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woodlands are salt tolerant forest eco system of intertidal areas along coastlines (Hamilton and Snedekar, 1984; refered to Aschbacher *et al.*, 1994). Mangroves are coastal vegetation that have unique characteristics which permit survive on both marine and terrestrial environment. They have biological adaption system to adjust to day by day changes of nature, for example, temperature, saltiness and inundation period. In a few nations mangroves are utilized as wild life sancturies, securing coastline and river banks against tidal bores and cyclones.

PROBLEM STATEMENT

Coringa mangrove woodlands are under threat and are declining day by day. The changing aspirations, changing lifestyles, contamination of ocean water, unpredictable and low rainfall; chopping woodlands, limited access to clean water/sanitation and the inappropriate and degrading fishing practices has created problems at the coastal regions in general In addition to this The East Godavari estuarine area is facing the difficulties of erosion of coastline from the Godavari river mouth, shifts in sand spits bringing out the loss of mangrove vegetation and low discharge of river water to the Kakinada bay. The mangrove woodlands of the area is highly vulnerable to the climate change. Increasing saltiness and precipitation pattern also affects the species distribution, change in biodiversity and species migration

Referring to the current situation, the integrated technical research of remote sensing and GIS Plays a very crucial part in detecting present situation. Integrating and compilation of all data related to Land use activities and forest cover variations provide detailed guide line for managing natural resources urgently.

METHODOLOGY

The general flowchart below describe some main tasks for making land use maps of 1996, 2001, 2006, 2010, 2015 and mangrove forest cover change detection and site suitable zoning for Mangrove afforestation in Kakinada.

RESULTS AND DISCUSSION

LU/LC Analysis

The images utilized for this study were extracted from a Landsat 5 Thematic Mapper (TM) and Landsat 8 (OLI) scenes are taken. Ground resolution of these images is 30 meters. Landsat TM records data in seven different bandwidths. These bandwidths are broken down into portions of the visible, infrared, and thermal infrared regions of the electromagnetic spectrum. From these various bandwidths a great deal of information about the land cover can be displayed and analyzed.

Land Cover Categories

For the purposes of this study the terms LU and LC have been joined as one of the entity for the depiction of the landscape within the study area. It will be noted that while land use and land cover are considered as isolated entities they have been combined in this study in order to conform with the level of detail. Also, finer levels of inquiry would most likely need to separate measures of land use and land cover and/or to use more detailed levels of the classification scheme.

Supervised Classification

The LULC maps of the whole five years present mangrove woodlands occupied area near coastline. Shrimp farm were found surrounding the mangrove territory. The outputs from maximum likelihood were utilized to establish preliminary land use mapping of each five

