A MODEL FOR BIOMASS ASSESSMENT

E-023

SUBMITTED BY:

Dr. Stephen J. Walsh
Associate Professor

Dr. George P. Malanson
Assistant Professor

Dr. John D. Vitek
Associate Professor

Dr. David R. Butler
Assistant Professor

Department of Geography
Oklahoma State University

&

in conjunction with

USDA/Agricultural Research Service

SUBMITTED TO:

Dr. Norman N. Durham, Director
Water Research Center
Oklahoma State University

March 14, 1983
Introduction

The surface of the earth is a complex system responding to the input of energy, natural and human. Human use of the surface for maximum agricultural efficiency requires knowledge of the interactions of all variables involved in the system. Broad categories of phenomena, including the atmosphere (weather and climate), biosphere (vegetation, fauna, and human activity), hydrosphere (precipitation, runoff, infiltration, fluvial erosion, and evapotranspiration), and the lithosphere (soil, topography, and parent material), can be identified as the major variables in any assessment. Assessment of interactions requires data from various sources. The emergence of remote sensing as a source of data for assessments in the last decade permits the development of more accurate predictive models. Refinements in data acquisition, such as improved resolution, the use of radar, and the correlation of detailed surface observations with satellite overpasses, provide researchers with the capability to assess inter-relationships and create accurate models.

A conceptual model, Figure 1, illustrates the interaction of the Department of Geography/CARS and the USDA/Agricultural Research Service with components of the natural system for the purpose of creating a predictive model for biomass assessment. CARS, the remote sensing center at Oklahoma State University, plus ARS of the USDA bring different skills to this joint research effort. ARS is actively engaged in collecting field data from the Little Washita River watershed in south-central Oklahoma. Rain gauges, stream gauges, measures of biomass, and plant reflectivity constitute one aspect of data needed for model development. CARS will provide data from Landsat, specifically related to the thematic mapper, and radar images obtained from aircraft to assess the land cover of the study area. Characteristics of soil have been provided by the SCS. In addition, a previous research effort, Stadler & Walsh (1982-83), investigated the assessment of evapotranspiration from remotely sensed data through the use of a computerized geographic information system.

Study Area

The Agricultural Research Service (USDA) has maintained and operated a dense network of recording raingauges on a study reach of the Washita River basin in central Oklahoma (Figure 2). This network covers a 1,500 square mile area of the southern Great Plains with gauges spaced on a 3- by 3- mile square grid. In addition to this network from which measurements of rainfall input have been made continuously for more than 20 years, 50 sub-drainage areas and small watersheds have been instrumented to measure runoff, sediment yield and water quality for hydrologic and erosion research studies. Consequently, a large statistical data base exists from which hydrologic and erosional processes have been modeled for small field size watersheds.

General Approach

The general approach to be taken extends the use of satellite data, specifically Landsat 4, to biomass research. Ground truth monitoring stations will be established on a large basin watershed in an effort to relate surface measurements to data collected by Landsat 4. Time and spatial measurements at the various ground sites will be related to specific satellite scenes during
Figure 1. Conceptual Framework

Walsh & Malanson

- variables
- correlations
- techniques
- models
- integration

Vitek & Butler

- VEGETATION
- SOIL
- WEATHER
- GULLYING
- GULLY DEVELOPMENT

Inputs

ARS

GEOG/CARS

Phase One & Two

ARS & GEOG/CARS

REGIONAL MODEL OF BIOMASS ASSESSMENT
the growing season. The relationships developed will be used to determine parameter values required by the models. Four ground sites, representing two major landuses on the Little Washita River watershed, have been established in the fall of 1982 to determine soil-water-plant biomass status for range and crop landuses. Hand-held radiometer measurements for Landsat 4 bands are being made on satellite overpasses and interim dates. Biomass clippings, soil moisture, and surface, air, and soil temperature measurements are being compiled also on these dates. Climatic variation across the area is measured continuously from the raingauge network and from a climatic station maintained in the area.

Additional field data are required and a larger number of sample sites are needed to appropriately investigate the variation within the watershed for model development. The USDA/ARS are providing some field technicians, equipment, and research scientist time. This proposal calls upon OSU to slightly exceed the USDA/ARS cost-share and to principally direct OSU funds toward radar images, Landsat digital data, and to some field equipment. The remotely sensed data are the primary materials for landcover assessment. The field equipment will allow an OSU field team to increase sampling capacity. Subsequent research efforts will benefit from this equipment which does not duplicate existing devices.

