ASAPTERRA

ADVANCING SAR AND OPTICAL METHODS FOR RAPID MAPPING

Developing Improved Optical Rapid Mapping Methods by combining Orfeo Tool Box and recent satellite data in the fire mapping domain

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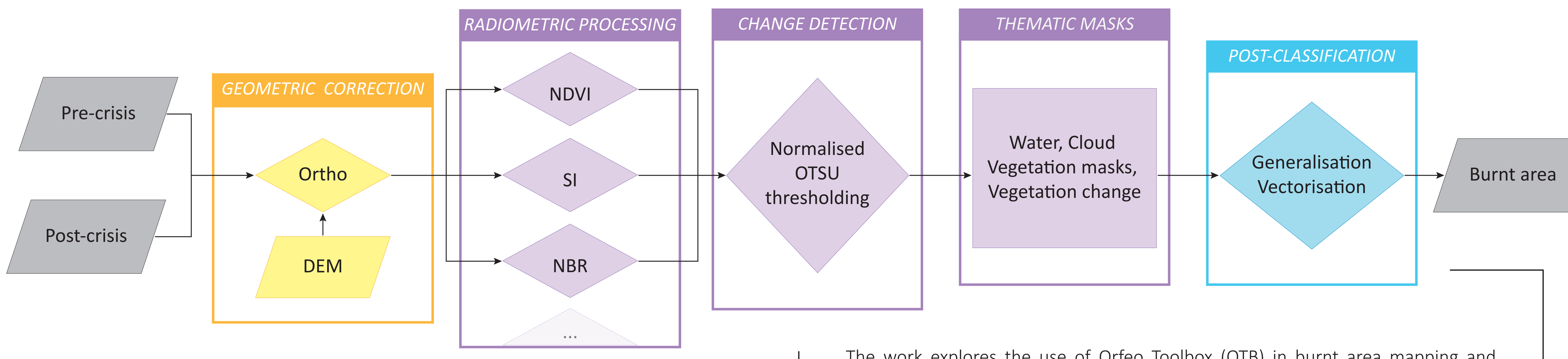
This work is carried out within an ESA General Support Technology Programme project called "Advancing SAR and optical methods for rapid mapping" (ASAPTERRA) that is led by the DLR with ICube-SERTIT as a partner. Both partners have extensive International Charter "Space and Major Disaster" experience and are now part of the Copernicus Emergency Management Service Rapid Mapping consortium providing emergency response mapping to civil protection and humanitarian organisations.

The project's main application objectives include the development of robust and transferable, fast and accurate methods to significantly enhance rapid mapping techniques for three types of natural hazards floods, landslides and fires using SAR and optical satellite image resources.

In this poster the focus is on fire / burn scar mapping. These methods and results are also applicable to fire monitoring and burn-scar mapping.

Work on improved satellite based rapid mapping geo-information extraction techniques is presented leveraging existing partner R&D projects such as the FP7 PREFER (Space-based Information Support for Prevention and REcovery of Forest Fires Emergency in the MediteRranean Area) project in the fire and fire impact mapping domain, capitalising on existing knowledge while trying to fill in holes especially in automatization.

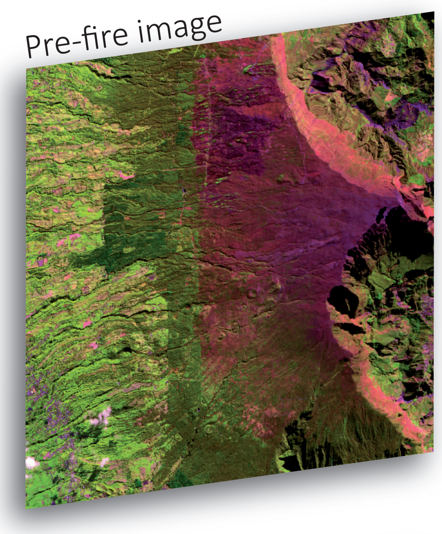
The work concentrates on the use of European satellite sensors from national missions and ESA's EO missions, such as the Pléiades, Sentinel-2 optical sensor missions with the aim to better characterize the potential and limitations of these sensors and their synergy.



