PROCEEDINGS
of the
NINTH INTERNATIONAL SYMPOSIUM
ON
REMOTE SENSING
OF
ENVIRONMENT

Volume 1

107000-1-X

Volume I

PROCEEDINGS of the NINTH INTERNATIONAL SYMPOSIUM ON REMOTE SENSING OF ENVIRONMENT

15 - 19 April 1974

Conducted by

Center for Remote Sensing Information and Analysis
Environmental Research Institute of Michigan

in cooperation with

The University of Michigan
Extension Service

Sponsored by

Willow Run Laboratories
Environmental Research Institute of Michigan

Institute of Science and Technology
The University of Michigan

Office of Applications
National Aeronautics and Space Administration

Federal Highway Administration
U. S. Department of Transportation

U. S. Geological Survey
U. S. Department of the Interior

U. S. Coast Guard
U. S. Department of Transportation

Division of Water Control Planning
Tennessee Valley Authority

U. S. Department of Agriculture

NAC Incorporated
Tokyo, Japan

Office of Research and Development
and
Office of Water Program Operations
U. S. Environmental Protection Agency

National Oceanic and Atmospheric Administration
U. S. Department of Commerce

Office of Scientific Research
U. S. Air Force

Willow Run Laboratories
ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
Ann Arbor, Michigan

PROGRAM COMMITTEE

Jerald J. Cook, Chairman
Environmental Research Institute of Michigan

R. H. Alexander, U. S. Geological Survey

J. S. Bailey, Office of Naval Research

W. H. Bailey, McLean, Virginia

L. R. Breslau, U. S. Coast Guard

A. J. Calio, National Aeronautics & Space Administration

W. O. Davis, National Oceanic & Atmospheric Administration

J. D. Herold, The University of Michigan

R. F. Holmes, Environmental Protection Agency

M. R. Holter, Environmental Research Institute of Michigan

R. H. Miller, U. S. Department of Agriculture

V. E. Noble, Naval Research Laboratory

A. B. Park, Earth Satellite Corporation

H. Rib, Federal Highway Administration

E. M. Risley, U. S. Geological Survey

J. E. Sater, Arctic Institute of North America

A. R. Stevens, Tennessee Valley Authority

J. C. Wilkerson, U. S. Naval Oceanographic Office

R. S. Williams, Jr., U. S. Geological Survey

G. J. Zissis, Environmental Research Institute of Michigan

PROGRAM

MONDAY APRIL 15

Registration, Rackham Lobby

Welcome and Introduction
M. R. HOLTER, Executive Vice President, Environmental Research Institute of Michigan, Ann Arbor, Michigan

SESSION 1
(Rackham Lecture Hall)

Chairman: HANS DOLEZALEK, Office of Naval Research, Arlington, Virginia

Some Features of the Urban Environment of Tokyo by Remote Sensing
IWAO TSUCHIYA, Meteorological Research Institute, Tokyo, Japan

Estimation of Population Density in Tokyo Districts from ERTS-1 Data
SHUNJI MURAI, Institute of Industrial Science, University of Tokyo, Tokyo, Japan

An Examination of the Extent of Fire in the Grassland and Savanna of Africa Along the Southern Side of the Sahara
WALTER DESHLER, University of Maryland, College Park, Maryland

Environmental Studies of Iceland with ERTS-1 Imagery
RICHARD S. WILLIAMS, JR., U. S. Geological Survey, EROS Program, Reston, Virginia; ÁGÚST BÖÖVARSSON, Icelandic Surveying Department; STURLA FRIÐRIKSSON, Agricultural Research Institute; GUOMUNDUR PÁLMASON, National Energy Authority; SIGURJÓN RIST, National Energy Authority; HLYNUR SIGTRYGGSSON, Icelandic Meteorological Service; KRISTJÁN SAEMUNDSSON, National Energy Authority; SIGURÖUR THORARINSSON, University of Iceland; INGVI THORSTEINSSON, Agricultural Research Institute; Reykjavík, Iceland

A Method of Specifying Remotely Sensed Units for Soil Sample Points
G. A. MAY, G. W. PETERSEN, F. Y. BORDEN and D. N. APPLEGATE, The Pennsylvania State University, University Park, Pennsylvania

Computer Recognition of Aerial Multispectral Photography Using Optical Density of Object
YOSHIZUMI YASUDA and YASUFUMI EMORI, Institute of Color Technology, Chiba University, Japan

Geologic Interpretation of ERTS-1 Satellite Images for Aswan Area, Egypt
E. M. EL SHAZLY and M. A. ABDEL-HADY, Academy of Scientific Research and Technology; M. A. EL GHAWABY and I. A. EL KASSAS, Atomic Energy Establishment, Cairo, Egypt

Classification and Mapping of Coal Refuse, Vegetation Cover Types, and Forest Types by Digital Processing ERTS-1 Data
F. Y. BORDEN, B. F. MEREMBECK, D. N. THOMPSON, B. J. TURNER and D. L. WILLIAMS, The Pennsylvania State University, University Park, Pennsylvania

Transference of ERTS-1 Spectral Signatures in Time and Space
B. F. MEREMBECK, F. Y. BORDEN and D. N. APPLEGATE, The Pennsylvania State University, University Park, Pennsylvania

A Remote Sensing Study of Pacific Hurrican Ava
D. ROSS, National Oceanic and Atmospheric Administration, Miami, Florida; B. AU, Naval Research Laboratory, Washington, D. C.; W. BROWN, Jet Propulsion Laboratory, Pasadena, California; and J. MCFADDEN, National Oceanic and Atmospheric Administration, Miami, Florida

A Clustering Algorithm for Unsupervised Crop Classification
L. BORRIELLO, CSATA, Bari, Italy and F. CAPOZZA, TELESPAZIO, Rome, Italy

BREAK

SESSION 2
(Rackham Lecture Hall)

Chairman: HAROLD RIB, Federal Highway Administration, Washington, D. C.

