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Tree population and above-ground biomass changes in two disturbed tropical dry evergreen forests of peninsular India

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Abstract: Changes in tree species diversity, stand density and above ground biomass (AGB) were investigated in two tropical dry evergreen forests (Kuzhanthaikuppam - KK and Thirumanikkuzhi – TM) of peninsular India by recensusing all trees (≥10 cm girth at breast height) after 10-year interval (1995-2005). In 10 years, tree diversity decreased by 7.7% in site KK and 15% in TM. Tree density declined by 10.5% in KK, but increased by 17.5% in TM. During the 10-year interval, basal area in site KK marginally increased by 2.3% and in TM it decreased by 6.8%. Two species were added, 4 species were lost and 22 species survived in site KK, while in site TM, just one species was added, 5 species were lost and 21 species survived. Changes in the abundance of individual tree species after 10 years revealed a considerable variation. Overall, *Memecylon umbellatum*, a shade-tolerant, understory species suffered the highest density loss (135 stems ha^{-1}). During the census interval (1995 to 2005), the total AGB increased by 2% in KK and 11.52% in TM. There was no significant variation in the AGB across various tree girth classes between 1995 and 2005. The total AGB for lower girth class (<20 cm dbh) decreased by 2.28% in site KK and gained by 27.4% in site TM. The observed changes in stem density, basal area and total AGB can be attributed to cumulative effect of site quality and human activities. Quantitative analysis of tree population changes is a key factor for predicting and understanding present status of tropical forests.

Resumen: Se investigaron los cambios en la diversidad de especies arbóreas, la densidad del rodal y la biomasa aérea (AGB) en dos bosques tropicales secos perennifolios (Kuzhanthaikuppam - KK y Thirumanikkuzhi – TM) de la India peninsular, por medio de un censo repetido de todos los árboles (≥ 10 cm de perímetro a la altura del pecho) después de un periodo de 10 años (1995-2005). En este periodo la diversidad de árboles decreció en 7.7% en el sitio KK y 15% en TM. La densidad de árboles disminuyó en 10.5% en KK, pero aumentó en 17.5% en TM. Durante los 10 años, el área basal en el sitio KK aumentó de forma marginal en 2.3% y en TM decreció en 6.8%. Se añadieron dos especies, se perdieron cuatro y sobrevivieron 22 en el sitio KK, mientras que en el sitio TM sólo se añadió una especie, se perdieron cinco y sobrevivieron 21. Los cambios en la abundancia de especies arbóreas individuales después de 10 años mostraron una variación considerable. En general, *Memecylon umbellatum*, una especies del sotobosque tolerante a la sombra, sufrió la mayor pérdida en su densidad (-135 tallos ha^{-1}). Durante el periodo correspondiente al censo (1995 a 2005), la AGB total incrementó en 2% en KK y 11.52% en TM. No hubo una variación significativa en la AGB en las diferentes categorías perimétricas entre 995 y 2005. El AGB para la clase perimétrica menor (< 20 cm dap) decreció en 2.28% en el sitio KK y ganó 27.4% en el sitio TM. Los cambios observados en la densidad de tallos, área basal y AGB total pueden ser atribuidos al efecto acumulativo de la calidad de sitio y las actividades humanas. Los análisis cuantitativos de los cambios en las poblaciones arbóreas son un factor clave para predecir y entender el estado actual de los bosques tropicales.

