An Examination of Land Use and Land Cover Changes in Muvattupuzha River Basin using GIS

Shaina Beegam N, Prince ArulRaj , J Brema

Abstract: Land is the most important natural resources as far as human beings are concerned. The utilization of land is changing due to the emerging growth of population. The consequences due to change in land use not only affect human beings but at the same time affect the ecosystem also. The emerging effect of change of land use due to urbanization results in flooding and drought condition. This study has been carried out to understand the land use and land cover changes using GIS in a semi-arid region, Kerala, India. For this, the study area has been selected as Muvattupuzha River Basin. Land use land cover changes studies are very much important for planners as well as economists for better land utilization. It has been concluded from the study that built up area has increased during the study period from 110.9 km^2 to 504.42 km^2, which indicates that urbanization is the main factor which causes the bi-variational changes of land and flood occurrence.

Keywords: GIS, Land Cover, Land use, Resource

I. INTRODUCTION

The conversion of land utilization in a large scale results in devastation of ecosystems which is contributed by human intervention. The various land use constituents like forest, grassland, wetland, undergo diverse effects of transformable changes in varying degrees [4].Another most destruction on living environment by humans is the mining and quarrying operations carried for various purposes on land like minerals [2]. Remote sensing and GIS is considered to be the most efficient tool for all planners and decision makers to estimate the land use land cover changes [5]. The most challenges faced by the river basin are floods and droughts which are induced due to urban sprawling. The temporal changes of land use have direct relationship with the hydrological realm [3]. The present study is the analysis of land use and land cover changes in Muvattupuzha River Basin in Kerala.

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II. LITERATURE REVIEW

Yasodharan and Bindu (2015) [5] studied the changes in land use and its features in Kadalundi River basin of Kerala It was reported that paddy and areca nut are grown in valleys, agriculture area was the major land use type and Kadalundi River is the only major source of water for the region.

Mayaja and Srinivasa (2017) [3] attempted to land evaluate the use -land cover changes in Pampa River basin based on remote sensing. The study concluded that human intervention had a strong effect on basin ecology and drought situation in the Pampa river basin. They also reported that a comprehensive policy planning is needed. Jiya George et.al (2016) [1] studied the land use -land cover through a change detection study in the Aluva Taluk using remote sensing techniques. Their work revealed that the built-up land increased by 6 % and plantations by 3%. It has been concluded that study on land use changes is very important for planning and implementation, to meet the human needs and welfare. Nikhil Raj and Azeez (2010) [4] discussed the spatial and temporal changes of Bharatapuzha River basin. It has been concluded that there has been changes in land use-land cover with reduction in vegetative cover , wet land and with increase in road density.

III. STUDY AREA

The study area selected for the research is Muvattupuzha River basin, which is situated in Ernakulam district of Kerala. The word 'Muvattupuzha comprised of three words 'Moonu" meaning three, 'aaru" means small river "puzha" also means river. Muvattupuzha River (or moovar) comprises of three rivers namely Kothamangalam River (Kothayaar), Thodupuzha River (Thodupuzhayaar) and Kaliyar River which merge to form a single river as Moovar or Muvattupuzha river. This river flows up to Vembanad in Vaikkom and then confluences with Arabian Sea. The Muvattupuzha River is one of the perennial rivers in central Kerala. The river basin spreads over Idukki, Kottayam, Alappuzha and Ernakulum districts of central Kerala

The river basin lies between $9^0 30'49.33''N$, $10^0 5'17.46''N$ latitudes and $76^0 23' 10.98''E$, $76^0 24'5.51''E$ longitudes. The river has a length of 121 km running through Muvattupuzha town with a catchment area of 2670 km^2. The major source of water is from The Muvattupuzha River, the confluence of three rivers and of that

Retrieval Number: C6642098319/19©BEIESP
DOI:10.35940/ijrte.C6642.098319
Journal Website: www.ijrte.org

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Thodupuzha River is the major source of water, which makes the Muvattupuzha River to overflow and floods the low lying areas during heavy monsoon period. The major part of the river basin comprises of crystalline rocks and the prevailing climate is tropical humid climate. The study area is shown in Fig.1
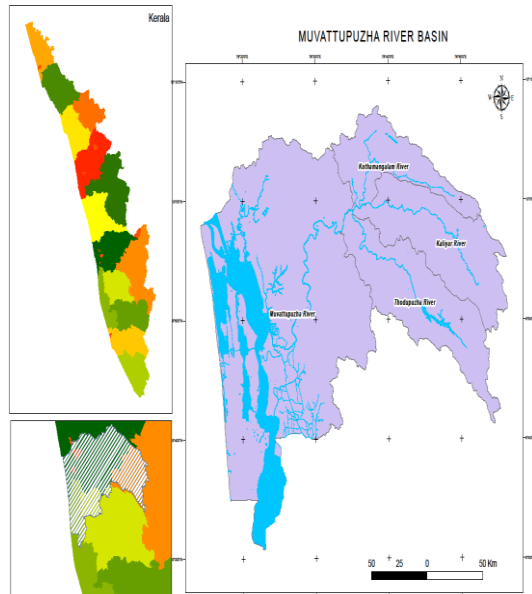