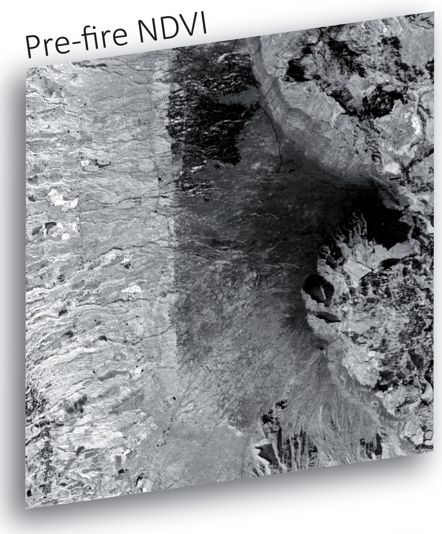
The work explores the use of Orfeo Toolbox (OTB) in burnt area mapping and moreover in an operational rapid mapping context. OTB development is supported by the French space agency (CNES) and constitutes a library of open source remote sensing image processing tools. Methods are chosen to be easily repeated, require little adjustment, take into account pre and post fire imagery (multi-temporal) and use normalised indices to reduce terrain effects and eliminate clouds.

BURNT AREA MAPPING

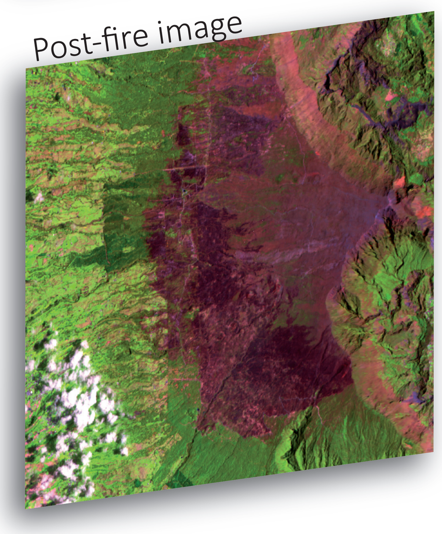
