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Horizontal and Vertical Distributional Pattern of Mangroves along Devgad to AcharaEstuaries, Southern Coast of Maharashtra

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Abstract:

A diverse array of mangrove species thrives in the intertidal zones of coastal regions and wetlands situated along coastlines. Mangroves exhibit greater significance in coastal regions compared to inland areas or estuaries due to their ability to serve as a protective barrier against natural disasters such as tsunamis, cyclones, and high winds, which primarily impact coastal areas. The historical and ongoing changes in the extent and quality of intertidal mangrove forests have been significant, and these changes are expected to persist in the present and future. The meticulous analysis of mangrove distribution can effectively mitigate the multitude of challenges arising in coastal regions. The demarcation of the horizontal and vertical distribution of mangroves was accomplished through the utilization of Google Earth Image and SRTM data, respectively. The current study presents an analysis of the spatial distribution pattern, both horizontally and vertically, of mangroves within the estuaries comprising from Devgad to Achara. The distribution of mangroves is predominantly concentrated in either the central regions of estuaries or in areas that are difficult to access.

Keywords: Mangroves, Horizontal, Vertical, Distribution Pattern, Estuary

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Introduction:

Mangroves serve as a protective barrier against strong winds and provide coastal areas with defense against the impact of tidal waves, cyclones, flash floods, and tsunamis. The distribution of mangrove plants is influenced by four key elements: the frequency of tidal currents, salinity, groundwater, and temperature. A diverse array of mangroves, encompassing different types and species, flourish within intertidal zones situated in coastal regions and wetland areas adjacent to coastlines. Mangroves possess significant importance across various dimensions. Firstly, from a biological standpoint, they exhibit a remarkable level of fauna biodiversity. Fisheries and other aquatic species frequently utilize mangroves as habitats during certain stages of their life cycles. Secondly, from an ecological perspective, mangroves fulfill crucial roles in terms of fertilization, stabilization, filtration, and serving as a foundation for food chains and nurseries for numerous fish and invertebrate species. Lastly, from an economic

perspective, mangroves offer a wide range of timber and non-timber forest products that contribute to the support of rural economies. Additionally, they have substantial potential for ecotourism (Ajonina, G., D. A., and Kairo, J., 2008).

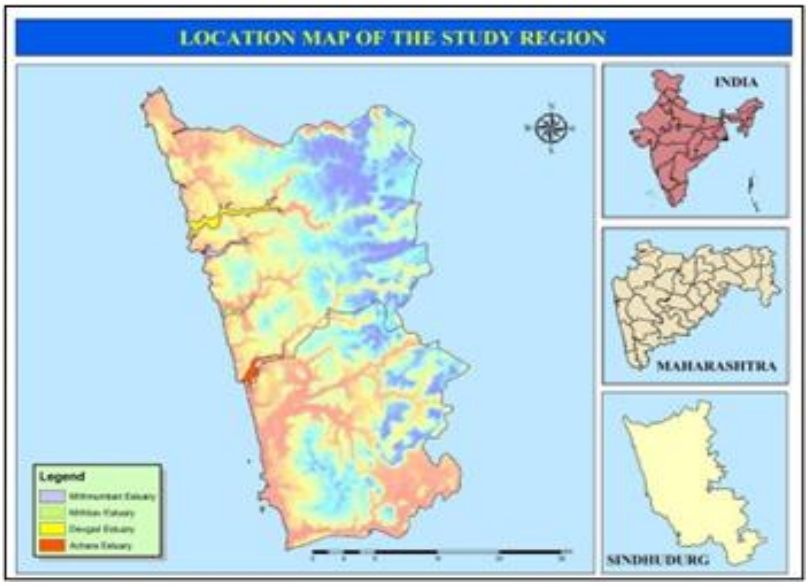
Mangrove forests tend to flourish within the intertidal zone, between the sea and the land, predominantly in tropical and subtropical regions across the globe, specifically between approximately 30° N and 30° S latitude. It is interesting to note that the most extensive distribution of mangroves is observed within the latitudinal range of 5° N and 5° S (Giri et al., 2011). According to Jia et al. (2023), accurate assessment of the extent of mangrove forests requires the availability of datasets that encompass comprehensive information regarding geographical distributions and patch patterns. The evaluation process plays a crucial role in facilitating the implementation of requisite sustainable management practices. The increasing human population residing in estuary regions potentially exerts a discernible influence on the mangrove ecosystem. The aforementioned impacts will result in the degradation of the mangrove ecosystem, leading to a reduction in its overall extent. As stated by Upadhyay and Mishra (2008), the maintenance of a healthy mangrove ecosystem needs the implementation of continuous monitoring. Mangrove forests possess the capacity to sequester huge amounts of carbon dioxide (CO2) and other greenhouse gases from the atmosphere. These gases are effectively captured and stored within the carbon-dense, waterlogged soils of mangrove ecosystems, where they can remain for extended periods of time. In the context of climate change, the provision of this ecosystem service is of utmost importance (Alongi, D. M., 2016). These precious resources provide a wide range of ecological and commercial products, including medicinal plants, timber, and fuel, among others. Consequently, the widespread accessibility and affordability of these natural resources renders them increasingly susceptible to anthropogenic destruction. Mangrove forests serve as a sanctuary for various fauna, including animals, birds, insects, and marine mammals (Mugade N. R. and Sapkale J. B., 2017).

