Chapter – III

Species Diversity under the Topographic Variability

3.1 Relevance

The indigenous flora in coastal region plays a significant function in alleviates the face against erosion through natural extreme event and also afford habitat for flora and fauna. Coastal sand dunes provide with a barrier against coastal extreme events such as landfall, storm surges, and tidal inundation during cyclonic events (Rao et al., 1984). They also act as a source of sand to replenish the beach during phase of erosion. So the management of coastal floras is very much significant for the continuing fortification of beach face possessions. The soils in coastal areas are generally lacking in most significant nutrients, exceedingly brackish and generally deficient in water and accordingly are very unforgiving on flora. Many plants have tailored and grow in the callous coastal environment due to quite a lot of continuous adaptation practices.

Floristic multiplicity refers to the diversity and inconsistency of flora in a studied region. The climatic and altitudinal gradient has resulted in a diversity of flora categories under micro geomorphological component of the delicate coastal setting. Coastal habitations are exceptionally delicate and vulnerable to human activities accordingly studies of vegetation ecology are much more significant to predict the responses regarding landscape monitoring. This present study has been carried out regarding the floral species distribution and diversity at Ramnagar-I and Ramnagar-II coastal Administrative Blocks.

3.2 Delineation of the Transects

To consider the floral species diversity under the different topographic variability present study deals with the transect method. During the field observation Present study deals with sample survey process at 75 grids (each grid considered in 500 m × 500 m) into three transects, having 25 grids for each transect extending from southern most point to northern point of the study area (Fig. 3.1). The Transects have also been traced in three sites near Jaldah Mohana, near Tajpur and Old Digha according to the compact vegetation diversity of floral species.

After delineation of these three transects rigorous field has been conducted to identify the species and accordingly present study comprises with Shannon Diversity Index method, Sorenson’s Coefficient method and Hierarchical Cluster Analysis (HCA) method for understanding the species richness, evenness and homogenization of the plant ecology .

On the other hand by using the high resolution DEM researcher recognized the micro zonation of topography according to the elevation attributes of landscape. Simultaneously relation between species diversity and landscape characterizes have also been considered.

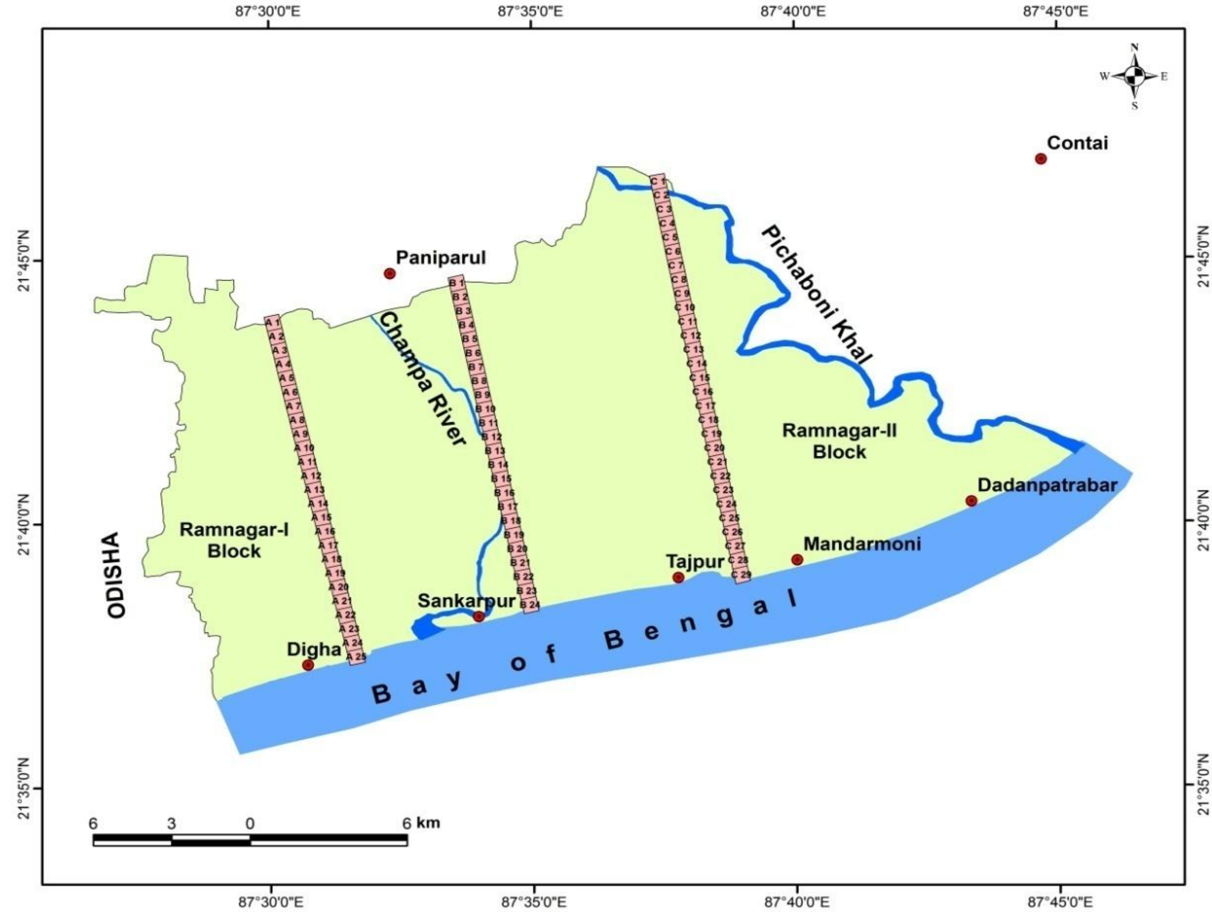

Fig. 3.1: Sample survey grid of delineated three transects (A, B and C).

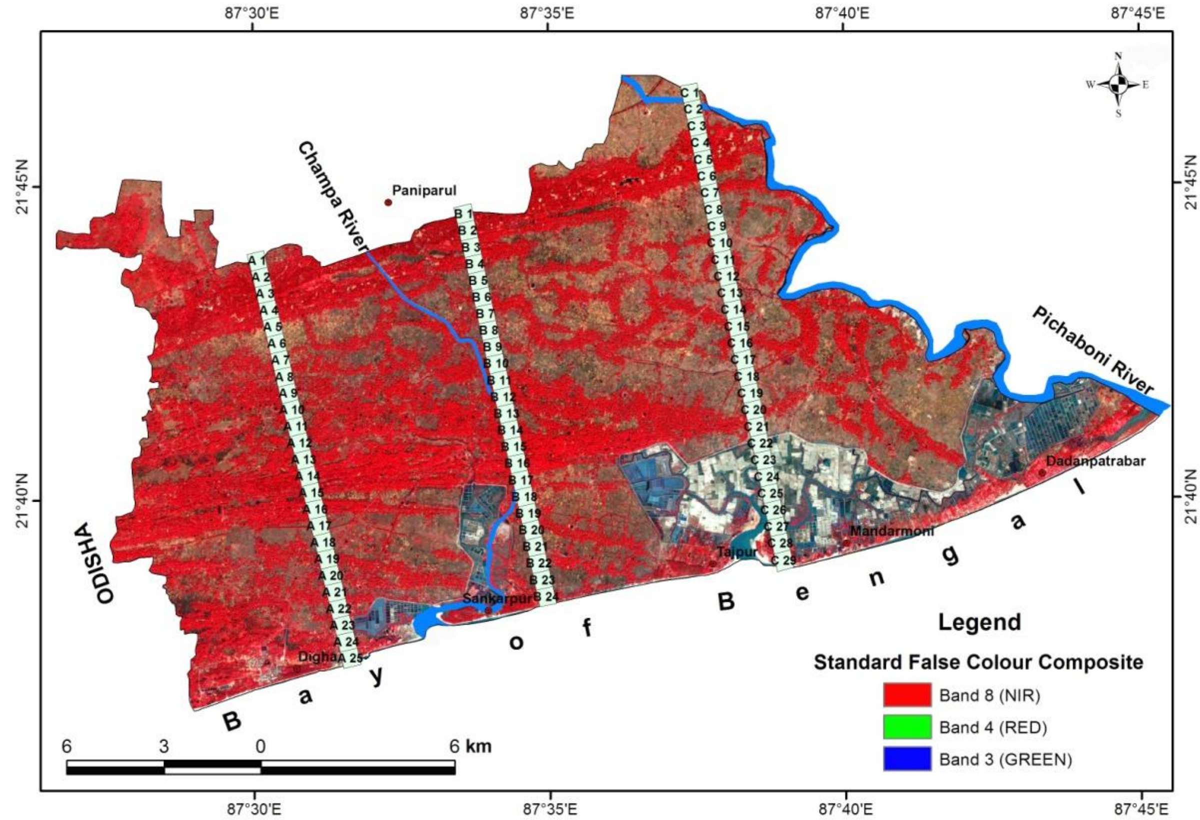

Fig. 3.2: Superimposed of transects on Sentinel image with Standard False Color Composite (FCC).

Last of all Normalized Difference Vegetation Index (NDVI) method has been incorporated for grid wise categorization of vegetation and obtained the species diversity and community homogeneity under diverse micro topographic units.

These three transects (e.g., A, B, C) have been demarcated in the Standard False Color Composite (FCC) of Sentinel-2 MSI images for the smooth identification of the vegetation coverage of the studied region (Fig. 3.2). Simultaneously Sentinel data with near infrared band has also been used to access the healthy vegetation types as the data has a very accurate reflection from the vegetation. From this mapping it is very clear to identify the spatial pattern of different types of vegetation of the studied coast.

3.3 Identification of Floral Species

Extensive field survey has also been conducted to identify the diversity of species which have present in each grid (Plate 3.1). During the field survey, GPS tracker is enable for tracking the route of the study area for touching the each and every grid of individual transects (Fig. 3.3).

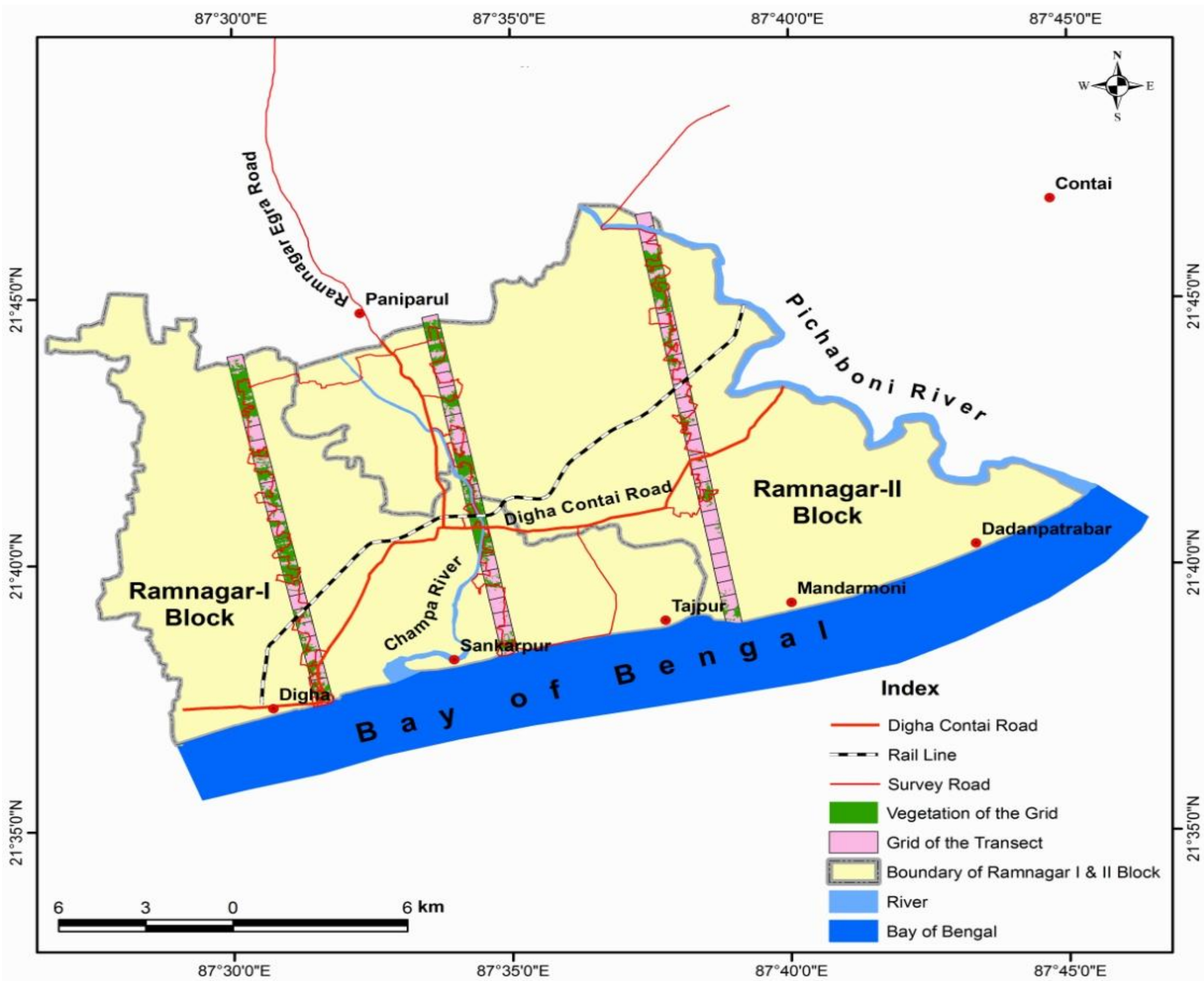

Fig. 3.3: Vegetation diversification survey in each grid along the selected three transects with the GPS tracker.

