BUILDING FOOTPRINT EXTRACTION FROM HIGH RESOLUTION REMOTE SENSING DATA- A CASE STUDY ON AYYAPPANKOVIL, ELAPPARA AND UPPUTHARA VILLAGES (IDUKKI DISTRICT, KERALA)

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ABSTRACT

Delineating different types of physical and cultural features present in the earth is the important part of remote sensing and image analysis. The study carried out is to extract building footprints along flood prone zones for the village Ayyappankovil, Elappara and Upputhara, Idukki district, Kerala. First the image is split and merged together using segmentation process, and then various raster processes were applied such as probability, Reclump, Dilate, Erode and size filter etc. Then the Raster image is converted into vector file and cleanup process was applied like Generalize, smooth and Vector probability filter to get desired output. Finally, settlements from respective villages are digitized to know the accuracy of extraction.

INTRODUCTION

Delineation of various features along the earth surface is an important aspect of remote sensing (Dahiya Susheela et.al, 2013). Emerging countries experiences dynamically changing urban agglomerations causing rapid changes in their urban infrastructure due to population growth and other socio-economic developments. Collecting information regarding buildings on qualitative and quantitative are necessary to monitor the changes in settlement structure, housing sectors, spatial and infrastructures planning with all basic necessities etc (Bachofer Felix, et.al 2015). Detection of buildings is an important aspect to analyse the extent of damage caused by natural disasters such as Flood, Earthquake, Dam burst etc (Pushparaj Jalingam et.al,2017). Automatic building extraction is increasing used for infrastructure planning nowadays. In the past decade Aerial photo datasets were used to manually digitize the buildings which is a cost-effective and time consuming process. The recent availability of high resolution satellite sensors such as Quickird, IKONOS, Worldview, Pleiades etc provides new possibilities for automated extraction of buildings (Jin Xiaoying et.al, 2005).

Many researchers have attempted the automatic extraction of buildings using various sensors such as high resolution satellite images (Dahiya Susheela et.al, 2013, Bachofer Felix, et.al 2015, San Koc. D et.al 2010, Jin Xiaoying et.al, 2005, Jinghui Duan et.al,2004, Nex F et.al,2013, Pushparaj Jalingam et.al,2017, Theng Bee Lau, 2006, Zhou GUO, et.al, 2013). Researchers like (Zhang Keqi et.al,2006, Kim Kyahyouk et.al,2011) studied extraction of building footprints from Airborne LIDAR data. (KIM NAMHYUN,2011) extracted building footprints by combining high resolution SAR inferometry and Quickbird images.

In India this is a problem because there is no specific pattern in building construction. Buildings are more congested and clustered where there is no significant boundary between different types of work places, settlements and industries are all mixed together. In a place like Idukki district this becomes more difficult because the buildings are located in hill tops and the surface is more undulating rather than flat terrain. Unlike other places forest cover here is thick that at some places they mask spectral signature of the buildings. Some buildings are separate and some are closely packed to distinguish between one another. Since buildings and roadways give of same signature it becomes extremely difficult to identify separate buildings during normal classification. Spectral reflection for various features such as buildings and roads are nearly identical, hence it requires more than spectral resolution to map buildings such as Shape, Size, Texture etc (Dahiya Susheela et.al, 2013).

NEED FOR STUDY

Three villages from Idukki district namely Ayyappankovil, Elapara and Upputhara villages were chosen for this study. Nearly 14.8% of the total area of Kerala is prone to flooding among which 0.89% of the area comes under Idukki district (Kerala state disaster management authority). The villages of Ayyappankovil, Elapara and Upputhara are situated along the bank of river Periyar. Periyar River is the dominant water source for these areas agricultural purpose. An excessive number of settlements are present near the river bank practicing agriculture. Dam burst can result in one of the worst flood events. Mullaperiyar dam is situated on the upstream of Periyar river. It lies in the seismic zone III as per the seismic zoning map of India where an intensity of earthquake on Richter scale VII is expected. Any structural damage due to major earthquakes triggers a release of large quantities of water letting loose downstream causing social and economic causes (Kerala state disaster management profile, District disaster management plan, Idukki). In order to avoid such a disaster an effective management plan is required. Every plan is based upon the created thematic maps of that particular area. The total amount of buildings and settlements present within the flood prone area, must be calculated to identify the extent of human lives and economic values will be lost. The study has been carried out the to delineate the buildings that are prone to floods along these villages.

