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Fast Mapping Results Provide Deeper Insights

Wildfires & Remote Sensing

In the beginning of the summer this year, a large fire in the area of the Mount Parnitha National Park near Athens in Greece resulted in the loss of approximately 5,000 ha of forest area, shrublands and agricultural land. Considering the extent and the consequences of the damage caused by the large fire, the Aristotle University of Thessaloniki began to collaborate with national authorities to provide all the necessary information to develop forest protection and restoration plans.

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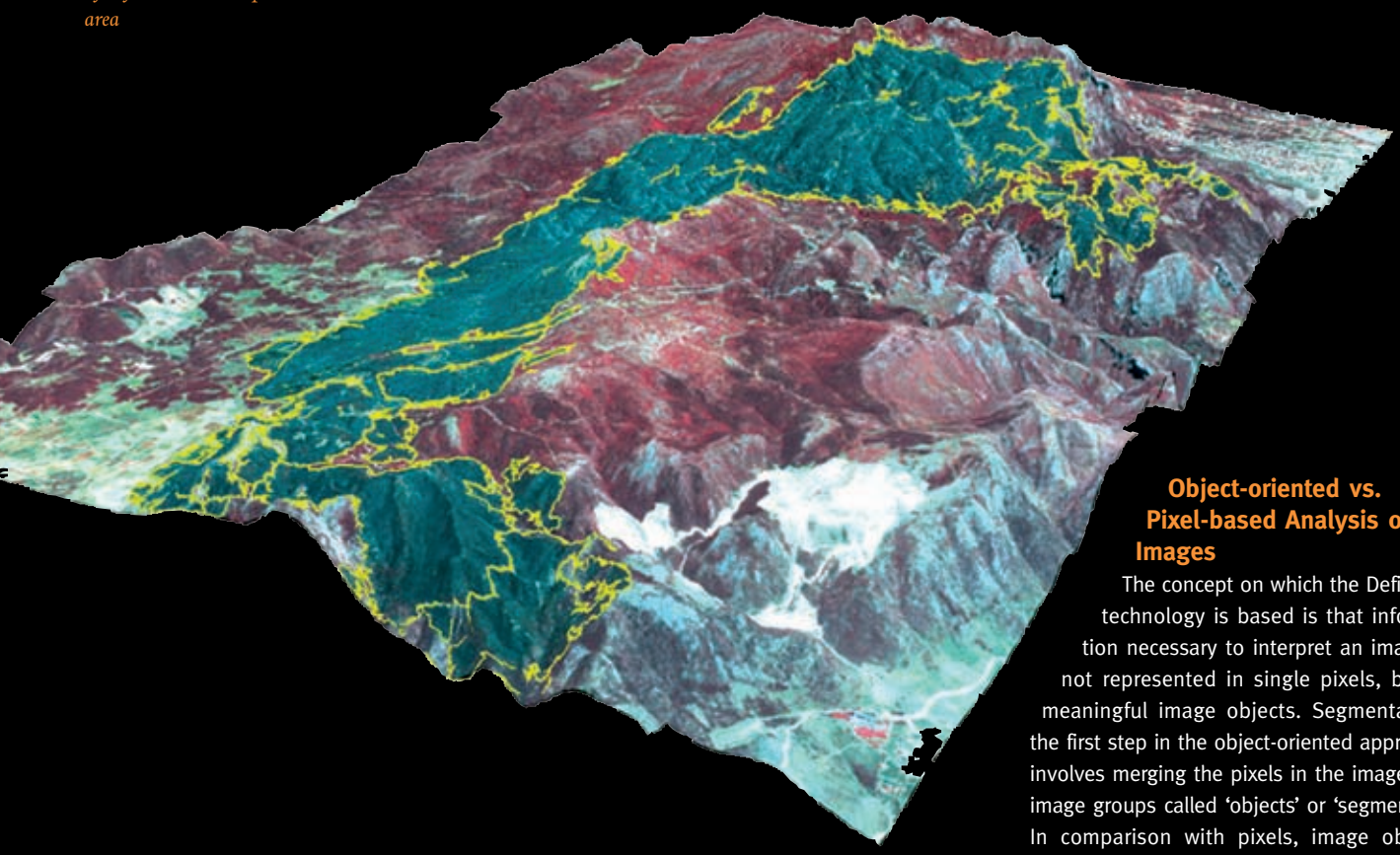


3D view of the Mount Parnitha forest fire damage. The dark area surrounded by a yellow outline represents the burned area

When a forested area is damaged by fire, detailed and current information concerning the location and extent of the burned areas is required by forest managers to assess economic losses and ecological impacts, and to monitor land use and land cover changes. Detailed mapping is also important for modelling the atmospheric and climatic impacts of biomass burning. Moreover, accurate assessment assists in evaluating the effectiveness of measures taken to rehabilitate the fire-damaged area, and in allowing forest managers to identify and target areas for intensive or special restoration, thus avoiding long-term site degradation. In order to estimate the ecological impact of fires on Mediterranean ecosystems, reliable monitoring and effective analysis techniques need to be implemented.

