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Population Growth and Land Use Change: An Evaluation Based on the Physiographic Divisions of Thiruvananthapuram District, Kerala using Remote Sensing and GIS

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Abstract: ***The increasing population and its effect on land always remained an important topic of discussion. Thiruvananthapuram, being the state capital and the seat of administrative activities along with the added advantage of being an important IT centre, the influence of population is considerably increasing. The study made use of census data from 1971 to 2011. Land use data for the period was obtained from topographic sheets and satellite imageries. The work revealed that lowland area remained the zone of preference of population in the district along with the midland areas. Majority of the built up land is seen along the midland and lowland areas while the forest area is concentrated along the highland portion of the district. Land use underwent substantial changes in the district and during the period conversions between different types of land uses took place frequently. The major factors which can be attributed to these changes are mainly population growth, increasing construction activities and government policies.***

Keywords: Population growth, Land use, Remote Sensing and GIS.

1. Introduction

Land is the most important natural resource on earth and the basis for all development. This merit initiated the human beings to alter it in a way useful for them. In the present era of uncontrollable population growth, to keep land free from human interventions is merely impossible. The awareness of the importance of land use / land cover change has led to focused study on the process, causes and consequences of these changes. Land use is a decisive aspect capable of causing global changes and this led to the study of varying population and land use in Thiruvananthapuram district. For a better understanding of the changes, the study was conducted based on physiographic units.

2. Study Area

Thiruvananthapuram district lies in the southern part of Kerala (Fig 1) extending between the latitudes 8° 17' 25" to 8° 51' 46" N and longitudes 76° 40' 25" to 77° 17' 6" E with 2192 sq.km area. The altitude of the area varies from MSL to 1900 mts. The main rivers are Neyyar, Karamana and Vamanapuram. The important backwaters are Veli, Kadinamkulam, Anchuthengu and Edava-Nadayara Kayal and there is also a fresh water lake at Vellayani. The population of the district is 3,307,284 (2011 census). It is the second most populous district in the state and is the densest district with 1506 persons/sq.km (2011 census).

3. Material and Methods

3.1 Data Used

The study uses two sets of data which includes historical documents (published maps and texts) and remote sensing data. Land use maps of 1966-67 was extracted from topographic maps of 1966-67 (1:50000) and 2011 was extracted from Indian Remote Sensing (IRS) LISS III images (23 mts). For the preparation of recent land use/cover maps, field verification was also conducted and the maps were corrected using Google earth images. Visual interpretation techniques were also incorporated in the work. This provided a platform for the detailed analysis of land use change, as the reliability of the results depends on accurate identification of various features, fieldwork and a wide knowledge of the environment in the study area (Mas and Ramrez 1996; Arnold 1997).

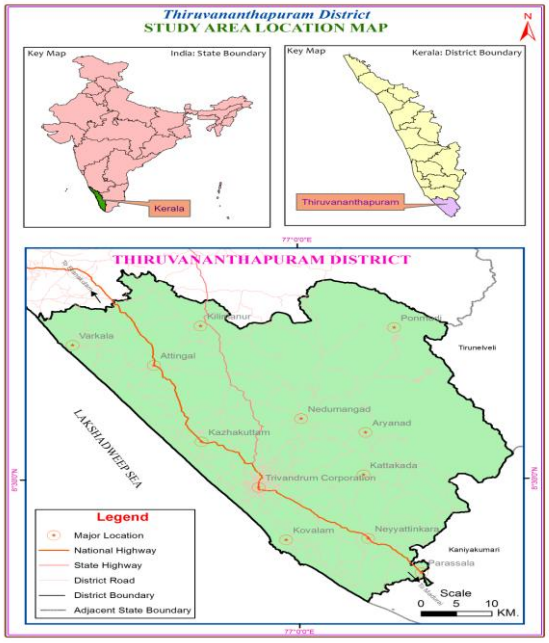


Figure 1: Study Area

3.2 Data processing

The processing of the compiled data was in the following sequence: the scanned topographic maps of 1966-67, which was used as the base map, was geo-referenced and the boundary and the land use classes were extracted. The latest data was extracted through the visual interpretation of satellite imageries and corrections was done using Google earth images and also through field visit. The district was divided into highland, midland and lowland based on the relief (Fig. 2) i.e., area with altitude less than 20 mts was grouped under lowland, 20 to 100 mts as midland and above 100 mts was classified as highland. The land use/cover of the study area was classified into ten types, namely, settlement with mixed trees, airport, built-up land, paddy field, forest, grassland, sandy area, scrub land, wasteland and water bodies. Arc GIS 9.3 software was used for the editing and preparation of maps.

