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Coconut area mapping and change detection analysis of coconut growing areas of Coimbatore and Tirupur district of Tamil Nadu, India

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ABSTRACT

Coconut, an important perennial tree largely grown in Tamil Nadu to the extent of 4.61 lakh hectares. In this study, attempt has been made to create a spatial data base on spatial changes of coconut acreage in Coimbatore and Tiruppur districts of Tamil Nadu. The methodology involves digital classification of satellite image and identifying coconut plantations and creation of spatial database of coconut area in Coimbatore and Tiruppur districts for the period 2019 and compare the same with 2013 data. Total area of coconut under Coimbatore and Tiruppur was found to be 80,065 and 58,357 ha respectively. A comparison between area obtained from this study and the area statistics released by Coconut Development Board data was done using paired t-test and the p-value was 0.005, which showed that there was no significant difference between the two data and the RMSE value was also found to be low, which indicated that this methodology can be adopted for mapping the coconut area. Change detection analysis showed that the area decreased in Coimbatore to the tune of 5.4 per cent, whereas there was not much change in Tiruppur district and reduction in area was only 0.2 per cent. The accuracy was worked out by comparing the assessment based on the Remote sensing data and the government estimates which showed a difference of 9.54 per cent indicating the accuracy of 90.46 per cent.

Key words *: Coconut Remote sensing, Overlay analysis, Change detection*

Introduction

Coconut (*Cocos nucifera* L), a perennial crop is being cultivated largely in the tropics and subtropics of India, the Philippines, Malaysia, Sri Lanka, and Indian Ocean and South Pacific islands. It is a multi-utility palm and plays a noteworthy role in the 10 million farming communities in India and economy of those countries mentioned above (Naresh Kumar *et al.*, 2008). Coconut based products demand is increasing annually and is projected to increase to about 17 billion nuts by 2020 (Naresh Kumar *et al.*, 2008). Coconut is also known as ''Kalpavriksha,'' a term derived from the ancient Indian language Sanskrit meaning ''Heaven's Tree'' which provides humans with everything they want. It is the most important crop cultivated in states of South India (Tamil Nadu, Kerala, Karnataka and Andhra Pradesh) which plays a significant role in the agrarian economy of these States. The palm flourish well where rainfall is plentiful (>200 cm annually) and well distributed. In summer months, if rainfall is scare, the palm needs

good irrigation. Lack of irrigation is one of the major reasons attributed to the low level of productivity of coconut (Carr, 2011; Surendran *et al*., 2019).

Coconut is grown in more than 80 countries around the world and in India it is largely grown in Kerala (7.708 lakh ha) followed by Karnataka (5.138 lakh ha) and Tamil Nadu (4.61 lakh ha) (CDB,2020). Coconut, an important perennial tree largely grown in Tamil Nadu to the extent of 4.61 lakh hectares. In Tamil Nadu it is grown in almost all the district and majorly in Coimbatore, Tiruppur, Thanjavur, Dindigul and Kanyakumari. The complexity of the data requirement for decision-making and planning for management of coconut ecosystem makes the conventional method of collecting data rather difficult. More over collection of information through hierarchy of aggregation of farm, village, block, district, state and national level create undue delay and approximation of information. The use of satellite based remote sensing technique has proved itself as a strong and unbiased information system at regular intervals of time. Remote sensing techniques have been operationally used in many countries to provide basic information on crops, soils, water resources and the impact of drought and flood on agriculture.