Pre-fire image



Pre-fire NDVI

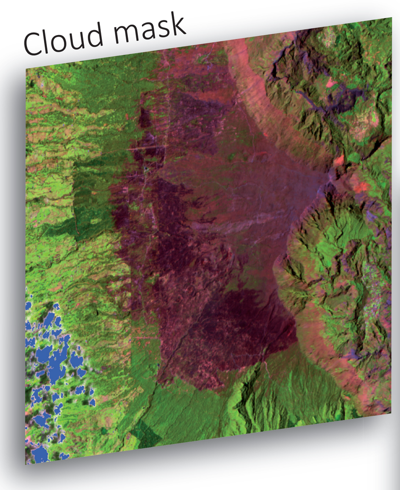


Post-fire image

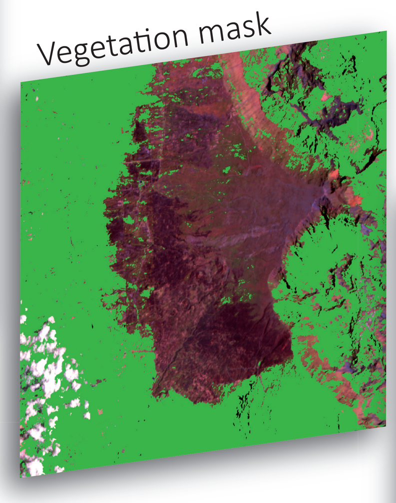


Post-fire NDVI

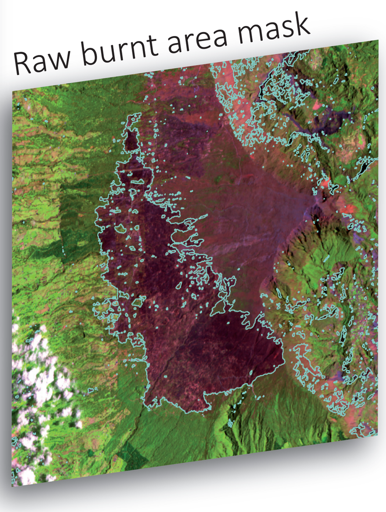
Cloud mask



Vegetation mask

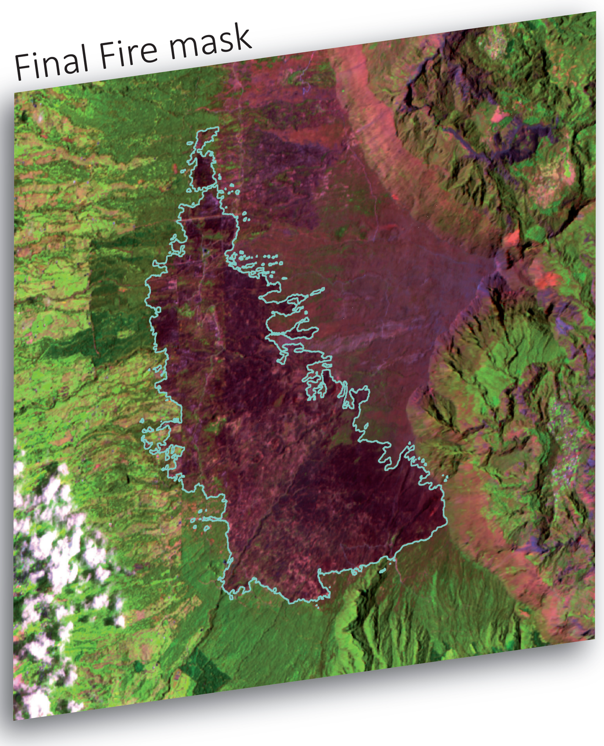


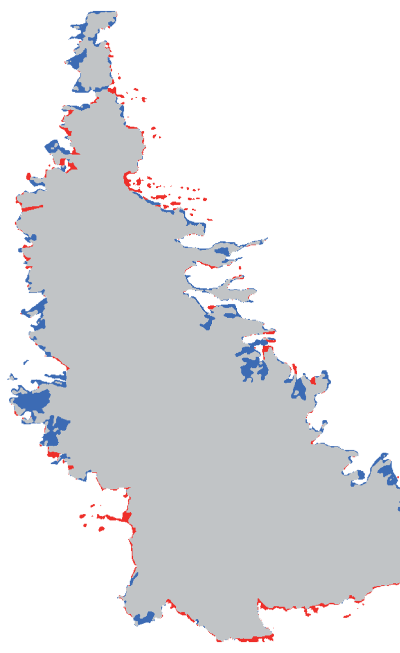
Raw burnt area mask



New more automatic methods:
Improved (semi-) automatic and operational detection of burnt areas using VHR and HR optical data (Pléiades-1A/1B and Sentinel-2 type), plus ancillary data sets, are illustrated.

