



## Assessment of species diversity and topographic variability on beach dune complex of digha Sankarpur coastal tract, Purba Medinipur district, West Bengal, India

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### Abstract

Biodiversity monitoring is mainly focused on the awareness of the species diversity and habitat dynamism. Coastal habitats are extremely fragile and susceptible in this environment, so the study of vegetation ecology is desired to predict the responses of landscape ecological connectivity. Recently, several amazing frameworks have been projected for evaluating the conservation status of communities or ecosystems. Hence, the present study assimilates a transect method with the Shannon-Wiener Diversity Index (SWDI), Sorenson's Coefficient (SC) and Hierarchical Cluster Analysis (HCA) to establish the diversity of coastal habitats under topographic variability. A sample survey has been conducted on 75 grids (500 m×500 m) in three transects (Transect- A, B & C), each transect occupied 25 grids which are extended from the southern to northern direction across the shoreline of the study area. Transects have been delineated in three instantaneous sites (Mandarmani, Sankarpur and New Digha sector) based on diverse plant community and topographic variability. The study mainly identifies 106 types of plant species in 75 grids of three transects. Transect-B shows a very high value (4.29) of SWDI because the better abundance of species occurred by this transect rather than transect-A and C. Sorenson's Coefficient is 0.6885 and 0.7731 of AB, BC and AC transect respectively. The AC-transect occupied the common groups of species based on SC index value (0.7692) due to the topographic predictability. The Present study reveals the interrelationships between plant species and landform units and the study also analyzed the morphological characteristics with the landscape variability. These areas are inadequately susceptible to infrastructure development and contain high soil moisture and subsurface groundwater sources to progress the coastal habitats.

**Keywords:** normalized difference vegetation index (NDVI); digital elevation model (DEM); shannon-wiener diversity index (SWDI); sorenson's coefficient (SC) and hierarchical cluster analysis (HCA).

### Introduction

The native vegetation of coastal areas plays a significant role to stabilize the surface against wind erosion and provides habitat diversity for wildlife. So the protection of coastal vegetation is significant for the drawn-out shield of beachfront zones. It is not adequate to depict the patterns of species turnover at an ecotone territory, as a result of how species categories are reacting to the environment and the overall dissemination of these species along with the inclination (Noss, 1990; Heywood and Watson, 1995; Menon and Bawa, 1997; Turner *et al.*, 2003; Gross *et al.*, 2009) [18, 12, 16, 24, 11]. Coastal vegetation provides a barrier against coastal hazards such as landfall, storm surges, and tidal inundation during cyclonic events (Rao *et al.*, 2007) [20]. They also act as a source of sand to refill the beach during the phase of erosion. The soil of coastal areas has occurred in the absence of significant nutrients, deficient in water and accordingly very challenging for the floral community. Many plants have tailored capability in the callous coastal environment because of a serious transformation rehearses (Heywood and Watson, 1995; Gaston, 2000) [12, 10].

The hotspot of financial improvement incorporates reclamation, coastal tourism, marine aquaculture and pollutant emissions. Along with the rapid economic development in Digha coastal zones, the coastal population pressure gradually increases. Human excessively plunders biological resources and the abuse and deployment activities of open land are also exaggerated. (Chee, 2004; De Fries *et al.*, 2004; De Groot, 2006) [5, 7, 6]. The

lack of assets and disintegration of the ecological environment is getting increasingly serious, which mainly reflects the exorbitant recovery of tidal flats and wetlands. So the natural vegetation coverage and cultivated land are reduced because of rapid infrastructure development (Zonneveld, 1990; Bastian, 2001; Opdam *et al.*, 2001) [25, 1, 19]. Infrastructure development changes the pattern of cultivated land, forestland, wetland, and water surface etc. The balance of salt and sea aquaculture keeps on growing activities which prompts an expansion of environmental threat affectability and weakness in the coastal areas (Farley and Costanza, 2010; Leimona, 2011) [8, 14]. Moreover, the level of biological risk increments of the coastal areas reveals an assortment of hazards, for example, sea-level rise, seawater interruption, coastal flooding and waterlogging etc. caused by climate change activities (Redfern and Williams, 1996) [21]. In this way, it is essential to consider and to understand the environmental changes in Ramnagar coastal zone. Accordingly, the primary goal of this study is to investigate the advancement appearances of coastal ecology and association with the fringe environment in Ram nagar Province. The indigenous flora of the coastal region plays a significant function to improve the surface stability against erosion as well as natural extreme events. So the management of coastal floras is very much significant for the continuing strengthening of beach face possessions. Rapid urbanization depicts a large diminution of arable land,

annihilation of habitat, execution of species, and reduction of net primary productivity. Due to the rapid urbanization, the impact of human activities on the environment will unswervingly alter the unique land use pattern and cause the change of land use/land cover, thus intensely distressing the Earth's ecosystem.

### Materials and Methods

The present study deals with the transect method to assess the floral species diversity at the micro-level. Transects have been delineated in three significant sites of the study area such as Mandarmani, Sankarpur and New Digha sector based on the abundance of floral species and topographic variability. Floral communities are classified through the several image arithmetic operation considering with the spatiotemporal (March, 2018 and December, 2018) satellite (Sentinel MSI-2) imagery. Finally, the estimated band coefficient and Normalized Difference Vegetation Index (NDVI) are combined for the categorization of the vegetation types of the study area. The NDVI proportion is determined by partitioning the distinction between the near-infrared (NIR) and red bands for each pixel of the image (Rouse *et al.*, 1974). NDVI reflects the vegetation health and supervising the modification of vegetation character and it remains the most acquainted index to detect live green plant canopies in multispectral Remote Sensing data.

After delineation of these transects, rigorous fieldwork has been conducted to identify the species community and micro topographic units. High resolution interpolated Digital Elevation Model (DEM) and methodical fieldwork assisted to distinguish and validate the micro topographic units of the coastal area (Kamila *et al.*, 2020). Consequently, the present study comprises the Shannon Wiener Diversity Index, Sorenson's Coefficient and Hierarchical Cluster Analysis methods for understanding the richness, evenness and homogeneity of the plant ecology. SWDI is a diversity index to determine the species diversity of a community numerically. Diversity indices bear the cost of supplementary information about community composition (specifically species richness). The HCA process endeavors to recognize comparatively homogeneous groups of cases (or variables) based on preferred individuality.