Figure 1: Research Procedure

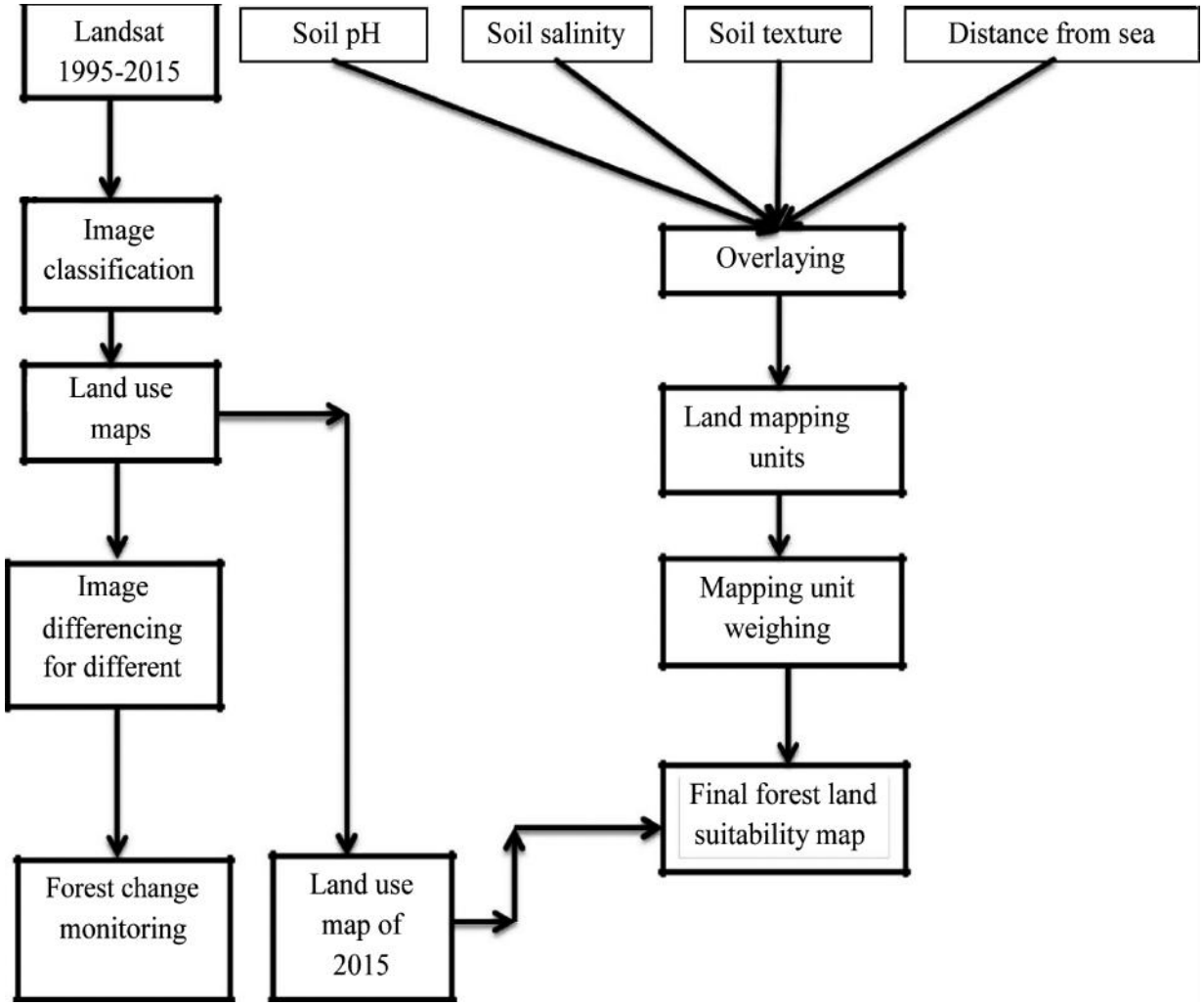


Table 1: LU LC Classification Categories

LU LC Classification Categories	Level-1
1	Mangroves
2	Aqua culture or salt pans
3	Agriculture
4	Builtup area
5	Stable mud flats
6	Sand
7	Water body

images. The maps were verified and recoded form ground data and produced the LULC map. Urban area was found decreasing from 1996-2001 because of the terrific cyclone occurred in the 2000 lot of built up area got damaged in kakinada but its area was constant in 2001, 200, 2015. In 2010 its area is slightly decreased which might be caused from misclassification between stable mud flats and urban area. Some of the water bodies also misclassified with aqua culture due to the similar spectral characteristics.

From the results we can clearly observe that the mangrove are was decreased from 1996 to 2001 due to increase of aqua culture and salt pans and from 2001 to 2005 we can see increase of mangrove forests because in 2004 afforestation is done by M.S Swaminathan foundation. So we can see the tremendous increase in mangrove forests and from 2005 to 2010 again there is a decrease in mangroves due to the increase in aqua culture and salt pans and from 2010 to 2015 again there is a gradual decrease of mangroves.

These are LULC 1996, LULC 2001,LULC 2010, LULC 2015:

Figure 2: Changes of Mangrove Forests

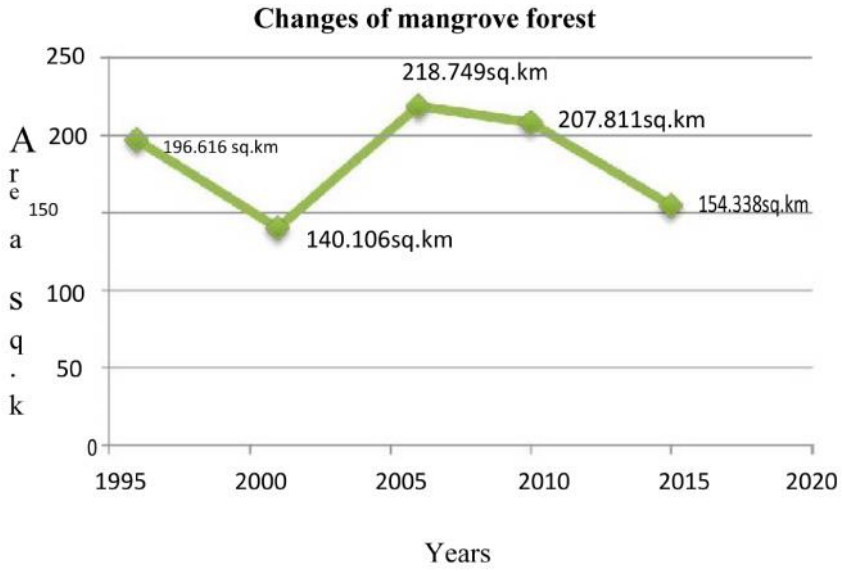


Figure 3: Land Use Map Derived from Landsat-5 (1996)

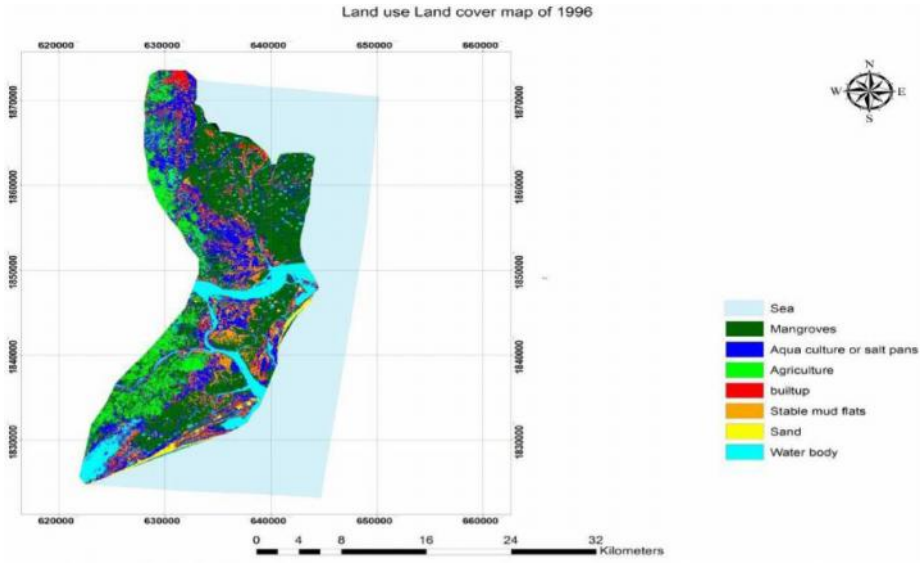


Figure 4: Pie Chart of LULC (1996)