OBJECTIVE OF THE STUDY:

1. To conduct various raster process such as Segmentation, Probability, Size filter etc for building extraction.
2. Digitization of buildings within the flood prone areas of the villages.
3. Validation of results by comparing extracted and digitized results.

DATA USED AND METHODOLOGY

Extraction of Buildings requires high resolution satellite images. We used Quickbird high resolution satellite images to extract the buildings and Toposheets of (1:50000) scale from survey of India for base maps preparation and Ground control points for accuracy assessment.

DATA PRODUCTS UTILIZED					
S.NO	Nature of Data	Year	Source	Purpose	Resolution
1	Toposheets	1977	Survey of India	Basemap	1:50,000
2	Quickbird Imagery	2016	State emergency Operation centre	Building extraction	0.6 mts

Table 1: Data products

The methodology used in the project is Imagine Objective in ERDAS 2014. It allows users to extract features based on their pixel value, shape, size and texture. The overall methodology is given in the below flow chart.

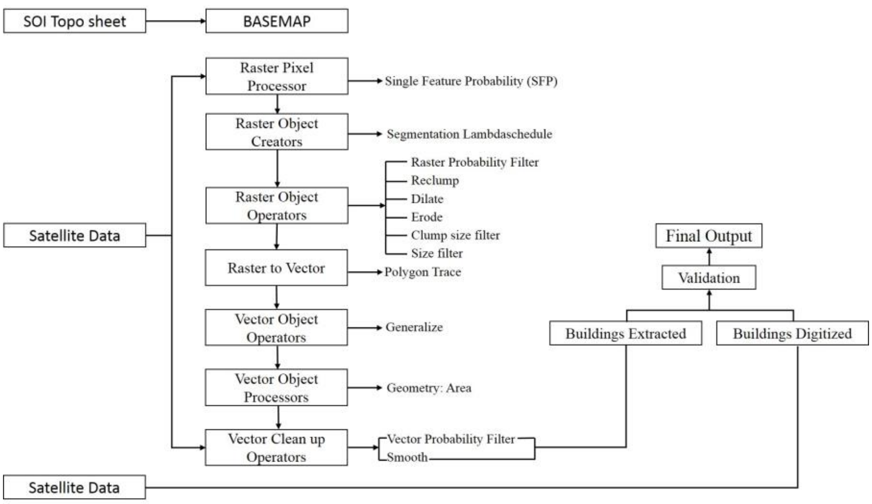


Figure 1 (Methodology)

STUDY AREA:

Idukki is one of the 14 districts of Kerala formed in 26^{th} January 1972. The District lies between latitude $9^{0}15'$ and $10^{0}2'$ North and longitude $76^{0}37'$ and $77^{0}25'$ East. It is the second largest district of Kerala with an area of 436345 sq.km which constitute 11.6% of the total area. The district borders Pathanamthitta to the south, Kottayam to the southwest, Ernakulam to the northwest and Thrissur to the north and Coimbatore, Dindigul and Theni Districts of Tamil Nadu to the east. The Periyar, Thodupuzhayar and Thalayar are the important rivers of the Idukki district. Idukki is also known for its Hydroelectric power project. The Idukki dam, Largest double curvature Arch dam of Asia is located at Idukki township. The Idukki Hydroelectric power project caters about 60% of the states total electricity. A Major Portion of the district covered by dense forest and tea, coffee, Cardamom plantations etc. As per official records 50% of the district falls under forest. According to 2011 census the district as a population of 1108974 with 91% literacy rate (District census Handbook, Idukki, 2011).

