Estimation of bamboo resources in Kerala by remote sensing techniques

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ESTIMATION of bamboo *Bambusa bambos*, an important raw material for paper and pulp industry, is traditionally carried out by field surveys. This is a laborious and time-consuming task. The objective of this project is to develop a method for rapid assessment of bamboo availability. Satellite images from IRS 1C, launched in 1996, made available images of sufficiently high resolution, which could be used for estimation of resources at species level. Bamboo is a plant with many peculiarities. It grows for 40–45 years, flowers gregariously and dies. It would take several years for it to establish again. As per forestry regulations, a prescribed number of culms are extracted once in few years from each clump. Bamboo has many peculiarities which make them distinct in satellite images. Some of these are: (i) bamboos occur in a deciduous environment, but bamboos bear green leaves when surrounding trees are in the process of shedding leaves, (ii) bamboos bear narrow leaves and amidst broad-leaved trees they produce distinct reflectance pattern in satellite images, (iii) the radiating appearance of bamboos makes them distinguishable in aerial photographs and satellite images.

The Wayanad region which is a prime habitat of bamboo was taken up as a test case to standardize the methodology and to check the feasibility. Three ranges, Muthanga, Sultans Battery and Kurichiat in the Wayanad Wildlife Sanctuary were taken up for the study. The region is mostly gently undulating with altitudes ranging from 800 to 1000 m. The region is drained by the east flowing Nul Puzha river and its tributaries. Bamboo is seen mostly along the rivers and streams. In some parts of the study area bamboo had flowered in 1993. The main source of data was satellite images taken by the Indian Remote Sensing Satellite (IRS 1C). In the present study, images in green, red, near infra red and middle infra-red regions (0.52–0.59 μm, 0.62–0.68 μm, 0.77–0.86 μm, 1.55–1.7 μm) of the LISS III sensor of IRS 1C were used. Satellite images taken in February 1997 were obtained from the National Remote Sensing Agency (NRSA) in CD ROM format. In addition to this, aerial photographs in 1 : 15,000 scale taken during 1990–92 available in the institute were also used. For the present study, IDRISI[1], a rastor-based GIS package and GIS Link[2], a set of programs developed at the Kerala Forest Research Institute for supplementing GIS and image processing packages were used. The area was practically devoid of other species of bamboos.

The estimation of bamboos is done forest range wise. In cases where the vegetation of few adjoining ranges is similar, image of these ranges can be extracted together and the initial steps carried out. For other areas individual ranges are separately extracted. Methods used for estimating bamboo resources could be classified into four steps. The first step consists of extraction of LISS III images from CDs and preparation of RGB composite. The second step is field visits for ground truth collection, third step is supervised classification of the images and fourth step is estimation of area. Maps of the area are digitized using a module of GIS Link. These maps were used as masks to eliminate regions outside range boundary, for preparing maps for registration and legends and boundaries during final printing. In the present study, 16 training sites of bamboos, forests, plantations and agriculture classes were defined. The maximum likelihood algorithm was used for classification. The bamboo is classified into four density classes. They are bamboo brakes, more than 50% area covered by bamboos, 25–50% area covered by bamboos and sparse bamboo areas. The quantity of bamboo in class I plot of 100×100 m was estimated by complete enumeration. The quantity was estimated to be about 100 tons of green bamboo per hectare. Other studies confirm this as a reasonable estimate[3]. The classified, resampled, reclassed, masked image gives bamboo under different categories in terms of number of cells. Area of one cell can easily be calculated using standard GIS procedures. Bamboo is found primarily distributed along courses of rivers and streams.

Bamboo in the maximum density class in the three ranges Muthanga, S. Battery and Kurichiyat ranges are 12.7 km^2, 7.87 km^2 and 15.23 km^2 respectively (Table 1). Other categories also show difference between the ranges. This is to some extent due to flowering and dying of bamboos in parts of these ranges during 1992–1993. Figure 1 shows the status of bamboos in the Muthanga range. Other landuse categories in the figure have been merged to show bamboos clearly.

Initial attempts with limited field knowledge led to misclassification of sprouting eucalyptus as bamboo. However, when the eucalyptus was included in the training sites, the computer was able to classify them accurately. Paddy is also expected to have signature similar to that of bamboo. In the present study this effect was avoided by masking of all cultivation areas.

