Satellite based Segregation of MSW dumping sites using digital image processing

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Handling socio-economic issues related to Municipal Solid Waste (MSW) or its valorisation demands identification of its dumping sites. Although in societies where MSW is managed properly, location of dumping sites is usually decided before start of the dumping, whereas, developing countries usually lack in such planning systems and people throw off their waste away from residential area without any knowledge of the government (Mahmood et al., 2016; Mahmood et al., 2017). Such a scenario demands identification of MSW dumps at larger scale so that the next process either about generation of energy from it, assessing its environmental impacts or planning their sustainable solutions can be started. The use of freely available satellite data in this regard is a good option as it provides economic alternative of field surveys and a wider viewing of any area (Mahmood et al., 2016; Mahmood et al., 2017). The simple way to identify MSW open dumps using remotely sensed satellite data is to use visual analysis that requires higher spatial resolution and a concentrated, detailed watch of the area. In this study an attempt has been made for the computer based segregation of the MSW dumps from other land covers and within themselves using their spectral response patterns captured by Landsat-8 satellite.
This work has been started by developing spectral signatures of MSW dumps and other landcovers for making desired discrimination. Visible, Near InfraRed (NIR) and Midle InfraRed (MIR) bands of the satellite image were stacked together, followed by zonal statistical operation. Training areas from various dumps including main MSW open dump of Faisalabad (MF-MSWOD), New MSW Open Dump of Faisalabad (NF-MSWOD), Mahmood Booti MSW Open Dump of Lahore (MB-MSWOD) and Saggian have been used as zones for the zonal statistical operation. These also include vegetation cover around these dumps, soil patches and different residential densities.

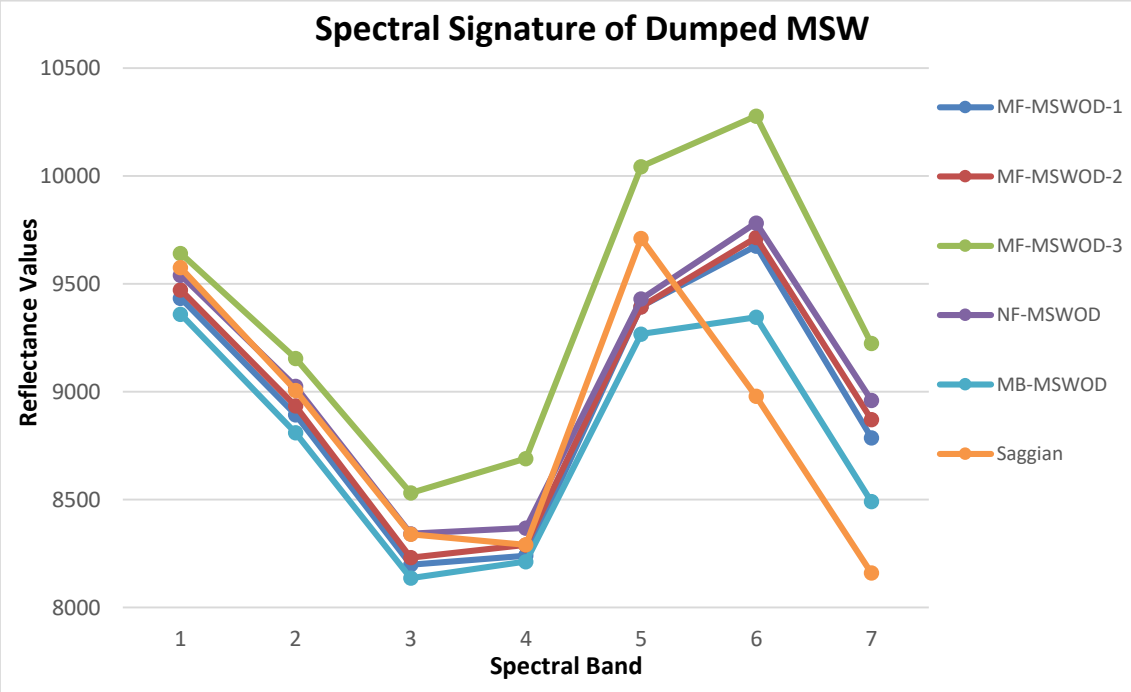

Figure 1. Spectral signature of dumped MSW at different dumps

Spectral behavior of open dumped MSW has been shown in figure 1. Three of the sampled locations have been picked from MF-MSWOD, whereas other dumps including NF-MSWOD, MB-MSWOD and Saggian are taken as single unified sample. In general, the spectral values of dumped MSW lies around 9500 in band-1 that decreased to around 9000 in band-2 and the decrease continue to about 8300 in band-3. Band-4 of Landsat-8 falls in red color range of visible spectrum where spectral values of dumped MSW are bit higher than that of the band-3, which represent spectral response in green color range. Dumped MSW reflect relatively higher in band-5 and band-6 that fall in wavelength range of NIR & MIR respectively. If compare mutually, reflection is higher in band-6 than that of the band-5 for the target, the only exception found is for Saggian that reflects more in band-5 than band-6. MSW dump at Saggian is not in use now and the waste is covered with soil as a result of blowing winds, so in its case the spectral response is somehow different from others. Finally, the signature curve drops down once again for all

