VOLUME - 12, ISSUE - 05, MAY - 2023 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Earth Science

IDENTIFYING THE ECOTOURISM SUITABILITY SCORE FOR MARINA BEACH AND ELLIOT'S BEACH OF CHENNAI COAST, TAMIL NADU, INDIA.

Yuvaraj R M	Assitant Professor, Department of Geography, University of Madras, Chennai, Tamil Nadu, India
S. Ambrisha*	Research Scholar, Department of Geography, Queen Mary's College, Chennai, Tamil Nadu, India.*Corresponding Author
S.Muthunagai	Assistant Professor, Department of Geography, Queen Mary's College, Chennai, Tamil Nadu, India

ABSTRACT At the Chennai Coast in Tamil Nadu, India, research is done. Finding out whether Marina Beach and Elliott's Beach are suitable for ecotourism is the study's main goal. For the research using the ecotourism suitability index methodology, land use, land cover, erosion, accretion, beach type, beach width, proximity to bus stop, proximity to train station, and suspended sediment load have all been taken into account. The suitability index of eco tourism is assigned into 4 (four) classes, which are: Class S1 (Highly suitable), Class S2 (Quite Suitable), Class S3 (Suitable with condition) and Class N (Not Suitable). Result of analysis indicates that coast area of Marina Beach and Elliots beach area comes in the class of Highly suitable (S1) by score total of 129 or 95.5 % and 116 or 85.9 % respectively. According to the research, Marina Beach has a sand feature as a land use land cover, 213 metres of beach width, good clarity (500 mg/L), is located 361 metres from a bus stop and 681 metres from a train station, has moderate erosion, and has not experienced any accretion. The beach type is white sand. Likewise, Elliots Beach has a sand feature as a land use land cover, with 222 metres of beach width, good clarity (600 mg/L), 642 metres from the bus stop, and 2351 metres from the railway station, which is high. There is moderate erosion and no accretion, and the sand is of the beach type, which is white. Marina beach has high tourism suitability index as compared to Elliot's beach. By considering marina beach, all the eight parameters are considered to be fine whereas Elliot's beach has far away accessibility this is the main reason for lowering the tourism suitability.

KEYWORDS : Eco-Tourism, Suitability, Geo-Spatial, Remote Sensing, Chennai Coast

Introduction

When it comes to tourism as a tool for economic development, international organizations like the World Bank say that coastal tourism is typically geared toward protecting endangered habitats and biodiversity while ignoring trade-offs between conservation and utilization. As a result, appropriate measures must be taken to generate economic benefits from marine areas while also providing protective benefits. Therefore, government policies for tourism planning aim for a model based on diversity, quality and sustainability that can improve the competitiveness of destinations. Indicators of sustainable tourism can assist evaluate destinations and establish more appropriate policies during the planning and implementation phase [3]. Clean water, healthy coastal habitats, and a pleasant environment are necessary for successful coastal tourism. The majority of recreational activities depend on a variety of living marine resources, such as fish, shellfish, wetlands, coral reefs, and so on. Coastal tourism is protected from threats connected with natural coastal hazards such as storms, hurricanes, and tsunamis, ensuring its long-term viability. Coastal tourism and recreation are growing in volume and diversity quicker than almost any other activity in coastal sectors and the near-shore coastal ocean. Ocean and coastal tourism is usually regarded as one among the most rapidly increasing fragments of the tourism industry [1,13]. Beach management has always prioritized recreation and coastal protection [2].

GIS applications offer new and expansive research opportunities when evaluating coastal systems, especially for the execution of human development and coastal geography has offered by Geographical Information System (GIS) applications. Mapping shorelines and the complex features that make up its system have been constantly progressing, looking for new technologies to expand upon human understanding and interpretation of the seashore precinct. The present observation involves a kind of multi-criteria evaluation method using GIS [14] as a practical instrument to appraise the appropriateness of Marina beach and Elliot's beach of Chennai for sustainable tourism destinations using land use land cover, beach width, sea water turbidity, distance to bus stop, distance to railway station, erosion, accretion [12] and beach type by means of Tourism Suitability Index (TSI). The matrix of suitability has considered to calculate the TSI on the basis of significant of the each considered parameter which will encourage tourism-related operations in the area [10,16,17,18].