The intricate root system of mangroves effectively traps sediment, which is rich in nutrients. As a result, mangrove ecosystems serve as highly favorable habitats for the growth and development of prawns, crabs, and various fish species. This paper aims to present an analysis of the horizontal and vertical distribution patterns of mangroves within the Devgad, Mithmumbri, Mithbav, and Achara estuaries.

Study Area:

The present investigation is centered on the examination of mangroves located in the southern coastal region of Maharashtra, in close proximity to the Arabian Sea. The area primarily consisted of the marshes located at the estuaries of Devgad, Mithmumbri, Mithbav, and Achara (Figure 1). The study only considered about 400 ha in Study area (Devgad, Mithmumbri, Mithbav, and Achara) in province located in the Study region.

Figure 1: Geographical Location of the study area



Source: Based on https://www.diva-gis.org/Data, Survey of India Toposheet and SRTM data

Methodology:

Landsat satellite images of the study area were obtained from the United States Geological Survey (USGS) with a spatial resolution of 30 m. We used Landsat 8 OLI with the spatial resolutions of 30 m with no cloud cover to monitor the mangrove area change (Nguyen, L. D et. Al. 2019).

The demarcation of mangrove distribution patterns in estuaries was conducted using Google Earth images and SRTM data, which allowed for the analysis of both horizontal and vertical distribution. In order to obtain data regarding the horizontal distribution of mangroves, each estuary was partitioned into one-kilometer segments, spanning from the mouth region to the upstream area. In order to assess the vertical distribution of mangroves in relation to their altitudinal characteristics, the estuary region has been divided into distinct zones, including but not limited to the ranges of 0-3 m, 3-6 m, 6-9 m, and so forth.

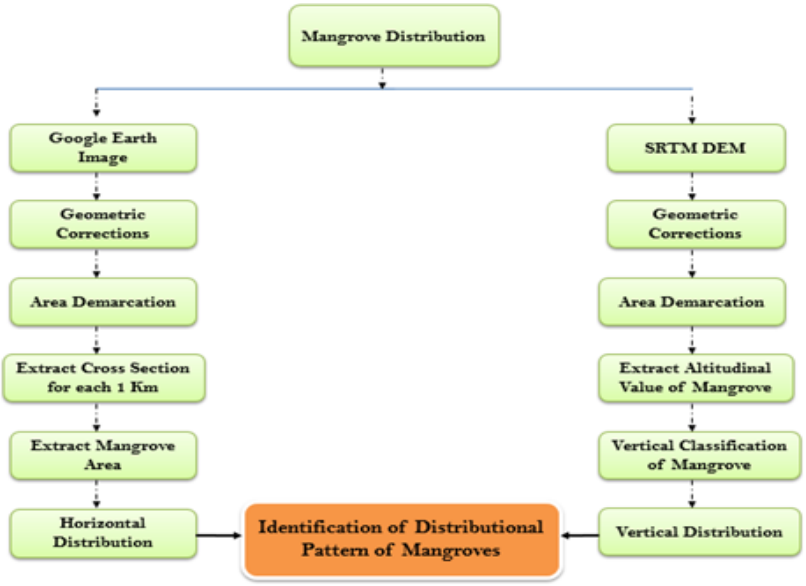


Figure 2: Methodology

Results and Discussion:

Mangroves are known by several local names in different locations. Mangroves are also known as chipi, kandal, khajan, hurshi, hurra, tivar, and bhidshi. The name mangroves refer to an ecological group of plant species known as the salt tolerant forest ecosystem, which offers a number of ecological and economic products and services while also supporting a variety of other coastal and marine ecosystems (Mugade, N. R., & Sapkale, J. B., 2017). The world's mangroves, an evergreen forest environment that can salt tolerant, are typically situated in tropical and subtropical intertidal areas between 32 N and 38 S latitude (Singh, J. K., 2020)