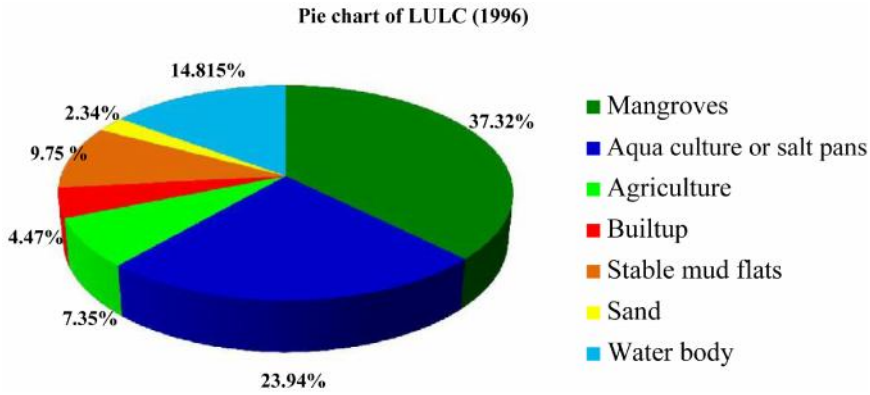


Figure 5: Landuse Map Derived from Landsat-5 (2001)

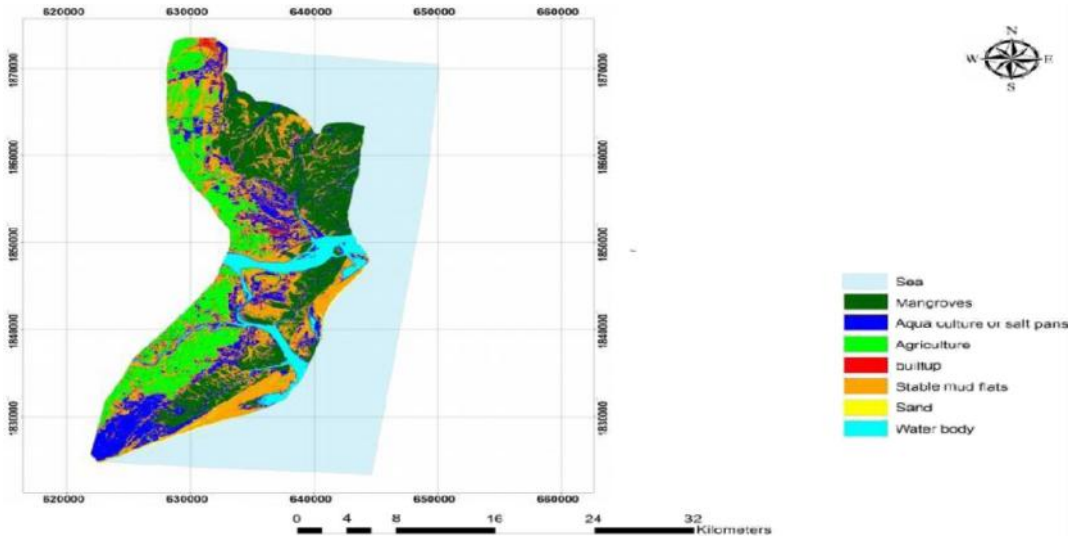


Figure 6: Pie Chart of LULC (2001)

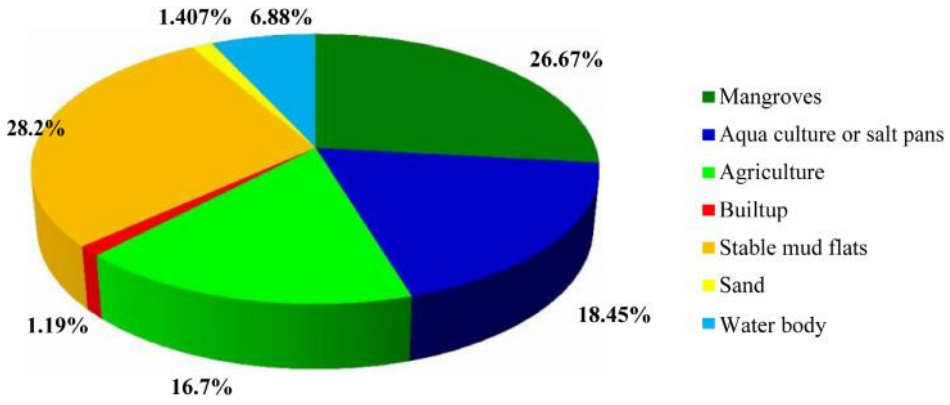


Figure 7: Landuse Map Derived from Landsat-5 (2006)

