

Research Paper

Ecological Implications of Land Use Dynamics in Kerala

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ABSTRACT

Land is the predominant limited resource required for the development of agricultural sector. The philosophy and methods of land use in Kerala have changed over the past half century. The present research attempt to analyse the ecological implications of land use dynamics in Kerala. Intra and inter-sectoral budgeting of the nine land use classes were done for the period from 1985 to 2019. The intra-sectoral budgeting indicated that within the ecological sector, the major land use shifts occurred from barren and uncultivable land to other sub-sectors. The inter-sectoral budgeting analysis showed that with an exception in period IV, the area under the non-agricultural sector exhibited a substantial increase in Kerala in the remaining periods as well as overall period.

HIGHLIGHTS

- ① The land shifts in Kerala have taken place from ecological sector and agricultural sector to non-agricultural sector.
- ① There is a consistent increase of land put to non-agricultural uses in Kerala.
- ① The substantial land shifts from undesirable ecological sector is conducive for both desirable ecology as well as agricultural sector of the state.

Keywords: Budgeting, inter-sectoral, land shifts, structural break, urbanisation

Indian agriculture is a harbinger for economic development and poverty alleviation. The agriculture sector in our country has gone through several stages of development over time, encompassing a wide range of institutional initiatives, activities as well as policy and technology regimes (Parappurathu and Chand, 2012). Land, one of the prime natural resources is the basic input for agriculture. Land use is “the overall arrangements, activities and inputs that people undertake in a specific land cover type” (Gregorio and Jansen, 1998). According to Pushpam (2009), land use is a paramount indicator for describing any ecosystem, and the use, protection and management of land resources are essential for developing agricultural economy of any region. Due to the burgeoning population and plethora of human needs, the evaluation of physical land resources and their utilization patterns have become increasingly important in all type of economies, over and above

that, land use dynamics is a composite phenomenon which is influenced by a variety of socio-economic, agro-climatic and ecological aspects (Ramasamy *et al.* 2005; Premakumar and Vinothkhanna, 2015). Decisions on land use considerably impact biodiversity, supply of agricultural commodities, ecosystem services and societal welfare (Claassen and Tegene, 1999; Jose and Padmanabhan, 2015). The intensive and extensive use of land has resulted in its deterioration of quality and quantity dimensions. Kerala, a tropical state in South India is renowned for its dynamic history of land use change. These changes reveal a complex pattern, especially given the wide range of physical events and complexities of land use planning. Rejula and

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Sigh (2014) remarked that changes in land use pattern in Kerala represent a severe danger to food security as well as environmental sustainability. The trend of land use shifts from agricultural to non-agricultural sector has been escalating day after day in Kerala. In this backdrop, the present study has been undertaken with the objective to assess the ecological significance of land use dynamics in Kerala by budgeting the intra-sectoral and inter-sectoral shifts among different land use classes and sectors.

METHODOLOGY

The analysis of the present study is exclusively based on secondary data. The time series data on area under various land use classes as well as GSVA from agriculture at constant prices were obtained from Statistics for Planning, Agricultural Statistics at a Glance published by the Government of Kerala for the period 1985-2019. The entire study period of 35 years was subdivided into six sub-periods. The sub-periods were obtained by doing structural break analysis (Bai and Perron, 1998) of the GSVA agriculture data in R studio software. The analysis resulted in obtaining 5 break points, therefore, the six phases obtained for the study are Period I (1985-89), Period II (1990-94), Period III (1995-2003), Period IV (2004-2009), Period V (2010-2014) and Period VI (2015-19).

Assessment of shifts in land use classes

The land use shifts in the state were analysed with the help of a simple identity of linearly additive land use changes, with the assumption that, land area of the state being constant, land use changes can occur only through inter-class transfers. The analysis was done based on the methodology propounded by Pandey and Tiwari in 1987 and utilized by (Wani *et al.*, 2009; Gairhe, 2011; Pandey and Ranganathan, 2018; Amale and Shiyani, 2019)

$$R = F_r + P + M + N + U + W + F_c + F_o + C \quad \dots(i)$$

Where, R = Total reporting area (hectares)

F_r = Area under forest (hectares)

P = Area under permanent pastures (hectares)

M = Area under miscellaneous tree crops (hectares)

N = Area under non-agricultural uses (hectares)

U = Barren and uncultivable land (hectares)

W = Cultivable wastes (hectares)

F_c = Current fallow (hectares)

F_o = Fallows other than current fallow (hectares)

C = Net area sown (hectares)

Differentiating R with respect to time, we get the equation (i) as

$$\Delta R = \Delta F_r + \Delta P + \Delta M + \Delta N + \Delta U + \Delta W + \Delta F_c + \Delta F_o + \Delta C \quad \dots(ii)$$

