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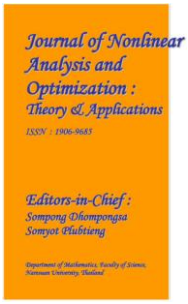

SUSTAINABLE COASTAL TOURISM: A CARBON-FOOT PRINT, SEQUESTRATION, OPTIMAL CARRYING CAPACITY APPROACH

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Abstract

There are ample of studies that indicate contiguous relation between tourism activity and economic benefits. The tourism activities are likely to generate externalities both positive and negative. The economic benefits can be viewed as positive externalities but environmental impact of tourism activities implies negative externalities that cannot be ignored. The positive externalities if not monitored and controlled will itself generate negative ones so it is also imperative to acknowledge the cost that local communities will incur when a tourism model is built up. Before it is too late to realize that the sustainability factor in tourism can be addressed only when Economic and Environmental benefits are synchronized. Normatively they should go hand in hand. Moreover the Coastal Ecological Structure is highly fragile and vulnerable to negative externalities.

Analyzing the externalities, economic benefits and environmental impact that will be created due to tourism activity and explore the possibility to combat the negative externalities is required. The area of study is coastal tourism destinations in Raigad district of Maharashtra.

The unprejudiced study is undertaken to evaluate environmental cost in terms of carbon foot print(Huang & Tang, 2021) and to analyze variations in carbon foot prints and to explore carbon sequestration possibility and optimal carrying capacity of tourist. The methodology includes estimation of carbon footprints due to tourism activity across various coastal destinations on one hand and to estimate carbon sequestration and beach carrying capacity on other hand. Data related to generation of carbon foot print is collected primarily through interviewing to tourists and stakeholders and data related to the forest. The carbon sequestration capacity is estimated secondarily on the basis the tree forestation zone in that area where as beach carrying capacity is also estimated as per the WTO standards.

The proposed research work aims to inferentially analyse the Carbon footprints, Beach carrying capacity and Number of trees using Multiple Regression Model. The investigator believes that it can help in formulating a comprehensive policy at Macro-Level.

Keywords: *Externalities, Carbon-Foot Print, Sustainability, Optimal Carrying Capacity*

Introduction

Environmental issues are one of the most critical issues that need to be addressed by all the nations in the world. Economic Development in general has given rise to externalities in all the areas of economic activities. The UNDP (2015) sustainable development goal clearly signifies climate action, life below water and life on land as fundamentally important. Economic Development should go hand in hand with the Environmental enrichment to ensure sustainability. The three pillars of sustainability are social, economic and environmental and they cannot be mutually exclusive. Tourism is considered as fast growing industry in across the world. Coastal tourism has greater economic value as well as it is vulnerable tourism that is likely to impact the fragile coastal biodiversity significantly. In order to reap the economic benefits of tourism for longer period sustainable coastal tourism becomes necessary condition. The coastal area in Maharashtra which is popularly known as Konkan starts from Palghar District and extends till Sindhudurg district encompassing Raigad and Ratnagiri District. These

districts have a rich touristic profile and have lot of potential for tourism and tourism activities. Some of the coastal destinations have dual-combinational features for beach and religious tourism. Increasing tourism activities in these belts have started supporting the local economy thereby generating various economic benefits in these regions on hand but on the other hand it has also started generating externalities. Gole. P (1997) carried out a detailed study on conservation of bio-diversity of the west coast between Mumbai and Goa and suggested various recommendations to protect the Coastal biodiversity that will be in the long term interest of the localities. There are multiple impacts of tourism activities on Air, Water, Vegetation, Soil, Geology and Wildlife. (Clarke, 2000)
The entire world has started facing the impact of global warming and tourism destinations especially coastal destinations are more vulnerable to externalities and therefore it is not only indispensable to assess environmental impact through various methods but also explore measures to combat externalities. The question is whether we are ready to measure the cost the tourism activities which is likely to increase if carried out carelessly.

Rationale for the Study

The peak season in Konkan starts from November to March. During summer and rainy season tourism is moderate. The coastal biodiversity is the main factor that drives the coastal ecology. Coastal tourism activities are more prone to externalities. There is a tradeoff between economic benefits and environmental benefits though it is desirable that they should go hand in hand. It is often a common experience that the former undermine the later. However every economic activity comes with a cost and some costs are very difficult to measure. The social cost of tourism related that society has to bear are negative externalities. Economic Activities are more highlighted than the environmental cost. Therefore, It is imperative to assess the environmental cost. The need of the hour is use of natural resources in a very responsible manner which means that responsible tourism will ensure sustainable tourism.

