create employment opportunities in order to fight poverty and misery (Bill 2001). One way to deal with this problem is to enumerate the carrying capacity. Any tourism beyond the acceptable carrying capacity should be strictly prohibited, the carrying capacity can be in relation to environment, social and economical (Trakolis 2003). An environmental approach defines it as the ability of natural resources and ecosystem to support the tourism development.

The lack of management and planning has resulted in the destruction and degradation of several resort areas and scenic attractions, affected fragile ecosystems and the environment, and created adverse impacts on host's cultures. Because of such effects tourism has been criticised and charged with destroying the very resources on which it is founded. The need for the proper management of tourism is thus essential for its development.

Varkala, a coastal town in Thiruvananthapuram district is a fast developing tourism destination, which is increasingly attracting many Indian and foreign tourists. The areal extent of the study area falls within 8° 71' to 8° 78' N latitude 76° 67' to 76° 72' E longitude. It covers a total area of 29.62 km². The study area experiences a moderate climate, just as in other parts of the state, and is in general free from extremes of hot and cold. Varkala has witnessed great developments in its infrastructure since the advent of the tourism industry. There has been a boom in the hospitality sector in Varkala in the recent years owing to the popularity of its beaches and various religious spots in the area. Lovely coconut palm areas and the gentle wind from the sea attract many nature tourists. Calm sea in the tourist seasons gives a good opportunity to enjoy the sea and do sun bathing in Varkala. Calm back waters (Kilimukkam and Nadayara Kayal) are fringed by coconut palms and the boating in this setting are really enjoyable. Roads with sparse traffic and the whole range of accommodation and food, friendly local people and fishermen, good road and rail connections, fresh air etc. attract tourists. The beach carrying capacity studies in the area were carried out during the period of 2004 to 2011 at different seasons.

2. Methodology

Carrying capacity is 'the maximum level of visitor use an area can accommodate with high levels of satisfaction for visitors and few negative impacts on resources' (McNeely and Thorsell 1987). The

World Tourism Organisation (WTO) defines the concept of carrying capacity as follows: "The maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic and socio-cultural environment and an unacceptable decrease in the quality of the visitors' satisfaction" (cited in PAP/RAC 1997).

Hunter (1995) gives a more precise definition by distinguishing four different types of carrying capacity:

"*Physical carrying capacity* – the limit of a site beyond which wear and tear will start taking place or environmental problems will arise.

"*Psychological (or perceptual) carrying capacity* – the lowest degree of enjoyment tourists are prepared to accept before they start seeking alternative destinations.

"*Social carrying capacity* – the level of tolerance of the host population for the presence and behaviour of tourists in the destination area, and/or the degree of crowding users (tourists) are prepared to accept by others (other tourists).

"*Economic carrying capacity* – the ability to absorb tourism activities without displacing or disrupting desirable local activities."

Papageorgiou and Brotherton (1999) underline what they think the central point of the concept of carrying capacity is: "In a recreational context, central to all definitions of carrying capacity is the idea of maintenance of the integrity of the resource-base and the provision of a high-quality recreation experience to users." To calculate this figure it is necessary to establish maximum use estimates. In practice, many planners rely on defining what constitutes a 'tolerable level' of visitation which can be sustained over time. The maximum sustainable capacity of an area requires the careful planning of geographically separated access points and placement of tourist's facilities to avoid excessive contacts between different groups visiting the area at the same time. Issues of seasonality need to be incorporated within both animal and human communities. Much attention to the problems of estimating carrying capacity has been given by the WTO (WTO/UNEP 1992) who recommends a formula (Bouillon 1985) for estimating tourist carrying capacity as:

$$\text{carrying capacity} = \frac{\text{area used by tourists}}{\text{average individual standard}} \quad (1)$$

The denominator is usually expressed as persons/metre², which is carefully defined for each case by evaluating psychological and ecological capacity. According to Shackley (1996), in order to determine environmental factors it is necessary to know the size of the area and usable space, fragility of the environment, wildlife resources and topography and vegetation cover. According to the WTO (1988), a beach should not have more than 1000 people per hectare. Therefore, each beach tourist should have at least 10 m² of the beach area. A reconnaissance

survey was carried out to collect the ground information. The GIS database generated from the topographic sheets was further updated with the latest changes in the study areas. Ground truth was collected during the field visit with the help of satellite image, SOI topographical sheets, GPS and magnetic compass. The image elements were correlated with the ground truth and the interpretation key was developed. The tonal variation representing different classes was marked on the hard copy image. The entries were made in the field description form at each of the sample point. Base maps including drainage, roads, settlement and study area boundary were extracted from the SOI topographical sheet (1969) no 58 D/14 and 58 D/9. Delineation of a beach map was prepared using map info version 5 and 7.

