Habitat Assessment and Biomass Estimation of Little Andaman Island of Archipelago Group of Andaman Sea using ALOS PALSAR DEM and Synthetic Aperture Data (SAR) Data

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Abstract:

Shore platforms with bays, coves and promontories are located along the shore fringe areas of little Andaman. A few drainage channels are extended across the inner lands and cutting across the shoreline to feed the back shore wetlands by linking with open marine environment dominated by coral habitats. Over 90 percent areas of the island are occupied by dense forests of evergreen, semi evergreen, littoral and mangrove vegetations. They are the home land of Onge and Nicobarese of ancient tribal communities from time of immemorial.

Three significant reef terraces (5m, 12m & 20 m), pseudokarstic caves on shaly limestone(dark color) along the shore fringed cliffs and promontories, some springs on the vertical fall line of terrace cliffs and 'Ria' estuaries with mangrove swamps highlight the major geomorphic features on the eastern parts of the entire island. Shell limestone, calcareous sandstone, claystone and coral rags are major rock types of the island platforms. Mangrove swamp clays, beach sands and other carbonate rocks are found on the shoreline sequences of the island. The present paper deals with the physiographic settings, impacts of recent tectonics and tsunami incidence on the shore fringe areas, karstified processes and landforms, and estimation of biomass with Synthetic Aperture Radar (SAR) data of Little Andaman island of Archipelago Group. The study reveals that the geographical habitats of Little Andaman are physiographically diversified along the shore fringe areas of the island which are prone to the vulnerability of earth quakes and Tsunami hazards and the dense

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biomass can support the homeland of ancient tribal communities in the island though the fringe areas are prone to several hydrologic hazards. The conservation of the shore fringe habitats are needed to support the restore environment at present with the habitat assessment approach.

1.0Introduction:

The Andaman group of islands extent from 8degree north latitude to 13 deg north latitude as an Archipelago across the bay of Bengal and Andaman Sea in India. The little Andaman is located towards the south of Rutland island(South Andaman district) and separated by 10 deg channel from the main group of island. the island is formed by carbonate rocks (calcareous sandstone, coralline limestone and Shaly limestone) of the ancient formation within Oligocene to Pleistocene period the Holocene and recent deposit are found along the coastal fringes, shore platforms, coral banks, mangrove swamps of the intertidal region.

Topographically, the island is elevated upto 87 m in the central part and gradually decending to the surface of 5 meters elevation towards the coastal fringes Around Andaman Sea and Bay of Bengal. Marine terraces of different heights are extended all along the island interior and they are transversely cut by drainage channels with formation of waterfalls across the break of slope (e.g. Whisper Waterfall). The river mouths towards the northern shore are subsided and widened to support the large tidal flat and mangrove vegetations in the carbonate set up of the island.

Larger parts of the island are covered by dense vegetations of tall evergreen forests , littoral fringe forests and mangrove forests. Only the coastal parts of Hut Bay, Buttler Bay & Herbinder Bay are showing the location of human settlements and tourisim resorts along the eastern shoreline. The Stone Age people of a few numbers (ongis tribe) are also living in the natural habitat of the forested island of this region.

2.0Aims and Objectives

The purpose of the present work includes:

- Micro topography and habitat zonation of the oceanic island with ALOS PALSAR DEM, Sentinel 2 A image, Google Earth Images and field validation techniques.
- Biomass estimation of the remote island with the help of field based alometric equation techniques. The alometric equation techniques are used in this study to estimate the biomass of the island ecosystem.

3.0 About the Study Area:

The island is fringed with coral banks (at 5 to 10 m depth), shore platforms and river mouths which are affected by upliftment and subsidence during the period of 2004 earth quakes of the region. The coastal fringe forests were affected by long drift in the tsunami incidence along the shoreline. Inter tidal mangroves of a few areas (Buttler Bay) are shifted towards interior parts and converted into supratidal environment after the seismic uplift. The 1.5 m reef terrace is developed at Harminder bay after the incidence of great earthquake of 2004(Fig:1) .

