Land Use Change in 3 Decades at Tourist Hotspots in Goa

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BY

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DECLARATION

I declare that the present thesis entitled “Land Use Change in 3 Decades at Tourist Hotspots in Goa” is a consolidation of an original work which has been carried out by me under the guidance of Professor Pranab Mukhopadhyay, Economics, Goa Business School, and the same has not been submitted to any other university or institution for the award of any other degree, diploma or other such titles.

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CERTIFICATE

This is to certify that Ms Dina Venisha Fernandes has worked on the thesis entitled "Land Use Change in 3 Decades at Tourist Hotspots in Goa" under my supervision and guidance. This dissertation is being submitted to Goa University, Taleigao Plateau, Goa, for the award of the degree of Masters in Economics, it is a record of an original work carried out by the candidate herself and has not been submitted for the award of any degree, diploma, a scholarship or fellowship of this or any other university.

Professor Pranab Mukhopadhyay

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Abbreviations

LULC	Land Use Land Cover
SEDAC	Socioeconomic Data and Application Center
NDBI	Normalized Difference Built-up Index
EBBI	Enhanced Built-up and Bareness Index
NIR	Near-Infrared
MIR	Mid-Infrared
IBI	Index-based Built-up Index

CHAPTER 1

INTRODUCTION

1.1 Background

Tourism is a cultural, social and economic event. It is the movement of people outside their normal environment for business or personal activities.[1] There are various benefits of tourism, like in terms of revenue, employment generation, development of infrastructures, a sense of cultural exchange among citizens and foreigners and also there are several other benefits. Numerous tourists travel to encounter the hosting country's traditions, culture and cuisines. Hence it is very much profitable to stores, local restaurants, shopping centers and so on.[2]

Governments that depend on tourism focus mostly on development of infrastructure of their country. It eventually leads to new roads, parks, ameliorate public spaces etc. In addition, local people undergo a chance for educational and economic growth.

There are 3 primary forms of tourism

Domestic tourism, where a visitor moves out of their residence but within the country itself. Example: An Indian visiting other parts of India.

Inbound tourism is when a visitor comes to visit a country, who isn't a resident of that particular country. Example: A Russian visiting India.

Outbound tourism, when a resident visits a completely different country outside their country of residence. Example: An Indian visiting Russia.[3]

[1] https://www.igi-global.com/dictionary/professional-training-in-tourism-for-the-fourth-industrial-revolution/30288
[2] https://globaledge.msu.edu/blog/post/55748/the-importance-of-tourism-on-economies

[3] from https://www.visitbritain.org/introduction-tourism

Tourism in Goa

Goa is India's tiniest state having the fourth smallest population, located on the western coast. The state has an idiosyncratic mix of Portuguese and Indian culture which attracts approximately 2.5 million visitors annually. Goa is well-known for its beautiful beaches, palm trees and the incredible nightlife.

Goa is divided between two districts namely, North Goa and South Goa. North Goa being famous for beaches like Calangute, Anjuna and others.[4] The Aguada fort, Boghdeshwara temple, Divar island etc. South Goa, for its silent beaches like Palolem, Agonda and so on. Se Cathedral, Dudhsagar Waterfall etc. Goa also provides its tourists with river carnivals, river rafting, hot air balloons, scuba diving, paragliding, bungee jumping and several other activities.

According to India Brand Equity Foundation (IBEF) Goa's Gross Domestic Product stood at Rs. 815.02 billion in 2020-21. Goa has a well- developed physical, social and industrial infrastructure. It also has an international airport, port infrastructure and a well- established foundation for the pharmaceutical industry.[5]

Consequences of Tourism

The rapidly increasing tourism and in terms of providing various goods and services to the tourists has put a lot of stress on Land demand and has altered Land Use and Land Cover which has resulted in depletion of natural resources, increase in built up areas, decrease in vegetation, soil erosion, natural habitat loss etc.

Land Use Land Cover

Land cover alludes to the surface cover on ground, like infrastructure, forests, water, bare land etc. While land use tells us about for what purpose a particular land is being used for. It basically gives us an explanation of how people use land for socio-economic activities. LULC maps play a remarkable role in observing, designing and directing programmes at local, national and global

[4] https://www.tourmyindia.com/states/goa/
[5] https://www.ibef.org/states/goa

levels. This kind of data gives us a better picture about how to utilize land, formulate policies for development purposes and hence to ensure sustainable development.

1.2 Research Question

- How has LULC changed and transformed into built up areas?

1.3 Objectives

- To study the changes taking place in a particular tourist hotspot.
  Here the aim is to examine the changes taking place in the tourist hotspot with respect to build up.
- Comparing changes in land use of Goa due to tourism.
  Here the comparison is done between 2 years that is 1990 and 2020, how the land has been transformed and changed between these 3 decades.

1.4 Data Source

For this study analysis, secondary data from Landsat 5 and 8 were used from the United States Geological Survey (USGS) Earth Explorer which is a website that allows users to download images. The data collected was as follows: Images from Landsat 5 were collected for the year 1990 and Landsat 8 were collected for the year 2020. Similarly, the Goa shape file was downloaded from Socioeconomic Data and Application Center (SEDAC) (2001 Census).

1.5 Methodology

For the analysis of changes in built up area the years taken into consideration were 1990 and 2020 as I wanted to see how build up has changed over 3 decades and 2020 being the most recent one. The analysis was carried out with the help of the QGIS software where the Landsat images and shape file were used. The first step was preprocessing Landsat images for atmospheric correction than the Index based Built up index (IBI) formula which includes 3 indices namely Normalized difference built-up index(NDBI), Soil adjusted vegetation index (SAVI) and The Modified normalized difference water index (MNDWI) was calculated for a

particular clipped area to get clear details about buildup and then it was extracted to the study area. The focus was only with respect to build up area which was highlighted in Red.

Remote sensing

Remote sensing is a technique to acquire the physical properties of a particular area without physically being present over there. It permits the users to visualize, capture and analyze features and objects on the earth's surface. Remote sensing uses various sensors like satellites, drones, airplanes and so on to capture images. For earth observations, image resolutions also have to be considered, there are 3 types of resolutions.

Spatial resolution, Spectral resolution and Temporal resolution.

Spatial Resolution depends on the pixel size. The smaller the pixel size the more details will be provided and hence it will have a very high spatial resolution.

Spectral Resolution gives us the spectral details in each band. High spectral resolution will have narrow bands compared to low spectral resolution which will have broader bands.

Temporal Resolution refers to the time taken for a satellite to completely cover a full orbit.

There are 2 types of Remote Sensing. Active sensors and Passive sensors.

Active sensors are the ones which dispense their own source of energy from the satellite onto the surface to capture the image. While passive sensors are the ones which use energy from the sun to capture the image.

Remote sensing can be used for numerous tasks like tracking clouds to predict the weather conditions, analyzing the growth of a particular area in terms of changes in buildup, vegetation etc. Remote sensing can also be used for disaster management, warnings before a disaster, ensuring safety during the disaster and also getting back to normal conditions after the disaster.

Build up area and Build up Index

Build up areas are defined as the existence of roofed structures or buildings. It mostly excludes the other segments of urban environments such as roads, gardens, parks commercial sites, industrial sites etc.[6] There are several build up indices which are proposed in literature and these indices help to extract the urban sprawl with the help of satellite data. All the build up indices are widely used for monitoring urban growth. It has also been revealed that build up indices are quite sensitive to the various factors related to seasonality, image resolution and study area location. Some build up indices also include bare land and bare soil as build up areas which is a big limitation with respect to build up index. [7]

1.6 Scope of the study

The scope of the study was only confined to buildup areas for specific tourist hotspots in Goa. It was a comparison between 2 years, 1990 and 2020 as to how buildup has changed between these 3 decades. And finally it was also compared with non - tourist areas to analyze the difference with respect to tourism.

[6] https://data.oecd.org/biodiver/built-up-area.htm
[7] https://opg.optica.org/josaa/viewmedia.cfm?uri=josaa-35-1-35&seq=0&html=true

CHAPTER 2

REVIEW OF LITERATURE

There has been increasing literature about how Remote Sensing can be used to measure economic development. The Socio-economic data at desegregated level aren't available and also the data is not consistent so researchers wanted an alternative so they used Remote Sensing at lower level. A study conducted by Banerjee et al., 2002 assessed Socio-Economic analysis in Dehradun through Remote Sensing and GIS. The objectives of this study was to investigate the mapping procedures of social indicators using GIS, to see the density as well as population growth of Dehradun, the distribution of slum population, the land use pattern and finally the social, economic and biological characteristics of the population. Authors used the satellite images of IKONOS and ran the analysis in two GIS based software i.e. ERDAS and ARCView. Authors created a polygon of the Dehradun city consisting of wards, an excel database was also created with socio- economic data and hence both were joined together i.e. the wards and the database file. Authors found that the population of Dehradun had an increasing trend and the south, central and western parts of the city were densely populated, it was also seen that the slum areas had a marked growth leading to different social problems and it has been revealed that high slum population were related to areas having high and medium population densities, with respect to biological characteristics the city was in approval of the girl child. But it has been noted that the male literacy was higher than the female literacy. And to conclude with it has been stated that population growth has had increasing pressures on the land resources. Through this article we come to know that remote sensing can be used for economic analysis.

Remote Sensing can also help with respect to Land use and land cover and hence here is a study was carried out by Dewan & Yamaguchi in 2009 on Land use and Land cover change in Greater Dhaka, Bangladesh using remote sensing to promote sustainable urbanization. The purpose of this study was to evaluate LULC changes at the study area between 1975 and 2003 and to examine the forces of land use change. For this Landsat images were used to examine LULC changes, geometric corrections were also done for all the images. Fieldwork was also conducted for this study and based on it a ground truth map was also produced. Authors used the Anderson

Scheme Level 1 method for LULC classification and 100 training points were given for accurate results. The outcome of this study highlighted that in 1975 the dominant land types were lowlands, cultivated areas and water bodies but as years passed these lands were utilized for residential, academic, commercial and business purposes. Due to the ever growing demand for housing the agricultural areas and lowlands have turned to build up. It was observed rapid urbanization has had widespread effects on environmental degradation.

Remote sensing data can be used to analysze the impact of rising tourism on land use and land cover. A study conducted by Yagoub & Kolan, (2006) examine changes in land use and land cover of the coastal zone of Abu Dhabi from 1972 - 2000. Landsat satellite images were obtained from the Global Land Cover Facility. Authors engaged this study into 2 steps. First, classification of data into LULC types. Second, change detection analysis with respect to LULC types. The analysis was done with the help of Environment for Visualizing Images and the ARCGIS software. The results hence provide information that woody vegetation declined from 122 to 27 km^2, likewise wetlands reduced from 432 to 168km^2 and all this was due to the rapid urbanization and industrialization along the coast. Barren lands increased from 1972 to 1990 as the wetlands were transformed to bare land due to non-accessibility of moisture and backwater but bare land decreased from 1990 to 2000 due to urban and suburban developments.

