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Pattern Recognition of Satellite Imageries of Somwarpet Taluk of Kodagu District :Land Use Patterns Classification

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ABSTRACT: The land use, land cover classification of satellite imagery is compelling to analyses derives the knowledge. The current scenario playing vital role in pattern classification to recognize pattern behaviour through the machine learning algorithms are utilized for pattern recognition and their performance. The imagery obtained by Sentinel-2 Satellite on February 2018 for Somwarpet Taluk, Kodagu District (Karnataka) using ERDAS IMAGINE image processing. In order to classify land cover types, training is needed to create a set of statistics that describes the spectral response patterns of each type of land cover draw the features, the quality of training feature set ensures the success of classification in accuracy nearer to ground truth. Maximum Likelihood Classification, Minimum Distance to Mean Classification, Mahalanobi's Distance Classification and Spectral Correlation Mapper Classification were outperformed algorithms. Accuracy of the classification of data set and classifier were optimized the misclassification using confusion matrix. F-measure value and Kappa coefficients validate to measure the overall accuracy, user's accuracy, producer's accuracy. Maximum likelihood classification was out performing with highest overall accuracy by 72.72 % than other three algorithms.

Keywords: Accuracy assessment, Classification algorithm, Kappa statistic, ERDAS Imagine.

INTRODUCTION

Remote Sensing science phenomenon to obtaining geo information about an item, geographic area, through the analysis of data acquired by A tool that is remotely with the item, area under study using of satellite/aircraft based sensor technologies emerged as a major tool in analyzing the composite environmental resource application. RS imagery several applications in mapping land-utilize and land cover, agriculture, soils mapping, ranger service, town planning, archaeological survey, military perception, and geomorphologic study, among diverse uses. Research zeroing on image classification has since quite a while ago pulled in the consideration of the remote-sensing community because categorization results are the basis for many natural and socioeconomic applications. Remote sensing image analysis is done to take out useful information about the earth surfaces. This is done by the land use and land cover classification. In this classification each pixel of the image is classified to a land class based on it spectral reflectance value. The Pattern recognition algorithms like Maximum likelihood classifier, Mahalanobis distance classifier, Minimum distance to mean classifier and Spectral correlation mapper are used.

Machine learning technique can be useful in a supervised and unsupervised learning. Supervised Classification is a modus operandi for identifying spectrally related areas on an image by identifying 'training' sites of ground truth targets and then extrapolating ground truth spectral signatures to other areas of unidentified targets. Processing whole image can be classified in given number of the classes in the training set. The GIS systems have hardware, software, and actions to facilitate the supervision, manipulation, analysis, modeling, demonstration, and display of geo-referenced data to solve composite issues regarding planning and organization of resources. The scope of the present investigation is land use classification utilizing digital image characterization techniques, their examinations precision evaluation. Appraisals of areas under each land use pattern class. Sudhakar *et al.* (1999) analysed IRS-IB LISS-II data for land use categorization with special of forest kind mapping of Jaldapara, wildlife sanctuary using MLE, contextual and neural network classification were applied and got the accuracy 91 %, 95 % and 87.42 %.

Dwivedi *et al.* (2004) estimated the potential of ML classifier, minimum distance classifier, Mahalanobis distance in deriving data on LULC over part of Ethiopia. The results verified the pre-eminence of neural network (NN) classifier over per-pixel Gaussian maximum likelihood classifier and minimum distance classifiers. Sharma and Leon Bren (2005) reviled the supervised classification using Maximum likelihood algorithm for the study area falling in the Solan district of Himachal Pradesh. Lu D and Q. Weng (2007) studied Non-parametric classifiers such as a neural network (NN), knowledge-based classification and decision tree classifier, have progressively happen to important approaches for multisource data classification.

