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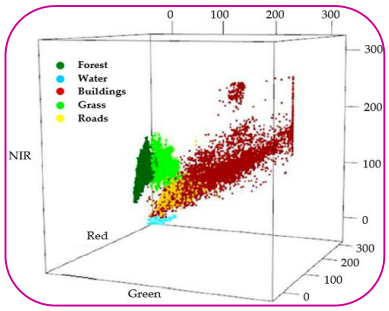
LULC IS A PROCESS OF GROWTH IN BBMP – APPLYING REMOTE SENSING



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ABSTRACT:

The changes are common in Land Use and Land Cover because of Human interface in the Geographical environment. Every day earth surface changes while fulfilling the requirement of the human beings. Bangalore city is the third populous city in India after Mumbai and Delhi. Stands in 18th positions in the world in term of the populations. Bangalore growth is goes back to 1500 but actually growth took place after 1990s. In 2001 the entire Land Use and Land Cover had been changes because of the Rapid Urbanization, Globalization and Government policies. The present study shows the growth using the Land Use and Land Cover changing process in BBMP region. The research paper is based on the Remote Sensing Technology and different temporal duration satellite imageries. ERDAS software has been used to classify the satellite imageries. IRSP6, Resource Sat 2 and Carto Sat I Imagery have been used. Bangalore city is having 709 sq km. geographical area. Using the available satellite imagery 2nd order classification done and analysis the LULC of BBMP to show the growth. Main objective is to show the change occurs in LULC in BBMP to shows the growth.

KEYWORDS : *LULC, BBMP, ERDAS, LISS4, Carto Sat and Resource Sat.*

INTRODUCTION

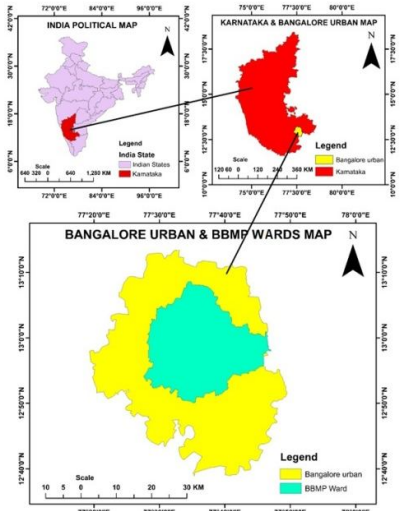
Land Use and Land Cover is one of the issues creating topic in the world. LULC is not a static it is a dynamic, because of the change in the human life style, behaviour and approach towards the environment, changes the Land Use and Land Cover of the Geographical area. Land is the stage on which all human activities are being conducted and the source of the materials needed for this conduct. Human use of land resources give rise to "land use" which varies with the purposes it serves, It could be food production, provision of shelter, recreation, extraction and processing of materials, as well as the bio-physical characteristics of land itself. Hence, land use is being shaped under the influence of two broad sets of forces – human needs and environmental features and processes. Neither one of these forces stays still; they are in a constant state of flux as change is the quintessence of life. Changes in the uses of land occurring at various spatial levels and within various time periods are the material expressions, among others, of environmental and human dynamics and their interactions which are mediated by land. Although the terms land cover and land uses are often used interchangeably, their actual meanings are quite distinct. Land cover refers to the surface cover on the ground, vegetation, urban infrastructure, water, bare soil or other. Identifying, delineating and mapping land cover is important for global monitoring studies, resource management and planning activities. Identification of land cover establishes the baseline from which monitoring activities (The growth and development of Bruhat Bengaluru Mahanagara Palika (BBMP) Region-Approaching Geospatial Technology) can be performed. It provides the ground cover information for baseline thematic maps.

In the analysis of land use and land cover change, it is first necessary to conceptualize the meaning of change to detect it in real world situations. At a very elementary level, land use and land cover change means (quantitative) changes in the areal extent (increases or decreases) of a given type of land use or land cover, respectively. It is important to note that, even at this level, the detection and measurement of change depends on the spatial scale; the higher the spatial level of detail, the larger the changes in the areal extent of land use and land cover which can be detected and recorded.

