SPACE-AGE VINICULTURE

PILOT PROJECTS AT FOUR VINEYARDS IN NORTHERN GREECE HAVE CONFIRMED THAT SATELLITE IMAGERY MAY BE USED BY AGRONOMISTS AND WINEMAKERS IN OPTIMISING THE MANAGEMENT AND HARVESTING OF WINE GRAPES. VANA GIAVI AND PENELOPE RICHARDSON REPORT

In the past decade, agriculture in Europe and worldwide has undergone a substantial change, bringing increased food security and production. But this has led to significant harmful environmental consequences in terms of water pollution, greenhouse gas emissions and damage to our natural surroundings. At the same time, very high-resolution multispectral satellite data such as from WorldView-2 gradually became more available, providing data in the red/near-infrared transition zone of the vegetation reflectance spectrum, which marks the boundary between absorption by chlorophyll and scattering by leaves' internal structures. This combination was the motivation that brought remote sensing researchers from the National Technical University of Athens in Greece together with grape growers and winemakers.

Every year since 2012, concurrent satellite, airborne and field campaigns have been scheduled during the 'veraison' period, the 10-15 day time-window during which grapes change their colour and begin ripening. During the growing season, the maturity and quality of grapes vary across a region and even within a single vineyard. Winemakers carefully monitor the grapes throughout the season to determine when nutrients, pesticides and additional water should be applied to optimise growth. As the harvest nears, the winemakers examine grapes for signs of maturation and sugar content to select the precise time for picking. Vines are even categorised by grape quality and assigned to specific barrels/tanks in anticipation of the wine they will yield.

Winemakers and viticulturists rely on several tools to monitor crop health and grape ripening, including handheld reflectance spectrometers. In this project, a 512-band spectrometer operating in the 350-1050nm range was used to collect spectral signatures of 20 grape varieties and derive numerous vegetation indices related to leafiness, maturity, chlorophyll content and other indicators of vigour and grape quality. This project used data from the Worldview-2 satellite, since it combines high spatial and spectral resolution while covering large agricultural regions.

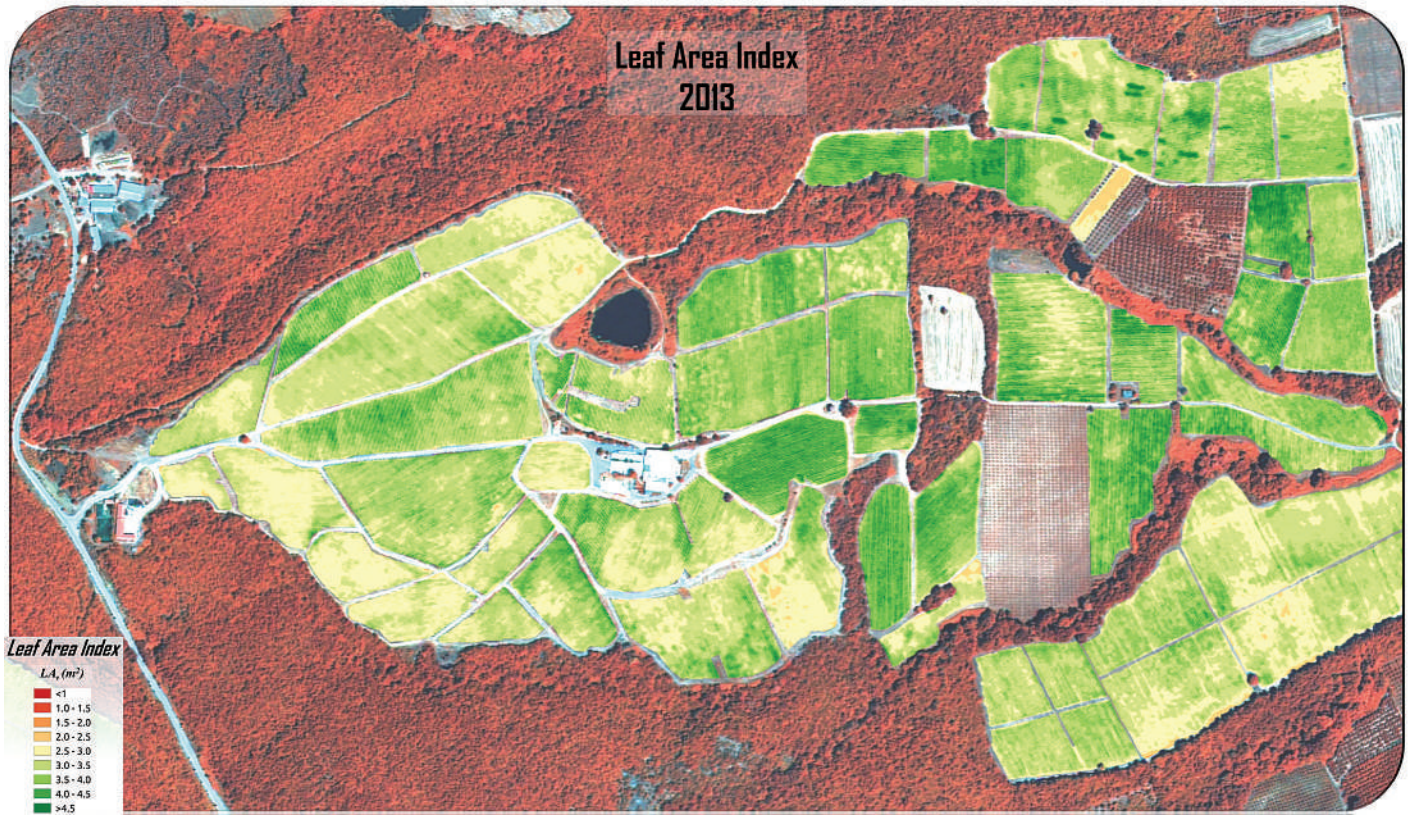
"The handheld spectrometer, as every sampling procedure, is a time-consuming method of capturing data," says Konstantinos Karantzalos, assistant professor at the university's Remote Sensing Laboratory.