of the samples as the reflectance in band-7 is less than that of the band-6. However, the samples vary greatly for their response to band-7, MF-MSWOD-3 is the oldest waste at the site that gives highest reflectance. The second group is formed by MF-MSWOD-1 (fresh waste), MF-MSWOD (five-year-old waste) and NF-MSWOD, they all have almost similar response corresponding band-4, band-5, band-6 and band-7. MB-MSWOD and Saggian have lowest reflectance for both band-6 and band-7. Ignoring Saggian due to mixing of soil signature, all the dumped MSWOD samples have highest spectral value in band-6 and lowest in band-3.

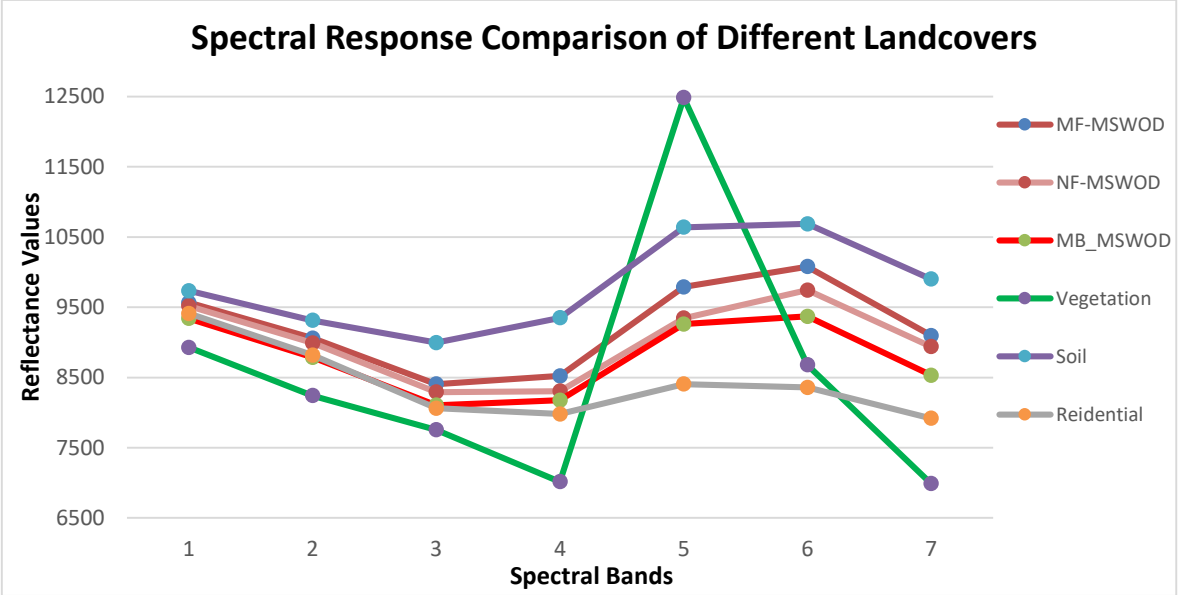

Figure 2. Spectral signature of various land covers

For understanding this mixing of land covers their spectral signatures have been plotted over a common graph as shown in figure 2. Vegetation cover, representing major part of the subset image does not mix with the MSWODs, as it is spectrally quite different from rest of the land covers. However spectral curves of residential area, soil and MSWODs are almost giving similar patterns. Graph pattern of soil is similar to MSWODs but the curve forms relatively higher, showing its high reflectance in all bands, especially from band-3 to band-7. Therefore, its discrimination can be made from MSWODs on the basis of its high albedo. Spectral behavior of residential area remains exactly same from band-1 to band-4 and then a slight difference is observed in intensity of the reflected radiation, but with the same pattern as that of the MSWODs. The difference in band-5 and band-6 can be utilized for separating MSWODs and residential area, but it requires an extensive work for the development of band ratios that can highlight the difference. Development of such band ratios requires better spatial as well as spectral resolution than provided by the used data of Landsat-8.

References:

Mahmood, K., A., Batool, F., Faizi, M. N., Chaudhry, Z., Ul-Haq, A. D., Rana, and S., Tariq. 2017. "Bio-thermal effects of open dumps on surroundings detected by remote sensing-Influence of geographical conditions". *Ecological Indicators*, 82: 131-142.

Mahmood, K., S. A., Batool, and M. N., Chaudhery. 2016. "Studying bio-thermal effects at and around MSW dumps using satellite remote sensing and GIS". *Waste Management*, 55: 118-128.

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