Human Intervention in Coastal Regulation Zone of Salcete Taluka.

Ms. Tanvi Deshpande[1],Mr. Sudhakar Pardeshi[2]

[1]Assistant Professor in Geography, Rosary College of Commerce & Arts, Navelim.

[2]Professor, Department of Geography, Savitribai Phule Pune University, Pune.

tanvideshpande19496@gmail.com, sdpardeshi@gmail.com

Introduction- Land use and land cover transformation refers to the process of change dynamics in land features from one form to another during periodical times due to natural or human induced transformation activities (Kaliraj et al., 2017). Change analysis of features of Earth's surface is essential for better understanding of interactions and relationships between human activities and natural phenomena. According to Butt et al., (2015) the study of land use and land covers enables to study the impact of human interference in the coastal environment. The study of coastal environment gives an idea of phase of exploitation level. According to Kaul and Ingle (2012), land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes.

Rapid increase of population, expansion due to urbanization and developmental activities related to tourism are altering the existing state of land use and land cover features. In order to manage and protect coastal environment from further exploitation, land use and land cover changes must be studied. This study deals with the land use and land cover changes within the 500 m zone of coastal area. LANDSAT Satellite images have been used to classify and map land use and land cover changes with different techniques and data sets. The change detection is carried out using ERDAS IMAGINE 2014 and SAGA software. The land use taken into consideration to study the changes are agriculture land, fallow land, built up, barren land, sand, vegetation and water. Land use change detection on a spatial basis would be a significant requirement for developing effective land management and planning policy in many coastal areas (Islam et al., 2016).

Objectives:

The objective of the paper is to study the changes in land use and land cover change detection in Coastal Regulation Zone of Salcete taluka. Looking at the increasing mass tourism along the coasts and increasing human interference in fragile coastal ecosystem and to reduce the further damage and raise awareness, the study can be useful.

Study Area: The study area consists of coastal areas of Salcete taluka, which is a sub-division of South Goa district in the Indian state of Goa. Salcete taluka lays in coordinates of 15° 12' 44.82" N and 74° 4' 23.628" E. Coastal area of Salcete taluka occupies the territory of about 27 km of straight continuous beach strip and numerous sand dunes along the Arabian Sea, with Utorda beach in north and Betul Beach at the mouth of Sal River in the south. The Salcete taluka consists of ten major beaches namely Utorda, Majorda, Betalbatim, Colva, Sernabatim, Benaulim, Varca, Cavelossim, Mobor and Betul along with other small beaches such as Carmona, Fatrade. The Location map of study area is given in Figure 1.

