Information Extraction from Remote Sensing Image (RSI) for a Coastal Environment Along a Selected Coastline of Tamilnadu

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Abstract: With rapid development in spatial technology and with availability of tremendous amount of satellite data, studying and analyzing environment of an area especially along coast has become more meaningful. The synoptic view and repetitive coverage have paved way for such analysis under uniform illumination. Moreover the ability of such data in digital format and its nature has opened many unknown avenues to be explored in the arena of information extraction. At the same time, they have equally introduced certain complexities such as different digital values in different spectral region and varying spatial and radiometric parameters. Hence, applying them in specific field of theme requires knowledge on the inherent characteristics of satellite data and also about the theme of application. In the present paper, a discussion on the inherent characteristics of satellite data and its utility in extracting information on the type of land units along a coastal environment has been carried out.

Keywords*:* remote sensing image (RSI), DN values, information extraction, image processing, coastal environment

1. Introduction

Remotely sensed image (RSI) and derived image databases are the fastest growing archives of spatial information that provide ample information about our earth. Tremendous amount of information hidden in these data collection play a crucial and significant role in wide range of analysis and applications. Analysis of Remote Sensing Image (RSI) is a major application domain used for various feature extraction and pattern recognition involved in natural resources assessment, hazards and environmental monitoring activities such as coastal area (Paul, 2000; Fonlupet, 2001), sea grass and mangrove ecosystem (Farid, 2002), beach morphology (Teodoro, *et.al.,* 2008) and coastal hazards (Garcin *et al*, 2008; Roemaer *et al* 2010). The process of information extraction from RSI (Yu et.al., 2000) exploit the interaction of objects on the earth with electromagnetic spectrum (ems) such as reflection, refraction and absorption, which in turn gives rise to the term spectral behavior. This spectral behavior is well exploited to identify and categorize each objects and to generate information database of any specific theme (Chen and Wang, 2004). Hence it requires an understanding on the inherent characteristics of different objects in different spectral region, attenuation or noise of signals involved due to atmospheric particles, capability of sensors and various measures of pre-processing of satellite data (Mass and Nithya, 2010) and at last types of image processing for information extraction procedures especially for coastal environment.

2. Characteristics of Remotely sensed Image (RSI)

RSI is characterized by digital values that represent the spectral reflectance of various objects as recorded by sensors on-board satellite. A digital image (of RSI) is an array of numbers depicting spatial distribution of a certain field parameters such as reflectivity of EM radiation by objects, emissivity or topographical elevation. It consists of discrete picture elements called pixels. Associated with each pixel is a number represented as digital number (DN) that depicts the average radiance of relatively small area within a scene. The range of DN values being normally 0 to 255. The size of this area effects the reproduction of details within the scene. Size of the pixel is inversely proportional to the details of a scene. For example, when the pixel size is reduced more scene detail is preserved in digital representation, which is termed as the spatial resolution of the sensor. The larger the size of the pixel, the greater the details and relatively more information about the objects of study could be obtained. That is, the spatial resolution of RSI plays a role in determining the capability of degree of information that could be obtained from a scene as well as details of an object. Similarly, the

ability of sensor to record details of EM radiation of an object in narrower spectral region (bandwidth) provide ample scope to discriminate among objects as well as with in the same type of objects (Moran *et.al*., 1992).