In a similar vein, land use change may involve either (a) conversion from one type of use to another – i.e. changes in the mix and pattern of land uses in an area or (b) modification of a certain type of land use. Modification of a particular land use may involve changes in the intensity of this use as well as alterations of its characteristic qualities/attributes – such as changes from low-income to high-income residential areas (the buildings remaining physically and quantitatively unaltered), changes of suburban forests from their natural state to recreation uses (the area of land staying unchanged), and so on. In the case of agricultural land use, Jones and Clark provide a qualitative typology of land use changes: Intensification, Extensification and Abandonment.

STUDY AREA:

Bangalore is the capital city of the state of Karnataka in India. Bangalore grows the fastest in Asia and its urban area began to form in 1991. Bangalore is the capital of Karnataka. Because of its burgeoning IT industries, Bangalore is nicknamed India's "Silicon City." Also, it is an international air hub. Bangalore Local Administrations is Bruhat Bangalore Mahanagara Palika (BBMP), the biggest urban area with an extent of 709 sq. km. Bangalore is now the commercial center of new technology of India. Its roles and responsibilities include the "orderly development of the city" — zoning and building regulations, health, hygiene, licensing, trade and education, as well as quality of life issues such as public open space, water bodies, parks and greenery. The BBMP represents the third level of government (the Central Government and State Government being the first two levels). BBMP is run by a city council composed of elected representatives, called "co-operators", from each of the wards. It is positioned at 12.97° N 77.56° E and covers an area of 2,190 square kilometres (850 sq. mi), and the BBMP Geographical area is 709sq.km. A landlocked city, Bangalore is located in the heart of the Mysore Plateau (a region of the larger Deccan Plateau) at an average elevation of 920 meters (3,020 ft.).



Map 1: Study Area Map of BBMP

DEMOGRAPHY:

Bangalore has a population of 8,443,675 in the city and 10,456,000 in the urban agglomeration, up from 8.5 million at the 2011 census, Bangalore is a megacity, and the third-most-populous city in India and the 18th-most-populous city in the world. Bangalore was the fastest-growing Indian metropolis after New Delhi between 1991 and 2001, with a growth rate of 38% during the decade. The city claims an area of 709 square kilometres and with a population density marked in 2011 of over 4 thousand per square kilometre - one can assume it has become denser. Bangalore has a diverse religious distribution. BBMP is divided into 8 zones and 198 wards.

OBJECTIVES:

The major objective of the research papers is to understand the LULC process towards the growth in BBMP. Paper also concentrated on the Assessing LULC changes during the 2001 to 2018. Quantification analysis of LULC in BBMP area. The causes behind the change in the LULC in BBMP area.

DATA AND METHODOLOGY:

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object. For the present research Panchromatic and Multi Spectral Satellite imagery have been used. The data's are available in separate tiles, after geo-referencing the tiles mosaic the tiles to get the BBMP area and finally subset the tiles to the study area. Below are the important satellite imagery and their resolutions.

Satellite Imagery	Resolution
IRS P6 / LISS 4	24 Mtrs
Resource Sat 2	5.8 Mtrs
Carto Sat 2	2 Mtrs

Clawson also discusses "Good" in terms of essentially qualitative generalities based on the usefulness of the data. He assumed that 95% of all data should be correctly classified. Five characteristics of a good classification as outlined by Clawson are as follows;the classification should deal exclusively with activities. Non activity data can be input at a later stage. It should be flexible in detail of aggregation and combination. It should be amenable to machine processing. There are three types of land classifiers- Purpose classifiers, Operation sequence classifiers and Context classifiers.

The present land use / land cover classification is based on two approaches, they are: **The first is referred to as the image approach**: Studying the latest remote sensing satellite imaginary better than one meter resolution on required scale.**The second is the information approach**: Defining information needs of user departments and building a land use / land cover classification scheme.