The equation (ii) is rearranged as:

$$\Delta R = \Delta E + \Delta N + \Delta A$$

Where, ΔE is the net change in the ecological sector, ΔN is the net change in the non-agricultural sector and ΔA is the net change in agricultural sector.

$$\text{Here } \Delta E = \Delta F_r + \Delta P + \Delta M + \Delta U$$

$$\Delta N = N_a$$

$$\Delta A = \Delta W + \Delta F_c + \Delta F_o + \Delta C$$

Within the ecological sector, land use shifts can occur like a shift from miscellaneous tree crops (M), permanent pastures (P) to forests (F_r). Shift from forests (F_r) to permanent pastures (P) and from barren land (U) to forest (F_r). The possible shift from M and P to F_r may not have adverse ecological effects, while a shift from F_r to P can cause the same. Similarly, a shift from F_r and M to U can result in adverse ecological effects, whereas a shift from U to F is highly desirable. Thus, in this context, the ecological sector (E) was again divided into two sub-sectors *viz.*, (i) desirable ecology (E_1), which includes F_r , P and M. (ii) undesirable ecology (E_2) consisting of only barren land (U). The net changes within the ecological sector can be budgeted as—

$$\Delta E = \Delta E_1 + \Delta E_2 = (\Delta F_r + \Delta P + \Delta M) + (\Delta U) \quad \dots (iii)$$

The net changes in agricultural sector is budgeted as the following,

$$A = \Delta F_c + \Delta F_o + \Delta W + \Delta C \quad \dots(iv)$$

Since there is no probability that a land use change can occur from non-agricultural to the agricultural sector, the net changes within the agricultural sector will have substantial ecological effects. If the net change in the agricultural sector is positive ($+\Delta A$), it would be at the cost of the ecological sector, whereas if the net change in agricultural sector is negative ($-\Delta A$) the land shift might have occurred from the agricultural sector to the other two sectors. If there occurs a positive net change to the agricultural sector ($+\Delta A$) along with an increase in the net area sown ($+\Delta C$), it would be conducive for the agricultural growth in the country. Hence, the overall inter-sectoral land use shifts were budgeted as:

$$\Delta R = \Delta E_1 + \Delta E_2 + \Delta A + \Delta N \quad \dots(v)$$

Thus, the inter-sectoral budgeting facilitates the assessment of direction of land use shifts.

RESULTS AND DISCUSSION

Intra-sectoral dynamics of land use in Kerala

The annual rate of change of various land use classes in hectares are presented in Table 1. The intra-sectoral budgeting of land use shifts within the ecological sector showed that the area under permanent pastures, miscellaneous tree crops, barren and uncultivable land were declining at a faster rate. The deceleration was observed to be more in case of barren and uncultivable land. From Table 1, it is lucid that barren and uncultivable

land declined by -2131 ha per annum, followed by land under miscellaneous tree crops (-1413 ha per annum) and permanent pastures (-123 ha per annum) within the ecological sector.

In the case of forests, the shift is noticed to be zero. This is because the area under forests in Kerala remained constant throughout the study period. The budgeting of land use shifts within the agricultural sector indicated that the current fallow, fallow other than current fallow exhibited an increase in area in most of the phases. Therefore the land shifts from these categories to other land use classes within the agricultural sector was very meagre. Except for period IV and period V, the area under cultivable wastes declined annually. The net area sown declined annually by -5505 ha, -18537 ha, -7166 ha and -3363 ha during period III, period IV, period V and period VI. The major land shifts within the agricultural sector have taken place from cultivable waste land and net area sown. The rate of shift of cultivable wastes and net area sown for the overall period was -758 ha and -4850 ha. In the case of land put to non-agricultural uses, the shift occurred only during period IV. In the remaining sub periods of study, the land put to non-agricultural uses showed an increase in area annually. For the overall period, the area under land put to non-agricultural uses increased at the rate of 5214 ha per annum. Budgeting of the non-agricultural sector indicated that there is a consistent increase of land put to non-agricultural uses in Kerala with an exception in period IV.

Table 1: Intra-sectoral dynamics of land use in Kerala

Period	NA		Ecological sector				Agricultural sector		
	N	F _r	P	M	U	W	F _o	F _c	C
Period I (1985-89)	1575	0	-325	-3025	-4278	-4550	-350	675	10278
Period II (1990-94)	7587	0	-289	-1143	-3510	-4991	509	360	1478
Period III (1995-03)	8226	0	-126	-2394	-2181	-1684	1346	2319	-5505
Period IV (2004-09)	-4161	0	-14	-1068	-1126	5121	685	1377	-18537
Period V (2010-14)	9444	0	-44	-354	-1818	532	1873	-2323	-7166
Period VI (2015-19)	7353	0	-1	-102	-466	-173	-1562	-1588	-3363
Overall (1985- 2019)	5214	0	-123	-1413	-2131	-758	556	414	-4850

Note: 1. Period I- 1985-86 to 1989-90, Period II- 1990-91 to 1994-95, Period III- 1995-96 to 2003-4, Period IV-2004-05 to 2009-10, Period V- 2010-11 to 2014-15, Period VI-2015-16 to 2019-20 and Overall Period- 1985-86 to 2019-20.