Liao et al., (2019) Conducted a study of seven protected areas of Hainan Island, China between 1987 and 2017 to figure out what was causing mangrove changes. This study focused on seven protected areas between 1987 and 2017. They wanted to find the factors leading to mangrove changes. Authors used Landsat images at 30m spatial resolution as they wanted to analyze long term changes. The images were downloaded from the United States Geological Survey (USGS) Earth Explorer. Ground surveys were also done along with Google Earth images to collect information about mangrove species. Support vector machine (SVM) classification was used to separate mangrove and non-mangrove areas. For overall accuracy (OA), they used the user's accuracy(UA), the Kappa coefficient and producer's accuracy (PA) to find the clear accuracy between the classified images and ground-truth. It was found that the total overall decrease of mangrove forest accounted for 9.3%. The factors that lead to the decline were natural as well as various human activities, mangrove forests were converted to several other land uses due to human activities. From 2009 Hainan Island was said to be an international tourist destination.

Similarly, Boori et al., (2015) analyzed LULC disturbance due to tourism in Jeseniky Mountain, Czec Republic. Authors performed a comparative study for 3 years, 1991, 2001 and 2013. They selected 3 tourist sites to analyze the tourism effect. The aim was to detect the aftermath of tourism on land cover such as pastures, agriculture, forests and settlements. Landsat 5, Landsat 7 and Landsat 8 images were taken from NASA's archive of Landsat images. They were further processed in the ArcGIS software. In the beginning unsupervised classification was carried out and after field visitation supervised classification was obtained. The Digital Elevation Model (DEM) was applied to separate the high elevation area from the low elevation area. The results showcase that forest land and agriculture made up the largest percent with 40% and 35% in 1991 and vice versa in the year 2013. Pastures showed a decreasing trend while forest and water bodies depicted an increasing trend. Authors have further said that the unfounded way of land use like transformation from farmland to woodland has led the way to land degradation. Finally, the authors have winded up saying that the land cover disruptions were not only related to tourism but also other factors like snow damage, wind, agriculture harvesting, population growth and socio-economic activities.

Rimba et al., (2020) identified LULC change from 2000 to 2025 driven by tourism growth in Bali. To identify and predict the LULC change for 25 years, authors incorporated The Land Change Model technique so as to help policy makers to issue policies to control urbanization. For this study authors used Landsat Thematic Mapper and Landsat 8 images. The LULC maps were classified into 5 categories, namely open area, agriculture, mangrove, built up and vegetation. This was done with the supervised classification and 100 survey points were assigned in this classification, the main focus was on built up areas. To measure the exact accuracy of LULC the Kappa coefficient was employed. The outcome of this study showed that build up areas increased from 2000 to 2015 from 4,88.7 Ha to 25,589.8 Ha. It was visible that a majority of areas were converting from agriculture to build up. To conclude with, tourism activities drive major LULC changes and it thus creates social, physical and environmental issues. Environmental problems such as water shortages, job conversion to the tourism sector and poor garbage management. And for the change analysis it was predicted that build up will continue to grow due to the increasing demand for housing and the development of tourism

related activities. And the major conversion will take place on farmlands and so it needs quick actions by the policy makers to control LULC change especially in the areas of agriculture.

Another study on Multiscale analysis of LULC and NDVI variation in Nang Rong district, northeast Thailand was carried out by Walsh et.al, (2001). The goal of this study was to look into the scale dependence of statistical relationships between certain variables such as biophysical, geographical variables, social and plant biomass levels and the spatial organization of Land Use and Land Cover. Authors analyzed the contrast in plant biomass with the help of NDVI. In the beginning an unsupervised classification was run followed by supervised classification. In this study Canonical correlation was included to inspect the relationship between the biophysical variables (i.e., plant biomass, slope angle, soil wetness and elevation) and population variables. Land pop was incorporated as a measure of density and population pressure. Ordinary least-squares regression along with dummy variables was used to examine the relationship between the selected variables and NDVI. Results of this study convey that the significance of biophysical and social factors on plant biomass at various temporal periods and spatial scales were significant and that social variables were highly definitive at finer spatial scales for describing the variation in environmental variables and plant biomass levels.

Ara et al., (2021) wanted to find about the Impact of Tourism on LULC and LST at a coastal Island in Bay of Bengal. St. Martin's Island is the frequently visited tourist destination of Bangladesh, and it is widely famous for its coral ecosystem. The author's focus was mainly on the coral reefs and surface temperature as the changes in surface temperature affected the local microclimate and coral reef. So the authors selected some locations at St. Martin's Island and tried to quantify them on the basis of tourist pressure index (TPI). The next target was to explain the relationship between LULC change, TPI and LST for the year 2005 till 2019. First, a supervised classification was employed with six land classes namely built up, waterbody, vegetation, sandy, agriculture and coral reef. It was found that LST and build up showed an increasing trend, while vegetation was on a decreasing side. With respect to the relationship between TPI and LULC, it was seen that the changes in LULC were more repeated in areas where TPI was high. And the increase in LST was escalated due to the frequent changes in LULC. In the last decade it was seen that agricultural lands were reduced and a large number of hotels and resorts were constructed. A correlation analysis was also conducted regarding the

relationship between LST and TPI, and through this it was observed that the commute in mean LST was higher in areas where the TPI score was more. In simple words, the LST was high in places which were recognized as high tourist attractions.

Kausar et al., (2016) studied about Spatio-temporal LULC Analysis of Murree by using GIS - and remote sensing. The objectives of the research were as following, to analyze the spatial and temporal land models of the region of Murree. Precisely the study would find about the spatial patterns of LULC, built-up area and deforestation. The study utilized Landsat 4 and 7 images for the analysis from USGS global visualization viewer. Then began the spatial analysis, images were first processed for reflectance, next, different bands were combined to intensify the images for extraction regarding the necessary information. A supervised classification was then employed for the LULC map. All analyses were completed using the ARC-GIS software. The results revealed that the built up area increased to 69.1% from 57.37% during the study period itself. As well there is an increase in settlements to cater to the needs of population growth. But in 2005 the buildup showed a decreasing trend just because the area was hit by an earthquake. The following were the recommendations given by the authors. There is a high need for pre-planned and proper strategies. The rapid increase in urbanization is affecting the local biodiversity and hence it needs to be protected. And finally the study also recommends further research to analyze the changes in particular areas and the factors that cause these changes also combined with specific time periods.

Ishtiaque et al., (2017) analyzed the Rapid Urban Growth in the Kathmandu Valley in Nepal. The author found that there has been no analysis done with respect to LULC in this valley since 2000 and so they carried out this analysis with the help of Landsat images. The study's aim was to monitor the LULC change from 1989 to 2016 and also the urban growth of the Himalayan cities and to assist in the management of urbanization. For this study Landsat images were downloaded from the USGS earth explorer and were processed for atmospheric correction later a pixel based approach was used to detect LULC change as well a post- classification comparison method was used to understand the nature of change. In the pixel based approach supervised as well as unsupervised classification were followed to provide accurate results. The training points given for classifications were at least 50. But with respect to agriculture , 90 points were taken since the study area consisted of more of these classes. Results pinpoint that during the 1980 the

urban areas weren't much but they expanded during the 1990s in the study area. During the study it was found that in the study area comprised 26% of built up area while the agricultural area was decreasing at 1.8% per year. With respect to the change pattern the rise in built up came mainly from the change of agricultural land to urban areas. In 1989 out of 34,000 ha of agricultural land, 8880 ha was converted to build up by 2016.

Indrawan et al., (2022) This paper gave information regarding LULC change in Badung Regency in Bali. The Bali Island being exploited due to the numerous tourism activities taking place the authors aimed to analyze LULC change from 2010 to 2020 and also to predict the changes in 2030. In this research Landsat and Sentinel images were used for the analysis. To recognize objects better the bands were exhibited in Red, Green and Blue format. The band combination used was, 321 for Landsat as well as the Sentinel images. The data was progressed using the ENVI and ArcMap software's. The results for 2010 to 2015, the major change was seen in the paddy fields which increased by 6,89.08 ha in contrast the forested areas decreased by 6,033.6 ha. The regions covering built up mangroves, mixed gardens and shrubs showed an increasing trend while Uplands were found to be depleting but water bodies did not change much. The results for 2015 to 2020 the major change was seen in built up areas which showed an increasing trend due to urbanization while forests, mangroves, uplands, shrubs and paddy fields showed a decreasing trend. But water bodies did not even change.

Garrard et al., (2016) examined the Land Use and Land Cover change in Sagarmatha National Park, which is a world heritage site in the Himalayas of Eastern Nepal. The objectives of the study were to examine LULC change from 1992 to 2011.and how local people perceive LULC changes. For this LULC maps were generated from the Department of National Parks and Wildlife Conservation (DBPWC) and The International Centre for Integrated Mountain Development (ICIMOD). After generating the images, the first step was to field verify the LULC classifications and then the LULC were further improved finally an accuracy assessment was done with the help of Rapid eye images, IKONOS and field photographs and then set side by side with the LULC maps. Field interviews were also conducted in this research to find about the local people's perception regarding the consequences and causes of LULC changes and 56 people were interviewed during the time period 2009 to 2011. As well some workshops where the people were told as to why these workshops are being conducted and so the people were

asked to list down the LULC changes as many as they could and also the drivers for change. The final results found from this research were that ice and snow cover decreased by 43% while the areas covered by soil and rock and glacial lakes expanded. And the major decrease in ice and snow was related to an increase in temperature. Settlement areas conveyed a very small change but this also had a high impact on the resources near the settlements. Forest indicated a decreasing trend while agricultural lands remained constant. Rapid tourism also led to the development of many settlements, the local people said that the lodges and hotels weren't sufficient enough during the peak tourist season and so there was a need for the construction of the needed requirements. Which resulted in the increase of built up areas.

Mahapatra, (2019) conducted a study with respect to Spatio - temporal analysis of land use and land cover changes in the Little Andaman Island using geospatial techniques. The aim of this assessment is to help out the Andaman Administration to formulate policies for better planning and preparing island management. For this analysis Landsat 2, Landsat 5 and Landsat 8 images were used, the survey of India topo sheets were included and as well field visits were done to confirm the LULC classifications. The land use classes were built up and mining areas. The results found were that built up comprised of roads, ponds, industries and settlement areas. The buildup increase was associated with infrastructure development, population, tsunami shelters and tourism developments. From field visits it was found that the island has a good network of roads. The forest area being the largest component gradually decreased from 87.59% in 1976 to 83.29% in 2017. It was found that the little Andaman is well preserved. As the forest class decreased by 1 to 4% in the last 41 years. As the little Andaman island being under the category of "Island Coastal Regulation Plan" it has to follow the guidelines laid by the "Island Protection Zone." So in order to arrange an island resource management plan, information on coastal land cover and land use is necessary. In this study, land cover and land use changes are assessed in detail and can be used to prepare a resource management plan such as conservation of coral reef areas, mangrove restoration, prohibition of mining of sand from beaches and so on.

Chu et al., (2020), assessed the influence of Tourism activities on Hainan Island, China. The aim of this study is to evaluate the impact of tourism activities on LST. The data sources of this study are MODIS terra Vegetation Indices, MODIS Terra LST products, LULC data and POIs. For the preprocessing NDVI and LST, products were sorted out from Google Earth Engine and were

clipped to the study area. Authors analyzed tourism as well as non-tourism sites. For POIs and land use data there were 4 sub-classes namely accommodation sites, orchard sites, residential sites and tourism sites. And there were 152 accommodation sites, 109 orchard sites, 179 residential sites and 2319 tourism sites. Images from 2000 to 2019 were used to calculate NDVI with respect to tourism and non- tourism sites. For LULC a simple land cover change grid was calculated using the QGIS software to find the link between land change and tourism development. For the results it was found that the LST in the tourism sites was much more than non-tourism sites. With respect to NDVI the vegetation loss was mostly seen towards the shorelines and the values of NDVI were lower in tourism sites as compared to non-tourism sites. A major portion of 245 km^2 cropland and 185 km^2 of dense forest was converted to urban areas.

