THE MONADNOCK

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THE MONADNOCK

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In preparing a new format for The Monadnock, we are much indebted to the Clark University Alumni who contributed helpfully with encouragement and suggestions. An effort has been made to keep the best of the old, yet interject something new. We feel that such features as the Alumni News and The Workroom Today should remain an integral part of this publication. Other features, such as the articles, are distinctly different and will hopefully offer the alumni a broader picture of the current work now going on at Clark.

It is our good fortune to have the assistance of the alumni. We are eager to have your comments and criticisms and earnestly hope that you will communicate to us your impressions of this new format.

The Monadnock is the alumni magazine of the Clark University Geographical Society and is published yearly by Clark University Press in Worcester, Massachusetts.

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Report from the Director

In preparation for this message, I've read through the issues of Monadnock, from the first, in January, 1927, when Monadnock was initiated as a semi-annual publication, to last year's. I am struck by the fact that much of Monadnock's earlier concerns are today's concerns--from the discreetly frantic appeals of editors for written and fiscal contributions; to the inauguration of the Field School (in 1928, when, incidentally, the word "field party" was first used); to the interest in teaching and the use of educational media ("Moving Pictures for Schools" was a 1931 article title); to the first message by a director of the School to Alumni, to changes in the Geography Building and a student geographical series (all first developed in the 1940 issue); to messages by incoming directors (Samuel Van Valkenburg in 1946 and Raymond Murphy in 1963).

I am especially mindful of Dr. Murphy's comments of last year, when, in speaking of trends in American Education, he described the change from "a pleasant, thoughtful scholarly pursuit to a frenetic urge to get ahead." This underscores some very serious choices that students and faculty alike have to make these days in charting our professional courses.

I would like to feel that the gap between "the good old days" of the past and "the better days" of the future, to which Raymond alluded in his 1965 message, will not be as wide here at Clark as it is in most areas of graduate education. Perhaps this issue of Monadnock, with new format, larger, and (hopefully) more eye-appealing, serves to emphasize this point. It represents a change, but one that is in keeping with past strength and traditions.

We have in this past academic year initiated a number of changes, all calculated to strengthen Geography as a research and teaching field. New faculty appointments, new courses, new graduate student support frameworks, and new programs are undertaken in part to preserve the philosophy of "the good old days," when devotion to scholarship and academic integrity was the major criterion by which efforts were weighed. This will continue to be our major criterion.

Some measure of success has rewarded our efforts this year. First, additions to the staff include: (1) Dr. Jeremy Anderson, Assistant Professor, who comes to us after several years as a faculty member at the University of Maryland. Dr. Anderson has his A.B. from Yale and his A.M. and Ph.D. from the University of Washington. His specialization is agricultural geography and the U.S.S.R. Together with Dr. Snead, he will assume responsibility for the re-inaugurated field camp; (2) Mr. George F. McCleary, Assistant Professor, who comes to us from the University of Wisconsin. Professor McCleary will take over cartographic responsibilities from Guy Burnham and develop a program in these lines. He has his A.B. from Yale, his A.M. and (pending) Ph.D. from the University of Wisconsin. (3) Dr. Terrence W. Beed, Visiting Assistant Professor of Urban and Economic Geography. Dr. Beed is currently a visiting professor at the University of Hawaii. He has his A.B. and Ph.D. from the University of Sidney.

Secondly, our sources of graduate student support, from Clark University, the Office of Education, and the National Science Foundation, have increased appreciably. Approximately sixteen fully-paid fellowships (mainly research, but some as assistantships) and several additional stipends will be available, so that a total of $53,000 in cash support (exclusive of tuition grants) will be given to 1966-67 graduate students--a significant change over previous years, and a welcome one! The list of incoming students, when published next fall, will show that representatives from high-calibre colleges and universities can be attracted to Clark, given the support framework that is competitive with that of other leading Geography graduate departments.