After completing the minute surveying processes into the each and every grids (500 m × 500 m) of every transects, it is documented that there were 40 types of floral species into the transect-A, 44 types of species were present in transect-B and transect-C series have 23 types of plant species (Annexures 1, 2, 3). Finally, transect wise floral species diversity survey depicts that there were 106 species present throughout the selected three transects with 75 grids (Annexure 25).

Plate 3.1: Identification of floral species at low lying coastal tract (road side vegetation).

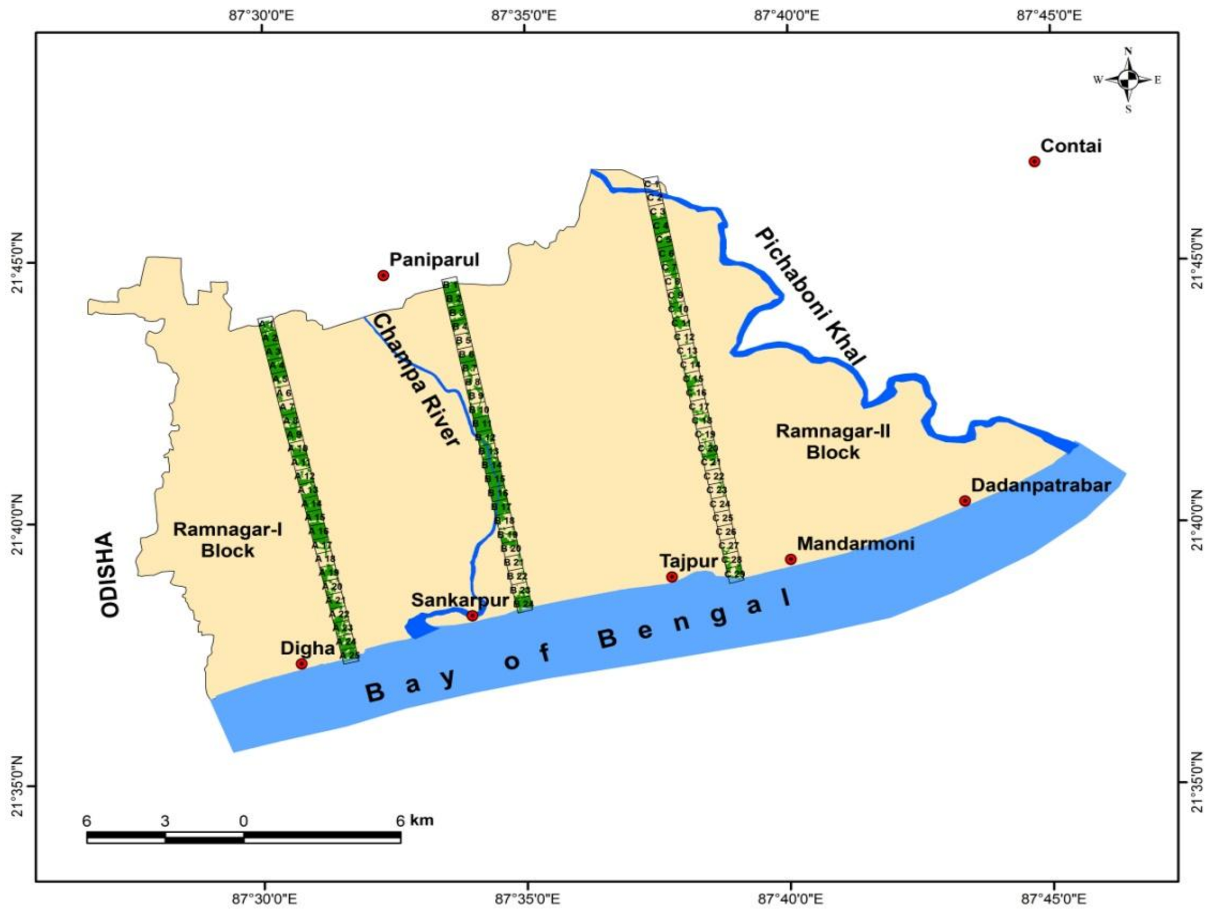

Fig. 3.4: Grid wise spatial distribution of species communities along three transects.

The spatial distribution patterns of the identified floral species of each grid are delineated for the spatial zonation of the vegetation into three transects (Fig. 3.4). After that the occupied areas of the floral species in each and every grid are being calculated for assessing the zonal approach of the species in every grid.

Plant ecology has also been categorized into different classes like grass, heath, scrub, small tree and large tree (Annexures 4, 5, 6) in a primary level for the monitoring of biodiversity status of the studied region. Simultaneously the relation has also been recorded during the field survey among the percentages of the occupied plants, altitudinal variation and field moisture condition to formulate the further species monitoring strategies.

3.4 Normalized Difference Vegetation Index (NDVI)

Vegetation categorization through image arithmetic operation has been conducted with consideration of two time's seasonal data such as March, 2017 and November, 2017. The NDVI technique is applied for the categorization of the vegetation types (Figs. 3.5, 3.6). A NDVI is an equation which comprises with the amount of energy reflected to the infrared region by the plants. The green plants absorb solar radiation to generate through photosynthesis (Rouse et al., 1974). So that NDVI is directly related to the vegetation health as vegetation reflects very well in the near-infrared part of the electromagnetic spectrum.

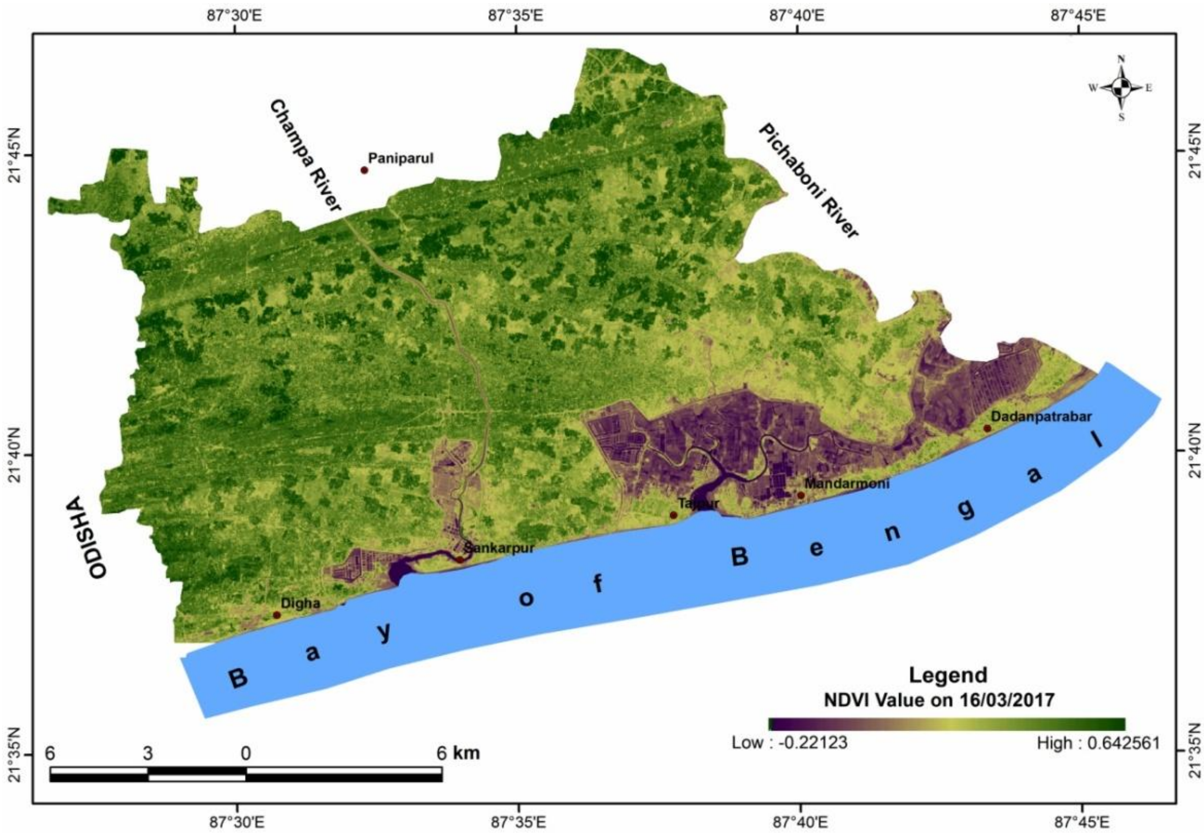

Fig. 3.5: Normalized Difference Vegetation Index of Boro cultivated season (November, 2017).

Green leaves have a reflectance of 20% or less in the 0.5 to 0.7 micrometer (µ) ranges (green to red) and about 60% in the 0.7 to 1.3 micrometer (µ) ranges (near-infrared). These spectral reflectances are proportioned between themselves which reflected over the incoming radiation in each spectral band individually; hence, they take on values between 0.0 and 1.0. Thus, the NDVI itself varies between -1.0 and +1.0. Negative values of NDVI (values approaching -1) correspond to deep water. Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow. Low, positive values represent shrub and grassland (approximately 0.2 to 0.4), while high values indicate temperate and tropical rainforests (values approaching 1). The typical range is between about -0.1 (for a not very green area) to 0.6 (for a very green area).

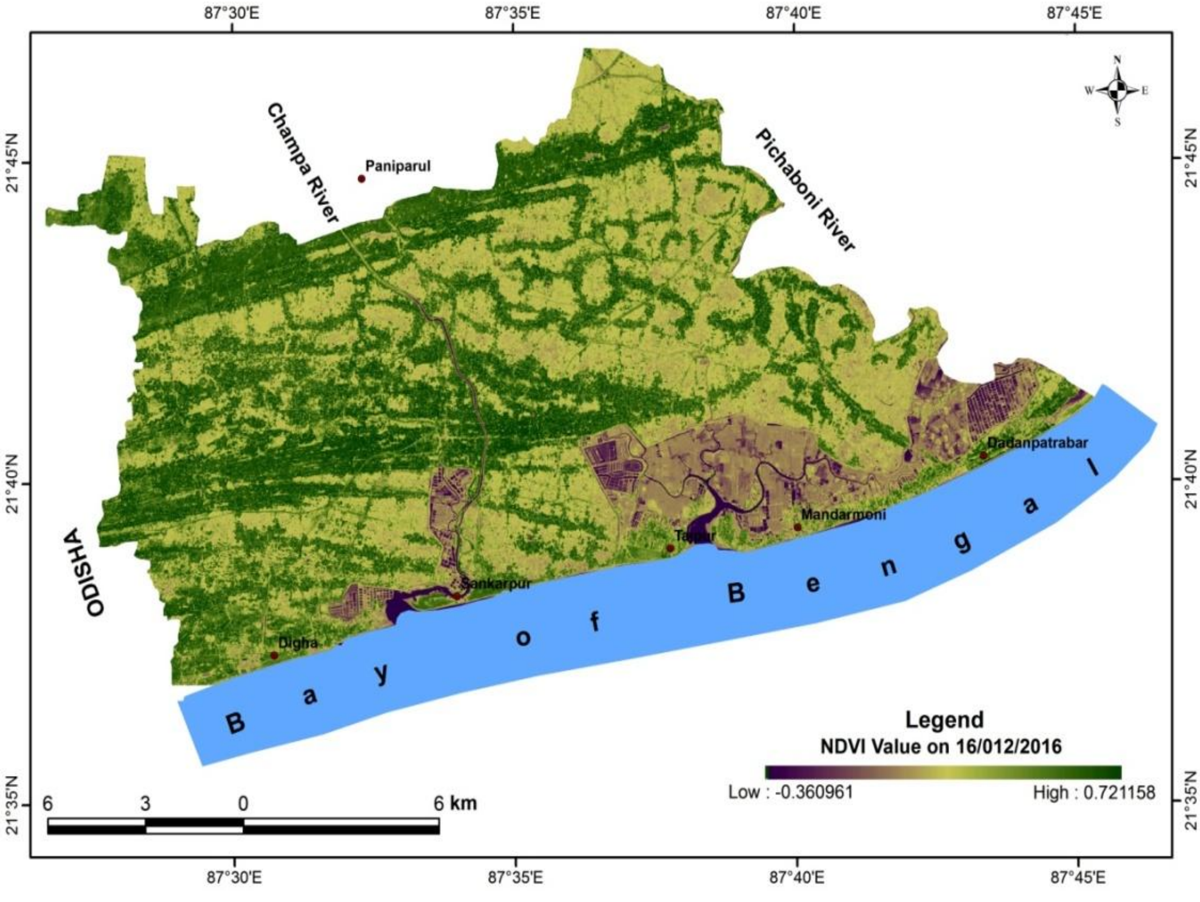

Fig. 3.6: Normalized Difference Vegetation Index of non cultivated season (March, 2017).

