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Identification of coconut plantation in Kasaragod district of Kerala with the help of satellite image

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Coconut (*Cocos nucifera* L.) is an important horticultural tree crop of humid tropics. It is versatile in its adaptability to a wide range of soil and climatic conditions. It thrives well in coastal alluvium of both the west and east coasts, river alluvium of the deltaic regions and the laterite and red loam soils of the inland areas. It is estimated that 70% of the cropped area in the Kasaragod district is under sandy loam soil, where the water retention is very poor. Even though coconut tolerates negligent farming, it responds favorably to scientific management (Thampan, 2). Coconut palm exhibits wide variability in its productivity ranging from 30 to 200 nuts and there are palms that produce 400 nuts also (Iyer, 3). The west coastal state of Kerala has the largest area in the country with 10.1 lakh ha (26.3% of the total area of the state) producing 5,759 million nuts (5,702 nuts/ha) during the last decade.

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Along with coconut, rubber, cashew and spices like pepper and cardamom are also important crops in Kerala. Hence, monitoring of all these crops are essential to understand the real position of the crops. The modern tool of remote sensing is a better option to try to understand the trend of growth of all these crops. It has a capability to provide real-time data with synoptic and repetitive coverage, which gives significant advantage over traditional methods. In the present study, it has been attempted to identify the coconut plantations in the Kasaragod district of Kerala to make a model for identifying it amongst the other plantation crops of the district.

MATERIAL AND METHODS

The Kasaragod district is the northern most district of Kerala extending from 11°30' north to 12°48' north latitude and from 74°56' to 76°30' east longitude bordered on the north and east by the Dakshin Kannada district of Karnataka on the south by the Kannur district of Kerala and on west by the Arabian sea. The district has a total geographical area of 1,992 sq. km. The annual rainfall ranges between 3000-3500 mm with the mean annual temperature of 26°C. Soil is lateritic loamy. Satellite images of Kasaragod have been collected from the National Remote Sensing Agency (NRSA), Hyderabad, with the help of longitude and latitude and path-row for the month of March 1999 IRS-1C LISS III FCC digital data. The images were overlapped and corrected with the help of a boundary map of Kasaragod district of the same scale, i.e. 1:25,000 with the help of IDRISI32 software. The image enhancement of classification was done for getting the proper idea of vegetation. These interpreted maps were taken to the field and checked for coconut plantation and other vegetation for obtaining the exact areas.

RESULTS AND DISCUSSION

The land cover class vegetation can be made up of several land use classes. It can be natural vegetation, forestry or agricultural vegetation. Within these classes, vegetation can be separated based on species, biomass, disease infestation etc. In all the cases most interesting data can be found in the visible, near infrared and middle infrared regions. Species distribution and health conditions are some examples of vegetation remote sensing applications. The Thematic Mapper operates in seven spectral bands. The band designations, spectral ranges, and principal applications are given in Table 1. Spectra for vegetation come in two general forms: green and wet (photosynthetic) and dry non-photosynthetic vegetation, but there lies a seemingly continuous range between the two. The reflectance spectrum of foliage shows a low reflectance (0.05) in the

Table 1. Thematic Mapper Band Designations, spectral ranges and principal applications.

Band No.	Spectral range (μm)	Principal applications
1	0.45-0.52	Coastal water mapping, differentiation of soil from vegetation and differentiation of deciduous from coniferous flora.
2	0.52-0.60	Vegetation vigor assessment.
3	0.63-0.69	Vegetation discrimination.
4	0.76-0.90	Determining biomass content and delineation of water bodies.
5	1.55-1.75	Indicative of vegetation moisture and soil moisture. Useful for differentiation of snow from clouds.
6	10.40-12.50	Vegetation stress analysis, soil moisture discrimination and thermal mapping.
7	2.00-2.35	Discriminating rock types, and hydrothermal mapping.

(Landsat thematic mapper data applications, 1988, National Remote Sensing Agency, Andhra Pradesh).

visible part of the spectrum (400-700 nm), while for solar irradiance it is maximum. Light is absorbed by vegetation for photosynthesis. In the near infrared (NIR), foliage has a high reflectance (~ 0.5), with a very rapid transition between red and NIR regions at (-750 nm). This is completely different from the reflectance spectrum of the background material, i.e. soil, against which the leaves are usually observed. Soil reflectance gradually increases at higher wavelengths over the same region, though its absolute reflectance varies with soil type and moisture content (wet soil being darker than dry soil). Hence, the ratio or difference between the two spectral bands on either side of 750 nm gives a measure of the quantity of foliage present.