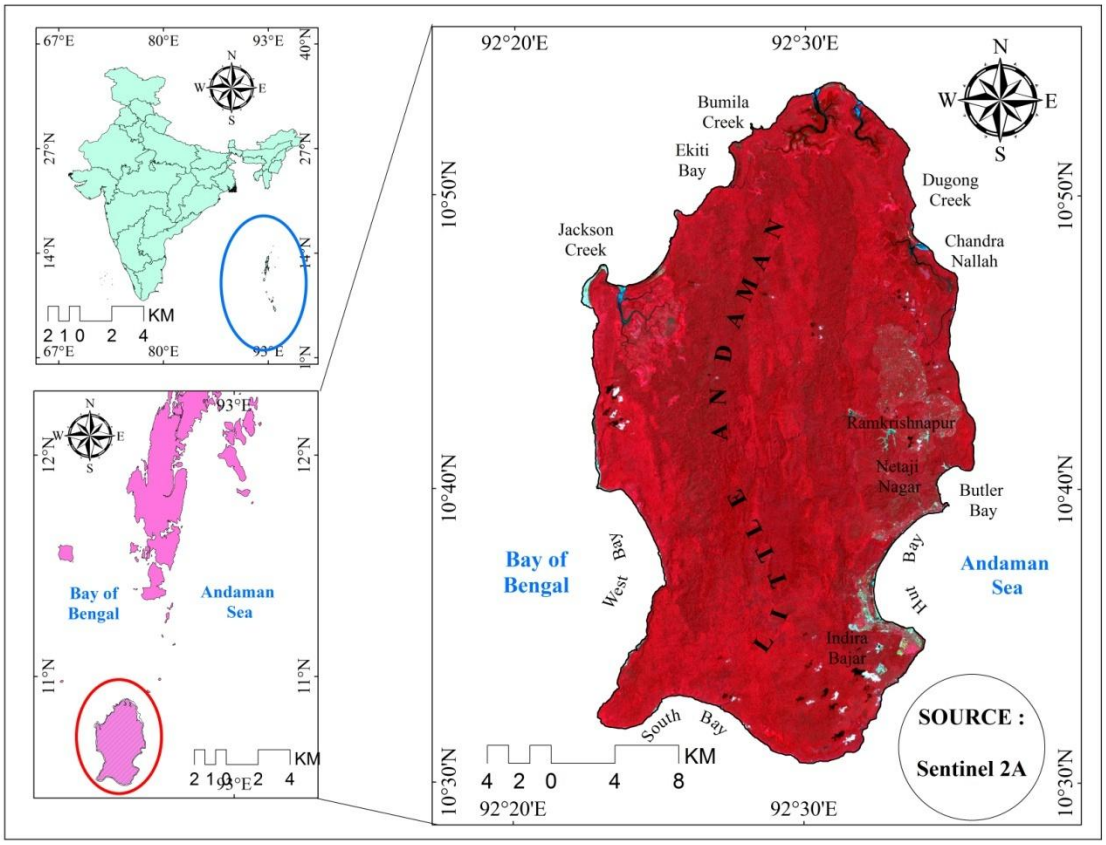

Figure 1: Location map of the study area

4.0 Materials & Methods:

The Sentinels are the satellites of European Space Agency (ESA), designed to deliver a vast amount of data and imagery for Europe's Copernicus program. The Contour map has been generated on the basis of ALOS PALSAR DEM (Source: https://www.asf.alaska.edu/) & SOI Toposheet. The Sentinel 2 (Source: https://cophub.copernicus.eu), ALOS PALSAR DEM and

SOI Toposheet data's are processed for the Geomorphological map & Habitat map . Forest Types and Normalized Difference Vegetation Index (NDVI) Map is prepared with the help of Sentinel -2 Multispectral satellite images(Table:1) .

The biomass estimation have been validated with 30 sample plots (10x10 m) which determined the coordinates at the centre of each plot by using a GPS and Tape . The steam diameters & tree height (measured in distance finder Instrument) of all standing trees in the sample plot are recorded and measured. Finally the estimation of the Above ground Biomass (AGB) with the help of field Survey (Alometric Equation) in the Little Andaman has been done(Figure:2).

4.1 Materials and Data Uses:

Sentinel 2	**No of Bands: 12**
	Data Acquisition: March 04,2019
	Resolution :10m
	Source: https://cophub.copernicus.eu
Alos Palsar	Date: July 07,2007
	Beam Mode:FBD
	Path: 503
	Erame :200
	Flight Direction: Ascending
	Polarization: HH+HV
	Nadir Angel: 34.3
	Resolution : 12.5 m
	Source: https://www.asf.alaska.edu/
Google Earth	

