Dynamics of Land Use Pattern in Madurai District of Tamil Nadu in Nexus With Common Property Land Resources

ABSTRACT

This paper explores the dynamics of land use in Madurai district as it possesses the largest other fallow lands (48.28 per cent). Time series data on nine-fold classification for the study district of Tamil Nadu was collected from *Season and Crop Reports of Tamil Nadu* published by Government of Tamil Nadu. The collected data from 1997-98 to 2017-18 were analysed using Compound Growth Rate and Cuddy Della Instability Index. Retention probability of land use pattern and forecasting was done using Markov Chain Analysis. The results from past two decadal analysis revealed an increasing trend of Common Property Land Resources (CPLRs) from 25.75 per cent to 48.28 per cent was observed. Among various categories of CPLRs other fallow lands (4.54 per cent per annum) and culturable wasteland (6.77 per cent per annum) have shown significant positive growth rate and whereas net sown area showed negative growth rate (-2.24 per cent per annum). The instability index was the highest in Current fallow lands (73.51). The predicted land use changes have also reflected the threatening scenario of increasing nature of current fallows and other fallow lands and declining nature of net sown area for the next decade. Hence, policy should be focused to stabilize the agricultural lands and to manage the increasing CPLRs for their sustainability besides supporting the beneficiary's livelihood.

Keywords: Land Use Pattern, CPLR, Instability, probability

1. INTRODUCTION

Land serves as crucial natural resource for many developmental activities. Consequently, access to land and control over its uses becomes the prime sources of conflict within and between communities throughout human history. Like any other resource, land has two dimensions, viz., quality and quantity, and crucial aspects are under serious threat due to intensive and extensive use of land for both agricultural and non-agricultural purposes [1]. A significant proportion of such resource is used in common by people who have common user rights (not necessarily ownership rights) is known as Common Property Resources [2]. This includes forests, village lands, grazing lands, streams, rivers, groundwater as well as man-made resources like irrigation tanks, community wells and village roads [3]. In India, out of 330 million ha of total land area, only around 140–147 million ha are being cultivated. The remaining 190 million ha exist in various forms of common properties that support occupations such as forestry and livestock rearing and provide daily requirements like food, fuel, fodder and medicines to pro-poor and poor rural households. Inadequate rural employment opportunities, especially in the slack season, mean that the local commons can make substantial contributions to household incomes. Local CPLRs also act as insurance against uncertainty in the absence of complete contingent markets. Access to such resources which ameliorate risks associated with natural CPRs may be the only available non-human asset. However, the existence of imperfect markets results in an intimate link between the rural economy and its natural resource base [4]. According to one estimate, the CPR land area of the country is 21.55 per cent of the total geographical area [5] and estimates range from 9 to 28per cent in different districts, based on a village level survey [6].

Moreover, according to another estimate, 14.81–15 per cent of the total geographical area is non-forest CPRs in 16 major states [7]. [8] studied the status of CPLRs in southern districts of Tamil Nadu and documented the upsurge in the availability of CPLRs in six districts, such as Madurai, Pudukkottai, Tirunelveli, Sivagangai, Virudhunagar and Tuticorin. On the contrary Ramanathapuram and Karur districts faced a decline in the availability of CPLRs from 19.05 per cent to 50.39 per cent in 1998-99 to 13.17 per cent to 46.89 per cent in 2014-15 respectively. In view of above, the present study was carried out in Madurai district to analyse the status and stability analysis of land use pattern in general Common Property Resources (CPLRs) in particular there by to forecast their sustainability.

2. METHODOLOGY

2.1 STUDY AREA

The total geographical area of Madurai district is 3,74,173 hectares. About 104827 hectares (28 percent) is under other fallow lands whereas the land under net sown area is 102640 hectares accounting for 27.43 per cent during 2017-18. Thus, Madurai district is purposively chosen due to the dominance of other fallow lands, diminishing net sown area, increasing trend of Common Property Land Resources (48.48 per cent in 2017-18) and the socio-economic characteristics of the localist favours the need for this study. Some of the indicators of Madurai district are shown in Table 1.

Comment [SG1]: What is the actual area, 3,741.73 ha or 3.74173ha? Clarify.