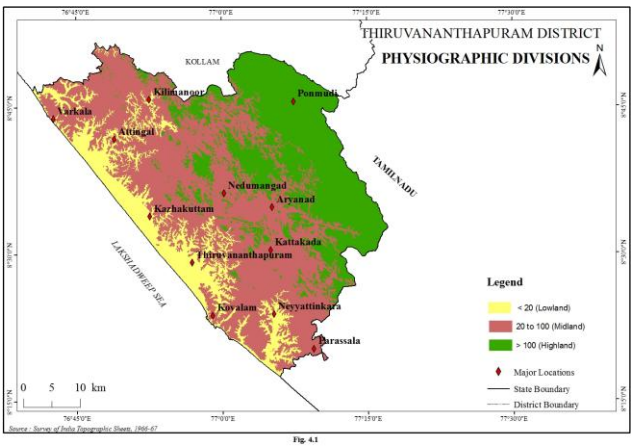


Figure 2: Physiographic Divisions of Thiruvananthapuram District

4. Changes in the Population Growth

The concentration of population on the basis of physiographic divisions revealed that lowland area remained the most preferred region by the residents of the district. It was seen that the region remained the favourite choice since the beginning of the study period i.e. in 1971, about 54.82 percent population resided in this zone. It increased to 55.42 percent in 1981 and in the next decade, a slight decrease to 54.85 percent and to 51.89 percent in 2001 (Table 1). As per 2011 census, 55.25 percent of the population resided in lowland. Proportion of population residing in midland shows only minute variations. During 1971, 38.58 percent people resided in this zone, increased to 39.21 percent in 1981, 39.94 percent in 1991. It again increased to 43.09 percent in 2001, but in 2011, 40.05 percent of total population of the district resided in this zone. Decrease in population concentration can be witnessed along the highland regions. About 6.58 percent of population resided in this zone during 1971. This decreased to 5.35 percent in 1981 and to 5.20 percent in 1991. In 2001, 5.01 percent population stayed here and according to the 2011 census, 4.69 percent population of the district was from this zone. Thus as per the study, lowland region remained the zone of high population concentration in Thiruvananthapuram district followed by midland region while population percentage is seen decreasing in the highland region. Decade wise population growth rate reveals that during 1971-81, growth rate along midland regions were high (20%) along with lowlands (19.36 %), while highland regions showed negative growth rate (-3.94%) (Table 2). During 1981-91, highland recorded 10.29 percent growth while midland and lowland recorded 15.60 and 12.32 percent growth rates respectively. Thus in this decade also midland region recorded high growth rates. This continued in 1991-01 also during which, 18.41 percent was the growth rate of midland, where as 5.79 and 3.84 percents were the growth of highland and lowland region. During 2001-11, except lowland (8.68%), the other two physiographic divisions recorded negative growth rates. Thus the latest data shows that lowland regions is the zone of preference of population, but the overall growth rate of population for the forty years reveals that both the midland and lowland zones has almost close growth rate i.e., 35.83 and 33.91 percent respectively. So it is clear that the lowlands of the district were preferred by the people since long back. Midland areas also had high population concentration but as per recent census, negative growth rate was reported in this zone but still holds one third of the population of the district. The redrawing of the boundary of the corporation which was fully included in the lowland zone can be a major cause in this reduction along with the general reduced growth rate experienced in the district.

Table 1: Population Concentration in Different Physiographic Division of Thiruvananthapuram District 1971 to 2011

Physiographic divisions	1971			1981			1991			2001			**2011**		
	Persons	Male	Female	Persons	Male	Female	Persons	Male	Female	Persons	Male	Female	Persons	Male	Female
Lowland	54.82	54.66	54.98	55.42	55.27	55.57	54.85	54.78	54.91	51.89	51.87	51.91	55.25	55.29	55.21
Midland	38.58	38.68	38.48	39.21	39.35	39.08	39.94	40.01	39.87	43.09	43.15	43.03	40.05	40.07	40.02
Highland	6.58	6.64	6.52	5.35	5.37	5.34	5.2	5.2	5.2	5.017	4.978	5.05	4.69	4.63	4.75
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 2: Growth Rate of Population in different Physiographic Divisions of Thiruvananthapuram District 1971 to 2011