The OSU Center for Applications of Remote Sensing will process all aircraft and satellite data. Through the recent launching of Landsat 4, greater spectral, spatial, and radiometric resolution are now available for greater precision in landcover evaluation.
Vegetation-Water Analysis

The amount and condition of vegetation are important parameters in models of basin hydrology (Crawford and Linsley, 1966). The combination of the Thematic mapper, thermal, and radar imagery from Landsat 4 may provide an accurate and economical source of current data on vegetation. Weigand et al. (1982) discussed the use of remote sensing to assess the effect of drought on plant canopy development. We will evaluate the new higher resolution sensors launched in 1982 for use in monitoring canopy development and for detecting actual evapotranspirative processes. These sources of data can be used in hydrological models to assess evapotranspiration, drought stress, and crop growth, and to address general questions of soil and water conservation.

We will determine which Landsat data source, or combination of sources, best predicts the variables of importance in hydrological models. Total foliar cover, leaf area index (LAI), and biomass will be measured at ground stations by line intercept, point intercept, and clipping and weighing methods (Mueller-Dombois and Ellenberg, 1974). Actual transpirative processes will be computed by measuring the diffusion resistance of leaves, leaf temperatures, and leaf water potential. These values are used in models of water movement from the soil, through the plant, and into the atmosphere (Nobel, 1974). Measurements will coincide with Landsat overflights.

The soil water status will also be measured. ARS has neutron probes and will sample soil moisture to 1.0m depths with these at selected points. These probes will be supplemented by soil samples for gravimetric measures of soil moisture. We will expand the area of soil moisture measurement to coincide with the measures of plant moisture with soil hygrometers buried at extended sample locations. We can then quickly sample soil and plant moisture at a given site without disturbance.

The eventual goal of this work on vegetation and soil is to be able to use satellite data to update models of crop growth, drought stress, and soil and water conservation for large regions. At this stage we will establish which remote sensing variables correlate with which ground truth variables. We will use path analysis and regression to construct simple predictive models. Future work will develop the simple models into regional models designed for soil and water management.

Gully Analysis

Surface erosion has a major impact on biomass in Oklahoma as well as other agricultural areas. Erosion removes soil and plant nutrients, thereby reducing biomass productivity. Changes in climate coupled with changes in landuse and landcover can be correlated with erosion. The present configuration of the surface can be mapped for comparison with conditions in the past and the future.

Assessing past climatic changes in Oklahoma is possible through examination of annual growth rings in post oak (Harper, 1961) and other tree species (Fritts, 1976). Growth patterns in tree-rings in trunks and roots may also provide data on dates of gully erosion inception and rates of gully development (LaMarche, 1966; Graf, 1977; Carrara and Carroll, 1979), as can historical documentation and past aerial photos.
Climatic (Bariss, 1971, 1977; Graf, 1980) and human agents (Graf, 1979; Bariss and Bronger, 1981) have been cited as causes of gully erosion in the Great Plains and semi-arid west. In the case of climatic agents, tree-ring (dendrochronologic) analysis allows construction of a chronology of climatic change as well as a chronology of gully erosion, particularly in areas where historical data are geographically and temporally limited. In the case of the human agent, chronologies of gully development and rates of erosion are also available in the dendrochronologic record.

Through analysis of (1) the twenty years of instrumented meteorologic data available in the study area; (2) rates of gully erosion; (3) historical documentation; and (4) comparisons with the tree-ring record for this period, a model of climatic factors likely to enhance gully development can be developed. Dendrochronologic data then allow assessment of the likelihood of gully erosion in the past, and with the historic data, provide a predictive base for assessing the return interval of climatic conditions conducive to gully erosion.

Correlation of erosion with climate, landuse and landcover is an essential component of a major model of biomass change. Field measurements on gullies, however, require many man-hours. Can field measurements be replaced by assessment of the surface with aircraft radar? This remote sensing technique has shown promise in assessing changes in topography. If topography, namely points of accelerated erosion, can be monitored, a model of surface change can be integrated with a model of biomass change to create a predictive model for vegetation/water assessment.