Table 1 Comprehensive National Land Use / Land Cover Classification System:

Sl No	Level I	Level II
1	Built Up	Built Up (Urban),Built Up (Rural)
2	Agricultural Land	Crop Land, Fallow, Plantation, Tree Groves
3	Forest	Evergreen, Semi, Deciduous, Scrub, Grassland, Mangrove etc.
4	Natural / Semi Natural Grassland and Grazing Land	Alpine, Tropical, Manmade Grassland
5	Wastelands	Salt-affected land, Scrub land, Sandy areas, Mine dumps, Industrial dumps, stony wastes.
6	Wetlands	Inland Wetland, Coastal Wetland
7	Water Bodies	River, Canal, Lakes, Reservoir
8	Others	Mining, Quarry, Bricks Kilns, snow covered or Glacial area

For the present study LULC classification is made on the basis of available of the satellite imagery. Below table represent the representing class of LULC.

Table 2: Land use and land cover classification based Satellite imagery.

Sl No	Classification	Includes
1	**Built-up Areas**	Residential, Commercial, Transportation and other built up areas
2	**Waterbody Areas**	Natural and Manmade Lakes
3	**Greenery Areas**	Agricultural land, Forests, Scrubs and Grasslands
4	**Other Areas**	Vacant land, non-usable for agriculture and other purpose, dumping yards, masked areas if any, quarry etc.

RESULT AND DISCUSSION:

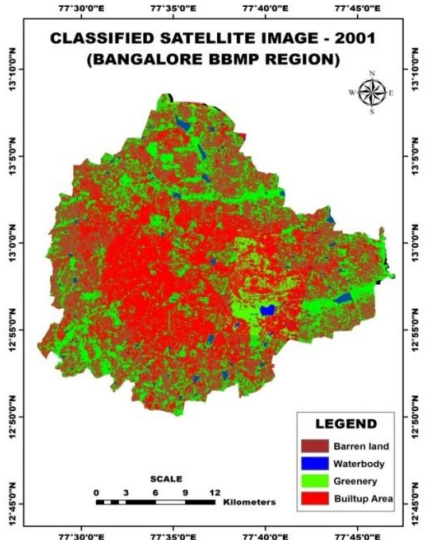
The land use / land cover pattern of a region is an outcome of natural and socioeconomic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense anthropogenic pressure. Hence, information on land use/land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. Land use effects land cover and land cover affects land use. A change is either however, is not necessarily the product of the other. Shifting land use patterns driven by a variety of factors result in land cover changes that affect the environment. Land cover can be altered by the forces other than anthropogenic. Natural events such as flooding, fire, climatic fluctuations and ecosystem dynamics can also initiate modifications upon land cover. Globally, land cover today is altered principle by direct human use, livestock raising, forest harvesting and management and urban and suburban construction and development. Land use change, as one of the main driving forces of global environmental change, is central to the sustainable development debate. The types of land use are distinguished as land cover conversion, i.e., the complete replacement of one cover type by another, and land cover modification, i.e., more subtle changes that affect the character of the land cover without changing its overall classification. Land use change occurs at every Spatio-temporal scale.

CAUSES AND CONSEQUENCES:

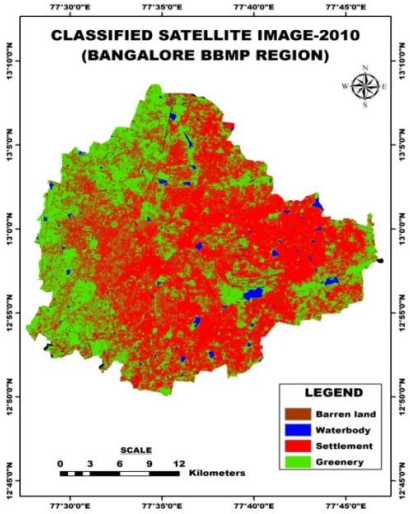
Changes in land use and land cover date to prehistory and are the direct and indirect consequence of human actions to secure essential resources. More recently, industrialization has encouraged the concentration of human populations within urban areas (urbanization) and the depopulation of rural areas, accompanied by the intensification of agriculture in the most productive lands and the abandonment of marginal lands. All of these causes and their consequences are observable simultaneously around the world today. **Biodiversity loss:** Biodiversity is often reduced dramatically by LULCC. When land is transformed from a primary forest to a farm, the loss of forest species within deforested areas is immediate and complete. Even when unaccompanied by apparent changes in land cover, similar effects are observed whenever relatively undisturbed lands are transformed to more intensive uses, including livestock grazing, selective tree harvest and even fire prevention. The habitat suitability of forests and other ecosystems surrounding those under intensive use are also impacted by the fragmenting of existing habitat into smaller pieces (habitat fragmentation), which exposes forest edges to external influences and decreases core habitat area. Smaller habitat areas generally support fewer species (island biogeography), and for species requiring undisturbed core habitat, fragmentation can cause local and even general extinction. **Climate Change:** LULCC plays a major role in climate change at global, regional and local scales. LULCC can increase the release of carbon dioxide to the atmosphere by disturbance of terrestrial soils and vegetation, and the major driver of