Fig .1 Study Area

IV. MATERIALS AND METHODS

The basin boundary was obtained from Irrigation Design Research Board (IDRB) Trivandrum. In order to study the land use changes, Landsat 8 satellite imageries of 30 m resolution were downloaded corresponding to the years 1998, 2008 and 2018 from USGS earth explorer website. The imageries were obtained corresponding to the month of February to avoid cloud correction. The imageries were classified using unsupervised maximum likelihood classification in pixel wise tool of ArcGIS 10.1 software.

In the study, the categories considered for the land use classification were water bodies, mixed crop plantation, forest, agricultural area, built-up area, grassland, rock exposure, wetlands and scrub.

V. RESULT AND DISCUSSION

The LULC maps of Muvattupuzha River Basin for the years 1998, 2008, 2018 are shown in Fig 2, Fig 3, and Fig 4 respectively
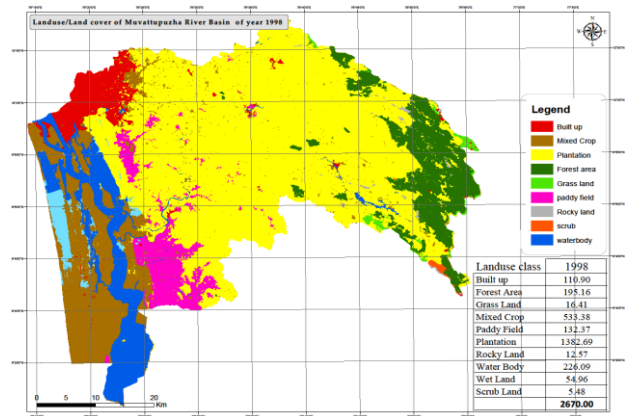

Landuse class	1998
Built up	110.90
Forest Area	195.16
Grass Land	16.41
Mixed Crop	533.38
Paddy Field	132.37
Plantation	1382.69
Rocky Land	12.57
Water Body	226.09
Wet Land	54.96
Scrub Land	5.48
	2670.00

Fig 2 LULC of MRB corresponding to the year 1998

Landuse class	2008
Built up	214.44
Forest Area	194.96
Grass Land	13.02
Mixed Crop	330.15
Paddy Field	50.72
Plantation	1611.73
Rocky Land	3.45
Water Body	205.40
Wet Land	44.70
Scrub Land	1.83
	2670.00
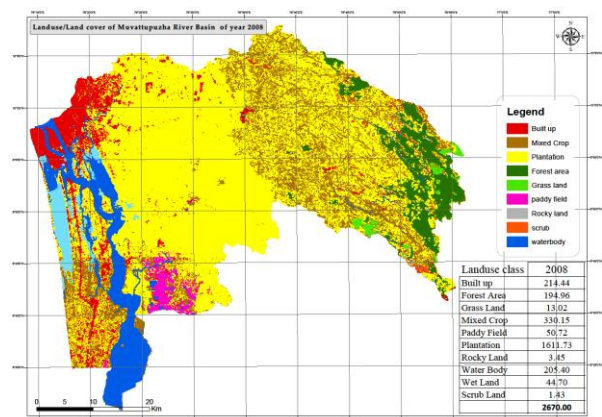
Fig 3 LULC of MRB corresponding to the year 2008

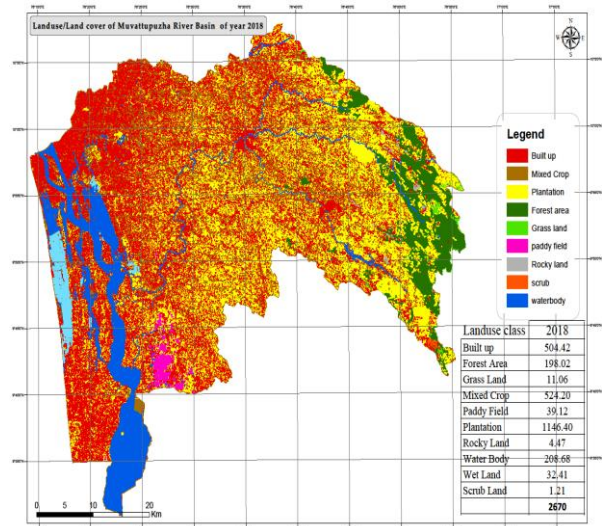| Landuse class	2018
Built up	504.42
Forest Area	198.02
Grass Land	11.06
Mixed Crop	524.20
Paddy Field	39.12
Plantation	1146.40
Rocky Land	4.47
Water Body	208.68
Wet Land	32.41
Scrub Land	1.21
	2670

