SEMI-ANNUAL STATUS REPORT

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NASA-sponsored

Cornell University Remote Sensing Program

December 1, 1978 - May 31, 1979

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June 1979

INTRODUCTION

The primary objective of the NASA-sponsored, Cornell University Remote Sensing Program is to promote the application of aircraft and satellite remote sensing, particularly, in New York State. In accordance with NASA guidelines, this is accomplished through conferences, seminars, instruction, newsletters, news releases, and most directly, through applied research projects. Each project must be, in some way, unique; essentially noncompetitive with commercial firms; and potentially, benefit- or action-producing. Relatively little emphasis is placed on technology transfer, per se.

The activities of the Remote Sensing Program staff, from December 1, 1978 to May 31, 1979, are reviewed in this Semi-Annual Status Report, the fourteenth to be submitted to NASA since the Program's inception in June 1972.

COMMUNICATION AND INSTRUCTION

Contacts and Cooperators

The Program staff spends many hours discussing remote sensing with representatives of various federal, state, regional, county and local agencies, public and private organizations, the academic community, and foreign countries.

During the past six months, members of the Program staff presented remote sensing research or orientation papers at the 45th Annual Meeting of the American Society of Photogrammetry, at a special Conference on Landsat Applications in New York State (30 state, county or university participants), and at a Cornell University review of Programs in Engineering (35 industrial representatives); and Program staff attended the 13th International Symposium on Remote Sensing of Environment in Michigan (Appendices E and F). In conjunction with the Program's Seminar in Remote Sensing, the staff hosted speakers from three private companies, one university, four U.S. government agencies, one Canadian government agency, and one international research agency in Italy (Appendix F). In addition, during the past year, one member of the Program staff presided over the Central New York Region of the American Society of Photogrammetry, which includes some 200 professionals and students. Another member, at the request of and funded by the U.S. Agency for International Development, travelled to Thailand and the Philippines to assess the potentials of remote sensing programs in these countries.

Along with receiving project cooperators from the Taylor Wine Company and the N.Y.S. Agricultural Experiment Station, Program staff provided remote sensing consultations or orientation sessions for visitors from the N.Y.S. Department of Environmental Conservation, the Southern Tier East Regional Planning and Development Board, N.Y., the Environmental Management Council and Soil and Water Conservation District of Cayuga County, N.Y., Land Care, Inc., of Boonville, N.Y., the State University of New York at Buffalo, N.Y., Ulster County Community College, N.Y., and the Soviet Union. Many new and continuing dialogs were also held via the mail and telephone, particularly in the course of developing new remote sensing projects (Appendix D).

Newsletters

By highlighting remote sensing activities at Cornell while reporting other items of interest, the Program's "Cornell Remote Sensing Newsletter" continues to serve as an important link to and beyond the Cornell community (Appendix H). The number of Newsletter recipients has grown steadily to more than 500 individuals or groups in over 40 states and 20 countries (Appendix G).

Seminars

The Program's weekly Seminar in Remote Sensing, a one-credit hour course in the School of Civil and Environmental Engineering, returned after a fall semester hiatus. In bringing experts from government, industry and other institutions to Cornell to discuss a wide range of remote sensing topics, the Seminar attracted audiences of from 50 to 70, with a course registration of 27 graduate and 26 undergraduate students from 13 Cornell divisions (Appendix F).

Courses, Special Studies and Workshops

Cornell's curriculum in Aerial Photographic Studies and Remote Sensing, and the possibilities for research through special topics courses, professional master's design projects and M.S. or Ph.D. theses, have been reviewed in earlier Semi-Annual Status Reports. During the spring semester, 1979, for example, over 100 students were enrolled in formal courses in this area, and ongoing graduate thesis investigations included: a remote sensing analysis of lateritic engineering materials for Thailand (Pichit Jamnongpipatkul, Ph.D. candidate); detection and categorization of inactive surface mines with small scale remotely sensed data (Jan Berger, M.S. candidate); Landsat analysis of flooding in the western plains of Venezuela (Rafael Avila, M.S. candidate); and mineral exploration in the western Adirondacks, N.Y. (Caren Rubin, MEC candidate). Other topics being considered for remote sensing thesis research include arid regions (William Teng, Ph.D. candidate), tropical crops (Elaine Aderhold, M.S. candidate), and coastal environments (William Hafker, M.S. candidate).

Typical of the Program staff's extracurricular instructional activities during the past six months are an invited paper, "Remote Sensing for the User," presented at a Conference on Landsat Applications in New York State; and an overview of the Remote Sensing Program, presented to industrial representatives from some 35 companies (Appendix F).

DATA AND FACILITIES

As described in earlier reports, staff research and instruction have been enhanced through continued acquisition of a wide range of remotely sensed, aircraft and satellite data, and through extension of capabilities for their analysis and interpretation. These data, along with Program facilities and equipment, are made available at no cost to cooperators, students and other interested users.

With assistance from the NASA Office of University Affairs, the Program has received Landsat, Skylab, high altitude and low altitude coverage of sites in the Northeast, and new high altitude aircraft missions were scheduled for the summer, 1979. The U.S. Environmental Protection Agency has also overflown Program-selected sites at no cost to the Program; and imageries have been obtained from the U.S.A.F. Rome Air Development Center, the U.S. Geological Survey, the U.S. Department of Agriculture, the St. Lawrence Seaway Development Corporation, the National Air Photo Library of Canada, the Tri-State Regional Planning Commission, the National Archives, Eastman Kodak Company and several commercial mapping firms.

The Program maintains or has access to a spectroradiometer and selected image analysis equipment (i.e., zoom and non-zoom stereoscopes, density slicer, color-additive viewer, Zoom Transfer Scope, densitometer, stereoplotters, and other photogrammetric and photographic instruments). The Program also maintains a series of computer routines for analyzing multispectral digital data. These routines have received increased usage in Program-sponsored, spinoff and thesis investigations with Landsat and aircraft scanner data.

PROJECTS COMPLETED

During the six-month period, December 1, 1978 to May 31, 1979, the Cornell Remote Sensing Program staff completed three applied research projects:

1. Developing In Situ Flood Estimators with Landsat Imagery.

2. Preliminary Analysis of Vineyard Yield Assessment.

3. Evaluating Landslide and Erosion Susceptibility.

The projects are summarized here, and pertinent material on each is included in an appendix.

1. *Developing In Situ Flood Estimators with Landsat Imagery.*

In a feasibility study conducted cooperatively with the N.Y.S. Board of Hudson River-Black River Regulating District, Landsat imagery was used as the primary source of information on the extent of flooding in the Black River Basin of northern New York State (Appendix A). Landsat images depicting flood conditions during several flood seasons were analyzed to identify flood prone areas and to develop an empirical relationship between areas of flooding and river discharge measurements. Successful refinement of this relationship will allow real-time estimation of the extent of flooding to be made on the basis of in situ discharge measurements. (A follow-up investigation with the Black River Regulating District has been proposed and tentatively accepted for funding by the Office of Water Research and Technology, U.S.D.I.)

2. *Preliminary Analysis of Vineyard Yield Assessment.*

The Program staff is working with the Taylor Wine Company, Inc., and the N.Y.S. Agricultural Experiment Station in examining the extent to which remotely sensed data might provide useful information for assessing vineyard-related problems. The first phase of the investigation, an evaluation of vineyard drainage, was completed and described in the Program's 7th Semi-Annual Status Report (Dec. 1975). The second phase of the investigation, an airphoto assessment of plant vigor, was completed and described in the Program's 9th Semi-Annual Status Report (Dec. 1976). For the current phase of the investigation, the staff examined relationships between vineyard yield and those morphologic and spectral characteristics of the vines that could be measured through aerial photographic and airborne multispectral scanner data (Appendix B).

Although the data and results have certain important limitations, they point to the potential for developing remote sensing as a tool for predicting yield. Follow-up studies are being planned.

3. *Evaluating Landslide and Erosion Susceptibility.*

At the request of the Director of the Planning Board of Albany County, N.Y., the Program staff completed an assessment of active and potential landsliding and erosion in a region of known land stability problems in the county (Appendix C). Derived from multi-date and multi-scale photographs, and soils and geologic reports, the information will be used by the Albany County Planning Board in its review of the many subdivision and development proposals that are received regularly. The information will thus provide critical input to controlling the development of potentially hazardous or erosive areas.

PROJECTS IN PROGRESS

Program-Sponsored

As of June 1, 1979, the Program staff was conducting two projects under the NASA grant: (1) An Assessment of Sand and Gravel Mining, and (2) A Landsat Analysis of Snow Distribution. The objectives, cooperators, users, expected benefits and actions, and status of these projects are described, as follow:

1. An Assessment of Sand and Gravel Mining.

-cooperators/users:	Planning Dept. of Fulton County, N.Y.; Town of Mayfield, N.Y.
-benefits/actions:	Zoning to be based on airphoto interpreted information
-expected completion date:	August 1979

In order to allow for compatible zoning adjacent to the existing sand and gravel mining operations in the Town of Mayfield, N.Y., the Fulton County Planning Department requested the Program to provide information regarding the extent of sand and gravel deposits in the town. Medium and small scale (NASA high altitude aircraft) photography are being used as the primary source of information.

2. A Landsat Analysis of Snow Distribution.

-cooperator/user:	N.Y.S. Office of Parks and Recreation
-benefits/actions:	More reliable data for planning recreational facilities; development of a remote sensing technique for estimating snow occurrence
-expected completion date:	Pilot study--December 1979

At the request of the N.Y.S. Office of Parks and Recreation, the Program staff is examining techniques for estimating the distribution of snow on the basis of Landsat and ground station measurements. This project is a repeated attempt to complete a study begun in 1975, but terminated because of the lack of applicable Landsat and other satellite data.

In general, if an effective methodology can be developed in the pilot study, the Office of Parks and Recreation would implement a statewide project, publishing the results--temporal and spatial distribution of snow--as a state planning document.

Spinoff Projects

During the past six months, the Program staff has been involved in a remote sensing analysis of some 40 chemical waste landfills in the Niagara Falls area of New York. Funded by the N.Y. Department of Health, this work follows the Program-sponsored assessment of Love Canal (13th Semi-Annual Status Report, Dec. 1978), as well as earlier leachate detection studies which were funded jointly by NASA and EPA.

As noted, the Program has also received tentative grant approval for a follow-up investigation of flood modeling with Landsat. This 12-month study would begin in October 1979 and be funded by the Office of Water Research and Technology, U.S.D.I.

FUTURE PROJECTS

The Program staff is continually soliciting and receiving proposals for new remote sensing, applied research projects (Appendix D). As described, criteria for project acceptance are that the project must be, in some way, unique; that project acceptance would not compete unduly with private companies or consultants; and that, if completed successfully, the project would produce tangible benefits or actions by defined users.

Among topics that are under current consideration are:

1. With the *St. Lawrence-Eastern Ontario Commission, N.Y.*--defining river currents as inputs to oil spill response modeling (Appendix D).

2. With the *St. Lawrence-Eastern Ontario Commission, N.Y.*--determine near-shore river/lake bottom types (Appendix D).

3. With the *New York State Office of Parks and Recreation*--develop approaches for identifying and characterizing beaches for a coastal zone management program.

Depending on user interest, personnel and available funds, any of these as well as other projects may be undertaken.

PROGRAM STAFF

The Program staff includes Prof. Ta Liang, principal investigator, Prof. Arthur J. McNair and Dr. Warren R. Philipson, co-investigators, Mr. Thomas L. Erb, research specialist, Mr. Jan P. Berger, graduate research assistant, Mr. John G. Hagedorn, computer data analyst, and Ms. Pat Webster, secretary. Prof. Donald J. Belcher and Dr. Ernest E. Hardy are general consultants to the Program, and for specific projects, assistance has been provided by many Cornell and non-Cornell personnel. Students who have contributed significantly to the Program staff effort over the past six months include William R. Hafker, Jay N. McLeester and William L. Teng.

LIST OF APPENDICES

APPENDIX A

DEVELOPING IN SITU FLOOD ESTIMATORS USING MULTI-DATE LANDSAT IMAGERY

STATE OF NEW YORK

BOARD OF HUDSON RIVER-BLACK RIVER REGULATING DISTRICT

BLACK RIVER AREA OFFICE
491 EASTERN BOULEVARD
WATERTOWN, NEW YORK 13601
PHONE 788-5440 A.C. 315

March 21, 1979

Dr. Warren R. Philipson
Office of Water Research and Technology
Department of the Interior
Cornell University
Ithaca, New York 14853

Dear Dr. Philipson:

We are in receipt of your research proposal for the development of a relationship between Black River discharge measurements and the extent of river basin flooding. The discharge measurements are as recorded at the U.S.G.S. station maintained in Watertown, New York (58 year period of record). The flooding occurs at an annual or more frequent interval period in the 40± square mile basin - Carthage to Lyons Falls area.

The preliminary study using Landsat satellite data covering 9 and 18 day interval scenes together with discharge measurements taken for specific high water periods provided a cost analysis basis for damage estimates. However, if your research project is funded for another year, weather cooperating, a more reliable model should be developed.

The District, as a cooperator, and a direct beneficiary of the demonstration feasibility study, would use this refined empirical model in its flood assessment at various river stages. Comparable results should be applicable to other similar river basins, not upon the same basis, but derived by like methodology.

We appreciate your fine cooperation in this matter. The staff of the District has followed with interest the evolution of experimental operation of Landsat Satellite applications in relation to snow cover monitoring and run-off forecasting. However, your project appears to have a more practical approach to a current problem in this drainage area.

We shall be happy to continue to furnish stream gauge information with related crest flood elevation data at any specific time frame you request.

Thank you for your cooperation.

Sincerely,

K. H. Mayhew

K. H. Mayhew
Chief Engineer

KHM:FTM

DEVELOPING IN SITU FLOOD ESTIMATORS USING MULTI-DATE LANDSAT IMAGERY

J.N. McLeester and W.R. Philipson

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Paper presented at the 45th Annual Meeting
of the American Society of Photogrammetry
19-23 March 1979, Washington, D.C.

DEVELOPING IN SITU FLOOD ESTIMATORS USING MULTI-DATE LANDSAT IMAGERY

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Remote Sensing Program
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BIOGRAPHICAL SKETCHES

Jay N. McLeester is a senior in Civil and Environmental Engineering at Cornell. A research assistant with the Remote Sensing Program, he won the American Society of Photogrammetry/Bausch & Lomb Photogrammetric Award for the best paper by a college student, 1977, and was awarded the Legislative Council for Photogrammetry scholarship for 1978.

Warren R. Philipson received his B.C.E., M.S. in Civil Engineering, and Ph.D. in Soil Science (Agronomy) from Cornell. Since 1965, he has taught, conducted research and participated in remote sensing projects in various parts of the world. A senior research associate in Civil and Environmental Engineering, he co-directs the Remote Sensing Program.

ABSTRACT

Landsat satellite imagery is being used as the primary source of information on flooding in the Black River Basin of northern New York State. Landsat images (Band 7) depicting flood conditions during several flood seasons since 1973 were obtained for analysis. Visual interpretation of these images is providing the basis for quantitatively relating in situ measurements of river discharge with the total area and geographic locations of inundation. This, in turn, will provide real-time estimation of flood losses over the entire river basin. This practical and inexpensive approach can provide sufficiently reliable information, and is applicable in other similar river basins.

INTRODUCTION

Approximately 65 kilometers of the Black River in northern New York State floods annually, inundating farm land and breaching local roadways. Ground surveys of the actual areas flooded are incomplete and thus inadequate for estimating agricultural and other losses. Previous studies have demonstrated that Landsat satellite data can be used effectively for delineating areas of river flooding (e.g., Deutsch and Ruggles, 1974; Rhode et al., 1976; Sollers et al., 1978). This study was undertaken to determine whether a correlation could be established between in situ measurements of river discharge and Landsat-derived measurements of river flooding. Such a relationship would allow the total area and specific locations of river flooding to be estimated in real time. These estimates would be of significant value for assessing damage and planning flood control.

METHODS AND MATERIALS

Study Area

The study area involves a highly flood-prone reach of the Black River in Lewis County, New York (Figs. 1 and 2). It extends approximately 65 kilometers from Lyon Falls to Carthage, being depicted on six 1:24,000 scale, U.S. Geological Survey topographic maps (Brantingham, 1966; Glenfield, 1966; Lowville, 1966; W. Lowville, 1943; Carthage, 1943; and Croghan, 1966). This area is known locally as "Black River Flats," as the net change in river elevation for the entire reach amounts to only three meters. The local vegetation is absent or without foliage through most of the spring flood season, allowing generally unobstructed overhead monitoring of flood waters.

Scene Selection

A computer listing of available Landsat imagery of the study area was obtained from the U.S. Geological Survey, EROS Data Center. In addition, data on river discharge and flooding since the launch of Landsat-1, in July 1972, were acquired from the New York State Board of Hudson River-Black River Regulating District (Table 1). Nine Landsat scenes (i.e., nine dates) were selected for analysis on the basis of favorable cloud cover conditions and the immediate history of river discharge for those dates of coverage.

Positive, 70mm, 1:3,369,000 scale transparencies of band 7 (near-infrared, 0.8 to 1.1 micrometers) multispectral scanner images were obtained of the scenes judged to be most useful. Band 7 images were chosen because of the relatively high spectral contrast between water and most surroundings in the near-infrared region.

Image Analysis and Information Extraction

The 70mm images were enlarged photographically and 3x4 inch projection plates were created. A lantern projector and rear-view projection screen were then used to obtain a final enlargement to 1:84,000, approximately 40 times the scale of the original image. The projected images of flood conditions were traced directly onto matte acetate, with a non-flood scene used to delineate the river channel. Flood boundary determination was based upon visually detectable changes in image densities between flood and non-flood scenes. Areas, such as swamps, which have continually low infrared reflectance would not be classified as flooded or flood stressed unless the area was encompassed by a more prominent flood boundary.

A general knowledge of flood susceptibility was obtained from the acetate sheets by overlaying various combinations of dates. For area measurement, however, flood boundaries were enlarged to 1:24,000 scale, U.S. Geological Survey map overlays, using a Zoom Transfer Scope. The area of flooding depicted on each overlay was measured with a polar planimeter, and the total area of inundation was tablulated for each date.

A "best estimate" curve was developed to relate the area of flooding in the most critical portion of the river basin (Lowville Quadrangle) to discharge measurements recorded at a single river gage station, some 30 kilometers downstream (Watertown). The construction of the curve is reviewed in Figure 3.

In general, the discharge measurements were adjusted to allow for: (1) the one-day delay between flooding in the area of interest and the time the corresponding discharge reaches the gage station, and (2) the effects of a reservoir ("Stillwater") which is used to reduce downstream discharges during flood periods. Further, because Landsat scenes obtained after peak discharges may show areas of standing water which are not directly related to the discharge reported for that scene date, all areas of standing water which were not connected directly to the river were subtracted from the total area of flooding for that scene. (The occurrence of standing water which might be present after a higher flood stage has passed can be reduced by applying images acquired during periods of increasing river discharge, i.e., rising waters, but such coverage was not available.)

These data were used to construct an envelope in the manner described in Figure 3, where the envelope is defined by the limiting points b and c. The best estimate curve was then located within the envelope by assuming the following: (1) if the time delay between the observed discharge and the previous peak discharge were one to seven days, the best estimate would be a point on line b-c less than 20% of the distance from c; (2) if the delay were 8 to 15 days, the best estimate would be 20% to 50% of the distance; and (3) if the delay exceeded 15 days, the best estimate would be closer to b than to c. These assumptions were based upon previous reports of the approximate number of days that flood effects remain detectable on infrared imagery (e.g., Sollers et al., 1978), and the rate of decrease in river discharge from the previous peak to the time of observation. A smooth curve was fitted to the nine points.

To test one method for using river discharge measurements to estimate flooding at any location, the specific locations of inundation were determined for each date from the 1:24,000 scale map overlays, using a 0.5-by-0.5 kilometer grid system referenced to UTM coordinates. For each 0.5-by-0.5 kilometer grid cell, the percentage of inundation was estimated using a 5-by-5 data take-off subgrid. These values were tabulated and adjusted to levels of discharge using the best estimate curve, in order that flooding in any cell could be related to river discharge measurements.

RESULTS AND DISCUSSION

The location of the Black River in New York State is shown in Figure 1, and flood conditions interpreted from selected Landsat images (Table 1) are shown, for a portion of the river, in Figure 2. Some improvement in the determination of flood boundaries might accompany the use of color composites, other color or photographic enhancement technique, or digital data, and this possibility will be explored.

As described, the Landsat interpreted flood boundaries for nine dates (scenes) were enlarged to 1:24,000 scale U.S. Geological Survey topographic map overlays, where the river channels were found to agree generally within 100 meters. The total areas of inundation, measured from the 1:24,000 scale map overlays and subsequently adjusted, are listed in Table 1. No adequate ground surveys of flooded areas were conducted during the period of obtained coverage, but when compared to a survey conducted in 1970 (Waller and Ayer, 1975), the total areas of inundation were found to agree within 10%. In general, areas of inundation corresponding to higher discharges were found to be in closer agreement than those corresponding to lower discharges.

The best estimate curve relating river discharge (at Watertown) to the area of flooding in the most critical portion of the river basin (Lowville Quadrangle) is illustrated in Figure 4. Although subject to error, the curve is within an envelope which allows a range of areas for a single value of discharge. As described, this lack of specificity is caused by the inability to eliminate all possible effects of higher flood levels from images obtained after peak discharges. Refinement of the curve will accompany additional data; especially if two or three images are recorded just prior to peak discharges, when measured areas of inundation can be more directly related to specific discharge values.

One portion of the Lowville Quadrangle, which was gridded into 0.5-by-0.5 kilometer cells, is shown in Figure 5. The estimated percentages of inundation in each cell, corresponding to a range of river discharges, are reported in Table 2. These estimates will also improve as the best estimate curve is refined.

In conclusion, it is felt that Landsat data can provide valuable information on flooding in the Black River Basin of New York as well as in other similar river basins. Visual methods for extracting flood boundary information are practical and inexpensive. They appear to be sufficiently reliable for developing empirical models which use river discharge measurements to estimate the extent of river flooding on a real-time basis.

ACKNOWLEDGMENTS

This study is being conducted with the support of NASA Grant NGL 33-010-171, and with the cooperation of Kenneth H. Mayhew, Chief Engineer of the New York State Board of Hudson River-Black River Regulating District. The authors would also like to thank Ta Liang, Professor In Charge of the Cornell Remote Sensing Program, for reviewing this manuscript.

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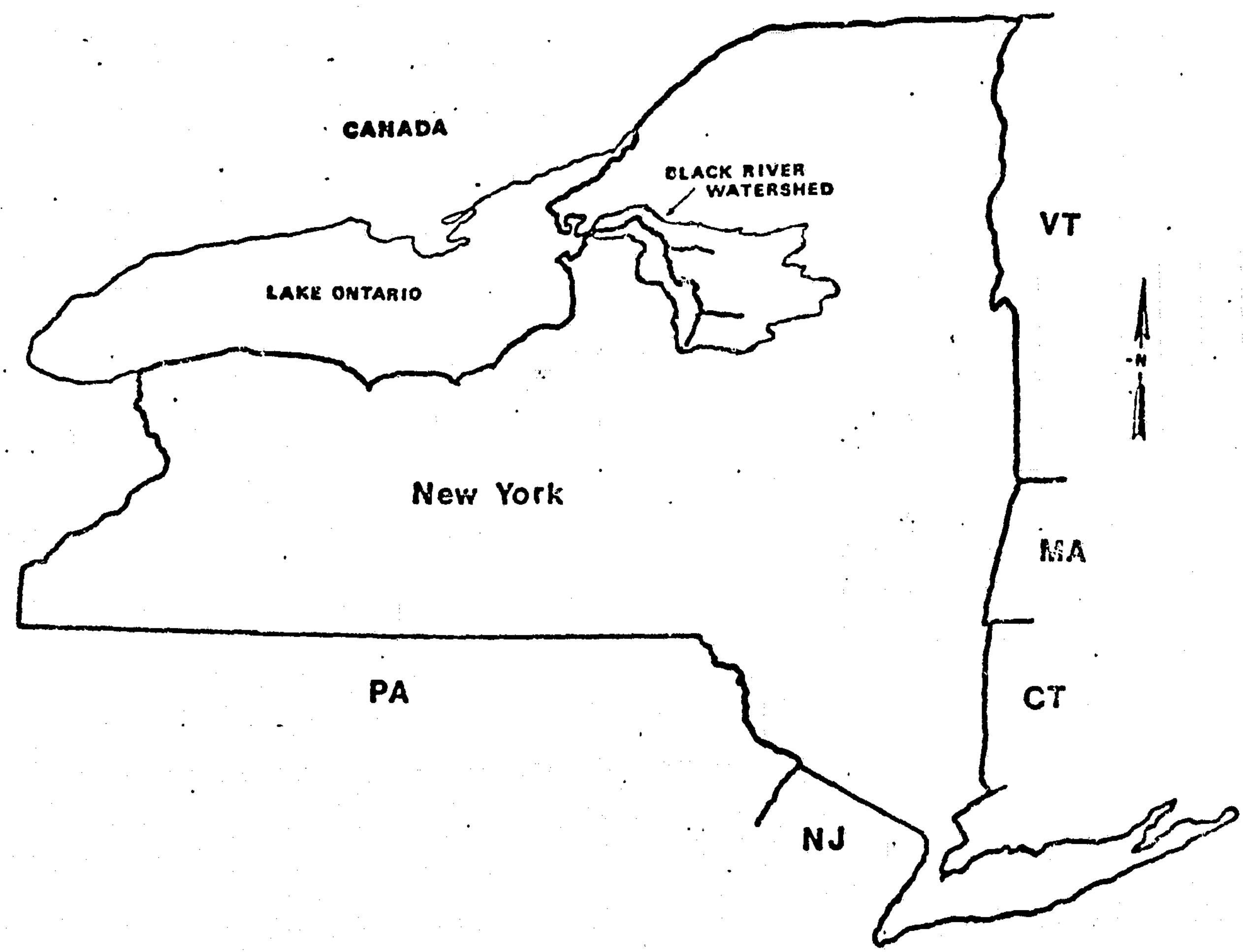


Figure 1a. Location of Black River watershed in New York State.

BLACK RIVER WATERSHED

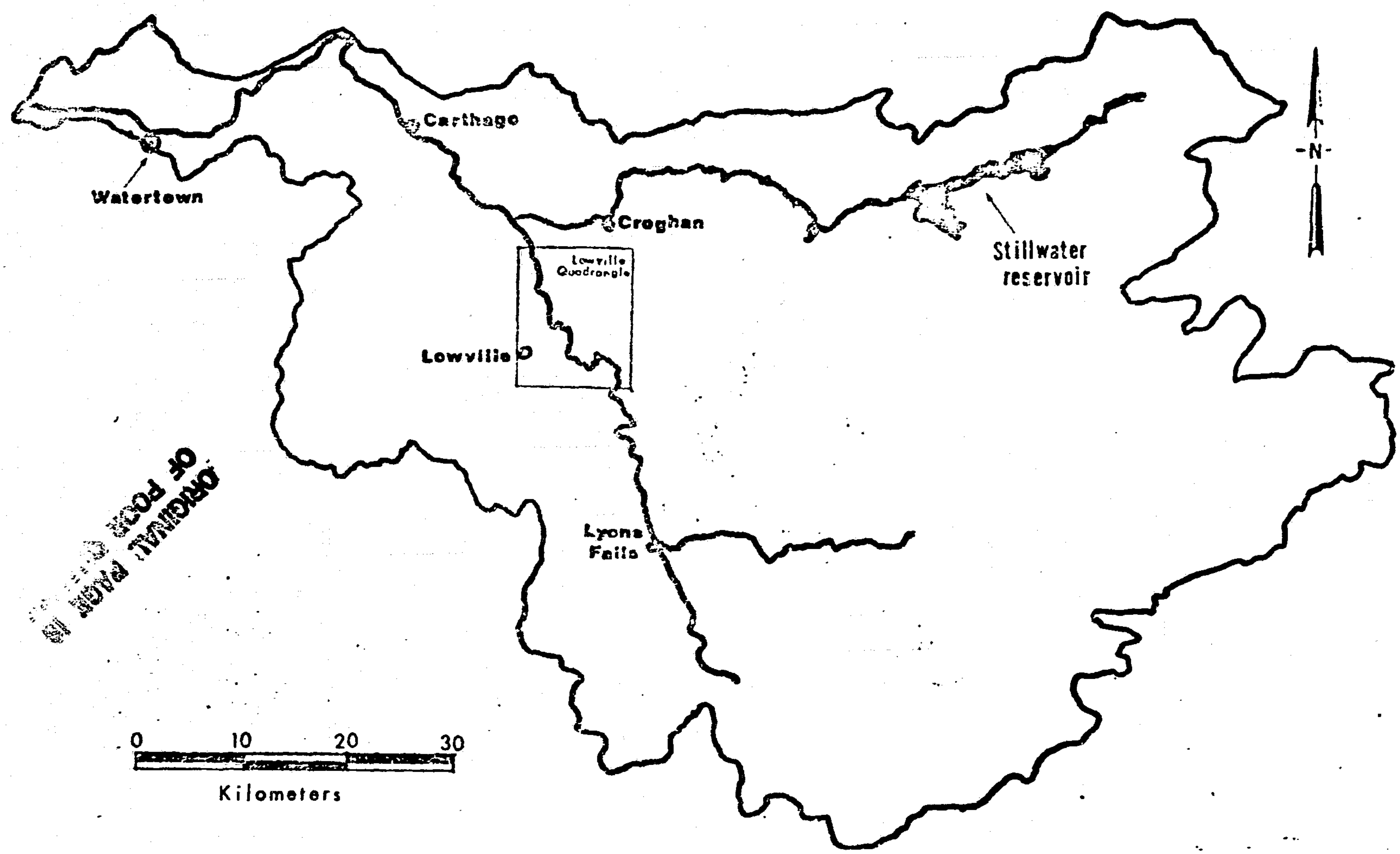


Figure 1b. Black River watershed and location of Lowville Quadrangle.

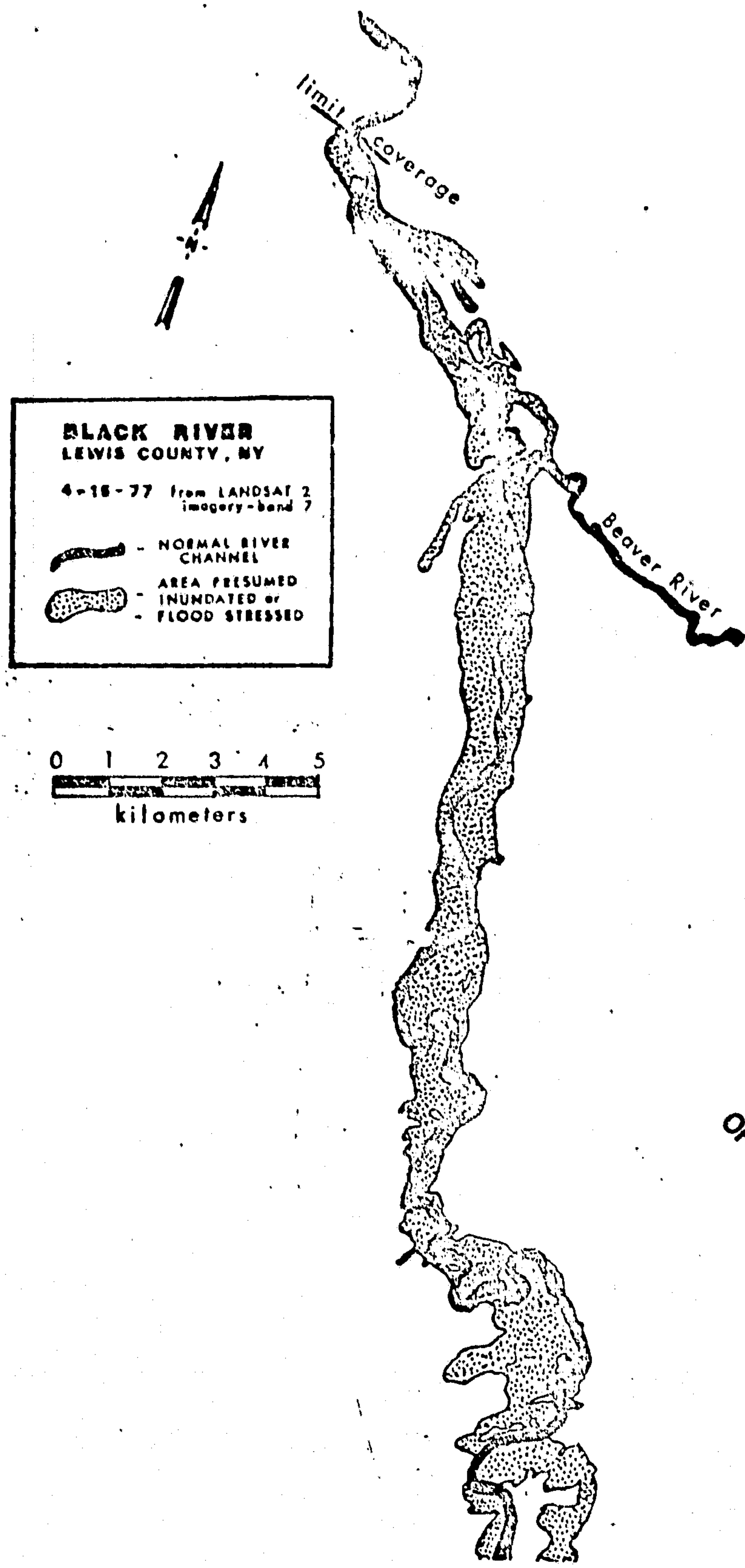


Figure 2a. Landsat-interpreted flooding of a portion of the Black River, N.Y., on April 15, 1977.

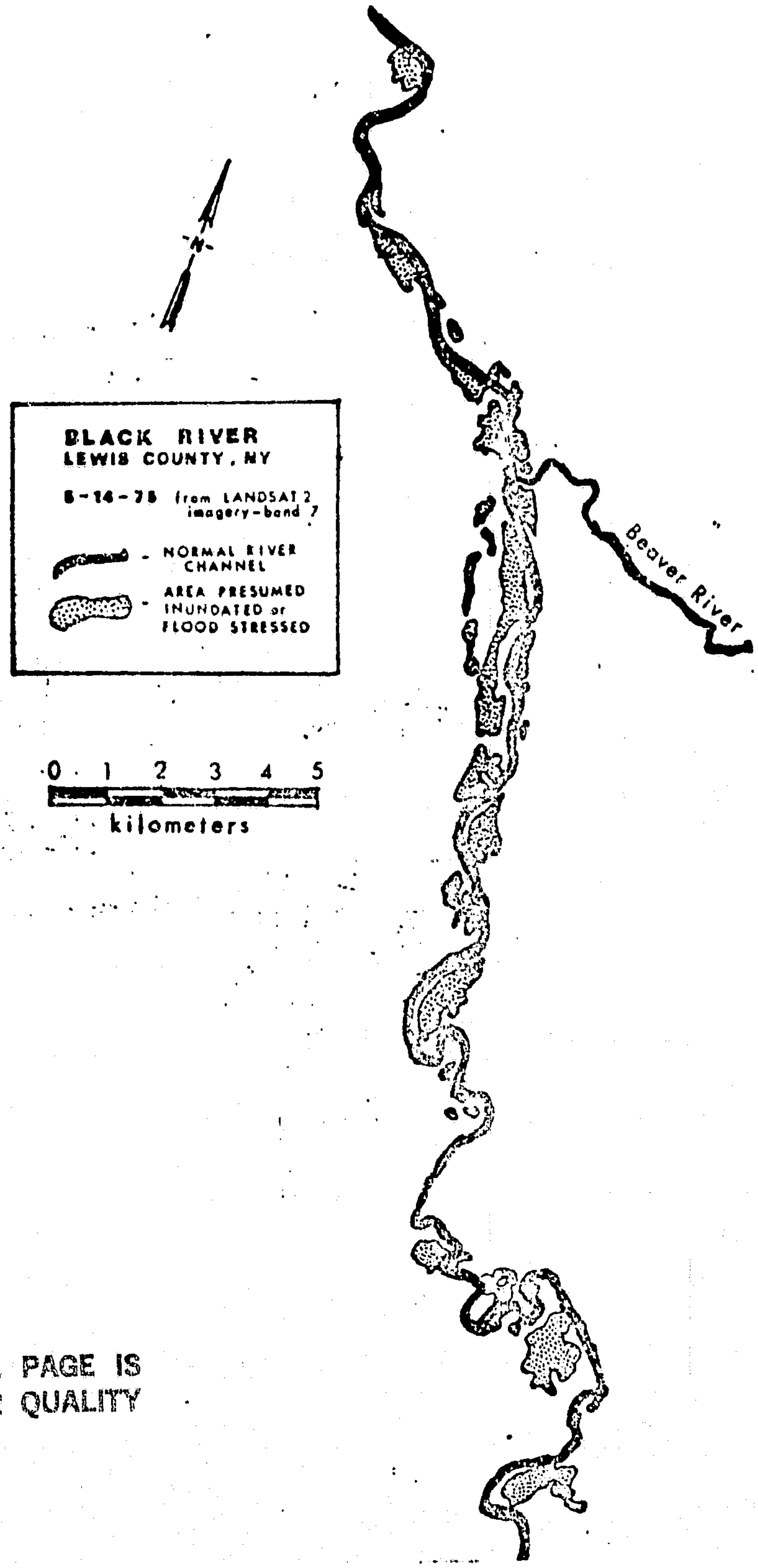


Figure 2b. Landsat-interpreted flooding on May 14, 1975, showing several areas of isolated standing water.

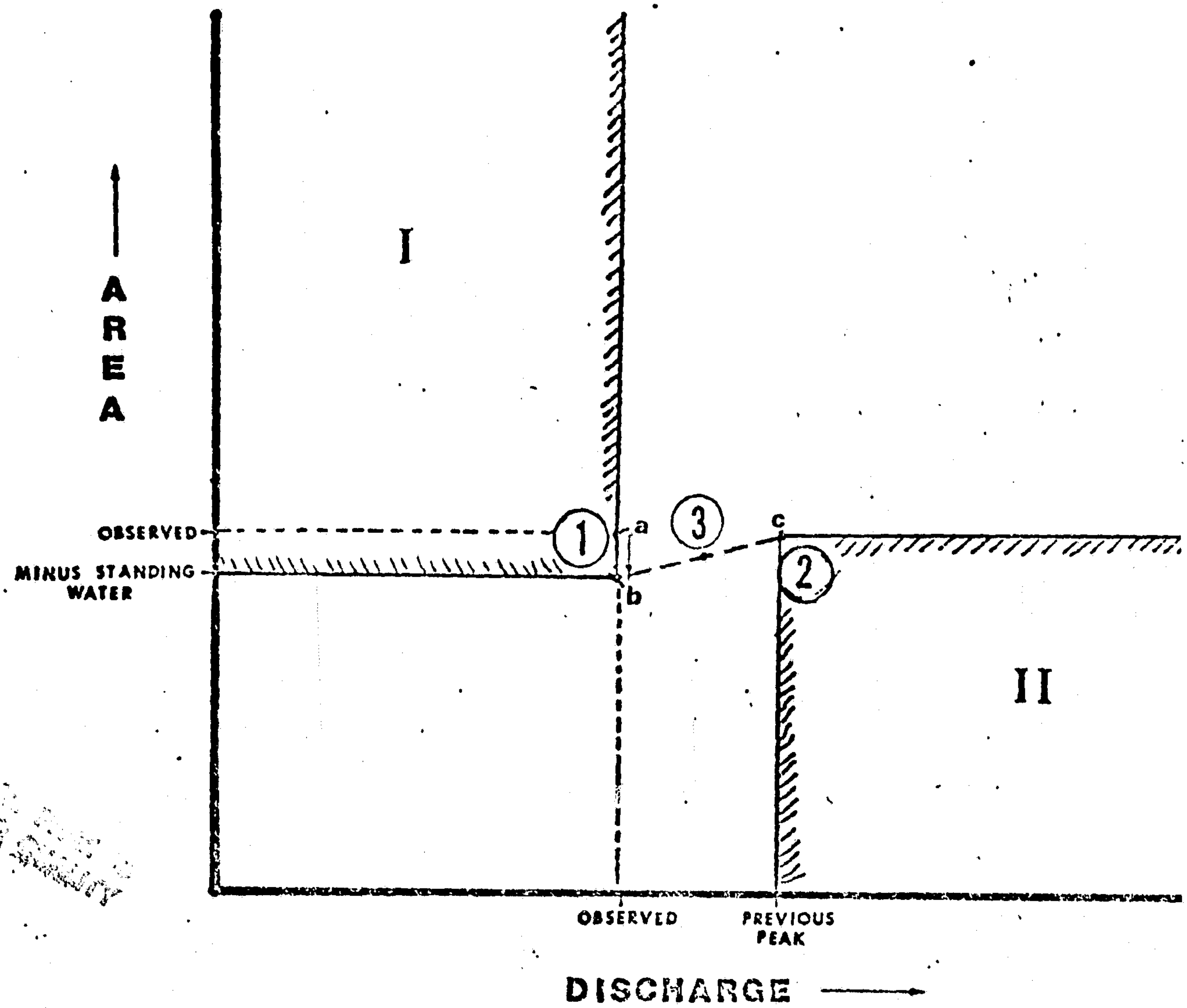


Figure 3. Development of curve for relating area of inundation to river discharge in Black River Basin, N.Y.

1. The area interpreted as inundated from a Landsat scene is plotted versus the discharge (adjusted for delay) for that date (Point a). As needed, the area is adjusted downwards by subtracting any isolated areas of standing water (Point b). The adjusted area is the maximum possible area of inundation that can be produced by the observed or a lesser discharge. This generally eliminates region I from consideration.

2. The total unadjusted area interpreted as inundated is the smallest area of inundation that could have been produced by the previous peak discharge or any higher discharge (Point c). This generally eliminates region II from consideration.

3. The best estimate point is located along the line from "b" to "c," allowing for (1) the time delay between the observed discharge and the previous peak discharge, and (2) the rate of decrease in river discharge.

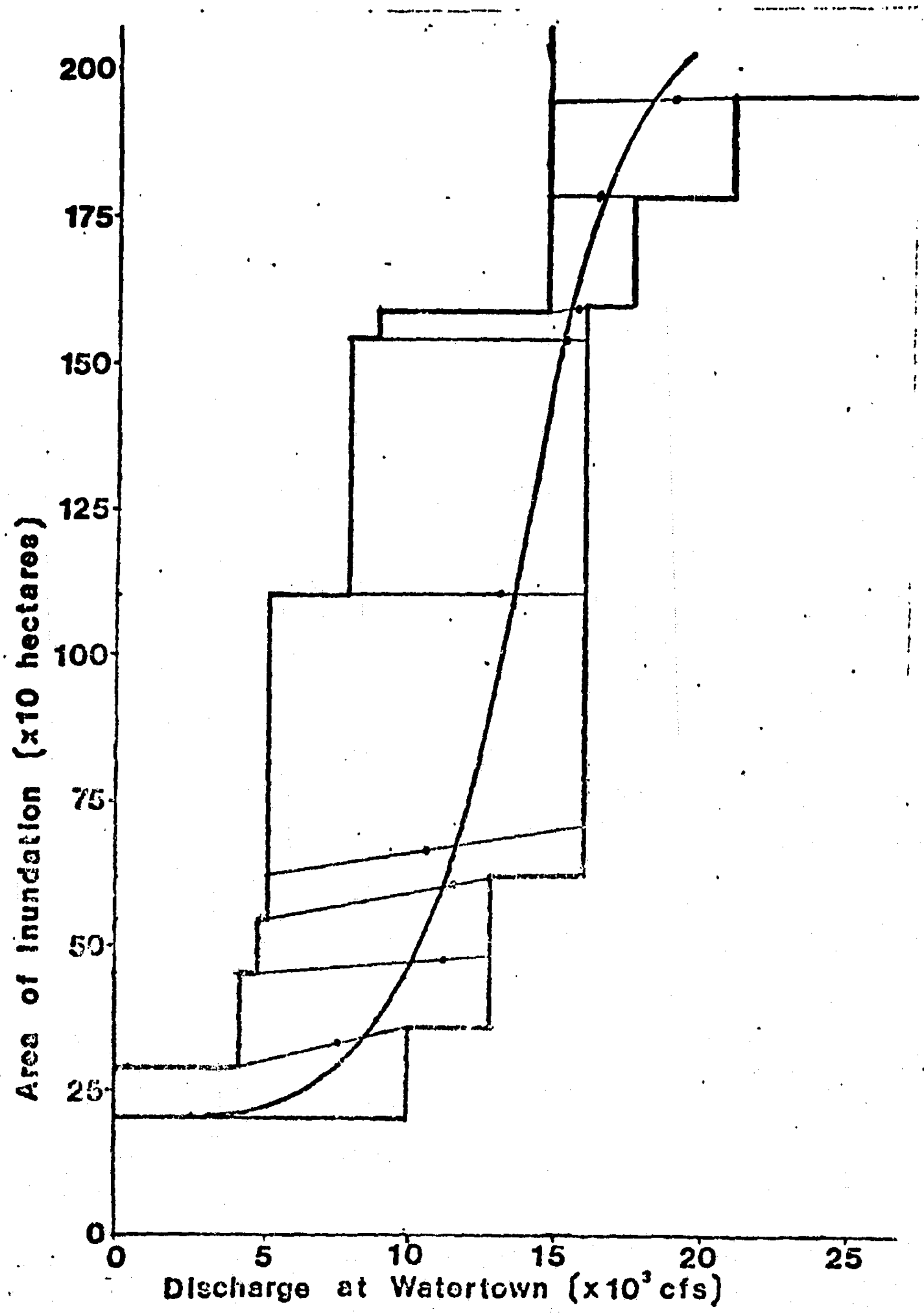


Figure 4. Area of inundation versus river discharge for the Lowville Quadrangle, New York.

