Burnt Area Monitoring In Near-Real Time – Combining High Spatial And Temporal Resolution

Challenge

Devastating fire events in Europe (e.g. Greece 2023/24, Spain 2022) and also on a global scale (e.g. Chile 2024, 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 Northern Africa. The content is updated 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, it is analysed here which bands yield the highest benefit for burnt area analysis.

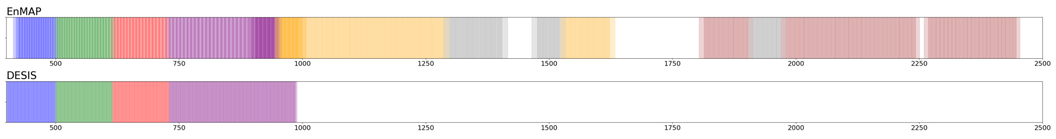

Figure 1: Comparison of EnMAP (top) and DESIS (bottom) spectral wavelength spectrum (400 – 2500 nm)

Methodology

Preprocessing

As a preceding step, we generated a geospatial footprint for each archived EnMAP acquisition from textual metadata. We intersected each footprint with NASA FIRMS active fire locations, for fires occurring within two weeks before the scene acquisition. This time range was chosen to ensure that the burnt area is still visible in the scene and not already diminished by regrowing vegetation. We then transferred intersecting hotspots and the footprint geometry to H3 grid cells (level 10, approximately matching the hotspot data's ground sampling distance) and calculated the ratio between burnt and total area for each scene. We thus generated a list of the complete EnMAP scene archive which could be ranked by covered fire activity. Next, we ordered to top ten scenes of the ranked list from the DLR EOWEB data portal.

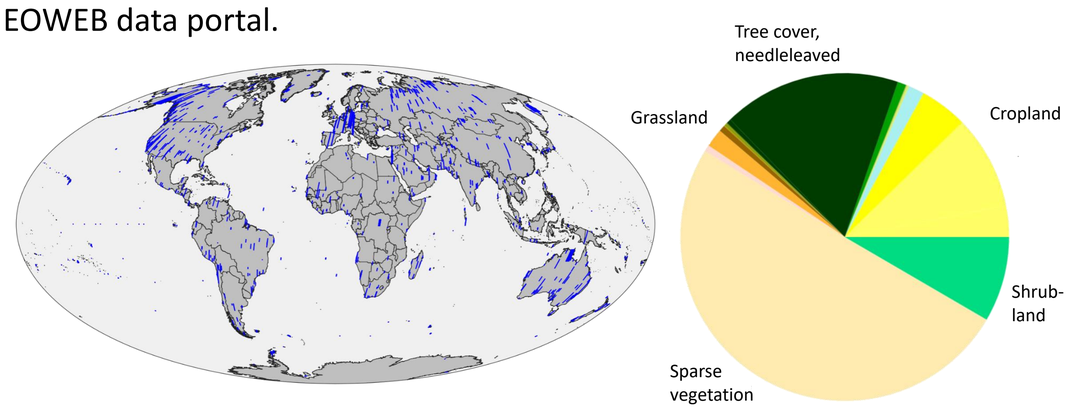

Figure 2: Available EnMAP scenes (left, complete archive) and covered wildfires separated by affected land cover class.

Processing

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 (29 in total) of each selected EnMAP scene.

We used the burnt area methodology implemented in the ZKI Fire Monitoring system (which requires two input bands), using red band 44 as the first input (this band is, e.g., used by the EnMAP toolbox for NDVI generation). For the second input, we iterated over all available NIR bands.
Since a proper reference was unavailable, we visually determined the most accurate result of one input scene and used the wavelength (band 125, 1274 nm) as a reference for the other results to be compared against. In table 1, each cell represents the mean IoU (weighted by area) of all analysed scenes using the given NIR wavelength.
While DESIS does not feature wavelengths in the SWIR domain, EnMAP provides 54 SWIR bands. The study was therefore repeated for the short-SWIR (SSWIR) domain, using the default NIR band (70) as second input.

