

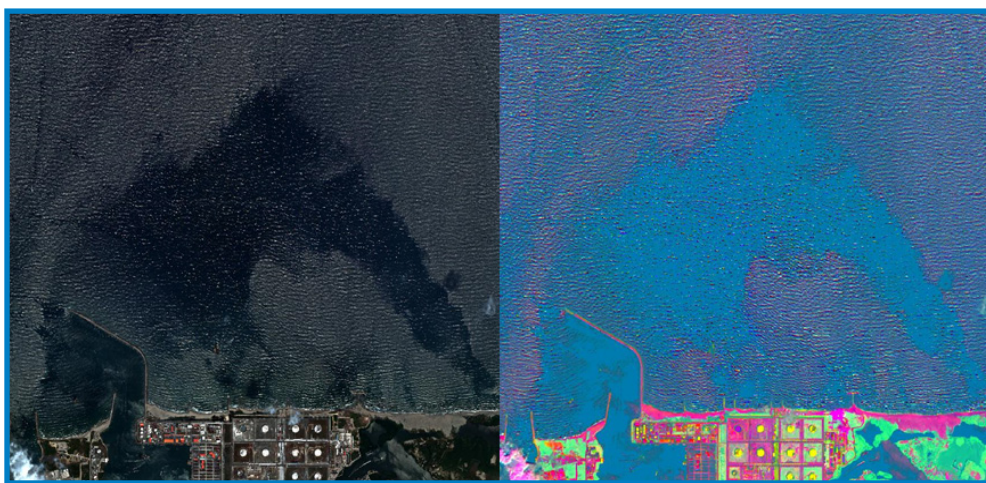


Short-wave Infrared Imagery (SWIR)

Utilizing the DigitalGlobe WorldView-3 satellite, European Space Imaging are able to offer our customers access to information in the short-wave infrared (SWIR) part of the electromagnetic spectrum. WorldView-3 expands deeper into the infrared spectrum than any other commercial imaging satellite, and provides rich data for precisely identifying and characterizing many objects otherwise not visible to the human eye or via the regular eight multispectral bands.

What is SWIR?

Utilizing the WorldView-3 satellite, European Space Imaging is capable of delivering very high resolution imagery options incorporating 16 spectral bands to allow for automated information extraction for various applications. WorldView-3 integrates a market first revolutionary sensor with eight additional SWIR spectral bands. This allows for the expansion of the current uses of remotely sensed data to create more innovative ways to better understand and manage our changing planet.



The above image shows how SWIR data can be used to detect oil spills. The left image is the natural color satellite image and the right image has had the SWIR spectral bands applied. Oil is visible as indicated by the color pink in the image. © DigitalGlobe

Company Information

European Space Imaging is a leading supplier of global very high-resolution (VHR) satellite imagery and derived services to customers in Europe, North Africa and CIS countries.

Operating a multi-mission capable ground station enables optimized image collection results taking into account real-time weather information and giving customers the highest degree of flexibility.

With a reputation for expert and personalized customer service it has been providing tailored VHR imagery solutions to meet the diverse project requirements of its customers since 2002.

SWIR Applications

Due to minimal atmospheric influence or noise in this part of the electromagnetic spectrum, as well as an enhanced ability to differentiate among ground materials, the SWIR bands open the door for automated information extraction to save time, money and possibly lives. With SWIR we are able to capture unique information for materials identification, wildfire response, food security, mining/geology and other applications.

Possible applications of SWIR:

- Materials identification
- Wildfire response
- Food security
- Mining/Geology
- Mineral exploration
- Vegetation
- Urban planning
- Disaster management (oil spill)
- Snow and ice discrimination
- Soil moisture detection