Sobhani et al., (2021) studied the Habitat Integrity in Protected areas which were threatened by LULC changes and fragmentation, a case study in Tehran Province, Iran. In this study the period was from 1989 to 2019. The aim of this study was to inspect the landscape facet and study the change of those facets. To find the changes in LULC, Landsat images were downloaded from the USGS earth explorer. The GPS pointing technique was used to numerically correct the images. The Anderson scheme, which is an excellent system for presenting LULC details and classifications. Applying training samples for Land Use Land Cover classes, 600 samples were scrutinized from the collection, 300 samples were scrutinized for algorithms and 300 samples were assessed for classification. In the end, classification precision was scanned against ground truth data. In the study area, built-up appeared to be increasing very rapidly with 11.95% in 2019 contrast to 10.43% in 1989. At the Tangeh Vashi Natural Monument, bare land showed an increasing trend with 81.42% in 2019 in contrast to 80.84% in 1989. Many tourism ventures were available in the Tangeh Vashi area, like rock climbing, mountaineering etc. These ventures have given rise to increased habitat fragmentation and the destruction of high-density pastures.

Dey et al., (2018) conducted a study on Geospatial Assessment of Tourism Impact on Land Environment of Dehradun Uttarakhand India. Authors assessed the impact of tourism for the following years 1972, 2000 and 2016 with the help of GIS techniques and remote sensing. The objective of this article was to analyze land use and land cover in Dehradun and to determine the impacts of tourism on natural slope. For this, authors used Landsat images from USGS earth explorer. Using satellite images authors performed object based image classification to obtain

land use and land cover and also ASTER-DEM to determine the topography of Dehradun. The LULC was classified into vegetation, built up, scrub, forest, plantation agriculture and water bodies; they also categorized the climb of the region as strong, moderate, gentle, extreme, steep, and very steep. Results showed that built up area increased from 1972 to 2000, and at the same time waterbodies, forest cover, vegetation and agriculture showed a dwindle. Authors found that the built-up area has been increasing from gentle slope to very steep slope. The constructions taking place on the steep, very steep and extreme slope were inclined to landslides and other natural disasters.

In 2015, Singh and co-authors tried to Predict Decadal and spatial LULC changes through Cellular Automata Markov Chain Models using Earth Observation Datasets and Geo information for the Allahabad district of Uttar Pradesh, India. For this analysis a non- segregated approach was applied to analyze the spatial and temporal changes in the study area for the years 1990, 2000 and 2010. Authors wanted to predict land use change from 2010 and 2020 based on CAMCM to conserve the natural characteristics. This study used multidate and multisensory satellite images, socioeconomic statistical data, and also field investigation was conducted, the LULC classification was performed utilizing the unsupervised classification technique. Authors found that built up area showed an increasing trend, while the fallow and waste land showed a decreasing trend. They say that the increase was probably due to migration of residents towards the Allahabad district, which offered better education, job opportunities, business and education. With the help of CAMCM it was predicted that the classes of waste land and fallow land was about to turn into agricultural class, the forest class designates a major transformation, some will change to water bodies and agricultural class. It has been attributed to an increase in deforestation activities. The other fallow land class will also change and will transform into water body, waste land class, agriculture class, and other fallow land. The waste land class will also see a transformation; it will mostly be converted into agricultural and other fallow land class.

Naik et al., (2018) conducted a research testing the Impact of LULC change on coastal tourism in Kundapura, Karnataka. The study attempted to examine the LULC changes for the time period 2006 and 2016. Multi-temporal remotely sensed data and GIS techniques were used in this study. The study area was drawn out from the topographical map, and to carry out change detection,

LULC maps were used in this study. The changes happening in Land Use and Land Cover patterns were acquired by comparing the 2006 and 2016 LULC maps. It was found that agriculture was the presiding activity of the coastal belts of Karnataka. The LULC analysis found a negative change in the agricultural land/farming. The agricultural area covered 55.38km in 2006 while it declined to 36.92km in 2016 an acute decrease of about 18.46km of land was observed and now it has changed into built-up area. The emigration of rural people into the flourished cities and the lack of skilled workforce available for agricultural practices are the major reasons for the decrease of agricultural land. Wetlands which were an important part of the environment were found that only a very tiny area of wetland was present in that area now and wetlands have been showing a decreasing trend. The study found that a big chunk of population settlement was in the coastal areas causing overutilization of the coastal resources and therefore harming the coastal ecology. Authors also gave recommendations, saying that the government should stimulate the development of the agricultural sector in the region by providing incentives to the farmers.

Khalid et al., (2015) The Geospatial mapping of the Srinagar city. This paper used integrated approaches of remote sensing to analyze the changes in LULC, tourist utility and heritage of the Srinagar city. For this analysis Multi-temporal data was acquired from Landsat MSS, field surveys were conducted using google earth and handheld GPS for the accuracy assessment. Authors employed the supervised classification to classify the images and as well the Gaussian maximum likelihood classifier was used. There were 13 LULC classes namely aquatic vegetation, agriculture, built up, bare land, rocks, horticulture, riverbed, shrubs, pasture, horticulture, snow plantation and water. From the results it was found that horticulture and agriculture covered 15% and 23 % respectively and build up was almost 40%. Three hundred and thirty-four heritage sites were mapped during field surveys and with respect to tourist utility 405 tourist utilities were classified. Authors finally concluded saying that the LULC change is mostly driven due to deforestation, increase in population and unplanned urbanization and hence there is a need for sustainable planning.

Vijay et al., (2016) assessed the tourism impact on LULC and natural slope in Manali, India, published on the Cross Mark journal. The aim of this study was to analyze the changes in Land use and land cover in the region of Manali and to find the impact of tourism on natural slope and

land use. Global positioning system and Geographic Information System were used to assess the impact of tourism on land use, land change and natural slope. For the analysis of natural slope, ASTER DEM was used in the study. The images were classified with the assistance of training data which was collected during the ground surveys. The classes were allotted as per the Anderson classification scheme so as to calculate the slope in percentage. As per the results Built-up is increased from 4.7% to 15.7% while there was a decrease in the forest from 45.2% to 36.3 % and also there was a slight decrease in the scrub forest from 14.2% to 13.1%. Bare rock occupied areas along the places of high elevation and river. Due to the rapid increase in tourism at the study area, the inflow of tourists as well as number of hotels is increasing rapidly which inferred that Manali had an excessive tourism pressure. Built-up was not so visible on very steep slopes till 2000 but it was noticed in 2005 and 2012 due to the various developmental activities towards very steep slopes.

CHAPTER 3

DATA AND METHODS

To begin with, Landsat images were downloaded from the USGS Earth Explorer website.[8] Goa shapefile at the village level (census 2001) was obtained from SEDAC.[9] I used the QGIS software to process images and generate results.

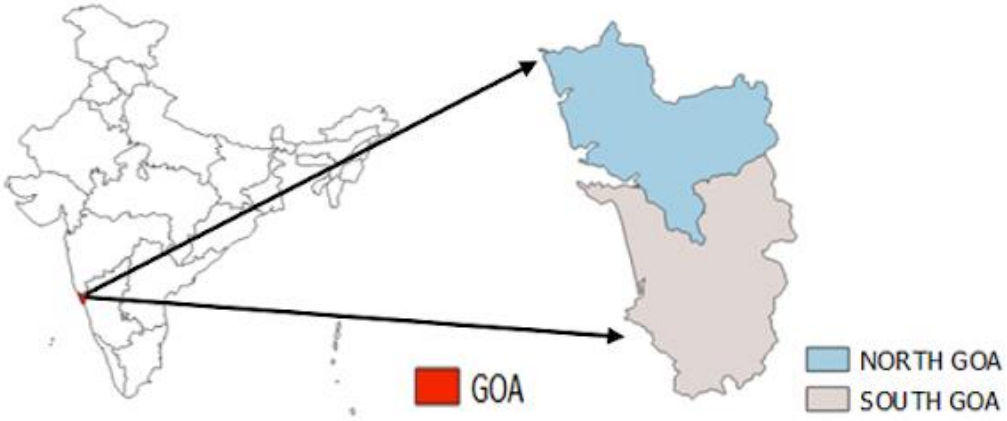


Fig. 3.1 India Fig. 3.2 Goa

Figure 3.1 shows a map of India with the state of Goa highlighted in red.
Figure 3.2 shows a map of Goa divided into two districts, North Goa in blue and South Goa in grey.

[8] https://earthexplorer.usgs.gov/
[9] https://sedac.ciesin.columbia.edu/

Fig 3.3 Goa village shape file with study areas

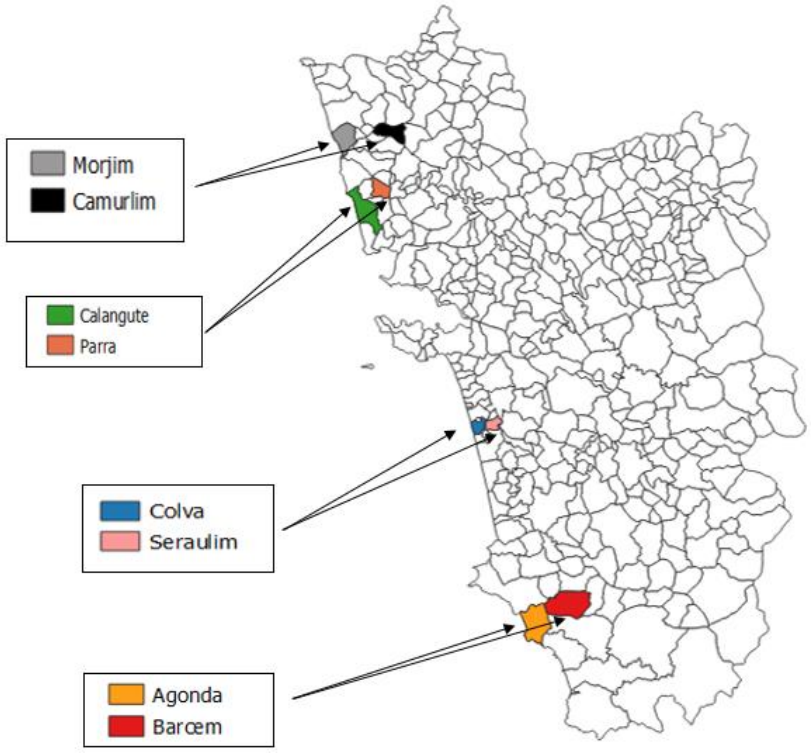


Fig 3.3 shows the Goa village shape file along with the study areas. The village highlighted in Grey is the village of Morjim and Black being Camurlim in the North. The one highlighted in Green is Calangute and Brown is Parra in the North. The village highlighted in Blue is Colva and Seraulim highlighted in Pink in the south. Agonda highlighted in Yellow and Barcem in Red in the south.