Chennai is capital state of Tamil Nadu, India, located on the western shore of Bay of Bengal. Chennai Marina beach is the second longest beach in the world and their coordinates are 13°03'15.05" N and 80°17'1.25" E. Elliot's beach is known for its own varied heritage, influence of modern facilities and pleasurable coast region and their coordinates are 12°59'58" N and 80°16'21"E., The Velankanni Church and the Ashtalakshmi temple are situated nearby. There are many restaurants near the beach to fulfill the visitors' needs. The people sustain their livelihoods through fisheries, tourism, and small scale business near the coastal area [4,5] identified Marina beach, Thiruvanmiyur beach and Elliot's beach as the most tourist visited beaches in Chennai. As we all know that marina seashore is longest beach in India and second longest shoreline in the world but the suitability of beach in mathematical value has to be calculated to facilitate the identification of its suitability for tourism related operation at beach.

Material and Methods

Research location has been shown in the Figure 1. Marina Beach is a natural urban beach in Chennai, Tamil Nadu, India, along the Bay of Bengal. The beach is the longest natural urban beach in the nation, stretching 6.0 kilometres from near Fort St. George in the north to Foreshore Estate in the south. Elliot's Beach is located in Besant Nagar, Chennai, India. It is named after Edward Elliot, a former chief magistrate and superintendent of police in colonial Madras, and it serves as the terminus of Marina Beach coast. The Ashtalakshmi Kovil and the Annai Vailankanni Church are

close by. Data for the land use land cover classification has obtained from United States Geological survey (USGS) Landsat 8 operational Land Imager (OLI) with 30 meter resolution with path 142 and row 51 for the year 2021. Visual interpretation is used to identify different land use types in the satellite images [15]. Each land use type is delineated using on-screen digitization of ArcGIS 10.8.

Several studies on shoreline change have already been conducted in India using remote sensing and Geographic Information System (GIS) methods at various times in the recent past [6,7]. Wave action and alongshore currents are also important for accretion and attrition of coasts, which perhaps can be easily observed and computed utilizing geospatial approaches and automatic calculations by the extended tool of ArcGIS [8].

For shoreline extraction, each multi-temporal satellite image was digitized manually and independently. The data from various time periods was then entered into the Digital Coastline Analysis System (DSAS) for additional computation of shoreline change over a 20-year period, from 2001 to 2022. The Object ID (a unique number provided to each item), shape (polygon), date (original survey year), and shape length, ID, and uncertainty values are all used in the DSAS programme to compile shorelines coordinates. In the attribute table, shorelines extracted at different times were merged as a single feature, resulting in a single shape file including numerous shorelines. By precisely digitizing the direction and contour of the outer coastline baseline, the cross shore transacts for calculating the shoreline change are gathered and generated. The rates of shoreline change were calculated using a USGS-developed ArcGIS tool and the DSAS version 4.2. The study employed statistical techniques such as Linear Regression Rate (LRR) and End Point Rate (EPR) in DSAS. The Global Positioning System (GPS) has used to get the latitude and longitude of the each bust stop and railway station alongside the coast area (i.e., nearer to the shore). This points has been plotted in ArcGIS to find the distance between the coastal location and bus stop or railway station using Proximity analysis.

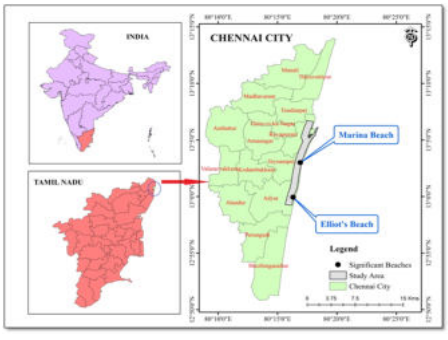

Figure 1: Location of the Beaches

The sediment supply density analysis was done using Landsat 8 data to show the sediment patterns and suspended amounts for Chennai coast. The analysis used band 4 from Landsat 8 to specify what spectral range of DN (Digital Number) values represent the different amounts of suspended sediment. First, the only area needing analysis is the water, in this case coastal water along Marina beach and Elliot's beach. Therefore, a mask was created using the Landsat NIR Band in an overlay with Band 4, which refined the spectral analysis to just the water. Second, using the sediment classification reflectance values, the raster image was reclassified to match the amount of suspended sediment