Final Fire mask



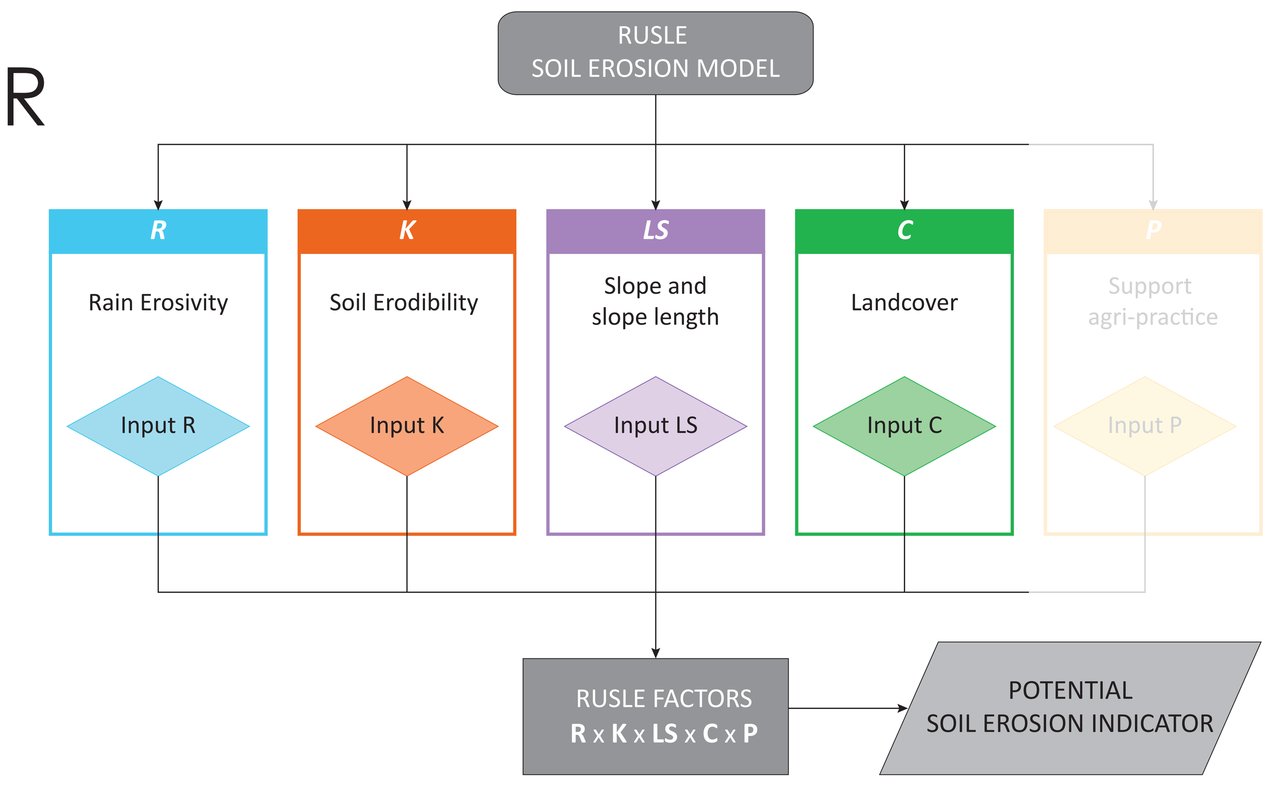


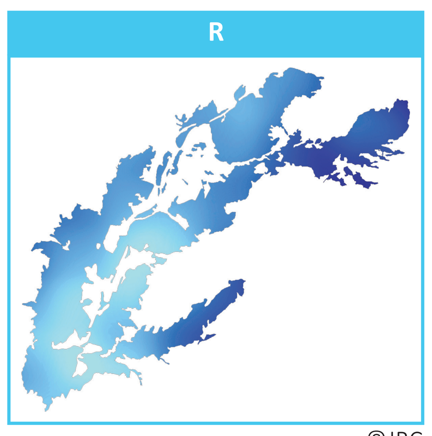
Correctly classified burnt pixels
Commission error burnt pixels
Omission error burnt pixels

Validation
The comparison of raw results derived from SPOT 4 data acquired the 12/12/2011 with field mapping provided by the French National Forestry Office (ONF) indicates 92.7% agreement, 5.2% omission and 2.1% commission errors. Then, with a minor operator validation step the final results reach 98% correctly classified pixels.

