Spatio-temporal patterns of optimal Landsat data for burn severity index calculations: Implications for high northern latitudes wildfire research

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Background

A group of indices, including dNBR, RdNBR, and RBR, are commonly used as proxies for burn severity in various ecosystems. The calculation of these indices requires two Landsat images (one before the fire and one after the fire) and ideally, they should be acquired during the same time of year (thus forming optimal image pairs (OIPs)). However, due to the unique environmental conditions of the high northern latitudes, such requirements may not be easily met. This study systematically assesses this situation and calls for attention to the associated implications.

Analysis

Regional analysis: We examined 12 randomly selected fires in Alaska that had multiple OIPs and calculated their burn severity indices. Continental analysis: We calculated the number of OIPs for all wildfires (32,769 fires in total) that occurred in the US and Canada during 1985-2017 on Google Earth Engine.

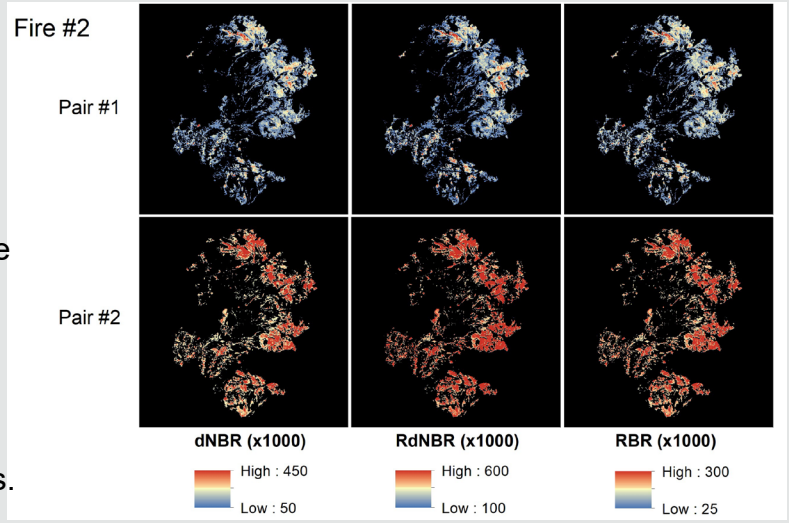

Figure 1 Comparisons of dNBR, RdNBR, and RBR that were calculated for one of the 12 fires based on two different OIPs. The same color scheme is applied to the same index calculated to illustrate the differences.

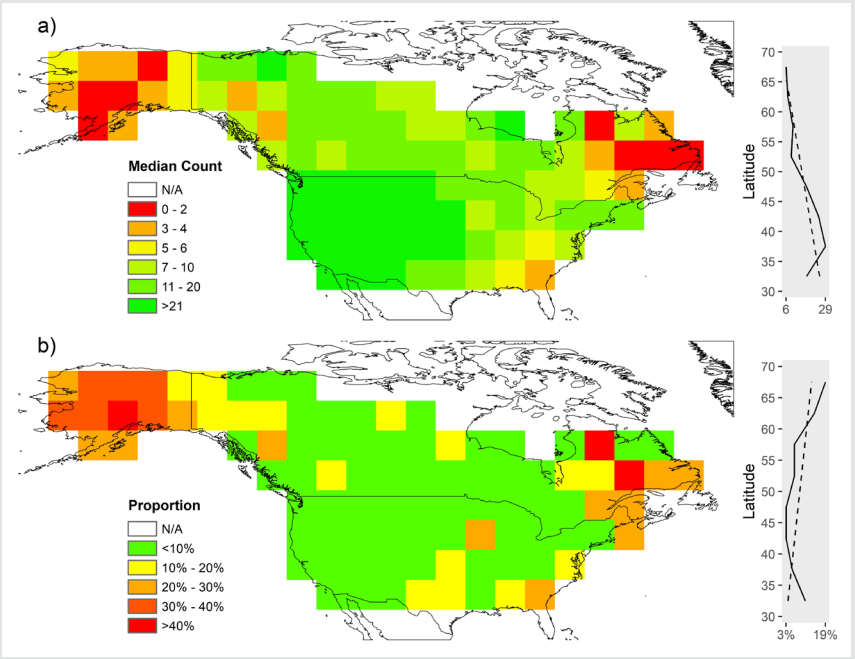

Figure 2 Distribution of median OIP counts (a) and proportion of fires with no OIP (b) based on 5º × 5º cells. The solid lines in the graphs on the right show the latitudinal distribution of the mean value of each 5º row of the corresponding metric, with the black dashed lines representing the linear trend of each metric.

Results

Regional analysis (Fig 1): When the number of OIPs is low, the performance of the calculated indices is unreliable. Continental analysis (Fig 2): With the increase in latitude, the number of available OIPs decreases. In Alaska, this issue is particularly severe. A considerable amount of fires have fewer than 2 OIPs.

Significance

This study highlights a caveat related to the application of burn severity indices in the high northern latitudes that has not been previously examined: the performance of the commonly used indices could be quite unreliable even when they are calculated based on OIPs. Several potential solutions are offered, including lowering the criteria for OIPs and incorporating additional data sources into the calculation of the burn severity indices.