$$Reflectance = \frac{M_p Q_{Cal} + A_P}{Sin(\vartheta_{SE})}$$

Where, M_p = Band-specific multiplicative rescaling factor
Q_{cal} = Quantized and calibrated standard product pixel values (DN)
A_p = Band-specific additive rescaling factor
ϑ_{SE} = Local sun elevation angle.

Beach type and beach width has been extracted from the land use land cover map which has utilized for finding the suitability of beach tourism.

The investigation of beach suitability is executed successfully to make sure the suitability of vicinity for the enrichment of coast area of beach tourism for recreation category. The calculation of Tourism Suitability Index (TSI) [9];

$$TSI = \sum \frac{N_i}{MR} X\ 100\%$$

Where,
TSI = Tourism Suitability Index (in %)
Ni = Each parameter
MR = Maximum rate of a tourism category

Ni = (Wi X Si)
Where,
Wi = Weight of the individual parameter
Si = Score of the individual parameter

Category X1 (Very Suitable) receives a score of 4, with a rate of 80 percent to 100 percent. With a rate of 60 percent to 80 percent, Category X2 (Adequate) receives a score of 3. Category X3 (Compatible with condition) receives a score of 2, with a rate of 40% to 60%. With a rate of 40%, Category X4 (Not Suitable) receives a score of one.

Coast tourism suitability is divided into four categories: Highly Suitable (S1), Quite Suitable (S2), Suitable with Conditions (S3), and Not Suitable (S4) (N). The following is the definition of these classes: X1 stands for "very suitable." This suitability class does not have a substantial boundary factor for a specific natural usage, or if it does, it must be minor or non-existent.

Quite Appropriate (Category X2). This suitability class has a high boundary factor for specific preservation-based uses. This border factor can influence tourism activity enjoyment and even profit, but it can also boost tourism activity input. Suitable with Condition (Category X3) There are more boundary factors to meet in this suitability class. These border elements can limit satisfaction, thus they must be brought into consideration throughout tourism activities to preserve ecosystem stability.

Not suitable (category X4) because this suitability class contains a truly heavy or permanent boundary factor, developing the natural tourism activity listed in Table 01 may be challenging.

Result and Discussion

The recreation Suitability of beach tourism of Coastal Area at Marina beach and Elliots beach has been performed using tourism suitability index with help of 8 (eight) parameters such as Land use land cover, sediments, erosion, accretion, Beach width, distance to bus stop, distance to railway station and beach type.

Land use land cover of the study place has been segregated into seven categories they are built up, Groynes (barrier of stones to check erosion), Vegetation, Water bodies, Sand feature, Open land and Industries shown in the Figure 2. The land use land cover at the marina beach and Elliot's beach is sand feature which indicates that both the beach getting the maximum score for suitability index shown in the Table 2.

The distance between the closest road on the beach and the beach boundary that is still under the vulnerability of sea water is used to calculate beach width [11].

The average beach width of the study area is 64.3 meters. The result shows that marina beach has the width of 213.8 meters and Elliot's beach has the width of 198 meters shown in the Figure 3 which are having maximum score shown in the Table 2. The clarity of Beach is still regulated by the commotion in the waters. On the basis of the satellite data, it is found that Average Sediment load of the study vicinity is 600 mg/L. The sediment load of the beach at marina is 600 mg/L, indicating a high clarity rate, as evidenced by the clean appearance of the waters base when viewed from the water surface. However, Elliot's beach has a little higher sediment load of 700 mg/L, as shown in Figure 2. Marina beach getting the maximum score whereas Elliot's beach getting lesser s score shown in the Table 2.