Generally, NDVI provides a basic assessment of vegetation health and a means of supervising the alteration in vegetation character over time and it remains the most well known and used index to detect live green plant canopies in multispectral remote sensing data.

The NDVI ratio is calculated by dividing the difference in the near-infrared (NIR) and red bands by the sum of the NIR and red colors bands for each pixel in the image as follows:

NIR = (NIR+RED) / (NIR-RED)

On the basis of the band ratio (NDVI), grid wise vegetations are being categorized in three types such as vegetation of the low lying coastal plain surface (30 km^2), vegetated beach ridge surface with sloping flats and older natural levees (48 km^2) and ridge crest vegetations (53 km^2). Such a minute categorization of the floral species is alienated through the spectral response of different groups of species in each and every grid (Fig. 3.7).

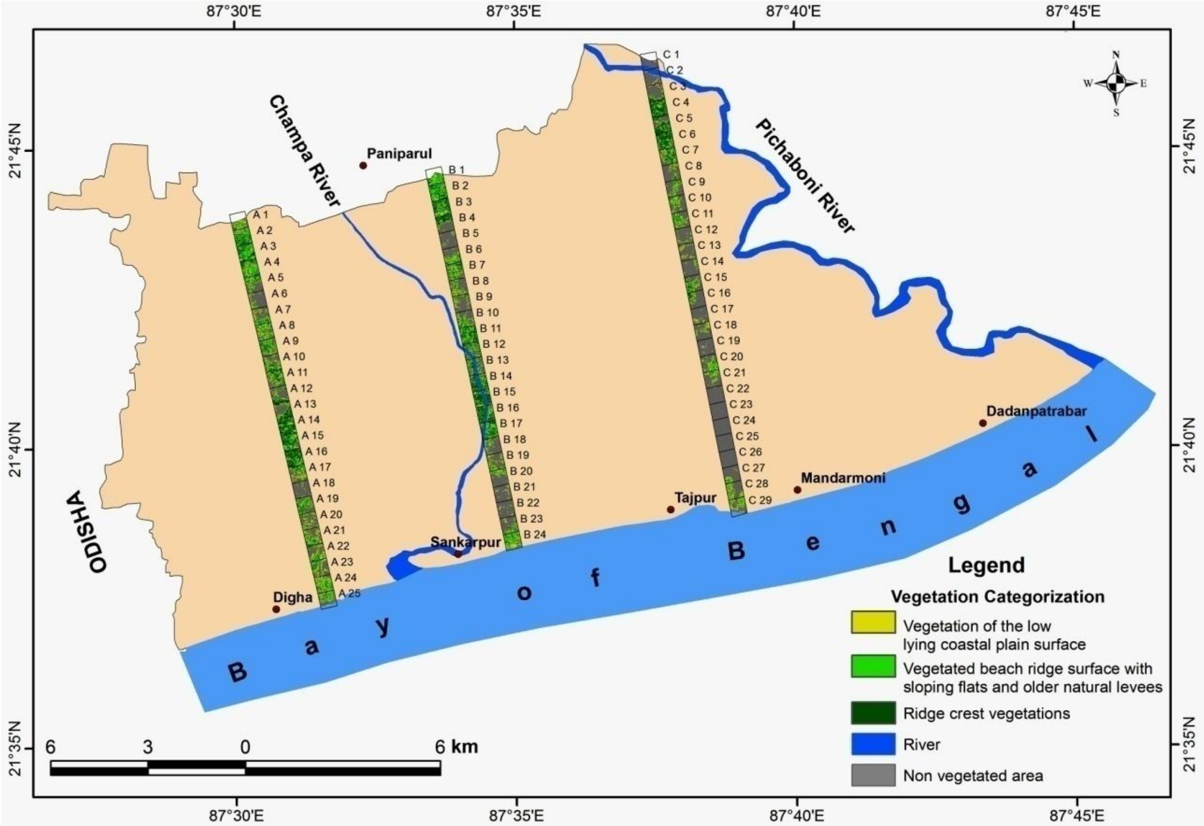

Fig. 3.7: Transect wise vegetation classification with topographic character.

Plate 3.2: Presence of vegetation communities in settlement areas.

3.5 Species Categorization

With the help of this minute grid wise floral species classification through NDVI, researcher has been prepared spatial zonation map of the species by the spreading out the concern signature of the plants to the entire study area. On the other hand classification map of sampling site can be reflects the actual scenario of the plant community in and around the study area (Plate 3.2; Fig. 3.8). However, Sentinel data gives the better resolution than other open source images, so the distributions of the vegetations are well matched of this region.

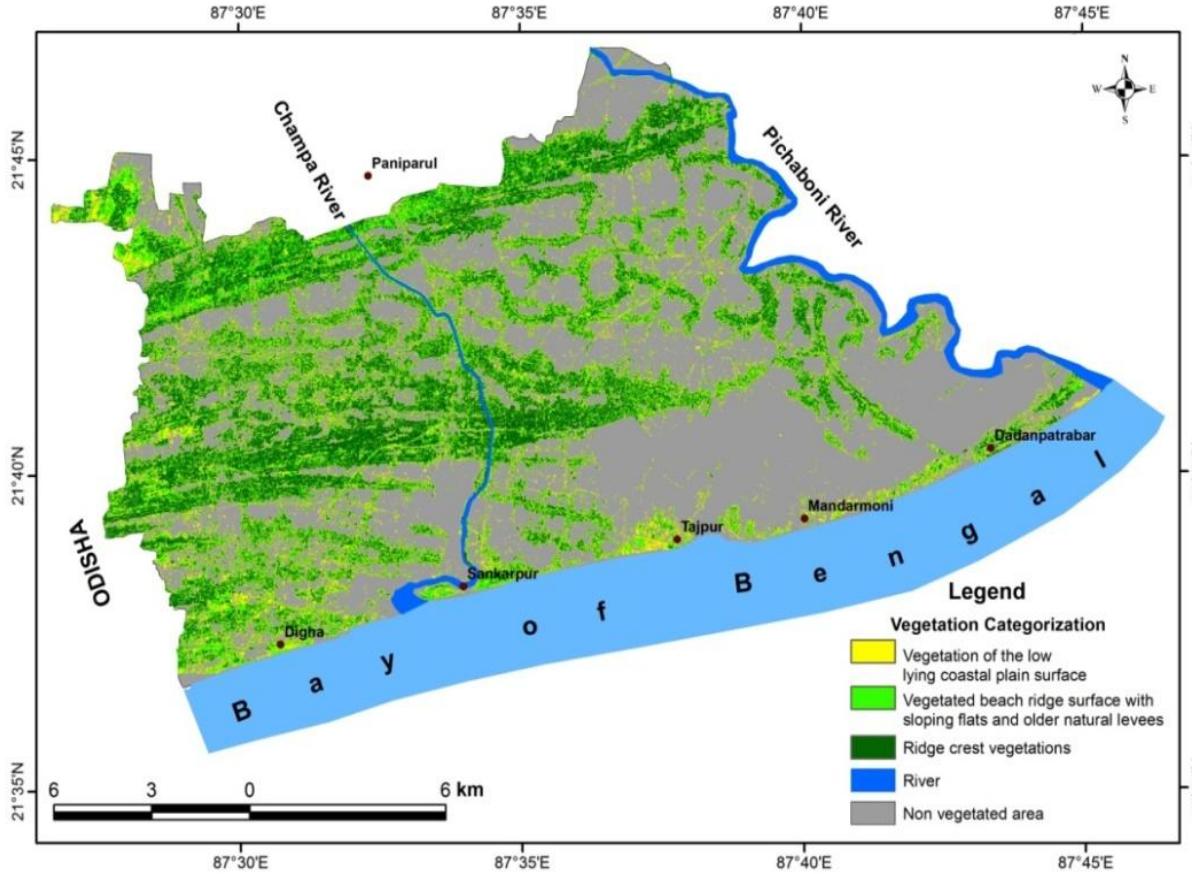

Fig. 3.8: Overall scenario of vegetation types with different topographic units.

3.6 Identification of Micro Landscape Units

The present study also deals with very high resolution DEM for the understanding of the micro landscape units of the entire region of the study area. The DEM is classified (Fig. 3.9) on the basis of elevation (m) in six (6) units such as, modern tidal flood plain (0 m - 3 m); estuarine flood plain and paleo tidal basin and inter dune valley flats (3 m - 6 m); beach ridge and natural levees (6 m - 9 m); dune flat and dune terraces (9 m - 12 m); moderately high dune ridge ranges from 12 m - 15 m (Plate 3.3) and isolated dune ridge (15 m -18 m) to understand the coastal morphological setup.

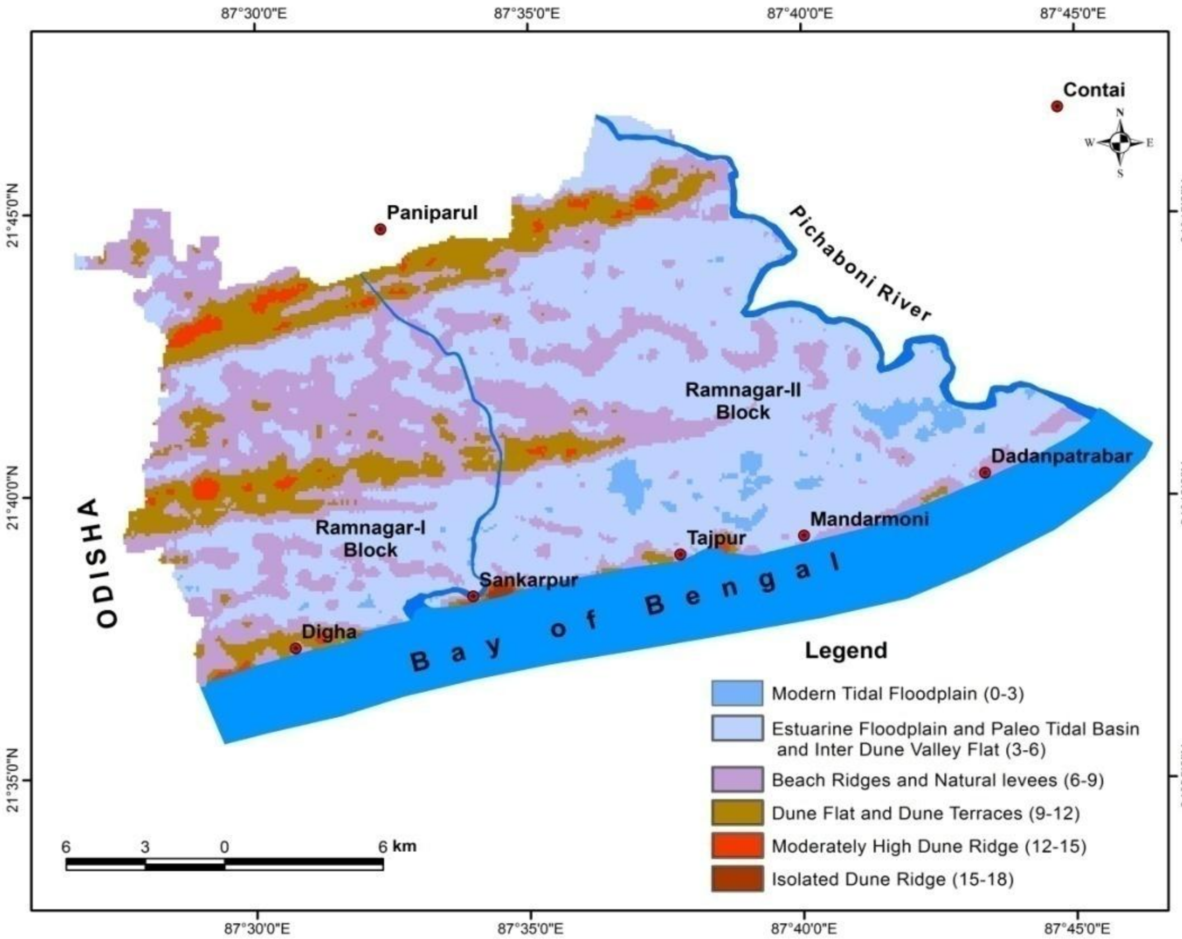

Fig. 3.9: Topographic micro zonation of coastal landforms.