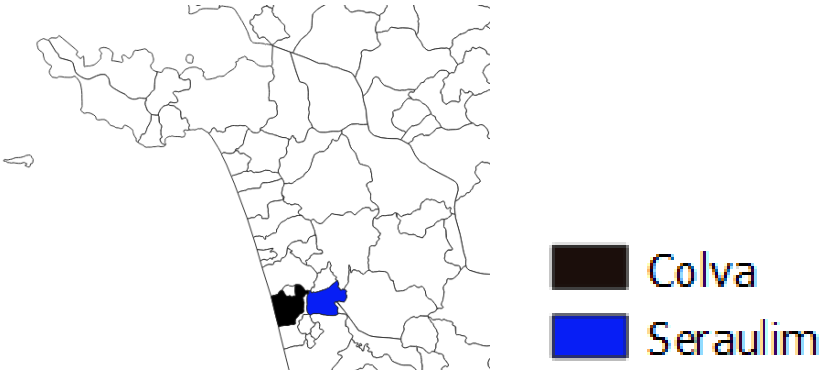
This analysis covers 8 study areas, 4 Tourist and 4 Non-Tourist areas. The tourist areas are Colva and Agonda in the South, Calangute and Morjim in the North. The Non-Tourist areas being Seraulim and Barcem in the South, Parra and Camurlim in the North. The comparison was done between Colva and Seraulim, Agonda and Barcem in the South, Calangute and Parra, Morjim and Camurlim in the North. The Non-Tourist or Inland areas were selected by creating a buffer within 4 kilometers from the Tourist Hotspot.

To create Buffer

Import the shapefile in QGIS, select the particular study area by using the select features by area, right click on the shape file, click on vector in the top bar, next select geoprocessing tools, buffer, give input layer Goa village shapefile, enable the selected feature option, later give the distance in kilometers. The buffer will appear, displaying the villages within a radius of 4 kilometers.

- Colva and Seraulim

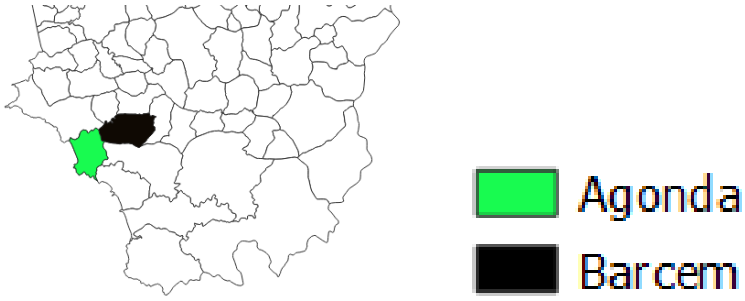
Fig 3.4 Colva and Seraulim



This image (fig 3.4) exhibits the South Goa District, where the village of Colva is in black and the village of Seraulim is in blue. And Seraulim was within the radius of 4 kilometers.

- Agonda and Barcem

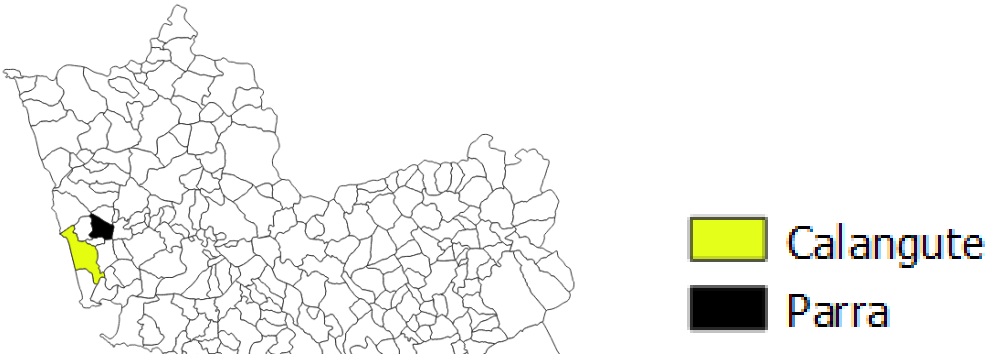
Fig 3.5 Agonda and Barcem



This image (fig 3.5) displays the South Goa district; the two highlighted villages are the study areas. The one in green is the village of Agonda while in black is the village of Barcem. Barcem was within 4 kilometers radius of Agonda.

- Calangute and Parra

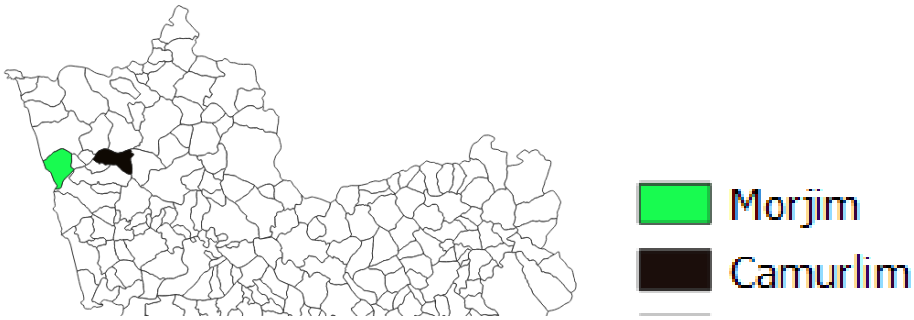
Fig 3.6 Calangute and Parra



This image (fig. 6) displays the North Goa District, where the study areas are highlighted in Yellow and Black, where the village of Calangute is in Yellow and Parra in Black. Where Parra is within the radius of 4 kilometers near Calangute.

- Morjim and Camurlim

Fig 3.7 Morjim and Camurlim



This image (fig 3.7) shows the North Goa District, where the two areas above in Green and Black are the study areas, Black indicating Camurlim the inland area within the radius of 4 kilometers to Morjim and Morjim which is marked in Green.

Methods

The methodology of this study is explained into 4 sections. Section I: Data collection, Section II: Atmospheric correction, Section III: IBI formula, Section IV: Extraction of data at study area.

Section I: Data collection

In this study Landsat images were downloaded for the years 1990 and 2020. The details of the satellite images are displayed in Table 3.1.

Table 3.1: Acquired satellite data sensor characteristics

Sensor	Characteristics	Path and Row	Date of Acquisition	Data Source
Landsat 4 - 5 TM C2 L1	Number of bands: 7 Cloud cover: 0	Path: 146 Row: 49 (WRS-2)	7th February 1990	United States Geological Survey
Landsat 4 - 5 TM C2 L1	Number of bands:7 Cloud cover:0	Path:147 Row:49 (WRS-2)	3rd April 1990	United States Geological Survey
Landsat 4 -5 TM C2 L1	Number of bands:7 Cloud cover:0	Path:146 Row:50 (WRS-2)	7th February 1990	United States Geological Survey
Landsat 8-9 OLI/TIRS C2 L1	Number of bands:11 Cloud cover: 0	Path: 146 Row: 49 (WRS-2)	26th December 2020	United States Geological Survey
Landsat 8-9 OLI/TIRS C2 L1	Number of bands: 11 Cloud cover: 0	Path: 147 Row: 49 (WRS-2)	30th October 2020	United States Geological Survey
Landsat 8-9 OLI/TIRS C2 L1	Number of bands: 11 Cloud cover: 0	Path:146 Row: 50 (WRS-2)	26th December 2020	United States Geological Survey

Section II: Atmospheric Correction

After downloading landsat images, it was pre-processed for atmospheric correction to remove cloud cover or any atmospheric noise. QGIS software was used in the analysis where the raw images were imported. In the SCP plugin Band set was selected and the images were added into Band set 1, next was preprocessing in which Landsat was chosen where the folder of the raw images and the MTL file had to be added, apply DOS1 atmospheric correction was checked The same procedure was followed for all images.

Section III: IBI formula

Various formulas, such as NDBI, EBBI were tested on this study to determine which could clearly extract built up area. But most of the built up index results shows bare land and uncultivated agricultural land as buildup. Comparatively, IBI shows improvements in results but does not eliminate the problem. The IBI results are quite better than other builtup index. For my analysis I have followed the IBI formula to calculate builtup area of selected tourist hotspots of Goa. The IBI formula was used from the article by Xu, H. (2008).

$$IBI = \frac{2MIR/(MIR+NIR) - [(NIR/(NIR+Red)) + (Green/(Green+MIR))]}{2MIR/(MIR+NIR) + [(NIR/(NIR+Red)) + (Green/(Green+MIR))]}$$

For the construction of the IBI formula 3 indices had been employed

- Normalized difference built-up index (NDBI).
- Soil adjusted vegetation index (SAVI),
- The Modified normalized difference water index (MNDWI)

For the analysis, I used Landsat 5 and Landsat 08 images from 1990 and 2020, respectively. Landsat images are made up of multispectral bands that are classified according to the wavelength

captured by the satellite. The Landsat 5 satellite has seven bands, whereas the Landsat 8 satellite has eleven bands. Due to differences in bands and associated wavelengths, the IBI formula for landsat 5 and landsat 8 is as follows.

Table 3.2: IBI Formula

IBI Formula
Landsat 4-5 $\frac{[2(\text{Band 5}/(\text{Band5}+\text{Band4})-[\text{Band4}/(\text{Band4}+\text{Band3}))+(\text{Band2}/(\text{Band2}+\text{Band5}))]}{[2(\text{Band5}/(\text{Band5}+\text{Band4})-[\text{Band4}/(\text{Band4}+\text{Band3}))+(\text{Band2}/(\text{Band2}+\text{Band5}))]}$
Landsat 8 $\frac{[2(\text{Band6}/(\text{Band6}+\text{Band5})-[\text{Band5}/(\text{Band5}+\text{Band4}))+(\text{Band3}/(\text{Band3}+\text{Band6}))]}{[2(\text{Band6}/(\text{Band6}+\text{Band5})-[\text{Band5}/(\text{Band5}+\text{Band4}))+(\text{Band3}/(\text{Band3}+\text{Band6}))]}$

The Raster calculator in QGIS was used to calculate IBI and was processed for the extraction of buildup.

Section IV: Extraction of data at study area.

After all the images were processed in the raster calculator, the data was than extracted at the study area. Then the raster calculated images had to be masked with the study areas using raster clip tool. After each image data was extracted the next part to change color coding, for build up area in red color and non built up in grey colour. The images were then verified using a false colour composite and Google satellite image, to which QGIS can directly connect to.

False colour composite means a false colour image which is used to enhance or reveal features which are invisible to the human eye. A false colour composite is a multispectral image which uses the standard visual Red, Green and Blue (RGB) band range for interpretation. This false colour image can be produced using various colour combinations. The colour scheme depends upon the type of objects that need to be highlighted. A false colour combination magnifies variety of objects in the image, assigning each object a specific colour.

The falsecolour is obtained if all the images are in band set 1 and the RGB is turned on. In the falsecolour the brighter colours indicated built up areas but some was also represented bare land and so the values have to be identified properly, while in the google satellite the buildup could be seen clearly, but this was only in the case of 2020 as the google satellite gives the most recent picture of the world.

Measuring build up area

Finally the build up was measured by square meters. The first is to find out the lowest and highest values of build up. The values in red had to be taken into consideration. Next using a raster calculator a separate raster layer was created with built Up area having binary number 1 and non built up area having binary number 0.

