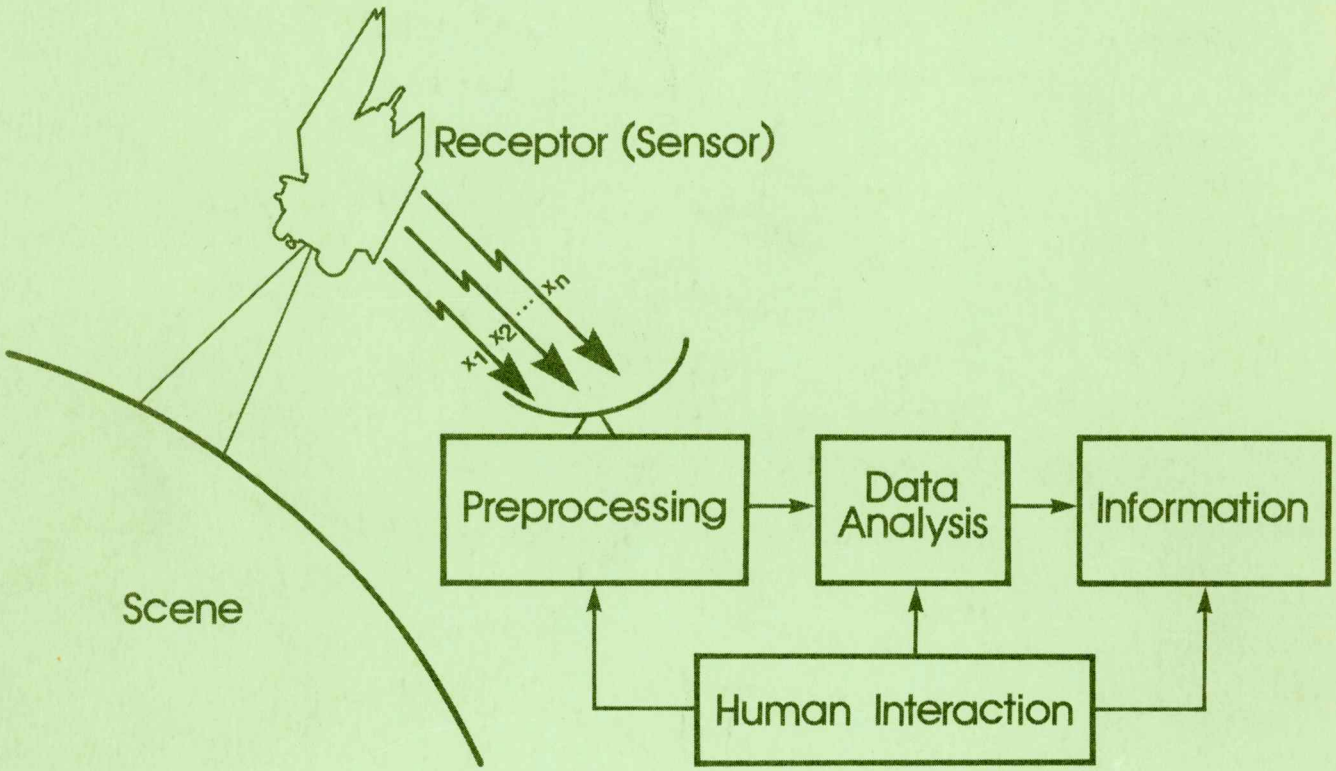
Seventh International Symposium

Machine Processing of Remotely Sensed Data

with special emphasis on

Range, Forest, and Wetlands Assessment



June 23-26, 1981

Proceedings

Purdue University
Laboratory for Applications of Remote Sensing
West Lafayette, Indiana 47907 USA