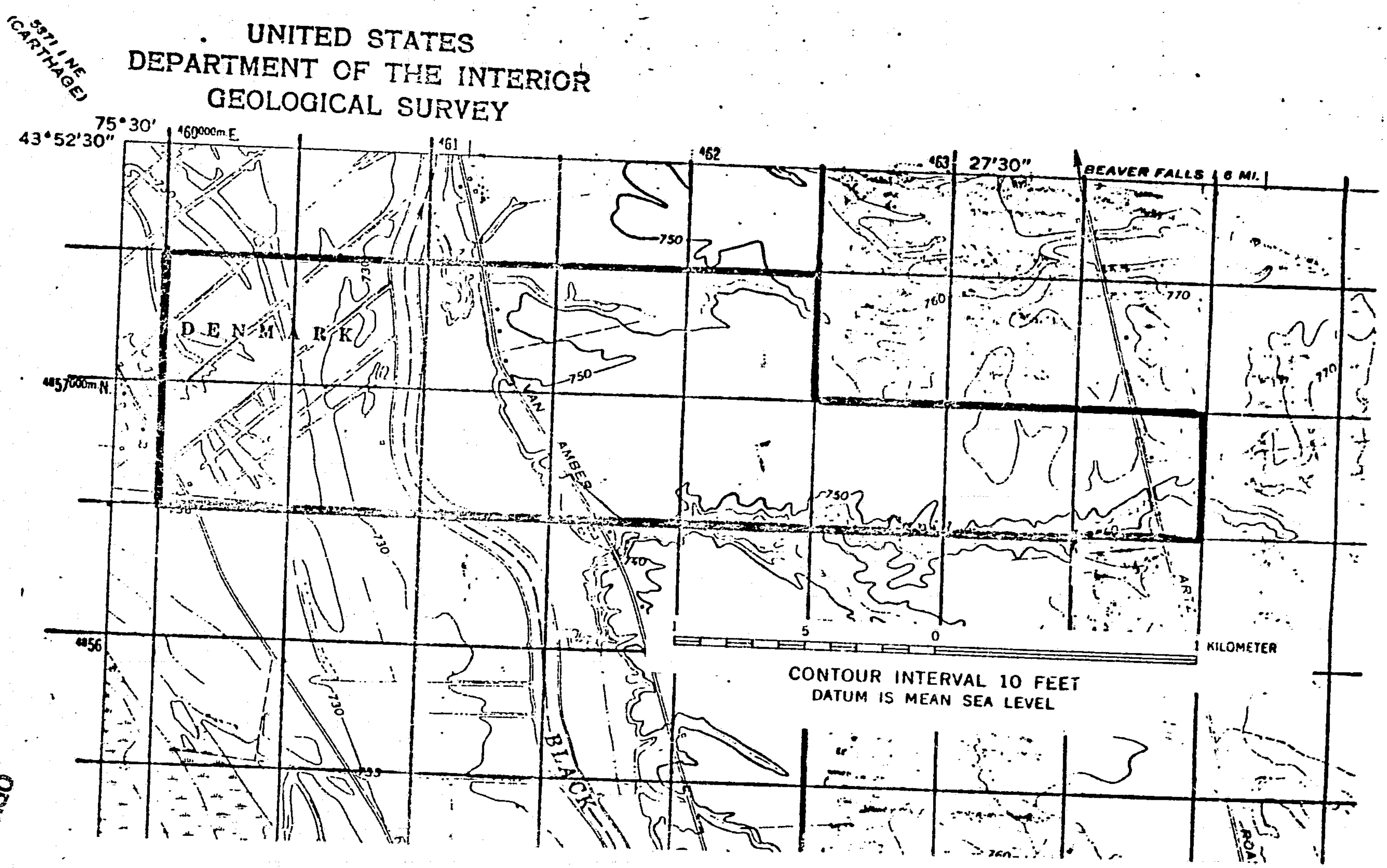


Figure 5. Portion of gridded Lowville Map (original 1:24,000 scale) with cells corresponding to those in Table 2 within outlined area.

Table 1. Discharge data and Landsat-interpreted inundation for selected dates, in Black River Basin, N.Y.

Date	Net Discharge 1/ Watertown (cfs)	Previous Peak 2/ Discharge (cfs)	Time Delay Between Peak Discharge 3/ and Image Date (days)	Inundation (hectares)
11-16-72	5,145	12,831	5	414*
4-9-73	8,842	16,037	5	2568*
6-2-73	4,131	9,940	10	181
5-14-75	4,711	17,760	23	1032
3-24-76	14,510	15,860	1	2311
4-29-76	7,810	24,260	27	1748
4-15-77	13,971	20,900	14	3541*
5-3-77	4,800	17,630	8	660
4-28-78	11,829	17,592	14	3120

1. "Net Discharge Watertown" = [Discharge at Watertown (day after image date)] - [Discharge at Croghan (on image date)]

2. "Previous Peak Discharge" = [Peak discharge at Watertown] - [Discharge at Croghan (on day before peak at Watertown)]

3. "Time Delay Between Peak Discharge and Image Date" = [Image date + 1 day] - [Peak discharge date]

* Observed inundation only, cloud cover obscured portions of study area.

Table 2. Estimated percentages of inundation at grids located in portion of Lowville Quadrangle for given discharges of the Black River at Watertown.

	Net Discharge at Watertown (cfs x 10^2)								
Cell number*	25	50	75	100	125	150	175	200	225
48570-4600	0	0	0	18	53	88	100	100	100
48570-4605	0	5	24	43	62	81	100	100	100
48570-4610	20	20	20	20	33	48	62	77	92
48570-4615	0	0	0	0	0	0	0	0	0
48570-4620	0	0	0	0	0	0	0	0	0
48565-4600	0	0	2	23	44	66	87	100	100
48565-4605	0	0	11	33	54	75	96	100	100
48565-4610	0	0	13	29	46	62	79	95	100
48565-4615	0	0	0	0	2	3	5	6	7
48565-4620	0	0	0	0	0	0	0	0	0
48565-4625	0	0	0	0	0	0	0	0	0
48565-4630	0	0	0	0	0	0	0	0	0
48565-4635	0	0	0	0	0	0	0	0	0
Total (hectares)	5	6	17	41	73	105	132	144	149

*Cells in this table correspond to those outlined in Figure 5. Numbers are based on UTM coordinates of southwestern corner of cell.

APPENDIX B

PRELIMINARY ANALYSIS OF VINEYARD YIELD ASSESSMENT

PRELIMINARY ANALYSIS OF VINEYARD YIELD ASSESSMENT WITH REMOTELY SENSED DATA

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14853

May 1979

PREFACE

This study was supported by NASA Grant NGL 33-010-171, and conducted in cooperation with the Taylor Wine Company, Inc., Hammondsport, N.Y. Warren R. Philipson directed the analysis; Jay N. McLeester selected the fields for study and made the photogrammetric measurements; and John G. Hagedorn performed the computer data analysis tasks. Consultations were provided by Nelson J. Shaulis and Robert M. Pool of the N.Y.S. Agricultural Experiment Station, Geneva, N.Y.

Ta Liang
Professor and
Principal Investigator

INTRODUCTION

Earlier work by staff of Cornell's Remote Sensing Program has shown the value of aerial photographic analyses for evaluating new vineyard site drainage conditions and for assessing the general health of vineyard plants. As a follow-up investigation, Cornell staff set out to examine relationships between vineyard crop yields and those morphologic or spectral characteristics of the vines that could be measured through remotely sensed data. It was believed that these relationships could provide insight into vineyard crop management practices and, at least to some extent, be applicable in predicting yield.

METHODS AND MATERIALS

Study Area and Data

At the request of the Cornell Remote Sensing Program, the National Aeronautics and Space Administration (NASA) acquired color infrared aerial photographic coverage and 11-channel multispectral scanner data over vineyards along the western side of the southern portion of Keuka Lake, in New York State (Fig. 1). The photographic and scanner data were acquired simultaneously at midday on 22 June and 26 August 1977; the thermal channel of the scanner was also operated during predawn hours on these two dates. Flight and data parameters are outlined in Table 1.

The photographic films were provided to the investigators by NASA as duplicate, positive transparencies. Selected portions of the multispectral scanner data were provided on computer-compatible magnetic tapes; the specific flight lines, or parts of flight lines, provided had been selected by the investigators from paper print output (visicorder) of the thermal channel.

The analysis focused on fields owned by the Taylor Wine Company, Inc., of Hammondsport, N.Y. Vineyard data made available for the study included detailed information on the vines in each field (e.g., variety, age, spacing), and yield as determined by the average weight of bins of each variety collected from each field section.

For this preliminary study, 16 field sections, planted to three varieties were included; six sections were devoted to Concord, five to Catawba, and five to Delaware. The selection of the specific field sections was based on the number, homogeneity and age of the vines in the sections, and the quality of both the June and August imagery of the sections.

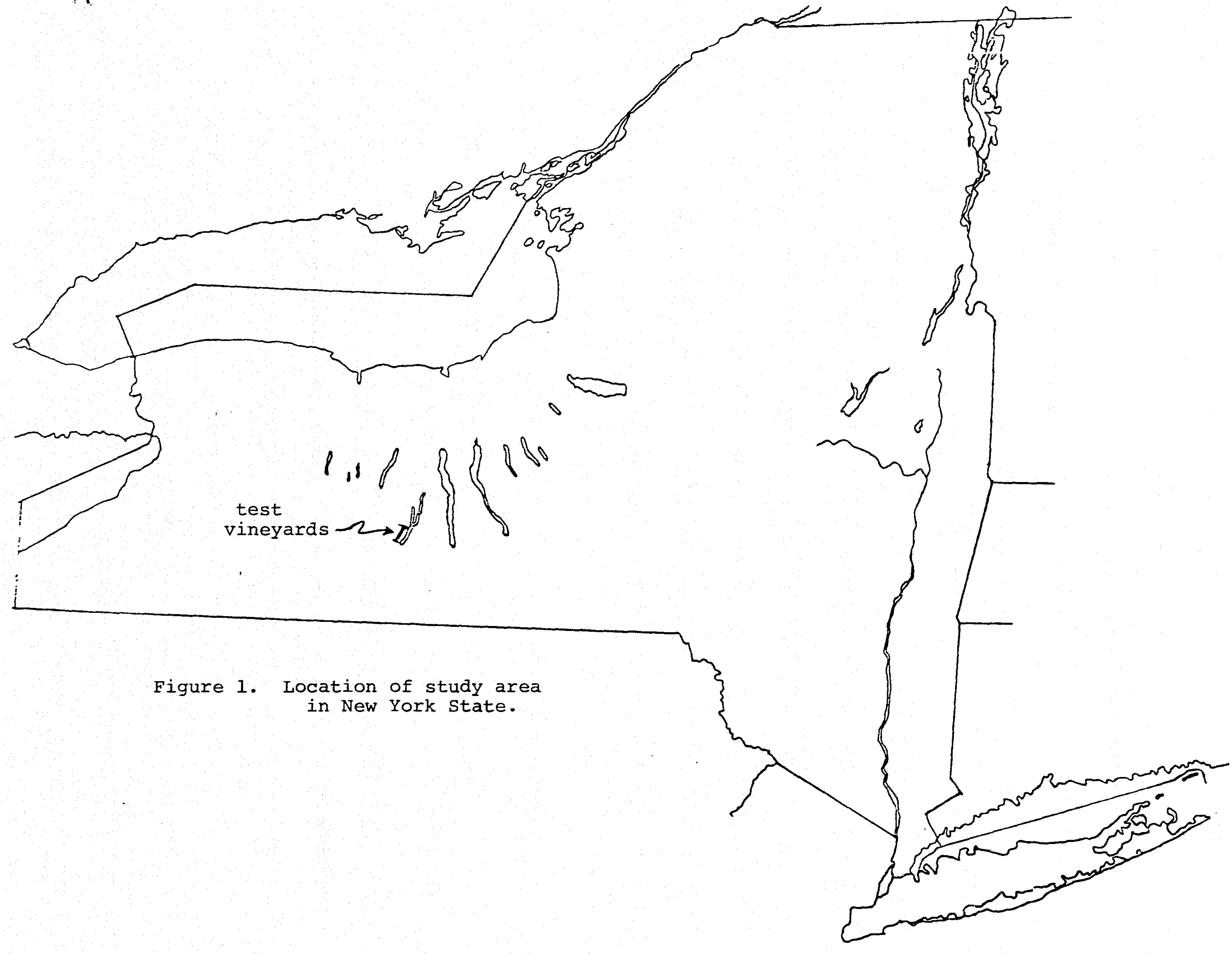


Figure 1. Location of study area
in New York State.

Table 1. Remotely sensed data acquired for vineyard analysis.

SENSOR	NATURE OF DATA	FORM OF DATA
metric camera; 9 inch (23 cm) format; 6 inch (15 cm) lens	color infrared film, 2443; scales of 1:14,000 & 1:6,000	duplicate positive transparencies
multispectral scanner; instantaneous field-of-view of 2.5 milli-radians	scanner senses simultaneously in 11 channels (range in micrometers) 1) 0.411-0.438 2) 0.449-0.484 3) 0.490-0.532 4) 0.532-0.572 5) 0.572-0.611 6) 0.612-0.652 7) 0.653-0.692 8) 0.692-0.737 9) 0.762-0.856 10) 0.953-1.031 11) 8.0-14.0	visicorder prints of thermal channel; computer-compatible tapes of selected flight lines or of parts of lines

FLIGHT DATES: 22 June and 26 August 1977, daytime (all data) and predawn (Chan. 11 only).

FLIGHT ALTITUDES: nominally 3,000 and 7,000 ft. above mean terrain (915 and 2,130 meters).

Photographic Measurements

At the recommendation of Dr. Nelson J. Shaulis, Cornell Professor Emeritus of Pomology and Viticulture, two plant morphological factors were considered: the continuity of the vines in June and the width of the canopy in August. These were determined from the aerial photographs.

Canopy continuity was determined for each field section by using the June photographs to estimate the percentage of trellis that was covered by vines. The percentage for each field section was based on a sample of approximately three trellises for every twenty trellises, or approximately 15% of the total length of trellis in the section.

The percentages of canopy continuity were determined as follows:

1. The length of an entire trellis (row) was measured from the film, using a comparator (scale) viewed through the monoscopic mode of a zoom stereoscope.

2. In the same manner, the number and lengths of gaps in the vine canopy along the trellis were measured and summed.

3. The total length of gaps was adjusted (increased) to account for relief displacements (Appendix).

4. The proportion of continuous canopy was then calculated as the total trellis length minus the total length of gaps, divided by the total trellis length. This quantity was multiplied by 100 to obtain a percentage, and the values for a field section were averaged.

Canopy width in each field section was determined from the August photographs based on a sampling of approximately two sites per acre. Each sample site in each field section consisted of a portion of six adjacent trellises, approximately 13 meters in length.

The average canopy width at each sample location was determined in the following manner:

1. The scale of the photograph at the sample site location was computed by comparing the photographic distance between the first and sixth trellis with the reported ground distance.

2. The clear spacing between adjacent canopies was measured from the film using a bar comparator scale, viewed through the monoscopic mode of a zoom stereoscope. Different width bars, varying by 0.001 inch (0.025 mm), were "fitted" between the adjacent canopies and the widths recorded.

3. The average canopy spacing over the six trellises (i.e., 5 distances) was calculated and scaled to ground.

4. This average ground distance was subtracted from the average ground distance between the six trellises (i.e., avg. row spacing - avg. canopy separation) to arrive at an average canopy width.

The average canopy widths for all sample sites within each field section were averaged, and a correction factor was applied to account for photographic relief displacement (Appendix).

Multispectral Scanner Data Analysis

Only the lower altitude scanner data were included in the present study. These data have a ground resolution of approximately 2.3-by-2.3 meters (7.5-by-7.5 ft.).

The 16 field sections were located through refinement of computer printout brightness maps. The average radiance value (digital count, 0 to 255) in each spectral region (channels 1 to 11) was then calculated for each section, and subsequently correlated with yield and related values for the section. Because the relative differences among sections were the principal quantities of interest, no attempt was made to calibrate the radiometric values or correct for atmospheric interactions.

RESULTS AND DISCUSSION

The results of this preliminary analysis are summarized in Table 2. Included are vine characteristics of the three varieties in the 16 field sections considered; multiple correlation coefficients between the varieties' 1977 yields and the averaged radiometric responses from the sections, as sensed in 11 spectral regions, on two 1977 flight dates; and multiple correlation coefficients between selected other factors of interest.

Three points are of importance in interpreting these results.

1. The number of field sections for any of the three varieties is too small to allow statistically valid statements.

2. The 1977 growing season followed a particularly harsh winter resulting in anomalously low yields (cf. 1976 yields, Table 2).

3. Yield values used in this analysis are based on average yields for the variety and may not be entirely accurate for the sections actually considered.

Even with these limitations, the results still provide a clear indication that further analysis is warranted and desirable. The high correlations between yield and the August spectral responses for Concord are notable, as are several other correlations. The negative relationship between yield and most factors is of interest and cannot be fully explained.

As a final note, it is emphasized that multiple or nonlinear correlations (regressions) have not been examined, nor have relationships between yield and spectral or temporal ratios. Follow-up studies and possibly new aerial missions over closely monitored vineyards are being planned.

Table 2. Characteristics of test vineyards and correlations between yield, spectral and morphological factors.

Variety	DELAWARE	CONCORD	CATAWBA
No. Fields	5	6	5
Yield, tons/acre[1]			
mean, 1977 (stan. dev.)	1.31 (0.36)	1.87 (0.37)	3.52 (0.74)
mean, 1976 (stan. dev.)	2.51 (1.01)	5.09 (0.57)	3.97 (1.39)
Vine Continuity, %			
mean, June 77 (stan. dev.)	80.9 (5.9)	87.9 (2.4)	84.5 (2.9)
Canopy Width, feet			
mean, Aug 77 (stan. dev.)	2.48 (0.77)	4.05 (0.26)	3.85 (0.39)

CORRELATED VARIABLES	R^2		R^2		R^2	
	6/77	8/77	6/77	8/77	6/77	8/77
Yield 1977						
vs. Chan 1	(-)[2].02	(-).63	X[3]	(-).81	(-).05	(-).22
Chan 2	(-).02	(-).64	X	(-).88	(-).06	(-).20
Chan 3	(-).01	(-).62	X	(-).91	(-).06	(-).20
Chan 4	X	(-).58	X	(-).93	(-).07	(-).24
Chan 5	(-).01	(-).65	X	(-).93	(-).07	(-).17
Chan 6	(-).01	(-).68	X	(-).91	(-).06	(-).11
Chan 7	(-).01	(-).68	X	(-).91	(-).04	(-).11
Chan 8	0.09	(-).51	X	(-).92	(-).03	(-).50
Chan 9	0.62	(-).40	0.01	(-).90	(-).02	(-).72
Chan 10	0.77	(-).45	0.02	(-).89	(-).01	(-).68
Chan 11	(-).15	(-).95	(-).34	(-).42	(-).12	(-).01
Continuity	0.31		(-).26		0.09	
Width		0.04		(-).03		(-).03
Yield 76	0.98		(-)0.66		0.20	
[Yield 76 / Yield 75]	0.80		(-)0.10		0.08	
Continuity vs. Width	X		0.02		(-)0.27	

Notes: [1] Non-metric units used to conform with vineyard records.
[2] Sign of R is given in parentheses.
[3] X denotes R^2 less than 0.010.

APPENDIX

PHOTOGRAMMETRIC CORRECTIONS APPLIED TO PHOTOGRAPHIC MEASUREMENTS

Relief displacement of vines on the photographs will tend to reduce the observed size of gaps between vines (affecting canopy continuity) and between rows (affecting canopy width).

Two vines are shown in the figure. It is assumed that foliage is primarily restricted to the upper portion of the vines, being a distance of z above ground. The gap between the two vines is D + G'.

From the aerial photograph, the observed gap between the two vines would be g in the photograph or G on the ground. Because the height of the aircraft above ground, H, is large compared to z, then G' is approximately equal to G. Photo-derived measurements of the gap between the two vines would thus be short by the distance D.

By similar triangles in the figure, f/r = h/D; where f = the focal length of aerial camera; r = the photo distance from the nadir point of the photograph to the image of the vine; h = the height of the vine foliage; and D = the ground distance obscured from overhead view. Solving for D,

$$D = hr/f$$

If the aerial photograph was taken vertically (i.e., no tilt), the distance r may be measured from the center of the photograph.

Canopy Continuity

The correction factor that was added to each gap between vines in a row is:

$$D' = 3r'(\cos \phi)/f$$

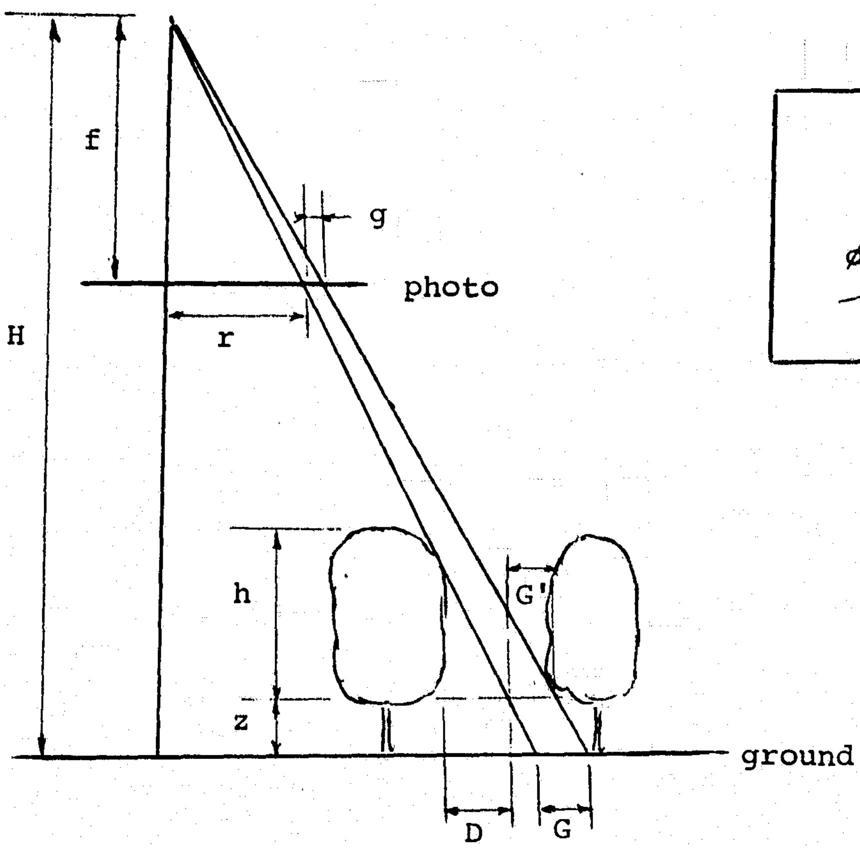
where: 3 feet is the assumed average height of the foliage, h; r' is the photo distance between the center of the photograph and the center of the field section being considered; ϕ is the angle between the radial line r' and the trellis (row) orientation; and f = focal length. If the camera had been pointed perpendicular to the rows (ϕ = 90 degrees), there would be no correction (cos ϕ = 0 and D' = 0).

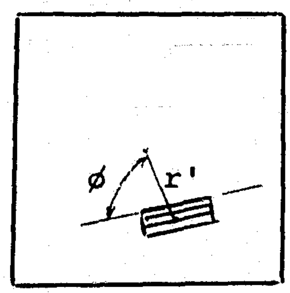
Canopy Width

The correction factor that was subtracted from the final measurement of canopy width for each field section is:

$$D' = 3r'(\sin \phi)/f$$

where the variables are defined above. The effect of this correction is to increase the observed gap between rows and thereby decrease the measured canopy width. In general, if the camera had been pointed parallel to the trellises (rows), there would be no correction (ϕ = 0 degrees; sin ϕ = 0; and D' = 0).





APPENDIX C

EVALUATING LANDSLIDE AND EROSION SUSCEPTIBILITY IN ALBANY COUNTY, N.Y.

LANDSLIDE AND EROSION SUSCEPTIBILITY WITHIN THE NORMANS KILL DRAINAGE BASIN, ALBANY COUNTY, NEW YORK

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14853

May 1979

PREFACE

This study was performed by Jan P. Berger under the direction of Ta Liang and Warren R. Philipson. The work was requested by Lawrence Smith, Director of the Planning Board of Albany County, N.Y., and supported by NASA Grant NGL 33-010-171. This report is accompanied by four map overlays.

INTRODUCTION

Land stability is an important consideration of planning agencies in their review of subdivision and development proposals. Of particular concern to the Planning Board of Albany County, N.Y., is the assessment of landslide and erosion potential within the Normans Kill drainage basin of the county. Combinations of specific soils and topography in the basin result in areas that are subject to landsliding and erosion. This study was performed to identify areas where landslides and erosion have been active as well as areas of potential problems.

STUDY AREA

The study area, some 290 square kilometers (110 sq. mi.) in northeastern Albany County, N.Y., covers two U.S. Geological Survey 7-1/2 minute topographic maps, "Voorheesville" and "Albany," and encompasses most of the Normans Kill drainage basin (Fig. 1). This region, part of the Hudson Valley lowland, is marked by low drumlin hills and rounded knolls in the Southwest, stream dissection along the Normans Kill, and an irregular dune landscape in the Northeast.

The area is an old lake plain, characterized by deep glacial lakebed deposits, with many areas of sand and glacial till (Ruedemann, 1930; LaFleur, 1965). In general, the lakebed deposits are subject to landsliding and erosion, especially on steeper slopes. The sandy areas on steeper slopes are subject to erosion by water; and if their vegetative cover is removed, the sandy areas on any slope are susceptible to wind erosion. Glacial till, depending on local composition and slope, may have slight to moderate potential for erosion by water.

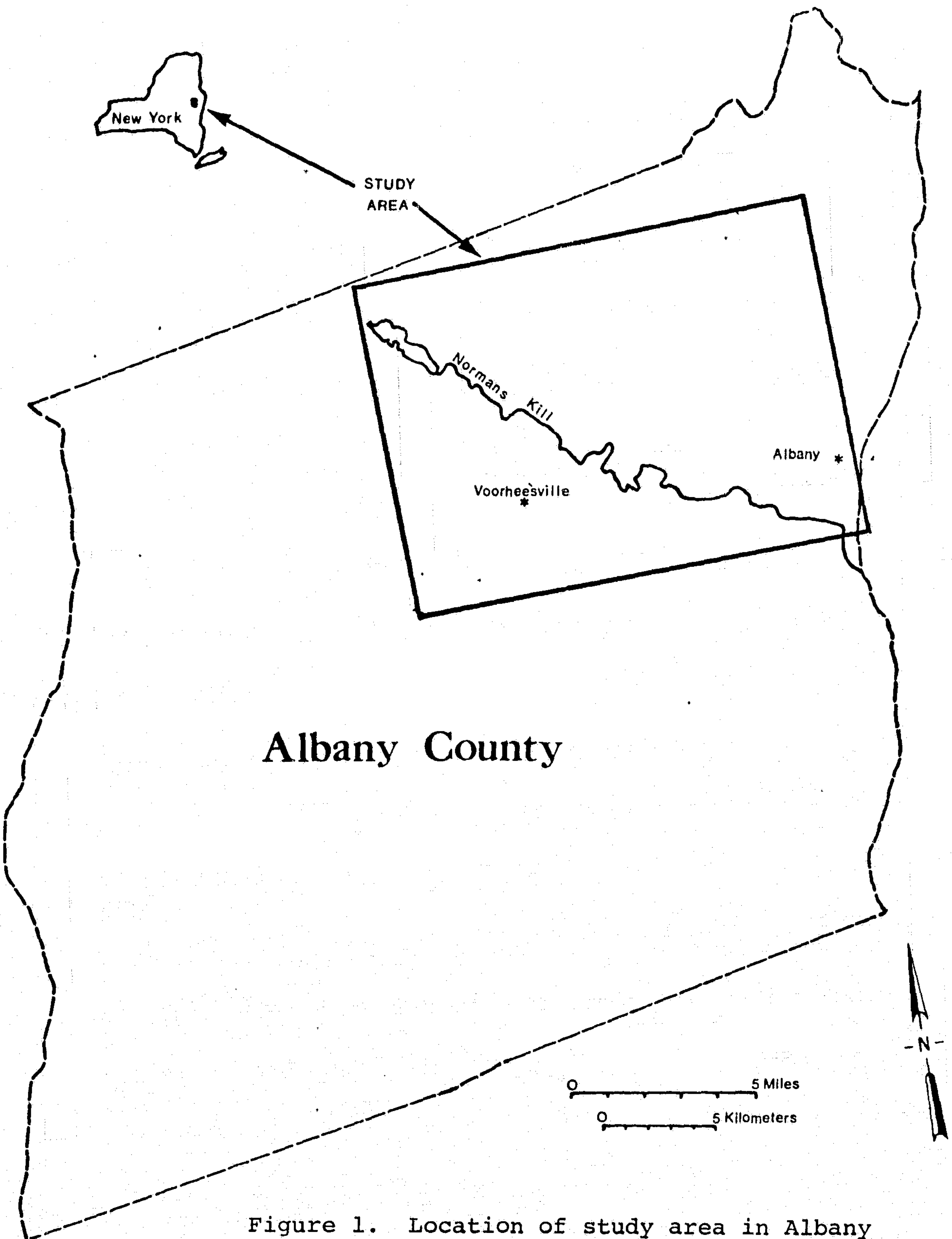


Figure 1. Location of study area in Albany County, New York.

MATERIALS AND METHODS

Information Sources

The primary sources of information used in this investigation were the 1936 Soil Survey of Albany and Schenectady Counties, N.Y., and accompanying 1:62,500 scale map (Lounsbury and Wildermuth, 1936); the 1953 Albany and 1954 Voorheesville U.S. Geological Survey 1:24,000 scale topographic maps; and various available aerial photographs as listed in Table 1.

Table 1. Aerial photographic coverage used in study

Date	Type of Data	Scale	Source
28 May 52	b & w contact print*	1:20,000	U.S. Dept. Agriculture
9 October 60	idem	idem	idem
26 March 68	idem	1:24,000	Lockwood Mapping Inc.
5 October 69	idem	1:40,000	U.S. Dept. Agriculture
30 April 73	color infrared film	1:130,000	NASA

* All black-and-white (b & w) prints were derived from panchromatic films.

Identification of Active Areas

Active erosion and landslides were located through stereoscopic analysis of the aerial photographs. Unless remedied, areas that have been active in the past are likely to be active now, or become active in the future (Rib and Liang, 1978). Therefore, all available photographic coverage for the study area was utilized. The 1968, 1969 and 1973 photographs were used to evaluate the Voorheesville quadrangle; and the 1952, 1960, 1969 and 1973 photographs were used to evaluate the Albany quadrangle (Table 1). Regions interpreted to encompass active areas were delineated on the photographs and visually tranferred onto acetate overlays to the Voorheesville and Albany 1:24,000 scale maps.

Identification of Potential Areas

Areas believed to be potentially susceptible to erosion and landsliding were identified by relating soils information with slope. In some cases, the aerial photographs were used to check or observe areas of the various susceptibility classifications, but most of the interpretations and delineations were based on the soil survey and topographic maps.

Soils were grouped according to parent material--lakebed (clay), sand, or till. Within the study area, every soil reported to be erosive or unstable was mapped onto a 1:62,500 scale overlay as one of the three parent material groups. These delineations were tranferred visually onto acetate overlays to the Voorheesville and Albany 1:24,000 scale maps. Map overlays depicting areas of slopes greater than 10% were also made from the 1:24,000 scale topographic maps.

The 1:24,000 scale map overlays, depicting soils and slopes, were then registered, and their information combined, to compile overlays depicting landslide and erosion susceptibility.

RESULTS AND DISCUSSION

Areas of active and potential landsliding and erosion are depicted on the accompanying 1:24,000 scale overlays for the U.S. Geological Survey topographic maps, for Voorheesville and Albany, N.Y. As described, the active areas were derived through interpretation of aerial photographs. The potential areas were derived primarily from topographic and soil survey information with limited aerial photographic checks.

In developing the map overlays, areas of lakebed deposits on slopes greater than 10% were classified as having high potential for landsliding (map unit 1). Lakebed deposits on slopes less than 10% were classified as having a slight to moderate potential for landsliding (map unit 2). Sand deposits on slopes exceeding 10% were classified as having high potential for erosion by water and, if uncovered, high potential for wind erosion (map unit 3). Sand deposits on slopes less than 10% were classified as having a slight to moderate potential for water erosion but, if uncovered, a high potential for wind erosion (map unit 4). Areas of glacial till, regardless of their slope, were classified as having a slight to moderate water erosion potential (map unit 5). The remaining areas were classified as being stable and should pose no special problems if normal care is taken during their development (map unit 6). These areas are characterized by soils that are reported to be stable and that show no signs of instability in the aerial photographs.

In general, most of the landslide problems are found in the lakebed deposits that are dissected by gullies and streams, especially on the outside of channel meanders. Erosion problems occur in these areas as well as in the sandy areas northeast of the Normans Kill, and to a lesser extent, in some areas of glacial till.

The map overlays are intended to be a guide in assessing the susceptibility for landsliding and erosion within the Normans Kill basin of Albany County, N.Y. Because of the possible inaccuracies of the original soil survey, the topographic maps, and map transfer and enlargment, on site investigations are imperative. This is especially true given the amount of development that has occurred since the soil survey (1936) and the topographic mapping (1953 and 1954). Similarly, active landsliding and erosion that has occurred since 30 April 1973--the date of the most recent aerial photographs analyzed--could not have been detected.

LITERATURE CITED

LaFleur, R. 1965. Glacial lake sequences in the Eastern Mohawk-Northern Hudson region. In Guidebook: Field Trips in the Schenectady Area, 37th Annual Mtg. N.Y. State Geol. Assoc. 23 pp.

Lounsbury, C. and R. Wildermuth. 1942. Soil survey of Albany and Schenectady Counties, New York. Series 1936, No. 16. U.S. Dept. of Agriculture, Cornell Univ. Exper. Station. 79 pp.

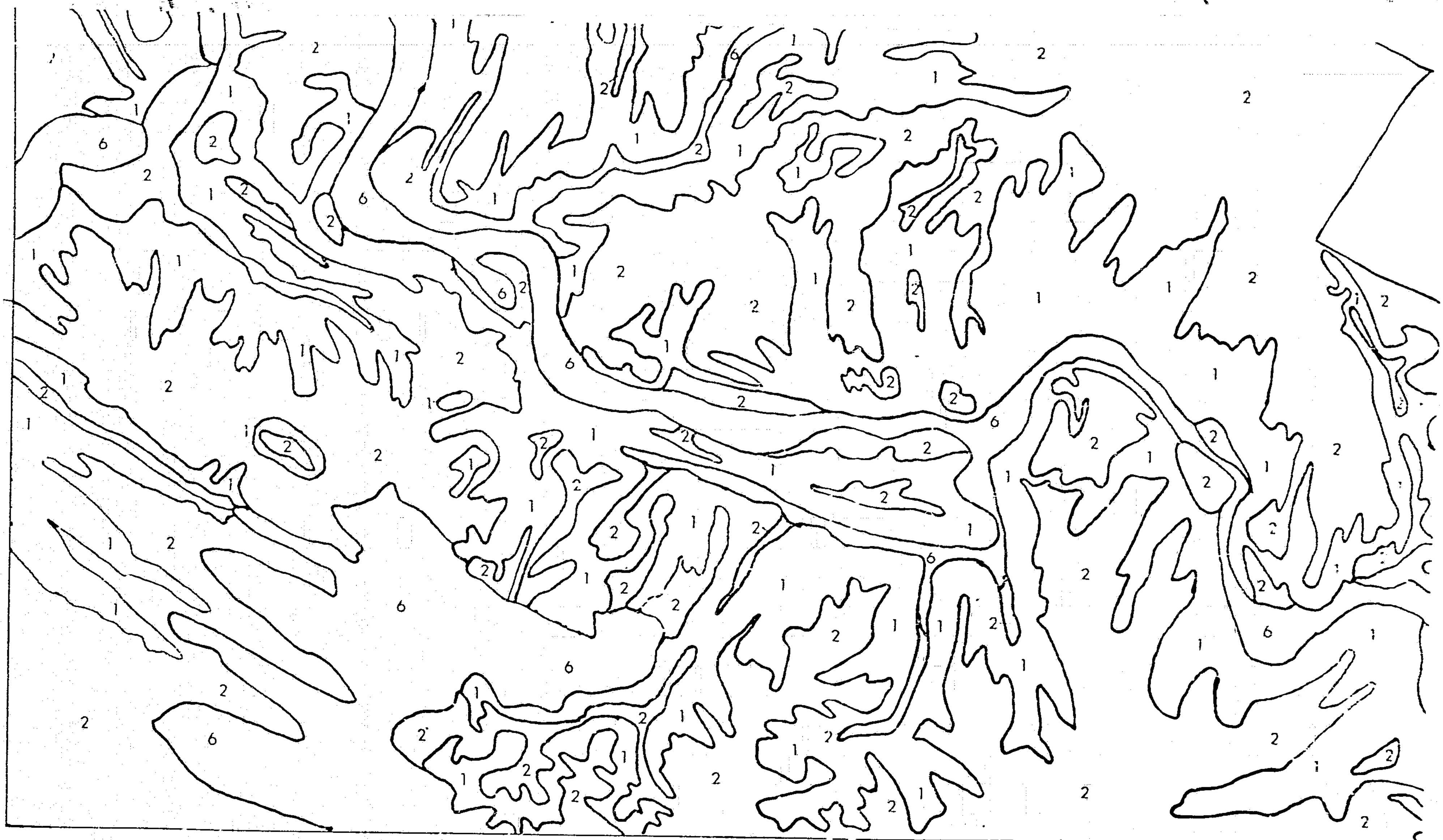
Rib, H. and T. Liang. 1978. Recognition and identification. Chapter 3. In Landslides: Analysis and control. Special Report 176, Transportation Res. Board. Nat. Acad. Sciences, Washington, D.C.

Ruedeman, R. 1930. Geology of the Capital district. N.Y. State Mus. Bull. 285. State Univ. of N.Y., Albany. 218 pp.

ACCOMPANYING MAP OVERLAYS

(all overlays are to U.S. Geological Survey 7-1/2 minute, 1:24,000 scale topographic maps)

1. Landslide and Erosion Potential, Albany Quadrangle
2. Landslide and Erosion Potential, Voorheesville Quadrangle
3. Active Landsliding and Erosion, Albany Quadrangle
4. Active Landsliding and Erosion, Voorheesville Quadrangle



LANDSLIDE AND EROSION POTENTIAL

-lakebed deposits-

1. high (slopes > 10%)
2. slight to moderate (slopes < 10%)

EROSION POTENTIAL

-sand deposits-

3. high by water; high by wind, if uncovered (slopes > 10%)
4. slight to moderate by water; high by wind, if uncovered (slopes < 10%)

-till deposits-

5. slight to moderate by water (all slopes)

SCALE 1:24000

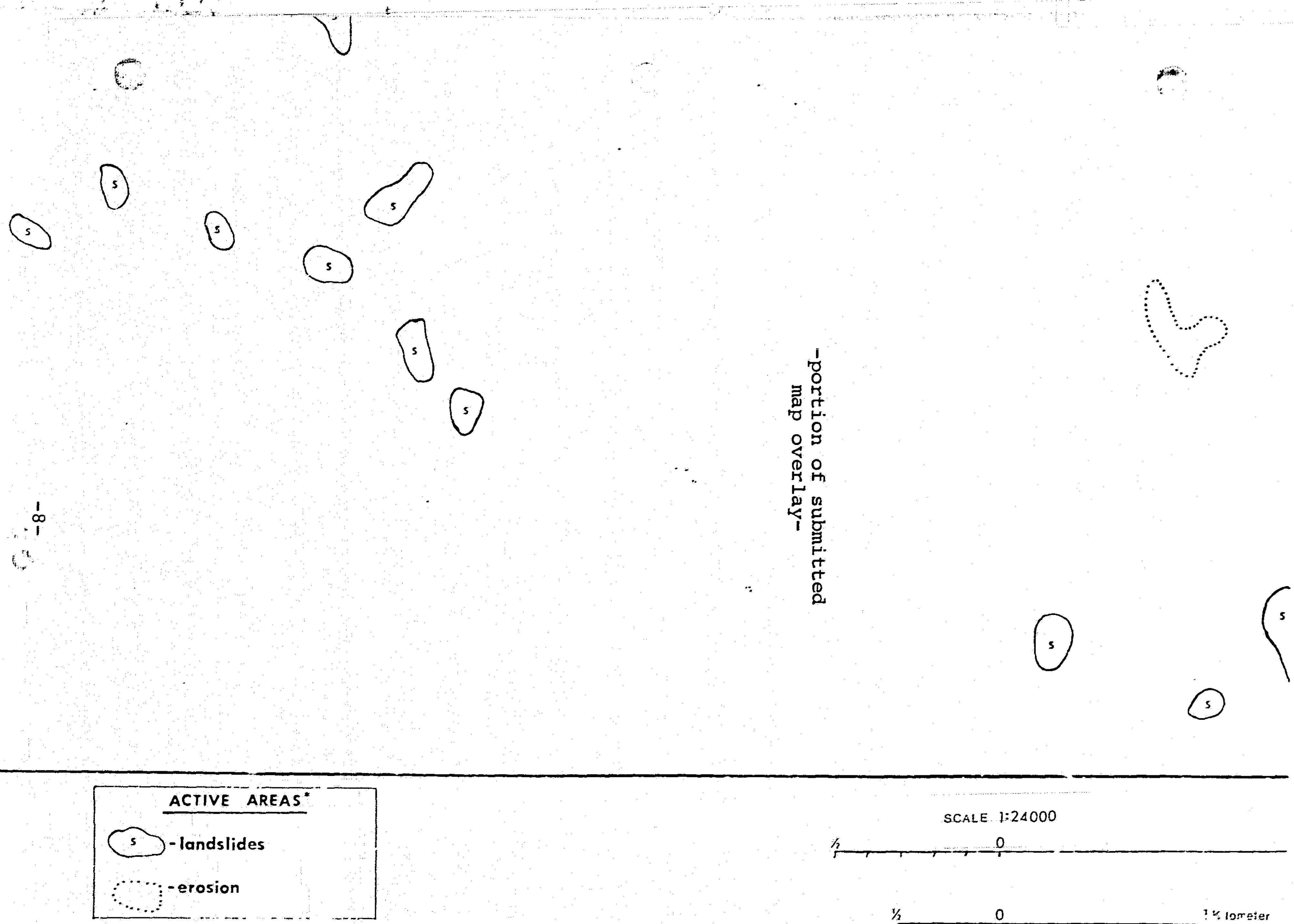
½ 0

½ 0 1

OTHER AREAS

6. no special landslide or erosion problems, except along boundaries; crosscheck on active area overlay

-portion of submittal map overlay-



*As of 30 April 1973; based on interpretations of aerial photographs

-portion of submitted map overlay-

APPENDIX D

PROJECT-RELATED CORRESPONDENCE

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Robert F. Flacke,
Commissioner

March 7, 1979

Mr. Jan Berger
Cornell University - Remote Sensing
School of Civil & Environmental Engineering
Hollister Hall
Ithaca, New York 14858

Dear Mr. Berger:

I would like to thank you for the report, Remote Sensing Assessment of Dam Flooding Hazards, which you sent to this office.

The program presented in the report will be utilized to inventory and inspect smaller dams in the western part of New York State. At present, remote sensing is used in specific dam problems.

I suggest that the U.S. Army Corps of Engineers be informed of said report. The Corps is involved with dam inspection nationwide and I feel the many states that are in the early stages of dam inspection could benefit greatly from your program. I will informally discuss this matter with personnel of the New York District.

Sincerely Yours,

Kenneth D. Harmer
Dam Safety Inspection Coordinator

KDH:dr

SAMPLE PROJECT
REQUEST

THE CAYUGA COUNTY
ENVIRONMENTAL MANAGEMENT COUNCIL
5th FLOOR - COUNTY OFFICE BUILDING - 160 GENESEE STREET
AUBURN, NEW YORK 13021
TELEPHONE (315) 253-1276

January 23, 1979

Mr. Warren Phillipson
Sr. Research Associate
Cornell University
School of Civil and Environmental
Engineering
Hollister Hall
Ithaca, New York 14853

re: remote sensing applications

Dear Mr. Phillipson:

I would like to request a meeting to discuss the possibility of remote sensing problem solving in Cayuga County. Following our phone conversation last week I have spoken with James Hotaling the Manager of the Cayuga County Soil and Water Conservation District. He has some interesting ideas and mutual concerns, and would like to join us. Could we meet at your office on the afternoon of January 30th or the 31st? I will contact you for your consideration later this week.

Thanks for your attention.

Sincerely,

Robert Brower
Senior Planner

RB:cd

SEE ATTACHED
SUGGESTED TOPICS

Cayuga County
Soil and Water Conservation District

January 19, 1979

Staff

JAMES A. HOTALING
Jordan, N.Y.
District Manager

CLARK H. JILLSON
Jordan, N.Y.
District Technician

JEAN B. HITCHCOCK
Treasurer and
District Secretary

TO: Robert Brower, Senior Planner
Cayuga County Planning Board

FROM: James Hotaling, District Manager, CCS&WCD
Robert Ingham, District Conservationist, SCS

RE: Remote Sensing, Cayuga County

Dear Rob,

Contained below are the Conservation District's and Soil Conservation Service's thoughts on possible application of remote sensing in Cayuga County. Ideally, remote sensing would allow us to determine to what degree agricultural activities influence water quality. A majority of our office's efforts are aimed at controlling soil erosion by water, and, in particular, the accelerated erosion caused by man's actions on the land. Protection of our soil resource base, minimizing pesticide, sediment and nutrient transport into our watercourses are all actions we take to maintain and improve water quality. Our ultimate goal is to slow down and possibly reverse the cultural eutrophication of our streams and lakes. Hopefully, remote sensing can aid us in these efforts.

Specifically, we are interested in the following:

1. Obtain base-line data for the county on a watershed by watershed basis to compare how effective our land management practices have been; eg. a view of the Dutch Hollow Brook watershed in 1979 and another view 5 years later showing improved water quality after soil conservation measures have been installed.

2. Determine how many acres of the county are adequately treated and how many more need conservation treatment.

3. Obtain the number of land users with the most critical soil erosion problems, so that those areas can be targetted for immediate action.

Cayuga County
Soil and Water Conservation District
248 GRANT AVE. AUBURN, N.Y. 13021 PHONE (315) 252-4171

Staff

JAMES A. HOTALING
Jordan, N.Y.
District Manager

CLARK H. JELSON
Jordan, N.Y.
District Technician

JEAN B. HITCHCOCK
Treasurer and
District Secretary

ORIGINAL PAGE IS
OF POOR QUALITY

4. Identify agricultural point sources of pollution; eg. muddy discharges from field drainage tiles, or locating farms that have their milkhouse waste linked directly to pipes discharging into ditches or streams.

5. Comparison of water quality between plowed and unplowed fields in Spring under high runoff conditions.

6. Locate sources of severe animal waste runoff from barnyards which runs directly into ditches or streams.

7. Locate areas of the most critical streambank erosion.

8. Locate other sediment sources such as construction sites, road-banks, urban developments, forested lands.

9. Locate heavy growth areas of aquatic vegetation in all lakes of the county.

10. In addition, the identification of non-point sources of pollution along our lakeshores in the form of seepage from inadequate or faulty septic systems would be of tremendous value towards stemming the proliferation of excessive aquatic plant growth.

At this point in time we do not know the exact capabilities of remote sensing and our questions may be too broad or too limited. The value of the results of remote sensing techniques become important only if practices are implemented to correct the identified problems. And any management decisions relative to pollution control must be made with costs and benefits closely examined. We welcome the opportunity to discuss our ideas further with you and Cornell as soon as possible. Hopefully our conservation efforts can be enhanced and improved by remote sensing.

Sincerely,

Robert Ingham
District Conservationist

James Hotaling
District Manager

Project Proposal
Cornell University
Remote Sensing Program

Contact: Stephen M. McNally
Energy Coordinator

PROBLEM: In order to operate an effective Weatherization Program (Energy Retrofitting) and Residential Energy Evaluation Program, it is necessary to isolate and identify the residences with the greatest heat loss. Due to various sociological reasons the opposite information is received (i.e. the more energy efficient homes are identified).

POSSIBLE SOLUTION: By doing High Altitude or Satellite Infra-Red Techniques, the most energy inefficient. Housing would be targeted for further investigation. In conjunction with a portable, hand-held infra-red scanner, we feel that a more effieient priority system could be established. This would lead to a mor more effective programming of education and retrofitting efforts. The project would also provide a geographic/demographic breakdown of the areas in the County with the most inefficient housing stock and thus make planning a great deal easier.

