SEE THE WOOD AND THE TREES

AN EU PROJECT TO CREATE A FOREST MONITORING APPLICATION THAT CAN EXPLOIT VERY HIGH RESOLUTION IMAGERY HAS COME TO FRUITION. STRATOS STYLIANIDIS LOOKS AT WHAT ITS NEW FORSAT SOFTWARE HAS TO OFFER

In recent years, the international forestry sector has changed dramatically in terms of economic importance and status. The responsible management bodies of governments, international organisations and industries alike have made great efforts to improve efficiency in forest mapping by investing in state-of-the-art information and data acquisition technologies.

Public administration, forestry departments, civil protection agencies, local and regional authorities and any other public or private organisation related to forest management is looking for remote sensing capacities and technologies offering reliable, accurate and high level information, quickly and at reduced costs.

Traditionally, forest monitoring and information-gathering is done through expensive and time-consuming field studies in combination with aerial surveys (visual, aerial imagery and range sensors). This is followed by digital data analysis in image processing suites and GIS to derive basic parameters, such as area coverage, species, height, volume, health, damage, change and deforestation. Subsequently the map and statistical data are used for management decisions, implementations of regulations or simply for industry operations.

The satellite earth observation industry has foreseen such market opportunities and responded to these increasing demands. With tens of satellites offering ground resolutions of 50cm currently operational or planned in the future, the investments and the confidence in this constantly growing market are very high. Many of these very high resolution (VHR) sensors enable stereoscopic acquisitions from space and represent a less expensive, faster and more agile technology to provide planimetric and volumetric information on forest and terrain coverage, if compared to aerial imagery and range data.

Importantly, satellite systems offer several advantages to aerial photography and laser scanning: access to remote areas, no overflight permissions needed, a much greater ground coverage capacity, image acquisitions automatically repeated until cloud free coverages of an area of interest are given, and the availability to access more spectral bands for thematic studies (for example, vegetation health).

From images to 3D metrics

To exploit the potential of VHR satellite imagery for forest mapping and obtaining convincing 3D forest information, the choice of the software solution for data processing is critical. FORSAT, which stands for 'A satellite image processing platform for high resolution forest assessment', is a research project co-funded by some European national funding authorities and the European Commission (EC), with the aim of raising the current technological capacity of aerial imagery combined with airborne laser scanning and developing a stand-alone tool to process satellite images and extract 3D information for forest cover mapping applications.

The project began in 2012 and ended last year, having succeeded in generating a software solution called FORSAT that responds to the needs of being simple to use, efficient for forest mapping and flexible, as it was designed to respond to the strict requirements of users in the forest domain. FORSAT includes units for geometric and radiometric processing of satellite imagery and 2D/3D information extraction as well as 3D surface comparison for change detection. It supports most of the available HR and VHR optical imagery, including IKONOS, GeoEye-1, WorldView-1/2, SPOT-5 and Pléiades-1A/B, and can be easily updated to work with similar images from future missions.

Following a rigorous photogrammetric approach for sensor geometric modelling, state-of-the-art image processing solutions and advanced matching strategies, satellite images are georeferenced and matched to automatically extract millions of corresponding (homologous) points between the stereo images and calculate their 3D coordinates in a ground reference system. This point cloud is then interpolated in a regular digital surface model (DSM) for further study in GIS environments.

Biomass estimation and volumetric change detection

One of the first applications of stereo satellite images and DSMs is the estimation of canopy height and thus the derivation of forest volume. When managing forests for old growth and wildlife habitat, information such as canopy cover (above image), tree size (height and crown diameter), biomass, life form, large tree density, crown volume, and vertical foliar diversity is routinely needed. When historical data are available, automatic change detection of forest/non-forest areas gives very important information in forest volume change. During this operation the position accuracy of the surface models are critical. In fact, even if the DSMs have coordinates in the same reference system, residual geopositioning errors due to, for example, lack of ground information during the image georeferencing, will cause a 3D misalignment between the surfaces and therefore false volume change computations. To avoid that, FORSAT applies an advanced algorithm for surface matching and alignment at sub-pixel precision level, before computing the 3D differences between the surface models.