Headwater migration of stream erosion occurs in response to the input of energy (precipitation), change in landcover (accelerate overland flow), change in base level (disruption equilibrium), or human activity of various sorts. Once initiated, gully erosion may proceed at a rapid rate. Based upon air photos in the 1930's, rates of change over 50 years can be calculated. Periodic coverage during the past 50 years allows rates of change to be assessed for short and long term periods. Accurate measurements of the present conditions are necessary to analyze previous conditions. Field measurements can be correlated with aerial photographs. Once the present conditions are known, the ability of radar to assess these conditions can be evaluated.

Radar has been used to efficiently derive morphometric characteristics of a gully network. Significant information regarding size, shape, configuration, and other attributes of the surface can be derived. Sequential radar images over a period of time can allow assessment of rates and forms of gully development, providing input which with paleogeomorphic, soils, vegetation, and meteorologic data allows the construction of a model of gully development.
BUDGET: July 1, 1983 - June 30, 1984

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BUDGET SUMMARY:

PROJECT TOTAL

OSU CONTRIBUTION - $37,681.00

USDA/ARS CONTRIBUTION - $30,000.00
References Cited


VITAE

STEPHEN J. WALSH
February, 1983

1024 Preston Avenue
Stillwater, OK 74074
Home: (405) 377-8279
Office: (405) 624-6250

EDUCATION

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EXPERIENCE

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PROFESSIONAL INTERESTS

Organizations

Oklahoma Academy of Science; Association of American Geographers; American Society of Photogrammetry and Remote Sensing; Society of the North American Cultural Survey; Sigma Xi.

Participated in


Project Head—Inventory and identification of natural area preserves within the State of Oregon. These natural areas exhibit relatively undisturbed natural vegetation, unique vegetation, and/or unique geologic or hydrologic characteristics. The inventorying was achieved by use of high altitude color infrared aerial photo interpretation, and LANDSAT satellite data; Environmental Remote Sensing Applications Laboratory, (ERSAL), Oregon State University, Corvallis, Oregon, June, 1975 to June, 1977.


Investigator, Oregon State Water Resources Department; involving the use of U-2 color infrared aerial photography for land use classification of various drainage basins to evaluate water uses and needs, February, 1977.


Vice-Chairman Elect of the Oklahoma Academy of Science, Geography Section, November, 1977.

Presentation, Aerial Photography Workshop to the Tulsa, Oklahoma Metropolitan Area Planning Commission; focus: land use differentiation through use of aerial photography and orthophotography, also identification of urban structures; residential, commercial, industrial, etc., November, 1977.
Participated in: (continued)

Director, Remote Sensing Symposium: "Remote Sensing Applications in Resource Management," March 15-16, 1978, Oklahoma State University. Discussion topics: forestry, land use, water resources, and wildlife management; the Symposium featured nationally recognized speakers in the field of remote sensing. The Remote Sensing Symposium which was offered through Arts and Sciences Extension was supported in part by the National Aeronautics and Space Administration (NASA).


Chairman-Elect of the Oklahoma Academy of Science, Geography Section, November, 1978.


Forest Hydrology Seminar, Broken Bow, Oklahoma, Oklahoma State Department of Forestry and U.S. Forest Service, June, 1978.


Participated in: (continued)

Presentation, "Map and Photographic Interpretation," National Science Foundation Funded Workshop, Oklahoma State University, June, 1979.


Participated in: (continued)


Presentation, "Remote Sensing and Information Systems," Horizons in Water Research Institute, Oklahoma State University, Stillwater, Oklahoma, April, 1982.


Proposal Reviewer, Geography and Regional Science Division, National Science Foundation, April, 1982.


Presentation, "Incorporation of Socioeconomic Data in Geographic Information Systems," OK Dept. of Economic and Community Affairs, April, 1982.


Presentation, Utilization of Automated and Conventional methods in Surveying and Mapping, USGS, Rolla, Missouri--

Invited poster presentations:
Participated in: (continued)


Publications

Report: "Inventory of State-Owned Lands for Potential Natural Areas (Southern Oregon)," Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, Oregon, March, 1976, pp. 35.

Report: "Inventory of State-Owned land for Potential Natural Areas (along Central Oregon Coast)," Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, Oregon, March, 1976, pp. 48.

Report: "Inventory of State-Owned Lands for Potential Natural Areas (Northeast Oregon)," Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, Oregon, December, 1976, pp. 41.