THE CAYUGA COUNTY
ENVIRONMENTAL MANAGEMENT COUNCIL
5th FLOOR - COUNTY OFFICE BUILDING 160 GENESEE STREET
AUBURN NEW YORK [illegible]
TELEPHONE [illegible]

1. We are in the process of organizing environmental data files on a town to town basis. Our data should be sufficient to allow us to review or generate environmental assessments. We have no current land use data. We have no vegetative cover inventory. We have no air quality data. We have little information on climate or precipitation patterns. We have little information on ground water systems.

2. We believe a problem may exist in the wetlands at the south end of Owasco Lake. An access road and Hurricane Agnes changed the surface hydrology to the extent the extensive tree kills may be occurring.

3. We are interested in determining the feasibility of land disposal of sewage effluent from the Moravia Sewage Treatment Plant.

SAMPLE PROJECT REQUEST

County of Fulton

COUNTY BUILDING
JOHNSTOWN, NEW YORK 12095

Telephone (518) 762-4832

PLANNING DEPARTMENT

PAUL J. O'CONNOR, Director

February 1, 1979

Dr. Warren Philipson
Remote Sensing Program
Hollister Hall
Cornell University
Ithaca, NY 14853

Dear Warren,

Regarding your recent request to Paul O'Connor for some type of photointerpretation studies to be conducted, we have the following suggestions:

Through the use of multi-spectral, infrared photography, is it possible to determine the extent of surface and sub-surface pollution from septic systems, surface runoff, barnyard runoff and road surface runoff?

Through the use of traditional aerial photography, can the extent of erosion and sedimentation be determined for particular areas--specifically those streams which enter the Great Sacandaga Lake?

The communities which we believe this type of work would apply to include the Towns of Oppenheim, Ephratah, Caroga, Bleecker, Mayfield, Northampton and Broadalbin.

We hope that these suggestions are of use to you; and if you would like to follow through on these, or have any comments or questions regarding the above, please feel free to call.

Sincerely,

Bernard Schmelz

Bernard Schmelz
Senior Planner

BS:sk

SAMPLE PROJECT
REQUEST

ST. LAWRENCE-EASTERN ONTARIO COMMISSION

317 WASHINGTON ST., WATERTOWN, N. Y. 13601
PHONE (315) 782-0100
EXTENSION 263-4

ERNEST J. LA BAFF, Chairman WILLIAM E. TYSON, Executive Director

March 5, 1979

Warren R. Philipson
Sr. Research Associate
Cornell University
Remote Sensing Program
School of Civil and Env. Eng.
Hollister Hall
Ithaca, NY 14853

Dear Warren:

As you requested I am forwarding information regarding the two topics you feel you can pursue for the Commission. Each is detailed below.

1) Defining river currents as inputs to oil spill response modeling - In order to reduce negative impacts of oil spills on the St. Lawrence River the Commission is developing a spill response model. A copy of the project scope of work is attached.

It is desired that you pursue the objective of identifying and delineating river currents in the area between Tibbets Point and the St. Lawrence - Franklin County line. Identification of currents will provide information required regarding probable oil movement subsequent to a spill in relation to sensitive ecological and economic areas. This identification will assist in developing a containment/clean-up stategy to be followed in the event of a spill.

Specifically, it would be of value if areas with currents could be identified. This in turn identifies areas without such currents. If delineation of direction and velocity is possible this would also be of value. The direction of flow is of greater importance than velocity.

Sections 4 and 5 of the attached scope address the question of expected benefits of the overall project.

2) Determining near-shore river/lake bottom types - In an effort to develop a CMP for the area it became evident that there was almost no information regarding bottom type. The objective of your efforts would be to identify and delineate bottom types in the near shore area (generally less than 30 feet of water) of Lake Ontario and the St. Lawrence River. This information would assist in fisheries management by assisting in the identification of spawning and other areas the various fish are dependent upon. It would allow, if replicated later, an evaluation of land management techniques implemented to reduce upland erosion and the subsequent sedimentation that occurs.

Short term direct benefit would be the identification of spawning areas and then incorporation into the coastal management program. Longer term benefit would be the ability to access the impact of upland erosion control measures in order to develop an efficient and effective management program.

Hopefully this background will assist you. I am available to meet with you if you feel it would be beneficial. If additional information is required, feel free to contact me.

Sincerely,

Daniel J. Palm
Prin. Coastal Zone
Resources Specialist

as

Attachment

APPENDIX E

RECENTLY PRESENTED RESEARCH PAPERS

DEVELOPING IN SITU FLOOD ESTIMATORS
USING MULTI-DATE LANDSAT IMAGERY

J.N. McLeester and W.R. Philipson

Remote Sensing Program
Cornell University
School of Civil and Environmental Engineering
Ithaca, New York 14853

Paper presented at the 45th Annual Meeting
of the American Society of Photogrammetry
19-23 March 1979, Washington, D.C.

-PAPER IS INCLUDED IN APPENDIX A-

A METHODOLOGY FOR DAM INVENTORY AND
INSPECTION WITH REMOTELY SENSED DATA

J.P. Berger, W.R. Philipson and T. Liang

Remote Sensing Program
School of Civil and Environmental Engineering
Cornell University
Ithaca, New York 14853

Paper presented at the 45th Annual Meeting
of the American Society of Photogrammetry
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A METHODOLOGY FOR DAM INVENTORY AND INSPECTION WITH REMOTELY SENSED DATA

J.P. Berger, W.R. Philipson and T. Liang

Remote Sensing Program
School of Civil and Environmental Engineering
Cornell University
Ithaca, New York 14853

BIOGRAPHICAL SKETCHES

Jan P. Berger received his B.A. in Geology from Hamilton College, and he is currently completing an M.S. in Aerial Photographic Studies and Remote Sensing at Cornell. He has worked as a NASA-Viking Mission intern at the U.S. Geological Survey Center for Astrogeologic Studies, and as a graduate teaching assistant in airphoto interpretation at Cornell. He is presently a graduate research assistant in Civil and Environmental Engineering.

Warren R. Philipson received his B.C.E., M.S. in Civil Engineering, and Ph.D. in Soil Science (Agronomy) from Cornell. Since 1965, he has taught, conducted research and participated in remote sensing projects in various parts of the world. A senior research associate in Civil and Environmental Engineering, he co-directs the Remote Sensing Program.

Ta Liang received his B.E. from Tsing Hua University, China, and his M.C.E. and Ph.D. from Cornell. He has conducted research and taught courses in airphotos and physical environment evaluation at Cornell since 1957. In consulting and research, his international experience covers all major geographic regions. A professor of Civil and Environmental Engineering, he is principal investigator of the Remote Sensing Program.

ABSTRACT

A methodology is presented to increase the efficiency and accuracy of dam inspection by incorporating remote sensing techniques into field-based monitoring programs. The methodology focuses on New York State and places emphasis on readily available remotely sensed data--aerial photographs and Landsat data. Aerial photographs are employed in establishing a statewide data base, referenced on county highway and U.S. Geological Survey 1:24,000 scale, topographic maps. Data base updates are conducted by county or region, using aerial photographs or Landsat as a primary source of information. Field investigations are generally limited to high-hazard or special problem dams, or to dams which cannot be assessed adequately with aerial photographs. Although emphasis is placed on available data, parameters for acquiring new aircraft data for assessing dam condition are outlined. Large scale (1:10,000) vertical, stereoscopic, color-infrared photography, flown during the spring or fall, is recommended.

1. INTRODUCTION

The failure of dams or other water impoundment structures can have disastrous consequences. In 1972, a National Program of

Inspection of Dams was established by Public Law 92-367. With this law, the U.S. Army Corps of Engineers became responsible for inventorying and inspecting larger dams throughout the United States (i.e., dams at least 25 feet high, with impoundments of at least 15 acre-feet; or at least 6 feet high, with impoundments of at least 50 acre-feet). In New York State, however, this represents only about ten percent of the State's dams. Although the Federal effort is substantial, states such as New York will still have the major responsibility for dam safety. Further, in New York and likely other states, dam inspection has been based solely on field assessment--a near impossible task.

Remote sensing from aircraft or spacecraft offers one means to increase the efficiency and accuracy of field-based, dam inspection. The application of aerial photographs and other remotely sensed data can potentially provide useful information for all required tasks: (1) inventorying dams (includes determining location and size of impoundment, dam type and height, spillway type, and reservoir and dam use); (2) determining their hazard class (categorized on basis of downstream land use and cover); and (3) assessing their condition (includes detection of leaks, overtopping, erosion, deterioration and obstructions).

In this paper, a methodology is presented which incorporates the use of aerial photographs and Landsat satellite data into the New York State Dam Safety Program.* Although the methodology focuses on New York State, similar procedures could be adopted by other states. The methodology has, and is presented in, two phases; the first being the establishment of baseline information, and the second being the implementation of a baseline update (Fig. 1).

2. ESTABLISHING BASELINE DATA

To develop a monitoring procedure, a data base that identifies and characterizes all known dams and reservoirs, at some particular date, must be prepared. New York State's Dam Safety Program operates on a county by county approach, with baseline information already collected for more than half of the counties in the State. These existing data were derived through field inspection and State permits, which are required for constructing all but the smallest water impoundment structure. The data are organized in files and recorded on county highway maps (generally, 1:62,500 in scale) and U.S. Geological Survey topographic maps (1:24,000 in scale). A systematic procedure for preparing data bases for the *remaining* counties follows.

(1) Select County

If data bases for all remaining counties are to be completed in one effort, the order in which counties are selected is arbitrary. If the inventory is to be conducted in stages over

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* A more complete description of the methodology, as well as a review of the value and use of remote sensing for dam inspection, can be found in the report from which this paper was derived, Berger et al., 1978.

more than one season, however, "priority counties" might be chosen. A priority county could be one with a large number of dams, many high-hazard dams, or possibly a large number of older dams. A complete review of existing permit and file information is needed if priority counties are to be identified.

(2) Assemble Existing Dam Information

The State maintains files on all dams with permits, and these are grouped by county. Unless recently field checked, however, the file information is subject to error. The dams may have been removed, they may never have been built, or they may have been incorrectly located or described in the permit. To prepare an accurate county data base, the file information must be compared with image-derived information and/or field checked, and plotted on current map bases.

(3) Acquire Appropriate Maps

The most recent county highway maps and U.S. Geological Survey 1:24,000 scale, topographic maps should be acquired for recording the data base information. It is possible that these maps depict new dam or reservoir information which is not found in the existing files or, if the maps post-date the images, on the available remotely sensed images.

(4) Acquire Appropriate Aerial Photographs

Recent aerial photographic coverage of each county is needed to inventory dams. Although Landsat data are useful for identifying reservoirs and general land use, their resolution is inadequate for obtaining information on most dams.

It is recommended that existing, stereoscopic aerial photographs be borrowed or examined at county or various other offices throughout the state. Most of the available photographs of New York and other states are panchromatic (black-and-white), at scales between 1:15,000 and 1:40,000. These should be adequate, especially if they were acquired during periods of minimum vegetative cover (early spring or late fall). Much information can also be derived from high-altitude (small scale) photographs. If available, color-infrared or color photographs would be preferred over panchromatic coverage because they normally afford more information (Table 1).

(5) Inventory Water Bodies

All county water bodies larger than 0.4 hectare should be located using the maps or more recent aerial photographs. With aerial photographs, the most efficient procedure is to scan the entire area covered by each photograph. High-altitude, color-infrared photographs are normally ideal for this task because of the large area covered by each photograph and the spectral contrast between water and its background in the infrared region.

Photo-identified surface waters which are not shown on the county or topographic maps should be recorded on the maps, preferably on acetate overlays. Similarly, water bodies which appear on the maps but not on more recent photographs should be noted on the overlays. They may have been removed, or they may have dried up permanently or temporarily. The use of map overlays is desirable because baseline information can be recorded without permanently obscuring map features. In addition, as new maps are acquired, only the overlays need be transferred.

(6) Inventory Dams

The inventory of dams includes confirming the existence of known dams as well as finding new dams. As each water body is identified on the most recent aerial photographs, stereoscopic analysis should be employed to search for any impounding structures. All identified dams should be recorded on the acetate overlays, and other possible sites derived from the permit files should also be noted.

A map overlay labeling system should be adopted for designating each dam and defining the information source from which it was identified. For example:

.Number of dam:	a number assigned to each dam by the state
.Information source:	A - aerial photograph S - satellite data P - permit F - field check
.Date of information source(s):	a four digit number designating the month and year of the information source(s); the day may be recorded in the files
.Hazard class:	a - low, b - medium, or c - high

The code "502-A0776c" would signify dam number 502, which was located and evaluated from aerial photographs flown in July 1976, and determined to be a high-hazard structure. If a field check is conducted the following month, the code on the overlay would be changed to 502-F0876c. With this system, the last inspection procedure is readily noted from the map code, and field checks or future updates can be planned accordingly.

A file card corresponding to each coded dam can be compiled to give additional information and to summarize other file data. If desired, all information could be entered into a computer for storage, retrieval, and update. The data should include at least the following:

- .Nature of information sources, e.g., type and scale of imagery.
- .County and nearest downstream city, town, or village, with the population and distance from the dam.
- .U.S. Geological Survey 1:24,000 scale, topographic map name.
- .Coordinates of dam site (longitude and latitude or U.T.M.).

.Name of dam or impoundment and river or stream.

.Type of dam, year completed, height, purpose, maximum capacity and condition.

(7) Site Assessment

Information obtained during field inspections conducted after or near the date of the photography will serve to establish the baseline data on a photo-identified dam. In lieu of such information, a complete photographic assessment of the dam site should be performed when the dam is identified. This includes collecting inventory data, categorizing the hazard class, and evaluating the condition of the dam and site. The assessment is principally a visual, qualitative evaluation, although photogrammetric measurements can be made of reservoir size and dam height (Thompson, 1966). The descriptive evaluation should be placed in the appropriate file.

(8) Field Inspection

When establishing the initial data base, field checks should be made if the date of the information source is relatively old (for a high-hazard dam, "old" may be as recent as one year); if new or removed water bodies and/or dams are identified on the photographs or maps; or if the information is derived from permits that post-date the photography. In general, field inspection is also recommended for high-hazard dams, large dams, large reservoirs, and older dams. In some cases, written or verbal communication with the dam owner or responsible county official may suffice and eliminate the need for a field visit. When information is collected, appropriate additions, changes, and deletions can be made on the overlays and in the files.

3. UPDATING BASELINE DATA

Statewide or regional updates of larger water bodies and major changes in land use can be achieved rapidly with satellite data; however, a thorough inventory and inspection of dam sites requires the use of permit file, map, aerial photographic and field information. A methodology for conducting detailed (e.g., county-level) inventories and inspections will be described, followed by an approach to conducting more generalized updates.

3.1. Detailed Data Base Update

A detailed update of baseline data will derive information from various sources in an effort to plan and expedite field inspections. Steps for accomplishing this update are, as follows:

(1) Assemble Required Data

Assemble all permit and file information collected since the last update. It is assumed that as new permits were issued and file information received, the data were appropriately recorded on the basemap overlays. The update will serve to confirm this information. Acquire the most recent aerial photographs and any new county highway or topographic maps.

(2) Impoundment and Dam Identification

If new maps were acquired, they should be compared with the data base overlays for new information when the overlays are transferred to the new maps. Whenever possible, aerial photographs should be used for impoundment and dam identification. Performing this survey with the county and topographic base maps close at hand will aid in locating all known or proposed dam sites. If recent, countywide aerial photographic coverage is available, proceed to Step (3); if it is not, satellite data can be used to locate major changes in surface waters, and thereby confirm permit information and possibly identify illegal impoundments (Sec. 3.2). If new aerial photographic coverage is not anticipated in the near future, field checks to identify new, altered or removed water bodies should follow, as outlined in Step (4).

(3) Site Assessment

When a dam site is encountered on the aerial photographs, it should be fully assessed, with file and base map overlay data appropriately added or updated (Sec. 2). As noted, a complete photographic assessment of each dam site should be made before considering another site, and all new information should be labeled as photo-checked.

(4) Field Checks

Field investigations are critical to dam safety inspection. In general, high-hazard dams and large dams or reservoirs should be field checked regularly even when no problem conditions are detected through photographic analysis. Field inspection is also required whenever a complete evaluation of a dam site cannot be performed with recent photographs (e.g., if a spillway is obscured from view by tree cover), or whenever a dam is determined through photographic analysis to be a high-hazard dam or have some problem condition. In contrast, no field inspection is required of a low-hazard dam for which no change in hazard class and no problem condition is detected through analysis of recent photographic coverage. Moreover, as will be described in Section 4, the actual number or frequency of field checks could be reduced significantly if new remotely sensed data were flown specifically for the purpose of dam site inspection.

3.2. Generalized Data Base Update

If a rapid, regional update of water bodies and major land use changes is desired, the information may be derived from satellite data. This type of update may be warranted if permits indicate a large number of dams have been constructed since the last update, or simply, if recent photographs are not available. On the other hand, a satellite-derived update should not be performed if the data base is old; a detailed update will be required.

Land cover change detection with Landsat Multispectral Scanner (MSS) data is more accurately achieved by computer analysis than by manual (visual) analysis. Computer-compatible tapes, computer access, and special computer software are required

(NASA, 1975; Carter et al., 1977). In general, the analysis requires two dates of Landsat data, one being close to the date of the existing data base (preferred) or older, and the other being the most recent scene available. Both tapes should be of scenes imaged in the late summer. Using appropriate computer software packages, new, removed, or changed water and cultural features can be found for an interim update.

Although manual analyses of satellite images are limited, they may be the only methods that can be implemented before a field check if aerial photographs or computer access are not available. For manual analysis of Landsat data, black-and-white spectral transparencies of late-summer MSS band 7 (near-infrared) images, in a 23-by-23cm (9-by-9 inch) format, are recommended. Using a standard overhead projector whose position and orientation can be controlled, a single, positive transparency can be projected onto the current county map and overlay. Water bodies on the map can be compared to the superimposed image for data base update. Although the higher resolution, Landsat-3 Return Beam Vidicon (RBV) images would also provide useful information, four RBV images must be purchased to cover the same area as that covered by a single MSS image, and the RBV data are panchromatic, which is less effective than infrared for distinguishing water.

As an alternative to simple projection of single images, two dates of each scene could be employed in a multi-date analysis. For example, by "sandwiching" and registering positive and negative band 7 transparencies of an old and recent date, respectively, and by viewing the composite over a source of white light, new water bodies (larger than approximately 10 hectares) will appear as light-toned areas. Other change-detection techniques which make use of an additive-color viewer or diazo might also be employed (Reeves, 1975).

In general, certain land covers, agricultural or climatic differences between the two dates, clouds and cloud shadows can all be sources of confusion for manual or computer approaches to change detection. Furthermore, an aerial photographic or field check is always needed to confirm Landsat-derived information.

4. COLLECTION OF NEW REMOTELY SENSED DATA

It is improbable that New York or any other state would expend funds to fly new remote sensing coverage of all dams in the state, on a regular basis. Sensing for monitoring or assessing the condition of selected problem or high-hazard dams may be economically viable, however, and the development of such a program should be considered.

4.1. Sensor Selection

For monitoring dam sites, a sensor must provide data which will allow an assessment of spatial and spectral relationships. This requirement can only be filled with an imaging sensor. The selection of a particular imaging system will be dependent upon the number and size of impoundments to be monitored, and the availability of equipment, facilities and/or funds. Considering the most useful spectral bands for obtaining dam-related information (Table 1), and recognizing that these bands can be sensed in various ways, it is apparent that nearly all features of interest can be evaluated successfully with a single lens, photographic frame camera and a single color-infrared film. Dam-site monitoring might be conducted more comprehensively with several films (multiple cameras), through multispectral filtering of a single film (multi-lens camera), or with additional sensors. Thermal data, for example, might prove quite valuable for detecting dam leaks or other possible problems, especially if the data were acquired during night-time hours (Table 1). But the advantages of utilizing a single film and a single lens camera are manifold.

4.2. Photographic Scale

Although the complete design of an aerial photographic mission is beyond the scope of this paper, it is noted that the mission design that is optimum for detecting reservoirs and dams would be somewhat different from that of a mission for evaluating hazard class, and quite different from that of a mission for assessing dam condition. All are governed by the camera utilized, the aircraft, whether oblique or vertical photography is to be acquired, and the spatial, spectral and temporal (seasonal and diurnal) characteristics of the features of interest.

Many aspects of dam site monitoring can be accomplished with small scale photographs (1:80,000 to 1:130,000); while medium scale photographs (1:20,000±) are better for "all-purpose" monitoring--inventory, evaluating hazard class and, to a large degree, assessing dam condition. Medium scale, panchromatic photographs are likely to be the primary tool for monitoring because they are acquired periodically by various agencies which normally make them available for distribution. But if new photography is to be flown for assessing the condition of selected problem or high-hazard dams, it is recommended that large scale photographs be acquired.

4.3. Photographic Monitoring of Dam Condition

As outlined in Table 2, color-infrared aerial photographs of the dam structure and its surroundings should be obtained. If landsliding or excessive erosion is judged to be a possible problem, the land surrounding the reservoir should also be photographed; if the impoundment is small, coverage of the entire reservoir might be obtained.

The primary photographic coverage should be stereoscopic and vertical. Oblique photographs, such as those obtainable with a hand-held camera from the window of an aircraft, might be a valuable supplement, especially for inspecting a dam's downstream face. But oblique photography is not an acceptable replacement for vertical photography.

In general, the scale of the vertical photography should be compatible with the size of the dam structure and the other areas to be photographed. Under no circumstances, however, should the scale be smaller than 1:10,000, and scales as large as 1:5,000 are recommended.

Aerial photographic sensing for assessing dam condition should be conducted with high sun angles. In addition, although the likelihood of detecting potential problems should increase as the vegetation or snow cover decreases, a grass cover could serve to enhance wetness or erosion. The optimum period for photographic sensing in New York State would thus be during the early spring or late fall. Notably, the duration of acceptable sun angles may be relatively short at these times.

In conclusion, aerial photographic monitoring of dam sites is one means to increase the efficiency of field operations and/or to reduce the total number of field visits. Similar to the value and purpose of remote sensing for all facets of dam inspection, photographic monitoring is not a replacement for field inspection.

ACKNOWLEDGMENTS

Principal support for this investigation was through funds provided by the United States Department of the Interior, Office of Water Research and Technology, as authorized under the Water Resources Research Act of 1964. Other funds, provided by Grant NGL 33-010-171 from the National Aeronautics and Space Administration, supported the preliminary development of the remote sensing methodology. The authors would like to ackowledge the cooperation of the staff of the Dam Safety Program, of the New York State Department of Environmental Conservation, and in particular, Kenneth D. Harmer.

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4. Reeves, R.G. (ed.). 1975. Manual of remote sensing. 2 vols. Amer. Soc. Photogrammetry, Falls Church, Va. 2144 pp.

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Table 1. Spectral bands for monitoring dams.

TASK OR OBJECT DIFFERENTIATION	REFLECTED RADIATION PRIMARY	REFLECTED RADIATION SECONDARY	VALUE OF THERMAL
I. Inventory			
reservoir vs. background	I*	R	High
dam vs. water	I	R	High
dam vs. vegetation[1]	R	G,B	Mod.
dam vs. soil[1]	B	-	Mod.
dam type[2]	-	-	-
dam height[2]	-	-	-
spillway, wet vs. background	I	R	High
spillway, dry vs. vegetation[1]	R	G,B	Mod.
spillway, dry vs. soil[1]	B	-	Mod.
spillway type (wet)[3,4]	I	R	High
spillway type (dry)[2,4]	-	-	Low
reservoir/dam use[3]	R,G	B,I	Low-Mod.
II. Hazard Classification			
topography[2]	-	-	-
land use (cultural)[3]	I,R	G,B	Low-Mod.
III. Condition Assessment			
non-overflow section:			
.leaks	I	R	High
.earth dam erosion, breaching or overtopping[3]	I,R	-	Mod.
.concrete dam breaching or overtopping[3]	I	R	Low-Mod.
spillway deterioration:			
.wet spillway[3]	I	R	High
.dry spillway[2]	-	-	-
choked spillway where obstructions are:			
.floating or surface[3]	I,R	-	Low-Mod.
.submersed[3]	G,B	-	Low
land surrounding impoundments[3]	I,R	-	Low-Mod.

Notes: *I, infrared; R, red; G, green; B, blue

[1] Assumes concrete structure.

[2] Object differentiation or completion of the task is principally a problem of spatial analysis.

[3] Analysis of spatial properties may be at least as important as spectral analysis.

[4] Categorization of spillway type as internal or external assumes the spillway has been detected.

Table 2. Mission parameters for aerial photographic sensing of dam conditions.

PRIMARY DATA:	**VERTICAL PHOTOGRAPHY**
.Cameras	one camera; single lens; format of 70mm or larger.
.Film/Filter	color infrared (Kodak Aerochrome Infrared 2443 or 3443); filter with cut-off about 0.4μm (Wratten 12 or 15).
.Scale	dam structure, 1:5,000 to 1:10,000. reservoir & surroundings, 1:10,000.
.Overlap	for stereoscopic coverage, consecutive photos should overlap by at least 50%, and preferably 60%.
.Constraints	flights should be conducted during: a. early spring or late fall (minimum vegetation and no snow) b. highest possible solar altitude c. periods of less than 20% cloud cover
OPTIONAL DATA:	**OBLIQUE PHOTOGRAPHY**
.Cameras	one camera; single lens; format of 35mm or larger.
.Film/Filter	(see above).
.Scale	variable, preferably 1:5,000± of dam face.
.Overlap	if possible, obtain stereoscopic coverage.
.Constraints	(see above); all oblique photographs should be acquired during the mission to acquire vertical photographs; no special flights are recommended.

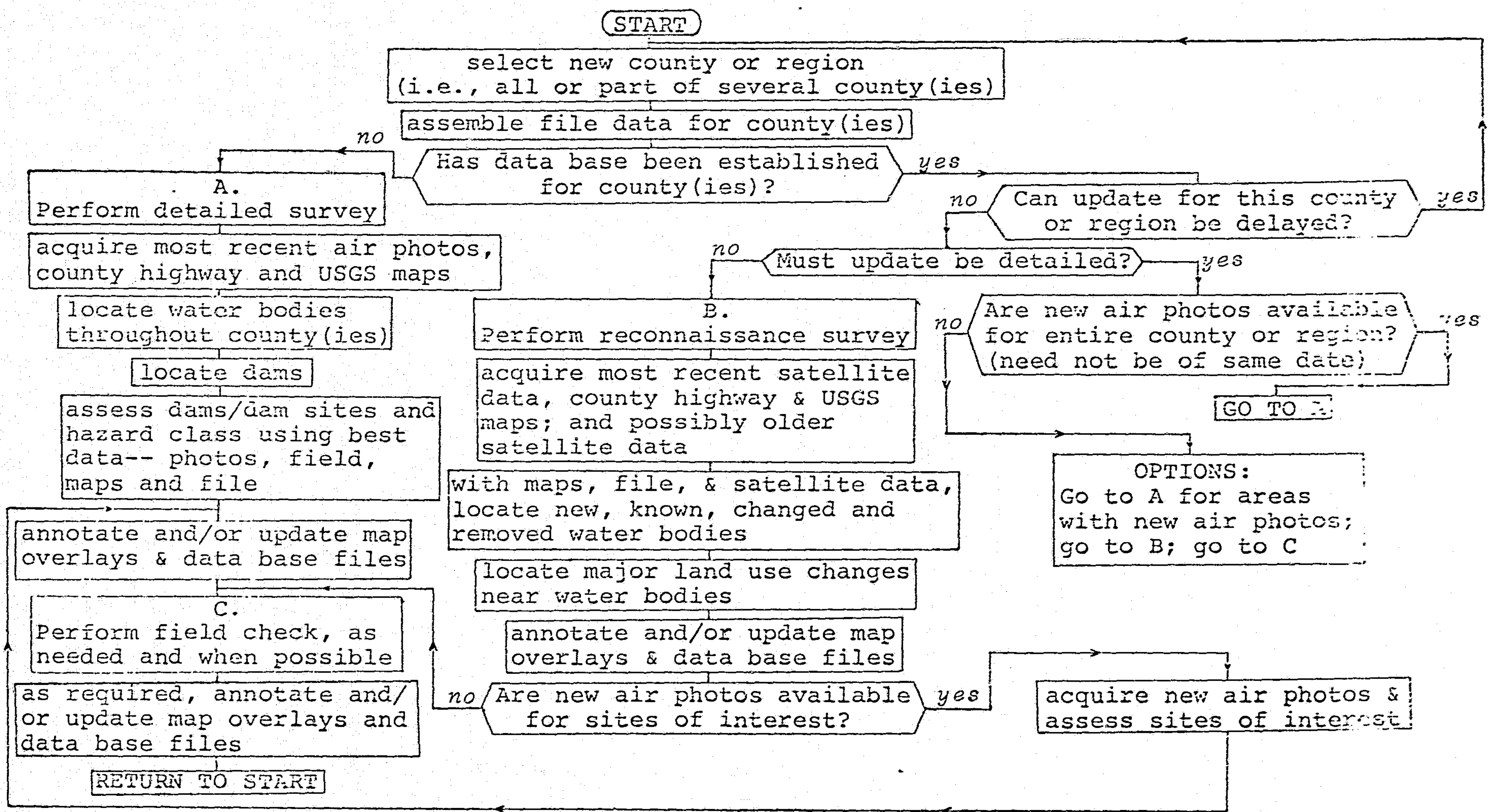

Figure 1. Principal steps for dam inventory and inspection.

APPENDIX F

RECENT SEMINARS AND ORIENTATION SESSIONS

SEMINAR IN REMOTE SENSING

List of Seminars

Spring Term 1979

Date	Speaker	Topic
Jan 24	Warren R. Philipson Cornell University	Organizational Meeting--Overview of Seminars and Introduction to Remote Sensing
Jan 31	Barry S. Siegal Sr. Remote Sensing Geologist Ebasco Services Inc. Greensboro, North Carolina	Geologic Site Investigations with Remotely Sensed Data
Feb 14	Walley W. Brown Sr. Scientist/Biologist Earth Satellite Corp. Washington, D.C.	Wetland Mapping Utilizing Aerial Photography
Feb 21	Robert L. Talerico Research Coordinator Forest Service, USDA Broomall, Pennsylvania	Quantifying Hardwood Defoliation with the Scene Color Standard Technique
Mar 7	George E. Courville Program Manager Department of Energy Washington, D.C.	IR Thermography and Building Heat Loss Analysis
Mar 14	Thomas J. Schmugge Physical Scientist NASA/GSFC Greenbelt, Maryland	Microwave Radiometry and its Applications
Mar 28	Paul G. Teleki Staff Geologist U.S. Geological Survey Reston, Virginia	The Seasat Synthetic Aperture Radar
Apr 4	William E. Collins Assistant Professor Columbia University New York, N.Y.	Spectral Properties of Natural Targets with an Airborne, 500-Channel Spectroradiometer
Apr 11	Gregory M. Wickware Lands Directorate Canada Centre for Inland Waters Burlington, Ont., Canada	Wetland Classification and Environmental Monitoring Using Digital Data

Date	Speaker	Topic
Apr 18	R. Michael Hord Manager, Applications Development Institute for Advanced Computations Alexandria, Virginia	Digital Image Processing on the Illiac IV
May 2	Benny M. Sørensen Project Manager Commission of the European Communities Joint Research Center Ispra, Italy	The European Ocean Color Scanner Experiment 1977 in the North Sea

Conference on LANDSAT Applications in New York State
STATE UNIVERSITY OF NEW YORK AT ONEONTA

April 6, 1979

AGENDA

9:15 - 10:00 AM	**COFFEE HOUR**	Rm. 321, Milne Library
10:00 - 11:00	**TOPIC:** *The Eastern Resources Remote Sensing Applications Center (ERRSAC) Program* **SPEAKERS:** Dr. Phil Cressey and Mr. Tom Austin, NASA/Goddard.	Rm. 318, Milne Library
11:00 - 12:00	**TOPIC:** *A State's Applications Program: Vermont* **SPEAKERS:** Mr. Brian Stone, State of Vermont Dr. Roy Whitmore, University of Vermont	Rm. 318, Milne Library
12:00 - 1:15	**LUNCH**	Hunt College Union
1:15 - 2:00	**TOPIC:** *Cornell University's Remote Sensing Program: Remote Sensing for the User.* **SPEAKERS:** Dr. Warren Philipson, Cornell University	Rm. 318, Milne Library
2:00 - 3:00	**TOPIC:** *Automated Geographic Information Systems related to LANDSAT Technology* **SPEAKER:** Professor Paul Baumann, State University of New York at Oneonta	Rm. 318, Milne Library
3:00 -	Small group discussions	Rm. 318 and 321 Milne Library

Co-sponsored by the NASA/Eastern Resources Remote Sensing Applications Center and the Department of Geography, State University of New York at Oneonta.

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CORNELL UNIVERSITY

WHAT'S NEW?

The Centers and Programs in Engineering

May 8-9, 1979

The Technical Program

8:30 - 9:10

The Materials Science Center (MSC)
Herbert H. Johnson, Professor of Materials Science and Engineering, Director.

9:10 - 9:50

The Center for Environmental Research
Gilbert Levine, Professor of Agricultural Engineering, Director.

9:50 - 10:30

The Center for Applied Mathematics
William F. Lucas, Professor of Operations Research and Industrial Engineering.

11:00 - 11:40

The Laboratory of Plasma Studies
Ravindra N. Sudan, Professor of Electrical Engineering and Applied and Engineering Physics, Director.

11:40-12:15

The Program in Remote Sensing
Ta Liang, Professor of Civil and Environmental Engineering, Director.

2:25 - 3:05

The Cornell Program for the Study of the Continents (COPSTOC)
Sidney Kaufman, Professor of Geological Sciences.

1:45 - 2:25

The Cornell Program on Submicrometer Structures (PRCSUS)
G. Conrad Dalman, Professor and Director of the School of Electrical Engineering.

3:05 - 3:50

The Cornell Injection Molding Project (CIMP)
Shan-Fu Shen, John Edson Sweet Professor of Mechanical Engineering, Co-Principal Investigator.

WHAT'S NEW?

The Centers and Programs in Engineering

Participant	Participant	Participant	Participant
Dr. D. E. Ordway President Sage Action, Inc. P.O. Box 416 Ithaca, NY 14850	Dr. Cecil C. Angell Asst. Chief Engineer Engineering Dept. 90 Rochester Prod. Div. General Motor 1000 Lexington Avenue Rochester, NY 14603	J. P. Williams Manager, Analytical Services Research Corning Glass Works Sullivan Park Corning, NY 14830	Dr. Jim Burns Corning Glass Works Corning, NY 14870
W. G. Martin III Manager, Corp. Plastics Lab Emerson Electric Company 8100 W. Florissant St. Louis, MO 63136	Christopher J. Witt Director, Engineering Dev. Cntr. Mail Stop CO2-14 Grumman Aerospace Corporation Bethpage, NY 11714	Dr. Donald L. Pieper General Manager - Engineering Continental Can Company Research & Engineering 1350 West 76th Street Chicago, IL 60620	Dr. John Forman IBM Labs Endicott, NY 13760
Leonard Kent Engineer Corning Glass Works FRC-2 Sullivan Park Corning, NY 14870	Peter S. DiPasquale Asst. Director Manufacturing Technology Div. Eastman Kodak Company Building 35 Rochester, NY 14650	Dr. Edgar Watson, Jr. Staff Research Chemist Technology Evaluation & Forecasting Standard Oil Company (Indiana) P.O. Box 400 Naperville, IL 60540	Dr. Karl Guyler AMP, Inc. Old Rt. 111 RD #2 Glen Rock, PA 17327
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Werner E. Haas Research Fellow Xerox Corporation 800 Phillips Road, Bldg. 114 Webster, NY 14850	Thomas J. Henry Manager - Engineering General Electric Company P.O. Box 5000 Binghamton, NY 13902	Jack W. Dennis Staff Engineer Caterpillar Tractor Co. Technical Center, Bldg. A Peoria, IL 61629	Dr. Charles Broaddus Director, Food, Paper & Coffee Technology Div. The Procter & Gamble Co.--Miami Valley Labs P.O. Box 39175 Cincinnati, OH 45247
John F. Barrows Asst. Director Research Labs. Carrier Corporation Syracuse, NY 13221	Dr. Thomas L. Henson Director, Research & Engineering Chem & Met Division GTE Sylvania Towanda, PA 18848	Louis B. Allen Manager, Materials & Processes IBM Dept. E-40, P.O. Box 6 Endicott, NY 13760	Albert D. Tuttle Vice President, R & D New York State Electric & Gas Corp. 4500 Vestal Parkway East Binghamton, NY 13902
Carl G. Anderson Manager, Research & Development Chicago Pneumatic Tool Company 2200 Bleecker Street Utica, NY 13503	Joseph W. Kosalek Manager, Technical Services Wilson Sporting Goods Co. Kellogg Road Cortland, NY	J. Earl Thomas Manager, Advanced Development NCR Corporation 950 Danby Road Ithaca, NY 14850	Mr. E. Martin Remick Senior Engineer (Thermal) Corning Glass Works--SP-DV-2 Corning, NY 14830
Dr. Allen M. Alper Operations Manager Chem & Met Division GET Sylvania Towanda, PA 18848	Harry Shawl Project Engineer Wilson Sporting Goods Co. Kellogg Road Cortland, NY	Vincent A. Scotto Development Engineer IBM, Dept. T 59, Bldg. 28-3 1701 North St. Endicott, NY 13760	Mr. Dennis M. Peel Director, Research & Development Gleason Works Rochester, NY
			Mr. Walter A. Schratz Manager, University Relations Westinghouse Electric Corp. Ardmore Blvd. and Brinton Rd. Pittsburgh, PA 15221

APPENDIX G

NEWSLETTER RECIPIENTS

CORNELL REMOTE SENSING NEWSLETTER

LIST OF RECIPIENTS

CAMPUS GROUPS AND INDIVIDUALS*

1. Administration

F.H.T. Rhodes	(President, Cornell)
W.K. Kennedy	(Provost, Cornell)
J.W. Spencer	(Special Ass't. to President)

2. Administrative Programming Service

C. Selvarajah

3. Aerospace Studies (Air Force R.O.T.C.)

J. Levisky	(Major)

4. Agricultural Economics

O.D. Forker	(Chairman; Prof.)
D.J. Allee	(Prof.)
H.E. Conklin	(Prof.)
G.R. Fohner	(Research Specialist)
K.V. Gardner	(Sr. Extension Assoc.)
W.C. Hunt	(Extension Assoc.)

5. Agricultural Engineering

D.A. Haith	(Assoc. Prof., Civil & Envir. Eng'g. and Agr. Eng'g.)
L.H. Irwin	(Assoc. Prof.)
W.J. Jewell	(Assoc. Prof.)
G. Levine	(Prof.; Dir. Center for Envir. Research)
R.C. Loehr	(Dir., Environmental Studies; Prof., Civil and Envir. Eng'g. and Agr. Eng'g.)
D.C. Ludington	(Assoc. Prof.)

6. Agronomy

R.F. Lucey	(Chairman; Prof.)
R.W. Arnold	(Prof.)
D.R. Bouldin	(Prof.)
W.F. Croney	(Sr. Ext. Assoc.)
M. Drosdoff	(Prof. Emer.)
E.R. Lemon	(Prof.; Soil Scientist, U.S.D.A.)
G.W. Olson	(Assoc. Prof.)
J.H. Peverly	(Asst. Prof.)
A.R. Van Wambeke	(Prof.)

7. Anthropology

8. Applied and Engineering Physics

A.F. Kuckes	(Prof.)

9. Astronomy

F.D. Drake	(Dir., Nat'l. Astronomy & Ionosphere Center; Prof.)
M.O. Harwit	(Prof.)
C. Sagan	(Dir. Planetary Studies; Assoc. Dir. Radiophysics and Space Research; Prof.)
Y. Terzian	(Prof.)
J. Veverka	(Assoc. Prof.)

10. Atmospheric Sciences (Agronomy)

B.E. Dethier	(Prof.)
W.W. Knapp	(Assoc. Prof.)
A.B. Pack	(Sr. Extension Assoc.)

11. Biological Sciences

12. Boyce Thompson Institute

E.H. Buckley	(Plant Biochemist)
J.S. Jacobson	(Plant Physiologist)

13. City and Regional Planning

S. Saltzman	(Chairman; Prof.)
B.G. Jones	(Prof.)
S.W. Stein	(Prof.)

14. Civil and Environmental Engineering

R.N. White	(Dir. School of C.E.E.; Prof., Structural Eng'g.)
G.B. Lyon	(Asst. Dir.; Assoc. Prof., Envir. Eng'g.)
J.F. Abel	(Assoc. Prof., Structural Eng'g.)
D.J. Belcher	(Prof. Emer.)
J.J. Bisogni	(Asst. Prof., Envir. Eng'g.)
W.H. Brutsaert	(Prof., Envir. Eng'g.)
R.I. Dick	(Prof., Envir. Eng'g.)
L.B. Dworsky	(Prof., Envir. Eng'g.)
T.L. Erb	(Research Specialist, Remote Sensing Program)
G.P. Fisher	(Prof., Envir. Eng'g.)
C.D. Gates	(Prof., Envir. Eng'g.)
P. Gergely	(Prof., Structural Eng'g.)
J.M. Gossett	(Asst. Prof., Envir. Eng'g.)
J.G. Hagedorn	(Data Analyst, Remote Sensing Program)
S.C. Hollister	(Prof. Emer.)
A.R. Ingraffea	(Asst. Prof., Structural Eng'g.)

* Newsletters are sent to the main office of each department listed as well as to various individuals within the department. In addition, Newsletters are provided to graduate and undergraduate students, upon request.

14. Civil and Environmental Eng'g. (Cont.)

G.H. Jirka	(Asst. Prof., Envir. Eng'g.)
P.R. Jutro	(Sr. Research Assoc., Envir. Eng'g.)
F.H. Kulhawy	(Assoc. Prof., Structural Eng'g.)
T. Liang	(Prof., Remote Sensing Program)
J.A. Liggett	(Prof., Envir. Eng'g.)
P. Liu	(Asst. Prof., Envir. Eng'g.)
D.P. Loucks	(Chairman, Envir. Eng'g.; Prof.)
W.R. Lynn	(Prof., Envir. Eng'g.)
W. McGuire	(Prof., Structural Eng'g.)
A.J. McNair	(Prof., Civil and Envir. Eng'g.)
A.H. Meyburg	(Prof., Envir. Eng'g.)
A.H. Nilson	(Chairman, Structural Eng'g.; Prof.)
N. Orloff	(Assoc. Prof., Envir. Eng'g.)
T. Pekoz	(Assoc. Prof., Structural Research Mgr.)
W.R. Philipson	(Sr. Research Assoc., Remote Sensing Program)
D.A. Sangrey	(Assoc. Prof., Structural Eng'g.)
R.E. Schuler	(Assoc. Prof., Envir. Eng'g. and Economics)
C.A. Shoemaker	(Asst. Prof., Envir. Eng'g.)
F.O. Slate	(Prof., Structural Eng'g.)
J.R. Stedinger	(Asst. Prof., Envir. Eng'g.)
G. Winter	(Prof. Emer.)

15. College of Agriculture and Life Sciences

D.L. Call	(Dean)

16. College of Architecture, Art and Planning

K.C. Parsons	(Dean; Prof.)
H.W. Richardson	(Assoc. Dean; Assoc. Prof.)

17. College of Engineering

T.E. Everhart	(Dean)
P.R. McIsaac	(Assoc. Dean; Prof., Electrical Eng'g.)
F.J. Ahimaz	(Dir., Eng'g. Basic Studies; Prof.)

18. Computer Graphics

D.P. Greenberg	(Dir.; Prof., Arch.)

19. Computer Science

20. Design and Environmental Analysis

21. Ecology and Systematics

J.P. Barlow	(Assoc. Prof., Oceanography)
P.F. Brussard	(Assoc. Prof., Ecology)
G.E. Likens	(Prof., Ecology)
P.L. Marks	(Assoc. Prof., Biology)

22. Education

R.B. Fischer	(Prof.)
V.N. Rockcastle	(Prof.)

23. Electrical Engineering

R. Bolgiano, Jr.	(Prof.)
M. Kim	(Prof.)
W.H. Ku	(Prof.)
S. Linke	(Prof.)
C. Pottle	(Assoc. Prof.)
G.J. Wolga	(Prof.)

24. Entomology

25. Entomology Extension

26. Floriculture and Ornamental Horticulture

M.I. Adleman	(Assoc. Prof., Landscape Architecture)
A.S. Lieberman	(Prof., Landscape Architecture)
P.J. Trowbridge	(Asst. Prof., Landscape Architecture)

27. Geological Sciences

J.E. Oliver	(Chairman; Prof.)
J.M. Bird	(Prof.)
A.L. Bloom	(Prof.)
C.E. Karig	(Assoc. Prof.)
J. Ni	(Research Specialist)
W.B. Travers	(Assoc. Prof.)

28. History of Art

29. International Agriculture

J.F. Metz	(Director; Prof., Marketing)
L.W. Zuidema	(Asst. Director)

30. International Studies, Center

31. Landscape Architecture Grad. Program

L. Mirin	(Asst. Prof.)

32. Materials Science and Engineering

33. Mechanical and Aerospace Engineering

34. Media Services

A.S. Moffat	(Science Newswriter)

35. Military Science (Army R.O.T.C.)

36. Modern Languages and Linguistics

E.J. Beukenkamp (Instructor)

37. Natural Resources

W.H. Everhart	(Chairman; Prof.)
H.B. Brumsted	(Assoc. Prof.)
J.W. Caslick	(Senior Research Assoc.)
L.S. Hamilton	(Prof.)
R.R. Morrow	(Prof.)
R.T. Oglesby	(Prof.)
M.E. Richmond	(Assoc. Prof; Program Leader, Coop. Wildlife Research Unit)
W.R. Schaffner	(Research Assoc.)
J. Skaley	(Research Asst.)
B.T. Wilkins	(Assoc. Prof.; Program Leader, Sea Grant Advisory Service)

38. Naval Science (Navy R.O.T.C.)

39. N.Y.S. Agricultural Experiment Station, Ithaca

T. Hullar (Assoc. Director)

40. Operations Research and Industrial Engineering

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A. Schultz	(Prof.)
B.W. Turnbull	(Assoc. Prof.)

41. Planning and Facilities

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42. Plant Pathology

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S.V. Beer	(Assoc. Prof.)
J.C. Studenroth	(Research Asst.)
H.D. Thurston	(Prof.)

43. Pomology

W.J. Kender (Chairman; Prof.)

44. Public Information

M.B. Stiles (Staff Writer)

45. Resource Information Laboratory

E.E. Hardy (Director)

46. Rural Sociology

H.R. Capener (Prof.)

47. Sociology

48. Sponsored Programs

T.R. Rogers (Director)

49. Theoretical and Applied Mechanics

50. Thermal Engineering

51. Unclassified Students

E.L. Ziegler, Jr. (Director)

52. University Archives

G.P. Colman (Librarian)

53. U.S. Plant, Soil and Nutrition Laboratory

54. Vegetable Crops

* * * * *

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(b) R.H. Rogers
(c) T.W. Wagner

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National Park Service
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Mr. G.A. Hanuschak
Statistical Report Service
U.S. Dept. Agriculture
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Mr. Maurice B. Harrison
Bernard Lodge Factory
Spanish Town, Jamaica, W.I.

