IN-43
CR 67850
~~142~~
9P

FINAL REPORT TO NASA GRANT #NAG 5-548

Principal Investigator

Daniel B. Botkin

Programmer Analyst

Tad E. Reynales

May 1, 1987

(NASA-CR-180512) [EARTH SCIENCE RESEARCH] Final Report (California Univ.) 9 p Avail: NTIS HC A02/MF A01 CSCL 05B

N87-24733

Unclas

G3/43 0067850

This progress report consists of two parts: I EXECUTIVE SUMMARY; II: manuscripts that provide details of our progress.

SECTION I: EXECUTIVE SUMMARY

During the current grant period, the work was driven by the NASA decision to phase-out this research, and therefore our primary goals were to (1) complete as much of the work which had been begun as possible; (2) complete manuscripts for publication; (3) transfer or archive data which were considered important and/or useful for future research. It was necessary for our small group at UCSB to pick up many tasks formerly done by NASA personnel, and to take over coordination and archiving much of the data.

Work accomplished during this period included:

1) completion of the analysis of ground-truth data from the boreal forest plots in the Superior National Forest. These data were collected during two field seasons and represented the most thorough and detailed study of its kind for ground verification of remote sensing. This work included:

(a) completion of development of statistical methods for dimension analysis, i.e. for developing equations to estimate the biomass of trees from measurements of diameter and height. This required the development of new statistical algorithms and extensive statistical analysis as presented in the attached manuscript by Fieveson.

(b) Application of the dimension -analysis equations to the data obtained from ground-truth plots, to estimate biomass for these the application of this software to the data set. These results are described in the attached manuscript by Woods, Botkin, and Feiveson; (c) in cooperation with F. Hall and his staff at Goddard Space Flight Center, classification and analyses of remote sensing images of the Superior National Forest were done as a test of new techniquesto determine forest biomass and ecological state by remote sensing. In this work we have achieved new methods to classify vegetation in regard to ecological successional status as well as taxonomic status. From this classification, it has been possible to determine the change in vegetation over a decade, as discussed in the attached manuscript by Hall et al. These represent a new use of remote sensing imagery.

During this grant period, the following efforts were made to archive data, or transfer data to UCSB so that they could be used in subsequent research:

1) Field data from the 1983 and 1984 field seasons in the Superior National Forest, Minnesota, were archived on computer diskettes. This information included both dimension analysis data (bark area, branch, needle or leaf, and bole data) and plot data (canopy and understory composition) for 1Ø5 plots characterized as "aspen", "spruce", "mixed species", or "jack pine".

2) Landsat MSS imagery for the study region, rectified and classified at Goddard Space Flight Center, was archived on diskette and computer tape.

3) C13Ø "maze" overflights with the Thematic Mapper Simulator were rectified and mosaicked. They are archived on diskette and tape.

Concerning the 1st and 2nd goals, three manuscripts are attached as primary material for this report. These are:

"New Dimension Analyses with Error Analysis for Quaking Aspen and Black Spruce" K.D. Woods, D. B. Botkin, and A.H. Feiveson.

"Error Analysis of Leaf Area Estimates made from Allometric Regression Models" A.H. Feiveson and R.S. Chhikara.

"Ten Year Change in Forest Succession and Composition Measured by Remote Sensing." Forrest G. Hall, Daniel B. Botkin, Donald G. Strebel, Kerry D. Woods, and Scott J. Goetz.

A fourth manuscript concerns the extensibility of the methods and data developed in Minnesota to other forest regions. ("Statistically Defined Biomass Estimation for a Major Vegetation Region", D. B. Botkin, K.D. Woods, J.L. Star, and J.E. Estes) We have revised this manuscript to reflect a more accurate representation of previous estimates of the maximum and minimum extent of the boreal forest in Canada, which in turn affects total biomass estimates. Estimates of the maximum and minimum extents were obtained by comparing three independent maps of the vegetation of Canada -- one from Rowe (1972)[1], one from the National Atlas of Canada (1974)[2] and one from the Russian National Atlas (1964)[3]. Using image processing software from ERDAS, Inc.* each map was converted from its original projection to an Albers Equal Area projection; the three maps were then rectified to one another. Overlays were then produced using geographic information system software from ERDAS, Inc.

The maximum and minimum extents of the boreal forest that were estimated above differ by a factor of approximately 2, thus suggesting the need for more accurate mapping. Under a private foundation grant, we will begin a study in Canada this summer that will include both mapping and sampling of the boreal forest.

* Earth Resources Data Analysis System, Inc., Atlanta, GA

A fifth manuscript in preparation ("Linking the JABOWA Forest Growth Model to Remotely-Sensed Data", D. B. Botkin and T.E. Reynales) involves testing a forest growth simulation model (JABOWA) with the 10 year change data described above. For purposes of testing the model, the ecological states classified at GSFC (using a variety of ground truth information and training areas selected on 1:24,000 aerial photographs and TM simulator imagery) were accepted, although they are subject to change as a result of statistical testing for accuracy or evaluation of additional ground truth at GSFC. They are:

1) closed coniferous forest
2) mixed coniferous and broadleaf forest
3) regenerating vegetation
4) open-canopy broadleaf forest
5) closed-canopy broadleaf forest
6) clearings
7) water
8) clouds
9) unknown or background

Using the ERDAS image processing system at UCSB, the two classified images were compared with respect to ecological state changes. The resulting change images showed large areas where logging or fire had created clearings followed by regeneration; they also showed that the rest of the landscape was very patchy and that some unexpected ecological state transitions were frequent.

The JABOWA forest growth model, running on an IBM PC XT/370, was then used to simulate the ten-year change in plots representing the first six of these categories in 1973. A simplified species complement, consisting of aspen, black spruce, and jack pine, was utilized in these simulations to save processing time. The results of the simulation were then assigned to one of the 9 classes, and the proportions of each type of outcome over 20 iterations (20 replicate plots) was determined. These proportions were then compared to those found in the 1983 image.

Although this document is a final report under NASA grant # NAG 5-548, we plan to continue analysis and use of the data under alternative funding sources.

1. Rowe, J.S. Forest Regions of Canada, Canadian Forest Service, Department of Fisheries and the Environment, 1972.

2. National Atlas of Canada, Department of Energy, Mines and Resources, CANADA, 1974.

3. Physical Geographic Atlas of the World, Academy of Sciences U.S.S.R. and Board of Geology and Cartography GGK, U.S.S.R., 1964.

PART II: Detailed Documentation of Progress