Symposium at a Glance

TUESDAY JUNE 23		WEDNESDAY JUNE 24	THURSDAY JUNE 25	FRIDAY JUNE 26	
7:45-	Registration East Foyer of Stewart Center	II.A Classification Accuracy Assessment Procedures Rm. 202	IV.A Understanding and Characterizing the Forest Scene/Rm. 202 Rm. 202		
9:00- 12:00	OPENING PLENARY Fowler Hall	II.B Geologic Applications of Remote Sensing Rm. 210	IV.B Rangeland and Land Use Applications of Remote Sensing/Rm. 210	9:00- 12:00	CLOSING PLENARY Fowler Hall
8:30 - 11:30		II.C Preprocessing and Systems/Rm. 214	IV.C Remote Sensing and Georeference Information Systems/Rm. 214		
Breaks: 10:00-10:30, Rm. 206			Visit the Exhibit Room		
1:30 - 4:30	I.A Effective Techniques for Classifying Forest Cover Rm. 202	III.A Special Reports and Discussion Sessions Focused on Two Recent National Wrokshops Rm. 202	V.A Forest Resource Information Through Remote Sensing Rm. 202	OPEN HOUSE at LARS Flex 2	
	I.B Agronomic Applications of Remote Sensing Rm. 210	III.B Wetlands and Water Resources Assessment Rm. 210	V.B Remote Sensing and Georeference Information Systems/Rm. 214		
		III.C Image Data Modeling and Analysis Rm. 214			
Breaks: 3:00-3:30, Rm. 206					
7:30- 9:30	POSTER PAPER PRESENTATIONS Rm. 206	5:30 Chicken Barbecue at Fort Ouiatenon			

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Preface

These proceedings serve as the written record of the papers presented at the Seventh International Symposium on Machine Processing of Remotely Sensed Data, held at Purdue University, June 23-26, 1981. The texts of 99 invited and contributed papers (including poster papers) are contained in this volume. We all recognize, however, that no written text can do an adequate job of recording the information exchange that takes place during coffee breaks, over meals or in the evening, as well as during the question and answer sessions after the papers. The Symposium was designed to allow for adequate exchange of information among the attendees at times other than during the formal presentations. The poster paper session on Tuesday evening, an informal barbeque at Fort Ouiatenon on Wednesday evening, and a discussion session Thursday evening helped to stimulate opportunities for informal discussions and exchanges of ideas and view points.

This 1981 Symposium focused attention on forest, range and wetland assessment. This theme was highlighted by opening and closing plenary sessions which addressed the topics of "Meeting Forest Information Needs Through Remote Sensing: What Is the State-of-the-Art?" and "Monitoring the World's Forest Resources: Today and Tomorrow." Between the opening and closing sessions, a series of three parallel technical sessions was held. The first of these series focused on forest resources and included sessions on the topics of "Effective Techniques for Classifying Forest Cover," "Classification and Accuracy Assessment Procedures," "Understanding and Characterizing the Forest Scene," and "Forest Resource Information Through Remote Sensing." The second group of sessions was directed at non-forestry applications and included sessions on "Agronomic Applications of Remote Sensing," "Wetlands and Water Resources Assessment," and "Rangeland and Land Use Applications of Remote Sensing." The third series of sessions was directed at the machine processing aspects of remote sensing systems. It included sessions on "Preprocessing and Systems," "Image Data Modeling and Analysis," "Remote Sensing and Geo-referencing Information Systems." Three sessions during the week featured panel discussions in order to encourage audience participation and general discussion.

A large measure of the success of this Symposium goes to the co-sponsoring and cooperating organizations and to the members of the program committee and session chairmen who represented these groups. The cooperation, time, and efforts of the various members of the Symposium Program Committee, as well as the session coordinators, session chairmen, and particularly the authors of the many fine papers presented are deeply appreciated. These people are congratulated for a job well done.

There was a total of 227 participants at this Symposium, including 51 from foreign countries. Thirty-three states within the U.S. and 15 foreign countries were represented. To facilitate further communication among participants of the Symposium and others who may wish to contact various authors or participants, we have included a list of the session chairmen, authors, and other participants on pages 711 through 723.

Copies of these proceedings are available from Purdue University, from the American Society of Photogrammetry, or from the IEEE. The addresses of these organizations are shown at the beginning of the proceedings.