Mr. William Harting
Tri-State Regional Planning
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Dr. Hassan M. Hassan
Survey Department
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Prof. F.M. Henderson
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Dr. Gary K. Higgs
Dept. Geology & Geography
Mississippi State University
Mississippi State, Mississippi

Mr. Gregory A. Hill
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APPENDIX H

RECENT NEWSLETTERS

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

SEMINAR IN REMOTE SENSING--SPRING '79

The Seminar in Remote Sensing (CEE A696) is a one credit-hour course in the School of Civil and Environmental Engineering. Seminars are held on Wednesdays, at 4:30 p.m., in Hollister Hall. Each week a different topic on remote sensing research, developments or applications is presented by a guest speaker from industry, government, Cornell or other institution. The audience generally includes students and staff from at least ten Cornell departments.

Many of the spring semester seminars have been scheduled. The speakers include: William Collins, Columbia University (airborne spectroradiometric studies); Walley W. Brown, Earth Satellite Corp. (wetland mapping); Robert Talerico, U.S. Forest Service (forestry studies); James C. Hammack, Defense Mapping Agency (hydrographic applications); George E. Courville, U.S. Department of Energy (thermal sensing and energy conservation); Thomas Schmugge, National Aeronautics and Space Administration (microwave radiometry); and Paul G. Teleki, U.S. Geological Survey (Seasat's imaging radar). Consult the Newsletter and weekly seminar announcements, or contact Warren Philipson (tel. 607-256-4330), for current information.

Seminars scheduled for January are, as follows:

Wed., 24 Jan — Organizational meeting--Overview of Seminars and Remote Sensing: Ta Liang and Warren Philipson, Cornell.

Wed., 31 Jan — (Topic: Remote Sensing for Power Plant Siting): Dr. Barry Siegal, Ebasco Services, Inc., Greensboro, North Carolina.

SATELLITE UPDATE

A "pre-launch" review of four earth resources satellites--Landsat-C, the Heat Capacity Mapping Mission Satellite, Seasat-A and Nimbus G--was included in the March 1978 Newsletter (v.6, n.7). The status of each is, as follows: Landsat-C was launched on 5 March 1978 and redesignated Landsat-3. Although the Return Beam Vidicon and Multispectral Scanner (MSS) reflective band systems have provided data since launch, problems have been experienced with the MSS thermal band. Presently, real-time thermal data are being acquired with one detector, and these data are being duplicated to fill a vacant data line caused by the failure of the second detector. (continued, p.2).

CALL FOR PAPERS

The 8th Annual Remote Sensing of Earth Resources Conferences will be held at the University of Tennessee Space Institute, 27-29 March 1979. Proposals for papers on all facets of remote sensing should be submitted to: Dr. F. Shahrokhi, Conference Director, Univ. of Tenn. Space Institute, Tullahoma, Tenn. 37388. Proposals must be received by 10 January 1979. They should include a titled abstract (approx. 150 words), together with the author's name, address and position.

LANDSAT DATA FROM NON-U.S. SOURCES

According to the Landsat Data Users Notes (Nov. 78, no.3), listings of Landsat data received and processed by Brazil, Canada and Italy will be available from the EROS Data Center by early 1979. Information regarding coverage and the appropriate country to contact will be in geographically retrievable format and will be available to all users. Contact the EROS Data Center, U.S. Geological Survey, Sioux Falls, S.D. 57198 (tel. 605-594-6511) for details.

SHORT COURSES

Digital Image Processing of Earth Observation Sensor Data; 5-9 Feb; $530 fee; Contact: Continuing Engineering Education, George Washington Univ., Washington, D.C. 20052.

Remote Sensing and Digital Information Extraction; 12-16 Feb; $530 fee; Contact: George Washington Univ. (see above).

7th Alberta Remote Sensing Course (designed to instruct multidisciplinary users in application, acquisition and interpretation of Landsat and aircraft imagery); 26 Feb-2 Mar; $135 fee; Contact: Alberta Remote Sensing Center, 11th Floor, Oxbridge Place, 9820 - 106th St., Edmonton, Albt., Canada T5K 2J6 (phone 403-427-2381).

Satellite Update, continued

Seasat-A was launched on 27 June 1978 and redesignated Seasat-1. The visual and infrared radiometers failed in September, and the spacecraft's power system failed in October. Before shutdown, however, a large volume of visual, infrared and, especially, microwave data had been acquired.

The Heat Capacity Mapping Mission Satellite and its dual-channel radiometer have functioned well since launch on 26 April 1978. Data processing and distribution are now getting into full operation. Similarly, Nimbus G, now designated Nimbus 7, was placed in orbit on 24 October 1978, and first look data from all sensors are of good quality.

SELECTED ARTICLES

Holderman, F., M. Bohner, B. Bargel and H. Kazmierczak. 1978. Review of automatic image processing. Photogrammetria 34:6:225-258.

Kirschner et al. 1978. Map unit composition assessment using drainage classes defined by Landsat data. Soil Sci. Soc. Amer. Jour. 42:5:768-771.

Legeckis, R. 1978. A survey of worldwide sea surface temperature fronts detected by environmental satellites. Jour. Geophysical Research 83:C9:4501-4522.

Mengers, P. 1978. Low contrast imaging. Electro-Optical Systems Design 10:10:20-26.

Mintzer, O.W. and D. Spragg. 1978. Mini-format remote sensing for civil engineering. Transportation Eng'g. Jour. of ASCE 104:TE6: 847-858.

Journal of Research of the U.S. Geological Survey 1978, v.6, n.6.
- -Gaydos & Newland. Inventory of land use of the Puget Sound region using Landsat digital data.
- -Gaydos, L. Low-cost computer classification of land cover in the Portland area, Oregon, by signature extension techniques.

Photogrammetric Eng'g. & Remote Sensing 1978. v.44, n.8 (Aug.)
- -Warne, D.K. Landsat as an aid in the preparation of hydrographic charts.
- -Eyton & Kuether. Macrophotography of satellite images.
- -Best & Smith. Photographic contrast enhancement of Landsat imagery.
- -Richardson, S.L. Remote sensing on a shoestring.
- -Bauer et al. Area estimation of crops by digital analysis of Landsat data.
- -Civco et al. A technique for evaluating inland wetland photointerpretation: The Cell Analytic Method.
- -Jordan et al. Use of manual densitometry in land cover classification.
- -Hunka, G.W. Aided-track cursor for improved digitizing accuracy.

The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330).

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

PRELIMINARY ASSESSMENT OF LOVE CANAL LANDFILL

During the past summer, leaching of toxic chemicals from the Love Canal landfill in Niagara Falls, N.Y. caused the site to be declared a Federal disaster area, and some 240 homes were scheduled to be evacuated. At the height of the crisis, officials of the New York State Department of Health requested the staff of the Cornell Remote Sensing Program to assist in determining the extent of leachate migration. In order to provide a rapid response in evaluating the site, Program staff relied solely on interpretation of aerial photographic coverage available at Cornell. This included medium scale, panchromatic coverage acquired in 1938, 1951 and 1966. These dates were significant because, in 1938, the landfill was an open canal in a generally undeveloped area; dumping had occurred during the 1940s and early 1950s; backfilling had begun by 1951; and the canal was covered and the area built-up by the mid-1950s.

Through stereoscopic analysis of the photographs, Cornell staff: (1) assessed the area's physiographic setting, (2) compiled time-sequential, 1:24,000 scale map overlays depicting generalized land use and drainage, and (3) identified critical sites for field sampling, based primarily on interpretation of soil and drainage patterns. In addition, the basic parameters for flying new, color-infrared aerial photography of the area were outlined for State Health personnel. The entire effort was completed over a two-day period. (continued, p. 2).

REMOTE SENSING FACULTY POSITION OPEN AT CORNELL

Cornell University's School of Civil and Environmental Engineering is seeking to fill one faculty position in Remote Sensing, at the assistant or associate professor level. Applicants should have a thorough background in airphotos and remote sensing, with a Ph.D. degree in engineering or natural sciences. Academic and professional experience should have emphasis in quantitative remote sensing and digital analysis, and/or qualitative remote sensing and applications. The position will involve teaching and advising undergraduate and graduate students, and developing and conducting research in various disciplines. The teaching and research will interface with airphoto interpretation. Please send a detailed resume and references to Professor Ta Liang, Remote Sensing Program, School of Civil and Environmental Engineering, Hollister Hall, Cornell University, Ithaca, N.Y. 14853. Cornell is an equal opportunity/affirmative action employer and welcomes applications from women and minority members.

SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing is held on Wednesdays, at 4:30 p.m., in Hollister Hall. Anyone is welcome to attend. Seminars scheduled for February are, as follows:

Wed., 7 Feb — Spectral Properties of Natural Targets Observed with an Airborne, 500-Channel Spectroradiometer: W. Collins, Columbia Univ. & Goddard Institute for Space Studies, New York, N.Y.

Wed., 14 Feb — Wetland Mapping Utilizing Aerial Photography: W.W. Brown, Earth Satellite Corp., Washington, D.C.

Wed., 21 Feb — Quantifying Hardwood Defoliation with the Scene Color Standard Technique: R.L. Talerico, U.S. Forest Service, Broomal, Pa.

Wed., 28 Feb — Hydrographic Remote Sensing: J.C. Hammack, Defense Mapping Agency Hydrographic Center, Washington, D.C.

ASCE CALL FOR PAPERS

During the Spring 1980 Convention of the American Society of Civil Engineers, to be held in Portland, Oregon in April 1980, the Remote Sensing Committee of the Aerospace Division will sponsor a technical session, "Applications of Aerial Remote Sensing in Mining and Evaluation of Geologic Hazards." Five papers describing the practical use of aerial sensors in mining industry applications, or in the detection or evaluation of geologic hazards related to engineering projects or the environment, are desired. Authors should send a one-page abstract and brief resume to: Dr. Donald B. Stafford, Dept. of Civil Engineering, Clemson Univ., Clemson, S.C. 29631, before 1 March 1979.

CALL FOR PAPERS

The 7th Biennial Workshop on Color Aerial Photography in the Plant Sciences will be held at the University of California-Davis, 15-17 May 1979. Those wishing to present a paper or participate in an informal poster session should submit a titled summary of about 200 words; their name, address, position and professional affiliation; the estimated time of presentation (20 mins. max.); and the required visual aids. This information should be sent to: Mr. William M. Cielsa, USDA Forest Service, FI & DM/Methods Application Group, 2810 Chiles Rd., Davis, Calif. 95616, before 15 March 1979.

Love Canal, continued

State personnel have sampled all recommended sites and flown new 35mm and 70mm photography. The Remote Sensing Program has acquired additional "historic" aerial photographs and background reports, and consultations are continuing. Funds to support the Cornell staff's participation have been provided by an ongoing grant from NASA to the School of Civil and Environmental Engineering. For further information, contact Warren Philipson at Cornell, or Dr. C. Stephen Kim, Chief, Biometrics Lab., Div. of Labs. & Research, N.Y.S. Dept. of Health, Empire State Plaza, Albany, N.Y. 12201 (tel. 518-474-1518).

SELECTED ARTICLES AND PUBLICATIONS

Brown, R.J. & J. Cihlar. 1978. Introduction to aerial thermography applications in energy conservation programs. Research Report 78-2. Canada Centre for Remote Sensing, Ottawa. 25p.

Proceedings 12th Int'l. Symp. on Remote Sensing of Environment. Held April 1978, in Manila. 2382 pp. Available: E.R.I.M., Box 8618, Ann Arbor, Mich. 48107. ($60 + post./handling, $2.50 in U.S.).

Swain, P.H. & S.M. Davis (eds.). 1978. Remote sensing: The quantitative approach. McGraw-Hill Inc. 396p. ($39.50).

<u>Photogrammetric Eng'g. & Remote Sensing</u> 1978. v.44, n.9 (Sept.)

- -Murtha, P.A. Symposium on remote sensing for vegetation damage assessment.
- -Murtha, P.A. Remote sensing and vegetation damage: A theory for detection and assessment.
- -Heller, R.C. Case applications of remote sensing for vegetation damage assessment.
- -Watkins, T. The economics of remote sensing.
- -Welby, C.W. Application of Landsat imagery to shoreline erosion.
- -Rao et al. Crop discriminability in the visible and near infrared regions.
- -Lawton & Palmer. Enhancement of linear features by rotational exposure.

The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330).

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

REMOTE SENSING AND U.S. FOREIGN POLICY

by
Charles K. Paul

Dr. Paul is with the Agency for International Development, where he is Manager of Remote Sensing Programs, in the Office of Science and Technology. He received his M.S. and Ph.D. in Photogrammetric and Geodetic Engineering at Cornell, in 1967 and 1970, respectively. The views expressed here are those of Dr. Paul and do not necessarily reflect the views or policy of the Cornell Remote Sensing Program.

There can no longer be any doubt that scientists play a significant role in focusing international concern on the plight of dissidents who are denied basic human and political rights. Actions of individual scientists of the American Association for the Advancement of Science and the Federation of American Scientists have vividly exposed the suppression of Soviet Jewish scientists and, for better or for worse, have affected recent U.S./Soviet scientific, and even political, relations. Pakistan's refusal to sign international nuclear regulatory agreements saw the subsequent shutting off of all U.S. foreign assistance, which was just started up again late in 1978. The role of communications satellites in the voice links through the White House-Kremlin "hotline" and the severe storm predictions by weather satellites to prepare for disaster are obvious examples of the effects of science on our foreign policy. But the most inconspicuous scientific tool of them all guarantees for most people on the earth at least a certain degree of comfort each night before they go to sleep--the guarantee that SALT agreements are verifiable, and the belief that the provisions of these agreements are being verified. This tool is the quiet, unobtrusive remote sensing sentinel of space. The impact of these satellites on our foreign policy is unfathomable. *(cont'd. p.2)*.

SHORT COURSES

Air and Space Technology in the Forest Environment; 19-24 Aug; $300 fee; Contact: NASA Technology Transfer Project, Humboldt State Univ., Arcata, Calif. 95521 (tel. 707-826-3112).

Advanced Topics in the Analysis of Remote Sensing Data; 14-18 May; $595 fee; Contact: Prof. P.H. Swain, LARS, 1220 Potter Dr., West Lafayette, Ind. 47906 (tel. 317-749-2052).

SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing is held on Wednesdays, at 4:30 p.m., in B-14 Hollister Hall. Anyone is welcome to attend. Seminars scheduled for March, and a change in the last February seminar, are as follows:

Wed., 28 Feb	(Topic: Oceanographic Surveys): Dr. Alexander Malahoff, Chief Scientist, National Ocean Survey, NOAA, Rockville, Md.
Wed., 7 Mar	IR Thermography and Building Heat Loss Analysis: Dr. George E. Courville, U.S. Department of Energy, Washington, D.C.
Wed., 14 Mar	Microwave Radiometry and Its Applications: Dr. Thomas Schmugge, NASA Goddard Space Flight Center, Greenbelt, Md.
Wed., 21 Mar	No Seminar, Spring Vacation
Wed., 28 Mar	(Topic: Seasat's Imaging Radar): Dr. Paul G. Teleki, U.S. Geological Survey, Reston, Va.

Foreign Policy, cont'd.

Yet as these satellites attempt to limit man's materialistic preparations for war, they at the same time can address man's questions regarding the war of the coming century--the war on global poverty. If NASA's Large Area Crop Inventory Experiment (LACIE) verified nothing else, it did show that we can indeed survey accurately and timely the Soviet wheat crop. If one scales this technology down to a more appropriate, multi-stage technique, with aerial photos and large numbers of field enumerators, existing and future satellite systems offer great potential to provide accurate crop statistics where it really counts--in the developing world. The U.S. Department of Agriculture and the Agency for International Development have initiated just such a technique in twelve developing countries in Latin America, Africa, and Southeast Asia. The economic benefits of accurate crop statistics in the developing world are measurable: (1) they permit agricultural ministries to buy on international markets if shortfalls appear imminent, or export if crop excesses appear likely; (2) they can govern the U.S. P.L. 480 Food for Peace Program, by avoiding excess food exports to countries with larger-than-expected crop production, the excess of which reduces food prices in that country and thus lowers income gained by small farmers; and (3) they can, if they reveal probable large harvest production, serve as collateral for small farmers to acquire bank loans for farm improvements. In several countries of the Sahel and south Asia, the social benefits translate directly to human lives.

It is in the training of remote sensing technology where shoulder-to-shoulder scientific diplomacy is played out. Remote sensing is clearly a U.S.-dominated technology, still today. The developing world looks mostly to us for technical assistance in both learning the technology and developing national institutions to carry out resource exploration on their own. If our present space policy continues, our lead in developing satellite remote sensing systems and programs benefiting the third world will erode around 1983, with both the French and the Japanese overtaking us. This erosion in U.S. leadership has forced A.I.D. to coordinate its development of regional remote sensing centers with the United Nations and industrialized nations of Europe and Asia. The regional centers are thus able to accommodate, and encourage, students who would otherwise not be able or willing to attend an institution if it were run strictly by the U.S. or solely by another industrialized nation. Examples of this professional contact in regional remote sensing centers are numerous: the Nairobi center sees Somalians, Ugandans, and Tanzanians working together on common resource problems; the Soviets have offered us satellite data and technicians in Upper Volta; and the Vietnamese, Thai, and Chinese will be attending the Bangkok center. Remote sensing, because of its objective view, its ignorance of political borders, its exciting, space-oriented technology, and its search for resource clues over large areas, is geopolitics in evolution.

SELECTED ARTICLES AND PUBLICATIONS

Civco, D.L., W.C. Kennard & M.W. Lefor. 1978. Handbook of remote sensing imagery of Connecticut. Storrs Agr. Exp. Sta. Bulletin 448. 98p. Avail: Agr. Publications Office, U-35, College of Agr. & Natural Resources, Univ. of Conn., Storrs, Conn. 06268 ($2.00).

Rango, A., et al. 1979. Snow-covered area utilization in runoff forecasts. Jour. Hydraulics Div., ASCE 105:HY1:53-66.

The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330).

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

MONITORING DAMS WITH REMOTELY SENSED DATA

The value and use of remotely sensed aircraft and satellite data for inventorying dams, determining their hazard class, and assessing their condition were reviewed in a recent study by staff of Cornell's Remote Sensing Program. The work culminated in the development of a methodology for increasing the efficiency and accuracy of field-based dam inspection by incorporating remote sensing techniques into state or federal monitoring activities.

The methodology focuses on the New York State Dam Safety Program, placing emphasis on readily available remotely sensed data--aerial photographs and Landsat satellite data. Aerial photographs are employed in establishing a statewide data base, referencing dam information to county highway and U.S. Geological Survey 1:24,000 scale topographic maps. Updating of the data base is performed on a county or regional basis using aerial photographs or Landsat data as a primary source of information. In general, field inspections are limited to high-hazard or special problem dams, or to dams which cannot be assessed adequately with aerial photographs. (continued, page 2).

SURVEY FOR URBAN-MOSQUITO CONTROL

In a NASA-sponsored demonstration project for the New York State Department of Health, staff of Cornell's Remote Sensing Program completed an airphoto survey of potential mosquito breeding sites in an urban area of central New York. A comprehensive inventory of over 400 permanent and seasonal wet sites was derived entirely through stereoscopic analysis of 1:5,000 scale panchromatic aerial photographs, supplied by the U.S.A.F. Rome Air Development Center. All inventory data were submitted to State Health officials on an overlay to a 1:9,600 scale planimetric map. (continued, page 2).

CONFERENCES

2nd Congress Quebec Remote Sensing Association; 3-4 May; in Sherbrooke, Canada; Contact: Dr. Ferdinand Bonn, Dept. de Geographie, Univ. de Sherbrooke, Sherbrooke, Quebec, Canada J1K 2R1.

Symposium on Measurement, Mapping, Management in the Coastal Zone from Virginia to Maine; 21-23 May; in New York, N.Y.; sponsored by American Congress on Surveying and Mapping; Contact: MMM Symposium, Federal Building, Suite 32-120, 26 Federal Plaza, New York, N.Y. 10007.

3rd International Conference on Cartographic Processing and Analysis of Satellite Imagery; 19-22 June; in Toulouse, France; Contact: G.D.T.A., 18, avenue Edouard-Belin, 31055 Toulouse Cedex, France.

SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing is held on Wednesdays, at 4:30 p.m., in B14 Hollister Hall. Anyone is welcome to attend. Seminars scheduled for April are, as follows:

Wed., 4 Apr	Spectral Properties of Natural Targets Observed with an Airborne, 500-Channel Spectroradiometer: William E. Collins, Columbia Univ. & Goddard Inst. for Space Studies, N.Y., N.Y.
Wed., 11 Apr	Wetland Classification and Environmental Monitoring Using Digital Data: Gregory M. Wickware, Lands Directorate, Canada Centre for Inland Waters, Burlington, Ontario, Canada.
Wed., 18 Apr	Digital Image Processing on the Illiac IV: R. Michael Hord, Institute for Advanced Computation, Alexandria, Virginia.
Wed., 25 Apr	NO SEMINAR--Remote Sensing Symposium in Michigan

Monitoring Dams, cont'd.

Although the methodology places emphasis on available data, the parameters for acquiring new aircraft data are outlined and various sensors are considered. Large scale (1:10,000) vertical, stereoscopic, color-infrared aircraft photography, flown during periods of minimum vegetation and no snow, is recommended for assessing dam condition.

The study was conducted by Jan P. Berger under the direction of Warren R. Philipson and Ta Liang, and with the cooperation of Kenneth D. Harmer of the New York State Department of Environmental Conservation. Funding was provided by a grant from the Office of Water Research and Technology, U.S.D.I., and by an ongoing grant for applied research from the National Aeronautics and Space Administration. Copies of the final report, "Remote Sensing Assessment of Dam Flooding Hazards: Methodology Development for the New York State Dam Safety Program," are available from NTIS, 5285 Port Royal Rd., Springfield, Va., 22161 (NTIS No. PB289371; $3.00 microfiche, $5.25 paper copy). A limited number of copies of the report are also available from the Remote Sensing Program, Cornell Univ., Hollister Hall, Ithaca, N.Y. 14853, for a charge of $5.00 per copy.

Mosquito Survey, cont'd.

Selected field checks by county health personnel verified the accuracy and value of the airphoto inventory. All ground-level sites sampled had mosquito larvae or cast skins. In addition, the inventory pointed out one potential drawback of conventional ground surveys in urban areas--over 15% of the identified sites were water accumulations on rooftops. Although no mosquito larvae were found at any of the rooftops sampled, most sites supported varying degrees of plant and insect life, indicating that mosquito breeding could occur during the summer. Based on these findings, officials of the State Health Department are currently considering aerial surveys in other parts of the State.

The airphoto analysis was performed by William R. Hafker under the direction of Warren R. Philipson. For further information, contact Dr. Philipson at Cornell, or Dr. Charlie Morris, N.Y.S. Dept. of Health, Illick Hall, Rm. 133, College of Environmental Science & Forestry, Syracuse, N.Y. 13210 (tel. 315-473-8751).

SHORT COURSES

Remote Sensing Techniques and Applications in Arid Lands; 14-25 May; $650 fee; Contact: Philip N. Slater, Committee on Remote Sensing, Bldg. 94, Univ. of Arizona, Tucson, Ariz. 85721 (tel. 602-626-4242).

4th Annual Institute of Cartographic Methods and Remote Sensing Applications; six 3-credit courses conducted over two 5-week sessions from 4 June to 10 Aug.; $85/credit or $1,000/total on non-credit basis, plus fee; Contact: Prof. Bruce LaRose, Inst. of Cartography, Pace University, Briarcliff Manor, N.Y. 10510 (tel. 914-769-3200).

RECENT PUBLICATION

Todd, W.J. 1978. A selective bibliography: Remote sensing applications in land use and land cover inventory tasks. NTIS document #PB-283027/AS, 33pp. (N.T.I.S., 5285 Port Royal Rd., Springfield, Va. 22161, $3.00 microfiche, $4.50 paper copy.)

The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330).

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

FLOOD MODELING WITH LANDSAT

In a NASA-sponsored feasibility study, Landsat satellite imagery was used as the primary source of information on the extent of flooding in the Black River Basin of northern New York State. Similar to many other low gradient rivers, the Black River floods regularly, inundating farm land and breaching roadways. The average annual flood damages are estimated to exceed $500,000; however, ground surveys of inundation may be incomplete and thus inadequate for estimating losses.

Landsat images (band 7, 0.8-1.1μm) depicting flood conditions during several flood seasons since 1973 were obtained for analysis. Through visual interpretation of photographically enlarged and projected images, the flood boundaries were delineated on matte acetate at a scale of approximately 1:84,000. A qualitative assessment of flood boundary changes and flood prone areas was obtained from the acetate sheets by overlaying different combinations of dates. For area measurements, however, the flood boundaries were further enlarged to 1:24,000 scale, U.S. Geological Survey map overlays. The area of flooding depicted on each map overlay was then determined with a planimeter, and the total area of inundation was tabulated for each date.

A "best estimate" curve was developed to relate the area of flooding in the most critical portion of the basin to discharge measurements recorded at a station some 30 kilometers downstream. Successful refinement of this curve will allow real-time estimation of the extent of flooding to be made on the basis of in situ discharge measurements.

The study was conducted by Jay N. McLeester under the direction of Warren R. Philipson. A follow-up investigation has been proposed, and this would employ various visual enhancement techniques and Landsat digital data to improve the flood boundary delineation and curve reliability. For further information, contact Dr. Philipson at Cornell, or Mr. Kenneth H. Mayhew, Chief Engineer, N.Y.S. Board of Hudson River-Black River Regulating District, 491 Eastern Boulevard, Watertown, N.Y. 13601 (tel. 315-788-5440).

SEMINAR IN REMOTE SENSING

The final seminar of the spring semester will be held on Wednesday, 2 May, at 4:30 p.m., in B-14 Hollister Hall. Anyone is welcome to attend. The speaker, Benny M. Sørensen, is a project manager with the Joint Research Center of the Commission of the European Communities, and he is located at the Ispra Establishment, Varese, Italy. His topic is "The European Ocean Color Scanner Experiment 1977 in the North Sea."

CORNELL STUDENT RESEARCH IN REMOTE SENSING

Topics which are currently being investigated by Cornell students in Aerial Photographic Studies and Remote Sensing (Civil and Environmental Engineering) are: a remote sensing analysis of lateritic engineering materials for Thailand (Pichit Jamnongpipatkul, Ph.D. candidate); detection and categorization of inactive surface mines with small scale remotely sensed data (Jan Berger, M.S. candidate); Landsat analysis of flooding in the western plains of Venezuela (Rafael Avila, M.S. candidate); and mineral exploration in the western Adirondacks, N.Y. (Caren Rubin, MEC candidate). Other topics being considered for remote sensing thesis research include arid regions (William Teng, Ph.D. candidate), tropical crops (Elaine Aderhold, M.S. candidate), and coastal environments (William Hafker, M.S. candidate). For further information, contact the student, c/o Remote Sensing Program, Cornell Univ., Hollister Hall, Ithaca, N.Y. 14853.

NEWS MISINFORMATION

Contrary to recent news reports, infrared surveys to assess building insulation do require special sensors. They cannot be performed with infrared photographic films. National news reporters are apparently unimpressed by the remote sensing community's efforts to correct this misconception.

REMOTE SENSING FACULTY POSITION OPEN AT CORNELL

Cornell University's School of Civil and Environmental Engineering is seeking to fill one faculty position in Remote Sensing, at the assistant or associate professor level. Applicants should have a thorough background in airphotos and remote sensing, with a Ph.D. degree in engineering or natural sciences. Academic and professional experience should have emphasis in quantitative remote sensing and digital analysis, and/or qualitative remote sensing and applications. The position will involve teaching and advising undergraduate and graduate students, and developing and conducting research in various disciplines. The teaching and research will interface with airphoto interpretation. Please send a detailed resume and references to Professor Ta Liang, Remote Sensing Program, School of Civil and Environmental Engineering, Hollister Hall, Cornell University, Ithaca, N.Y. 14853. Cornell is an equal opportunity/affirmative action employer and welcomes applications from women and minority members.

WORKSHOPS/SHORT COURSES

Eastern Regional Remote Sensing Workshop; 4th Friday, every month; at NASA Goddard Space Flight Center; no cost; Contact: Dr. Nicholas Short, ERRSAC, NASA/GSFC, Code 902.1, Greenbelt, Md. 20771 (tel. 301-344-5515 or 800-638-0748).

Terrain Analysis--Interpretation of Aerial Photographs & Images; 18-22 June; in Sioux Falls, S.D.; $450 fee; Contact: Ms. Lisa Underkoffler, Continuing Education Summer Program, Harvard Graduate School of Design, Gund Hall L-37, Cambridge, Mass. 02138 (tel. 671-495-2578).

Remote Sensing & Image Interpretation; 18-22 June; at Univ. Minn.; $110 fee; Contact: Eugene Anderson, Office of Special Programs, 405 Coffey Hall, 1420 Eckles Ave., Univ. of Minnesota, St. Paul, Minn. 55108 (tel. 612-373-0725).

CONFERENCES/MEETINGS

Annual Meeting, Central New York Region-Amer. Soc. Photogrammetry; 18 May; in Ithaca, N.Y.; Contact: William Teng, Cornell University, 464 Hollister Hall, Ithaca, N.Y. 14853 (tel. 607-256-4330).

Remote Sensing for Natural Resources--An Int'l. View of Problems, Promises & Accomplishments; 10-14 Sept.; at Univ. Idaho; Contact: Univ. of Idaho, Office of Continuing Education, Moscow, Idaho 83834.

SELECTED ARTICLES AND PUBLICATIONS

Hsu, S. 1979. The Mahalanobis Classifier with the generalized inverse approach for automated analysis of imagery texture data. Computer Graphics & Image Processing 9:117-134.

NASA Lyndon B. Johnson Space Center. 1978. Skylab EREP investigations summary. NASA SP-399. NASA, Washington, D.C. 386 pp. (Available: Superintendent of Documents, U.S. Gov't. Printing Office, Washington, D.C. 20402; no. NAS 1.21:399; stock no. 033-000-00741-8; $13.50).

Proc. 4th Canadian Sympos. Remote Sensing. Held May 1977, Quebec. Papers in French or English. 626 pp. Available: Canadian Aeronautics & Space Inst., Saxe Bldg., 60-75 Sparks St., Ottawa, Ont., Canada K1P 5A5. ($40).

Russell, O.R., R.V. Amato & T.V. Leshendok. 1979. Remote sensing and mine subsidence in Pennsylvania. Jour. Transport. Eng'g., ASCE 105:TE2:185-198.

Staff Report. 1979. Getting the global picture: Lidar in orbit. Optical Spectra. 13:3:46-51.

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Stutzman, W., F.W. Collier, & H.S. Crawford. 1979. Microwave transmission measurements for estimation of the weight of standing pine trees. IEEE Transac. Antennas & Propagation. AP-27:1:22-26.

Tyler, J.E. 1979. In situ quantum efficiency of oceanic photosynthesis. Applied Optics 18:4:442-445.

Welsted, J. 1979. Air-photo interpretation in coastal studies--Examples from the Bay of Fundy, Canada. Photogrammetria 35:1:1-27.

Wolfe, W.L. and G.J. Zissis (eds.). 1979. The infrared handbook. Office of Naval Research, Arlington, Va. 1700 pp. (Available: ERIM, Attn. Order Dept., P.O. Box 8618, Ann Arbor, Mich. 48107; $25 in U.S., $30 outside U.S./plus $1.25 surface mailing.)

Applied Optics 1978. v.17, n.21

- Baures & Duvernoy. Statistical spatial filtering: Application to aerial photographs.
- Cannon et al. Comparison of image restoration methods.
- Genda & Okayama. Estimation of soil moisture and components by measuring the degree of spectral polarization with a remote sensing simulator.
- Fujii et al. Incoherent optical heterodyne detection and its application to air pollution detection.
- Peppers & Ostrem. Determination of wave slopes from photographs of the ocean surface: A new approach.

Bulletin of Amer. Metereological Soc. 1978. v.59, n.12

- Gruber & Winston. Earth-atmosphere radiative heating based on NOAA scanning radiometer measurements.
- Houghton & Suomi. Information content of satellite images.
- Rasool, I. NASA's role in weather prediction.

IEEE Transactions on Geoscience Electronics 1979. GE-17, no.1

- Fung, A. Scattering from a vegetation layer.
- Kaupp & Holtzman. Skylab scatterometer measurements of Hurricane Ava.

IBM Jour. of Research & Development 1978. v.22, n.5

- Santisteban & Munoz. Principal components of a multispectral image: Application to a geological problem.
- Hernandez & Flores. Machine processing of remotely sensed data: Three applications in Mexico.

ITC Journal 1978. n.4

- Sicco Smit, G. Shifting cultivation in tropical rainforests detected from aerial photographs.
- Spiers, B. A vegetation survey of semi-natural grazing lands (dehesas) near Merida, S.W. Spain.

Photogrammetric Eng'g. & Remote Sensing 1978. v.44, n.10 (Oct.)

- Tonelli, A.M. Surface texture analysis with thermal and near infrared scanners.
- Scarpace, F.L. Densitometry on multi-emulsion imagery.
- Scarpace & Friederichs. A method of determining spectral analytical dye densities.
- Piech et al. The blue-to-green reflectance ratio and lake water quality.

Photogrammetric Eng'g. & Remote Sensing 1978. v.44, n.11 (Nov.)

- Tucker, C.J. A comparison of satellite sensor bands for vegetation monitoring.
- Talerico et al. Quantifying gypsy moth defoliation.
- Hsu, S. Texture-tone analysis for automated land-use mapping.
- Whitlock et al. Penetration depth at green wavelengths in turbid waters.
- Dellwig & Bare. A radar investigation of north Louisiana salt domes.
- White, M.E. Reservoir surface area from Landsat imagery.

(continued, p4.)

Photogrammetric Eng'g. & Remote Sensing 1978. v.44, n.12 (Dec.)
-Special issue on digital terrain models--ten papers.

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-Welch, R. Acquisition of remote sensor data with linear arrays.
-Thompson, L. Remote sensing using solid-state array technology.
-Tracy & Noll. User-oriented data processing considerations in linear array applications.
-Wright, R. Sensor implications of high altitude low contrast imaging.
-Colvocoresses, A. Multispectral linear arrays as an alternative to Landsat D.
-Doyle, F. A Large Format Camera for Shuttle.
-Takamoto et al. Stereo measurement of the optic disc.
-Gammon & Carter. Vegetation mapping with seasonal color infrared photographs.
-Lemme & Westin. Landsat-simulating radiometer for agricultural remote sensing.

Photogrammetric Eng'g. & Remote Sensing 1979. v.45, n.2 (Feb.)
-Masry & McLaren. Digital map revision.
-Thompson & Wehmanen. Using Landsat digital data to detect moisture stress.

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-Carter et al. Wetland classification and mapping in western Tennessee.
-Dalsted et al. Detection of saline seeps by remote sensing techniques.
-Henderson, F. Land-use analysis of radar imagery.
-Theis, J. Transferring today's changes onto yesterday's maps.
-Grunthal & Smith. Photogrammetry is many things.

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-Sobur et al. Remote sensing applications in the southeast Sumatra coastal environment.
-Curran, P.J. A photographic method for the recording of polarised visible light for soil surface moisture indications.
-Holyer, R.J. Toward universal multispectral suspended sediment algorithms.
-Knowles, S.H. Oceanographic measurements using radio interferometer techniques.
-Ikeda & Stevenson. Time series analysis of NOAA-4 sea surface temperature data.

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-Kondratyev & Pokrovsky. A factor analysis approach to optimal selection of spectral intervals...
-Fuller & Rouse. Spectral reflectantance changes accompanying a post-fire recovery sequence in a subarctic spruce lichen woodland.
-Miller & Carter. Rational land use decision-making: The Natchez State Park.
-Evans, R. Air photos for soil survey in lowland England...
-Turk, G. GT Index: A measure of the success of prediction.
-Bauer et al. Identification and area estimation of agricultural crops by computer classification of Landsat MSS data.

SUMMER VACATION/ADDRESS CHANGES

Volume VII of the Cornell Remote Sensing Newsletter ends with this May issue. The Newsletter is currently received by more than 500 individuals and groups in 40 states and 20 countries. As planned, Volume VIII of the Newsletter will begin next September. Notices of address changes should be sent to the Remote Sensing Program (see below).

The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330)

SEMI-ANNUAL STATUS REPORT

of the

NASA-sponsored

Cornell University Remote Sensing Program

June 1 - November 30, 1978

NASA Grant NGL 33-010-171

Principal Investigator: Ta Liang

Co-Investigators: Arthur J. McNair
Warren R. Philipson

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14853

December 1978

Cornell University
REMOTE SENSING PROGRAM
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
HOLLISTER HALL
ITHACA, NEW YORK 14853
(607) 256-4330, 256-5074

December 8, 1978

NASA Scientific and Technical
Information Facility
P.O. Box 8757
Baltimore-Washington International Airport
Maryland 21240

Subject: NASA Grant NGL 33-010-171

Gentlemen:

In accordance with the provisions of the subject grant, we are transmitting herewith two (2) copies of our 13th Semi-Annual Status Report, covering the period June 1 to November 30, 1978. In addition, three (3) copies of this report are being sent directly to Technology Transfer Division, NASA Headquarters, Washington, D.C. 20546 (Attention: Mr. J.A. Vitale).

Sincerely yours,

Ta Liang

Ta Liang
Principal Investigator

TL/pw

xc: Mr. J.A. Vitale, NASA Headquarters
Mr. T.K. Sandridge, NASA Headquarters
Deans A. Schultz and P.R. McIsaac
Mr. T.R. Rogers and Mr. F.J. Feocco
Director R.N. White

INTRODUCTION

The primary objective of the NASA-sponsored, Cornell University Remote Sensing Program is to promote the application of aircraft and satellite remote sensing, particularly, in New York State. In accordance with NASA guidelines, this is accomplished through conferences, seminars, instruction, newsletters, news releases, and most directly, through demonstration projects. Each demonstration project must be, in some way, unique; essentially noncompetitive with commercial firms; and potentially, benefit- or action-producing. Relatively little emphasis is placed on technology transfer, per se.

The activities of the Remote Sensing Program staff, from June 1 to November 30, 1978, are reviewed in this Semi-Annual Status Report, the thirteenth to be submitted to NASA since the Program's inception in June 1972.

COMMUNICATION AND INSTRUCTION

Contacts and Cooperators

During the past six months, the Program staff spent many hours discussing remote sensing with representatives of various federal, state, regional, county and local agencies, public and private organizations, the academic community, and foreign countries.

In addition to receiving project cooperators from the U.S. Environmental Protection Agency, the New York State Department of Health, the New York State Department of Environmental Conservation, and the Planning Department of Tompkins County, N.Y., the Program staff also provided remote sensing consultation to visitors from the U.S. Army Cold Regions Research Engineering Laboratory, the New York State Commission on Tug Hill, and the State University of New York at Binghamton. Among the many visitors seeking information on remote sensing or Cornell capabilities in remote sensing were those from the Environmental Management Council of Cayuga County, N.Y., the Eastman Kodak Co., Exxon Corp., the Soviet Union, and the Commission of the European Communities' Joint Research Center, in Italy.

Many new and continuing dialogs were also held via the mail and telephone, particularly in the course of developing new remote sensing demonstration projects (Appendix G). Moreover, Program staff traveled to discuss or conduct projects with representatives of the New York State Board of Hudson River-Black River Regulating District, the New York State Department of Environmental Conservation, the New York State Department of Health, the New York State Office of Parks and Recreation, the U.S. Army Corps of Engineers, and the U.S. Air Force Rome Air Development Center (Appendices A, E, F and G).

Newsletters and News Releases

The Program's "Cornell Remote Sensing Newsletter," continued to provide a valuable link to and beyond the Cornell community. The Newsletter, which highlights remote sensing activities at Cornell while reporting other items of general interest, is now received monthly by more than 475 individuals and groups in some 30 states and 15 foreign countries (Appendices H and I).

Program investigations continued to receive publicity through local and nationally distributed news items (e.g., "ASCE News," Appendix G). National and Canadian concern for problems associated with the Love Canal in Niagara Falls led to numerous newspaper and radio reports on the Program's involvement (Appendix A).

Seminars

For six years, the Program's weekly Seminar in Remote Sensing has brought experts from government, industry and other institutions to Cornell to discuss remote sensing topics with students and staff. The Seminar was not held during the fall semester, 1978, in order to devote more time to other activities, but planning for the spring semester is well underway. Speakers from NASA, the U.S. Department of Energy, the U.S. Geological Survey, the Defense Mapping Agency, and Earth Satellite Corporation have been scheduled, and others have been invited.

Courses, Special Studies and Workshops

Cornell's curriculum in aerial photographic studies, photogrammetry and remote sensing, and the possibilities for research through special topics courses, professional master's design projects, and M.S. or Ph.D. theses, have been reviewed in earlier Semi-Annual Status Reports. During the fall semester, 1978, Program staff offered a special, six-week course, "Remote Sensing of Environment," for 20 freshman engineers. In addition, one "special topics" course is focusing on digital analysis of remotely sensed data, thereby laying the groundwork for a regular course on this subject. Typical of the Program staff's extracurricular instructional activities over the past six months are an invited seminar delivered to some 20 students and staff in geology at Hamilton College in Clinton, N.Y.; a special orientation lecture given to some 60 Cornell students in a course in landscape architecture; and another orientation lecture given to some 15 Cornell students in a course in Army R.O.T.C.

DATA AND FACILITIES

As described in earlier report, staff research and instruction have been enhanced through continued acquisition of a wide range of remotely sensed, aircraft and satellite data, and through extension of capabilities for their analysis and interpretation. These data, along with Program facilities and equipment, are made available at no cost to cooperators, students and other interested users.

With assistance from the NASA Office of University Affairs, the Program has received Landsat, Skylab, high altitude and low altitude coverage of sites in the Northeast, and two new high altitude aircraft missions were recently flown over New York's Finger Lakes Region. The U.S. Environmental Protection Agency has also overflown Program-selected sites at no cost to the Program; and imageries have been obtained from the U.S.A.F. Rome Air Development Center, the U.S. Geological Survey, the U.S. Department of Agriculture, the St. Lawrence Seaway Development Corporation, the National Air Photo Library of Canada, the Tri-State Regional Planning Commission, the National Archives, Eastman Kodak Company and several commercial mapping firms.

The Program maintains or has access to a spectroradiometer and selected image analysis equipment (i.e., zoom and non-zoom stereoscopes, density slicer, color-additive viewer, Zoom Transfer Scope, densitometer, stereoplotters, and other photogrammetric and photographic instruments). The Program also maintains a series of computer routines for analyzing multispectral digital data. These routines are receiving increased usage in Program-sponsored and spinoff investigations with Landsat and aircraft scanner data.

PROJECTS COMPLETED

During the six-month period, June 1 to November 30, 1978, the Cornell Remote Sensing Program staff completed five demonstration projects:

1. Preliminary Assessment of Leachate Migration from the Love Canal Landfill, Niagara Falls, N.Y.

2. Landsat Analysis for Pheasant Range Management in New York State.

3. Selection of Sites for Dredge Spoil Disposal and Subsequent Recreational Development, Columbia County, N.Y.

4. Examination of Agricultural Districts for Possible Changes in Zoning, Columbia County, N.Y.

5. Inventory of Potential Mosquito Breeding Sites in an Urban Setting, Rome, N.Y.

The projects are summarized here, and pertinent material on each is included in an appendix.

1. Preliminary Assessment of Leachate Migration from the Love Canal Landfill, Niagara Falls, N.Y.

Leaching of toxic chemicals from the Love Canal Landfill in Niagara Falls, N.Y., caused the site to be declared a State and Federal disaster area and 237 homes to be evacuated. The Program staff was requested by officials of the N.Y.S. Department of Health to assist in determining the extent of leachate migration.

Using aerial photographic coverage acquired in 1938, 1951 and 1966, staff members analyzed the soils and geology of the area, compiled time-sequential, map overlays of land use, and identified the most critical sites for field sampling (Appendix A). In addition, the basic parameters for collecting new aerial photographs of the area were outlined for State Health personnel.

All recommended sites have been sampled, new 35mm and 70mm photography has been flown, and consultations--including those with the legal staff of the U.S. Environmental Protection Agency--are continuing. The value of remote sensing has been demonstrated to the extent that the State is funding the Program to conduct a remote sensing evaluation of 38 other industrial landfills in the Niagara Falls area.

2. Landsat Analysis for Pheasant Range Management in New York State.

Working closely with the New York State Department of Environmental Conservation (DEC), Program staff examined the value of Landsat data for separating land cover types being considered for inventory under the DEC's pheasant habitat management program (Appendix B). As discussed in the Program's report to the DEC, Landsat data could not provide adequate separability of all cover types of interest when single dates of Landsat were analyzed digitally or when multiple dates were analyzed manually. Supervised classification of Landsat digital data from two dates would likely prove successful, and some improvement in separability with manual methods would likely accompany improvements in the quality of imagery. These possibilities as well as changes in the land cover types to be inventoried are now being considered by the DEC. It is probable that some level of cooperative effort will follow.

3. Selection of Sites for Dredge Spoil Disposal and Subsequent Recreational Development, Columbia County, N.Y.

At the request of the Planning Director of the Planning Board of Columbia County, N.Y., Program staff identified and assessed the best five zones for disposing of Hudson River dredge spoil and subsequently developing river-oriented recreation (Appendix C). Land stability, land use and cover, aesthetics, proximity to population and existing recreation, and water quality were evaluated at each zone using multi-date, medium and high altitude aerial photography and background reports. The information submitted to the County Planning Board is providing fundamental input to the development of a comprehensive coastal zone management plan and to County proposals for funding for implementing this plan.

4. *Examination of Agricultural Districts for Possible Changes in Zoning, Columbia County, N.Y.*

Another project conducted at the request of the Planning Board of Columbia County, N.Y., involved inventorying land use (as "active agriculture", "inactive agriculture" or "other") and providing a preliminary assessment of soils as "prime agricultural soils" (Appendix D). This countywide study was performed using high altitude aerial photographs and the existing reconnaissance soils report. The submitted information has been used for general planning, and it will be used by the County Planning Board and Agricultural Committee in reviewing the County's eleven agricultural districts. It is expected that the Program's submissions will provide the basis for changing agricultural district boundaries as well as related town zoning classifications. (The review of agricultural districts requires public hearings, and the complete process will not be finalized for about two years.)

5. *Inventory of Potential Mosquito Breeding Sites in an Urban Setting, Rome, N.Y.*

As a follow-up to earlier work on characterizing known mosquito breeding sites with the New York State Department of Health (12th Semi-Annual Status Report, June 1978), Program staff demonstrated the value of aircraft remote sensing for inventorying potential mosquito breeding sites in an urban area (Appendix E). Using large scale panchromatic photographs, acquired by the U.S. Air Force over most of Rome, N.Y., members of the Program staff performed a comprehensive inventory of wet sites (permanent and temporary) occurring at ground level as well as on roof tops. This information guided selected field checks by State and county health personnel, who had spent the summer of 1978 collecting ground data to determine the need for urban-mosquito spray operations in Rome and two other New York State cities.