The study area is located in the Ayyappankovil, Ellapara and Upputhara villages of Udumbanchola and Perumade taluks which is present along the river Periyar. These areas mainly practice agriculture and most of them are dependent on the river based water source. Many settlements are built around the river hence during flood they suffer severe causalities both public and government resources. This study mainly focuses on extracting the buildings present within the inundation area.

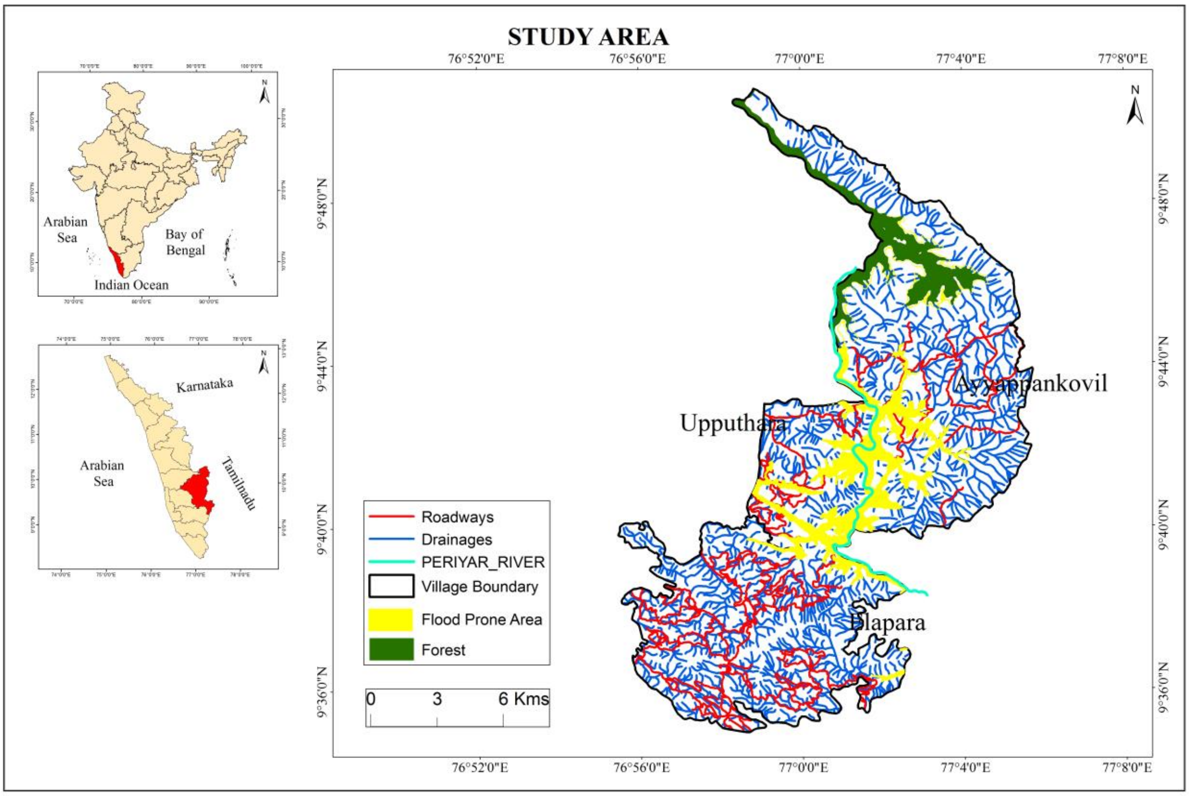


Figure 2: Study Area

DATA ANALYSIS

The Toposheets obtained from the survey of India were georeferenced in GIS environment and important features such as Settlements, Roads, Forests and waterbodies were digitized to form Basemap. The multi-spectral and Panchromatic data of the Quickbird imageries were merged together in ERDAS Imagine Environment. Extraction of any features requires training samples, these samples were selected using Single feature probability method (Figure 3) of Imagine Objective. The samples were grouped into 0 and 1 where lower value represents the training samples and higher value represents the non-training samples. Pixels that are spatially connected and have similar values are grouped in a single segment using Segmentation Lambdaschedule method (Figure 4). Followed by Probability filter (Figure 5) is used to delineate the buildings. The probability value lies between 0 and 1. The probability value chosen is 0.40. Followed by probability, Reclump (Figure 6), Erode (Figure 7) and Clump size (Figure 8) filter were used. Reclump assigns a unique value for each raster object extracted. Erode tool removes the nearby pixels that are not included in the training samples. By performing Clump size filter (Figure 10), the extra pixels are vomited than the amount set of pixels set. The amount of pixels is set at 2000. The final step is to convert the raster to into vector files (Figure 11).

The raster files are converted to vector using polygon trace tool that traces the edge of the polygon to form an object and stored as shapefile. Further Generalize and Geometry tools were used. Generalize removes the unnecessary vertices and Geometry calculates the area of each file. Finally, smooth tool is applied to get a desired shape. Once complete the buildings were manually digitized and compared with the extracted values for accuracy.

