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Henry Lachowski
Nationwide Forestry Applications Program, USDA Forest Service, Salt Lake City, UT

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Henry Lachowski
Nationwide Forestry Applications Program
USDA Forest Service
2222 West 2300 South
Salt Lake City, UT 84119

Abstract

The USDA Forest Service uses various forms of remote sensing in resource-management activities. Geographic information systems (GIS) are used to manage data, including remotely sensed data, in forest plan development, ecological mapping, and similar tasks requiring spatial information. An overview of remote sensing tools used in the Forest Service includes aerial photographs, airborne video, satellite sensors, and positioning systems. Discussion of applications considers the periodic assessment of forestland and resource-management plans, using as an example Mark Twain National Forest in southern Missouri. Vegetation mapping and old-growth mapping are illustrated by an example from the Santa Fe National Forest. Airborne video tied to a GPS is used in the southwestern region for forest pest management. Remote sensing and GIS are seen as important tools for land management, including management of rangelands. An extensive training and awareness program is designed to broaden the awareness of remote sensing technologies, to upgrade and maintain skill levels of Forest Service employees, and to provide training for specific tasks, applications, and new techniques. The needs of today's resource managers call for more current and consistent information. Proper combination of technologies and training should provide for the collection and utilization of data for multiresource use in a cost-effective manner.

INTRODUCTION

The USDA Forest Service has been using various forms of remote sensing to assist in a variety of resource-management tasks. The Forest Service considers remote sensing to be an integral part of information management, providing input for forestwide databases. An important source of land-cover information, especially of the vegetation layer for geographic information systems (GIS), data layers obtained from remote sensing are used primarily in forest plan development, in implementation and monitoring, in ecological mapping, and in many other tasks requiring spatial information.

Remotely sensed data include aerial photographs, i.e., imagery from airborne and spaceborne devices, such as multispectral scanners and video cameras. Positioning systems, such as the global positioning system (GPS), are used in conjunction with remotely sensed imagery to assist in locating various features. Analysis and interpretation of remotely sensed data are done in a georeferenced framework, most often in a GIS environment. The GIS and image analysis is often used as a combined capability. This means that (1) remote sensing/image analysis is an important data source for GIS databases, (2) analysis requires access to layers stored in a GIS, and (3) results of analysis of remote sensing data are stored as new layers in the database.

REMOTE SENSING TOOLS USED IN THE FOREST SERVICE

Following is a short description of some—but not all—of the remote sensing tools being used by the Forest Service. The use of these tools is increasing throughout the agency.

Aerial Photographs

Aerial photographs have been in use in the Forest Service for over fifty years. They provide an important historical perspective of our forests and are indispensable for a variety of assessments and mapping tasks (Greer et al. 1990). Information from photographs can now be digitized directly into a GIS database with the use of an analytical stereoplotter (Bobbe and Hoppus 1992).

Airborne Video

Video has existed since the start of television. Recent applications from airborne platforms have provided a powerful tool for resource managers. A video camera can be mounted in a small airplane, and imagery can be viewed as soon as the flight is complete. Video imagery linked with GPS can provide locational information for each frame, allowing the user quickly to find specific areas on maps or images (Bobbe and Ishikawa 1991).

Satellite Scanners

The Forest Service currently uses data from two satellites—Landsat and SPOT—and is also making considerable use of AVHRR for fuel mapping over large areas and for forest mapping across the United States. Data from these satellites, once geocoded and terrain-corrected, can be used in a GIS in two forms. The first is to create an image backdrop for display with other layers; the second and more widely used is to classify digital data into land-cover classes and to store the results in raster and/or polygon format in a GIS. These layers can then be used for a variety of applications, such as modeling. Digital satellite imagery has been used for large area forest assessment, for detection of change (Sader 1988), and for statewide inventories (Winterberger and LaBau 1988).

