A land use/land cover classification of IRS (LISS – III) multispectral data using Decision Tree and SVM classification mechanism

Nirav Desai [1], Parag Shukla [2]

[1] Research Scholar, Atmiya University, Rajkot, India

[2] Research Supervisor, Atmiya University, Rajkot, India

Corresponding Author Email: niravdesai.research@gmail.com

ABSTRACT

Identification of the effect of human activities on our planet concerns over worldwide land use and land cover change is very complex. Land Use and Land Cover refer to the utilization of land through events like agriculture, different types of cultivation areas, residential areas, and the physical features on the earth's surface like the sea, mangroves forest, vegetation cover, and water bodies. However, empirical techniques used for this type of classification are cost-effective and laborious. This paper is focused on remote sensing images and various supervised classifications to identify various Land Use/Land Cover. This research work aims to use images taken from IRS (LISS III) platform to perform supervised classification. The study was performed to compare the performance of Supervised classifiers Decision Tree and SVM to classify different land use land cover classes. The Decision tree classifier gives better results than SVM for the study area. The decision tree classifier achieved 89.97 %. and SVM 81.90 %. It revealed that Decision Tree did better across different levels of occupancy of Land use/Land Cover.

Keywords: remote sensing, multispectral satellite image, classification, Decision Tree, SVM

1. INTRODUCTION

Remote Sensing is a science of obtaining information about objects or areas from a distance, typically from aircraft or satellites. Satellite imagery is images of Earth collected by imaging satellites functioned by governments and businesses around the world. A multispectral image captures image data within specific wavelength ranges across the electromagnetic spectrum (EM). More than 100-nanometer resolution. Less the 10 bands.

Land use is defined as a sequence of actions performed on to the land to carry out by humans, with the purpose to gain products and/or benefits using land resources. Land cover is defined as the vegetation or buildings which take place on the earth. Examples of land covers include agricultural land, forest, grassland, and wetland. And land-use refers to the biophysical state of the earth's surface and immediate subsurface, containing soil, topography, surface water and groundwater, and human structures. (Elaalem et al., 2013) Land use specifies how persons are using the land, whereas land cover specifies the physical land type. Both the types of data are obtained from analysis of the satellite images

As we struggle to recognize the effect of human actions on our planet, concerns over global land use and land cover change are rising. (Okin et al.) Land Use/Land Cover (LULC) classification is very important because it offers data for the monitoring of natural resources in different geographical positions. For eras, remote sensing has been used as a tool to produce

Land Use/Land Cover maps. (Chan et al, 2008). Actions prevalent in an area can be obtained from Land Use / Land Cover (LULC) classification. Land Use/Land Cover refers to the utilization of land through activities like agriculture, different types of cultivation areas, residential areas, and the physical features on the earth's surface like the sea, mangroves forest, vegetation cover, and water bodies. However, empirical techniques used for this type of classification are cost-effective and laborious. Furthermore, practically it is impossible to obtain real-time data by manual human resource-based techniques. Remote sensed imagery is the most popular method to capture data on Land Use/Land Cover. Remote sensing imagery when used for Land Use/Land Cover classification one can get rid of all the above-mentioned problems Image classification is an important technique in remote sensing for image analysis and pattern recognition. Image classification is a process where decision rules are developed and used to assign pixels into classes that have similar spectral and information features (Campbell et al,.2008)(homer et al,.2004)(lu et al,.2007).

This paper is focused on various supervised classifications. The main goal of this research work is to use images taken from IRS (LISS III) platform to perform supervised classification. We will use supervised classification mechanisms such as SVM and Decision Tree and compare the result.

2. MATERIALS AND METHOD

2.1 Study area

The research was performed in Navsari and Valsad district situated in the South region of Gujarat state, India. Navsari district is located at 21° 07' N and 73° 40' E whereas Valsad district is located at 21° 36' N and 72° 59' E **(Figure 1).**

