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Sentinel-2 Based Burn Area Severity Assessment Tool in Google Earth Engine

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Abstract : Fires are one of the foremost factors of land surface disturbance in diverse ecosystems, causing soil erosion and land-cover changes and atmospheric effects affecting people's lives and properties. Generally, the severity of the fire is calculated as the Normalized Burn Ratio (NBR) index. This is performed manually by comparing two images obtained afterward. Then by using the bitemporal difference of the preprocessed satellite images, the dNBR is calculated. The burnt area is then classified as either unburnt (dNBR<0.1) or burnt (dNBR>= 0.1). Furthermore, Wildfire Severity Assessment (WSA) classifies burnt areas and unburnt areas using classification levels proposed by USGS and comprises seven classes. This procedure generates a burn severity report for the area chosen by the user manually. This study is carried out with the objective of producing an automated tool for the above-mentioned process, namely the World Wildfire Severity Assessment Tool (WWSAT). It is implemented in Google Earth Engine (GEE), which is a free cloud-computing platform for satellite data processing, with several data catalogs at different resolutions (notably Landsat, Sentinel-2, and MODIS) and planetary-scale analysis capabilities. Sentinel-2 MSI is chosen to obtain regular processes related to burnt area severity mapping using a medium spatial resolution sensor (15m). This tool uses machine learning classification techniques to identify burnt areas using NBR and to classify their severity over the user-selected extent and period automatically. Cloud coverage is one of the biggest concerns when fire severity mapping is performed. In WWSAT based on GEE, we present a fully automatic workflow to aggregate cloud-free Sentinel-2 images for both pre-fire and post-fire image compositing. The parallel processing capabilities and preloaded geospatial datasets of GEE facilitated the production of this tool. This tool consists of a Graphical User Interface (GUI) to make it user-friendly. The advantage of this tool is the ability to obtain burn area severity over a large extent and more extended temporal periods. Two case studies were carried out to demonstrate the performance of this tool. The Blue Mountain national park forest affected by the Australian fire season between 2019 and 2020 is used to describe the workflow of the WWSAT. This site detected more than 7809 km2, using Sentinel-2 data, giving an error below 6.5% when compared with the area detected on the field. Furthermore, 86.77% of the detected area was recognized as fully burnt out, of which high severity (17.29%), moderate-high severity (19.63%), moderate-low severity (22.35%), and low severity (27.51%). The Arapaho and Roosevelt National Forest Park, California, the USA, which is affected by the Cameron peak fire in 2020, is chosen for the second case study. It was found that around 983 km2 had burned out, of which high severity (2.73%), moderate-high severity (1.57%), moderate-low severity (1.18%), and low severity (5.45%). These spots also can be detected through the visual inspection made possible by cloud-free images generated by WWSAT. This tool is cost-effective in calculating the burnt area since satellite images are free and the cost of field surveys is avoided.

Keywords : burnt area, burnt severity, fires, google earth engine (GEE), sentinel-2
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