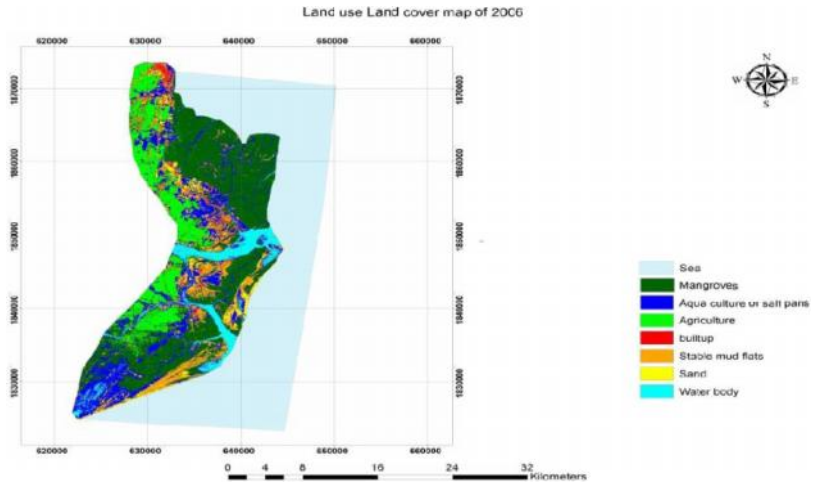


Figure 8: Pie Chart of LULC (2006)

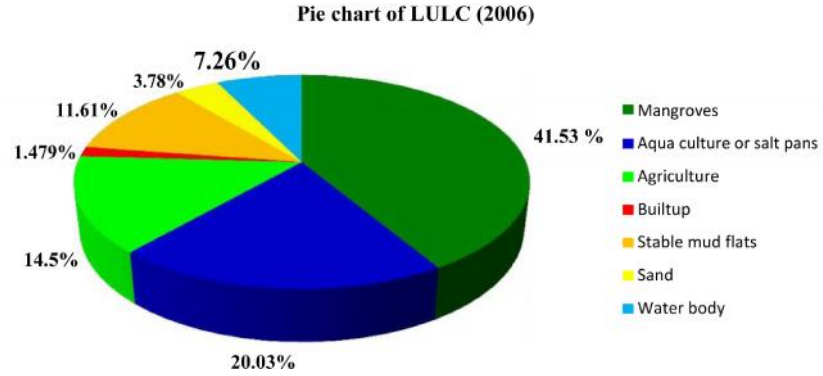


Figure 9: Land Use Map Derived from Landsat-5 (2010)

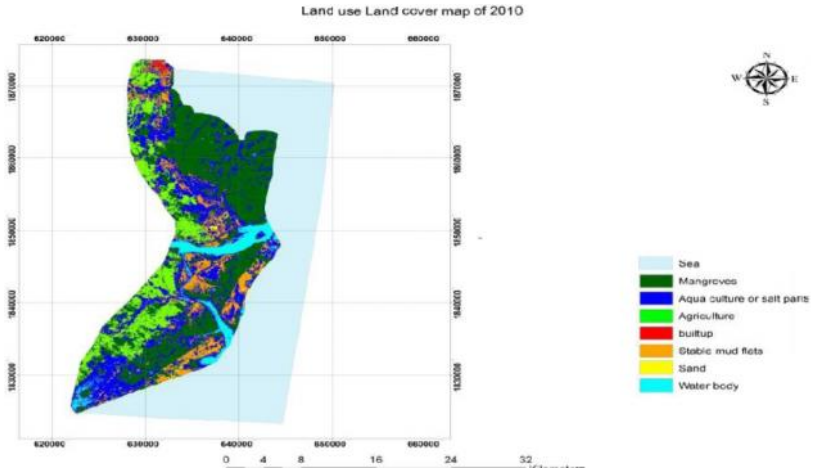


Figure 10: Pie Chart of LULC (2010)

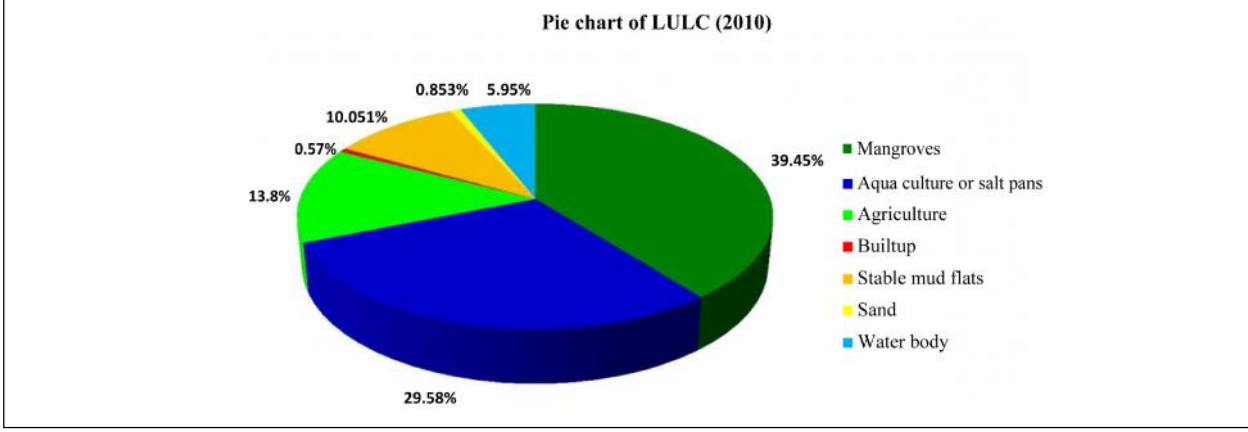


Figure 11: Land Use Map Derived from Landsat-8 (2015)