### Study Area

The studied coastal tract is characterized by sand dunes, longshore currents, major river emancipations, less turbid but high saline seawater influence, the cusped delta of the Jaldha river and neo-tectonic depressions in the north direction. The area is mostly covered by sandy clay and silty loam soils which are developed under a brackish environment and this type of soil has a high water retaining capacity (Fig. 1).

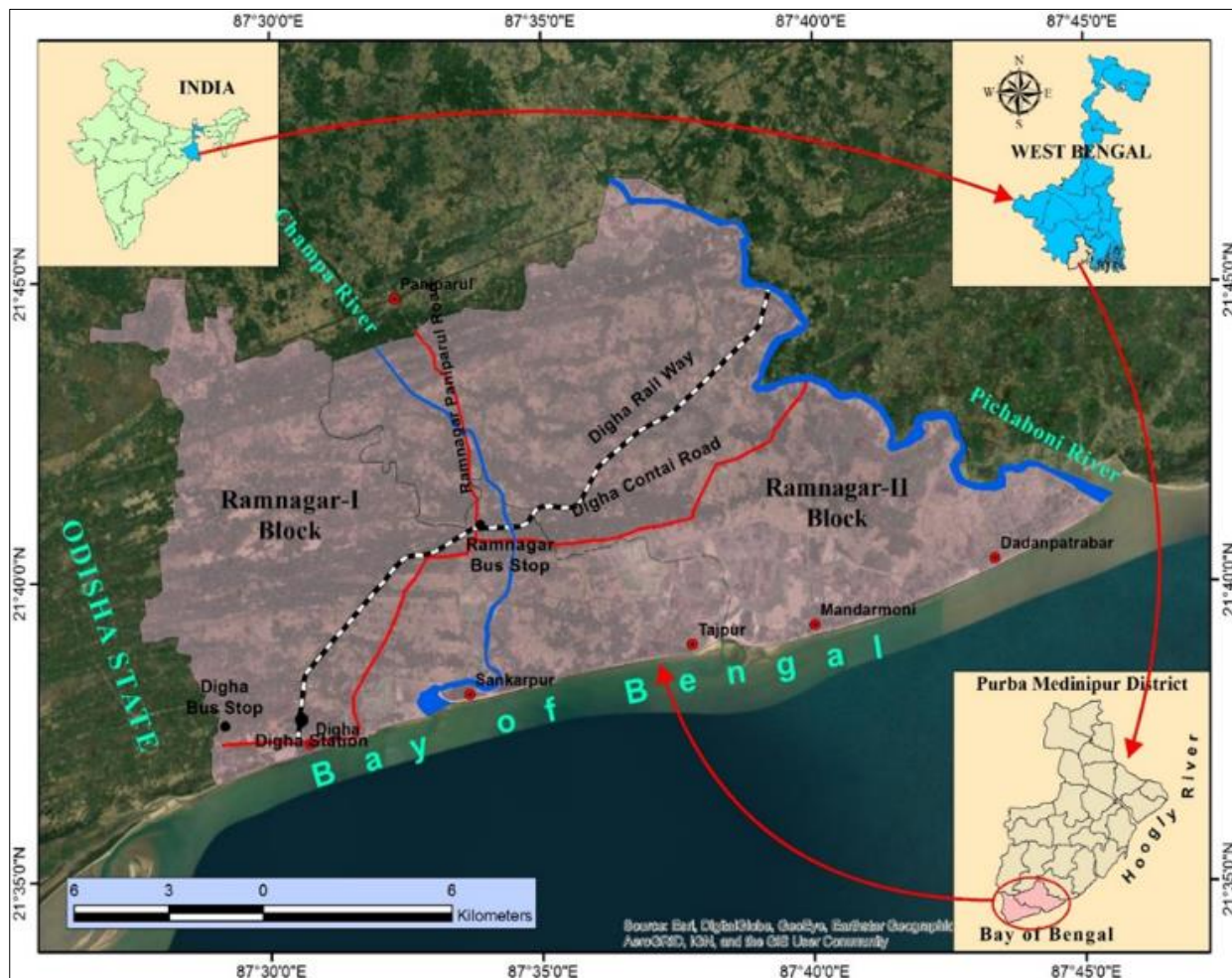


Fig 1: Location map of the study area.

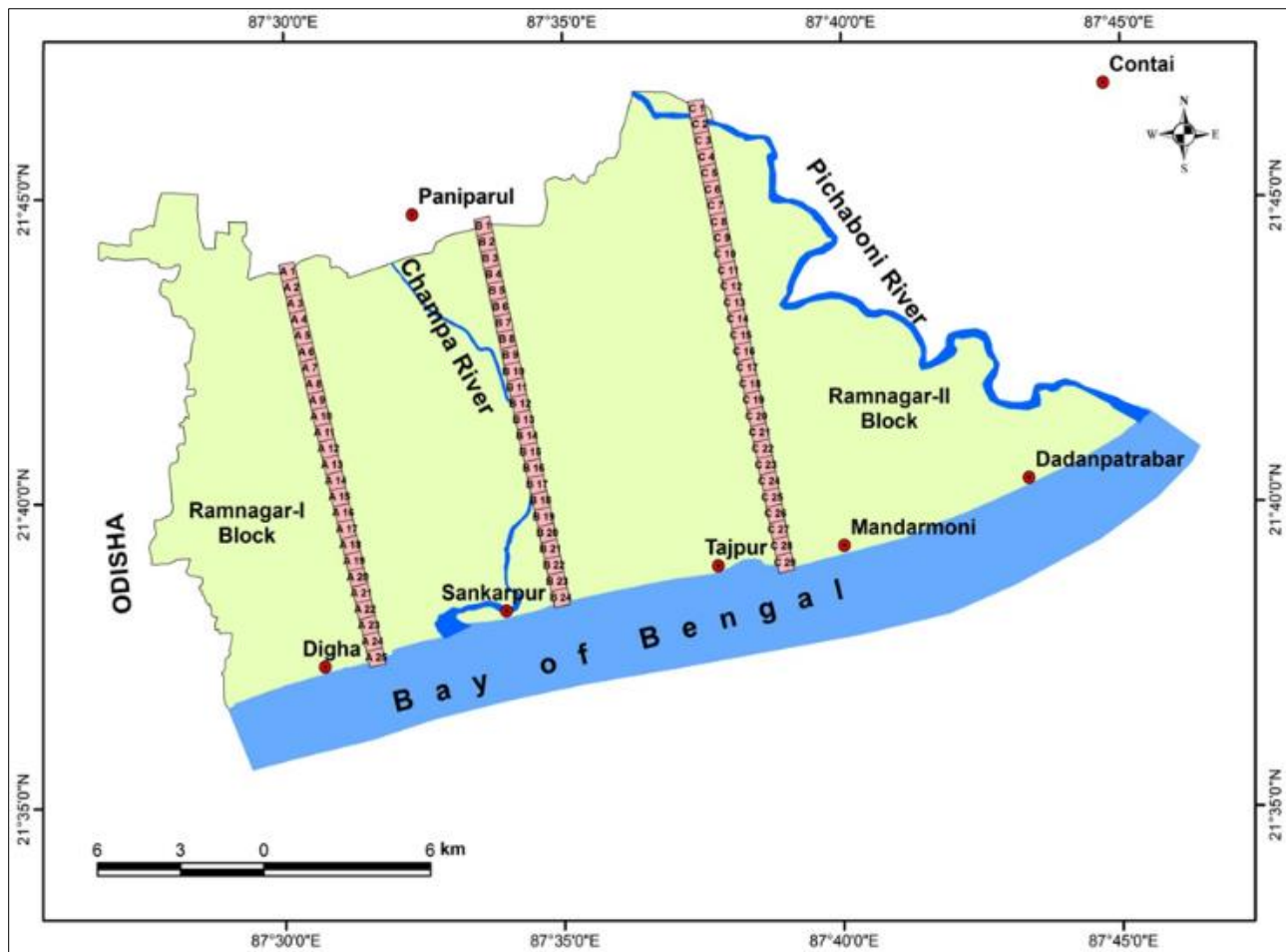
Climatic variability of the study area is very emblematic among Monsoon and Pre-Monsoon seasons. The temperature differs from 9° C (least) in winter to 38° C (greatest) in summer. Relative stickiness ranges between 90%–96% and low atmospheric pressure is found throughout the summer and Monsoon period and wind dominantly blows from offshore areas. There is no extensive forest land in the study area and natural vegetation, so the study area primarily consists of grasses (e.g., *Sesuvium portolacrastum* and *Ipomoea bioloba*) and herbs (e.g., *Lantana camara*, *Acanthaceae* sp, and *Calotropis gigantea*). Trees like casuarinas, eucalyptus

