The Pharma Innovation Journal 2019; 8(6): 363-367

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(6): 363-367

www.thepharmajournal.com
Received: 04-04-2019
Accepted: 08-05-2019

Nithya Selvaraju
Research Scholar, Dept. of Remote Sensing and GIS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

KP Ragunath
Assistant Professor, Dept. of Remote Sensing and GIS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

S Pazhanivelan
Professor, Dept. of Remote Sensing and GIS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Balaji Kannan
Associate Professor, Dept. of Soil and Water Conservation Engineering, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Venkatesan
Senior Research Fellow, Dept. of Remote Sensing and GIS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Correspondence
Nithya Selvaraju
Research Scholar, Dept. of Remote Sensing and GIS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Mapping of sugarcane area using sentinel 1a SAR satellite data

Nithya Selvaraju, KP Ragunath, S Pazhanivelan, Balaji Kannan and Venkatesan

Abstract
A research was conducted to mapping of sugarcane areain Cuddalore district of Tamil Nadu using Sentinel 1A C band VH polarized SAR satellite data during January 2018 December 2018. 29 temporal series data downloaded from https://scihub.copernicus.eu/dhus/, were pre-processed to derive dB and σ° values by using the customized Maps cape software. The dB value was found to be minimum of -17.7738 at planting to germination stage (4-5 weeks Feb and Mar) and maximum of -12.8387 at grand growth phase (5^{th} month onwards Aug, Sep, Oct). Phonological variation of sugarcane crop and the multi temporal features were extracted from temporal dB of VH polarized images. Total Sugarcane area was assessed to be 11,849 ha. Accuracy of the map to validate with the ground controls had been done by the confusion matrix, which having the overall accuracy around 88.25% and the kappa co-efficient of 0.77.

Keywords: Sentinel 1A SAR data, VH polarization, dB value, and mapping

Introduction
Sugarcane is one of the important sugar crop and it also gives the by-products of bagasse, molsses and ethanol, nowadays ethanol is used instead of petroleum. In India, Sugarcane is grown around 47.74 lakh hectares in major states of Uttra Pradesh, Maharashtra, Karnataka, Bihar, Gujarat, Tamil Nadu and others with an overall production of 3550.9 lakh tonnes during 2017-2018 (Department of Agriculture and farmers Welfare). In Tamil Nadu, nearly 1.83 lakh hectares were occupied by sugarcane with a production of 165.2 lakh tonnes. Districts like Trichy, Karur, Erode, Cuddalore, Viluppuram, etc, are represented as major sugarcane growing areas. The sugarcane cultivated area for cuddalore district was recorded as 16280 ha during 2017-2018. Area estimation is a complex process due to reduced cropping period of many crops. So, the spatial technology is considered to be more advantageous over other conventional methods. Remote sensing plays an important role in agriculture for crop identification, crop monitoring and area mapping. The climate and environment dependent sensors like, optical, multispectral and hyper spectral images are used for crop identification. Object based image analysis and Data mining are employed with Landsat TM and ETM+ which improved the identification and monitoring of sugarcane crop (Vieira *et al.*, 2012) [8]. With the advent of MODIS time series data, classification of Sugarcane crop was made possible. From the MODIS data, Enhanced Vegetation Index (EVI) was derived and the unsupervised classification of Tree forest, Soybean like large planting and harvesting period crop resulted in a negative correlation with the sugarcane crop. Whereas, it was quite opposite for Pasture and grass land (Xavier *et al*., 2006) [9]. To overcome these, Microwave remote sensing considered to be more advantageous over optical, multispectral and hyper spectral remote sensing. It works in all the adverse climatic condition, as it can penetrate into the clouds and rain splashes. From various processing and classification algorithm, crops can be effectively identified in the spatial scale from the backscattering co-efficient of the RADAR data. The identification and monitoring of sugarcane crop by remote sensing can be done with different bands (C, L, X, P) of microwave data. Backscattering response from the different crops varies at different incident angle, polarizations and wavelengths of the sensors. The sugarcane crops can be effectively identified by LAI from the HH-HV polarized ASAR data using the empirical and theoretical model (Hui Lin *et al*, 2009) [4]. Spectral and temporal profile matching of ENVISAT data and Landsat data along with the CANASAT maps for the sugarcane crop had been effectively distinguished (Iannini *et al.* 2015) [6]. Evaluation of backscattering signal from the ALOS – L, RADARSAT – X, Sentinel – C data with different

polarizations were used for the effective crop identification. (Molijn 2018) [6]. Rice, Maize, Groundnut crop identification and area mapping was demonstrated using the Sentinel 1A SAR data (Nelson *et al* (2014) [7] and Deiveegan *et al* (2017) [1]. From the above information, the Sugarcane area mapping is presented here under.