A study to test the stability of a spectral mixture modeling method was taken up to generate land-cover maps of coconut in Kasaragod district, Kerala. High level of accuracy was achieved for the coconut land-cover analysis using SMA of DN values. (Palaniswami *et al*., 2006). Balajikannan *et al.* (2017) mapped the coconut growing areas of Tamil Nadu for the year 2013 and generated district wise coconut map and statistics using remote sensing and GIS techniques. In recent years the area under coconut is changing spatially and temporally due to drought and pest attack (whitefly) and this result inthe reduction of the area as well as the production of coconut plantations. Spatial information on coconut area changes and destroyed plantations are lacking and which is possible by change detection analysis using temporal satellite images. In order to assess this changing trend spatially the current investigation was carried out to map the coconut growing areas and to study the changes in major districts *viz.*, Coimbatore and Tiruppur using remote sensing and GIS techniques which is reliable, can give near-real time data and cost effective.Hence, this research study was attempted to create a spatial data base on spatial changes of coconut acreage in Coimbatore and Tiruppur districts of Tamil Nadu.

Materials and Methods

The methodology involves i) digital classification of satellite image and identifying coconut plantations and creation of spatial database of coconut area in Coimbatore and Tiruppur districts and ii) Integration of the coconut area map generated during 2013-14 through overlay analysis and studying the changes happened over the years spatially.The base layers used for this project will be the digital map of district and block boundaries for two districts and the Survey of India Toposheet grid (1:50,000 scale) to assist the image interpretation work in a systematic manner so as to ensure complete coverage of the study area. The flow chart showing the methodology to be adopted in coconut area mapping and change detection is presented in Fig. 1.

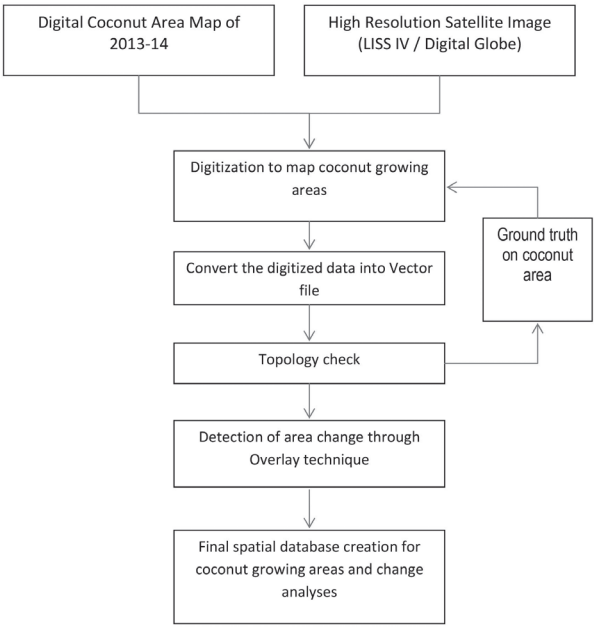

Fig. 1. Flow chart explaining the methodology for creating coconut spatial database

The remote sensing data used for generating coconut area will be of high resolution satellite image (LISS IV data and Digital Globe data). The cloud free satellite images were collected in the temporal window from June 2018 to July 2019. The data obtained needs to be converted into reflectance value to calculate the vegetation indices. This process has been done by using the following equation

$L\lambda = MLQcal + AL$

where,

$L\lambda$ = TOA spectral reflectance (Watts/ m^2 * srad * μm).

ML = Band-specific multiplicative rescaling factor from the metadata

AL = Band-specific additive rescaling factor from the metadata

Qcal = Quantized and calibrated standard product pixel values (DN)

Results and Discussion

Area statistics of Coconut growing areas of Coimbatore and Tirupur districts

The coconut growing areas obtained in the form of map was then used for estimating the area. Since the data is in spatial form, area calculation for each administrative block of Coimbatore and Tiruppur districts of Tamil Nadu was generated. Table 1 shows the block wise area of coconut in both the districts of Tamil Nadu. In the case of Coimbatore district, Anamalai, Pollachi (N), Kinathukadavu and Pollachi (S) registered higher coconut area and the least area of 582 ha was observed in Annur block.

With respect to Tiruppur, Udumalai and Gudimangalam registered higher coconut area and Uthukuli block registered the lowest area of 542 ha, respectively. Total area of coconut under Coimbatore and Tiruppur was found to be 80,065 and 58,357 ha respectively. Detection of coconut area based on the spectral signatures is depicted in Figure 2.