Table 1. Socio Economic Indicators of Madurai District

Particulars	**2001**	**2011**
Demography (numbers)		
Population	2578201	3038252
Urban population	1444176	1846801
Cultivators	129240	92719
Agrl.Labourers	228083	372828
Others	295478	841792
Livestock (numbers)		
Sheep	216416	184433
Goat	238588	297052
Total Livestock	698674	703500
Gross District Domestic Product (Rs. In Lakhs)		
Primary Sector	74841	84771
Tertiary Sector	704759	1268355
Rainfall and temperature		
Precipitation(mm)	961.6	875
Maximum Temperature (ºC)	41º C	
Minimum Temperature (ºC)	25º C	

Source: District profile, office of Deputy Director of Statistics, Madurai (2001 and 2011).[9]

2.2 Method of data collection

The present study is based on an analysis of secondary data on land use pattern in Madurai district. The time-series data on nine-fold classification for the study district of Tamil Nadu was collected for the period from 1997-98 to 2017-18 from *Season and Crop Reports of Tamil Nadu* published by Government of Tamil Nadu [10]. To assess the growth rate and stability, following methodology were adopted in this study.

2.2.1 Tabular Analysis

It is used for the presentation of some of the analysed data such as changes in land use classification of the study district. Appropriate per centage was worked out and presented in the form of tables. (Table.2)

2.2.2 Compound Growth Rate Analysis

Compound growth rates of various land use categories were worked out based on log-linear regression equations.

$$Y = ab^t e_t$$

Where,

Y: Dependent variable for which growth rate was estimated

a: Intercept

b: Regression coefficient

t: Years which takes values, 1, 2…, n

e_t: Disturbance term for the year t

The compound growth rate (g) in per centage was then computed from the relationship,

g = (Antilog of b -1) *100

2.2.3 Cuddy Della Instability Index (CDII)

Instability index is a simple analytical technique to find out the fluctuations or instability in any time-series data. It is estimated as follows:

(i) Estimate the parameters of a log-linear trend line for the variable (Yt) for which instability is to be estimated.

(ii) If the estimated parameter is statistically significant, then the instability index

(I) is defined as

$$I = CV \times \sqrt{1 - R^2}$$

where CV= coefficient of variation for the time-series calculated as

CV = (S.D/Mean) ×100, where, S.D. = standard deviation

(iii) If the estimated parameter in the regression equation in step (a) is not significant, then the CV itself is the instability index.

2.2.4 Markov chain analysis

The Markov chain analysis with steady-state transitional probability will be used to study the shifts in the land use classification [11,12]. Markov chain analysis involves developing a transitional probability matrix 'P', whose elements, P_{ij} indicate the probability of district land use classification switching from one classification 'i' to another 'j' over time. The diagonal element P_{ij} where i=j, measures the retention probability of respective land use classification.

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

Where,

E_{it} = Shift in land use of the district to the j^{th} classification in the year t

E_{it-1} = Shift in land use of the district from i^{th} classification in the year t-1

P_{ij} = the probability that district land use will shift from i^{th} classification to j^{th} classification

e_{jt} = the error term which is statistically independent of E_{it-1}
N = the number of land use classification

3. RESULTS AND DISCUSSIONS

3.1 Common Property Land Resources

Common Property Land Resources (CPLRs) are the resources accessible to the whole community of a village and to which no individual has exclusive property rights. CPLRs include forest lands, barren and uncultivable lands, cultivable waste land, permanent pastures and grazing lands and other fallow lands. It forms the main thrust of the rural households who depend on the CPLRs to meet household need and ensuring the welfare of the family. This involves collection fodder for their livestock, fire wood collection, tamper for marketing and self -use, collection of raw materials for rural artisans and collection of traditional medicinal plants for curing minor diseases, harvesting crops and collection of forest product.

Comment [SG2]: Collection of Fodder.

