Urbanisation and Dynamic Changes in Land Use Pattern in Tamil Nadu

E. Gayathri[1] and Dr. K. Sita Devi[2]

[1]Ph.D Scholar and [2]Professor,

Department of Agricultural Economics, Faculty of Agriculture, Annamalai University,

Annamalai Nagar -608002 , Tamil Nadu.

*Corresponding E-mail: gayathrielangovan00@gmail.com

Abstract

Urbanization is the outcome of the social, economic and political developments that have led to urban concentration and growth of large cities and changing land use patterns. Due to Urbanisation there occurs change in land use pattern. So, the study focuses on the change or shift in the land use pattern over past 30 years. The data collected was analysed and resulted briefly in the study. Though Tamil Nadu is a rapidly urbanising state in India. The specific objectives of the study is to examine the dynamic changes of land use pattern and measure the instability in different land use categories in the study area. The tools of analysis used in the study was percentage analysis, growth rate, Markov chain analysis and instability index. The results of the study were tabulated and discussed. The dynamics of land use pattern in the study area over the last three decades reveals that there was a significant increase on land put to non-agricultural uses.

Key words - land use pattern, urbanisation, instability, Markov chain analysis.

1. INTRODUCTION

Urbanisation is an increase in the number of people living in towns and cities. Urbanisation occurs mainly because people move from rural areas to urban areas and it results in growth in the size of the urban population and the extent of urban areas. India is a rapidly urbanising country and shares most characteristic features of urbanisation in the developing countries. The level of urbanization in the country as a whole increased from 25.71 per cent in 1991 to 31.16 per cent in 2011 – an increase of 5.45 percentage points during this period. Among the various states in India, Tamil Nadu is the third urbanized state as per 2011 Census, and it has an urban population of 34.9 million, 48.45 per cent of its population living in urban areas *vis-à-vis* the national average of 31.16 per cent.

Urbanization is the outcome of the social, economic and political developments that have led to urban concentration and growth of large cities and changing land use patterns. Land-use change has broad lines of impact, with a potential for influencing economic growth, quality of life, management of environmental resources, and national food supply. A country's socioeconomic priorities at any given time shape the drivers of the land-use change. According to FAO (2000), Land use is the arrangements, activities and inputs that people undertake on a certain land cover type. It is defined as a process, which assigns each tract of land in an area to its proper class in a system of classes in terms of the qualities or characteristics with which the classification is concerned (Wani *et al.,* 2009).

According to 2011 census, Tamil Nadu state has a population of 72,147,030 persons, of this male constituted 50.17 per cent and females constituted 49.83 per cent. The rural population accounted for 51.60 per cent and the urban population accounted for 48.40 per cent. The total geographical area of Tamil Nadu is 1,34,90,530 hectares of which land put to non-agricultural uses is 26,60,505 hectares, i.e., 19.72 per cent of geographical area and the net area sown is 47,38,297 hectares, which is 35.13 per cent of total geographical area. Nearly 28,26,622 hectares is left as fallows which constituted 20.95 per cent of geographical area. Of this, other fallows constituted 19,06,243 hectares 14.13 per cent and current fallows constituted 9,20,379 hectares 6.82 per cent. Forest constitutes 21,56,574 hectares, i.e.,15.99 per cent of total geographical area, Barren and uncultivable land accounted for 4,57,414 hectare 3.39 per cent, while 3,21,968 hectares 2.39 per cent is left as cultivable waste.

2. Objective of the Study

The specific objectives of the study is

1. To analyse the temporal changes in land use pattern over the years in the study area.
2. To measure the instability in different land use categories in the study area.
3. To examine the dynamic changes of land use pattern for three decades of Tamil Nadu.