and *Acacia auriculiformis* have been planted in this area, while coconut, banana, bamboo and mango are indigenous floral species.

**Results and Discussions**

**Delineation of the Transects**

The present study deals with the sample survey method including 75 grids (each grid considered in 500 m × 500 m) of three transects. Each transect has 25 grids and every single transect is extended from the southernmost point to the northern point of the study area (Fig. 2).



**Fig. 2:** Sample survey grid of delineated three transects (A, B and C).

Based on the extensive investigation of every grid (500 m × 500 m), it is documented that 40 types of floral species are present in

the transect-A; 44 types of species are present in transect-B and transect-C have 23 types of plant species (Tables 1, 2, 3).

**Table 1:** Types of dominant species and micro topographic units of Transect-A (November, 2018).

Grid No.	Landscape units	Species types
A 1	Inner coastal plain surface	15
A 2	Inner coastal plain surface with beach ridge slope	21
A 3	Beach ridge surface with narrow swale valley	13
A 4	Beach ridge surface	23
A 5	Beach ridge fringed coastal plain surface	32
A 6	Inner coastal plain surface	32
A 7	Inner coastal plain surface with narrow beach ridge segment	33
A 8	Inner coastal plain surface with narrow beach ridge segment	27
A 9	Inner coastal plain dominated by beach ridge surface	28
A 10	Inner coastal plain dominated by beach ridge surface	21

A 11	Inner coastal plain surface with beach ridge remnant surface	21
A 12	Inner coastal plain surface with beach ridge slope	18
A 13	Beach ridge surface	31
A 14	Beach ridge surface	26
A 15	Beach ridge separated by swale valley	40
A 16	Beach ridge surface	36
A 17	Inner coastal plain surface	34
A 18	Inner coastal plain surface	29
A 19	Inner coastal plain surface with levee bank	31
A 20	Inner coastal plain surface	31
A 21	Inner coastal plain surface with levee bank	20
A 22	Inner coastal plain surface with beach ridge remnant	28
A 23	Inner coastal plain surface with beach ridge and modified wetland remnant	33
A 24	Backshore beach ridge surface	20
A 25	Foreshore beach dune landscape	09
Each grid is considered 500 m × 500 m = 2,50,000 m <sup>2</sup> (0.25 km <sup>2</sup> )		

**Table 2:** Types of dominant species and micro topographic units of Transect-B (November, 2018).

Grid No.	Landscape units	Species types
B 1	Beach ridge landscape	13
B 2	Beach ridge landscape	25
B 3	Beach ridge with swale topography	28
B 4	Inner coastal plain with beach ridges	17
B 5	Inner coastal plain surface	20
B 6	Inner coastal plain surface with older levee bank	29
B 7	Inner coastal plain surface with older levee bank	36
B 8	Inner coastal plain surface with older levee bank	43
B 9	Inner coastal plain surface on the bank of Champa river	44
B 10	Inner coastal plain with levees bank	22
B 11	Inner coastal plain with levees bank	26
B 12	Inner coastal plain with Champa river	27
B 13	Inner coastal plain with Champa river	22
B 14	Inner coastal plain surface with beach ridge slope and Champa river course	27
B 15	Inner coastal plain with beach ridge surface and Champa river course	35
B 16	Inner coastal plain with beach ridge surface and Champa river course	09
B 17	Inner coastal plain with beach ridge surface and Champa river course	05
B 18	Inner coastal plain surface on the bank of Champa river course	11
B 19	Inner coastal plain surface with older levee ridge	19
B 20	Inner coastal plain surface with older levee ridge	13
B 21	Inner coastal plain surface	14
B 22	Inner coastal plain surface	12
B 23	Backshore low land surface	13
B 24	Foreshore dune landscape	18
Each grid is considered 500 m × 500 m = 2,50,000 m <sup>2</sup> (0.25 km <sup>2</sup> )		