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Resumo: As mudanças na diversidade especifica das árvores, densidade das parcelas e biomassa aérea (AGB) foram investigadas em duas florestas tropicais secas sempreverdes (Kuzhanthaikuppam – KK e Thirumanikkuzhi – TM) da Índia peninsular procedendo-se a um recenseamento de todas as árvores (de perímetro à altura do peito ≥10 cm) depois de um intervalo de 10 anos (1995-2005). Nos 10 anos, a diversidade da componente arbórea decresceu 7,7% na estação KK e 15% na TM. A densidade arbórea decresceu cerca de 10,5% em KK, mas cresceu 17,5% em TM. Durante aquele intervalo de 10 anos, a área basal na estação KK aumentou marginalmente de 2,3% enquanto decresceu 6,8% em TM. Duas espécies foram adicionadas, 4 espécies foram perdidas e 22 espécies sobreviveram na estação KK, enquanto na estação TM somente foi adicionada uma espécie, 5 espécies foram perdidas e 21 espécies sobreviveram. As mudanças na abundância individual das espécies arbóreas depois de 10 anos revelou uma variação considerável. No seu conjunto a *Memecylon umbellatum*, uma espécie tolerante à sombra, as espécies de sub-coberto sofreram a perda mais elevada de densidade (135 troncos ha^{-1}). Durante o intervalo dos censos (1995 a 2005), o AGB total aumentou de 2% em KK e 11,52% em TM. Não houve variação significativa em AGB através das várias classes de perímetro entre 1995 e 2005. O AGB total para a classe de perímetro mais baixa (DAP < 20 cm) decresceu de 2,28% na estação KK e ganhou 27,4/ na estação TM. As mudanças observadas na densidade dos troncos, área basal e AGB total pode ser atribuída ao efeito cumulativo da qualidade da estação e das actividades humanas. A análise quantitativa das mudanças na população arbórea é um factor chave para a predição e compreensão do status actual das florestas tropicais.

Key words: Above-ground biomass, basal area, peninsular India, tree population changes, tropical dry evergreen forest.

Introduction

Quantitative floristic inventories provide necessary context for planning and interpreting long-term ecological research (Phillips *et al.* 2003). Long-term studies of tree population dynamics are critical for our understanding of the conservation needs of tropical forest ecosystems (Condit 1995; Hubbell & Foster 1990; Sheil *et al.* 2000). Such long-term monitoring can often provide detailed descriptions of regional disturbance regimes and an understanding of the responses of key biota to various types of disturbance (Zimmerman *et al.* 1996). Monitoring can aid in collecting reliable scientific information on habitat composition, structure and dynamics, and in evaluating existing management approaches and their impacts on forest ecosystems (Dallmeier & Comiskey 1998). Interest in tree mortality and forest dynamics has increased recently, because forest dynamics is thought to be involved in the maintenance of tree species diversity (Lewis *et al.* 2004). Further, studies of long-term dynamics in forests threatened by human activities are particularly valuable (Fashing *et al.* 2004).

Above-ground biomass (AGB) is a useful measure for assessing changes in forest structure (Brown *et al.* 1999) and an essential aspect of studies of carbon cycle (Cairns *et al.* 2003; Keller *et al.* 2001; Ketterings *et al.* 2001). AGB data can also be used to understand changes in forest structure resulting from succession or to differentiate between forest types (Cairns *et al.* 2003). Indeed, remnant vegetation can play a critical role in forest recovery, promoting rapid increase in species richness, tree density, and above-ground biomass (Guariguata & Ostertag 2001). Several studies have suggested that the impacts of disturbance, and recovery from disturbance may account for either the increase in stem turnover rates (Sheil 1995), or the increase in above-ground biomass (Chambers & Silver 2004; Korner 2003). It is well known that the large number of published biomass equations can result in substantial variation in stand-level AGB estimates (Araujo *et al.* 1999; Baker *et al.* 2004; Chambers *et* *al.* 2001), because AGB is strongly correlated with trunk diameter (Brown 1997; Brown & Lugo 1992; Clark *et al.* 2001).

Tropical dry evergreen forests are distributed on the eastern (Coromandel) coast of India (Parthasarathy & Sethi 1997) and extend 50 km landward from the coast (Mani & Parthasarathy 2005), northern Sri Lanka (Blasco & Legris 1973), north-eastern Thailand (Bunyavejchewin 1999), southwest China (Hongmao *et al.* 2002), Jamaica (Kelly *et al.* 1988) and Bahamas (Smith & Vankat 1992). The tropical dry evergreen forests are ecologically important because of their unique biotic communities (Bunyavejchewin 1999), and it is necessary to invoke interest in tree population studies on a long-term basis. The main objectives of the present study are to determine changes in tree population and tree AGB in two tropical dry evergreen forest sites over a ten-year period. These sites experience various anthropogenic disturbances.