3.1.1 Extent of changes in Common Property Land Resources during last three decade

The recent two decadal changes in the various categories of land is presented in Table 2. It could be inferred from the table that there had been a marginal decrease in the forest land from 13.48 per cent in 1997 to 12.95 per cent in 2017-18. Among the several categories of Common Property Land Resources, other fallow lands have shown an increasing trend from 6.71 per cent to 28.02 per cent during the last two decades. Reversely, the net sown area has declined from 43.50 per cent to 27.43 per cent. However, the total CPLRs had increased over the years from 25.75 per cent (1997-98) to 48.28 per cent (2017-18). Madurai being in the dry region experiencing erratic distribution of rainfall, abnormal weather conditions and lack of availability of seasonal irrigation water led to the reduction of net sown area and led to increase in fallow lands, land put to non-agricultural waste and culturable waste. This is also due to the labour scarcity for agricultural works which in turn leads to the transformation of agricultural to non-agricultural sector. The abundance of sheep population particularly in dry areas was mainly due to making use of agricultural fallow lands followed by abandoning of agricultural activities (Table 1). Hence a strong policy should be framed by the government to better governance by government and community for the better use of increasing CPLRs in a sustainable way on one hand and improving the quality of CPLR on the other, thereby to support the stakeholders such as landless labourers, agricultural labourers who depend on cattle rearing, non-agricultural labours and rural artisans dependent on CPLRs for their livelihood.

Table 2. Extent of changes in various types of CPLRs during last three decades.

(Numbers)

Year CPLRs	1997	2007	2017
Forest	50452 (13.48)	48473 (12.95)	48473 (12.95)
Barren and Uncultivable lands	15783 (4.22)	13160 (3.52)	13064 (3.49)

Cultivable Waste	4824 (1.29)	6498 (1.74)	14057 (3.76)
Permanent Pastures and other Grazing Land	185 (0.05)	233 (0.06)	233 (0.06)
Other Fallow Lands	25117 (6.71)	65167 (17.42)	104827 (28.02)
Total CPLRs	96361 (25.75)	133531 (35.69)	180654 (48.28)
Others			
Land Put to non-agricultural uses	62583 (16.72)	75211 (20.10)	75597 (20.20)
Land under Miscellaneous Tree crops and Grove	1361 (0.36)	3033 (0.81)	2514 (0.67)
Current Fallows	50792 (13.57)	20573 (5.50)	12768 (3.41)
Net sown area	162776 (43.50)	141825 (37.90)	102640 (27.43)
Subtotal (Others)	277512 (74.17)	240642 (64.31)	193519 (51.72)
Total Geographical Area	374173 (100.00)	374173 (100.00)	374173 (100.00)

(Values in the parentheses indicate the per centage to the respective total)
(Source: Season and Crop Report (1997-98 to 2017-18), Directorate of Economics and Statistics).[10]

3.2 Per Capita Availability of CPLRs in the study district

Per Capita Availability of CPLRs for the two census periods is presented in table 3. Though the trend in CPLRs had increased over the years, per capita availability has reduced from 0.06 to 0.05 hectare when comparing the recent two census periods. This is probably due to increasing population (table 1.) and pressure on land especially on CPLRs which are more prone to privatization and encroachment.

Table 3. Percapita Availability of CPLRs and PPLRs in the study district.

Year	2001	2011
Population (numbers)	25,78,201	30,41,038
Total CPLRs (hectares)	152871	153756
Percapita Availability	0.060	0.050

(Source:1. Population details collected from Records of office of the Registrar General and Census Commissioner of India, 2001 and 2011 [13]
2. data on CPLRs collected from Season and Crop Report and Census report (2001 and 2011), Directorate of Economics and Statistics) [10]

3.3 Compound Growth Rate of Different Land use categories of Madurai District

Growth rates were worked out for land use pattern to get a detailed picture of the dynamics of land use classification in the study district. Decade-wise Compound Growth Rate analysis for the period 1997-1998 to 2017-18 was done. The results indicated that land put to non-

agricultural uses was recorded positive growth rate and is significant. This may be due to the rising urbanization and industrialization lead to an increase in area. (Table 1). The growth in Culturable wastelands during the past two decades was shown a sharp positive trend and it was very severe in the recent decade (9.31 per cent) than the previous one (3.42 per cent per annum). The latest decadal area of culturable wastes had increased more than 50 per cent over the past decade. It shows that no efforts have been taken to bring that cultivable lands into agricultural uses. Land under miscellaneous trees and grooves had shown the highest positive trend during the previous decade (17.81 per cent). But this trend however become a negative growth rate of 1.72 per cent per annum during 2007-17. Net sown area had shown a negative trend and it greatly reduced during recent decades to the extent of 4.34 per cent per annum. It is also clear from the table 2. that the net sown area had drastically reduced from 43.50 to 27.43 per cent. On the contrary, other fallow lands had shown a sharp increasing trend of 4.22 per cent per annum. Finally, it could be concluded that the area under CPLRs in the study district had shown an increasing trend. Secondly the decrease in net sown area and increase in the culturable wastelands and non-agricultural land indicated that population indulging in agricultural activities was declining. (Table 1). This poses a major challenge to the government to stabilize the agricultural lands and to manage the increasing CPLRs for their sustainability and to support the beneficiary's livelihood.