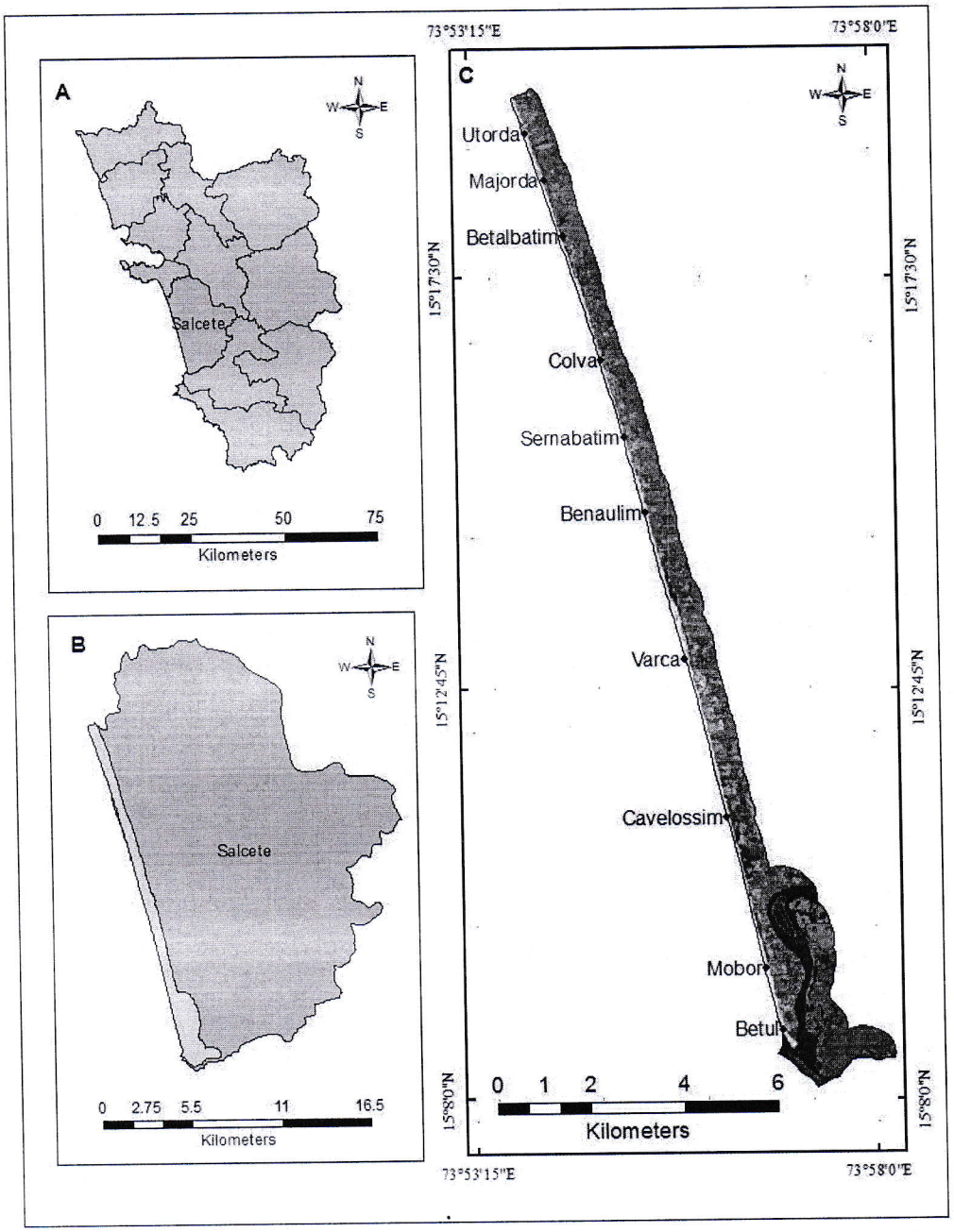

Figure 1- Location Map of Study Area.

Database and methodology: The present study required digital spatial data in order to input and process in ArcGIS 10.3, SAGA (System for Automated Geoscientific Analyses) and ERDAS IMAGINE 2014 software. Primary data is based on personal observations and field visits. Most of the work is based on secondary data i.e. satellite images of LANDSAT 7 ETM and LANDSAT 8 images of year 2000 and 2017 of 30 m resolution each and SOI toposheet index number 48 E/15, 48 E/16 at scale of 1:50,000 are used. LANDSAT data is available to public

and are downloaded from United States Geological Survey (USGS) website (https://earthexplorer.usgs.gov/). Table 1 displays the data used and derived for the analysis.

Sr. no.	Data source	Data information derived
1.	SOI toposheet 48 E/15 , 48 E/16 (1:50,000)	High tide line
2.	LANDSAT 8 images (28-03-2017) LANDSAT 7 ETM (14 -03-2000)	LULC, Change detection using SAGA

Table 1: Data source and data derived.

The toposheet has been georeferenced and projections are given as WGS 1984 datum with 43N zone. Using ArcGIS 10.3, high tide line has been demarcated from toposheet and using shapefile of Salcete taluka, a buffer of 500 m is created to demarcate and extract the Coastal Regulation Zone of Salcete taluka. The image processing and stacking is done in ERDAS IMAGINE 2014 software. Supervised classification and accuracy assessment has been done to study the land use and land cover (LULC). The images are classified into seven main classes namely sand, agricultural land, barren land, vegetation, water bodies, fallow land and built up. The areas of each class are calculated and further change detection is carried out in Microsoft Excel using data from the images and the changes are displayed using bar graphs. SAGA software is used to study the change detection. The supervised classification images are given as input in SAGA to study the change detection.