3. Materials and Methods

Tamil Nadu is purposively selected for this study area, and is one of the rapidly urbanising state in India. The study is based on the secondary data land use pattern of the study i.e., nine fold classification. The data was obtained from Directorate of Economics and Statistics, Government of Tamil Nadu for the period from 1990-91 to 2019-2020, which is combined and analysed as three decades i.e., Decade I (1990-91 to 1999-2000), Decade II (2000-01 to 2009-10) and Decade III (2010-11 to 2019-2020).

3.1 Tools of Analysis

3.1.1 Growth Rate Analysis

The compound growth rates of area under different land use categories were estimated to capture the temporal changes in the land use pattern. Exponential function of following form was used to estimate the growth rates

$$Y_t=Y_o\ (1+r)^t \text{---------- (1)}$$

Where,

Y_t = Area under the land use category at time t (ha)

r = Compound rate of growth of Y

Y_o = Initial year area under the land use category (ha)

By taking natural logarithm of (1),

$$\text{In } Y_t = \text{In } Y_o + t \text{ In } (1+r) \text{ ---------- (2)}$$

Now letting,

$\beta_1 = \text{In } Y_o$

$\beta_2 = \text{In } (1+r)$

Equation (2) can be written as

$$\text{In } Y_t = \beta_1 + \beta_2 t \text{---------- (3)}$$

Adding the disturbance term to (3), it can be written as

In $Y_t = \beta_1 + \beta_2 t + U_i$

Yt = Area under the land use category at time‘t’ (ha)

t = time in years

β_1 = constant term

β_2 = regression co-efficient

This log linear function was fitted by using Ordinary Least Square (OLS) method. The compound growth rate (r) was obtained using the formula.

$$r = (\text{Antilog of } \beta_2 - 1) \times 100$$

3.1.2 Instability Index

To study the variation in the land use pattern, Coppock’s Instability Index (Coppock, 1962) was used, which is algebraically expressed in the following form:

$$V = \frac{1}{N}\left[\log \frac{X_{t+1}}{X_t} - m\right]^2$$

The instability index is = $(\text{Antilog of} \sqrt{V} - 1) \times 100$

Where,

X_t= Area under land use category in time‘t’

n = Number of years

$N = n^{-1}$

$$m = \frac{1}{N}\sum_{t=1}^{n-1} (\log X_{t+1} - \log X_t)$$

3.1.3 Markov Chain Analysis

The dynamic changes in the land use pattern were analyzed using the first order Markov chain approach using LINGO software. Central to Markov chain analysis is the estimation of the transitional probability matrix ‘P’ whose elements, P_{ij} indicate the probability (share) of land use pattern switching from i^{th} category to j^{th} category over time. The diagonal element P_{ij}, where i=j, represents the retention share of respective land use pattern in terms of area. This can be denoted algebraically as

$E_{jt} = \sum_{i=1}^{n}(E_{it} - 1)\, P_{ij} + e_{jt}$

Where,

E_{jt} = Area under land use category to the j^{th}land use category in the year t

E_{it-1} = Area under i^{th}land usecategory during the year t-1

P_{ij}= The probability of shift in area under i^{th} land use category to j^{th} land use category

e_{jt} = The error term which is statistically independent of $E_{i\,t-1}$

n = The number of land use categories

The transitional probabilities P_{ij}, which can be arranged in a (m x n) matrix, have the following properties:

$\sum_{i=1}^{n} P_{ij} = 1$ And $0 \le P_{ij} \le 1$

Thus, the expected share of each land use category during period 't' is obtained by multiplying the share of these land use categories in the previous period (t-1) with the transitional probability matrix.

The transitional probability matrix is estimated using linear programming (LP) framework by a method referred to as minimization of Mean Absolute Deviation (MAD), the formulation is stated as

Min, OP* + I e

Subject to,

X P* + V = Y

GP* = 1

P* ≥ 0

Where,

P* is a vector of the transitional probabilities P_{ij} to be estimated

O is the vector of zeros

I is an appropriately dimensional vector of areas

e is the vector of absolute errors

Y is the proportion of area to each land use category.

