SEMI-SUPERVISED CLASSIFICATION OF LAND COVER BASED ON SPECTRAL REFLECTANCE DATA EXTRACTED FROM LISS IV IMAGE

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ABSTRACT:

A methodology is proposed for extracting information on land cover based on hyperspectral reflectance data derived from satellite image, without supervising with ground truth. The reflectance percentage, being a characteristic feature of the ground object acts as an indirect guidance to the classification and hence the method is named semi-supervised classification. It is tried with IRS LISS IV image of a specific part of southern West Bengal, India. At least three categories, *viz.* vegetation, waterbody and open land are distinctly identified with the present technique. It is hoped that a method like this is more useful in the analysis of hyperspectral imagery, which is an area of upthrust in future.

1. INTRODUCTION

The present work proposes a methodology for extracting information on land cover from hyperspectral or multispectral satellite images, without supervising with ground truth. The DN value is converted to reflectance for different bands and pixels and the reflectance-wavelength curve is plotted. Comparing it with standard spectral libraries (ASTER, 1999) one can obtain correct information on the ground feature and classify accordingly. The method avoids, in classification the supervision with ground truth. But the reflectance percentage acts as an indirect guidance to the classification and hence the method is named semi-supervised classification. The accuracy depends on the correctness of both the spectral standard and the fineness in resolution of wavebands. Thus the method is more oriented to hyperspectral remote sensing, which calls for accuracy in ground spectral standardization (Muttiah, 2002) and finer resolution in wavelength (Alberotanza, 1999, Blackburn, 1998).

The subject under consideration is the land cover of a part of southern West Bengal, India (Table 1). It contains natural resources like vegetation, open land and waterbodies including river and swamp. The above matrix of diversified sets deserves classification, whereas the recent ground truth with Survey of India Topographical Map is not available. The available map dates back to 1978. Therefore, although the current location and extent of the separable categories may be assigned, proper identification is difficult. More precisely, one may execute unsupervised classification but not supervised classification. Under such circumstances, the present technique of distinguishing features on the basis of hyperspectral reflectance data directly derived from the satellite image is found suitable, provided the proper spectral standard is available. We have tried the method on the IRS LISS IV image (Table 1) of the mentioned area and distinctly identified at least three categories, *viz.* vegetation, waterbody and open land.

2. METHODOLOGY

The physical properties of ground features determine the wavelength dependence of their

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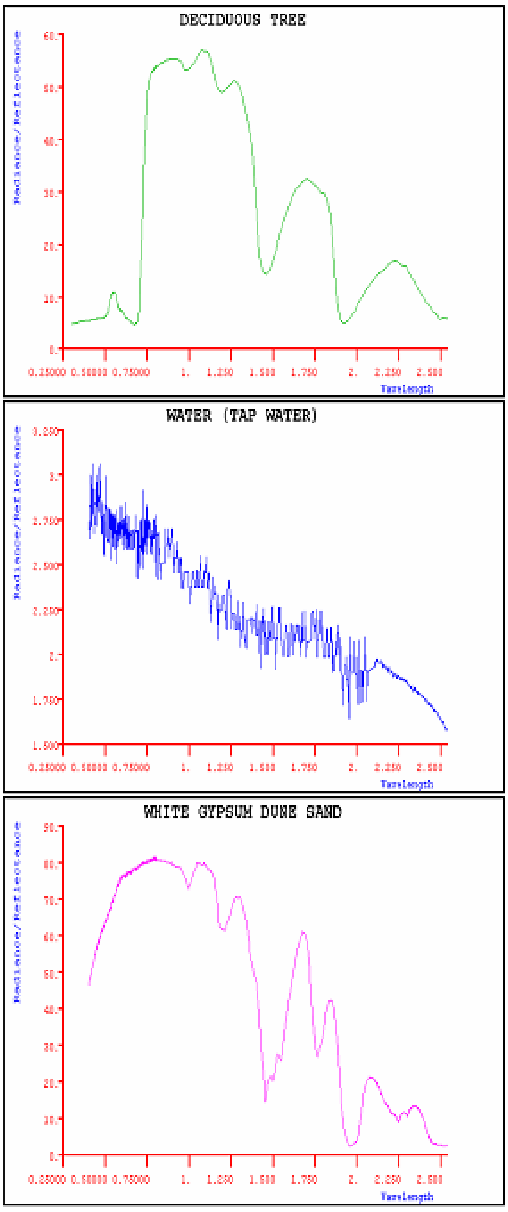