Capturing satellite data during veraison

Greek geospatial imagery company TotalView worked with European Space Imaging (EUSI) in Germany to acquire imagery from the WorldView-2 satellite over the study area in Northern Greece during veraison. Through careful coordination with personnel at the vineyards, WorldView-2 captured image data in the midst of veraison at the same time field crews were collecting spectrometer data. At the same locations, grape sampling and analysis of the 'must' – the grape juice before and during fermentation – were performed during ripening stages and harvesting. TotalView delivered both eight-band multispectral and 40cm panchromatic data to the Remote Sensing Laboratory at the National Technical University of Athens, which corrected the data for radiometric and atmospheric variations before it was pan-sharpened.

Correlating satellite and spectrometer data

The canopy of the vines is detected and several indices are computed automatically during processing. Concrete relationships are then established by correlating the satellite observations with certain



Mapping leaf area index from WorldView-2 satellite data in Naoussa, Greece. Map © Remote Sensing Laboratory, NTUA. Image © European Space Imaging

biophysical and biochemical quality parameters from samples of the grape and the canopy and laboratory analysis.

Researchers at the laboratory then derived 30 common broadband vegetation indices from the satellite data relating to vegetation, chlorophyll, carotenoids, carotenoid-chlorophyll ratio and anthocyanins.

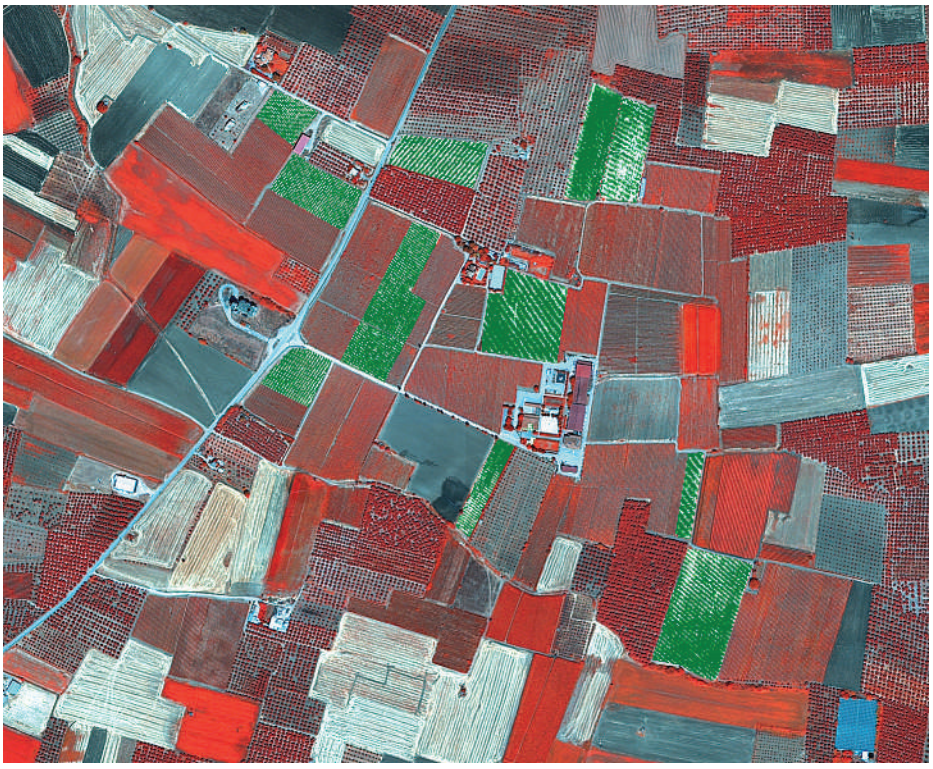
Next, they analysed the correlation with similar indices extracted from the handheld spectrometer data. Correlation rates exceeding 80% between the two methods of measuring spectral reflectance confirmed the satellite data could be used as a means of monitoring crop health.

