GIS for Agribusiness

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GIS for Agribusiness

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Colombian Coffee Growers Federation Improves Crop Forecasting with GIS

By Jim Baumann, Writer, ESRI

The coffee harvest is a historic component of the Colombian economy that can be traced back more than 300 years to the arrival of Jesuit priests from Venezuela, who began its cultivation. Today, the harvest represents about 10 percent of Colombia's total exports, and the industry employs more than 500,000 people in its coffee production operations. Most farms are small producers, with less than five hectares of coffee trees under cultivation.

In 1927, the Federación Nacional de Cafeteros de Colombia (FNC) was formed to represent the interests of the small coffee growers in the country. However, because of the large number of coffee growers, FNC faced a problem in centralizing the data collected from these farms. This impacted the federation's ability to negotiate better coffee prices based on coffee yield predictions across the entire country.

To improve its forecasting capabilities, FNC conducted an extensive survey of coffee production in Colombia nearly 20 years ago. The resultant Encuesta Nacional Cafetera (ENC) is the standard by which the regularly updated Sistema de Información Cafetera (SICA) is still referenced today. SICA is a system that provides the fundamental data infrastructure and strategic information used in the design, formulation, and tracking of Colombian coffee farming. It is based on ArcGIS Server and used for online information analysis, planning,

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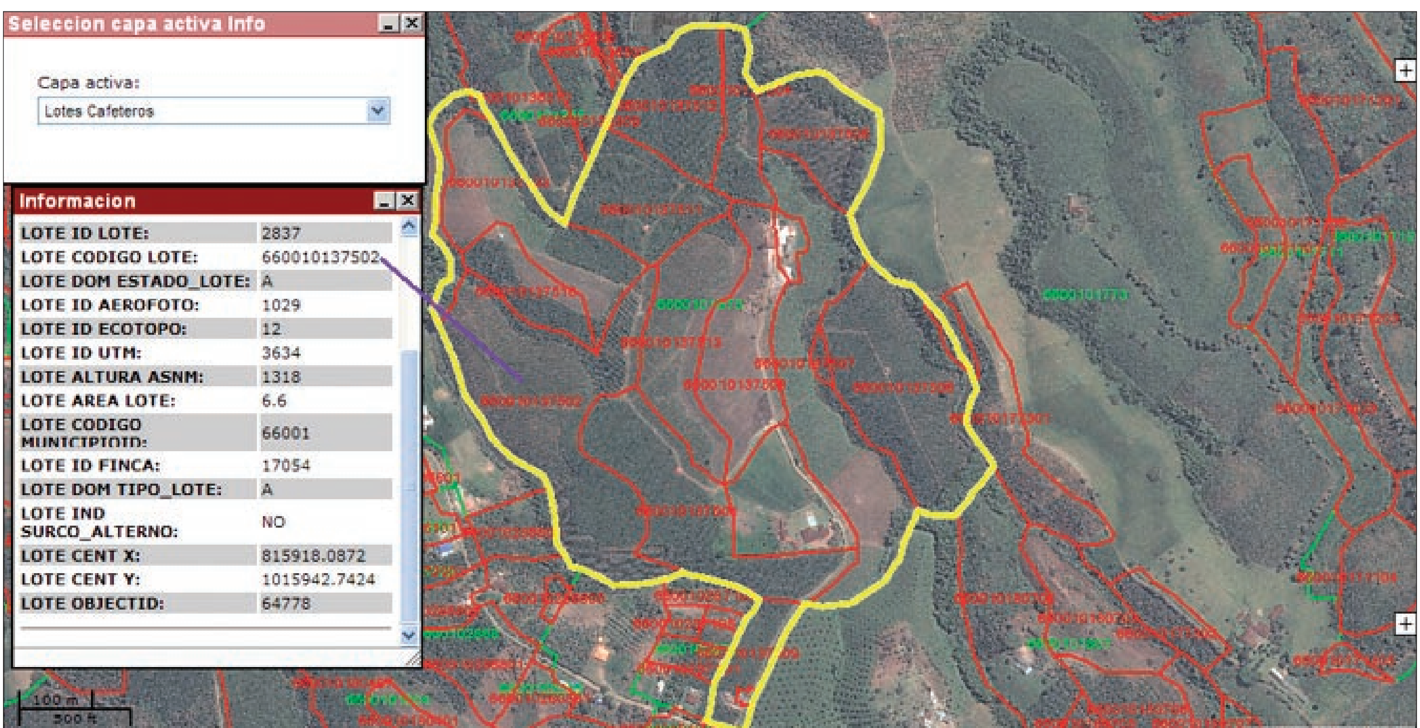
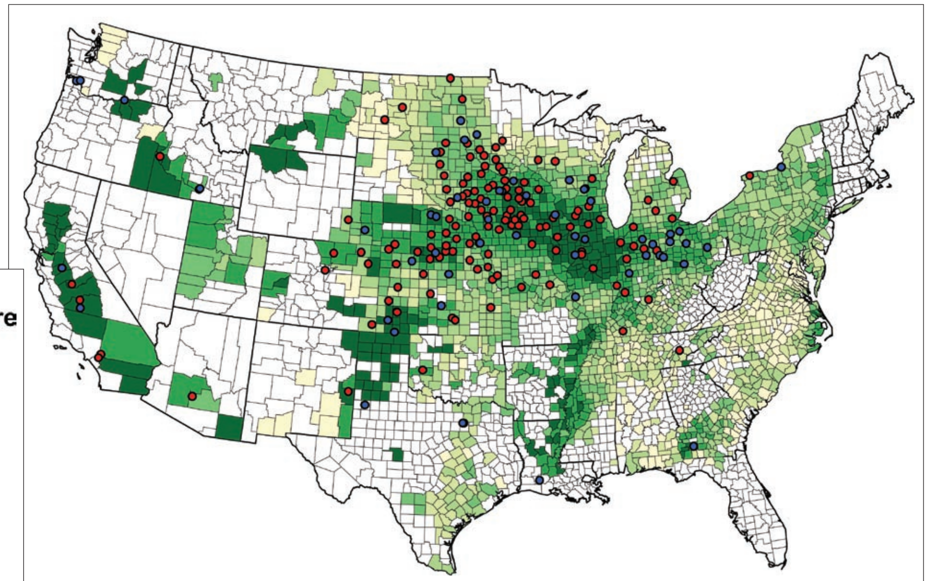


