LAND USE LAND COVER CLASSIFICATION USING UNSUPERVISED CLASSIFIERS AND VARIOUS POLARIMETRIC SAR DATA TYPES

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ABSTRACT:

The polarimetric SAR (Synthetic Aperture Radar) data available from various sensors has got lot of importance for land use land cover classification. Both airborne sensors and space borne sensors are providing the polarimetric SAR data and therefore any suitable data sets can be acquired from the respective sensors for the land use land cover classification of an area. This polarimetric SAR data is available in various forms such as amplitude data and phase data as far as the type of information carried by the signal is considered. With respect to the type of polarization various sensors provide the polarimetric SAR data having different polarization information such as dual polarization (co-polarization i.e., HH, VV and cross-polarization i.e., VV, VH), quad-polarization (HH, HV, VH and VV) in the case of linear polarization. Similarly dual hybrid-polarization such as RH, RV data is also available in the case of circular polarization provided by RISAT-1 sensor. Polarimetric SAR data of the study area provided by various space borne sensors such as RISAT-1(dual hybrid polarization, RH & RV), ENVISAT (co-polarization i.e., HH, VV) and SENTINEL (cross-polarization, VV & VH) have been considered for land use land cover classification of the study area. The raw data sets have been pre-processed and then unsupervised classification methods (Isodata and K-means) have been implemented. The Iterative Self Organizing Data Analysis Technique (ISODATA) is a self organizing classification method as it does not require training class inputs. Because of the iterative nature this algorithm passes through the image sufficient number of times before coming to a meaningful conclusion. K-Means unsupervised classification is also based on the clusters of the pixels formed by iterations. Isodata could give an overall accuracy 0f 71.6% along with kappa coefficient of 0.62 while the K-means could give an overall accuracy of 73.1% and kappa coefficient of 0.64. These results are obtained with Sentinel data sets which are higher compared to the other SAR data sets that are used in the present study and are close to the results that are obtained with optical data.

Keywords: *SAR, Polarimetry, Land-use/land-cover classification, Support Vector Machine, Accuracy*

1. INTRODUCTION

The need of information about the land use and land cover classification is increasing from time to time due to the changes that are taking place because of various reasons such as industrialization, urbanization and natural calamities etc. Though this land use and land cover classification can be done with the help of optical data the dependency on polarimetric SAR data has been increasing because of its advantages compared to optical data (D.Singh 2011). Visakhapatnam city is one of the fastest developing cities in Asia with lot of scope for job opportunities because of many upcoming industries in addition to the existing industries. With this the population has also been increasing year by year. Therefore the urban development authorities may require time to time information for proper planning and development in order to cater needs of various sectors. This can be fulfilled by analyzing the area with the help of available space technologies such as Geographical

Information Systems (GIS), Global Positioning System (GPS) and Remote Sensing etc (R. Manonmani 2010). The polarimetric SAR systems which have been launched into the space as a part of remote sensing are providing lot of useful data images that can be used for various applications covering all over the globe. Therefore by selecting the suitable polarimetric SAR data from one of the SAR sensors and by applying efficient methodologies, the purpose of land use land cover classification of an area can be fulfilled more effectively. The dual polarization bands VV, VH available in Sentinel data set have been combined into VV+VH to get more classification results. In the case of ENVISAT data set HH band has been selected for classification purpose since the backscattering coefficients obtained with HH are better than the backscattering coefficients obtained with VV band (Y. Murali Mohan Babu 2014). M-delta decomposition method has been preferred in the case of RISAT-1 data set as it gives better accuracy results as compared to those of m-chi and m-alpha decomposition methods (Y. S. Rao 2013).

2. STUDY AREA

Visakhapatnam which is one of the fastest developing cities in Asia belonging to the state of Andhra Pradesh, India has been selected as the study area. The city is the head quarter of Visakhapatnam district. Entire city area covering both urban and rural areas has been investigated which is existing between the latitudes of 17^0 10' and 17^0 56' N and longitudes of 83^0 08' and 83^0 40' E. This city is existing on the sea coast of Bay of Bengal..

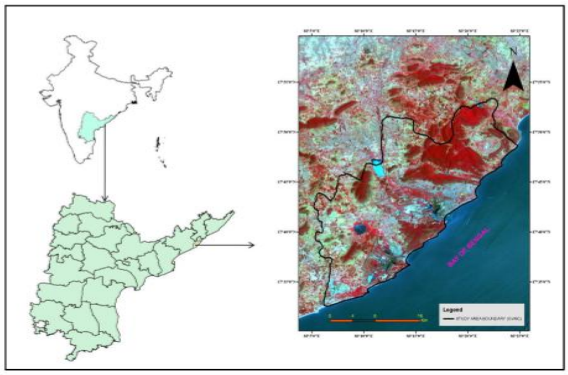

Figure1. Location Map of the Study Area

3. DATA USED

Polarimetric SAR data sets of RISAT-1(dual hybrid polarization, RH & RV) data, ENVISAT (co-polarization i.e., HH, VV) data and SENTINEL (cross-polarization i.e., VV, VH) data have been used for the land use land cover classification. Optical data of LANDSAT is also considered in the present study as a reference.