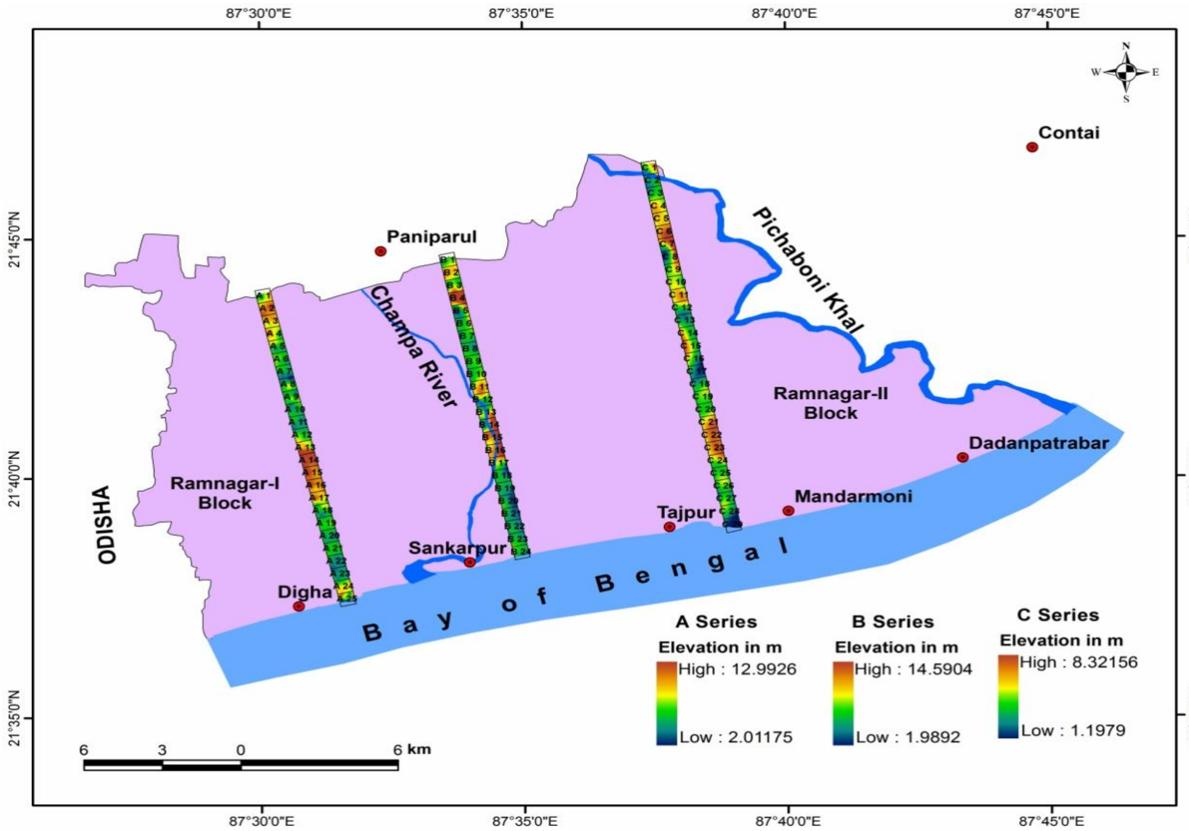

Fig. 3.10: Grid wise altitudinal range of Transect A, B and C.

Anybody can identified a very precise micro topographic units with a high resolution interpolated DEM. So present study is comprises with high resolution interpolated DEM to understand the diverse altitudinal variation in each grid of three transect. The variation of elevation fluctuates in transect-A, B and C sequentially 2.01 m to 12.99 m, 1.98 m to 14.59 m and 1.19 m to 8.32 m (Fig. 3.10).

Plate 3.3: Presence of Saal forest in beach dune complex areas (altitude ranges from 12 m to 15 m).

3.7 Relation between Micro Topography and Floral Species

After the consideration of elevation in each transect, the longitudinal profile has been drawn from seaward side to landward side to assess the grid wise micro terrain units. Each and every grid represents the different types of landscape units (Annexures 7, 8, 9).

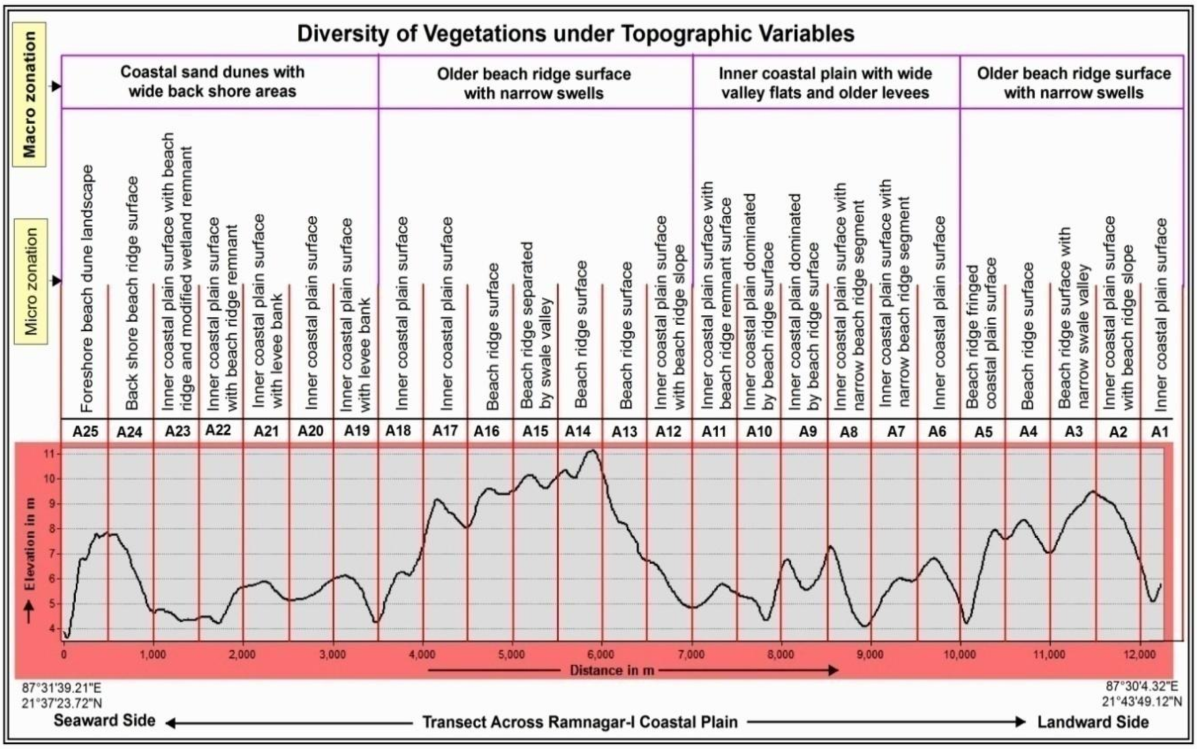

Fig. 3.11: Diversity of vegetation under topographic variables of 'A' transect.

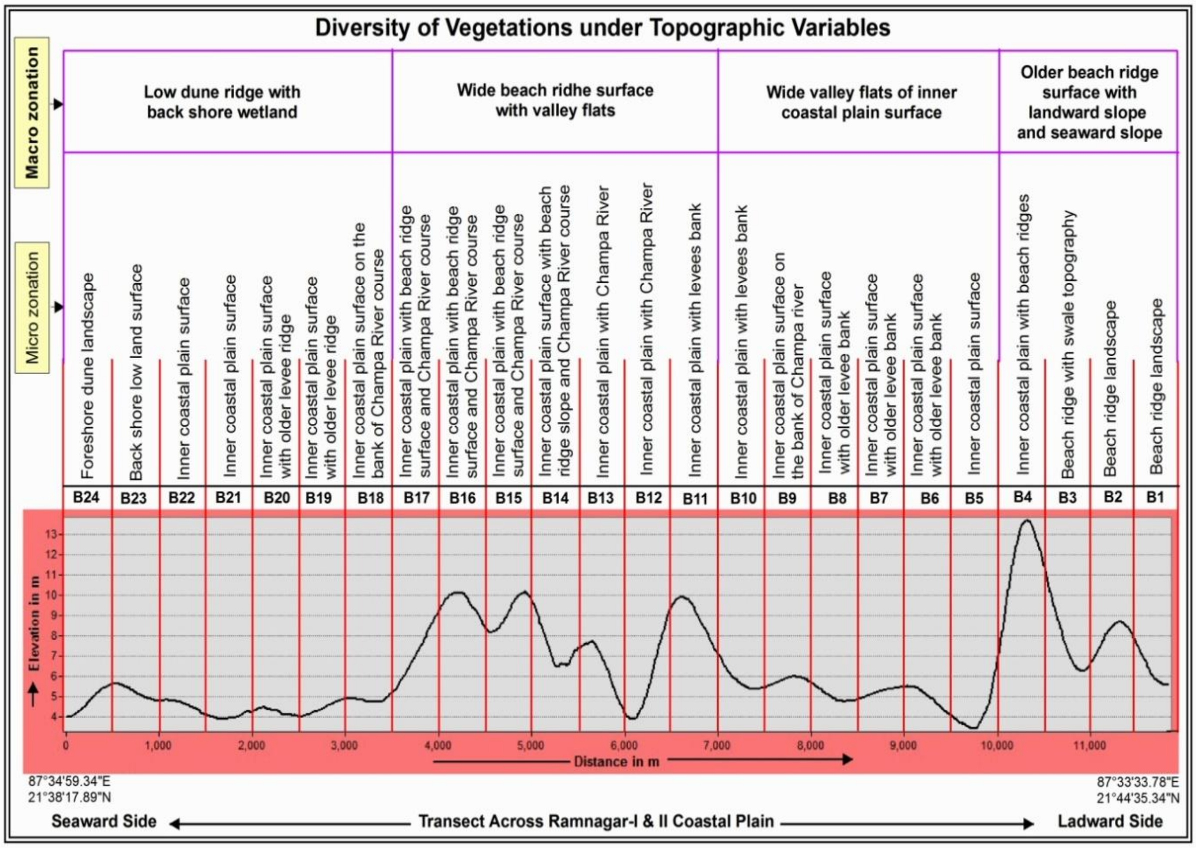

Fig. 3.12: Diversity of vegetation under topographic variables of 'B' transect.

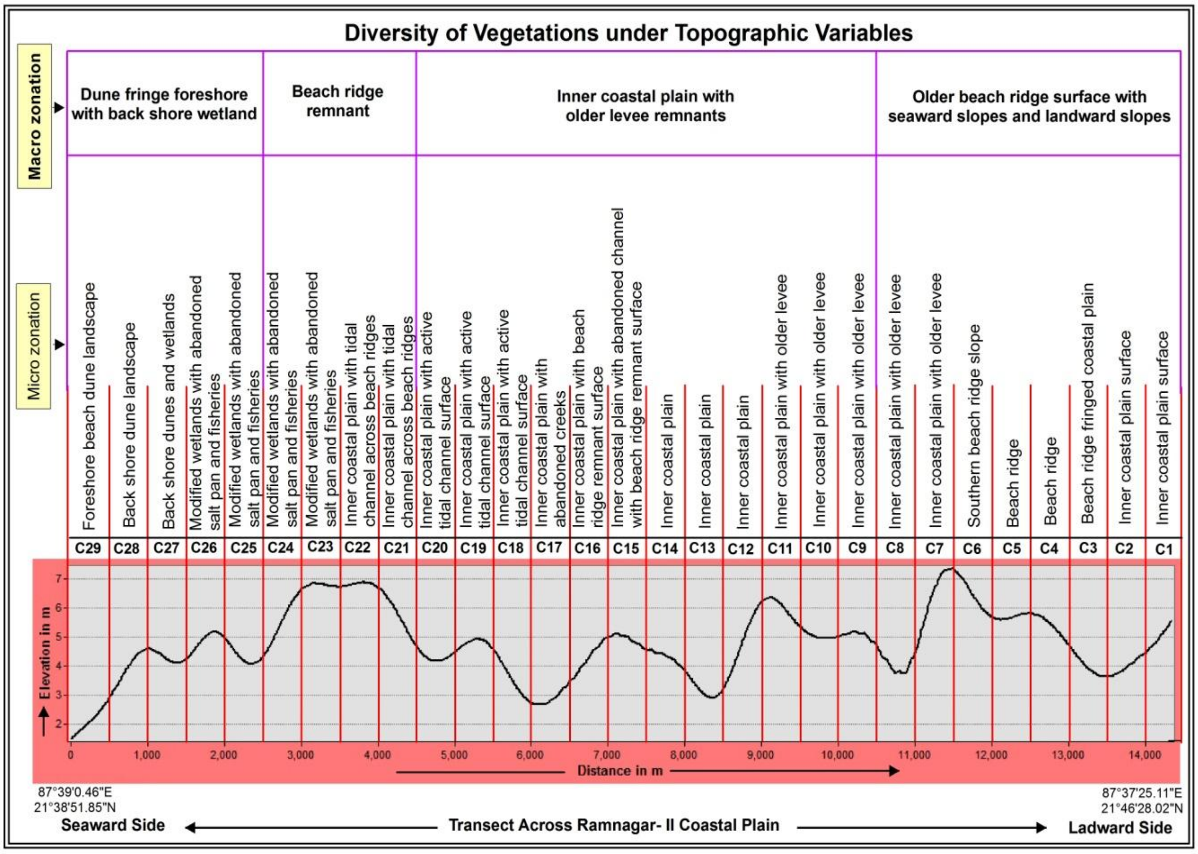

Fig. 3.13: Diversity of vegetation under topographic variables of 'C' transect.

