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Estimation of Urbanization Induced Land Cover Reclamation using Remote Sensing Technique in Vallarpadam and Mulavukad Islands, Kerala

Sajith. K S[1], M.V. Harindranathan Nair[2], Sooraj. N P[3], Maneesh Kumar. S. K[4], Vidya. P. V[5]

[1, 2 3, 4, 5]School of Environmental Studies, Cochin University of Science and Technology

Abstract: ***Vallarpadam and Mulavukad islands cover large paddy fields and have been transmuted to urban lands to establish the human settlement. During past decades, the conversion took place here because of the lack of profit from the Paddy cultivation, converting these lands into other suitable forms. The changes in the LULC of this area was estimated using Remote Sensing and GIS technique. Multi-temporal satellite data for 2000, 2010 and 2020 were used for the image classification. The change detection analysis showed that substantial changes occurred during the study period, with an increase of urban land showing an expeditious trend of urbanization.***

Keywords: Land Use Land Cover, Remote sensing, Change detection, supervised classification, Urbanization, Pokkali

1. Introduction

The rapid changes on the earth surface lead to significant impacts on the environment. The increased population creates a large scale impact on the surrounding. The increase of population eventually increases the rate of human settlements by conversion of earth surfaces. This development can bring indefinite urban development and industrial expansions as it is important to human livelihood. As per the current trends, the conversion of land into different land use types as per the requirement of the development activity and alter the natural habitat and landscape so that large scale environmental impacts can be expected in the future. The Land Use land Cover (LULC) having an important role in environmental functioning and maintain the balance of relationships with humans and their interactions [1]. The growing anthropogenic pressure increases the large scale reclamation of vegetative and aquatic systems. The quantification of LULC change using remote sensing techniques helps to understand the human impact on ecosystems and habitats [2].

The LULC observation by satellite data provides a clear view of the gravity of reclaimed vegetative agricultural lands and the current status of the land forms[3]. A detailed estimation of the reclamation that occurred can be helpful to identify the urbanization potential of the area, and it can be achieved by a wide range of software applications and statistical tools. The map prepared by this technique can interpret the changes in different LULC types [4]. Comparison of different intervals of the LULC can produce the characteristics of the impacts that happened in the area. It can be utilized to better ecosystem restoration and sustainable development[5].Comparison of the maps will give detailed assumptions on the land surfaces, reclamation status and newly emerged land uses[6].Conversion of LULC mainly happened due to the increased demand of land for residential establishments and connectivity[7]. The study's accuracy is an important factor in analyzing the changes with exact percentage of reclamation and can be accessed with the help of a reference map[8].

The current study focused on the potentiality of Vallarpadam and Mulavukad Islands in to a large urban zone and the reclamation of the agricultural lands. A large area in these Islands was converted to urban lands for facilitating the Cochin City development and industrial establishment. The islands' shorelines have an abundance of mangrove population, and a good percentage of it was removed to facilitate container terminal and its connectivity.

2. Study Area

The Vallarpadam and Mulavukad Islands play an important role in Cochin's development with immense potential of urban growth, carrying the International shipping facility and wide road network for goods transportation. It is lying in the Vembanad backwater system with a close connection to the Arabian Sea. Earlier, these Islands were connected with water transport systems. After the development of Goshree bridge, it has been developed very fast and is very close to the heart of the city. Extensive Tourism development activities were established over here with large hotels and International Convention centers.

