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Full Length Research Paper

An investigation into land use dynamics in Karnataka – An ecological perspective

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Abstract

Agriculture is a land-based activity and as such land and water is major factors of production. The present research attempts to analyse land use dynamics in Karnataka, the study was based on the secondary data on land use pattern for nine fold classification were collected for the period from 1980-81 to 2008-09 for all the districts of Karnataka. In order to study intra and inter sectoral shift land use, the land classes have grouped into three broad sectors(i) Ecological sector (ii) Non agricultural sector (iii) Agricultural sector and multiple linear regression models fitted to aggregate sectoral terms indicated, extent of small and marginal farmers have negative impact on area under desirable ecological sector and urbanisation has influence on land shift towards non agriculture.

Keywords: Land use dynamics, Sectorial change, OLS-estimates

INTRODUCTION

Land is an integral part of the eco-system. The way in which land is used can have profound impact on the economy. Land use planning aims at selecting and put into practice land uses aiming to meet the present needs of the people while safeguarding resources for the future. Thus land use polices will have significant role in maintaining ecological balance, environmental health and at the same time meet the basic needs of the population. India, with only 2.3 per cent of world's total land area supports 18 per cent of human and 15 per cent of livestock population in the world.

The Land is the hub point around which most of the economic activities of the individuals or society are connected. It is relatively more inelastic in supply. Hence, it is essential to understand the dynamics of present land use systems and its ecological implications.

Understanding the dynamics of land use change is a scientific challenge of considerable importance to humanity. The classical economist viewing the process of land utilisation in Malthusian and Recardian prophecies propounded that the law of increasing natural resources scarcity operates on the economy leading economy into stationary state.

Analysis of land use by the geographers is more or less governed by the broad taxonomic considerations. The classification involve both extent and intensity of natural resources use, on the other, there are attempts even to classify the regions based on flora and fauna by biological scientists. The environmentalists would view the land use from perspective of conservation of natural resources or by level of degradation of resources and maintenance of ecological balance. They also use bio-classification where dependence of different land uses is implicitly assumed. Social scientists have attempted to examine the role of land use in meeting basic requirements and as well process of development of the economy. The inherent characteristics of land resources, viz., its inelastic nature of supply, immobility and localization of resources are mainly the key factors for the emergence of the concept, i.e.," Land use". In the present paper an attempt is made to study the land use dynamics in Karnataka and aims to document the intra and inter-sectoral land use dynamics in Karnataka from ecological perspective.

Review of literature

Bardhan and Tewari (2010) have studied the land use dynamics in India and land under-utilisation. Possible land use shifts within the ecological sector were postulated. To study the intra and inter-sectoral land use dynamics, the methodology as described by Pandey and Tiwari (1987) is adopted in this study. The state-wise distribution of different categories of land use at two periods of time i.e 1992-93 and 2005-06 were considered for the analysis. From the analysis they have concluded that within the ecological sector, forests account for the highest share of land area at around 23 percent while permanent pastures and grazing land and miscellaneous trees and groves together account for 4.5 percent of total geographical area(desirable sub-sectors). Barren and uncultivable land constitute about 6 percent (undesirable ecological subsector) within the agricultural sector net area sown accounts for the largest share of 46 percent of total reporting area at all-India level. And states of west Bengal, Tamil nadu, Bihar and Kerala have very high shares of 11-19 percent of their reporting area under non agricultural uses.

Nadkarni and Deshpande (1979) studied the climatic and institutional factors affecting under-utilised lands viz., other fallows, current fallows and culturable wastes in Karnataka and Maharashtra states. Regression equations were tried, taking the cross-section observations of all 37 districts separately for proportions of under-utilised lands.

