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Potential Remote Sensing Applications

Who will use them now and tomorrow?

123171 is a guess

Introduction

In the past five years, a great deal of interest in the potential uses of remote sensing and automatic data processing techniques has been generated. How can remote sensing be used? Does it have applications I can use? These are two familiar questions which can be answered by learning more about LARS and by considering your own information needs.

Potential Tasks

The following are three lists of potential tasks which may be accomplished by the use of remote sensing techniques. The categories are grouped by the apparent degree of difficulty of obtaining information by remote sensing techniques. This is only a partial list. After attending the conference, we hope you will be able to expand this list with additional potential applications.

Category A - The following tasks appear to be feasible with present equipment and techniques:

1. Map bodies of water (lakes, rivers, streams)
2. Produce winter wheat acreage maps
3. Produce green vegetation maps
4. Map roadways
5. Obtain measurements of relative surface temperatures
6. Map bare soil (light colored, dark colored soils)
7. Detect plant stress

Category B - The following tasks are more difficult, but it seems reasonable that they can be accomplished:

1. Map wet soil areas
2. Map and measure acreage of crop species
3. Produce topographic maps
4. Map and measure acreage by forest type
5. Characterize soil permeability
6. Map and measure acreage of crops severely damaged by wind and hail

Category C - The following tasks are difficult but perhaps possible:

1. Measure crop cover density
2. Measure available soil moisture
3. Detect and measure crop disease areas
4. Detect and measure areas of insect infestation
5. Predict crop yields
6. Detect plant nutrient deficiencies
7. Produce weed survey maps
8. Detect and locate certain water pollutants

Applications in Natural Resources

To provide more information about these potential applications, five broad classes of natural resources--land (soils), vegetation, animals, water resources, and climate--will be discussed briefly.

Land (soils)

To date, LARS personnel have developed the capability to map bare soil areas. Depending on the time of year that these data were collected, this measurement could provide information on fallow acreage, amount of fall plowing and the acreage to be planted to a certain crop.

LARS personnel have been able to detect soil moisture differences, but this technique is not highly accurate and must be refined. Such information is useful in natural resource management. The detection of drought conditions, before it is visible to the naked eye, would alert the operator to the need for irrigation. A map of soils under continual conditions of saturation would provide a guide for the drainage engineer and useful data to water resource management personnel.

For resource planning purposes, the mapping of land use patterns would be of infinite benefit. Such a map would provide an inventory of present land uses and with time would follow the change of land use.

Mapping land according to its use capabilities would be another important application somewhat related to land use patterns. Land use capability maps are based on the physical and chemical properties of the soils and such properties can be detected by remote sensors. Such techniques would be

utilized to analyze an area after non-reuseable resources had been removed. For example, this technique would be helpful in reabilitating a strip mine area.

Saline soils can be detected and mapped. The capability to perform this task would prove valuable to the irrigation and drainage engineer involved in developing land to be brought under irrigation. Also, such information would be important to the manager of an area where saline conditions were developing.

Mapping of soils is a primary concern to the soil surveyor, who must delineate differences in soil color, soil texture, topography, moisture holding capacity, and drainage properties of soils. Remote sensing techniques have been successfully used to obtain such information in preliminary studies. This appears to be a great contribution in the field of soil classification and survey.

Vegetation

Vegetative cover maps and knowledge of the exact acreages and distribution of planted crops would be of great benefit to a world that is critically short of food. Such information would serve as an inventory of the total world cropland, giving the total grain supply, amount of pasture available, and a forest inventory. This kind of information has important international implications. The same kind of information on a much smaller scale is basic to regional and national planning for agricultural development and natural resource management. Livestock industry and range management personnel would benefit immeasurably if rather accurate information concerning range conditions would be available periodically. The identification and location of overgrazed, undergrazed, and droughty areas would be very useful to anyone involved in land or range management. This and other data would provide an estimate of available forage on range lands and would aid in the prediction of quality animals for slaughter and their movement to market.

The type of plants in an area such as "increaser" and "decreaser" plants, which indicate the increase or decrease of certain plant species, are important measures of range pasture management needs. Thus, surveys of vegetative cover would produce useful maps to ranchers and range management personnel.

Crop yield predictions are of great utility to those involved in harvesting, marketing, processing, storing, and transporting agricultural products.

Identifying and mapping weed infestations would be valuable information to the producer and to the herbicide industry. The capability of automatically identifying and

mapping weed species would be a valuable tool to the scientist in: (1) weed density studies, (2) studies on the effectiveness of herbicides, (3) following the invasion rate of a particular species into a new area, (4) weed growth and development studies, and (5) studies of the effects of weeds on crops.

The detection and location of disease and insect infestations would be valuable information in alerting the producer to the conditions of his crop and the need for action. Such information would also serve as a guide to help government officials in establishing areas of quarantine to prevent the spread of the disease or insect pest. The capability to detect and map such areas automatically would be an invaluable tool to the researcher in his study of the disease--its spread, its cycle, its control, and the prediction of its increase. Also, industry personnel would be able to plan more effectively by knowing where diseases were occuring and where crop yields would be reduced.

Identifying and mapping of forest species would be valuable information to those who are responsible for forest management, including the harvest of trees and reforestation projects. The mapping of burned over areas and areas of regrowth and monitoring cut over areas are important information to forest management personnel.