Result and Discussion:

1. Land use and land cover analysis by Supervised Image Classification using ERDAS IMAGINE 2014 software.

Muttitanon and Tripathi (2005) stated that land use and land cover changes have become an essential component in current strategies for managing natural resources and monitoring environmental changes. With the increase in need and greed of human beings, the rate of exploitation also increases. According to Fabbri (1998), coastal zones have been exploited by the man at a greater extent for the growth of an industry, resource extraction, tourism and urbanization, which have led to the flourishing of coastal economies. The land use and land cover is dynamic in nature and is believed to change with respect to both natural and human factors. The long term change assessment of coastal area of Salcete taluka i.e. within coastal regulation zone has been studied for a period of 17 years i.e. 2000 to 2017 using LANDSAT images and the same has been represented in Table 2 and Figures 2, 3 and 4.

Classes	2000 km^2 area	2000 area %	2017 km^2 area	2017 area %	Change difference (%)
Agriculture land	2.99	17.18	1.73	9.94	-7.24
Barren land	3.21	18.45	3.35	19.25	0.8
Fallow land	1.49	8.56	1.72	9.89	1.33

Sand	1.26	7.24	1.29	7.41	0.17
Built up	0.39	2.24	0.59	3.39	1.15
Vegetation	6.29	36.15	6.99	40.17	4.02
Water	1.77	10.17	1.73	9.94	-0.23
Total	17.40	100	17.40	100	-

Table 2: Land use and land cover data for year 2000 and 2017 based on LANDSAT images. (Source: Image classification)

From the analysis of supervised classification data, it was found that land features have undergone tremendous change under the impact of both natural and anthropogenic factors. The accuracy assessment result of classified LANDSAT images showed the overall accuracy as 95.65% and 96.67% and overall Kappa coeffient statistical values of 0.94 and 0.95 for the year 2000 and 2017 respectively. Figure 5 represents the supervised classification maps of year 2000 and 2017.

The comparative analysis of year 2000 and 2017 as shown in Figure 4 gives an outlook that there is decrease in agriculture land (17.18% in 2000 to 9.94% in 2017) and consequently increase in fallow land from 8.56% in 2000 to 9.89% in 2017. For the year 2000, agriculture land covered 17.18% of the total area which decreased to 9.94% by 2017. With the increasing tourism activity, the built up in forms of resorts, beach shacks, recreational parks increased from 2.24% in 2000 to 3.39 % in 2017. There is also increase in the barren land. In 2000 the barren land covered 18.45% of the area which increased up to 19.25% by 2017. However there has been a small amount of change for sand (7.24% in 2000 and 7.41% in 2017) and water (10.17 % in 2000 to 9.94 % in 2017). On contradictory to all these, vegetation has increased at from 6.29 km^2 to 6.99 km^2. As per the personal and locals perception, land utilization pattern has changed over years for the recreational purpose.

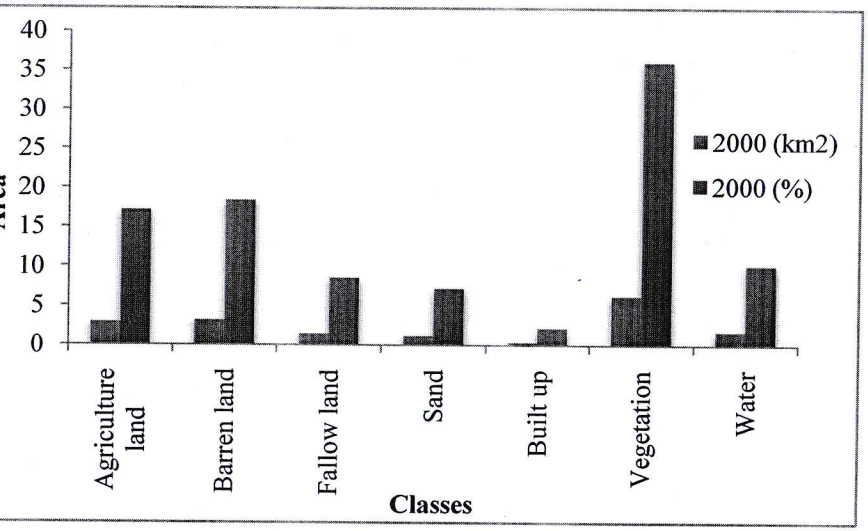

Figure 2- Class wise area (in km^2 and %) in year 2000.