POST FIRE SOIL EROSION INDICATOR

Indicating post-fire soil erosion vulnerability
Vulnerability to soil erosion can be indicated in the immediate aftermath of a fire taking into account the burnt area(s), vegetation loss and 3D topographic factors.
Here, the RUSLE index is proposed to indicate soil erosion vulnerability incorporating the rainfall erosivity (R) and soil erosidibility (K) factors provided by the JRC's European Soil Data Centre (ESAC). The agri-practice support (P) factor is not considered. The topographic Slope / Slope length (LS) factor is derived from an interpolated SRTM digital elevation model (DEM).
The method was implemented during the PREFER project over Reunion Island and Mediterranean sites and, in ASAPTERRA, is being automated with a focus on Sentinel-2 data usage. Preliminary Sentinel-2 results are presented is this poster for a fire occurring over Andalusia.





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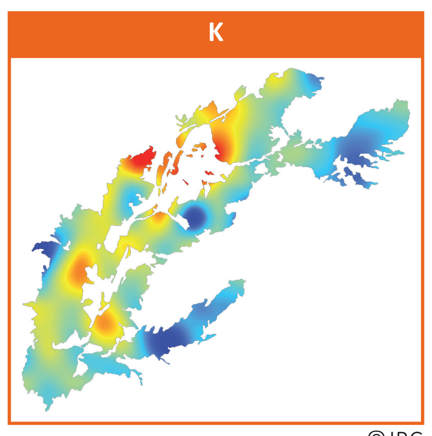

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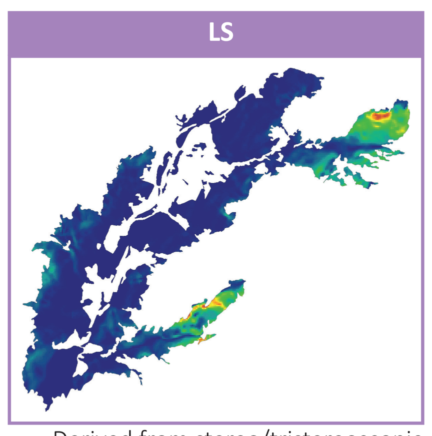
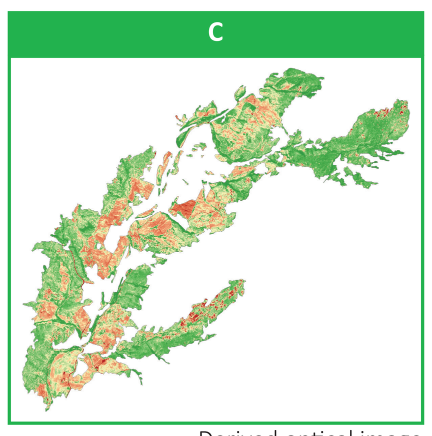
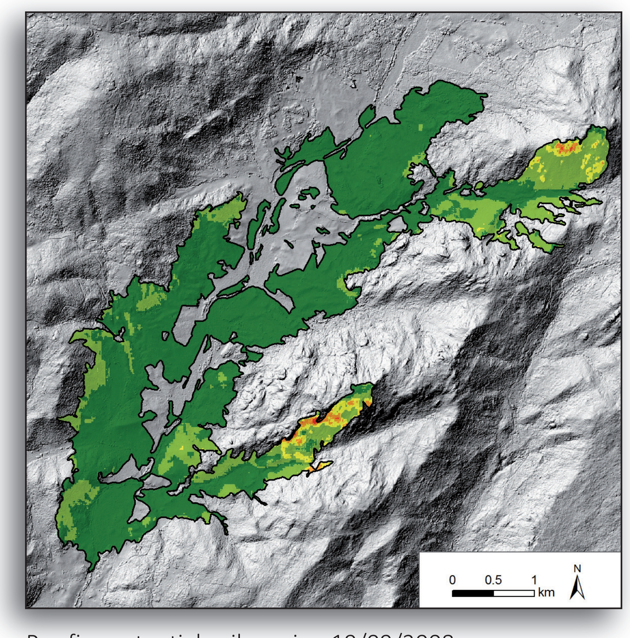