Materials and methods

Site description and characteristics

The study site, Kuzhanthaikuppam (KK-11º45' N lat. and 79º38' E long.) and Thirumanikkuzhi (TM-11º43' N lat. and 79º41' E long.) are 6 km apart from each other and located on the Coromandel coast of Tamil Nadu, south India. The elevation of site KK is 20 m while that of TM is near sea level and the forest area in both the sites is about 1.5 ha. The mean annual temperature is 28.5±1.92ºC and the mean annual rainfall is 1378±116.86 mm during the decade 1992-2002. The climate is tropical dissymmetric with the bulk of the rain falling during the northeast monsoon (October to December). These sites are also 'sacred groves' or 'temple forests' composed of native plant species and preserved as a result of the religious belief of the local people. The sites were selected based on variation in soil type (alluvial in TM and red ferralitic in KK), forest stature (mean stand height ~ 8 m in KK and ~12 m in TM), and anthropogenic disturbance. Site disturbance scores were determined based on the extent of anthropogenic activities such as firewood collection, temple visitors' impact, grazing by cattle and goats, other resource removal and cultural attachment of the local people. The qualitative assessment of the various types of disturbance was ranked as rare (1), occasional (2) or frequent (3) (Table 1).

Table 1. Past and present disturbance status (1- ranked as rare; 2- occasional; 3- frequent) of two tropical dry evergreen forest sites, KK and TM, in peninsular India.

Attributes	KK		TM	
	1995	2005	1995	2005
Site encroachment (land use within the forest)				
(i) for construction of temple	0	2	0	1
(ii) Soil/pebble mining	1	3	0	1
Bridle path used	2	3	1	2
Temple visitors' impact: area used for	1	2	1	1
(i) vehicle parking (area occupied)				
(ii) cooking inside the forest	1	2	1	2
(iii) festive occasion use	1	2	1	2
Grazing (cattle/goat)	2	3	1	2
Cultural attachment of local people	1	3	1	2
Resource removal				
(i) firewood	2	3	1	2
(ii) others: medicinal plants, edible fruits & soil	2	3	1	2
Agricultural impact	1	3	1	3
Approach road to temple (width)	1	3	1	2
Total score	15	32	10	22

Field methods

During 1995 two 1-ha (100 m x 100 m) plots were established, one each in site KK and TM (Parthasarathy & Karthikeyan 1997). These plots were subdivided into 10 m x 10 m subplots as workable units. During the initial census all trees and lianas ≥10 cm gbh (girth at breast height) were identified and their girth measured at 1.3 m from the ground level. For multi-stemmed trees, bole girths were measured separately, basal area calculated and summed. In 2005, all trees ≥10 cm gbh were re-measured. From the initial (1995) database, liana data were removed and tree data were only used to compare with the recensus (2005), to analyse tree population changes at species and community level.

Data analysis

The α-diversity (Shannon & Simpson index) was calculated (as in Magurran 2003) for changes of abundance of individuals in the study plots. To compare changes in the observed and expected number of tree species over 10 years, the data were subjected to a Chi-square test. The frequency distribution of stem density in various size-classes in site KK and TM was compared using Kolmogorov-Smirnov one-sample test (Zar 1999). A regression equation was used to estimate above-ground biomass (AGB) of all trees ≥3.18 cm dbh (which is equivalent to ≥10 cm gbh) following Chave *et al.* (2005): $\ln(AGB) = a + b\ln(D) + c(\ln(D))^2 + d(\ln(D))^3 + \beta_3\ln(\rho)$, where five parameters ($a = -1.602$; $b = 2.266$; $c = 0.136$; $d = -0.0206$; $\beta_3 = 0.809$) are constants and assumed that they do not depend on forest type. This simple regression model suggests that the total above ground biomass (AGB, in kg) of a tree with diameter D should be proportional to the product of wood specific gravity (ρ, represent an oven-dry mass (105 ºC, 48 h) divided by green volume, not an air-dry wood density). Chave *et al.* (2005) obtained this equation using a large dataset of 2410 trees ≥ 5 cm diameter, directly harvested in 27 study sites across the tropics. Wood specific gravity (oven dry) data was taken for analysis from our earlier study (Mani & Parthasarathy 2007).