"We were very satisfied because WorldView-2 provided atmospherically corrected images that correlated with the field observations," says Karantzalos.

He notes that certain spectral indices are known to indicate the health of specific grape varieties better than others. By further correlating satellite reflectance with the in-situ quantitative and quality parameters, the research team generated maps for the target vineyards.

For example, three key geospatial maps indicated the variation in leaf area index, index of maturity at harvest and colour index of red grapes. With a spatial resolution of less than half a meter, each map showed subtle variations in plant and fruit conditions within individual vineyards.

"Using this information, the winemaker could decide where to apply nutrients and where to use insecticides or schedule a selective harvesting process by gathering together the top quality grapes," says Karantzalos.

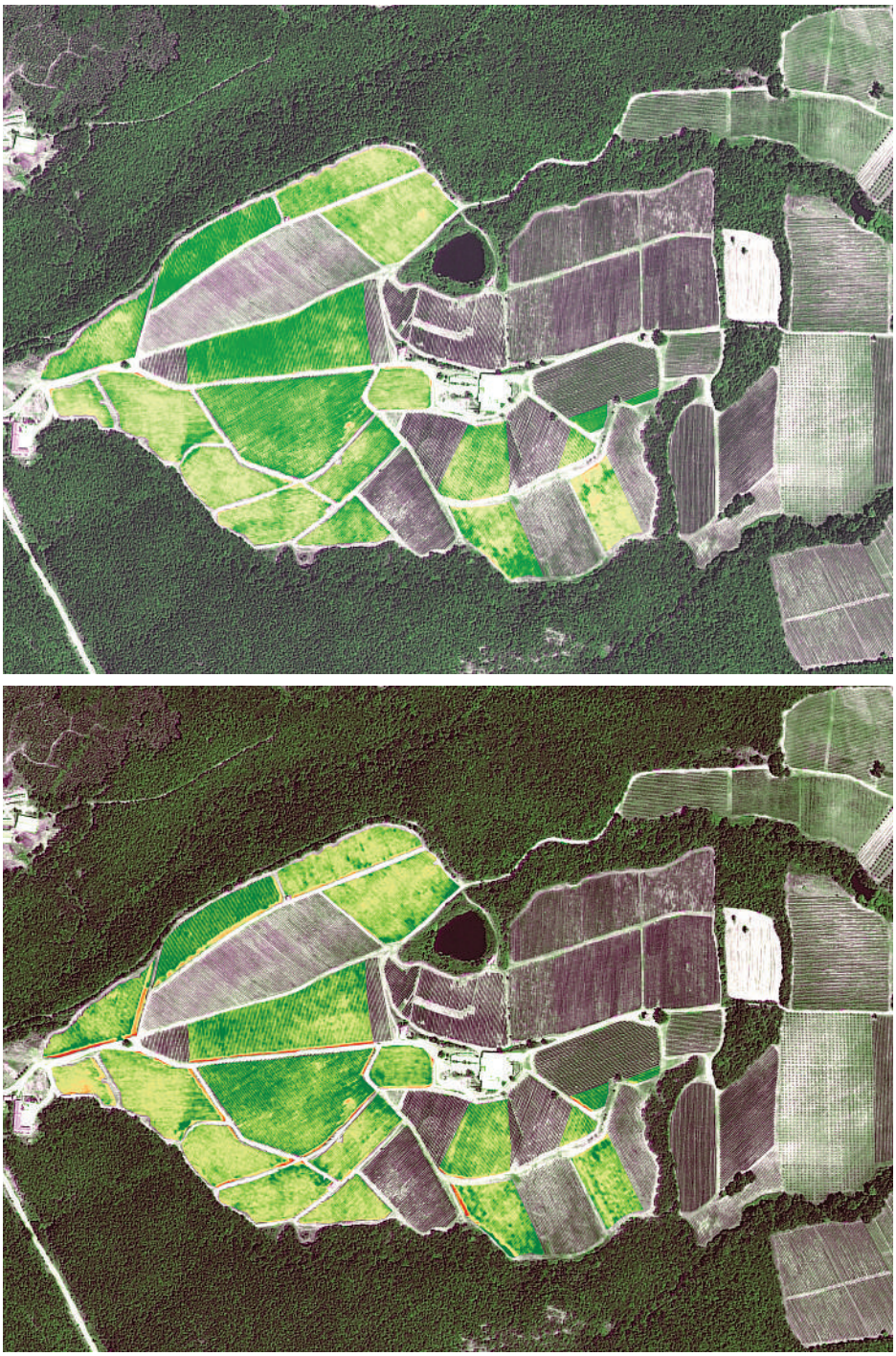


Canopy greenness map over Megaplatanos in 2012 derived from WorldView-2. Grape variety: Chardonnay. Map © Remote Sensing Laboratory, NTUA. Image © European Space Imaging

Finally, geospatial maps were produced that provided quantitative information about the performance of the plants and estimation about the oenological potential, phenolic composition and chromatic characteristics of the fruits and must.

A more efficient solution

Capturing in-situ spectral reflectance, along with grape sampling and must analysis for several hectares, is time-consuming. The pilot project suggests that pan-sharpened multispectral satellite imagery may be an efficient and cost-effective complement to – or even replacement for – the traditional



Canopy greenness map over Naoussa in 2013 (top) and 2015 (bottom) derived from WorldView-2. Grape variety: Ksinomavro. Map © Remote Sensing Laboratory, NTUA. Image © European Space Imaging

ground-based methods of assessing grape health across regions and within vineyards.