Third, we have begun to revise our course and catalogue offerings, broadening both our undergraduate and graduate training base. A new and experimental introductory undergraduate course is being initiated. The curriculum as a whole is being redesigned, with a two-year M.A. and a three-year Ph.D. residence requirement. Field camp will be integrated with a fall field techniques course, coming as a three-week period in either January or June.

Fourth, a new cartography laboratory will be opened by fall (in the first floor of the east wing of the library) and the workroom will be completely remodeled, with private carrells for each graduate student, a lounge, and separate soundproofed typing facilities. The Libbey Library, too, will be remodeled.

Fifth, a series of new programs, including a Summer Institute in Geography for Students and Faculty from Small Southern Colleges (Negro and white), which is supported by a grant from the NSF; an Academic-Year Institute in Geography for High School Geography Teachers; and an M.A. Program for Geography and Education (both of the latter supported by the Office of Education) will be initiated.

This is an age when large-scale financial assistance is both necessary for a Geography center to maintain a position of excellence, and is available. We have received grants from governmental foundations and bureaus in excess of $300,000 for 1966-67, for university, student and faculty support to further our programs. But the issue is not how to obtain support, but whether we will use support wisely and in consonance with our overall teaching and research objectives. Our present staff, with its emphasis upon three streams--economic and urban geography, environmental perception and behavior, and geography and its teaching--is being encouraged to pursue these lines of specialization, and it is to such a purpose that we are developing new programs.

As a newcomer to the School's faculty ranks, I am particularly appreciative of the manner in which my colleagues have helped to orient me to Clark's manners and traditions. Raymond Murphy has provided wise counsel and guidance, and my other associates--Henry Warman, Robert Kates, Rodman Snead and Martyn Bowden--have given unstintingly of themselves in the work of refashioning the School so as to meet today's challenges and opportunities in Geography. To Guy Burnham, who agreed to remain with us for this academic year, I am also deeply indebted. Finally, to all Clark alumni, I want to emphasize that the University Administration, and President Howard B. Jefferson in particular, is giving our efforts the unsparing support that Geography both needs and deserves at Clark University.

Saul B. Cohen

ALUMNI NEWS

Lewis M. Alexander is the Chairman of the Department of Geography at the University of Rhode Island, in Kingston. He is also the Director of the Law of the Sea Institute and a Consultant in Geography for the Department of State. He has recently written The Northeast: Tradition and Change, to be published this spring by Van Nostrand as part of the "Searchlight Series." Next year (1966-67) Dr. Alexander will take a sabbatical leave to do research on the United States and the Law of the Sea.

Agnes M. Allen is the Dean of the School of Arts and Science at Northern Arizona University, in Flagstaff. She is planning her retirement from this position on July 1, 1966, but will continue to teach Geography for at least two more years.

Robert H. Arnold is Assistant Professor of Geography at Illinois State University, in Normal, having received his M.A. at Clark in 1964. He is, in his words, "still happily single," and is presently working on his doctoral dissertation: "Commercial Recreation in the Urban Environment."

Rollin S. Atwood is Professor of Geography in the School of International Service at American University, in Washington, D.C., and is hard at work trying to improve Geography's image in interdisciplinary area studies.

Simon Baker is Assistant Professor at the Department of Geography of the University of Arizona, in Tucson, having received his Ph.D. at Clark in 1965. He now has three children--two girls, 6 and 2, and a son, age 4. In January, 1966, his article, "The Utility of Tropical Regional Studies," appeared in The Professional Geographer, and he recently directed his students in preparing an Atlas of Arizona, being considered for publication. He is currently engaged in research in aerial photo interpretation: the extraction of the maximum amount of quantitative data from air photos.

Nicholas Bariss is Assistant Professor at the University of Omaha. He reports that he has a new son, Peter, who was born on February 3, 1965. Last summer Mr. Bariss attended the VIIth INQUA Congress and presented a paper on loess topography. He is currently engaged in completing his Ph.D. and will then work on various problems of loess-morphology.