Positioning Systems

The navigation and positioning systems are generally not considered to be remote sensing systems. However, they are very important tools for data collection. The global positioning system is a widely used satellite-based system that gives a location in terms of latitude, longitude, and elevation (Gerlach and Jasumback 1989). The accuracy of GPS ranges from "geodetic quality" (within centimeters of true location) to "resource quality" (within meters), depending on the quality of receivers and collection methods used. The system can be used to trace directly features on the ground, such as roads, trails, fire damage, and other point, line, or area features. This is done by placing a receiver antenna at an unknown location or by walking, driving, or flying along a road, trail, boundary, or other feature.

EXAMPLES OF APPLICATIONS OF REMOTE SENSING

The Forest Service has a number of field applications of remote sensing data (Bain 1991). In most of these applications, satellite data provide information on vegetation and other land-cover types and are incorporated into GIS (USDA Forest Service 1992a).

The following examples of applications of remote sensing illustrate a cross section of current requirements. Monitoring of forest plans, vegetation mapping and old-growth modeling, and vegetation mapping/monitoring on rangelands are a few of the areas in which spatial information and analysis have become important.

Monitoring Forest Plans

Forest Land and Resource Management Plans require periodic assessment of current conditions against what was defined in the plan's standards and guidelines. In Mark Twain National Forest, located in southern Missouri, two Landsat Thematic Mapper (TM) images (acquired in 1982 and 1989) were used to detect land-cover changes over the seven-year period and to compare them to the plan's standards and guidelines. The changes detected with Landsat were field verified (about 84 percent accuracy) and stored in a GIS. This, along with management areas and ownership boundaries, allowed the monitoring of selected standards and guidelines related to certain vegetation conditions. This process proved to be a very efficient and economical method of forest plan monitoring and acquiring data for GIS (Platt et al. 1992, Maus et al. 1992).

Vegetation Mapping and Old-Growth Modelling

The location and quantity of "old-growth" forests, in conjunction with threatened and endangered species, are very important management issues. The Southwestern Region used vegetation layers derived from Landsat TM and existing ecological data to model old growth on Santa Fe National Forest (Gonzales et al. 1992). The procedures are similar to those developed in the Pacific Northwest Region (Teply and Green 1990). Three vegetation-related layers were derived with the following accuracies:

1. Crown closure (four classes): 82% accuracy
2. Vegetation cover (nine classes): 77% accuracy
3. Tree size (five classes): 76% accuracy

These vegetation layers, along with other GIS data layers, have a multitude of applications for management of natural resources, old-growth mapping being just one of them. The derived vegetation information is current, is consistently and economically produced, and has a known accuracy.

Range Allotment Mapping/Monitoring

Remote sensing provides range managers with a way to extrapolate field sampling over large land areas, and GIS provides for spatial analysis and customized mapping of the stored data. The Southwestern Region utilized airborne video tied to GPS locational information to identify unique vegetation types for mapping with Landsat TM (USDA Forest Service 1992b). A video camera mounted in an aircraft and linked with GPS provided several hours of "ground" information at various swath widths (zoom factors) ranging from sixty to one thousand feet. This procedure was patterned after the technology developed by Forest Pest Management. The GPS locational information allowed the range conservationists to identify the video images on maps and on georeferenced Landsat imagery. A computer-assisted classification of Landsat imagery was done for several allotments. This provided range managers with current information in a digital format and focused their more costly field-data collection process on specific problem areas.

A combination of remote sensing and GIS provides important tools for range managers. Data derived from various remote sensing sources and stored in a GIS help to determine suitable and unsuitable lands for livestock grazing, to derive habitat types, and to identify potential range structural improvements and pasture-management alternatives.

TRAINING AND AWARENESS

The Forest Service has established an extensive training and awareness program in the applications of remote sensing. The objectives are to

1. Broaden the awareness of remote sensing technologies
2. Upgrade and maintain the skill level of Forest Service employees
3. Provide training for specific tasks, applications, and/or new techniques

Training and awareness programs are designed and delivered at various levels of the Forest Service organization through several outlets. Training is offered by Forest Service units, by universities, and through contractual agreements.