Govender *et al.* (2008) studied to compare the classification of selected vegetation types using both hyper-spectral and multispectral satellite remote sensing data. Jhade and Patil (2019) performed the Maximum Likelihood Supervised Classification and Unsupervised Classification using ERDAS 2015 imagine processing. Maximum likelihood classification out performed with maximum overall accuracy of 72.99 percent, Jwan Al-Doski *et al.* (2013) studied image classification techniques and explains two common techniques K-means Classifier and Support Vector Machine (SVM). Madhura and Suganthi Venkatachalam (2013), have done a classification of different land use land cover categories from the raw satellite image using supervised classifiers and performances of the algorithm are studied and found MLE produced the 93.33% overall efficiency and minimum distance showed the overall classification accuracy of 85.72% and Mahalanobis gave the overall accuracy of 90.00%. Patrick *et al.* (2019) presented a patch-based land use and land cover classification approach using Sentinel-2 satellite images. Ce Zhang (2019) proposed Joint Deep Learning (JDL) model incorporates a multilayer perceptron (MLP) and convolutional neural network (CNN), and is implemented via a Markov process involving iterative updating. Manuel *et al.* (2019) proposed a general CNN, with a fixed architecture and parametrization, to achieve high accuracy on LULC classification over RS data from different sources such as radar and hyperspectral.Patil *et al.* (2014), have studied Classification of complex features of Remote sensing satellite imageries color pixels' variability of patterns whereas deployed minimum distance algorithm, supervised classification, ML classification, Kappa Coefficient, Classification Accuracy, f-measure, Error Matrix Algorithms. Talukdar *et al*. (2020) examined the six machine-learning algorithms, namely random forest (RF), support vector machine (SVM), artificial neural network (ANN), fuzzy adaptive resonance theory-supervised predictive mapping (Fuzzy ARTMAP), spectral angle mapper (SAM) and Mahalanobis distance (MD). Mukhtar (2016) studied Land Use Land Cover Change Detection from the use of land satellite imageries for 1985, 1991 and 2003. The results of the study shown that built-up area increased from 1985 to 2003 with 11.80 % in 1985, 17.90 % in 1991 and 26.20 % in 2003 while vegetation cover and bare surface are highly decreasing.

The scope of the present investigation is land use classification utilizing digital image characterization techniques, their examinations precision evaluation. Appraisals of areas under each land use pattern class. The objective of study was to classify the satellite image based on Efficient Algorithm with suitable distance measure and thresholds and validate the pattern classification.

MATERIAL AND METHODS

A. Study Area

Study was conducted during the year 2018. Study area consists of Somwarpet Taluk of Kodagu District, Karnataka state, India, which lies between 12° 35' 47.7348" N latitude and 75° 50' 41.7084" E longitude. The principle crops grown in the area are coffee and spice crops such as cardamom, peppers, oranges, ginger, and vegetables. Coffee is the major crop in the region. (Fig. 1) Location map of study area Karnataka state.

Location map of study area Karnataka state

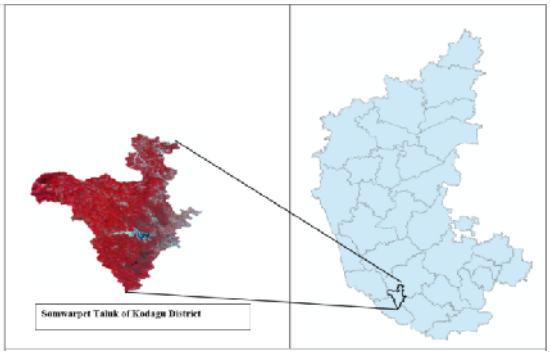

Fig. 1. Location map of study area Karnataka state.

B. Detail of Image data

Sentinel-2 is a European optic imaging satellite that started on 7 March 2017. It is the second Sentinel-2 satellite launched as part of the Western European Space Agency's Copernicus Program, as well as and its particular orbit will be phased 180 degrees against Sentinel-2. The satellite holds wide swath high-resolution multispectral imager with 13 spectral bands. It will provide information for farming and forestry, amongst others allowing for prediction of |plants yields. The topographical map of the study area is over-arranged on this image to abstract the digital image of the study area. The spatial resolution of the imageries is 10 meters. The images were recorded in three spectral bands, Blue (0.490-0.52µm), Green (0.560-0.58µm), Red (0.6650.688µm) and near Infrared (0.842-0.86µm). ERDAS imagine software remained used for structures extraction for the study. Ground truth data collected during the field visits in the study area and the top sheets are used to complete the work of choice of training areas for each and every category for training the classifier in supervised classification. A part of data

was used as test spots for assessing classification accuracy.

C. Details of Land Cover Classes Considered

The classes of interest were prudently selected and defined to successfully perform digital image category.

