Reprinted from the Indian Forester, Volume 138, No. 3, March, 2012

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THE
INDIAN FORESTER

P.O. New Forest
DEHRADUN (INDIA)

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Introduction

Human – nature relationship from time immemorial is manifested either through massive exploitation of natural resources for the benefit of the mankind, or conservation/maintenance of natural resources through religious/cultural beliefs. This traditional mode of conservation can be best viewed in sacred groves which are usually patches of forests protected by local communities on cultural and religious grounds. Apart from their socio-religious importance, groves are often considered as centres of native biota and providers of valuable ecosystem services (Malhotra *et al.*, 2001). Western Ghats, a mountain chain along the west coast of peninsular India, is one of the global biodiversity hotspots. The mountains as well as the narrow strip of west coast alongside it, from northern Maharashtra to southern tip of Kerala, are dotted with numerous sacred groves (Chandran *et al.*, 1998) under different names as per communities and cultures associated with them.

Present day conservation strategy and management often emphasises on sustainable benefits from the conservation so as to promote peoples' participation (Sunderlin *et al.*, 2005). In the traditional system of sacred grove conservation, religious interests were supreme and market interest was apparently subdued; infact there was in general strict community control on resource utilisation from the groves, barring certain non-timber products.

This paper presents a case study to depict the positive influence in terms of biodiversity and carbon sequestration of long-term protection of a sacred grove - Devaravattikan , Siddapur taluk in the central Western Ghats.

Methods

Study sites

The case study pertains to Devaravattikan (14° 18' 23"N lat ,74° 52' 14"E long), a 1.8 ha sized sacred grove in the Mattigar village of Siddapur taluk in the Uttara Kannada district of central Western Ghats region of Karnataka. The grove is surrounded by agricultural fields towards one side and *Acacia* plantation and village settlement on other sides. The region receives south-west monsoon during June to October with an average annual rainfall 3000-4500 mm. and temperature ranges between 15° and 38° C. Geologically, this area is mostly made up of large out crops of granites and soil is sandy-loamy type (Forest Working Plan, 2003).

Vegetation analysis

Tree species (>30 cm in girth) of the grove were enumerated in 1991 and in 2009. Tree height and girth at breast height (GBH) were recorded. Transect cum quadrat method was used for shrub and herb layers . Quadrats measuring 5 m X 5 m were laid for shrub layer and within the shrub quadrat smaller sub-quadrats of 1 m X 1 m were laid for herb study.

Species diversity, dominance and richness were calculated following Shanon-Weiner index (Shanon and Wiener, 1963), Simpson dominance index (Simpson, 1949) and species richness index (Margaleaf, 1958). Woody species were arranged into several girth class categories to understand the population structure.

Carbon estimation

Species level above ground biomass was calculated through basal area equations and an indirect estimation was done for calculating below ground biomass (Murali *et al.*, 2005; Ravindranath and Ostwald, 2008).

Above Ground Biomass (AGB) (t/ha) = -2.81 + 6.78 (BA), $r^2 = 0.53$, BA = Basal area in m^2/ha.

Below Ground Biomass (t/ha) = 0.26 * AGB

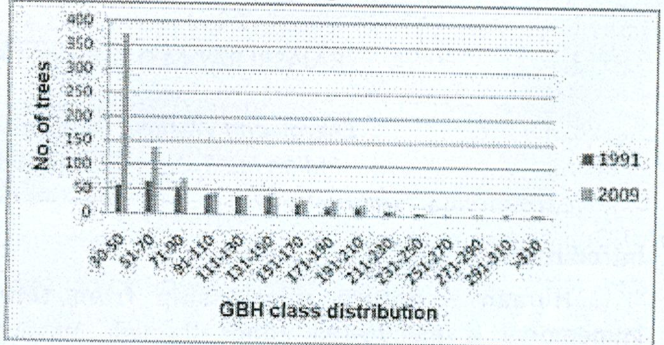
The resultant biomass was multiplied by 0.5 for estimating carbon storage. Changes in the biomass and carbon stock in the fragment after 18 years were computed by deducting the benchmark year values from the final year values. The annual average gain or loss of carbon was calculated by dividing the net change for the study period, i.e., 18 years.