Simultaneous Active and Passive Microwave Response of the Earth - The Skylab Radscat Experiment
R. K. MOORE, J. P. CLAASSEN, A. C. COOK, D. L. FAYMAN, J. C. HOLTZMAN, A. SOBTI, W. E. SPENCER, F. T. ULABY and J. D. YOUNG, The University of Kansas Remote Sensing Laboratory, Lawrence, Kansas and W. J. PIERSON, V. J. CARDONE, J. HAYES and W. SPRING, City University of New York Institute of Oceanography, Bronx, New York and R. J. KERN, General Electric Valley Forge Space Center, Philadelphia, Pennsylvania and N. M. HATCHER, NASA Johnson Space Center, Houston, Texas

Feasibility of Using Multiplex Slar Imagery for Water Resource Management and Mapping Vegetation Communities
ROBERT A. SHUCHMAN and BEN DRAKE, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Extraction of Urban Land Cover Data from Multiplexed Synthetic Aperture Radar Imagery
M. LEONARD BRYAN, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Land-Use Planning Aided by Computer Cellular Modelling/Mapping System to Combine Remote Sensing, Natural Resources, Social, Economic, and Cadastral Data
HARRY W. SMEDES, U. S. Geological Survey, GEORGE NEZ and LARRY SALMEN, Federation of Rocky Mountain States, Denver, Colorado; KEITH TURNER, Colorado School of Mines, Golden, Colorado; and EDWIN LUTZEN, Missouri Geological Survey, Rolla, Missouri

SESSION 3
(Rackham Amphitheater)

Chairman: JOHN E. SATER, Arctic Institute of North America, Washington, D. C.

Signatures of Various Earth Surfaces Measured by the Nimbus-5 Microwave Spectrometer
K. F. KUNZI, R. L. PETTYJOHN and D. H. STAELIN, Massachusetts Institute of Technology, Cambridge, Massachusetts; and J. W. WATERS, Jet Propulsion Laboratory, Pasadena, California

A Study of Microwave Emission Properties of Sea Ice - Aidjex 1972
D. C. MEEKS, Aerojet ElectroSystems Company, Azusa, California; R. O. RAMSEIER, Department of the Environment, Ottawa, Ontario, Canada; and W. J. CAMPBELL, U. S. Geological Survey, Tacoma, Washington

Investigation of Radar Discrimination of Sea Ice
S. K. PARASHAR, A. W. BIGGS, A. K. FUNG and R. K. MOORE, University of Kansas Center for Research, Lawrence, Kansas

Areal Extent of Snow in Forested Regions: A Practical Estimation Technique Using ERTS-1 Data
WILLIAM C. DRAEGER and DONALD T. LAUER, School of Forestry and Conservation, University of California, Berkeley, California

ERTS Applications in Thailand, A Progress Report
PRAYONG ANGSUWATANA, Department of Mineral Resources; CHUMNI BOONYOBHAS, BOONCHANA KLANKAMSORN, Royal Forestry Department; JOSEPH MORGAN, U. S. Geological Survey; MANU OMAKUPT and STAFF, Land Development Department; PONGPIT PIYAPONGSE, Department of Agriculture; and KHID SUVARNASUDDHI, SUVIT VIBULSRESTH, Applied Scientific Research Corporation, Thailand

Passive Microwave Sensing of Moist Soils
A. E. BASHARINOV, L. F. BORODIN, A. M. SHUTKO, Academy of Sciences of the USSR, Moscow, USSR

Interpretation of the Deep Structure of Epiplatform Mountain Country on Space Photographs
V. I. MAKAROV, Geological Institute of the USSR Academy of Sciences, Moscow, USSR

The Deep Structure of the Tajic Depression on Space Images of Different Scale
S. F. SKOBELEV, Geological Institute of the USSR Academy of Sciences and YU. K. SHCHUKIN, VNII Geophysica, Moscow, USSR

The Progress of Investigations in the USSR on the Use of Radar Imagery for Geological Purposes
V. B. KOMAROV, V. A. STAROSTIN and B. P. NYAVRO, Ministry of Geology of the USSR, Leningrad, USSR

TUESDAY APRIL 16

SESSION 4
(Rackham Amphitheater)

Chairman: BERNARD ZAVOS, National Oceanic and Atmospheric Administration, Rockville, MD.

Remote Measurement of Atmospheric Temperatures by Raman Lidar
THOM A. CONEY and JACK A. SALZMAN, NASA, Lewis Research Center, Cleveland, Ohio

Optical Crosswind Measurement Techniques
ERICK T. YOUNG and THOMAS H. PRIES, Atmospheric Sciences Laboratory, U. S. Army Electronics Command, White Sands Missile Range, New Mexico

On the Detectability of Atmospheric Carbon Monoxide by Microwave Remote Sensing
J. FULDE and E. SCHANDA, Institute of Applied Physics, University of Berne, Berne, Switzerland

Determination of the Aerosol Content in the Atmosphere from ERTS-1 Data
M. GRIGGS, Science Applications, Inc., LaJolla, California

The Effect of Atmospheric Water Vapor on Automatic Classification of ERTS Data
DAVID E. PITTS, WILLIAM E. McALLUM, NASA Johnson Space Center and ALYCE E. DILLINGER, Lockheed Electronics Company, Houston, Texas

On the Natural Limitations of Target Differentiation by Means of Spectral Discrimination Techniques
M. J. DUGGIN, CSIRO Minerals Research Laboratories, North Ryde, New South Wales, Australia

BREAK

SESSION 5
(Rackham Lecture Hall)

Chairman: ROBERT H. ALEXANDER, U. S. Geological Survey, Washington, D. C.