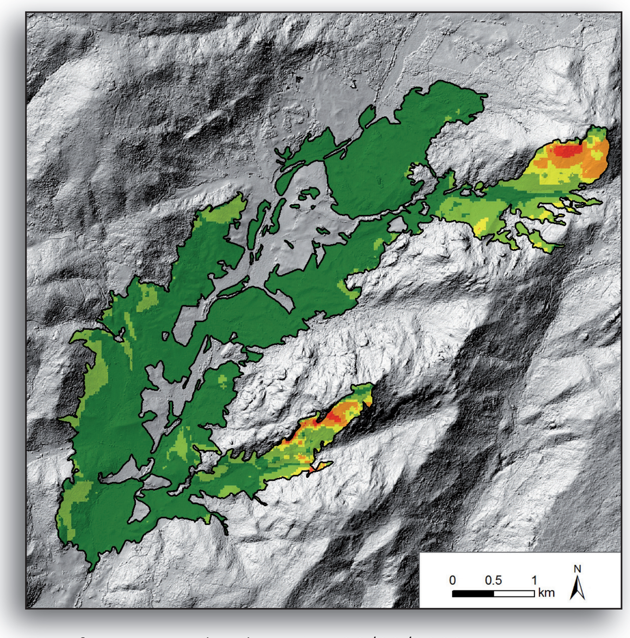
Derived from stereo/tristereoscopic optical image or from other DEM



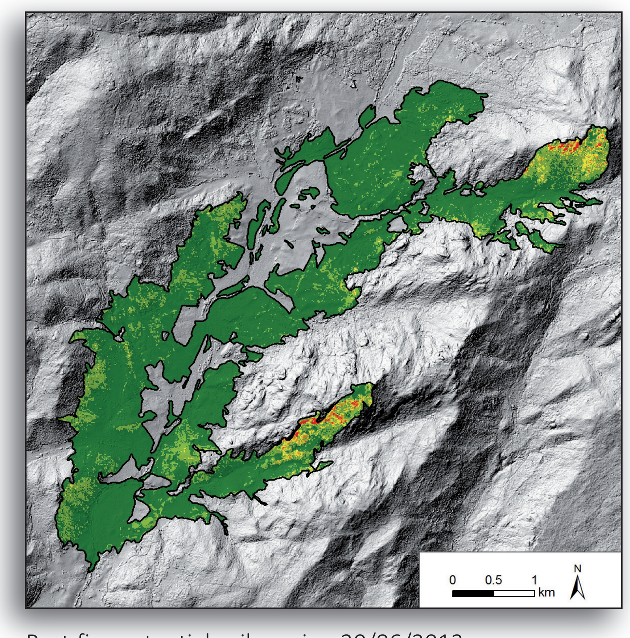
Derived optical image



Pre-fire potential soil erosion 19/09/2008
(C factor derived from SPOT4 data)