After creating a raster layer of builtUp and non Built Up area next is to calculate built Up area by square meters. For this, from the processing tools ‘raster layer unique values’ used to calculate built Up area for each study area and year wise. In raster layer unique values browser one to supply details like input raster and DN value in my case the value is 1.

Next you move to processing, toolbox, raster analysis under which raster layer unique values report need to be selected, where input layer would be Colva Buildup 2020, under unique values report you save to file by giving a name and run. You will get results viewer, under which you have to click on the file path link which will give the build up area.

For the new layer you can give the platted unique values as the values will be 0 and 1. So you have to right click on the layer, properties, platted unique values under render type and classify,

change the colour accordingly, 1 for build up and 0 for other than build up, apply and ok. Finally, for the final output to be displayed the images were put in new print layout under project using the add map and also the legend using the add legend icon.

Study Areas

Colva

The Colva village is part of the South Goa district, situated in the Salcete taluka. It is a coastal village on the west coast of India. The geographical area of Colva is 287 hectares/ 2.87 square kilometers. The famous Colva beach stretches around 2.4km with white powdered sand and coconut palms along its shore. Colva is a famous tourist destination mostly visited for its beach, shacks, hotels, pubs, guest houses, food stalls, restaurants and bars. The ethnicity of this village essentially consists of farmers and fisher folks, with farming and fishing as its main source of income.

Colva in the beginning was a large barren uninhabited land until a few fisherfolk communities settled there as migrants. Colva was a province of the Portuguese from 1510 to 1961, Colva in those days was the village of the Portuguese Roiz family and they were the descendants of D. Diogo Rodrigues and he was known as the landlord of Colva. The entire shore of Colva as far as Betalbatim was owned by the different descendants of the Roiz family until the late 20th century after which the parts were handed to the Government of Goa. During the 18th century Sebastião José Roiz who was one of the descendants of the Roiz family ordered the villagers of Colva to plant coconut trees along the coastline, but the villagers thought that the trees wouldn't sustain as the soil was white and infertile. However today the coastline is fringed by the coconut trees.

Colva is still well known for Our Lady of Mercy church, known as Igreja de Nossa Senhora das Mercês, which was founded in 1630 and the church houses the miraculous statue of Menino Jesus. The feast of Menino Jesus is celebrated in October for which thousands of people assemble. With respect to climate, Colva features a hot and humid climate for most of the year. The month of May is said to have the highest temperature of over 35 °C. Colva has a very short winter season between mid-December and February. The local language spoken by the people of

Colva is the Saxtti dialect of Konkani, while Portuguese is spoken by the elite and the older generation. English, Hindi and Marathi are also widely understood and spoken in the locality.

There is an initiative taken up by the government with respect to Iconic Tourist Sites so as to develop the tourist areas. For the selection of a site the initiative takes into account, how famous the area is, the footfall of the area and how well the areas are connected with the tourists.

The Union Ministry selected Colva beach under the "Iconic Tourist Sites Development Project". Hence the government plans to work on infrastructure and tourism areas so as to make the areas a better place for the visitors. The Ministry hopes that the villagers of Colva will come together to support the government and make the initiative a successful one. The secretary of the Union Tourism Ministry, Rashmi Verma planned to come up with a well-thought master plan for Colva to achieve the goal of making Colva beach as the Iconic Tourist Site.

There is also another initiative taken by the Goa state Biodiversity Board to assess the Colva beach and gather data about flora, fauna and endangered species so as to study about the right use of land from the beach and how it impacts the environment and furthermore the analysis will also give solutions to address the drawbacks and to make the land better.

The frequently visited places of Colva are Club Margarita, Colva beach, Zorro Jeweller's and the various resorts and hotels.

Seraulim

The village of Seraulim is situated in the Salcete taluka of South Goa District. It is 31 kilometers away from the state capital. Its total geographical area is 3.63 square kilometers. The village is well known for its 4 lakes. Duncolim Dakte Tollem, Duncolim Vodlem Tollem, Seraulim Dakte Tollem and Seraulim Vodlem Tollem. These 4 are considered to be the best for water harvesting.

Due to these water bodies it also makes the village an important Bird Sanctuary. Another activity that extensively takes place in this village is Toddy Tapping. There is also a railway station at this village which was built in 1973.

The name of the village is derived from its earlier name Survali which means place of God. The village was well sustained and maintained where agriculture was a way of life but now the state government's proposal for additional two railway tracks and a western bypass will create havoc in the village disturbing the village life, water bodies and agricultural fields.

Agonda

Agonda is a small village situated in the canacona taluka in the South Goa district. Its geographical area is 1.89 square kilometers. It is encircled by 120 acres of forest and is famous for the Agonda beach which is 2kms long and it is a lonely beach fringed with casuarinas and palms, it is one of the most isolated beaches of Goa and is known as the silent beach of Goa. It is one of the only four beaches in Goa designated as Turtle nesting site under the Coastal Regulation Zone 2011 notification. It is during the month of September that the beach serves as a nesting ground for Olive Ridley Turtles.

In the year 2016 Agonda was ranked fourth as traveler's choice on Trip Advisor's. The majority of accommodation at this village is in the form of beach huts, there is only a single road which runs through this village which is skimpy populated with small stores, cyber cafes and a few restaurants. Most frequently visited places at Agonda are Galgibaga beach, Agonda beach, Rock formations, Chapoli Dam etc. There are also various events that take place at the village but the Fiestero music festival is held at the Leopard Valley.

Also a very unique feature is noticed when anyone visits any bar or restaurant at the village. A small bookstore or library is available for the visitors who love to spend their time reading. The visitors can also get books of their own language and liking too. Tourists lazing around love the magnificence of this breathtaking village and enjoy reading books for hours with a beer in their hand. If at all the tourists are not content with the beautiful lifestyle provided by the beach huts and other housing centers, a 5-star Resort or Hotel is always at their disposal.

A stay at La Gratitude is a delightful one for those who want a premium lifestyle. An ideal place for visitors to spend time with a book, upside-down in a yoga asana or with little or no nightlife is Agonda. There are large numbers of foreigner-run yoga institutes, Ayurveda and meditation set-ups at the village which offer daily classes and courses.

Barcem

Barcem is a village located in the Quepem Taluka of South Goa. It is situated 69 kilometers towards south from the state capital. Barcem's geographical area is 17.23 square kilometers. According to the 2009 stats Barcem is also a gram panchayat and it nearest town for all economic activities is Quepem.

The village is surrounded by swaying coconut palms and lush hills where a segment of the Velips live. Velips were the first few settlers in Goa who were known as jungles at their home back then. All these Tribal's had moved away in seek of education and job opportunities though they have left behind their huts and the forests on which they used to depend for their daily supplies, what brings them back to their roots is their cultural festival 'Shigmo'. Where they honour the forest deity for good harvest.

The village suffers from water shortages, the people entirely depend on rainfall and springs since it is a hilly village, wells and the springs dry up during the summer season and so the Government has to take care about the water needs of this village. In 2013 the MLA said the government will spend about 26 crores through the JICA project which will lay a pipeline from Selaulim dam to the village additionally there will be 20 large tanks which will act as reservoirs across the village.

Calangute

Calangute is a village in the North Goa district, set in the Bardez taluka. It is located 15km from the state capital, Panaji. Its geographical area is 7.01 square kilometers. Calangute is known as the Queen of beaches. The maximum tourist arrival is during Christmas and New Year and experiences dense traffic during these seasons.

It is well known for its accommodation facilities as there are large number of hotels scattered all over the place. The famous destination is the St. Alex Church where the inside of the church displays the beauty of the ornate altars and architectural style. With a spectacular increase in the tourist's strength, it has an outstanding count of Guesthouses and Hotels. Calangute has all the

primary amenities such as post offices, eateries, medical centers, resorts, foreign exchange offices and internet safes.

It is also surprising to know that the count of internet cafes is soon likely to go ahead than the number of cafes housed at Panaji which is the capital of Goa. The frequently places visited at Calangute are Benz Celebrity Wax Museum, Tibetan market, Casino Palms, Ayurveda centers, Flying Fish, Alex Church which has a very eye-catching architecture, it features two different towers, a white doom and the altars. It is one of the oldest churches in the North.

Parra

The village of Parra is in the Bardez taluka, North Goa District. The geographical area of the village is 1.82 square kilometers. According to the 2019 stats the village of Parra comes under the Calangute assembly and Bardez is the nearest town to Parra for all their major economic activities. It is said that the Parra church is dedicated to St. Anne which was built in 1649. Parra covers a vast land which is mostly agricultural land with a few residential areas. The residents of Parra are popularly known as Porrikars.

The village of Parra is very famous for its sweet red watermelons. But for some Parra is known for the English institute of The Sacred Heart of Jesus School. The mostly attracted place of Parra is Titto, Alvito Antiagos, Alex Saldanha, Alva Mar Restaurant, and Emerald Lawns. There are also many goldsmiths which reside at Parra, the famous manufacturer of beautiful imitations jewelers Nicholas and Gregory reside at Parra and their jewelry is marketed countrywide. There are also a couple of lakes at this village which irrigate the fields during the summer season, one well known is the Ganesh Tollem. And also there are two famous bars which serve Feni known as Vintage Moti Bar and Simao.

Slowly Parra is becoming famous for tourists as it’s a quiet and a nice place away from noise and crowded beaches. Several films have also been shot at this village, the film that increased it fame was Dear Zindagi which featured a particular road lined with groves of coconut trees and came to be known as the Parra Coconut Tree Road.

Morjim

The Morjim village is in the Pernem taluka, North Goa district. It is set 20 kilometers from the state capital. It covers an area of 1.09 square kilometers. It is home to a variety of birds and the Olive Ridley Turtles. It came to be known as “Little Russia” because of the huge concentration of the Russian emigrants living there.

The Morjim beach is the nesting and hatching habitat for Olive Ridley Sea Turtles, and they are provided with the highest degree of protection under the Indian Law of Wildlife Protection Act 1972 and egg poaching or any disturbance to their habitat and turtles is punishable under the Indian Law. The protection with respect to marine turtles and their habitat was taken up by the local community began between 1995 and 1996 after discussions with the environment protection groups, but before this the eggs were poached by the fishermen’s but later after the discussions they became really protective. The forest department also pays a monthly stipend to the local volunteers who are involved in the marine turtle conservation efforts done at Morjim.

The Morjim youth has also campaigned internationally on the Greenpeace Ship Rainbow Warrior. The Olive Ridley Turtles being endangered, the tourism department of Goa made various efforts to conserve them. But sadly in 2011 the turtles could be hardly seen due to light pollution, over-urbanization and noise pollution. The frequent places visited at Morjim are Ashwem beach, Morjim beach, Konkan explorers, Yoga and Ayurveda centers, Octopus Surf School and so on. It is also said that wildlife at Morjim has been doomed and the village is anticipated to be the next Calangute.

Camurlim

Camurlim village is located in the Bardez taluka, North Goa district. The village is 7 kilometers away from Mapusa city. Its geographical area is 8.727 square kilometers. It is a very attractive village naturally laid in a quiet scenery of paddy fields with the Chapora river steadily slowing along the palm fringed banks. It is one of the distinctive hamlets of North Goa which apparently varies in the deafening pollution of the city to the very cool and calm climate that one can observe here amidst its original surroundings of lush green plantations and hills.