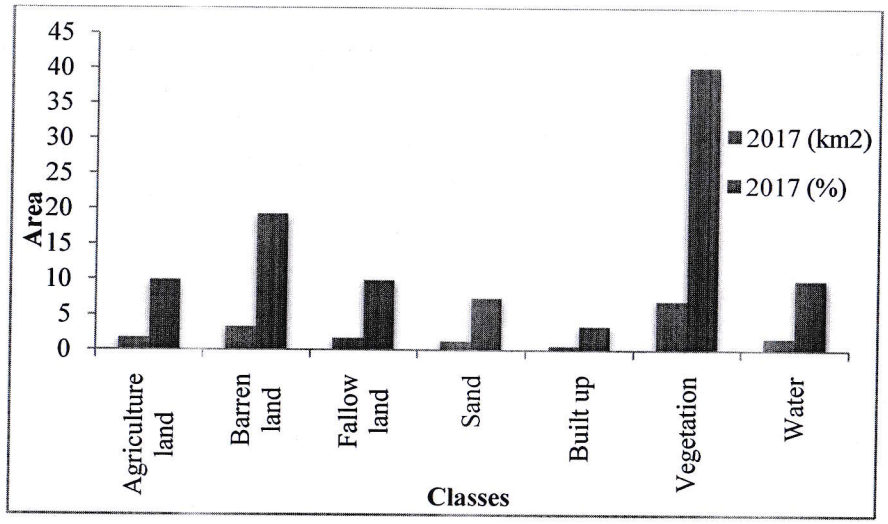

Figure 3- Class wise area (in km^2 and %) in year 2017.

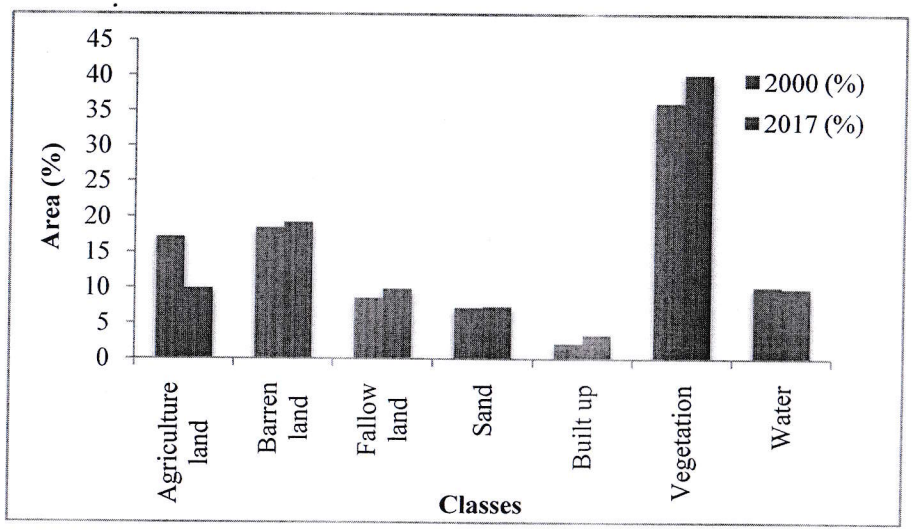

Figure 4- Class wise change in area (in %) from year 2000 to 2017 based on LANDSAT images.