Design Concepts for Land Use and Natural Resource Inventories and Information Systems
RONALD L. SHELTON, Department of Resource Development, Michigan State University, East Lansing, Michigan and ERNEST E. HARDY, Department of Natural Resources, Cornell University, Ithaca, New York

Interactive Computer Processing for Land Use Planning
E. EARLE NELSON, Earth Information Services, McDonnell Douglas Corporation, Huntington Beach, California

Use of ERTS-1 Imagery for Land Evaluation in Pennington County, South Dakota
C. J. FRAZEE, P. H. RAHN, F. C. WESTIN and V. I. MYERS, South Dakota State University, Brookings, South Dakota and South Dakota School of Mines and Technology, Rapid City, South Dakota

Some Findings on the Applications of ERTS and Skylab Imagery for Metropolitan Land Use Analysis
VALERIE A. MILAZZO, Geographic Applications Program, U. S. Geological Survey, Reston, Virginia

The Role of ERTS-1 Processed Data for Transportation Planning in Michigan
RICHARD E. ESCH, Michigan Department of State Highways and Transportation, East Lansing, Michigan and BUZZ SELLMAN, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Land Type Analysis for Regional Land Use Planning From Photomorphic Mapping: An Example for Boulder County, Colorado
JANET E. NICHOL, University of Aston, Birmingham, England

Sahelien Arid Zone Rehabilitation and Development Programming Using ERTS and Skylab Imagery as a Data Base
N. H. MACLEOD, J. S. SCHUBERT and R. FANALE, The American University, Washington, D. C. and Goddard Space Flight Center, Greenbelt, Maryland

BREAK

Keynote Address: Importance of Remote Sensing Technology to the International Community and in Particular to the Third World
Dr. GARNET A. BROWN, Ministry of Mining and Natural Resources, Kingston, Jamaica

SESSION 6
(Rackham Amphitheater)

Chairman: ROBERT F. HOLMES, Environmental Protection Agency, Warrenton, Virginia

Flood Inundation in the Southeastern United States from Aircraft and Satellite Imagery
GERALD K. MOORE and GARY W. NORTH, U. S. Geological Survey, Bay St. Louis, Mississippi

Mapping of the 1973 Mississippi River Floods by the NOAA-2 Satellite
D. R. WIESNET, D. F. McGINNIS and J. A. PRITCHARD, U. S. Department of Commerce, NOAA, National Environmental Satellite Service, Hillcrest Heights, Maryland

A Hydrogeomorphic Approach to Evaluating Flood Potential in Central Texas from Orbital and Suborbital Remote Sensing Imagery
VICTOR R. BAKER, Department of Geological Sciences; ROBERT K. HOLZ, Department of Geography; STEVEN D. HULKE, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas

Investigation of the Effects of Construction and Stage Filling of Reservoirs on the Environment and Ecology
R. E. RIGGINS, H. E. BALBACH and R. K. JAIN, U. S. Army Corps of Engineers, Construction Engineering Research Laboratory, Champaign, Illinois

Application of Remote Sensing to the Location of Hydrologically Active (Source) Areas
ACHI M. ISHAQ and DALE D. HUFF, Department of Civil and Environmental Engineering, The University of Wisconsin, Madison, Wisconsin

The Use of Remote Sensing and Natural Indicators to Delineate Floodplains - Preliminary Findings
S. C. SCOLLERS, Office, Chief of Engineers, Washington, D. C., and G. W. PETERSEN, D. L. HENNINGER and F. Y. BORDEN, The Pennsylvania State University, University Park, Pennsylvania

BREAK

Evaluation of ERTS-1 and Aircraft Data for Assessing Internal Drainage in Irrigated Agriculture
DENNIS W. RYLAND, FRED A. SCHMER and DONALD G. MOORE, Remote Sensing Institute, South Dakota State University, Brookings, South Dakota; and WILLIAM A. LIDSTER, United States Bureau of Reclamation, Denver, Colorado

Use of Visible, Near-Infrared, and Thermal Infrared Remote Sensing to Study Soil Moisture
M. B. BLANCHARD, Ames Research Center, NASA, Moffett Field, California, RONALD GREELEY, University of Santa Clara, California; and ROBERT GOETTELMAN, LFE Corporation, Richmond, California

Moisture Detection from Skylab
JOE R. EAGLEMAN, University of Kansas, Lawrence, Kansas

Remote Detection of Soil Surface Moisture
E. H. STOCKHOFF and R. T. FROST, General Electric Space Sciences Laboratory, Philadelphia, Pennsylvania

On the Feasibility of Remote Monitoring of Soil Moisture with Microwave Sensors
R. W. NEWTON, S. L. LEE and J. W. ROUSE, JR., Remote Sensing Center, Texas A&M University, College Station, Texas; and J. F. PARIS, Lockheed Electronics Company, Houston, Texas

Operational Use of Satellite and High Altitude Remote Sensing for the Generation of Input Data for Water Demand Models
LARRY R. TINNEY, JOHN E. ESTES, KONAI H. THAMAN and RANDOLPH R. THAMAN, Geography Remote Sensing Unit, University of California, Santa Barbara, California

SESSION 7
(Rackham Lecture Hall)

Chairman: GEORGE J. ZISSIS, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Interactive Machine Assessment of Critical Land Resources Using ERTS-1 Data
WILLIAM W. KUHLOW and LAWRENCE T. FISHER, The University of Wisconsin, Madison, Wisconsin

An Automated and Repeatable Data Analysis Procedure for Remote Sensing Applications
B. J. DAVIS and P. H. SWAIN, LARS, Purdue University, West Lafayette, Indiana

New Application of Remotely Sensed Data Processing Technique
T. SAKATA and H. SHIMODA, Department of Electro-Photo-Optics, Tokai University, Hiratsuka Kanagawa, Japan

Adaptive Processing of Multispectral Scanner Data Using a Decision-Directed Kalman Filter
ROBERT B. CRANE, Environmental Research Institute of Michigan, Ann Arbor, Michigan

An Improved Version of the Table Look-Up Algorithm for Pattern Recognition
W. G. EPPLER, Lockheed Electronics Company, Houston, Texas

Implementation of an Advanced Table Look-up Classifier for Large Area Land-Use Classification
CLAY JONES, JSC, Earth Resources Laboratory, NASA, Bay St. Louis, Mississippi

Modifications in a Computer-Implemented Method for the Detection and Extraction of Objects in Aerial Photographs
S. KLAUSNER and D. KARMELI, Technion, Israel Institute of Technology, Haifa, Israel

Automatic Data Processing for Non-Mathematicians
G. PRESTON, Remote Sensing Unit, University of Aston, Birmingham, England

BREAK

Digital Image Correction and Information Extraction
RALPH BERNSTEIN, IBM Corporation, Gaithersburg, Maryland

SICLOPS: A System of Computer Programs for Rectified Mapping of Airborne Scanner Imagery
M. M. SPENCER, J. M. WOLF and M. A. SCHALL, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Effect of Atmospheric Haze and Sun Angle on Automatic Classification of ERTS-1 Data
J. POTTER, R. HILL and M. SHELTON, Lockheed Electronics Company, Houston, Texas

Skylab S-192 Ratio Codes of Soil, Mineral, and Rock Spectra for Ratio Image Selection and Interpretation
R. K. VINCENT and W. W. PILLARS, Environmental Research Institute of Michigan, Ann Arbor, Michigan

STANSORT: Stanford Remote Sensing Laboratory Pattern Recognition and Classification System
F. R. HONEY, A. PRELAT and R. J. P. LYON, School of Earth Sciences, Stanford University, Stanford, California

WEDNESDAY APRIL 17

SESSION 8
(Rackham Lecture Hall)

Chairman: VINCENT E. NOBLE, U. S. Naval Research Laboratory, Washington, D.C.