Table:1 various data types used in the study

4.2 Methodology

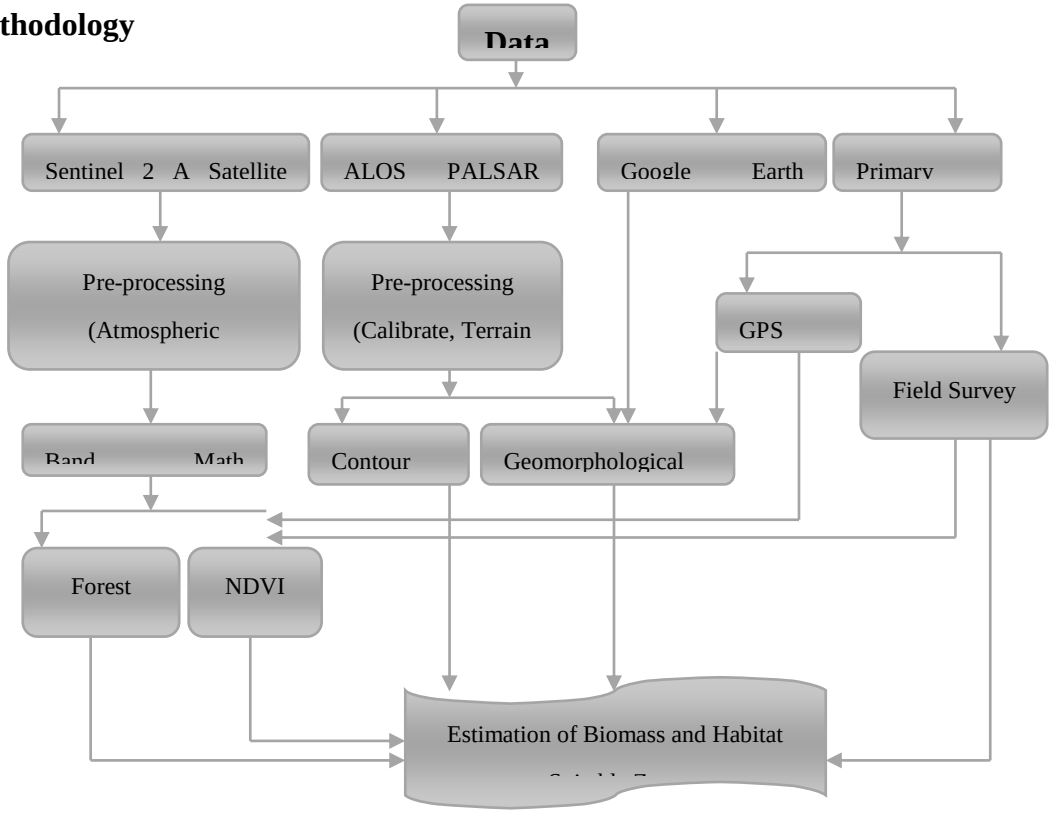

Figure2: Methodological Flow Chart of the Study

5.0 Results & Discussion:

The Little Andaman forms the southernmost of the Andaman group of islands in the Bay of Bengal, lying between latitudes 10° 30' and 10° 55' N and longitudes 92° 221 and 92° 371 E. The island is mostly fiat and about 80% of the land area is covered by tropical evergreen and deciduous rain forests. There are no major perennial rivers on the island.

5.1 Contour Plan:

The contour map helps us to identify the range of elevation of a geographical area. The contour is generally marked depending on the elevation range(Fig:3).