Results and discussion

Tree population changes

Recensus of two tropical dry evergreen forest sites revealed a considerable variation in species richness, density and basal area of trees over a decade (1995 to 2005). During the 10-year gap, total species richness declined by 7.7% in site KK and 15% in TM (Table 2). Two species (*Azadirachta indica* and *Pavetta indica*) were added, 4 species (*Glycosmis pentaphylla*, *Ficus benghalensis*, *Ormocarpum cochinchinensis* and *Walsura trifoliata*) were lost and 22 species survived in site KK; while in TM, just one species (*Cassia fistula*) was added, 5 species (*Benkara malabarica*, *Cordia obliqua*, *Euphorbia antiquorum*, *Ficus amplissima* and *Maytenus emarginata*) were lost and 21 species survived. No significant difference existed between the observed and expected number of tree species in recensus at both the sites ($\chi^2_{(9)} = 16.92$, $P < 0.05$). Over 10 years, tree density decreased by 10.5% in site KK, but increased by 17.5% in site TM. During the same period, basal area in site KK marginally increased from 14.6 to 14.9 m^2 ha^{-1} (2.3%) and in TM it decreased by 6.8% (i.e. 28.9 to 27.0 m^2 ha^{-1}) (Table 2). The alpha diversity indices (Shannon & Simpson index) changed marginally between 1995 and 2005. The Shannon index increased from 2.07 to 2.14 in site KK and decreased from 2.23 to 2.11 in site TM. The Simpson index decreased from 0.20 to 0.18 in site KK which could be due to loss of 197 stems, but increased from 0.16 to 0.18 in site TM.

In the lower girth class of 10-30 cm gbh, tree density decreased by 32.5% (847 to 572 stems ha^{-1}) in site KK (Table 2) and this can be attributed to combined effect of stem removal as fuel wood by local people and also due to progression to next girth class. In site TM, tree density increased by 26.7% (i.e. from 550 to 679 stems ha^{-1}), which is in conformity with the result obtained from another tropical dry evergreen forest site (Venkateswaran & Parthasarathy 2005). The decrease in density of small stems (10-30 cm gbh) in site KK is in line with the findings of Janzen (1970), Clark & Clark (1984), Connell *et al.* (1984), Primack & Hall (1992) and Newbery *et al.* (1999), who also reported that the density of small trees decreased over time. Moreover, tree density distribution across different diameter classes indicates how well the growing forest is utilizing site resources (Hitimana *et al.* 2004). Overall, the larger size class (151-180 and >180 cm gbh) suffered maximum loss in stem abundance as well as basal area in site KK, which could be due to site encroachment (soil/pebble mining) and selective felling of voluminous specimen of tree species such as *Drypetes sepiaria*, *Pterospermum canescens*, *Vitex altissima* and *Syzygium cumini* for household construction. Logging may be disproportional, such that the basal area in larger diameter classes has become reduced as also reported by Hitimana *et al.* (2004) in western Kenya. The basal area at site TM for stems >180 cm gbh increased by 8.7%, but with a decreased tree density. Segura *et al.* (2003) found that high frequency of larger trees resulted in a reduction of total stand density but have higher basal area because of nutrient rich and productive conditions (bottom of the watershed) in the tropical dry forest of Mexico. The results of site TM (i.e. a reduction in stem density and increase in basal area at higher girth class, Table 3) are thus comparable to the above cited works due to presence of a man-made pond constructed adjacent to the study plot. The stem density in various size-classes of trees in the two sites did not show a significant variation (Kolmogorov-Smirnov one-sample test, $D_{(7)} = 0.483$, $P > 0.05$).