The type and color of sand give their own value to the aesthetics of the beach itself, where beaches with white sand are very popular for visitors [10]. Marina Beach and Elliots Beach are both sandy beaches (white sand) with distinct appearances (Figure 3). It is made up of loose elements like sand and silt (gravel). The beach's wave and current are the primary determinants of the beach's type since they constantly deposit sand (or other loose material) on the shore. Since both beaches having the beach type of white sand they are getting maximum score in measuring the tourism suitability shown in the Table 2.

Erosion will take away the sand on the beach which will reduce the beach width and eminence of the shore. Erosion of the research place has been measured with help of satellite images. On an average the considered study location has low level of erosion shown in the Figure 2. The erosion level of marina beach and Elliot's beach is low which indicates the maximum score for measuring the tourism suitability shown in the Table 2.

Accretion of the sea waves will accumulate the sand which will increase the beach width and excellence of the shore. The preponderance of the location in the study place has no accretion (Figure 2) but Marina beach and Elliot's beach has moderate level of accretion which is shown in the Table 2.

Table 1 The Matrix of the Suitability of Coast Area for Beach Tourism

Parameters	Weight	Category (X1)	Score	Category (X2)	Score	Category (X3)	Score	Category (X4)	Score	Maximum Score
LULC	3	Sand	4	Open Land	3	Vegetation	2	Built-Up, Industries, Gyrones	1	12
Beach Width (In Meters)	5	> 30	4	10-30	2	< 10	1	-	-	20
Suspended Sediment Load (In Mg/L)	3	< 600	4	600 - 800	2	> 800	1	-	-	12
Proximity to Bus Stop (In Meters)	5	< 500	4	500 - 1000	2		1	-	-	20
Proximity to Railway station (In Meters)	4	< 500	4	500 - 1000	2	> 1000	1	-	-	16
Erosion	3	No	4	Low	3	Moderate	2	High	1	12
Accretion	4	High	4	Moderate	3	Low	2	No	1	16
Beach Type	5	White Sand	4	Mud	2	Concrete, Stone	1	-	-	20
Total Score										128

Convenience of accessibility to the beach is most significant for the beach tourism. In common, marina beach and Elliot's beach have only two modes of accessibility at large they are public bus and railways. Average distance to bus stop in the research place is 756.6 meters. Distance from nearest bus stop to beach at marina is 361 meters whereas distance from nearest bus stop to Elliot's beach 442 meters. The average distance to railway station in the study place is 1119.2 meters shown in Figure 3. Distance from adjacent railway station to beach at Marina is 681.4 meters whereas distance from adjacent railway station to Elliot's beach is 2351 meters shown in the Table 2.

In an attempt to access the tourism suitability of the shores on account of accessibility, both Marina beach and Elliot's beach score maximum by means of bus transport whereas both beaches score less as far as accessibility is considered by means of rails.

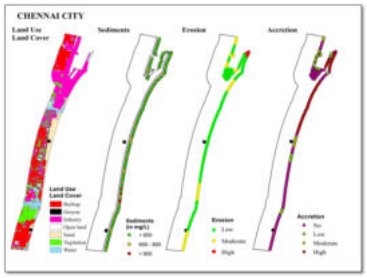

Figure 2: Responsible parameters for site suitability for Tourism part 1

The weight of the separate parameters and suitability score of each beaches based on the eight parameters has been combined in an attempt to derive the tourism suitability status of the Marina beach and Elliot's beach. The suitability score of the shore at marina and Elliot's beach is 113 and 103 respectively. The overall tourism suitability index for the Marina over and above Elliot's Beach is 88% and 80 % respectively. Marina beach out performed Elliot's beach in view of tourism suitability index which is shown in the Table 2, Figure 4 and Figure 5. Tourism suitability index has proved to be one among the significant methods to identify the appropriateness of beach tourism [16,17]. With the intention of forecast the competence of a certain beach, some studies also did the evaluation of the beach's carrying capacity [10,18].