Report: Development of Landsat/Geobased Information System Requirements for an Oklahoma Substate Demonstration Project," NASA/Earth Resources Laboratory, NSTL Station, Mississippi, with J. D. Vitek and M. S. Gregory November 1982, 33 pages.


Principal Investigator, "Development and Equipment Acquisition for Center for Applications of Remote Sensing," Oklahoma State University, March, 1979, $215,000.


Principal Investigator, "Land Use Mapping Within the Emergency Planning Zone, Blackfox Nuclear Power Station, Inola, Oklahoma," Public Service Company of Oklahoma, December, 1979, $30,000.


Principal Investigator, "Identification of Natural Area Preserves Through Remote Sensing Techniques," Oklahoma Department of Tourism and Recreation and Ozark Regional Commission, June, 1980, $16,000.


Principal Investigator, "Strip-Mine, Reclamation of Surface Coal Mines, Oklahoma Department of Mines, June 1, 1981, $10,000.


Principal Investigator, Development of Requirements for a sub-state Landsat/Geobased Information System; NASA/Earth Resources Laboratory, Mississippi, September, 1981, $17,950.


Co-Principal Investigator, "Development of a Model for Regional Evapotranspiration Estimates Through Use of Satellite Data," Oklahoma State University Water Research Institute, July 2, 1982, $12,000.


COURSES TAUGHT

Remote Sensing (Introduction and advanced)

Physical Geography

Climatology

Oceanography

World Regional Geography

Geography of the United States
MASTER'S THESSES


VITA

George Patrick Malanson

Department of Geography
Oklahoma State University
Stillwater, OK 74078
(405) 624-6521, 6024

114 1/2 W. Elm Ave.
Stillwater, OK 74074
(405) 743-4075

Birth: 12 July 1950, Clinton, MA

Education:

1968-1972, B.A. (Art, South Asia Area Studies) Williams College
(Williamstown, MA)

1973, language school (Hindi) U.S. Department of State
Foreign Service Institute
Rosslyn, VA

1974-1975, part-time Georgia State University
(Geography) Atlanta, GA

1976-1978, M.S. University of Utah
(Geography) Salt Lake City, UT
(Thesis: "Distribution of plant species in hanging gardens of the
Narrows, Zion National Park, Utah" under J. Kay)

1978-present, doctoral University of California
(Geography) Los Angeles, CA
(Dissertation: "Demographic simulation of post-fire succession of
Californian coastal sage scrub" under W.E. Westman)

Awards and Honors:

1981 University Fellowship, University of California
1978 Outstanding Graduate Student Award, Department of Geography,
University of Utah
1972 Dean's List, Williams College
1971 Dean's List, Williams College

Research Grants:

1983 Research Grant, Association of American Geographers
1982 Chancellor's Patent Fund Research Grant, University of
California, Los Angeles
1981 Conference Travel Grant, University of California
1980 Research Travel Grant, University of California
1980 Library Search Grant, University of California
1979 Conference Travel Grant, University of California
1978 University of Utah Student Research Grant in Geography
1977 Research Grant, Zion National History Association
1977 University of Utah Student Research Grant in Geography
1977 Research Grant-in-Aid, Sigma XI, the Scientific Research Society
of North America
Publications:


Unpublished research reports:


Unpublished papers presented at conferences:


Teaching experience:

1977-1978 Teaching practicum, Department of Geography, University of Utah, assisting one quarter each for "Conservation of Natural Resources" and "Biogeography".

1978-1980 Teaching assistant, Department of Geography, University of California, Los Angeles, conducting discussion/lab sections in "Man and the Earth's Ecosystems" 4 quarters, "Biogeography" 2 quarters, and "Physical Environment" 1 quarter.

1980 Instructor, Los Angeles Community College District faculty seminar on ecological field methods, 1 day.
Teaching experience, cont.:

1982-1983 Visiting Assistant Professor, Department of Geography, Oklahoma State University, teaching two sessions of "Introduction to Physical Geography" and one section of "Conservation of Natural Resources" each semester, plus a graduate seminar on "Recovery Processes in Damaged Ecosystems".