1) Agricultural crops 2) Plantation crops
5) Barren land 6) Scrub land

D. Methods of Image Classification

Image classification is the process of separating the image into different areas with some similarities and labelling the regions using supplementary ground truth information. In the present study, supervised method is used for image classification. All classification is done using ERDAS imagine software in at the Karnataka State Remote Sensing Application Centre, Department of Information Technology and Biotechnology, Government of Karnataka, (KSRSAC), Bengaluru-560 097. Supervised classification is the method generally used for quantitative analysis of remote sensing image data known cluster. It sits using suitable algorithms to label the pixels within an image as representing particular ground cover types, or class.

E. Maximum likelihood classifier

Maximum Likelihood Classifier (Gaussian): A statistical decision rule that examines the probability function of a pixel for each of the classes, and assigns the pixel to the class with the highest probability. Gaussian maximum likelihood classifier uses variance and co-variance to classify an unknown pixel of spectral response pattern. This classification is depends on probability density function related with a specific signature. Pixels are assigned to most likely class based on a comparison of the posterior probability that it belongs to each of the signatures being considered.

F. Classification using Mahalanobis Distance Algorithm

In Mahalanobis distance algorithm each pixel follows a multivariate normal distribution. This classifier based on the correlations between variables by which different patterns can be identified and analyzed. It measures the similarity of an unknown sample set to a known one. Its approach is different from Euclidian distance. It takes into account the correlations of the data set and is scale-invariant.

G. Minimum Distance to means Classification Algorithm

In this strategy the spectral response vectors of each class are modelled to have mean vectors. The mean vectors of the classes are assessed from training sets of each class. The Euclidean distance of a pixel from the mean vector of each class is figured and the pixel is allocated to a class for which this distance is shortest. It is used to classify unknown image information; it additionally limits the distance between image information and class in multi-feature space. The distance is characterized as an index of similarity so that the minimum distance is identical to the maximum similarity.

In the current study, a broad land use pattern /land cover classification system is adopted with seven categories for each training area as follows.

Land use/Land cover categories of Somwarpet Taluk of Kodagu District.

3) Built-up 4) Forest
7) Water body

H. Spectral Correlation Mapper Classification Algorithm

The Spectral Correlation Mapper (SCM) strategy is imitative of Pearsonian Correlation Coefficient that eliminates negative correlation and keeps up with the Spectral Angular Mapper (SAM) characteristic of minimizing the shading impact resultant in better outcome. The SCM fluctuates from -1 to 1 and cos (SAM) fluctuates from 0 to 1. The function cos (SAM) is like the Pearsonian Correlation Coefficient, the big difference is that the Pearsonian Correlation Coefficient normalizes the dinformation, centralizing itself in the mean of x and y."

I. Accuracy Assessment

In many cases, classification accuracy is expressed as a comparison between known reference data (ground truth) and the results of an automated classification**.** The classification accuracy can be evaluated using confusion matrix or error matrix based on of producer's accuracy, user's accuracy and overall accuracy with kappa coefficient and f measure. F measure provides the precision of the classifier including misclassification. The necessity for accuracy assessment at first emerged as part of algorithm development, and it was reached out into an important tool for users of land cover items.

RESULTS

Fig. 2 representing the Supervised classification map of Somwarpet Taluk of Kodagu District using Maximum Likelihood Algorithm, whereas Table 1 indicating the user accuracy, producer's accuracy and f- measure for Maximum Likelihood Classification Algorithm. Fig. 3 revealed the Supervised classification map of Somwarpet Taluk of Kodagu District using Minimum Distance Algorithm, Table 2 pertaining the user accuracy, producer's accuracy and f- measure for Minimum Distance Algorithm. Fig. 4 showing the Supervised classification map of Somwarpet Taluk of Kodagu District using Mahalanobis Distance Algorithm, Table 3 representative the user accuracy, producer's accuracy and f- measure for Mahalanobis Distance Algorithm. Fig. 5 indicative of the Supervised classification map of Somwarpet Taluk of Kodagu District using Spectral Correlation Mapper Algorithm, Table 4 indicate the user accuracy, producer's accuracy and f- measure for using Spectral Correlation Mapper Algorithm. Table 5 shown the value of Kappa Coefficients for each algorithm and its test of significance. Kappa coefficients shows the difference between how much agreements is actually observed agreement compared to how much agreement would be

expected to be present by chance alone expected agreement. Table 6 reveals the area estimates for each class by each algorithm with reference data. Table 7 shown the Overall accuracy of different methods used for study area.