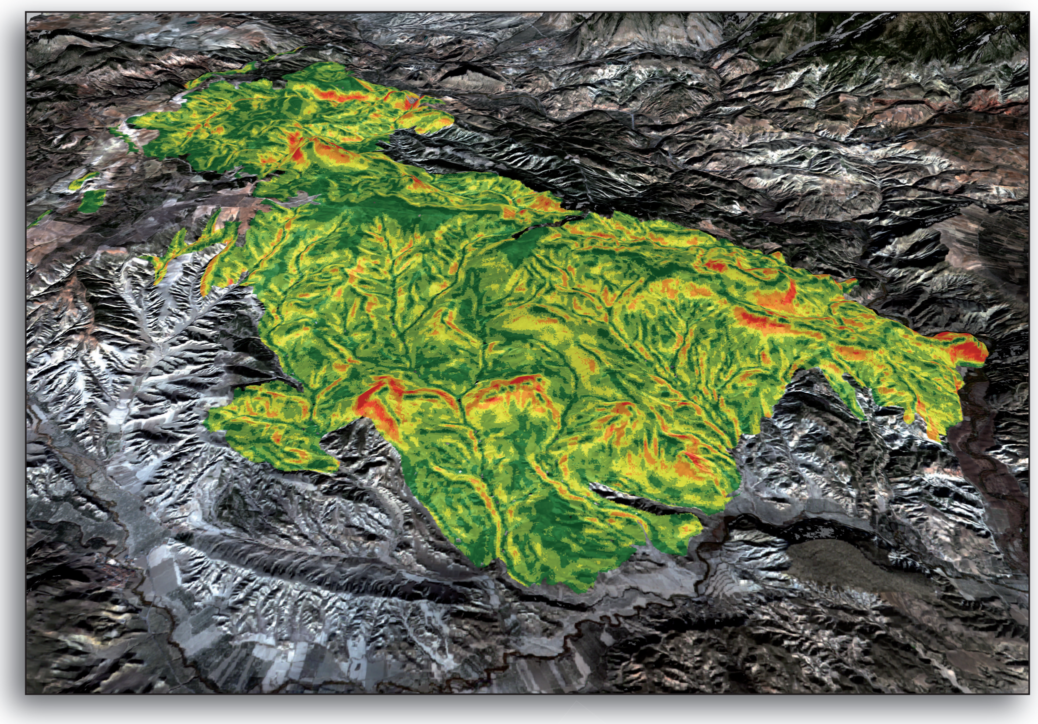
Post-fire potential soil erosion 28/09/2009
(C factor derived from SPOT4 data)



Post-fire potential soil erosion 30/06/2013
(C and LS factors derived from Pléiades-1A data)

Low
Low Moderate
Moderate
High
Very High

Potential soil erosion indicator



Example of a Soil Erosion Susceptibility Index (SESI) recovery type product (REC-3DFDA) generated in ASAPTERRA for PREFER over the fire affected area obtained during the Copernicus EMS Rapid Mapping EMSR127 activation. In particular this map concerns a fire in Andalusia, Spain with the SESI being mapped at 10m resolution using Sentinel-2 data acquired the 06/12/2015.

Results & Perspectives
The burn scar mapping method is proven over Reunion Island and Mediterranean sites from a thematic accuracy and speed of execution perspective given the objective of incorporating burn scar mapping into operational rapid mapping work-flows. The resulting accuracy levels are high, precise enough to reduce potential manual intervention and hence saving time. Improved post-classification techniques will further reduce manual manipulation.

In the context of fire impact assessment this work explores the integration of 3D information to rapidly deliver fire related soil erosion vulnerability mapping based on the RUSLE method, integrating JRC distributed RUSLE factors. With a focus on updating the RUSLE index provided by the JRC for fire induced vegetation loss and increased soil erosion vulnerability this product is elaborated also as a possible contribution to portfolios within Copernicus EMS EFFIS and Risk and Recovery contexts.

This High Resolution optical imagery work with ASAPTERRA is especially important in the light of the arrival of Sentinel-2 data, whose widespread availability in the next fire season (2016) should complement existing data sources during emergencies, permitting burn scar detection and monitoring, combined with soil erosion vulnerability mapping for specific fire events and also within the context of season long monitoring.

This work has received funding through the ASAPTERRA project within ESA's General Support Technology Programme (GSTP) with the backing of the CNES and the DLR.
Part of this work has received funding through PREFER from the European Union's Seventh Framework Programme (FP7) for research, technological development and demonstration under grant agreement no. 312931.
The burn scar mapping over the Reunion Island is facilitated by SPOT4 and SPOT5 data provided during SAFER, a European Union FP7 project and agreed to by Airbus DS.