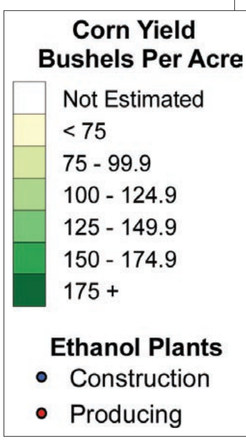
An individual parcel is selected within FNC's coffee crop sample area. Displayed data includes its latitude-longitude location and various identification codes.

2007 Corn for Grain Yield per Harvested Acre by County and Ethanol Plants

By Gail Wade

Existing ethanol production sites, as well as those under construction, are shown along with the National Agricultural Statistics Services' (NASS) county estimates for corn for grain yield per harvested acre by county. Driven by growing ethanol demand, U.S. farmers planted over 15 percent more corn acres in 2007. The NASS Annual County Estimates Program provides for the collection of crop data through cooperative agreements with each state. NASS field offices set annual county estimates for crop acreage, yield, and production and submit them to headquarters





Existing and future ethanol production sites are overlaid on a U.S. county map depicting corn crop production (*ESRI Map Book,* Volume 24).

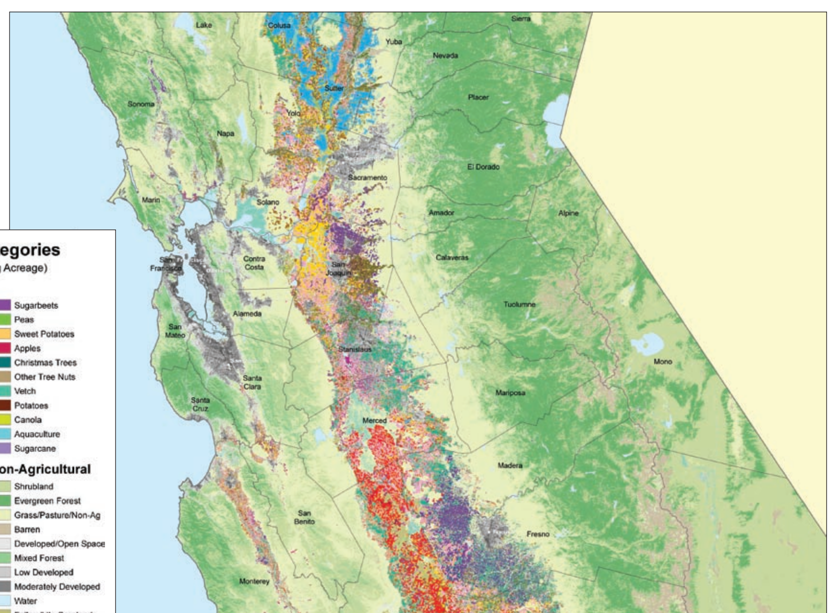
(Courtesy of U.S. Department of Agriculture, National Agricultural Statistics Service)