Figure 1. Standard spectral responses of ground features (ASTER 1999)

spectral response that is recorded in the satellite data. For instance, vegetation has high near-infrared (NIR) and low red reflectance, water has low NIR reflectance, whereas soil has constant reflectance over a wide range of NIR wavelength. Conventionally the above features are quantified in terms of spectral indices. However, a spectral standard like that of Figure 1 can present a more prominent recognition with continuous wavelength scan of reflectance.

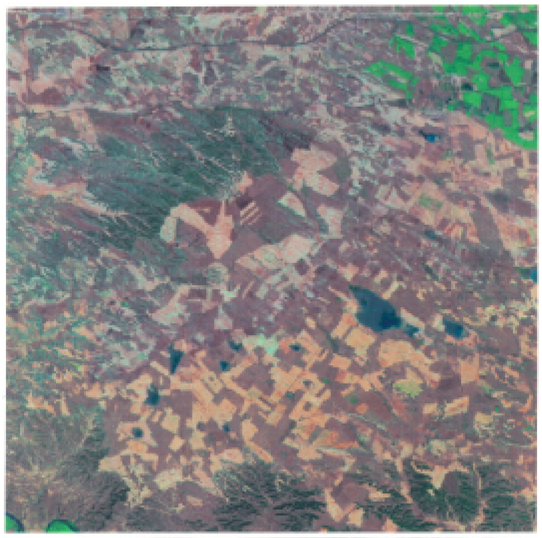


Figure 2. Landsat TM 6 band image of Los Monegros (NE Spain) semiarid land, used as a standard image with known results (Mather 2004).

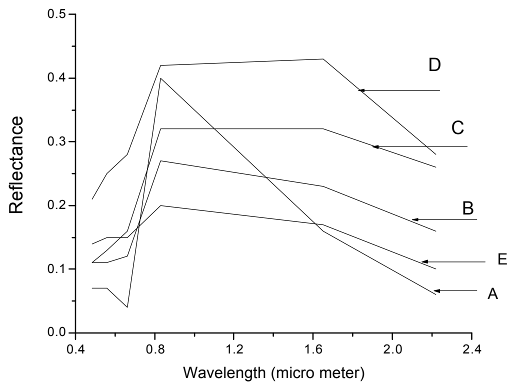


Figure 3. Reflectance-wavelength plot derived from Figure 2 for different ground features: (A) vegetation, (B) stressed vegetation, (C) dry grass, (D) gypsum rich soil and (E) water. Reflectance variation for a certain feature among different pixels was within 10%.

Similar information was obtained by converting DN values into reflectance and plotting against wavelength. All the analyses were done using standard image processing software (Mather, 2004). At first, the validity of the present method was tested with a standard image (Figure 2) with known results. The characteristic reflectance-wavelength plots averaged over different pixels representing different ground features are shown in Figure 3. Since the image had only six bands, reflectance values could be obtained corresponding to six spot values of wavelength, each averaged over the range of one band. Hyperspectral plot with fine wavelength resolution like Figure 1 could not be obtained. However, comparing the spot values of reflectance for different ground features in Figure 3 with those of Figure 1 we conclude that the distinct nature of each feature is indicated from the image. The reflectance (curve A) of vegetation in Figure 3 sharply increases at around 0.8µm and decreases at higher wavelengths. As the vegetation becomes stressed (curve B) and dry (curve C), the reflectance approaches that of bare soil (curve D). The reflectance of water (curve E) is marked by its lower value compared to that of the other objects, specifically at infrared region.