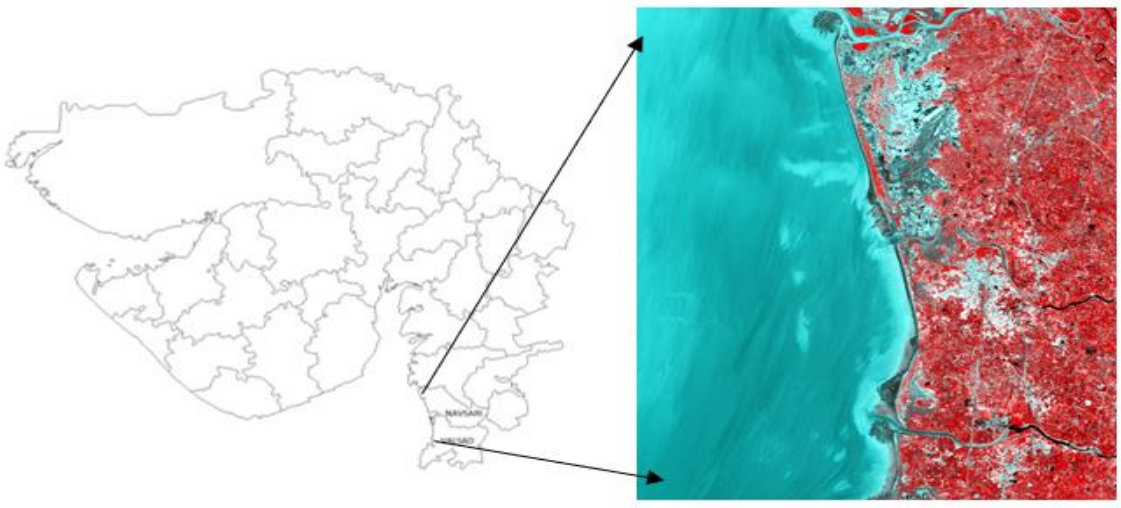

Figure 1. study *area*

2.2 Land Use Land Cover Definition

Land use is described as a sequence of activities performed on the land to carry out by humans, with the purpose to acquire products and/or benefits using land resources. Land cover is characterized as the vegetation or constructions which take place on the earth. Examples of land covers contain agricultural land, forest, grassland, and wetland. And land-use refers to the

biophysical state of the earth's surface and immediate subsurface, containing soil, geography, surface water and groundwater, and human structures. (Elaalem et al., 2013) Land use denotes how persons are using the land, whereas land cover identifies the physical land type. Both types of data are found from the analysis of the satellite images.

2.3 Image acquisition and processing

LISS- III data was obtained on 18th, January 2018. At the time of data acquisition, cloud cover was less than 25%. The image was obtained from National Remote Sensing Centre, ISRO (bhuvan-app3.nrsc.gov.in). Image acquisition coincides exactly with the one covered by an extensive field survey. Additional image processing was performed in ENVI V.4.6. Image processing systems (IPS) are a significant key to help remote sensing applications and have grown in number and capability in the last many years. (Elaalem et al., 2013. Image processing techniques have been built to support the understanding of remote sensing images and to retrieve as much info as possible from the images. The selection of specific techniques or algorithms depends on the areas as per particular necessities.

2.4 Image Classification

There are various image classification methods for land use and land cover. The classification technique can be "supervised" or "unsupervised". Different land use and land cover types can be split from an image using several image classification algorithms using spectral features, i.e. the "brightness" and "color" value contained in each pixel. The supervised classification contains classifications like SVM, ANN, and Decision Tree. Each pixel in the entire image is then classified as appropriate in one of the classes depending on how it is closed to its spectral features in the training areas. In unsupervised classification, the algorithms group the pixels in the image into separate clusters, depending on their spectral features. Each cluster will then be allocated a land use and land cover type by the analyst. All classifications were performed using an inbuilt function of ENVI 4.6® image analysis software.

2.4.1 Decision Tree Classifier*:* A decision tree is built top-down from a root node and contains separate.20ing the data into subsets that contain instances with parallel values (homogenous). The decision tree classifiers are effective than single-stage classifiers. With this classifier, decisions are made at several levels. Decision tree classifiers are also labeled multi-level classifiers. In constructing a decision tree classifier, it is necessary to construct an optimum tree to achieve the highest possible classification accuracy with the minimum number of calculations (Kulkarni,.2001)

2.4.2 SVM :

SVM is a great classification technique that has been largely used in the field of pattern recognition. The support vector machine optimization problem tries to discover a good quality splitting hyperplane amongst two classes in the higher dimensional space.

A supervised classification method was used to cluster pixels in the dataset into classes parallel to defined training classes. Built-in complex non-linear classifications algorithm SVM was applied to classify an image. Decisions for the classification and partition of all the land use classes were made by manual observation of reflectance patterns of all land use classes. A cluster of (n) numbers of reflectance patterns of all land use classes was plotted as a graph to identify decisive Digital Numbers of respective bands.