This cross profile shows the macro and micro zonation of the topography and also the diversity of plant community under the different topographic variables (Figs. 3.11, 3.12, 3.13). The diversity of vegetation is distributed in the different character of the terrain in each and every grid. On the other hand the nature of the topography controls the variability of the plant species community of the region.

3.8 Vegetation Diversity Analysis through Shannon Weiner Diversity Index

Shannon-Weiner Diversity Index is a diversity index to determine the species diversity in a community with a mathematical way. Diversity indices afford additional information about community composition than basically species richness.

Diversity indices of present significant information are concerning infrequency and commonness of species in a community. The capability to enumerate diversity in this technique is a significant instrument for biologists trying to comprehend community construction. This is the most extensively used diversity index in the ecological literature (Begon et al., 1996).

The Shannon Diversity Index (H) is a special index that is typically used to differentiate species diversity in a community. Like Simpson's index, Shannon's index accounts for both profusion and consistency of the species present. The quantity of species 'i' comparative to the total amount of species (pi) is considered, and then reproduced by the usual logarithm of this section (ln pi). The consequential result is summed across species and multiplied by -1 (Magurran, 1988)

$$\text{Shannon Diversity Index (H)} = -\sum_{i=1}^{s} \mathrm{p}_i \ln \mathrm{p}_i$$

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^{th} species

Ln= The natural logarithm.

The Shannon index is exaggerated by both the amount of species and their equitability, or consistency. A superior quantity of species and a extra even distribution both augment multiplicity as calculated by H. Shannon's equitability (E_H) can be intended by dividing H by H_{max} (here H_{max} = ln(S). The highest diversity (H_{max}) of a sample is established when, all species are uniformly profuse. Equitability supposes a value between 0 and 1 with 1 being absolute consistency. We can contrast the real diversity value to the extreme probable diversity by means of a determination called evenness. The evenness of the sample is get hold of from the formula (Rosenzweig, 1995):

$$\text{Evenness } (E_H) = H/H_{max}$$

where,

H= Shannon-Wiener diversity index

H_{max}= The Maximum Diversity [ln(S)]

S = Total number of species.

3.8.1 Community Similarity

Calculating community resemblance (what the communities have in general in conditions of species) helps us to determine if we are contrasting transect to transect. Sorenson's Coefficient provides a value between 0 and 1, the closer the value is to 1, the more the communities have in general. Absolute community overlap is equal to 1; absolute community dissimilarity is equal to 0. The equation is:

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

where, C is the number of species of the two communities has in common, S1 is the total number of species found in community 1, and S2 is the total number of species found in community 2.

Sorenson's Coefficient (CC) is 0.769230 between transect A and B

Sorenson's Coefficient (CC) is 0.688524 between transect B and C

Sorenson's Coefficient (CC) is 0.773109 between transect A and C

3.8.2 Species Richness

The amount of species per sample is determined of richness. The more species present in a sample, the 'richer' the sample.

Species richness as determined on its own obtains no account of the amount of individuals of each species present. It provides as much heaviness to those species which have very little individuals as to those which have a lot of individuals.

3.8.3 Species Evenness

Evenness is a measure of the relative profusion of the diverse species making up the richness of vicinity. The Shannon Wiener Diversity Index is calculated for evaluating the richness and evenness of the sampled plants which characterizes the species diversity in a community (Annexures 10, 11, 12) and Sorenson's Coefficient computes for consideration of community similarities on the study area (Table 3.1).

Table 3.1: Species diversity estimation through Shannon Diversity Index.

Transect	Shannon Diversity Index (H)	The maximum diversity (H_{max})	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

Shannon Diversity Index (H) value is 4.00, 3.93 and 3.57 for the transect A, B and C, consequently evenness is 0.94, 0.91 and 9.00 for the transect A, B and C. Accordingly, the vegetation richness and evenness is higher in transect 'A' and 'B' than C (Fig. 3.14).

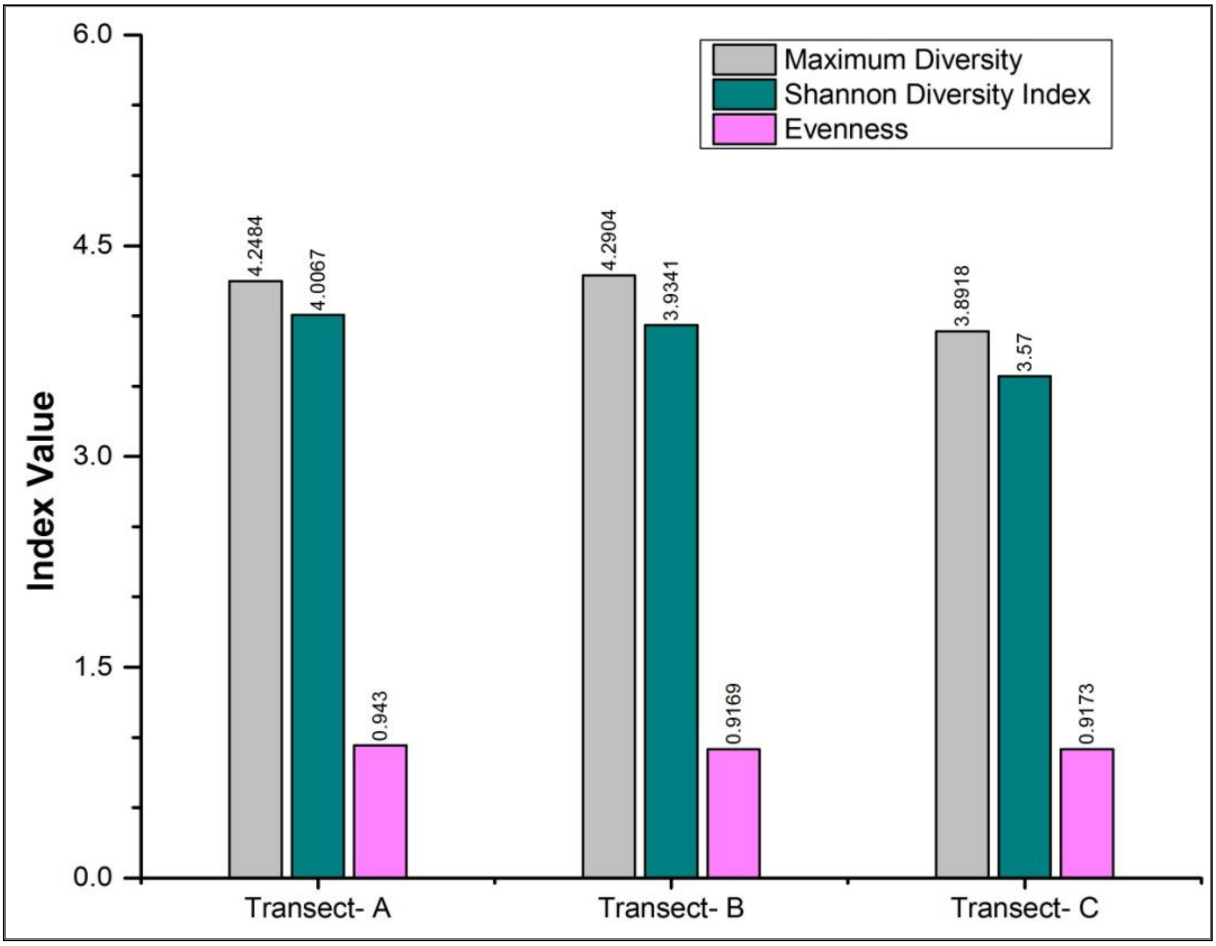

Fig. 3.14: Comparative analysis of maximum diversity, Shannon diversity, and evenness of three transects.

3.9 Spatial Variability of Plant Community

Grid wise species types are plotted in a linear way against each other to showing the comparative changeability of the plant community of AB, BC, AC and ABC transects (Fig. 3.15). The species communities are familiarly close to the Grid-1 to Grid-14 in AB Transect, Grid-15 to Grid-24 in BC Transect and there is no similarity of species in AC Transect. So the comparative linear pattern of the species category of ABC transects reflects the presence of heterogeneous group of plant community dominated by the topographic attributes of the landscape units.

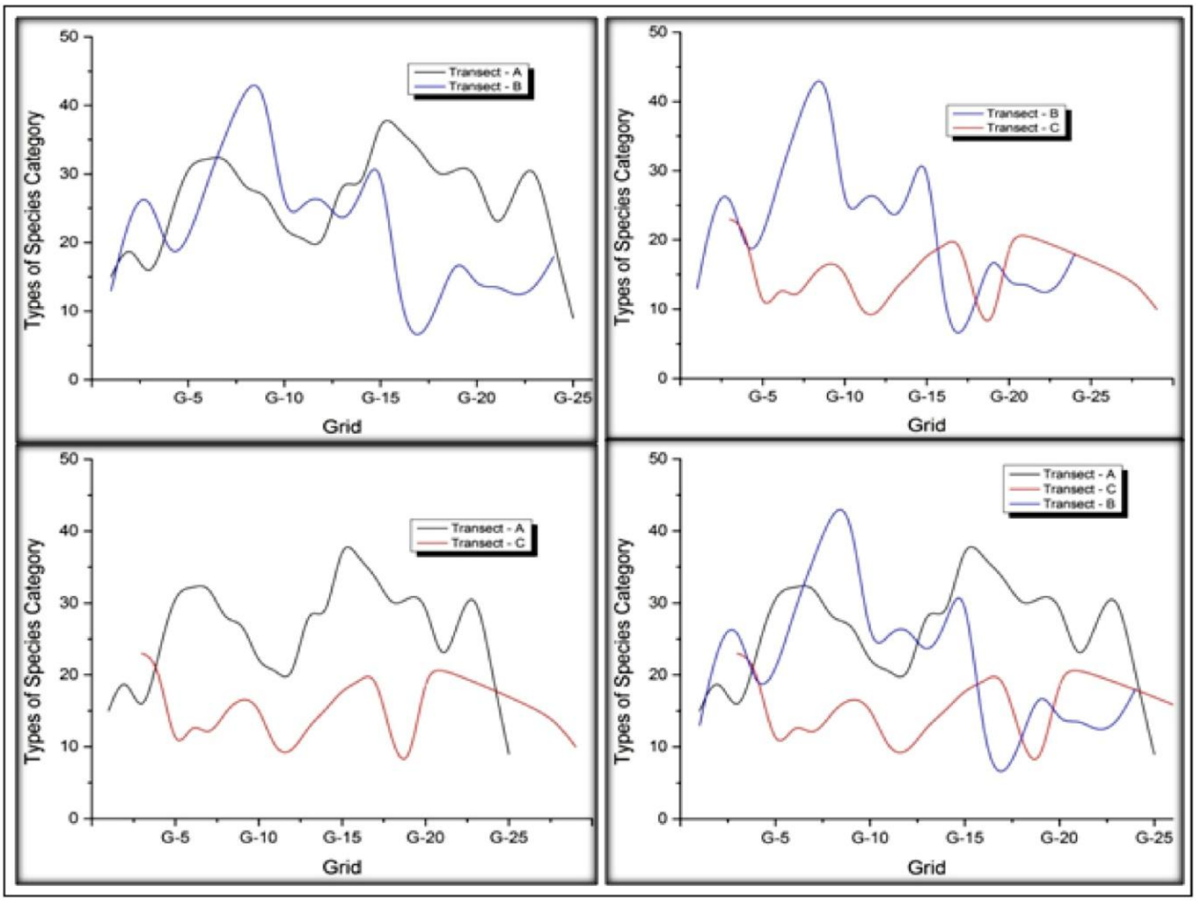

Fig. 3.15: Showing the relationships of different floral species between AB, BC, AC and ABC transects.