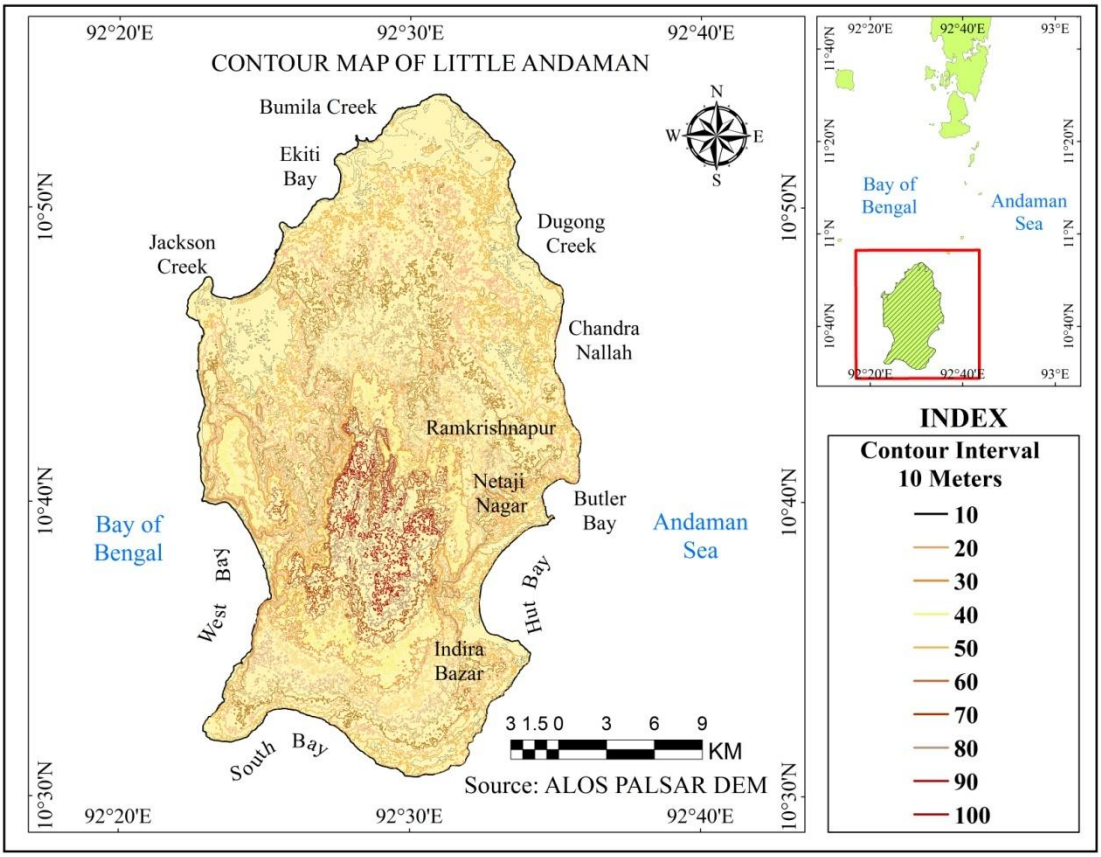

Figure :3 Contour map of Little Andaman with 10 Meter Interval

contour map helps in understanding the terrain characteristic. In the study area, the highest contour is 100 mt. in the middle part of the Little Andaman. And the lowest contour is 10 mt. on the upper and western part of the coast.

5.2 Geomorphological Diversity:

The word geomorphology derives from three Greek words: gew (the Earth), morfh (form), andlogo~ (discourse). Geomorphology is therefore 'a discourse on Earth forms'. The term was coined sometime in the 1870s and 1880s to describe the morphology of the Earth's surface (e.g. de Margerie 1886, 315), was originally defined as' the genetic study of topographic forms' (McGee1888, 547), and was used in popular parlance by 1896.

The present study reveals that the island occupies over 70% areas under elevation of 20 m surface. The surface elevation of 90 m to 115 m occupy the hillocks dominated by limestone near by the Hut Bay . However the southeastern of the island are formed with calcareous mudstone and a grey to yellowish-white limestone of 10 m and 20 m surface near harmindar Bay(Figure:4).

The three marine terraces of 10m, 20m & 30m height represent raised beach surfaces of different period s. the island interior of 30m terrace margins is fringed with abandoned cliff ranging from 60m to 80m in elevation and produced a significant break of slope to develop waterfall across the channels. The areas under 10 m elevation are crenulated with embayment's, subsided valleys and Bays towards north and occupy an wide range of littoral forests and mangrove forests. Most of the river mouth is uplifted and the middle sections are ponded with salt waters during tsunami processes.

