REMOTE SENSING TECHNOLOGY AND MATERIALS FOR USE IN EXTENSION PROGRAMS

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The launch of the space age has brought satellite TV, battery-powered hand tools, new light-weight metal alloys, heat resistant ceramics, and space blankets into many everyday activities. Extraordinary new views of Earth taken from the moon and by meteorological and earth resources satellites have revolutionized weather forecasting, natural resource monitoring, and exploration geology. Data from satellites provide new information sources and constitute an integral part of the technology called *remote sensing*.

This technology is defined as "the measurement or acquisition of information of some property of an object or phenomenon by a recording device that is not in physical or intimate contact with the object or phenomenon under study" (Colwell 1983). The technology is very old; for as long as people have perceived distant objects and made mental and physical records, they have employed the basic techniques of this technology. When photography was developed in the mid-nineteenth century, the tools for remote sensing began to emerge; early cameras were carried aloft by balloons, pigeons and kits, and then by airplane in 1909. Although tremendous advances in remote sensing technology awaited the era of space travel, computers and advanced electronics, useful application of remote sensing to natural resource management began much earlier.

Aerial photographs have been used for about 50 years by federal agencies and other land managers as a tool for mapping vegetation, distinguishing physiographic features, depicting land use changes, administering crop production control, etc. The major sources of these photos have been federal agencies such as the U. S. Department of Agriculture, Forest Service, Agriculture Stabilization and Conservation Service, and the U. S. Department of Interior, Bureau of Land Management. These agencies from time to time (usually ten- to fifteen-year intervals) would contract to have aerial photographs taken at various scales (1:12,000 to 1:20,000) covering the land area under their management or administrative jurisdiction. Through these earlier years most technological advances were improvements in aircraft, cameras, films, filters, and film processing and were generally classed as refinements of existing technology.

To this existing technology new advances have been added in sensor development, analytical techniques and demonstrated applications of the technology (Colwell 1983; Johannsen and Sanders 1982). Sensor systems with new names--multispectral scanners, imaging spectrometers, synthetic-aperature radar--extend the ability to "see" into portions of the electromagnetic spectrum unavailable to the human eye and photographic films. These new capabilities make it possible to detect changes in moisture content of plants, the temperature of plants, soil, water, and rock and to see through smoke and cloud cover to image the earth below. This new technology is now becoming available to resource managers, including private farmers and ranchers for use in acquiring information for better management.

The competition in allocation of resources and the continued economic pressures on production agriculture make it imperative that both public and private land managers have accurate and timely information for decision-making processes. An initial requirement is for complete inventories of resources, supplemented by subsequent comparative information for determining rates and direction of changes of the resource base, and for monitoring the results of management programs. Remote sensor products in common use for resource management include satellite multispectral scanner data and aerial photography. These are frequently used for inventory and monitoring purposes to provide information needed for planning and management.

Since 1972, the United States has sponsored an earth resources satellite system known as Landsat. The fifth in this series was launched in March 1984. Each satellite has been equipped with a multispectral scanner that provides pictures of the earth of sufficient detail for mapping geomorphic features, soils, and natural plant communities, for making some crop identifications, for detecting major plant phenological events (leafing out and senescence) and hydrologic changes, and for monitoring other changes such as those caused by fire, strip-mining and irrigation development. The data are archived and constitute a historical record of land cover and use and changes therein.

Landsat data are available as pictures and forms suitable for processing with a computer. The maps prepared by analysis of these data forms can depict kinds, amounts, and locations of vegetation types, wildlife habitat, fuels for wildfires on rangelands, widespread insect damage in forests, and flooding of agricultural land. The vegetation maps may be used as a first stage of an inventory that can also include one or two scales of aerial photography and field data measurements. Each data level serves as a "stage" in a statistically designed sampling procedure.

"Conventional" aerial photography has long meant 9" x 9" black and white photographs; however, other films, notably natural color and color infrared, and other film formats (70 mm and 35 mm) have become increasingly common during the past two decades. One person, using aerial photographs, can evaluate a tremendous area and a large number of sites; data so obtained contain one less source of variation than if the data were acquired by several field crews. Furthermore, the data can be extracted from the photographs any time during the year; acquisition of information is not restricted to a field season. Aerial photographs can be acquired at extremely small scales (1:130,000) up to very large scales (1:600); each scale has its advantages and disadvantages and appropriate application. Generally speaking, however, the smallest scale should be used that can be reliably employed, this has the benefit of reducing costs and some sources of variation among photographs.

The information that can be extracted from aerial photographs is highly dependent on the knowledge the interpreter already possesses about the resource area. This is particularly true when working with smaller scales of photography, although the amount of extractable information can be considerable given sufficient training and experience.

Photointerpreters can be more readily trained to use large scale photography. Trees and shrubs can be identified and measurements made of heights and ground cover. Identification of tree and shrub species is very much a function of growth form, size, foliar density, branching pattern, leaf size, and similar characteristics that permit a plant species to be very distinctive in appearance or, conversely, to look very similar to other species. Season of photography is also extremely pertinent to species identification and should be timed to image the species of interest when its contrast with other species is maximized. Very large-scale photography (scale ≃ 1:600) can be used to assess surface stones with one-inch diameters, pedestalling around stones and plants, and the integrity of bunchgrass clumps. Color infrared (CIR) film at all scales is frequently preferred to black and white or natural color because of the contrast that is achieved between photosynthetic plant material and the soil background.

The following are two examples of how remote sensing can be used in Extension programs.

(a) Coordinated resource plans are being encouraged by federal land management agencies in dealing with livestock permittees on public rangeland. The process brings all concerned parties together: U. S. Forest Service, Soil Conservation Service, Bureau of Land Management, and Fish and Wildlife Service; Oregon State Departments of Forestry and Fish and Wildlife, Extension Service, and the private land owner. Together, they work out a coordinated management plan for the use of resources on a given allotment in a manner that best meets the resource objectives of all parties concerned, including those of the producer. Extension agents can use their role to present new information and technology that may be helpful to the process.

For instance, water availability on arid or semiarid ranges has long been a limiting factor to livestock distribution and proper range utilization. Color infrared photographs can be used to detect small moist areas, seeps or springs, and associated vegetation that indicate candidate locations for water development.

Other examples pertinent to range management programs could include uses of satellite pictures to measure the area of range fires and seeded areas and for monitoring flooding as is occurring in the Harney and Warner Lakes Basins.

(b) Another possibility for use of remote sensing techniques in Extension programs is in the area of irrigated crop management. Color infrared 35 mm film is being used by some large farming operations to monitor crop conditions on a weekly basis. Extension agents could use this technique as a great assistance in visually showing producers the effect on crops of:

improper fertilizer placement,
poorly functioning irrigation systems,
insect or plant disease outbreaks,
changes in soils,
drainage problems, etc.

Remote sensing technology provides new tools that Extension educators can use to help managers and producers remain competitive, productive, and successful managers of the vegetation, soil, and water resources.

REFERENCES

Colwell, R. N. (Editor-in-Chief). 1983. Manual of Remote Sensing, Second Edition. American Society of Photogrammetry, Falls Church, Virginia. Vols. I and II, 2440 p.

Johannsen, C. J., and J. L. Sanders (Editors). 1982. Remote Sensing for Resource Management. Soil Conservation Society of America, Ankeny, Iowa. 665 p.

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