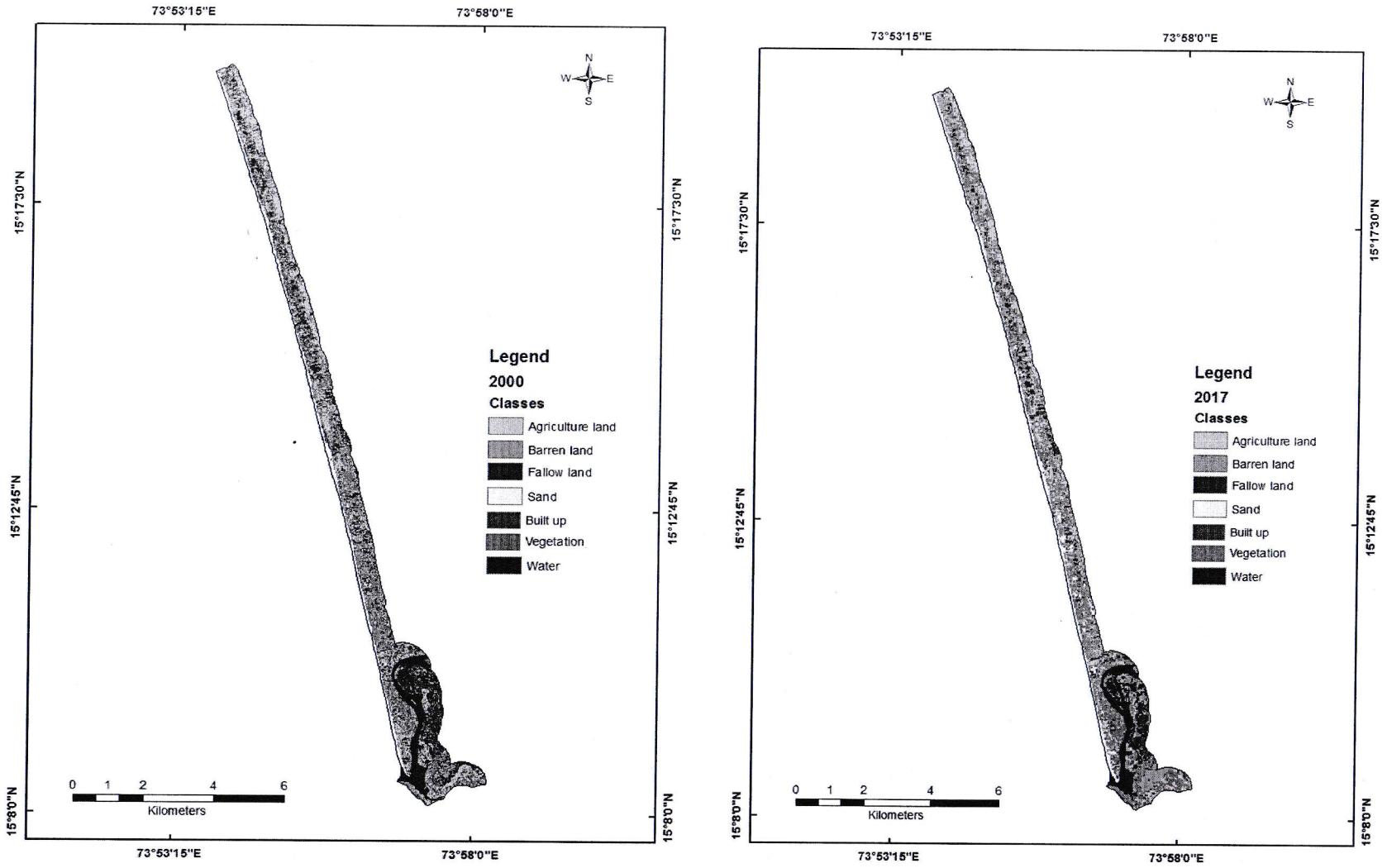

Figure 5- Supervised classification maps of LANDSAT image 2000 and 2017.