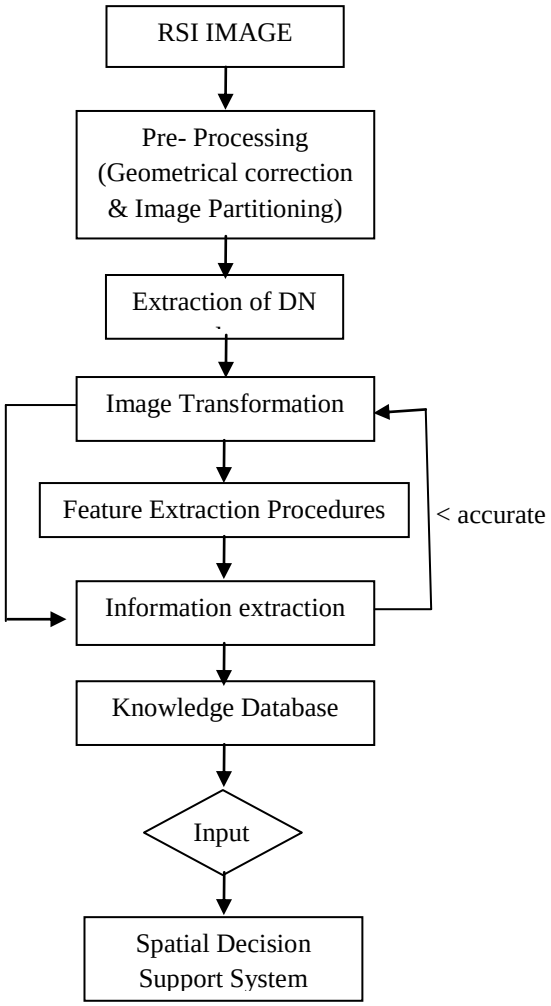

Figure 1. Flow chart showing information extraction from Remote Sensing Image

Thus, the spatial and spectral characteristic of RSI determine the scope of feature identification, discrimination within a specified object pattern, and details of information about objects and accuracy of information about an object.

The characteristics of RSI add complexity in processing the data in terms of size, data handling capability, feature extraction and accuracy of such information extraction. Moreover, data handling requires an understanding of data format such as Band Interleaved by Pixel (BIP), Band Interleaved by Lines (BIL) and Band Sequential Format (BSQ); the range of DN values of objects so as to segregate and identify features of area of interest as Knowledge database. Apart from these intrinsic things, effect of influence of noise on image data such as radiometric error and atmospheric attenuation apart from error due to earth rotation is to be taken care of adapting adequate measure which is termed as pre-processing the data along with generating sub-set image and tiles.

As explained above, the images of a dataset are selected according to criteria related to the application. In the preprocessing phase, feature extraction techniques are applied to these images. The mining process is a spatial data mining system prototype able to characterize spatial data using rules, compare, associate, classify and group datasets, analyze patterns and perform data mining in different levels. The extracted information may be directly integrated as "knowledge" input into any other decision making support systems. A typical information extraction procedure in RSI environment is shown in figure 1.

In the present study such a procedure is adopted to study the RSI data for extracting information of objects specifically along a coastal environment (Pais-Barbosa *et.al.*,2007). RSI is studied to extract various features such as sand, canal, river, waterbody, vegetation and saltpan based on their DN values in multispectral bands (R,G,B), textural form and pattern and position of DN values.

3. Analysis of RSI

Remote sensing image data is converted into digital number values and processed correction using Erdas Imagine software. The DN value in each band varies with the nature of objects. That is the same object will carry four DN values if the remote sensing image is a four band data image. This sort of variation in DN values in different spectral region allows the user to exploit and identify features individually for information extraction. For example waterbodies show high reflection in the first band (blue regions) and totally absorbed in the third band (red region). Any increase in DN values in the third band indicates the degree of turbidity of waterbody and presence of suspended solids in it. In this way not only the information on the identification of features is extracted but also the information on the nature of that feature as well.

In the analytical part, information extraction is the final step. The remotely sensed data is subjected to quantitative analysis to assign individual pixels to specific classes and it employs *priori* or *apriori* knowledge for categorization of pixels to some intelligent objects. Even in *apriori* approach, ground truth verification is required so as to assess the accuracy of the information derived through image processing and its reliability.

In the present study, a small tile image of a coastal area near Marakkanam town in Tamilnadu is selected and clustering technique is applied on it to analyse for extraction of possible information on the coastal features (Teodoro *et.al.*, 2009). Clustering or unsupervised approach to extract information of a coastal area would give significant reconnaissance information about the

objects and could be used for further intensive studies (Zaki, . With the domain expertise available features such as canal, saltpan, sandy area, waterbody, lagoon and sea are identified from the image. The results of the analysis are discussed in the following section.

4. Results and Discussion

The resultant output as derived from applying clustering algorithm on the selected satellite data IRS-LISS III brought out information on the general setting of various land features and interaction between land and sea (Figure 2).