However normative we are, it is simply difficult to change the mindsets of the tourist and make them responsible and accountable for their tourism activities.
(Hall, 2001)"Tourism can have harmful impacts on the physical and a marine environment has now become well recognized. However, that tourism automatically has a negative effect has now become something of a truism in much of the contemporary travel literature. Undoubtedly, unplanned and poorly managed tourism development can damage the natural environment, but the overall understanding of the interaction between tourism and the environment particularly within coastal areas is necessary."
(Lenzen et al., 2018) state that global carbon footprint has been increasing overtime and accounts for over 8% of greenhouse gas emissions.
The question is can there be a mechanism that can consistently monitor the viable coastal tourism activities and ensure a steadiness among economic and environmental benefits so that the touristic profile of the destination remains for long period. The number of tourist visitors, the number of accommodations and the number of activities at the coastal destinations will largely determine the economic benefits of tourism whereas the carbon foot prints generated that is the amount of greenhouse gases(Yoro & Daramola, 2020) that are generally measured as CO_2 equivalent, beach carrying capacity relates to maximum number of people a tourist destination can accommodate at a particular time without affecting the environmental imbalance and satisfaction level of tourist. Number of trees in such belts will influence the environmental concerns. The total length of the costal line across konkan is around 720 kms. The coastal districts constitute of ecologically critical habitats(Liao et al., 2023) identified along Indian coast and therefore development with responsibility is crucial to combat the externalities and mitigate the negative externalities by designing a holistic approach for sustainability.

Literature Review

Four issues(Jennings, 2004) are responsible for the changing relationship between coastal tourism and shoreline management: an increase in, and the changing nature of tourist-related pressure at the coast; advances in shoreline management approaches including the adoption of Integrated Coastal Zone Management (ICZM) principles, the geomorphologic behavior of coastal systems.

(Kumar et al., 2023) focused on strategies to mitigate negative impacts. Specifically, the study examined and analyzed case studies of successful ecotourism projects in different parts of the world. (Ren et al., 2019) undertook dynamic study of carbon footprints and carbon carrying capacity in Sichuan province..

(Mejjad et al., 2022) analyzed the critical social and economic roles the coastal tourism industry plays while the steady and uncontrolled growth of this sector and related activities compromise these coastal countries' ecology and environmental quality.

(Da Silva, 2002) explored the concepts of physical carrying capacity (number of individuals a beach can physically accommodate) and social carrying capacity.

(Chen & Teng, 2016) undertook a study to understand management priorities and estimate carrying capacity ach from tourists' perspective.

(Insani et al., 2020) undertook carrying capacity estimation to support tourism coastal management system in Indonesia

Most of the above studies directly or indirectly address the issue of environmental sustainability with reference to tourism. It is imperative to analyse and explore the possibility of sustainable tourism in Konkan belt of Maharashtra as well.

Objective of the study

The area of study is restricted to the tourism destination belts of Raigad district namely Nagaon. Akshi. Alibag, Varsoli, Kashid, Shrivardhan, Diveagar, Harihareshwar. The beach carrying capacity, carbon footprints generated and number of trees will determine the ecological health of the coastal tourism destination.

The objective of the study is

- to evaluate carbon foot print generated on the basis of carrying capacity
- to analyze the relationship between carbon footprints, carrying capacity and number of trees.

Limitations of the study

The study delimits to consider carbon footprints estimate from electricity usage, transportation and food consumed only. The tourism activities are not taken into account. Moreover it is difficult to get the real time data related to various activities like sports and adventures and therefore the study considers estimated data for the analysis. The study assumes that maximum carrying capacity for estimating total carbon footprints.

Further the study considers only tree as source for carbon sequestration, real carrying capacity (Insani et al., 2020)of the beach for analysis and is restricted to the coastal tourism destinations of Raigad District.

Research Design and Analysis

The research consist of collecting data with respect to 4 important variables

The analysis includes collection of data primary as well as secondary. The primary data is collected by interviewing and stake holders such as respective forest office divisions. The secondary data is collected from the online sources using google earth and google earth pro.

In order to track carbon footprints the following factors such as transportation, electricity consumption, tourism activities and food consumption, use of mobile phone on an average of 195 minutes. The average carbon foot prints were estimated considering 4 members per family.

For data related to Carbon sequestration the total number of trees in the tourism destination were considered as bench mark for which the data is obtained from the respective forest office division. The sequestration capacity of tree was taken as 25 kg for a year and average sequestration was considered for per day.
The data related to beach carrying capacity is estimated through the Google earth for which the area of beach was considered as bench mark after considering the benchmark of WTO (1988) as 10sq.m per tourist.
Popular beaches namely Nagaon, Alibaug, Akshi, Kashid, Shrivardhan, Diveagar, Velas, Harihareshwar, Varsoli and Velas were selected understudy. The data was generated using good earth pro and google earth, Carbon footprint estimation was done after identifying beach carrying capacity as per the UNWTO specifications (1988). The information related to number of trees was collected by interviewing the Forest Division Officers of Roha Division.