X is a block diagonal matrix of lagged values of Y

V is the vector of errors

G is a grouping matrix to add the row elements of P arranged in P* to unity.

4. Result and Discussion

4.1 Average area and changes in land use pattern in the study area

The average area under different land use categories in Tamil Nadu over the periods from 1990-91 to 2019-2020 was worked out separately for three decades and as presented in Table 1.

Table 1. Average Area Under Land Use Categories in Tamil Nadu

(in lakh hectares)

Land use Classification	Decade I (1990-91 to 1999-2000)	Decade II (2000-01 to 2009-10)	Decade III (2010-11 to 2019-2020)
Forests	21.44 (16.48)	21.20 (16.28)	21.41 (16.26)
Barren and uncultivable land	4.94 (3.80)	4.93 (3.79)	4.73 (3.59)
Land put to non agricultural uses	19.08 (14.67)	21.05 (16.17)	23.31 (17.70)
Land under permanent pastures and other grazing land	3.25 (2.50)	3.61 (2.77)	3.25 (2.47)
Cultivable wastes	1.23 (0.95)	1.14 (0.87)	1.08 (0.82)

Miscellaneous tree crops and groves	2.31 (1.78)	2.69 (2.07)	2.37 (1.80)
Current fallows	10.55 (8.11)	10.09 (7.75)	10.71 (8.13)
Other fallows	10.93 (8.41)	15.24 (11.71)	17.67 (13.42)
Net area sown	56.32 (43.30)	50.22 (38.58)	47.16 (35.80)
Total area	130.06 (100)	130.17 (100)	131.70 (100)

(Note: values in the parantheses indicates percentage to total area)

From the above table, it is concluded that the average area under different land use categories were more or less equal in three decades but in Decade III we could see an increase in area under land put to non-agricultural use and fallow lands (23.31 and 28.38 percent) and there is a decline in net area sown (47.76 per cent) when compared to Decade I and Decade II, the total area was around 130 per cent and net area sown was above 55 percent in Decade I and above 50 per cent in Decade II. This may be due to decrease in agricultural practice which leads to agricultural land loss.

4.2 Changes in land use pattern

The changes in different land use categories in Tamil Nadu over the years was calculated with percentage change in area under land use pattern from Decade I to Decade II and III and is given in Table 2. The results revealed that there is a wide fluctuation in the area under land use pattern was seen from decade I to decade III i.e from 1990-91 to 2019-2020 and only slight variation was seen with decade I and II .

Table 2. Changes in Area Under Different Land Use Categories in the Study Area

Land use Classification	Decade I &II	Decade I & III
Forests	-1.14	-0.14
Barren and uncultivable land	-0.29	-4.31
Land put to non agricultural uses	10.31	22.16
Land under Permanent pastures and other grazing land	11.12	0.11
Cultivable waste	-7.86	-12.12
Miscellaneous tree crops and groves	16.50	2.76
Current fallows	-4.43	1.52
Other fallows	39.44	61.60
Net area sown	-10.83	-16.27
Total area	0.08	1.26

4.3 Growth rate of different land use categories

The growth in the area under different categories of land use in Tamil Nadu over a period of 30 years (1990-91 to 2019-2020) and a disaggregated analysis for the three decades was done using the compound growth rate analysis. The results are presented in Table 3.

Table 3. Growth Rates of Land Use Pattern in Study area

Land use Classification	Decade I (1990-91 to 1999-2000)	Decade II (2000-01 to 2009-10)	Decade III (2010-11 to 2019-2020)	Overall Period (1990-91 to 2019-2020)
Forests	-0.07	-0.114	0.24***	0.004
Barren and uncultivable land	-1.04	0.18	-1.08***	-0.24***
Land put to non agricultural uses	0.85	1.07***	3.00***	1.06
Land under Permanent pastures and other grazing land	2.04***	-2.26	-0.32***	-0.07
Cultivable waste	0.16	-1.01***	-0.26***	-0.63
Miscellaneous tree crops and groves	0.54	-1.21**	-1.65	0.02
Current fallows	0.34	-0.85	-1.31	0.84
Other fallows	1.62**	-0.32	2.37	2.35
Net area sown	-0.74**	0.36	-0.52	-0.86
Total area	-0.02	0.03**	0.52***	0.07***