California's Agricultural Land Cover—2007 Cropland

By Patrick Willis and Lee Ebinger

This map focuses on crop-specific land cover by identifying over 40 crop categories and includes major noncrop categories. The categorized Cropland Data Layer imagery shown on the map was produced by the National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture (USDA).

A decision-tree classification approach was applied using ground-truth data from NASS and the USDA Farm Service Agency, a combination of satellite imagery from Indian Remote Sensing Advanced Wide Field Sensor and National Aeronautics and Space Administration Moderate Resolution Imaging Spectroradiometer sensors, and ancillary data sources.



A county map of California depicts the locations and abundance of more than 40 agricultural crops and noncrops found throughout the state (*ESRI Map Book,* Volume 24).

(Courtesy of U.S. Department of Agriculture, National Agricultural Statistics Service)

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Colombian Coffee Growers Federation Improves Crop Forecasting with GIS

sustainability policies, decision making, competitive analyses, environmental monitoring, crop forecasting, farm registration, and quality assurance.

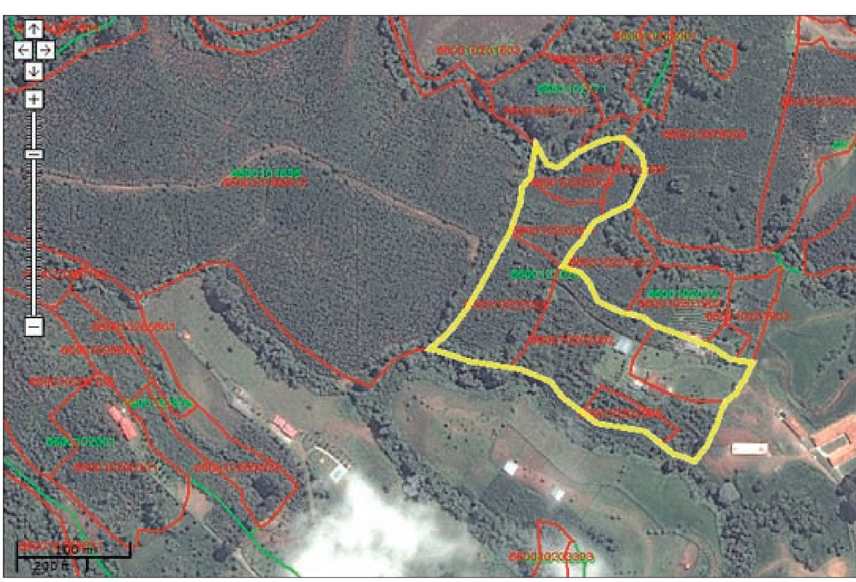
The model ENC survey included a collection of aerial photographs that were orthorectified using ESRI's geographic information system (GIS) software for inclusion in the original SICA geographic database. Today, the ArcGIS Server Image extension is used to manage and publish the large volumes of geospatial imagery that it collects from remote-sensing sources, such as orthophoto mosaics, satellite imagery, and aerial photography, for inclusion in SICA. The technical staff at FNC uses ENVI image processing software for multitemporal analysis and research on the collected imagery.

Crop forecasting is carried out using ArcGIS analytic tools on SICA data, which includes georeferenced samples collected by FNC field service teams within specified cultivated areas. To conduct the biannual sampling process, more than 1,000 field technicians harvest both ripe and unripe beans from coffee trees in each specified area. The beans are counted and weighed, then statistical processes are applied to extrapolate crop estimates for the succeeding six-month period. After completing their samplings, the FNC field service teams upload the crop yield data into the SICA geodatabase through either an Internet-based server application or a custom-built ArcGIS Mobile application. Because the FNC GIS is Web based, near real-time updating of the SICA database can now be performed.

