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A Study on Habitat Loss of Mangrove Swamps/Salt Marshes over a Period in Visakhapatnam Urban Environment, Andhra Pradesh, India

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Abstract
The present study provides a baseline data on ecological status of mangrove swamps and salt marshes for their conservation and management in Visakhapatnam coastal environments. An ecological survey of outer harbor mangrove swamps and salt marshes was conducted to generate baseline data on mangrove plant species and habitats status during the period from September 2014 to June 2015. This study on mangrove swamps of Visakhapatnam outer harbor indicates that rapid decline of mangrove species and habitat loss was observed in area wise and species composition that showed decline of 15-20 mangrove species during the year 1998 to 6 species at present. The study was extensively done concentrating on the degradation of mangroves in the particular area which was not done before.

Keywords: Carbon sequestration, Mangrove swamps, Pollution mitigation, Salt marshes.

1.0 Introduction:
Mangrove is a tree or shrub which grows in tidal, tropical waters and coastal swamps having numerous tangled roots that grow above the ground and forms dense thickets. Assemblages of mangrove woody trees and shrubs are called mangrove forests/swamps. Mangrove forests are distributed in the inter-tidal region between sea and land in the tropical and subtropical regions of the world approximately 30^0N and 30^0S latitudes(Giri *et. al.*, 2010).At least 35% of the area of mangrove forests has been lost in the past two decades (Ivan Valiela *et. al.*,2001). Mangrove swamps protect the coastal areas from erosion, storm surges (especially during hurricanes) and tsunamis. They break down the pollutants or contaminated soils and play a significant role in carbon sequestration process. The mangrove ecosystem is one of the most productive ecosystems on the globe, despite being one of the most threatened. The land area covered by the mangrove ecosystem has been reduced by more than half in the last 40 years. (Walter *et. al.*, 2014). The loss of ecosystem services due to mangrove destruction/conversion is likely to be different between biogeographic, geographic regions and forest types (Lee, *et. al.*, 2014). Deforestation or inappropriate management of mangrove catchment areas may silt up mangrove systems and affect their health status and regeneration, thus diminishing their protective function and ecosystem services (Wever *et. al.*, 2012). Unfortunately, the world's mangroves are rapidly degrading due to rising coastal population, climate change, and destruction for coastal development, agriculture, and aquaculture. Considering their value for the environment and coastal communities, mangrove conservation should become a priority and effort must be invested to find new and successful methods for conserving mangrove ecosystems (Alyssa, 2012).

The successful vegetation largely depends on the reproductive nature, fruit and seed setting behavior of the species (Ghosh *et. al.,* 2012).Coastal ecosystems such as mangroves can reduce risk to people and infrastructure from wave damage and flooding. The continued provision of these coastal defense services by mangroves is dependent on their capacity to adapt to projected rates of sea level rise (McIvor *et al.,* 2013). Mangrove forest species mostly thrive in harsh environment at the land sea interface; and it is suggestive that environmental conditions vary along land sea gradients, informing the species specific natural constellation in optimally favorable zones based on their habit and tolerance to prevailing conditions (Olagoke *et. al.*, 2013). Despite of being effected by natural calamities, mangroves were naturally recruiting seismically repositioned intertidal surfaces, and growing well (Brown *et. al.*, 2015).Mangrove forests are considered as probable and efficient sink of atmospheric carbon (Chaudhari *et. al.*, 2015). Mangrove species are uniquely adapted to tropical and subtropical coasts, and although relatively low in number of species, mangrove forests provide at least US $1.6 billion each year in ecosystem services and support coastal livelihoods worldwide. Globally, mangrove areas are declining rapidly as they are cleared for coastal development and aquaculture and logged for timber and fuel production (Beth *et. al.*, 2010). The ecological and economic importance of mangrove ecosystems is well established and highlighted by studies establishing a correlation between the protective function of mangroves and the loss of lives and property caused by coastal hazards. Nevertheless, degradation of this ecosystem remains a matter of concern, emphasizing the fact that effective conservation of natural resources is possible only with an understanding of the attitudes and perceptions of local communities (Badola *et. al.*, 2011). Mangrove forests are among the world's most productive ecosystems and are the only forests situated at the confluence of land and sea in tropical and subtropical latitudes. Mangroves are one of the biologically diverse ecosystems in the world, rich in organic matter and nutrients and support very large biomass of flora and fauna. With continuing degradation and destruction of mangroves, there is a critical need to understand the biodiversity of the mangrove ecosystems (Pawar, 2011). Mangrove forests could play a crucial role in protecting coastal areas from sea level rise caused by climate change (Van Maanen *et. al.*, 2015). Due to over exploitation of mangrove species and habitat loss now these mangroves are in threatened status. The present study provides a baseline data on ecological status of mangrove swamps and salt marshes for their conservation and management in Visakhapatnam coastal environments.