The primary Forest Service organization responsible for training in remote sensing is the Nationwide Forestry Applications Program (NFAP) located in Salt Lake City. NFAP develops and conducts training in cooperation with regional and experiment station training coordinators. The initial emphasis was on utilization of aerial photographs, the most commonly used remote sensing tool. During the past few years, the emphasis has been broadened to include airborne videography, global positioning system, digital image analysis, and integration of remote sensing into GIS. These requirements are growing as new technologies become available.

A typical training session lasts three to five days and is conducted at a national forest, in a regional office, or at another location convenient to attendees. This proximity minimizes the cost of travel and also gives an opportunity to include a field exercise, a very important part of training. Training materials are usually tailored to the specific needs of the group.

The Forest Service's entry into the digital GIS world increases training needs. Many resource managers need to be aware of the new technologies that will assist in their jobs. Others need to learn new skills in order to fit into the evolving Forest Service organization.

The needs of today's resource managers call for more current and consistent information, ranging from small stands to entire national forests, including adjacent non-Forest Service lands. There are many tools, such as remote sensing and GIS, available to forest-resource managers. Proper combination of technologies and training should enable the collection and utilization of data for multiresource use in a cost-effective manner.

REFERENCES

Bain, S. 1991. Forest Service remote sensing summary, 1991. U. S. Department of Agriculture, Forest Service, Washington, D.C.

Bobbe, T., and P. Ishikawa. 1991. Real time differential GPS: An aerial survey remote sensing application. U. S. Department of Agriculture, Forest Service Report, Salt Lake City, Utah.

Bobbe, T., and M. Hoppus. 1992. Creating riparian vegetation GIS database from high altitude color infrared stereomodels. U. S. Department of Agriculture, Forest Service Report, Salt Lake City, Utah.

Gerlach, F. L., and Jasumback, A. R. 1989. Digitizing natural resources with GPS. *In* Remote sensing: An economic tool for the nineties. Proceedings of the twelfth Canadian symposium on remote sensing. IGARRS '89. July 10–14, 1989. Vancouver, Canada.

Gonzales, J., M. Barry, H. Lachowski, P. Maus, J. Johnson, and V. Landrum. 1992. Vegetation classification and old growth modeling in the Jemez Mountains. Santa Fe National Forest. Nationwide Forestry Applications Program, U. S. Department of Agriculture, Forest Service, Salt Lake City, Utah.

Greer, J., M. Hoppus, and H. Lachowski. 1990. Color infrared photography for resource management. Journal of Forestry 88(7): 12–17.

Maus, P., V. Landrum, J. Johnson, H. Lachowski, B. Platt, and M. Schanta. 1992. Utilizing satellite data and GIS to map land cover change. *In* GIS 92: Working smarter. Proceedings of the sixth international symposium on geographic information systems. FRDA Report No. 173. Vancouver, Canada.

Platt, B., M. Schanta, H. Lachowski, P. Maus, V. Landrum, and J. Johnson. 1992. Forest plan monitoring—role of remote sensing & GIS on the Mark Twain National Forest. U. S. Department of Agriculture, Forest Service Report, Salt Lake City, Utah.

Sader, S. 1988. Remote sensing investigations of forest biomass and change detection. Pages 31–42 *in* Satellite imageries for forest inventory and monitoring proceedings. IUFRO 4.02.05. University of Helsinki, Hyytiala, Finland.

Teply, J., and K. Green. 1990. Old growth forests—how much remains? Aster Publishing Corp., Eugene, Oreg.

USDA Forest Service. 1992a. Information management: A framework for the future. U. S. Department of Agriculture, Forest Service, Washington, D.C.

USDA Forest Service. 1992b. Use of remote sensing in range applications. Nationwide Forestry Applications Program, U. S. Department of Agriculture, Forest Service, Salt Lake City, Utah.

Winterberger, K., and V. LaBau. 1988. Remote sensing inventory applications in applied vegetation inventories—the Alaska experience. Pages 163–171 *in* Remote sensing for resource inventory, planning and monitoring. Proceedings of the second Forest Service remote sensing applications conference. April 11–15, 1988. National Space Technology Laboratories, NSTL, Miss. and Slidell, La.; American Society of Photogrammetry and Remote Sensing, Falls Church, Va.