UDC 634.8.

MODERN INFORMATION SYSTEMS FOR DEVELOPMENT OF GEORGIAN VINEYARD MANAGEMENT

Nodar Natenadze
Scientific-Research Center of Agriculture, Tbilisi, Georgia
Nodari.Natenadze@srca.gov.ge

Abstract

The objective of this paper is to characterize the use of GIS in a specific organization, describing the system and its practical usage for development of Georgian vine management. A specialized area of land and crop study can be examined in the area of wine-making and vineyard management. GIS technology has been employed in the wine industry by many producers seeking to maximize the quality and quantity of their product. Remote sensing and GIS have been used for day-to-day vineyard management in a quasi-to-fully operational fashion in the American west coast and several other regions of the world for the past five to ten years [1,2]. Mapping technology can be used to provide cost-effective solutions for agricultural applications. Integrating GIS, GPS, and remote sensing technologies provides growers with the information they need at a scale they can use. As the accuracy and capabilities of these technologies improve, agriculture is poised to take full advantage of the benefits.

Key words: GIS, GPS, Vineyard, Management, Wine-making, Mapping

Introduction

Depending on the modern structure of agriculture of Georgia, first of all, it may be considered as the priority of the fields that are currently functioning at a certain level and create competitive products. From this point of view, one of the important fields for Georgia is considered viticulture and winemaking, for which more effort is needed for the information provision, management and development of this field.

One of the prerequisites for the development and better management of this field is the technology of modern data spatial analysis technologies – geographic information systems (GIS), which are successfully used in almost every field of human activity in many countries of the world. The world practice has shown that computer systems based on Geographical Information System (GIS) are the most comprehensive software tools for systematization, organized storage and spatial-thematic analysis. GIS is a common standard format for geographical data (data with spatial and time component). It is the technology of data storage, distribution and multilateral analysis across the world.

Geographic Information System is a computer system based on computer maps and databases that are used for data collection, storage, management and analysis. G I S consists of several main directions:

1. Geographical information systems.

A) Creating digital topographical maps based on existing maps and aerospace photographs, making updated computer maps; B) Entering and processing spatial data, retrieving data, systematization, classification and organizing. Building geodesic bases, organizing of spatial and attributable information in a modern format of data storage - in the geographical information database; C) Create thematic maps - thematic visualization of spatial data; D) Spatial Planning - Developing and implementing of decision making information systems with all necessary visual materials; E) Spatial Analysis - Distance analysis, networked analysis (short routes, construction of the distribution network, analysis of service zones, etc.), density analysis, topographic and relief analysis (vision zones, inclination, exposition, etc.), hydrological Analysis, etc. F) Geostatical analysis - spatial interpolation, calculating and visualization of analytical parameters dissemination in space (eg, air pollution data analysis); G) Time analysis - Spatial-time review of development processes in space, review of accumulated information in a different time frame.

2. Databases and Programming.

A) Creation of computer information system - centralized storage of company data in a data base and development of the management system for the database; B) Creation of working software with databases - creation of information system software that includes data inspection, add, edit, search, analysis, report formation and other informational analytical blocks; C) Creation of search system - search and visualization of information; D) Conduct statistical analysis; E) Operational formation of accounts;

Basic part

The possibility of development of Georgian vineyard management by the modern information systems let's consider as an example, Seven Hills Vineyard in Milton-Freewater, Oregon, grows grapes for sale to premium wineries; they have purchased software and services from SureHarvest, a company based in Soquel, California, that was founded in 1999. By using personal digital assistants (PDAs) equipped with global positioning systems (GPS), SureHarvest's geographical information system (GIS) software, barcode readers and radio frequency identification (RFID) tags, these powerful tools can help vineyard and winery staff develop the wide range of information they now collect into a comprehensive vision for how they should operate the winery. The global positioning system is a satellite-based device that allows them to determine the exact latitude and longitude of each test site in the vineyard. The SureHarvest software presents information much the way reference maps use translucent overlays to add layers of detail to the display. Together, they synchronize data so that the vineyard staff and the winemaker can rapidly analyze data collected in the field [3].