Table 3.2: Spatial distribution of vegetation diversity along the different landscape units.

Grid No.	Landscape Unit	Vegetation types
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 13	Beach ridge surface	31
A 15	Beach ridge separated by swale valley	40
A 16	Beach ridge surface	36
A 23	Inner coastal plain surface with beach ridge and modified wetland remnant	33
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 15	Inner coastal plain with beach ridge surface and Champa River course	35
C 3	Beach ridge fringed coastal plain	23
C 4	Beach ridge	22
C 16	Inner coastal plain with beach ridge remnant surface	19
C 17	Inner coastal plain with abandoned creeks	21

C 20	Inner coastal plain with active tidal channel surface	21
C 21	Inner coastal plain with tidal channel across beach ridges	21

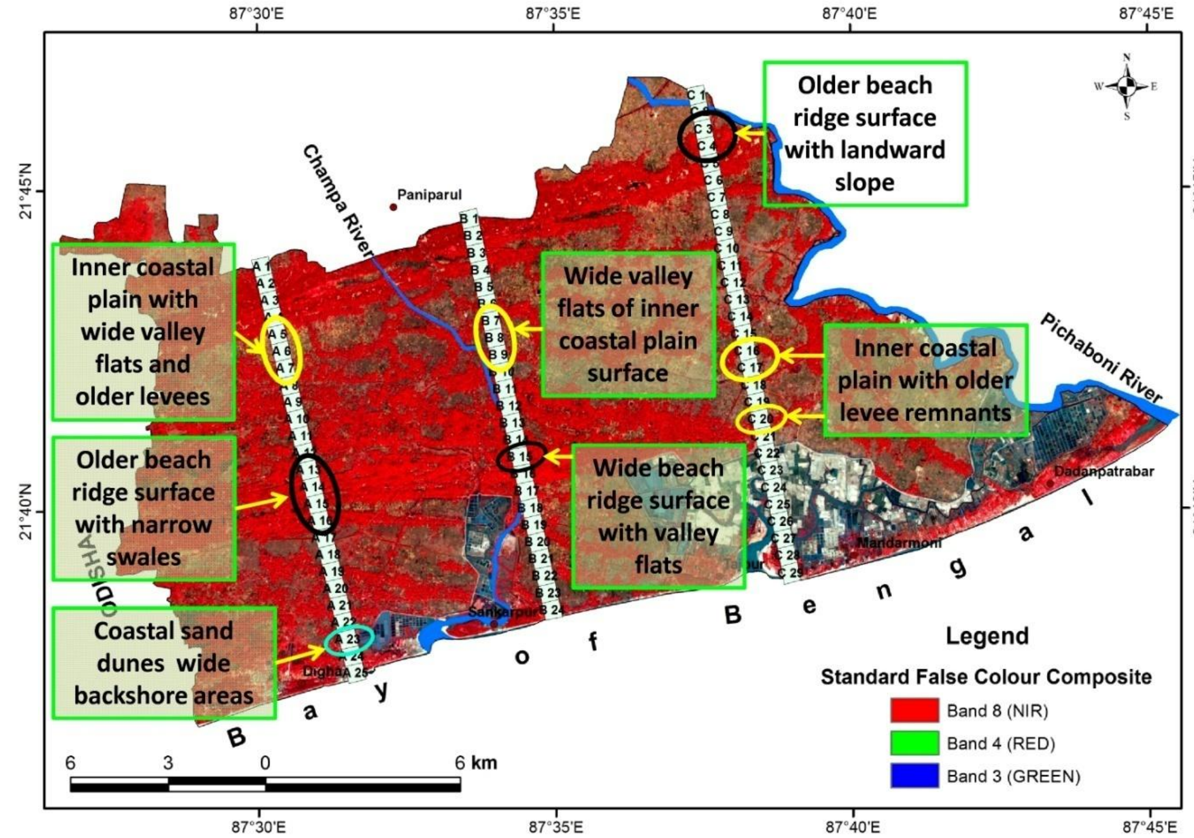

Fig. 3.16: Relationships of vegetation characteristics with diverse geomorphic features.

Plate 3.4: Existence of mangrove and salt marsh in Sankarpur wetlands.

The maximum diversity of vegetations are present in the beach ridge surface; beach ridge fringed coastal plain surface; inner coastal plain surface with narrow beach ridge segment; beach ridge separated by swale valley; inner coastal plain surface with older levee bank; inner coastal plain with abandoned creeks and inner coastal plain with beach ridge remnant surface in the transect of A, B and C (Table 3.2). Finally, the spatial distributions of different plant diversity zones are integrated with the micro topographic units of coastal landscape (Fig. 3.16; Plate 3.4).

3.10 Interrelationship between Habitats and Morphological Units

Coastal landforms, any of the relief distinctiveness present along any seashore are the consequence of a combination of processes, sediments and the geology of the coast itself. The maritime province of the world is made up of a extensive diversity of landforms obvious in a continuum of dimensions and shapes ranging from soothingly sloping beaches to high cliffs yet coastal landforms are best well thought-out in two broad categories: erosional and depositional. In fact the general outlook of any coast may be illustrated in stipulations of one or the other of these categories. It should be renowned that each of the categories has various types of processes and special kind of biological possessions which are always functioning for built up the coastal surroundings. The present study area is also incorporated several kinds of habitation unit like Large tree, Small tree, Scrub land, Heath land and Grass land which are highly inter-connecting and interact with each other, accordingly this individuals ecosystem buildups the vast coastal ecosystem (Table 3.3).

Table 3.3: Calculation of areas in diverse morphological units and plant ecology.

Sl. No.	Plant ecology	Areas of plant ecology (km^2)	Percentage of area (%)	Morphological units	Area of morphological units (km^2)	Percentage of area (%)
1	Large tree	37.86	12.86	Isolated dune ridge (15 m-18 m)	0.31	0.11
2	Small tree	49.48	16.81	Moderately high dune ridge (12 m-15 m)	4.61	1.57
3	Scrub land	41.55	14.11	Dune flat and dune terraces (9 m-12 m)	37.96	12.89
4	Heath land	4.23	1.44	Beach ridge and natural levees (6 m-9 m)	90.83	30.85
5	Grass land	13.12	4.46	Estuarine flood plain and Paleo tidal basin and inter dune valley flat (3 m-6 m)	154.23	52.39
6	No plants	148.15	50.32	Modern tidal flood plain (0 m-3 m)	6.45	2.19
Total		294.39	100.00		294.39	100.00

From the Table 3.4 it is very clear that small tree habitation is much more frequent than other habitation of floral species whereas the heath land habitation is occupied a very small sort of land. Other habitation zones are lies in between the land cover of these two classes. The present study also highlighted that small tree habitation with 33.79 % area occupancy is sum of different micro morphological unit. 33.79 % of land occupancy is 0.04

% from isolated dune ridge (15 m-18 m), 1.01 % from moderately high dune ridge (12 m-15 m), 7.87 % from dune flat and dune terraces (09 m-12 m), 20.46 % from beach ridge and natural levees (06 m-09 m), 4.43 % from estuarine flood plain and paleo tidal basin and inter dune valley flat (03 m-06 m) and 0.02 % from Modern tidal flood plain (00 m-03 m). So it is very clear that beach ridge and natural levees area is highly covered with small tree habitation with 20.46 %. On the other hand each and every habitation zones are also occupied the beach ridge and natural levees portion with a large amount of land percentage than other micro morphological units. So the micro morphological unit mainly beach ridge and natural levees has an immense significance in connection with the floral species diversity as well as affluence of floral species.

Table 3.4: Percentage of area occupied by the plant ecology in different morphological units.

Sl. No.	Morphological units	Occupied area of plant ecology (Total area 146.24 km^2)				
		Grass land area in percentage (%)	**Heath land area in percentage (%)**	**Scrub land area in percentage (%)**	**Small tree area in percentage (%)**	**Large tree area in percentage (%)**
1	Isolated dune ridge (15 m-18 m)			0.03	0.04	0.14
2	Moderately high dune ridge (12 m-15 m)	0.13	0.07	0.19	1.01	1.75
3	Dune flat and dune terraces (09 m-12 m)	2.13	0.57	5.32	7.87	7.96
4	Beach ridge and natural levees (06 m-09 m)	2.02	1.07	16.99	20.46	10.73
5	Estuarine flood plain and Paleo tidal basin and inter dune valley flat (03 m-06 m)	3.04	1.04	5.86	4.43	5.29
6	Modern tidal flood plain (00 m-03 m)	1.66	0.14	0.01	0.02	0
	Total area in percentage (%)	8.97	2.89	28.58	33.79	25.84

Plate 3.5: Vegetation covers of Contai-Paniparul beach ridge section and Mandarmani sand dune section (Near Jaldha), November, 2018.

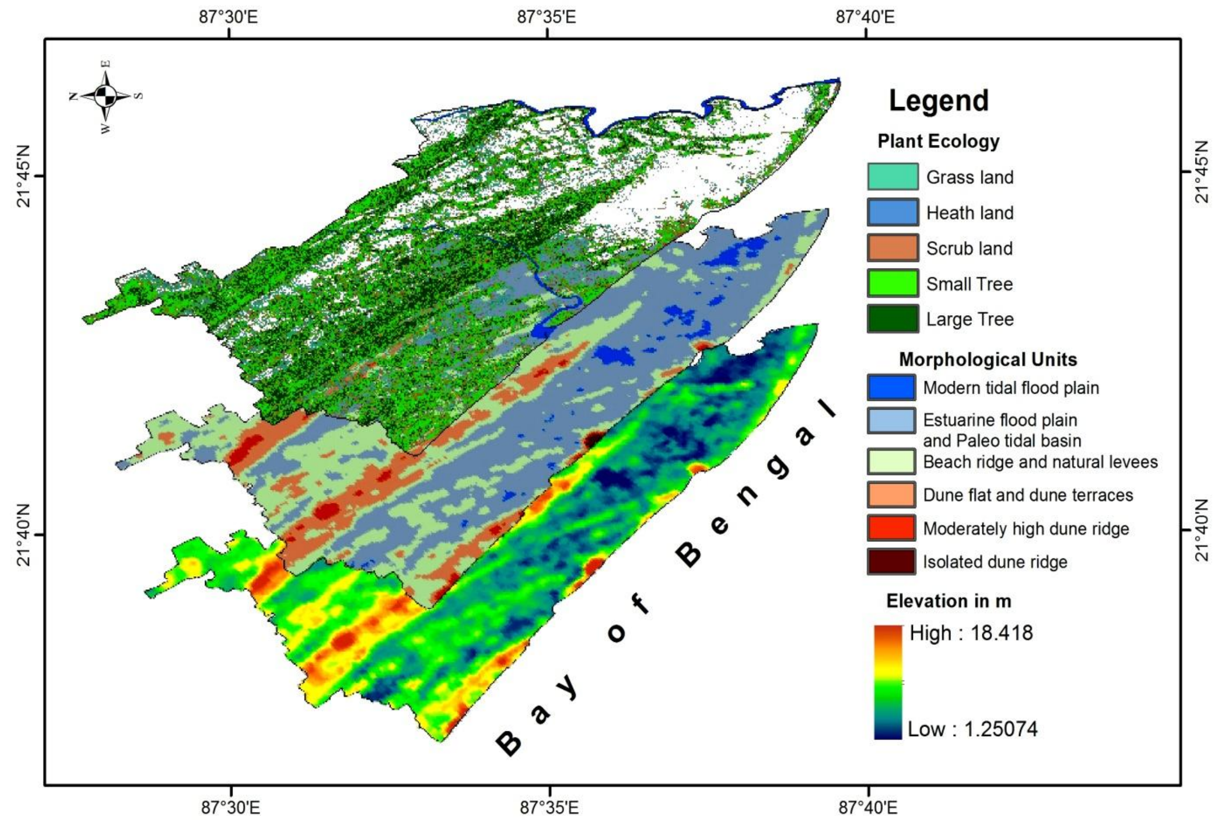

Fig. 3.17: Superimposed layers of elevation, morphology and plant ecology for the understanding of habitat variability at local levels.

The present study also highlighted that small tree habitation with 33.79 % area occupancy is sum of different micro morphological unit. 33.79 % of land occupancy is 0.04 % from isolated dune ridge (15 m-18 m), 1.01 % from moderately high dune ridge (12 m-15 m), 7.87 % from dune flat and dune terraces (09 m-12 m), 20.46 % from beach ridge and natural levees (06 m-09 m), 4.43 % from estuarine flood plain and paleo tidal basin and inter dune valley flat (03 m-06 m) and 0.02 % from Modern tidal flood plain (00 m-03 m). So it is very clear that beach ridge and natural levees area is highly covered with small tree habitation with 20.46 %. On the other hand each and every habitation zones are also occupied the beach ridge and natural levees portion with a large amount of land percentage than other micro morphological units. So the micro morphological unit mainly beach ridge and natural levees has an immense significance in connection with the floral species diversity as well as affluence of floral species (Fig. 3.17).

