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Abstract
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Burnt Area Monitoring in near-real time – Combining high spatial and temporal resolution

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Challenge

Devastating fire events in Europe (e.g. Greece 2023, Spain 2022) but also on a global scale (e.g. Chile 2024, see example below, Canada 2023) show the importance to mitigate wildfire spreading as early as possible. This implies the availability of timely, accurate and robust information. The Center for Satellite-based Crisis Information (ZKI) Wildfire Monitoring System, operated at the German Aerospace Center (DLR), is a research platform providing satellite-derived burnt area information for Europe and North Africa. The information is provided in near-real time whenever new satellite overpasses are available. In order to provide the highest possible update frequency, the system supports a multitude of input sensors. While the system is primarily based on mid-resolution data, latest developments have been focussing on enhancing the results with higher-resolution data as soon as these data become available. This includes the DLR sensors DESIS and EnMap, the first two hyperspectral sources utilized by the system. However, since the sensors feature 235 and 222 spectral bands, respectively, efforts have been undertaken to define which bands yield the highest benefit for burnt area analysis.

Methodology

As a preceding step, we prepared a geospatial footprint for each archived DESIS and EnMAP acquisition from textual metadata. Then, we merged each footprint with NASA FIRMS active fire information intersecting the footprint and occurring within two weeks before the scene acquisition. The combined active fire area is then set in relation to the footprint area, which allows for a ranking of archived DESIS / EnMAP scenes by contained fire activity. In a following step, we ordered all scenes which were found to feature more than 5% fire activity from the DLR EOWEB data portal. Since the near-infrared (NIR) domain is well known to yield the highest benefit for the task of burnt area derivation (due to its chlorophyll-dependent characteristics), we performed a brute-force approach by analyzing each NIR band (103 and 29, respectively) of each selected DESIS/EnMAP scene with the burnt area methodology used by the ZKI Fire Monitoring system. Each result was compared against a reference from the NASA MCD64A1 burnt area dataset and evaluated by means of the Jaccard Index (IoU). The results are attributed with the mean Fire Radiative Power (FRP) of the active fire data, to obtain information about fire intensity together with the burnt area perimeter. For the final result, area-weighted mean IoU values were determined for each bandwidth in order to identify the bands with the highest suitability for burnt area derivation.

Expected results

Early results indicate that the optimal NIR wavelength for burnt area derivation is located around 820 nm for burnings with average FRP. However, this value is dependent on various factors, such as the intensity of the actual burning. This is interlinked with the affected vegetation type and its health status, amongst others. The study determines a set of optimal wavelengths for burnt area derivation in relation to identified factors such as fire intensity, affected land cover type and vegetation health. The results represent valuable information for hyperspectral burnt area mapping, and can be considered a solid base for an automated analysis process. The findings are not only applicable for the DESIS and EnMAP sensors used in this study, but to all hyperspectral sensors featuring bands in the NIR domain. Besides supporting wildfire related studies, the identified wavelengths represent valuable information in the field of sensor development. Instruments targeted at wildfire detection and analysis can thus be designed in an optimized way. This work is one of the first broad-scale hyperspectral wildfire analysis studies available und illustrates the suitability of hyperspectral data for wildfire-related research in the future.

Outlook for the future

The results indicate that there is no single optimal wavelength to be chosen. Rather, the input band should be selected in accordance with the fire intensity present in a given scene. Optimized results could be achieved, when the input band is chosen for each burnt region individually. Further developments of the platform will presumably support the analysis of active fire FRP values in a pre-processing step, selecting the most suited band or band combination for the analysis of specific sub-regions of the scene.

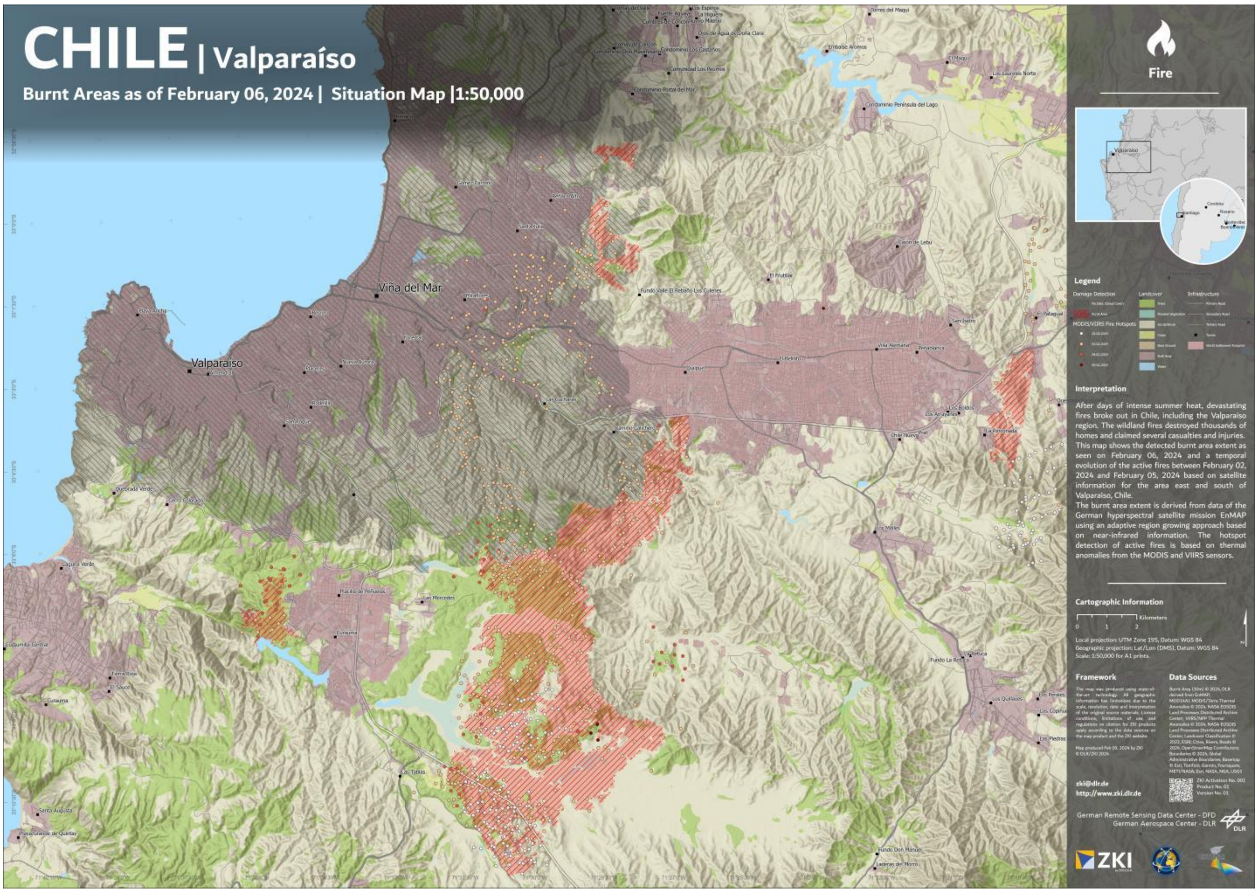

Figure (a) Example burnt area derived from EnMAP data for a devastating fire near Valparaíso / Chile, Feb. 2024