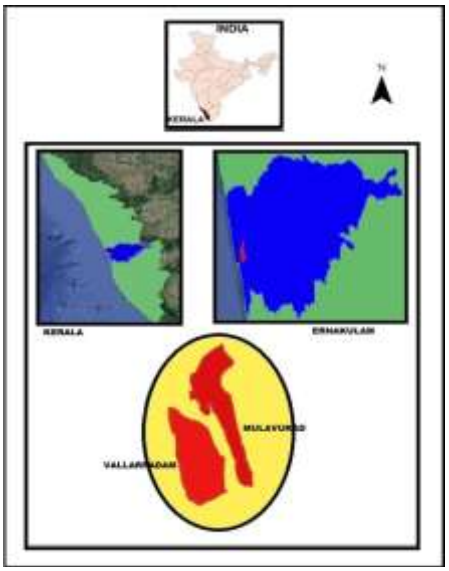

Figure 1: Study Area Map

Mulavukad is locally known as Bolgatty Islands. Mulavukad Island spreads over an area of 3.644 km^2 and which is lies between Longitude 9^0 58'57"N - 10^0 02'14"N and Latitude 76^0 16'05" E - 76^0 15'20"E. Mulavukad Island comes under Mulavukad Panchayat administration and is neighboring to the urban center of Kerala. It does not exhibit such a character. Fishing and caging of fishes are the main occupation of the peoples and practice paddy cultivation of salt tolerant rice brand Pokkali. Mulavukad has a maximum temperature in March, April and May about 31.4 and has a lower temperature of 23.2 degrees; hence this Island is a tropical humid climate land [9]. Soilexhibits a saline character due to the tidal deposits (fluvio marine deposit) [9].

Vallarpadam Island is an ancient landscape spread over an area of 4.560 KM2 and a part of Mulavukad Panchayat. Vallarpadam Island lies east to the Vypin island and west to the Mulavukad island within the Longitude 9^0 58'40"N - 10^0 00'49"N and Latitude 76^0 15'12"E - 76^0 14'24"E. Both Mulavukad and Vallarpadam Islands together form the Mulavukad Panchayat. Vallarpadam Island lies very close to the mouth of Cochin estuary. Both Vallarpadam and Mulavukad Island is a typical low land area covered with wetlands and mangroves.

3. Materials and Methods

The LULC changes induced by urbanization were analyzed for 2000, 2001 and 2020 using Remote sensing and GIS techniques. LANDSAT images were collected for the respective years from USGS Earth Explorer. The Survey of India topo sheet was used to prepare the base map (1968/1:50000). Spatial data processing such as georeferencing of toposheets and demarcation of the study area boundary was performed using the spatial analyst tool available in the Arc GIS 9.1.[6].For current study Eight LULC classes were identified for image classification. Image preprocessing, classification and post-classification procedures were carried out with ERDAS Imagine Supervised classification method with maximum likelihood classifier used for the classification [8]. The accuracy of the classified output was also assessed. Multi-temporal changes in the LULC were detected by generating a Change matrix using Arc GIS [7].

4. Result and Discussion

The study revealed the large scale changes in the land use land cover of the study area. It witnessed very significant effects on the environmental parameters. Urban lands show a tremendous increase during the study period, while the other major LULC classes showed a decreasing trend. The shore lines of the Islands faced potential LULC conversion during the construction of the International container terminal and associated infrastructural developments.

Vallarpadam Island has been faced rapid change during the past years. The effect of urbanization occupied a large area for urban activities. The Urban land has been increased by 8.64% from 2000 to 2020 and it has been converted almost all land uses in different range and with an area of 1.769 km^2. The paddy land showed an increase in 2010 compared to 2000 followed by a decrease in 2020 with 1.716 km^2 area. The major reclamation happened to paddy land because of the decreased percentage and conversion to urban lands. As per the current tendency of encroachment it's going effect large scale reclamations in future. Currently the paddy land is being utilized for aqua-cultural purposes as the latter provides more financial returns. This trend may lead to the abandonment of paddy cultivation and further conversion to urban land in the near future.

This Island had less vegetation area 0.0117 km^2 in 2000, and it showed a marginal change of 0.58% in 2020. The major impact occurred to the Mangrove patch in the area showing a 7.06 % decrease. In 2000 it was 0.539 km^2 with 11.82% area and it decreased to 8.14% in 2010 and large scale reclamation happened during the 2010 - 2020 period, which reached 4.76 % with a 0.217 km^2 areas. Barren land was decreased from 2000 to 2020, as it had been transformed to urban lands. Many paddy and vegetative areas are slowly converting to the barren land and later convert to urban lands. 0.656 km^2 area of Barren land has been converted to 0.535 km^2 during the period of study. During the 2000 period, negligible area of road has been present in here, many of the connecting roads were graveled, and sand made. The primary connection to the Island was boat service until the construction of Goshree Bridge; during 2010 periods, well-established roads were developed in connection with the formation of Vallarpadam Container Terminal with a 5.07 %.