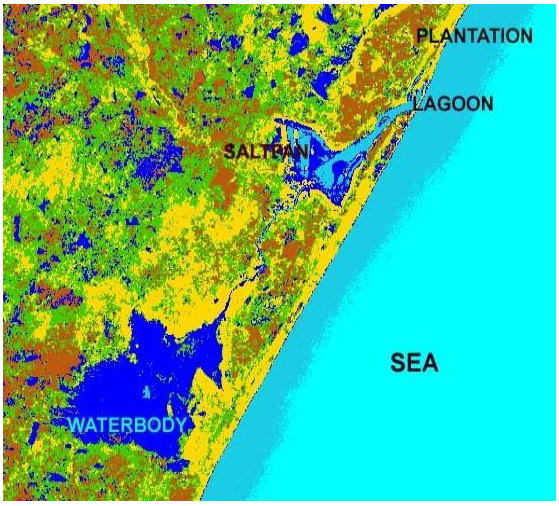

Figure 2. Resultant image of clustering

Further, to understand the significance of such information extraction, two smaller tiles have been selected and similar clustering or unsupervised procedure is applied. Such image could bring out more significant information and clearly showed more number of features. For example, lagoon area as shown at the upper part of Figure 2 (Yedayanthittu lagoon) is selected as a separate tile image and clustering algorithm is applied on it. The resultant image obtained revealed segregation of many minor features such as crop, vegetation, plantation, sand and water bodies (Figure 3). Even among the object "water body", distinguishing of turbid water along the coastline, deep sea water, and mixing of brackish water and fresh water in the lagoon could be observed.

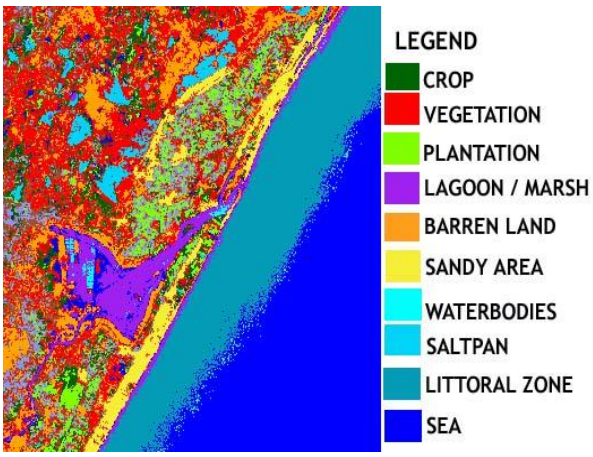

Figure 3. Resultant unsupervised image showing Lagoon ecosystem

Such variations among the water bodies as shown above is due to the varying spectral properties due to their composition (salt water and freshwater), content (sediments and soils), turbidity and mixing with vegetation. Similarly another water body, shown at the bottom part of Figure 2, a freshwater lake, is taken as the second image tile to demonstrate the significance of understanding DN values in different spectral region (Blue, Green, Red, InfraRed). A similar approach is adopted and while applying the algorithm following observations are made. Among the waterbodies, "sea", and water along the shore line called "littoral zone" and "fresh water" in the tank could be easily separated and clearly identified. There was no much confusion among pixels as the class intervals are increased. "Sand" could be easily identified and segregated as an homogenous object. This may be due to its high reflectance behaviour having high DN values compared to other objects such as "crop "and "plantation".

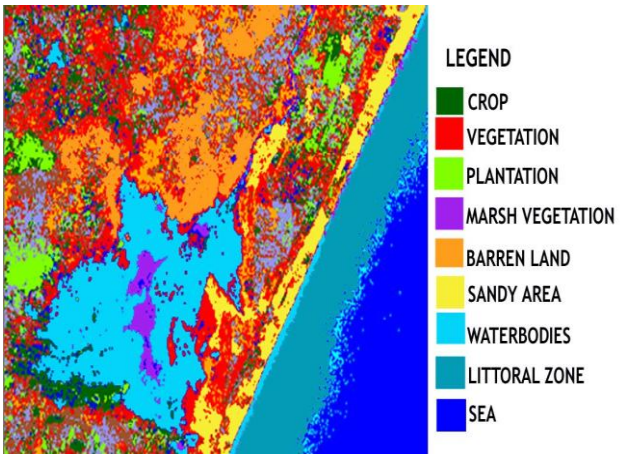

Figure 4. Resultant unsupervised image showing Freshwater ecosystem

While studying the output image, it was observed that specific feature "marsh vegetation" is seen at the middle of the fresh water. The ground truth field verification showed that small stunted growth of marshy vegetation could be observed at the middle as well at the top part of

the waterbody. This may be due to the interaction of tidal water into the freshwater during monsoons and storms allowing the growth of salt tolerant floral species. Despite the use *apriori* approach, certain specific information could be brought out which otherwise may not be possible. Such a type of specific information helped to understand the degree of information extracted using clustering or unsupervised technique and at the same time enable to appreciate the interaction mechanism of nature with electromagnetic spectrum (ems), which is duly recorded in the remote sensing data. Analysis of remote sensing image in digital format and application of information extraction using unsupervised or clustering technique and observation has led to certain conclusion, which is discussed in the following section.