this change is deforestation, especially when followed by agriculture, which causes the further release of soil carbon in response to disturbance by tillage. Though LULCC certainly plays a critical role in greenhouse gas emissions, the complexity and dynamic interplay of land use processes favoring net accumulation versus net release of carbon dioxide and other greenhouse gases makes it a poorly constrained component of our global budgets for these gases; an active area of current research. **Pollution:** Changes in land use and land cover are important drivers of water, soil and air pollution. Perhaps the oldest of these is land clearing for agriculture and the harvest of trees and other biomass. Vegetation removal leaves soils vulnerable to massive increases in soil erosion by wind and water, especially on steep terrain, and when accompanied by fire, also releases pollutants to the atmosphere. This not only degrades soil fertility over time, reducing the suitability of land for future agricultural use, but also releases huge quantities of phosphorus, nitrogen, and sediments to streams and other aquatic ecosystems, causing a variety of negative impacts (increased sedimentation, turbidity, eutrophication and coastal hypoxia). Other agricultural chemicals, including herbicides and pesticides are also released to ground and surface waters by agriculture, and in some cases remain as contaminants in the soil. The burning of vegetation biomass to clear agricultural fields (crop residues, weeds) remains a potent contributor to regional air pollution wherever it occurs, and has now been banned in many areas. **Other impacts:** Other environmental impacts of LULCC include the destruction of stratospheric ozone by nitrous oxide release from agricultural land and altered regional and local hydrology (dam construction, wetland drainage, irrigation projects, increased impervious surfaces in urban areas). Perhaps the most important issue for most of Earth's human population is the long-term threat to future production of food and other essentials by the transformation of productive land to nonproductive uses, such as the conversion of agricultural land to residential use and the degradation of rangeland by overgrazing.

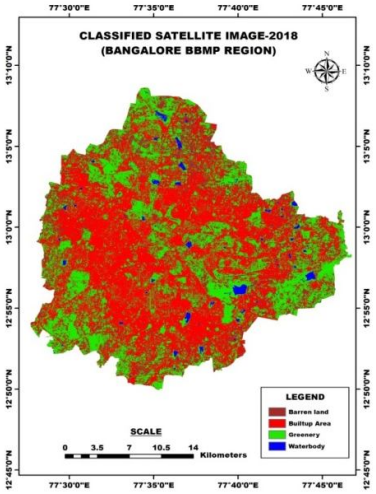
Land Use and Land Cover Classification: to understand the changes happens in the BBMP region to analysis the growth. I have done the supervised classification using the 3 temporal data sets. 2001 I have used LISS4 Multi spectral data. For 2010 Resource Sat 5.8 meter resolutions. For 2018 Carto sat 2 data have been used.



Map 2: 2001 Classified Sattelite image of BBMP Region



Map 3: 2010 Classified Sattelite image of BBMP Region



Map 4: 2018 Classified Sattelite image of BBMP Region

The use of a hybrid approach classification, which combines pixels and objects, has been shown to be suitable for the identification of Landscape Units that contain a variety of land cover objects using VHSR images. However, the pixel-based classification of remote sensing images performed with different classifiers usually produces different results. With the combination of the outputs of a set of classifiers it is possible to obtain a classification that is often more accurate than the individual classifications.The above classified are not giving 100% result, using the Hybrid classification we can get 70 to 80 percent result after that we should depend on the field survey and CDP Plans of the city. The 2018 satellite imagery represents the nearer result to the BBMP region.