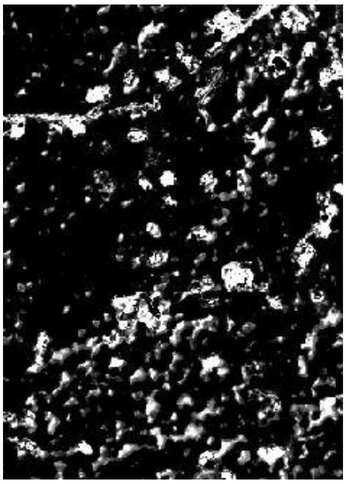


Figure 3: SFP

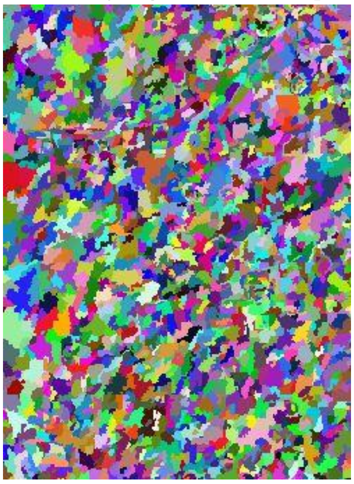


Figure 4: Segmentation

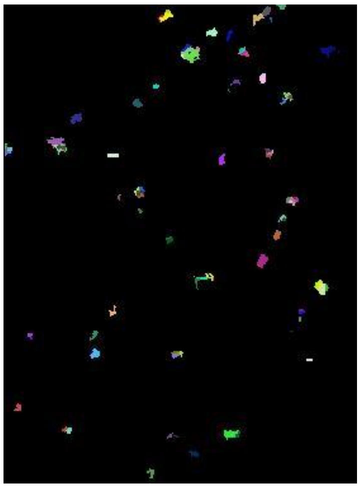


Figure 5: Probability Filter

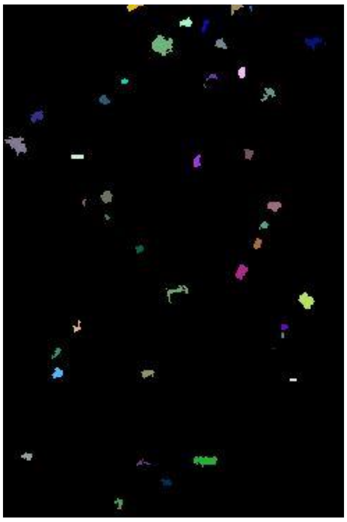


Figure 6: Reclump

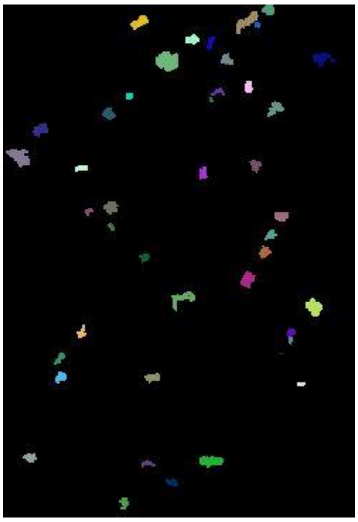


Figure 7: Dilate

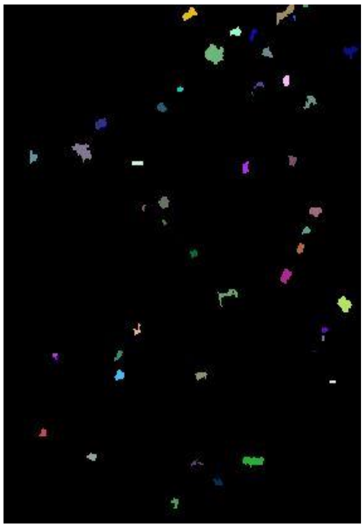


Figure 8: Erode

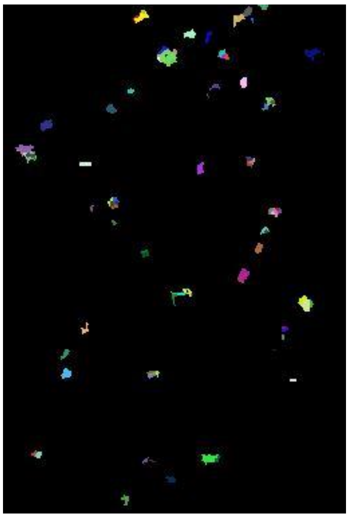


Figure 9: Size Filter


Figure 10: Reclump

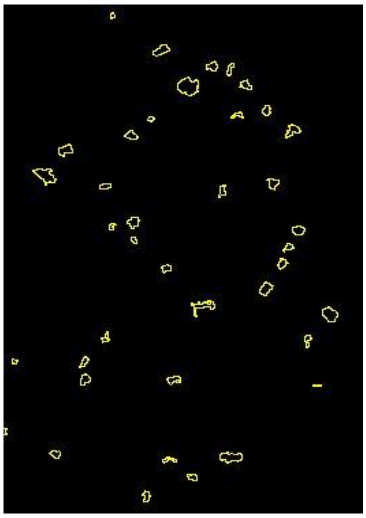


Figure 11: Polygon Trace

RESULTS AND CONCLUSION

The method described above extracts buildings from the satellite image. The buildings extracted from Ayyappankovil, Upputhara and Elappara are shown in the figure and the buildings digitized are shown in the figure. Digitized settlements in Ayyappankovil (Figure 13), Upputhara (Figure 15) and Elappara (Figure 17) were 1125, 735 and 85 respectively. The total number of features extracted from Ayyappankovil (Figure 12), Upputhara (Figure 14) and Elappara (Figure 16) were 1348, 733 and 100 respectively.

Villages	Total Digitized	Total Extracted	Extracted	Not Extracted	Wrongly Extracted
Ayyappankovil	1125	1348	929	294	419
Upputhara	735	733	457	153	278
Elappara	85	100	63	14	37