The village got its name because this village was once inhabited by Camara-halli or Blacksmiths. The major occupation of the people of this village is extraction of laterite stones for building purposes. The village is majorly populated by Catholics but there are also people of other religions living in that village.

Besides extraction of stones, toddy tapping is also widely practiced due to the plentiful coconut palms in the village. People living here are also well known worldwide for the various handicrafts made from coconut palms. Along with cashew feni and coconut the village is also known with respect to the extraction of sea shells. In the village the mode of communication has also improved due to the advent of employment and educational opportunities. It is also known that the people of this village are extremely religious and call on to their respective deity whether it is St. Rita or Goddess Santeri. According to some data provided on Geolysis Local in the year 2009, the total agricultural area of Camurlim is 3.1438 square kilometers, while 0.118 square kilometers is for non-agricultural use and 0.9896 is covered by uncultivated or barren land.

CHAPTER 4

ANALYSIS

Tourist Areas

- Colva

Fig 4.1: Colva 1990

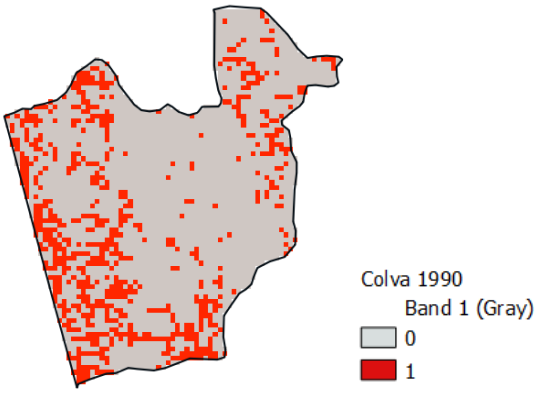
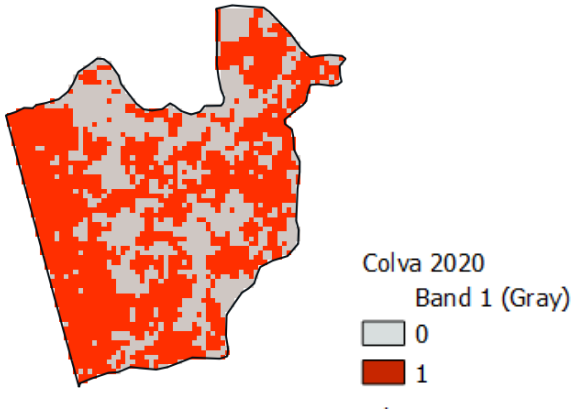


Fig 4.2: Colva 2020



From the above images it is quite visible that the buildup has increased from 1990 (fig 4.2) to 2020 (fig 4.1). The value 1 in Red indicates build up, while 0 in Grey is other than build up.

During 1990 the buildup of Colva was quite lesser as compared to 2020.

For Colva 1990 the build up values ranged from 1.7346 to 1.7693.

The measured build up area for 1990 was 626400m^2.

Compared to 2020 the values ranged from 1.6228 to 1.7637 and the measured build up area was 1776600m^2.

The build up area for Colva increased from 626400m^2 in 1990 to 1776600m^2 in 2020.

- Agonda

Fig 4.3: Agonda 1990

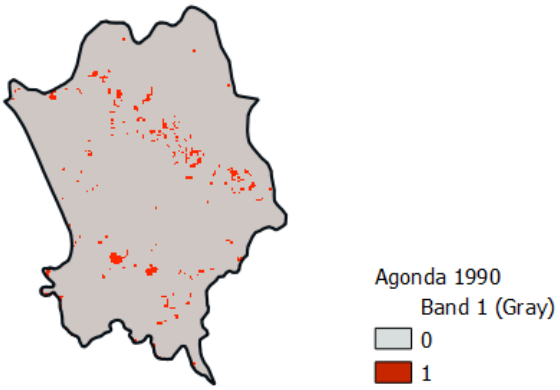
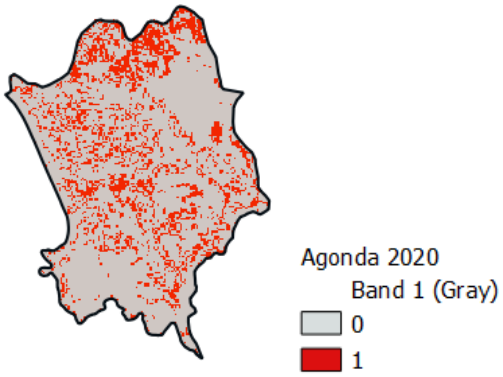


Fig 4.4: Agonda 2020



The above images exhibit the build up of Agonda in 1990 (fig 4.3) and 2020 (fig 4.4).

Red colour signifying build up and Grey signifying other than build up areas.

The build up of Agonda has increased from 1990 to 2020 as displayed above.

The values of build up for Agonda 1990 ranged from1.8139 to 1.8819 and the build up area was 421200m^2.

The values for 2020 with respect to build up ranged from 1.6733 to 1.6919 and the measured build up area was found to be 3175200m^2.

The build up area for Agonda increased from 421200m^2 in 1990 to 421200m^2 in 2020

- Calangute

Fig 4.5: Calangute1990

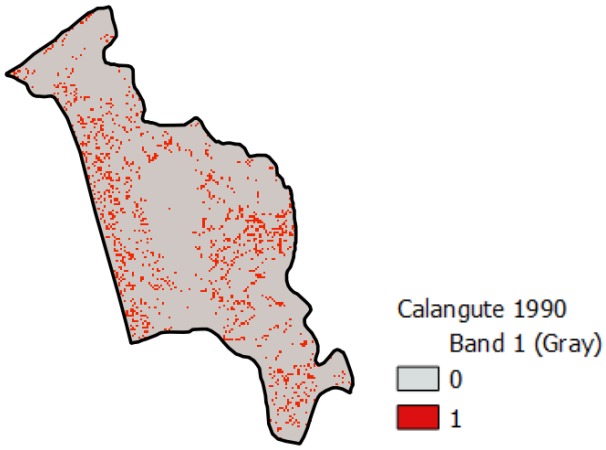
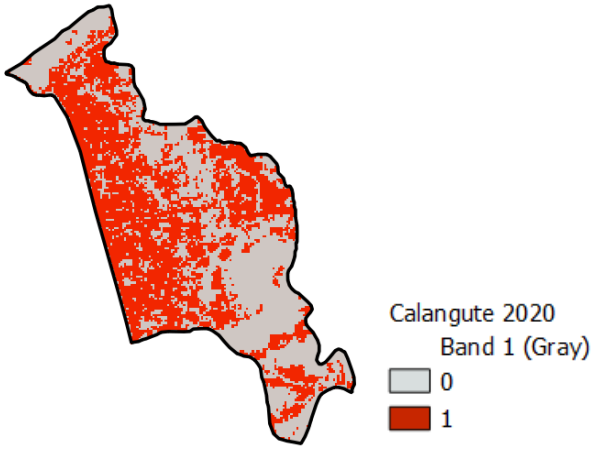


Fig 4.6: Calangute 2020



With respect to Calangute the above figures display the build up of Calangute in 1990 (fig 4.5) and 2020 (fig 4.6).

In which red depicts the build up while the grey areas are other than build up.

The values of build up for 1990 ranged from 1.7326 to 1.7448 and the build up area measured was 1153800m^2.

Compared to 2020 the values ranged from 1.6457 to 1.7959 and the build up area was 6162300m^2.

The build up for Calangute increased from 1153800m^2 in 1990 to 6162300m^2 in 2020

- MORJIM

Fig 4.7: Morjim 1990

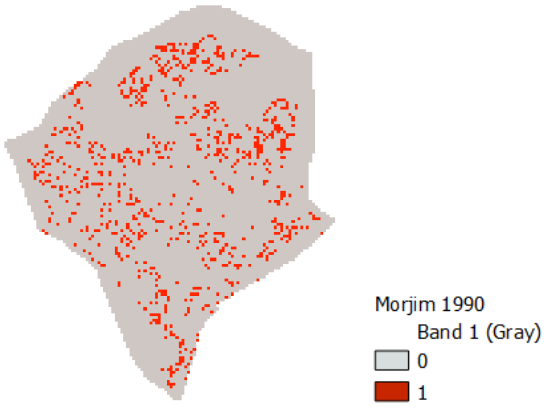
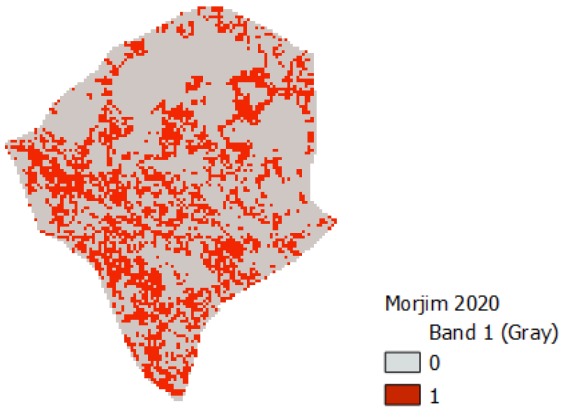


Fig 4.8: Morjim 2020



The legend of Morjim exhibit Grey 0 as other than build up areas while the value 1 in Red signify build up areas.

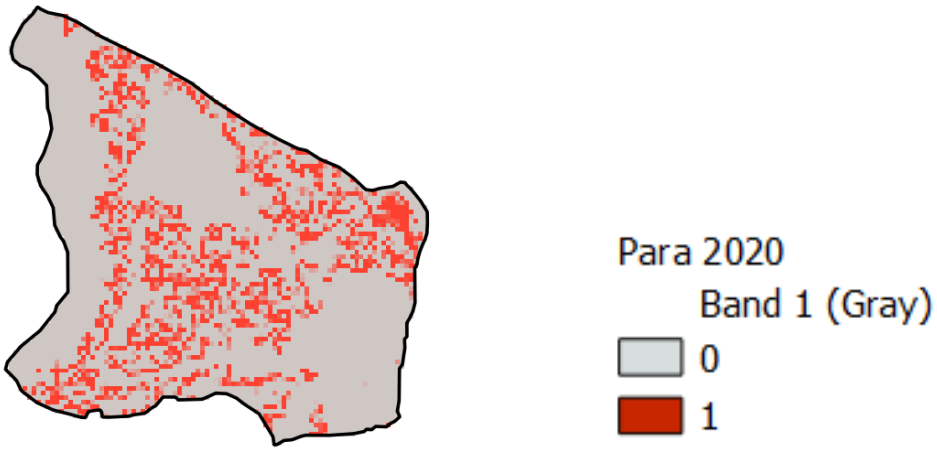
The build up in 1990 (fig 4.7) was lesser as compared to 2020 (fig 4.8). The values of buildup in 1990 ranged from 1.7315 to 1.7193 and the calculated build up was 723600m^2. And for 2020 the values ranged from 1.6327 to 1.6937, the measured build up was 2524500m^2.