3. Results and Discussion

It was with concern and recognition of the need to understand coastal systems in terms of developing sustainable tourism that the concept of carrying capacity arose in the context of tourist areas; the intention being to avoid the saturation levels that both put natural systems at risk and disturbed the users' quality of enjoyment. In the case of beaches, their planning and management will depend on innumerable factors, but without doubt, what should be a condition in terms of utilization is the carrying capacity. The importance of this indicator is fundamental in the following: as the recreational use of a beach intensifies, the quality of enjoyment for the users can diminish. Beaches are highly valuable tourist resources; therefore determination of their carrying capacity is an essential factor for their sensible use and management.

3.1 Available beaches and beach areas for tourism

Beaches are the most attractive tourism destinations worldwide. Beach formation is a seasonal phenomenon, thus the beach formation season is depicted as the peak tourism season, which is September to March in Varkala area.

There are nine pocket beaches in Varkala which are named from south to north as:

1. *Chilakkur beach*. The average beach area in Chilakkur in the peak tourism season is 8750 sq. m. and 1500 sq. m. in the off-season. The Chilakkur area has some fishermen's colony and groins to prevent the attack of the sea. Compared to other areas the sea in Chilakkur beach is rough, especially in an off-season period. But in a peak season, the beach is beautiful with a panoramic view of the sand and the view of fishermen's boats including country boats.
2. *Enikkal beach*. Enikkal beach is a small pocket beach in a peak tourism season. The average beach area is 1250 sq. m., but in an off- season it

reduces to 500 sq. m. There is a fresh water spring flowing from the cliffs into Enikal beach. The fresh water spring enables tourists to have a fresh water bath after sea water bath. The beautiful view of the sea from above the cliff of Enikkal beach is an unforgettable experience to tourists. A stream flowing in this area carries the waste water from Varkala town and nearby houses onto the beach.

3. *Papanasam beach*. The most popular and elongated beach area in Varkala is Papanasam beach. The available beach area in a peak tourism season is 12250 sq. m. and in an off-season 3000 sq. m. The Papanasam area has the beach throughout the season. The area is particularly important for religious rituals like 'Vavubali' and the centuries old Janardhana swami temple. There is a good number of resorts concentrated around the beach. Two streams carry the waste water from hotels and resort into the beach and form the major environmental problem on the beach.
4. *Black sand beach*. It is a very small pocket beach with black sand, situated north of Papanasam beach. The beach is available only in a peak season and is located above the seawall. The beach area is only 950 sq. m. but in an off-season it is reduced to 50 sq. m. or even absent.
5. *Thiruvambadi beach*. The beach is also a pocket beach formed during the peak tourism season. The available beach area in a peak tourism season is only 1300 sq. m., but in the off-season it reduces to 600 sq. m. The sea is very calm during the peak tourism season and very rough in off season.
6. *Odayam*. It is a very small pocket beach with the available beach area of 1125 sq. m., in an off-season it being only 300 sq. m.; a few resorts are also found around the beach.
7. *Manthara beach*. It is a very small pocket beach and the available beach area during the peak tourism season is 500 sq. m., which completely disappears in the off-season.
8. *Vettakada beach*. The beach in Edava panchayath has an available beach area of 450 sq. m. in the peak season and only 250 sq. m. in the off-season.
9. *Kappil beach*. The Kappil region is one of the most beautiful beach areas partitioned by a sand bar with the sea on one side and back water on the other side. The sand bar extends for 10000 km² in the peak season and for 3500 km² in the off-season.

3.2. Total beach area

The total beach area in a peak tourism season is 100,000-135,950 m². The average beach area is 117,725 m², but the available beach area is 29,300 m². The total beach area in an off-season is between 60,850-87,300 m² and the available beach area is 9,650 m².