Land cover pattern is directly correlated to coastal management strategies. The local people of the present low lying deltaic coast are recurrently altering the land cover pattern in accordance to their necessities without discerning the initiation risk which related with the land use practices. Now a day the wetland and marshy land misrepresented into the industrial fish farming sectors and shrimp farming plots. In this context the coastal dwellers should follow the scientific land use practice and at the same time they should also be aware about the advent risks produced by the unscientific land use pattern.

3.11 Hierarchical Cluster Analysis

The Hierarchical Cluster Analysis (HCA) process endeavors to recognize comparatively homogeneous groups of cases (or variables) based on preferred individuality.

3.11.1 Single Linkage

Single linkage also referred to as adjacent neighbor or bare minimum method. This determination describes the detachment between two clusters as the minimum distance found between one case from the first cluster and one case from the second cluster (Florek, 1951).

This method will initially fabricate a case processing summary (first table) which records the figure of applicable cases, the number of absent cases and also the distance compute that was selected (i.e., the Squared Euclidean Distance). The proximity matrix is the second table in the production, if applied for. The matrix records the squared Euclidean distance that was considered between all pairs of cases in the initial step of the cluster process. Proximity matrix is a shortened adaptation of the matrix that demonstrates the distances between cases had the minimum squared Euclidean distance (approximately .000) and were consequently the first two cases to be connected mutually (Blei and Lafferty, 2009).

Table 3.5: 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

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

Proximity matrix

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 3.6: 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 3.7: 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

3.11.2 Agglomeration Schedule

It exhibits how the hierarchical cluster analysis increasingly clusters the cases or explanations. Each row in the program illustrates a phase at which two cases are mutual to form a cluster, using an algorithm expressed by the distance and linkage choice. The agglomeration program records all of the phases in which the clusters are collective until there is only one cluster outstanding after the final stage. The coefficients at every one stage symbolize the distance of the two clusters being collective (Norusis, 2010).

The principle of the agglomeration schedule is to support the investigator in recognizing at what position two clusters being combined are measured too diverse to form a homogeneous group, as evidenced by the initial great augment in coefficient values (Tables 3.5, 3.6, 3.7). As pointed out earlier, a hierarchical cluster analysis is finest demonstrated with a dendrogram, a visual exhibit of the clustering process. The upright lines in the dendrogram correspond to the grouping of clusters or the stages of the agglomeration schedule. They also point out the distance between two amalgamation clusters (as characterized by the x-axis, situated above the plot). As the clusters being merged become more heterogeneous, the upright lines will be situated farther to the right side of the plot, as they symbolize bigger distance values. While the upright lines are analytical of the distance between clusters, the horizontal lines signify the disparity of these distances (Figs. 3.18, 3.19, 3.20). The horizontal lines also attach all cases that are a fraction of one cluster which is significant when determining the ultimate number of clusters after the discontinuing decision is completed (Brereton, 1992).

3.11.3 Icicle Plot

Icicle plot exhibits the similarity between two cases. The icicle plot is easier to understand when investigating it from the underneath to the crest. Each of the dark grey bars in the plot symbolizes one case. However, it is significant to note the vicinities between cases and when they become in the shade. The point at which the space between two cases becomes shaded signifies when the cases were connected mutually (Figs. 3.21, 3.22, 3.23).

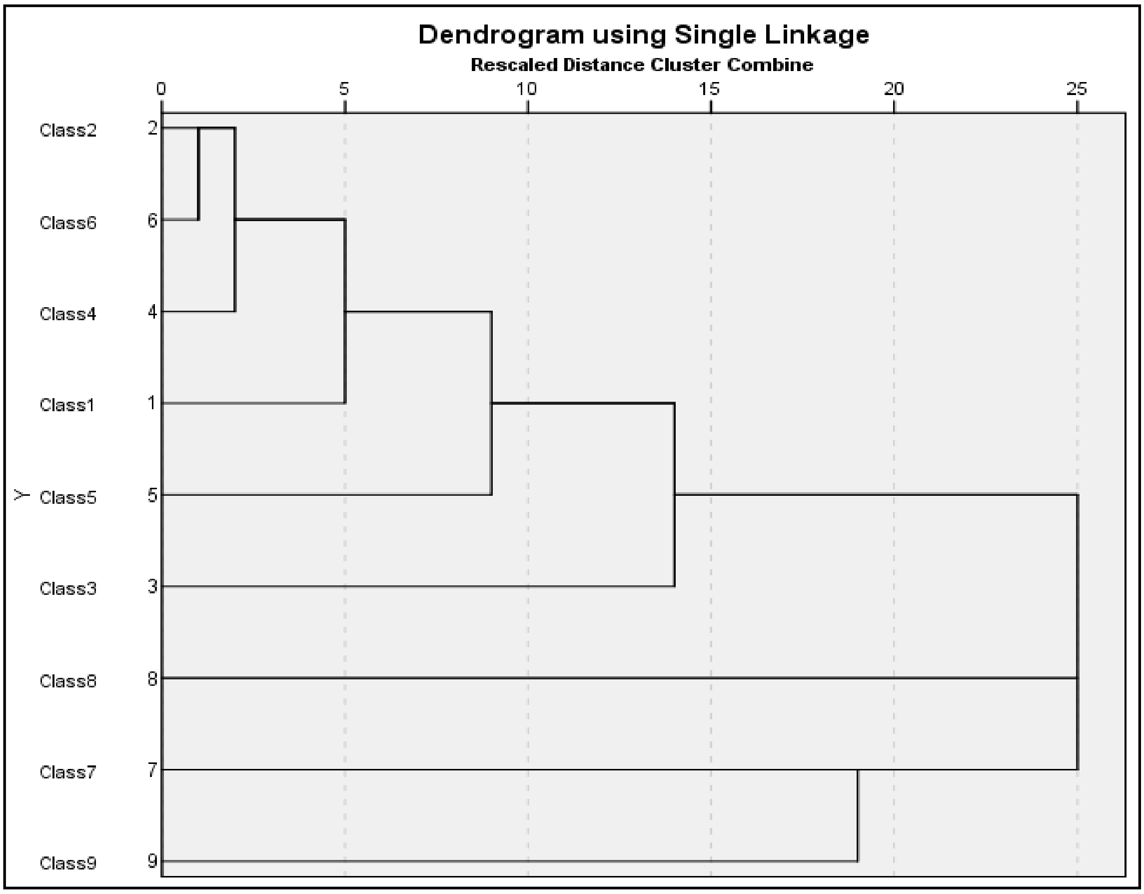

Fig. 3.18: Dendrogram from hierarchical cluster analysis with single linkage of transect-A.

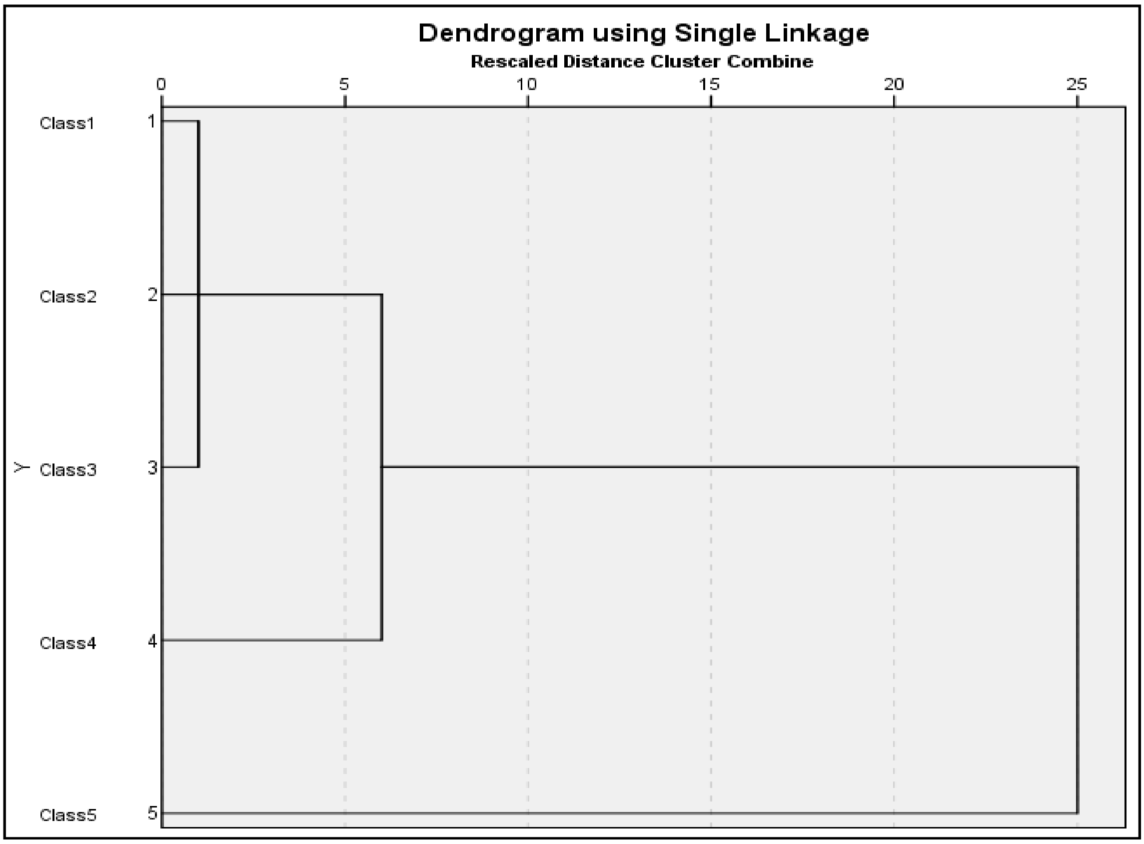

Fig. 3.19: Dendrogram from hierarchical cluster analysis with single linkage of transect-B.

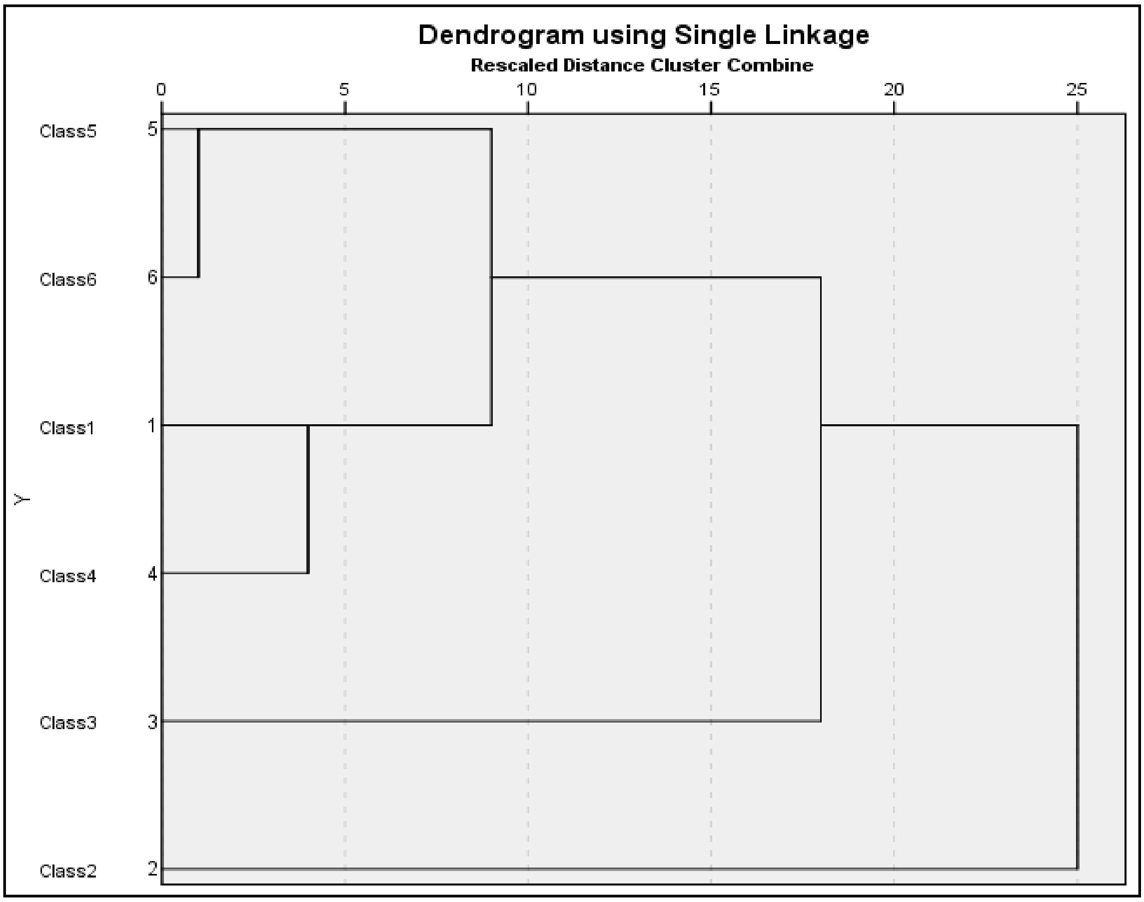

Fig. 3.20: Dendrogram from hierarchical cluster analysis with single linkage of transect-C.