The build up of Morjim increased from 723600m^2 in 1990 to 2524500m^2 in 2020

Non- Tourist Areas

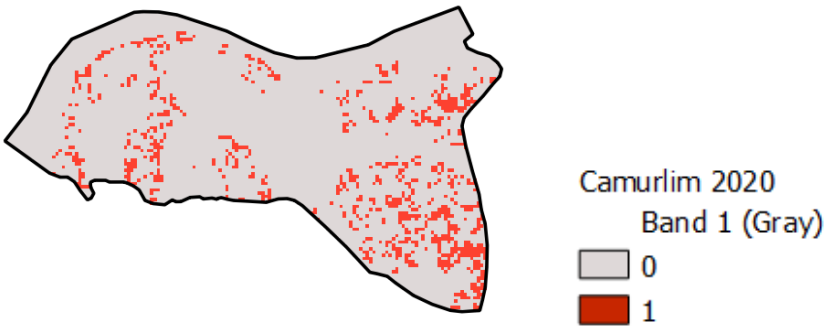
As the extraction of build up for non-tourist areas of 1990 was difficult through false colour images, the build up for 2020 was only used in this analysis for comparison. Extracting build up for 2020 was easier because Google Satellite was used. Google satellite gives the recent picture and it wouldn't have given a clear picture about build up in 1990 and hence only 2020 images were compared with the Tourist Areas of 2020.

Fig 4.9: Parra 2020



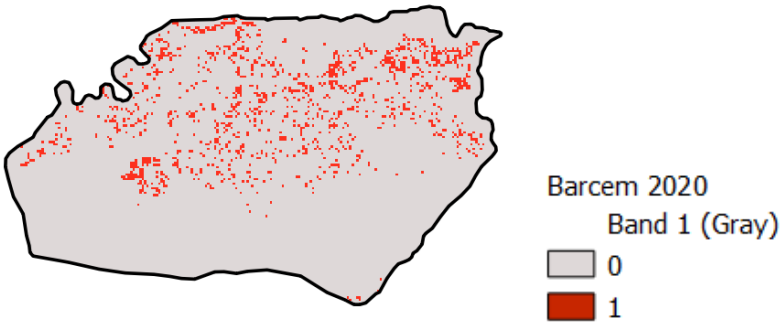
The image of Parra (fig 4.9) in Grey displays other than build up while the red colour displays build up areas. The values of build up for 2020 ranged from 2.1476 to 2.1683 and the calculated build up was 711900m^2.

Fig 4.10: Camurlim 2020



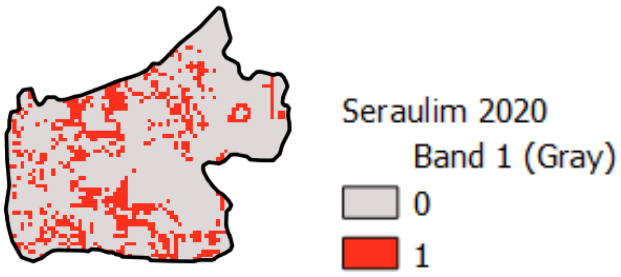
Similary in the above legend `1 indicates build up and 0 indicates other than build up (fig 4.10). The build up values for Camurlim ranged from 2.1464 to 2.1785 and the calculated build up was 805500m^2.

Fig 4.11: Barcem 2020



Here in this image (fig 4.11) the Red colour exhibits build up and Grey colour exhibits other than build up areas. The build up values ranged from 1.7119 to 1.7299 and the measured build up was 1207800m^2.

Fig 4.12: Seraulim 2020



In the legend, the Red colour displays the build up area while the Grey colour displays other than build up areas (fig 4.12). The values of build up for seraulim 2020 ranged from 1.7046 to 1.7295 and the measured build up was 621900m^2.

Colva and Seraulim (2020)

Fig 4.13: Colva Build up 2020

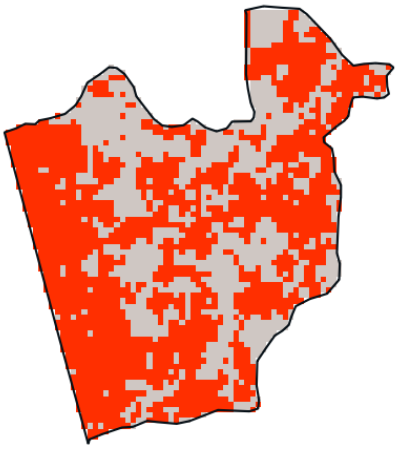


Fig 4.14: Seraulim Build up 2020

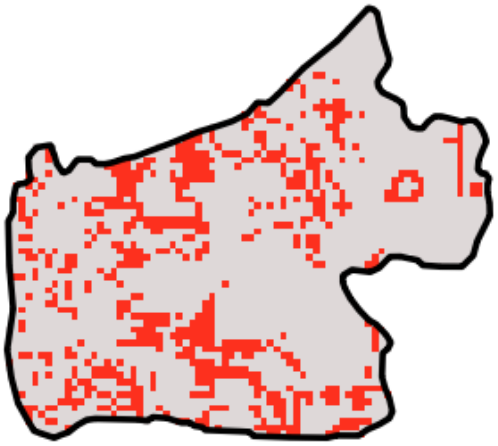


Table 4.1 Build Up of Colva and Seraulim

Village	Meaured Build Up
Colva	1776600m^2
Seraulim	621900m^2

From the images above it is clearly visible that the build up at Colva (Tourist area) (fig 4.13) is more as compared to Seraulim (Non-Tourist area) (fig 4.14). The measured build up is also more for colva which is 1776600m^2 while for Seraulim its only 621900m^2.

Agonda and Barcem (2020)

Fig 4.15 Agonda Build up 2020

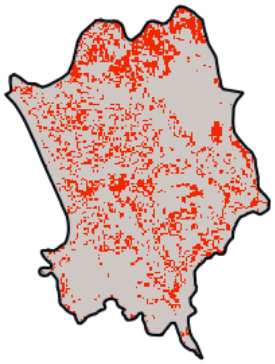


Fig 4.16 Barcem Build up 2020

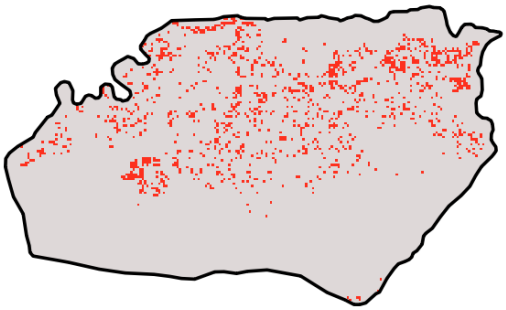


Table 4.2 Build Up of Agonda and Barcem

Villages	Measured Build Up
Agonda	3175200m^2
Barcem	1207800m^2

The images above exhibit that the tourist area, Agonda (fig 4.15) has more build up than Barcem (fig 4.16).

Also the build up area calculated for Barcem is much lesser, 3175200m^2 as compared to Agonda which is 1207800$m^{2.}$

Calangute and Parra (2020)

Fig 4.17 Calangute Build up 2020

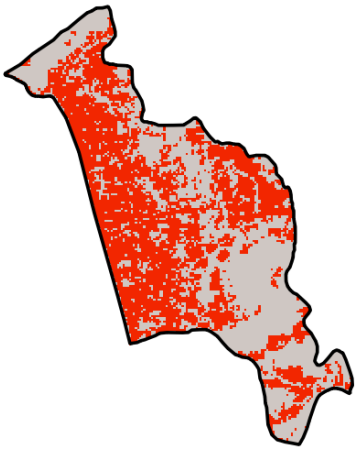


Fig 4.18 Parra Build up 2020

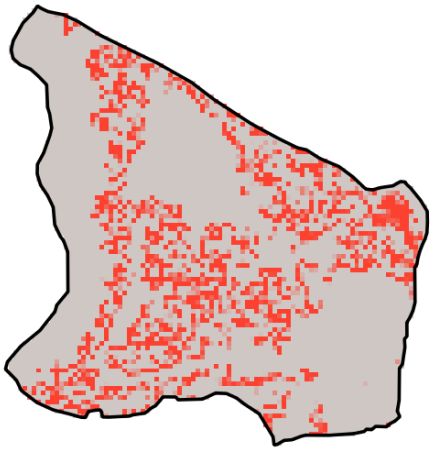


Table 4.3 Build Up of Calangute and Parra

Villages	Measured Build Up
Calangute	6162300m^2
Parra	711900m^2

As seen in the table above, the measured build up for Tourist area Calangute (fig 4.17) is much more as compared to the Non-Tourist area Parra (fig 4.18). The former has 6162300m^2 and the latter has 711900m^2. The images clearly show that Calangute has more build up compared to Parra.

Morjim and Camurlim (2020)

Fig 4.19 Morjim Build up 2020

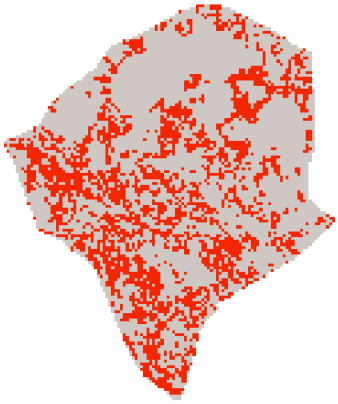


Fig 4.20 Camurlim Build up 2020

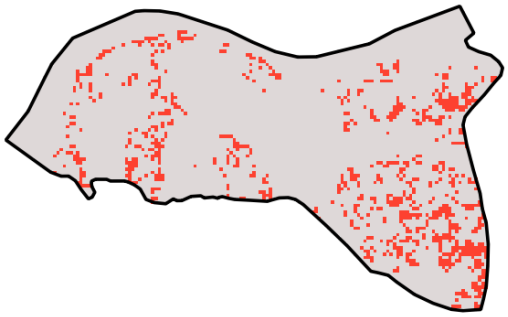


Table 4.4 Build Up of Morjim and Camurlim

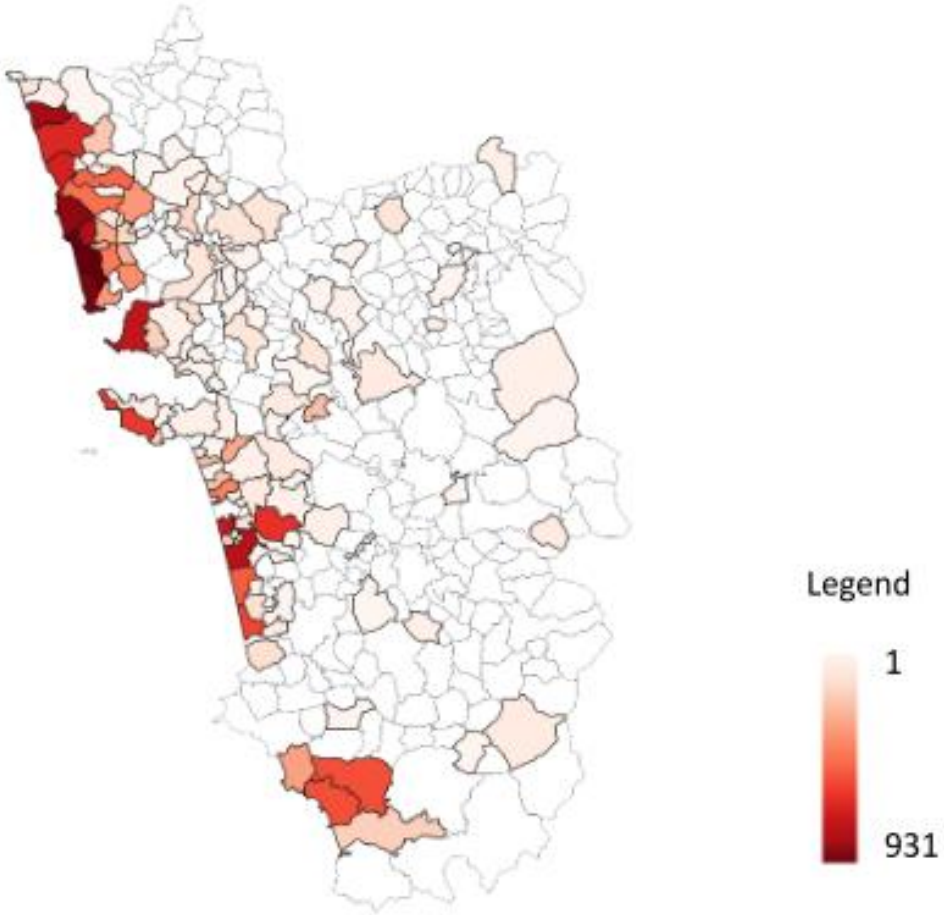
Villages	Measured Build Up
Morjim	2524500m^2
Camurlim	805500m^2

Similarly, here it can be seen seen that the Tourist area Morjim (fig 4.19) has more build up than the Non-Tourist area Camurlim (fig 4.20). The measured build up for Morjim in 2020 was 2524500m^2 and for Camurlim it was only 805500m^2.