Table 1. Beach area- Varkala

SI. No.	Name of Beach	Beach area in peak season (Sq. m)	Average beach area in peak season (Sq. m.)	Available beach area in peak season (Sq. m.)	Beach area in off- season (Sq. m.)	Average beach area in off- season (Sq. m.)	Available beach area in off-season (Sq. m.)
1	Chilakkur beach	5000-12500	8750	4000	3500-8000	5750	1500
2	Eanikkal beach	500-2000	1250	1250	300-1000	650	500
3	Papanasam beach	10000-15000	12250	10000	6000-10000	8000	3000
4	Black sand beach	700-1200	950	950	0-100	50	-
5	Thiruvambadi beach	1600-1800	1700	1300	500- 1250	875	600
6	Odayam beach	1000-1250	1125	850	250- 750	500	300
7	Manthra beach	500-1000	750	500	0-400	200	-
8	Vettakkada beach	700-1200	950	450	300-800	550	250
9	Kappil sand bar	80000-100000	90000	10000	50000- 65000	57500	3500
Total area (Sq. m.)		100000-135950	117725	29300	60850-87300	74075	9650

3.3. Carrying capacity of Varkala beach

The available beach area in a peak tourism season is 29,300 m². Thus, the optimum number of tourists in a peak tourism season is 2,930. The available beach area in an off-season is only 9,650 m² and the optimum number of tourists in off seasons is calculated as 965. The sea is comparatively rough and a fewer number of pocket beaches in an off-season prevents the tourist enjoyment there. The study area Varkala is at the brim of carrying capacity, hence, further tourism activities should be strictly regulated there.

The measurement of beach areas for physical carrying capacity evaluation was performed by da Silva (2002) in Sines coast of Portugal. The physical carrying capacity of the Varkala area indicates that

about 2930 tourists can be accommodated at a time in the peak tourism season. The number of tourist arrivals varies from hundreds to thousands in a peak tourism season per day. The total bed capacity of Varkala is found to be 1969; the rooms are mainly meant for foreign tourists and tourists from other places. But quite a number of local tourists visit Varkala each day, and they also need the beach area for recreation. According to Silva et al. (2007) beaches are classified as below:

- Type 1 – urban beach with intensive use;
- Type 2 – non-urban beach with intensive use;
- Type 3 – infra-structured beach with conditional use;
- Type 4 – non infra-structured Beach with conditional use;
- Type 5 – restricted use beach;
- Type 6 – prohibited use beach.

Table 2. Carrying capacity of beaches in Varkala

SI. No	Name of Beach	Available beach area in peak season (Sq. m.)	Carrying capacity of beaches in peak season (In. nos)	Available beach area in off season (Sq. m.)	Carrying capacity of beaches in off-season (In. nos)
1	Chilakkur beach	4000	400	1500	150
2	Eanikkal beach	1250	125	500	50
3	Papanasam beach	10000	1000	3000	300
4	Black sand beach	950	95	-	-
5	Thiruvambadi beach	1300	130	600	60
6	Odayam beach	850	85	300	30
7	Manthra beach	500	50	-	-
8	Vettakkada beach	450	45	250	25
9	Kappil sand bar	10000	1000	3500	350
Total area (Sq. m.)		29300	2930	9650	965

For each category there are different criteria associated with the measurement of the carrying capacity of the beach, with the first ones, type 1 and 2 associated to a more heavy demand and thus

supporting higher densities. The other types are the ones that present some environmental sensitivity, therefore they must be carefully managed. The last one, type 6, is the case of beaches that for some

reason are without safety conditions for beach users. The study points out that Varkala comes under type 2 category of beaches, i.e. – Non-Urban Beach with intensive use. Johnson and Thomas (1996) argue that the present interest in tourism capacity is linked to the growth in tourism combined with increasing awareness of environmental issues. It helps the management to plan a strategy, which reflects a predetermined set of environmentally and socially desirable conditions (Williams and Gill 1991).

Considering the tourism industry, the need to adopt a 'sustainable' approach is exacerbated by its fragility and sensitivity to change, its multi-sector nature, and its marked dependence on the quality of the host environment and communities; 'tourism which degrades any elements of host communities and nations threatens its own future' (Manning 1999). Managing of existing destinations is a key element in this research, the need to redefine tourism development in the existing destinations on a more sustainable basis. Recreational carrying capacity is 'the amount of development and activity a body of water can handle before it starts to deteriorate,' as defined by Jacquie Colburn of the New Hampshire Department of Environmental Services (Doshi 2006).

Tourism activities began in time immemorial, early travels were mainly for sustaining livelihood activities, but the modern travel and tourism are mainly for pleasure and recreation; this results in exploitation of newer and newer areas without any concern for nature. The over exploitation of the tourism areas can result in pollution and destruction of natural flora and fauna, the natural beauty of the area and adverse social, economic and cultural impacts on local population. Tourism development based on carrying capacity and sustainable development becomes relevant in this scenario for proper management of natural resources, thus the present as well as future generations may enjoy nature's beauty and thereby enhance tourist flows and revenues.