The results of this investigation shows that, supervised classification of remotely sensed imagery gives significant information in land use land cover pattern in the form of different objects on the ground surface. The supervised classification techniques Maximum Likelihood, Minimum Distance to mean, Mahalanobis Distance and Spectral Correlation Mapper were performed to the images. These classifier classify the data in seven classes (Agricultural crops, Plantation crops, Built-up, Forest, Barren land, Scrub land) as shown in Fig. 2-5.

Table 1: Maximum Likelihood Classification Algorithm.

Classification Category	Precision (P)	Recall (r)	F-Measure F=2Pr/(r+P)	Producer's Accuracy%	User's Accuracy %
Agriculture Crop	0.74	0.79	0.76	78.78	74.29
Plantations Crop	0.57	0.65	0.61	65.38	56.67
Built up	0.77	0.85	0.81	85	77.27
Forest	0.80	0.76	0.78	76.19	80
Barren land	0.67	0.53	0.59	52.63	66.67
Scrub land	0.69	0.58	0.63	58.05	69.23
Water bodies	0.86	0.92	0.89	92.3	85.71

Table 2: Minimum Distance to Mean Classification.

Classification Category	Precision (P)	Recall (r)	F-Measure F=2Pr/(r+P)	Producer's Accuracy %	User's Accuracy %
Agriculture Crop	0.69	0.67	0.68	64.86	68.57
Plantations Crop	0.43	0.48	0.46	46.42	43.33
Built up	0.64	0.74	0.68	73.68	63.64
Forest	0.65	0.62	0.63	61.9	65
Barren land	0.73	0.48	0.58	47.83	73.33
Scrub land	0.50	0.52	0.51	52	50
Water bodies	0.71	0.87	0.78	86.96	71.43

Table 3: Mahalanobis Distance Classification.

Classification category	Precision (p)	Recall (r)	F-Measure F=2rp/r+P	Producers Accuracy %	User's Accuracy %
Agriculture Crop	0.57	0.63	0.60	58.82	57.14
Plantations Crop	0.33	0.40	0.36	38.46	33.33
Built up	0.59	0.72	0.65	72.22	59.09
Forest	0.65	0.54	0.59	54.17	65.00
Barren land	0.67	0.38	0.49	38.46	66.67
Scrub land	0.46	0.67	0.55	66.67	46.15
Water bodies	0.75	0.70	0.72	70.00	75.00

Table 4: Spectral Correlation Mapper Classifier.

Classification Category	Precision (p)	Recall (r)	F-Measure F=2rp/r+P	Producers Accuracy %	User's Accuracy %
Agriculture Crop	0.69	0.65	0.67	64.87	68.57
Plantations Crop	0.50	0.60	0.55	60.00	50.00
Built up	0.73	0.89	0.80	80.00	72.28
Forest	0.70	0.61	0.65	56.00	70.00
Barren land	0.67	0.42	0.51	41.67	66.67
Scrub land	0.54	0.64	0.58	63.67	53.87
Water bodies	0.71	0.87	0.78	86.96	71.43

Table 5: Kappa Coefficients and its Test of Significance.

Classification Algorithm	Kappa(K)	Variance of K	P-Value
Maximum Likelihood	0.68*	0.00172	<0.01
Minimum Distance to Mean	0.546*	0.00184	<0.01
Mahalanobis Distance	0.487*	0.00214	<0.01
Spectral Correlation Mapper	0.58*	0.00210	<0.01

Table 6: Area estimated for Somwarpet Taluk of Kodagu district (hectares) using following classifications and Reference Data values.

Classes	Reference Data	Maximum Likelihood	%	Minimum Distance to Mean	%	Mahalanobis Distance	%	Spectral Correlation Mapper	%
Agriculture Crops	20425.57	20311.00	99.44	18995.78	93.00	16953.22	83.00	15727.69	77.00
Plantations Crops	43746.10	44150.00	100.92	38496.57	88.00	48120.71	110.00	33247.03	76.00
Built up	6922.84	7208.00	104.12	10384.27	150.00	9807.26	141.67	8792.01	127.00
Forest	19952.03	19349.54	96.98	23942.43	120.00	15740.51	78.89	26120.36	130.92
Barren land	3129.23	3418.00	109.23	2628.55	84.00	5532.46	176.80	11552.22	369.1
Scrub land	2973.13	2654.00	89.27	2690.26	90.49	1754.15	59.00	2203.56	74.12
Water bodies	3037.65	3096.00	101.92	3048.68	100.36	2278.23	75.00	2543.67	83.74
Total	100186.50	100186.50	100	100186.50	100	100186.50	100	100186.50	100.00

Table 7: Overall accuracy (%) of different methods for study area.