Mapping the Large Fire of Parnitha

The area constitutes the nucleus of the Parnitha National Park and is a wooded area, noted primarily for its spreads of the endemic Cephallonia fir (Abies cephalonica) on relatively poor and dry soil, its temperate coniferous-tree forests (chiefly consisting of Pinus halepensis), maquis, mountainous grasslands, rocky hills, springs and streams. The Parnitha National Park commands particular ecological interest, and constitutes a reserve for the protection and preservation of Southern Greece's flora and fauna. Parnitha's proximity to the urban sprawl of Athens,

coupled with its great aesthetic and ecological value, accentuate its importance in the area. To accurately map the burned areas of Mt Parnitha, the Aristotle University of Thessaloniki chose an object-based classification approach and an Ikonos high resolution image that was captured nine days after the fire. The estimation of the ecological impact on the environment was made using an in-house developed software called Burned Area Statistics (BAS).

Use of technology

Satellite data have been used extensively for many years for the detection and mapping of fire-affected areas. Image analysis techniques such as object-based classification have been developed in the recent past. For instance, the Definiens Enterprise Image Analysis Suite utilizes object-based classification to identify burned areas and helps to automate processes and incorporate expert knowledge to deliver consistent and accurate results. A further benefit of automating the process is that once a model for the evaluation has been created, it can be distributed to and used by end-users, such as agencies, with only slight calibrations necessary to achieve comparable, consistent results.

Object-oriented vs. Pixel-based Analysis of Images

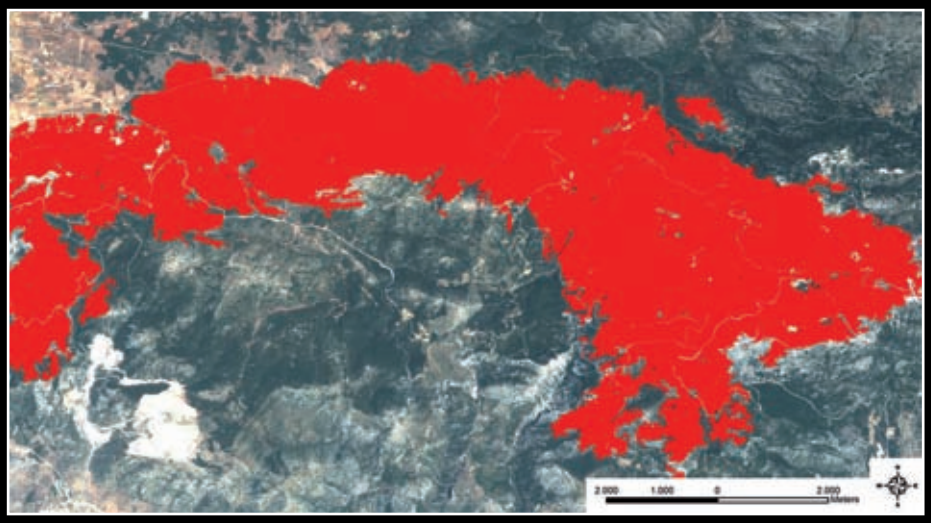
The concept on which the Definiens technology is based is that information necessary to interpret an image is not represented in single pixels, but in meaningful image objects. Segmentation, the first step in the object-oriented approach, involves merging the pixels in the image into image groups called 'objects' or 'segments'.

In comparison with pixels, image objects carry much more useful information, and therefore can be characterised by far more attributes, such as form, texture, neighbourhood or context, than pure spectral or spectral-derivative information. The advantages of object-oriented analysis are meaningful statistic and texture calculation, an increased uncorrelated feature space using shape (e.g. length, number of edges, etc.) and topological features (neighbour, super-object, etc), and close relation between real-world objects and image objects. This relation improves the value of the final classification and cannot be fulfilled by common, pixel-based approaches. The use of traditional classification techniques have been often reported to create confusion that can affect the accuracy of mapping, the most troublesome of which can be summarized as follows:

- spectral overlapping between slightly burned areas and other non-vegetated categories, especially water bodies, urban areas and bare soil;
- spectral overlapping between burned areas and shaded unburned areas;
- spectral overlapping between burned areas and unburned forest.