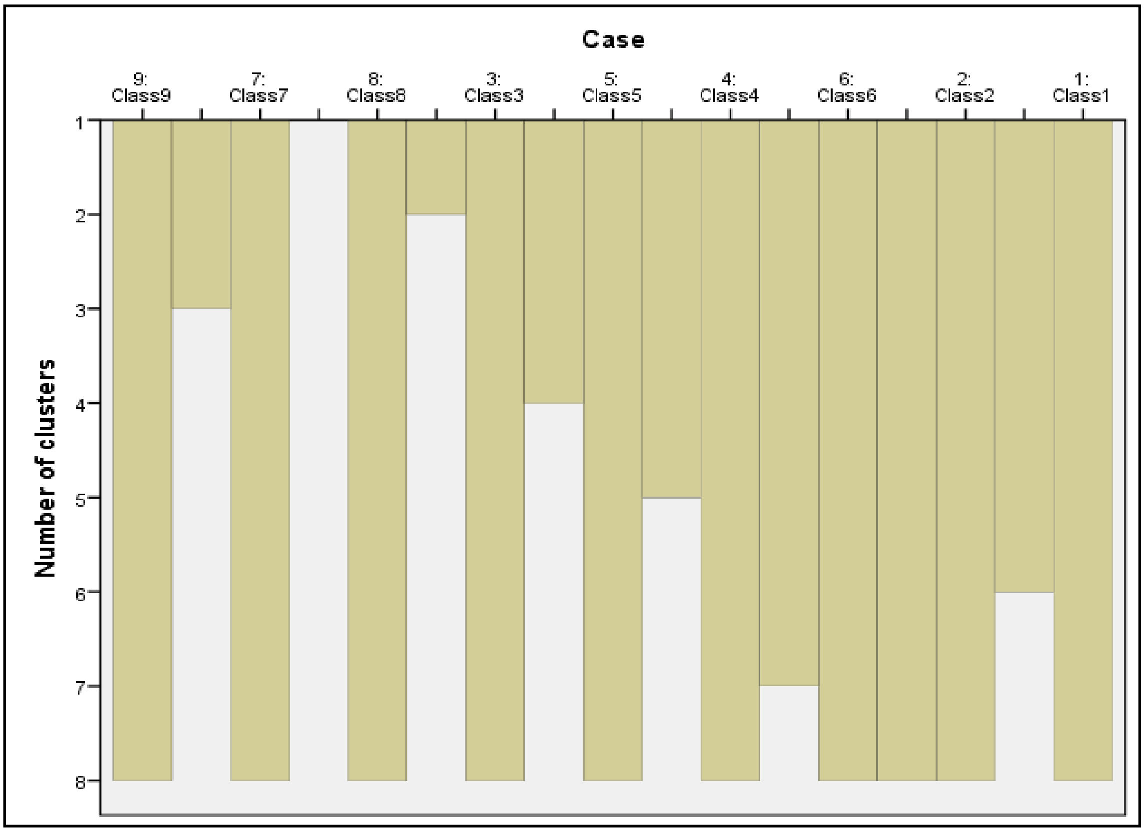

Fig. 3.21: Icicle plot of transect-A for exhibits the similarity between two cases.

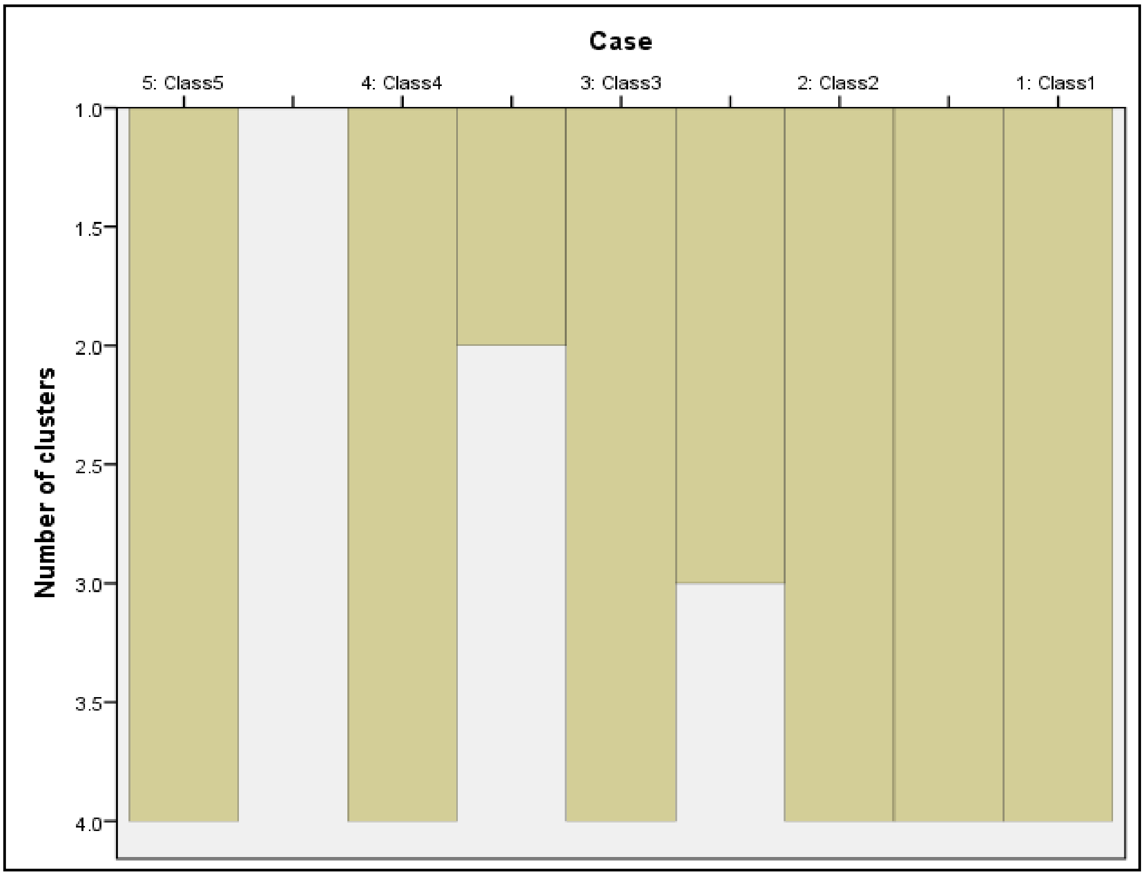

Fig. 3.22: Icicle plot of transect-B for exhibits the similarity between two cases.

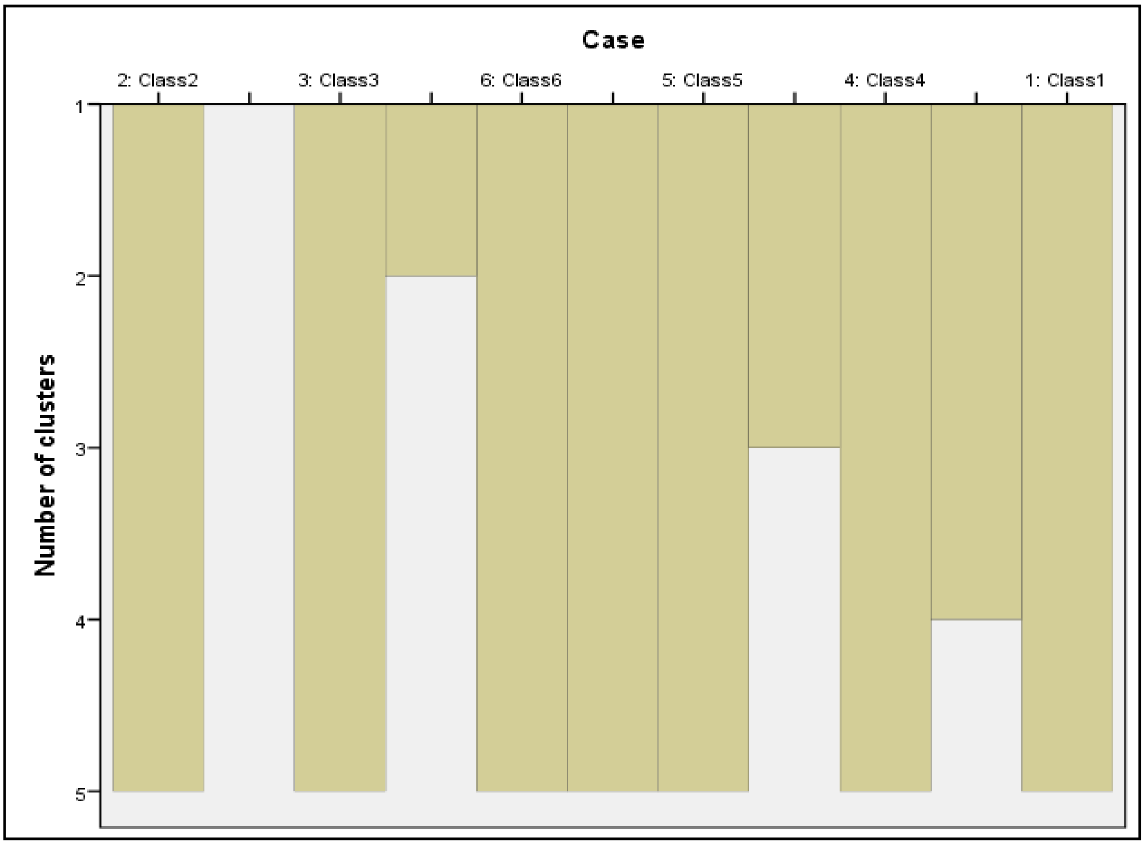

Fig. 3.23: Icicle plot of transect-C for exhibits the similarity between two cases.

The greatest horizontal lines characterize the major differences. Consequently, an extended horizontal line designates that two clusters (which are unlike to each other) are being combined and recognizes where it is most select to stop the clustering process. Comparable to the agglomeration schedule, if the upright and horizontal lines are close to one another, then this would recommend that the intensity of homogeneity of the clusters amalgamated at those stages is comparatively stable

The Present study reveals that the relationships between vegetation and landform units of the coastal chenier plain surface and examined the morphological characteristics over the landscape instability. Transect B shows the very high Shannon diversity index (4.29) because of greater species abundance of this transect rather than transect A and C. The Sorenson's Coefficient is 0.7692, 0.6885 and 0.7731 of AB, BC and AC transect respectively. So, the AC transect occupied the common communities of species due to the topographic variability and hierarchical cluster analysis result represents to identify relatively homogeneous groups of species (variables) based on landscape characteristics.

3.12 Major Findings

The followings are the major findings of this concern chapter:

- There are five types of vegetation community in the study area as they are identified through the transact method (e.g., grasses, heaths, scrubs, small trees and large trees) in the present area.

- There are 106 types of species and 25 types of micro landscape ecological units in the present study area and they have been identified in the form of indiscriminate deployment into the isolated micro landscape units.

- The vegetations are widely distributed and extended over the beach ridge surface; beach ridge fringed coastal plain; swale topography; inner coastal plain with abandoned creeks and older natural levee bank surfaces.

- The maximum diversity of vegetation is found in transect B (4.29) in compare to other two transects, whereas transect A shows very high Shannon diversity index (4.00) while transect A denotes a very high evenness character than the other two transects.

- The Sorenson's Coefficient is 0.7692, 0.6885 and 0.7731 of AB, BC and AC transect respectively, which indicates that the presence of species communities are common in AC transect when the estimated value is close to 1.

- The interrelationship between habitats and morphological units demonstrate the inter-connecting activities with each other in this particular sensitive ecosystem. The micro morphological unit mainly beach ridge and natural levees has an immense significance in connection with the floral species diversity as well as affluence of floral species.

- The hierarchical cluster analysis result shows that the vegetation belongs to relatively homogeneous groups of species community. Therefore, B transect has carried out more heterogeneous characteristics than other two transects in the present study. Accordingly, A and C transect denote the consistency of clustering habit of the species.