Materials and Methods

Study area

The study area of Cuddalore lies between 11°54'38.956" N and 78°52'11.956" E. The total cultivated area is around 313223 ha and out of which irrigated and rainfed area are 185925 ha (59%) and 123696 ha (41%) respectively. Paddy, Black gram, Green gram, Gingelly, Sugarcane and Cotton crops are majorly cultivated due to the tropical climatic condition and the annual rainfall of 1250 mm, annual mean temperature of 28.2° C with the following soil types of red loam, lateritic, black, sandy costal alluvium.

Satellite data

European's Copernicus program frames the first mission of Sentinel 1, works with the C – band Synthetic Aperture Radar (SAR) instrument. Sentinel-1A has only been operational since September 2014. Its own illumination, Sentinel-1A can provide continuous measurements independent of daylight or weather conditions, since C-band radar is not affected by the cloud cover because of its active remote sensing RADAR (Zeng *et al.*, 2006) [10].

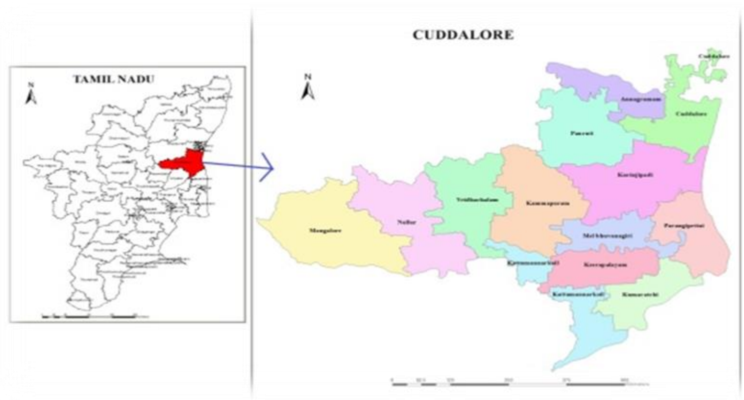

Fig 1: Study area – Cuddalore district

VH polarization of Ground Range Data (GRD) with Interferometric Wide swath (IW) of 12 days temporal interval Sentinel 1A C-band SAR data was collected between 12-Jan-2018 and 26-Dec-2018 for sugarcane crop identification. VH polarization was used for Sugarcane monitoring due to its sensitiveness to the vegetation, spatial resolution of around 20 m and having the swath width of 250 km. Details of the satellite data are presented in the table-1.

Table 1: Characteristics of Sentinel1-A (IW-GRD) Data

Parameters	GRD
Pixel value	Magnitude detected
Coordinate system	Ground Range
Polarizations	Single (VV), Cross (VH) and Dual (VV+VH)
Ground range coverage (km)	251.8
Radiometric resolution (dB)	1.7
Bits per Pixel	16
Resolution (range x azimuth) (m)	20.4 x 22.5
Pixel spacing (range x azimuth) (m)	10 x 10
Incident angle	32.9°
Number of Looks	5 x 1
Range look bandwidth (MHz)	14.1
Azimuth look bandwidth (Hz)	315
Equivalent Number of Looks (ENL)	4.4
Absolute location accuracy (m) (NRT)	7

Ground control points

Random stratified sampling method was adopted to the ground truth data collection with the help of Gramin 20X hand held GPS device. In the study area of Cuddalore district, around 104 points were collected, which includes 78 sugarcane and 31 non-sugarcane points to be used in crop identification and classification.

Methodology

A fully automated processing chain developed by Holecz *et al*. (2013) [2] was used to convert the multi-temporal SAR Ground Range Data (GRD) into terrain geo-coded σ° values. The processing chain was module within the Mapscape-RICE software. Multi-strip data mosaicked to form the single frames orbit and temporal acquisition along with their azimuth to form the long slant range geometry data. Multi-temporal data with the images of the same observation geometry and mode were co-registered in slant range geometry. The multi-temporal / time-series speckle filter was applied to the temporal data of the study area, in which the same resolution element on the ground was illuminated by the radar beam in the same way and corresponds to the same slant range coordinates in all images of the time series. A range-Doppler terrain geocoding approach was applied to convert the two dimensional slant range terrain coordinates to the tree dimensional object coordinates of a spatial system. Anisotropic Non-Linear Diffusion image processing technique was simultaneously enhance the features quality which remove the noises in neighbouring areas of the image and it is adapted to the linear images (i.e) in edges. The study area was subsetted from the raster images for the purpose of sugarcane crop identification.