Panday and Tewari (1987) have studied the ecological implications of land use dynamics in Uttarpradesh by considered the basic land use statistics, as published by the State Directorate of Agriculture (Agriculture Statistical Division) for the period from 1967-68 to 1983-84.Both linear and log-linear time trend equations were estimated on the land use for the state as well as its different economic regions for finding the annual rates of change in various land use classes by dividing total geographical area into nine fold classes. In this study the total land endowment was conveniently grouped into three broad sectors, viz.,(i)Ecological sector comprising of Forest, Permanent pastures and other grazing lands, Miscellaneous trees and groves which is not included in the net area sown and barren and uncultivable land. (ii) Non-agricultural sector comprising of Area under non agricultural use. (iii)Agriculture sector comprising of Cultivable wastes, net area sown, current fallows and fallow land other than current fallows. From this the possible directions of major inter-sectoral as well as intra-sectoral land use changes were hypothesised. In addition, the Compound growth rates in different land use classes were also estimated from the trend equation.

Ramaswamy et.al (2005) have studied the dynamics of land use pattern in different districts of Tamilnadu and have identified the factors affecting changes in area under fallow lands using simple statistical and econometric analysis. Log-linear regression equation was used to estimate the growth rates and instability in area under different land use categories was estimated using Instability index.

Ratna Reddy (1991) has done a study on under-utilisation of land in Andhra Pradesh. He has estimated the relationship between current fallows and rainfall with the help of time series data using simple regression. From this, he concluded that the extent of land utilisation or under-utilisation largely depends on the availability of the resources.

METHODOLOGY

The study is based on time series data on land use pattern for nine fold classification collected over the districts of Karnataka for the period of 1998-99 to 2008-09 from the Directorate of Economics and Statistics, Department of Agriculture, Government of Karnataka. In order to study intra and inter sectoral land use dynamics the methodology suggested by Panday and Tewari (1987) is adopted in the study. The authors have grouped the various land use classes into three broad sectors

(i) Ecological sector comprising of: Forests (F_r), Permanent pastures and grazing lands (P), Miscellaneous trees and groves not included in net area sown (M), and Barren and uncultivable land (U). Further, ecological sector has been classified under two broad groups, namely, (a) Desirable ecology (E_1) comprising of Fr, M and P and (b) Undesirable ecology (E_2) comprising of U.

(ii) Land under Non agricultural sector (N).

(iii) Land under Agricultural sector comprising of: Net area sown (W), cultivable waste (C),
Current fallows (F_c), and Fallow land other than current fallows (F_o).

Land area in the state/districts being constant it is assumed that the land use changes can only occur through inter-class transfers and hence land use changes over time is linearly additive.

The land use statistics in the state is generally reported under the nine fold classification. Accordingly, the land use accounting identity can be expressed as:

$$R= F_r + P + M + N+ U + W + C+ F_c + F_o \ldots\ldots\ldots (1)$$

Where,

R= Total reported area.

The accounting identity for land use changes over time is expressed as:

$$\Delta R= \Delta F_r + \Delta P + \Delta M + \Delta N + \Delta U + \Delta W+ \Delta C + \Delta F_c + \Delta F_o \ldots\ldots\ldots (2)$$

Where Δ represent change over period of time.

Thus the net changes in the ecological sector (ΔE) can be budgeted as:

$$\Delta E= \Delta E_1 + \Delta E_2 = (\Delta F_r + \Delta P + \Delta M) + (\Delta U) \ldots\ldots\ldots (3)$$

Similarly, the net changes in the agricultural sector (ΔA) can be budgeted as:

$\Delta A = \Delta C + \Delta F_c + \Delta F_o + \Delta W$ . . . . . (4)

As there is no possibility of land use shift from the non-agricultural sector to the agricultural sector, the net changes in the agricultural sector will have serious ecological implications. This net change, if positive (+ΔA), will be at the cost of the ecological sector; if negative (-ΔA), the land use shift may occur to ecological or non-agricultural or both sectors, but definitely at the cost of the agricultural sector. In addition, the changes within the agricultural sector will also have some implications towards ecology and/or agricultural growth.