Extensive Summer Upwelling on Lake Michigan During 1973 Observed by NOAA-2 and ERTS-1 Satellites
ALAN E. STRONG, HARRY G. STUMPF, JULIA L. HART and JOHN A. PRITCHARD, U. S. Department of Commerce, NOAA, National Environmental Satellite Service, Hillcrest Heights, Maryland

Remote Sensing of Western Lake Superior
KIRBY STORTZ and MICHAEL SYDOR, Lake Superior Basin Studies Center, University of Minnesota, Duluth, Minnesota

Scanning Thermal Plumes
F. L. SCARPACE, R. P. MADDING and T. GREEN III, The University of Wisconsin, Madison, Wisconsin

The Use of Remote Sensing in Limnological Studies
C. T. WEZERNAK, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Automatic Classification of Eutrophication of Inland Lakes from Spacecraft Data
ROBERT H. ROGERS, LARRY E. REED and NAVIN J. SHAH, Bendix Aerospace Systems Division, Ann Arbor, Michigan; and V. ELLIOT SMITH, Cranbrook Institute of Science, Bloomfield Hills, Michigan

BREAK

Correlation of Multispectral Imagery with Water Analysis - The Ross Barnett Reservoir Remote Sensing Project
D. L. WERTZ, W. T. MEALOR, M. L. STEELE and J. W. PINSON, University of Southern Mississippi, Hattiesburg, Mississippi

The Economic Impact of Remote Sensing Data as the Source of Nonpoint Pollution Monitoring and Control
W. L. MILLER, Purdue University, West Lafayette, Indiana

Preliminary Results of Fisheries Investigation Associated with Skylab-3
K. SAVASTANO, E. PASTULA, R., and G. WOODS, National Marine Fisheries Service; and K. FALLER, Earth Resources Laboratory, NASA, Bay St. Louis, Mississippi

Rapid Stock Assessment of Pilchard Populations by Aircraft-Borne Remote Sensors
D. L. CRAM, Sea Fisheries Branch, Cape Town, South Africa

SESSION 9
(Rackham Amphitheater)

Chairman: ROBERT H. MILLER, U. S. Department of Agriculture, Washington, D. C.

Determining Range Conditions and Forage Production Potential in California from ERTS-1 Imagery
DAVID M. CARNEGGIE and STEPHEN D. DEGLORIA, Remote Sensing Research Program, University of California, Berkeley, California

Grass Canopy Bidirectional Spectral Reflectance
JOHN E. COLWELL, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Remote Sensing Applications: Forest Tree Disease Detection and Vegetation Classification Within the Sub-Boreal Forest Region
ROBERT W. DOUGLASS, MERLE P. MEYER and DONALD W. FRENCH, The Pennsylvania State University, Mont Alto, Pennsylvania

Forest Defoliation Assessment with Satellite Imagery
WAYNE G. ROHDE, Earth Satellite Corporation, Washington, D. C. and HARRY J. MOORE, Plant Protection and Quarantine Animal and Plant Health Inspection Service, Hyattsville, Maryland

Spectral Reflectance Studies on Mineral Deficiency in Corn Plants
H. A. YOUNES, Agricultural and Biological Research Division, National Research Center; R. M. ABDEL-AAL, Soils and Water Research Institute, Ministry of Agriculture; M. M. KHODAIR, National Institute of Standards; and A. G. ABDEL-SAMIE, Agricultural and Biological Research Division, National Research Center, Dokki, Giza, Egypt

BREAK

Agricultural Resources Investigations in Southern France and Northern Italy
Authors of the European Communities, of the French Institutes C.E.A.R.N., C.E.S.R., I.N.R.A., S.C.V., and of the Italian Institutes C.A.T.A., E.N.R., I.S.C., I.S.P., I.N.P.L. and L.G.L.

Thermal Behaviour of Some Rice Fields Affected by a Yellows-Type Disease
C. DeCAROLIS and G. BALDI, Rice Research Center, Mortara; S. GALLI, Joint Research Center, Ispra; and G. M. LECHI, GEOLAB, National Italian Research Council, Milano, Italy

First Results From the Crop Identification Technology Assessment for Remote Sensing (CITARS)
F. G. HALL, NASA, JSC, Houston, Texas; M. E. BAUER, LARS, Purdue University, West Lafayette, Indiana; W. A. MALILA, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Vegetation Analysis with ERTS Digital Data: A New Approach
J. S. SCHUBERT, Goddard Space Flight Center, Greenbelt, Maryland and N. H. MACLEOD, The American University, Washington, D. C.

ERTS-1 Data for Classifying Native Plant Communities--Central Colorado
RICHARD S. DRISCOLL and RICHARD E. FRANCIS, U.S.D.A., Forest Service; JAMES A. SMITH and ROY A. MEAD, Colorado State University, Fort Collins, Colorado

SESSION 10
(Rackham Lecture Hall)

Chairman: JOHN C. WILKERSON, U. S. Naval Oceanographic Office, Washington, D.C.

Computer Derived Coastal Water Classifications Via Spectral Signatures
D. K. CLARK, J. B. ZAITZEFF, L. V. STREES and W. S. GLIDDEN, NOAA, National Environmental Satellite Service, Washington, D.C.