(** and *** indicate significance at 5 per cent and 1 per cent levels respectively)

The results indicated that the growth rate in area under forest increases 1 percent level of significance in Decade III. The barren and uncultivable land is negatively significant in decade III. The land put to non-agricultural uses shows positive growth with increasing 1 per cent level of significance during past two decades. The growth rate of land under permanent pastures and other grazing land is significant but it declined from positive to negative from Decade I to Decade III. The cultivable waste shows a negative growth with 1 percent level of significance. The area under miscellaneous tree crops and groves has shows negatively 5 percent significant and decreasing growth from Decade II. The growth of area under current fallows has a negative trend and other fallows shows significance only in Decade I but then decreasing and increasing rate. Same way, it was seen that the growth rate of net area sown shows a significancy only in Decade I and further it decreases in a negative rate.

4.4 Instability Index of Land Use Pattern

Instability index is a measure of extent of variability or the absence of stability in time series data and hence the instability indices for various land use categories were worked out for the overall period (1990-91 to 2019-2020) and also separately for three decades and the results are presented in Table 4.

Table 4. Instability Index for Land Use Pattern in the study area

Land use Classification	Decade I (1990-91 to 1999-2000)	Decade II (2000-01 to 2009-10)	Decade III (2010-11 to 2019-2020)	Overall period
Forests	37.07	36.99	36.89	37.07
Barren and uncultivable land	38.09	37.76	37.95	38.14
Land put to non-agricultural uses	40.40	38.16	37.75	40.66
Land under Permanent pastures and other grazing land	37.19	39.11	39.57	39.58
Cultivable waste	37.10	38.29	37.22	39.04
Miscellaneous tree crops and groves	38.62	38.50	38.13	39.84
Current fallows	41.90	45.63	41.13	43.03
Other fallows	39.63	41.03	39.38	45.83
Net area sown	39.36	38.56	37.98	40.03

From the Table 4, it could be seen that current fallows shows higher instability in each decade, while considering year to year variations land put to non-agricultural uses shows declining instability and the area under forest cover shows lower instability in each decade and overall period. When comparing with overall period area under other fallows shows higher instable variation.

4.5 Dynamic Changes of Land Use Pattern

Markov chain analysis to study the dynamics of land use pattern in the study area using secondary data on area under different categories of land use over time, by estimating the transitional probability matrices. The probability of retaining the particular land use category and shifting pattern was interpreted by studying the diagonal and off diagonal elements of transitional matrix. The transitional probability matrix for dynamic changes in the land use pattern of Tamil Nadu was estimated using the data on land use pattern from 1990-91 to 2019-2020. The results of Markov chain model is represented in Table 5.

It could be seen from the table that the diagonal elements represent the probability of retention of existing area under land use pattern. The probability retention of existing area under forest was estimated 72.93 per cent in Decade I, 75.23 per cent in Decade II and 91.74 per cent in Decade III. The probability of shift occurs in area under other fallows 17.05 per cent, 9.15 percent in current fallows and 0.87 per cent in land put to agricultural uses in Decade I. In Decade II, the probability of shift in area was estimated 18.89 percent of net area sown and 5.88 percent of miscellaneous crops. In Decade III, the probability of shift in area was estimated only 5.23 percent and 3.04 percent in current and other fallows. However, it gained from land use pattern 4.49 percent in Decade II, and in each it gained from current fallows (7.23 per cent,6.72 per cent, 1.94 per cent), other fallows (9.82 per cent, 4.65 percent, 2.91 per cent) and net sown area (7.01 per cent, 5.74 per cent and 2.22 per cent). Similarly the probability retention of barren and uncultivable land was 43.82 per cent, 60.77 per cent and 0 per cent in each decades. The probability of retention in area under land put to non agricultural uses (95.99 per cent, 91.50 per cent and 97.38 per cent), permanent pastures and other grazing land (42.65, 37.58 and 0 per cent), cultivable wastes (17.94 per cent and 0