Changes in the composition of trees species

Changes in the abundance of individual tree species after 10 years (Appendix Table 1) revealed that the stem density of species such as *Memecylon umbellatum* (stem count decreased by 135 stems ha^{-1}) and *Tricalysia sphaerocarpa* (-32 stems) declined greatly in site KK. Whereas in site TM, two species *Drypetes sepiaria* and *Pleiospermium alatum* lost 18 individuals each. This is because of the selective felling of stems for fence posts, construction purpose and for other agricultural implements. Such selective elimination of species would affect forest species composition and stand structure (Smiet 1992). As for the density changes, population gain was more for *Pterospermum xylocarpum* (+36 stems) in site KK, while in TM it was for *Lepisanthes tetraphylla* (+66), *Tricalysia sphaerocarpa* (+66), *Diospyros ebenum* (+22), *Mallotus rhamnifolius* (+13) and *Atalantia monophylla* (+12). Out of the total tree species, 25% (6 species) in site KK and 22.7% (5 species) in TM were represented by single stems in 2005 recensus. Primack & Hall (1992) found that species with small population sizes are more prone to local extinction because the mortality of a few individuals will lead to the total loss of representation in the plot.

Table 2. Summary of tree diversity inventory during 1995 and 2005 in 1-ha plots of tropical dry evergreen forest at site KK and TM (AGB - Above-ground biomass).

Variables	KK			TM		
	1995	2005	Net change	1995	2005	Net change
Tree species	26	24	- 2	26	22	- 4
Genera	23	21	- 2	25	22	- 3
Family	18	16	- 2	20	17	- 3
Stem density (no. ha^{-1})	1229	1032	- 197	832	978	+ 146
Basal area (m^2 ha^{-1})	14.6	14.9	+ 0.34	28.9	27.0	- 1.9
Shannon index	2.07	2.14	+0.07	2.23	2.11	-0.12
Simpson index	0.20	0.18	-0.02	0.16	0.18	+0.02
ln (AGB) (kg ha^{-1})	3754.53	3829.51	+75.25	2756.71	3074.16	+317.67

Table 3. Tree density and basal area (m^2 ha^{-1}) by girth classes (gbh) at site KK and TM in1995 and 2005.

	KK						TM					
	Density			Basal area (m^2 ha^{-1})			Density			Basal area (m^2 ha^{-1})		
GBH (cm)	1995	2005	Net change	1995	2005	Net change	1995	2005	Net change	1995	2005	Net change
10-30	847	572	- 275	3.93	2.41	- 1.52	550	697	+ 147	1.72	2.19	+ 0.47
31-60	309	339	+ 36	5.48	5.49	+ 0.01	103	112	+ 9	1.94	1.68	- 0.26
61-90	57	98	+ 41	2.60	4.98	+ 2.38	79	73	- 6	5.05	3.83	- 1.22
91-120	12	19	+ 7	0.98	1.59	+ 0.61	41	48	+ 7	4.67	4.69	+ 0.02
121-150	1	4	+ 3	0.28	0.50	+ 0.22	23	18	- 5	3.59	2.85	- 0.74
151-180	1	0	- 1	0.26	0	- 0.26	15	12	- 3	3.58	2.64	- 0.94
>180	2	0	- 2	1.10	0	- 1.10	21	18	- 3	8.43	9.16	+ 0.73

Changes in the above-ground biomass (AGB)

During the census interval (1995-2005), the total AGB marginally increased by 2% (+75.25 kg ha^{-1}) in site KK and 11.52% (+317.67) in TM (Table 2). A number of studies (Araujo *et al.* 1999; Brown *et al.* 1989; Cairns *et al.* 2003; Kale *et al.* 2004; Ketterings *et al.* 2001; Lodhiyal & Lodhiyal 2003; Saldarriaga *et al.* 1988; Overman *et al.* 1994; Verwijst & Telenius 1999) have reported a high correlation of biomass with dbh (diameter). The present study also showed a high r^2 value (Fig. 1); the small threshold of stems (≥3.18 cm dbh instead of ≥10 dbh) considered in this study could have contributed to this.