The collected data is also analyzed by Cenicafé, FNC's research center, and the federation provides reports to its members regarding its critical findings. Current research topics include erosion management, soil remediation, and the multiple ways in which the coffee harvest is affected by changing environmental factors such as variations in rainfall and temperatures.

FNC also monitors the socioeconomic issues that affect the coffee farmer. SICA maintains information regarding the educational opportunities for FNC members, the condition of the infrastructure in their towns and villages, and the health care facilities available to them.

GIS has proved to be an invaluable resource for the Federación Nacional de Cafeteros de Colombia and its constituent farmers. The technology not only provides a wide range of services related to coffee crop forecasting and associated research but also allows the federation to track the quality of life of its members. This provides a compelling example of the power of GIS and how it can help improve the socioeconomic conditions of people throughout the world.



FNC selects sample areas for coffee crop forecasting twice a year.

A traditional home in colombia's coffee-growing region.

ESRI on the Road

ESRI International User Conference
July 12–16, 2010
San Diego, California, USA
www.esri.com/events/user-conference/index.html

10th International Conference for Precision Agriculture
July 18–21, 2010
Denver, Colorado, USA
http://icpaonline.org

ESRI Latin America User Conference
September 22–24, 2010
Mexico City, Mexico
www.sigsa.info/lauc2010

National Future Farmers of America Agricultural Career Show 2010
October 20–22, 2010
Indianapolis, Indiana, USA
www.ffa.org/

ESRI Europe, Middle East, and Africa User Conference
October 26–28, 2010
Rome, Italy
www.esri.com/events/emea/index.html

Share Your Story

Submit an article to *GIS for Agribusiness* to share your knowledge and innovative ideas about your work with GIS in agriculture. Please contact the editor, Jim Baumann, at jbaumann@esri.com for additional information.

The Irish Agricultural Catchments Programme

Supporting Sound Agricultural Practices with GIS

By Sarah Mechan, Data Manager, and Edward Burgess, Adviser
(David Wall, soil scientist, and Ger Shortle, program manager, contributed to this article.)

In partnership with farmers and other stakeholders, the Irish Agricultural Catchments Programme (ACP) is mandated to support productive agriculture while protecting water quality. It is funded by the Irish Department of Agriculture, Fisheries and Food and run by Teagasc, Ireland's Agriculture and Food Development Authority.

ACP advisers provide an intensive advisory and planning service to farmers in small river catchment areas (500 to 2,900 hectares) with support from their colleagues both locally and nationally. They help the farmers improve their profitability and implement the necessary agri-environmental measures contained in the National Action Programme (NAP) recently introduced under the European Union (EU) Nitrates Directive. This directive aims to protect water quality across Europe by preventing nitrates and phosphorus from agricultural sources polluting surface and groundwater.

To facilitate the operation of the program, two ArcGIS software-based applications were recently introduced by ACP. One is used to select drainage catchments for monitoring purposes, and the other manages soil analysis results and fertilizer recommendations.

Catchment Selection Application

The selection of catchments was influenced by EU guidelines that indicate that monitoring efforts be concentrated in "areas of intensive crop and livestock production . . . with elevated nitrate concentrations . . . adjacent to existing or projected eutrophication areas . . . with similar land use, soil type, or agricultural practice." Thus, it was necessary to devise a method for selecting small catchments (from 400 to 1,200 hectares) that were farmed intensively, predominantly either grassland or arable, and at risk of high phosphorus or nitrogen losses from land into the rivers that drain them.

In beginning the selection process, ACP first examined national catchment data to generate a list of 1,300 possible small river catchments, which were divided into two broad categories—grassland and arable cropping. The data analyzed included land use, forestry, area of peat, livestock density, nonagricultural land use, arable cropland, forage areas, housing density, geology, and soil types. A Multi-Criteria Decision Analysis (MCDA) approach was employed in the analysis. That is, selection criteria were given weightings, which reflected how they affected the suitability of the catchments for monitoring by ACP.