Note: NA- Non- agricultural sector, N-Area under non-agricultural uses, F_r- Forests, P-Permanent pastures, M-miscellaneous tree crops, U- Barren and uncultivable land, W-cultivable wastes, F_o- Fallow other than current fallow, F_c-Current fallow, C- Net area sown; Annual rate of change of land use classes expressed in hectares.

Table 2: Inter-sectoral budgeting of land use shifts in Kerala

Land use sector	Period I	Period II	Period III	Period IV	Period V	Period VI	Overall
Ecological sector ($\Delta E = \Delta E_1 + \Delta E_2$)	-7628	-4942	-4702	-2208	-2217	-569	-3668
Desirable ecological sector (ΔE_1)	-3350	-1432	-2521	-1082	-398	-103	-1536
Undesirable ecological sector (ΔE_2)	-4278	-3510	-2181	-1126	-1818	-466	-2131
Agricultural sector (ΔA)	6053	-2644	-3523	-11352	-7084	-6687	-4638
Non-agricultural sector (ΔN)	1575	7587	8226	-4161	9444	7353	5214
Net sectoral changes	0	0	0	-17722	142	97	-3092

Note: The net sectoral change is equal to algebraic sum of $\Delta N + \Delta E_1 + \Delta E_2 + \Delta A$.

Note: Annual rate of change of land use classes expressed in hectares.

Inter-sectoral budgeting of land use shift in Kerala

The land shifts among the ecological sector, agricultural sector and non-agricultural sector are analysed and presented in Table 2. It is evident that the ecological sector declined by 7628 ha, of which the share of desirable ecological sector and the undesirable ecological sector was 43.91 per cent and 56.08 per cent per annum respectively. The substantial land shifts from the undesirable ecological sector is favourable to both desirable ecology as well as agricultural sector of the state. That is the land shifts have taken place from barren and uncultivable land and this trend is favourable to the state.

The agricultural sector increased annually at the rate of 6053 ha and this can be attributed to the increase in net area sown in the respective period. The non-agricultural sector increased at an annual rate of 1575 ha, therefore during period I, no land shifts have taken place from agricultural sector to other sectors. This throws the light that land shifts were favourable in the respective period. In period II, period III and period IV, the land shifts have occurred from ecological sector and agricultural sector. The ecological sector declined at an annual rate of -4942 ha, -4702 ha and -2208 ha in period II, period III and period IV respectively. The land shift from agricultural sector happened at an alarming rate in period IV. During the same period, the agricultural sector got declined at an annual rate of -11352 ha. This was mainly due to the exorbitant decline in net area sown in the respective period. The non-agricultural sector increased appreciably by 7587 ha and 8226 ha annually in period II and period III, whereas in period IV, the sector declined at an annual rate of -4161 ha. Similar to previous phases, land shifts happened for ecological sector

and agricultural sector in period V and period VI. In ecological sector, the shift was observed to be more for barren and uncultivable land. The area under non-agricultural sector showed an annual increase of 9444 ha and 7353 ha in period V and period VI. From the budgeting analysis, it can be stated that, the land shifts in Kerala have taken place from ecological sector and agricultural sector to non-agricultural sector. In the overall period, the ecological sector decreased at an annual rate of -3668 ha in which the desirable ecological sector and undesirable ecological sector decreased by -1536 ha (41.87%) and -2131 ha (58.09%) respectively. The area under agricultural sector got declined annually by -4638 ha whereas the area under non-agricultural sector surged by 5214 ha. The area under non-agricultural sector exhibited a substantial increase in area in majority of the phases of study. The reason for the same can be attributed to conversion of agricultural land into residential and industrial area.

CONCLUSION

The shift of area from desirable ecological sector to undesirable ecological sector as well as non-agricultural sector have serious ecological implications. As the net change is negative for agricultural sector of the state, the land use shift occur to ecological and non-agricultural sector at the cost of agricultural sector. These pattern of land shifts are unfavourable for the state's ecological sustainability and agricultural growth, therefore suitable policies for enhancing the area under agricultural sector as well as desirable ecological sector needs at most priority. Moreover, the land shift towards non-agricultural sector necessitates a more rational approach to urbanisation and industrialisation policies in the state. Agricultural

and rural development programmes, collective farming *etc* needs to be promoted on an extensive scale to bring underutilised lands under cultivation. Even strict enforcement of acts pertaining to land use in Kerala is strongly recommended for evading underutilisation and land conversion.

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