The AGB changes across diameter classes at site KK and TM varied consistently (Fig. 2). The observed difference in AGB across the girth classes between 1995 and 2005 did not show a significant variation (Kolmogorov-Smirnov one-sample test, $D_{(6)} = 11$, $P > 0.05$). The total AGB for lower girth class (<20 cm dbh) decreased by 2.28% (-76.9 kg ha^{-1}) in site KK and gained 27.4% (+440.04 kg ha^{-1}) in site TM. In contrast, in the 21-40 cm dbh class, the AGB increased by 46.9% (170.03 kg ha^{-1}) in site KK and decreased 1.8% (13.62 kg ha^{-1}) in site TM. The AGB of middle girth classes (41 to 81cm dbh) decreased in site TM (Fig. 2). Changes in tree diameter can be used to predict changes in total AGB, and also the stand AGB. Overall, the AGB in two sites of tropical dry evergreen forests appears to vary in relation to anthropogenic disturbances and similar findings were reported in tropical moist forest in Africa (Gaston *et al.* 1998) and central Amazon (Laurance *et al.* 1997). It has been realised that estimation of biomass is important (Chave *et al.* 2001; Nascimento & Laurance 2004), but till date no robust methods have been developed for the estimation of biomass (Murali *et al.* 2005). A comparison of the AGB estimates of the present study with others is difficult because of variation in the methods employed for AGB estimation in different studies. However, many biomass equations have been developed, variously including tree diameter, height, wood density, and tree form factor as explanatory variables (Brown *et al.* 1989). The choice in any particular study is important, as different equations can give rise to very different AGB estimates when applied to the same forest inventory data (Araujo *et al.* 1999). Equation choice, therefore, poses a significant problem for regional-scale comparison of AGB estimates, because the variation caused by