**Table 3:** Types of dominant species and micro topographic units of Transect-C (November, 2018).

Grid No.	Landscape units	Species types
C 1	Inner coastal plain surface	NA
C 2	Inner coastal plain surface	NA
C 3	Beach ridge fringed coastal plain	23
C 4	Beach ridge	22
C 5	Beach ridge	08
C 6	Southern beach ridge slope	14
C 7	Inner coastal plain with older levee	11
C 8	Inner coastal plain with older levee	15
C 9	Inner coastal plain with older levee	17
C 10	Inner coastal plain with older levee	16
C 11	Inner coastal plain with older levee	09
C 12	Inner coastal plain	09
C 13	Inner coastal plain	13
C 14	Inner coastal plain	15
C 15	Inner coastal plain with abandoned channel with beach ridge remnant surface	18

C 16	Inner coastal plain with beach ridge remnant surface	19
C 17	Inner coastal plain with abandoned creeks	21
C 18	Inner coastal plain with active tidal channel surface	10
C 19	Inner coastal plain with active tidal channel surface	06
C 20	Inner coastal plain with active tidal channel surface	21
C 21	Inner coastal plain with tidal channel across beach ridges	21
C 22	Inner coastal plain with tidal channel across beach ridges	NA
C 23	Modified wetlands with abandoned salt pan and fisheries	NA
C 24	Modified wetlands with abandoned salt pan and fisheries	NA
C 25	Modified wetlands with abandoned salt pan and fisheries	NA
C 26	Modified wetlands with abandoned salt pan and fisheries	NA
C 27	Back shore dunes and wetlands	15
C 28	Back shore dune landscape	13
C 29	Foreshore beach dune landscape	10
Each grid is considered 500 m × 500 m = 2,50,000 m <sup>2</sup> (0.25 km <sup>2</sup> )		

On the other hand, the micro zonation of topography (according to the elevations) and geomorphological attributes of the landscape are identified through the high-resolution DEM and occurrence of geomorphic signature of the field. Simultaneously,

the interrelationship between species diversity and landscape characteristics has been depicted to establish the ecological connectivity of the coastal track (Fig. 3).

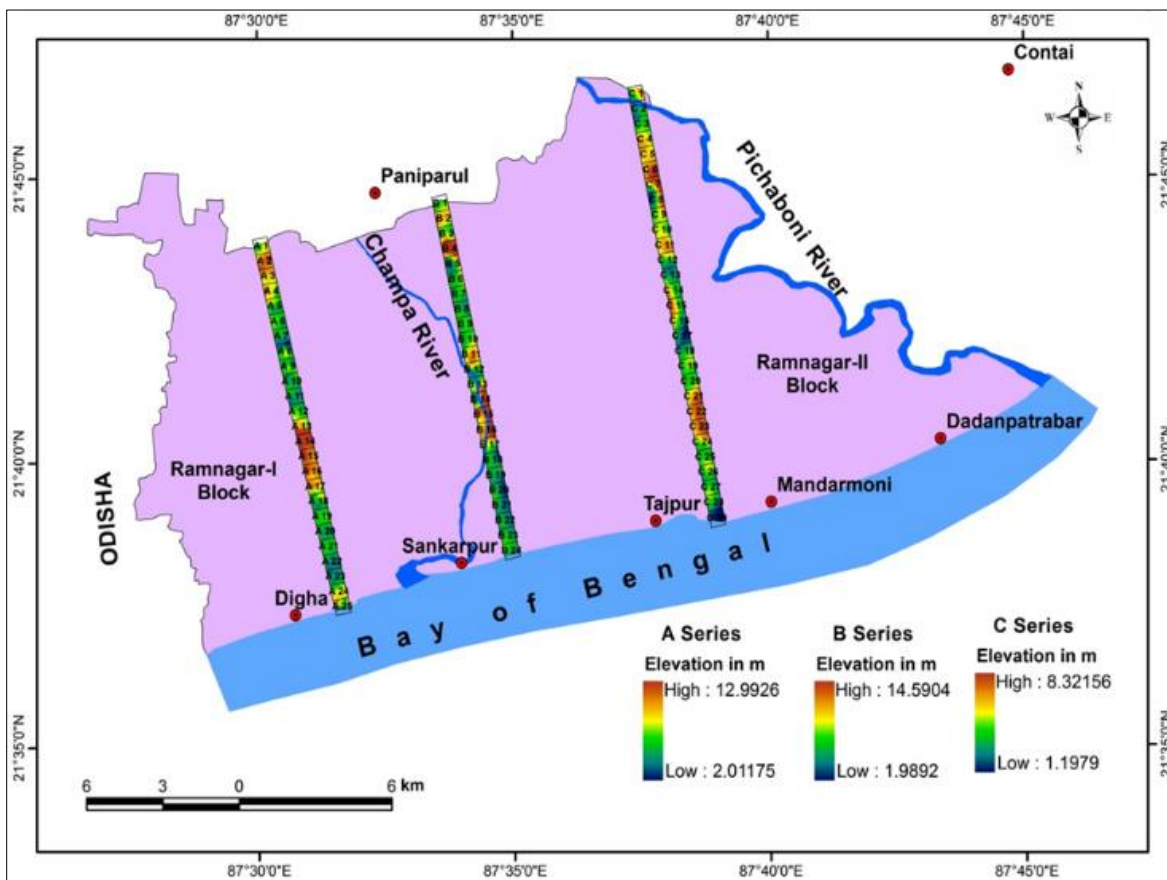


Fig 3: Grid-wise altitudinal variation of Transect A, B and C.

**Normalized Difference Vegetation Index**

NDVI is a condition that contains the sum of energy reflected in the infrared region by the plants. The green plants absorb sunlight for photosynthesis.

Thus, the NDVI is legitimately identified with catching the signature of vegetation health. Apart from that, the vegetation reflects the energy very well in the near-infrared region of the electromagnetic spectrum (Rouse *et al.*, 1974). Green leaves have a reflectance of 20% or less in the 0.5 to 0.7 micrometer ( $\mu$ )

extend (green to red) and about 60% in the 0.7 to 1.3 micrometer ( $\mu$ ) range (close infrared) of the electromagnetic range.

This reflectance is proportioned between themselves which reflected over the approaching radiation in each phantom band separately along these lines, they take esteems somewhere in the range of 0.0 and 1.0. In this manner, the NDVI value shifts between - 1.0 and +1.0 however, the negative estimations of NDVI (values drawing closer to - 1) show the deepwater portion of the surface.