Table 2: Total number of Settlements Extracted and Digitized

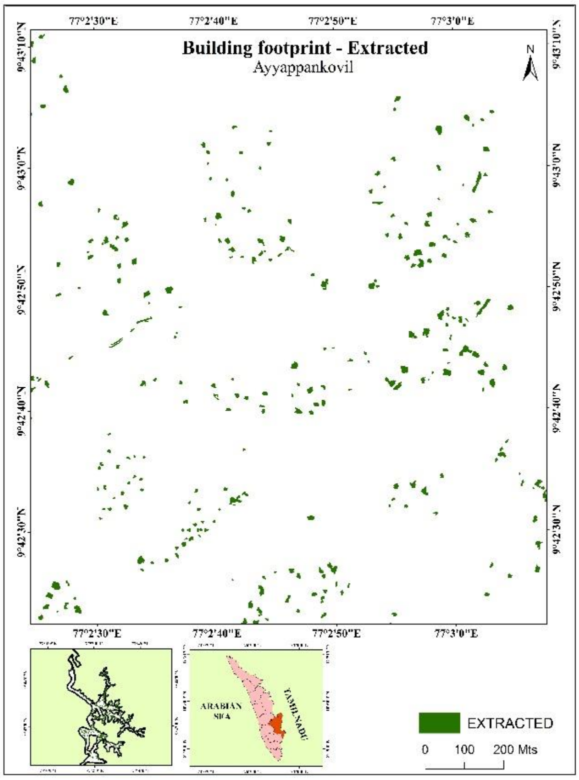


Figure12: Ayyappankovil Extracted

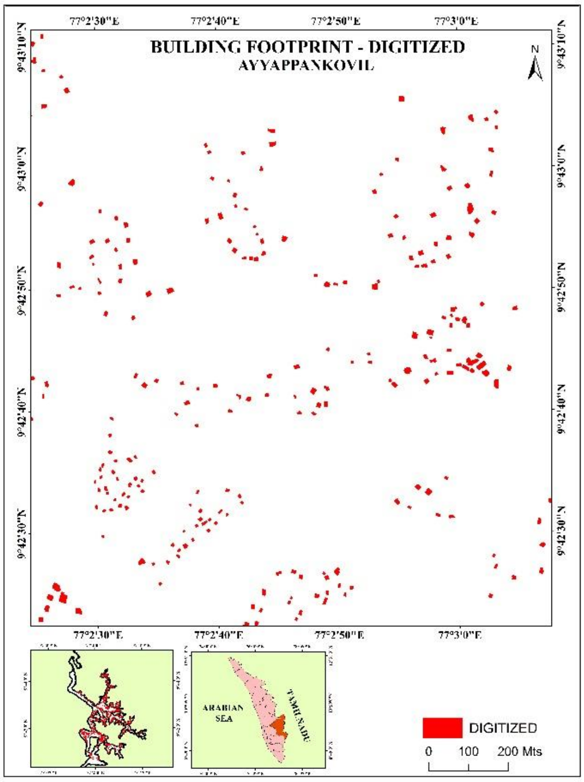


Figure 13: Ayyappankovil Digitized

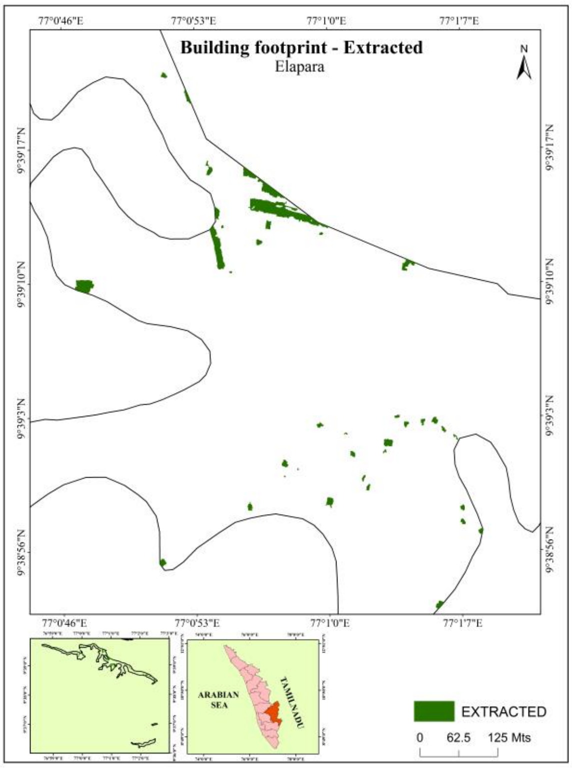


Figure14: Elapara Extracted

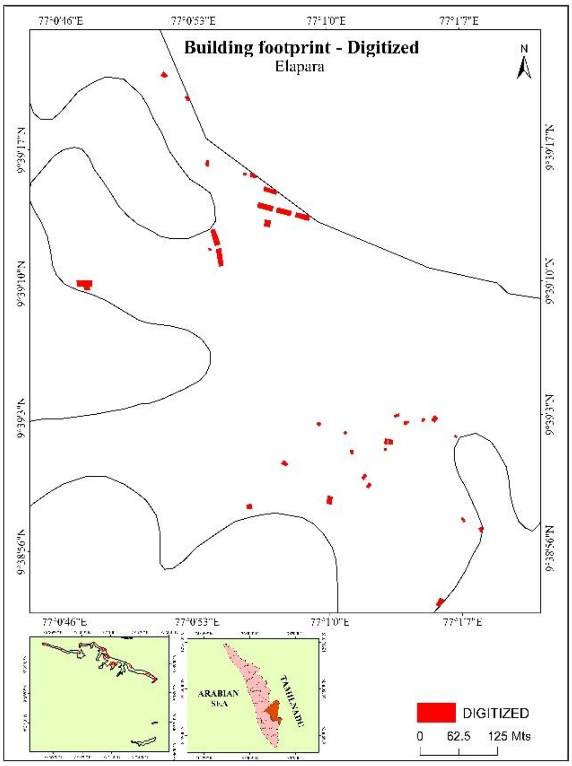


Figure 15: Elapara Digitized

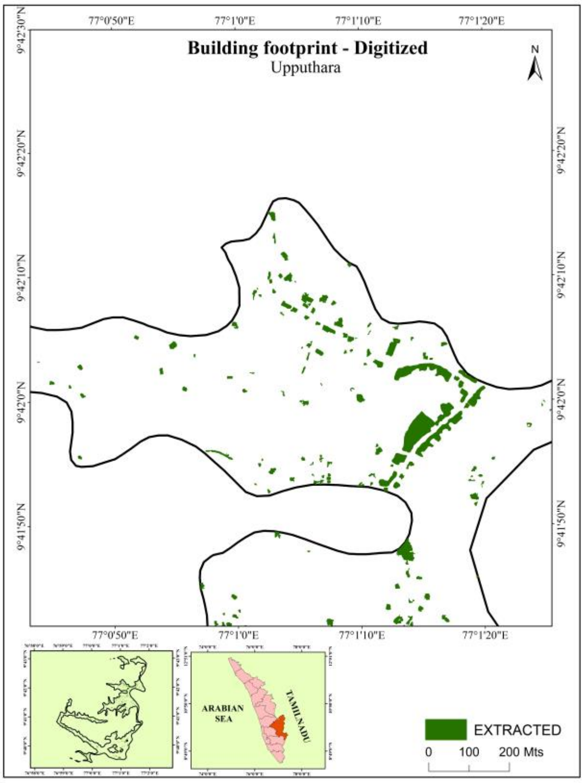


Figure16: Upputhara Extracted

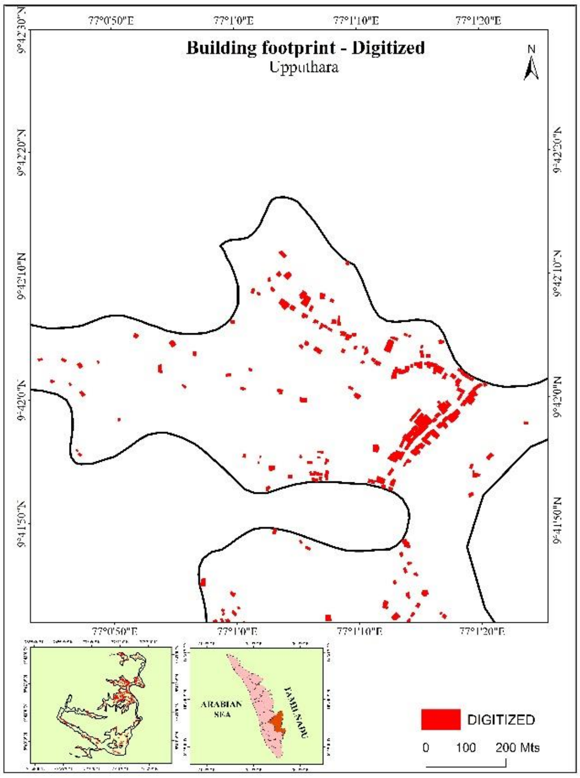
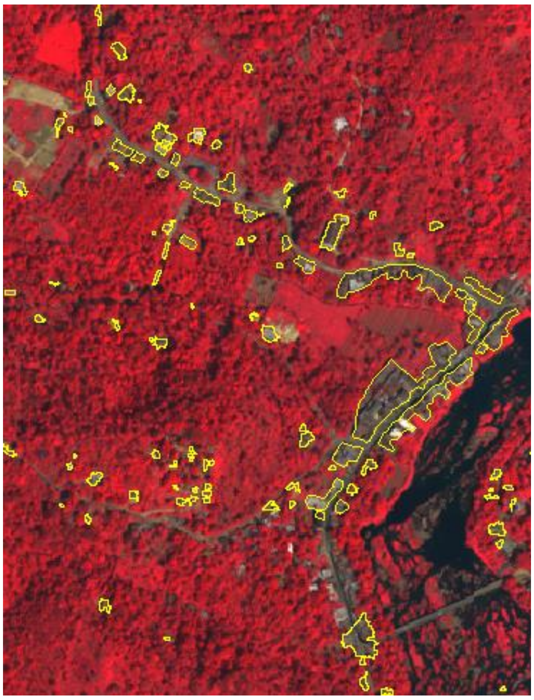
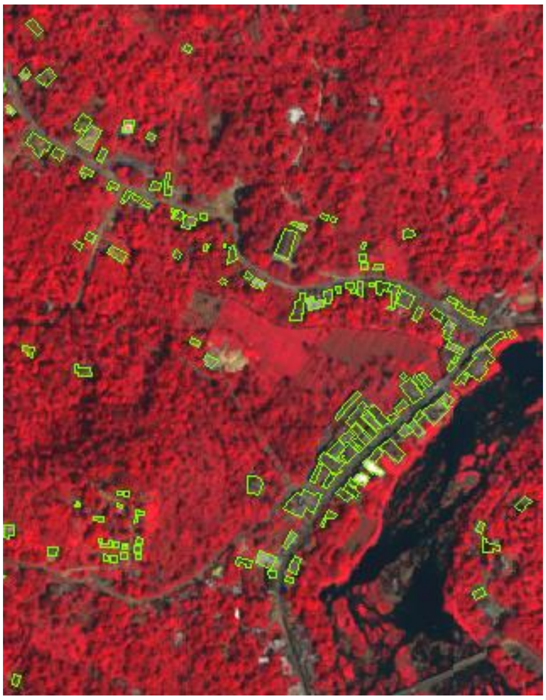


Figure 17: Upputhara Digitized

Some of the settlements and buildings are very close to one another that these buildings joint together to form a single building. These features are more found in the township were most of the shops and other buildings were built. These images are shown in the figure.

CONCLUSIONS

The quality of the results can be improved by adding extra features like shadow if present on the ground. It’s still being difficult to extract buildings on places like Idukki district because some of the houses rooftops are covered with asbestos sheet which produce same reflectance value as a road or other barren surface and also in many houses they have the tendency to grow ornamental plants which can highly mask the spectral signature of the house. In order to get better results in an undulating terrain like Idukki district incorporation multi datasets will be required such as LIDAR data that distinguish various features and feature based classification. Using these two process combined we can effectively increase the percent features extracted.

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