Employment experience:


1976 Cartographic draftsman, Wm. Moore Survey and Mapping Co., 146 Grafton St., Shrewsbury, MA

1977-1978 Research assistant, Department of Geography, University of Utah, Salt Lake City, UT (land use assessment and mapping for proposed suburban development in northern Utah, and vegetation mapping for proposed power plant sites in southern Utah on NASA grant to M.K. Ridd and R.M. McCoy, PIs)

1980 Biogeographer, Archaeology Division, ESCA-Tech Corp., 3001 Red Hill Ave., Costa Mesa, CA

1980-1981 Research associate, Department of Geography, University of California, Los Angeles, CA (assembling a computer model of post-fire succession of coastal sage scrub, on NSF grant to W.E. Westman, PI)

Membership in professional groups:

American Association for the Advancement of Science
Association of American Geographers
California Botanical Society
Ecological Society of America

Professional activities:

1976-1977 Student representative, Graduate Studies Committee, Department of Geography, University of Utah

1977-1978 Chairman, Student Advisory Committee, Department of Geography, University of Utah

1980-1981 Graduate Student Representative, Department of Geography, University of California, Los Angeles

1981 Student representative, Resource Geographer Search Committee, Department of Geography, University of California, Los Angeles.
Work in progress:

Manuscripts submitted:

Gradient modeling and archaeology. revising for Journal of Scientific Archaeology with E. Ingbar.

Post-fire succession in Californian coastal sage scrub: the role of basal resprouts. submitted to Madrono with W. E. Westman

Fire interval as a niche axis in Californian coastal sage scrub. Submitted to Oecologia.

Linked Leslie matrices for the simulation of succession. Submitted to Ecological Modelling.

Coastal sage scrub in the fire management scenario of southern California. Submitted to Annals, Association of American Geographers.

Fire history of Venturan subassociations of Californian coastal sage scrub. Submitted to Journal of Biogeography.

Intensity as a third factor of disturbance regime and its effect on community diversity. Submitted to American Naturalist.

The rise and fall of the Uintah Valley Indian Reservation: perception and policy. Submitted to Yearbook of the Utah Geological Association.

Papers Scheduled for presentation:

Analysing Gaussian distributions of species importance values. Special session on methodology in biogeography at the 79th Annual Meeting of the Association of American Geographers, Denver, April 1983.

Research in progress:

Linking simulations of fire behavior and heat release with simulations of soil heat flow.

Future research scheduled:

Recovery of chaparral on sites differing in fire interval and fire intensity (with J.F. O'Leary)

Periodicity and magnitude of mass wasting events, the maintenance of slide paths, and their utility as fuel breaks in fire management plans in Glacier National Park (with D. Butler)
JOHN D. VITEK

VITA

Personal Data

Date of Birth: August 16, 1942
Place of Birth: St. Paul, Minnesota
Family: Wife - Margaret Children - Mark and Alan
Social Security Number: 395-40-1601

Professional Experience

Assistant Dean, Graduate College & Associate Professor of Geography, Oklahoma State University, 1982 -
Coordinator of Environmental Sciences, Oklahoma State University, 1982 -
Associate Professor of Geography, Oklahoma State University, 1980-82
Assistant Professor of Geography, Oklahoma State University, 1978-80
Assistant Professor of Physical Geography, Univ. of Michigan-Flint, 1974-78
Chairman of Physical Geography, Univ. of Michigan-Flint, 1976-77
Visiting Professor of Geology, University of Michigan-Ann Arbor, Summer 1977
Assistant Professor of Geophysics, State Univ. of New York - Buffalo, 1971-74
Part-time Instructor of Geography, University of Iowa, 1976-70
Cartographer, Department of Geography, Northern Illinois University, 1965-67

Education

Ph.D. University of Iowa, Iowa City, 1973 (Geography)
M.A. University of Iowa, Iowa City, 1970 (Geography)
B.S. Wisconsin State University, Stevens Point, 1964 (Mathematics & Geography)

Publications

Norris, Robert E., Harries, Keith D., & Vitek, John D., 1982, Geography: An Introductory Perspective; C.E. Merrill, Columbus, 472 pages.

Chapters in Books


\textbf{Articles}


Hanson, P.O., Vitek, J.D., & Hanson, S., 1979, Awareness of tornadoes: The importance of an historic event; The Journal of Geography, vol. 78, (no. 1), p. 22-25.

Hanson, S., Vitek, J.D., & Hanson, P.O., 1979, Natural disaster: Long-range impact on human response to future disaster threats; Environment and Behavior, vol. 11 (no. 2), p. 268-284.