Coastal Wetlands Analysis From ERTS MSS Digital Data and Field Spectral Measurements
VIRGINIA CARTER, U. S. Geological Survey, Reston, Virginia; JANE SCHUBERT, Goddard Space Flight Center, Greenbelt, Maryland

California Nearshore Processes, ERTS-1
DAVID D. STELLER, Geoscience Division, Geosource International, Seal Beach, California; and DOUGLAS M. PIRIE, U. S. Army Corps of Engineers, SanFrancisco, California

Surface Currents Along the California Coast Observed on ERTS Imagery
PAUL R. CARLSON, U. S. Geological Survey, Menlo Park, California

Correlation of Coastal Water Turbidity and Current Circulation with ERTS-1 and Skylab Imagery
V. KLEMAS, M. OTLEY, W. PHILPOT and C. WETHE, College of Marine Studies, University of Delaware, Newark, Delaware; and R. ROGERS and N. SHAH, Bendix Aerospace Division, Ann Arbor, Michigan

BREAK

Boundaries of ERTS and Aircraft Data Within Which Useful Water Quality Information can be Obtained
W. G. EGAN, Grumman Aerospace Corporation, Bethpage, New York

Ocean Internal Waves off the North American and African Coasts from ERTS-1
JOHN R. APEL and ROBERT L. CHARNELL, Atlantic Oceanographic and Meteorological Laboratories, NOAA, Miami, Florida; RICHARD J. BLACKWELL, Jet Propulsion Laboratory, Pasadena, California

Detection of Several Sea States Around Japan from Multispectral Scanner Imageries by ERTS-1
KANTARO WATANABE, Tokai University, Shizuoka-ken, Japan

Activities of the Laboratoire de Meteorologie Dynamique (CNRS) Concerning Remote Sensing Techniques and Their Applications to Earth Resources and Environment
F. BECKER and F. SIROU, Centre National de la Recherche Scientifique, Bellevue-Meudon, France

Lake Ontario Water Mass Delineation from ERTS-1
JOHN C. MUNDAY, JR., Department of Geography, University of Toronto, Erindale College, Clarkson, Ontario, Canada

SESSION 11
(Rackham Amphitheater)

Chairman: ROBERT H. MILLER, U. S. Department of Agriculture, Washington, D.C.

Color Terrain Map of Yellowstone National Park, Computer-Derived from ERTS-MSS Data
RALPH R. ROOT, National Park Service, Denver, Colorado; HARRY W. SMEDES, U.S.G.S., Denver, Colorado; NORMAN ROLLER, Environmental Research Institute of Michigan, Ann Arbor, Michigan; DON DESPAIN, National Park Service, Yellowstone Park, Wyoming

Inventories of Delaware's Coastal Vegetation and Land-Use Utilizing Digital Processing of ERTS-1 Imagery
V. KLEMAS and D. BARTLETT, College of Marine Studies, University of Delaware, Newark, Delaware; R. ROGERS and L. REED, Bendix Aerospace Systems Division, Ann Arbor, Michigan

Texture Analysis with Fourier Series
H. MAURER, Department of Geography, University of Zurich, Zurich, Switzerland

On the Survey of Sea Water Pollution of the Seto Inland Sea by ERTS Pictures
JOJI IISAKA, Scientific Center, IBM Japan

Land Use Classification Accuracies and Ground Truth Correlations from Simultaneously Acquired Aircraft and ERTS-1 MSS Data
A. J. RICHARDSON, M. R. GAUTREAUX, R. J. TORLINE and C. L. WIEGAND, U. S. Department of Agriculture, Weslaco, Texas

BREAK

Investigation into the Spectral Signature of Agricultural Crops During Their State of Growth
TH. A. de BOER, Institute for Biological and Chemical Research on Field Crops and Herbage, Wageningen; N.J.J. BUNNIK, H.W.J. van KASTEREN, D. UENK, W. VERHOEF, NIWARS, Delft; G.P. de LOOR, Physisch Laboratorium TNO, The Hague, The Netherlands

Radar Cross Sections of Vegetation Canopies Determined by Monostatic and Bistatic Scatterometry
E.P.W. ATTEMA, L.G. den HOLLANDER, Delft University of Technology, Delft; TH. A. de BOER, D. UENK, Institute for Biological and Chemical Research on Field Crops and Herbage, Wageningen; W.J. ERADUS, G.P. de LOOR, Physics Laboratory TNO, The Hague; H. van KASTEREN, J. van KUILENBURG, NIWARS, Delft, The Netherlands

Photographs from Balloons: Their Use in Agronomy and Management of Environment
C.M. GIRARD-GANNEAU and M.C. GIRARD, Institut National Agronomique, Paris, France

The Interpretation and Use of False-Colour Infra-Red and True Colour Photography of Part of Argentina Obtained by Skylark Earth Resources Rockets
D.S.H. DRENNAN and C.J. BRAY, University of Reading; I.R. GALLOWAY, University of London; J.R. HARDY and C.O. JUSTICE, University of Reading; E.S. OWEN-JONES, University of London, R.A.G. SAVIGEAR and J.R.G. TOWNSHEND, University of Reading, Reading and London, England

Infrared Aerial Photography and Ground Tests of Thermal Structure of Dry Steppe Landscape
B. V. VINOGRADOV, A. A. GRIGORYEV, and V. B. LIPATOV, Institute of Geography of Academy of Science, Moscow, USSR

Some Results of Photography of Agricultural Lands and Crop Fields of Sal Steppe Test Site from Spacecraft Soyuz-9
B. V. VINOGRADOV, V. I. SEVASTYANOV, and E. V. SERDYUKOVA, Institute of Geography of Academy of Science, Moscow, USSR

Methods of Filtering Photoimages and Their Applications to Geological Problems
V. B. KOMAROV and YU. V. UGLEV, Ministry of Geology of the USSR, Leningrad, USSR

SESSION 12
(Rackham Lecture Hall)

Chairman: EDWARD M. RISLEY, U. S. Geological Survey, EROS Program, Reston, Virginia

Review and Appraisal: Cost-Benefit Analyses of Earth Resources Survey Satellite Systems
EVELYN S. PUTNAM and ROMAN KRZYCZKOWSKI, INTERPLAN Corporation, Santa Barbara, California

Use of Results from ERTS-1 Experiments to Evaluate Benefits From Operational Earth Resources Survey Systems
H. THEODORE HEINTZ, JR. and PAUL M. MAUGHAN, Earth Satellite Corporation, Washington, D.C.