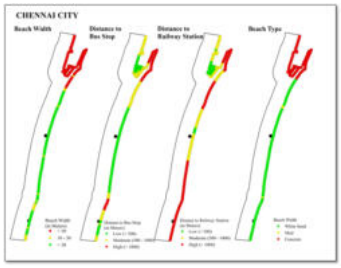

Figure 3: Responsible parameters for site suitability for Tourism part 2

Figure 4 Satellite view of Marina Beach (left) and Marina Beach (right)

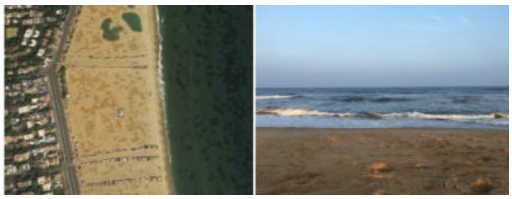

Figure 5 Satellite view of Elliot's Beach (left) and Elliot's Beach (right)

Table 2 The Matrix of the Suitability of Marina Beach and Elliot's Beach

Parameters	Weight	Marina Beach			Elliot's Beach		
		Category	Score	Maximum Score	Category	Score	Maximum Score
LULC	3	Sand	4	12	Sand	4	12
Beach Width	5	213.2 Meters	4	20	198 Meters	4	20
Suspended Sediment Load	3	600 mg/L	4	12	700 mg/L	2	6
Proximity to Bus Stop	5	361.4 Meters	4	20	442 meters	4	20
Proximity to Railway station	4	681.4 Meters	2	8	2351 meters	1	4
Erosion	3	Low	3	9	Low	3	9
Accretion	4	Moderate	3	12	Moderate	3	12
Beach Type	5	White Sand	4	20	White Sand	4	20
Total Score				113	Total Score		103

Limitation of the Study

The foremost limitation is non availability of data related to nearby marine species which is considered as the significant source to improve the beach water sports which will increase the suitability of the particular beach. In future the studies must be carried out with the aim to find the best spot of maximum beach suitability along the coast of Chennai. So that government can focus on that particular spot to develop beach to improve tourist economy.

Conclusion

Maintaining coastal symbiosis of the natural oceanic phenomena and human development is a first step in the urbanization of the world's coastlines. Though managing all the steps and processes that need to be considered when analyzing a new section of beach's potential for coastal structures, erosional and depositional models in from other sources and from areas with similar geomorphic and geographic attributes can help begin a new project. By understanding that physical phenomena that shape the coast, for instance sea water turbidity, beach erodobility, accretion, beach width, beach type, proximity to accessibility and land use, decisions can be more accurately determined and managed if construction is to be instituted. By analyzing these features using the tourism suitability index, different attributes can have varied importance reliant on the location and trends found there. Marina beach has high tourism suitability index as compared to Elliot's beach. By considering marina beach, all the eight parameters are deemed to be fine whereas Elliot's beach's accessibility is far. That is the main reason for lowering the tourism suitability. Government needs to advance the accessibility in respect of railway followed by bus transport in special reference to Elliot's beach.

Acknowledgement

Authors are thankful to USGS and Google earth pro for allow us to access the satellite images.

Conflict of Interests:

The authors say they have no competing interests..