The efficiency, accuracy and cost for aerial surveys appear attractive to State Health officials, especially as regards the opportunity to identify water accumulations on roof tops--sites which had not been included in the summer field surveys. It is likely that further assistance will be given to the State in testing and designing a survey plan.

PROJECTS IN PROGRESS

Program-Sponsored

As of December 1, 1978, the Program staff was conducting two projects under the NASA grant: (1) Estimating flooding in Black River Basin, N.Y., with Landsat and in-situ data, and (2) Assessment of vineyard-related problems. The objectives, cooperators, users, expected benefits and actions, and status of these projects are described, as follows:

1. *Estimating Flooding in Black River Basin, N.Y., with Landsat and in-Situ Data*

-cooperator/user: N.Y.S. Board of Hudson River-Black River Regulating District

-benefit/action: Reliable estimates of inundation and consequent damage obtained in real time; methodology applicable in other river basins.

-expected completion date: Preliminary Results - February, 1979

Landsat imagery is being used as the primary source of information on flooding in the Black River Basin of northern New York State. Approximately 65 kilometers of the Black River floods annually, inundating farm land and breaching roadways. Ground surveys of the actual areas flooded are incomplete and thus inadequate for estimating agricultural and other losses.

Landsat images (band 7) depicting flood conditions during several flood seasons since 1972 were obtained for analysis. Visual interpretation of flood boundaries is providing the basis for quantitatively relating in-situ measurements of river discharge with the areas and locations of inundation. This, in turn, will provide a model for real-time estimation of flood losses over the entire river basin.

2. *Assessment of Vineyard-Related Problems*

-cooperators: Taylor Wine Company and other vineyards; N.Y.S. Agricultural Experiment Station, Geneva, N.Y.; Cornell Depts. of Plant Pathology and Pomology; Eastman Kodak Co.

-users: Taylor Wine Co. and other vineyards; N.Y.S. Cooperative Extension.

-benefits/action: Appropriate action by vineyards on range of problems assessed with remotely sensed data; development of remote sensing as a vineyard management tool; ultimately, improved production.

-expected completion date: June 1979

The Program staff is examining the extent to which remotely sensed data might provide useful information for assessing vineyard-related problems. The first phase of the investigation, an evaluation of vineyard drainage, was completed and described in the Program's 7th Semi-Annual Status Report (Dec. 1975). For the second phase of the investigation, Program staff used large-scale color infrared aerial photographs to assess plant vigor. This project was discussed in the Program's 9th Semi-Annual Status Report (Dec. 1976). Follow-up studies of vineyard siting, crop vigor, yield-related factors and practical monitoring techniques are being conducted using low altitude, multispectral aircraft data acquired for the Program by NASA during the summer 1977. Although some delay was experienced in obtaining the computer-compatible tapes of the multispectral scanner data, an analysis of yield-related factors is now underway.

Spinoff Projects

During the past six months, members of the Program staff have been involved in two non-NASA funded projects which arose directly from Program-sponsored investigations. As a consequence of earlier work on remote sensing strategies for inventory dams (9th Semi-Annual Status Report, Dec. 1976), the U.S. Department of the Interior, Office of Water Research and Technology funded a one-year investigation, "Remote Sensing Assessment of Dam Flooding Hazards: Methodology Development for the New York State Dam Safety Program." Copies of the final report were recently submitted to the NASA grant monitor, and excerpts are included here, in Appendix F.

A second spinoff project involves a remote sensing analysis of nearly 40 landfills in the Niagara Falls, N.Y., area. Funded by the New York State Department of Health, this work follows the Program-sponsored assessment of Love Canal (Appendix A), as well as previous leachate detection work which was funded jointly by NASA and the EPA.

Inactive Project

With Program staff assistance, Cornell's Physical Plant Operations (PPO) contracted for an airborne thermal survey of campus steamlines (6th Semi-Annual Status Report, June 1975). After studying the thermal data for steamline leaks, personnel of the PPO requested that the Program utilize the data to evaluate roofing insulation of campus buildings. With these data as a focal point, the Program staff began a study to develop an airborne survey/analysis methodology which would characterize roofing materials as well as insulation needs. Toward this end, the Program requested NASA to overfly the campus area during the winter and spring of 1976. Only the spring mission was flown, and the data were not supplied to the Program until five months after the mission. These delays were accompanied by changes in personnel and initiation of projects with more immediate "payoffs." During this period, many similar studies were conducted by other research groups in the United States and Canada. Although it was expected that the thermal investigation would be re-defined and re-initiated, this has not yet occurred.

FUTURE PROJECTS

The Program staff is continually soliciting and receiving proposals for new remote sensing demonstration projects. As noted, criteria for project acceptance are that the project must be, in some way, unique; that project acceptance would not be competing unduly with private companies or consultants; and that, if completed successfully, the project would produce tangible benefits or actions by definable users.

Among topics under current consideration are (Appendix G):

1. With the *Planning Board of Albany County, N.Y.*--assess landslide susceptibility within the county.

2. With the *Department of Environmental Control of Suffolk County, N.Y.*--evaluate relationship between salinity and changes in the configuration of the barrier island inlets to Long Island's south shore bays.

3. With the *New York State Office of Parks and Recreation*--study the protection, maintenance and enhancement of recreational resources on barrier island (Jones Beach and Fire Island).

Depending on user interest, personnel and available funds, any of these as well as other projects may be undertaken.

PROGRAM STAFF

The Program staff is comprised of Prof. Ta Liang, principal investigator, Prof. Arthur J. McNair and Dr. Warren R. Philipson, co-investigators, Mr. Thomas L. Erb, research specialist, Mr. Jan P. Berger, graduate research assistant, Mr. John G. Hagedorn, data analyst, Ms. Deborah Halpern, photographic laboratory technician, and Ms. Pat Webster, secretary. Prof. Donald J. Belcher and Dr. Ernest E. Hardy are general consultants to the Program and, for specific projects, assistance has been provided by many Cornell and non-Cornell personnel. Students who have contributed to the Program staff effort over the past six months include David W. Adams, William R. Hafker, Jay N. McLeester and William L. Teng.

LIST OF APPENDICES

APPENDIX A

PRELIMINARY ASSESSMENT OF LEACHATE MIGRATION FROM THE LOVE CANAL LANDFILL, NIAGARA FALLS, N.Y.

Cornell University
REMOTE SENSING PROGRAM
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
HOLLISTER HALL
ITHACA, NEW YORK 14853
(607) 256-4330, 256-5074

27 September 1978

Dr. Steve Kim
N.Y.S. Department of Health
Division of Laboratories and Research
Empire State Plaza Laboratories
Albany, New York 12201

Dear Steve:

Please forgive my delay in providing you a summary of our Program's "Love Canal" activities, completed or undertaken since my initial letter of 4 August 1978. Chronologically, they include the following:

1. On 5 August, I accompanied you on the aircraft flight to obtain hand-held, color infrared, 35mm slides of the site and vicinity. I provided some assistance in defining photogrammetric parameters, and I obtained a series of 35mm color slides with my own camera. (You have copies of my slides.)

2. On 9 August, Ta Liang and Thomas Erb (Professor In-Charge of our Remote Sensing Program and Research Specialist, respectively) visited the Love Canal area for field observations.

3. On 9 and 10 August, our staff examined the 35mm slides obtained on 5 August and the 70mm color infrared transparencies flown by the N.Y.S. Department of Environmental Conservation on 7 August. (Both sets of slides, with some omitted, were sent to Ithaca via Mall Airway by Fred Muller.) An examination of these slides, together with a re-examination of the 1938, 1951 and 1966 aerial photographs, allowed us to respond to your telephone requests for recommended sampling sites. (The DEC slides were returned to Albany by Ed Horn, who visited campus on 8 Sept.; we still have the Health Dept. slides.)

4. Several interviews were given during the next few days. Cornell's Public Information Office prepared a brief news item on our participation, and a radio interview was taped. Other calls were received from Ithaca, Buffalo and Albany news stations or newspapers, as well as from CBS News in New York.

5. George Shanahan and Steve Zelson, of the U.S. Environmental Protection Agency legal staff, visited with Prof. Liang and me on 15 August. They examined the 1938, 1951 and 1966 photographs and requested our interpretation, primarily, as regards a possible ditch between Love Canal and the Niagara River. They also requested assistance in locating any additional pre-1966 photographs.

6. We determined that other dates of photography were available from several sources (accompanying table). We ordered this additional coverage of the Love Canal area, and advised Shanahan and Zelson of its existence.

7. On 8 September, we responded to your telephone request for an assessment of possible dumping near the 93rd Street School.

8. You provided us with ground data and background material on the Love Canal. As we receive the additional aerial photographs, we are (slowly) initiating further site analyses.

As you realize, all of our activities to date have been conducted under our NASA grant. I would be happy to expand on any of the above.

Very truly yours,

Warren

Warren R. Philipson
Sr. Research Associate

WRP/pw
cc: Prof. Ta Liang

AERIAL PHOTOGRAPHIC COVERAGE ORDERED OR
ON HAND FOR ANALYSIS OF LOVE CANAL AREA

Date	Nominal Scale	Source
25 Sept. 38	1:20,000	National Archives
14 Oct. 51	1:20,000	ASCS, U.S. Dept. Agriculture
26 May 56	1:12,000	Rist-Frost-Warneck & Partners
16 May 58	1:20,000	Rist-Frost-Warneck & Partners
1958	1:20,000	ASCS, U.S. Dept. Agriculture
15 Jan. 60	1:60,000	U.S. Geological Survey
3 Sept. 60	1:28,000	Nat'l. Air Photo Library, Canada
26 Nov. 62	1:38,000	U.S. Geological Survey
7 May 63	1:24,000	U.S. Geological Survey
12 June 66	1:20,000	ASCS, U.S. Dept. Agriculture

Notes: (1) All photographs are black-and-white panchromatic.
(2) The 1958 photographs ordered from the ASCS/USDA may be the same as those from Rist-Frost-Warneck & Partners, an engineering/surveying company in Watertown, New York.
(3) Other post-1970 aerial photographs of the area are available from several sources. These include small-scale, partial coverage by Canadian agencies in 1970, 1972, 1975 and 1976; as well as larger scale, complete coverage by U.S. firms. Only the Canadian photographs have been ordered.

Cornell University
REMOTE SENSING PROGRAM
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
HOLLISTER HALL
ITHACA, NEW YORK 14853
(607) 256-4330, 256-5074

4 August 1978

Dr. Steve Kim
N.Y.S. Department of Health
Division of Laboratories and Research
Empire State Plaza Laboratories
Albany, New York 12201

Dear Dr. Kim:

We have completed our preliminary assessment of potential sites of leachate contamination associated with the Love Canal landfill in Niagara Falls, N.Y. The findings are based entirely on stereoscopic analysis of "historic" aerial photographic coverage; new coverage and, of course, field investigations are recommended.

Included in or with this letter are: (I) a list of the aerial photographs used in the study; (II) our copies of the 1938 photographs (please return); (III) a brief description of the geology of the landfill area; (IV) a series of 1:24,000 scale map overlays depicting drainage and related conditions in 1938, 1951 and 1966; (V) a 1:24,000 scale map overlay depicting sites for immediate field investigation; (VI) recommendations for flying new photography; and (VII) general comments.

I. Aerial Photographs Used in Study (all black & white contact prints at scales of 1:20,000 to 1:24,000).

DATE	SOURCE	PHOTO NUMBERS
25 Sept 1938	National Archives	ARE-18-80 and 81
14 Oct 1951	U.S. Dept. Agr.	ARE-5H-214 and 215
12 June 1966	U.S. Dept. Agr.	ARE-2GG-25 and 26
29 April 1968	Lockwood Mapping	NY-10-1577-1672 and 1673

II. 1938 Aerial Photographs (stereoscopic pair enclosed).

III. Geology of Area

The landfill area lies within the floodplain of the Niagara River. It is characterized by relatively flat topography with minor irregularities. In general, the local surface sediment will be predominantly coarse materials (coarse silts to sands), with finer sediments found associated with topographically depressed areas and channel scars produced during periods of flooding. Subsurface sediments are highly variable. Boundaries of sediment types are unpredictable both vertically and horizontally, and randomly situated lenses of sands, silts or clays, as well as buried channel scar material are not uncommon. The ground water table is normally high. Because of the nature of the subsurface materials, it is difficult to determine local directions of ground water flow. The dolomitic limestone bedrock is generally no more than three meters from the surface.

IV. Drainage Map Overlays--1938, 1951 and 1966 (enclosed)

A stereoscopic analysis of the multi-date photographs was performed, tracing drainage and related information onto acetate overlays. This information was subsequently transferred to a U.S. Geological Survey 1:24,000 scale topographic map base. The enclosed map overlays are described as follows:

1938: The Love Canal landfill was open and operating in 1938. The map overlay depicts the location of the landfill and drainways in the vicinity.

1951: The landfill was partly backfilled by 1951, and substantial residential development had taken place, especially in the poorly drained area west of the landfill. The map overlay depicts the canal, backfilled portions, drainways, and the principal area of residential development.

1966: By 1966, the landfill was completely backfilled, and a school and residences had been erected on or adjacent to the site. These developments and the drainways are shown in the map overlay.

V. Field Sampling Points--Map Overlay (enclosed)

The 1:24,000 scale map overlay depicts the area presumed to be affected by landfill leachate and selected locations for monitoring surface or ground water quality.

VI. Recommendations for New Photography

The leachate contamination may be rather extensive. New aerial photography over the area would be of value to the field program, primarily in providing evidence of where to sample. The basic parameters of an aerial photographic mission are listed below. A thermal survey of the area is not recommended. Further assistance in planning, implementing or contracting for an aircraft mission would be provided upon request.

film: Kodak Aerochrome Infrared, 2443 or 3443; (a true color film such as Kodak 2445 or 2448, would be a useful supplement).

filter: Wratten 12 or Wratten 15 with color infrared film.

scale: 1:5,000; (smaller scale coverage, say 1:10,000, may be a useful supplement).

time of flight: solar noon--sun should be as high as possible; best if cloud-free.

season: wet periods will maximize the number of observed problem sites; avoid heavy tree foliage.

coverage: obtain complete stereoscopic coverage over the area south to the Niagara River, west to Cayuga Creek, north to Black Creek (and Bergholtz Creek), and east about 2 kilometers from the landfill. River shoreline and creeks noted above should be included.

VII. General Comments

As noted, it is difficult to predict the direction of ground water flow in this area because of the variability of the flood-plain soils. Although the general pattern is from east to west, localized surface and subsurface flow from west to east will likely be encountered. Given that the soils are relatively shallow, leachate infiltration of the bedrock through fractures should also be expected.

As a final note, we are anxious to learn if and how the enclosed information is used, and we are prepared to provide further assistance using funds from our NASA grant. Any citation of assistance should refer to the staff of Cornell's NASA-sponsored Remote Sensing Program (several individuals contributed to the results). I have enclosed a sheet which describes our Program.

Very truly yours,

Warren R. Philipson

Warren R. Philipson
Sr. Research Associate

WRP/pw

Encs.

SYRACUSE POST-STANDARD/SATURDAY, AUG. 12, 1978

Assess Spread of Toxics

CU Aerial Photo Analysts Work on Love Canal Project

ITHACA (UPI) — Aerial photography experts from Cornell University are helping state and federal officials define the spread of toxic chemicals in the chemically contaminated Love Canal area in Niagara Falls.

A five-man team of analysts from the College of Engineering are using 1930s photographs taken of the area before the canal was filled in, to determine its original drainage pattern.

Warren R. Philipson, who heads the team, said Friday the information provides a base for testing how widely the chemicals have leached away from the landfill site.

Also being used in the analysis are photographs of the area taken in the 1950s and 1960s and showing the development of homes and how the original drainage pattern has been distorted.

Along with the older photos, Cornell engineers also are analyzing photos taken in the past week.

Using infrared photos, engineers are able to pcik out indications of the possible spread of the chemicals by observing the health of vegetation and moisture conditions.

About 235 families have begun evacuating their homes on the waste dump used by the Hooker Chemical and Plastics Corp. during the late 1940s and early 1950s. The canal now poses a health threat because cancer-causing chemicals are leaching into the soil and seeping into home basements.

4A ROCHESTER DEMOCRAT AND CHRONICLE Sunday, Aug. 13, 1978

Caution the key to cleanup

NIAGARA FALLS (UPI) — State health officials said yesterday massive precautions, including detoxification showers, disposable work clothes and gas masks, are being planned for the cleanup of the chemically-contaminated Love Canal.

"Significant precautions will be taken," said Louis Violanti, regional engineer for the state Department of Health.

He said the plans, being formulated by environmental, health and disaster aid officials, also call for air packs and mobile toxic analysis units. The plans are aimed at providing maximum safety for workers.

A federal emergency has been declared in the area where oozing chemicals from a chemical landfill closed 25 years ago are seeping into basements and backyards, forcing the evacuation of 234 families from their homes because of threats of their health.

Violante said plans also involve regular washing of all bulldozers, excavators, trucks, road graders and pumps, and for around-the-clock security patrols of the site.

The first phase of the cleanup will include digging two parallel trenches 10 to 12 feet deep running the three-block length of the landfill. Work won't begin until all the families are moved out.

Two deep wells will be sunk at the end of the trenches to collect materials, Violante said. Water flowing into the wells will be pumped into a 30,000 gallon storage tank at the site.

Violante said liquids from the tank will be fed through the "Blue Magoo," the Environmental Protection Agency's mobile filtration system, and then fed into the city sewer system.

He also said scientists will be monitoring and testing ahead of the construction work for explosive gases dangerous chemicals known to be in the site, and for highly toxic chemicals, like sulfur dioxide, that have not yet been found.

The safety plans must be approved by state Health Commissioner Robert Whalen and area residents before construction begins, officials said.

Violante said construction was scheduled to start Tuesday, but because of the mass evacuation, the starting date would be delayed at least two more weeks.

More than 40 families have been relocated with relatives, at motels or at apartments at the Niagara Falls Air Force base.

The state and federal governments are paying moving expenses and have offered to pay "fair-market" values for the homes.

Meanwhile, a five-man team of aerial photography experts from Cornell University is comparing 40-year-old photographs with current ones of the area to help determine the canal's original drainage pattern.

State health officials say infrared aerial photographs and old maps indicate that the Love Canal dumping site may have extended from Frontier Avenue south to the Niagara River, more than 200 yards.

Deputy Health Commissioner Glenn Haughie said the chemicals dumped on the site by the Hooker Chemical and Plastic Corp., 25 years ago show up in light green patches on the infrared photographs. This green runs beyond the southern boundary of the residential area "as though the canal extended all the way to the river."

Haughie also said some 1938 aerial photographs "have been interpreted as showing an extension of the canal to the river."

Officials said there are no homes there and the first phase of cleanup operations doesn't call for any remedial efforts.

Saturday, Aug. 12, 1978 ITHACA JOURNAL 3

Cornell aids in pollution search

By PHILIP LERMAN

Experts in aerial photography at Cornell University are helping state Department of Health officials in assessing the potential spread of chemical contamination throughout the Love Canal and Niagra Falls area.

Using photos owned by Cornell of the site as it was in the 1930's, when the canal was still open, a team from the College of Engineering has been able to determine the original drainage pattern of the area.

"Luckily, the area had been photographed several times," said Warren R. Philipson, a senior research associate in the college of Civil and Environmental Engineering. "And luckily, we had those photos here at Cornell."

Philipson explained that by looking at the original drainage patterns, and by looking at subsequent photos to see the change in the drainage of the canal over the years, the team has been able to come up with a good guess about where the contaminated drainage might be going.

"We don't think it's migrated very far in general," Philipson said.

The project, funded largely under the Remote Sensing Program by NASA, was initiated to help state health officials decide where to test water samples for contamination.

In addition, the Cornell team took aerial photos of the Love Canal area last week with color-infrared film, which Philipson said is useful in observing the health of vegetation and the moisture conditions of the area. These can also be helpful in studying the spread of contaminants, he said.

Syracuse Herald-American, Sunday, Aug. 13, 1978

Contaminated area may be enlarged

NIAGARA FALLS (AP) — Recent infra-red photographs and 1938 aerial pictures provided by Cornell University appear to indicate a forgotten section of the contaminated Love Canal lieing beyond what were thought to be the former dump's borders, health officials here said.

The suspected additional area of contamination has great significance because it may link the known danger area to the Niagara River, which is an international body of water forming the boundary between the United States and Canada, and which flows into Lake Ontario.

The federal Environmental Protection Agency was trying to determine to what extent chemicals left in this previously unsuspected area may have leaked into international waters.

The discovery of the forgotten stretch came as state officials prepared to an-

(Concluded on Page 10)

Greater contamination feared

(From Page One)

nounce the first phase of remedial cleanup plans for the area that is known to be contaminated.

State Deputy Health Commissioner Glenn Haughie said Friday that chemicals dumped in the region by the Hooker Electrochemical Co., now Hooker Chemicals and Plastics Corp., 25 years ago show up on the infra-red photos as light green streaks.

Haughie said this tell-tale green line runs beyond that was thought to be the southern border of the landfill at Frontier Avenue "as though the canal extended all the way to the river."

In addition, Haughie said, 1938 aerial photographs given to the department by Department of Engineering "have been interpreted as showing an extension of the canal to the river."

"We have nothing conclusive to show that (the canal) communicates directly with the river, said David Axelrod, director of the Health Department's Divison of Laboratories and Research, "but the evidence points in that direction."

There are no houses near the new section and currently no plans to perform remedial work there.

The plans for the $840,000 first phase of remedial work for the already-known canal site were set to be released tomorrow.

These plans are thought to depend heavily on a private consulting firm's recommendations to the City of Niagara Falls that an underground tile system be built to drain off dangerous chemicals from the former dumping ground.

Runoff from the sewer system would be fed through an EPA-designed carbon-activated filtering system and then sent through Niagara Falls' regular sewage system.

State officials from the other two departments in the Love Canal task force — health and transportation — meanwhile worked on plans to round out medical records by testing former residents and to evacuate the 237 families living on the two streets bordering the canal.

The state has promised that the 97 families in the inner ring of houses directly abutting the canal will be moved before remedial work starts.

The Love Canal, the ditch left behind by a never-completed 19th-century project by developer William Love to create a shortcut between the Niagara River and Lake Ontario, was used as a dump by Hooker and from 1943 until 1953, company officials said.

THE ITHACA TIMES • AUGUST 17-23, 1978

No Love for Love Canal

Experts in aerial photography at Cornell University are helping state Health Department officials **assess the potential spread of contaminated chemicals** throughout the Love Canal area in Niagara Falls.

Using photographs of the site taken in the late 1930s before the canal began to be filled in, a team of analysts in the College of Engineering at Cornell has been abie to determine the original drainage pattern of the area.

According to Warren R. Philipson, a senior research associate, who heads Cornell's five member team, this information provides a base for testing how widely the chemicals have leached away from the landfill site itself.

Also being used in the analysis are photographs at Cornell of the area in the 1950s and 1960s showing the historical development of the area and the ways the original drainage pattern has been distorted.

The work being done for the state at Love Canal is provided for under a grant to Cornell from the National Aeronautircs and Space Administration.

The pictures at Cornell are part of **one of the world's largest university collections of photographs covering the entire globe.** Some date back to the early 1930s. They are part of the Remote Sensing Program in the College of Civil and Environmental Engineering at Cornell.

APPENDIX B

LANDSAT ANALYSIS FOR PHEASANT RANGE MANAGEMENT IN NEW YORK STATE

LANDSAT ANALYSIS FOR PHEASANT RANGE MANAGEMENT IN NEW YORK STATE

Remote Sensing Program
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July 1978

ACKNOWLEDGMENTS

This study was supported by NASA Grant NGL 33-010-171, and conducted by Brian L. Markham at the request of Peggy R. Sauer, Supervising Wildlife Biologist, New York State Department of Environmental Conservation. Several other staff and students of the Remote Sensing Program contributed to the work. Warren R. Philipson assisted in project direction and development; Josephine Ng implemented the digital analyses of the satellite data; Ann E. Russell and Laurie B. Schuller collected and compiled the cropping data; Jeffrey R. Gregrow provided additional crop information; Deborah Halpern performed the photographic darkroom work; and Pat Webster typed this manuscript.

Ta Liang
Professor In Charge,
Remote Sensing Program

INTRODUCTION

As part of the pheasant habitat management program of the New York State Department of Environmental Conservation (DEC), there is a need to relate pheasant densities to the State's land cover patterns. The DEC has identified twelve land cover types that should be inventoried, with a minimum mapping unit of approximately four hectares. Seven of the twelve cover types had already been mapped by the statewide Land Use and Natural Resources Inventory, LUNR* (Table 1); however, five cover types of interest had not been separated: (1) hay, (2) corn, (3) other (small) grains, (4) soybeans, and (5) truck crops. This study set out to test remote sensing methods that might be adopted by the DEC for separating these cover types in the Finger Lakes-Lake Plains Region, the area of New York which supports the densest population of pheasants.

APPROPRIATE REMOTELY SENSED DATA

In general, two types of remotely sensed data would be potentially applicable for inventorying the five land cover types of interest, aerial photographs and Landsat satellite data.

Aircraft Photography

The existing aerial photographic coverage of New York State is predominantly medium scale (1:15,000-1:40,000), stereoscopic, black-and-white, panchromatic photography (normally 0.5-0.7μm), flown within the last ten years, during the early spring or fall. Because of age and season, this coverage is not appropriate for crop identification.

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*The LUNR is a computer-based inventory, derived primarily through interpretation of 1:24,000 scale, panchromatic aerial photographs, flown mainly in 1967-1968. Although ten years out of date, the LUNR data seemed to provide a reasonable representation of the seven categories in test areas. Moreover, the LUNR demonstrates how these categories could be updated using the comparable but more recent aerial photographs that cover most of the State.

Table 1. Land cover types selected by State for pheasant-related inventory and LUNR equivalents.

STATE-SELECTED TYPES	LUNR EQUIVALENT*
1. Brushland	1. Forest Brushland (Fc)**
2. Woods	2. Forest Lands (Fn)**
3. Forest Plantations	3. Forest Plantations (Fp)
4. Orchards & Vineyards	4. Orchards & Vineyards (Ao, Av)
5. Fallow fields (inactive agriculture)	5. Inactive Agriculture (Ai)
6. Pasture	6. Pasture-permanent (Ap)
7. Wetlands	7. Wetlands (Wb, Ww)
8. Hay (alfalfa, timothy, etc.)	8. } included under active cropland (Ac and At)
9. Corn	9. } included under active cropland (Ac and At)
10. Other Grains (wheat, oats, barley, etc.)	10. } included under active cropland (Ac and At)
11. Soybeans	11. } included under active cropland (Ac and At)
12. Truck crops and Plowed land	12. } included under active cropland (Ac and At)

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* LUNR: Land Use and Natural Resources Inventory of New York State.

** The demarcation between Fc and Fn is nominally 30 feet, while State would prefer 15 feet.

Most of the Finger Lakes Region is also covered with high-altitude (1:130,000 scale), color infrared photography (3-layer film; 0.5-0.6μm, 0.6-0.7μm and 0.7-0.9μm), flown by NASA for the Cornell Remote Sensing Program on May 7, 1975. Season and age also caused this coverage to be of little value for crop identification.

If aerial photographs were to be the primary tool, it would have been necessary to fly new photography over the entire Lake Plains-Finger Lakes Region.* Given the size of the area, this would have been an expensive task, especially since the DEC would be interested in periodically updating the inventory.

Landsat Data

At the time of this study, there were two operating Landsat satellites (1 and 2). Each carried a multispectral scanner (MSS) which collected solar-reflected radiation in four parts of the electromagnetic spectrum: 0.5 to 0.6μm (green, designated band 4), 0.6 to 0.7μm (red, band 5), 0.7 to 0.8μm (near infrared, band 6) and 0.8 to 1.1μm (near infrared, band 7). Radiation in these four spectral bands was sensed through optics which subtended a ground area of 79-by-79 meters (0.6 hectares), corresponding to the smallest element of a 185-by-185km Landsat picture (i.e., a "resolution element," "picture element" or "pixel").

The Landsat data are available in image form, there being one image for each spectral band or four "spectral" images for each Landsat scene; or they are available in digital form, there being one high density, computer-compatible tape (CCT) for each Landsat scene. At the time of this study, a positive 70mm transparency of a spectral

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*High-altitude, color and color infrared photography over most of the Finger Lakes was flown by NASA for other Cornell studies on May 26, 1978. The films were received on June 26, 1978, after the analysis had been terminated.

image cost $8 (i.e., $32 for all images of a scene), and a CCT cost $200. Although digital analysis of the CCTs is nearly always more costly than analysis of the images, the digital data provide the maximum amount of spatial and spectral information.

Each satellite passed overhead about 9:30 a.m., every 18 days. Although the satellites were once separated by a 9-day interval, orbital changes resulted in one satellite preceding the other by 12 days and subsequently following the other by 6 days. Another significant development was that band 4 of the Landsat-1 MSS ceased operating in March 1977.

Unlike most aerial photography, the spatial resolution of Landsat MSS data (0.6 hectares) is insufficient for extracting much if any information on crop texture or crop-associated features, and Landsat data provide no information on crop height. For cover type studies with Landsat, emphasis must be placed on spectral information (e.g., different crops can be separated if they reflect different amounts of solar radiation in the same spectral band). Landsat data provide quantitative information on visible and near-infrared spectral reflectance; they are repetitive (subject to cloud cover and haze), and available at a comparatively low cost.

In general, if a methodology for using Landsat data to separate the cover types of interest could be developed--primarily on the basis of spectral or spectral/temporal differences--then the Landsat satellites would provide an effective tool for the DEC. The minimum size mapping unit of four hectares is compatible with Landsat resolution, and overall, the Landsat system is scheduled for future upgrading.

DATA FOR ANALYSIS

Landsat Data

The Landsat coverage of New York's Finger Lakes Region, collected at times of less than 80% cloud cover, during the growing season of 1977, is listed in Table 2. For the digital analyses, the CCT

Table 2. Landsat coverage of the Finger Lakes Region, N.Y., collected at times of less than 80% cloud cover, during April to October, 1977. (Source: EROS Data Center, Sioux Falls, S.D.)

DATA TYPE MULTISPECTRAL

IMAGERY TYPE	SCENE ID	PATH,ROW	FILM SOURCE	QUALITY	CLOUD	EXPO DATE	SCENE CENTER POINT	SCENE SCALE	MICROFILM	CCT	CCP
LANDSAT-2 (MSS)	8301314441500	017,030	B&W 2.2"	8,8,5,5	10%	10/31/77	N43D07M59S W076D54M00S	1:3,369,000	0000	F	P
CORNER POINT COORDINATES=#1:N43D42M39S W075D29M56S ,#2:N44D03M12S W077D41M49S ,#3:N42D12M26S W076D07M41S ,#4:N42D32M22S W078D16M29S											
LANDSAT-2 (MSS)	8299514451500	017,030	B&W 2.2"	5,8,8,8	50%	10/13/77	N43D12M59S W076D51M59S	1:3,369,000	0000	P	P
CORNER POINT COORDINATES=#1:N43D47M25S W075D28M29S ,#2:N44D07M48S W077D39M34S ,#3:N42D17M50S W076D05M55S ,#4:N42D37M36S W078D13M59S											
LANDSAT-1 (MSS)	8586013591500	017,030	B&W 2.2"	M,8,8,8	20%	06/26/77	N43D13M59S W077D03M59S	1:3,369,000	0000	P	P
CORNER POINT COORDINATES=#1:N43D49M25S W075D40M35S ,#2:N44D08M38S W077D52M53S ,#3:N42D18M59S W076D16M38S ,#4:N42D37M36S W078D25M50S											
LANDSAT-2 (MSS)	8294114462500	017,030	B&W 2.2"	8,8,8,8	50%	08/20/77	N43D06M00S W076D54M59S	1:3,369,000	2100340048	F	P
CORNER POINT COORDINATES=#1:N43D40M53S W075D30M29S ,#2:N44D01M33S W077D43M08S ,#3:N42D10M05S W076D08M23S ,#4:N42D30M07S W078D17M57S											
LANDSAT-1 (MSS)	8584214012500	017,030	B&W 2.2"	M,8,8,8	50%	08/08/77	N42D27M00S W077D20M59S	1:3,369,000	1100610657	F	P
CORNER POINT COORDINATES=#1:N43D02M43S W075D58M15S ,#2:N43D21M50S W078D09M34S ,#3:N41D31M48S W076D33M55S ,#4:N41D50M20S W078D42M13S											
LANDSAT-2 (MSS)	8292314492500	017,030	B&W 2.2"	8,8,8,8	10%	08/02/77	N43D04M59S W076D52M59S	1:3,369,000	2100330678	F	P
CORNER POINT COORDINATES=#1:N43D39M51S W075D27M54S ,#2:N44D01M00S W077D41M07S ,#3:N42D08M39S W076D06M24S ,#4:N42D29M09S W078D16M32S											
LANDSAT-1 (MSS)	8562414030500	017,030	B&W 2.2"	M,8,8,8	40%	07/21/77	N43D06M00S W077D07M59S	1:3,369,000	1100600776	F	P
CORNER POINT COORDINATES=#1:N43D41M42S W075D43M59S ,#2:N44D01M09S W077D57M11S ,#3:N42D10M28S W076D20M21S ,#4:N42D29M18S W078D30M25S											
LANDSAT-2 (MSS)	8290514501500	017,030	B&W 2.2"	8,8,8,8	20%	07/15/77	N43D04M59S W076D54M59S	1:3,369,000	2100321240	Y	P
CORNER POINT COORDINATES=#1:N43D39M56S W075D30M10S ,#2:N44D00M48S W077D43M14S ,#3:N42D08M50S W076D08M17S ,#4:N42D29M03S W078D18M15S											
LANDSAT-2 (MSS)	8288714511500	017,030	B&W 2.2"	8,8,8,8	10%	06/27/77	N43D06M59S W076D52M59S	1:3,369,000	2100320491	P	P
CORNER POINT COORDINATES=#1:N43D41M35S W075D28M39S ,#2:N44D02M27S W077D40M44S ,#3:N42D11M12S W076D06M46S ,#4:N42D31M26S W078D15M48S											
LANDSAT-1 (MSS)	8578814064500	017,030	B&W 2.2"	M,8,8,8	20%	06/15/77	N43D09M00S W077D06M59S	1:3,369,000	1100590566	F	P
CORNER POINT COORDINATES=#1:N43D44M19S W075D43M12S ,#2:N44D03M58S W077D55M41S ,#3:N42D13M39S W076D19M50S ,#4:N42D32M42S W078D29M13S											
LANDSAT-1 (MSS)	8577014083500	017,030	B&W 2.2"	M,8,8,8	10%	05/28/77	N43D15M00S W077D10M59S	1:3,369,000	1100590060	F	P
CORNER POINT COORDINATES=#1:N43D50M43S W075D47M59S ,#2:N44D09M20S W078D00M15S ,#3:N42D20M17S W076D23M16S ,#4:N42D38M20S W078D32M26S											
LANDSAT-2 (MSS)	8285114525500	017,030	B&W 2.2"	8,8,8,8	10%	05/22/77	N43D15M00S W076D50M59S	1:3,369,000	2100310329	F	P
CORNER POINT COORDINATES=#1:N43D49M17S W075D27M30S ,#2:N44D09M46S W077D38M25S ,#3:N42D19M53S W076D05M04S ,#4:N42D39M45S W078D12M58S											
LANDSAT-1 (MSS)	8575214101500	017,030	B&W 2.2"	M,5,8,8	50%	05/10/77	N43D15M00S W077D07M59S	1:3,369,000	1100580168	F	P
CORNER POINT COORDINATES=#1:N43D50M26S W075D45M01S ,#2:N44D09M20S W077D56M54S ,#3:N42D20M17S W076D20M37S ,#4:N42D38M36S W078D29M25S											
LANDSAT-2 (MSS)	8283314535500	017,030	B&W 2.2"	8,8,8,8	30%	05/04/77	N43D12M00S W076D52M59S	1:3,369,000	2100300407	P	P
CORNER POINT COORDINATES=#1:N43D46M29S W075D29M15S ,#2:N44D06M58S W077D40M39S ,#3:N42D16M40S W076D06M51S ,#4:N42D36M33S W078D15M12S											
LANDSAT-2 (MSS)	8281514545500	017,030	B&W 2.2"	5,5,8,8	20%	04/16/77	N43D10M59S W076D54M59S	1:3,369,000	2100291073	P	P
CORNER POINT COORDINATES=#1:N43D45M46S W075D30M33S ,#2:N44D06M26S W077D43M03S ,#3:N42D15M12S W076D08M29S ,#4:N42D35M14S W078D17M53S											

of the July 15, 1977, Landsat-2 scene was acquired, and the CCT of an August 2, 1976, Landsat-2 scene (#8258014582500) was already on file having been obtained earlier for an unrelated study. For the manual (non-computer) analyses, selected spectral images were acquired of the following 1977 scenes: May 4, May 22, June 27, August 2, and August 26. These images were purchased as 70mm, positive transparencies and subsequently enlarged.

Ground Data

Ground data for use in verifying the interpretation of the Landsat data were collected in three areas within the Finger Lakes Region (Fig. 1): (1) along Interstate 81, south of Tully, N.Y. ("Tully area," approx. 35 km^2); (2) along Cayuga Lake, near King Ferry, N.Y. ("King Ferry area," approx. 35 km^2); and (3) along Owasco Lake, near Owasco, N.Y. ("Owasco area," approx. 15 km^2).

The ground data were collected during July and August 1977. They consisted of field observations of land cover types and interview-derived data on land cover (crop) types that were present in 1976. The field boundaries and cover types were recorded on enlarged, black-and-white prints of available high-altitude aerial photographs.

Auxilliary Cropping Data

To aid the interpretation and selection of imagery, a "calendar" of planting, growth and harvesting dates of the major field and truck crops in the Finger Lakes-Lake Plains Region was prepared from several interview and literature sources (Fig. 2).

SINGLE DATE ANALYSES

Procedure

The initial attempts to discriminate the five cover types of interest involved the use of Landsat data in digital form. Although computer analysis techniques are nearly always more expensive than manual approaches, for problems requiring spectral recognition,

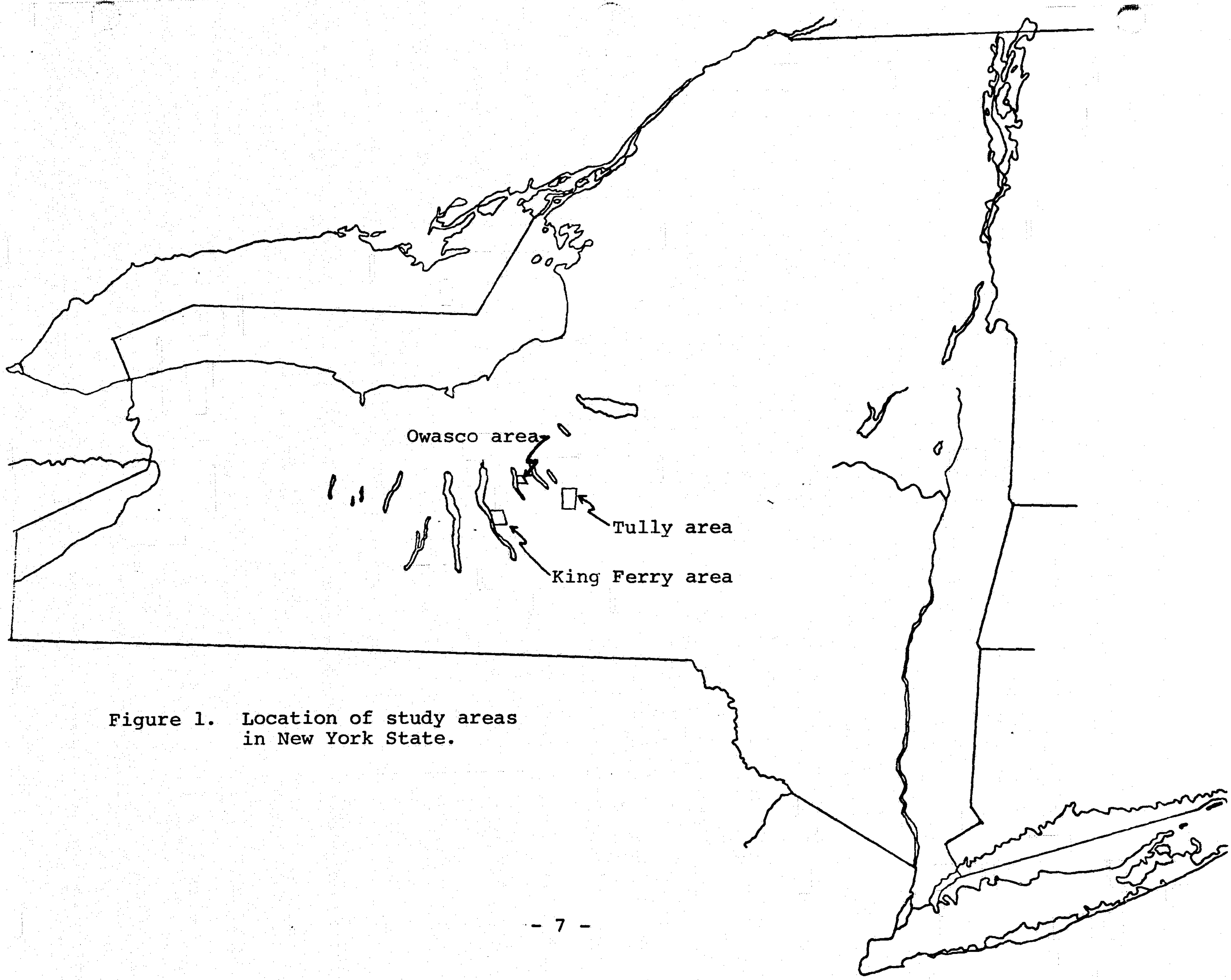
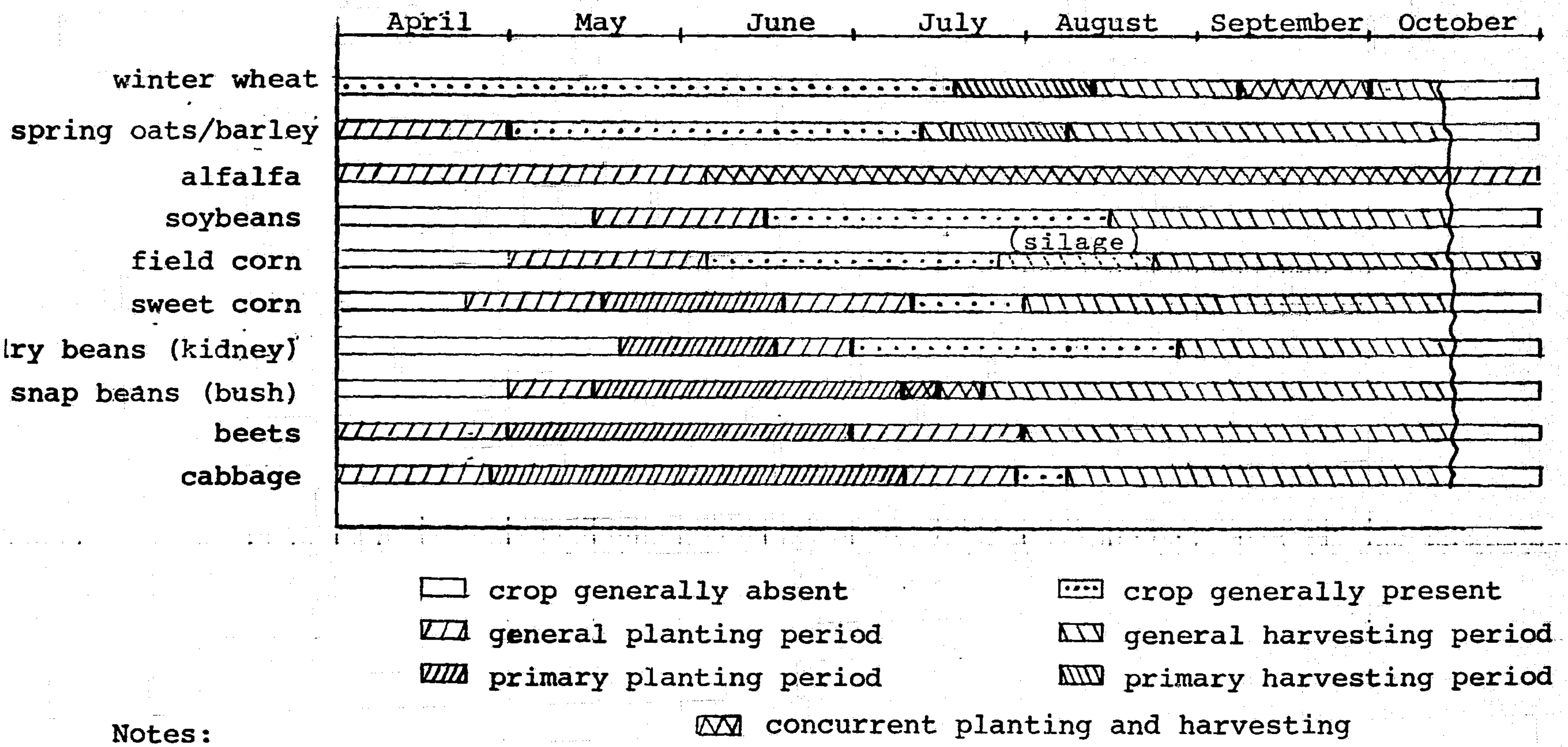


Figure 1. Location of study areas in New York State.

Figure 2. Crop calendar for Finger Lakes Region and western New York State.



Notes:

1. Data compiled primarily from: "Cornell Recommends for Field Crops, 1977" and "Commercial Vegetable Production Recommendations, 1977," from the N.Y.S. College of Agriculture and Life Sciences, Cornell University, Ithaca, N.Y. Average weather and the most common farming practices are assumed.

2. Most fields of alfalfa, a perennial crop, are not planted every year.

3. Field corn is planted 10 days before the average last frost date, and beginning in late-July, it may be cut for silage.

computer techniques will normally indicate whether the desired information is derivable from the data. Failure to separate the cover types with digital data would indicate that manual analyses would also be unsuccessful, however, the reverse is not necessarily true.

A July 15, 1977, Landsat-2 scene was chosen for analysis because the crop calendar indicated that most fields should have crops on this date (Fig. 2). The CCT of an August 24, 1976, Landsat-2 scene, on hand for another investigation, was also analyzed.

The digital analyses were conducted using a supervised classification procedure. This involves "training" the computer to separate the various categories of interest on the basis of their spectral value. The essential steps are: (1) using the ground data, choose test sites in the Landsat scene (e.g., test site 1 includes pixels--picture elements--that depict fields known to have corn; test site 2: pixels depicting alfalfa fields; etc.); (2) have the computer generate selected statistics on the spectral characteristics of the chosen sites (e.g., calculate the average values of the spectral responses of corn and alfalfa in the test sites, for each spectral band); and (3) input these statistics to algorithms that classify all pixels of the scene, or portion of the scene, into the category to which it is most similar spectrally (e.g., pixels displaying spectral values closer to those of the test site corn than to those of the test site alfalfa will be classed as corn).

Several data pre-processing routines were used in an attempt to improve the classification. These include canonical analysis, where the spectral data are transformed to provide maximum separaability among test site categories, and ratioing, where the ratio of a pixel's value in one spectral band to its value in another spectral band is computed and used to represent the pixel. No special attempt was made to eliminate atmospheric effects (e.g., haze) from the data.