Fig 4 LULC of MRB corresponding to the year 2018

Table1. LULC Classification of Muvattupuzha River Basin

LULC Category	Area occupied in Sq.km		
	1998	2008	2018
Built up	110.90	214.44	504.42
Forest Area	195.16	194.96	198.02
Grass Land	16.41	13.02	11.06
Mixed Crop	533.38	330.15	524.20
Paddy field	132.37	50.72	39.12
Plantation	1382.69	1611.73	1146.40
Rocky Land	12.57	3.45	4.47
Water Body	226.09	205.40	208.68
Wet Land	54.96	44.70	32.41
Scrub Land	5.48	1.43	1.21
Total	2670	2670	2670

Built up land

It is the developed area in which residential buildings or other building structures are present. During the study period the built-up area increased from 110.9 km^2 in 1998 to 504.42 km^2 in 2018. The increase in the built up area between the years 2008 and 1998 is found to be 93.36%.The increase in built up area between the years 2018 and 1998 is found to be 354.84%. This increase in percentage is very high. This increase clearly showed the developmental change happened in the basin area. This increase in built up area can be seen not only in the town area but also in the outskirts.

Forest

Forests are thick canopies of trees. In the study area, the area covered by forest remains the same throughout the study period. There has been no encroachment due to the activities of inhabitants, deforestation, cultivation or plantation during the study period and hence the area remains the same. Forest in the study area represents the evergreen/semi evergreen and deciduous forest and it covers an average area of 196.04 km^2.

Grassland

The grassland concerned in the study area includes the area under herbs and small trees. The grassland in the study area was identified as 16.41 km^2, 13.02 km^2 and 11.06 km^2 during the years 1998, 2008 and 2018 respectively. This can be mostly seen in the highland areas. The reduction in grass land area indicates that the areas are converted into buildings or settlements due to the low land value. The decrease in the grass land area between the years 2008 and 1998 is found to be 20.62% and that for years 2018 and 1998 is found to be 32.56%. This percentage decrease is high.

Mixed Crop

Mixed crops are those crops having two or more crops on the same land with one crop being the major crop. In the study area, several mixed crops like pineapple, banana, areca nut, tapioca, coca, ginger, turmeric, pepper and rice are grown. The total area of mixed crop is 533.38 km^2 in 1998 which reduced to 330.15 km^2 in 2008 and then increased to 524.20 km^2 in 2018. These changes are may be due to price fluctuations for the products. When the subsidiaries from the government are not received, it reflects in the market value and crop production. The climatic changes in the basin are also a reason for the changes in mixed crop-area. It is also observed that there is a gradual shift from cash crops to food crops. Increase in mixed crop area in the latter period, indicates that government offers more subsidiaries for certain crops.

Paddy field

In the study area, the paddy field area can be seen in the outskirts except the town limits. In 1998, paddy field existed for an area of 132.37 km^2, it has reduced to 50.72 km^2 in 2008 and has still reduced to 39.12 km^2.The reasons for reduction in paddy field area are likely to be the encroachment of inhabitants and developmental activities. The decrease in the paddy field area between the years 2008 and 1998 is found to be 61.68 % and the decrease in paddy field between the years 2018 and 1998 is found to 70.45%. This percentage decrease is very high. Non-availability of farmers, govt. subsidies, non-conducive market value and drought condition has led to the conversion of paddy field into commercial or residential buildings.

Plantation

Plantation includes the area under coconut, rubber, tea and coffee. The major plantation area in the study area includes that of area under coconut and rubber. In 1998, the area covered under plantation was 1382.69 km^2, which increased to 1611.73 km^2 in 2008 and decreased to 1146.40 km^2 in 2018. These variations are mainly due to the cultivation of pepper, tapioca etc in addition to rubber in the upper areas of the basin. The highlands of the study area had forest earlier and the area almost remain the same. Demolition of rubber trees for homely activities saw mills are also reasons for the reduction in the plantation area. The increase in the plantation area between the years 2008 and 1998 is found to be 16.57 % and the decrease in plantation area between the years 2018 and 1998 is found to 17.09 %.Apart from this, the inhabitants occupied the plantation spaces with small industrial activities which led to the decrease in plantation area.