George Beishlag (M.A. Clark 1937) is living in Baltimore, Maryland and is Chairman of the Geography Department at Towson State College in Baltimore. Last summer he conducted an NDEA summer institute in Geography at Towson. He wrote "Maryland" in the World Book Encyclopedia and "Maryland" in the Book of Knowledge, both of which articles are in editing. He also wrote Chapter 7, "The Outdoors Laboratory," in The Teaching of Geography, to be issued by the NCGE.

Paul Beaudet is now here at Clark (see The Workroom Today), having obtained leave from Buffalo State, where he is Associate Professor of Geography. He is hard at work on his dissertation.

Gwen Bell is Assistant Editor of EKISTICS, and in that capacity will travel to Athens for EKISTICS month, July, 1966. This will include a one-week symposium on urban documentation and retrieval and the Delos Cruise. Gwen and her family will soon move to Pittsburgh, where she will take the position of Assistant Professor in the Graduate School of Development and International Administration and the Department of Geography at the University of Pittsburgh.

Mildred Berman (M.A. Clark 1950, Ph.D. Clark 1963) is Associate Professor of Geography at Southern Connecticut State College, in New Haven. She recently traveled to Central America to visit Mayan urban sites and has had an article accepted for publication: "Human Organization."

Hans Boesch, who was at Clark in 1934-35, is now Professor of Geography at Zurich University and the Director of the Geographical Institute there. He has recently written a German translation of "A Geography of World Economy" which will appear sometime this year. Last year he produced a series of maps, with text, on global production, which appeared in Geographische Rundschau. He plans to concentrate on human geography in South Asia and the Far East.

Leonard W. Bowden is Assistant Professor of Geography at the University of California, Riverside. He is the advisor to the Geography Branch of the Office of Naval Research, in Washington, D.C., having taken his leave from the University of California until September, 1966. His paper, Diffusion of the Decision to Irrigate (Geography Research Paper No. 97, University of Chicago Press) appeared in April, 1965.

David E. Buerle (Ph.D. Clark 1965) is Assistant Professor of Geography at the University of Rhode Island in Kingston. His recently-completed dissertation was entitled Some Measurements of Boston and New York City Social Influence on their Common Hinterland.

Harry H. Caldwell (Ph.D. Clark 1951) was promoted last year to Professor and Chairman of the Geography Department at the University of Idaho, in Moscow. He was the Director of last year's NDEA Geography Institute there.

Claira Campbell (M.A. Clark 1966) is the Geographer for Natick Laboratories, in Natick, Mass. She recently worked as a labor market analyst for the State of New Hampshire, doing a study of benefit recipients for the Department of Employment Security. She has made plans to complete her residency requirements for her Ph.D. at Boston University during the academic year 1966-67.

Albert S. Carlson is Professor of Geography at Dartmouth College. He is also Executive Secretary for the Dartmouth-Lake Sunapee Region Association, in Lebanon, New Hampshire, which is a 38-community promotion and development agency. He has held this position for 20 years. He is still the Dean of Lebanon College Evening School.

Mary L. Caruso is an elementary school principal in Roslyn Heights, N.Y., and was the author of Ocean Harvest, published by the Knopf Company in 1961. She is now working as collaborator on a 6th grade Geography text.

Philip M. Caughey is teaching Geography at Muzzey Junior High School in Lexington, Mass. He was remarried in April, 1965, to the former Mrs. Doris Guild of Malden, Mass., and plans to retire from teaching in June, 1967.

Thomas W. Chamberlin (Ph.D. Clark 1946) is Academic Dean and Professor of Geography at the University of Minnesota in Duluth.

Catherine E. Cox (M.A. Clark 1942) is Assistant Professor of Geography at Massachusetts State College in Fitchburg, Mass. She participated in the Asian Institute last summer at the University of Hawaii.

George S. Corfield is living in Lincoln, Nebraska, and is Chairman of the Department of Geography and Geology at the University there. He plans his retirement this June. In August, 1966, he will travel to Central and Southern Europe, after teaching in the NSDA program in Geography at Mississippi State University during the summer.