Multi-temporal features of minimum, maximum, mean, minimum date, maximum date, and coherence data of VH polarizations were extracted by using the feature extraction tool in Mapscape-RICE software. These were having the certain range which regarding to the Sugarcane crop extracted by point sampling tool in QGIS 2.18.20.

The parameterized classification algorithm was used to categorize the image pixels in the land cover by quantitatively evaluating the spectral response of the unknown classifying pixels.

Validation and accuracy of the predicted and observed values has been carried out by using the Kappa confusion matrix. The class has been carried out based on the distribution of features in the corresponding pixels. The classified and misclassified values have been carried out in the error matrix of the corresponding dataset (Lillesand *et al*, 1994) [3]. The accuracy of the study was assessed by the producer's accuracy / average accuracy and the users accuracy / average reliability, which was extracted from the confusion matrix.

Results and Discussion

The study attempted based on area mapping of Sugarcane using Sentinel 1 A SAR satellite data. Temporal dB of the crops had been derived from Sentinel 1 A SAR data processed in the Mapscape - RICE software. Entire cropping period shows good vegetation as it is an annual crop (Figure.2).

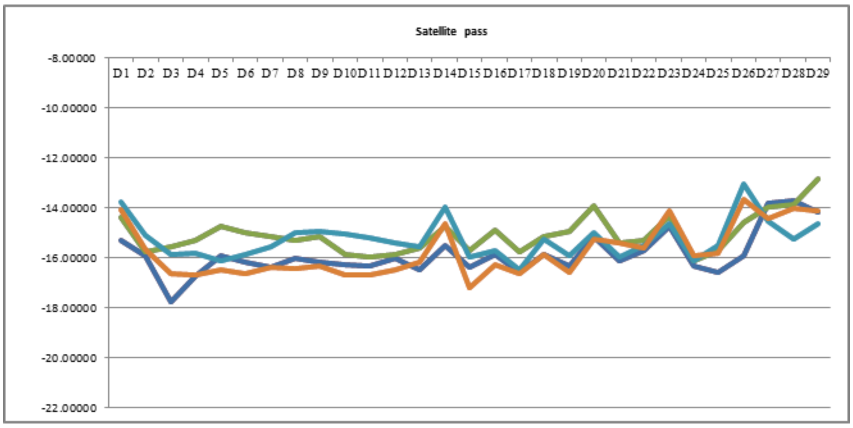

Fig 2: Temporal dB curve of Sugarcane from the VH polarization.

The minimum and maximum temporal backscattering values of sugarcane were extracted and presented in the table 2. The Maximum and minimum dB values of the study site was recorded as -12.83 and -19.11 in VH polarization. From which the dB values of sugarcane and other crops compared with ground truth data and the accuracy to be derived.

Phonological variations from the multi temporal features maximum, minimum, mean were extracted for the sampling locations of sugarcane crops. Study area was found to be VH_{min} range of -19.11 to -15.30 with the mean value of -16.71 and VH_{max} range -15.90 to -12.83 with the mean value -14.43 (Table 2).

Table 2: Minimum and maximum and mean values of multi temporal features

MTF	MIN	MAX	MEAN
VH min	-19.12	-15.90	-16.71
VH max	-15.30	-12.84	-14.44
VH mean	-17.41	-14.82	-15.92
CC min	0.02	0.09	0.05
CC Max	0.07	0.22	0.14
CC Mean	0.04	0.13	0.09

Through the classification the similar information pixels were grouped to form a thematic map. Maximum likelihood classifier was adapted to the multi temporal SAR image.

Fig 3: Sugarcane area map

The total sugarcane area in the classified map was assessed to be around 11,849 ha. It distributed to the administrative blocks of the Cuddalore district presented in the table 3.

Table 3: Block wise Sugarcane area for Cuddalore district

District	Block	Area
Cuddalore	Annagramam	604.2
	Cuddalore	1075.36
	Kammapuram	958.6
	Kattumannarkovil	397.36
	Keerapalayam	559.12
	Kumaratchi	444.36
	Kurinjipadi	1334.56
	Mangalore	1005.4
	Bhuvanagiri	659.72
	Nallur	1498.04
	Panruti	901.72
	Parangipettai	1007.16
	Virudhachalam	1403.56
	TOTAL	11849.16

Validation and accuracy of the sugarcane and non-sugarcane points were carried out by using the Kappa confusion matrix. Two classes (Sugarcane and non-sugarcane) were used for the accuracy assessment. This is having the positive relation to sugarcane – sugarcane crop, non-sugarcane – non-sugarcane crops, negative relation of sugarcane – non-sugarcane crops, non-sugarcane – sugarcane crop points (Table. 4).