The Tully area was used as the primary area for analysis, and the King Ferry area was used as a secondary area (Fig. 1). Certain crops present in the King Ferry area were not present in the Tully area. The Owasco area was used to check the applicability of classifications developed in the Tully or King Ferry areas.

Results

July 15, 1977 data:

The crops in the Tully area were primarily corn and alfalfa, with some oats and truck crops (mainly cabbage); while corn, alfalfa, oats, wheat and beans (snap, red kidney and soybean) were the principal crops in the King Ferry area. The spectral characteristics of these crops are shown in Table 3. Being at various growth stages, alfalfa exhibited a wide range of spectral values. The crop was arbitrarily separated into two spectral categories which were thought to correspond to recently cut and uncut alfalfa fields. Similarly, in the King Ferry area, corn was separated into two categories (apparently, early and late-planted) and beans into three categories (soybeans; unharvested snap beans and red kidney beans; and harvested snap beans and/or late-planted snap or kidney beans--essentially bare fields).

The results of spectrally classifying the canonically transformed test site categories are reported in Tables 4 and 5. A computer printout for part of the classified King Ferry area is presented in Figure 3.

August 24, 1976 data:

The analyses conducted with the 1976 data were not as extensive as those with the 1977 data, principally because the 1976 ground data were obtained by interview during 1977 and were thus judged to be of lower reliability. The spectral characteristics of the crops in the Tully area on August 24, 1976 are reported in Table

Table 3. Means and standard deviations, in parentheses, of spectral radiance counts of test site cover types in Finger Lakes Region, N.Y., as recorded by Landsat-2 on July 15, 1977.

TEST SITE CATEGORIES	NUMBER PIXELS	LANDSAT SPECTRAL BANDS			
		4	5	6	7
Tully Area Test Sites					
Corn	71	16.9 (0.9)	14.2 (1.1)	58.1 (4.6)	31.8 (3.0)
Alfalfa-1*	49	18.2 (1.0)	16.2 (1.7)	66.1 (4.9)	35.4 (2.4)
Alfalfa-2*	26	20.7 (1.9)	22.3 (3.1)	52.5 (2.6)	25.4 (1.7)
Oats	24	16.8 (0.8)	14.7 (1.4)	53.5 (4.9)	28.1 (3.4)
Cabbage	8	22.1 (1.7)	21.4 (1.4)	73.9 (4.2)	36.1 (2.0)
King Ferry Test Sites					
Corn-1**	76	20.2 (2.0)	18.2 (2.7)	60.1 (2.3)	31.9 (1.6)
Corn-2**	57	33.2 (5.1)	42.0 (8.6)	54.6 (6.4)	22.4 (2.9)
Beans-1***	56	28.4 (2.7)	34.8 (5.5)	50.3 (3.6)	21.6 (2.3)
Beans-2***	17	26.2 (1.7)	26.9 (2.3)	63.0 (3.2)	29.9 (1.3)
Soybeans	15	19.8 (1.4)	16.9 (1.1)	77.3 (7.3)	41.1 (3.8)
Alfalfa-1*	38	20.0 (1.2)	16.6 (1.1)	66.0 (5.6)	34.8 (3.2)
Alfalfa-2*	15	22.3 (1.6)	23.9 (1.6)	45.5 (4.1)	21.7 (2.1)
Oats	24	23.6 (2.0)	27.2 (2.7)	40.8 (2.5)	18.4 (1.2)
Wheat	46	21.3 (2.5)	25.6 (2.7)	38.6 (4.9)	17.0 (2.8)

* 1-cut, 2-uncut. Alfalfa fields were at different stages of growth. The separation into cut and uncut is somewhat arbitrary.

** Compared to corn-1, corn-2 appears to be late-planted.

*** 1: includes cut and late-planted snap beans and, possibly, red kidney beans.
2: includes red kidney beans and, possible, uncut snap beans.

Figure 3. Computer printout of a portion of the spectrally classified King Ferry area.

(Each symbol denotes a pixel of 15 July 1977 Landsat data, classified after canonical transformation.)

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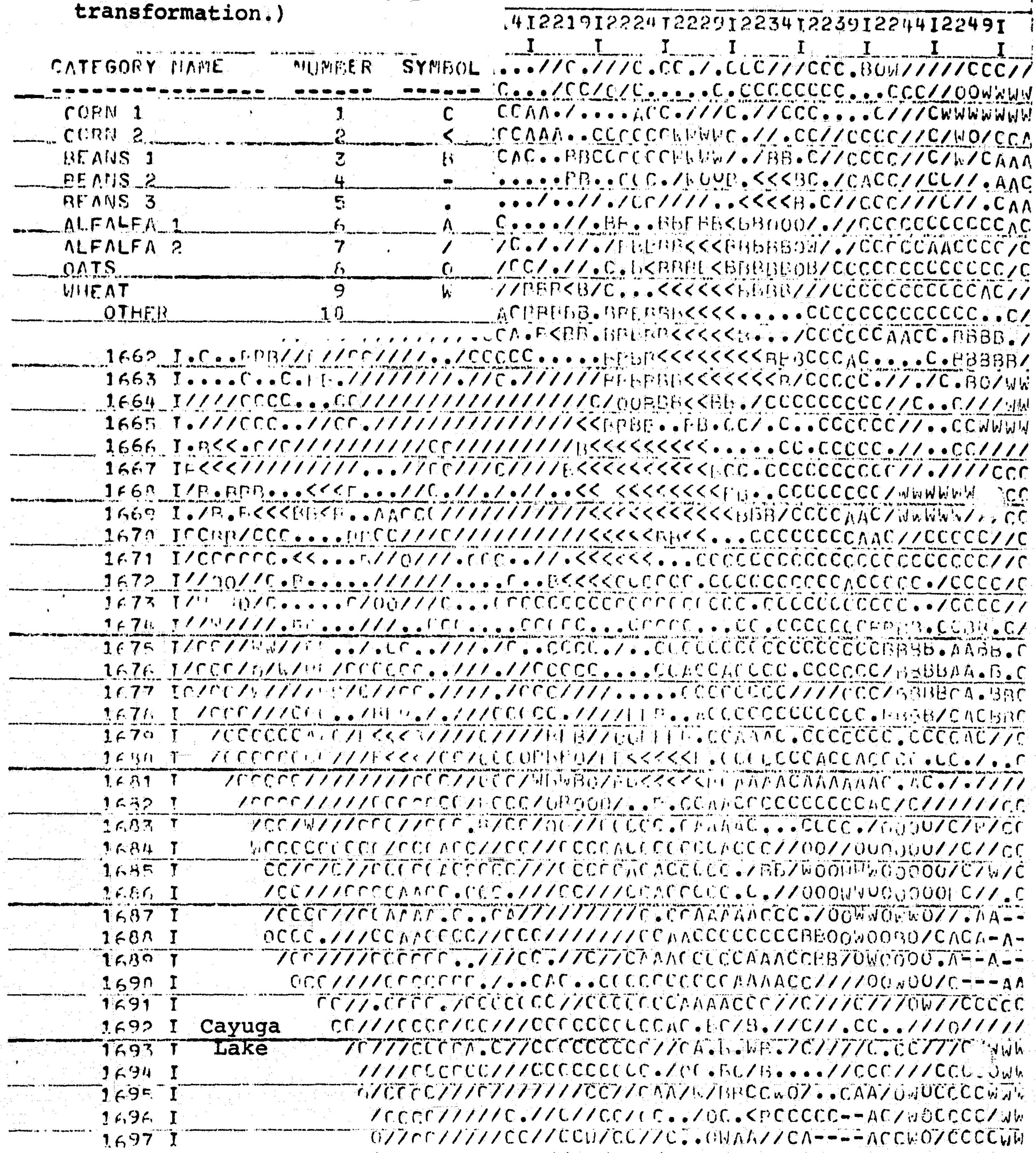

CATEGORY NAME	NUMBER	SYMBOL
CORN 1	1	C
CORN 2	2	<
BEANS 1	3	B
BEANS 2	4	-
BEANS 3	5	.
ALFALFA 1	6	A
ALFALFA 2	7	/
OATS	8	0
WHEAT	9	W
OTHER	10	

6. No detailed statistics were generated for the King Ferry area crops, although their general characteristics were examined.

Discussion

Compared to the Tully area, a valley, the King Ferry area is more open, somewhat lower in altitude, and generally, more representative of the Finger Lakes Region. In addition, field sizes tend to be smaller in the Tully area, making it more difficult to obtain reliable statistics on the spectral characteristics of the cover types.

As evidenced in Table 3, some differences in the spectral characteristics of cover types were observed between the two areas, especially in the responses of spectral bands 4 (green) and 5 (red). On the other hand, the generally higher band 4 and 5 responses in the King Ferry area are likely to be at least partly attributed to greater amounts of haze over this area. More significantly, some spectral differences, such as those exhibited by oats in the July Landsat scene (Table 3), are thought to be related to a difference in growth stage. Oats in the Tully area were likely to be at an earlier stage of growth, a possibility which could not be confirmed due to the lack of concurrent ground data.

Although the values presented in Tables 4 and 5 provide only an indication of the accuracy obtainable with spectral classification, it is clear that certain problems were and would be encountered. Within the Tully area, in July, the principal confusion was between oats and corn, with some confusion between alfalfa and corn (Table 4). In August, corn and alfalfa appeared to be generally separable, although some confusion would be expected between harvested corn and cut alfalfa fields (Table 6). The spectral differences for oats in Table 6 may be related to differences in cultivation practices after harvest (or, possibly

Table 4. Results of spectrally classifying the July 15, Tully area test site pixels using a Euclidean distance classifier following canonical transformation.

CLASSIFIED CATEGORIES	ACTUAL TEST SITE CATEGORIES Corn	Alfalfa	Oats	Cabbage
Corn	45 (63%)	7 (9%)	11 (46%)	0 (0%)
Alfalfa	6 (8%)	65 (87%)	1 (4%)	0 (0%)
Oats	20 (28%)	3 (4%)	12 (50%)	0 (0%)
Cabbage	0 (0%)	0 (0%)	0 (0%)	8 (100%)
No. Pixels	71	75	24	8

Table 5. Results of spectrally classifying the July 15, King Ferry area test site pixels using a Euclidean distance classifier following canonical transformation.

A. Pixel Assignments Based on Five Categories

CLASSIFIED CATEGORIES	ACTUAL TEST SITE CATEGORIES Corn	Beans	Soy.	Alf.	O.& W.
Corn	96 (72%)	8 (11%)	0 (0%)	12 (23%)	0 (0%)
Beans-1,-2	29 (22%)	60 (83%)	0 (0%)	1 (2%)	1 (1%)
Soybeans	0 (0%)	3 (4%)	11 (73%)	8 (15%)	0 (0%)
Alfalfa	6 (5%)	1 (1%)	4 (27%)	30 (57%)	6 (9%)
Oats and Wheat	2 (2%)	1 (1%)	0 (0%)	2 (4%)	63 (90%)
No. Pixels	133	73	15	53	70

B. Pixel Assignments Based on Three Categories

CLASSIFIED CATEGORIES	ACTUAL TEST SITE CATEGORIES Corn & Beans	Soy. & Alf.	O.& W.
Corn and Beans-1,-2	194 (94%)	13 (19%)	1 (1%)
Soybeans and Alfalfa	9 (4%)	53 (78%)	6 (9%)
Oats and Wheat	3 (1%)	2 (3%)	63 (90%)
No. Pixels	206	68	70

Table 6. Means and standard deviations, in parentheses, of spectral radiance counts of test site cover types in Tully area, N.Y., as recorded by Landsat-2 on August 24, 1976.

TEST SITE CATEGORIES	NUMBER PIXELS	LANDSAT SPECTRAL BANDS			
		4	5	6	7
Corn	39	15.7 (1.0)	14.0 (1.2)	53.2 (4.3)	30.8 (2.2)
Alfalfa	79	16.6 (0.8)	14.2 (1.4)	70.1 (5.5)	39.9 (3.7)
Cut Fields (Alfalfa and Corn?)	31	19.7 (1.1)	26.4 (2.3)	48.4 (3.7)	24.4 (1.9)
Oats-1 (?)	12	18.7 (1.3)	19.3 (0.6)	54.4 (3.4)	27.9 (1.0)
Oats-2 (?)	16	14.4 (1.2)	13.4 (0.9)	44.4 (1.9)	25.4 (1.0)

to erroneous ground data), since oats are normally harvested by August 24.

In the King Ferry area, in July, little confusion was observed between oats (and wheat) and corn, however, some overlap between alfalfa and corn was still apparent (Table 5). In addition, much spectral overlap was exhibited by corn and snap and red kidney beans (apparently between recently planted corn and bean fields and recently harvested bean fields) and by alfalfa and soybeans. Although not shown, three groups of crops showed evidence of separability with the August 24 data: (1) alfalfa and certain bean fields (soy? and kidney?), (2) uncut corn, and (3) wheat and oats, cut alfalfa, and certain bean fields (cut snap beans?). For both the July and August data, the nature of the ground data did not allow the cause of confusion to be determined completely.

MULTI-DATE ANALYSIS

Procedure

Given that few of the cover types of interest could be reliably separated on a single date of Landsat data, it was decided to proceed to a multi-date ("time-sequential" or "temporal") approach. Multi-date analyses of Landsat data can take advantage of cropping patterns as well as reflectance differences, and are therefore potentially more accurate than single date analyses in separating crops. The crop calendar indicated that data collected during either mid-May to early June or mid-August would be most useful (Fig. 2).

Minimally, the mid-May data should allow separation of overwintered crops (wheat and alfalfa) from spring-planted crops (corn, oats, soybeans and truck crops); the wheat and alfalfa should exhibit a near-complete vegetative cover, whereas most of the other crops would be in the early stages of growth or not yet planted. Also, the early spring planted crops (primarily oats and barley) might be separable from the late-spring planted crops, as they would be in a later stage of growth. Spectral differences between wheat and alfalfa might also allow their differentiation.

The mid-August data should allow separation of most of the small grains (wheat, oats and barley) from corn, soybeans and most truck crops; the small grains would be mostly harvested whereas these other crops would not. The small grains might show some similarity with recently cut alfalfa fields and with harvested snap bean fields.

During the growing season (May-September) of 1977, eight Landsat scenes had less than 40% cloud cover (Table 2). Selected images (positive 70mm transparencies) were obtained of the following dates: May 4, May 22, and June 27, August 2 and August 26. Preference was given to Landsat-2 coverage, as band 4 of Landsat-1 was not functional. The May and August scenes were chosen as being closest to the desired times; the June 27 scene was obtained to assess what additional information it might provide. Clouds or haze over the study areas prevented the May 24 and August 26 data from being of value.

For the multi-date analysis, it was decided to use images instead of the computer compatible tapes, given the expense of the tapes and computer processing. Photographic enlargements of the Tully and King Ferry portions of the band 5 (red) and band 7 (near infrared) images were made for the May 22, June 27 and August 2 dates. These enlarged transparencies (both positives and negatives) were analyzed in an additive-color viewer. This device allows as many as four transparencies to be projected simultaneously onto the same screen, with each transparency being projected by a variable intensity, white light source, through either a red, green, blue or clear filter. Thus, positive and negative images of different dates as well as of different spectrum bands were superimposed, using different color assignments, and evaluated.

Results and Discussion

Only gross assessment of the spectral nature of the agricultural fields could be performed through visual methods since only three or four levels of gray could generally be distinguished on any one image. As such, it was usually impossible to ascertain much more than whether or not the fields had a vegetative cover.

Within the agricultural field areas, the band 7 (near-infrared) image was almost a negative of the band 5 (red) image. Fields with a full vegetative cover would be low in red reflectance and high in near-infrared reflectance; bare (or recently cut) fields would be high in red reflectance and low in near-infrared reflectance. Although most of the information for any date could be thus obtained from either the band 5 or band 7 image, the band 5 images were preferred because they usually showed sharper field boundaries.

For the additive-color viewer, the combination of spectral band, color and date that seemed to provide the best discrimination, in the most easily interpreted form, used three band 5, positive images: the May 22 image was projected through a red filter, the June 27 image through a blue filter, and the August 2 image through a green filter.* At least three categories of crops, or groups of crops, of interest were generally separable with this combina-

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* This combination as well as others could also be obtained with diazo using a subtractive-color process. Results comparable to those obtained in this study would be gotten by overlaying a cyan diazo exposed with the band 5, May 22 image; a yellow diazo exposed with the band 5, June 27 image; and a magenta diazo exposed with the band 5, August 2 image. This diazo combination is being submitted to the DEC with this report.

tion: (1) alfalfa hay, (2) corn, beans and truck crops, and (3) small grains (oats and wheat). The alfalfa appears brown, greenish brown, green or occasionally dark blue; the corn, beans and truck crops appear red, magenta, white or occasionally yellow (snap beans); and the small grains appear yellow, yellowish green or green. Although the separability was not as good as desired (alfalfa could be confused with wheat, and oats could be confused with snap beans), this combination could give generalized information on the distribution of these cover types in the Finger Lakes Region, if non-cropped areas were excluded using LUNR data.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

Neither the single dates (July 15, 1977 and August 24, 1976) of Landsat, analyzed digitally, nor the combination of dates (May 22, June 27 and August 2, 1977), analyzed manually, provided adequate separability of all cover types of interest--hay, corn, small grains, soybeans and truck crops. It would seem that, on any one date, the crop reflectance differences in the spectral regions sensed by Landsat are insufficient for crop discrimination. It would also seem that combining standard product Landsat images of different dates will not provide the required separations. The standard product images can generally provide only gross spectral separations (e.g., whether or not the field is cropped), and therefore differences in cropping pattern (calendar) must be relied upon. In some cases, the differences in cropping patterns are not sufficient to allow crop separation.

Two alternative approaches to attempt to obtain the desired information from Landsat data involve combining the digital and multi-date analyses. The first approach would perform a supervised classification of Landsat digital data from two dates. The two recommended dates would fall within the periods of

May 20 to June 5 and either July 10 to 20 or August 10 to 20.*
With well-distributed ground data for training the classifier, four groups of crops should be adequately separated: alfalfa hay, small grains (oats, wheat and barley), soybeans, and corn together with truck crops and dry beans. Some additional separations within the last category should also be possible (e.g., cabbage).

The mid-July period is probably preferable for use in combination with the May data, as the separation of oats from other crops should be clearer. If data from all three periods were cloud-free, however, their combined use should further improve the classification accuracy, though at a substantially higher cost. Such a multi-date, digital analysis would have been possible with the 1977 data. It was not attempted because of the high cost of data acquisition and analyses, and consequent low likelihood of implementation by the DEC--even if the method was demonstrated successfully. Decreased computing costs with wider availability of array processor-type equipment might cause this alternative to merit future consideration.

The second alternative is to: (1) use digital processing to enhance the spectral differences between the crops of interest on different dates, (2) produce new images of the enhanced data, and (3) overlay these enhanced images with an additive-color or subtractive-color process. Combining enhanced images of the May 20 to June 5 and July 10-20 or August 10-20 dates would probably produce separations similar to those made with

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*Unusual growing conditions might require adjustment of these times. The first period (May 20-June 5) was chosen to be after the overwintered crops (wheat, alfalfa) have "greened," after early spring crops have started to show some vegetative cover, but before most spring crops have grown much. The July 10-20 period was chosen to be just prior to wheat-oats harvest, both of these crops having matured. The August 10-20 period was chosen to be after oats and wheat had been harvested, but before the harvest of most other crops.

computer-classification of the same dates. These analyses may take less computer time than classification, but they would require the special capability of outputting onto film.

The system for producing standard product Landsat images is scheduled to be upgraded in September 1978. The higher quality images will have been subjected to several digital processing techniques, in addition to improved image recording. Higher radiometric and geometric fidelity, increased effective resolution, along with improved tonal contrast of the images should be apparent. The improved images should increase the capacity to separate the crops of interest (being a form of the second alternative listed above), but more selective enhancements may still be necessary.

Other alternatives that might also be considered include supplementing either the single-date or multi-date analyses, reported here, with extensive field surveys; or, as a final note, redefining the cover types that must be separated.

APPENDIX C

SELECTION OF SITES FOR DREDGE SPOIL DISPOSAL AND SUBSEQUENT RECREATIONAL DEVELOPMENT, COLUMBIA COUNTY, N.Y.

COLUMBIA COUNTY PLANNING BOARD

70 NORTH THIRD STREET, HUDSON, NEW YORK 12534
Telephone (518) 828-3375

RALPH I. WILLIAMS, Chairman
Claverack, New York 12513

ARTHUR KOWEEK, Vice Chairman
Hudson, New York 12534

GRANVILL HILLS, Secretary
Hudson, New York 12534

ALAN P. MUIR
Planning Director

August 10, 1978

Warren R. Philipson
Remote Sensing Program
Hollister Hall
Cornell University
Ithaca, New York 14853

Dear Warren:

I would like to thank you for the work you did using remote sensing and high altitude data in preparing the reports on potential Hudson River recreation areas and the viability of agricultural lands in Columbia County; we are pleased with the scope and quality of both reports.

Presently, both are being circulated to various agencies in the hope that the information produced will create some interest in the use of your findings in local and state programs.

We will let you know how we make out.

Sincerely,

Alan P. Muir
Planning Director

APM:de

SELECTION OF SITES FOR DREDGE SPOIL DISPOSAL AND SUBSEQUENT RECREATIONAL DEVELOPMENT IN COLUMBIA COUNTY, N.Y.

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14853

July 1978

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PREFACE

This analysis of dredge spoil/recreation sites was performed by William R. Hafker under the direction of Warren R. Philipson and Ta Liang. The work was requested by representatives of the Planning Board of Columbia County, N.Y., and supported by NASA Grant NGL 33-010-171.

INTRODUCTION

The Hudson River coastline of Columbia County, New York, offers unique and scenic areas for river-oriented recreation, but few recreation facilities are presently available for public use. Periodic dredging of the Hudson River shipping channel, required for navigation, can provide the materials useful for developing suitable sites. The purpose of this study was to identify and assess the best sites for dredge spoil disposal and subsequent recreational development.

MATERIALS AND METHODS

Study Area

Columbia County is located on the eastern border of New York State (Fig. 1). The City of Hudson, the County Seat, lies approximately 50 km south of Albany and 190 km north of New York City. The Hudson River, designated as a coastal zone under the Federal Coastal Zone Management Act of 1972, forms the western border of the County. Much of the approximately 50 km coastline slopes rapidly inland, leaving little flat land along the shore. A major railroad line runs along the shore, restricting access to the river.

Materials

The primary materials used in this study were aerial photographs, topographic maps, and selected maps and reports provided by the Columbia County Planning Board (Table 1).

Methods

It was decided that sites would be selected from existing land masses rather than from submerged areas. Four criteria were employed in the initial screening process.

Table 1.

Primary Reference Materials

A. Aerial Photographs

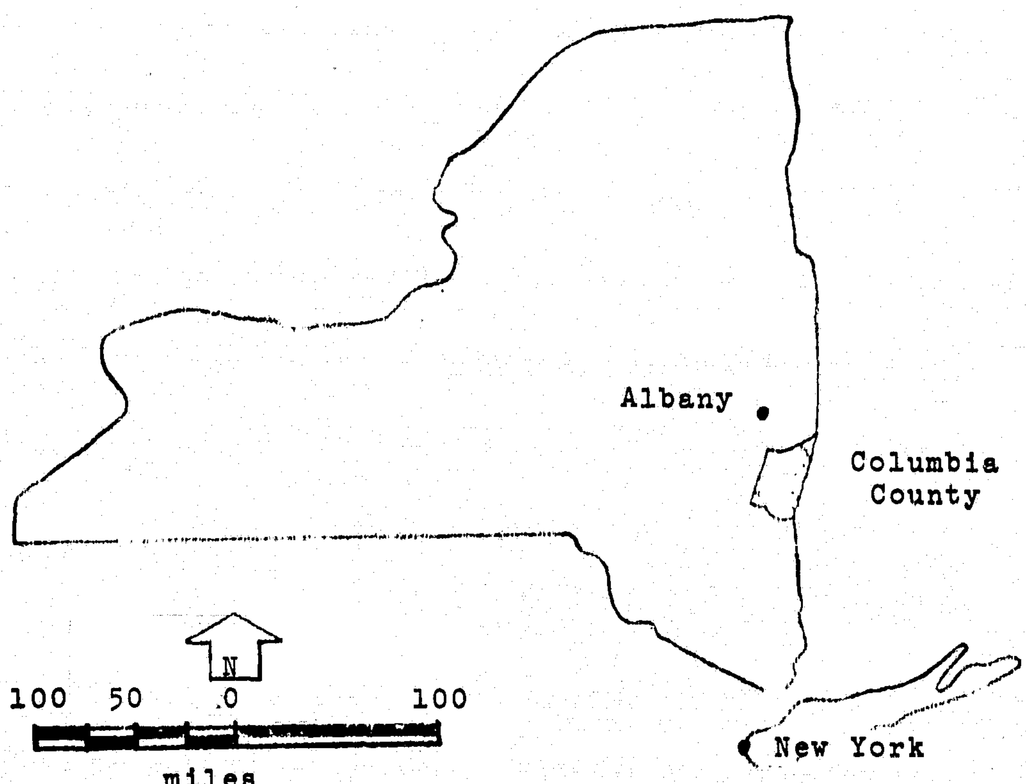
Date	Scale	Film Type	Source
Sept. 1959	1:20,000	panchromatic	U.S. Dept. of Agriculture (ASCS)
March 1968	1:24,000	panchromatic	N.Y.S. Land Use & Natural Resource Inventory (LUNR) [Lockwood Mapping]
April 1973	1:130,000	color infrared	NASA

B. Topographic Maps

U.S. Geological Survey, 7.5 minute, 1:24,000 scale: Ravena 1953, Hudson North 1953, and Hudson South 1963.

Figure 1.

Columbia County in New York State



1) Size: The sites were required to be at least 20 hectares (49 acres). This criterion would insure that significant quantities of spoil could be disposed of and a substantial recreation area could be developed if desired. Size was estimated from the 1973 NASA photographs, the most recent source of information on possible shoreline changes.

2) Location and Access: The sites were required to be located entirely shoreward of the railroad tracks along the coast, with existing or possible access available. The location restriction would facilitate dredge spoil disposal and reduce the hazard of repeated crossings of the railroad tracks by users of any recreation facilities. This factor was determined using the 1973 NASA photographs. Access routes were determined from the 1973 Columbia County Highway Map, the U.S.G.S. topographic maps, and the 1973 NASA photographs. Future access possibilities were determined by considering extension of existing roads, while taking into account such obstacles as slope, marsh, or incompatible land use. Although access by road was given primary consideration, especially good sites for boat access were also noted.

3) Slope: The sites were required to have slopes of less than 5% over most of their area. This restriction would help to insure that spoil disposal would be both possible and safe. Areas that met this criterion were identified by a study of U.S.G.S. topographic maps and the 1973 photographs.

4) Existing Private, River-oriented Recreation: Areas having privately owned, river-oriented recreation facilities were rejected, with the assumption that the County was seeking new areas for development.

Based on these four criteria, five general areas, or "zones," were selected and evaluated with regard to the following:

1) Land stability: Stability refers to the likelihood that the land would be relatively permanent, maintaining its shape and topography, in the face of expected natural processes. This was assessed by a time-sequential analysis of the available photographic coverage, assuming that changes in the configuration of the land would indicate erosiveness or instability.

2) Land Use/Cover: The land use and cover, from 1959 to 1973, was examined to determine if the land was available and suited for the intended uses. Overlays of each zone showing the land use/cover in 1973 were compiled at a scale of 1:24,000 using the 1968 N.Y.S. Land Use and Natural Resource Inventory classification for reference. Appendix A contains descriptions of the terms used in the overlay series.

3) Aesthetics: The existence of any especially pleasant or unpleasant views from each zone was assessed using the 1973 NASA photographs.

4) Proximity to Population Centers and Existing Recreation Areas: The distance that people would be required to travel to reach these zones, as well as the travel required to reach alternative recreation areas is an important factor. Straight-line distances were measured between approximate central points of relevant areas on the 1973 Columbia County Highway Map and the County's 1977 Existing Land Use Map. The population centers considered are the largest areas of residential concentration.

5) Water quality: The quality of water at a given zone determines what type of river-oriented activities could be supported. The Columbia County Stream classification map was used to determine the quality of water in a zone with the knowledge that water quality is variable over time and will depend largely on the actions and care of its various users. The

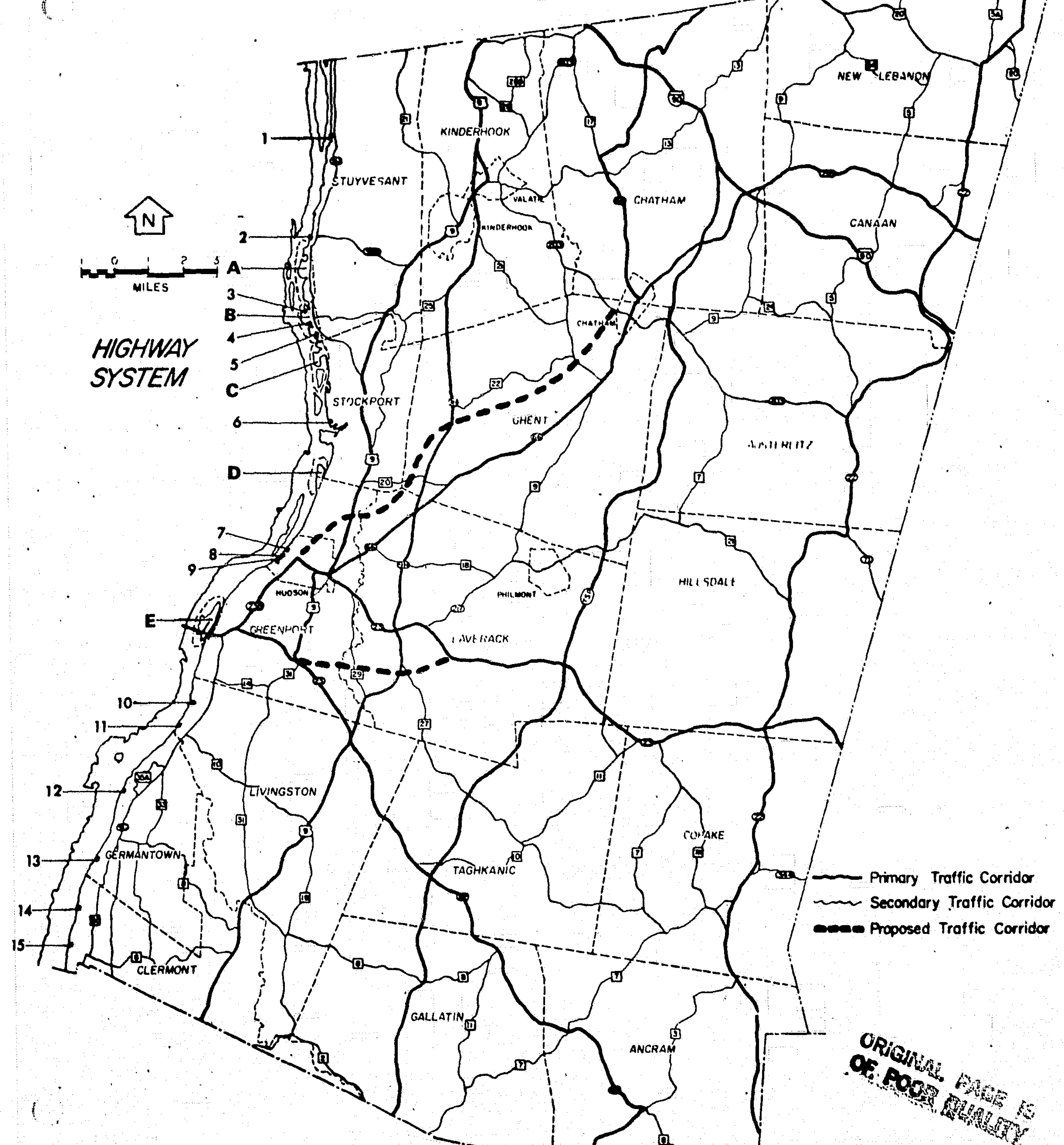
existence of backwater or stagnant areas was assessed using the 1973 photographs, since water quality problems in such areas could be a problem in the development of a complete recreation facility.

RESULTS

On the basis of size, location and access, slope and existing recreation facilities, five zones were selected as well-suited for both disposal of dredge spoil and recreational development. These are shown in Figures 2 and 3. Also shown in Figure 2 are the 15 sites that offer existing road access to the river shore. As can be seen, only one zone (Zone B) contains existing public access routes.

These five zones were evaluated for land stability, land use and cover, aesthetics, proximity to population and existing recreation centers, and water quality. The results are presented on the following pages.

Figure 2.
Five Study Zones, A-E, And 15 Points Of Access To Hudson River In 1973.



• - location of existing access (refer to Appendix B)

( ) - boundary of study zone

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Figure 3.

Wetlands And Recent Dredge Spoil Disposal Sites Along Columbia County, N.Y., Coastline, 1973*

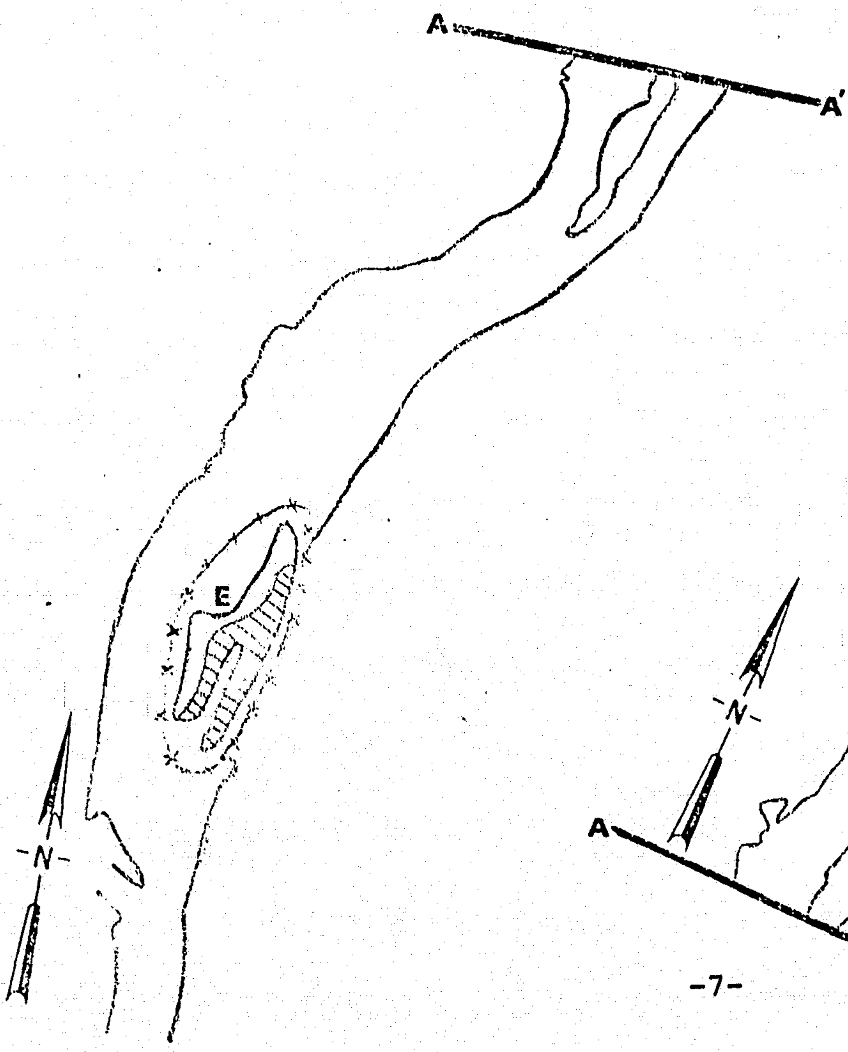
areas of recent dredge spoil disposal

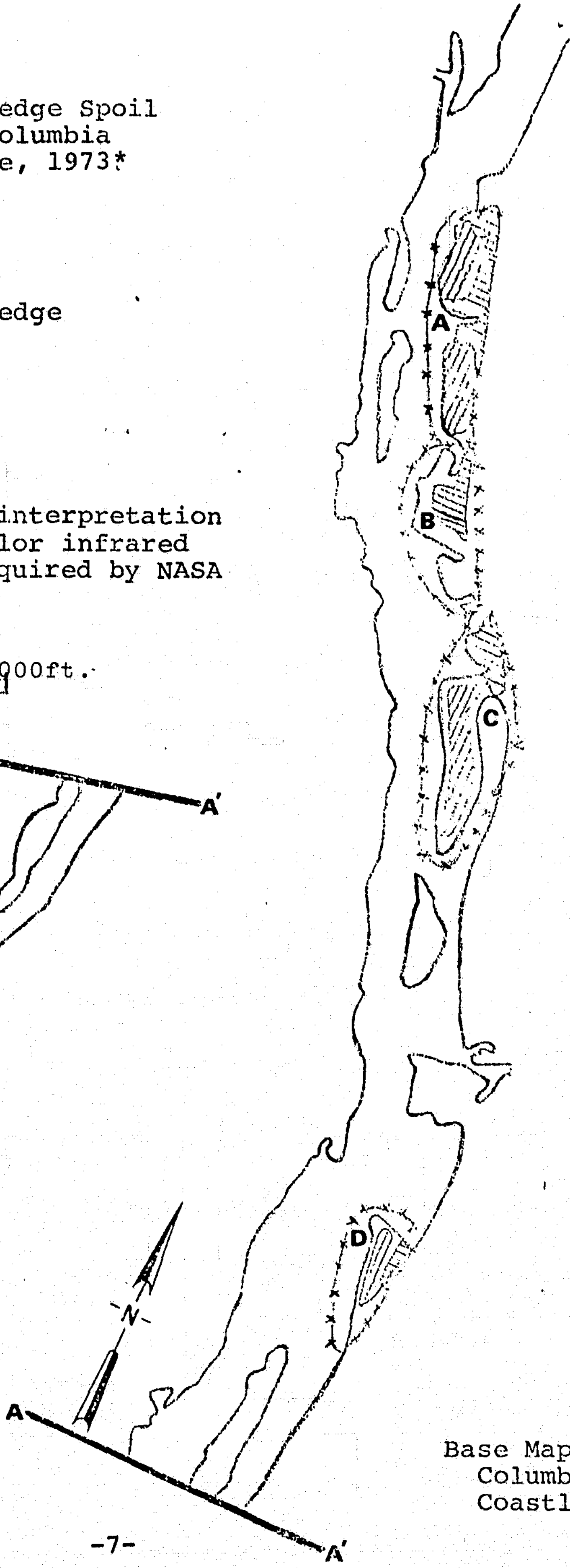
wetland areas

zone boundary

*Information based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

5000 0 5000ft.





Base Map:
Columbia County
Coastline Map

ZONE A

Characteristics as of 1973

(Figs. 3 and 4)

Area: Approximately 70 hectares (173 acres).

Land Stability: Stable; no apparent change in size or configuration from 1959 to 1973.

Land Use/ Cover: 1959 - The zone consists of marsh or scrub bogs and forested brushlands.

1973 - Two large previously forested brushland areas have been used for dredge spoil disposal and now exist as bare or sparsely vegetated sand.

As of 1973 nothing in the use of this or nearby land indicates that Zone A would be used for any purpose other than dredge spoil disposal.

Access: None exists but favorable future access routes are available (Fig. 4).

Aesthetics: Views of Coxsackie, N.Y., Coxsackie Island, marsh on Bronck Island, wooded and farmed areas.

Distance: See Table 2. Zone A is the zone farthest from the City of Hudson, N.Y.

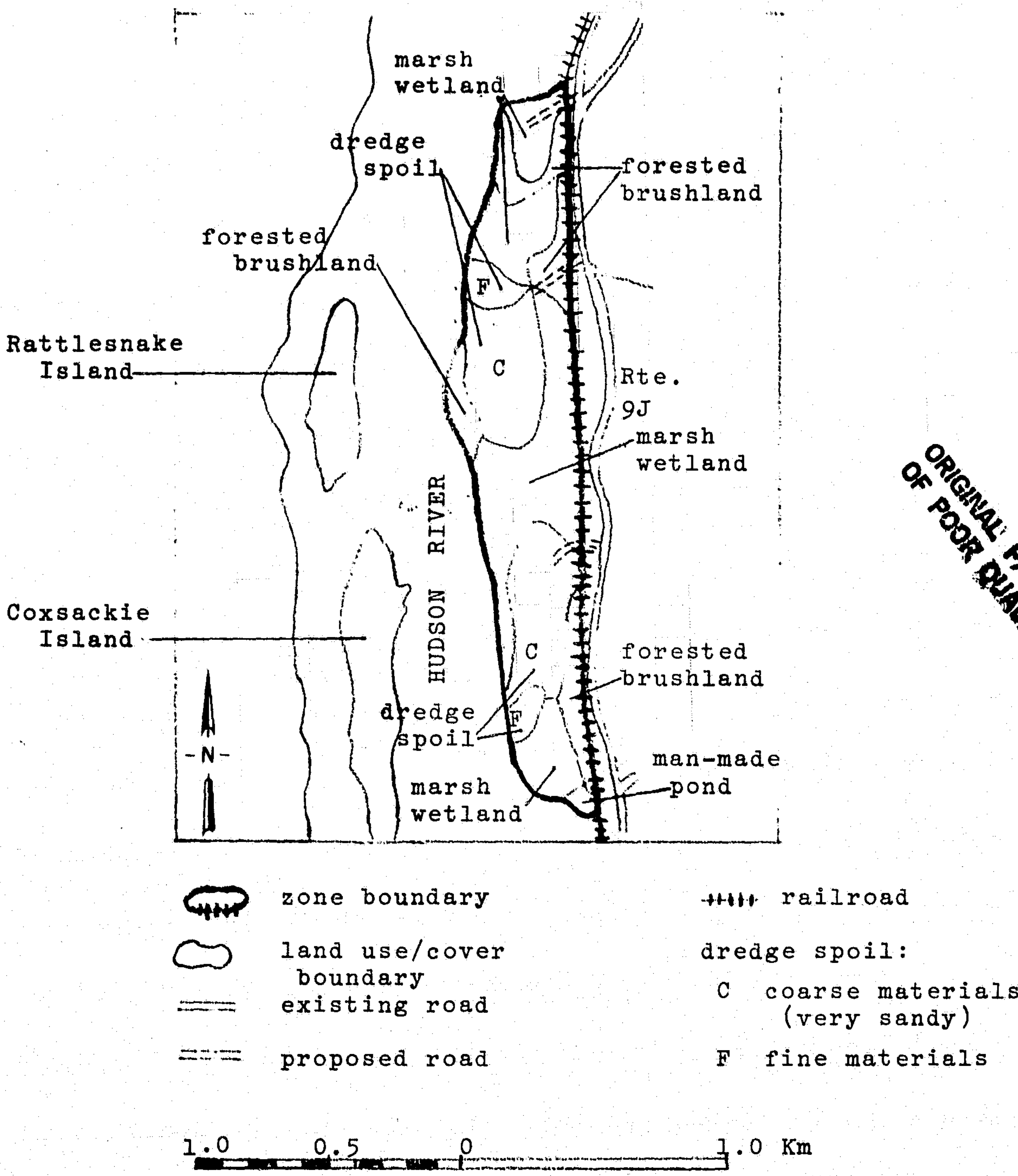
Water Quality: Only in contact with free-flowing Hudson River water.

Relative Advantages: All parts of the zone appear suited for spoil disposal; access to the zone would be easily constructed from New York State Route 9J; marsh in northern half of the zone could be dredged to form a sheltered beach or launching/mooring area with possible use for ice skating.

Relative Dis-Advantages: This zone is farthest from the City of Hudson; diversion of runoff from the hills may be required; future spoil capacity may be reduced due to relatively recent spoil disposal.

Figure 4.

Zone A



Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

Base Maps: 1953 U.S.G.S. topographic maps, Hudson North, N.Y. and Ravena, N.Y.

ZONE B

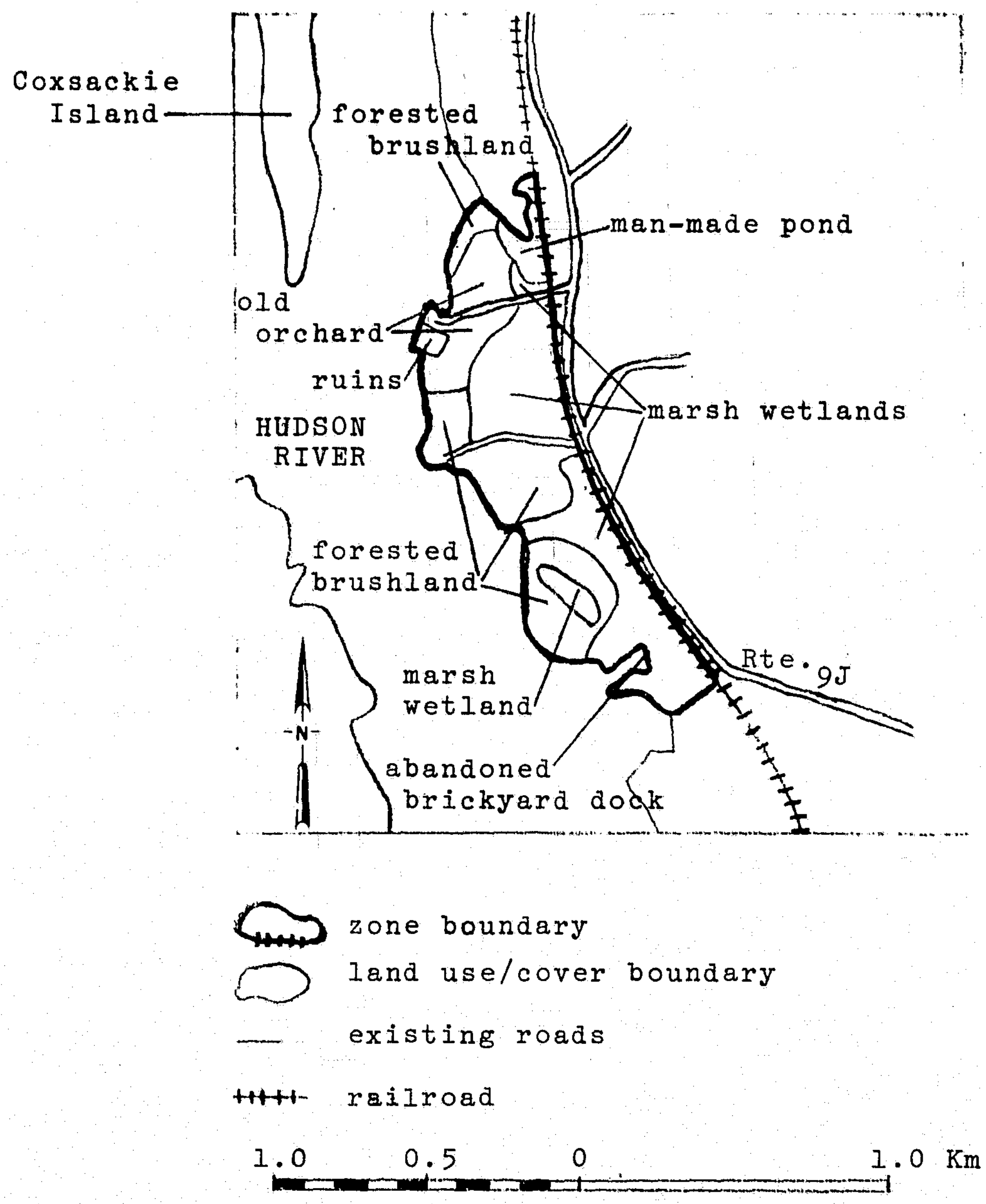
Characteristics as of 1973

(Figs. 3 and 5)

Area:	Approximately 55 hectares (134 acres).
Land Stability:	Stable; no apparent change in size or configuration from 1959 to 1973.
Land Use/ Cover:	1959-1973 - The zone consists of forested brushlands and marsh wetlands over most of its area. The northern coast is occupied by an old orchard, located on an elevated rock landform. A man-made pond is present at the north end, near the railroad track. An abandoned brickyard and its dock are located at the southern end. Some residential development is present along Ferry Road. Deterioration of the orchard indicates that it no longer serves a commercial purpose. There has not been an expansion of residential dwelling units from 1959 to 1973, suggesting no trend to alter the land use of this area.
Access:	Access to the zone exists (Fig 5).
Aesthetics:	Views of Coxsackie, N.Y., Coxsackie Island, Stockport Middle Ground, wooded and farmed areas.
Distance:	See Table 2.
Water Quality:	Only in contact with free-flowing Hudson River water.
Relative Advantages:	The varied topography offers good vantage points to view the surroundings; road access exists; suitable spoil disposal sites are present and not recently used; a site for boat access could be established by remodeling the abandoned brickyard dock.
Relative Dis-Advantages:	Parts of the zone are not suitable for spoil disposal; private ownership (orchard and houses) in the area is an obstacle to development of a recreational facility.