percent), miscellaneous tree crops and groves (52.94, 0 and 52.07 per cent), current fallows (22.48 per cent, 30.23 per cent, 47.77 per cent), other fallows (40.26, 43.01 and 94.08 per cent), net area sown (79.62, 76.92, 76.78 per cent) were estimated in three decades.

The results of Markov chain analysis indicated that land put to non-agricultural uses was found to be more stable and the major category it gained from cultivable waste. The area under land put to non-agricultural uses could retain as high as more than 90 per cent in each decades and it gained majorly above 39 per cent from cultivable waste. This could be due to development of infrastructures to make a move in rural areas to urban areas.

Table 5. Dynamic Changes of Land Use Pattern for Three Decades

Land Use Categories	Time	Forests	Barren and uncultivable land	Land put to non agricultural uses	Permanent pastures and other grazing land	Cultivable waste	Miscellaneous tree crops and groves	Current fallows	Other fallows	Net area sown
Forests	Decade I	**0.7293**	0.0000	0.0087	0.0000	0.0000	0.0000	0.0915	0.1705	0.0000
	Decade II	**0.7523**	0.0000	0.0000	0.0000	0.0000	0.0588	0.0000	0.0000	0.1889
	Decade III	**0.9174**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0523	0.0304	0.0000
Barren and uncultivable land	Decade I	0.0000	**0.4382**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5618
	Decade II	0.0000	**0.6077**	0.3347	0.0000	0.0000	0.0000	0.0000	0.0576	0.0000
	Decade III	0.0000	**0.0000**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
Land put to non agricultural uses	Decade I	0.0000	0.0000	**0.9599**	0.0368	0.0000	0.0000	0.0000	0.0033	0.0000
	Decade II	0.0449	0.0401	**0.9150**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Decade III	0.0000	0.0000	**0.9738**	0.0119	0.0040	0.0000	0.0103	0.0000	0.0000
Permanent pastures and other grazing land	Decade I	0.0000	0.0000	0.0000	**0.4265**	0.0000	0.0000	0.0000	0.5735	0.0000
	Decade II	0.0000	0.0427	0.0000	**0.3758**	0.0525	0.2605	0.0000	0.2685	0.0000
	Decade III	0.0000	0.0000	0.0000	**0.0000**	0.0000	0.0000	0.0000	0.0000	1.0000
Cultivable waste	Decade I	0.0000	0.0000	0.3899	0.0000	**0.1794**	0.0000	0.0000	0.4307	0.0000
	Decade II	0.0000	0.0000	0.0000	1.0000	**0.0000**	0.0000	0.0000	0.0000	0.0000
	Decade III	0.0000	0.0000	0.0000	0.7277	**0.0000**	0.0000	0.0000	0.0000	0.2723
Miscellaneous tree crops and groves	Decade I	0.0000	0.0000	0.0000	0.0000	0.0000	**0.5294**	0.4706	0.0000	0.0000
	Decade II	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**	0.0000	1.0000	0.0000
	Decade III	0.0000	0.4793	0.0000	0.0000	0.0000	**0.5207**	0.0000	0.0000	0.0000