Clark N. Crain (Ph.D. Clark 1951) is Professor of Geography at the University of Denver. He has made two trips to South and South East Asia, as Chief Advisor for the Upper Indus Regional Plan in West Pakistan and directing contracts on Physical Environment.

Harold F. Creveling (Ph.D. Clark 1951) is the head of the Geography Department at East Stroudsburg State College, in Pennsylvania. During the 1965 summer term he was Visiting Professor of Geography at the University of Oklahoma. He is a member of the Recreation and Wild Life Committee of the Water Resources Association of the Delaware River Basin. Dr. Creveling plans to visit the Southwestern part of the U.S. during the summer of 1966 for research on recreation in this area.

Floyd F. Cunningham (Ph.D. Clark 1930) has at this point served thirty years as Chairman of the Department of Geography at Southern Illinois University. He has co-authored the third and fourth books in a Social Studies series published by Benefic Press: You and the Americas and You and the World. His other activities include being a member of the Editorial Board of The Record, a publication of Kappa Delta Pi, the Honor Society of Education.

Nadine H. Deacon is a part-time lecturer at the University of Toronto and York University (Toronto) Geography Departments. She is now preparing a series of lectures on the Middle East. In February of 1965 she visited Egypt and is currently re-visiting the entire Mediterranean area--Egypt, Lebanon, Syria, Jordan, Israel and Greece.

Aubrey Diem (M.A. Clark 1956) is Associate Professor of Geography at the University of Waterloo. With the benefit of a grant from the Foreign Area Fellowship Program, he spent six months in Europe studying urban problems in Stockholm, Amsterdam, Zurich, and London. He has published an article, "An Alternative to Unplanned Urban Growth," in The Canadian Geographer, Vol. IX, No. 4, 1965. He plans to continue doing research in this field and to write a book on the regional Geography of Western Europe.

John E. Dornbach is living in Seabrook, Texas, and is the Chief of the Lunar Surface Technology Branch, Advanced Spacecraft Technology Division, Manned Spacecraft Center, NASA. He is working hard on Project Apollo.

George T. Downey (M.A. Clark 1965) is living in Columbus, Ohio, and is the Visiting Instructor for the Department of Geography at Ohio State University. He will shortly return to Clark to do research for his dissertation.

Bart J. Epstein (Ph.D. Clark 1956) is the Manager of B.F. Goodrich Company's Retail Real Estate.

Wilma Belden Fairchild (M.A. Clark 1937) is the Editor of Geographical Review and recently authored an article appearing in that Journal, "Adventures in Longevity: Fifty Years of the Geographical Review," Geog. Rev., Vol. 66, No. 1, January, 1966, pp. 1-11.

Bradley Fisk, Jr. (M.A. Clark 1950) is the Professor of Geography and History at the Cape Cod Community College in Hyannis, Massachusetts. He has taken up a new line of business: President of Arey's Pond Boatyard, Inc.

Roy Jackson Fletcher is Lecturer at State University of Buffalo (New York) and is engaged in dissertation research and work on a climate paper. He plans a trip to Japan in early summer, 1966.

Edwin J. Foscue is living in Dallas, Texas and is Professor Emeritus of Geography at Southern Methodist University. He spent last August and September in Alaska and has just returned from a visit to the Mediterranean Region. He is currently engaged in writing a book on the geography of bridges.

J. Keith Fraser (Ph.D. Clark 1964) is the Chief of the Toponymy Division, Geographical Branch, Department of Mines and Technical Surveys, Ottawa, Canada. He also holds the position of Executive Secretary, Canadian Permanent Committee on Geographical Names. Somehow he finds the time to be a sessional lecturer at the Department of Geography, Carleton University, in Ottawa.

Alfonso J. Freile (Ph.D. Clark 1961) is Professor at the Universidad Central de Venezuela (School of Geography) and proudly informs us that he has a four-year-old daughter. His published articles include: Provincias fisiograficas de Venezuela (1964); Villa Paez, un estudio regional (1965); Itato de la Virgen, monografia geografia (1965); and Bibliografia Geografia de Venezuela (1964). He plans to finish Regiones Climaticas de Venezuela, for publication this year, and to spend his sabbatical leave abroad doing research at the British Museum and the Indian Archives, studying old maps.