2. Change detection (2000-2017 LANDSAT images) by using SAGA software.

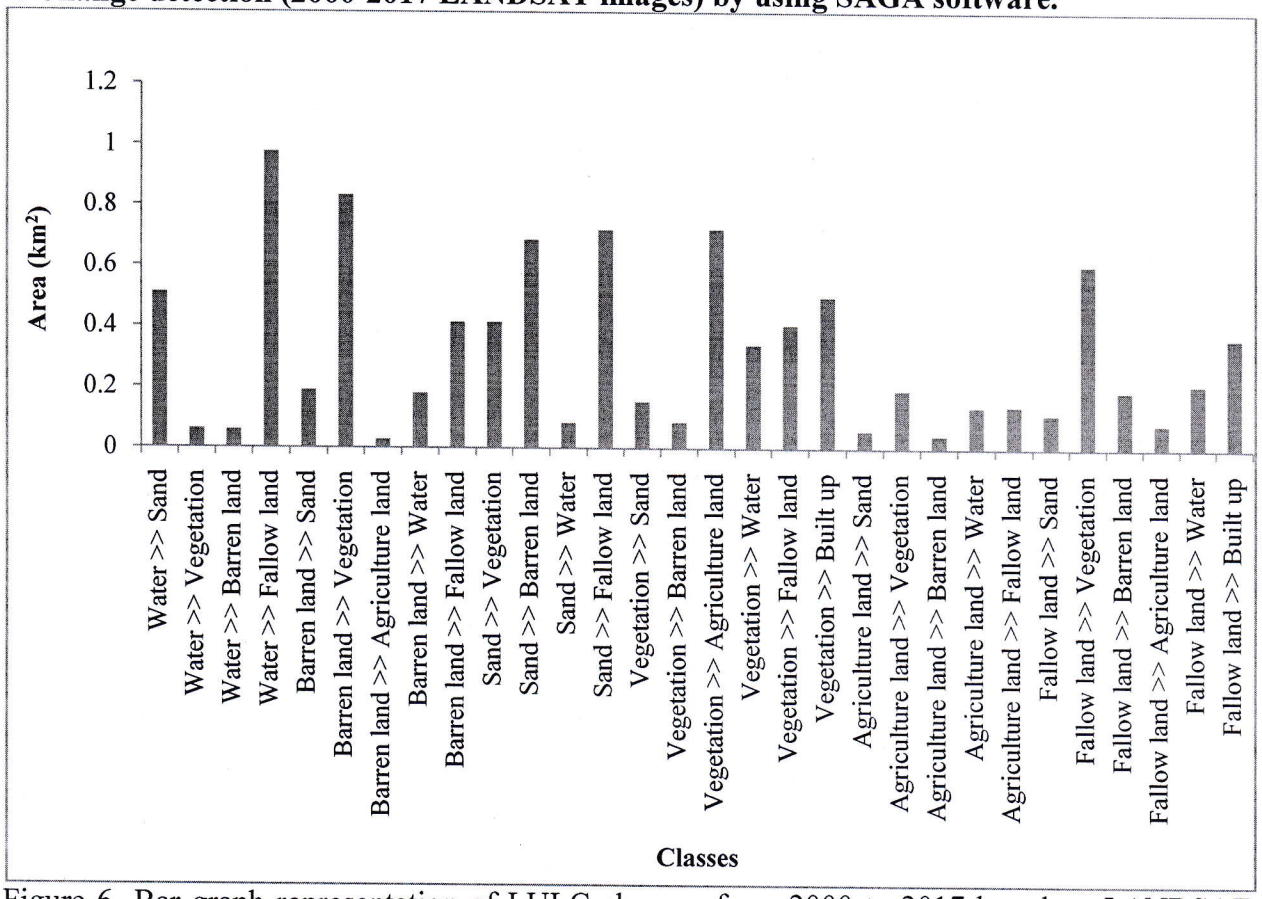

Figure 6- Bar graph representation of LULC changes from 2000 to 2017 based on LANDSAT images. (Source: SAGA)

The graph in the Figure 6 illustrates the changes that have occurred in the natural distinct feature over a period of 17 years. Water has majorly been reclaimed into fallow land at a higher area conversion i.e. almost 1 km^2 is seen along the banks of River Sal which is in the extreme south of the Salcete taluka. A part of water body has been occupied by sand, which is represented by a sand bar formed at the mouth of River Sal. It has been observed that a major part of the barren land is converted into vegetation followed by the fallow land. Whereas, there is less alteration of barren land into other classes such as agricultural land and water. Area under sand cover has been converted into fallow land followed by barren land and vegetation. Vegetation cover has been converted to agriculture land to some extent which is seen in the extreme north of the study area in villages of Utorda. Vegetation has also been converted into built up on a large scale. Most of the agriculture land has been converted into other classes with majority increase in the vegetation. The conversion of agriculture land into fallow land may be because of change in the perception of the local farmers and progress towards the tourism related economies. Fallow land has been converted into vegetation followed by built up and water. Fallow land is occupied by the vegetation. The conversion of fallow land into built up might be attributed to increase in the number of houses and tourists related infrastructure. This indicates more people are moving towards the coastal areas. Figure 7 shows the change detection map over a period of 17 years.

