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Validation of Geospatial model for Biodiversity Characterization at Landscape Level—a study in Andaman & Nicobar Islands, India

P.S. Roy [a,*], Hitendra Padalia [b,1], Nidhi Chauhan [b,1], M.C. Porwal [b,1], S. Gupta [b,1], S. Biswas [c,2], R. Jagdale [d,3]

[a] *National Remote Sensing Agency, Balanagar, Hyderabad 500 037, India*
[b] *Forestry and Ecology Division, Indian Institute of Remote Sensing (NRSA) 4, Kalidas Road, P.O. Box 135, Dehradun 248 001, India*
[c] *Botany Division, Forest Research Institute (ICFRE), Dehradun 248 001, India*
[d] *SandT Park, University of Pune, Pune 411 007, Maharastra, India*

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Abstract

The present paper deals with Biodiversity Characterization at Landscape Level, preparing thematic maps for spatial representation of landscape parameters and then validation of the geospatial model using a three-tier approach, viz., landscape analysis, field data extrapolation and geospatial analysis, for two groups of islands in Indian subcontinent. On-screen visual interpretation approach based on IRS LISS-III and Landsat TM data sets was used to delineate the vegetation communities. Field survey attributes on species diversity, economical/medicinal uses and endemism were suitably linked with satellite image-derived landscape attributes in a geospatial domain. The landscape parameters, viz., fragmentation and disturbance index, clearly indicate that Nicobar Islands are less disturbed compared to Andaman. The phytosociological data of different vegetation types collected from 544 stratified sample points was recorded with ground coordinates. The plant communities of Andaman show high plant diversity in terms of number of species (523 species) and more heterogeneity compared to those of Nicobar (347 species). Biological richness was estimated as a function of six biodiversity attributes (i.e., spatial, phytosociological, social, physical, economical and ecological) to stratify forest vegetation in two phytogeographically distinct groups of tropical islands, viz., Andaman and Nicobar, using a customized software, *SPLAM*.

Validation of ecological indices had always been a major challenge for ecologist. Here, we discuss a validation technique using field-driven species regression equations for fragmentation (FR), disturbance (DI) and biological richness (BR) indices

* Corresponding author. Tel.: +91 40 23875932; fax: +91 40 23875932.
E-mail addresses: psr@nrsa.gov.in, roy_ps@hotmail.com (P.S. Roy), biswassas@rediffmail.com (S. Biswas), rajendra@unipune.ernet.in (R. Jagdale).
[1] Tel.: +91 135 2744518.
[2] Tel.: +91 135 2751213.
[3] Tel.: +91 20 5693449.

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and propose improvements in the biological richness methodology. The research question of establishment of linkages between expressions of diversity at different scales is sought and thereby validating the existing model outputs has been proposed. The sensitivity of in-field measurements with landscape parameters has been explicitly analyzed. During validation, the species richness, diversity and mean basal area have shown slow decrease with sudden rise in intermediate levels followed by a steep decline at increasing levels of fragmentation and disturbance. The empirically derived regression coefficient has significant correspondence ($p < 0.05$) in terms of community response in both island's groups. The vegetation communities in the forested landscape possess significant linkages with landscape scale processes, viz., FR and DI, as evident by the degree of correlation. The heterogeneity measured as diversity in habit group shows community dimensions in different spatial zones. The generation of baseline data on community ecology allows prioritization of planning process and evolves specific management practices. It may be concluded that the improved biodiversity assessment model and the designed validation techniques have enhanced the reliability of model thus widened the scope for its application in the rapid biodiversity assessment.

Keywords: Biodiversity; Fragmentation; Disturbance; Biological richness; Andaman & Nicobar Islands; Validation; Regression analysis

1. Introduction

Ever since the call of United Nations Convention on Environment and Development (UNCED), inventory and assessment of existing levels and spatial pattern of biodiversity in various parts of the world are increasingly being done using various ecological modelling techniques (Noss et al., 1995; Ricketts et al., 1999; CBD, 2001; Anon., 2003). The understanding of the priorities of biodiversity conservation and management has resulted in a shift on approach from conservation of a single species to habitats through interactive network of species at landscape level (Orians, 1993; Edwards et al., 1994). Landscape ecology sought to understand the ecological functions of larger areas (Romme and Knight, 1982; Forman and Godron, 1986). *Biological richness* is a cumulative property of an ecological habitat and its surrounding environment, which has emerging implications for conservation and planning. The choice of precise, ecologically sensible and interpretable model is pertinent for biodiversity assessment (Austin and Gaywood, 1994). But lack of validation and uncertainty in the assessment of such relationships of different biodiversity attributes remains a serious issue in ecological modelling (Felding and Bell, 1997). Developing statistical methods to test the validity of such models has been a difficult task (Fielding, 2002). The major development in the advancement of regression analysis has been using various linear models (Yee and Mackenzie, 2002) for modelling spatial distribution of species and communities (Guisan et al., 2002). The polynomial regression provides a summary of the trend as well as means of explaining the value at any location within the modelled spatial patterns, whereas explanatory models provide insights into the ecological processes that produce patterns (Austin et al., 1990). The relationships determined using statistical models could ascertain the strength of the relationship between a response (e.g., plant community parameters) and explanatory variables derived through landscape metrics (e.g., patch shape, size and diversity).

The landscape pattern properties were analyzed using various quantitative indices that measured the heterogeneity of landscape within a specific distance (Baker and Cai, 1992). Fragmentation increases the vulnerability of patches to external disturbance with consequences for the survival of these patches and of the supporting biodiversity (Nilsson and Grelsson, 1995). Patchiness contributes to the diversity (Hansson, 1996) and controls the flow of materials, energy, organisms and information through the environment (Wiens et al., 1985; Wiens, 1994). Similarly, a landscape with higher porosity value indicates high level of interaction among landscape elements, thus, heterogeneous habitats with high degree of fragmentation (Forman and Godron, 1986). Interspersion and juxtaposition are measures of the connectivity of areas of similar type. Interspersion is a measurement of spatial intermixing of the vegetation types that represents landscape diversity and dispersal ability of the species (Mead Roy et al., 1981). Studies have been carried out computing various landscape metrics, namely patch shape, size, amount of edge, isolation, arrangement, fragmentation, porosity, patchiness, interspersion and juxtaposition (Forman