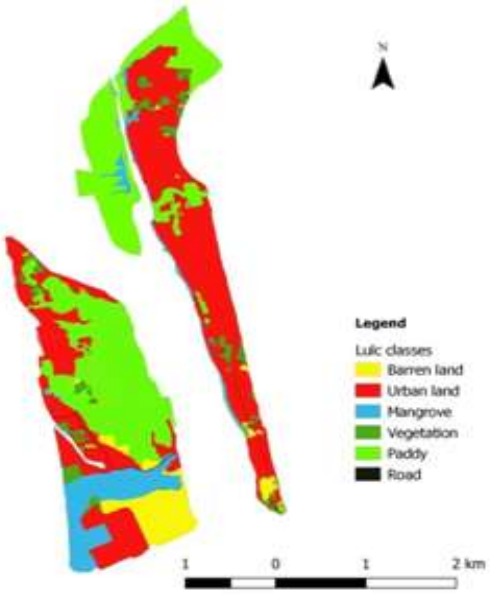

Figure 2: LULC Map- 2000

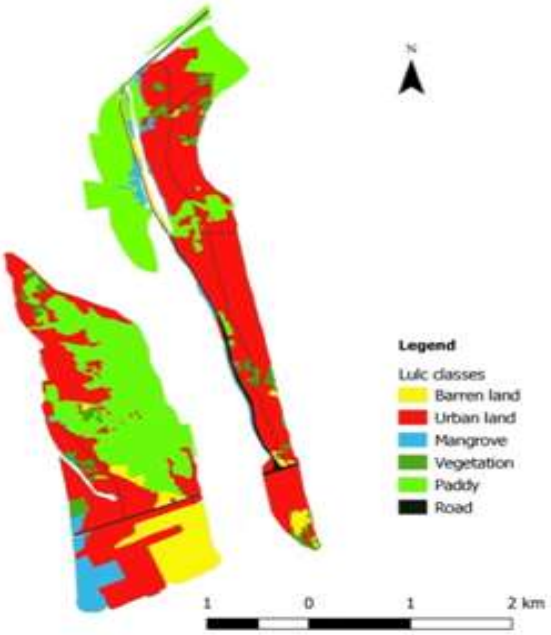

Figure 3: LULC Map- 2010

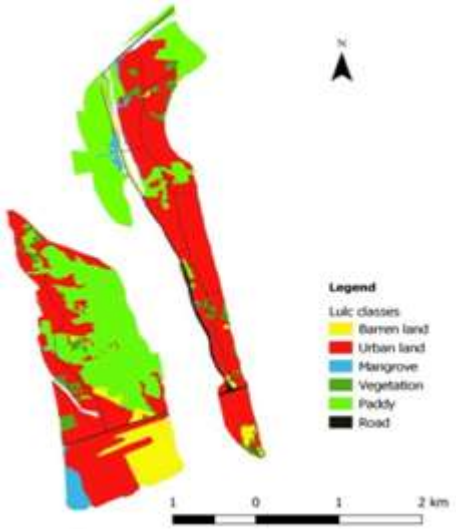

Figure 4: LULC Map- 2020

The Mulavukad Island showing large scale changes to urban lands with large infrastructural developments. The LULC maps for the year 2000, 2010 and 2020 were given in Fig 1, Fig-2 and Fig-3. The Urban land increased to 2.083 km^2 from 1.318 km^2 during the 2000 to 2020 time interval, many of the lands has been converted to urban lands due to large scale human settlement development in 2000 itself. From 2000 to 2010, connectivity to Cochin City developed; hence, the migration of people increased large scale as it's very close to the city and very less land value than city areas. Urban growth converted many land uses to urban lands listed in Table-2, and area-wise changes are expressed in Fig -7 .The paddy area decreased to 6.88% during the period observed. The paddy areas have been used for fish cultivation and some areas are left blank because ofa lack of profit from the paddy cultivation. Vegetative cover in the area shows gradual decreases from 2000 to 2020, which is 0323km^2 to 0.128 km^2 with a percentage of 5.33. The percentage-wise LULC change is depicted in Fig-8.

Mangrove patches in the island decrease to 6.55 % during the observed period, the development of container road has removed mangrove patches. Barren land has been converted to urban lands, a large area has been now developed for infrastructural development and it's decreased to 2.87% .The major Road development in this area is the container road which was constructed for goods transportation. Road increased to 1.98% in the 2020 period. The major change happened in 2010 to 2020 period.