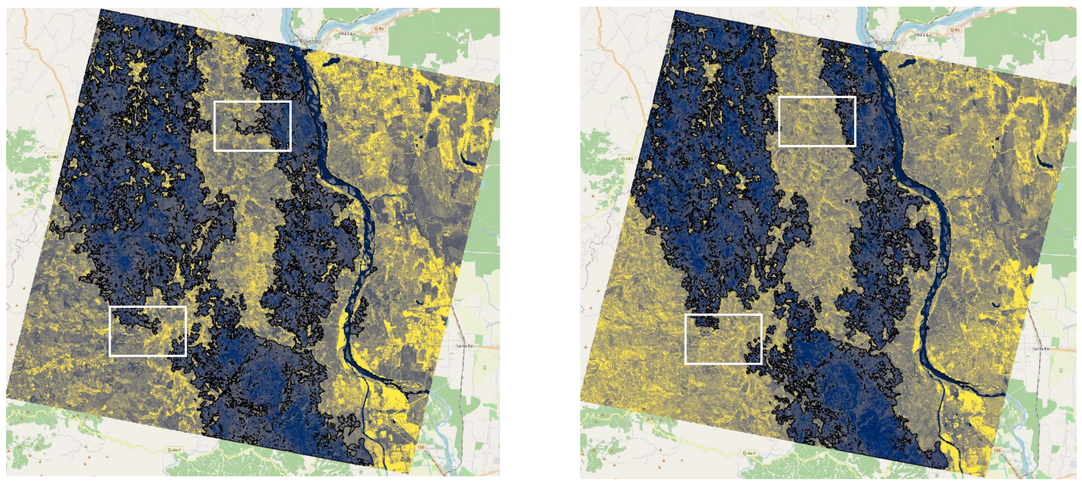

Figure 3: EnMAP, Nuble / Chile, 2023/02. Differences in derived burnt area. Left: 730 nm, right: 828 nm

Results

The results show that the optimal NIR wavelength for burnt area derivation, when only red and NIR are available, is located around 820 nm (EnMAP band 69). The weighted mean IoU across all test scenes regarding this wavelength is 0.86. However, if wavelengths from the SSWIR domain are available, best results are achieved with EnMAP NIR band 70 (827 nm) and SSWIR band 110 (1108 nm), resulting in 0.92 IoU. Using SSWIR/NIR instead of red/NIR was found to yield an performance increase up to 16%.

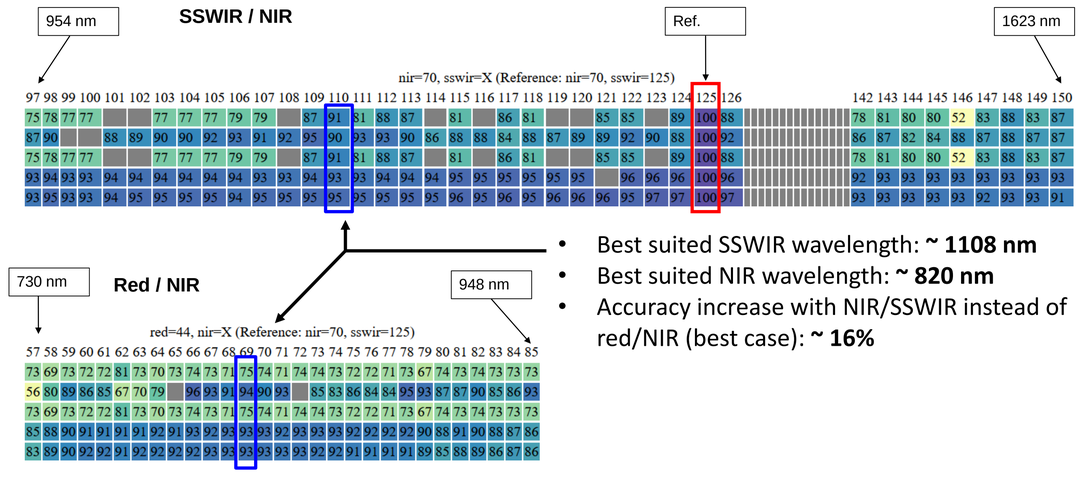

Table 1: Wavelength suitability analysis

Conclusions

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/SSWIR 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.

Dr. Michael Nolde, Moritz Rösch, Dr. Torsten Riedlinger
German Aerospace Center (DLR)
German Remote Sensing Data Center (DFD)
michael.nolde@dlr.de | www.dlr.de/eoc

ZKI® Fire Monitoring Service