Physiographic zones	**Growth Rate of Population**				
	1971-81	1981-91	1991-01	2001-11	1971-2011
Lowland	19.36	12.32	3.84	8.68	33.91
Midland	20	15.6	18.41	-5.12	35.83
Highland	-3.94	10.29	5.79	-4.46	6.61
Total	18.07	13.5	9.76	2.07	33.4

5. Changes in the Land Use

Analysis of physiographic division shows that, along the lowland region, settlement with mixed trees dominated and constituted 53.58 percent area during 1966-67 (Table 3). This increased to 59.91 percent areal coverage as per the recent data. Paddy field which was spread in 28.16 percent area was reduced to 7.01 percent as per 2011 data. Built up area increased from 4.87 percent to 25.03 percent area in the forty years time period. Considering the midland region, 14.14 percent area was under paddy during 1966-67 which decreased to 3.84 percent as per 2011 data. Settlement with mixed trees was also reduced from 82.32 percent of 1966-67 to 78.32 percent in 2011 data. While built up land increased from 1.30 percent to 16.86 percent during the study period.

Along the highland region, reduction in area was witnessed in forest land which was reduced from 42.35 percent areal coverage of 1966-67 to 28.85 percent as per the 2011 data. Built up showed an increase from 0.52 percent area of 1966-67 to 5.97 percent in 2011. Scrub land area also increased from 0.36 percent area to 10.81 percent area as per the latest data. Settlement with mixed trees also increased from 49.54 percent to 51.34 percent during the study period

Table 3: Area under Various Land Use Categories Based on Physiographic Zones in Thiruvananthapuram District 1966-67 to 2011

Sl.No.	Land Use Categories	Lowland				Midland				Highland			
		1966-67		2011		1966-67		2011		1966-67		2011	
		Area (sq.km.)	Area (%)	Area (sq.km.)	Area (%)	Area (sq.km.)	Area (%)	Area (sq.km.)	Area (%)	Area (sq.km.)	Area (%)	Area (sq.km.)	Area (%)
1	Settlement with mixed trees	175.71	53.58	196.45	59.91	573.25	82.32	545.40	78.32	576.37	49.54	597.27	51.34
2	Aerodrome	1.48	0.45	3.25	0.99		0.00		0.00		0.00		0.00
3	Built-up land	15.98	4.87	82.07	25.03	9.05	1.30	117.40	16.86	6.00	0.52	69.51	5.97
4	Paddy field	92.34	28.16	22.99	7.01	98.46	14.14	26.75	3.84	37.21	3.20	3.12	0.27
5	Forest	0	0	0	0.00	3.31	0.47	1.34	0.19	492.68	42.35	335.64	28.85
6	Scrub land	0	0	0	0.00		0.00	1.21	0.17	4.23	0.36	125.80	10.81
7	Grassland	0	0	0	0.00		0.00		0.00	5.79	0.50	0.36	0.03
8	Wasteland	0.17	0.05	0.92	0.28	0.31	0.04	1.69	0.24	22.93	1.97	17.67	1.52
9	Sandy area	18.67	5.69	4.54	1.39		0.00		0.00		0.00		0.00
10	Water bodies	23.56	7.18	17.67	5.39	12.02	1.73	2.60	0.37	18.22	1.57	14.16	1.22
	Total	327.90	100	327.90	100.00	696.38	100.00	696.39	100.00	1163.42	100.00	1163.53	100.01