Results and Discussion

Sacred groves of Western Ghats, in the past were in continuity with secondary forests in different stages of vegetation succession, often the results of regeneration on past shifting cultivation fallows . There has been, in recent past, rising awareness on the history and importance of sacred groves. As a positive outcome of the rising conservation ethos, a 1.8 ha grove were protected with fence involving local people in the Mattigar village of Siddapur amidst diverse landscape elements i.e. agricultural field, plantation and human habitations.

Comparative analysis of the two time scale data has shown that protection promoted the species richness, family richness, increment in basal area and overall per centage of endemics (Table 1) probably due to restriction in cattle grazing, resource extraction and entry by humans. Tree species richness is recorded to increase from 7.42 to 9.48. Of these, 81 per cent are evergreen and 19 per cent are deciduous. Among the new members the presence of endemics, *Actinodaphne hookeri, Beilschmieda fagifolia, Diospyros assimilis, Garcinia indica* and *Drypetes confertiflorus* are noteworthy. Girth class distribution at the two time scale do not show much difference except for the presence of high number of individuals in lower girth class category in 2009, showing greater recruitment of trees when protection was provided (Fig. 1). Basal area increased from 53.5 m^2/ha to 63.7 m^2/ha, mostly contributed by low girth class members (18.8 per cent in 2009 in comparison to 10.3 per cent in 1991) whereas middle and high girth class members remain stable. There is almost two time increment in stem density from 208.3/ha to 424.4/ha contributed by young individuals. Increment of endemism (37→45 per cent) could be attributed to two possible factors. Perhaps seeds and seedlings of endemic members were present at earlier study period which in course of time grew uninterruptedly and became prominent elements at the time of present study. It is also possible that the seeds of these endemic species could have been brought in by birds and bats from the adjacent evergreen forest belt. Similarly, regeneration study shows better potential,

Fig. 1



GBH class distribution in Devaravattikan in two time period (1991 and 2009)

especially for tree species. A good number of tree members are present in seedling and sapling forms among which Western Ghats endemics are prominent (66 per cent). The good canopy cover, availability of soil moisture and less disturbance may be the contributing factors for endemics survival. In the ground vegetation layer, forest species dominate over the open area species.

Per cent contributions of evergreen and deciduous members and canopy height on an average remain same in study period. This could be due to the isolation of the grove and more of exposed edges and gaps. Fragmented nature also inhibits gain of the maximum potential height for many tree species as taller trees turn vulnerable to wind falls, thus, average canopy height could not improve in this time period; the "wind damage hypothesis" (D'Angelo *et al.*,2004). The presence of secondary elements like *Holigarna arnottiana, Aporusa lindlyana, Olea Dioica* and *Terminalia paniculata* reflects the disturbances and exposure to relatively long rainless period of about six months. Family importance value index shows dominance of Myrtaceae, Anacardiaceae and Clusiaceae members (Table 2) and the 18 years time

Table 1

Comparison of the vegetation profile (for tree species only) of Devaravattikan sacred grove in 1991 and 2009.

Attributes	1991	2009
Species richness	7.42	9.48
Shannon-Wiener Diversity Index	3.18	3.41
Simpson's Dominance Index	0.0625	0.0484
Total individuals	375	774
Stem density (no. / ha)	208.3	424.4
Basal area (m2 / ha)	29.79	35.23
Average canopy height (mt)	14.13	13.39
Endemism (%)	37.04	45.21
Carbon value (tC / ha)	125.48	148.73

Table 2

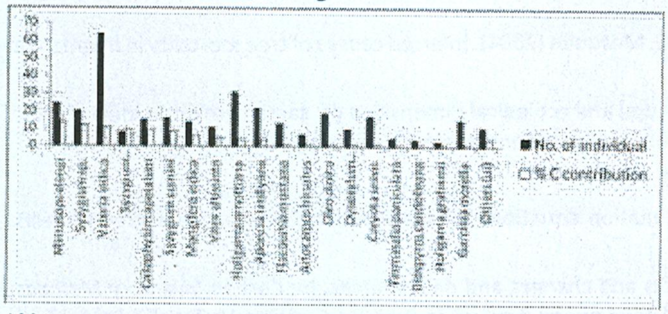
Top ten families based on the family importance value (FIV) index in two time period

