Land use Land cover studies and its effects on Valuation using GIS Techniques in Madurai Town Planning Area, Tamilnadu, India

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Abstract Landuse land cover mapping practices over period in Madurai district varies due to increase of urban and rural migration. Valuation of land in urban areas is very important tool towards economic impact on human communities. Madurai is a temple city located on Vagai river bank which attract most tourists and also increase the urban areas due to various factors such as rural migration, Population increase. With the evidence from Government Land Register (GLR) and Present Market Rate (PMR )Values the Population is directly proportional to the value of land. Population increase last 12 years and built-up areas also increased. This paper studies the urban sprawl using land use land cover changes over the period of 2007 to 2019 between GLR and PMR values as per real estate practices in India. Using GIS techniques the analysis of urban sprawl of the city as well GLR, PMR values relationship by interpolation method to assess the land valuation practices which followed by Government of India.

Keywords: Urbanization; Land use and Land cover;, GIS; Present Market Rate.

1. INTRODUCTION

Landuse is the one of important factor on this world, where how people are utilizing the land by different way such as building, agriculture and other purposes. Land cover is the identified by its cover type of region such as forests and other areas. Land use Land Covers mapped using satellite images by image processing techniques and GIS analysis. Growth of city rapidly changes over the period called urban sprawl which also important factor for planning and real estate land valuation for future progress of communities. To balance the conservation and developmental pressure the analysis of land use is very important. Disturbance of productive land, urban encroachment, and depletion of forests are some of the issues that drive land use studies (Malleswara Rao et al. 2012). Valuation is estimation of land or property. Land use data will helpful towards the assessment of land value with GLR (Government Land Register) and PMR (Privilege Market Rate) (Maulik and Chakraborty. 2011). The expansion of urban area are predicted and the reason for urbanization with land valuation practices are analyzed for future real estate development and land assessment towards the guideline practices. GIS may be one of useful technique to identification change detection of land use which indirectly helps to the estimation of land values. In this paper interpolation method was used (Inverse distance weight) technique (Shougeng et. al, 2013) for overlay analysis with land use and urban sprawl. (Mokhamad Surianto et.al, 2019) in his research explained about the rapid development of Blora District that it affects the distribution of the market value of the land. The results showed that from eight observed variables, six variables that significantly affect the value of land, namely variables of distance to the city centre, distance to the local market, accessibility, land use, availability of facilities and infrastructure, and land location. Study area of the map shown in the fig.1.(Aitkenhead, M. J et.al,2011) stated An evidence integration rule set is applied to evidence lists to produce conclusions of different strength regarding individual classes, and the most likely class identified. The only expert system design implemented currently within the methodology is a neural network model,
although the system has been designed to accept information from decision trees, fuzzy k-means and Bayesian statistics as well (Sang et al. 2011). (Jannet C. Bencure et.al 2019) holistic and objective way of weighing geospatial factors through expert consultation, legal reviews, and evidence (i.e., news) will provide more realistic results than a regression-based method that does not comprehend valuation factors (i.e., physical, social, economic, environmental, and legal aspects). The analytic hierarchy process (AHP) enables these factors to be included in the model, hence providing a realistic result. The innovative land valuation model (iLVM), developed in this study, is an inclusive approach wherein experts are involved in the selection and weighing of 15 factors through the AHP. The model was validated using root mean squared error (RMSE) and compared with multiple regression analysis (MRA). In their study, Garmin GPS was used for capturing the location in various parts of Madurai. The GLR and PMR was collected with the help of GPS for land in Madurai (Longley et al. 2010). The change that has happened over time, landcover maps taken during different years are needed. With this information, people can evaluate the past as well as gain insight into the possible effects of their current decisions before they are implemented (Seto et al. 2011). Bigdeli et.al (2013) new method for classification of hyperspectral data based on a band clustering strategy through a multiple Support Vector Machine system. The proposed method uses the band grouping process based on a modified mutual information strategy to split data into few band groups. After the band grouping step, the proposed algorithm aims at benefiting from the capabilities of SVM as classification method. So, the proposed approach applies SVM on each band group that is produced in a previous step. Finally, Naive Bayes (NB) as a classifier fusion method combines decisions of SVM classifiers. Experimental results on two common hyperspectral data sets show that the proposed method improves the classification accuracy in comparison with the standard SVM on entire bands of data and feature selection methods.

![Figure 1. Study Area](image)

**2. STUDY METHODOLOGY**

**2.1 Spatial and Field Data Collection:**

Landsat Satellite Images are collected between the year 2007 and 2019. Sensors of Landsat 7 & 8 ETM, ETM+, TM, and OLI (Source: https://earthexplorer.usgs.gov/) are primary source of this Satellite images. Image resolutions area 30m and 23.5 meter and Metadata information provided as below

Landsat Product Identifier: LE07_L1TP_143053_20070601_20170103_01_T1
Landsat Scene Identifier: LE714305320007152ASN00
Acquisition Date: 2007/06/01
Scan Line Corrector: OFF
Collection Category: T1
Collection Number: 1
WRS Path  143
WRS Row  053
Date L-1 Generated  2017/01/03
Start Time  2007:152:04:55:31.2928749
Stop Time  2007:152:04:55:58.0469375
Station Identifier  ASN
Day/Night Indicator  Day
Images are rectified using Georeferencing techniques with ground validated with signature file collected using GPS. Open source software QGIS & Grass used for analyzes the image and derives the land use data. GPS are commonly used for positioning and navigation. GPS data used field data of land or properties collection as one of the important parameter to identify the locations and various attribute information. GPS waypoints are collected with field data sheet to fill up the non-spatial data in various parts of Madurai. Field data sheet contains address and type of built-up such as residential, industry including ward number and streets. Also GLR and PMR values are integrated in the field data sheet for precisely integrate with land use information.