Materials Identification

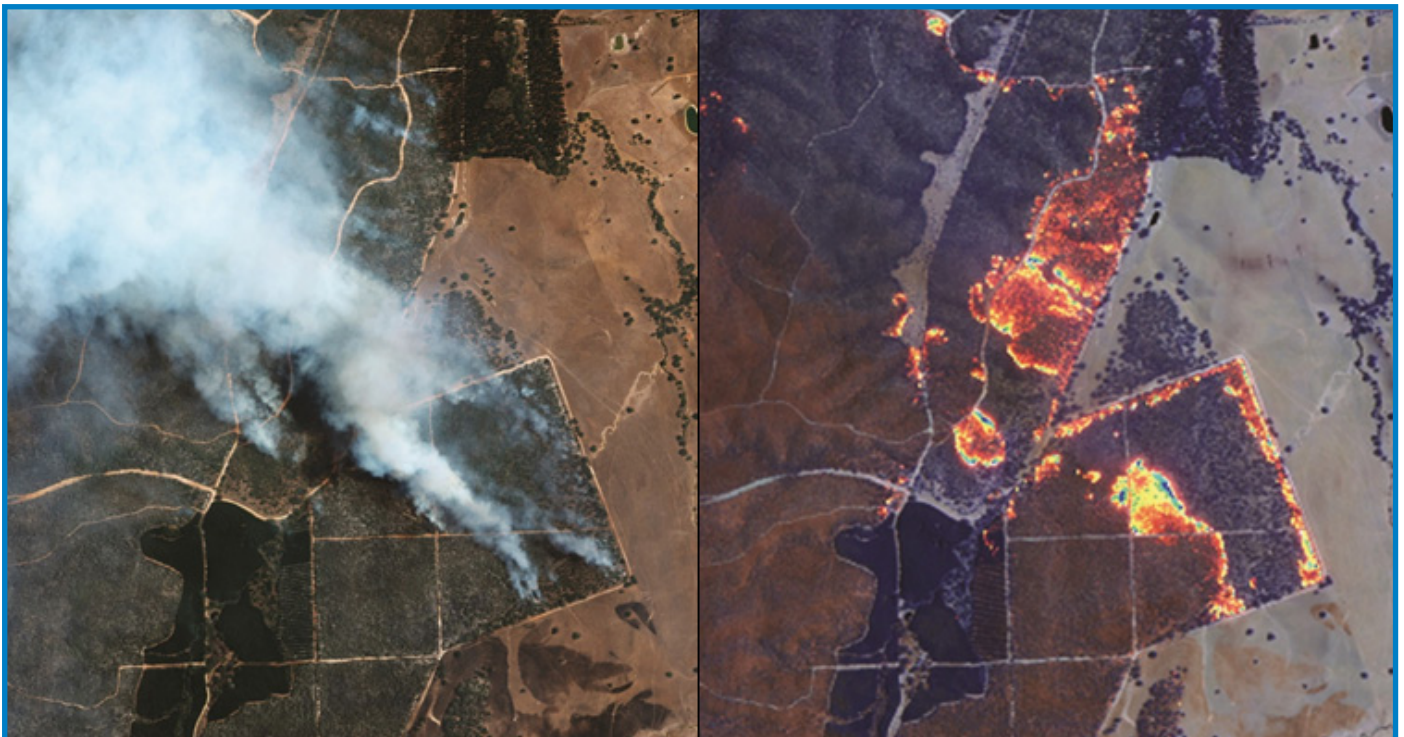
Many industries need to understand and identify different material types that may be present to meet their specific

requirements. Each industry has differing needs and uses for the application of SWIR. An insurance company may need to know roof types, while local governments may be more concerned with land cover types for tax assessment. With the SWIR bands on WorldView-3, accurate information not previously available can be gathered from satellite data to provide detailed information on or about the materials present. Materials that may look similar to the naked eye can be distinguished with SWIR.

Wildfire Response

Whether called a forest fire, bush fire, or wildfire, uncontrolled fires have a devastating impact on communities and natural resources. Wildfires can cover extensive areas, move at incredible speeds, and change direction without notice. Fast and effective detection is key to protecting infrastructure and ensuring communities' safety.

A critical factor in being able to respond to wildfires, is to have information about the location and severity in a timely manner. With the agility and spectral depth of WorldView-3, getting this information has never been easier. The unique SWIR bands not only penetrate smoke, allowing for a clear view of the ground, but they also pinpoint sites of active burning so that response efforts can be directed most efficiently.