Marilyn Hayden Furlong has married Ira Ellsworth Furlong, Associate Professor of Geology at Bridgewater State College. She herself is an Instructor of Geography at Bridgewater. She and her husband traveled through the Maritime Provinces of Canada, during which trip she collected cartographic materials to illustrate a paper presented by her husband at the Conference on Economic Geology of Massachusetts.

Kathleen M. Garrity (M.A. Clark 1934) is still residing in Worcester, Mass.

John L. George (M.A. Clark 1956) is Assistant Professor, Salem State College, Salem, Mass. His two daughters are now 6 and 5 years old, respectively. He is a full-time graduate student at Boston University, in the Geography Department.

Jon A. Glasgow (M.A. Clark 1958) is an Associate Professor at Bloomsburg State College, in Pennsylvania.

Janet L. Glen is an Associate Professor at Glassboro State College, New Jersey. This is a recent switch from her former position in secondary school teaching. She reports she is eager to finish her M.A.

Peter G. Goheen (M.A. Clark 1964) is working on his Ph.D. Dissertation at the University of Chicago, Department of Geography.

Loren Gould (M.A. Clark 1957) is Assistant Professor and Assistant Dean of Men at Worcester State College and is planning his yearly trip to "somewhere in the U.S. and Canada." He is still working on the geology of Massachusetts for a teacher's publication.

Donald W. Griffin (Ph.D. Clark 1963) is Assistant Professor of Geography at U.C.L.A. In consideration of the population explosion, he has no family expansion to report, but is the proud owner of a new home. He has traveled in West Africa, doing field work on Planning and Urbanization. Thereafter he went to Western Europe to rest up from that! In October, 1965, he presented a paper at the African Studies Association. Forthcoming are papers to be presented at Riverside, California (to the Association of Pacific Coast Geographers), Toronto, and the University of Wisconsin (on Urbanization, in June, 1966). He anticipates publication of one of his articles in the Annals of the A.A.G. In the meantime he has in progress research on Los Angeles and urbanization.

Andreas Grotewold (M.A. Clark 1950) is Associate Professor of Geography at the Department of Geography of the University of Missouri, in Columbia. He is progressing with his studies of international trade.

Alan Harris is Senior Lecturer in Geography at the University of Hull, in Yorkshire, England. He was married in December, 1965. He is working on the Historical Geography of East Yorkshire and parts of the English Lake District.

Dorothea Burton Hawley (Ph.D. Clark 1949) is living in Falls Church, Virginia, and has the position of Chief of the Soviet Branch, Transportation Office, Defense Intelligence Agency.

Rick Hecock is Assistant Professor of Geography at Eastern Michigan University. He has joined the Michigan Academy of Arts, Sciences and Letters. He anticipates doing some traveling, with no destinations specified.

Willard C. Hessen (M.A. Clark 1950) highly recommends his new field; his position is Director of Education at the Tamaroc Job Corps Conservation Center: "a fascinating and challenging venture into a new field of education." His two children are "getting old"--Mary Lynn (15) and Gary (5). Will is living on East Shore Drive, in Detroit Lakes.

David H. Hokans (M.A. Clark 1952) is a consultant and has engaged in the Playa Research Project for the Air Force (1962) and private research in northern Labrador and Quebec (1963). His present project is being carried out for the Great Northern Paper Company--glacial deposits in northwestern Maine. He is living in East Holden, Maine, and mentions the possibility of teaching in the future.

George M. Howe (Ph.D. Clark 1956) resides in Bloomfield, Connecticut, and is the Director of Meteorological Services at Travelers Research Center, Hartford. He has written unpublished reports on Weather and Extended Coverage (Insurance), the Impact of Weather on the Construction Industry, and a Guide to the Need of Automobile Air Conditioning.