Table 4. Compound Growth Rate (Percentage per annum) of Land use categories of Madurai District

Particulars	1997-98 to 2006-07	2007-08 to 2017-18	1997-98 to 2017-18
Forest	-0.58** (-4.62)	-	-0.23** (-5.49)
Barren and Uncultivable Land	-11.38 (-1.51)	-0.03 (-1.19)	0.71** (-3.84)
Land put to non-agricultural uses	1.89** (7.94)	0.05** (12.69)	0.89** (7.72)
Cultivable Waste	3.42** (5.25)	9.31** (3.44)	6.77** (8.67)
Permanent Pastures and other Grazing Land	1.35 (1.95)	-	0.34 (2.04)
Land under Miscellaneous Tree crops and Groves	17.81** (7.04)	-1.72** (-7.58)	2.86* (2.31)
Current Fallows	-23.71* (-3.30)	1.81 (0.25)	-1.75 (-0.55)
Other Fallow Lands	15.09* (2.80)	4.22** (8.29)	4.54** (3.36)
Net Area sown	-1.62 (-1.05)	-4.34** (-3.37)	-2.24** -4.36

Values in the parenthesis represent the t-value
** and ** indicate significance of growth rates at 5 and 1 per cent respectively.*

3.4 Instability Index of land use pattern in Madurai district

Instability index is a measure of the extent of variability or the absence of stability in time-series data. Thus, the instability index for the land use categories was worked out and are represented in table 5. It could be observed from the table that the highest instability index for the period 1997-2017 was recorded for current fallow. The highest instability in the current fallow showed high year to year fluctuations due to variations in rainfall as most of the agricultural lands were under rainfed conditions (table 1). It is followed by cultivable

wastelands which showed more fluctuation and instability was increasing over the decades. However, the forestlands have stabilized their area during the recent decade.

Table 5. Instability Index for land use pattern in Madurai district

Particulars	1997-98 to 2006-07	2007-08 to 2017-18	1997-98 to 2017-18
Forest	2.06	0.00	1.87
Barren and Uncultivable Land	9.00	0.30	7.17
Land put to non-agricultural uses	5.99	0.17	6.12
Cultivable Waste	11.98	31.37	46.69
Permanent Pastures and other Grazing Land	6.53	0.00	4.52
Land under Miscellaneous Tree crops and Groves	50.34	6.20	33.14
Current Fallows	81.85	68.12	73.51
Other Fallow Lands	46.46	14.44	31.75
Net Area sown	13.74	18.88	18.70

3.5 Markov Chain Analysis

The Markov chain analysis was performed using the software lingo 18.0. The results from table 6 indicated that the forest cover and permanent pastures and other grazing lands had shown the highest stability (100 per cent) which is followed by net sown area (92 per cent), miscellaneous trees and groves (83 per cent), land under non-agricultural uses (74 per cent) cultivable wastelands (71 per cent), other fallow lands (66 per cent) and barren and uncultivable lands (26.10 per cent). Current fallows have shown poor retention capacity of about 2.2 per cent.

Table 6. Transitional Probability matrix for Land Use Categories in Madurai District during 2007-2017

	FOR	BUL	NAU	CW	PPGL	MTG	CF	OF	NAS
FOR	**1.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BUL	0.000	**0.261**	0.739	0.000	0.000	0.000	0.000	0.000	0.000
NAU	0.000	0.091	**0.740**	0.035	0.000	0.000	0.000	0.134	0.000
CW	0.000	0.000	0.041	**0.710**	0.000	0.000	0.000	0.249	0.000
PPGL	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000
MTG	0.000	0.054	0.000	0.000	0.000	**0.083**	0.551	0.312	0.000
CF	0.000	0.015	0.042	0.003	0.000	0.015	**0.022**	0.766	0.136
OF	0.000	0.013	0.045	0.000	0.000	0.007	0.275	**0.660**	0.000
NAS	0.000	0.010	0.042	0.013	0.000	0.014	0.000	0.000	**0.920**