After Data collecting the data using GIS software points were plotted using lat long information which contains various attribute such GLR, PMR, and others. Old land values are collected from Government agencies for the validation. The Landsat satellite images was collected from 2007 to 2019 by USGS Earth Explorer for the research area. The accompanying information were arranged by the computerized Image Processing Software (ENVI) so as to order the pictures utilizing neighborhood calculation and mark set for Level 1 characterization, for example, Settlement (Build-up Area), Forest, Agriculture land, Wasteland including Fallow land and Water bodies by utilizing Unsupervised and Supervised grouping strategies was utilized. Interpolation (IDW) performed using GIS tool to plot the GLR and PMR values in the same study area. Fig.2 shows the methodology of study area.

![Figure 2. Methodology of GIS work flow](image-url)
2.2 Data Integration with GIS and Mapping

Various data sources were collated and presented in the form of attributes. After collecting data, was integrated with the GIS software using QGIS. The collected data were tabulated. The tabulated data were provided as input using inverse distance weighted (IDW) technique. With the help of IDW, an imaginary surface was designed with the GLR, PMR values and latitude and longitude details were also viewable and a cluster was formed. The land value can be easily interpreted with the output images. With the help of latitude and longitude (X,Y) and GLR, PMR(Z value), the spatial distribution map was derived from QGIS and also Madurai city area is divided into 3 zones named A, B and C based upon the spatial distribution map of GLR and PMR values. A is defined as area falling under low range lands values when B refers to area falling under medium range lands values and C refers to area falling under high range lands values.

3. SPATIAL ANALYSIS

The landuse and landcover for Town Planning Area of Madurai was prepared from satellite image and processed using image processing techniques for the year 2019 shown in Figure 3.

![Figure 3. Shows the Land use Land cover map 2019](image)

By using of GIS software, thematic layer land use prepared with field training sets and GIS overlay analysis such as clipping, editing and digitizing. After classification proper land use such as forest, wasteland, settlement area is derived using UTM coordinate system in square kilometer. Maximum area falls under agriculture area shown 877.145 sq.km and minimum area shows forest about 83 sq.km. 2019 image captured during summer season so wasteland projected was high about 800 sq.km. Urban and rural settlement was identified in LPA shows 223 sq.km in the overall area. This settlement area taken for urban sprawl study which was overlaid with GLR and PMR interpolated image for further analysis. Water bodies shows 220.441 sq.km which the source of water for entire study area which also impact of urban sprawl towards LPA. Fig.4 depicts statistics of year 2019 followed by Table 1.

Table 1. Land use Land Cover for year 2019

| 2019     | Area in Sq.km |
|----------|---------------|
| AGRI LAND| 877.145       |
| SETTLEMENT| 223          |
Figure 4. 2019 thematic layer statistics

In the Year 2007 land use land cover were mapped using Landsat ETM images acquired, and processed shown in the fig.5. This imagery is cloud free data in the summer season were taken into account for the land use accurate classification with the help of existing field signature training sets. This was used different iterations with K-means method for proper analysis. The settlement area shows less about 148 sq.km compare to 2019. Whereas Wasteland shows maximum area about 1200 sq.km and minimum area is forest which is unchanged. Agriculture and waterbody areas were 536 sq.km and 237 sq.km respectively shown in table 2. Fig.5 shows the map of LULC for 2007 in LPA area of Madurai.

|                | 2019 Area in Sq.km |
|----------------|--------------------|
| AGRI LAND      | 535.586            |
| SETTLEMENT     | 148                |
| FOREST         | 83                 |
| WASTE LAND     | 1200               |
| WATERBODY      | 220.441            |

Figure 5. Landuse Land Cover Map for 2007

The agriculture land has been slightly increased from 2007 to 2019 because of varies in acquisition time and cultivation may practice during this period. Agriculture land use increased from 535 sq.km to 877 sq.km. Whereas wasteland decreased is shown in the figure.6

Table 2: Landuse Land Cover for Year 2007

Table 3 shows the change identification of LULC. From the above Fig. 7, the change discovery of Landuse Land spread between 2007and 2019 shows Agriculture land has expanded 30%. The Settlement territory has additionally filled wide in range from 148 Sq.km to 223 Sq.km. The backwoods stays unaltered. The Barrel land has diminished from 1200 Sq.km to 800 Sq.km. Water bodies has indicated a slight reduction to 220.441 Sq.km from 237 Sq.km in the given table.4

