LAKE 2014: *Conference on Conservation and Sustainable Management of Wetland Ecosystems in Western Ghats*
Date: 13th -15th November 2014
Symposium Web: http://ces.iisc.ernet.in/energy

# BIODIVERSITY CONSERVATION IN HUMANISED LANDSCAPE – CHALLENGES AND OPPORTUNITY

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## ABSTRACT

The agenda on conservation of biodiversity usually inclines towards exclusionary approaches like protected area, reserve forest, national parks etc. However, recent findings indicate the importance of humanised landscape in this regard due to simultaneous operations of life supporting activities at various scale. Humanised landscape supports various life forms at different levels although magnitude of human intervention has paramount importance in this regard. Although, theoretical underpinning on these issues are better resolved, empirical findings are very much context and area specific even incomplete to some extent due to lack of detail knowledge on species interaction with nature. Recent technological advancements (e.g. GIS and remote sensing, niche modelling and connectivity analysis) offer ample opportunities to study various aspects of species life cycle and its association with landscape, thus resolving problems related to species management. This article deals with few case studies at landscape as well as species level to depict how current technologies improve our understandings on landscape dynamics and species existence.



## INTRODUCTION

The growing concern over rapid loss of species and their habitat prompts mankind to adopt several preventive measures like protected areas, reserve forests and so on. Although, these attempts offer solution to some extent, many a time satisfactory results are not obtained due to our lack of understanding to species requirement from its surroundings. The physical boundary of protected/reserve area often mismatches with species life-long activities which are quite evident especially for animals. For plants, although the interaction strategy is different the importance of surroundings over their survival cannot be undermined. Species presence in humanized/altered landscape is a persistent issue and has gained importance in recent time period. Studies have found that, production landscapes outnumbered protected areas in terms of biodiversity richness and ecosystem functioning (Fischer et al. 2006, Chazdon et al. 2009, Belair et al. 2010, Wilson et al. 2010). The inherent factors are water, energy and other forms of natural resources which are equally important for human being and other life forms, so competition exists. To deal with the survival of diverse life forms in altered landscape one has to pay attention from multiple view points. Apart from species specific factors, altered landscape counts for multiple stakeholders at different scale ranging from local users to regional even national interests. The tussle between biological/ecological integrity and maximum production often leads to conflicts among interest which ultimately affects overall developmental agenda.

Recent technological advancements offer ample opportunities to study the issue in multiple dimensions in biodiversity and ecosystem research so to formulate strategy in a more holistic manner. Techniques like, Geographic Information System (GIS), Remote Sensing (RS), Ecological Niche Modelling (ENM), Connectivity Analysis (CA) etc. link biotic, abiotic, social and economic parameters at different levels, compare and simulate scenarios at different situations, prioritise areas for attention and address evolutionary and ecological questions (Menon and Bawa 1997, Bunn et al. 2000, Salem 2003, Brooks et al. 2006, Sarkar et al. 2006, McRae et al. 2008 ). These techniques have advantages like minimum use of instruments at the user end, availability of free data and free of cost analytical tools, large online user base to get support on issues which make them popular worldwide. Although there are technical limitations in certain areas, the dynamic progress in the field will fill up the lacunae in near future. This paper deals with application of Remote sensing, Geographic information system and Ecological niche modelling in the heterogeneous landscape of Uttara Kannada district (Karnataka state of India) with an aim to understand land use dynamics as well as species survival in humanised landscape.

