Satellite-Derived Management Zones

Precision agriculture can be practiced at low cost.

Stennis Space Center, Mississippi

The term "satellite-derived management zones" (SAMZ) denotes agricultural management zones that are subdivisions of large fields and that are derived from images of the fields acquired by instruments aboard Earth-orbiting satellites during approximately the past 15 years. "SAMZ" also denotes the methodology and the software that implements the methodology for creating such zones. The SAMZ approach is one of several products of continuing efforts to realize a concept of precision agriculture, which involves optimal variations in seeding, in application of chemicals, and in irrigation, plus decisions to farm or not to farm certain portions of fields, all in an effort to maximize profitability in view of spatial and temporal variations in the growth and health of crops and in the chemical and physical conditions of soils.

As used here, "management zone" signifies, more precisely, a subdivision of a field within which the crop-production behavior is regarded as homogeneous. From the perspective of precision agriculture, management zones are the smallest subdivisions between which the seeding, application of chemicals, and other management parameters are to be varied.

In the SAMZ approach, the main sources of data are the archives of satellite imagery that have been collected over the years for diverse purposes. One of the main advantages afforded by the SAMZ approach is that the data in these archives can be reused for purposes of precision agriculture at low cost. De facto, these archives contain information on all sources of variability within a field, including weather, crop types, crop management, soil types, and water drainage patterns.

The SAMZ methodology involves the establishment of a Web-based interface based on an algorithm that generates management zones automatically and quickly from archival satellite image data in response to requests from farmers. A farmer can make a request by either uploading data describing a field boundary to the Web site or else drawing the boundary on a reference image. Hence, a farmer can start to engage in precision farming shortly after gaining access to the Web site, without need for incurring the high costs of conventional precision-agriculture data-collection practices that include collecting soil samples, mapping electrical conductivity of soil, and compiling multi-year crop-yield data.

Given the boundary of a field, a SAMZ server computes the zones within the field in a three-stage process. In the first stage, a vector-valued image of the field is constructed by assembling, from the archives, the equivalent of a stack of the available images of the field (see figure). In the second stage, the vector-valued image is analyzed by use of a wavelet transform that detects spatial variations considered significant for precision farming while suppressing small-scale heterogeneities that are regarded as insignificant. In the third stage, a segmentation algorithm assembles the zones from smaller regions that have been identified in the wavelet analysis.

This work was done by Damien Lepoutre and Laurent Layrol of GEOSYS, Inc., for Stennis Space Center.

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figure caption:
(2 columns)

Multiple Satellite Images of a Field are analyzed to identify zones for which different precision-agriculture treatments are needed.
Using Several Satellite Images Acquired Over the Last 10 to 15 Growing Seasons and Representing Different Weather Patterns
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