Estimating Burn Severity Using the Combination of Landsat and Sentinel-2 Data over the Horse River Wildfire

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ABSTRACT

Burn severity is a key factor in post-fire management in order to quantify and map fire impacts and, subsequently, plan the mitigation and rehabilitation treatments in the burned areas. The assessment of burn severity, particularly over large fires, is a time consuming and costly process from in-situ surveys alone, thus satellite-inferred burn severity data have become increasingly popular over the last decade for management and research purposes.

The Landsat TM is typically used for the assessment of post-fire effects due to its systematic repetitive coverage, large archival database, multispectral coverage in the visible, near infrared (NIR) and shortwave infrared (SWIR) portions of the spectrum, and 30-m spatial resolution is considered appropriate for fire mapping. The Differenced Normalized Burn Ratio (dNBR) is commonly used to determine the extent and degree of landscape change resulting from the fire, and calibrated using composite burn index (CBI), that was designed to assess burn severity by rating the average burn condition on a plot.

The lack of cloud-free pre-fire and post-fire image pairs is one of biggest challenges to use remote sensing data to estimate the burn severity, especially in the boreal forest in northern Alberta where the Horse River wildfire (~600,000 ha) occurred in Fort McMurray in May and June 2016. The combination of multiple satellites for the burn severity mapping is one of the solutions to the lack of cloud-free images, but the difference in radiometric characteristics across sensors imposes difficulties for dNBR calculation and interpretations.

We used the Horse River Wildfire as an example to investigate the feasibility to integrate the Sentinel-2 (launched in 2015) and Landsat 8 for the burn severity mapping over large fires. Three aspects were addressed: 1) the similarity and difference between these two sensors within the context of burn severity mapping, 2) the radiometric normalization to facilitate the comparison between pre-fire and post-fire imageries across sensors, and 3) the nonlinear regression analysis between image-derived dNBR and field-collected CBI values.

The preliminary results demonstrate that the integration of Sentinel-2 and Landsat 8 is feasible to map the burn severity of large fires. This approach allows for the operational use of the mix of Sentinel-2 and Landsat 8 to assess the post-fire effects in the future. However the coefficient of determination of the non-linear regression model between dNBR and field CBI values is only 0.49. This could be related to many factors such as the registration error between the CBI plots and images, the phonological inconsistency between the pre-fire and post-fire image acquisitions and the time lag of 90 days between the fire and field sampling time (it has been noticed that grass and aspen regrowth comes fast after the fire). These issues will be further explored in the future.