Land Use Type	Area	Acre	%	Area	Acre	%	Area	Acre	%

	in Sq Km			in Sq Km			in Sq Km		
	2001			2010			2018		
Built-up Areas	213	52633	30.04	312	77096	44.00	481	118858	67.84
Waterbody Areas	28	6918	3.94	23	5683	3.24	16	3953	2.25
Greenery Areas	270	66718	38.08	196	48432	27.64	115	28417	16.22
Other Areas	198	48929	27.94	178	43987	25.12	97	23970	13.69
Total	**709**	**175198**	**100**	**709**	**175198**	**100**	**709**	**175198**	**100**

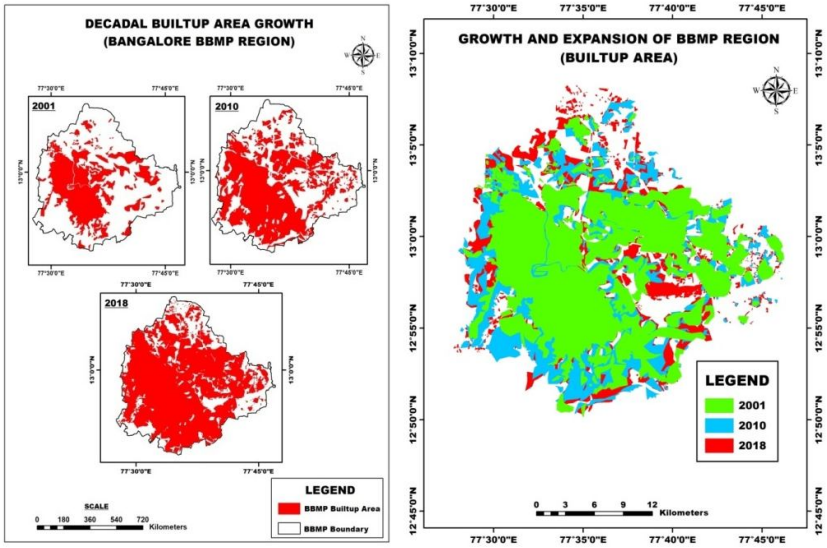
Table 3: Temporal Land Use Classification (The Total Geographical Area of under study is 709 sq km)

Land use of BBMP region in 2001: The land-use in the year 2001 for study area is dominated by the Greenery and Other Areas. Greenery includes Agricultural land, Forestry, Scrubs and Grasslands. The other class includes open land, waste land, stone-quarry and dumping-yards. There were increasing components of built-up area in the metropolitan city. **Built-up Areas:** Areas of human habitation developed due to non-agricultural use an that which has a cover of buildings, transportation and communication, utilities in association with water, vegetation and vacant lands are classified as built up. The study area covers BBMP Region. The total built-up land measures to 213 sq km in 2001, this has great increase since the 1995, in the year 1995 has 163 sq km. **Waterbody Areas:** This class comprises of surface water either impounded in the form of ponds, lakes and reservoirs or flowing as rivers. The effect of urbanizations has taken some heavy toll on the beautiful lakes in Bangalore. The lakes in the city have been largely encroached for urban infrastructure and as a result, in the heart of the city only 17 good lakes exist as against 51 healthy lakes in 1985. Urban development has caused 16 lakes getting converted to bus stands, Golf courses, play grounds and residential colonies, and few tanks were breached under the malaria eradication programme. Lake Development Authority has been governed in 2002, before that many lakes vanished due to encroachment and construction activity for urban infrastructure expansions. The city once had 280-285 lakes of which 7 cannot be traced, 7 are reduced to small pools of water, 18 have been unauthorized encroached by slums and private parties, 14 have dried up and are leased out by the Government. 28 lakes have been used by the Bangalore Development Authority to distributes sites and build extensions for residential areas. Over the years Bangalore city losing its one type of land use class because of the rapid urbanizations. **Greenery Areas:** It constitutes Agricultural land, forest, grassland and other type of land covered by vegetation. Out of geographical area of the city the share of the greenery was 270 sq. km. The converted areas used for the new layouts and many industrials built up. Many IT Companies were established in period in the boundaries of the urban areas. Bangalore is known for its green space and has a good ecology. The increasing urbanization has posed a serious threat on the spatial distribution of the forests area as well as in the quality / health of the forest. In BBMP some of the areas where natural vegetation is dominated by grasses or grass like plants and non-grass like herbs. Lands exclusively used for farming grasses are called meadows and pastures. Such grass land is found in the North and South West corner of the study area. **Other Areas:** The land use class named other constitutes vacant land, non-usable for agricultural purpose, dumping yards and quarry. These are more common sloping land where they are developed by the action of concentrated runoff. Such kinds of lands are found in the East and Northern Part of the Bangalore Metropolitan City.