Different surface types, such as water, bare ground or vegetation reflect radiation differently in various channels. The radiation reflected as a function of the wavelength is called the spectral signature of the surface (Table 2). Vegetation has a remarkably high reflection in the near infrared channel band 4 and a low reflection in the visible red channel band 3. This makes it possible to distinguish

Table 2. Wavelength and reflected colour as spectrum

Wave length (nm)	Visible/invisible spectrum (colour)
400-500	Blue
500-600	Green
600-700	Red
700-1100	NIR
1100-3000	MIR

vegetation areas from bare ground. The difference of reflection in channels 3 and 4 is higher for vegetation areas but insignificant for bare ground.

In reality, the images generated by remote sensing measurements in blue, red and green bands are combined by superimposing the transmission through blue, green and red filters, respectively and giving the image a spray of colours from which it is very difficult to understand any particular class. But by assigning colors complementary to observation band, one can improve the visual perception, which is known as FCC (False Colour Composite), where by assigning blue, green and red color to observation in green (0.52-0.59 µm), red (0.62-0.68µm) and near infrared (0.77-0.86am) spectral band, respectively of IRS LISS sensor.

The vegetation normally reflects predominantly in near-infrared region as compared to green or red spectral bands. Hence, vegetation appears red in standard FCC due to assignment of infrared band to red color The agriculture and forest would appear in pink to red depending on leaf greenness (as green band has been assign to blue colour, the blue-red composition will lead to pink colour and dark blue and red as blackish red) As the coconut cultivation is very vast in Kasaragod, the prediction of coconut from the FCC image is very easy. The important crops of Kasaragod and its approximate area can be used to obtain an idea.

With the knowledge of the main crops grown in Kasaragod (Table 3) and with the survey data of the district, it is easy to identify coconut plantation of Kasaragod in the FCC image itself (Fig. 1). A little

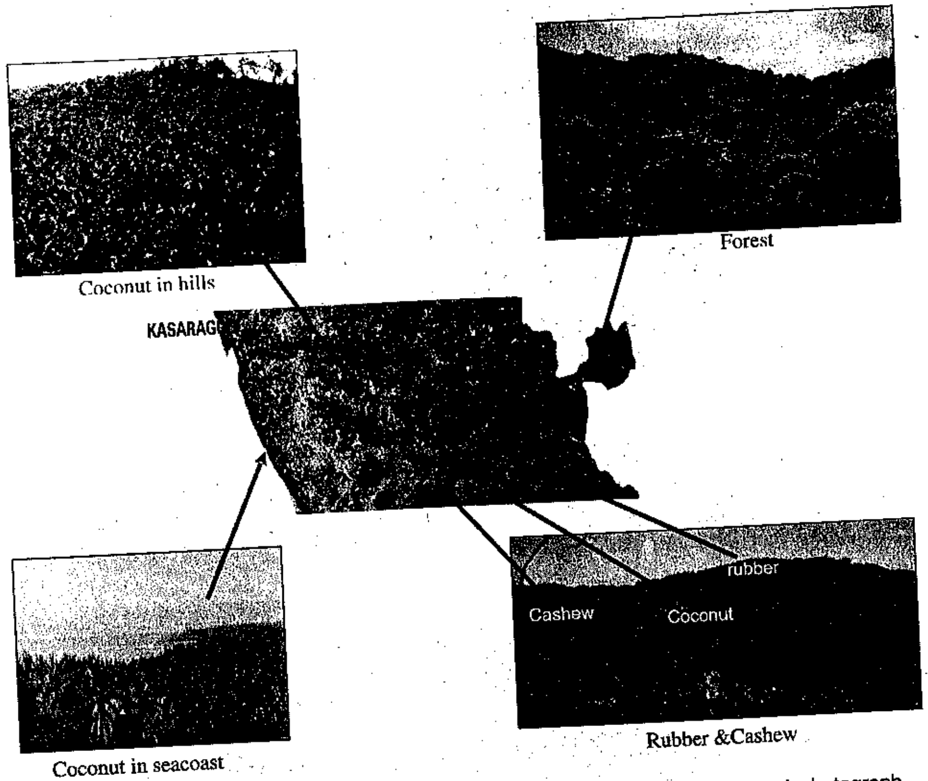

Fig. 1. Classified image of Kasaragod along the Chandragiri river and the ground photograph

Table 3. Area and production of major crops in Kasaragod district.