Catchments were also ranked by the risk of nitrogen or phosphorus moving from land into the water, based primarily on the drainage characteristics of the soil. Generally, more poorly drained soils have a greater risk of phosphorus loss through overland flow or runoff, while the more freely drained soils have a greater risk of nitrogen loss through leaching down through the soil.

Of the 1,300 eligible catchments initially identified, a short list of 50 top-ranking arable and grassland catchments was drawn up. These catchments were visited by ACP staff and assessed for their physical suitability as study sites. Five catchments were selected from this short list for detailed study by ACP, 3 that were predominantly grassland and 2 with a high proportion of arable farming. In general, the GIS-MCDA approach was highly efficient in handling the large number of input datasets and attribute ranges.

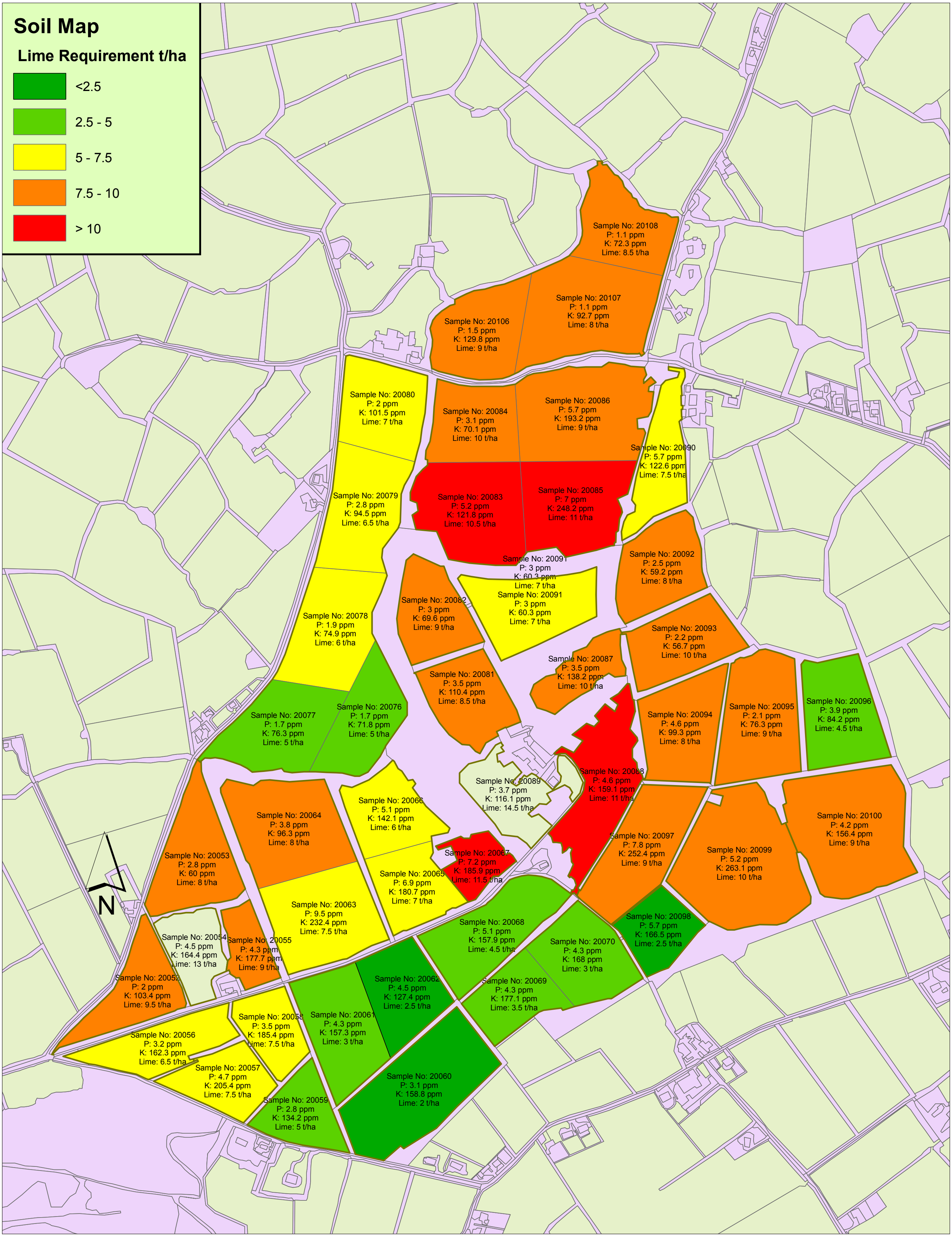
Presentation of Soil Analysis Results

Upon selection of the catchments for monitoring purposes, ACP needed to establish baseline soil nutrient levels for each catchment area. To achieve this, a census of soil nutrient status was undertaken. To accurately represent the variation in soil nutrients across the catchments, high-resolution soil sampling was employed (average area per sample was approximately two hectares). This high-resolution soil nutrient data facilitated the preparation of accurate nutrient management plans for catchment farmers. However, there was a risk that farmers would find them difficult to interpret given the high level of detail in the plans and the large number of land management units (whole fields or subfield areas).

To make the interpretation of the plans easier, it was decided to develop clearly labeled, color-coded maps. Each field and sample area was digitized and allocated a unique code as part of the catchment digitizing process. The sample area codes were then entered into a Laboratory Information Management System (LIMS) along with the corresponding soil sample code. This enabled the results to be linked back to produce intelligent maps. For each farm within the catchment areas, color-coded maps labeled with unique soil sample numbers can now be produced. Maps, illustrated by different colors displayed in each sample area, can be produced showing the phosphorus, potassium, and lime requirements of the crops to be grown. A set of maps can now be printed for each farm in less time than it would take to print the original soil analysis report. This analysis helps each farm increase its crop yield through precision farming methods and minimizes the leaching of chemicals into the watershed.

The most satisfying aspect is the feedback from the farmers. They find the maps very informative and easy to use, leaving the advisers more confident that nutrient management on these farms will be carried out in an accurate and informed manner. This technology can be used to overlay many years of soil analysis results to track temporal changes in soil fertility and nutrient management.

For additional information on the Agricultural Catchments Programme, visit the Agriculture and Food Development Authority Web site at www.teagasc.ie/agcatchments.



This soil index map indicates the concentrations of phosphorus, potassium, and lime in designated areas.