Evaluation of ERTS Data Utilization in Developing Countries
E. J. GREENBLAT, ECON, Princeton, New Jersey; D. S. LOWE, Environmental Research Institute of Michigan, Ann Arbor, Michigan; R. A. SUMMERS, System Planning Corporation, Arlington, Virginia

Panel Discussion of Cost-Benefit Evaluation of Satellite Earth Resources Survey Systems

THURSDAY APRIL 18

SESSION 13
(Rackham Lecture Hall)

Chairman: MARVIN R. HOLTER, Environmental Research Institute of Michigan, Ann Arbor, Michigan

A Feasibility Study on a Synthetic Aperture Radar Satellite (SARSAT) for Earth Resources Surveys
C. SKENDEROFF, Thomson-CSF, Velizy Villacoublay, France and J. R. COLDRICK, British Aircraft Corporation, Bristol, England

Investigation of Microwave Hologram Techniques for Application to Earth Resources
R. W. LARSON, R. W. BAYMA, Environmental Research Institute of Michigan; J. E. FERRIS, Radiation Laboratory, The University of Michigan; M. B. EVANS, J. S. ZELENKA and H. W. DOSS, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Range Focused Doppler Spectra (RFD): A Transformation of SAR Signal Film for Radar Scattering Analysis
PHILIP L. JACKSON, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Emissivities and Forward Scattering of Natural and Man-Made Material at Three Millimeter Wavelength
E. SCHANDA and R. HOFER, Institute of Applied Physics, University of Berne, Berne, Switzerland

Deteriorating Effects on 3 MM Wave Passive Imagery
G. SCHAERER and E. SCHANDA, Institute of Applied Physics, University of Berne, Berne, Switzerland

The Usefulness of Imaging Passive Microwave for Rural and Urban Terrain Analysis
D. N. BRUNELLE, J. E. ESTES, M. R. MEL, R. R. THAMAN, F. E. EVANISKO, University of California, Santa Barbara, California; and R. P. MOORE, C. A. HAWTHORNE, J. O. HOOPER, Naval Weapons Center, China Lake, California

BREAK

Microwave Radiometric Characteristics of Snow Covered Terrain
ROBERT P. MOORE and JOHN O. HOOPER, Naval Weapons Center, China Lake, California

Single Flight Stereo Radar Capabilities
GORDON E. CARLSON and GEORGE L. BAIR, University of Missouri, Rolla, Missouri

Electrically Scanning Microwave Radiometers
RAYMOND F. MIX, Aerojet ElectroSystems Company, Azusa, California

Measurement of Sea Surface Currents Using Airborne Doppler Radar and Inertial Navigation Systems
J.F.R. GOWER, Marine Sciences Directorate Environment Canada, Victoria, British Columbia, Canada

Thermal and Multispectral Scanning Within a Broad, Model-Type Interdisciplinary Program on Climate, Land Use and Environmental Protection by the Regional Planning Authority Frankfurt (RPU)
KLAUS VOLGER, Institut for Angewandte Geowissenschaften; ALEXANDER VON HESLER, Regional Planning Authority; HELLA BARTELS, German Federal Weather Service, Frankfurt, Germany

SESSION 14
(Rackham Amphitheater)

Chairman: LLOYD R. BRESLAU, U. S. Coast Guard Research and Development Center, Groton, Connecticut

A Practical Oil Sensor
GUY S. RAMBIE, JR., RAMCO, Irving, Texas

Remote Measurements of Water Pollution with a Lidar Polarimeter
T. C. SHEIVES, J. W. ROUSE, JR., and W. T. MAYO, JR., Remote Sensing Center, Texas A&M University, College Station, Texas

Multi-Spectral Remote Fluorimeter for Detection of Oil Films
H. G. ELDERING and W. A. WEBB, Baird-Atomic, Inc., Bedford, Massachusetts

Development of an Experimental Airborne Laser Remote Sensing System for the Detection and Classification of Oil Spills
J. F. FANTASIA and H. C. INGRAO, DOT/Transportation Systems Center, Cambridge, Massachusetts

Crude and Refined Petroleum Oil Structured Luminescence Signatures Induced by MV Laser or Lamp and Their Remote Sensing Applications
H. GERALD GROSS and MICHIYA MURAMOTO, McDonnell Douglas Astronautics Company, Huntington Beach, California

BREAK

Passive Microwave Sensing of Oil Slicks
JAMES P. HOLLINGER, E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D.C.

Multi-Frequency Radiometric Measurements of Foam and a Mono-Molecular Slick
B. AU, J. KENNEY, L. U. MARTIN, Naval Research Laboratory, Washington, D.C. and D. ROSS, NOAA, Miami, Florida

Oil Slick Detection by X-Band Synthetic Aperture Radar
J. R. KOTLARSKI and H. R. ANDERSON, Hughes Aircraft Company, Culver City, California

Airborne Oil Pollution Surveillance System
A. T. EDGERTON, Aerojet ElectroSystems Company, Azusa, California and G. WOOLEVER, U. S. Coast Guard, Washington, D.C.

SESSION 15
(Rackham Amphitheater)

Chairman: ANTHONY J. CALIO, National Aeronautics and Space Administration, Houston, Texas

Summary of Flight Performance of the Skylab Earth Resources Experiment Package (EREP)
A. E. POTTER, C. K. WILLIAMS, A. L. GRANDFIELD, K. J. DEMEL, M. C. TRICHEL, T. L. BARNETT, R. D. JUDAY, W. E. HENSLEY, N. M. HATCHER and W. E. McALLUM, NASA, JSC, Houston, Texas; J. T. McGOOGAN, NASA Wallops Station, Wallops Island, Virginia; J. C. JONES, Martin Marietta Corp., Denver, Colorado; Q. N. BRANDT, Lockheed Electronics Co., Houston, Texas; J. G. BRAITHWAITE and R. H. McLAUGHLIN, Environmental Research Institute of Michigan, Ann Arbor, Michigan; R. COLLINS, Itek Corp., Lexington, Massachusetts; W. H. PEAKE, Ohio State University, Columbus, Ohio; and R. K. MOORE, University of Kansas, Lawrence, Kansas

An Orbiting Visible/Infrared Spectrometer for Terrestrial, Atmospheric and Oceanographic Applications
G. R. PRUITT, Block Engineering, Inc., Cambridge, Massachusetts