Analysis and Discussion
Table 1.1

Location	**Potential Area (sq.m)**	**Actually accessible beach area (A in sq.m)**	**Approximate Carrying Capacity (A/10sq.m)**	**Carbon Foot Prints (Assuming full carrying capacity)**	**No. of trees 2500/hectare (approximate)**	**Carbon sequestration per day**
Nagaon	537224.85	200891.82	20089	230405.7633	5022	343.9726
Akshi	374099.33	73529.42	7352	84321.926	1838	125.8904
Alibaug	94156.51	13013.80	1301	14921.49425	325	22.2602
Varsoli	86030.68	86030.68	8603	98669.95775	2150	147.2602
Kashid	384090.04	145587.67	14558	166969.3415	3639	249.2465
Shrivardhan	152228.42	48191.67	48191	552714.6268	12048	825.2054
Divegar	354.207.76	62096.16	62096	712194.548	15524	1063.2876
Harihareswar	146146.6	117218.64	11721	134431.0793	2930	200.6849
Velas	42567.751	24752.80	2475	28386.39375	619	42.3972

Source: Google Earth, Google Earth Pro, Carbon footprint Calculator, Estimation based on online sources, Forest Department-Roha-Alibaug

Findings and Discussion
The discussion revolves around 3 Variables namely Carbon Foot Print, Carrying Capacity and Number of Trees and their values were estimated through the sources mentioned in table 1.1. It is practically difficult to get accurate measurement of carbon footprint, as it will vary daily. Further information related to number of trees was provided by the forest department. The actually accessible area was

taken as the bench mark for the study through Google Earth Pro software. Carbon Foot Print Estimated was taken as response variable whereas Carrying Capacity and Number of trees were taken as exogenous variables.

Initially a **Multiple Regression Model** was resorted to study the effect on response variable the following were the findings.

$$Yi = \beta 1 + \beta 2X1 + \beta 3X2 + ui$$

Yi: Carbon Foot Print
$\beta 1, \beta 2, \beta 3$ *parameters*
X1: Carrying Capacity ui : *error term*
X2: No. of Trees

Table 1.2

Serial No			**P value**
1	**Significance Value for F**		3.18E-94**
Regression Coefficients			
2	**Intercept($\beta 1$)**	-1.07187E-10	**0.041164**
3	**Slope($\beta 2$)**	11.46925	2.5E-69**
4	**Slope ($\beta 3$)**	-8.80955E-11	**0.335201**

**** indicate Statistical Significance**
Source: MS-Excel, Analysis Tool-Pak

The overall model is significant in explaining the relationship among the response variable i.e Carrying Capacity and predictors Carbon footprints and number of trees. This is obvious through the **Significant F-ratio** with **p-value very close to 0** for carrying capacity whereas t ratio is insignificant for Number of trees
as p value is 0.33. This is obvious due to **multicollinearity.** Interestingly, running a **separate regression showed a significant relationship with significant F and t ratios as per table 1.3 given below**
where it can be seen that the regression model shows significant influence of number of trees on the carbon foot print. It is evident that the **p value is nearly approaching zero** indicating significance.
Further, as per **Table 1.1** the carbon sequestration per day for each tourism destination is actually very low indicating that many other methods of carbon offset needs to be developed for sustainable tourism.

Table 1.3

Serial No			**P value**
1	**Significance Value for F**		6.56E-31**
Regression Coefficients			
2	**Intercept($\beta 1$)**	**12.6414**	**0.11**
3	**Slope($\beta 2$)**	**45.8759**	6.5607E-31**

**** indicate Statistical Significance**
Source: MS-Excel, Analysis Tool-Pak
However, the overall multiple regression model is impactful and Beach Carrying Capacity does impact the carbon foot print.

Recommendations

Tourism activities and human interventions will make coastal tourism vulnerable and prone to the negative impact. Further, it is practically impossible to forgo the economic benefits for the environmental benefits.

The limits of acceptable change is the buzzword in the tourism sector discussed across the world, certain policy measures can be undertaken to mitigate the negativities and ensure responsibility and solutions can be few of the above mentioned

1. Effective Tourism Management Strategies are crucial in safeguarding acceptable tourism, maximization of tourist satisfaction and minimization of negative externalities that tourism activity is likely to generate on the local population.
2. Information related to visitors arrival and stay and their flow across the nearby destinations is something that should be the priority of policy makers to address through designing of appropriate model.
3. The coastal length of Raigad district is 122 km out of which 9 coastal destinations for tourism are prevalent. The beach carrying capacity can be distributed across the coastline by identifying and developing the coastal areas which can be potentially tapped. This will reduce the carbon foot print load in a specific destination.
4. The economic benefits of tourism can be reaped by developing and spreading tourism across less popular destination. This will ensure the spread of carbon foot print and reduce its impact.
5. Carbon sequestration through trees will not alone attain sustainability in tourism. A sustainable tourism business exemplary that will use non-conventional source of energy will be required for sustainable tourism.

Conclusion

This study explores the possibility for further studies to be undertaken at the entire coastal belt of Maharashtra which constitutes of 5 Districts with variable ecological structures. A detailed study district wise can lead to more meaningful inferences that can be helpful in devising sustainable coastal tourism policies for Maharashtra State.

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