1.1 Study Area:

The Mangrove swamps and salt marshes are located at North- Eastern part of Visakhapatnam is characterized by swamps and wetlands are of inter tidal in origin, have embodied Eastern Ghats ridges, which are abutting the Sea (Bay of Bengal) in the eastern side. Soils in this area have mainly sandy texture with largely contaminated industrial effluents. The swamps are occupied with dominant mangrove trees of black mangroves (*Avicenniaofficinalis and Avicennia marina*). Climatic conditions of the study area shows three well defined seasons; dry, rainy and cold. This study was conducted at outer harbor (OH) mangrove swamps/salt marshes between $17^0 42^{'}$and17^0 $43^{'}$Latitudes & $83^0 15^{'}$and 83^0 $16^{'}$ Longitudes, extended in an area of approximately 55ha (0.55km^2).

2.0 Materials and Methods:

The aim of the study is to evaluate the amount of degradation took place over a period. The objectives include the proper restoration of the mangrove area and the lessening of the pollution from nearby industries of the study area. An ecological survey of outer harbor mangrove swamps and salt marshes was conducted to generate baseline data on mangrove plant species and habitats status during the period from September 2014 to June2015. Biological diversity of the mangrove swamps was enumerated based on in sight observations. The samples of leaves from different mangrove plant species were collected in airtight polythene covers for identification and to determine the species composition, their ecological status were analyzedin relation to industrial pollution impacts on the mangrove swamps/salt marshes.

3.0 Results and Discussion:

A total of six mangrove plant species and its associates were recorded from the outer harbor mangrove swamps. It was observed that the mangrove tree vegetation constitute the family *Avicenniaceae*is the only dominant tree found all over the swampy areas. The six species belongs to genus *Avicennia*, *Acanthus* and *Suaeda* of the families *Avicenniaceae, Acanthaceae* and *Chenopodiaceae* include *Avicennia officinalis, Avicennia marina* and *Avicennia alba*, *Acanthus ilicifolius, Suaeda maritime* and *Suaeda monoica* respectively. This swamp was once extended to an area of 320ha(3.12km^2)during the year 1998 comprises of dense growth of mangrove strands (15-20species) with families *Avicenniaceae, Acanthaceae, Pandanaceae, Chenopodiaceae, Verbanaceae and Convolvulacea* (Sattar, 1998).

Fig. 1: Map showing the study area 'Outer Harbour' in Visakhapatnam (Source: Google Earth).

Fig. 2: Pollutants discharged into the mangroves from nearby industries and outer harbor, Visakhapatnam.

A **B** **C**

Fig. 3: Mortality of mangrove plants due to release of industrial effluents and pollution

Table 1: Check list of plant species at outer harbor mangrove swamps/salt marshes, Visakhapatnam.

S.No	Family	Species	Habitat
1.	Avicenniaceae	Avicenniaofficinalis	Tree
2.	Avicenniaceae	Avicennia marina	Tree
3.	Avicenniaceae	Avicennia alba	Tree
4.	Acanthaceae	Acanthus ilicifolius	Shrub
5.	Chenopodiaceae	Suaeda maritime	Shrub
6.	Chenopodiaceae	Suaedamonoica	Shrub

Table 2: Present ecological status of outer harbor mangrove swamps ofVisakhapatnam