Available now

The FORSAT research project was co-funded by the national funding authorities of the participating countries (Cyprus, Switzerland, Austria, Turkey, and Spain) under EUROSTARS Programme (project number 7358), powered by EUREKA and the EC. After 24 months the project was successfully finished with a final meeting and an associated user workshop on October 2-3 last year, hosted in Nicosia, Cyprus, and the commercialisation of the FORSAT software.

To answer the needs of users from different sectors with diverse requirements, the FORSAT business model has been adapted to real market needs. Please check the FORSAT licensing scheme at www.forsat.eu.

TO EXPLOIT THE POTENTIAL OF VHR SATELLITE IMAGERY FOR FOREST MAPPING AND OBTAINING CONVINCING 3D FOREST INFORMATION, THE CHOICE OF THE SOFTWARE SOLUTION FOR DATA PROCESSING IS CRITICAL

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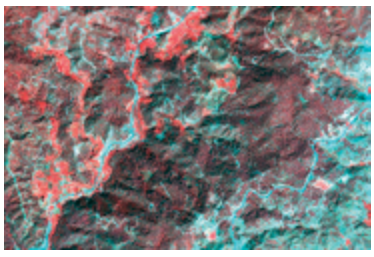
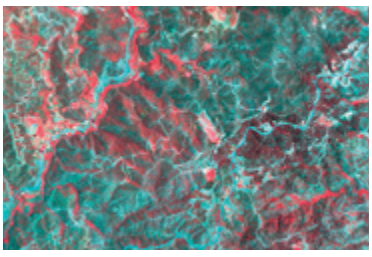
CASE STUDY

What is the biomass volume of a forest? I need to estimate deforestation between two epochs. What is the forest volume change after a fire event? What is the level of confidence of the estimate? A number of pilot projects located in Europe aimed at giving concrete answers to the above critical questions.

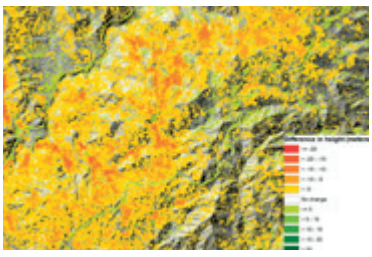
In Cyprus, the processing of two sets of stereo images acquired by the IKONOS sensor in 2001 and the Pléiades sensor in 2014 allowed for the surface modelling of the forest in Saittas at the two epochs and the estimation of the biomass change. Beside forest-related applications, FORSAT was also capable of detecting, delimiting and quantifying other changes, such as earthwork operations.



Ikonos 2001 (false colour image) (© European Space Imaging / DigitalGlobe)

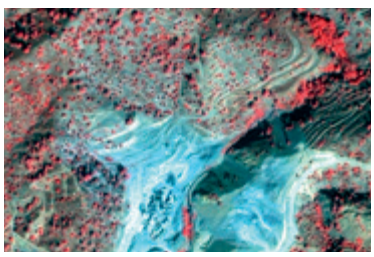


Pléiades 2014 (false colour image) (Pléiades © CNES 2014, Distribution Airbus DS)



3D differences visualised on digital surface model derived from Pléiades 2014 using FORSAT

Identification and assessment of deforestation caused by forest fire in Saittas, Cyprus and based on VHR satellite data of 2001 and 2014. Image processing and surface comparison were performed with FORSAT software.



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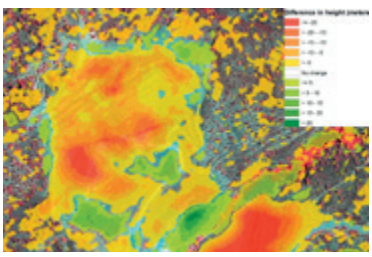

Difference in heights visualised on orthorectified false colour image of Pléiades 2014