Table 1: Specifications of the area and image under consideration

Geographical Extention	22°45’N - 23°00’N 88°00’E - 88°15’E
Survey of India Topographical Map No.	79B/1
Administrative location	State: West Bengal, District: Hooghly
Ground features	Alluvial plain of Damodar-Bhagirathi interstream rural area, agriculturally fertile, active channels, canals, ponds, swamps, roads, settlements etc.
Image type Number of lines Number of pixels Number of bands Average wavelengths	IRS LISS IV (2005) 2510 2322 3 Band 1: 0.555 µm Band 2: 0.650 µm Band 3: 0.815 µm

3. RESULTS AND DISCUSSION

The above technique was repeated for the IRS image of the area described in Table 1. The image is shown in Figure 4 and its unsupervised classified image is shown in Figure 5. The unsupervised classification done by standard

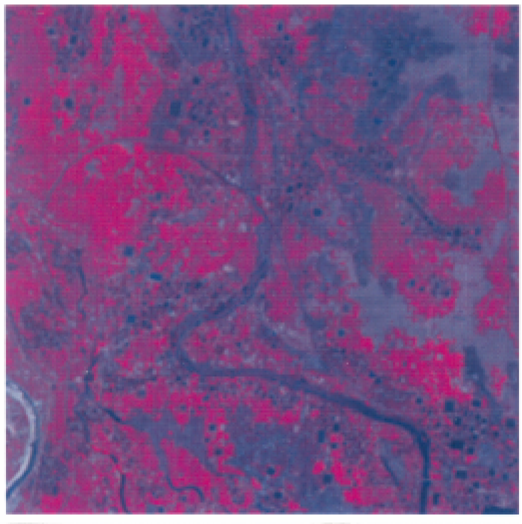


Figure 4. IRS LISS IV image (Table 1)

ISODATA technique provided with a first hand result that helped in identifying pixels of the same category. For simplicity and visual similarity with the original image, classification was done in only four categories. The corresponding reflectance- wavelength plot is shown in Figure 6. There are available only three spot values of average wavelength. However, the distinctness of the different features is obvious. It is concluded from the results of Figure 6 for different pixels that the pink regions of the image in Figure 4 indicate vegetation. The black lines and blackish spots represent river or canal and swamp, respectively. The white or ash spots are bare soil or fallow land.

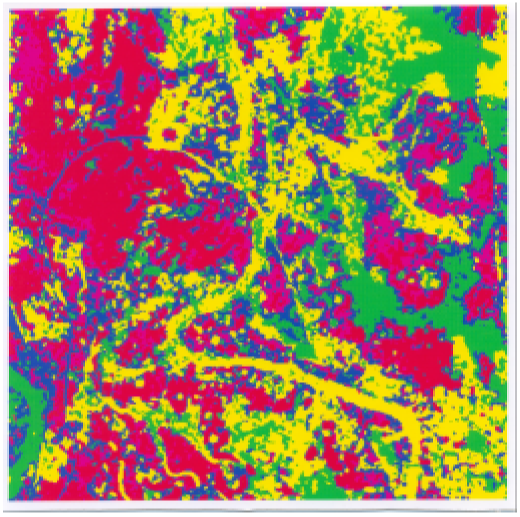


Figure 5. Unsupervised classified image of Figure 4.

distinct. Thus the reflectance study identifies the correct features.

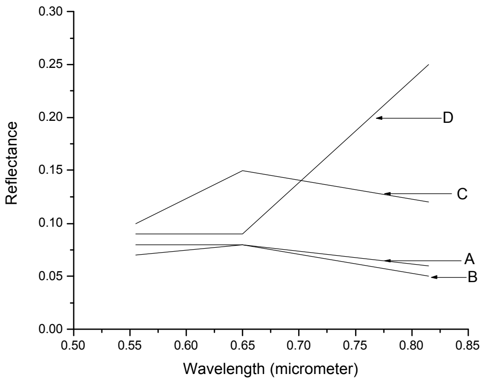
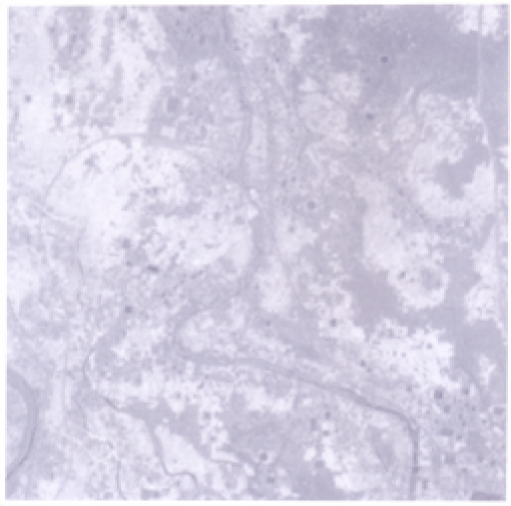