Gregory, M.S., Walsh, S. J., & Vitek, J.D., 1981, Mechanics of monitoring forest clearcuts and their regeneration; in Seventh International Symposium on Machine Processing of Remotely Sensed Data, Purdue University (LARS), 520-528.


Publications

Miscellaneous


Presentations at Professional Meetings


Vitek, J.D., Hanson, P.O., & Hanson, S., 1977, The Flint tornado of 1943: What is the impact on human behavior 22 years later?; Prog. Abs. Assoc. Am. Geog., p. 68.


Vitek, J.D., 1978, Natural hazards: Perception and planning for local events; Southwest Division, Assoc. Am. Geog., Houston, Texas.


Vitek, J.D., 1979, Summary presentation of workshop results; Fourth Annual Natural Hazards Workshop, University of Colorado, Boulder.


Walsh, S.J., Gregory, M.S., & Vitek, J.D., 1981, Inventorying forest clearcuts and monitoring vegetation regeneration through Landsat digital data; U.S. Forest Service, In-Place Resources Inventories, Orono, Maine.


Vitek, J.D., 1983, Description and analysis of sub-alpine lag surface; Assoc. Am. Geog., Accepted for presentation, Denver meeting, April 1983.

Awards, Grants & Honors

1964 - Dean's Honor List, Wisconsin State University, Stevens Point

1970 - NSF Trainee, University of Iowa, Iowa City

1976 - Special Merit Award, The University of Michigan - Flint

1978 - Tenure and Associate Professor, The University of Michigan - Flint

1979 - N.S.F. Travel Funds Grant for Participants in the Ninth Annual Binghamton Geomorphology Symposium

1979 - Walsh, S.J. & Vitek, J.D., Inventory of Clearcuts in Southeast Oklahoma Through the Application of Landsat Data; Oklahoma Department of Wildlife Conservation ($20,000)

1980 - Walsh, S.J. & Vitek, J.D., Inventory of Clearcuts in Southeast Oklahoma Through the Application of Landsat Data, Part Two; Oklahoma Department of Wildlife Conservation (30,000)

1980 - Tenure and Associate Professor, Oklahoma State University

1981 - Elected to Oklahoma State Chapter of Sigma Xi
1982 - Appointed Assistant Dean of the Graduate College
1982 - Appointed Co-ordinator of Environmental Sciences
1982 - Recipient of a Distinguished Service Award from The Society for the north American Cultural Survey (SNACS)
1983 - Determination of Physico-chemical Interaction Responsible for production of Acid Water and Dissolution of Toxic Metals from the Abandoned Lead/Zinc mines in northeastern Oklahoma, by Burks, S.L., Kent, D.C., and Vitek, J.D., to O.S.U. Water Resources Research, $83,000.

Professional Organizations (current)
Association of American Geographers, 1967 -
Chairman, Geomorphology Specialty Groups, 1980-81
American Association for the Advancement of Science, 1974-
Geological Society of America, 1970-
Binghamton Geomorphology Symposium - Chairman of Steering Committee, 1979-
Sigma Xi, 1981-
American Geomorphological Field Group, 1982-

Current Research
A. Development of stone polygons in the Sangre de Cristo Mountains, Colorado. This is the eighth year of a study to investigate rates of surficial movement of stones in the centers of the polygons. Data collected through the seventh year of this study will be presented at the Fourth International Permafrost meeting, Fairbanks, Alaska in July 1983.

B. 1983 will be the seventh year of collecting data on the development of a sub-alpine lag surface at 12,000 feet in the Sangre de Cristo Mountains. A preliminary statement of the first six years of record will be presented at the AAG meeting in Denver, April 1983.

C. Statistical analysis of fabrics in a Mount Mestas rock glacier will be undertaken with John R. Giardino, Texas Tech University. Goal is to produce a paper from the data during 1983.

D. Geomorphological mapping of the Culebra portion of the Sangre de Cristo Range in southern Colorado and northern New Mexico. This is a joint effort with John R. Giardino, Texas Tech University. I will map the west wide of the range and he the east. We will then combine our efforts into a joint publication.

E. Development of a patterned fen (string bog) in the Sangre de Cristo Mountains. Beginning in the summer of 1983, additional research will be undertaken on rates of change and hydrology of the bog.