## METHOD

**Study area:** The Uttara Kannada (North Canara) district is extending over an area of 10,291 $km^2$ under 11 taluks having 80% of forest area in the Karnataka state, India. Based on forest categories and topography, the district can be divided into 3 distinct agro-climatic zones namely narrow and flat coastal zone (Karwar, Ankola, Kumta, Honnavar and Bhatkal taluks), abruptly rising Sahyadri interior zone (Supa, Yellapura, Sirsi and Siddapur taluks), the flat eastern plains zone (Haliyal and Mundgod taluks), which joins the Deccan plateau. The average rainfall in the region varies from 4000- 5000 mm. The major vegetation types of Uttara Kannada have been broadly grouped as 'natural vegetation' which includes evergreen, moist deciduous and dry deciduous forests, 'plantations or monocultures' which includes plantations of *Tectona grandis* (Teak), *Eucalyptus* sp. (Blue gum) *Casuarina equisetifolia*, *Acacia auriculiformis*, *Acacia nilotica*, and other exotics. From early 80's the region is started experiencing changes in its forest cover through various unplanned developmental activities. This conversion has occurred largely at the expense of forests and grassland (Rao et al. 2013). For studying the land use dynamics, traditionally protected Kan forest patches (total four in number) as well as an area of 25 $km^2$ in Siddapur taluk was selected. The selection was based on available literature, forest department records and field work (Chandran and Gadgil 1998, Devar 2008, Ray et al. 2014).



**Study species:** *Syzygium travancoricum* Gamble (Family Myrtaceae) is a Western Ghats endemic tree species, clustered mostly in the southern area, however, recent discoveries confirmed its presence in wider areas compared to earlier reported distributions (Gamble 1935, Sasidharan 1997, Chandran *et al.* 2008). The tree is hygrophilous in nature, prefers water logged / moist area for its growth. Apart from its distribution from forest areas, the tree has also been reported from sacred groves or religiously protected forest patches. The species distribution in sacred groves is under severe pressure due to gradual shrinkage of the grove area and associated disturbances. In Uttara Kannada the species has been reported from scattered forest patches and protected areas. In view of the current land use practices in the region, it is therefore worthwhile to study the survival potential of the species in humanized landscape.

**Study of Landuse Dynamics:** Land use dynamics of the focal region has been studied using data acquired at regular interval through space borne sensors (Landsat Thematic Mapper and IRS-LISS IV [multispectral]). Landsat data of 1989, 1999 and 2004 were downloaded from the public domain (http://www.landsat.org) and IRS data (2010) were procured from the NRSC, Hederabad (http://nrsc.gov.in). These data were geometrically corrected for the UTM coordinate system of zone 43 using GCPs (ground control points). IRS data (5 mt. resolution) was resampled to 30 mt. as per Landsat data to maintain the similarity among the time series images. Land use analysis involved (i) generation of False Color Composite (FCC) of remote sensing data (bands— green, red and NIR). This helped in locating heterogeneous patches in the landscape (ii) selection of training polygons (these correspond to heterogeneous patches in FCC) covering 15 % of the study area and uniformly distributed over the entire study area, (iii)loading these training polygons co-ordinates into pre-calibrated GPS, (iv) collection of the corresponding attribute data (land use types) for these polygons from the field. GPS helped in locating respective training polygons in the field, v) supplementing this information with Google Earth (http://googleearth.com) and Bhuvan (http://bhuvan.nrsc.gov.in), and vi) 60 % of the training data has been used for classification, while the balance is used for validation or accuracy assessment (Ramachandra et al., 2012). Land use analysis was carried out using supervised pattern classifier—Gaussian Maximum Likelihood Classifier (GMLC) algorithm. Remote sensing data was classified using signatures collected from training sites that include predominant land use types. Mean and covariance matrix were computed using estimate of maximum likelihood estimator. This technique is proved to be a superior classifier as it uses various classification decisions using probability and cost functions (Ramachandra et al., 2012). Spectral classification inaccuracies were measured by a set of reference pixels. Based on the reference pixels, confusion matrix, kappa (K-hat) statistics and producer's and user's accuracies were computed.

**Ecological Niche modeling:** A total of eight occurrence points across Western Ghats have been shortlisted from twenty occurrence points based on their proximity. A 10 km buffer was used to select the points therefore, avoiding spatial correlations. 19 bioclimatic variables were downloaded from the worldclim (www.worldclim.org) dataset and they were shortlisted based on correlation matrix (r>0.7). Maxent (version 3.3.3k) has been used for modeling experiment and the resultant map was classified into suitable and unsuitable areas based on minimum training presence value. Modelling performance was assessed through AUC value. The potential distribution map was superimposed on regional land-use land cover map to select areas for further inventory.