Joseph B. Hoyt (Ph.D. Clark 1954) is Professor of Geography and Chairman of the Social Sciences Division, Southern Connecticut State College. He is revising "Man and the Earth" for publication in January, 1967. His future plans include development of Geography as an undergraduate major at Southern Connecticut.

Nancy Huntington Hudson, who lives in Brooklyn, New York, is the Adjudicator of the Passport Agency of the U.S. State Department, in Radio City. During 1965, she traveled to the Holy Land and Egypt and Istanbul.

Frederick Hung will leave his position of Geography Department Head at United College (Winnipeg, Canada) as of July, 1966. He will then assume the Chairmanship of the Department of Geography at the University of Guelph. In February of 1965, Fred was elected Guest Fellow of Morse College, Yale University. His recent publications include: "China and the West," Business Quarterly, December, 1965; "Vietnam," Focus, December, 1965; Book Review of Taiwan (by Itsich) in Geographical Review, January, 1966; and Book Review of J. Mirsky's "Great Chinese Travelers," in Geographical Journal, March, 1966. Fred reports that the new Guelph University Geography Department will add three new teachers annually--"young geographers with proved effectiveness in teaching required."

Esther Kinch Hunter (M.A. Clark 1940) is living in Rochester, N.Y.

Gilbert J. Hunter is Assistant Professor of Geography at Kutztown State College. He reports that that Department now numbers five men and is attracting students of a better calibre. He is writing a review of Urbanization in West Africa for Professional Geographer. He will attend the 1966 NDEA summer Institute at Minnesota to study methods of teaching introductory college Geography courses.

Harry K. Hutter (M.A. Clark 1930) is for the eleventh year a foreign student advisor, as well as Associate Professor of Geography at the University of Toledo. In April, 1965, he served as Vice President of the Geography Section of the Ohio Academy of Science in Athens, Ohio.

Albert H. Jackman (Ph.D. Clark 1953) is Chairman of the Department of Geography at Western Michigan University in Kalamazoo. He took a pack trip to Bob Marshall Wilderness, South Fork Flathead River in Northwest Montana in July, 1965. For this summer he plans a trip to Europe.

Preston E. James, the Maxwell Professor of Geography and Chairman of the Department at Syracuse, is planning the Presidential address at Toronto and a book on the History of Geographic Thought. He has completed two books: One World Divided (Blaisdell), and A Geography of Man (Blaisdell), 3rd Revised Edition, 1966. His two articles have appeared in the Journal of Geography: "A Conceptual Structure for Geography" and "A New Concept of the Circulation of the Atmosphere."

J. Granville Jensen (Ph.D. 1946) has no new news to report, merely confirming that he is Professor of Geography at Oregon State University.

Lane J. Johnson (Ph.D. Clark 1959) Assistant Professor of Geography at Wayne State University, is completing his study of "Local-Service Centers in New England." He is now beginning work on a reference volume, Analytical Techniques for Geographic Research.

Allan Wyne Jones is a Field Officer for the Wales Tourist Association. He was married in March of 1965 to the former Enid Huws of North Wales. He is doing general research on the tourist industry in Wales, with emphasis on tourist accommodations and flow patterns.

James P. Jones (M.A. Clark 1949) is Chairman of the Department of Geography and Geology at State College in Boston.

William F. Kane, Jr. (M.A. Clark 1954) has remained close to Clark. He is the Manager of Area Development for the Worcester Area Chamber of Commerce.

Frank Kelland (M.A. Clark 1954) is Assistant Professor of Geography at Montclair State College. His wife Marilyn (Clark M.A. 1954) has the same position at Newark State College. In addition, Frank teaches Cartography at Rutgers. The Kellands compiled a workbook in Physical Geography, Exercise in Physical Geography, published by William Brown Company of Dubuque, Iowa, and a map outline series, published by the Phillips Campbell Publishing Company of Little Falls, N.J.

Louis R. Keller (M.A. Clark 1929) is retired and lives in Cleveland Heights, Ohio.