Table 1: LULC changes of Vallarpadam Island from 2000-2020

LULC CLASS	2000		2010		2020	
	AREA km^2	AREA %	AREA km^2	AREA %	AREA km^2	AREA %
Urban Land	1.376	30.17	1.575	34.54	1.769	38.81
Paddy	1.683	36.91	1.719	37.69	1.716	37.64
Vegetation	0.117	2.56	0.107	2.35	0.090	1.98
Mangrove	0.539	11.82	0.371	8.14	0.217	4.76
Barren land	0.656	14.38	0.568	11.86	0.535	11.74
Road	0.189	4.16	0.22	5.42	0.231	5.07

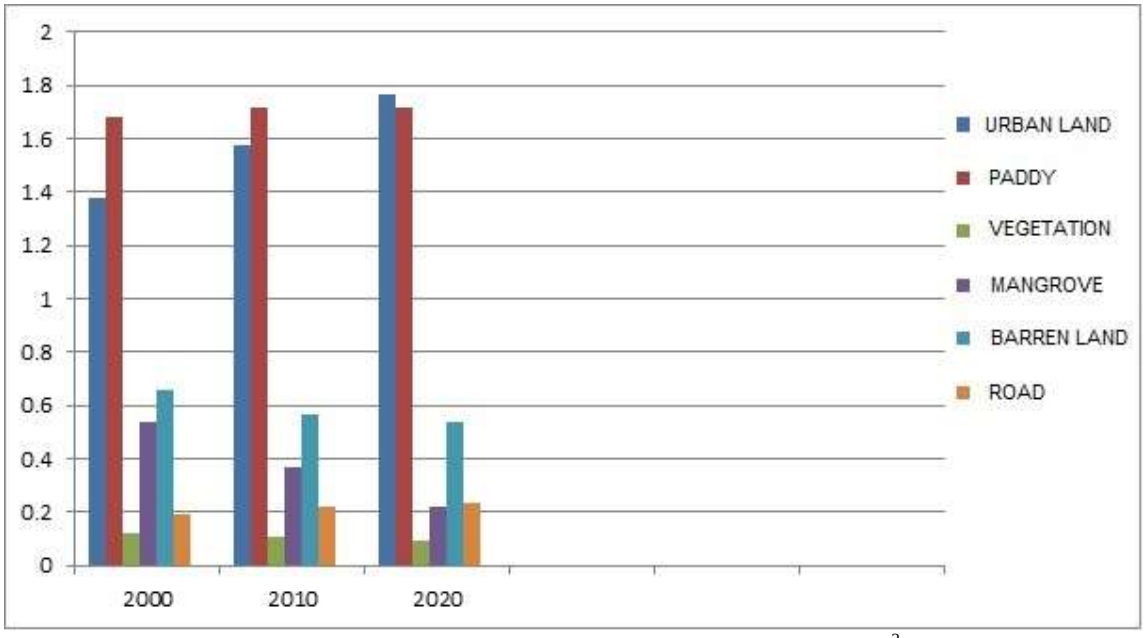

Figure 5: LULC Changes of VallarpadamIsland in Area (km^2)