SaskMapper—Promoting Healthy Agricultural Landscapes

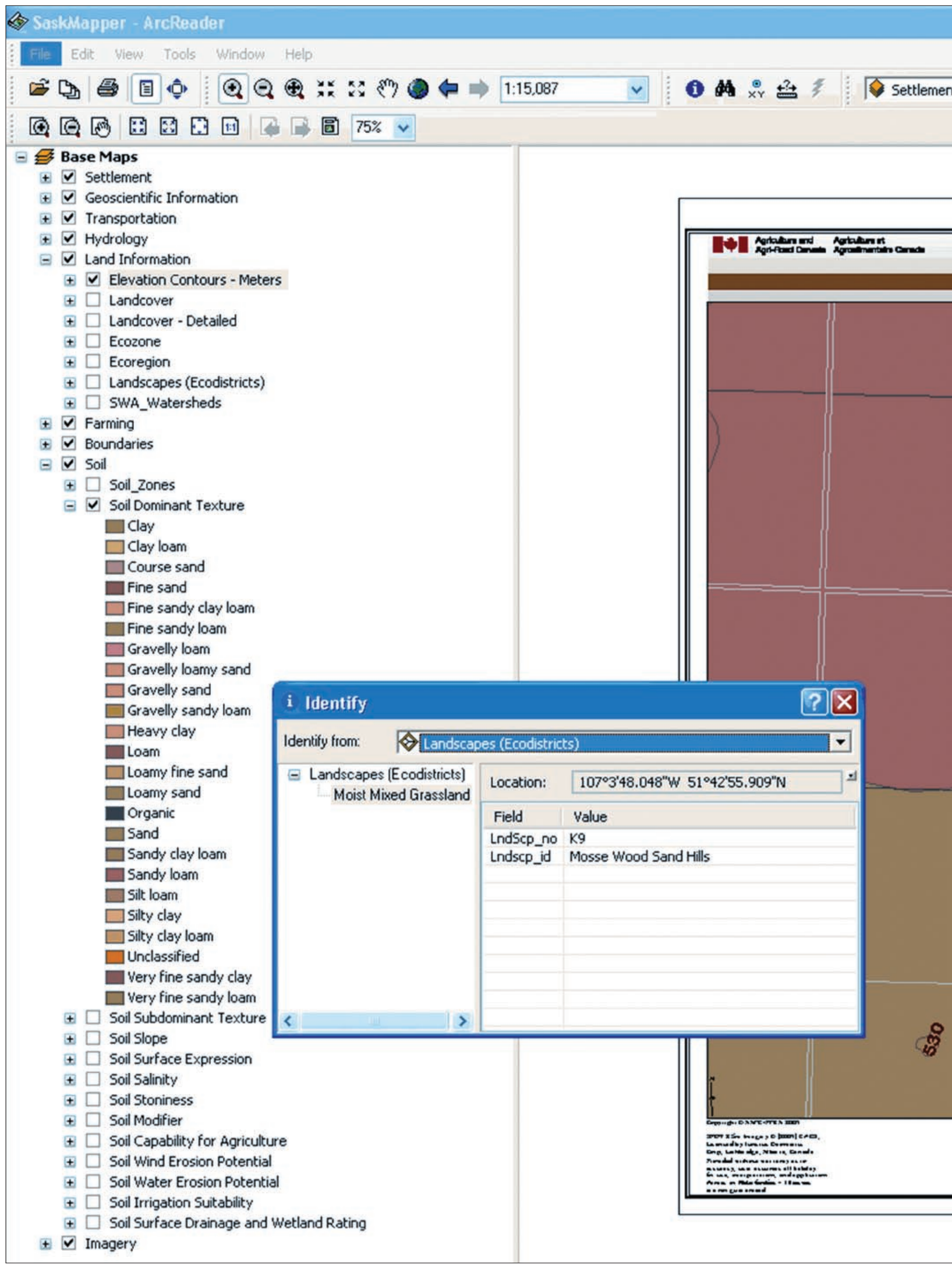
The Prairie Farm Rehabilitation Administration (PFRA) is a branch of Agriculture and Agri-Food Canada consisting of regional and field offices and specialty centers across Canada. The PFRA—headquartered in Regina, Saskatchewan—has been working with rural people for over 70 years to assist in decision making about sustainable land and water resource use and management. The department of over 760 employees works closely with Canadian producers on all agri-environmental issues to promote healthy and productive agricultural landscapes across Canada.

Recently, the Saskatchewan Region of PFRA developed the internal tool SaskMapper, an ArcReader application that allows staff with no previous GIS experience to create simple maps for reports, presentations, fieldwork, and environmental assessments. ArcReader is a component of ArcGIS and is used to view maps and GIS data. In developing SaskMapper, PFRA's main objective was to create something that was user-friendly and would allow users with little GIS knowledge to quickly and independently access the information they require.

SaskMapper resides on individual office servers and contains a number of unique data and imagery layers that are updated automatically on a nightly basis. There is a variety of features that make the application incredibly practical and versatile. For example, the static ArcReader template allows PFRA staff to always incorporate the necessary copyright information and departmental logos directly onto the maps. Layers and labels are scale dependent, meaning that as users zoom in, less detailed layers turn off and more detailed layers turn on. This allows faster data delivery and a more polished, professional look. It is especially helpful for PFRA because many users reside in smaller offices that have slower network connections. For ease of use, layers are conveniently grouped into categories like soils, boundaries, and land information, making them a snap to locate.

A major benefit of the SaskMapper application is that it provides access to departmentally purchased SPOT 2.5-meter satellite imagery that was previously very difficult for non-GIS staff to access. SPOT imagery provides continuity of environmental monitoring around the globe and is highly coveted as its enhanced