## RESULT

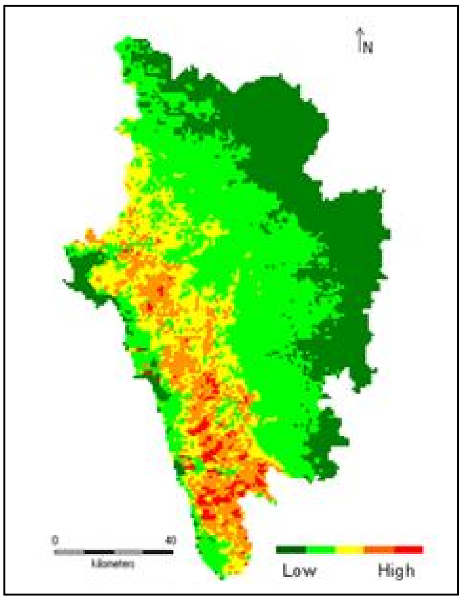
**Land Use Dynamics:** Temporal land use analysis of the 25 km$^2$ area shows that primeval evergreen forest cover is reduced from 10.22 % (1989) to 7.26 % (2010) due to anthropogenic activities. There is significant increment in agricultural activities and land conversions. The agricultural land has increased from 45.47 % (1989) to 63.25 % (2010). The built-up area has also increased from 2.22 to 4.40 % by 2010. A total of 14.38 % of area are covered with plantations (exotic plantations 9.38 % and agriculture 5.0 %). For selected Kan forests, there is a loss of evergreen forest cover ranges from 16% - 36% which is partly compensated by increment of semi-evergreen areas (~15%) in some of the forest patches (Table 1). However, Kan forests in Eastern plain region (Yekkambi, Bygadde etc.) have faced anthropogenic disturbances in comparison to their counterparts in Western Ghats section (Hosur, Kakkali etc.). Apart from change in forest cover, disturbances like agricultural intensification, plantations (both state and privately funded) have prominent role in eastern plain region. On the contrary, Kans in Western Ghats area has shown lesser human mediated disturbances (Fig 1). Overall accuracy of the classification ranges from 87.38% (1989), 91.25%(1999), 88.67% (2004) to 92.47% (2010).

**Ecological niche modeling:** The potential distribution map of the *S. Travancoricum* in Uttara Kannada has covered 9.7% of its total distribution in Western Ghats region. In Uttara Kannada, 27% (i.e. 3,579 $km^2$) of the total distribution area has shown medium to high probability for finding the species (Fig 2). The distribution map of Uttara Kannada was combined with local land use land cover map to find out suitable areas for inventory and restoration. The screening through land use land cover map has ultimately resulted into 1400 $km^2$ area for further inventory. Based on this finding a pilot level inventory has been made in 10 villages in Siddapur taluk and three distinct populations of *S. Travancoricum* has been found from the area.

| | Yekkambi | Bygadde | Hosur | Kakkali |
|---|---|---|---|---|
| Built-up | 1.33513 | 0.8 | 0 | 0.07184 |
| Water | 0.29792 | -0.4 | 0 | 0.14368 |
| Crop land | 7.82827 | 17.27 | 0.08 | 9.61708 |
| Open fields | -0.2483 | -0.88 | 0 | -0.0399 |
| Moist deciduous forest | -0.5442 | | | 3.0825 |
| Semievergreen forest | | -15.31 | 14.9 | |
| Evergreen forest | -27.564 | -19.37 | -15.93 | -24.081 |
| Scrub/grass lands | -0.2482 | 0.35 | 0.64 | 2.75356 |
| Acacia/Eucalyptus plantations | 5.01034 | 15.09 | 0 | 4.91669 |
| Teak/ Bamboo plantations | 5.89077 | 0.63 | 0 | 3.24136 |
| Coconut/ Areca nut / Cashew plantations | 8.09351 | 1.93 | 0.31 | 0.29462 |