Figure 6. Reflectance-wavelength plot derived from Figure 4 for different ground features: (A) active river channel, (B) waterbodies (pond, swamp etc.), (C) presently fallow land/ sandy area and (D) cropped area/ orchard.



7. NDVI equivalent of the pixels of Figure 4.

The above conclusions were supported by conventional techniques. The pixels identified with reflectance plot were experimented with known techniques. Figure 7 is the NDVI plot for different pixels derived from Figure 4. It is noted that the vegetated regions, indicated by red colour in Figure 4 are more enhanced. The same conclusion is obtained by band arithmetic. Figure 8 and Figure 9 exhibit the effect of doubling the contribution of NIR band and blue band, respectively. In the former case, the vegetation region becomes more prominent whereas in the later case it gets disordered. At the same time water, which has almost same reflectance in the two bands remains equally

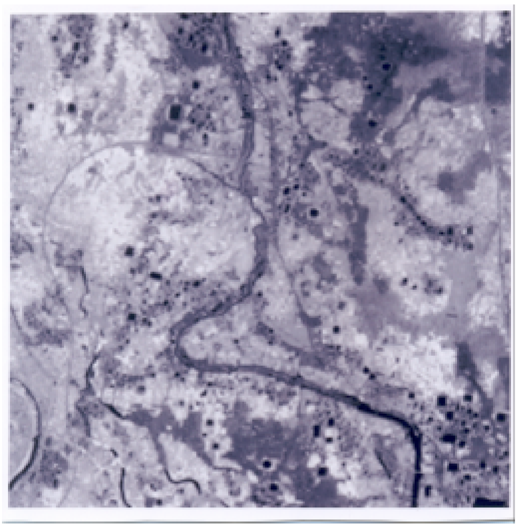


Figure 8. NIR band contribution doubled in Figure 4.

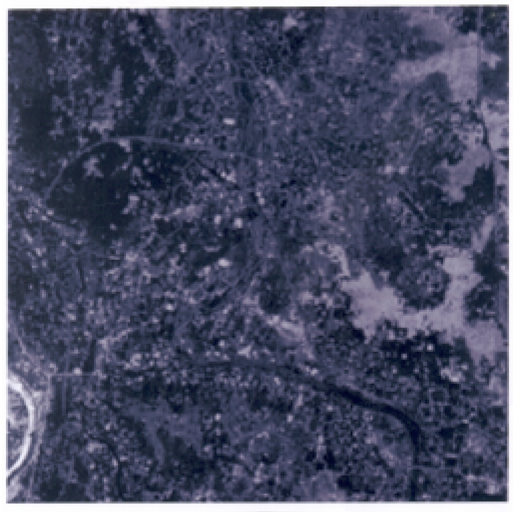


Figure 9. Blue band contribution doubled in Figure 4.

4. CONCLUSION

The present work proposes a methodology for extracting information on land cover based on hyperspectral reflectance data derived from satellite image. It offers a good alternative of supervised classification in absence of ground truth. It is named as semi-supervised classification because the reflectance percentage, a characteristic feature of the ground object acts as an indirect guidance. The technique is tried with IRS LISS IV image of a specific part of southern West Bengal, India. At least three categories, *viz.* vegetation, waterbody and open land are distinctly identified with the present technique. The technique works more accurately as the number of bands is increased. Therefore, It is hoped that a method like this is more useful in the analysis of hyperspectral imagery, which is an area of future importance.

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APPENDIX: Map of the area of study.