5. Conclusion

The analysis of RSI and observation has led to the following conclusions.

1. RSI could provide sufficient information on the land features as well coastal features.
2. Digital number (DN) values could be analysed for extracting useful information by applying appropriate processing techniques.
3. Identification and classification of objects without prior knowledge could be to some extent provide valuable information about the coastal environment.
4. Separability of different types of water bodies revealed the significance of the necessity understanding the interaction mechanism between *ems* and the objects.
5. It is possible to bring out certain specific information from clustering technique.
6. This type of study could give reconnaissance information about the coastal environment before going in for specific methods.
7. This type of approach would be more appropriate to derive baseline information about the selected study region and features along the coastal environment where predominant interaction between land and water exist.

Reference

[1] Chen, Y. and J.Z. Wang, "Image Categorization by Learning and Reasoning with Regions", Jou. of Machine Learning Research, Vol.5, pp 913-939, 2004

[2] Farid Dahdough-Guebas, "The use of Remote sensing and GIS in the sustainable management of Tropical ecosystem", Environment, Development and Sustainability No.4, pp 93–112. Kluwer Academic Publishers, Netherlands, 2002

[3] Fonlupt,C, "Solving the Ocean Color Problem using a Genetic Programming Approach", Applied Soft Computing, Vol. 1:1, pp. 63–72,2001.

[4] Garcin, M., Despratts, J.F., Fontaine, M., Pedreros., Attanayake., Fernando, S., Siriwardana, C.H.E.R., De Silva, U., and Poisson, B, "Integrated approach for coastal hazards and risks in Sri Lanka", Natural Hazards Earth Systems Science, No. 8, pp 577–586, 2008.

[5] Julea,A., M´eger,N., and Trouv´e, E, "Sequential patterns extraction in multitemporal satellite images" Proc. of 10th European Conf. on Principles and Practice of Knowledge Discovery in Databases (PKDD'06), Practical Data Mining Workshop: Applications, Experiences and Challenges, pp 94–97, 2006.

[6] Kumar, S., Ghosh, J,. and Crawford, M.M, "Best basis feature extraction algorithms for classification of hyperspectral data, IEEE Trans. Geoscience and Remote Sensing, Vol 29, No. 7, pp. 1368-1379, 2001.

[7] Moran, M.S., Jackson, R.D., Slater, P.N., and Teillet, P.M., "Evaluation of simplified procedures for retrieval of land surface reflectance factors from satellite sensor output", Remote Sens. Env., V 41, pp 169-184, 1992.

[8] Pais-Barbosa, J., Veloso-Gomes, F., and Taveiro-Pinto, F, "Coastal features in the energetic and mesotidal west coast of Portugal, Jou. Coastal research, SI50, pp 459-463, 2007.

[9] Roemer, H., Kaiser, G., Sterr, H., and Ludwig, R, "Natural Hazards and Earth System Sciences Using remote sensing to assess tsunami-induced impacts on coastal forest ecosystems at the Andaman Sea coast of Thailand", Nat. Hazards Earth Syst. Sci., No.10, pp 729–745, 2010.

[10] Stephan J. Maas, S.J and Nithya Rajan (2010), Normalizing and Converting Image DC Data Using Scatter Plot Matching, Remote Sens. 2010, V2, pp 1644-1661, 2010.

[11] Teodoro, A.C., Veloso-Gomes, F., and Goncalves, H., "Statistical technique for correlating TSM concentrationwith sea water reflectance using multispectral satellite data", Jou. Of Coastal research, Vol.24, SI 3, pp 40- 49, 2008.

[12] Teodoro, A.C., Pais-Barbosa, J., Veloso-Gomes, F., and Taveiro-pinto, F., "Evaluation of beach hydromorphological behavior and classification using Image classification Techniques", Jou. Coastal research, SI56, pp1607-1611, 2009.

[13] Yu, S., De Backer, S and Scheunders, P, " Genetic Feature Selection Combined with Composite Fuzzy Nearest Neighbor Classifiers for High-Dimensional Remote Sensing Data", IEEE International Conference on

Systems, Man and Cybernetics, Nashville, TN, pp. 1912–1916, IEEE Press, October 8–11, 2000.

[14] Zaki, M.J, "Spade: an efficient algorithm for mining frequent sequences", Machine Learning, Special issue on Unsupervised Learning, 42 (1/2), pp31–60, 2001.

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