Animals

Identification and a count of domesticated animals by species are important to SRS, USDA, industry, and producers in order to estimate market potentials. In order to conserve and preserve many species of wildlife, it is necessary to understand their habits and life cycles. Remote sensing techniques might be used effectively in such studies. Also, if the number of live animals by wildlife species were continually monitored, extinction of a species could be prevented before it occurred. Monitoring the movement of animals would improve our understanding of animal behavior under various conditions; this is important in ecological, behavioral, production and management studies.

If wild and domesticated animals having abnormal body temperatures could be located without excessive handling, this would be invaluable in locating sick animals before the illness reaches an advanced stage. Thus medication would be administered earlier then normally would be possible. Such detection devices would be useful in monitoring females for estrus especially as more artificial insemination is utilized by livestock producers.

Water Resources

Areas covered by water could be mapped to obtain such

information as soil drainage properties and flood conditions. Downstream flooding could then be predicted faster and more accurately.

Rainfall maps made immediately following rainstorms would provide a synoptic view of the geographical area receiving precipitation. Maps of snow cover are of real interest to the watershed engineer as an estimate of the snow cover, depth of snow, and water yield estimates.

Certain species of plants are often indicators of what is occurring or happening to a lake. For example, a large amount of phosphorus emptied into a lake causes a rapid growth of certain plants, and this is often referred to as the lake "blooming." Detection and mapping of such conditions would help to point out problems and serve as a guide in effective control programs.

To date, remote sensing techniques have been able to identify seven different groups or classes of water in the White River. Perhaps with refinement of such techniques, it will be possible to provide a synoptic picture required to isolate pollution sources in minor currents in a watershed. Estuaries with tidal action which cause downstream pollutants to be forced back upstream could perhaps be located and studied.

In water management, it is necessary to have a more thorough understanding of water loss by runoff and by evapotranspiration. A future application may be to utilize remote sensing to carry out a task which measures or monitors water movement.

It may be possible to use remote sensing to study the flow patterns and currents in the Great Lakes and other large bodies of water. This would be very useful in following and studying the streams of thermal pollution dumped in the lakes by nuclear power plants. Many questions are yet unanswered about this type of pollution and how it is dispersed.

Climate

Rainfall data collection and a measure of cloud cover are important in agricultural and forestry production. Amount of rainfall, intensity of rain, and geographical area covered are important in crop damage and production estimates.

Cloud cover has a direct affect on the amount of heat units received by a growing crop. This kind of information is important in making crop yield predictions for agricultural and horticultural crops and in production management decisions.

Both ambient and soil temperatures are important in crop production. Soil temperature information determines the optimum time of planting many crops and are also useful in estimating moisture losses.

Remote sensing techniques could provide a useful service by measuring and mapping crop areas damaged by hail and wind. Such information would be invaluable to the insurance industry.

Specific Users of Remote Sensing

Only a few of the potential and initial applications being made of remote sensing technology have been written herein. A complete list of potential beneficiaries from the application of these techniques is too vast to publish, but there are several which rapidly come to mind.

In many nations, automatic crop and soil surveys made with remote sensing techniques would be useful tools.

Agricultural Producer

The agricultural producer uses a great quantity of information in arriving at resource management decisions as does anyone involved in using and managing natural resources. If information from automatic crop surveys were available in near real time, there would be many benefits which could be derived from this service. Early detection and warning of crops or forests under stress caused by drought, insects, weeds, and diseases would become an invaluable aid in resource management. Early information about world crop conditions would have an important bearing on planned cropping and harvesting patterns. Characterization of forage cover on rangelands by remote sensing would bring a new dimension into range management methods.

Water Resource Management Personnel

Water resource management personnel would be interested in automatic survey maps showing soil moisture levels, ponded areas in fields and water levels in rivers and lakes.

Natural Resource Management Personnel

The detection of pollutants in natural resources and the automatic monitoring of our land, water and air would be invaluable in resource protection and management.

Government Agencies

Any new system which can add efficiency and economy to an important function of a government agency should be seriously considered. The Soil Conservation Service, the Economic Research Service, and the Statistical Reporting

Service are three agencies which collect, analyze, and classify large quantities of agricultural information. Automatic agricultural surveys offer these agencies the possibility of more timely and potentially more accurate survey information.

Chemical, Industry, and Transportation Personnel

The stockpiling and movement of agricultural chemicals to key distribution points at the appropriate time means success or failure to industry. Automatic surveys of crop conditions could alert industry to the specific needs for agricultural chemicals in a region. Early reporting of regional crop conditions and yield estimates could help to assure adequate harvesting, storage, and transportation facilities at the time and place of greatest need.

Development Agencies

International agricultural development agencies are private organizations and foundations as well as government agencies. They are involved in international agricultural and natural resource development programs. Some of these operate only in a very limited area. Others have rather sizeable operations and are involved in resource development planning at regional and national levels. The latter group could benefit greatly from automatic surveys of the soils and vegetation of a region. Basic to any development scheme in a country is an inventory of renewable and unrenewable resources. Remote sensing and automatic data processing may save much time and energy in characterizing the natural resources of an area hitherto unexplored or undeveloped.

Research Scientists

The research scientist whether he be an agricultural economist, an economic geographer, a soil scientist, a land use planner, a geologist or a hydrologist would use and needs remote sensing and automatic data processing methods to collect certain types of natural resource information for research purposes. With time, these techniques could be adapted readily to follow the changing land use patterns. Information such as changing cropping patterns, marketing trends, land use patterns, dates of various farming operations, water level, pollutant source would be made available.

Summary

Only those immediately involved in an occupation know its information needs. Hopefully, as more individuals become familiar with LARS's remote sensing technology, the horizon of applications can be expanded and developed.