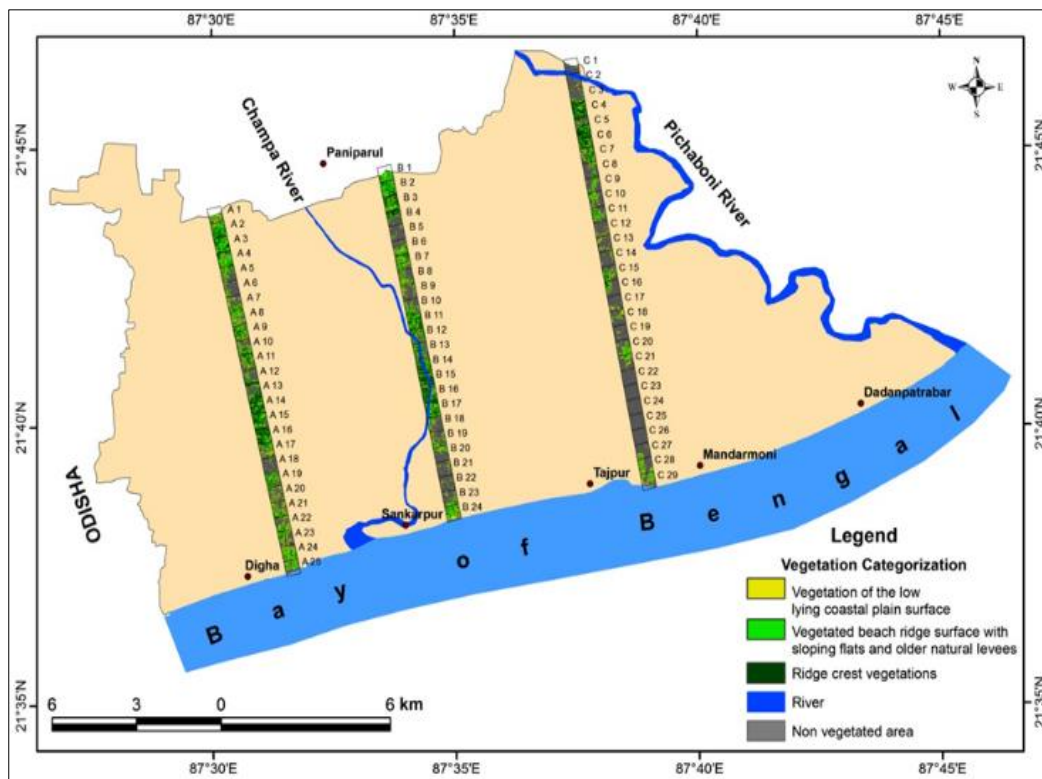


Fig 4: Transect wise vegetation classification with topographic character.

When the value near zero (- 0.1 to 0.1) it speaks to the desolate rock, sand and snow zones. Low and positive qualities speak to bramble and grassland (around 0.2 to 0.4), while high qualities demonstrate calm and tropical rainforests (values moving toward 1). The average scope of significant worth is about - 0.1 (for a not green region) to 0.6 (for a green region) of this specific zone. Grid-wise vegetation is categorized into three transects such as

vegetation of the low lying coastal plain surface (30 km<sup>2</sup>), vegetated beach ridge surface with sloping flats and older natural levees (48 km<sup>2</sup>) and ridge crest vegetations (53 km<sup>2</sup>) through the integrated NDVI technique. Such a minute categorization of the floral species is alienated through the spectral response of different groups of species in each grid (Fig. 4).

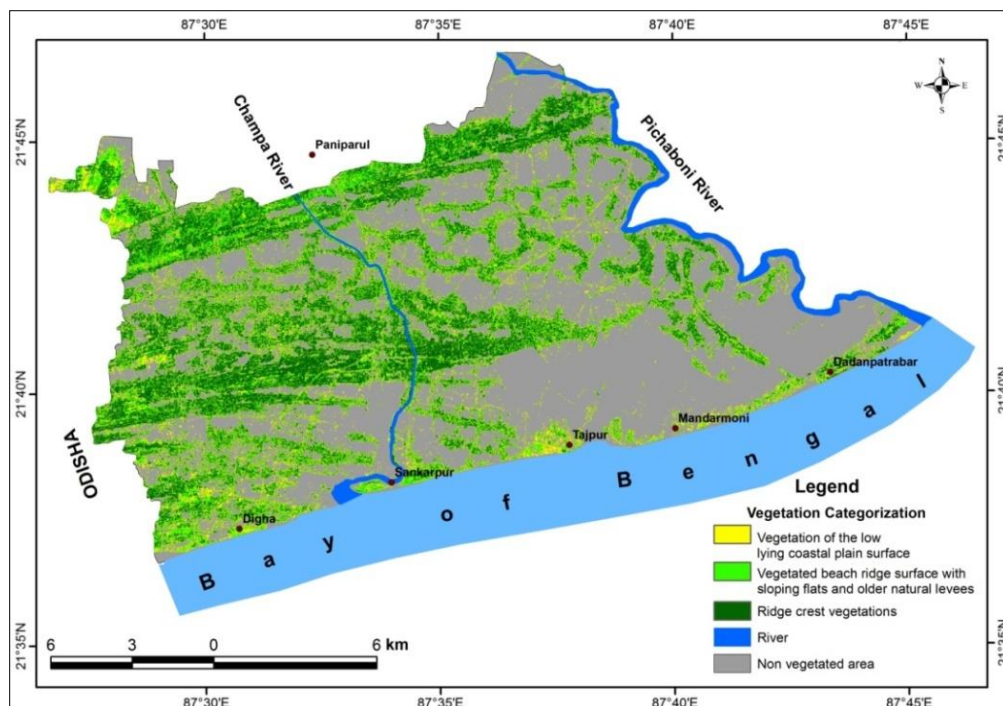


Fig 5: Overall scenario of vegetation types with different topographic units.

With the help of this infinitesimal grid wise floral species classification through NDVI, the study has been prepared a spatial zonation map of the species by spreading out the concern signature in the plants to the entire study area. On the other hand, the classification map of the transect reflects the actual scenario of the plant community of the study area (Fig. 5). However, the Sentinel image gives a better resolution than other open-source images, so the distributions of the vegetation are well matched of this region.