Algorithms	Maximum Likelihood	Spectral correlation Mapper	Minimum to mean distance	Mahalanobis distance
Overall accuracy	72.72	64.21	61.36	56.25

SUMMERY AND CONCLUSION

This study of the Somwarpet Taluk of Kodagu District Karnataka, India demonstrates that the utilization of spatial multi-transient satellite imagery with the guide of GIS and RS innovation can assume a fundamental part in computing spatial and temporal phenomena, previously it was not possible through traditional digital planning. In this study seven LULC classes were classified in the study area namely Agricultural Crops, Plantation Crops, Built up, Forest, Barren land, Scrub land and Water bodies. In the classification phase four supervised classification algorithms were deployed to classify the image. The four algorithms are maximum Likelihood classification algorithm, Minimum Distance, Mahalanobis Distance and Spectral Correlation Mapper were performed to the image. Several measures of classification accuracy were evalua ted in this study, namely overall accuracy, kappa coefficient and f measures.

Many measures of classification accuracy may be derived from a confusion matrix. The Kappa coefficient is used to describe the degree of agreement between classification and validation. In these algorithms Maximum Likelihood outperformed compare to all other algorithms for given satellite imagery data. MLE has the maximum value of Kappa coefficient 0.68 followed by SCM 0.58, Minimum Distance to mean 0.546 and Mahalanobis Distance 0.487. Overall accuracy also found maximum for MLE 72.72 followed by SCM 64.21, Minimum Distance 61.36 and Mahalanobis Distance 56.25. F measure also found maximum for MLE algorithms compare to all other algorithms used for this image. study area reveal that plantation crop represent the most important land use in Somwarpet taluk, main plantation crop of this area is coffee the second major type of land use is Agricultural crop followed by Forest, Build-up, barren land, water bodies and scrub land.

Maximum Likelihood Classification Algorithm

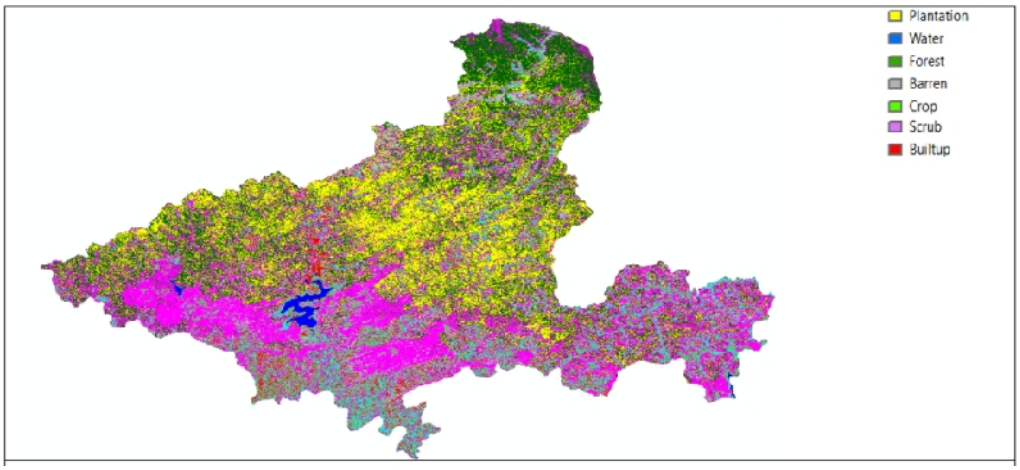

Fig. 2. Supervised classification map of Somwarpet Taluk of Kodagu District using Maximum Likelihood Algorithm.