SVM has many alternatives in kernel selection such as Linear, Polynomial, Sigmoid, and Radial Basis Functions (RBF) for SVM. We have classified the LISS- III image with each of these kernels. Kernel methods exploit information about the inner products between data items. RBF was chosen for its accuracy in classification (Vyas et al., 2011).

Model structure for image processing and classification is given in Figure 2.

3. MODEL STRUCTURE

Figure 2 Model Structure

4. RESULT AND DISCUSSION

A supervised classification mechanism like Decision Tree and SVM was applied to classify land use and land cover in the study area. The results confirmed that the study area was classified into Agriculture land, Mangrove Forest, Residential Area, Water Bodies, and Beach Land.

Figure 3. shows classified images coming from these classifiers respectively. The image classified with decision tree showed OAA (89%) and SVM gave OAA (82%). Tables show confusion matrices pre-pared for the image classified with the two classifiers (Decision Tree and SVM). Accuracy values were highest for classes with standardized distribution such as residential areas and water bodies. Both the tested classifiers showed relatively lesser accuracies for vegetation classes (Mangrove and Agriculture land) with the non-homogenous distribution. However, it is remarkable that in the present study both the selected classifiers were able to disguise between two vegetation variable classes agriculture land and mangrove forest.

Figure 3(a.) FCC

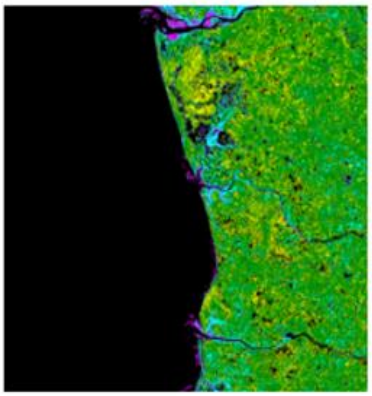

Figure 3(b.) Decision Tree

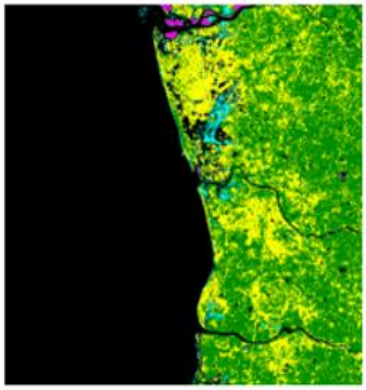

Figure 3(c.) SVM

Figure 3 Result Image

Figure 4. shows the algorithm for the decision tree of all the land use classes. Earlier, (Keshtkar et al.,2013) achieved an accuracy of 79 % for the classification of land use and land cover patterns with the help of a decision tree classifier for multispectral data set. Classification accuracy achieved in the present study is far better than mentioned above. Previously, (Punia et al.,2011) concluded that the decision tree classification gave better accuracy in comparison to earlier studies. Results in the present study are in agreement with this conclusion.