Fig-:6, LULC Changes of Vallarpadam Island in Percentage

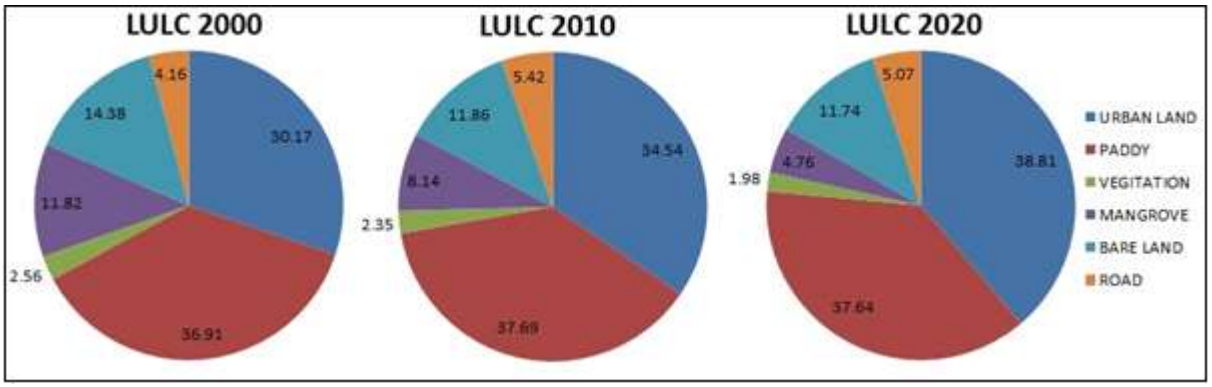

Figure 6: LULC Changes of Vallarpadam Island in Percentage

Table 2: LULC changes of Mulavukad Island from 2000-2020

LULC CLASS	2000		2010		2020	
	AREA km^2	AREA %	AREA km^2	AREA %	AREA km^2	AREA %
Urban Land	1.318	36.18	1.763	48.39	2.083	57.17
Paddy	1.397	38.35	1.214	33.33	1.147	31.47
Vegetation	0.323	8.86	0.219	6.02	0.128	3.53
Mangrove	0.377	10.34	0.295	8.09	0.138	3.79
Barren land	0.179	4.92	0.094	2.58	0.075	2.05
Road	0.049	1.35	0.058	1.59	0.072	1.98

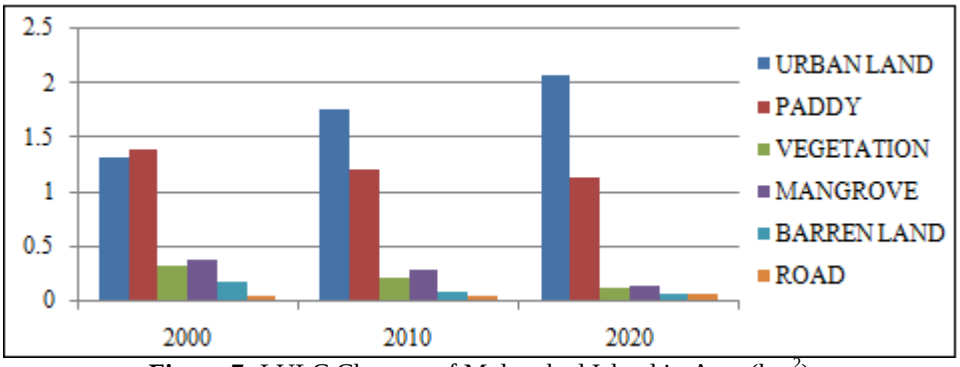

Figure 7: LULC Changes of Mulavukad Island in Area (km^2)

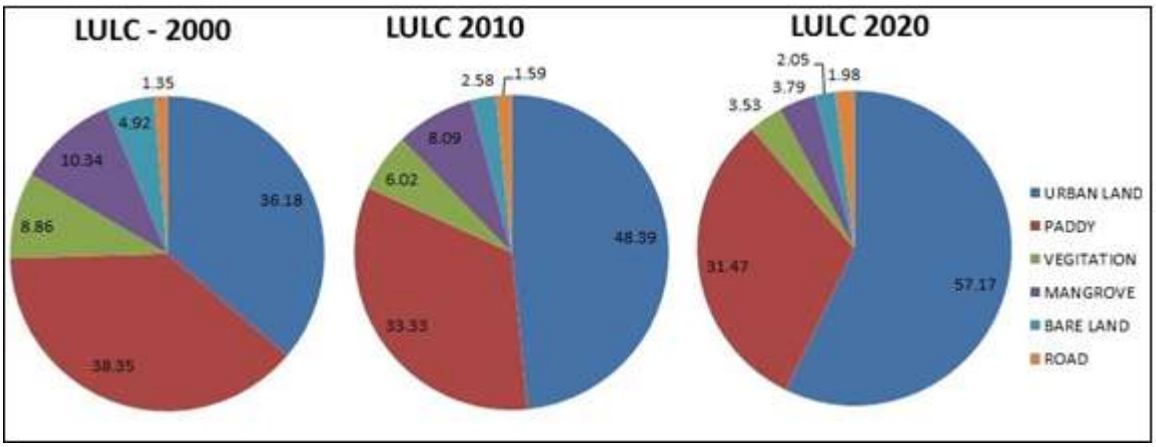

Figure 8: LULC Changes of Mulavukad Island in Percentage

5. Conclusion

The study estimated the LULC changes within the Vallarppadam and Mulavkad islands from 2000 to 2020. It revealed that both islands are facing rapid urbanization. The infrastructure development of Vallarpadam Container terminal may possess various threats to these islands.A large scale conversion of paddy fields can result alteration of habitats in the islands. The removal of Mangrove population in the shore line will increase the coastal erosion. The development should be in Sustainable manner that it could bring the Islands environmental condition a healthy one.

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