The overall inter-sectoral land use transfers can be budgeted as:

$\Delta R = \Delta E_1 + \Delta E_2 + \Delta A + \Delta N$ . . . . . (5)

Equation (5) is the same as equation (2), except that, being expressed in aggregate sectoral terms, facilitates quick glance at inter-sectoral transfers.

In order to examine the factors that influence of present land use, multiple linear regression models is fitted to the aggregate sectoral terms. Explanatory variables included in the model are, extent of normal rain fall, extent of small and marginal farmers, extent of area under irrigation, size of livestock, net area sown, urban and rural population in the districts of Karnataka.

RESULTS AND DISCUSSION

The sectoral land use shifts experienced by the districts of Karnataka during the period 1998-99 to 2008-09 is presented in Table 1. Districts have been classified in to three groups, namely, districts which have experienced significant positive shift under particular land use category, districts which have experienced significant negative shift and districts which have not experienced any shift during the study period. The results indicate that 25 districts out of 27 districts of Karnataka have experienced land shifts from other sectors to the non-agricultural sector. The extent of land shift to non agricultural sector is considerably high in Bangalore (urban), Dakshinakannada, Bijapur, Uttarakannada, Gulbarga, Hassan and Tumkur districts. On the other hand Udupi, Haveri, Shimoga, Belgaum, Chickmaglur, Gadag, Kodagu and Dharwad districts have experienced moderate shift in land towards non agricultural use during the study period. On the other hand Koppal and Raichur have not experienced any shift in land use towards non-agricultural use. However Kolar and Bangalore (rural) districts have registered negative shift which means the land has shifted from non agriculture use to other sectors. Further investigation revealed that negative shift observed in case of Bangalore (Rural) and Kolar districts can be mainly attributed to formation new districts which have been carved out of these two districts. Ramanagar district was carved out of Bangalore (Rural) and Chikkaballapur district was carved out of Kolar respectively. Thus negative shift observed in these two districts cannot be directly attributed to actual shifts taking place in land use. It is more problem of bifurcation of land use data across districts.

The shift in area under ecological sector was classified into desirable ecological sectors and undesirable ecological sectors during the study period. The result reveals that nearly fifteen districts have not experienced land shifts towards undesirable ecological sector. While rest of the twelve districts have registered negative shift which means the land under undesirable ecological sector have experienced decline during the study period.

It may be observed from the table that thirteen districts have registered positive shift in area towards desirable ecological sector. This can be mainly attributed to efforts made to improve area under forest through implementation of different afforestration programmes. On the other hand it may be observed from the table nearly in equal number of districts in the state, i.e., in fourteen districts have registered negative shift in area under desirable ecological sector indicating that there has decline in area under desirable ecological sector in these districts. More area is being brought under land use classes which is ecologically desirable. The negative shift range from as high as 74.6 ('000 ha.) in Bangalore (rural) to 0.01 in Koppal.

Nearly eleven districts have registered positive shift in land towards agricultural sector. While sixteen districts has registered negative shift in land indicating that the lands have moved away from agricultural sector. The highest negative shift is experienced by Kolar, Bangalore (rural), Bagalkot, Bangalore (urban) and Koppal.

In order to examine the factors that influences in the land shifts towards different ecological sectors consider in the study a multiple linear regression model has been attempted. Out of several explanatory variables considered for the analysis only those which have given a fairly a better fit is retained for the analysis. The OLS estimates of multiple linear regression models are presented in the Table 2. The regression equations were fit considering only 25 districts have two districts Bangalore (Rural) and Kolar are further bifurcated to form new districts namely Ramanagar and Chikkaballapur during the period considered for the analysis. Hence the data collected for two periods in respects of Bangalore (Rural) and Kolar was not comparable.

The Multiple linear regression model was fitted to the shift in land towards agricultural sector could explain 22 percent of the variation in the land shift towards the agriculture experienced across the districts in the state. The explanatory variables included in the regression equation are, rainfall, extent of small and marginal farmers, extent area under irrigation and rural population. None of the regression coefficients were statistically significant. The regression equation for desirable

Table 1. District-Wise Sectoral Land Use Dynamics (1998-99 TO 2008-09) Annual rate of change ('000 ha.)