Hotels and Guest Houses

The data with respect to Hotels and Guesthouses was taken from the Department of Tourism. The following Map (fig 4.21) displays the Hotels and Guesthouses in the villages, the darker Red indicates that the number of Hotels and Guesthouses are more in that particular village, it was found that the village of Calangute had the most number of Hotels and Guesthouses which were 931[10]. The lighter Red indicates a lesser number of Hotels and Guest houses.

Fig 4.21 Hotels and Guest houses



[10] https://www.goa.gov.in/wp-content/uploads/2021/09/RHwDoT.pdf

Table 4.5 Villages and the number of Hotels and Guest houses

District	Taluka	Village	Hotels and Guesthouses
North Goa	Bardez	Calangute	931
North Goa	Pernem	Morjim	100
South Goa	Salcete	Colva	135
South Goa	Canacona	Agonda	24

It was found that at Calangute in the Taluka of Bardez, North Goa it had the highest number of Hotels and Guest houses which were 931. At Morjim in the Taluka of Pernem, North Goa it had 100 Hotels and Guest houses. In the South, taluka of Salcete at the village of Colva they had 134 Hotels and Guest houses and finally in the South, in the taluka of Canacona, Agonda had only 24 Hotels and Guest houses. These were the 4 study areas of this analysis.

CHAPTER 5

LIMITATIONS AND CONCLUSION

There is no study without limitations and this study also has some limitations. The major limitation is with respect to the extraction of Build up. It was found that while extracting build up, bare land was also captured as build up. It was also noted that some build up areas were also not captured. Extracting build up for 1990 was a difficult task, as during this year the build up was very less and bare land was more and capturing build up was difficult. Most of the bare land was being captured as build up. In some areas water was also captured as build up, but all efforts have been made to capture build up but in some areas the build up was also captured as build up.

Tourism is said to be an economic, cultural and social activity which typically involves the movement of people outside their home environment for different purposes be it formal or informal. Goa is a well-known and famous destination for tourism. A lot of tourists visit Goa, and it has been increasing over the years. This study was conducted to find out whether tourism has an impact on the increase in build up. Here all the data used for analysis was secondary data. Remote sensing and GIS techniques were used in this study. Satellite images were downloaded from USGS Earth Explorer and were then used for analysis in the QGIS software.

In this study it was thus found that Tourism does have an impact on Build Up. The results of the analysis clearly exhibit an increase in build up in areas which were Tourist Hotspots as compared to the places which were Non-Tourist areas.

References

Retrieved from https://www.unwto.org/glossary-tourism

Retrieved from https://globaledge.msu.edu/blog/post/55748/the-importance-of-tourism-on-economies

Retrieved from https://www.visitbritain.org/introduction-tourism

Retrieved from https://www.globaltourismindia.com/states/goa/

Retrieved from https://www.tourmyindia.com/states/goa/

Retrieved from https://gisgeography.com/remote-sensing-earth-observation

Retrieved from https://www.usgs.gov/faqs/what-remote-sensing

Retrieved from https://earthdata.nasa.gov/learn/backgrounders/remote-sensing

Retrieved from https://data.oecd.org/biodiver/built-up-area.htm

Retrieved from https://eos.com/make-an-analysis/false-color

Retrieved from https://www.ibef.org/states/goa

Retrieved from https://www.satpalda.com/blogs/significance-of-land-use-land-cover-lulc-maps

Retrieved from https://www.theworldcounts.com/challenges/consumption/transport-and-tourism/negative-environmental-impacts-of-tourism/story

Retrieved from http://www.onefivenine.com/india/villages/South-Goa/Salcete/Colva

Retrieved from http://colvapanchayat.in/history/

Retrieved from http://www.onefivenine.com/india/Listing/Town/hotels/North-Goa/Bardez

Retrieved from https://www.goaholidayhomes.com/information/calangute.html

Retrieved from https://www.goaholidayhomes.com/information/agonda.html

Retrieved from https://villagepanchayatagonda.com/

Retrieved from http://www.onefivenine.com/india/villages/North-Goa/Pernem/Morjim

Retrieved from https://wikitravel.org/en/Morjim

Retrieved from https://earthexplorer.usgs.gov/

Retrieved from https://sedac.ciesin.columbia.edu/

Keola, S., Andersson, M., & Hall, O. (2015). Monitoring Economic Development from Space: Using Nighttime Light and Land Cover Data to Measure Economic Growth. World Development, 66,

Henderson, V., Storeygard, A., & Weil, D. N. (2011). A Bright Idea for Measuring Economic Growth. American Economic Review

Mellander, C., Lobo, J., Stolarick, K., & Matheson, Z. (2015). Night-Time Light Data: A Good Proxy Measure for Economic Activity? PLOS ONE, 10(10), e0139779.

Banerjee, A., Reddy, K. N., & Paul, P. (2002). Application of Remote Sensing and GIS in Demographic and Socio- Economic Analysis of Dehradun City. 8.

Dewan, A. M., & Yamaguchi, Y. (2009). Land use and land cover change in Greater Dhaka, Bangladesh: Using remote sensing to promote sustainable urbanization. Applied Geography, 29(3), 390–401.

Yagoub, M. M., & Kolan, G. R. (2006). Monitoring coastal zone land use and land cover changes of Abu Dhabi using remote sensing. Journal of the Indian Society of Remote Sensing, 34(1), 57–68.

Liao, Zhen, Zhang, & Metternicht. (2019). Understanding Dynamics of Mangrove Forest on Protected Areas of Hainan Island, China: 30 Years of Evidence from Remote Sensing. Sustainability, 11(19), 5356.

Boori, M. S., Voženílek, V., & Choudhary, K. (2015). Land use/cover disturbance due to tourism in Jeseníky Mountain, Czech Republic: A remote sensing and GIS based approach. The Egyptian Journal of Remote Sensing and Space Science, 18(1), 17–26.

Rimba, A. B., Atmaja, T., Mohan, G., Chapagain, S. K., Arumansawang, A., Payus, C., & Fukushi, K. (2020). IDENTIFYING LAND USE AND LAND COVER (LULC) CHANGE

FROM 2000 TO 2025 DRIVEN BY TOURISM : A STUDY CASE IN BALI. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLIII-B3-2020, 1621–1627

Walsh, S. J., Crawford, T. W., Welsh, W. F., & Crews-Meyer, K. A. (2001). A multiscale analysis of LULC and NDVI variation in Nang Rong district, northeast Thailand. Agriculture, Ecosystems & Environment, 85(1–3), 47–64.

Ara, S., Alif, M. A. U. J., & Islam, K. M. A. (2021). Impact of Tourism on LULC and LST in a Coastal Island of Bangladesh: A Geospatial Approach on St. Martin's Island of Bay of Bengal. Journal of the Indian Society of Remote Sensing, 49(10), 2329–2345.

Kausar, R., Baig, S., & Riaz, I. (2016). Spatio-temporal land use/land cover analysis of Murree using remote sensing and GIS. Asian Journal of Agriculture and Rural Development, 6(3), 50–58.

Ishtiaque, A., Shrestha, M., & Chhetri, N. (2017). Rapid Urban Growth in the Kathmandu Valley, Nepal: Monitoring Land Use Land Cover Dynamics of a Himalayan City with Landsat Imageries. Environments, 4(4), 72.

Indrawan, I. N. P., Widiatmaka, & Trisasongko, B. H. (2022). Land use land cover change in Badung Regency, Bali. IOP Conference Series: Earth and Environmental Science, 950(1), 012096.

Garrard, R., Kohler, T., Price, M. F., Byers, A. C., Sherpa, A. R., & Maharjan, G. R. (2016). Land Use and Land Cover Change in Sagarmatha National Park, a World Heritage Site in the Himalayas of Eastern Nepal. Mountain Research and Development, 36(3), 299.

Mahapatra, M. (2019). Spatio-temporal analysis of land use and land cover changes in the Little Andaman Island, Andaman, India using geospatial techniques. 13(2), 8.

Chu, L., Oloo, F., Chen, B., Xie, M., & Blaschke, T. (2020). Assessing the Influence of Tourism-Driven Activities on Environmental Variables on Hainan Island, China. Remote Sensing, 12(17), 2813.

Sobhani, P., Esmaeilzadeh, H., Barghjelveh, S., Sadeghi, S. M. M., & Marcu, M. V. (2021). Habitat Integrity in Protected Areas Threatened by LULC Changes and Fragmentation: A Case Study in Tehran Province, Iran. Land, 11(1), 6.

Dey, J., Sakhre, S., Gupta, V., Vijay, R., Pathak, S., Biniwale, R., & Kumar, R. (2018). Geospatial assessment of tourism impact on land environment of Dehradun, Uttarakhand, India. Environmental Monitoring and Assessment, 190(4), 181.

Singh, S. K., Mustak, Sk., Srivastava, P. K., Szabó, S., & Islam, T. (2015). Predicting Spatial and Decadal LULC Changes Through Cellular Automata Markov Chain Models Using Earth Observation Datasets and Geo-information. Environmental Processes, 2(1), 61–78.

Naik, S., Bhat, H. G., & Sreedhara, T. N. (2018). Impact of Land Use Land Cover Change on Coastal Tourism in Kundapura, Karnataka, Using Multi-temporal Remotely Sensed Data and GIS Techniques. Atna - Journal of Tourism Studies, 13(1), 1–18.

Vijay, R., Kushwaha, V. K., Chaudhury, A. S., Naik, K., Gupta, I., Kumar, R., & Wate, S. R. (2016). Assessment of tourism impact on land use/land cover and natural slope in Manali, India: A geospatial analysis. Environmental Earth Sciences, 75(1), 20.

Khalid, O. M., Manzoor, A. R., Zubair, L., Vakeel, S., & Nisar, K. (2015). Geospatial mapping of Srinagar City. Journal of Geography and Regional Planning, 8(6), 157–165.