In combination with other critical data, such as weather, soil maps and the microclimate of each area, critical and timely decisions can be reached with increased confidence about optimal farming practices during fertilisation, the application of herbicides and pesticides, and harvesting. Such a precision farming management system is based upon observing, measuring and responding to inter and intra-field variability in crops and can lead to increased yields, increased profitability of production through however, more sustainable, environmental-friendly agricultural practices.

"We plan to continue research using the WorldView-2 image data and believe a commercially viable service involving the creation of high-resolution vegetation index maps for winemakers could soon become reality," concludes Karantzalos.

"The accuracy and value of these maps will be greatly enhanced through collection of satellite data at multiple times during the growing season."

WE WERE VERY SATISFIED BECAUSE WORLDVIEW-2 PROVIDED ATMOSPHERICALLY CORRECTED IMAGES THAT CORRELATED WITH THE FIELD OBSERVATIONS

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Vineyards in Naoussa, Greece during the growing season. © Kir-Yianni

Vineyards in Greece during the growing season. © Alpha Estate © Karantzalos/Remote Sensing Laboratory, NTUA

GRAPE GROWERS SUPPORTING THE STUDY

Alpha Estate is located in the northwest part of Greece, the Amyndeon, Florina region. It was founded in 1997 by the viticulturist Makis Mavridis and chemist-oenologist Angelos Iatridis, who, after years of experience in various locations of Greece, chose the Amyndeon region to create his own wine.
www.alpha-estate.com

Kir-Yianni was founded in 1997 by Yiannis Boutaris, a leading figure in the Greek wine industry. Today, Stellios Boutaris, a fifth-generation winemaker, leads Kir-Yianni into the next phase of its history by exploiting the cornerstones of the Kir-Yianni philosophy: desire for innovation, respect for tradition and true knowledge of the wine, from the grape to the end consumer.
Vineyard map http://kiryianni.gr/winemaking/naoussa/