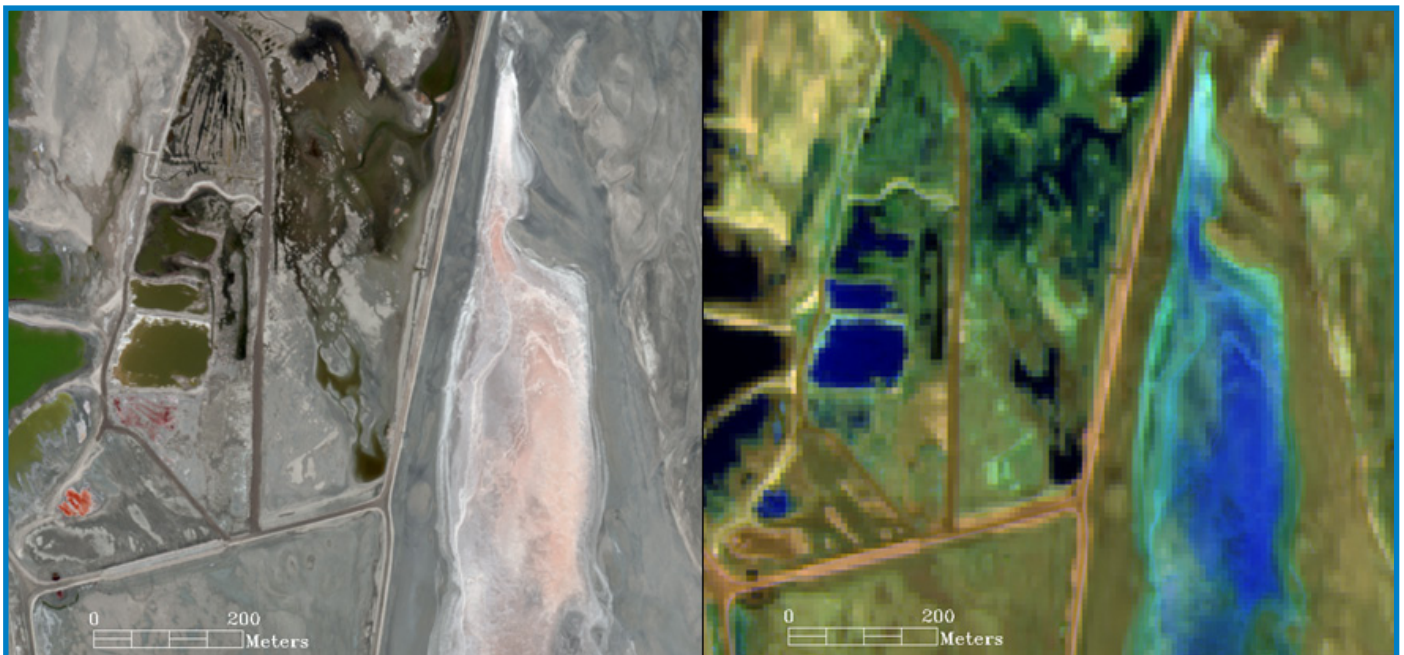
The above image shows how SWIR data can be used for thermal detection and to penetrate smoke and haze. The left image is the natural colour satellite image and the right image has had the SWIR spectral bands applied. As you can see, the smoke is gone and the areas affected by fire are clearly visible. © DigitalGlobe

Food Security

As the world focuses on increasing global food security, it is critical to improve small farm productivity and yield, while decreasing costs, minimizing the environmental impact with precision agriculture practices, and better manage agriculture production and associated inventory. It is important to take corrective action early in the growing season by understanding crop conditions. Factors such as crop health and stress caused by problems due to nutrient deficiency, moisture stress, and pests can be assessed and managed quickly to avoid future issues. Furthermore, with SWIR data you can go one step further and take preventive action as opposed to corrective action to ensure future crop success by assessing the soil mineral content and ensuring its compatibility with the intended crop to be planted.

WorldView-3 data is uniquely designed to observe and map these phenomena. Crop stresses change the green chlorophyll content of the leaves and replace them with carotenoids that have yellow and red colors visible wavelengths. In addition, SWIR bands are used to assess crop moisture, as another health indicator. Observing soil types and conditions before, during and after a crop season is important for managing crop health. WorldView-3 offers a window into underlying soil conditions and how such conditions might affect vegetation.

One of the agricultural community's best management practices relates to how much post-harvest crop residue is left on a field. Crop residue preserves soil moisture and prevents soil erosion during rainy months. SWIR spectral bands can be used to map and quantify how much crop residue is left behind, predicting the soil quality for future crops.



The above image shows how SWIR data can be used for soil moisture detection. The left image is the natural colour satellite image and the right image has had the SWIR spectral bands applied. The areas highlighted in blue shows the level of moisture present. The darker the shade, the more moisture. The areas highlighted in yellow indicate no moisture present. © DigitalGlobe

Mining / Geology

WorldView-3's spectral bands allow for unique mineral identification and chemical measurements. Energy from light is either transferred to molecules of matter or reflected away from them. Based on the mineral content, different materials absorb specific wavelengths of light and reflect others.

Electromagnetic absorptions in the SWIR wavelengths can be used for detecting materials containing anion groups such as Al-OH, Mg-OH, Fe-OH, Si-OH, carbonates, ammonium, and

sulphates - many of which are indicator minerals in the mining industry.

Exposed outcrops are manifestations of potential mineral ores or sub-surface deposits. While the geology and mining industries spend millions of dollars to identify potential mining sites during their exploration phase, WorldView-3 SWIR data can cut costs and increase efficiency by narrowing the potential area before field verification is planned.