1991 Family (FIV)	2009 Family (FIV)
Myrtaceae (47.9)	Myrtaceae (37.1)
Anacardiaceae (36)	Anacardiaceae (35)
Dipterocarpaceae (28.8)	Clusiaceae (25.8)
Clusiaceae (27.5)	Lauraceae (23.4)
Sapotaceae (20.1)	Dipterocarpaceae (19.1)
Verbanaceae (13.6)	Euphorbiaceae (18.2)
Euphorbiaceae (12)	Sapotaceae (15.3)
Combretaceae (11.14)	Oleaceae (12.1)
Ebenaceae (11.1)	Verbanaceae (11.9)
Melastomataceae (10)	Combretaceae (10.6)

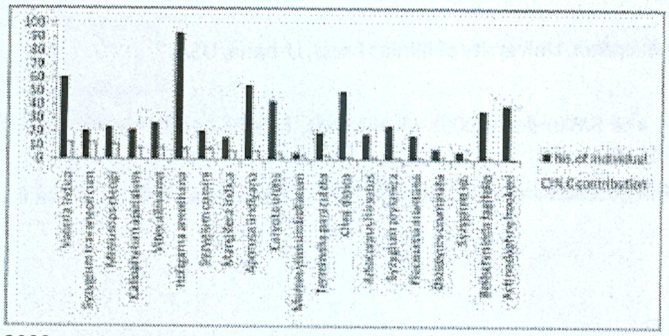
period also witnessed the entry of two families, viz., Lauraceae and Oleaceae into the first ten dominant families of the grove.

Carbon sequestration study showed promising results. Present carbon stock (148.73 tC/ha) and carbon sequestration rate (1.29 tC/ha/yr) are comparable to other reported studies in tropical forest areas (Bhat *et al.*, 2003; Terakunpisut *et al.*, 2007). Species wise carbon estimation revealed the dominance of top twenty species in total carbon storage at both time periods, i.e., 62 per cent in 1991 and 58 per cent in 2009. There is no relation between number of individuals of a species and its contribution to carbon storage. Species with more individuals, like *Vateria indica* and *Holigarna arnottiana* (1991) and *Holigarna arnottiana*, *Aporusa lindlyana* and *Olea dioica* (2009) contributed less compared to the species with fewer ones due to high number of lower girth class members (Fig. 2a). Presence of good number of young individuals ensures future carbon storage potential of the grove studied; on the other hand, middle and high girth class members bearing the signature of past carbon storage could continue if the grove remains relatively undisturbed. A detailed analysis of the tree species contribution to carbon sequestration showed that, 15 out of 20 topmost contributor species are common to both the time periods. These top 20 species either by their number or biomass contributed 62 per cent and 58 per cent carbon in 1991 and 2009, respectively. Moreover, girth class distribution of top 5 species at two time periods showed contrasting features. The middle to higher girth class members contribute much in earlier time period (1991), whereas, lower girth class members dominate the present time period (2009). The comparatively faster growth and large number of young members at current time scale, thus, surpasses older members in term of carbon storage. Contribution of such a small fragment in carbon sequestration is quite remarkable especially in agriculture and plantation dominated landscape.

Fig. 2a



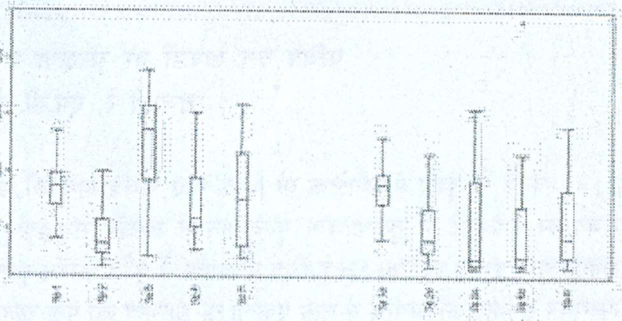
1991



2009

Carbon contribution of top 20 species in Devarabhattikan (1991 and 2009)
Sp.1-5 indicates top 5 species in 1991, Sp.1a-6, same in 2009.

Fig. 2b



Distribution of GBH values of top 5 carbon contributors in two time period.

Conclusion

This study highlights the role of local communities' in grove conservation as well as restoration of degraded sacred groves. Even simple protection measures (wire fencing etc.) with local awareness would help in protecting fragments of natural vegetation.