A Motion-Compensated Spatial Scanner
K. S. GORDON and J. R. MILLER, Centre for Research in Experimental Space Science, York University, Toronto, Canada

BREAK

The Remote Raman Spectrometer is a Viable Instrument for Remote Sensing of the Environment
STANLEY M. KLAINER, WILLIAM ARDEN and TOMAS HIRSCHFELD, Block Engineering, Inc., Cambridge, Massachusetts

Geologic Interpretation of Infrared Thermal Images in East Qatrani Area, Western Desert, Egypt
E. M. EL-SHAZLY, Academy of Scientific Research and Technology; M. A. ABDEL-HADY, Oklahoma State University and Academy of Scientific Research and Technology; and M. A. MORSY, Atomic Energy Establishment, Cairo, Egypt

Statistical Separability of Agricultural Cover Types in Subsets of One to Twelve Spectral Channels
R. KUMAR and L. SILVA, LARS, Purdue University, West Lafayette, Indiana

Multi-Aspect Techniques in Remote Sensing
WILLIAM A. MALILA, Environmental Research Institute of Michigan, Ann Arbor, Michigan

SESSION 16
(Rackham Lecture Hall)

Chairman: RICHARD S. WILLIAMS, JR., U. S. Geological Survey, EROS Program, Reston, Virginia

Geothermal Reconnaissance From Quantitative Thermal Infrared Images
KENNETH WATSON, U. S. Geological Survey, Denver, Colorado

Optical Data Processing Analysis of Stream Patterns Exhibited on ERTS-1 Imagery
DWIGHT EGBERT, JAMES McCAULEY, FAWWAZ ULABY, JAMES McNAUGHTON, University of Kansas Center for Research, Inc., Lawrence, Kansas

Remote Sensing of Rock Type in the Visible and Near-Infrared
JOHN W. SALISBURY and GRAHAM R. HUNT, Air Force Cambridge Research Laboratories, L. C. Hanscom Field, Bedford, Massachusetts

Prediction of the Fraunhofer Line Detectivity of Luminescent Materials
R. D. WATSON, U.S.G.S., Denver, Colorado; W. R. HEMPHILL, U.S.G.S., Reston, Virginia; T. D. HESSIN and R. C. BIGELOW, U.S.G.S., Denver, Colorado

Application of Radar Imagery to Environmental Geologic Mapping of Texas
P. JAN CANNON, Bureau of Economic Geology, The University of Texas, Austin, Texas

BREAK

Remote Sensing Techniques Applied to the Study of Italian Volcanic Areas: The Results of the Repetition of the Airborne I. R. Survey Compared to the Previous Data
R. CASSINIS, C. M. MARINO and A. M. TONELLI, University of Milan and C. N. R., Milan, Italy

Surface Compositional Mapping in the Wind River Range and Basin, Wyoming by Multispectral Techniques Applied to ERTS-1 Data
BETTE SALMON and ROBERT VINCENT, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Unsupervised Mapping of Geologic Features and Soils in California
ROBERT DILLMAN and ROBERT VINCENT, Environmental Research Institute of Michigan, Ann Arbor, Michigan

Remote Sensing to Detect the Toxic Effects of Metals on Vegetation for Mineral Exploration
N. P. PRESS, Nigel Press Associates, London, England

Science Considerations for an Orbital Radar Mapping Mission to Venus
DANIEL C. WYCHGRAM, Planetary Geology Lab., Martin Marietta Aerospace, Denver, Colorado

Elements of the Deep Structure of the Earth's Crust on the Space Images of the East Caucasus
V. G. TRIFONOV, Geological Institute of the Academy of Sciences of the USSR, Moscow, USSR

The Use of Space Photos for Search of Oil and Gas Fields
P. V. FLORENSKIY, Geological Institute of the Academy of Sciences of the USSR, I.M. Gubkin's Institute of Oilchemical and Gas Industry, Moscow, USSR

FRIDAY APRIL 19

SESSION 17
(Rackham Lecture Hall

Chairman: A. B. PARK, Earth Satellite Corp., Washington, D.C.

The Remote Sensing Program of the Geological Survey of Alabama
JAMES A. DRAHOVZAL, JACQUES L. G. EMPLAINCOURT, and CHARLES C. WIELCHOWSKY, Geological Survey of Alabama, University, Alabama

Application of ERTS Imagery to Indiana Coal Mining Problems
CHARLES E. WIER and HAROLD C. HUTCHISON, Indiana Geological Survey, Bloomington, Indiana; FRANK J. WOBBER, ORVILLE R. RUSSELL, ROGER V. AMATO and THOMAS N. LESHENDOK, Earth Satellite Corporation, Washington, D.C.

Resource Analysis Applications in Michigan
STEPHEN W. SCHAR and WILLIAM R. ENSLIN, Michigan State University, East Lansing; IRVIN J. SATTINGER, Environmental Research Institute of Michigan, Ann Arbor; JOHN G. ROBINSON, Bureau of Water Management, Michigan Department of Natural Resources Lansing; ROBERT S. FELLOWS, Soil Conservation Service, Lansing; KARL R. HOSFORD, Office of Land Use, Department of Natural Resources, Lansing; and JAN H. RAAD, Bureau of Transportation Planning, Department of State Highways and Transportation, Lansing, Michigan

Applications of Remote Sensing by the State of Nebraska
MARVIN CARLSON, REX PETERSON, RICHARD HOFFMAN, JAMES DREW, DONALD EDWARDS, GARY HERGENRADER, NORMAN ROSENBERG and LESLIE SHEFFIELD, The University of Nebraska; MARION BALL, Nebraska State Department of Water Resources; JAMES BARR, Nebraska State Office of Planning and Programming; GERALD CHAFFIN, Nebraska Game and Parks Commission; GERALD GRAUER, Nebraska State Department of Roads; RAYMOND HARTUNG, Nebraska State Department of Environmental Control; GERALD WALLIN, Nebraska Resources Commission, Lincoln, Nebraska

ABSTRACT

These Proceedings contain papers presented at the Ninth International Symposium on Remote Sensing of Environment, held April 15th through 19th, 1974, on the campus of The University of Michigan. The symposium was conducted by the Center for Remote Sensing Information and Analysis of the Environmental Research Institute of Michigan (formerly The University of Michigan's Willow Run Laboratories) as a part of a continuing program investigating current activities in the field of remote sensing.