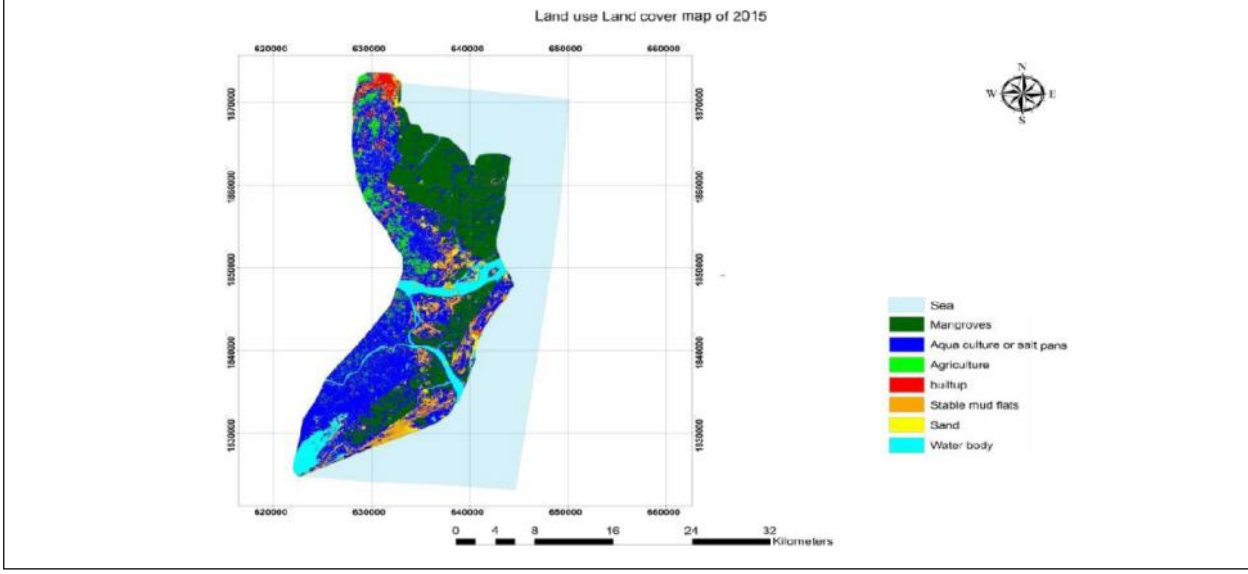


Figure 12: Pie Chart of LULC (2015)

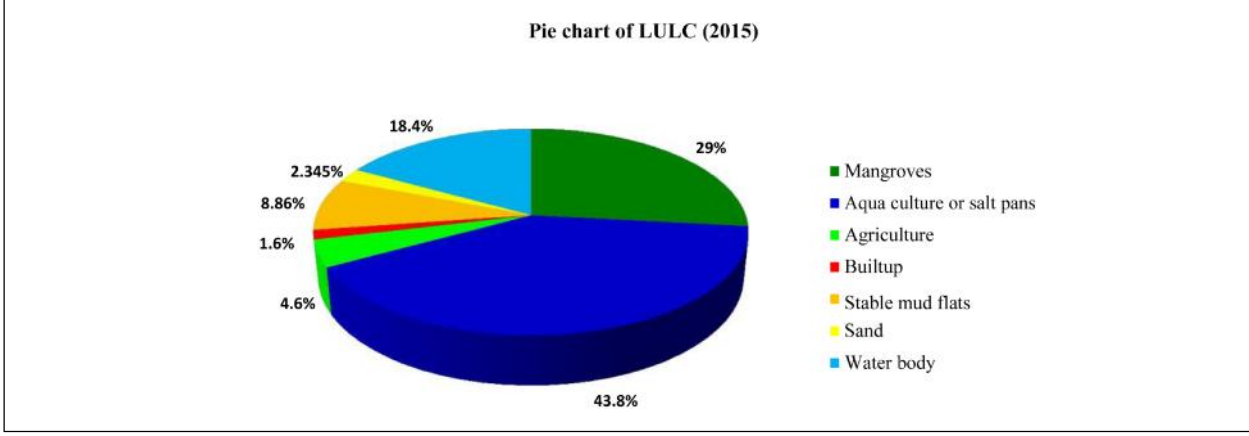


Table 2: Percentage Change of Land Use Land Cover from 1996 to 2015

Land Use Type	1996-2001	2001-2006	2006-2010	2010-2015
Mangroves	-10.72%	14.93%	-2.08%	-10.45%
Aqua culture or salt pans	-5.49%	1.53%	9.54%	14.22%
Agriculture	9.35%	-2.20%	-0.70%	-9.20%
Builtup	-3.28%	0.28%	-0.91%	1.03%
Stable mud flats	18.45%	-16.59%	-1.56%	-1.19%
Sand	-0.93%	2.37%	-2.93%	-1.49%
Water body	-7.92%	0.38%	-1.31%	12.45%

Suitability Analysis

To predict the suitable sites for plantation suitability of mangroves these factors were considered they are LULC (2015), Soil pH, Soil salinity, Soil texture, Distance from sea were considered. These factors are converted in to raster format using interpolation techniques. Using these factors with the help of AHP technique suitable sites are generated based on the experts advice.