REFERENCES

[1] Orams, M, "Marine tourism: development, impacts and management", Routledge, 2002.
[2] Bird ECF., "Beach Management",. Wiley, Chichester, 1996, 281p
[3] Blancas, F.J., González, M., Lozano-Oyola, M., & Pérez, F., "The assessment of sustainable tourism: Application to Spanish coastal destinations", Ecological indicators, vol. 10, no. 2, pp. 484-492, 2010. DOI: 10.1016/j.ecolind.2009.08.001
[4] Hall C.M., & S.J Page., "The geography of tourism and recreation: environmental, place and space", 4th ed, Routledge, 1999, pp. 1- 309.
[5] Leung, Y. F., Spenceley, A., Hvenegaard, G., & Buckley, R. "Tourism and visitor management in protected areas: Guidelines for sustainability," 1st ed, IUCN, Gland, Switzerland, 2018, pp. 1 - 96
[6] Alesheikh, A. A., Ghorbanali, A., & Nouri, N., "Coastline change detection using remote sensing", International Journal of Environmental Science & Technology, vol. 4, no. 1, pp. 61-66, 2007, DOI: 10.1007/BF03325962
[7] Kaliraj, S., Chandrasekar, N., & Magesh, N. S., "Evaluation of coastal erosion and accretion processes along the southwest coast of Kanyakumari, Tamil Nadu using geospatial techniques", Arabian Journal of Geosciences, vol. 8, no. 1, pp. 239-253, 2015. DOI: 10.1007/s12517-013-1216-7.
[8] Nassar, K., Mahmod, W. E., Fath, H., Masria, A., Nadaoka, K., & Negm, A., "Shoreline change detection using DSAS technique: Case of North Sinai coast, Egypt", Marine Georesources & Geotechnology, vol. 37, no. 1, pp. 81-95, 2019, DOI: 10.1080/1064119X.2018.1448912.
[9] Yulianda, F., Ekowisata Bahari sebagai Alternatif Pemanfaatan Sumberdaya Pesisir Berbasis Konservasi. FPIK IPB. Bogor. Disampaikan pada Seminar Sains 21 Februari (2007) pada Departemen Manajemen Sumberdaya Perairan.
[10] Fithor, A., Prayitno, S. B., Purwanti, F., & Indarjo, A., "Tourism suitability, and carrying capacity: prospect ecotourism (Case Study in Marina Beach Semarang)", E3S Web of Conferences, Nov., 2020, pp. 03010. DOI: 10.1051/e3sconf/202020203010
[11] Silva, C. D., Alves, F. L., & Rocha, R., "The management of beach carrying capacity: The case of northern Portugal", Journal of Coastal Research, pp. 135-139, 2007.URL: article.docx
[12] Mardiha Mokhtar , Muhammad Azri Fikri B. Ariffin , Mohd Effendi Daud , Masiri Kaamin , Mohamad Azim Mohammad Azmi , Nor Baizura Hamid, "Sediment Properties of Eroded Coastal Area at Batu Pahat, Johor, Malaysia", Environment and Ecology Research, vol. 10, no. 2, pp. 248 – 259, 2022. DOI: 10.13189/eer.2022.100214.
[13] Eneyo V. B. , Attah F. M. , Antai A. S. , Adie H. I. , Ochiche C. A., "Tourism Viability Status of Kwa Falls Ecotourism Site of Aningeje Rural Community, Cross River State, Nigeria", Environment and Ecology Research, vol. 10, no. 2, pp. 125 – 132, 2022. DOI: 10.13189/eer.2022.100202.
[14] Yuvaraj, R. M., & Dolui, B. "Statistical and machine intelligence based model for landslide susceptibility mapping of Nilgiri district in India", Environmental Challenges, vol. 5, 2021. DOI: 10.1016/j.envc.2021.100211
[15] Yuvaraj, R. M. "Assessment of Land Use/Land Cover and Its Dynamic Using Geospatial Techniques in Pudukkottai District of Tamil Nadu, India". Environment and Ecology Research, vol. 8, no. 4, pp. 85-99, 2020. DOI: 10.13189/eer.2020.080401
[16] Daniel A S. & Yosepus A H., "Analysis Of Hukurila Beach Tourism Land Suitability Hukurila Village South Leitimur Sub District Ambon City", International Journal of Advanced Research, vol. 8, pp. 1184-1194, 2020. DOI: 10.21474/IJAR01/10565.
[17] Budiasti, R. R., Suryanti, S., & Purnomo, P. W, "Tourism Suitability Analysis of Wediombo Beach, Gunungkidul Regency, Yogyakarta Special Region, Indonesia", Journal of Environmental and Agricultural Studies, vol. 3, no. 2, pp. 01-06, 2022. DOI: 10.32996/jeas.2022.3.2.1.
[18] Kelana, P. P, Pamungkas, W., & Arkham, M. N, "Beach recreation suitability and carrying capacity estimations for tourism development in Cianjur, West Java", In IOP Conference Series: Earth and Environmental Science, vol. 967, no. 1, pp. 012034, 2022. DOI: 10.1088/1755-1315/967/1/012034