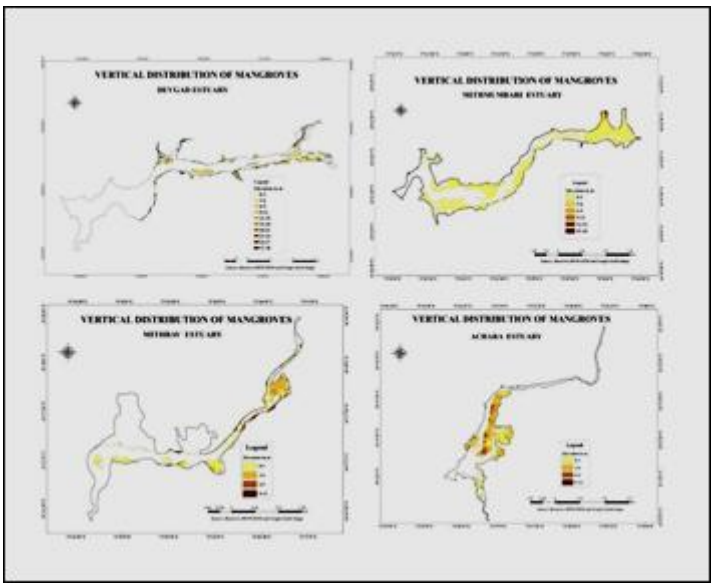
Vertical Distribution

Table 1: Vertical Distribution of Mangroves along Devgad to Achara Estuaries

Elevation (In m)	Mangrove Area (in ha)				
	Devgad Estuary	Mithmubari Estuary	Mithbav Estuary	Achara Estuary	Total
0-3	39.81	120.33	17.81	50.54	230.32
3-6	37.43	8.19	13.25	66.41	127.28
6-9	15.25	1.29	4.11	14.13	34.78

9-12	4.14	0.55	1	0.28	5.97
12-15	1.2	0.09	-	-	1.29
15-18	0.18	0.18	-	-	0.37
18-21	0.18	-	-	-	0.18
21-24	0.28	-	-	-	0.28
24-27	0.09	-	-	-	0.09
27-30	0.09	-	-	-	0.09

Figure 3: Vertical Distribution of Mangroves Devgad, Mithmumbari, Mithbav and Achara Estuaries



The expansive nature of the Devgad Creek's mouth results in a significant salinity level in the water salinity is 5.42 PPT, consequently leading to a scarcity of mangroves in that area. The mangrove vegetation occupies a total area of 39.81 hectares and 37.43 hectares within the elevation ranges of 0-3 meters and 3-6 meters, respectively. It is observed that the extent of mangrove coverage gradually decreases as one moves towards the upstream region of the Devgad estuary. The Mithmumbari estuary, situated at an elevation of 0-3 meters, exhibits a notable extent of mangrove vegetation spanning an area of 120.33 hectares, as indicated in Table 1. Mangroves exhibit robust growth at lower altitudes owing to the presence of a suitable equilibrium between saline and freshwater. The limited accessibility of the Mithmumbari estuary area resulted in minimal degradation of mangroves.

The Mithbav estuary was investigated, revealing a mangrove land area of 36 hectares, of which 31 hectares were found at elevations ranging from 0 to 3 meters and

3 to 6 meters. A significant portion of the Mithbav estuary has undergone conversion for the purpose of shrimp farming, leading to a reduction in the extent of mangrove vegetation. The Achara estuary exhibits a substantial presence of mangrove vegetation, which has been established through deliberate mangrove plantation efforts. The predominant distribution of mangroves was observed at elevations ranging from 0 to 3 meters, covering an area of 50.54 hectares and also at elevations between 3 and 6 meters, occupying a total area of 66.41 hectares.. According to the data presented in Table 1 and Figure 3, the research area exhibits a total mangrove cover of 230.32 hectares at an elevation range of 0-3 meters, and 127.28 hectares at an elevation range of 3-6 meters.

Figure 4: Mangroves in study area

Horizontal Distribution:

The absence of mangrove cover within a 3-kilometre radius of the Devgad estuary can be attributed to factors such as the estuary's expansive opening, limited availability of fresh water, and inadequate water depth. Consequently, a significant proportion of the mangrove vegetation can be observed at a range of 5 to 13 kilometres. The expansion of mangrove cover occurred progressively within a range of 1 to 8 kilometres along the Mithmumbari estuary (see Figure 5).