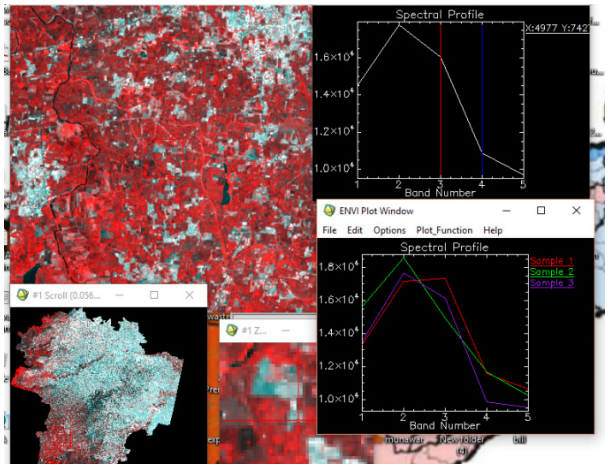

Fig. 2. Detection of Coconut area using spectral signatures

As mentioned earlier, it was observed that Coimbatore has largest area under coconut among the two districts (Fig.3). This was in accordance with the earlier findings of Balajikannan *et al.* (2017). A comparison between area obtained from this study and the area statistics released by Coconut Development Board / Agriculture department data was done using paired t-test and the p-value was 0.005, which indicated that there is no significant difference between the two data. Even though numerically there was difference between the set of data, RMSE was found to be low, which means that this

Table 1. Block wise Coconut area of Coimbatore and Tiruppur districts of Tamil Nadu

Sl. No.	Coimbatore district		Tiruppur district	
	Name of the Block	Coconut Area (ha)	Name of the Block	Coconut Area (ha)
1.	Anamalai	18579	Avinashi	1129
2	Annur	582	Dharapuram	3662
3	Karamadai	3177	Gudimangalam	11750
4	Kinathukadavu	11501	Kangeyam	4304
5	Madukkarai	4141	Kundadam	4429
6	Periya Naickenpalayam	1206	Madathukulam	4095
7	Pollachi (N)	14615	Mulanur	992
8	Pollachi (S)	9446	Palladam	1658
9	Sarkar.Sama.Kulam	1229	Pongalur	5310
10	Sulur	3038	Tiruppur	1147
11	Sulthanpet	6804	Udumalai	16952
12	Thondamuthur	5747	Uthukuli	548
13	-	-	Vellakovil	2381
	Total	**80065**		**58357**