**Species Diversity and Community Similarity**

The diversity index is worried about the inconsistency and regularity of species in a community. This method has a critical mechanism for biologists to identify the variety and know community structure. This is the most widely utilized diversity index in the ecological literature (Begon *et al.*, 1996) [2]. The Shannon-Winer Diversity Index (H) is an exceptional index that is classically used to segregate species diversity in a community. Like Simpson's index and Shannon's index represents both abundance and consistency of the species present. The quantity of species 'i' comparative with the aggregate sum of species (pi) is considered, and afterward imitated by the typical logarithm of this segment (ln pi). The considerable outcome is added across species and multiplied by -1 (Magurran, 1988) [15].

$$\text{Shannon Diversity Index (H)} = \sum_{i=1}^s p_i \ln p_i$$

Where,

H= Shannon-Wiener diversity index

S= Total number of species in the community (richness)

Pi = The proportion of S made up of the i<sup>th</sup> species

Ln= The natural logarithm.

The Shannon index is exaggerated by both the number of species and their impartiality or consistency.

An unbeatable amount of species varieties and an extra even dispersion of both expand variety is determined by H. Shannon's equitability (E<sub>H</sub>) can be proposed by dividing H by H<sub>max</sub> (here H<sub>max</sub> = ln(S)). The most noteworthy variety (H<sub>max</sub>) of a sample is set up when all species are consistently over-the-top. Equitability accepts an incentive somewhere in the range of 0 and 1 with 1 being outright consistency.

We can discriminate the actual diversity value to the exceptionally plausible diversity using an assurance which is called evenness. The evenness of the sample is determined from the equation (Rosenzweig, 1995):

$$\text{Evenness (EH)} = \frac{H}{H_{max}}$$

Where,

H = Shannon-Wiener diversity index

H<sub>max</sub> = The Maximum Diversity [ln(S)]

S = Total number of species.

The community similarity index comforts to determine the transect wise relationship of species. Sorenson's Coefficient provides a value between 0 and 1. In this context, the value close to 1 speaks to more communities. Although the absolute community assortment is equivalent to 1 and outright community dissimilarity is equivalent to 0.

$$\text{Sorenson's Coefficient (CC)} = \frac{2C}{S1 + S2}$$

Where C is the number of common species of two communities, S1 is the total number of species of community 1, and S2 is the total number of species of community 2.

Sorenson's Coefficient (CC) values are consecutively 0.769230, 0.688524 and 0.773109 between transect-A and B, transect-B and C and transect A and C.

**Species Richness and Evenness**

Richness is the presence of the species per sampling site. The more species present in a sample, the more affluent the sample. It gives generous weight to those species which have very little and proportion of individuals.

Evenness is a proportion of the universal abundance of the different species which is making the richness of the vicinity.

The SWDI index is calculated for evaluating the richness and evenness of the sampled plants which characterizes the species diversity in a community and Sorenson's Coefficient computes the community similarities of the study area (Table 4).

**Table 4:** Species diversity estimation through Shannon Weiner Diversity Index.

Transect	Shannon Diversity Index (H)	The maximum diversity (H <sub>max</sub> )	Evenness (EH)	Sorenson's Coefficient
Transect - A	4.0067	4.2484	0.9430	AB = 0.7692
Transect - B	3.9341	4.2904	0.9169	BC = 0.6885
Transect - C	3.5700	3.8918	0.9173	AC = 0.7731

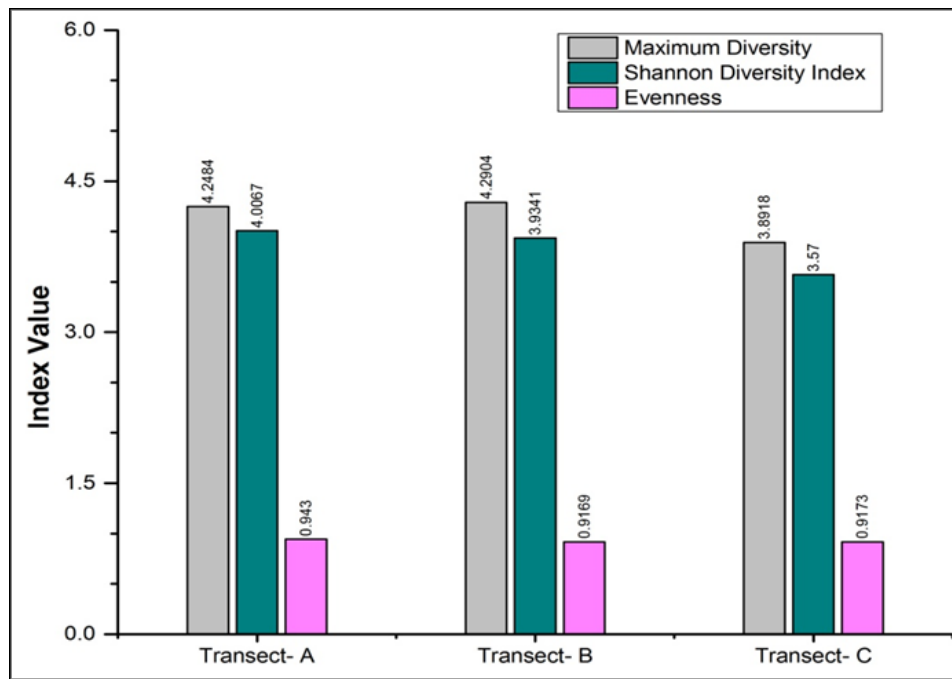


Fig 6: Comparative assessment of three transects.

The value of the SWDI index is 4.00, 3.93 and 3.57 for transect- A, B and C, consequently the evenness value is 0.94, 0.91 and 9.00 for transect- A, B and C. Hence, the vegetation richness and evenness is higher in transect- A and B than C (Fig. 6).

**Hierarchical Cluster Analysis**

**Single Linkage**

Single linkage indicates the contiguous neighbor or a fundamental technique for clustering. This strategy depicts the separation between two groups as the base separation found between one case from the primary cluster and another case from the subsequent cluster. (Florek, 1951)<sup>[9]</sup>. This strategy will first develop a case processing summary (first table) which records the character of relevant cases based on the number of missing cases and the separation (i.e., the Squared Euclidean Distance) contrast of preferred experiments. The proximity matrix is the second table of this method. The matrix records the squared Euclidean distance that was considered between all sets of cases in the underlying advance of the clustering process. The proximity matrix is a compact variant matrix that exhibits the remoteness

between cases, where the minimum squared Euclidean distance (roughly .000) to be joined reciprocally to the first two cases (Blei and Lafferty, 2009)<sup>[3]</sup>.

**Agglomeration Schedule**

It illustrates how the cluster analysis expanded the group of cases. Each track in the program shows a stage that is commonly shaped like a cluster of two cases, utilizing a calculation communicated by the separation and linkage decision.