Minimum Distance to Mean Classification

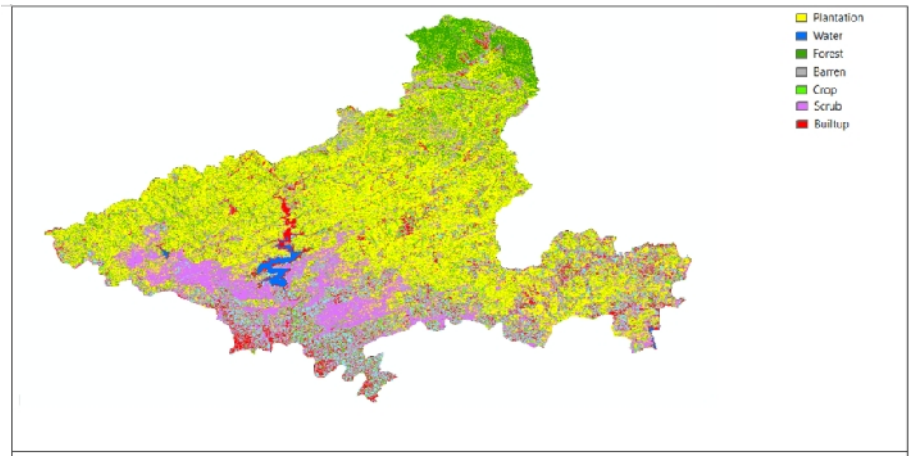

Fig. 3. Supervised classification map of Somwarpet Taluk of Kodagu District using Minimum Distance Algorithm.

Mahalanobis Distance Classification

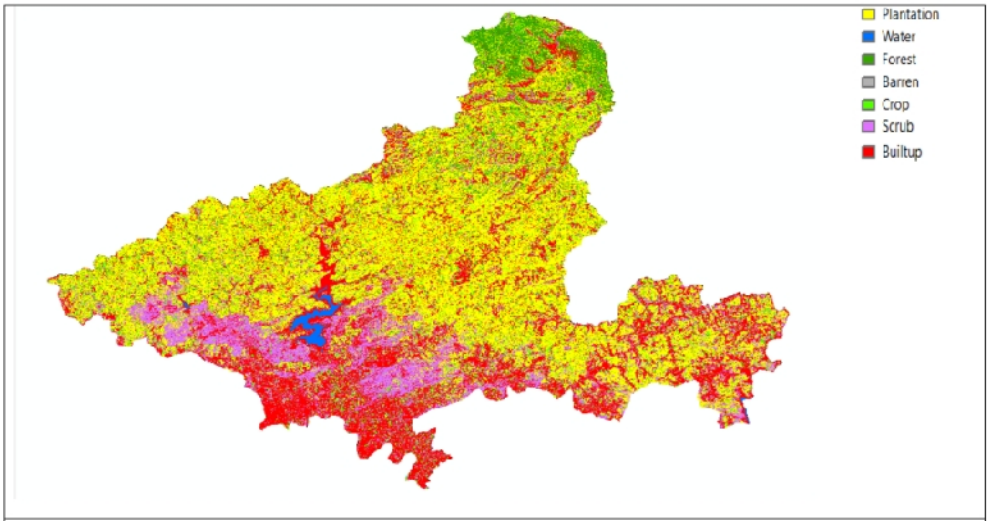

Fig. 4. Supervised classification map of Somwarpet Taluk of Kodagu District using Mahalanobis Distance Algorithm.

Spectral Correlation Mapper Classifier

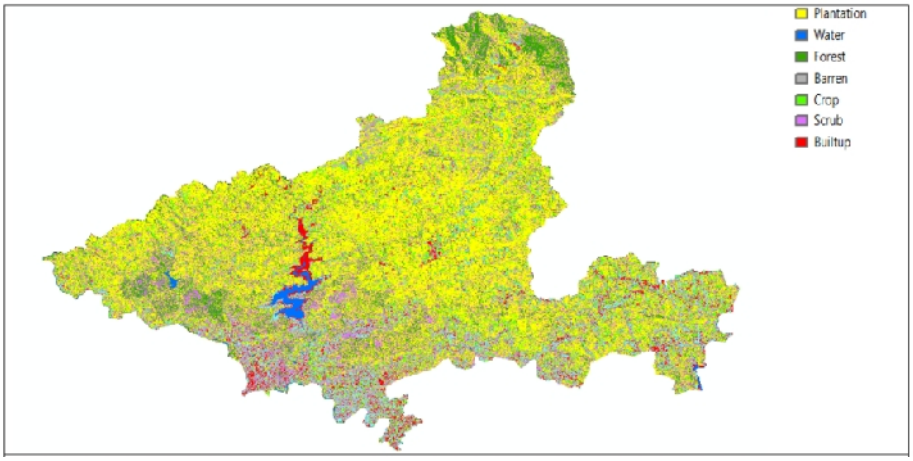

Fig. 5. Supervised classification map of Somwarpet Taluk of Kodagu District using Spectral Correlation Mapper Algorithm.

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Conflict of Interest. None.

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