Rocky Land

Some part of the study area consists of rocky exposure. Studies indicated that laterite and Charkonite were seen in some areas in the basin. The rocky land goes on decreasing in the study period which revealed that all land including the rocky part completely filled and mined and later converted into settlements and buildings. Economic developments and urbanization are the reasons for reduction in rocky area. The decrease in the rocky area between the years 2008 and 1998 is found to be 72.54 % and the decrease in rocky area between the years 2018 and 1998 is found to 64.46 %. This decrease in percentage is very high.

Water Body

This land cover category includes small streams, ponds, lakes and rivers. From the results, it has been observed that area under water bodies mostly remains unchanged. The small variations, that appeared in the results are might be due to the encroachment in the tank bunds and river banks.

Wetland

In the study area wetlands are found mostly in the Muvattupuzha sub basin region. It is identified that the wetland in the study area goes on decreasing during the study period. In 1998 the wetland area is 54.96 km^2 reduced to 44.70 km^2 in 2008 and again reduced to 32.41 km^2 in 2018.The decrease in the wetland area between the years 2008 and 1998 is found to be 18.68 % and the decrease in wetland area between the years 2018 and 1998 is found to 41.04 %.

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This decrease in percentage is very high. The wetlands near to town area have also been converted into commercial and residential zones. The rapidly growing built-up area led the decrease in wetland area. The wetlands along with rocky land have been demolished and converted into built-up area. The urbanization has lead to variation in climate change which has in-turn affected the wetland hydrology, plant communities and ecological functions of wetlands. Therefore it is important to preserve the wetland for sustaining the environment.

Scrub land

Scrub land dominates the small vegetative part of the land formed either naturally or by human activity. In 1998, the scrubland area has an area of 5.48 km^2 which reduced to 1.43 km^2 in 2008 and again reduced to 1.21 km^2 in 2018. The decrease in the scrub land area between the years 2008 and 1998 is found to be 73.97% and the decrease in area between the years 2018 and 1998 is found to be 77.86% .This percentage decrease is very high. The economic developments, small scale production, conversion of land into residential buildings are some reasons for the reduction in scrub land.

VI. SIGNIFICANT RESULTS

The most significant observations identified in the study area are the rapid increase in built up area, decrease in paddy field, transitional change happened in grass land to wet land, decrease in scrub land , marginal decrease and increase in mixed crop and plantation during the study period. In 2008, the areas like Vannapuram and some areas nearer to Kaliyar have been converted to rubber and coconut plantation. Later the land part is converted to built up and mixed crop. Mostly paddy field and agriculture area can be seen in Muthirakulam ,Vazhakkala, Arakuzha, Koothattukulam, Valakam and Thaipra. The lower regions are occupied by tapioca cultivation. The mixed crops can be seen in areas like Kaloorkad, Pothanicaud and Manjaloor. The town area has been occupied by settlements and commercial establishments. Apart from town area, the settlements are spreading in a haphazard manner. Settlements have developed in the water bodies' category also, which has resulted in small percentage reduction in water body. In Muvattupuzha sub basin, lowlands areas are wet land areas which are later converted into settlement. The exorbitant increase in settlement vividly exhibits that the area is highly prone to natural disaster like floods and soil erosion. This effect is being observed during the rainy seasons as floods for even a small amount of rainfall in the city limits.

VII. CONCLUSION

The study attempts to evaluate the land use land cover changes of Muvattupuzha River basin using Landsat 8 thematic layers corresponding to the years 1998, 2008 and 2018. The categories considered for the classification are as follows: mixed crop, forest, settlement, paddy field, plantation, wetland, grass land, rocky land and scrub land. The study shows that there are large variations in the areas under settlement, paddy field, mixed crop and plantations. From the study, it is concluded that the built-up area has increased during the study period and also a marginal decrease in the area under water bodies. The increase in built up area is found to be around 93% and 355% for the years 2008 and 2018 when compared with the year 1998.The urbanization has led to severe floods in the area especially during heavy rainy season. This study will be very useful for analyzing the impacts of flood and will be helpful for resource managers and planners by way of considering this as a preliminary data.

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Dr. J. Brema has an academic background with B.Tech in Civil Engineering, Postgraduate degree in Water Resources and Doctoral degree in Civil Engineering (Specialization in Water Resources). Apart from teaching, she has carried out research work and have published 90 research papers in national and international journals and conferences. Currently she is guiding 6 doctoral students. She is a Fellow of Institution of Engineers and a member of Indian Society of Technical education and Indian Water Resources Society. She has published a book on Rainfall Variation with reference to Landuse change- Noyyal Basin, Lambert Academic Publishing in the year 2017.

Retrieval Number: C6642098319/19©BEIESP
DOI:10.35940/ijrte.C6642.098319
Journal Website: www.ijrte.org

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