The need of the hour is to link up this traditional practice with current livelihood centric conservation

Acknowledgements

The authors are grateful to Mr. G.R.Rao, Mr.Visnu D. Mukri, Mr. Manjunath Naik and Mr. Shrikant Naik for their help during field work. The financial support from Indian Institute of Science is duly acknowledged.

SUMMARY

The impact of protection on the ecology and ecosystem services of a fragmented sacred grove of Karnataka in agricultural landscape was studied. Comparative assessment of two time scale data revealed positive influence of protection on vegetation in term of species richness, diversity, endemism and basal area. An increment in above ground biomass indicates groves potential for carbon

sequestration. Species level study on carbon storage finds the contribution of young individuals in recent time period.

Keywords : Ecology of sacred grove; Western Ghats Karnataka; Protection measure, Conservation

पवित्र वन खण्डों पर संरक्षण प्रभाव- कर्नाटक, भारत से एक विशेष अध्ययन

राजाश्री रे, एम.डी. सुभाष चन्द्रन और टी.वी. रामाचन्द्रा

सारांश

कृषि भू–दृश्य में कर्नाटक के विखण्डित पवित्र बाग की पारिस्थितिकी एवं पारितंत्र सेवाओं पर सुरक्षा के प्रभाव का अध्ययन किया गया। दो समयमान आंकड़ों के तुलनात्मक मूल्यांकन ने प्रजाति समृद्धता, विविधता, स्थानिकता और आधारिय क्षेत्र के संदर्भ में वनस्पति पर सुरक्षा का सकारात्मक प्रभाव दर्शाया। भूक्यूपरिक जैवमात्रा में वृद्धि कार्बन पृथक्करण के लिए बागों की क्षमता को दर्शाती है। कार्बन भण्डारण पर प्रजाति स्तर पर अध्ययन से हाल की अवधि में युवा एकलों के सहयोग का पता चला है।

References

Bhat, D. M., K. S. Murali and N. H. Ravindranath (2003). Carbon stock dynamics in the tropical rain forests of the Uttara Kannada district, Western Ghats, India. *Int J. Environ. Pollut.*, **19**: 139-149.

Chandran, M. D. S., M. Gadgil and J. D. Hughes (1998). Sacred groves of the Western Ghats of India. *In*: . *Conserving the Sacred for Biodiversity Management*. (P.S.Ramakrishnan, K.G.Saxena and U.M.Chandrashekara (eds.) Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, pp 211-231

D'Angelo, S. A., A. C. S. Andrade, S. G. Laurence, W. F. Laurence and R. C. G. Mesquita (2004). Inferred causes of tree mortality in fragmented and intact Amazonian forests. *J. Trop. Ecol.*, **20**: 243-246

Malhotra, K. C., Y. Gokhale, S. Chatterjee and S. Srivastava (2001). Cultural and ecological dimensions of sacred groves in India. Report. Indian National Science Academy, New Delhi & Indira Gandhi Rashtriya Manav Sangrahalaya, Bhopal

Margalef, D. R. (1958). Information theory in ecology. *Gen. Syst.*, **3**: 36–71.

Murali, K. S., D. M. Bhat and N. H. Ravindranath (2005). Biomass estimation equations for tropical deciduous and evergreen forests. *Agricultural Resources Governance and Ecology*, **4**: 81–92.

Ravindranath, N.H. and M. Ostwald (2008). Estimation of carbon stocks and changes and data sources. In: *Carbon Inventory Methods: Handbook for Greenhouse gas Inventory, Carbon Mitigation and Roundwood Production Projects*. Springer-Verlog, Berlin, pp. 237-270.

Shannon, C. E. and W. Weaner (1963). *The Mathematical Theory of Communication*, University of Illinios Press, Urbana, USA.

Simpson, E. H. (1949). Measurement of diversity. *Nature*, **163**: 688.

Sunderlin, W. D., A. Angelsen, B. Belcher, P. Burgers, R. Nasi, L. Santoso and S.Wunder (2005). Livelihoods, forests and conservation in developing countries: An overview. *World Development,* **33**: 1383-1402.

Terakunpisut, J., N. Gajaseni and N. Ruankawe (2007). Carbon sequestration potential in aboveground biomass of thong pha phum national forest, Thailand. *Appl. Ecol. Environ. Res.*, **5**: 93-102.