Table 4: Kappa cconfusion matrix for accuracy assessment of Sugarcane crop classification

Actual class from survey	Predicted class from the map			
	Class	**Sugarcane**	**Non-Sugarcane**	**Accuracy (%)**
	Sugarcane	69	9	88.5
	Non-Sugarcane	7	24	77.4
	Reliability (%)	93.3	75.9	85.3
Overall accuracy		85.3%		
Kappa index		0.71		

The average reliability and average accuracy of the map were calculated as 77.4 % and 88.5 % respectively. The overall accuracy of sugarcane in the cuddalore district was 85.3 % with the Kappa index of 0.71 which shows good accuracy of the map. While increasing the crop and non-crop points will increases the accuracy of the study site.

Conclusion

Maximum of the extracted dB values for sugarcane was found to be -17.7738 to -12.8387 in early germination stage and grand growth phases respectively. Sugarcane area map was generated with the accuracy of 85.3% and the kappa score of 0.71. The total sugarcane area in Cuddalore district during 2018 was estimated to be 12270 ha. Multi-temporal features *viz*, VH_{min}, VH_{max}, CC_{min}, CC_{max} might have improved the precision in discrimination of sugarcane crop in the study area. Accuracy of the classification can be further improved by assessing different combinations of Multi-temporal features in classification with more number of ground truth points.

Acknowledgment

This study was carried out through the Junior Research Fellowship funded by The Department of Remote Sensing and GIS, Directorate of Natural Resource Management, Tamil Nadu Agricultural University, Coimbatore, India under the NADP (RKVY) Scheme on ‘‘Remote Sensing based information for crop coverage, yield estimation and drought monitoring’’.

References

1. Deiveegan M. Mapping and modeling groundnut growth and productivity in rainfed areas of Tamil Nadu (Doctoral dissertation, Tamil Nadu Agricultural University Coimbatore), 2017.
2. Holecz F, Barbieri M, Collivignarelli F, Gatti L, Nelson A, Setiyono TD, Obico MR. An operational remote sensing based service for rice production estimation at national scale. In Proceedings of the living planet symposium, 2013.
3. Iannini L, Molijn R, Mousivand A, Hanssen R. Monitoring LULC dynamics in the Sao Paulo region through landsat and C-band SAR time series. In 2015 IEEE International Geoscience and Remote Sensing Symposium (IGARSS). 2015, pp.90-93.
4. Lillesand TM. RW kiefer. Remote Sensing and Image Interpretation, 1994, 3.
5. Lin H, Huang C, Fang C. The relationship between the leaf area index (LAI) of rice and the C-band SAR vertical/horizontal (VV/HH) polarization ratio. International Journal of remote sensing. 2009; 30(8):2149-2154.
6. Molijn RA, Iannini L, de Souza CW, Della Justina D, Rocha JV, Hanssen RF. The Effects of Sugarcane Productivity Anomalies on L-Band and C-Band SAR Signals. In IGARSS 2018-2018 IEEE International Geoscience and Remote Sensing Symposium. 2018, p.5371-5374.
7. Nelson A, Setiyono T, Rala A, Quicho E, Raviz J, Abonete P, Thongbai P. Towards an operational SAR-based rice monitoring system in Asia: Examples from 13 demonstration sites across Asia in the RIICE project. Remote Sensing, 2014; 6(11):10773-10812.
8. Vieira MA, Formaggio AR, Renno CD, Atzberger C, Aguiar DA, Mello MP. Object based image analysis and data mining applied to a remotely sensed Landsat time-series to map sugarcane over large areas. Remote Sensing of Environment. 2012; 123:553-562.

9. Xavier AC, Rudorff BF, Shimabukuro YE, Berka LMS, Moreira MAJIJoRS. Multi-temporal analysis of MODIS data to classify sugarcane crop. 2006; 27(4):755-768.
10. Zeng L, Xiao Q, Margariti A, Zhang Z, Zampetaki A, Patel S, Xu Q. HDAC3 is crucial in shear-and VEGF-induced stem cell differentiation toward endothelial cells. The Journal of cell biology. 2006; 174(7):1059-1069.