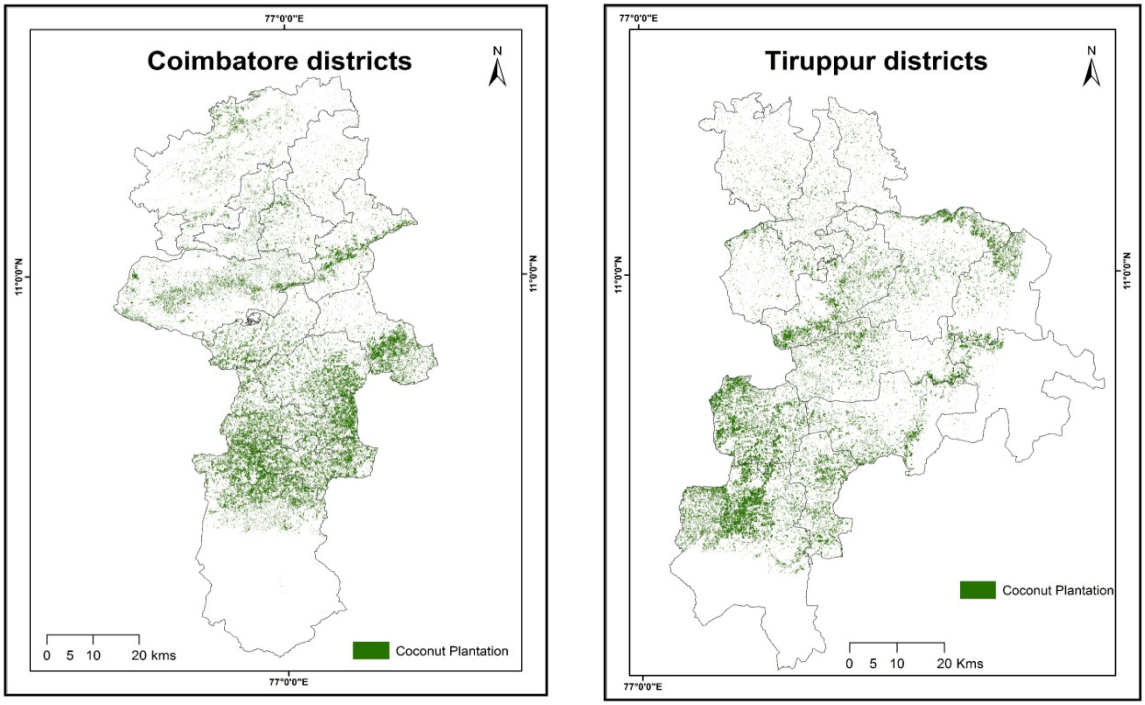

Fig. 3. Coconut growing areas of Coimbatore and Tirupur district

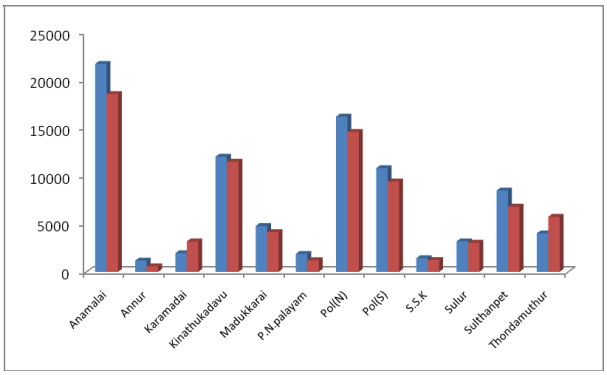

Fig. 4. Comparison of RS processed data and government source data of Coconut growing areas of Coimbatore district

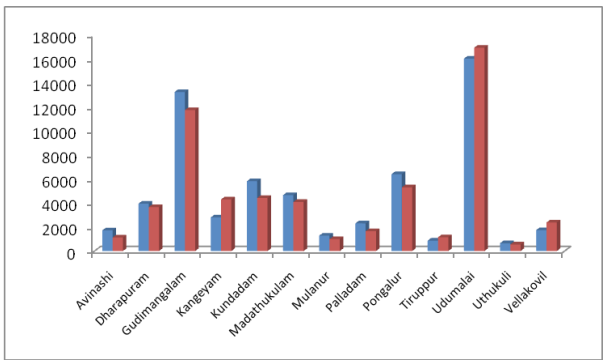

Fig. 5. Comparison of RS processed data and government source data of Coconut growing areas of Tiruppur district

methodology can be adopted for mapping the coconut area (Fig.4 and 5).

Change detection in coconut area from the base year 2013-14

The data on mapping of coconut area on the year 2013-14 has been utilized to understand the change detection with respect to the current study over the year and the results were presented in Table 2. As per the data, the area decreased in Coimbatore to the tune of 5.4 per cent, whereas there was not much change in Tiruppur district and reduction in area was only 0.2 per cent.

Table 2. Change detection in coconut area

	2013-14	2018-19	% Change
Coimbatore	84653	80066	5.4
Tiruppur	58550	58358	0.2

The results showed that the mapping of coconut growing areas can be successfully done using re-

mote sensing and GIS tools. The technique of remote sensing and GIS has proved to be a better tool for mapping of coconut growing areas.

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