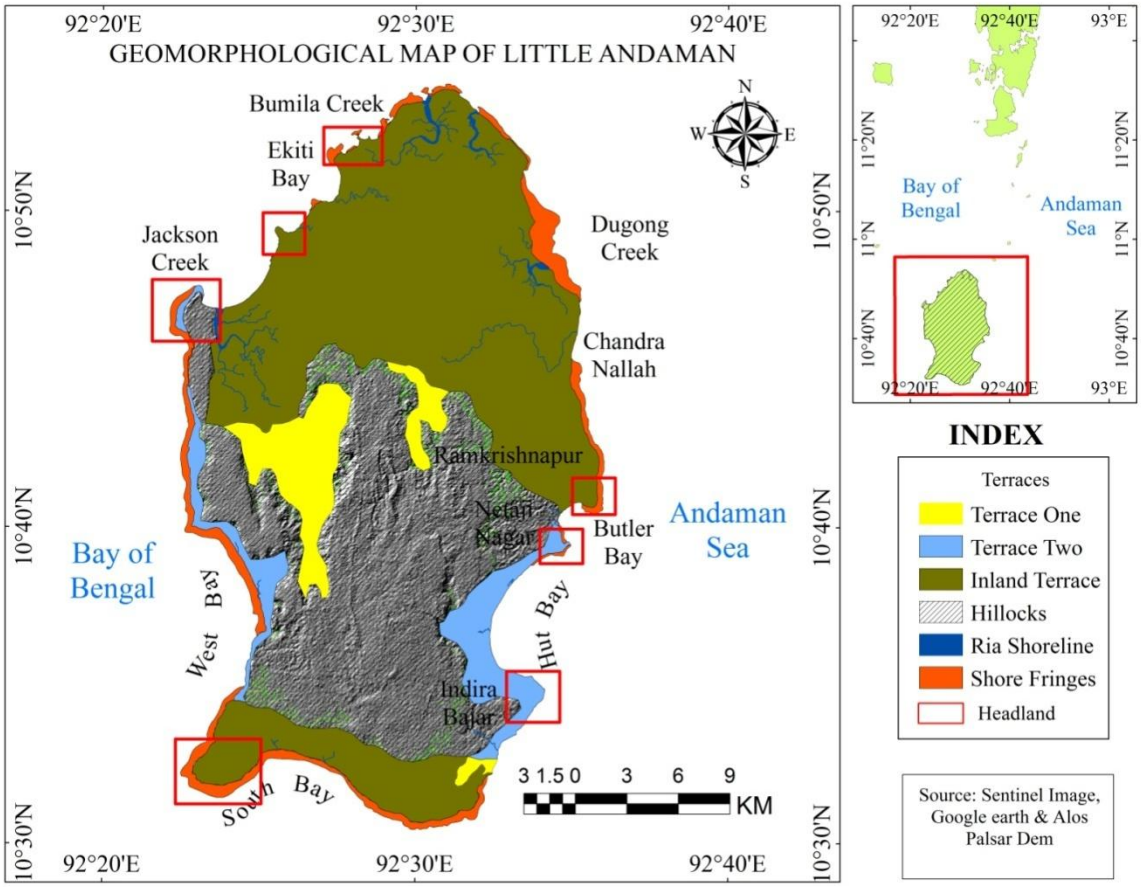

Figure 4 : The Map showing the Geomorphological Diversities of Little Andaman Island

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5.3 Forest Types Map:

The forest of little Andaman are classified into tropical evergreen forest , semi evergreen with under growths, littoral forests and mangrove forests with field based alometric equation uses.