4. PRE-PROCESSING

All the data sets have been pre-processed with suitable methodologies before implementing the classification techniques. The polarimetric phase data of RISAT-1 has been decomposed using Raney decomposition method and obtained m-alpha, m-chi and m-delta images. The polarimetric dual cross-pol amplitude data of SENTINEL having VV and VH information has been combined into VV+VH. Similarly the co-pol dual polarimetric data sets having HH, VV polarization of ENVISAT have been pre-processed and observed HH results are better than that of VV. PolSAR pro software is used for pre-processing the RISAT-1 data and SNAP software is used for pre-processing the data sets of SENTINEL and ENVISAT.

5. RESULTS AND DISCUSSIONS

The isodata and K-means classification methods belonging to unsupervised classification techniques have been implemented for all the polarimetric SAR data sets of SAR sensors which are considered for land use land cover classification of the study area. These classification methods have also been implemented for the optical data provided by LANDSAT sensor which is considered as a reference for the SAR data analysis.

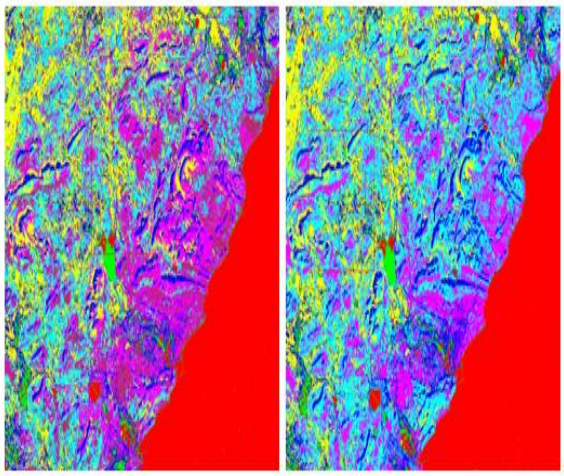

Fig.2 Isodata (left) and K-Means (right) Classified Images of LANDSAT-8 sensor

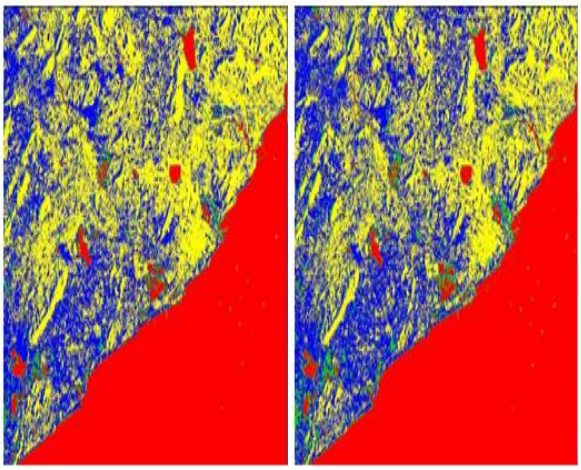

Fig.3 Isodata (left) and K-Means (right) classified images of SENTINEL sensor

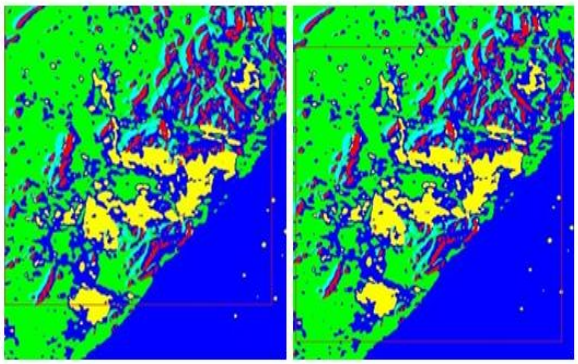

Fig.4 Isodata (left) and K-Means (right) classified images of ENVISAT sensor

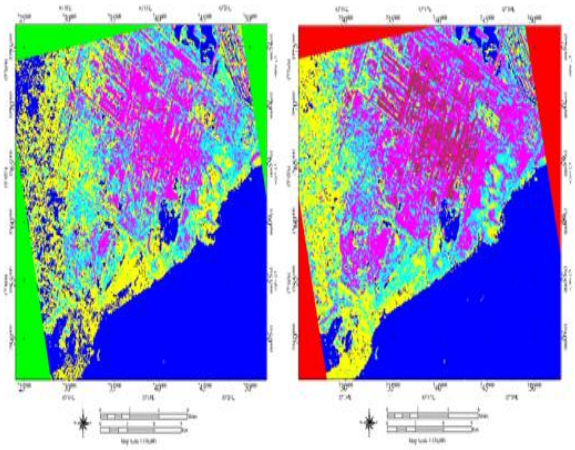

Fig 5. Isodata(left) and K-Means(right) classified images of RISAT-1 with m-delata decomposition

Classification	Isodata		K-Means	
	O.A (Overall Accuracy)	K.C(Kappa Coefficient)	O.A(Overall Accuracy)	K.C(Kappa Coefficient)
RISAT-1	36.078	0.212	56.562	0.472
ENVISAT	63.895	0.498	67.870	0.573
SENTINEL	71.645	0.622	73.160	0.642

LANDSAT	82.435	0.756	77.917	0.692

Table1. Comparison of accuracy and kappa coefficients of Isodata and K-means classifiers

6. CONCLUSION

In the present study the performance of various SAR sensors has been evaluated by implementing the unsupervised classification methods which do not require any inputs since they are developed on the iteration method. The unsupervised Isodata and K-means classification methods have been implemented for different types of SAR data sets in the present study. Classification accuracy results have been obtained by confusion matrix for all the classified SAR data images. K-means classification could give an overall accuracy (O.A) of 73.160 and Kappa coefficient of 0.642 which are a little higher than