The agglomeration platform records all the stages however, the clusters have consistently composed the cases until there is just one group remarkable after the last stage. The coefficients of each one stage represent the distance of the two clusters (Norusis and Inc, 2010)<sup>[17]</sup>.

The principle of the agglomeration schedule is to help the examiner for observing in what position of two clusters being merged and estimated too various to even consider forming a homogeneous group which is proven by the underlying increase value of the coefficient (Tables 5, 6, 7).

Table 5: Results of Hierarchical Cluster Analysis of Transect- A.

Case processing summary									
Cases									
Valid		Missing			Total				
N	Percent	N	Percent	N	Percent				
9	20.9	34	79.1	43	100.0				
a. Single Linkage									
Proximity matrix									
Case	Squared Euclidean Distance								
	1:Class1	2:Class 2	3:Class 3	4:Class 4	5:Class 5	6:Class 6	7:Class 7	8:Class 8	9:Class 9
1:Class1	.000	8113.00	29988.00	15044.00	11053.00	9868.00	35629.00	22616.00	27841.00
2:Class2	8113.00	.000	27577.00	5355.00	15928.00	4353.00	31270.00	31183.00	32168.00
3:Class3	29988.00	27577.00	.000	27150.00	14853.00	27730.00	37629.00	52998.00	33251.00
4:Class4	15044.00	5355.00	27150.00	.000	21375.00	7226.00	36749.00	44608.00	34421.00
5:Class5	11053.00	15928.00	14853.00	21375.00	.000	13547.00	30468.00	37175.00	33750.00

6:Class6	9868.00	4353.00	27730.00	7226.00	13547.00	.000	30623.00	27996.00	36709.00
7:Class7	35629.00	31270.00	37629.00	36749.00	30468.00	30623.00	.000	23287.00	18404.00
8:Class8	22616.00	31183.00	52998.00	44608.00	37175.00	27996.00	23287.00	.000	31667.00
9:Class9	27841.00	32168.00	33251.00	34421.00	33750.00	36709.00	18404.00	31667.00	.000
This is a dissimilarity matrix									
Agglomeration schedule									
Stage	Cluster combined		Coefficients	Stage cluster first appears		Next stage			
	Cluster 1	Cluster 2		Cluster 1	Cluster 2				
1	2	6	4353.00	0	0	2			
2	2	4	5355.00	1	0	3			
3	1	2	8113.00	0	2	4			
4	1	5	11053.00	3	0	5			
5	1	3	14853.00	4	0	7			
6	7	9	18404.00	0	0	8			
7	1	8	22616.00	5	0	8			
8	1	7	23287.00	7	6	0			

**Table 6:** Results of Hierarchical Cluster Analysis of Transect- B.

Case processing summary						
Cases						
Valid		Missing		Total		
N	Percent	N	Percent	N	Percent	
5	3.7	131	96.3	136	100.0	
a. Single Linkage						
Proximity matrix						
Case	Squared Euclidean Distance					
	1:Class 1	2:Class 2	3:Class 3	4:Class 4	5:Class 5	
1:Class1	.000	11882.000	24001.00	15241.00	43232.00	
2:Class2	11882.00	.000	12005.00	25655.00	37954.00	
3:Class3	24001.00	12005.00	.000	19272.00	28063.00	
4:Class4	15241.00	25655.00	19272.00	.000	30067.00	
5:Class5	43232.00	37954.00	28063.00	30067.00	.000	
This is a dissimilarity matrix						
Agglomeration schedule						
Stage	Cluster combined		Coefficients	Stage cluster first appears		Next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	1	2	11882.00	0	0	2
2	1	3	12005.00	1	0	3
3	1	4	15241.00	2	0	4
4	1	5	28063.00	3	0	0

**Table 7:** Results of Hierarchical Cluster Analysis of Transect- C.

Case processing summary						
Cases						
Valid		Missing		Total		
N	Percent	N	Percent	N	Percent	
6	26.1	17	73.9	23	100.0	
a. Single Linkage						
Proximity matrix						
Case	Squared Euclidean Distance					
	1:Class 1	2:Class 2	3:Class 3	4:Class 4	5:Class 5	6:Class 6
1:Class1	.000	16033.00	11111.00	3974.00	6443.00	10621.00
2:Class2	16033.00	.000	20434.00	14595.00	20162.00	26468.00
3:Class3	11111.00	20434.00	.000	11463.00	14538.00	17426.00
4:Class4	3974.00	14595.00	11463.00	.000	7109.00	9111.00
5:Class5	6443.00	20162.00	14538.00	7109.00	.000	2350.00
6:Class6	10621.00	26468.00	17426.00	9111.00	2350.00	.000
This is a dissimilarity matrix						
Agglomeration schedule						
Stage	Cluster combined		Coefficients	Stage cluster first appears		Next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	5	6	2350.00	0	0	3

2	1	4	3974.00	0	0	3
3	1	5	6443.00	2	1	4
4	1	3	11111.00	3	0	5
5	1	2	14595.00	4	0	0