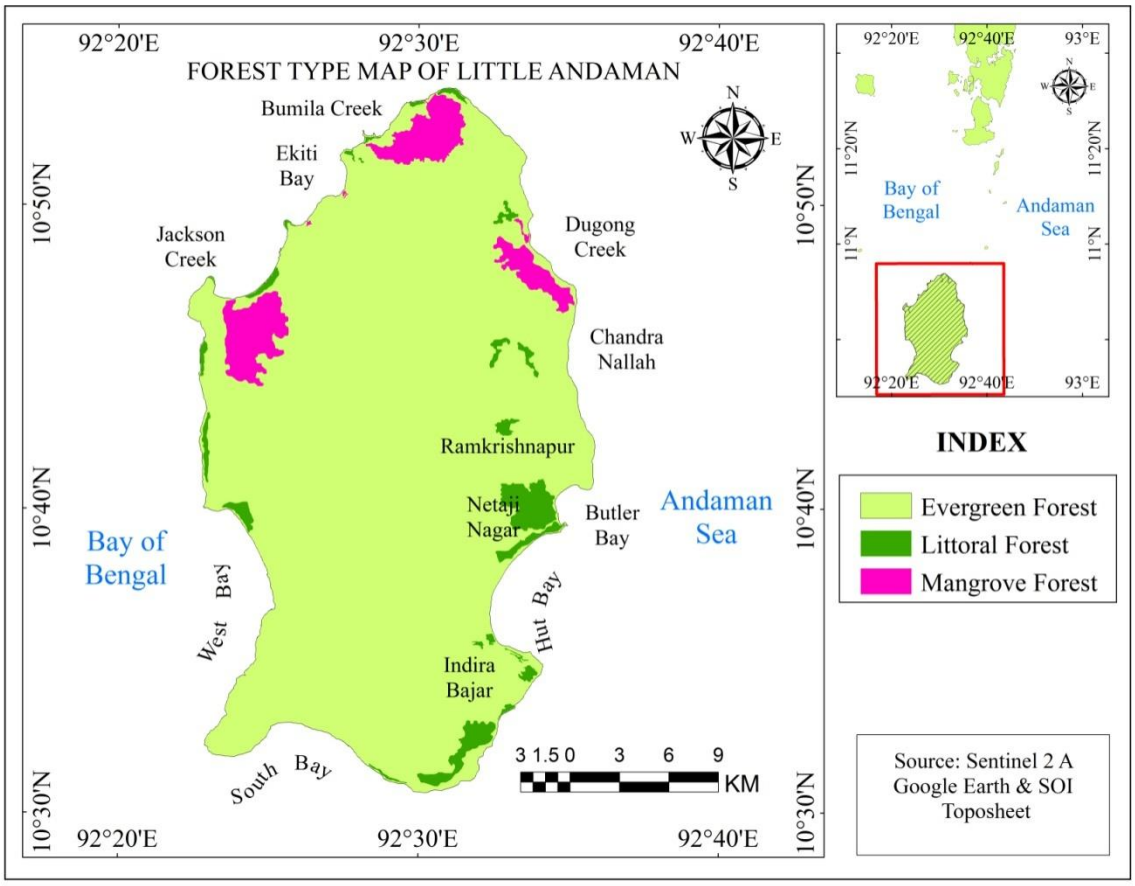

Figure 5 : Forest Types Classified on the Basis of Sentinel 2 and Google Earth Images

Field survey of each classes helped to estimate the biomass of 100m2 are in the ground and the final amount of biomass is calculated after the estimation of area under each forest in the island habitats . Finally the estimate habitat zonatations maps with the help of ground truth verification, Sentinel image and ALOS PALSAR dem data(Figure:5).

5.4 NDVI Map:

Normalized Difference Vegetation Index (NDVI) is a numerical indicator that use the visible and Near infrared bands of the Electromagnetic spectrum, and is adopted to analyse remote

sensing measurements and assess whether the target being observed contains live green vegetation or not.

$$NDVI= (DN_{NIR} - DN_R) / (DN_{NIR}+DN_R)$$

NDVI values range form +1.0 to -1.0. Areas of barren rock, sand, or snow usually show very low NDVI values (0.1 or less). Sparse vegetation such as shrubs and grasslands or senescing crops may result in moderate NDVI values(approximately 0.2 to0.5).