Roger M. Hoffer and Richard P. Mroczynski
Symposium Co-Chairmen

SYMPOSIUM CO-CHAIRMAN

ROGER M. HOFFER

Program Leader of the Ecosystems Research Programs, LARS, and Professor of Forestry, Department of Forestry and Natural Resources, Purdue University.

B.S. in Forestry from Michigan State University; M.S. and Ph.D. in Watershed Management from Colorado State University. Dr. Hoffer has been involved full-time in remote sensing research and teaching since 1974, and was a co-founder of LARS in 1966. He teaches three different courses on Remote Sensing of Natural Resources and has served as a principal investigator on Landsat, Skylab, and several other major remote sensing projects.

Professor Hoffer is author or co-author of more than 120 scientific publications and papers on remote sensing. He has presented invited papers at international meetings throughout the world and spent several weeks as a remote sensing specialist in Brazil, Thailand, Afghanistan, and Bolivia. He has been a consultant to several national and international agencies and has served on numerous technical panels at the request of NASA.

Dr. Hoffer is a member of the Society of American Foresters, American Society of Photogrammetry (where he has served as the Associate Editor of Photogrammetric Engineering and Remote Sensing and as Director of the Remote Sensing and Interpretation Division), Sigma Xi, Xi Sigma Pi, and several other professional and honorary societies. He received the 1978 Alan Gordon Memorial Award in recognition of his pioneering work in the field of remote sensing, is a Certified Photogrammetrist, and is listed in American Men and Women in Science.

RICHARD P. MROCZYNSKI

Associate Program Leader for Ecosystem Research Programs, LARS

B.S.F. in Forest Production and M.S. in Forestry, University of Illinois. Richard P. Mroczynski joined LARS in 1969 and has been involved with photointerpretation and Landsat Analysis.

Richard has been principal investigator and manager of a number of projects which involved the inventory of natural resources. Significant among these have been projects with: NASA and the St. Regis Paper Company involving the development of a Forest Resource Information System; Ducks Unlimited (Canada) for a Waterfowl Habitat Inventory over 200,000 square miles in Canada; and a Derelict Land Survey for the Indiana Division of Reclamation.

He is a member of the Society of American Foresters, active in that organization's Working Group on Photogrammetry and Remote Sensing. In addition, he has served in various capacities with the American Society of Photogrammetry and is a member of the American Forestry Association and the American Management Association.

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ACKNOWLEDGEMENTS

THE CO-CHAIRMEN WOULD LIKE TO TAKE THIS OPPORTUNITY TO EXTEND A SPECIAL THANKS TO THE FOLLOWING COMMITTEE MEMBERS WITHOUT WHOSE EFFORTS AND COOPERATION THE SYMPOSIUM WOULD NOT HAVE BEEN POSSIBLE.

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Opening Plenary

Meeting Forest Information Needs Through Remote Sensing: What is the State-of-the-Art?

SESSION CHAIRMAN: Mason C. Carter

Dr. Mason C. Carter, Professor and Head of Department, Forestry and Natural Resources at Purdue University. Dr. Carter received a B.S. degree in Forestry from Virginia Polytechnic Institute in 1955, and a M.S. degree in Plant Physiology from that Institution in 1957. He then attended Duke Univ. receiving the doctoral degree in tree physiology in 1959. Dr. Carter was then employed as a research forester, Southeastern Forest Experiment Station, Macon, Georgia, serving as a project leader in tree seed research. Dr. Carter joined the faculty at Auburn Univ. from 1960-1973 as associate professor, held a joint appointment in Botany and Microbiology; he was made Alumni Professor in 1969. Dr. Carter taught plant physiology and conducted an extensive research program in herbicide physiology. He assumed his present position in 1973. Dr. Carter is author or co-author of 64 scientific articles appearing in professional journals, and since coming to Purdue, has chaired or served on numerous professional committees. Presently he is a member of the SAF Committee on Accreditation, and a member of the American Forest Institute, Forest Industries Council, Industry Executives/Forestry Deans Committee. He is also a consulting member of International Paper Company's Forest Research Council.