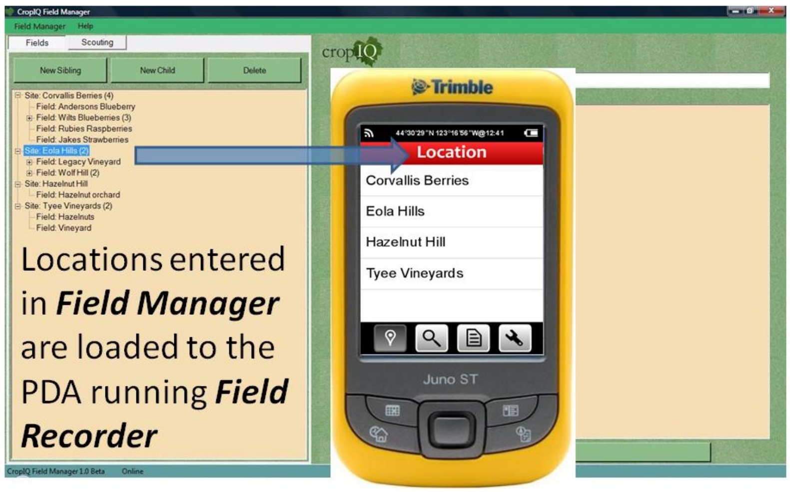
The GIS software is used to convert field data collected with GPS coordinates or georeferencing into user-friendly maps. The SureHarvest GIS tool offers fully integrated vineyard management software systems for vineyard operations, with the ability to display layers of information interactively and seamlessly with the database. The integrated software system allows users to collect data in the field as they monitor for 1) vine and soil moisture, 2) vine and berry development, 3) pests and natural enemies, and 4) yield estimate indication and pre-harvest Brix levels.

Team members can download a location that specifies data for tracking and analyzing detailed information for an entire ranch, a single block, a block subdivision or an individual row and vine. The vineyard staff can review soil type, irrigation patterns, leaf canopy, clusters per vine and berries per cluster, for example, and then determine how to balance these elements to produce the highest quality grapes. Eventually, they will scan all types of information from the vineyard directly into the PDAs. When they return to the winery from sampling in the field, they will download information such as bud break dates, cluster weight at lag phase (approximately 55 days after first bloom) and number of clusters per vine into winery computers. An important parameter, the Brix value (sugar content) is determined by a Hydrometer, which indicates a liquid's Specific Gravity (the density of a liquid in relation to that of pure water). The Brix scale is used to measure the ripeness of a grape and predict the expected alcohol level of the wine. Each degree of Brix is equivalent to 1 gram of sugar per 100 grams of grape juice; grapes gain more Brix value as they ripen. The sugar converts to alcohol during fermentation and therefore the higher the Brix, the greater the alcohol in the wine.

Mr. Christopher Van Coops, SureHarvest Vice President of Engineering, is responsible for managing all aspects of the company's software products and technical services. The company offers Farming InSight, a GIS-based decision support and reporting tool, which provides growers with a visual display of farming data, and Farming MIS (management information systems) software that helps to plan, schedule, record, map, analyze, and report farming management activities (Figure 1). ESRI ArcView is used to provide shapes and images applied to base maps in ESRI's map repository. The Manifold GIS software is then used to perform all necessary map analysis functions. The software is of a modular structure, meaning that groups of functions—such as pest and nutrition, soil and water, vineyard sampling and contract management—may each be purchased individually. However, all modules work seamlessly together to form a software system that serves the needs of each customer. (C. Van Coops, personal communication, December 3, 2010)[4].

Figure 1. SureHarvest - A Workflow Management System

The database may be configured as a stand-alone or a networked system. Alternatively, the database may be installed off-site and accessed over a secure Internet connection. The desktop user may "disconnect" from the main database and operate it in stand-alone mode, when necessary, and the data will be synchronized upon reconnection. The software has a very professional look. It is laid out using vineyard, block and sub-block hierarchies just like a Windows Explorer file system, making navigation intuitive. Blocks, sub-blocks or smaller units may be handled individually, or management groups can be created to make short work of some database tasks. Management groups can be created for anything the grower desires, such as all of the Merlot blocks, all of the vertical shoot position (VSP) trellis blocks or all of the E-W rows, etc. The data fields are almost all user-configurable. The software integrates with a PDA, as shown in Figures 2, used for remote data collection. The PDA may be synchronized with the parent database by any standard direct or wireless connection means. Vineyard operations are supported at many levels: from farm planning to assigning costs, to equipment operations and materials, to generation of work orders for vineyard tasks [5].



Field Manager "Fields" Tab   *Field Recorder* "Location" menus

Figure 2. PDA Display

In conjunction with data input via handheld devices and smartphones in the field or from workstations on the desktop, weather station data along with aerial and satellite remote earth sensing are additional valuable tools used by premium vintners and winegrape growers to gauge the health of their vineyards.

As an example, GrayHawk, an NDVI (Normalized Difference Vegetation Index) imaging, remote sensing and aerial photography company, maps vineyards in Napa, Sonoma and Santa Ynez valleys as well as the North Coast of California from a single-engine Cessna equipped with GPS navigation. NDVI images are obtained from 10,000 feet with a digital multi-spectral camera and special computer programs for transforming reflection image data into NDVI imagery. As shown in Figure 3, a computer then calculates pixel values for the red wave band and the near infrared band images. It divides the combined image into different color classifications based upon NDVI values. The bands represent the photosynthetic capacity of the vines compared to the standard infrared wavelength [6].