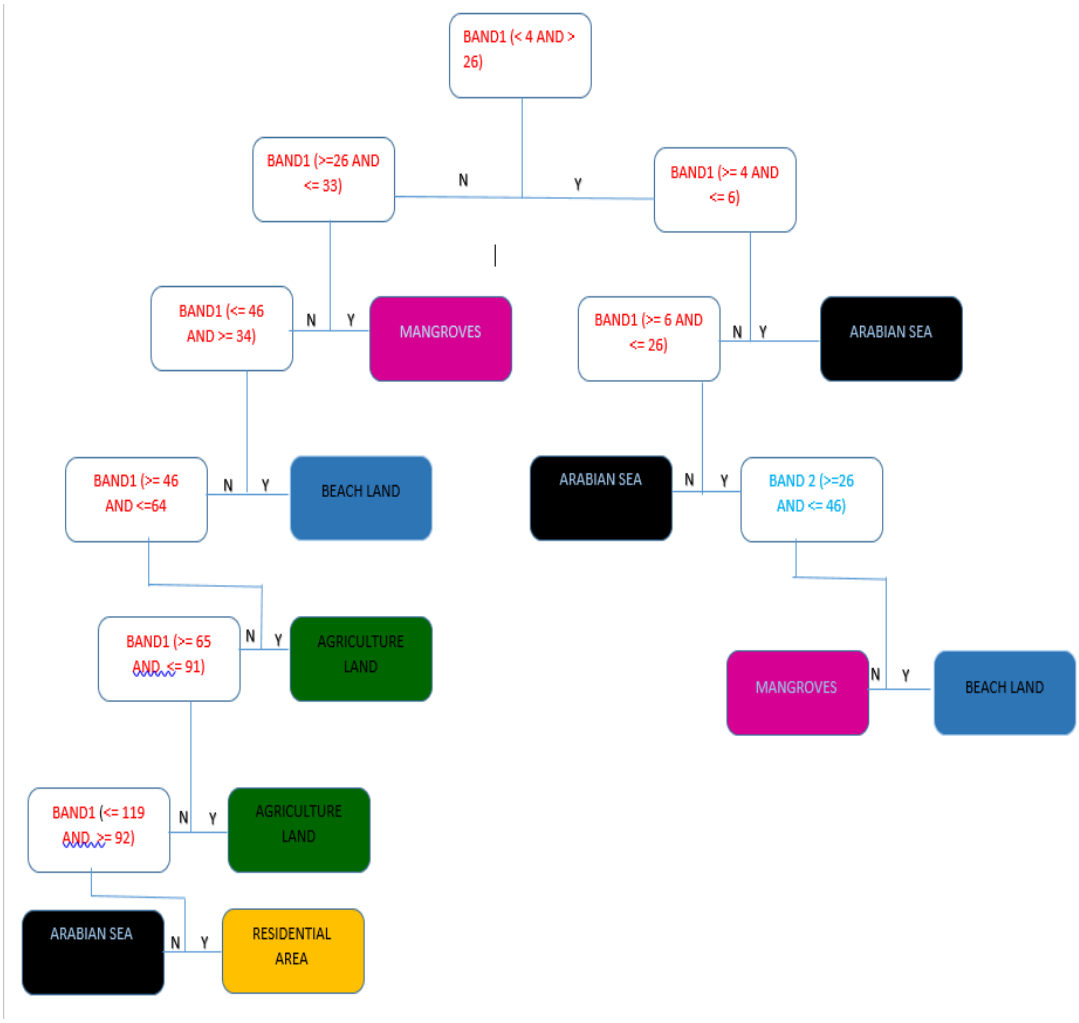

Figure 4 Decision Tree

SVM classifier in the present study achieved a reasonable accuracy number of 81% lesser than Decision Tree. Earlier,(Prasad et al., 2017) accomplished a higher accuracy of 93 % for the IRS LISS III data set. Furthermore, (Macintyre et al.,2020) and (Venkatalakshmi et al., 2005) achieved an accuracy of 73% and 90% for various kinds of multispectral data set. The present study was unable to attain a higher accuracy percentage for SVM.

Knowledge-based Decision Tree classification increased the outcomes as compared to the other supervised classification methods. The Decision Tree classification method is simple and does not depend on the understood hypothesis concerning the association between the spectral information and class proportions. The outcomes of this study prove that the Decision Tree can find the complex relationships amongst spectral bands and classes. And also can identify the most appropriate mixture of bands in increasing the class separability. Also, the structure of the Decision Tree is interpretable and shows the hierarchical relations among bands and class proportions. The results of classifications LISS-III image along with ancillary data demonstrate that Decision Tree