Table 1. Temporal change in land use pattern in selected kan forests (% changes occurred between 1989-2010)



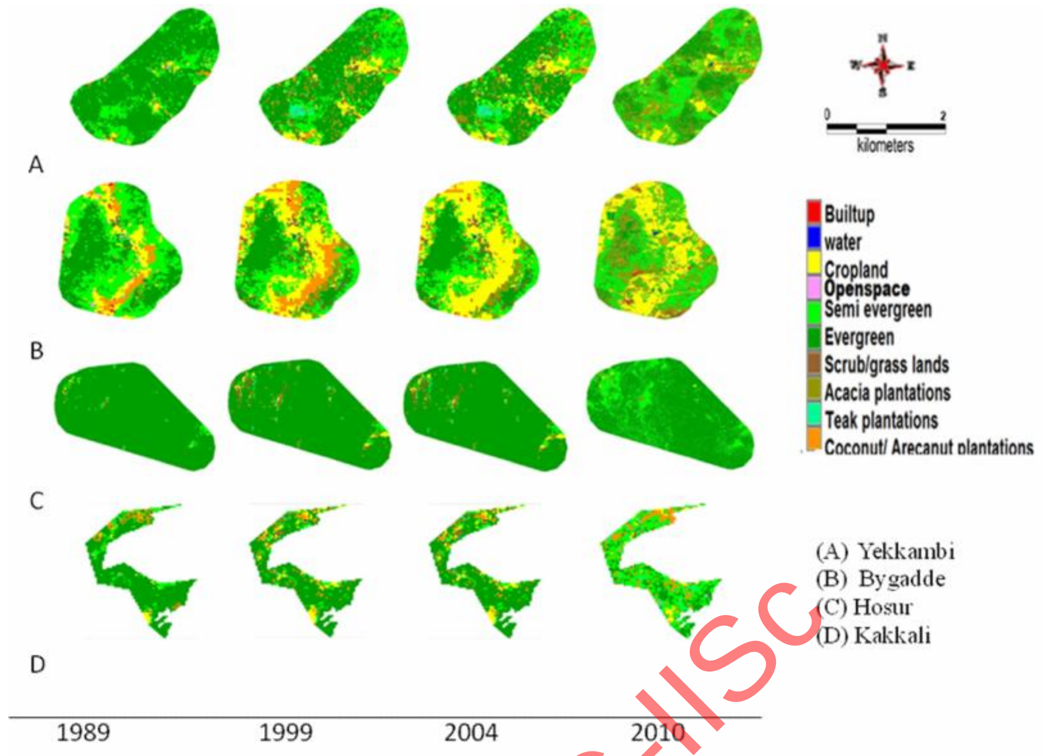



Fig 1. Land use dynamics in selected Kan forest areas



## DISCUSSION

The importance of humanized landscape for biodiversity conservation has been recognized worldwide. However, the issue becomes complex due to involvement of multiple factors apart from species and its interaction with surroundings. The contributing factors range from stakeholders at different level, socio-political scenario to land use decisions at local level. In this study, the temporal pattern analysis of the study landscape provides a thorough idea of the impact of human intervention on land cover and its consequences. The intensification of agricultural and plantation activities reduce forest cover in the region thus results into increment of forest patches. Compare to the western hilly terrain, eastern plain shows more disturbances which present more challenges for environmental planners to develop a suitable strategy for regional species conservation. On the other hand, niche modeling proves to be an effective way out to prioritise areas for survey and exploration work in the region which in course of time will provide a better understanding of the species ecological requirement. The need of the hour is to encourage landscape level research activities and participatory management planning to encompass all possible aspects of resource management.

## ACKNOWLEDGEMENT

We are grateful to (i) NRDMS division, the Ministry of Science and Technology, Government of India, (ii) The Ministry of Environment and Forests, Forest department, Government of India and (iii) Indian Institute of Science for the financial and infrastructure support. We thank Mr. Vishnu Mukri and Mr. Sreekanth Naik for the assistance during field data collection.

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