4. Conclusions and recommendations

Defining the carrying capacity of a beach is undoubtedly a complex issue, where consensus is hard to be achieved. This simple case study aimed at identifying some of the aspects, that condition this evaluation more than define the carrying capacity of the beach per se. Taking into consideration the factors such as beach topography, location of access points, parking availability, or the perception by users could actually be more important than the total sand area utilisable for recreational purposes. Since the distribution is not homogeneous all over the beach, the use of a standard density application is not appropriate.

The carrying capacity of a beach cannot be expressed as a fixed and rigid value; on the contrary, as defined by other authors (De Ruyk et al. 1997), it should oscillate between two tolerable thresholds,

allowing the management of the concept in an integrated, flexible and sustained way.

The coastal tourism destination Varkala is at the brim of the carrying capacity, further construction activities should be totally prevented in the area. The beach areas have been delineated using remote sensing and GIS techniques.

The major recommendations drawn on the base of the study are:

- 1) Tourism development should be within the carrying capacity.
- 2) The number of visitors to the area should be regulated.
- 3) Strict implementation of CRZ (Coastal Regulation Zone) and gain access to the sea.

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Dr. Brilliant Rajan - Ass. Professor, Department of Environmental Science, St. John's College, Anchal
Main research areas: Carrying capacity, environmental management, sustainable development.
Address: St. John's College, Anchal
Tel.: 9446917941
E-mail: brilliantrajan@gmail.com

Vincy Mary Varghese - Research Scholar at Centre for Remote Sensing and GIS, School of Environmental Science, Mahatma Gandhi University.
Main research areas: hydrological modelling, GIS, Remote sensing, environmental management, sustainable development.
Address: Kottayam, Kerala- 686 560
E-mail: vincybrilliant@gmail.com

Dr. Anakkathil Purushothaman Pradeepkumar - Reader at Department of Geology, University of Kerala, Kariavattom.
Main research areas: environmental disaster management, geology, petrology.
E-mail: geo.pradeep@gmail.com

Galimybių taikyti darnaus turizmo principus Indijos pietvakarių pakrantės paplūdimiuose analizė

**Brilliant Rajan¹, Vincy Mary Varghese²,
Anakkathil Purushothaman Pradeepkumar³**

¹ *Aplinkos mokslų fakultetas, Šv. Jono kolegija, Indija*

² *Aplinkos mokslų mokykla, Mahatma Gandžio universitetas, Indija*

³ *Geologijos fakultetas, Keralos universitetas, Indija*

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Pastaruoju dešimtmečiu besiplėtojantis priekrančių turizmas sąlygoja šių zonų plėtrą ir dažnai įvardijamas kaip vienas iš pagrindinių aspektų, lemiančių priekrantės problemas. Paplūdimiai šiose zonose turi didžiausią įtaką, todėl, galvojant apie priekrančių zonų darnią plėtrą, ypač svarbiais klausimais tampa paplūdimių planavimas ir valdymas. Keraloje priekrančių turizmas yra svarbus ekonomikos sektorius, todėl paplūdimių valdymas yra esminis veiksnys, leidžiantis palaikyti jų kokybės lygį ir užtikrinti regiono patrauklumą turis-tams. Nuo 1990 m. pradėti taikyti priekrantės zonos valdymo planai visai Keralos priekrantei, todėl ir paplūdimių planai šiuo metu yra privalomi. Ypač svarbus dėmesys skiriamas paplūdimių talpai, nes taip vertinamas antropogeninės įtakos gamtinei aplinkai lygis. Daug dėmesio skiriama gyventojų daugėjimo priekrančių zonose analizei, vertinant tai, kad priekrančių zonos talpos pajėgumai yra riboti. Todėl reikia valdyti svarbius priekrantės zonos aspektus. Turizmas yra viena didžiausių pasaulio verslo šakų, kur dirba 10 proc. darbuotojų, sudarančių 11 proc. pasaulio BVP. Prognozuojama, kad iki 2020 m. kelionių padaugės iki 1,6 mlrd. Indijos priekrantės zonos ekosistemos yra jautrios tokiai sparčiai turizmo ir apgyvendinimo plėtrai. Siekiant užtikrinti ilgalaikę regiono plėtrą, kai dėmesys skiriamas ne tik turizmo veikloms, priekrantės zonų turizmo planavimo ir valdymo procesai gali būti patobulinti geriau suvokiant socialines, ekologines sistemas ir jų tarpusavio ryšius. Straipsnyje analizuojama tiek priekrantės zonų darnumas, tiek jų galima talpa, atsižvelgiant į ilgalaikius regiono tikslus.