Land use of BBMP region in 2010: Bangalore Metropolitan City is one of the fastest growing cities in Asia as well as in World. It has the advantage of Globalization, Industrialization and Urbanization. Urban and Rural Fringe changing its characteristics every day. The type of land use also changes every day, and converting Bangalore into one of the Biggest and Largest city in the modern world. Since the last decade we can see the dramatic changes and growth in the Bangalore BBMP Land use patterns. **Built-up Areas:** In the period of 2001 to 2010 Bangalore Metropolitan City grew very drastically. In CBD and also in the Peri-urban region

many shopping malls were established, the important onc's are Phoenix Market City, Goplan Signature Mall, Meenaki Innovative Mall, Mantri Mall and Squares, Orioan Mall and others. Big apartments were constructed in the fringe of the city, example Whitefield, Yelahanka, Marathahalli, J.P. Nagar, Kengeri, Vidyaranya Pura. Many connectivity roads were constructed to connect and save the time of the commuters. IT Industries like Manyatha Embassy Business Park, Adarsh Tech Park, Global Technology Park, Bagmane World Technology Center and other Business centers were established. Built up area increased up to 44% in the BBMP region. **Waterbody Areas:** The land use of water bodies decreased since 2001 to 2010, at the end of the decade it has only 23 sq km. Many lakes were converted into commercial hubs, and some lakes were privatized. Now we have only few lakes in BBMP Region, those are also not in the good conditions. Lake development authority and Pollution Control Board taking some measures to save lakes. **Greenery Areas:** Agricultural land in and around the Bangalore Metropolitan City converting into yellow zone and again converting into Layouts. This leads to the development of the satellite towns, and the urban expansion finally results the Peri-urbanization. In 2010 Greenery has 196 sq km of the geographical area. Hesaraghatta forest and Banneraghataa are the some patches of forest available in BBMP Region. Lal Bagh, Cubbon Park, Indian Institute of Science is the some of the Green Patches available in heart of the city. **Other Areas:** These vacant land, Land not use full for the agricultural purpose, Stones quarry, dumping yards, percentage is also decreasing every year because of the commercial importance of the land uses. The points of Industrial waste and mining waste also increasing but that is not affected the Other Class of land use patterns. The comparison of land use between 2001 to 2010 shows drastic changes especially in terms of Greenery loss and water bodies' loss. There is a massive transformation of Agriculture loss and considerable loss of the lakes which had attributed to the increase of concrete structures of the Bangalore BBMP region. The agricultural land has decreased more than two fold, the lake area has decreased by one fold and there is a considerable forest area loss can also be noted here. But the built up has increased more than two fold and there is a notable increase in the waste lands too.