F. Surface geomorphology of the Tar Creek Watershed in northeast Oklahoma is being mapped and analyzed in conjunction with a grant. The purpose of the project is to assess how acid mine water is recharged, overland flow plus infiltration rates will be assessed.
Courses Taught

University of Iowa (1967-1970)
Cartography
Field Techniques

State University of New York - Buffalo (1971-1974)
Introduction to Physical Geography
Climatology
Cartography
Thematic Cartography
Theory and Techniques of Landform Analysis
Seminar in Physical Geography

University of Michigan - Flint (1974-1978)
Geomorphology
Advanced Geomorphology
Introduction to the Geosciences
Cartography
Surveying & Mapping
Natural Hazards
Environmental Issues
Climatology
Physical Geography of the City

University of Michigan - Ann Arbor (1977)
Geology Field Camp (8 weeks)

Oklahoma State University (1978-)
Physical Geography (Introductory)
Physical Geography (Advanced - Slopes and Slope Processes)
Climatology
Biometeorology
Natural Hazards
Summer Field Seminar in Colorado
Seminar: Slope Processes
Cartography
Field Observations & Mapping

Administrative Experience

1971-74 - SUNY-Buffalo
Department - Co-Director of Undergraduate Majors
Department - Member of the Graduate Committee

1974-78 - University of Michigan - Flint
Special Assignments
Co-Chairman, Summer 1976
Department Chairman, 1976-77
University Committee Assignments
Chairman, Curriculum Committee, 1976-77
Member, Curriculum Committee, 1976-78
Member, Student Affairs Committee, 1976-77
Member, Library and Instructional Resources Committee, 1976-78
Member, Urban Studies Interdisciplinary Program, 1974-77
Member, Council of Chairmen, 1976-77
Member, Science Building Subcommittee, 1974-77
Member, Honors Program Steering Committee, 1977-78

1978- - Oklahoma State University
Department, Member of the Graduate Committee, 1978-81, 1982-
Department, Member of the Travel Committee, 1980-82
Arts & Science, Member, Task Force on Special A&S Degree
Requirements, 1982
Arts & Science, Member, Classroom Advisory Committee, 1981-82
Arts & Science, Member, Curricular Affairs Committee
Assistant Dean of the Graduate College, 1982-
University Curriculum Committee, 1982-
Graduate Faculty Council, 1982-
University Task Force on Student Retention, 1983-
Program Coordinator, Environmental Sciences, 1982-
Environmental Sciences Review Committee, 1982
VITA

David R. Butler
Department of Geography
Oklahoma State University
Stillwater, Oklahoma 74078
(405) 624-6250 or 624-9059 (Home)

PERSONAL

Born: April 14, 1952, in Lincoln, Nebraska
Health: Excellent, no limitations
Marital Status: Married, no children

EDUCATION

1978-1982 University of Kansas, Lawrence, Kansas
Degree: Doctor of Philosophy in Geography

1976-1977 McMaster University, Hamilton, Ontario, Canada
Graduate Studies in Geography

1974-1976 University of Nebraska at Omaha
Degree: Master of Science in Geography

1970-1974 University of Nebraska at Omaha
Degree: Bachelor of Arts, Summa Cum Laude, Ranked #1
in the College of Liberal Arts and Sciences
Major: Geography, 4.0 average (A=4.0)
Overall Academic Average: 3.92

ACADEMIC HONORS, AWARDS, AND GRANTS

Postgraduate Level

O.S.U. College of Arts and Sciences Dean's Starter Grant, 1983-84, $2500.00.

Graduate Level

Doctoral Dissertation Defense Honors, 1982
National Science Foundation Doctoral Dissertation Research Grant EAR-8112316
University of Kansas Graduate School Dissertation Fellowship, 1980-81
University of Kansas Phi Kappa Phi Honor Society, 1981
Geological Society of America Research Grant, 1980
University of Kansas Graduate School Summer Fellowships, 1979 and 1980
University of Kansas Graduate School Travel Grants, 1979 and 1980
McMaster University Graduate Scholarship, 1976-77
Undergraduate Level

Outstanding Student, Department of Geography-Geology, University of Nebraska at Omaha, 1972-73 and 1973-74
University of Nebraska at Omaha Honors Scholarship, 1973-74
University of Nebraska at Omaha Regents Scholarship, 1970-73
Listed in "Who's Who Among Students in American Universities and Colleges, 1973-1974"
Phi Kappa Phi, Gamma Theta Upsilon, and Phi Eta Sigma Honor Societies