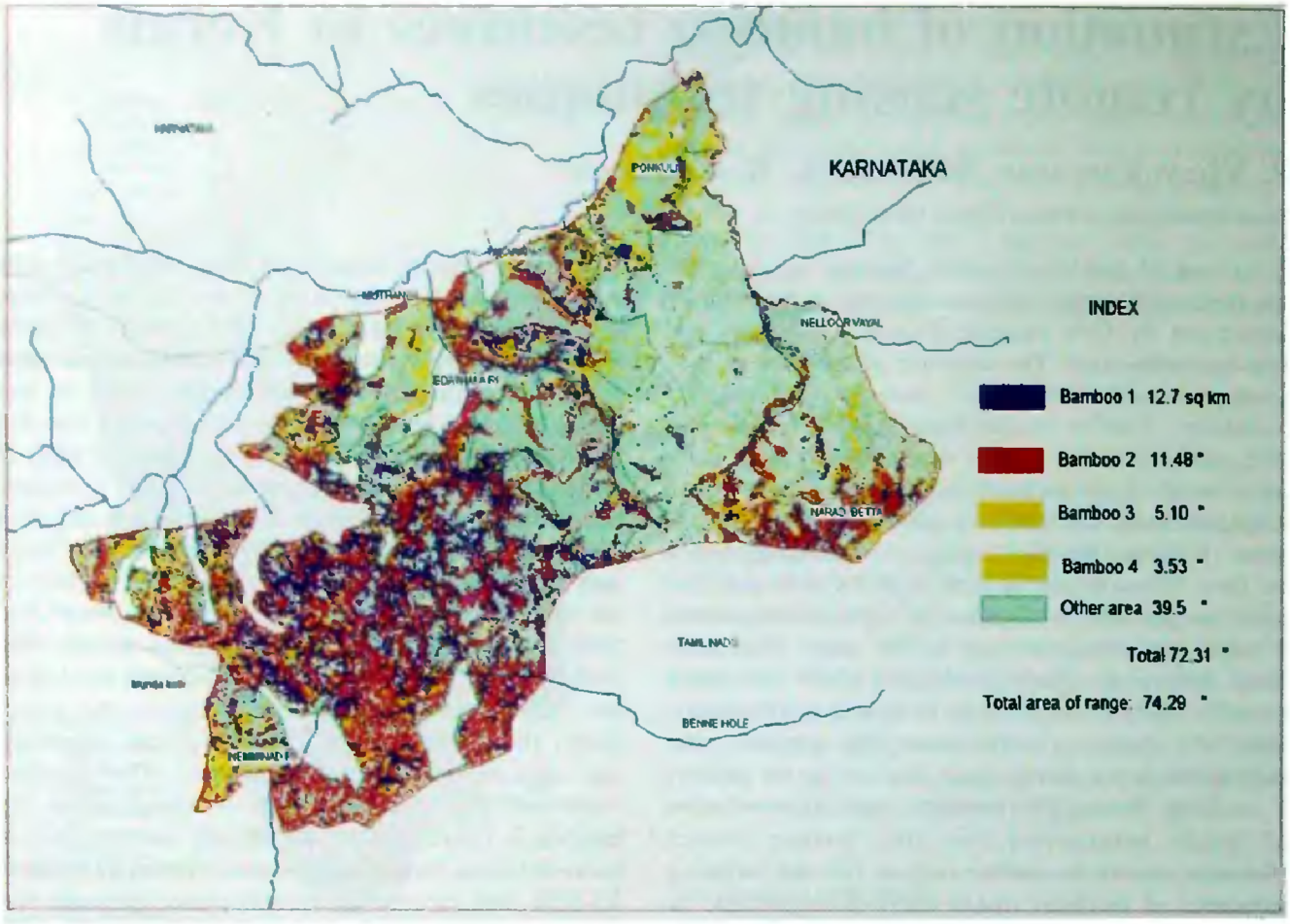

Figure 1. Status of bamboo in the Muthanga Range.

Table 1. Estimated area under different classes of bamboo in the three ranges

Class	Muthanga Range (km^2)	S. Battery Range (km^2)	Kurichiyat Range (km^2)	Total (km^2)
Non bamboo	39.50	51.43	46.98	137.91
Bamboo brakes	12.70	7.87	15.23	35.80
Bamboo > 50%	11.48	6.36	26.20	44.04
Bamboo < 50%	5.10	4.72	9.07	18.89
Bamboo sparse	3.53	12.90	7.10	23.53
Estimated area (km^2)	72.31	83.28	104.58	
Area of range (km^2)	(74.29)	(86.03)	(106.56)	

The maps obtained were very realistic and no maps with this much degree of details were available previously. Most of the major patches were ground checked for confirmation. Comparison with old aerial photographs turned out to be difficult as bamboo in many areas had flowered and disappeared.

IDRISI had to be supplemented with routines for image extraction, digitizing maps and preparing masks, preparation of correspondence files, and generation of hard copy output with programs from GIS Link which is maintained as a shareware program. Once the large number of steps involved in the processing are standardized, resource estimation over large areas can be carried out rapidly. Nearly 100 files of images, signatures and pallets have to be systematically named and stored in separate sub directories for each range. For example FCC, FCCR, FCCRM correspond to original, resampled and masked FCC; SUP, SUPR, SUPRC and SUPRCM stand for supervised, resampled, reclassed and masked files.

1. Eastman, J. R., *IDRISI for Windows, Users Guide Version 1.0*, Clark labs for cartographic technologies and geographic analysis. Clark University, Massachusetts, USA, 1995.
2. Nair, P. V., *GIS-LINK. User Manual*, Kerala Forest Research Institute, Peechi, 1998.
3. Prasad, S. N., *Conservation of Bamboo Resources of Karnataka*, Final report of Working Group on Bamboo Resources, Karnataka State Council for Science and Technology, Bangalore, 1981.

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