I A
Effective Techniques for Classifying Forest Cover

SESSION CHAIRMAN: Roger M. Hoffer

Roger M. Hoffer is Professor of Forestry and Leader of Ecosystems Research Programs, LARS, Purdue University. B.S. in Forestry, Michigan State University; M.S. and Ph.D. in Watershed Management, Colorado State University. Co-founder of LARS in 1966, Dr. Hoffer currently teaches three courses in Remote Sensing of Natural Resources. He has lectured consulted, and participated in remote sensing activities in many countries throughout North and South America, Asia, and Europe; has served as a principal investigator on Landsat, Skylab, and other major remote sensing projects, and has authored over 125 scientific papers and publications on remote sensing. Professor Hoffer's research has focused on the use and refinement of computer-aided analysis techniques for forestry applications, and on the study of the spectral characteristics of earth surface features.

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Agronomic Applications of Remote Sensing

SESSION CHAIRMAN: Craig Daughtry

Craig Daughtry is a research agronomist with the Laboratory for Applications of Remote Sensing at Purdue University. He has B.S. and M.S. degrees in agronomy and a Ph.D in crop physiology from Purdue University. Dr. Daughtry has actively participated in design, implementation, and analysis of crop inventory research at LARS. He is a member of the American Society of Agronomy, Crop Science Society of America, American Society of Photogrammetry and several honorary societies.

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II A
Classification Accuracy Assessment Procedures

SESSION CHAIRMAN: David G. Goodenough

David George Goodenough is a senior research scientist at the Canada Centre for Remote Sensing of Energy, Mines and Resources Canada. He is Head of the Methodology Section which is concerned with the physics, pattern recognition, systems development, and engineering of systems and spectroscopic laboratories for remote sensing data analysis. He is a member of several national committees concerned with remote sensing and space science and is the author of more than 34 technical publications.

Goodenough is an active member of the IEEE, the Canadian Remote Sensing Society, the American Astronomical Society, and the Pattern Recogniation Society. He is a non-resident professor in the Department of Electrical Engineering of the University of Ottawa and an Adjunct Professor in the Centre for Research in Experimental Space Science of York University.

II B
Geologic Applications of Remote Sensing

SESSION CHAIRMAN: William D. Di Paolo

William D. Di Paolo received his B.S. and M.S. in Geology from Northern Illinois University. After a few years as a geologist in industry in Illinois he joined USGS as a geologist in Flagstaff, Arizona. While there he did additional graduate work in geophysics and geochemistry at Arizona State University.

In 1974 Mr. Di Paolo joined BLM as District Geologist in the Winnemucca District office in Nevada. He has also been district geologist in the Phoenix District, and is a Registered Professional Geologist in Arizona. He spent a year as a Visiting Scientist with Purdue University's LARS and is currently with the Remote Sensing branch of BLM in Denver where he has been since 1979 working on projects in Idaho and Arizona.

II C
Preprocessing and Systems

SESSION CHAIRMAN: Frederic C. Billingsley

Frederic C. Billingsley has had over 30 years experience in electrical engineering following his receipt of three degrees from Rensselaer Polytechnic Institute, Troy, New York. Joining the Jet Propulsion Laboratory in 1962, Mr. Billingsley has been a Group Supervisor responsible for the development of the Image Processing Laboratory and the VICAR image processing systems. Subsequently, he (along with N. Bryant) defined the Land Use Management System, which has evolved into IBIS. Currently he is a member of the technical staff concerned with the development of future generation sensors using area array detectors. He is a senior member of IEEE and is an Associate Editor for the Computer Graphics and Image Processing Journal.

III A
Special Reports Focused on Two Recent National Workshops

PART I

SESSION CHAIRMAN: David G. Goodenough

David George Goodenough is a senior research scientist at the Canada Centre for Remote Sensing of Energy, Mines and Resources Canada. He is Head of the Methodology Section which is concerned with the physics, pattern recognition, systems development, and engineering of systems and spectroscopic laboratories for remote sensing data analysis. He is a member of several national committees concerned with remote sensing and space science and is the author of more than 34 technical publications.