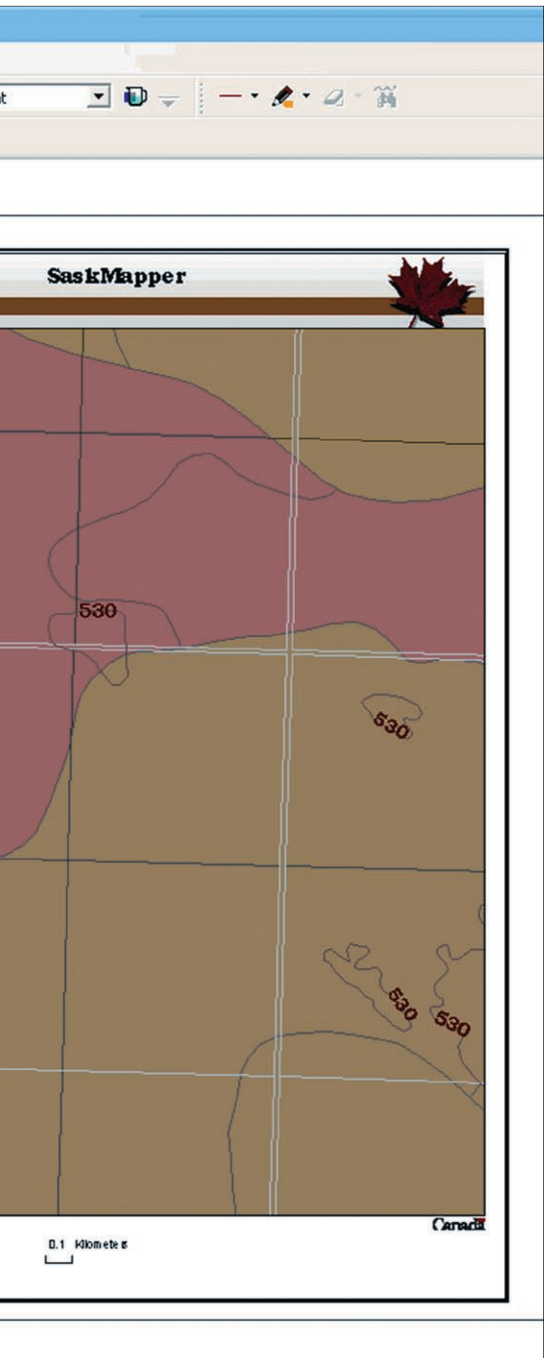
This article was originally printed in *ArcNorth News* and was based on information pertaining to and provided by Agriculture and Agri-Food Canada's (AAFC) Prairie Farm Rehabilitation Administration (PFRA). In 2009, the PFRA name was retired; its services and staff are now part of AAFC's new Agri-Environment Services Branch (AESB).



An example of SaskMapper displaying dominant soil textures. SaskMapper, an ArcReader application, displays essential information such as soil, transportation, hydrography, and cadastral datasets.

capabilities strike a perfect balance between high-resolution and wide-area coverage. This makes the imagery ideal for both urban and rural planning.

Technicians of the Canada Saskatchewan Farm Stewardship Program (CSFSP) use SaskMapper daily to help map plans for farmers who want to implement beneficial management practices. A farmer may want to restore a natural riparian area or relocate a livestock wintering site, and the bird's-eye view gained through SaskMapper maps is quite helpful in the planning process.



These maps are also used for reports and program applications and become a great tool when working with producers and other program staff who may not understand the intricacies of a producer's situation. This promotes the main objective of the program, which is to provide cost-shared incentives for producers who want to implement beneficial management practices in their farm operations. Previously, it would take a few days for technicians to create the desired map, but with SaskMapper, PFRA staff can now instantly create and print paper copies of a map to hand out to local producers.

In addition to increasing efficiency, SaskMapper has also proved to be an effective compliance tool. When preparing reports in compliance with the Canadian Environmental Assessment Act, engineers and environmental specialists would rely on photocopying countless paper maps and gathering information from many different sources for inclusion in their reports. This was time consuming and not an ideal solution, as the paper maps were static and limited in what they could represent. However, with SaskMapper, anyone involved in a particular project can create an on-demand, sophisticated, and accurate map that is easy to edit and contains any number of layers.

"SaskMapper has been invaluable to our association in that it has increased efficiency and enabled people to rely on themselves, thus creating a sense of independence," explains Carmen Kaweski, GIS analyst, PFRA. "Most of our users are not trained in GIS but find SaskMapper very user-friendly and, with little practice, become very proficient."

Additional information can be found at the Agriculture and Agri-Food Canada Web site at www.agr.gc.ca/pfra/.

ESRI News

Agriculture Special Interest Group Meeting at ESRI UC

The Agriculture Special Interest Group will hold its annual meeting at ESRI's International User Conference (ESRI UC) on Wednesday, July 14, from noon to 1:00 p.m. in Room 23C. Join your colleagues for a discussion of issues and opportunities regarding the use of GIS in agricultural applications.

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