S/No.		Districts having significant positive shift	Districts having significant negative shift	Districts having no shift
1	Non agricultural sector	Bagalkot(0.02), Bangalore(urban)(28.5), Belgaum(0.37), Bellary(0.09), Bidar(0.08), Bijapur(4.56), Chamarajnagar(0.07), Chickmaglur(0.27), Chitradurga(0.03), Dakshinakannada(7.22), Davangere(0.02), Dharwad(0.23), Gadag(0.27), Gulbarga(2.91), Hassan(1.82), Haveri(0.61), Kodagu(0.27), Mandya(0.13), Mysore(0.1), Shimoga(0.43), Tumkur(1.18), Udupi(0.89), Uttarakannada(4.08).	Bangalore (rural) (-9.3), Kolar (-18.0).	Koppal (0), Raichur (0).
2	Desirable ecological sector (Forests+ Perm. Past. + misc. trees)	Bagalkot(0.06), Bangalore(urban)(1.1), Belgaum(1.28), Bellary(0.34), Bidar(0.75), Bijapur(0.01), Chamarajnagar(0.04) , Chitradurga(0.01), Dharwad(0.04), Gadag(0.03), Gulbarga(0.33), Hassan(2.37), Raichur(0.01).	Bangalore (rural)(-74.6), Chickmaglur(-8.35), Dakshinakannada(-2.4), Davangere(-0.1), Haveri(-0.01), Kodagu(-12.0), Kolar(-85.4), Koppal(-0.01), Mandya(-1.88), Mysore(-1.07), Shimoga(-4.39), Tumkur(-10.0), Udupi(-0.5), Uttarakannada(-4.27).	-
3	Undesirable ecological sector (Barren and uncultivable land)	-	Bangalore(rural)(-16.8), Bangalore(urban)(-0.98), Bidar(-2.4), Dakshinakannada(-0.09), Gulbarga(-1.98), Hassan(-0.79), Kolar(-22.9), Koppal(-0.0006), Mandya(-0.07),Shimoga(-0.06), Udupi(-0.24), Uttarakannada(-3.39).	Bagalkot(0), Belgaum(0), Bellary(0), Bijapur(0), Chamarajnagar(0), Chickmaglur(0), Chitradurga(0), Davangere(0), Dharwad(0), Gadag(0), Haveri(0), Kodagu(0), Mysore(0), Raichur(0), Tumkur(0).
4	Agricultural sector (Culti. Wastes+Curr. Fallows +fallow land otherthan Curr.Fallows + NAS)	Bidar(0.57), Chamarajnagar(12.79), Chickmaglur(8.07), Chitradurga(0.04), Davangere(0.07), Kodagu(11.93), Mandya(18.56), Mysore(0.96), Shimoga(3.41), Tumkur(38.87), Uttarakannada(3.57).	Bagalkot(-73.4), Bangalore(rural)(-90.6), Bangalore(urban)(-17.7), Belgaum(-1.65), Bellary(-0.13), Bijapur(-4.57), Dakshinakannada(-4.82), Dharwad(-3.43), Gadag(-0.3), Gulbarga(-3.06), Hassan(-3.41), Haveri(-0.56), Kolar(-144), Koppal(-16.6), Raichur(-0.01), Udupi(-0.1).	-
5	Reported area	Bangalore(urban)(11.02), Bellary(0.3), Chamarajnagar(12.9), Chitradurga(0.084), Hassan(2×10^{-5}), Haveri(0.03), Kodagu(0.16), Mandya(16.75), Mysore(0.006), Raichur(0.003), Tumkur(55.66).	Bagalkot(73.3), Bangalore(rural)(-191.2), Belgaum(-5×10^{-4}),Bidar(-4×10^{-5}),Bijapur(-3×10^{-5}), Chickmaglur(-3×10^{-5}), Dakshinakannada(-0.09), Davangere(-6×10^{-5}),Dharwad(-3.15), Gadag(-3×10^{-5}), Gulbarga(-1.79), Kolar(-269.7),Koppal(-16.62), Shimoga(-5.14), Udupi(-6×10^{-5}), Uttarakannada(-3.74). Koppal, Shimoga, Udupi, Uttarakannada.	-

Table 2. OLS-estimates of Sectoral change in land use pattern.