The Process

Following the pre-processing of the data with Erdas Imagine, various levels of segmentation were formed in order to extract information on different scales of the image.



Ikonos satellite image of the burned area with the burned area highlighted in red

A generalized perimeter of the burned area was delineated using a large scale during the segmentation procedure. This showed the overall area affected by the fires. To identify the actual burned surface, a second segmentation level was added which allowed the exclusion of islands of unburned forest within the generalized perimeter. The generated object levels where then classified using a rule based approach combining spectral as well as texture and relational object attributes. All segmentation and analysis steps were formulated in a Definiens rule sets. The latter sets up a standard sequence of processes which can be applied repeatedly to large volumes of data varying over time or space.

The rule set used to generate the maps of Mt. Parnitha was developed within two days by the university.The Definiens software as well as the image interpretation knowledge and the experience gained from previous work using the same kind of image data (Ikonos) accelerated this process.

Altogether, the maps and statistics were produced within only three days. They were provided to the local forest fire service for use in post-fire management. The university is providing their support to the people effected by the multiple fires in Greece as a cost-free service and is sharing the models produced to analyse the burned areas with other authorities, for instance in the Peloponnese.

Forest managers typically use this information to:

- assess economic losses and ecological impacts;
- monitor land use and land cover changes including development of illegal settlements;
- model the atmospheric and climatic impacts of biomass burning;
- evaluate the effectiveness of measures taken to rehabilitate the fire-damaged area;
- identify and target areas for intensive or special restoration.

The results are utilized by the local forest service to declare the burned areas under 'special protection regime' and to develop the restoration plans. The national forest service uses the results to produce annual fire statistics. Local authorities can make better decisions, for example for improved pre-fire planning by assessing the effectiveness of fire suppression by the fire brigade.

Future outlook

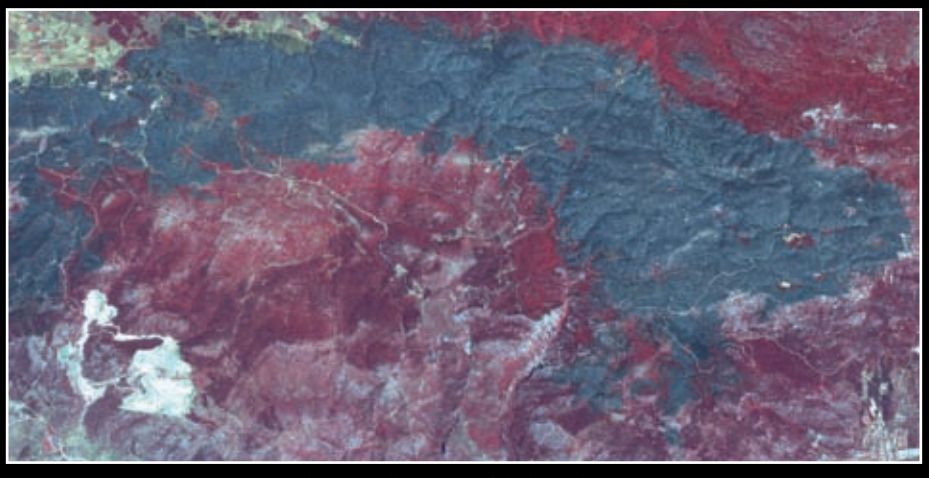
Looking ahead, the operational use of satellite imagery in forest management will include the calculation of fire risks and the creation of hot spot mapping in order to predict where existing fires may spread. For example, the International Charter 'Space and Major

Disasters' monitors fires, providing rapid assessment and thereby helping to mitigate the effects of disasters on human life and property.

The next steps will be to generate a standard library of Definiens rule sets which will then be distributed to the local authorities. Wrapped into an easy to use graphical user interface (GUI), these rule sets will be applied by local experts to generate maps addressing all aspects of forest fires even faster. This will enable the image analysis experts to transfer needed know-how to local agencies so that they can create maps on demand.

On a global scale, the ultimate goal is to provide decision makers with information services that help reduce wildfires. Not only do the fires destroy vegetation, life and habitat, they also contribute to atmospheric CO_2 concentration, intensifying the effects of global warming. The estimated total burned biomass in Europe by the end of August was 7.3 million tons leading to the emission of more than 12.3 million tons of CO_2. Image analysis solutions extract relevant information from increasingly high quality imagery provided by airborne and spaceborne systems and support end-to-end intelligence processes, maximizing the combined value of multi-source intelligence. Today, highly-automated standardized mapping provides accurate and up-to-date geospatial information which assists environmental efforts in populated as well as remote areas worldwide.

Fires this summer in Italy, Greece and Balkan. Credits: ESA



Ikonos satellite image of the burned area

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