Year	Area (ha)	Occurrence of families (no.)	Available families	Total species of mangroves (no.)
1988	320(ha)	6	*Avicenniaceae* *Acanthaceae* *Pandanaceae* *Chenopodiaceae* *Verbanaceae* *Convolvulaceae*	15-20
2015	55(ha)	3	*Avicenniaceae* *Acanthaceae* *Chenopodiaceae*	6

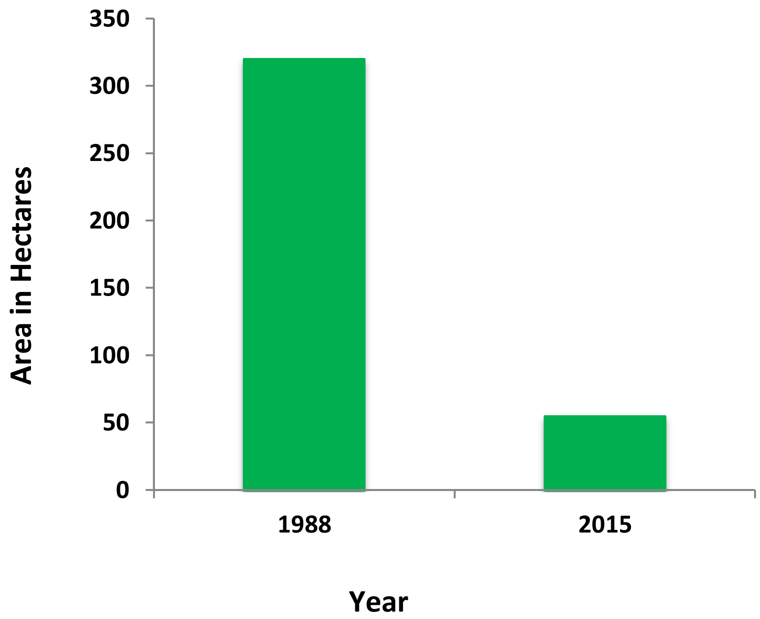

Fig. 4: The declination of mangrove area over a period of time (1988-2015)

Now these species are becoming very rare and threatened and some of the species were disappeared from the swamp areas due to anthropogenic impacts, industrial pollution, reduction in fresh water outflows, decrease in sediment loads into the mangroves, cyclones and storm surges, geomorphologic changes etc (Ramasubramanian and Ravishankar, 2004). But the main reason was due to industrial pollution and reclamation of habitats for establishment of industries. The chemical pollutants like Hydrogen sulphide (H_2S), Hydrogen chloride (HCl), Chlorine (Cl), Sulphur dioxide (SO_2), Carbon monoxide (CO), Carbon dioxide (CO_2) and Iron ore dust from port released in huge quantities (Fig: 2) and these flows into the mangrove swamp, thus causing the mortality of plants (Sattar, 1998) (Fig: 3). The loss of nutrients in soil also accounts for the disappearance of mangroves. Moreover over exploitation of mangrove swamps for traditional and commercial purpose as the local communities have always used the mangrove species as a source of fuel wood for cooking purpose and heating, and for constructing houses, huts, fences, matting and scaffolds (Daniel, 2002). For conservation of mangrove swamps and salt marshes of harbor area, the following measures have been recommended- Digging canals to reduce the salinity of soils, draining of stagnant water, planting of saplings and propagules of *Avicennia marina, Avicennia officinalis* and *Excoecaria agallocha* in collaboration with forest department and local NGO's to protect the areas from further degradation as these mangrove swamps and salt marshes were useful in pollution mitigation and carbon sequestration process.

4.0 Conclusion:

The present study on mangrove swamps of Visakhapatnam outer harbor indicates that rapid decline of mangrove species and habitat loss was observed in area wise and species composition that showed decline of 15-20 mangrove species during the year 1998 to 6 species at present with the most dominant ones; *Avicenniaofficinalis, Avicennia marina &Avicennia alba* and associates *Acanthus ilicifolius, Suaeda maritime* and *Suaedamonoica*. It was clearly evident that this degradation was mainly due to the pollutants releases from the nearby industries and factories like HPCL (Hindustan Petroleum Corporation Limited), VPT (Visakhapatnam Port Trust). The conservation measures are initiated in collaboration with Andhra Pradesh forest department and local NGO's for protection of these threatened mangrove swamps.

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