Table 2: Horizontal Distribution of Mangroves along Devgad to Achara Estuaries

Distance (In km)	Mangrove Area (in ha)				
	Devgad Estuary	Mithmubari Estuary	Mithbav Estuary	Achara Estuary	Total
0-1	0	3.42	0.05	0.28	3.75
1-2	0	23.62	6.66	25.85	56.13
2-3	0	25.07	5.17	59.55	89.79
3-4	1.44	17.46	8.49	20.71	48.1
4-5	2.24	9.99	4.84	13.08	30.15
5-6	10.26	7.42	10.88	0.5	29.06
6-7	9.26	31.89	0.61	4.1	45.86
7-8	15.15	12.42	-	6.73	34.3
8-9	5.64	-	-	3.03	8.67
9-10	7.92	-	-	-	7.92
10-11	6.41	-	-	-	6.41
11-12	16.75	-	-	-	16.75
12-13	20.19	-	-	-	20.19
13-14	3.45	-	-	-	3.45

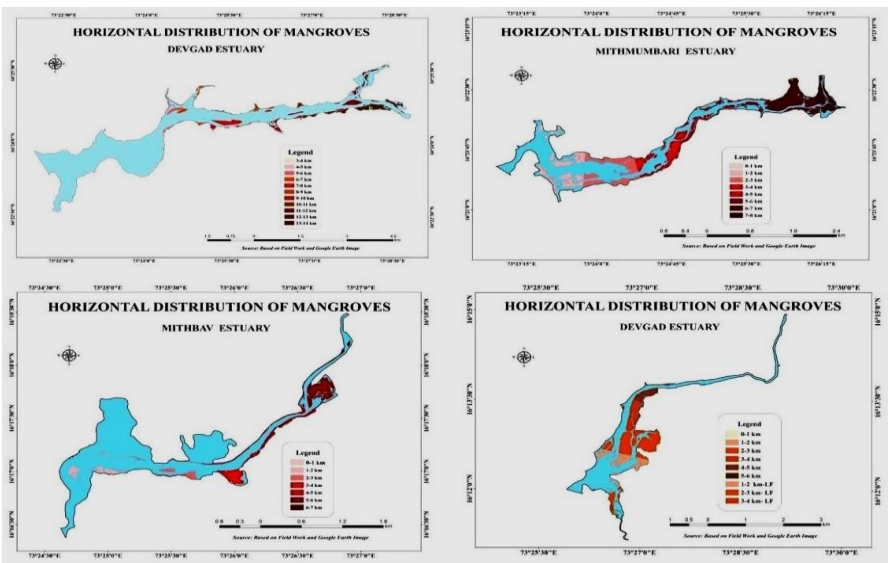


Figure 5: Horizontal Distribution of Mangroves Devgad, Mithmumbari, Mithbav and Achara Estuaries

The gradual distribution of mangrove cover in the Mithmumbari estuary can be attributed to the factor of inaccessibility. In the instance of the Mithbav estuary, the majority of the mangrove vegetation was observed at distances of 3-4 km and 5-6 km, corresponding to areas of 8.49 hectares and 10.88 hectares, respectively. Despite its relatively small size compared to other estuaries, the Mithbav estuary exhibits robust mangrove ecosystems. As a result of the implemented rehabilitation efforts, the Achara estuary currently exhibits a substantial presence of mangrove vegetation. Table 2 displays the respective areas of 25.85, 59.55, and 20.71 hectares at distances of 1-2, 2-3, and 3-4 kilometers.

Conclusion:

The findings of this study revealed that the Mithmumbari and Achara estuaries exhibit the highest extent of mangrove coverage. This can be attributed to factors such as the inaccessibility of the area, the physical characteristics of the estuary, and the implementation of mangrove replantation efforts in the respective locations. The Mithbav estuary exhibits the smallest extent of mangrove coverage, encompassing a mere 36 hectares, in comparison to other estuaries. This diminishment in mangrove land can be attributed to the conversion of such areas into shrimp ponds. The majority of mangroves are found within an elevation range of 0-6 meters, covering a total area of 357.60 hectares. This area accounts for approximately 89.88% of the overall mangrove coverage. In instances of horizontal distribution, mangroves exhibit a notable concentration within the central region of the estuary, specifically spanning a distance of 1-8 kilometres. This particular range encompasses an area measuring 333.39 hectares, accounting for approximately 83.24% of the total mangrove area. The Devgad estuary exhibits an exceptional feature in which there is a complete absence of mangroves within a distance of 1-3 kilometres.

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