that of Isodata classifier which cloud give an overall accuracy of 71.645 and Kappa coefficient of 0.622. Accuracy results of SENTINEL sensor are better compared to other SAR datasets in the present study and are close to the results that are obtained with optical data. Both Isodata and K-means classification methods could give moderate accuracy and kappa coefficient results for ENVISAT data set 63.895, 0.498 and 67.870, 0.573 respectively. As far as RISAT-1 data set is considered both Isodata and K-means classification could give lower accuracy and kappa coefficient values 36.078,0.212 and 56.562,0.472 respectively as compared to other data sets in the present study.

BIBLIOGRAPHY

[1] *Abdikan, S., Bilgin, G., Sanli, F.B., Uslu, E., Ustuner, M.,. "Enhancing land use classification with fusing dual-polarized TerraSAR-X and multispectral Rapid Eye data." Journal of Applied Remote Sensing 9(1), 096054 (2015).*

[2] *Cloude, S. E. "An entropy based classification scheme for land applications of polarimetric SAR." IEEE, 3(1), 1997: 68-78.*

[3] *Cloude, S.R and E. Pottier. "A review of target decomposition theorems in radar polarimetry." Geoscience and Remote Sensing 34, no. 2 (1996): 498-518.*

[4] *Cloude, S.R and E.Pottier. "An entropy based classification scheme for land applications."*

[5] *D.Singh, P.Mishra and Y.Yamaguchi. "LAND COVER CLASSIFICATION OF PALSAR IMAGES BY KNOWLEDGE BASED DECISION TREE CLASSIFIER AND SUPERVISED CLASSIFIERS BASED ON SAR OBSERVABLES." Progress In Electromagnetics Research B 30 (2011): 47-70.*

[6] *Krogager, E.,. "A new decomposition of the radar target scattering matrix." Electronics Letter 26, no. 18 (1990): 1525-1526.*

[7] *Lee, J.S. "Unsupervised terrain classification preserving polarimetric scattering characteristics." IEEE Transactions on Geoscience and Remote Sensing, no. 42(4): 722-731.*

[8] *Melgani, F., and Bruzzone, L.,. "Classification of hyperspectral remote sensing images with support vector machines." IEEE Transactions on Geoscience and RFemote Sensing, no. 42 (2004): 1778-1790.*

[9] *R. Manonmani, G. Mary Divya Suganya. "Remote sensing and GIS Application in change detection Study in Urban Zone*

Using multi-temporal satellite." (International journal of geomatics and geosciences) 1, no. 1 (2010).

[10] Y. Murali Mohan Babu, M.V. Subramanyam and M. N. Giri Prasad. ""Generation of Back Scatter Image for MRS Mode RISAT-1 Data"." 2014.

[11] Y. S. Rao, Shaunak De, Vineet Kumar and Anup Das. ""Full and Hybrid Polarimetric SAR Data Analysis for Various Land"." International Experts Meet on Microwave Remote Sensing, December 2013: 16-17.