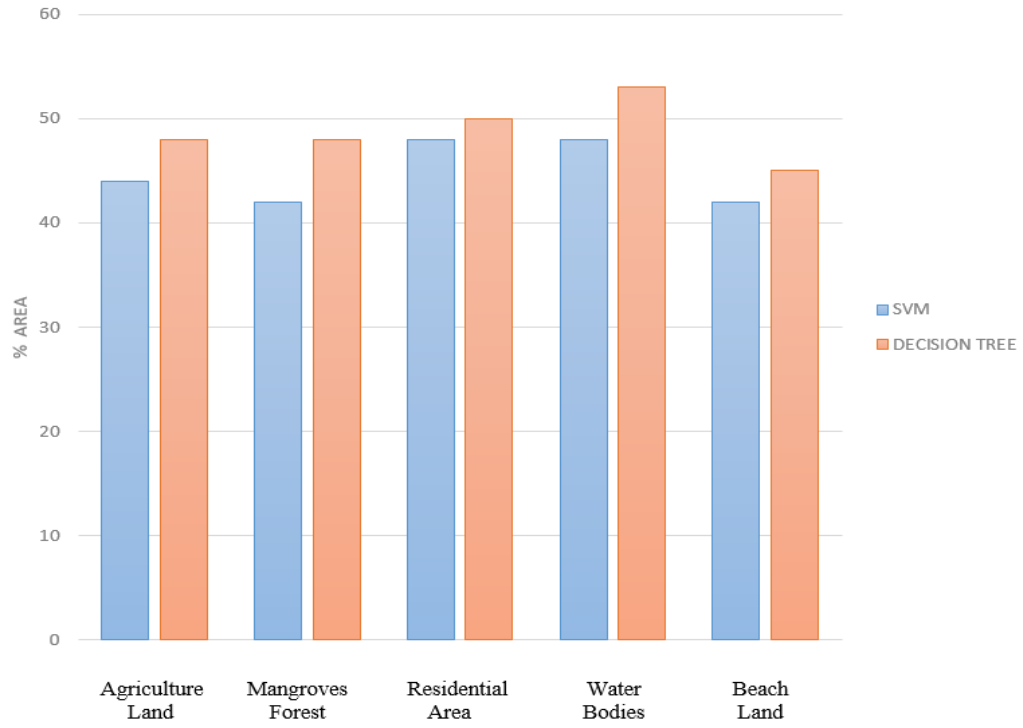

Figure 5. Percentage area occupied by 5 classes in the image subset classified with different classifiers

Table – I: Confusion matrix obtained using Decision Tree classifier.

	Agriculture Land	Mangrove Forest	Residential Area	Water Bodies	Beach Land	Total	% Accuracy
Agriculture Land	48	5	1	0	0	54	88.88
Mangrove Forest	3	48	0	3	0	54	88.88
Residential Area	2	0	50	0	2	54	92.59
Water Bodies	0	2	0	53	1	56	94.64
Beach Land	0	2	3	3	45	53	84.90
Total	53	57	54	59	48	271	
% Accuracy	82.75	84.21	92.59	89.30	93.75		

OAA = 89.97 % , Kappa Coefficient = 0.83.

Table II: Confusion matrix obtained using SVM classifier.

	Agriculture Land	Mangrove Forest	Residential Area	Water Bodies	Beach Land	Total	% Accuracy
Agriculture Land	44	7	3	0	0	54	81.48
Mangrove Forest	6	42	0	6	0	54	77.77
Residential Area	4	0	48	0	2	54	88.88
Water Bodies	0	4	0	48	4	56	85.71
Beach Land	0	3	4	4	42	53	79.24
Total	56	56	52	58	49	271	
% Accuracy	78.27	75.00	86.53	82.75	85.71		

OAA = % 82.61, Kappa Coefficient = 0.76.

The image classified with Decision Tree showed the highest OAA 89% and SVM showed 82% OAA. Tables I and II display confusion matrices prepared for the image classified with the two classifiers. Accuracy values were highest for residential areas and water bodies. Both the tested classifiers showed relatively lesser accuracies for beach land. The decision tree showed higher accuracy in water bodies and residential areas. And showed the same accuracy in agricultural land and mangrove forest, where SVM showed higher accuracy in residential areas and water bodies. Among the two classifiers tested, the Decision tree fared better for all land use land cover classes while SVM showed lesser performance. Figure 5. shows percentage area classified as each land use land cover class in the two classifiers

5. CONCLUSION

The study was carried out to compare the performance of classifiers (Decision Tree and SVM). Among both the classifiers, the Decision tree gives a better result than SVM for the study area. The decision tree achieved 89.97 % and SVM achieved 81.90 %. It revealed that Decision Tree did better across different levels of occupancy of Land use/Land Cover. The findings of the present study are encouraging for Land use and land cover using spaceborne multispectral data.