SWIR Specifications

Spectral Characteristics

SWIR 1	1195- 1225 nm
SWIR 2	1550- 1590 nm
SWIR 3	1640- 1680 nm
SWIR 4	1710- 1750 nm
SWIR 5	2145- 2185 nm
SWIR 6	2185- 2225 nm
SWIR 7	2235- 2285 nm
SWIR 8	2295- 2365 nm

Processing

Radiometric Corrections	Sensor Corrections	Resampling Options
<ul style="list-style-type: none"> - Relative radiometric response between detectors - Non-response detector fill - Conversion to absolute radiometry 	<ul style="list-style-type: none"> - Internal detector geometry - Optical distortion - Scan distortion - Any line-rate variations 	<ul style="list-style-type: none"> - 2 x 2 bilinear - Nearest neighbor (recommended) - Cubic convolution

Order Parameters

Product level	2A, OR2A, L3
Image bits/pixel	8 or 16 bits (16-bit data is strongly recommended)
File format	GeoTIFF,

Features

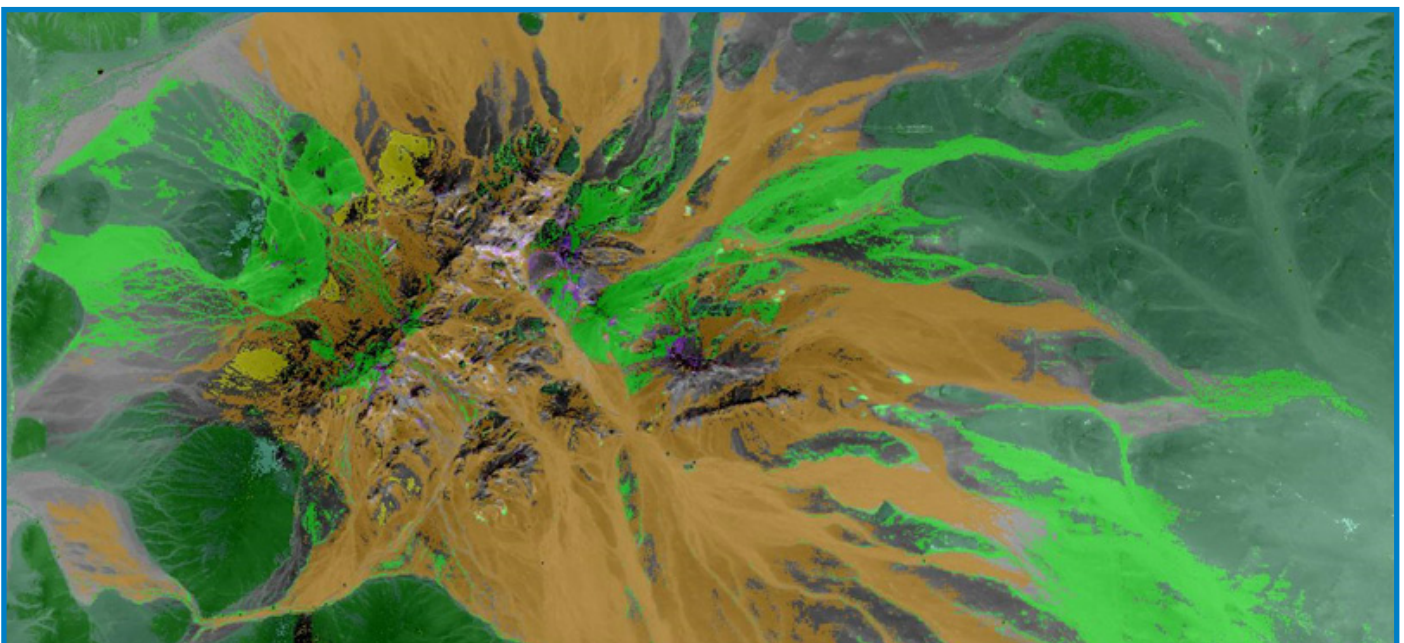
- High resolution and image accuracy at 7.5m CE90
- Nadir of 10.8km cross-track
- High radiometric response
 - 14-bit digitalization (up to 16,384 levels of gray scale)
 - Discrete non-overlapping bands
- Open systems
 - Imaging geometry supplied
 - Compatible with leading commercial software providers
- Imaging geometry, geometric calibration, radiometric calibration and other metadata supplied with satellite imagery

Benefits

- Ability to identify features and perform analyses that are not possible with visible and near-infrared alone
- Bands optimized for the detection of features of greatest interest
- Ideal for penetrating smoke, mapping minerals and identifying man-made features

Advantages of SWIR:

- Provide imagery during day and night
- Can penetrate thin clouds and haze
- Covert illumination
- Atmospheric aerosols have minimal effect on SWIR bands
- Detect heat via high-heat thermal emissions



The above image shows how SWIR data can be used for geologic rock and mineral identification. The yellow/brown areas identify goethite, the dark green areas identify chlorite, the light green areas identify clay and the purple areas identify sulfides. © DigitalGlobe