Presentations include those on the utilization of this technology by regional governmental units and by federal governmental agencies, as well as various applications in monitoring and managing the earth's resources and man's global environment. Ground-based, airborne, and spaceborne sensor systems and manual and machine-assisted data analysis and interpretation are included.

EDITORIAL NOTE

The papers contained herein are in the order of presentation. Those manuscripts not received in time to meet publication deadlines have been represented by comprehensive summaries wherever possible. An author index and the revised program are included as a supplement to the table of contents.

All illustrative materials are reproduced in black and white unless individual authors elected to provide their own color prints. Readers are requested to contact specific authors where color prints of black and white figures are desired.

Additional copies of these Proceedings may be obtained from:

Center for Remote Sensing Information and Analysis
Environmental Research Institute of Michigan
P. O. Box 618
Ann Arbor, Michigan 48107

REGISTRANTS OF THE NINTH SYMPOSIUM
ON REMOTE SENSING OF ENVIRONMENT

ABDEL-GAWAD, Monem
Science Center
Rockwell International
1049 Camino Dos Rios (POB 1085)
Thousand Oaks, California 91360

ABDEL-HADY, M.
Academy of Scientific Research and Technology
101, Kasr El Eini Street
Cairo, Egypt

ABRAM, Phil
Econ, Inc.
419 North Harrison Street
Princeton, New Jersey 08540

ADAMS, Gary F.
ERIM
Analysis Staff
P. O. Box 618
Ann Arbor, Michigan 48107

AGGARWALA, Rajendra K.
University of Michigan
1543 School of Natural Resources
Ann Arbor, Michigan 48104

ALDRICH, Robert E.
University of Michigan
School of Natural Resources
Ann Arbor, Michigan 48104

ALEXANDER, Robert
P. O. Box 2301
Washington, D. C. 20013

ALSID, Linda
American University-NASA
Biology Department
Massachusetts & Nebraska Aves., N. W.
Washington, D. C. 20016

AMBARUCH, Bob
IBM-FSD - K31
150 Sparkman Drive
Huntsville, Alabama 35805

ANDING, David C.
Science Applications, Inc.
P. O. Box 328
Ann Arbor, Michigan 48107

ANDERSON, William
Earth Satellite Corp.
1747 Pennsylvania Ave., N. W.
Washington, D. C. 20006

ANDRYCZYK, Roman
General Electric
Space Division
P. O. Box 8555
Philadelphia, Pennsylvania 19101

APEL, John R.
NOAA, Environmental Research Labs
Atlantic Oceanographic and Meteorological Labs
15 Rickenbacker Causeway
Miami, Florida 33149

APINIS, John
Ohio State University
1320 Kinnear Road
Columbus, Ohio

ARECCHI, Angelo V.
U. S. Coast Guard
R & D Center
Groton, Connecticut 06340

ASHFORD, D. M.
British Aircraft Corp.
Sounding Rocket Project Office
C. W. Division
Filton, Bristol, England, B599 7AR

ASHTON, Franklin C.
Philco-Ford
1002 Gemini
Houston, Texas 77058

AUSTIN, Thomas W.
University of Michigan
School of Natural Resources
Ann Arbor, Michigan 48104

AWOPETU, Abioye
Nigerian Mission to the United Nations
757 Third Avenue
New York, New York 10017

BACH, Sue
University of Michigan
School of Natural Resources
Ann Arbor, Michigan

BAILEY, W. H.
6611 Georgetown Pike
McLean, Virginia

BAILEY, William
Ambionics, Inc.
Woodward Building, Room 400
Washington, D. C. 20005

BAKER, Neal R.
University of Michigan
School of Natural Resources
Ann Arbor, Michigan 48104

BAKER, Victor R.
University of Texas at Austin
Department of Geological Sciences
Austin, Texas 78712

BALCOM, Scott
University of Michigan
School of Natural Resources
Ann Arbor, Michigan 48104

BALLIET, Jean L.
University of Michigan
School of Natural Resources
Ann Arbor, Michigan 48104

BARR, B. G.
University of Kansas
Space Tech. Center
2291 Irving Hill Road
Campus West
Lawrence, Kansas 66045

BARTELL, Sandra L.
University of Michigan
School of Natural Resources
Ann Arbor, Michigan 48104

BARTLETT, David S.
University of Delaware
College of Marine Studies
Newark, Delaware 19711

BARTOLUCCI, Luis A.
LARS
Purdue University
1220 Potter Drive
West Lafayette, Indiana 47906

BAYMA, Robert R.
ERIM
Analysis Staff
P. O. Box 618
Ann Arbor, Michigan 48107

BEANLAND, William C.
CML Satellite Corp.
1750 K Street, N. W.
Washington, D. C. 20006

BECK, Cyrus
Naval Air Development Center
Electro-Optics
Aero Electronics Tech. Dept.
Warminster, Pennsylvania 18974

BEETH, D. R.
Johnson Space Center
NASA
Houston, Texas 77058

BELCHAK, Thomas A.
Western Michigan University
Department of Geology
Kalamazoo, Michigan 49001

BENJEY, William G.
ERIM
P. O. Box 618
Ann Arbor, Michigan 48107

BENTLEY, Kenton
Lockheed
16811 El Camino Real
Houston, Texas 77058

BERNSTEIN, Ralph
IBM Corporation
Federal Systems Division
18100 Frederick Pike
Gaithersburg, Maryland 20760

BERTHIAUME, Jeffrey
U. S. Government
Washington, D. C. 20505

BLANCK, Erich
8021 Icking
Ichoring 25
West Germany

BLANTON, Brenda
University of Michigan
School of Natural Resources
Ann Arbor, Michigan 48104

BLYTHE, Richard
General Optionics
3555 N. Dixboro
Ann Arbor, Michigan 48105

BOCKES, Olin D.
U. S. Department of Agriculture
Soil Conservation Service
LIM Division
12th and Independence Ave., S. W.
Washington, D. C.

BOGART, Lowell E.
Kerr-McGee Corporation
Mineral Exploration
P. O. Box 25861
Oklahoma City, Oklahoma 73125