Land use of BBMP region in 2018: The land-use in the year 2018 for study area is covered wholely by the builtup areas. Greenery includes Agricultural land, Forestry, Scrubs and Grasslands., which are also decreasing at a high rate due to increasing builtup areas. The other class includes open land, waste land, stone-quarry and dumping-yards. There were increasing components of built-up area in the metropolitan city. The greenery,waterbodies and other areas are drastically getting vanished due to rapid growth and expansion of builtup areas in the BBMP region. **Built-up Areas**: Areas of human habitation developed due to non-agricultural use an that which has a cover of buildings, transportation and communication, utilities in association with water, vegetation and vacant lands are classified as built up. The study area covers Bangalore Metropolitan City and surrounding villages. The total built-up land measures to 213 sq km in 2001. But in 2018 it nearly 481 sq.km. **Waterbody Areas:** The effect of urbanizations has taken some heavy toll on the beautiful lakes in Bangalore. Over the years Bangalore city losing its one type of land use class because of the rapid urbanizations. In 2018, waterbodies are drying and vanishing at a huge rate along side the green covers. Only about 16 sq.km are left.**Greenery Areas:** It constitutes Agricultural land, forest, grassland and other type of land covered by vegetation. In 2018 greenery class reduced and only 115 sq. km., leftout in this class. **Other Areas:** The land use class named other constitutes vacant land, non-usable for agricultural purpose, dumping yards and quarry. These are more common sloping land where they are developed by the action of concentrated runoff. Such kinds of lands are found in the East and Northern Part of the Bangalore Metropolitan City. These lands are characterized by exposed massive rocks, sheet rocks, stony pavements or lands with excessive surface accumulating of stones that render them unsuitable for producing any green biomass.



Map 5: Growth and Expansion of Built-up area in BBMP Region

CONCLUSION:

The above map shows the how built-up area had been grown in the Bangalore city. Many satellite towns have been created to decrease the pressure in the city area. 101 wards to 198 wards have been changed. In the last 25 years, the region of Bangalore BBMP population is doubled and growing rapidly. Bangalore has many large, medium and small scale industries. After the year 1995, many IT industries were established, and finally Bangalore is considered as the Silicon Valley of India. Present census shows 138 villages are surrounding the BBMP region. Growth of a city is good for challenging development with other cities, but the residues caused by the growth is very serious. Shadow areas like slums, infrastructure, utilities, urban floods, public transportation, solid waste management, preservation of ecological spaces against urbanization, increasing demand for housing which all together stands as a big challenge for administrators and planners of Bangalore. All the maps, tables and graphs are totally relevant to the research, keeping in mind the study area and limitations. After comparing and analyzing all the maps, graphs, tables, visually interpreted` maps which are prepared in a geospatial platform to give a clear outcome of the objectives of the research. The research makes many things clear which is related to the land-use and land-cover of the Bangalore BBMP Region. For the classification of the study area, National Land-use and Land-cover classification scheme has been used. The study area has 709 sq.km, in which built-up area has increase drastically within the studied years, i.e., 2001-2018. In the year 2001, it was seen that the built-up area covers 213 sq.km to 481 sq.km.

By looking at the results emerging from the present study, keeping in view some of the critical problems of BBMP region, certain measures have been suggested for the immediate attention of the planning authorities concerned with Bangalore urban development. Followings are some of the suggestions and recommendations:Bangalore is one of the fastest growing cities in India, due to which it is becoming difficult to control the growth of the Bangalore City in terms of population, economics, environment, culture, etc. To control this gradual raising problems, government has to pass some bills and provide the infrastructure facilities for the surrounding cities and towns.The lack of infrastructure is one of the main drawbacks in the BBMP region, like road network, transportation facilities, undeveloped lakes and failure to identify the dumping yards, pollution and traffic congestion.The Master Plan prepared by the BBMP, BDA and BMRDA is not up to the mark for the current population. Information technology industries have growth and it is found in a single stretch from Hebbal to Electronic city, which includes Hennur, Banaswadi, Marathahalli, Whitefield, Silkboard and Koramangala region. We can nowhere else see such an IT hub. So

initiative should be taken by the government to build such an IT hub elsewhere.Waterbody areas are decreasing day-by-day, as seen from the analysis above, that the waterbody areas have drastically come down to an area of 16 sq.km from 28 sq.km (2001-2018). There is no funds for rejuvenation or even maintenance of the lakes in Bengaluru city. Some have dried up due to environment factors, some are occupied for built-up areas, some are getting polluted day by day. Authorities of different sections uses the traditional methods for civic works, instead if they have adopted the Geospatial techniques like GIS, GPS, etc. with the help of various NGOs and other organizations, government can improve the infrastructure facilities and maintenance. But it's still not too late to involve urban experts with strong government support, can come up with feasible solutions to save the region from pollution, global warming, etc. and to maintain the city's environmental scenario for the future.

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