Goodenough is an active member of the IEEE, the Canadian Remote Sensing Society, the American Astronomical Society, and the Pattern Recognition Society. He is a non-resident professor in the Department of Electrical Engineering of the University of Ottawa and an Adjunct Professor in the Centre for Research in Experimental Space Science of York University.

PART II

SESSION CHAIRMAN: Shirley M. Davis

Shirley M. Davis is Senior Education and Training Specialist at LARS. She is responsible for the design and development of educational materials and courses in the field of remote sensing. Ms. Davis' formal education in English literature (A.B. with Honors, Sweet Briar College; M.A. Western Reserve University) was augmented by experience as a teacher and training director before her employment at LARS in 1971. There she has served as editor, remote sensing data analyst, writer, instructor and instructional developer of courses and of educational material in print and electronic media. She is currently principal investigator on three technology transfer contracts. Since 1977, she has been a consultant in Instructional Development for the International Institute for Aerial Survey and the Earth Science (ITC), The Netherlands. She is a member of the American Society of Photogrammetry, Society for Technical Communications, the Remote Sensing Society (England), and Women in Communications.

III B
Wetlands and Water Resources Assessment

SESSION CHAIRMAN: C. Lisette Dottavio

Education: Ph.D., Dept. of Forestry
Purdue University
Work under Roger Hoffer
Research: Remote Sensing of Natural Resources

M.A., Dept. of Geography
University of Colorado

Employment: NASA/Goddard Space Flight Center
Earth Resources Branch
Job Title: Environmental Physical Scientist
Project Coordinator for Forestry Applications
Pilot Test which examines the utility of Landsat MSS for gypsy moth defoliation assessment.

III C
Image Data Modeling and Analysis

SESSION CHAIRMAN: Philip H. Swain

Philip H. Swain is associate professor of electrical engineering, Purdue University and Program Leader for Data Processing and Analysis Research at the University's Laboratory for Applications of Remote Sensing (LARS). B.S.E.E., Lehigh University; M.S.E.E. and Ph.D., Purdue University. Prof. Swain has been affiliated with LARS since 1966 and has contributed extensively to the development of data processing methods for the management and analysis of remote sensing data. His areas of specialization include theoretical and applied pattern recognition and methods of artificial intelligence. He is co-editor and contributing author for the textbook, Remote Sensing: The Quantitative Approach, (McGraw-Hill, 1978).

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IV A
Understanding and Characterizing the Forest Scene

SESSION CHAIRMAN: Frank G. Sadowski

Frank Sadowski is Senior Applications Scientist in Biosciences at the EROS Data Center in Sioux Falls. His principal duties include the research, design and implementation of cooperative demonstration projects and instruction in EDC-sponsored courses. Prior to coming to EDC, Mr. Sadowski was a Research Scientist with the Environmental Research Institute of Michigan for 10 years. Mr. Sadowski received his B.S. degree in Forestry from the University of Missouri in 1966 and his M.S. degree in Remote Sensing from the University of Michigan in 1974.

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IV B
Rangeland and Land Use Applications of Remote Sensing

SESSION CHAIRMAN: Richard A. Weismiller

Richard A. Weismiller is Program Leader for the Earth Sciences Research Program Area at LARS. B.S., Agronomy, with Highest Distinction, Purdue University; M.S., Soil Mineralogy, Purdue University; Ph.D., Soil Chemistry-Clay Mineralogy, Michigan State University. He joined LARS in 1973 after four years in the USAF, serving as a research scientist, Civil Engineering Research Division, Air Force Weapons Laboratory, Kirtland AFB, New Mexico. During May 1974-July 1980 Dr. Weismiller served as Associate Program Leader for Earth Sciences Research at LARS. He is a member of Phi ETA Sigma, Alpha Zeta, and Sigma Xi honoraries, the Soil Science and Clay Minerals Society, and the Soil Conservation Society of America. He is also listed in American Men and Women in Science. His publications are in the areas of remote sensing as related to soils and land use and infrared spectroscopy studies of clay minerals.