PROFESSIONAL MEMBERSHIPS

American Quaternary Association
Association of American Geographers
Biogeography Specialty Group, A.A.G.
Geomorphology Specialty Group, A.A.G.
Canadian Association of Geographers
International Mountain Society
Nebraska Academy of Sciences
Northwest Scientific Association
Society of Sigma Xi

AREAS OF INTEREST WITHIN GEOGRAPHY

Quaternary Paleoenvironments
Geomorphology
Dendrochronology and Natural Hazards Analysis
Palynology

PUBLICATIONS

Papers Published in Refereed Journals


Papers Published in Refereed Journals

Butler, David R., A late Quaternary chronology of mass wasting for a small valley in the Lemhi Mountains of Idaho. Accepted by Northwest Science, to be published in Volume 57, 1983.

Butler, David R., Rockfall hazard inventory, Ram River, Mackenzie Mountains, N.W.T. Accepted by The Canadian Geographer, to be published in Volume 27(2), 1983.


Papers Submitted


Butler, David R., Observations on historic high magnitude mass movements, Glacier National Park, Montana. Submitted to The Mountain Geologist.

Abstracts Published from Papers Presented


Abstracts Published from Papers Presented


Butler, David R.; Curtis J. Sorenson; and Wakefield Dort, Jr., 1983. Late Quaternary glacial/interglacial sequence, east-central Lemhi Mountains, Idaho, U.S.A. Sixth Biennial Conference on Quaternary Research, York University, Downsview, Ontario, Canada.

SEMINAR PRESENTATIONS

Late Pleistocene Paleogeography of the Lemhi Mountains, Idaho. October 1, 1982. Department of Geography, Oklahoma State University, invited speaker.

Interpreting Late Pleistocene Paleoenvironments. November 1, 1982. Department of Geography, University of Oklahoma, invited speaker.

Physical Landscapes of the Northwest Territories of Canada. February 4, 1983. Department of Geography, Oklahoma State University, invited speaker.


FIELD RESEARCH

FIELD RESEARCH

Summer, 1977  Member of physical geography research team from McMaster University; Mackenzie Mountains, Northwest Territories, Canada. Work involved dendrochronologic analysis of mass movement and flood sites, and hydrologic and water chemistry studies.


ACADEMIC EXPERIENCE

7/82-Present  Assistant Professor of Geography, Oklahoma State University
Courses- Quaternary Paleoenvironments
          Physical Geography
          Biometeorology

9/78-5/80  Teaching Assistant, University of Kansas
Courses- Physical Geography
          Environment and Man

9/76-8/77  Teaching Assistant, McMaster University
Courses- Geography of the U.S.A.
          Statistics

12/75-2/76  Instructor of Geology, Iowa Western Community College,
Council Bluffs, Iowa
Course- Introduction to Geology

9/74-5/76  Teaching Assistant, University of Nebraska at Omaha
Courses- Physical Geology
          Historical Geology

GRADUATE STUDENT SUPERVISION

Major Advisor For:
Mr. Jack G. Oelfke, thesis topic: "Mass-wasting events along the Lewis Overthrust, Glacier National Park, Montana: a natural hazards approach".

Committee Member For:
Mr. Ian Cherrill, thesis topic: "Identification of drought-stressed areas of agriculture using LANDSAT remote-sensing techniques (Oklahoma area)".

Mr. Carl Bryant, thesis topic: "Snow avalanche hazards in a portion of mountainous Washington".

OTHER WORK EXPERIENCE

OTHER WORK EXPERIENCE

8/77-9/77 Environmental Planning Consultant, Central Plains Engineering and Architecture, Council Bluffs, Iowa. Provided advice on completion of environmental impact statements submitted to the U.S. Army Corps of Engineers.

REFERENCES

Dr. Curtis J. Sorenson
Department of Geography-Meteorology
University of Kansas
Lawrence, Kansas 66045

Dr. Wakefield Dort, Jr.
Department of Geology
University of Kansas
Lawrence, Kansas 66045

Dr. William C. Johnson
Department of Geography-Meteorology
University of Kansas
Lawrence, Kansas 66045