Figure 5.

Zone B



Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

Base Map: 1953 U.S.G.S. topographic map, Hudson North, N.Y.

ZONE C

Characteristics as of 1973

(Figs. 3 and 6)

Area: Approximately 80 hectares (198 acres).

Land Stability: Stable; land shape and configuration altered by addition of dredge spoil between 1959 and 1968.

Land Use/ Cover: In 1959, this zone consisted of an island and peninsula both of which were covered by forested brushland. In 1973, the zone existed as one large peninsula as a result of dredge spoil disposal. The newly formed land and much of the forested brushland now are bare sand. A large shallow backwater area exists shoreward of the enlarged peninsula. An elevated rock landform exists at the north end of the zone.

Analysis of the zone and surrounding areas indicates no new trends in land use.

Access: None exists but favorable future access routes are available (Fig. 6).

Aesthetics: Views of lower Coxsackie, N.Y., Stockport Middle Ground, and wooded and farmed slopes.

Distance: See Table 2; Zone C has the shortest average distance to the major population centers considered.

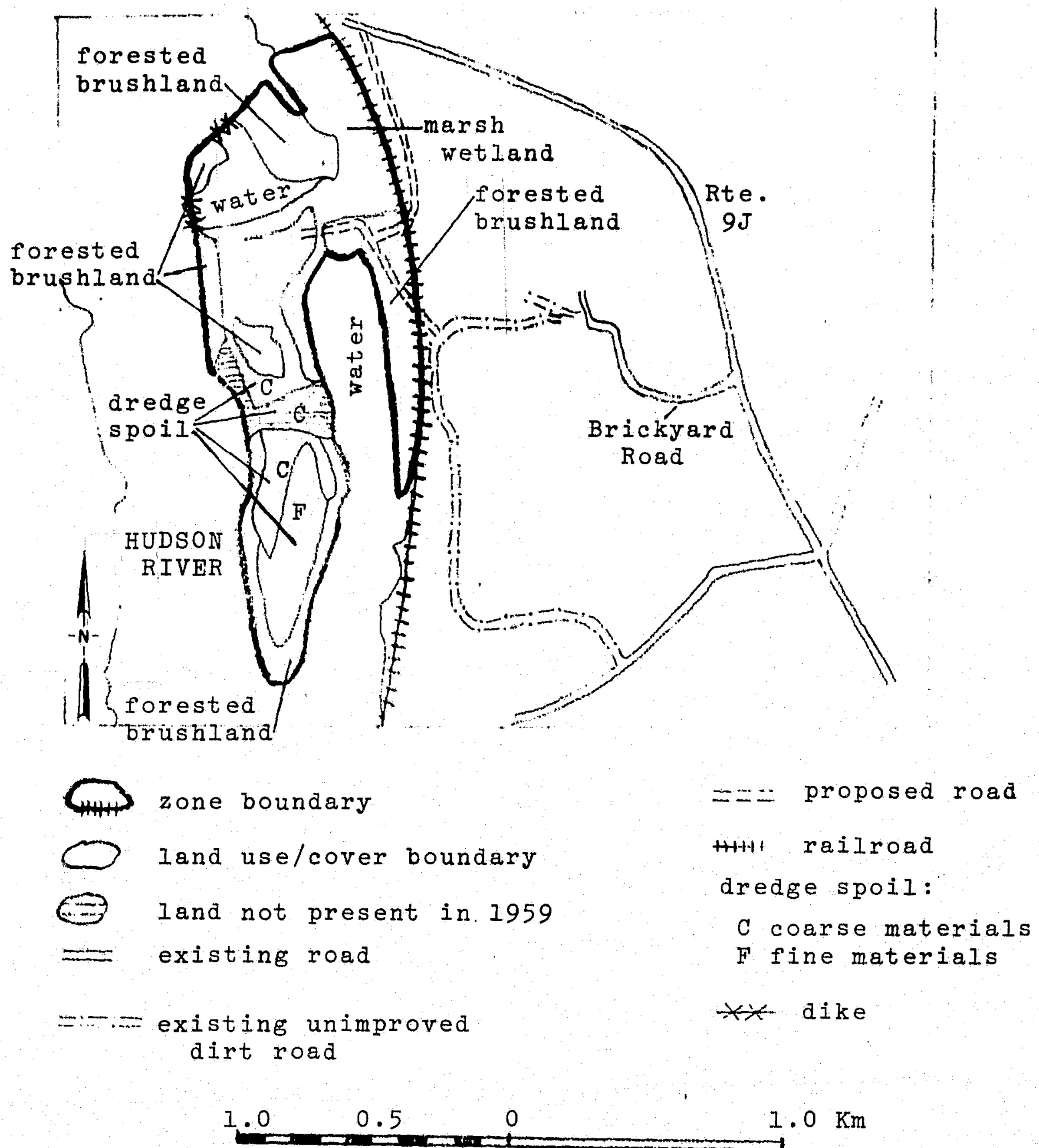
Water Quality: In contact with free-flowing Hudson River water. Backwater area may be somewhat stagnant.

Relative Advantages: Most of the zone could be used for spoil disposal; the elevated area provides a good vantage point of the surroundings; access could be easily established; the backwater area could be dredged and used as a marina, rowing and canoeing area, and ice skating, or filled with spoil; the diked area on the north could be secured, stocked and used for fishing.

Relative Dis-Advantages: Diversion of runoff from hills may be required; future spoil capacity may be reduced due to relatively recent spoil disposal; water quality problems may occur in the backwater.

Figure 6.

Zone C



Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

Base Map: 1953 U.S.G.S. topographic map, Hudson North, N.Y.

ZONE D

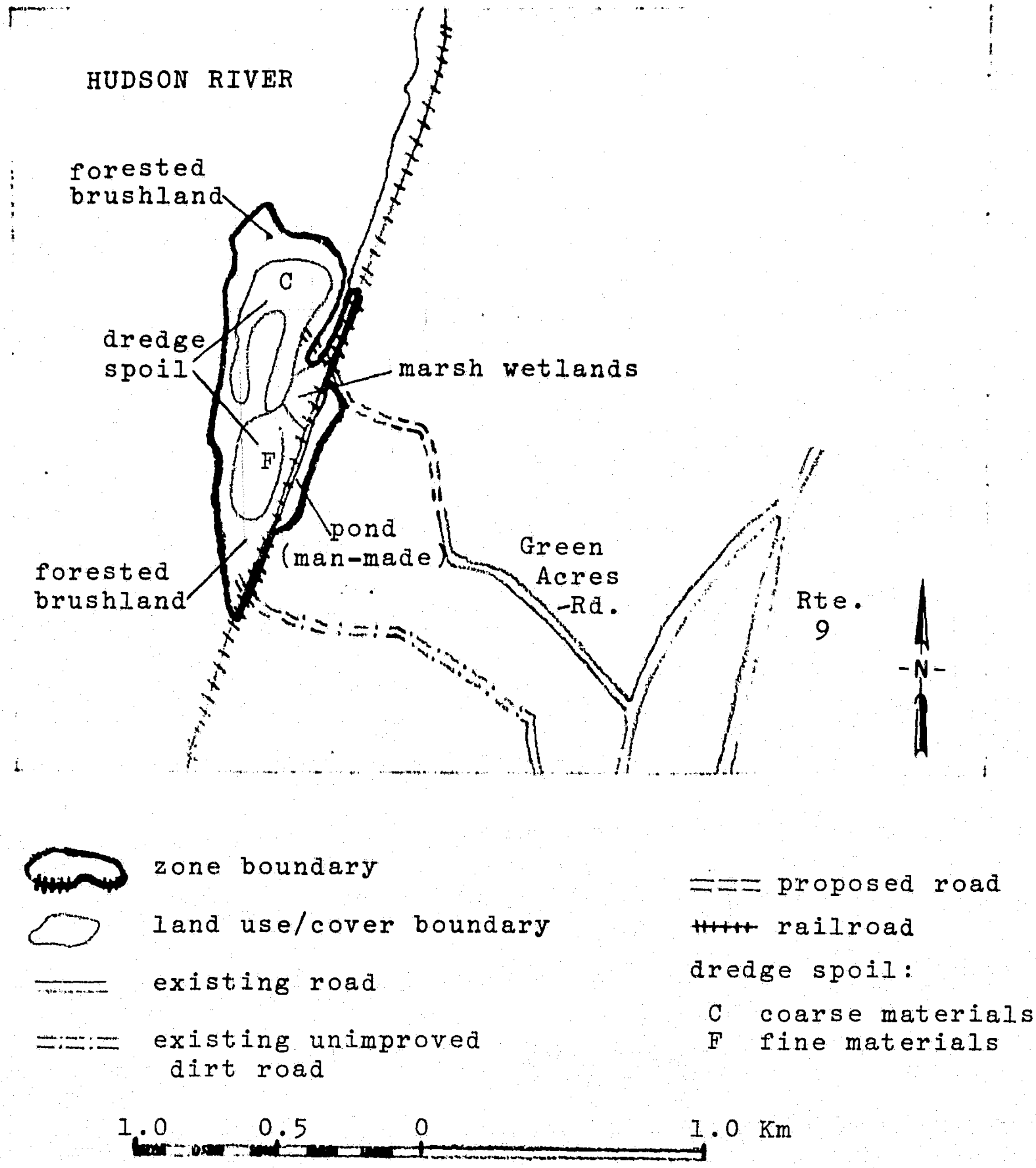
Characteristics as of 1973

(Figs. 3 and 7)

Area:	Approximately 30 hectares (74 acres).
Land Stability:	Stable, no changes noted.
Land Use/ Cover:	In 1959, this zone was covered with scattered patches of trees, except for the man-made pond and small marshy area near the pond. This zone was subsequently used as a spoil disposal site. In 1973, bare sand covered most of the once forested areas. The remainder of the zone was unchanged.
Access:	Access is not present and may be difficult to achieve.
Aesthetics:	Views of marsh lands, wooded and farmed areas, Middle Ground Flats, and the river front of Hudson, N.Y.
Distance:	See Table 2; Zone D is the zone closest to the City of Hudson.
Water Quality:	This area is in contact with free-flowing Hudson River water and the man-made pond. This pond seems to have no permanent source of water and may stagnate.
Relative Advantages:	The entire area could be used for disposal.
Relative Dis-Advantages:	Smallest area; difficult access; water quality problem with pond (if included); danger of excessive railroad crossings to pond (if included); no sheltered area for boat mooring; future spoil capacity may be reduced due to relatively recent spoil disposal.

Figure 7.

Zone D



Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973.

Base Map: 1953 U.S.G.S. topographic map, Hudson North, N.Y.

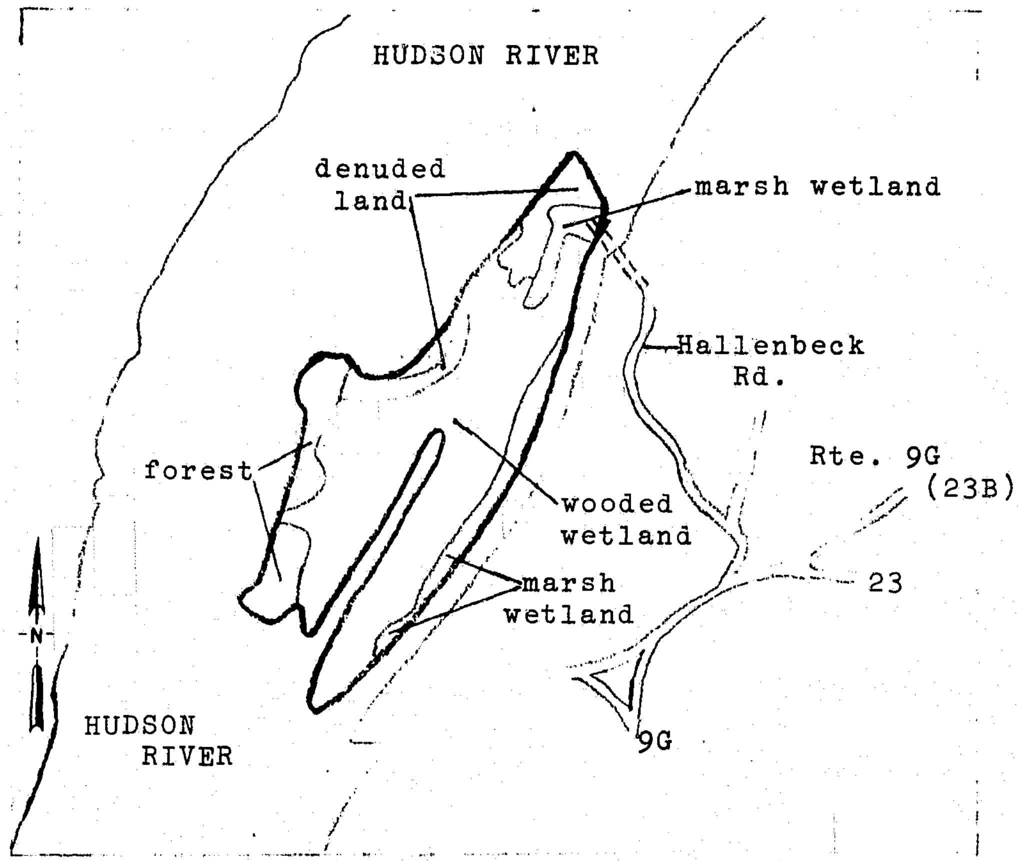
ZONE E

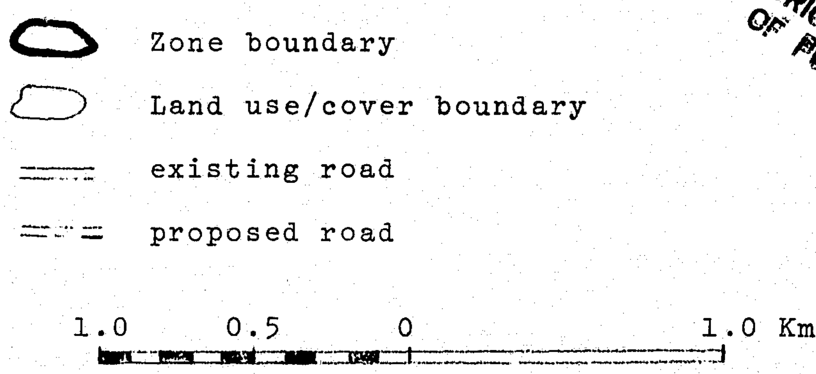
Characteristics as of 1973

(Figs. 3 and 8)

Area:	Approximately 65 hectares (160 acres).
Land Stability:	Stable; no change apparent.
Land Use/ Cover:	Virtually the entire island was a wooded wetland in 1959 with the exception of a forested band on the west coast and a marshy band on the east coast. A stretch of land along the northwest shore of the island was denuded between 1959 and 1973 and is now sparsely vegetated. Nearby land use does not appear to influence the use of Zone E. The extensive coverage of the zone by wooded wetlands makes it a fragile and ecologically valuable area.
Access:	No present access exists. Future access appears easy to achieve, but will require the construction of a short bridge to Rogers Island.
Aesthetics:	Views of forested and farmed areas, marsh, lower Catskill, N.Y., and the Rip Van Winkle Bridge (overhead).
Distance:	See Table 2; Zone E has the longest average distance (19 km) to the major population centers.
Water Quality:	Only in contact with free-flowing Hudson River water.
Relative Advantages:	The zone is a discrete piece of land; fairly well sheltered downstream area available for boat mooring.
Relative Dis-Advantages:	Requires short bridge to be built; composed largely of ecologically valuable, fragile wetlands; zone farthest from three of the larger population centers.

Figure 8.
Zone E





Based on interpretation of 1:130,000 scale, color infrared aerial photographs, acquired by NASA on 30 April 1973

Base Map: 1963 U.S.G.S. topographic map, Hudson South, N.Y.

Table 2

Straight-Line Distances (Km) From Zones To Population Centers And Existing Recreation Areas In Columbia County, N.Y.

POPULATION CENTER	ZONES A	B	C	D	E	RECREATION AREAS: Nearest Area	Major River-Oriented	Clermont State Park
Hudson	14	11	9	4	6	3	21	1
Chatham	16	16	15	17	25	0	39	20
Kinderhook	7	9	9	14	22	3	37	17
Philmont	18	16	14	12	16	4	27	12
Valatie	10	11	12	16	25	2	39	20
Average	13	13	12	13	19			
RECREATION AREAS								
Nearest Area	2	4	3	3	2			
Major River-Oriented	13	10	8	4	4			
Clermont State Park	31	29	28	23	16			

DISCUSSION AND CONCLUSIONS

There are at least five zones along the Hudson River coastline of Columbia County, N.Y., that seem well-suited for use as dredge spoil sites and recreation areas. As of 1973, the date of the most recent, available aerial photographic coverage of the coastline, these zones appeared to be physically suitable--size, location, slope, stability, land use/cover--and access to most of the zones either exists or could be constructed without undue difficulty. For land access, some protection, such as an overpass, might be desirable in the area of the railroad tracks; and, for water access, certain parts of the coastline could be transformed into favorably sheltered areas.

Among the significant factors that should be considered in planning or developing the zones are:

- The zones are all located in flood prone areas.
- Many of the zones contain substantial amounts of wetlands, a limited resource.
- Previous use of certain areas within the zones as dredge spoil sites may limit the quantity of spoil that can be added.
- Maintaining a vegetative cover on those sandy areas that are not to be left in sand may be difficult.
- Certain sites may require control of runoff from the shoreward hills.
- On-site water quality monitoring would be desirable and, likely, required for certain types of recreation.

APPENDIX A

Explanation of Terms Used in

"1973 Land Use/Cover and Access" Overlay Series

Denuded land - This is relatively bare land known to have been more heavily vegetated in the past 15 years. Identifiable recent dredge spoil sites are not included.

Dredge spoil - This is bare or sparsely vegetated land resulting from dredge spoil deposition.

Coarser material - the coarser sandy portion of the spoil.

Finer material - the finer portion of the spoil found in settling basin areas.

Forested brushland - This is land containing low standing trees and/or brush with some associated larger trees possibly present.

Man-made ponds - These are bodies of water of more than .5 hectares, and apparently at least partially the result of man's activities.

Marsh wetlands - These are lands that are usually wet or waterlogged, and support low growing marsh or bog type shrub vegetation.

Old orchards - This is land occupied by fruit trees, which are in a poor state of vigor.

Water - These are areas of water that are part of the Hudson River but have restricted flow due to interference by dikes, or large (greater than 20 hectares) backwater areas formed by the configuration of the surrounding land.

Wooded wetlands - These are areas that are wet much of the time and support a growth of trees or tall (greater than 1.5 m) shrubs.

APPENDIX B

Potential Recreation Sites
Based on Available Present Access

FIGURE 2 NUMBER	NAME	CONCLUSION
1	Carmelite Sisters	Insufficient land available
2	Midwood	(idem)
3	Cheviot	(idem)
4	North Germantown Anchorage	(idem)
5	Roe Jan Boat Club	(idem)
6	Oak Hill Landing	(idem)
7	Furgary Boat Club	(idem)
8	Hudson Power Boat Association	(idem)
9	Water Street State Boat Launch Site	(idem)
10	Columbiaville	(idem)
11	Abandoned Brickyard Dock	Acceptable for consideration
12	Newton Hook	(idem)
13	Nutton Hook	(idem)
14	Stuyvesant	Insufficient land available
15	Hook Boat Club	Existing river-oriented recreation

APPENDIX D

EXAMINATION OF AGRICULTURAL DISTRICTS FOR POSSIBLE CHANGES IN ZONING, COLUMBIA COUNTY, N.Y.

COLUMBIA COUNTY PLANNING BOARD

70 NORTH THIRD STREET, HUDSON, NEW YORK 12534
Telephone (518) 828-3375

August 10, 1978

Warren R. Philipson
Remote Sensing Program
Hollister Hall
Cornell University
Ithaca, New York 14853

Dear Warren:

I would like to thank you for the work you did using remote sensing and high altitude data in preparing the reports on potential Hudson River recreation areas and the viability of agricultural lands in Columbia County; we are pleased with the scope and quality of both reports.

Presently, both are being circulated to various agencies in the hope that the information produced will create some interest in the use of your findings in local and state programs.

We will let you know how we make out.

Sincerely,

Alan P. Muir
Planning Director

APM:de

PRELIMINARY ASSESSMENT OF AGRICULTURAL DISTRICTS IN COLUMBIA COUNTY, N.Y.

Remote Sensing Program
Cornell University
Hollister Hall
Ithaca, New York 14853

July 1978

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ACKNOWLEDGMENTS

This study was requested by representatives of the Planning Board of Columbia County, N.Y., and supported by NASA Grant NGL 33-010-171. The work was conducted by David W. Adams and William R. Hafker under the direction of Warren R. Philipson. Mr. Adams performed the land use inventory, and Mr. Hafker performed the soils and final analyses. This report is accompanied by two maps.

Ta Liang
Professor-In-Charge

INTRODUCTION

According to the 1974 U.S. Census of Agriculture, nearly one-third of Columbia County, N.Y., is being actively farmed. Similar to other New York State counties, Columbia County has adopted the use of "agricultural districts" to encourage the continuance of a strong agricultural industry. These districts are geographic zones established through legislation; they are intended to protect farmers from the effects of urbanization and to discourage non-agricultural development in good farming areas.

Agricultural districts in each county are subject to review and modification at eight-year intervals. This study was performed to provide land use and soils information required for evaluating the eleven districts in Columbia County.

STUDY AREA

Columbia County is located on the eastern border of New York State (Fig. 1). The City of Hudson, the County Seat, lies approximately 50 km south of Albany and 190 km north of New York City. The County contains some 166,800 hectares, approximately 37% of which were in farms, including woodland, in 1974. The land is generally hilly with most of the gently sloping land (less than 5% slopes) located in an 11 km-wide strip, inland from and parallel to the Hudson River, the County's western boundary.

The County's relief is shown on all or part of twenty-three 1:24,000 scale, U.S. Geological Survey topographic maps, compiled from 1944 to 1975. Generalized information on soils of the County is found in the 1929 Columbia County Soil Survey Report and accompanying 1:62,500 scale map (Lewis, H.G. and D.F. Kinsman. 1929. Soil survey of Columbia County, New York. No. 45, Series 1923. U.S. Dept. Agr. Washington, D.C. 43 pp.). Available aerial photographic coverage of the County includes 1:24,000 scale, panchromatic (black-and-white) photography flown in March 1968 by Lockwood Mapping, Inc., for the New

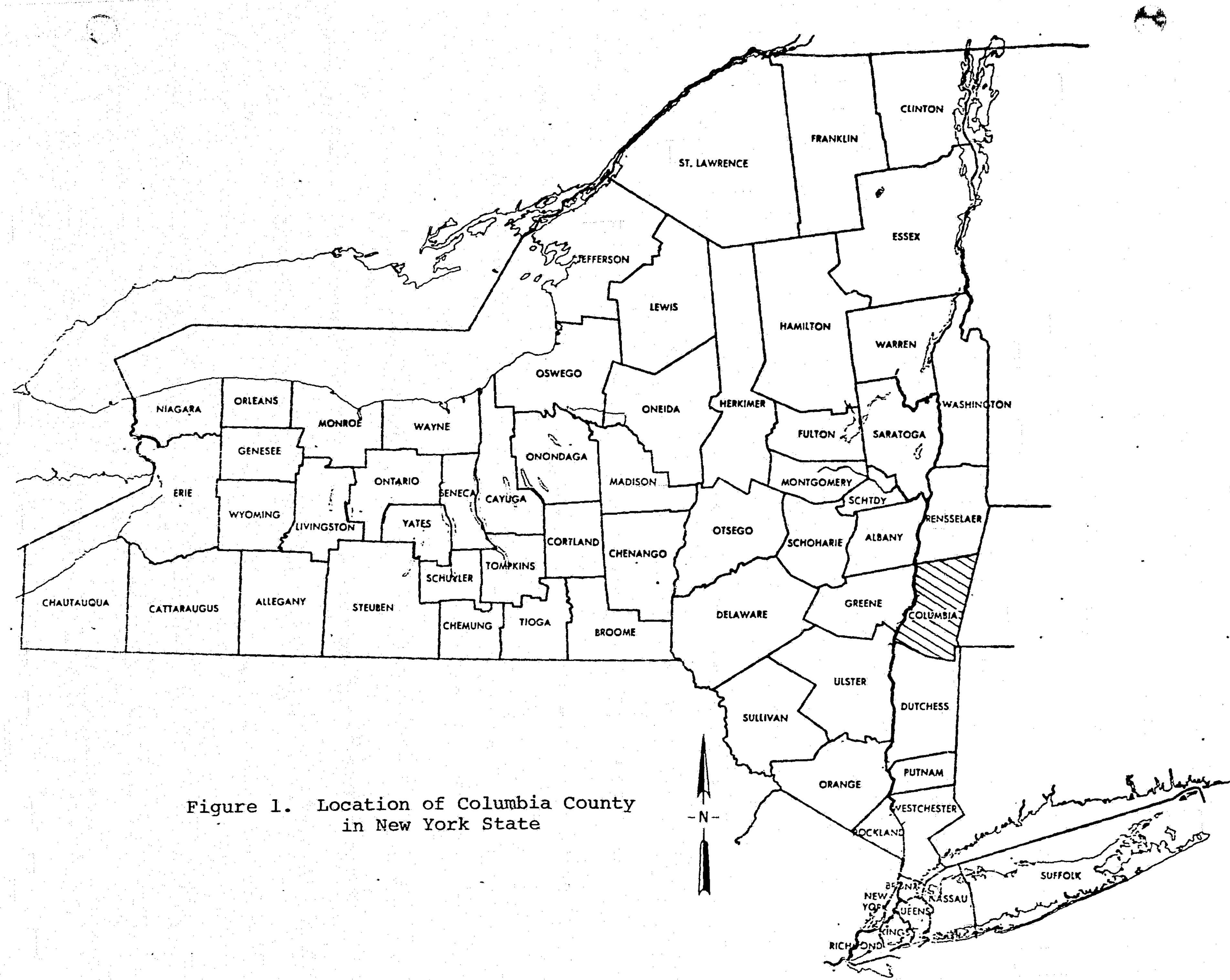


Figure 1. Location of Columbia County in New York State

York State Land Use and Natural Resources Inventory (LUNR); and 1:130,000 scale, color infrared photography flown in April 1973 by the National Aeronautics and Space Administration. The latter coverage does not include the extreme northeastern corner of the County.

PROCEDURES

Land Use Inventory

Detailed land use and land cover information for Columbia County is contained in the statewide LUNR, being based on the 1968 aerial photography. The study set out to update the LUNR information for two generalized categories of land use, active and inactive agriculture. Positive transparencies of the 1973, color infrared aerial photographs were analyzed with a zoom stereoscope on a light table, using the LUNR information as a reference. Acetate overlays to the 1:130,000 photographs were prepared showing "active agriculture," "inactive agriculture" and "other." A Zoom Transfer Scope was used to compile the delineations onto a single Mylar base map of approximately 1:95,000 in scale.

Although it was originally planned to derive a second, more recent update of the County's agricultural land use from Landsat satellite data, cloud-free Landsat coverage of the County was not available for appropriate periods (spring-summer) in 1976 or 1977.

Soils Information

The categorization of soils as "prime" or "prime land" is based on data collected in a detailed soil survey, which has not been performed for Columbia County. Many of the factors considered in rating soils can be evaluated through comprehensive interpretation of aerial photographs, however, such an analysis was judged to be beyond the scope of this study. As an alternative, it was decided to derive the soils information from the 1929 Soil Survey Report and check representative sites with the topographic maps and aerial photographs.

The descriptions of the County's soils were examined, and each soil was placed in one of the following categories: first bottom land (flood-prone), excessively moist, shallow, stony, droughty or other (i.e., no physical limitation other than slope). An acetate overlay of the 1:62,500 scale soil map was developed, excluding soils on slopes greater than 5%, swamps and tidal marshes. Selected areas containing soils of each category were located and analyzed on the 1968 aerial photographs. The presence of features not normally associated with the soils of a particular category was assumed to indicate inaccuracies (inclusions) in the soil mapping unit. Those categories that appeared to be mapped accurately were added to the slope and swamp limitations overlay.

General Evaluation

As a final step, the agricultural district boundaries were compared to the soils and 1973 agricultural land use information, with the aid of a Zoom Transfer Scope. Estimates were made of the proportions of each agricultural district in active or inactive agriculture, and the proportions of the districts that might contain prime farmland.

RESULTS AND DISCUSSION

Agricultural Land Use

The status of Columbia County's agricultural land use in 1973 is depicted on the accompanying 1:95,000 scale map. As described, this map of "active agriculture," "inactive agriculture" and "other," was derived through analysis of 1:130,000 scale aerial photographs, with LUNR information as a reference.

A comparison of the 1973 land use with the agricultural districts (Fig. 2) revealed that, on the average, approximately 45 to 60% of the area of a district was devoted to active agriculture. One district (No. 5) contained approximately 80% active farmland, four districts (Nos. 2, 3, 4 and 10) contained approximately 60 to 70% active farmland, and six districts (Nos. 1, 4A, 6, 7, 8 and 9) contained only about 30 to 40% active farmland.

Although often interspersed with active agriculture, inactive agriculture in 1973 usually occupied less than 10% of an agricultural district, with only one district (No. 6) having as much as 15% inactive agriculture. In certain areas, the ratio of inactive to active agriculture appeared to be substantially higher outside of the agricultural districts especially in the eastern part of the County.

Soils With Mapped Limitations

Areas of Columbia County with soils of less than 5% slopes, that are not swamp, tidal marsh or subject to flooding, are depicted on the second accompanying map, at a scale of 1:62,500. Soils that have not been excluded are potentially prime soils, but as much as 20 to 30% of the area is likely to be limited by excessive moisture or some other constraint (e.g., shallow or stony).

Based solely on their descriptions in the 1929 Soil Survey Report, the soil mapping units were categorized as: first bottom land, excessively moist, shallow, stony, droughty or other (i.e., no physical limitation other than slope). The results of this categorization, and the photographic assessment of the accuracy of this categorization, are reported in the table.

In general, the first bottom (flood-prone) lands appeared to be accurately mapped; the excessively moist and shallow soils that were not otherwise limited by slope appeared to contain too many inclusions and/or omissions; the droughty soils did not appear to be droughty; and the stoney soils, most of which were excluded by slope, could not be evaluated directly with aerial photographs.

The soils limitation map shows that, as expected, population centers generally occupy the better soils, along with the greater concentrations of active agriculture. Comparison of the soil limitations map to the agricultural districts (Fig. 2) indicates that more than 60% of the areas of the eastern districts (Nos. 1, 4A, 6, 8 and 9) have one or more limitation. In the western districts, this percentage is much lower.

SOIL LIMITATIONS BASED ON 1929 COLUMBIA COUNTY SOIL SURVEY REPORT AND 1968 AERIAL PHOTOGRAPHS

Categorization Based on Soil Survey Description	Soil Mapping Units Included in Categories*	Airphoto Evaluation of Reliability of Soil Categories
First Bottom Land	Hotaling, Livingston, Ondawa, Saco	Accuracy acceptable
Excessively Moist	Ghent, Hudson sl and sicl, Livingston, Lyons, Mansfield, Saco sicl, Stockbridge l, Meadow, Muck	Many inclusions and apparent exclusions; accuracy not acceptable
Shallow	All units described as having shallow phases	Many inclusions and apparent exclusions in areas not limited by slope; accuracy not acceptable
Stony	Dutchess sal, stl and stl, shallow phase; Gloucester, Stockbridge stl, Rough Stony Land	Not evaluated and not used
Droughty	Hinckley, Hoosic cosl and fsl, Otisville gsl	No evidence of droughty soils; accuracy not acceptable
Swamp and Tidal Marsh	Tidal marsh and various other units designated as swamp on soils map	Accuracy acceptable
Other (no reported physical limitations)	All remaining units	Many inclusions and exclusions; accuracy not acceptable

*Notation:

l	loam	gsl	gravelly sandy loam
sl	sandy loam	stl	stony loam
fsl	fine sandy loam	sal	slate loam
cosl	coarse sandy loam	sicl	silty clay loam

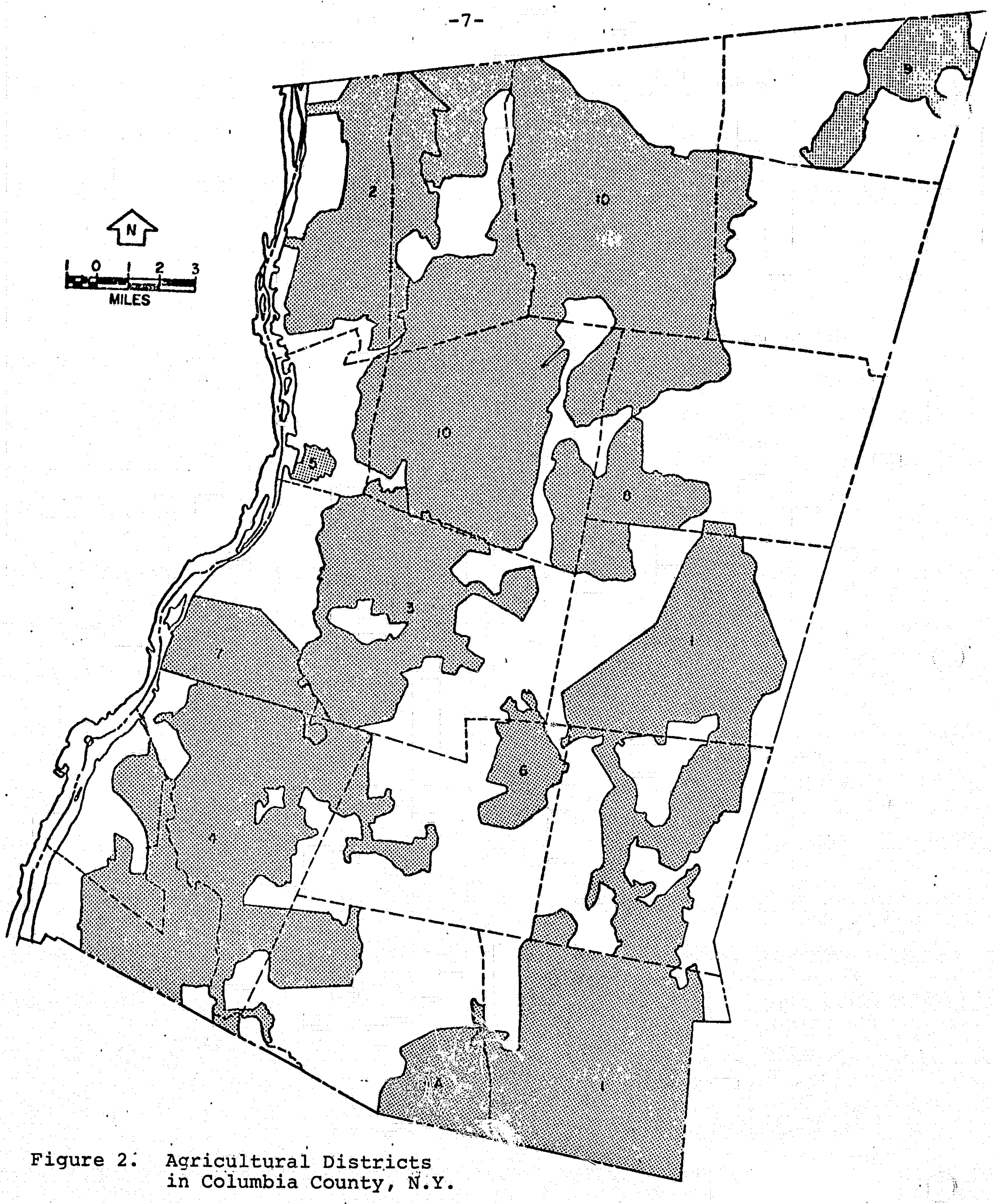
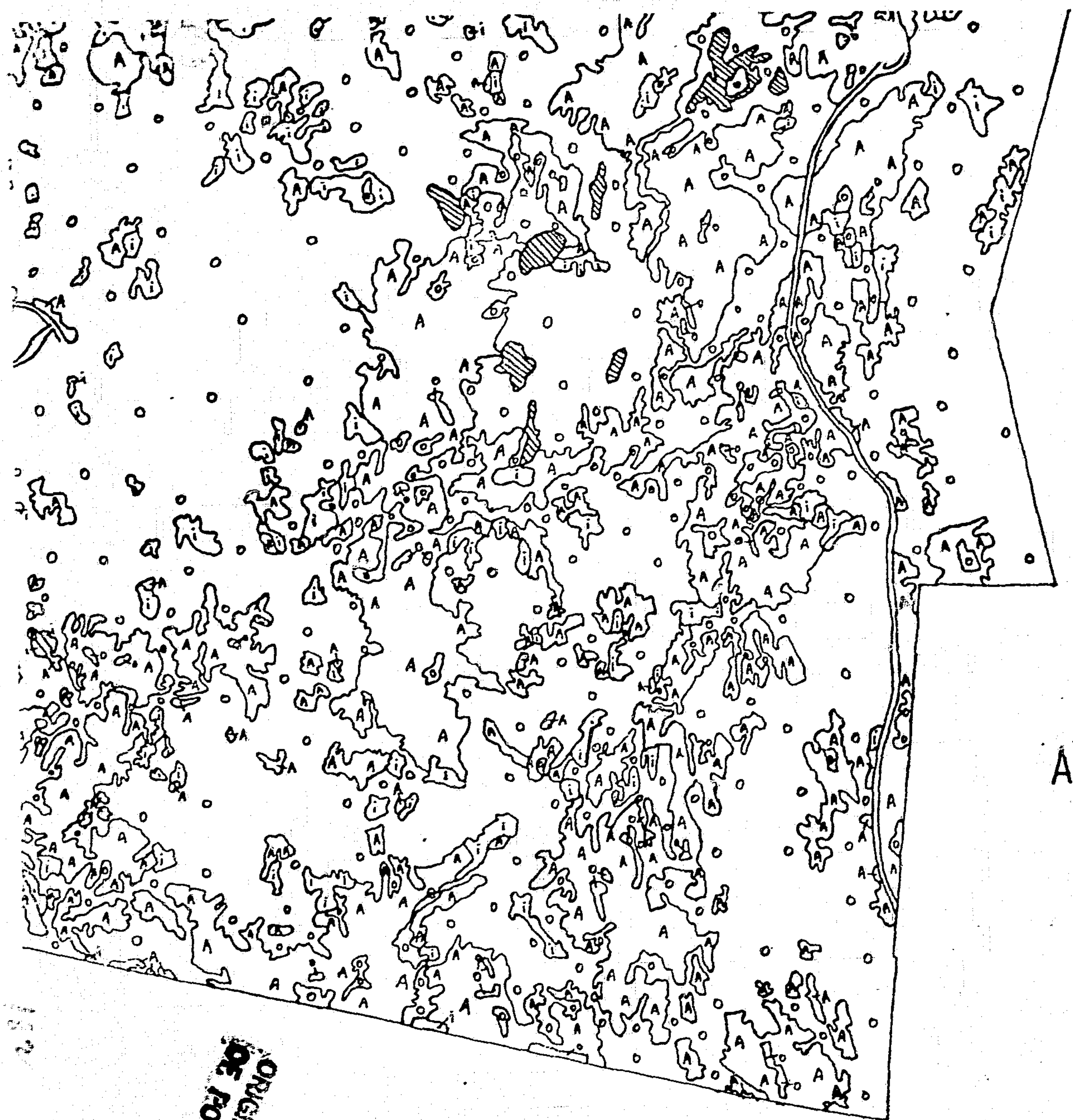
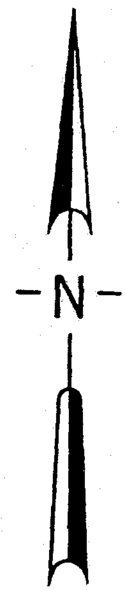


Figure 2. Agricultural Districts in Columbia County, N.Y.





ACTIVE AND INACTIVE AGRICULTURE IN COLUMBIA COUNTY, N.Y.

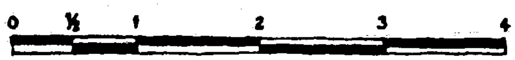
30 APRIL 1973

BASED ON INTERPRETATION OF 1:130,000 SCALE, COLOR INFRARED AERIAL PHOTOGRAPHS, FLOWN BY NASA ON 30 APRIL 1973

KEY:

A	ACTIVE AGRICULTURE
i	INACTIVE AGRICULTURE
O	OTHER

SCALE IN MILES



ONE INCH EQUALS 1½ MILES

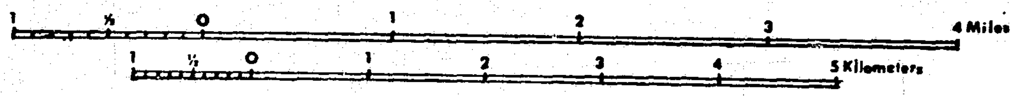
...portion of submitted map...

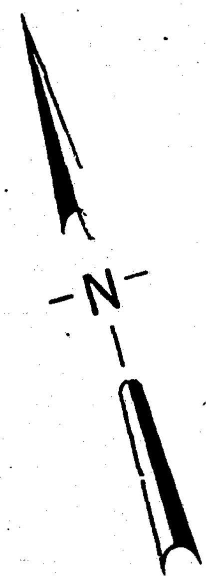
SELECTED SOILS LIMITATIONS, COLUMBIA COUNTY, N.Y.

Based on 1929 Columbia County Soil Survey and Interpretation of 1968, 1:24,000 scale, panchromatic aerial photographs

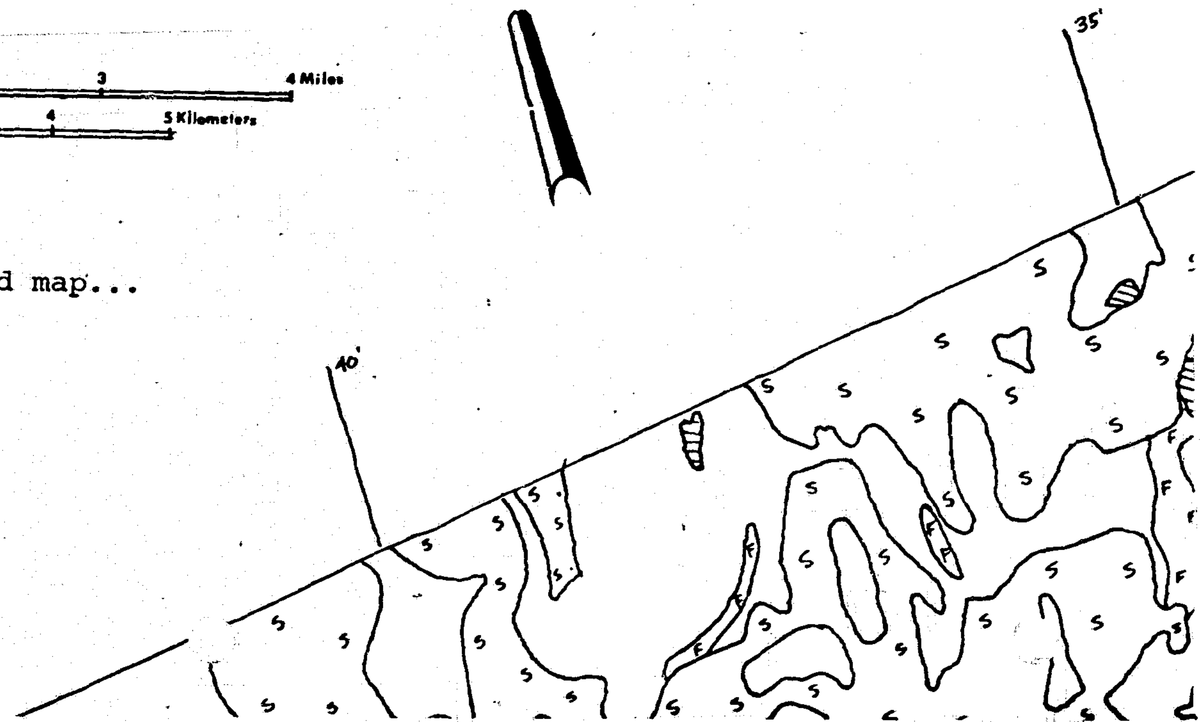
KEY

S	slopes greater than 5%
F	first bottom land (subject to flooding)
T	tidal marsh
W	swamp
No symbol	potentially prime soil, but may be limited by moisture, depth, stoniness, or some other factor





...portion of submitted map...



APPENDIX E

INVENTORY OF POTENTIAL MOSQUITO BREEDING SITES IN AN URBAN SETTING, ROME, N.Y.

cc: Dr. Philipson - Cornell University Remote Sensing Program

October 31, 1978

Dr. Bast - Bureau of Disease Control

Dr. Morris - Syracuse Area Office

Remote sensing of potential mosquito breeding areas-Rome, New York

An analysis of the mapping of the potential breeding areas of Rome, New York by Cornell University Remote Sensing Program personnel, as described in the accompaning letter from Dr. Philipson, pointed out one potential drawback of our conventional ground survey. Of the 408 breeding sites detected, 70 (17%) were rooftop water accumulations. Since Culex can breed in these types of accumulation, a field check of 16 roof-tops was made by Mr. Kwiat of the Oneida County Health Department. Although no larvae were found, most sites supported varing degrees of plant and insect life and further suggest that mosquito breeding may occur during the summer.

It is also apparent that the aerial survey was made more rapidly and at less expense than a systematic ground search for water accumulations. Time did not permit extensive field checking of the aerial survey results. However, all of nine ground level sites examined contained mosquito larvae or cast skins.