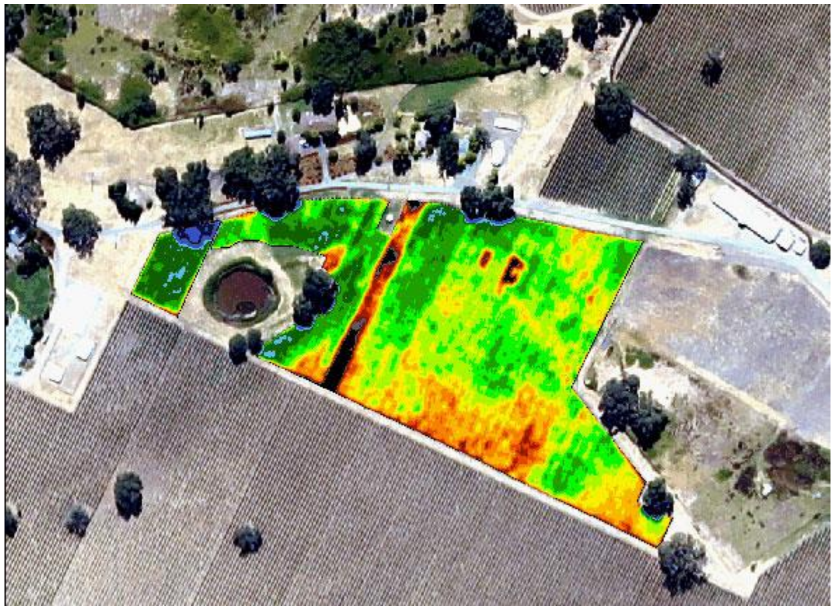


Figure 3. GrayHawk creates NDVI images to pinpoint unhealthy or dormant vines

The technology is sophisticated enough to recognize small differences in plant growth from changes in nutrition, leaf area, soil properties and irrigation patterns. It is a first step toward modeling relationships between water-holding capacities of the soil, leaf area, vine weights and lengths, percent of vine cover, percent of shaded area, and the crop coefficient, for example. The technology permits vineyard managers to track irrigation, mulching, mowing, tilling, disease and differential harvesting for each sub-block in the vineyard. Monitoring changes over time has proven to be one of the most valuable contributions of remote sensing for vineyard management.

Benefits of vineyard canopy management include improved wine quality, improved yield, reduced disease incidence and facilitation of mechanized operations. Remote sensing can potentially serve as a decision support tool in this regard by providing quantitative maps of leaf area. Value could be added to such a product in combination with yield data to calculate the leaf area to crop mass ratio, and then to provide a map of this vine ‘‘balance’’. For centuries, French vintners subscribed to the theory that the quality of the wine grape produced was driven in a large part by the environment. Terroir, the French term meaning soil or region, is used to describe the qualities of a wine attributable to the geographic origin of its wine grapes. Factors that define geographic origin can be described discretely using a GIS and include soils, slope, aspect, growing season and degree-days. When combined with features such as rootstocks, varieties, trellis systems, and irrigation systems, a specific variety of wine grape best suited to the site can be determined. Storing this information in a GIS provides growers a means to more effectively manage the inputs applied to a crop [7].

References

1. Johnson, L. F., D. E. Roczen, S. K. Youkhana, R. R. Nemani, and D. F. Bosch. "Mapping vineyard leaf area with multispectral satellite imagery." Computers and electronics in agriculture 38, no. 1 (2003): 33-44.
2. Taylor, James Arnold. "Precision Viticulture and Digital Terroir: Investigations into the application of information technology in Australian vineyards." PhD diss., Ph. D. Thesis. The University of Sydney (available at www. digitalterroirs. com–accessed 14/07/2015), 2004.
3. Ulrich T. “Technology with traction: Six innovations that can lighten your load”. Wines and Vines, September (2007) 23-29.
4. Vestra Resources, Inc. (2010). GIS for viticulture. Retrieved from: http://www.vestra.com/service/gis/gis-for-viticulture

5. Greenspan, M. “Vineyard management software”. Wine Business Monthly, July (2006) 2-8.
6. Matese, Alessandro, and S. F. Di Gennaro. "Technology in precision viticulture: A state of the art review." Int. J. Wine Res 7 (2015): 69-81.
7. Arnó, J., JA Martínez Casasnovas, M. Ribes Dasi, and J. R. Rosell. "Precision viticulture. Research topics, challenges and opportunities in site-specific vineyard management." Spanish Journal of Agricultural Research 7, no. 4 (2009): 779-790.