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Assessing the Theoretical Suitability of Sentinel-2 and Worldview-3 Data for Hydrocarbon Mapping of Spill Events, Using Hydrocarbon Spectral Slope Model

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Abstract : Identification of hydrocarbon oil in remote sensing images is often the first step in monitoring oil during spill events. Most remote sensing methods adopt techniques for hydrocarbon identification to achieve detection in order to model an appropriate cleanup program. Identification on optical sensors does not only allow for detection but also for characterization and quantification. Until recently, in optical remote sensing, quantification and characterization are only potentially possible using high-resolution laboratory and airborne imaging spectrometers (hyperspectral data). Unlike multispectral, hyperspectral data are not freely available, as this data category is mainly obtained via airborne survey at present. In this research, two (2) operational high-resolution multispectral satellites (WorldView-3 and Sentinel-2) are theoretically assessed for their suitability for hydrocarbon characterization, using the hydrocarbon spectral slope model (HYSS). This method utilized the two most persistent hydrocarbon diagnostic/absorption features at 1.73 µm and 2.30 µm for hydrocarbon mapping on multispectral data. In this research, spectra measurement of seven (7) different hydrocarbon oils (crude and refined oil) taken on ten (10) different substrates with the use of laboratory ASD Fieldspec were convolved to Sentinel-2 and WorldView-3 resolution, using their full width half maximum (FWHM) parameter. The resulting hydrocarbon slope values obtained from the studied samples enable clear qualitative discrimination of most hydrocarbons, despite the presence of different background substrates, particularly on WorldView-3. Due to close conformity of central wavelengths and narrow bandwidths to key hydrocarbon bands used in HYSS, the statistical significance for qualitative analysis on WorldView-3 sensors for all studied hydrocarbon oil returned with 95% confidence level (P-value ˂ 0.01), except for Diesel. Using multifactor analysis of variance (MANOVA), the discriminating power of HYSS is statistically significant for most hydrocarbon-substrate combinations on Sentinel-2 and WorldView-3 FWHM, revealing the potential of these two operational multispectral sensors as rapid response tools for hydrocarbon mapping. One notable exception is highly transmissive hydrocarbons on Sentinel-2 data due to the non-conformity of spectral bands with key hydrocarbon absorptions and the relatively coarse bandwidth (> 100 nm).

Keywords : hydrocarbon, oil spill, remote sensing, hyperspectral, multispectral, hydrocarbon-substrate combination, Sentinel-2, WorldView-3
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