A comparison of an aerial survey of Onondaga County with the county mosquito control program records would provide an excellent system to update the county survey and concomitantly verify the efficacy of the aerial survey technique for possible use in other counties.

Attachment

cc: Dr. Philipson - Cornell University Remote Sensing Program
Mr. Barry - Syracuse Area Office
Mr. Lambert - Oneida County Health Department
Mr. Chellemi-Onondaga County Health Department
Mr. Devendorf - Onondaga County Health Department
Mr. Marechek - Onondaga County Health Department

Cornell University
REMOTE SENSING PROGRAM
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
HOLLISTER HALL
ITHACA, NEW YORK 14853
(607) 256-4330, 256-5074

10 August 1978

Dr. Charlie Morris
N.Y.S. Department of Health
Illick Hall, Room 133
College of Environmental Science & Forestry
Syracuse, New York 13210

Dear Charlie:

I have enclosed a map overlay (Mylar copy and blue print) depicting potential mosquito breeding sites in Rome, N.Y. As you are aware, the 1:9,600 scale base map was obtained from the Oneida County Environmental Management Council.

In accordance with the overlay legend, all findings are based on stereoscopic analysis of 1:5,000 scale, panchromatic aerial photographs, flown on 15 June 1978. These photographs were provided as positive film transparencies by the U.S.A.F. Rome Air Development Center. The portion of Rome surveyed was determined by the extent of the photographic coverage.

The study was performed by William R. Hafker, working under our NASA Grant NGL 33-010-171. Please advise me if you find this information to be of value, and if we can be of any further assistance.

Very truly yours,

Warren.

Warren R. Philipson
Sr. Research Associate

WRP/pw

cc (without enclosures):
Ellsworth Hicks, RADC
Philip Lambert, Oneida County Health Department
Prof. Ta Liang

Encs.

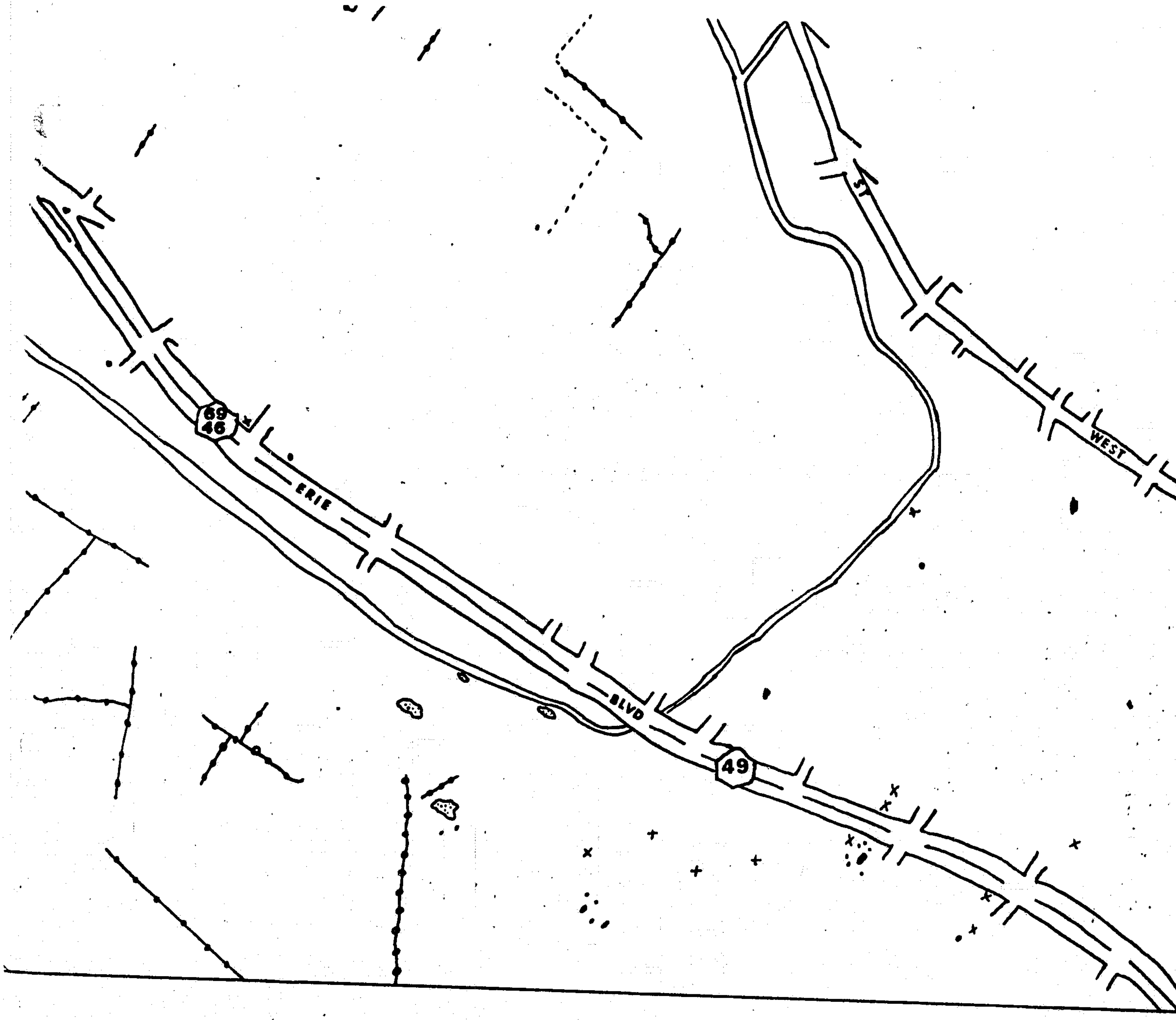
POTENTIAL MOSQUITO BREEDING SITES, ROME, N.Y.

Based on interpretation of 15 June 1978, 1:5,000 scale, panchromatic aerial photographs

Base Map: Rome North, Sheet No. 19; State of New York, Dept. of Public Works, Herkimer – Oneida Counties, Transportation and Regional Planning Study Area

KEY

- X - roof top ponding
- ⊙ - fountain
- area of standing water; relatively permanent
- area of standing water; probably temporary
- potential wet area, dry at time of photography
- area presumed to contain standing water (overhead view obscured)
- river or stream normally wider than 5 meters
- stream normally less than 5 meters wide
- dry ditch
- water-filled ditch
- ditch with some water
- area presumed to contain a ditch or stream (overhead view obscured)
- road



...portion of submitted map overlay...

CORNELL UNIVERSITY
REMOTE SENSING PROGRAM
AUGUST 1978

APPENDIX F

REMOTE SENSING ASSESSMENT OF DAM FLOODING HAZARDS

REMOTE SENSING ASSESSMENT OF DAM FLOODING HAZARDS: METHODOLOGY DEVELOPMENT FOR THE NEW YORK STATE DAM SAFETY PROGRAM[1]

Research Project Technical Completion Report

by

J.P. Berger, W.R. Philipson and T. Liang[2]

Project No. A-081-NY
October 1977 to September 1978
Annual Allotment Agreement No. 14-34-0001-8034

submitted to

The Office of Water Research and Technology
U.S. Department of the Interior
Washington, D.C. 20240

November 1978

[1]The work upon which this report is based was supported in part by funds provided by the United States Department of the Interior, Office of Water Research and Technology, as authorized under the Water Resources Research Act of 1964.

[2]Respectively, Graduate Research Assistant, Senior Research Associate, and Professor, Remote Sensing Program, School of Civil and Environmental Engineering, Cornell University, Hollister Hall, Ithaca, N.Y. 14853.

ABSTRACT

The value and use of remotely sensed aircraft and satellite data for inventorying dams, determining their hazard class, and assessing their condition is described. A methodology is developed to increase the efficiency and accuracy of dam inspection in New York State by incorporating remote sensing techniques into the State Dam Safety Program. This Program, which requires the continuous inventory and characterization of the more than 7,000 dams throughout the State, has been based on permit files and field inspection.

The methodology places emphasis on readily available remotely sensed data--aerial photographs and Landsat data. Aerial photographs are employed in establishing a statewide data base, referenced on county highway and U.S. Geological Survey 1:24,000 scale, topographic maps. Data base updates are conducted by region or county, using Landsat or aerial photographs as a primary source of information. Field investigations are generally limited to high-hazard or special problem dams, or to dams which cannot be assessed adequately with aerial photographs. Although emphasis is placed on available data, parameters for acquiring new aircraft data are outlined and various sensors considered. Large scale (1:10,000) vertical, stereoscopic, color-infrared aircraft photography, flown during the spring or fall, is recommended for assessing dam condition.

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ACKNOWLEDGMENTS

Principal support for this investigation was through funds provided by the United States Department of the Interior, Office of Water Research and Technology, as authorized under the Water Resources Research Act of 1964. Other funds, provided by Grant NGL 33-010-171 from the National Aeronautics and Space Administration, supported the preliminary development of the remote sensing methodology.

The authors would like to acknowledge the cooperation of the staff of the Dam Safety Program, of the New York State Department of Environmental Conservation, and in particular, Kenneth D. Harmer. Appreciation is also extended to Pat Webster, for typing this manuscript, and Deborah Halpern, for assisting in the preparation of the photographic examples.

APPENDIX G

SELECTED CORRESPONDENCE AND PROJECT-RELATED ITEMS

John M. Flynn, P.E.
Commissioner

SUFFOLK COUNTY
DEPARTMENT OF ENVIRONMENTAL CONTROL

XXXXXXXXXXXXX
65 Jetson Lane

Hauppauge N. Y. 11787
(516) 234–2622

September 13, 1978

Mr. Warren R. Philipson
Sr. Research Associate
Cornell University
Remote Sensing Program
School of Civil and Environmental Engineering
Hollister Hall
Ithaca, New York 14853

Dear Mr. Philipson:

As I have the prime interest in using remote sensing, Ellis Koch has requested that I respond to your letter of 18 April. My apologies for this long delay in replying.

There are two problems which I feel may lend themselves to study using remote sensing techniques.

1. The change in configuration of the barrier island inlets to Long Island's south shore bays.

2. The seasonal variation of turbidity in Long Island coastal waters.

The first item is one of immediate interest to us as inlet configuration may be an important factor in controlling the salinity of Great South Bay.

The second is of interest as regards plankton populations in our coastal waters. It is these biological populations that would be expected to vary seasonally and, in fact, there are data available (Nuzzi, 1973; Nuzzi and Perzan, 1974), indicating rather large changes in the turbidity of coastal waters that appear to be correlated to plankton populations.

I should think that there already may exist enough remote imagery to initiate both programs with the major problem being the concatenation of the varied disciplines, i. e., I don't know where to get started in researching the propery imagery and I look to you for assistance in this aspect of the study.

I am most interested in your thoughts on this matter and would appreciate any assistance that you can offer.

Sincerely yours,

Robert Nuzzi, Ph. D., Chief
Marine Resources Section

RN:ets
Enc.

cc: Ellis Koch

References:

Nuzzi, R. 1973 A synoptic study of the surface waters of Block Island Sound and surrounding waters, Part I. New York Ocean Science Laboratory Technical Report No. 0019.

Nuzzi, R. and U. Perzan, 1974 Phytoplankton and suspended particles. In An interdisciplinary study of the estuarine and coastal oceanography of Block Island Sound and adjacent New York coastal waters: ground truth. NYOSL Tech. Report No. 0027

Albany County Planning Board

891 WATERVLIET-
SHAKER ROAD
ALBANY, N.Y. 12205
(518) 869-0235

October 4, 1978

Mr. Warren R. Philipson
Cornell University
Remote Sensing Program
Hollister Hall
Ithaca, NY 14853

Dear Mr. Philipson:

Pursuant to our telephone conversation on Tuesday, October 3rd, I am forwarding descriptions of possible work tasks (which were originally requested from you in correspondence dated May 11, 1978).

Of considerable use to the Albany County Planning Board would be assessments of landslide and erosion potential within the County, especially within the Normans Kill drainage basin. Such assessments would be most valuable in the review of subdivision and development proposals referred to our office by municipal governments under the provisions of Section 239 of the New York State General Municipal Law.

At this time I cannot suggest additional projects, other than the ones I originally forwarded to you. If I can be of further service, please do not hesitate to contact me. Also, thanks very much for your willingness to provide our office with such potentially valuable information.

Sincerely,

Kevin Millington

KEVIN MILLINGTON
Planner

KM/bf

Coastal Erosion Reconnaissance Field Trip

Date: Monday, October 16, 1978

Theme: The theme of this field conference deals with the protection, maintenance and enhancement of the physical character of the natural and developed recreational resources that are located on dynamic barrier coastal systems.

We will focus on problems associated with the preservation of New York State's public recreational facilities located on the Jones Beach and Fire Island Barrier Systems.

Participants: A list of participants is included with the several publications and maps supplied to each participant. The following agencies/ institutions are represented:

- New York State Office of Parks and Recreation (OPR)
  - Long Island State Park and Recreation Commission (LISPRC)
  - Environmental Management
  - Development Bureau
- New York State Department of Environmental Conservation (DEC)
  - Water Management Group
  - Office of Environmental Analysis
- New York State Division of the Budget (DOB)
- Cornell University
  - School of Civil and Environmental Engineering,
  - Remote Sensing Program
- U. S. Army, Corps of Engineers

Itinerary: There are eight main stops included in the trip

Morning: On Jones Beach Barrier Island - travel by four wheel drive vehicle from Field 1 along shoreface to Field 9

Lunch

Afternoon: On the Fire Island Barrier - travel by four wheel drive vehicle from Field 5 to Democrat Point and then to the inlet side of Robert Moses State Park.

Trip Leaders:

Frank Hyland, Fred Wolff and Pete Buttner

Participants: Coastal Erosion Reconnaissance Field Trip 10/16/78

Col. Clark H. Benn, District Engineer, N.Y. District, U.S. Army Corps of Engineers (COE) (212) 264-9078 (N.Y.C.)

Dr. Peter J. R. Buttner, Director of Environmental Management, NYS Office of Parks and Recreation (OPR) (518) 474-0400 (Albany)

Thomas Connors, P.E., Director of Development, OPR, (518) 474-0481 (Albany)

David DeRidder, Asst. Engineer, Environmental Analysis, NYS Department of Environmental Conservation (DEC) Region I, (516) 751-7900 (Stony Brook)

Dr. Thomas L. Erb, Research Specialist, Remote Sensing Program, Cornell University (CU), (607) 256-4330 (Ithaca)

William Hafker, Research Assistant, CU, (607) 256-4330 (Ithaca)

Frank Hyland, P. E., Chief Engineer, Long Island State Park and Recreation Commission (LISPRC), (516) 669-1000 (Babylon)

James Kelly, Chief, Water Management Group, DEC (518) 457-3158 (Albany)

Orin Lehman, Commissioner, OPR, (518) 474-0443, (Albany)

Gilbert Nersesian, P. E., Chief, New Jersey Planning Group, COE, (212) 264-9078 (NYC)

Rudy Runko, Deputy Chief Budget Examiner, NYS Division of the Budget (DOB) (518) 474-6037 (Albany)

John Sheridan, General Manager, LISPRC, (516) 669-1000, (Babylon)

William Valentino, Budget Examiner, DOB, (518) 474-2330, (Albany)

Ivan P. Vamos, Deputy Commissioner for Planning and Operations, OPR, (518) 474-0449 (Albany)

Dr. Fred Wolff, Coastal Sedimentologist, Hofstra University, (516) 560-3291 (Hempstead)

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ASCE News

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Cornell Remote Sensing Program

The Remote Sensing Program in the Cornell University School of Civil and Environmental Engineering is endeavoring to establish communication links among persons interested in remote sensing and to solicit and conduct user-oriented demonstration projects. Under the leadership of principal investigator Dr. Ta Liang the program, in its seventh year, is funded primarily by a grant from NASA. The user-oriented demonstration projects are conducted at no charge to the user, if the project involves a unique benefit- or action-producing application of aircraft or satellite remote sensing in the northeastern United States. Recently completed projects include a study regarding leachate from the Love Canal landfill in Niagara Falls, N.Y. and an assessment of sites for river dredge spoil disposal and subsequent recreational development. A continuing project involves the use of both aircraft and satellite data to develop a remote sensing methodology for assessing dam flooding hazards. Further information can be acquired by writing Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, New York 14853.

APPENDIX H

NEWSLETTER RECIPIENTS

CORNELL REMOTE SENSING NEWSLETTER

LIST OF RECIPIENTS

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2. Administration

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J.W. Spencer	(Special Ass't. to President)

3. Administrative Programming Service

C. Selvarajah

4. Aerospace Studies (Air Force R.O.T.C.)

J. Levisky	(Major)

5. Agricultural Economics

O.D. Forker	(Chairman; Prof.)
D.J. Allee	(Prof.)
C.R. Bailey	(Research Ass't.)
H.E. Conklin	(Prof.)
G.R. Fohner	(Research Specialist)
K.V. Gardner	(Sr. Extension Assoc.)
W.C. Hunt	(Research Specialist)
B.F. Stanton	(Prof.)

6. Agricultural Engineering

D.A. Haith	(Assoc. Prof., Civil & Envir. Eng'g. and Agr. Eng'g.)
L.H. Irwin	(Assoc. Prof.)
W.J. Jewell	(Assoc. Prof.)
G. Levine	(Prof.; Dir. Center for Envir. Research)
R.C. Loehr	(Dir., Environmental Studies; Prof., Civil and Envir. Eng'g. and Agr. Eng'g.)
D.C. Ludington	(Assoc. Prof.)
O. Zolezzi	(Research Asst.)

7. Agronomy

R.F. Lucey	(Chairman; Prof.)
R.W. Arnold	(Prof.)
D.R. Bouldin	(Prof.)
W.F. Croney	(Sr. Ext. Assoc.)
M. Drosdoff	(Prof. Emer.)
E.R. Lemon	(Prof.; Soil Scientist, U.S.D.A.)
G.W. Olson	(Assoc. Prof.)

*Newsletters are sent to the main office of each department listed, as well as to various individuals within the department. In addition, Newsletters are provided to graduate and undergraduate students, upon request.

7. Agronomy (Cont.)

J.H. Peverly	(Asst. Prof.)
A.R. Van Wambeke	(Prof.)

8. Anthropology

R. Ascher	(Prof.)
J.S. Henderson	(Asst. Prof.)

9. Applied and Engineering Physics

A.F. Kuckes	(Prof.)

10. Astronomy

F.D. Drake	(Dir., Nat'l Astronomy & Ionosphere Center; Prof.)
M.O. Harwit	(Prof.)
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Y. Terzian	(Prof.)
J. Veverka	(Assoc. Prof.)

11. Atmospheric Sciences (Agronomy)

B.E. Dethier	(Prof.)
W.W. Knapp	(Assoc. Prof.)
A.B. Pack	(Sr. Extension Assoc.)

12. Boyce Thompson Institute

E.H. Buckley	(Plant Biochemist)
J.S. Jacobson	(Plant Physiologist)

13. Biological Sciences

14. City and Regional Planning

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B.G. Jones	(Prof.)
S.W. Stein	(Prof.)

15. Civil and Environmental Engineering

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G.B. Lyon	(Asst. Dir.; Assoc. Prof., Envir. Eng'g.)
J.F. Abel	(Assoc. Prof., Structural Eng'g.)
D.J. Belcher	(Prof. Emer.)
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W.H. Brutsaert	(Prof., Envir. Eng'g.)
R.I. Dick	(Prof., Envir. Eng'g.)
L.B. Dworsky	(Prof., Envir. Eng'g.)
T.L. Erb	(Research Specialist, Remote Sensing Program)
G.P. Fisher	(Prof., Envir. Eng'g.)
C.D. Gates	(Prof., Envir. Eng'g.)
P. Gergely	(Prof., Structural Eng'g.)

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- J.G. Hagedorn (Data Analyst, Remote Sensing Program)
- S.C. Hollister (Prof. Emer.)
- A.R. Ingraffea (Asst. Prof., Structural Eng'g.)
- G.H. Jirka (Asst. Prof., Envir. Eng'g.)
- P.R. Jutro (Sr. Research Assoc., Envir. Eng'g.)
- F.H. Kulhawy (Assoc. Prof., Structural Eng'g.)
- T. Liang (Prof., Remote Sensing Program)
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- P. Liu (Asst. Prof., Envir. Eng'g.)
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- W. McGuire (Prof., Structural Eng'g.)
- A.J. McNair (Prof., Civil and Envir. Eng'g.)
- A.H. Meyburg (Prof., Envir. Eng'g.)
- A.H. Nilson (Chairman, Structural Eng'g.; Prof.)
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- T. Pekoz (Assoc. Prof., Structural Research Mgr.)
- W.R. Philipson (Sr. Research Assoc., Remote Sensing Program)
- D.A. Sangrey (Assoc. Prof., Structural Eng'g.)
- R.E. Schuler (Assoc. Prof., Envir. Eng'g. and Economics)
- C.A. Shoemaker (Asst. Prof., Envir. Eng'g.)
- F.O. Slate (Prof., Structural Eng'g.)
- J.R. Stedinger (Asst. Prof., Envir. Eng'g.)
- G. Winter (Prof. Emer.)

16. College of Agriculture and Life Sciences

- D.L. Call (Dean, Prof.)

17. College of Architecture, Art and Planning

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- H.W. Richardson (Assoc. Dean; Assoc. Prof.)

18. College of Engineering

- A. Schultz (Acting Dean; Prof., Operations Research)
- P.R. McIsaac (Assoc. Dean; Prof., Electrical Eng'g.)
- F.J. Ahimaz (Dir., Eng'g. Basic Studies; Prof.)

19. Computer Graphics

- D.P. Greenberg (Dir.; Prof., Arch.)

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- P.F. Brussard (Assoc. Prof., Ecology)
- G.E. Likens (Prof., Ecology)
- P.L. Marks (Assoc. Prof., Biology)

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- R.A. McFarlane (Prof.)
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26. Entomology Extension

27. Floriculture and Ornamental Horticulture

- M.I. Adleman (Assoc. Prof., Landscape Architecture)
- A.S. Lieberman (Prof., Landscape Architecture)
- P.J. Trowbridge (Asst. Prof., Landscape Architecture)

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- A.L. Bloom (Prof.)
- B.L. Isacks (Prof.)
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- J. Ni (Research Specialist)
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34. Mechanical and Aerospace Engineering

35. Media Services

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46. Rural Sociology

H.R. Capener (Prof.)

47. Sociology

48. Theoretical and Applied Mechanics

49. Thermal Engineering

50. Unclassified Students

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51. University Archives

G.P. Colman (Librarian)

52. U.S. Plant, Soil and Nutrition Laboratory

* * * * *

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Los Banos, Philippines

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Tug Hill Commission
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Albany, New York

Mr. Fred C. Voigt
Herndon, Virginia

Mr. William H. Walker
Creative Communications
Services
Pittsford, New York

Mr. Ed Wallace
Mead Technology Laboratories
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ARC Weed Research Organization
Yarnton, Oxford, England

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Wilton, Connecticut

Mr. Charles Wielchowsky
Exxon Production Research Co.
Houston, Texas

Ms. Phoebe Williams
NASA Ames Research Center
Moffett Field, California

Mr. Gerald Willoughby
OVAA8 International Inc.
Philadelphia, Pennsylvania

Ms. Helene Wilson
Goddard Institute for Space
Studies
New York, New York

Mr. Charles Withington
Washington, D.C.

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(b) J.R. Lovegreen

Dr. Guirguis F. Yassa
Robinson Aerial Surveys, Inc.
Newton, New Jersey

Prof. Edward F. Yost, Jr.
Science Eng'g. Research Group
Long Island University
Greenvale, New York

Mr. Michael Ziskin
York Research Group
Stamford, Connecticut

Dr. Michael Zoracki
Pattern Analysis and
Recognition Corporation
Rome, New York

APPENDIX I

RECENT NEWSLETTERS

The Newsletter, a monthly report of articles and events in remote sensing, is sent to members of the Cornell community who have an interest in sensors and their applications.

THE SEVENTH YEAR

The Remote Sensing Program is funded primarily by a grant from the National Aeronautics and Space Administration (NASA) to the Cornell University School of Civil and Environmental Engineering. Since the Program's inception in June 1972, its staff has endeavored to strengthen instruction and perform research in remote sensing, building upon Cornell's thirty years of experience in aerial photographic studies; to establish communication links among persons interested or active in remote sensing; and to solicit and conduct user-oriented demonstration projects. These projects are conducted at no charge to the user if the project involves a unique benefit- or action-producing application of aircraft or satellite remote sensing in New York State or in the Northeast.

NASA-sponsored projects completed since May 1978 include (cooperators in parentheses): a comprehensive study and consultations regarding leachate from the Love Canal landfill in Niagara Falls, N.Y. (N.Y.S. Dept. Health); a Landsat analysis of land cover types related to pheasant range management (N.Y.S. Dept. of Environmental Conservation); an assessment of sites for river dredge spoil disposal and subsequent recreational development (Planning Dept., Columbia County, N.Y.); an evaluation of active agriculture and land quality as input to modifying agricultural districts (Planning Dept., Columbia County, N.Y.); and a survey and characterization of mosquito breeding sites in selected areas of central New York (N.Y.S. Dept. Health). (*continued, p. 2*).

ASP DIVISIONAL CHANGES/CALL FOR PAPERS

During the past year, the American Society of Photogrammetry underwent a series of name and structural changes. The Society's three divisions and their respective technical committees are as follows: (1) Primary Data Acquisition (sensor systems; environmental factors; data characteristics, quality and standards; data processing, reproduction and display; and vehicles and navigation); (2) Digital Processing and Photogrammetric Applications (image data processing techniques development; computational photogrammetry; automated cartography; instrumentation; close-range photogrammetry; cadastral surveys; transportation surveys; and standards); and (3) Remote Sensing Applications (education and interpretive skills; engineering applications; extraterrestrial sciences; geography and land use; geological sciences; hydrospheric sciences; and plant sciences). For further information contact: William D. French, Executive Director, ASP, 105 N. Virginia Ave., Falls Church, Va. 22046 (tel. 703-534-6617).

The ASP's 45th Annual Meeting will be held in Washington, D.C., from 18 to 24 March 1979. Proposals for papers on recent developments in primary data acquisition, digital processing and photogrammetric applications, and remote sensing applications should be submitted to: Thomas J. Lauterborn, ASP Technical Program Chairman, U.S. Geological Survey, 507 National Center, Reston, Va. 22092. Proposals should include the author's name, address and professional affiliation, a titled abstract of approximately 200 words, the estimated time for presentation (limited to 20 minutes), and the percentage of material presented in a previous talk or publication. Proposals must be received by 15 October.

SEMINAR IN REMOTE SENSING

The Seminar in Remote Sensing will not be held during the fall semester 1978, but will be offered again during the spring 1979.

Cornell's Remote Sensing Program *(cont'd)*

Continuing projects are using aircraft data to examine vineyard yield factors, satellite data to relate river discharge to flooded area, and both aircraft and satellite data to develop a remote sensing methodology for assessing dam flooding hazards. The latter project is being funded by the Office of Water Research and Technology, U.S.D.I., through Cornell's Center for Environmental Research.

The staff of the Remote Sensing Program includes Ta Liang, principal investigator, Arthur J. McNair and Warren R. Philipson, co-investigators, Thomas L. Erb, research specialist, John G. Hagedorn, data analyst, Deborah Halpern, photographic laboratory technician, and Pat Webster, secretary. Brian L. Markham and Josephine Ng, former staff members, left the Program during the summer. Donald J. Belcher and Ernest E. Hardy are general consultants to the Program, and Carl Diegert is a computer consultant. For specific projects, assistance has been provided by many Cornell and non-Cornell personnel. Students who have contributed to the Program staff effort over the summer include Jan P. Berger, William R. Hafker, Jay N. McLeester and David W. Adams.

MEETINGS AND SYMPOSIA

Regional Meeting, Central New York Region, Amer. Soc. Photogrammetry; 15 Sept; in Rochester; Contact: Walter R. Ambrose, Bausch & Lomb, Inc., P.O. Box 543, Rochester, N.Y. 14602 (tel. 716-338-6546).

Nat'l. Conf. on Capabilities & Limitations of Thermal Infrared Sensing Technology in Energy Conservation Programs; 20-21 Sept; in Chattanooga, Tenn.; (Amer. Soc. Photogrammetry, Dept. of Energy, and Tenn. Valley Authority); Contact: William French, Amer. Soc. Photogram., 105 N. Virginia Ave., Falls Church, Va. 22046 (tel. 703-534-6617).

4th William T. Pecora Memorial Symposium (application of remote sensing to wildlife management); 10-12 Oct; in Sioux Falls, S.D.; Contact: Dr. Michael E. Berger, Nat'l Wildlife Federation, 1412 16th St., NW, Washington, D.C. 20036 (tel. 202-797-6881).

Fall Convention, Amer. Congress Surveying & Mapping - Amer. Soc. Photogrammetry; 15-21 Oct; in Albuquerque, N.M.; Contact: Dr. Stan Morain, Technology Application Center, Univ. of New Mexico, Albuquerque, N.M. 87131 (tel. 505-277-4000).

LACIE Symposium (review & discussion of Large Area Crop Inventory Experiment conducted by NASA, USDA, NOAA and various university and industrial research personnel); 23-26 Oct; in Houston, Tex.; Contact: Industrial Economics Research Div., Texas A & M Univ., Box 83, College Station, Tex. 77843 (tel. 713-845-5711).

SELECTED ARTICLES AND PUBLICATIONS

Anderson, J.R. (ed.). 1977. Land use and land cover maps and statistics from remotely sensed data. Remote Sensing of Electro-Magnetic Spectrum 4:4:192.

Barrett, E.C. and L.F. Curtis. 1977. Environmental remote sensing 2: Practices and problems. Edward Arnold (Publishers), Ltd., London. 319 pp. ($34.50).

Gordon, H.R. 1978. Removal of atmospheric effects from satellite imagery of the oceans. Applied Optics 17:10:1631-36.

Kirman, J. 1978. A primer for satellite maps. (A teaching kit for instruction in Landsat remote sensing; contains 63 color Landsat images, etc.: for use at elementary and secondary levels, as well as university level). Puckrin's Production House Ltd., 35 Mill Drive, St. Albert, Alberta, T8N 1J5 Canada ($40).

The Newsletter is made possible by a grant from the NASA Office of University Affairs. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, New York 14853 (tel. 607-256-4330).

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LANDSAT ANALYSIS OF LAND COVER FOR PHEASANT MANAGEMENT

In a NASA-sponsored study conducted for the New York State Department of Environmental Conservation (DEC), the staff of Cornell's Remote Sensing Program examined the value of Landsat multispectral scanner data for separating five land cover types in central New York. These cover types--alfalfa, corn, other (small) grains, beans and truck crops --had not been differentiated in the statewide Land Use and Natural Resources Inventory, and were being considered for inventory under the DEC's pheasant habitat management program. The desirability and potential feasibility of using Landsat rather than aircraft data were established by the probable need for periodic inventory of these and other cover types over a major portion of the state (Finger Lakes and Lake Plains Regions), with a minimum mapping unit of four hectares.

To verify Landsat interpretations, ground data were collected at three Finger Lakes test areas. The areas ranged in size from 15 to 35 km^2; the data consisted of field observations of the cover types present in 1977, and interview-derived data on the cover types present in 1976. A crop calendar was also compiled.

The initial attempts to discriminate the cover types made use of Landsat computer-compatible tapes (CCTs). Failure to spectrally differentiate the cover types with digital data would indicate that manual (visual) analyses would also be unsuccessful, whereas the reverse is not necessarily true. A July 15, 1977, Landsat scene was chosen for analysis because most fields would have crops on this date. The CCT of an August 24, 1976, scene, on hand for an unrelated investigation, was also analyzed. The test areas in both scenes were categorized using non-parametric, supervised classification procedures (ORSER's minimum distance and parallelepiped classifiers), with and without pre-processing (canonical analysis, ratioing). It was found that few of the cover types of interest could be reliably separated on a single date of Landsat data. The study then adopted a multi-date ("time sequential") approach. (continued, page 2).

WASHINGTON, D.C., LAND COVER MAPS

The U.S. Geological Survey has published a "Folio of Land Use Maps of the Washington Urban Area" (Map Folio I-858; $11.75). Included are four previously published 1:100,000 scale maps (I-858-A through -D) showing Land Use, 1970, derived from high altitude aerial photographs, Annotated Orthophoto, 1970, Census Tracts, 1970, and Land Use Change, 1970-72. Two new maps in the folio show land cover compiled by computer classification of 1972 and 1973 Landsat data. One map is overprinted with locational features and place names (I-858-E; $2.75), and the other is overprinted with 1970 census tracts and the 1972 urban boundary (I-858-F; $2.75). All maps can be purchased from the USGS Branch of Distribution, 1200 South Eads St., Arlington, VA 22202. For further information, contact the Land Information and Analysis Office, MS 710, USGS National Center, Reston, VA 22092.

SHORT COURSES

Remote Sensing Technology & Applications; offered first full week of each month through 4-8 June 1979; Contact: D. Morrison, LARS/Purdue Univ., 1220 Potter Dr., W. Lafayette, Indiana 47906.

Image Processing & Pattern Recognition; 27 Nov-1 Dec; $495; Contact: Continuing Education in Eng'g. and Mathematics, P.O. Box 24902, UCLA Extension, Los Angeles, Calif. 90024.

Multidate analysis of Landsat data can take advantage of cropping patterns as well as reflectance differences, and are therefore potentially more accurate than single date analyses. Images instead of tapes were used for the multi-date analysis because of the relatively high cost of CCTs and computer analyses, and lesser likelihood of implementation by the DEC. Photographic enlargements of the test areas in the band 5 (red) and band 7 (near-infrared) images were made for three 1977 scenes, May 22, June 27 and August 2. These enlarged transparencies (positive and negative) were analyzed in an additive-color viewer, applying various spectral band/date/color assignments. In general, only gross assessment of the spectral content of the agricultural fields could be performed through visual methods since only three or four levels of gray could usually be distinguished on any image. At best, three groups of cover types were separable: (1) alfalfa, (2) corn, beans and truck crops, and (3) small grains (oats and wheat).

It was concluded that neither the single dates of Landsat, analyzed digitally, nor the combination of dates, analyzed manually, could provide adequate separability of all cover types of interest. Supervised classification of Landsat digital data from two dates would likely prove successful, and some improvement in separability with manual methods would likely accompany improvements in the quality of the imagery. These approaches as well as others are now being considered by the DEC.

The study was conducted by Brian L. Markham with assistance from several other staff members of the Remote Sensing Program. For further information, contact Warren R. Philipson at Cornell, or Peggy R. Sauer, Supervising Wildlife Biologist, N.Y.S. Dept. of Environmental Conservation, 50 Wolf Road, Albany, NY 12233.

APPALACHIANS/LANDSAT DATA SOUGHT

Dr. George Rabchevsky, Research Scientist at the American University, is establishing a collection and list of available/published Landsat geologic interpretations of the Appalachian orogen. The work is part of an NSF project, "Application of Plate Tectonics to the Location of New Mineral Targets in the Applachians." He would like to obtain/purchase reports, maps and other information on this topic. Of special interest are lineament/fracture maps and analyses related to stress fields and metallogeny. Please contact: Dr. George A. Rabchevsky, The American Univ., Beeghly Hall, Washington, D.C. 20006.

SELECTED ARTICLES AND PUBLICATIONS

El-Ashry, M.T. (editor). 1977. Air photography and coastal problems. Dowden, Hutchinson & Ross, Inc. Stroudsburg, Penn. 425 pp. ($32).

Soetanto. 1978. Aerial photography in Indonesia. Photogrammetria 34:3:79-87.

ITC Journal 1978. no. 1

-van Genderen et al. Guidelines for using Landsat data for rural land use surveys in developing countries.

-Tempfli & Makarovic. Transfer functions of interpolation methods.

-Bergsma, E. Field boundary gullies in the Serayu River Basin, Central Java.

-Miller, V.C. Solar stereo Landsat imagery.

-Leberl, F. Current status and perspectives of active microwave imaging for geoscience application.

The Newsletter is made possible by a grant from the NASA Office of University Affairs. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, New York 14853 (tel. 607-256-4330).

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RESOURCE INFORMATION LABORATORY--NEW PROGRAMS

In response to a significant increase in the interest of local governments and citizen's groups in the use of remotely sensed data for resource management decision-making, the Resource Information Laboratory (RIL), of Cornell's College of Agriculture and Life Sciences, has greatly expanded its training activities. Functioning as a unit of the New York State Cooperative Extension, RIL has developed and tested several programs, which are now ready for general use. Among these are a new approach to county resource inventory wherein the organizational problems are dealt with by working directly with local government officials to explain the need for inventories; working with volunteer groups to train them in inventory techniques; preparing the local population to accept new kinds of information; and, finally, working with decision makers in the use of the new information sources.

The New York State Land Use and Natural Resources Inventory (LUNR) continues to be a major component of the RIL information collection. Although LUNR data are based largely on 1968 aerial photography, interest in their use is still strong. Substantial effort has also been expended in obtaining new resource materials. Of major importance is the acquisition of a collection of New York State aerial photographs, flown for the U.S. Department of Agriculture since 1954. Together with LUNR, these photographs will provide opportunities for development of trend-line data, with as many as four or five dates available for much of the State.

For additional information concerning RIL and its services, contact: E.E. Hardy, Director, or Ms. E.M. Barnaba, Manager of Technical Services, at tel. 607-256-6520 or -6529. Mailing address: Resource Information Laboratory, Cornell Univ., Roberts Hall, Box 22, Ithaca, N.Y. 14853; site location: Brown Road (Tompkins County Airport road).

CALL FOR PAPERS FOR POSTER PRESENTATIONS

The 13th International Symposium on Remote Sensing of Environment will be held in Ann Arbor, Michigan, 23 to 27 April 1979. In addition to sessions of invited papers, the symposium will feature numerous poster sessions. Persons interested in contributing to a poster session should submit 30 copies of a 300 to 1,000 word summary to: Dr. Jerald J. Cook, Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, Mich. 48107 (tel. 313-994-1200). The summaries should designate a specific topic or subject area for evaluation, and they must be received by 1 December 1978.

SMALL-SCALE PHOTOS OF FINGER LAKES REGION

In support of several projects of Cornell's Remote Sensing Program, NASA flew high-altitude, aerial photographic coverage of New York's Finger Lakes Region on 26 May and 18 August 1978. Color and color-infrared coverage were obtained at a scale of approximately 1:120,000, over the area from N42°15' to 43°00' and W75°45' to 77°40'. The area photographed is comparable to that flown earlier during a NASA high-altitude, color-infrared photographic mission, on 7 May 1975.

As with all remotely sensed aircraft and satellite data acquired by NASA, the photographic coverage may be purchased from the U.S. Geological Survey, EROS Data Center, Sioux Falls, South Dakota 57198. Members of the Cornell Community who are conducting or planning investigations that might benefit from the use of the 1975 or 1978 photography should contact Dr. Warren R. Philipson, 464 Hollister Hall, 6-4330.

Chance, J.E. and E.W. LeMaster. 1978. Plant canopy light absorption model with application to wheat. Applied Optics 17:16:2629-2636.
Colcord, J.E. 1978. Thermal infrared imagery use in urban energy surveys. Transportation Eng'g. Jour., ASCE 104:TE5:637-651.
Gordon, H.R. 1978. Remote sensing of optical properties in continuously stratified waters. Applied Optics 17:12:1893-97.
Canadian Journal of Remote Sensing 1978. v.4., n.2.
(available from Canadian Aeronautics & Space Institute, 77 Metcalfe St., Ottawa, Canada K1P 5L6.)
-Bush & Ulaby. Crop inventories with radar.
-Starr & Mackworth. Exploiting spectral, spatial and semantic constraints in the segmentation of Landsat images.
-Alfoldi & Munday. Water quality analysis by digital chromaticity mapping of Landsat data.
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-Goodenough et al. Feature subset selection in remote sensing.
-Lowry & Brochu. An interactive correction and analysis system for airborne laser profiles of sea ice.
-Wadhams, P. Sidescan sonar imagery of sea ice in the Arctic Ocean.
Photogrammetric Eng'g & Remote Sensing 1978. v.44, n.5 (May).
-Kratky, V. Reflexive prediction and digital terrain modelling.
-Snyder, J.P. The Space Oblique Mercator projection.
-Fleming, J. Exploiting the variability of Aerochrome Infrared film.
-Brothers & Fish. Image enhancement for vegetative pattern change analysis.
-Johnson, R.W. Mapping of chlorophyl a distribution in coastal zones.
-Paul, C.K. Internationalization of remote sensing technology.
Photogrammetric Eng'g & Remote Sensing 1978. V.44, n.6.(June).
-Spencer, R.D. Map intensification from small format camera photography.
-Sheldon, J.W. In situ measurement of water transparency.
-Jensen et al. High-altitude versus Landsat imagery for digital crop identification.
-Sauchyn & Trench. Landsat applied to landslide mapping.
Remote Sensing of Environment 1978. v.7, n.2.
-Doda & Green. Spectral sunphotometry using a compact spectrometer.
-Bristow, M. Airborne monitoring of surface water pollutants by fluorescence spectroscopy.
-Smith et al. Use of Landsat-1 imagery in exploration for Keweenawan-type copper deposits.
-Huntington & Raiche. A multi-attribute method for comparing geological lineament interpretations.
-Burns & Brown. The human perception of geological lineaments and other discrete features in remote sensing imagery.
-Pratt et al. Recent advances in the applications of thermal infrared scanning to geological and hydrological studies.
The Photogrammetric Record 1978. v.9, n.51.
-Scogings, D.A. The experimental recording of petroglyphs and archaeological sites.
-Spencer, R.D. Film trials of aerial photography for forestry in Victoria, Australia.

The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330).

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ENGINEERING SYSTEMS--A CHALLENGE FOR REMOTE SENSING

by
Kam W. Wong

Dr. Wong, Professor of Civil Engineering at the University of Illinois at Urbana-Champaign, received his M.S. and Ph.D. in Photogrammetric and Geodetic Engineering at Cornell, in 1966 and 1968, respectively. The views expressed here are those of Dr. Wong and do not necessarily reflect the views or policy of the Cornell Remote Sensing Program.

Timely information on the physical environment, at an affordable price, is an invaluable asset for the design and planning of engineering systems. The complexity of modern societies has prompted the rapid development of rational and analytical decision making methods for the planning of engineering systems; however, the ability to reach an optimal plan and design for any problem depends on the quality and quantity of the data base. Thus, in addition to social, economic and technical data, information on the physical environment--land use, vegetative covers, surficial soils, topography, etc.--is of vital importance to the planning process. Can current remote sensing technology fulfill this need? Can it do so in the near future?

One is tempted to quickly answer, "Yes!" to both of these questions. The fact is, however, that after a decade of intensive research and development, remote sensing technology has made very little impact in the area of systems planning and design. The Landsat program has provided valuable data for mineral exploration, general land use classification, crop inventory, mapping of shallow seas, and many other endeavors. But in the planning and design of engineering systems, the gathering of data on the physical environment still depends largely on the tedious and conventional methods of photo interpretation and photogrammetry. (continued, page 2).

CORNELL'S LANDFORM SERIES

The Cornell University-U.S. Navy "Landform Reports" is an airphoto interpretation reference consisting of six volumes with approximately 600 pages and 600 photographs. Completed in 1951 by Ta Liang and others under the direction of Donald J. Belcher, the Landform Series has sections on: general analysis; sedimentary, igneous and metamorphic rocks; and waterlaid, glacial and windlaid materials. If a sufficient number of buyers can be located, this reference will be reproduced. Interested individuals should contact Mary McElroy, Head Librarian, Engineering Library, Carpenter Hall, Cornell Univ., Ithaca, NY 14853 (tel. 607-256-4318). The cost for the six volume set, with unmounted photographs, would be about $120 to $150.

CALL FOR PAPERS--MACHINE PROCESSING

The 5th Purdue Symposium on Machine Processing of Remotely Sensed Data will be held at Purdue University, 27-29 June 1979. Authors wishing to contribute a "long" paper should submit a 1,000-word summary by 15 December 1978. A limited number of "short" papers will be accepted on the basis of a one-page, double-spaced, typed abstract, received by 1 March 1979. Four copies of the long or short paper proposal should be sent to: Dr. Luis A. Bartolucci or Dr. L.F. Silva, Laboratory for Applications of Remote Sensing, Purdue Univ., 1220 Potter Dr., West Lafayette, Ind. 47906 (tel. 317-749-2052).

CALL FOR PAPERS--SATELLITE HYDROLOGY

The 5th Annual William T. Pecora Memorial Symposium will be held in Sioux Falls, So. Dakota, 11-15 June 1979. The symposium is sponsored by the American Water Resources Association and various other organizations, and its theme is satellite hydrology. Sessions of conventional and poster presentations will focus on: meteorology; snow and ice; surface water; ground water; soil moisture; environmental monitoring; coastal zone hydrology; and water use and management. Those wishing to contribute to the symposium should submit five copies of a 200-word, titled abstract to: Morris Deutsch, EROS Program, U.S. Geological Survey, 1925 Newton Square East, Reston, VA 22090 (tel. 703-860-7872), before 31 January 1979. Abstracts should include the name(s) and affiliation(s) of the authors, with an asterisk denoting the senior author. Authors must also enclose a separate page which lists their full mailing address(es) and telephone number(s).

Remote Sensing Challenge (continued)

Although conventional photo interpretation and photogrammetric mapping techniques can provide much of the data that is needed for engineering planning purposes, these techniques are heavily human-dependent; and time consuming processes are required to convert the collected data into computer compatible forms. Remote sensing techniques such as spectral analysis can yield data directly in digital form. To obtain data at an adequate level of resolution, however, huge quantities of data must first be processed. Such processing requirements test even the full capability of the most advanced computer systems. In addition, there is little indication that fully automatic techniques can soon be developed for the mapping of topography and surficial soils.

The challenge to the field of remote sensing remains to be met. Efficient systems for gathering medium to high resolution data should be developed. More efficient analysis techniques are needed to reduce the computational burden associated with spectral analysis. The problems of data storage and retrieval need in-depth study with the ultimate objective of creating integrated environmental data banks. Finally, there is need for a system of computed-assisted photo interpretation with which much of the data correlation tasks can be automated, leaving the human operator to perform the indispensable tasks of interpretation and identification.

SELECTED ARTICLES

Remote Sensing of Environment. 1978. v.7, n.3

-Stewart et al. The use of thermal imagery in defining frost prone areas in the Niagara fruit belt.
-Tucker, C.J. Post senescent grass canopy remote sensing.
-Hirosawa et al. Cross-polarized radar backscatter from moist soil.
-Robinove, C.J. Interpretation of a Landsat image of an unusual flood phenomenon in Australia.
-Abiodun & Adeniji. Movement of water columns in Lake Kainji.
-Viollier et al. Airborne remote sensing of chlorophyll content under cloudy sky as applied to the tropical waters in the Gulf of Guinea.
-Maul, G.A. Locating and interpreting hand-held photographs over the ocean; A Gulf of Mexico example from the Apollo-Soyuz Test Project.
-Anderson, A.C. Remote sensing in sea search and rescue.
-Idso et al. Wheat yield estimation by albedo measurement.

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Season's Greetings from the staff of the Remote Sensing Program!!!

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The Newsletter is made possible by a grant from the National Aeronautics and Space Administration. Comments or correspondence should be directed to Dr. Warren R. Philipson, Remote Sensing Program, Cornell University, 464 Hollister Hall, Ithaca, NY 14853 (tel. 607-256-4330).