S/No.	Dependent variables	Independent variable/regression coefficients						R2
		Intercept	RF	SF&MF	I	U	R	
1	ΔA	103.654NS (164.286)	-0.003 NS (0.005)	4.851 NS (4.085)	-0.000043 NS (0.00)	-	-0.503 NS (0.743)	0.22
2	ΔE1	-8.531NS (10.886)	0.003NS (0.004)	-5.581* (2.686)	0.000086* (0.00)	-	-	0.25
3	ΔN	-31.507* (12.695)	0.000 (0.001)	-	-	0.150* (0.057)		0.24

Figures in parenthesis indicate standard error, NS: Non significant, * : indicates significance at 5%,
Where, ΔA: Change in agricultural sector, ΔE1: Change in desirable ecological sector, ΔN: Change in non agricultural sector, R: Rainfall, SF&MF: Number of small and marginal farmers, I: Extent of area under irrigation, U: Urban population, R: Rural population.

ecological sector and land shifts towards non agriculture could explain 25 and 24 percent of the variation in the dependent variable respectively. It may be noted from the regression equation pertaining to area under desirable ecological sector that, extent of small and marginal farmers in the district have negative influence on area under desirable ecological sector.

Further it may be noted from the regression equation pertaining to non agriculture that urban population has significant positive coefficient. Thus it may be inferred that, the districts with higher urban population exert more pressure to shift land towards non agriculture use. However, when we compare this result with regression equation run in earlier section, with area under non-agriculture as dependent variable, the urban population included in regression equation has non significant co-efficient. This may be attributed to the fact that districts with higher changes in urban population have also experienced higher shift of area towards non agricultural use. This is explicitly captured when urban population was regressed on changes rather than absolute figures.

The nine fold land use category is being grouped into three broad groups with ecological perspective. It may be noted from the analysis as many as in sixteen districts the change in reported area between two periods considered for the analysis has turned out to be negative. This type of phenomenon is not unique to present study. The studies undertaken by Bardan. D. and S. K. Tiwari (2010) for different states have also noticed negative change in reported area for many states. Similarly Pandey. V. K and S. K. Tiwari (1987) in the study pertaining to land use dynamics in respect of different regions of Uttar Pradesh have also reported negative change in reported area.

Land shift towards non agriculture use may not be in the interest of maintaining ecological balance. But the trend indicates that many of the districts have experienced significant land shift towards non-agricultural use.

It may be noted from the analysis that land shift towards undesirable ecological sector has remained constant in many of the districts during study period. The analysis indicate the districts where the depletion of land under desirable ecological sector has taken place, the land has shifted to agricultural sector.

The other interesting results that can be read from the multiple linear regression is, extent of small and marginal farmers have negative impact on area under desirable ecological sector which comprises of area under forest, miscellaneous tree crops ant groves and pasture lands. Thus marginalisation of holdings will bring the lands which are unfit for cultivation under plough. On the other hand urbanisation has influence on land shift towards non agriculture.

CONCLUSION

It may be noted from the analysis that land shift towards undesirable ecological sector has shown stagnant in most of the districts during the study period. Extents of small and marginal farmers have negative impact on area under desirable ecological sector which comprises of area under Forest, Miscellaneous tree crops ant groves and pasture lands.

More attention should be given to increase area under forest through afforestation programmes in order to bring one-third geographical area under forest. Land use polices should not only take into account the demand for land from various sectors but it should also lay equal emphasis on maintaining ecological balance. And more stringent policy should be put in place to prevent land being shifted to non-agricultural use.

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