- LULC 2015
- Soil texture
- Soil salinity
- Distance from sea
- Soil pH
- Final land suitability map

From the result we can see that the place near to the sea are highly suitable and the mangroves

Figure 13: Reclassification of Land Use Land Cover (2015)

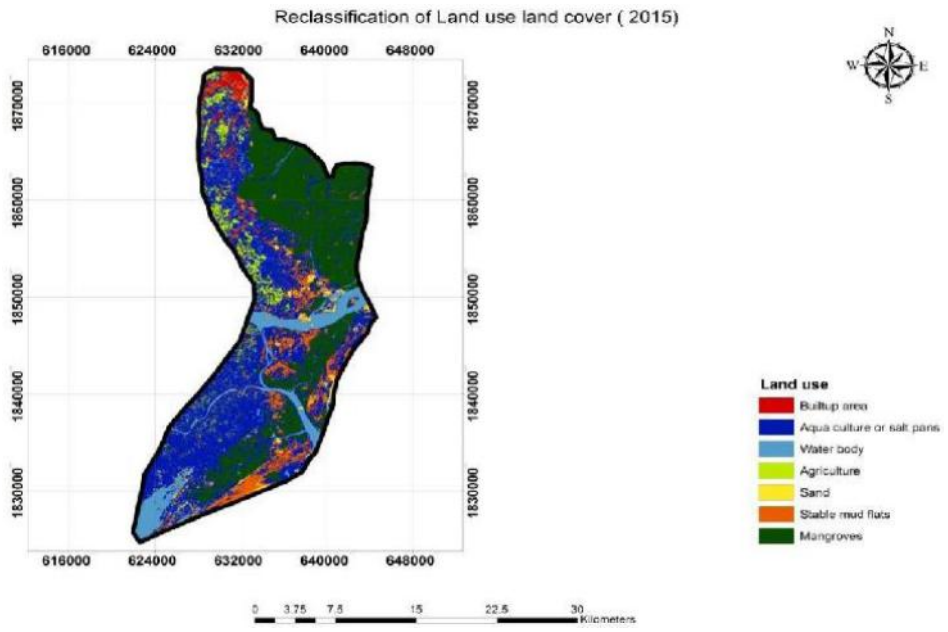


Figure 14: Reclassification of Soil Texture

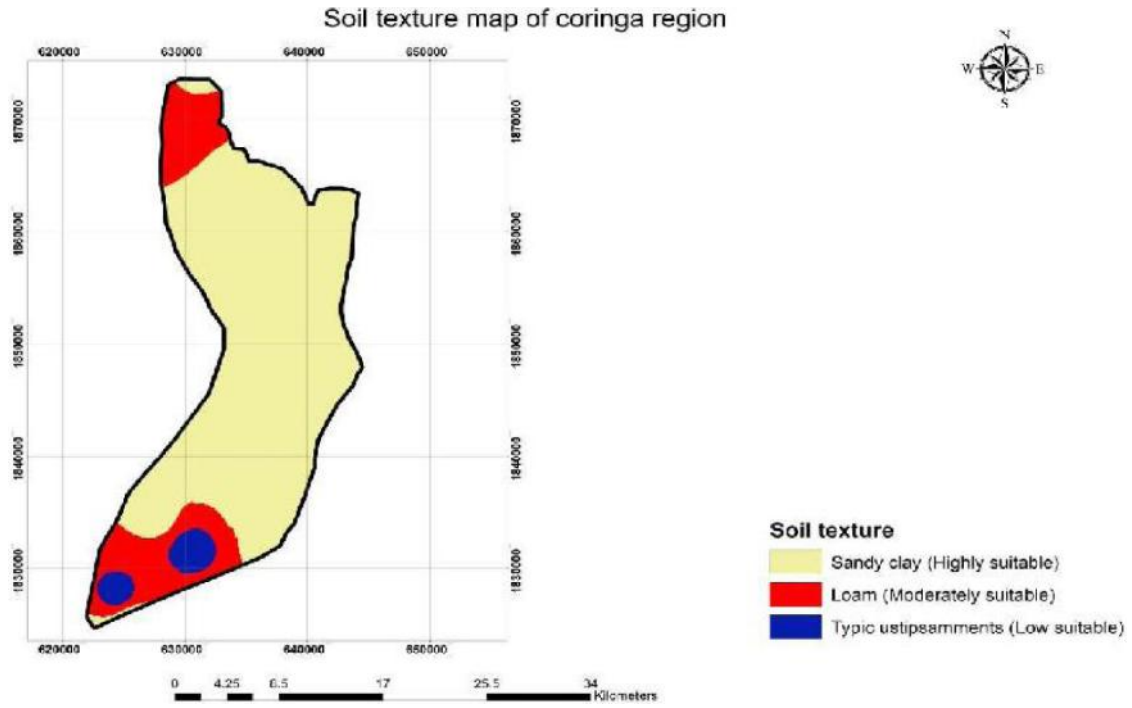


