ABSTRACT

The coastal zone is a complex ecosystem under the influence of various physical, chemical and biological processes. Physiographic and ecological processes in this zone are interlocked in a narrow expanse of land and water, to result in many biogeomorphic units such as rivers, wetlands, coastal lagoons, beaches, bays and estuaries. These dynamic units form habitats for many biological communities, and are often affected by various natural and anthropogenic factors, leading to the degradation of the habitats. For proper coastal management, mapping and monitoring of such units is essential. Remote sensing technology, in recent years, has proved to be advantageous for such mapping and monitoring. However, due to the spatial complexity of physiographic and ecological features along the coast, and due to inadequate spatial resolution of the sensors, processing of remotely sensed data results in less accurate maps of the coastal zone. This study addresses the problems of coastal mapping using multi-sensor satellite images, and attempts to use certain recent image processing techniques for extraction of more information about various coastal features in an accurate fashion.

Accordingly, certain conventional image enhancement techniques, which include contrast stretching, histogram equalization and principal component analysis were attempted to highlight the coastal features of three coastal study sites. The result shows that coastal features such as scrub, plantation, mangroves, marsh, mudflat, salt pan, sand dunes and lagoons are brought out clearly in the images of the three study sites while other features are not clearly seen. Similarly, image fusion techniques were implemented and tested on optical and microwave image data of these sites. Fusion brings out finer details such as dense and sparse mangroves, species/communities of mangroves, degraded mangroves, marsh, reclaimed mudflat, dry and wet mudflat, aquaculture ponds, salt pan, scrub, plantation, forest, sand dunes and lagoons. Similarly,
fusion of optical and thermal bands highlights coral reefs, soil moisture, plantation, scrub and sand dunes.

Image classification using unsupervised and supervised classification algorithms was also attempted to map the coastal features. While unsupervised classification, using ISODATA algorithm, produces maps of broad coastal land cover types, the accuracy of unsupervised classification is not satisfactory in all the study sites. Hence, supervised classification using Maximum Likelihood Classifier (MLC) was attempted. The result is a map with many information classes and with improved accuracy compared to unsupervised classification. It is observed that the overall accuracy decreases when the number of classes selected increases (89.3% for 5 classes, 80% for 10 classes, 76% for 15 classes and 74.8% for 18 classes). It is also observed that significant confusion occurs among certain classes, leading to decrease in classification accuracy. This is mainly due to spectral overlapping and sub-pixel mixture problem. Hence, sub-pixel classification (using spectral unmixing) was attempted to extract the coastal information in a more accurate fashion.

End-members spectra, which are an important input for spectral unmixing, were extracted and three fraction images (soil, vegetation and water) are generated. These fraction images are then validated using NDVI values and field data. NDVI and vegetation fraction values are positively correlated \( R^2 = 0.92 \) and \( 0.94 \) in LISS-III and TM images respectively, indicating the reliability of the sub-pixel classification. The accuracy of the unmixing model for deriving moisture proportion is 90.6%, while it is 80.6% for soil proportion. Comparison of the results of supervised classification and spectral unmixing shows that the latter is a superior technique for coastal landcover information extraction.

Thus, it is seen that image fusion highlights different coastal features in a better manner compared to the conventional image enhancement techniques. Also, spectral unmixing has potential for better estimation of sub-pixel proportions of coastal land cover types compared to the per-pixel classification processes.