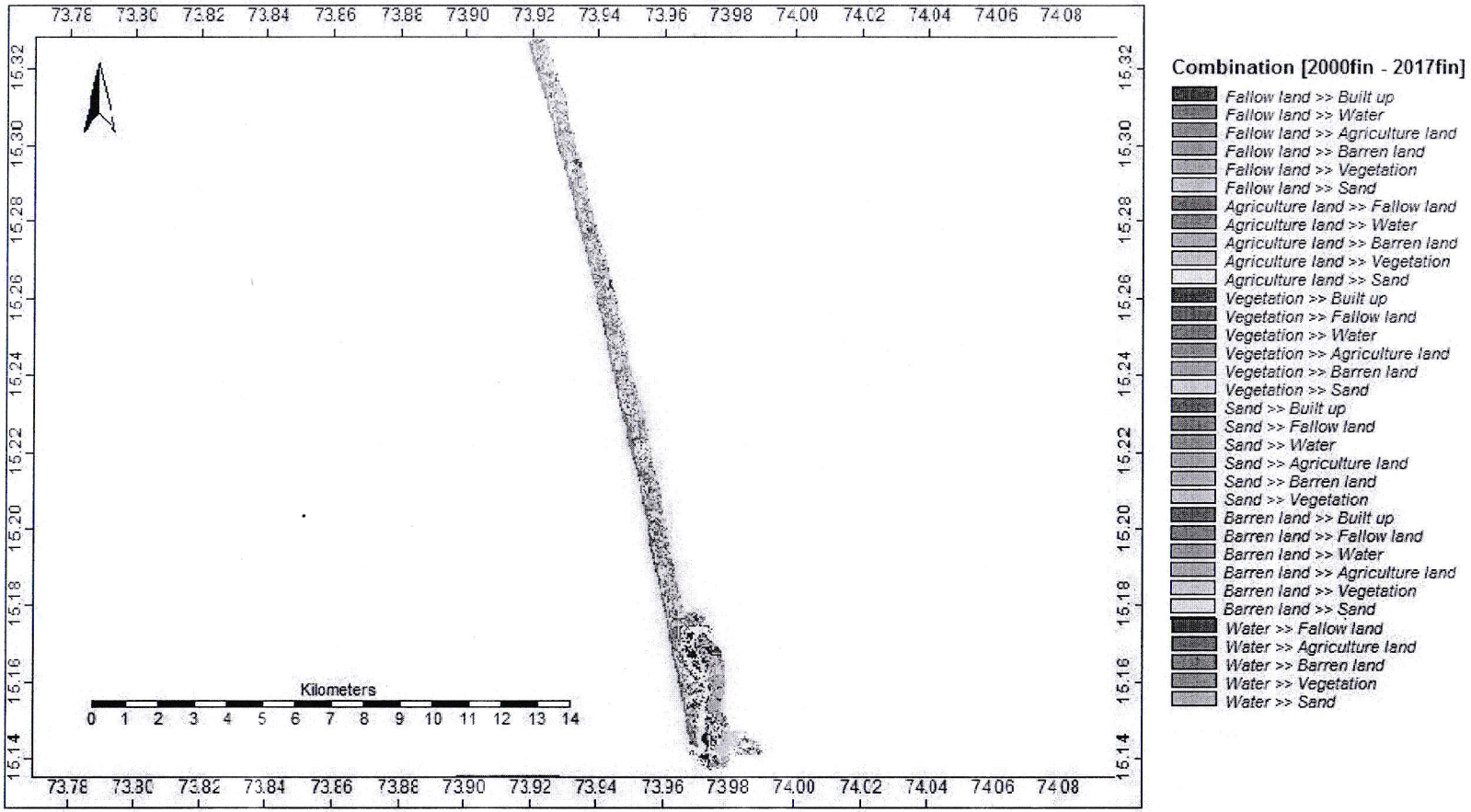

Figure 7-Change detection map for a period of 17 years.

(Source- SAGA)

Conclusion: From the analysis, it was found that the seven classes have undergone tremendous change under the impact of both natural and anthropogenic factors. For over a period of 17 years, the transformation within CRZ of Salcete taluka has been taken place at a greater extent. The accuracy assessment result of classified LANDSAT images showed the overall accuracy as 95.65% and 96.67% respectively. From the results of supervised classification for long term changes, it is found that, the agriculture land has decreased at much higher degree as compared to other classes. This might be attributed to the change in the perspective of locals due to an expansion of tourism. On the other hand, vegetation, barren land, fallow land and built up has shown an increase in the area. Sand and water have remained the same. The agriculture land decreased by 7.24%, whereas the barren land, fallow land, sand, built up, vegetation increased by 0.8%, 1.33%, 0.17%, 1.15% and 4.02% respectively. In the change detection of a coastal area of Salcete taluka, it was found that agriculture land has decreased and other land classes showed an increasing pattern. The change detection analysis using SAGA software facilitated to understand conversion of a feature class into other classes.

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