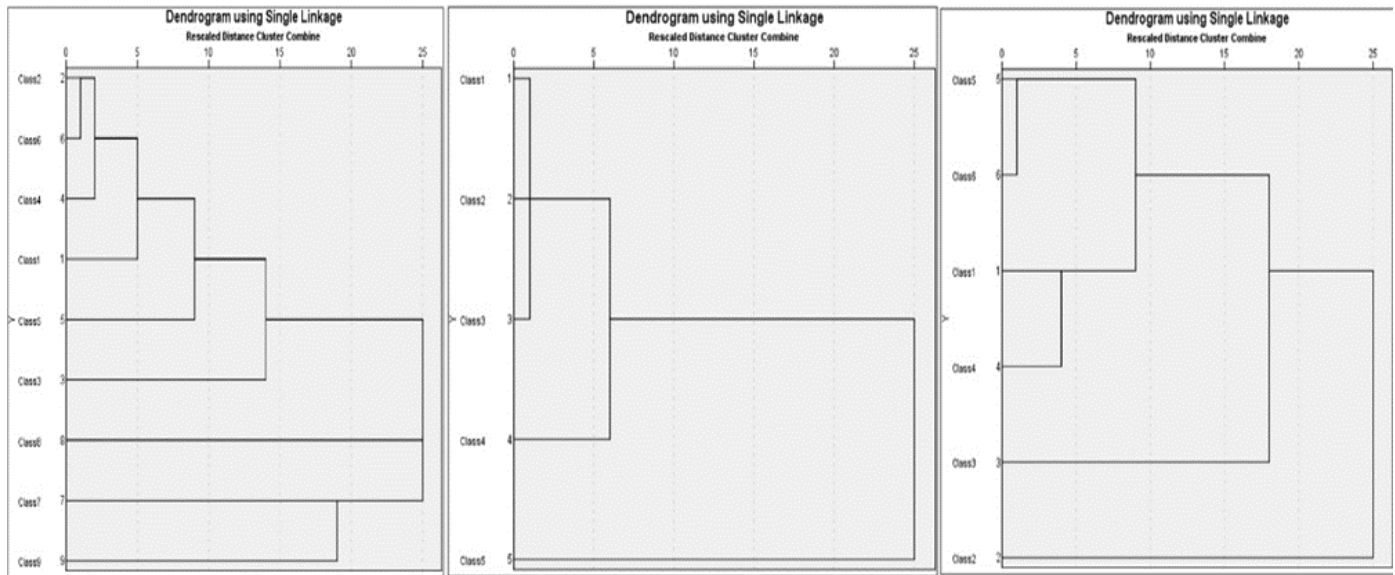


Fig 7: Dendrogram with single linkage of Transect-A, B & C (left to right).

As pointed out earlier, HCA is the best-exhibited grouping cycle with a dendrogram. The right sidelines in the dendrogram lie parallel to the grouping of clusters or the stages of the agglomeration schedule. They additionally demand attention to the distance between two amalgamation clusters (as characterized by the x-axis, situated above the plot). As the clusters being merged, the upstanding lines will be arranged beyond the right side of the plot. They represent a better distance of values and become more heterogeneous. While the upstanding lines are examined the distance between clusters then the horizontal lines indicate the discrepancy of these distances (Fig. 7). The horizontal lines additionally tag on all cases, there is a significant

fraction of one cluster while deciding a definitive number of clusters after the terminating decision is completed (Brereton, 1992) [4].

**Icicle Plot**

The icicle plot shows the comparability between the two cases. The icicle plot is more clear when examining it from the base to the top. Every one of the dark grey bars in the plot represents one case. However, it is significant to note the vicinities between cases and when they become in the shade. Where the space between the two cases becomes shaded that signifies the cases were connected equally (Fig. 8).

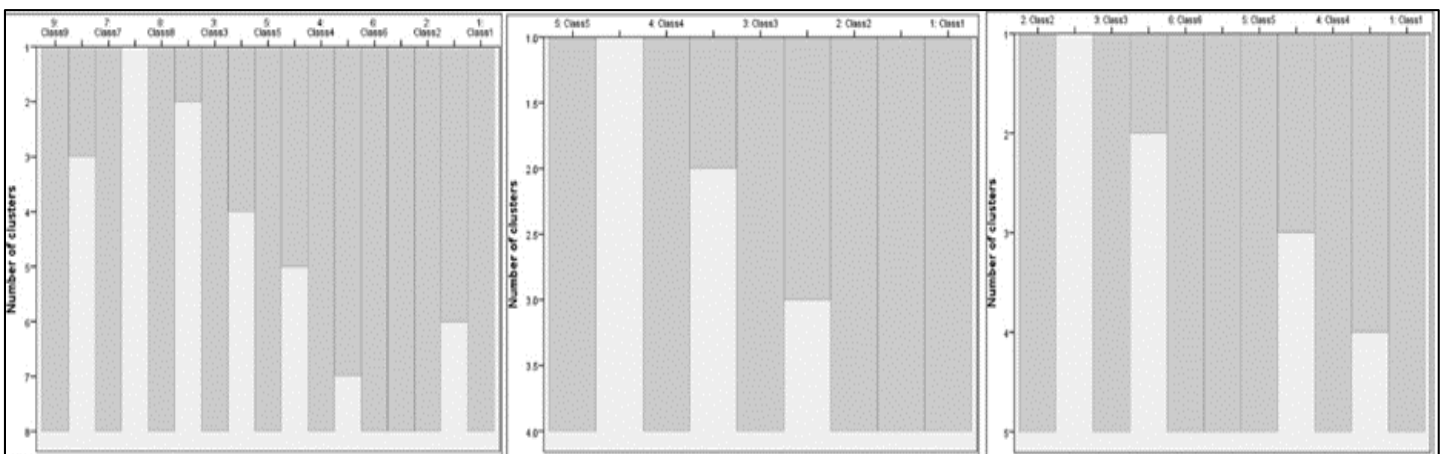


Fig 8: Icicle plot of Transect-A, B & C (left to right) to exhibits similarity between two cases.

The maximum horizontal lines describe the significant contrasts. Subsequently, an extended horizontal line assigns two clusters (which are unlike each other) which are joined and distinguish to stop the clustering process. Comparable to the agglomeration

Schedule, on the off chance of the upstanding and horizontal lines are closed to each other. At that point, this would suggest that the power of homogeneity of the groups amalgamated at those stages which are comparatively stable.

## Conclusion

The study reveals that the maximum diversity of vegetation is found in the transect-B (4.29) in comparison to the other two transects, whereas transect-A shows a very high Shannon diversity index (4.00). However, transect-A denotes a very high evenness character than the other two transects. The Sorenson's Coefficient is estimated at 0.7692, 0.6885 and 0.7731 for the AB, BC and AC transect respectively, which indicates the presence of species communities are common in the AC transect. The HCA result shows that the vegetation belongs to relatively homogeneous groups of species communities. In this study, transect-B has carried out more heterogeneous characteristics than the other two transects. Accordingly, transect-A and C denote the consistency of the clustering pattern of the species. Based on these assessments, the present study reveals that the habitat dynamism is very high in the beach ridge, beach ridge fringed coastal plain surface, swale topography, inner coastal plain with abandoned creeks and older natural levee bank surfaces. The study reflects there is a strong relationship between vegetations and the nature of coastal alluviums with marine and tidal influences. The coastal sand dunes and ancient beach ridges also act as the physical barriers and recharged rainwater reservoirs which can support the specific habitats for the coastal belt. The modern rate of shoreline recession and repeated tidal waves or storms may not destabilize the healthier sand dunes with densely vegetated covers, for which the settlements lying behind the physical barriers will be protected from advancing tidal waves and storm surge waters. Finally, these sensitive areas should be promoted for the extension of their physical and ecological functions along with the dynamic shoreline behavior at present.

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