Crop	Area (ha)	Production
Paddy	8,386	15,996 tonnes
Cashew	1,9962	10,530 tonnes
Rubber	22,284	23,732 tonnes
Coconut	60,196	391 million nuts

Source: Dept. of Economics and Statistics, Kerala

lighter tone of red or the pinkish tone was taken as coconut area, while bright red was for rubber and a little light was for cashew. However, the ordinary camera photos gave the proof that coconut has lightest shed of red next was cashew but rubber was noted with very dark red. Similar pattern was also reported by the study carried out in Kerala State Remote Sensing and Environment Centre (Anonymous, 1999). The digital image processing involves the modification of digital technology for improving the image

Table 4. Classification of image and crops.

Signature name	Red	Green	Blue	Shade	Classification
Class-1	0.680	0.453	0.553		Paddy
Class-2	0.666	0.557	0.633		Coconut
Class-3	0.730	0.608	0.669		Rubber
Class-4	0.779	0.432	0.550		Cashew
Class-5	0.778	1.000	1.000		Sandy barren land
Class-6	0.631	0.992i	0.848		Sallow area
Class-7	0.554	0.845	0.719		Settlements & road

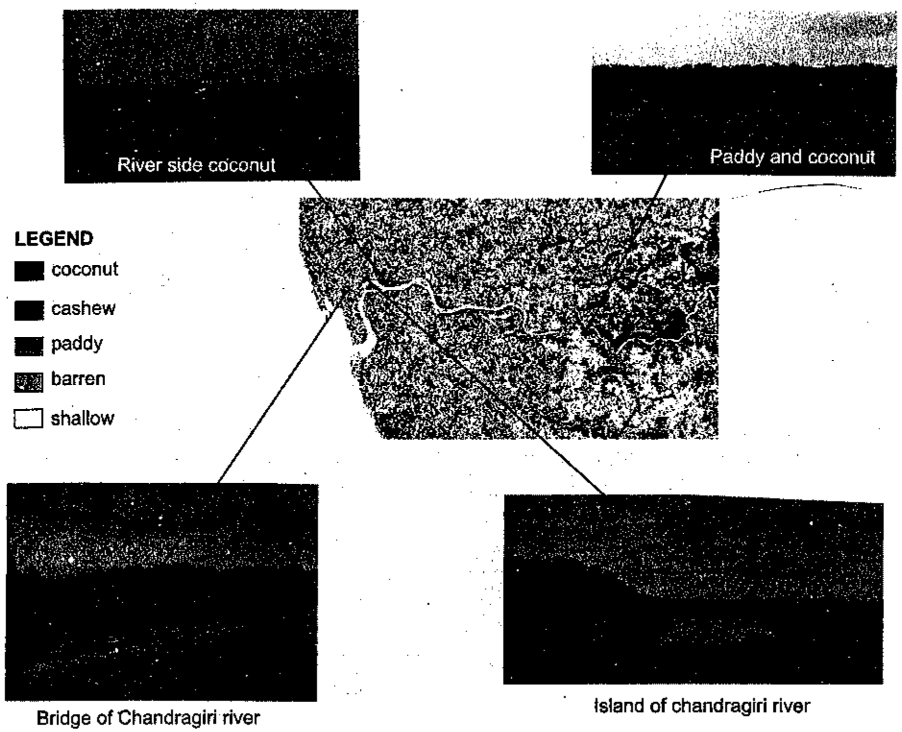

Fig. 2. Classified image of Kasaragod along the Chandragiri river and the ground photograph

qualities with the aid of computer, which is also known as image enhancement. Classification, namely, the pattern of recognition is one of the most often used methods for information extraction. A manually digitized basic attribute table was created and a classification of the image was done mainly giving the importance to the red tone of the FCC image of a portion of the district image. The table 4 gives the values as obtained with the help of ERDAS software.

The classified image attribute colours are given of own choice but the value of red, green and blue are the mean values of the same impression (signature) of the FCC image. The ground truth of the classified area taken and it also gave a satisfactory result (Fig. 2).

SUMMARY

Detection and quantitative assessment of green vegetation is one of the major applications of remote sensing for environmental resource management and decision-making. The spectral signature for the green plants are very characteristic and hence it is easy to understand and predict the area under a particular crop with the help of FCC image and classified image, when the knowledge about the crop is available as in the case of coconut in Kasaragod. A high resolution data such as 1: 25,000 and outline idea of the vegetation set up of the place is essential for such prediction. The coconut plantations of Kasaragod district were well understood in the FCC image and DN value classification on the computer screen with the help the ERDAS software. The colour variation was found very clear and the ground survey reports were also in agreement with the image.

Mapping of coconut resources in other parts of the country would be possible with the information generated from the present study, which could be used for planning coconut based industry.

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