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IV C
Remote Sensing and Georeference Information Systems

SESSION CHAIRMAN: Nevin A. Bryant

Nevin A. Bryant is responsible for the conceptualization and applications of geographic information systems based on digital image processing technology and the use of remotely sensed imagery at the Jet Propulsion Laboratory's Image Processing Laboratory.

Dr. Bryant received his B.A. degree from McGill University in Honours Geography; his M.A. degree from the University of Hawaii in Geography, and his Ph.D. from the University of Michigan.

Dr. Bryant has conducted field research in Western Samoa and Java, Indonesia related to the interaction between population growth and regional economics and has more recently undertaken projects related to vegetation and land use mapping. His present interest include data reduction and interpretation of satellite imagery, geographic information systems, and regional economic modelling with particular emphasis on metropolitan areas.

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V A
Forest Resource Information Through Remote Sensing

SESSION CHAIRMAN: G. Robinson Barker

G. Robinson Barker received his A.B. degree in History from Middlebury College in Vermont after serving four years in the Navy as a hurricane hunter. Following receipt of his M.F. degree in Management and Silvaculture from Yale, he joined St. Regis in Pensacola, Florida. After a few years work on forest inventory at the divisional level he became Operations Research Forester converting inventory to a computer based system. This lead to the position of Assistant Manager for Technical Forestry with complete responsibility for automated divisional information systems, including inventory. His accepted proposal to NASA of using Landsat as data source in forestry was then demonstrated to be feasible and he was appointed as Manager Forest Resource Information Systems for St. Regis Paper Company.

V B
Remote Sensing and Georeference Information Systems Continued

SESSION CHAIRMAN: Nevin A. Bryant

Nevin A. Bryant is responsible for the conceptualization and applications of geographic information systems based on digital image processing technology and the use of remotely sensed imagery at the Jet Propulsion Laboratory's Image Processing Laboratory.

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Closing Plenary

Monitoring the World's Forest Resources: Today and Tomorrow

SESSION CHAIRMAN: Bernard J. Liska

Education: B.S., 1953; M.S. 1955; Ph.D., 1957 in Dairy and Food Science from the University of Wisconsin

Employment:

1957-1959	Asst. Prof. Dairy Science, University of Florida
1959-1962	Asst. Prof. of Food Sciences, Purdue University
1962-1965	Assoc. Prof. of Food Sciences, Purdue University
1965-1975	Prof. of Food Science, Purdue
1967-1975	Director, Food Sciences Institute
1972-1975	Assoc. Director, Purdue Ag. Experiment Station
1975-1980	Director, Ag. Experiment Station
1980	Dean of Agriculture, Purdue

Main Interests: Teaching and research in food bacteriology and chemical residues in foods.

Memberships: Sigma Xi, American Dairy Science Association, International Assoc. of Milk and Food Sanitarians, American Chemical Society, Institute of Food Technologists, American Assoc. for the Advancement of Science.

Publications: Approximately 90 publications in foods area in scientific and technical journals. Scientific Editor of the Journal of Food Science 1971-1981.

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Poster Paper Session

SESSION CHAIRMAN: Douglas B. Morrison

Douglas B. Morrison received his B.S. degree from Montana State and his M.A. in Speech from the University of Washington, following three years in the service with U.S. Air Corps as a navigator. Additional graduate work was taken at Northwestern University and Purdue University.

After several years of personnel work with industry, Doug returned to education starting at Purdue in 1969. He began at LARS in June of 1974 with the new (at that time) Technology Transfer Program Area and has been Training Coordinator under that program since.

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I.A. Effective Techniques for Classifying Forest Cover

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I.B. Agronomic Applications of Remote Sensing

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III.A. Special Reports Focused on Two Recent National Workshops

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III.B. Wetlands and Water Resources Assessment

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III.C. Image Data Modeling and Analysis

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IV.A. Understanding and Characterizing the Forest Scene

Frank Sadowski
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IV.B. Rangeland and Land Use Applications of Remote Sensing

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IV.C. Remote Sensing and Georeference Information Systems

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V.A. Forest Resource Information Through Remote Sensing

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V.B. Remote Sensing and Georeference Information Systems

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