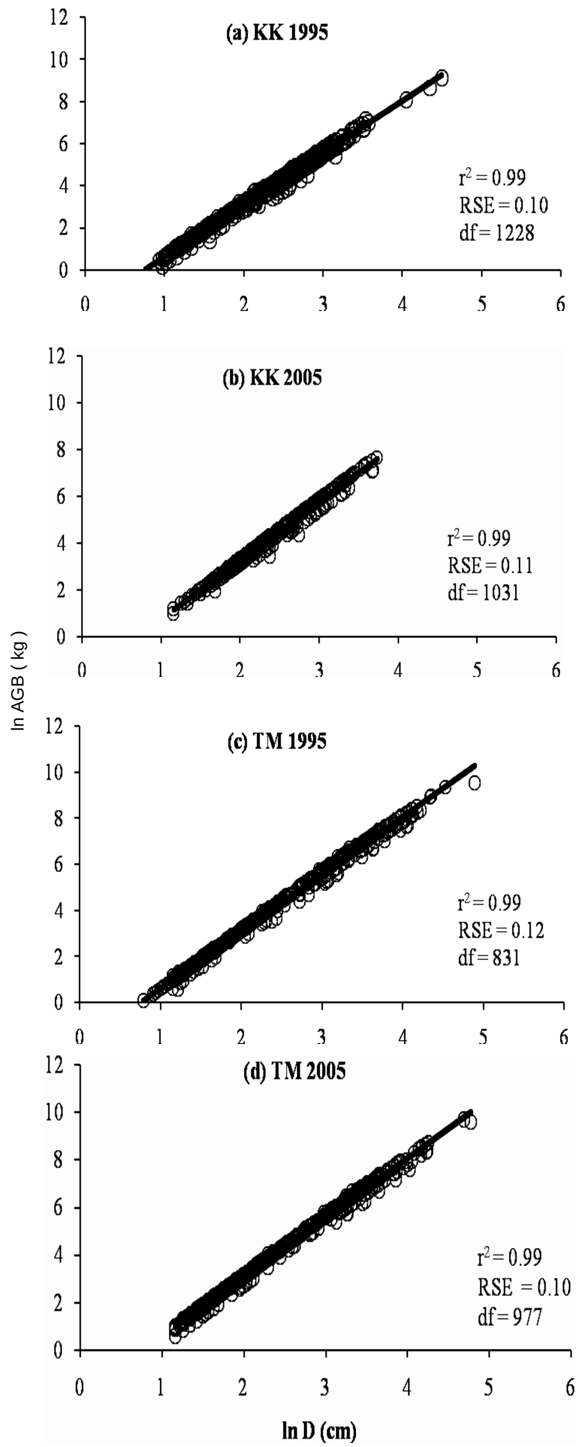

Fig. 1. Regression between the logarithm of D (cm) and logarithm AGB (kg) in sites KK and TM. Each dot corresponds to an individually weighed tree (RSE-Residual Standard Error).

environmental, structural and compositional gradients (Malhi *et al.* 2002; ter Steege *et al.* 2000), may be confounded with variation resulting from the use of different regression equations (Baker *et al.* 2004).

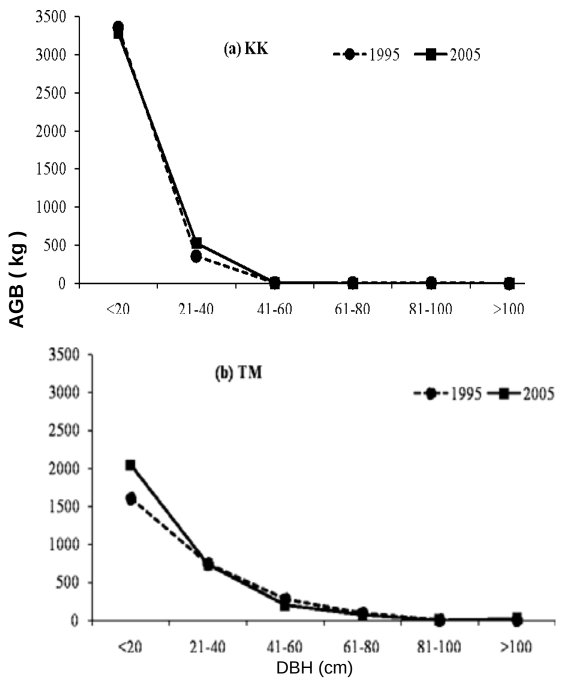

Fig. 2. Total above-ground biomass (kg ha^{-1}) change across diameter classes at site KK and TM obtained using $\ln(AGB) = a+b \ln(D) + c (\ln(D))^2 + d(\ln(D))^3 + \beta_3 \ln(\rho)$.

The studied forests are represented by small patches, or fragments, and are also closely linked with cultural tradition of the local people as sacred groves. At present, these sites experience disturbance due to cattle grazing, resource removal, and the land use systems, and many sacred groves are now threatened (Chandrashekara & Sankar 1998; Parthasarathy & Karthikeyan 1997). We conclude that the tree species richness and abundance showed a considerable change in ten year interval which are attributed to cumulative effect of site qualities and human activities inside the forest (i.e. selective felling of trees, vehicle parking, collecting fuelwood, cooking inside the forest during festive occasion) and change in land use patterns in areas adjacent to these forests. It is important that people realize the values of these patches of forests and make low levels of resource extraction in a rational manner which would facilitate sustainable resource use.

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Appendix Table 1. Tree species density (ha^{-1}) in 1995 and 2005 at sites KK and TM.