Figure 6. 2007 thematic layer statistics

From 2007 to 2019 which shares the landuse with horticulture and created region. Hold RF stays unaltered and Water body (water system source region) somewhat expanded. Table.3 shows the change identification of LULC. From the above Fig. 7, the change discovery of Landuse Land spread between 2007and 2019 shows Agriculture land has expanded 30%. The Settlement territory has additionally filled wide in range from 148 Sq.km to 223 Sq.km. The backwoods stays unaltered. The Barrel land has diminished from 1200 Sq.km to 800 Sq.km. Water bodies has indicated a slight reduction to 220.441 Sq.km from 237 Sq.km in the given table.4
Figure 7. Change detection of LULC 2007 -2019

Table 3. LULC Change detection between 2007-2019

|                      | 2007 (in Sq.km) | 2019 (in Sq.km) |
|----------------------|-----------------|-----------------|
| AGRI LAND            | 535.586         | 877.145         |
| SETTLEMENT           | 148             | 223             |
| FOREST               | 83              | 83              |
| WASTE LAND           | 1200            | 800             |
| WATERBODY            | 237             | 220.441         |

Table 4. Comparison between Government Land Register values in 2007 and 2019

|                      | A             | B             | C             |
|----------------------|---------------|---------------|---------------|
|                      | Min | Max  | Min  | Max  | Min  | Max  |
| Government Land Register for the year 2007 | 1.40 | 317.00 | 317.00 | 1240.00 | 1240.00 | 2775.00 |
| Government Land Register for the year 2019 | 19.00 | 2201.00 | 2201.00 | 4000.00 | 4000.00 | 5450.00 |

Table 4 shows GLR factor for A region increased from 1.4 to 19 between 2007 to 2019. The GLR for B and C region increased from 1241 and 2774 to 4000 and 5450 respectively. This averaged value arrives from the IDW methods by spatial distribution overlaid with landuse.

Table 5. Comparison between PMR values in 2007 and 2019

|                      | A  | B   | C  |
|----------------------|----|-----|----|
|                      | Min | Max | Min | Max | Min | Max |

Present Market Rate for the year 2007

|                | 10.00 | 2720.00 | 2720.00 | 4350.00 | 4350.00 | 5435.00 |
|----------------|-------|---------|---------|---------|---------|---------|

Present Market Rate for the year 2019

|                | 120.00 | 3581.00 | 3581.00 | 7040.00 | 7040.00 | 8770.00 |
|----------------|--------|---------|---------|---------|---------|---------|

Table 5, the PMR factor for a district expanded from 10 to 119 inside 12 years. The PMR for B and C locale expanded from 4348 and 5443 to 7041 and 8771, separately.

4. RESULT AND DISCUSSION

1. Wasteland was most extreme in LPA zones of Madurai around 1200 sq.km which exceptionally high look at other land use likewise land valuation was exceptionally low in all area in the year 2007. In 2019 wasteland decreases to 800 sq.km shares the land with settlement and agriculture land practices. Period 12 years most of the waste land was converted to industrial, urban, semi urban because of population growth also. Also some agriculture practices were increased during these periods. This shows urban sprawl continues and increases the land valuations, there are various constructions, Road development happened during this period. This cause real estate practices are developed with iconic growth.

2. With reference to 2019, the farming area covers the greatest region square kilometer with 877 Sq.km contrast with 535 sq.km in 2007. This shows the agriculture practices increases in 2019. This may due to various sources such increases in Vagai dam Water flow or canal irrigation sources. This shows good greenery compare to 2019. Agriculture land in some locations were converted to settlement have been recorded in the landuse mapping.

2. Built-up (settlement) area rapidly increase in LPA areas because core city development towards the population and migration other activities like construction and road development increased in 2019 compare to 2007. The area increased from 149 Sq.km to 222 Sq.km during this period. Which directly proportional to land valuation factors.

3. The forest area has not changed. The barrel land has diminished from 1200 Sq.km to 800 Sq.km. Water bodies has indicated a slight abatement to 220.441 Sq.km from 237 Sq.km.

4. The GLR is expanded from 1.4 to 19 inside 12 years. The GLR for B and C district expanded from 1241 and 2774 to 4000 and 5450.

5. The PMR is expanded from 10 to 119 inside 12 years. The PMR for B and C district expanded from 4348 and 5443 to 7041 and 8771

5. CONCLUSION

The level of increment of GLR and PMR esteems in 2007 differs from 49.10% to 92.63%. The expansion level of GLR and PMR esteems in 2019 changes from 24.05% to 91.59%.

The level of increment in GLR and PMR esteems means that the expansion in land esteems because of development of urbanization. The progressions in landuse landcover are demonstrated by the expansion in GLR and PMR. The development region has created indeed because of the development in populace. The populace development expands the need to develop and settlement territory.
Landuse Landcover study important factor to understand land valuation over the period in LPA areas for better planning and development. There are multiple opportunities towards economic growth of the city between this period were created. For this reason the study has taken to compare urban sprawl and land valuation.

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