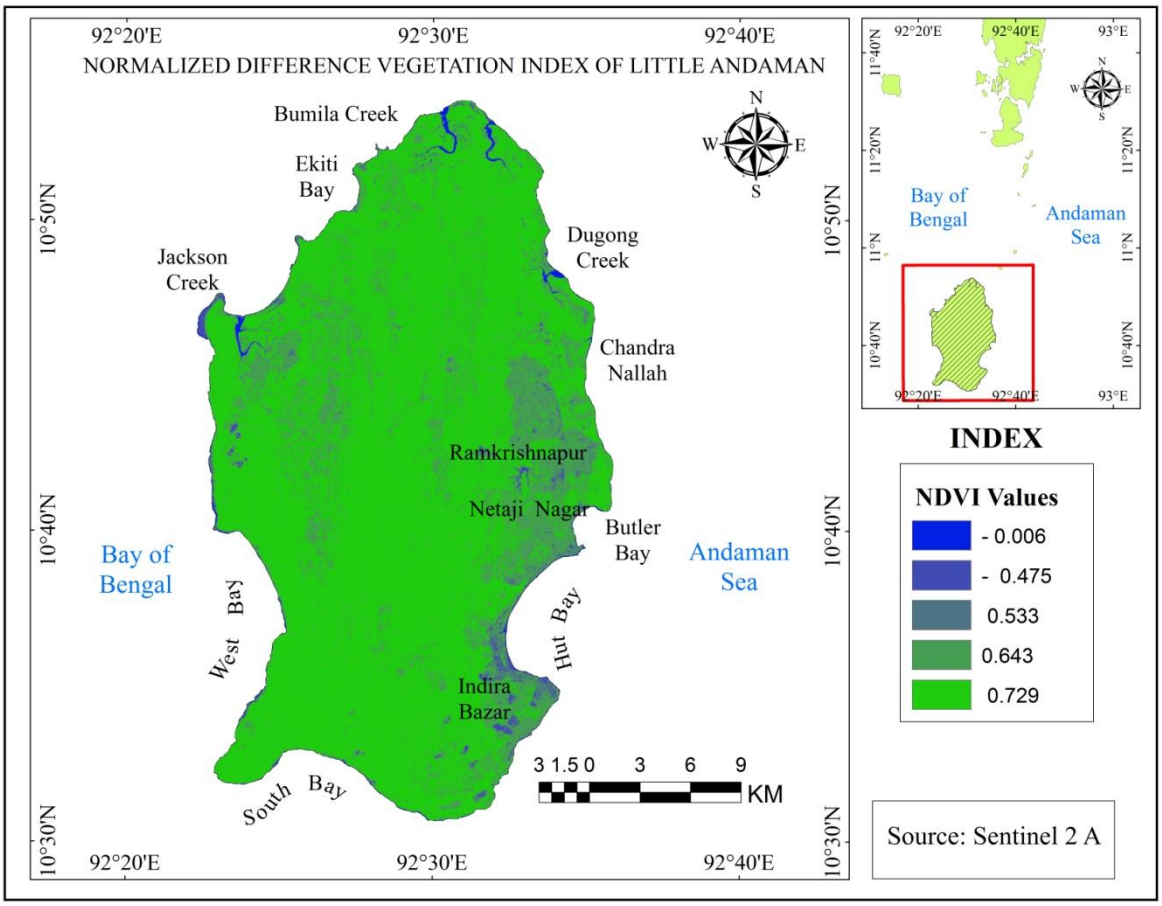

Figure 6: Normalized Difference Vegetation Index (NDVI) on the basis of Sentinel Image

In the present study area the 0.719 highest NDVI value and -0.006 is the lowest NDVI value. Highest NDVI value is found in the South to northern part of the island and other area of the study area west and east part are NDVI value is low(Figure:6). This portion NDVI value lies between range (-0.006- -0.475).

5.5 Habitat Zonatations with topographic surfaces :

The geographical habitats of Little Andaman are classified using the Sentinel 2 Multispectral images and Google Earth images to identify the ecological characters in Tropical oceanic island environment. They are classified as : i. Coral banks in the sub tidal areas below low tide cliff, ii.intertidal meadows dominated by sea grasses, iii mangrove swamps in the inter

tidal and supra tidal region, iv. The littoral forests on the reef terraces of 10 m elevations , v. Semi evergreen forests in the interior parts on under 30m to 60 m platforms and vi. The dense evergreen forests over the interior hills(Figure:7).

During the period of tsunami incident in 2004 some habitats like mangrove swamps and coralline banks were affected by upliftment and subsidence. The inter tidal mangroves on the eastern coastal fringes were shifted to the supra-tidal zones after immergence of the shore platform during the earthquake incidence (2004)