*(**FOR**: Forest, **BUL**: Barren and Uncultivable Land, **NAU**: Land put to non-agricultural uses, **CW**: Cultivable Waste, **PPGL**: Permanent Pastures and other Grazing Land, **MTG:** Land*

under Miscellaneous Tree crops and Groves not included in Net Area Sown, ***CF:*** *Current Fallows,* ***OF****: Other Fallow Lands,* ***NAS****: Net Area sown).*

3.5.1 Projection of land use changes

The forecasting of land use was done based on the transitional probability matrix shown in table 7. The predicted results showed an alarming nature of gradual reduction in net sown area and an increasing trend would be observed in current fallows and other fallow lands for the next decade. The another threatful trend is the increasing nature of barren and uncultivable lands while the other categories seem to have a stagnation in their growth.

Comment [SG3]: Another threatful.... Delete 'The'

Table 7. A projected change in land use pattern.

(Hectares)

YEAR	FOR	BUL	NAU	CW	PPGL	MTG	CF	OF	NAS
2020-21	48473	13140	75882	13629	233	2614	30763	106113	83325
2024-25	48473	13192	76074	13312	233	2572	32336	111172	76810
2029-30	48473	13256	76338	12930	233	2527	33982	116427	70009

*(****FOR****: Forest,* ***BUL****: Barren and Uncultivable Land,* ***NAU****: Land put to non-agricultural uses,* ***CW****: Cultivable Waste,* ***PPGL****: Permanent Pastures and other Grazing Land,* ***MTG:*** *Land under Miscellaneous Tree crops and Groves not included in Net Area Sown,* ***CF:*** *Current Fallows,* ***OF****: Other Fallow Lands,* ***NAS****: Net Area sown)*

CONCLUSION

The dynamics of land use pattern in Madurai district over the last two decades reveals that there was a significant decline in the forest and barren and uncultivable lands while the other fallow lands have showed an increasing trend from 6.71 per cent to 28.02 per cent during past twenty years. Contradictorily, the net sown area has sharply declined from 43.50 per cent to 27.43 per cent. First and foremost, this is probably due to the erratic distribution of rainfall, abnormal weather conditions and lack of availability of seasonal irrigation water leading to the reduction of net sown area and increasing trend of other fallow lands, land put to non-agricultural waste and culturable waste. Secondly, it might be due to labour scarcity for the agricultural sector. The abundance of sheep and goat population particularly in dry areas was mainly due to making use of fallow lands followed by abandoning of agricultural activities. Though the trend in CPLRs had increased over the years, Per Capita availability has reduced from 0.06 to 0.05 hectares which is probably due to the increasing population and pressure on land. Results on CGR estimation reveals that there is a decrease in net sown area and a sharp increase in the culturable wastelands followed by other fallows and non-agricultural land. It may be due that people indulging in agricultural activities were declining. Another reason could be the availability of scarce resources like labour which is concentrated much on irrigated lands thus neglecting the rainfed areas [14]. This pose a major challenge to the government to stabilize the agricultural lands in the rainfed areas and to manage the increasing CPLRs for their sustainability. The instability index for the study district was seen highest in the current fallow lands which might be due to the variations in rainfall since most of the agricultural lands were under rainfed conditions. The Markov chain analysis have also supported the above findings that the current fallows had shown a poor retention capacity of 2.2 per cent. The predicted land use changes have also reflected the threatening scenario of increasing nature of current fallows and other fallow lands and

declining nature of net sown area for the next decade. Thus, a strong policy should be framed to strengthen the agricultural sector by increasing the net sown area and by bringing the vast cultivable wastelands in to cultivation. Another challenging task is to frame better-decentralized governance for improving the quality and efficiency of CPLRs thereby facilitating the stakeholders such as landless labourers, cattle rearers, non-agricultural labours and the rural artisans who depend much on CPLRs for their livelihood.

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ABBREVIATIONS

CPLRs: Common Property Land Resources; CV: Coefficient of Variation.