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Nirav Desai[*1] & Parag Shukla[2]
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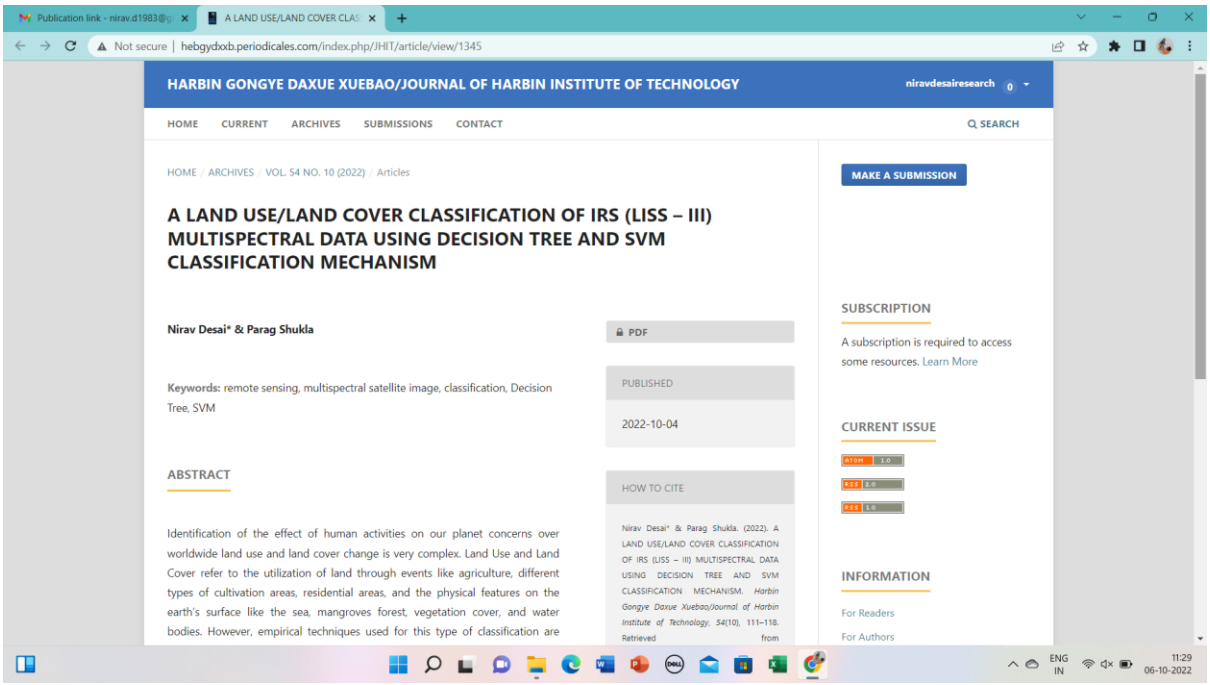

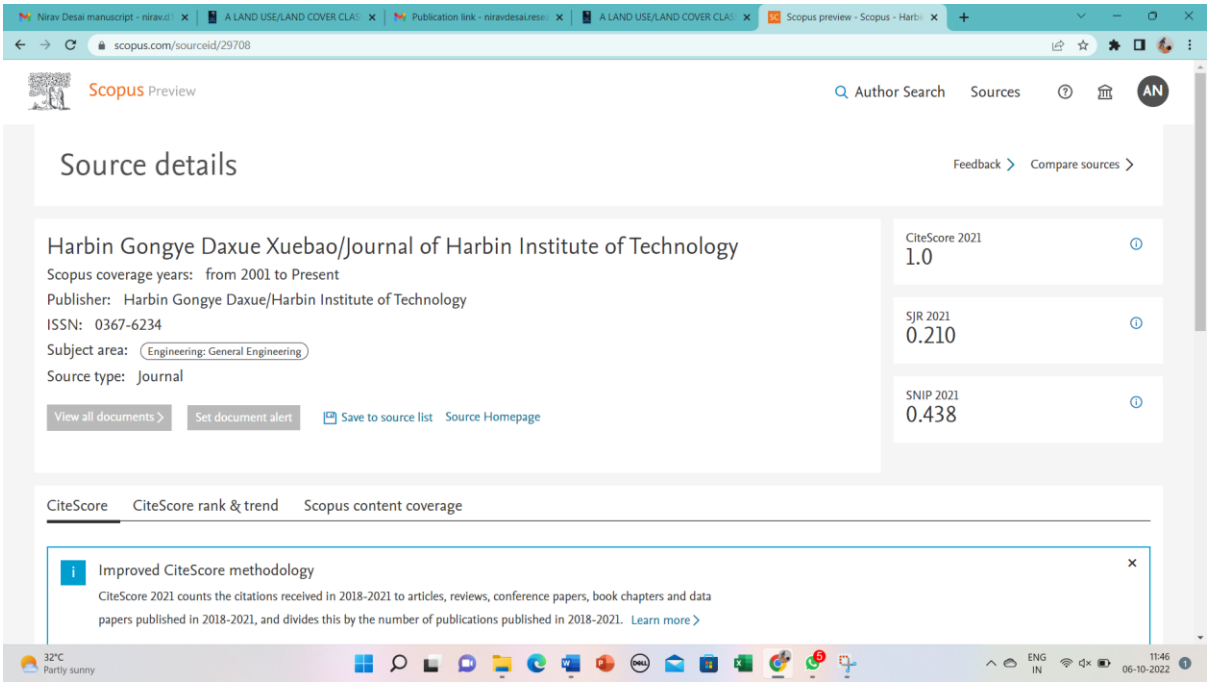
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