Species	KK			TM		
	1995	2005	Net change	1995	2005	Net change
Atalantia monophylla (L.) Correa (Rutaceae)	32	36	+4	69	81	+12
Azadirachta indica A. Juss. (Meliaceae)	0	1	+1	1	3	+2
Benkara malabarica (Lam.) Tirven. (Rubiaceae)	0	0	0	1	0	-1
Borassus flabellifer L. (Arecaceae)	0	0	0	1	1	0
Butea monosperma (Lam.) Taubert (Papilioniaceae)	9	8	-1	0	0	0
Cadaba trifoliata (Roxb.) Wight & Arn. (Capparaceae)	11	6	-5	12	21	+9
Canthium dicoccum (Gaertn.) Teijsm & Binn. (Rubiaceae)	18	12	-6	5	11	+6
Cassia fistula L. (Caesalpiniaceae)	1	1	0	0	1	+1
Chionanthus zeylanica L. (Oleaceae)	14	8	-6	1	1	0
Cordia obliqua Willd. (Cordiaceae)	0	0	0	3	0	-3
Dalbergia paniculata Roxb. (Papilionaceae)	0	0	0	1	1	0
Diospyros ebenum Koen. (Ebenaceae)	103	93	-10	17	39	+22
Diospyros ferrea (Willd.) Bakh. var. *buxifolia* (Rottb.) Bakh. (Ebenaceae)	1	1	0	0	0	0
Diospyros montana Roxb. (Ebenaceae)	13	6	-7	0	0	0
Drypetes sepiaria (Wight & Arn.) Pax & Hoffm. (Euphorbiaceae)	8	11	+3	67	49	-18
Euphorbia antiquorum L. (Euphorbiaceae)	0	0	0	1	0	-1
Ficus amplissima J.E.Smith (Moraceae)	0	0	0	2	0	-2
Ficus benghalensis L. (Moraceae)	3	0	+3	16	8	-8
Garcinia spicata (Wight & Arn.) J.D.Hook. (Clusiaceae)	64	60	-4	21	18	-3
Glycosmis pentaphylla (Retz) DC. (Rutaceae)	3	0	-3	9	11	+2
Ixora pavetta Andrews (Rubiaceae)	5	2	-3	2	3	+1
Lannea coromandelica (Houtt.) Merr. (Anacardiaceae)	0	0	0	1	1	0
Lepisanthes tetraphylla (Vahl) Radlk. (Sapindaceae)	44	35	-9	185	251	+66
Mallotus rhamnifolius Muell.-Arg. (Euphorbiaceae)	40	39	-1	60	73	+13
Maytenus emarginata (Willd.) Ding Hou (Celastraceae)	0	0	0	1	0	-1
Memecylon umbellatum Burm.f. (Melastomataceae)	449	314	-135	5	6	+1
Miliusa montana Leshchen. ex A. DC (Annonaceae)	11	10	-1	10	12	+2
Ormocarpum cochinchinensis (Lour.) Merr. (Papilionaceae)	1	0	-1	0	0	0
Pavetta indica L. (Rubiaceae)	0	1	+1	0	0	0
Pleiospermium alatum (Wall. ex Wight & Arn.) Swingle (Rutaceae)	1	1	0	57	39	-18
Pteropsermum xylocarpum (Gaertn.) Sant. & Wagh (Sterculiaceae)	15	51	+36	0	0	0
Pterospermum canescens Roxb. (Sterculiaceae)	91	82	-9	49	47	-2
Syzygium cumini (L.) Skeels (Myrtaceae)	4	2	-2	0	0	0
Tricalysia sphaerocarpa (Dalz.) Gamble (Rubiaceae)	283	251	-32	235	301	+66
Vitex altissima L. f. (Verbenaceae)	4	1	-3	0	0	0
Walsura trifoliata (A. Juss.) Harms (Meliaceae)	1	0	-1	0	0	0
Total	1229	1032		832	978	