Figure 15: Reclassification of Soil Salinity

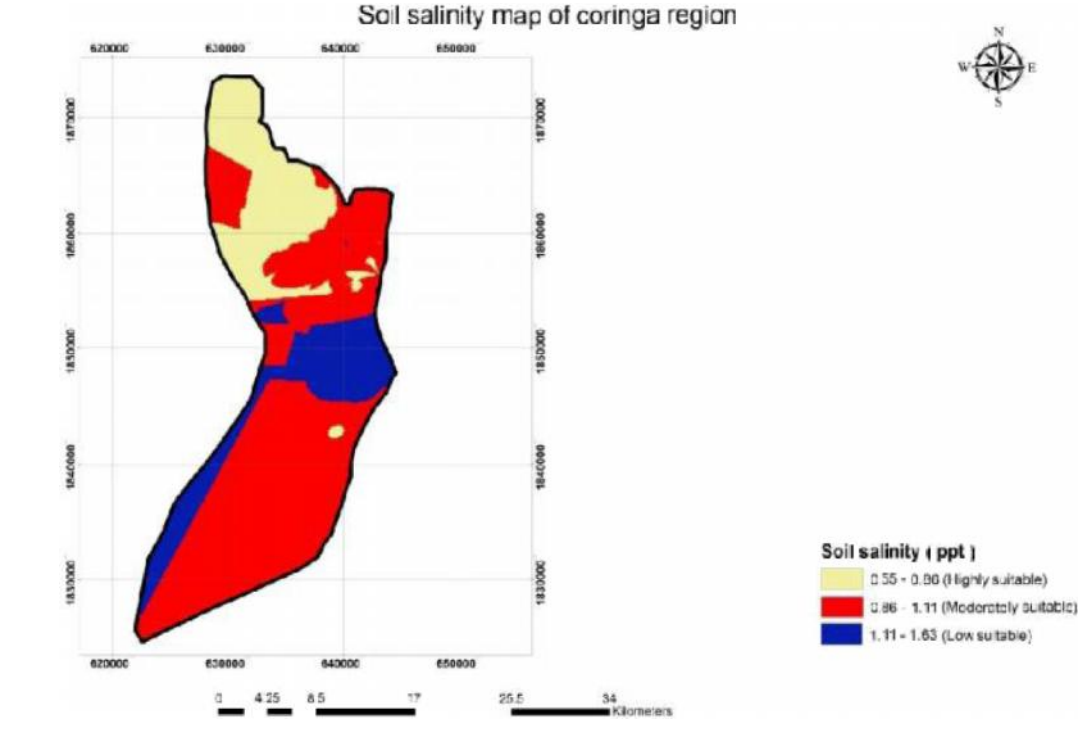


Figure 16: Reclassification of Distance from Sea

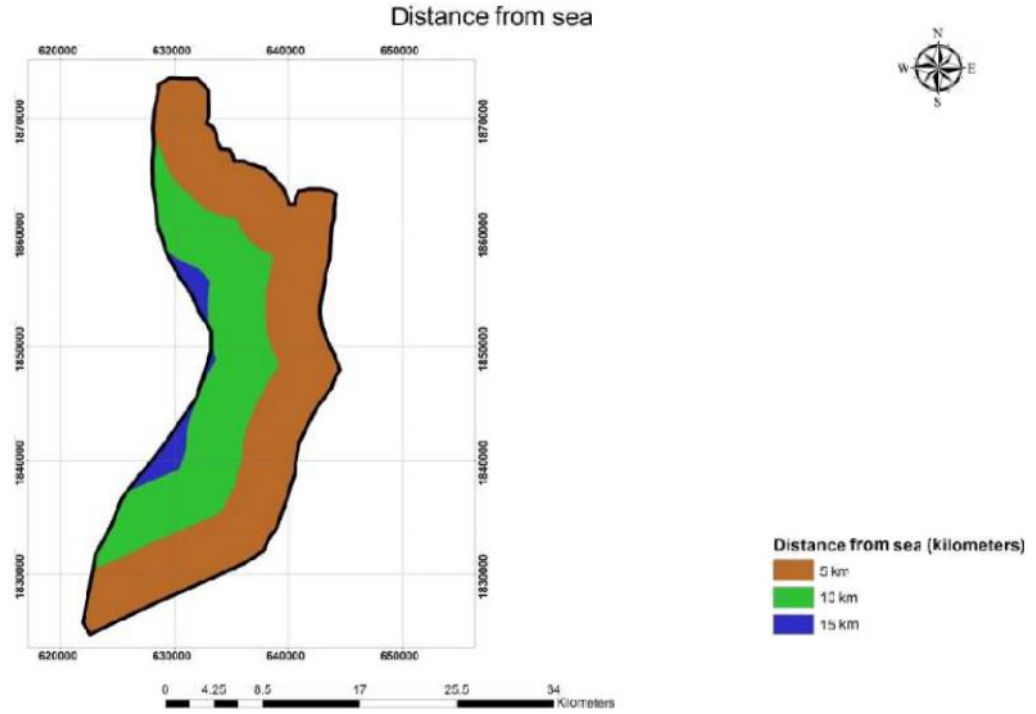


Figure 17: Reclassification of Distance from Sea

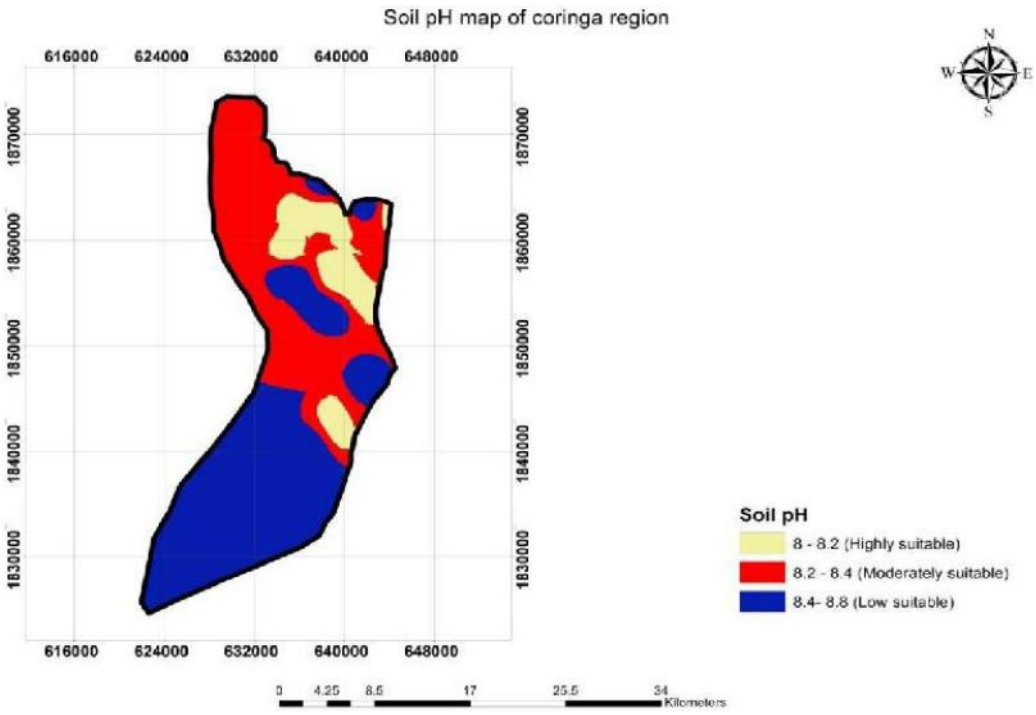


Figure 18: Land Suitability of Mangroves

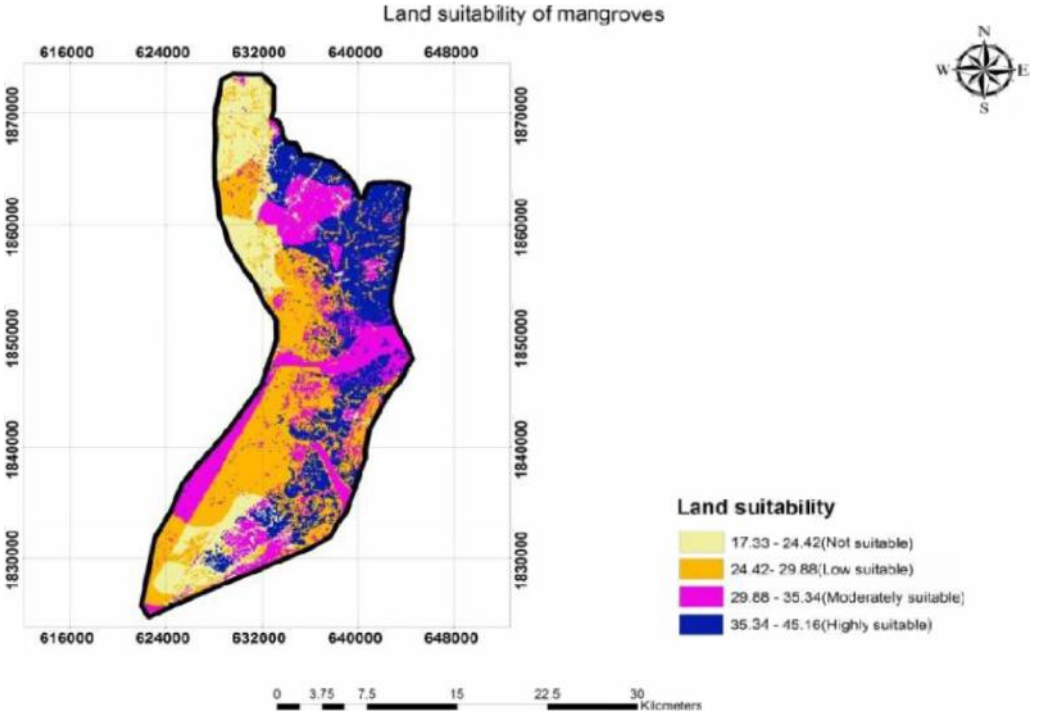
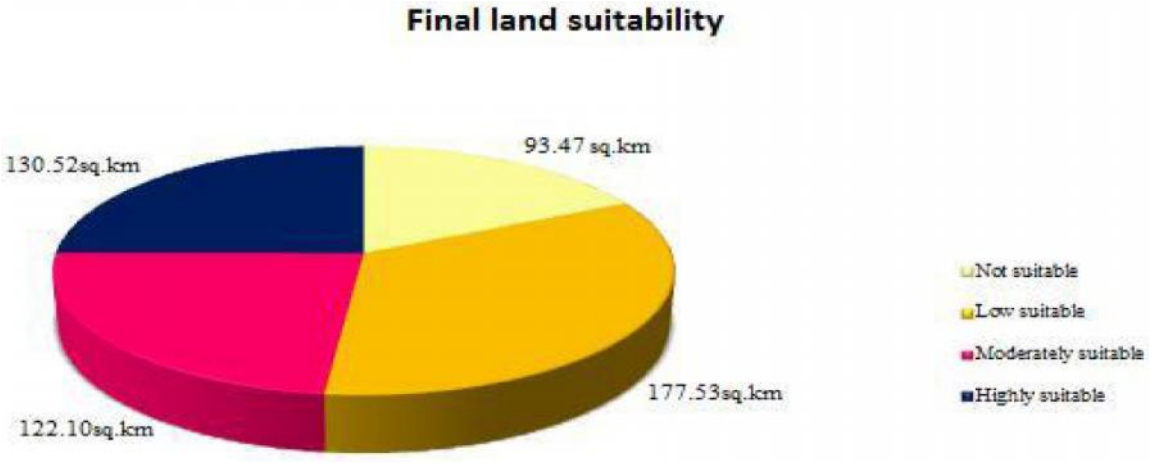


Figure 19: Final Land Suitability



are moderately suitable in the places where there are fish farms and stable mudflats and not suitable in the places where there are built up lands and agriculture. From the outcome it is clear that the spots where mangroves are highly suitable is the spots where mangroves are already existing.

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