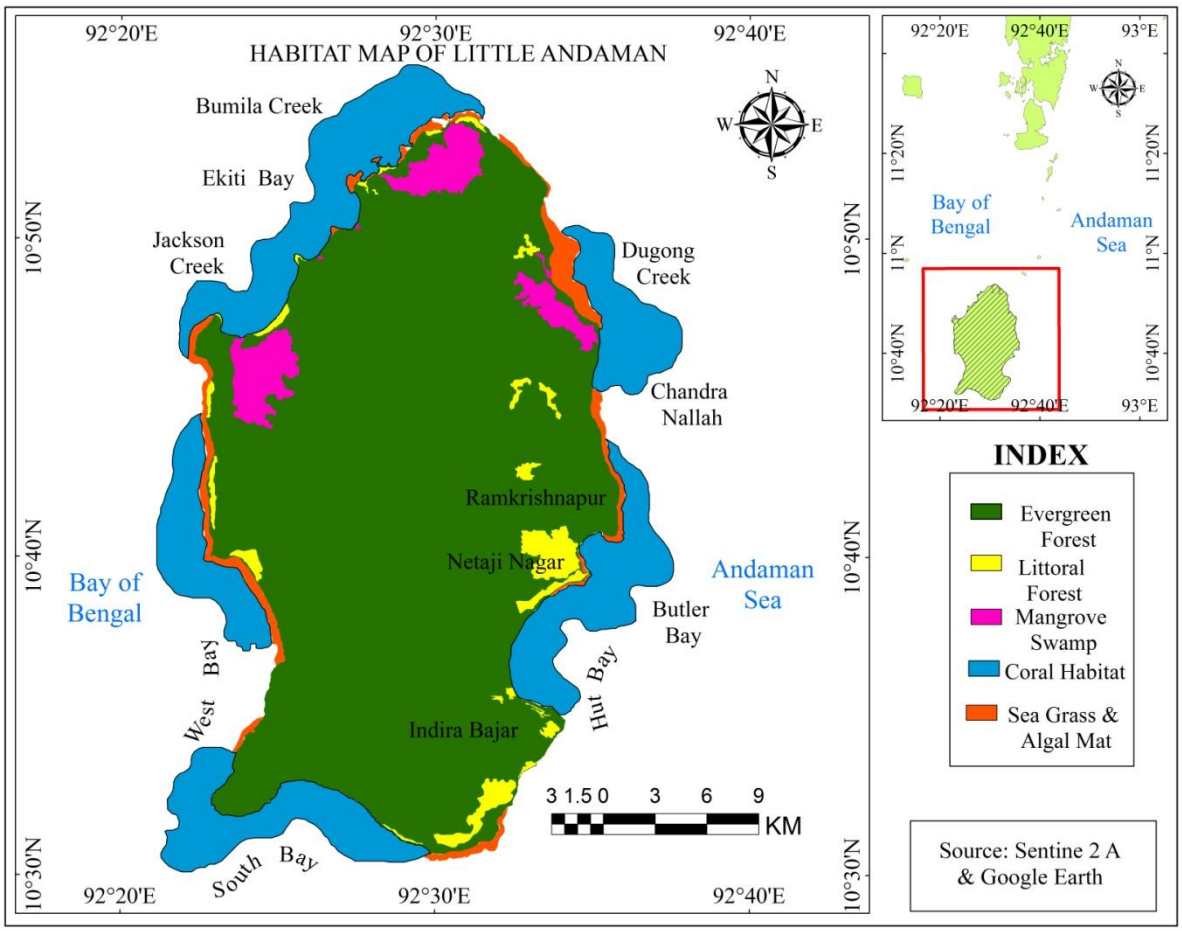

Figure7 : Habitat zonation map of Little Andaman Using Sentinel 2 Image

The biomass of a tree refers to the weight or mass of its living plant tissue and is generally expressed in units of metric tons (t). Live biomass can be separated into above ground (leaves, branches and stems) and below ground (roots) components.

5.6 Field Based AGB Estimation:

Using the Chave et al. (2005) allometric equation for moist tropical forest species the aboveground live dry biomass (AGB in metric tons) of a single tree can be calculated as:

$$\mathbf{AGB_{tree} = (\rho * Exp(-1.499 + (2.148 * \ln(D)) + (0.207 * \ln(D)^2) - (0.0281 * \ln(D)^3)) * 0.001}$$

Where,**ρ** refers to the wood specific density (g/cm^3), and **D** refers to the diameter at breast height(Table2).

Sl.No.	Forest Types	Area under each Forest (Km2)	Estimated Above ground Biomass (Metric tons)
1	Evergreen Forest	2480.95	8549353.7
2	Semi evergreen with Undergrowths	328.310	22653.39
3	Littoral Fringe Forests	42.189	3079.804
4	Mangrove forest	288.4	301229.2

Table 2: Biomass estimation of Four Different Habitats in Little Andaman

6. Conclusions:

The following conclusion may be done on the basis of the above study. The higher platforms and medium height platforms of the island provide the maximum amount of biomass (8549353.7 metric tones) which are dominated by evergreen and semi evergreen forests. The biomass is relatively lower on the shore fringed carbonate platforms with marine terraces and river mouths of calcareous mud stone claystone and reef materials on which the littoral fringe forests and mangrove forests are sparsely located with little under growths(3079.804 metric tones). A few areas of settlements are lying over the backshores of Hut Bay, Buttler Bay, Harmindar Bay & South Bay. Tourisim recreation infrastructures have been expanded along the backshores of the eastern and south eastern coasts of the island for coral watching, Jungle trekking, boating ,hook fishing and for viewing the nature. The biomass of the interior parts will be affected if the settlements and agricultural practices extend landward parts of the island. The littoral fringe forests of the eastern part of the island were affected by earthquake and tsunami activities held in the year 2004.

The micro topography from the ALOS PALSAR Dem shows the various topographic surfaces (four terraces) in the island bounded by 10m, 30 m, 60m & 100m contours. There is a strong relationship between the topography and location of forests

in the island. The areas under subsided valleys of river mouths are dominated by extensive mangrove forests. The other habitats are found in form of coral banks , sea grasses and channel fringe mixed forests and mangroves. Palm trees, Coconuts & Arica- nuts are planted in the platforms of 10m terraces and 30 m terraces on the eastern part of the island for agro forestry measurements to support the livelihood of local people.

Finally, the island ecosystems and their geographical habitats of Limestones areas need environment management to protect the soil erosion and surface runoff in the areas of cleared forests at present.

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