Table 4: Change of Land Use in Various Physiographic Divisions 1966-67 to 2011

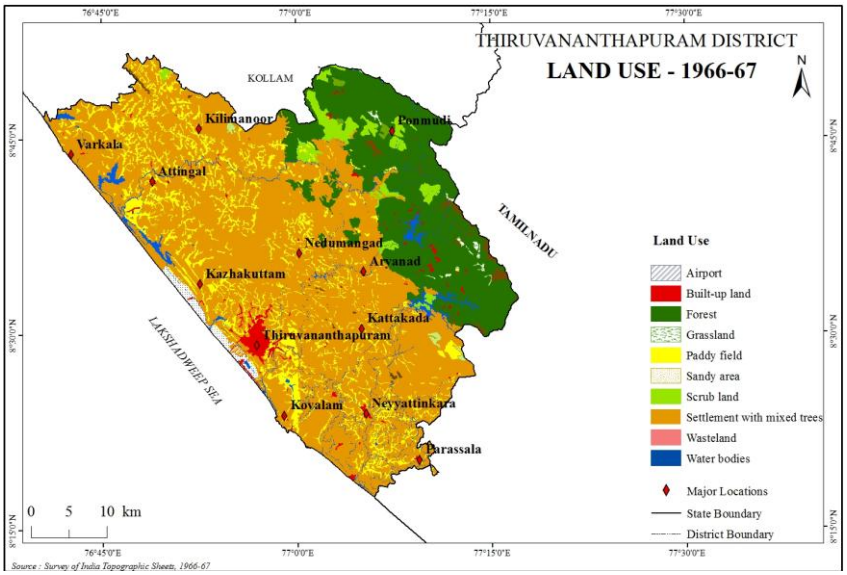
Sl.No.	Land Use Categories	Area (sq.km.)		
		Lowland	Midland	Highland
1	Settlement with mixed trees	20.74	-27.85	19.74
2	Aerodrome	1.77	0.00	-0.23
3	Built-up land	66.10	108.35	63.10
4	Paddy field	-69.35	-71.70	-73.35
5	Forest	0.00	-1.96	-5.00
6	Scrub land	0.00	1.21	-6.00
7	Grassland	0.00	0.00	-7.00
8	Wasteland	0.76	1.38	-7.24
9	Sandy area	-14.13	0.00	-23.13
10	Waterbody	-5.89	-9.42	-15.89

Thus the separate analysis of land use of physiographic divisions was useful in identifying the following characteristics:

- Built up area increased irrespective of physiographic divisions but was high along the midland region. About 108.35 sq.km area was added to built up in midland alone. Lowland and highland showed an addition of 66.10 sq.km and 63.10 sq.km each.
- Settlements with mixed trees showed a general trend of reduction in area. But along the lowland and highland area, this land use showed an increase of 20.74 sq.km and 19.74 sq.km each. This can be due to the fact that along the lowland the areas previously under paddy were widely changed to coconut farm and also for other cultivation. Along the highland areas bordering the forest was converted for either settlements or for plantation purposes.
- Reduction in area under paddy fields was common in all divisions and along the lowland and midland areas, but was slightly more along the midland area with a reduction of 71.70 sq.km was witnessed.
- Area under wasteland increased more along the midland (+1.38 sq.km) and lowland regions (+0.76sq.km) while it area reduced along the highland (-7.24 sq.km). This can be due to the increasing mining activities going on along these regions. Clay mining and stone quarrying are more active towards the midland areas of the district.
- Where as reduction in the area occupied by water bodies was more along the midland areas (-9.42 sq.km). This can be ascribed as the effect of increasing concentration of built up in this zone which forces the reclamation of small water bodies like ponds and tanks for construction purposes.

6. Conclusion

The present study, conducted to analyse the population changes and related land use variations of Thiruvananthapuram district showed that with the increasing population, land use has undergone considerable changes from 1966 to 2011 and conversion between different land use types took place frequently, especially among paddy fields, built up lands, wasteland sand scrub lands. The work unravels the effectiveness of remote sensing and GIS as effective tools for detecting and quantifying long term changes and patterns in population and land use change dynamics.



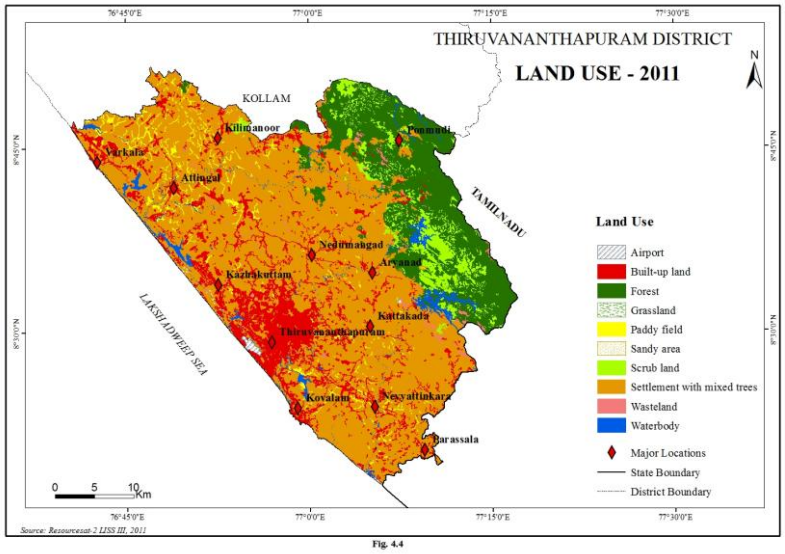


Fig. 4.4

7. Acknowledgements

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