Current fallows	Decade I	0.0723	0.0699	0.0136	0.0376	0.0148	0.0000	**0.2248**	0.0410	0.5259
	Decade II	0.0672	0.0553	0.0239	0.0113	0.0120	0.0153	**0.3023**	0.5126	0.0000
	Decade III	0.0194	0.0840	0.0196	0.0454	0.0185	0.0000	**0.4777**	0.0466	0.2888
Other fallows	Decade I	0.0982	0.0094	0.0097	0.0697	0.0239	0.0594	0.0000	**0.4026**	0.3271
	Decade II	0.0465	0.0248	0.0000	0.0000	0.0000	0.0000	0.0000	**0.4301**	0.4986
	Decade III	0.0291	0.0000	0.0260	0.0000	0.0041	0.0000	0.0000	**0.9408**	0.0000
Net area sown	Decade I	0.0701	0.0336	0.0000	0.0000	0.0105	0.0076	0.0819	0.0000	**0.7962**
	Decade II	0.0574	0.0000	0.0000	0.0210	0.0162	0.0070	0.1291	0.0000	**0.7692**
	Decade III	0.0222	0.0571	0.0000	0.0360	0.0153	0.0231	0.0786	0.0000	**0.7678**
Steady State Probability	Decade I	**0.1599**	**0.0360**	**0.1697**	**0.0259**	**0.0092**	**0.0174**	**0.0743**	**0.0832**	**0.4245**
	Decade II	**0.1615**	**0.0378**	**0.1689**	**0.2804**	**0.0086**	**0.2059**	**0.0714**	**0.1174**	**0.3858**
	Decade III	**0.1605**	**0.0343**	**0.1928**	**0.0241**	**0.0081**	**0.1694**	**0.0727**	**0.1396**	**0.3511**

The estimated steady state probability in Decade III reveals that if this land use pattern continues, in the future around more than 35 per cent in net area sown,19.28 per cent land put to non-agricultural uses, 16.94 per cent in miscellaneous crops,16.05 per cent in forest, 13.96 in other fallows,7.27 per cent in current fallows, 3.43 per cent in barren and uncultivable land, 2.41 per cent in cultivable waste and 0.81 per cent in permanent pastures and grazing land.

5. Conclusion

Urbanisation effects in the agricultural land loss as the effect of change in the area under land use pattern over the years resulted wide variation from 1990-91 to 2019-2020. The dynamics of land use pattern in the study area over the last three decades reveals that there was a significant increase on land put to non-agricultural uses. The results of Markov chain analysis indicated that land put to non-agricultural uses was found to be more stable and the major category it gained from cultivable waste. The area under land put to non-agricultural uses could retain as high as more than 90 per cent in each decades and it gained majorly above 39 per cent from cultivable waste. This could be due to development of infrastructures to make a move in rural areas to urban areas This was due to decrease in net area sown, forest cover area and increasing fallow lands. This agricultural land loss was mainly occurred due to urbanisation as rural – urban migration make a survive in urban area in expectation of well settled life infrastructure.

References:

1. N.Amirthalingam, K. Sita Devi, C.Prabakar and T.Ponnarasi. **An Economic Analysis of The Temporal Changes In Land Use Pattern In Tamil Nadu**
   Adalya journal,Volume 9, Issue 11 (2020).
2. FAO, **Land Cover Classification System (LCCS): Classification Concepts and User manual**
   Retrieved 1-July-2003, from the world wide web:(2000). http://www/fao/org./DOCREP/003/X0596e00,htm#p-10
3. R. Paramasivam, M. Umanath, V. Kavitha, A. Kuzhandhaivel Pillai and R. Vasanthi**Dynamics of Land Use Pattern and Cropping Pattern in Cuddalore district of Tamil Nadu.**
   Asian Journal of Agricultural Extension, Economics and Sociology, 19(3) (2017) 1-10.
4. I.Rosalin Geetha, A.Vijayavathi and S. Padma Rani, **Dynamics of Land Use Pattern in Madurai District of Tamil Nadu with Common Property Land Resources**
   Current Journal of Applied Sciences and Technology, 39(20) (2020) 30-40.
5. M. H. Wani, Baba, S.H., and Shahid, Yousuf, **Land Use Dynamics in Jammu and Kashmir**
   Agric. Econ. Res. Rev., 22(1) (2009) 145-154.