Edward S. Kersch (M.A. Clark 1958) is the senior City Planner of the Detroit City Planning Commission.

Harry B. Kircher (Ph.D. Clark 1961) is Associate Professor of Geography at Southern Illinois University. He is currently engaged in a study of the Central Mississippi Valley.

Esther J. Kistler (M.A. Clark 1938) is retired and lives in Nanticoke, Pennsylvania.

William A. Koetsch (M.A. Clark 1959) is Assistant Professor of History at Florida Presbyterian College and this year completed requirements for his Ph.D. at the University of Chicago. He plans on spending this summer in New England revising his dissertation for publication. He will also continue research on the history of American Geography in the 19th Century.

Richard J. Kopec (Ph.D. Clark 1965) is Assistant Professor at Wayne State University, where he will direct this year's NDEA summer institute. His article "Continentality Around the Great Lakes" was published in the Bulletin of the American Meteorological Society, Vol. 46, No. 2, February, 1965.

George Langdon (Ph.D. Clark 1951) is Professor of Geography at Pennsylvania State College, in West Chester. The second edition of his book, Exploring Earth Environments--A World Geography, was published by Thomas Y. Crowell Company in 1965. He now is at work on a book on North America.

Mary Ann Le Blanc teaches eighth grade geography in Gardner, Massachusetts. In August, she and her husband Ronald depart for Kenai, Alaska, to teach and travel for one or two years.

Minnie E. Lemaire (Ph.D. Clark 1935) is Chairman of the Department of Geology and Geography at Mount Holyoke College. She will attend the I.G.U. Regional meeting in Mexico this summer.

Dana A. Little (M.A. Clark 1951) is Director of the Planning and Research Division of the Maine Department of Economic Development, and he lives in Brunswick, Maine.

Trevor Lloyd (Ph.D. Clark 1940) is Chairman of the Geography Department at McGill University. He has re-

Richard F. Logan is Professor of Geography at U.C.L.A. His family evidently shares his zeal for travel: one daughter is married to a South West African rancher, the other to a District Officer in the Solomon Islands. From February to September of 1965, Dr. Logan did field work in South West

Africa. He also appeared before the World Court at The Hague as an expert witness in the South West Africa case. He will be the guest of the University of Stellenbosch (in South Africa) for its centennial celebrations.

Harriet Ruth Long (Ph.D. Clark 1965) is the Head of the Geography Department and Chairman of the Liberal Arts Program at Edinboro State College, in Pennsylvania.

Aleta and Robert Looker added a daughter to their family last July--it now stands at two girls and two boys. Aleta teaches one section of freshman Geography at Southern Connecticut State College, while Bob still does city planning and consulting work.

Arthur C. Lord (M.A. Clark 1959) is Assistant Professor of Geography at Millersville State College in Pennsylvania. He assures us that someday he will pass Spanish!

Sister Marion Lyons, S.C.H. (Ph.D. Clark 1959) is Lecturer in Geography at Regis College. She is writing a Geography textbook at the junior high school level. Sister Lyons traveled last year in India, the Middle East and Egypt, also re-visiting parts of Europe. She is currently involved in educational television in Boston.

Ronald M. McCall (M.A. Clark 1962) is Assistant Professor of Geography at Shippensburg State College. For this summer he plans on traveling in the U.S.

Shannon McCune (Ph.D. Clark 1939) is President of the University of Vermont, in Burlington and has had a new book published this year: Korea: Land of Broken Calm, Asia Library Series, Asia Society, and Van Nostrand Company, 1966. His plans are to continue study and research of the Geography of Asia, particularly Korea, Ryukyu Islands and Japan.

Grace Lee McIntosh is living in Rome, New York and "enjoying (her) four grandchildren."

Wallace E. McIntyre (Ph.D. 1951) has spent the 1965-66 academic year as a Special Auditor at Harvard University.

Frederick S. Merriam is a Sales Representative for Waddell and Reed, Inc., in New York City.

James A. Minogue (M.A. Clark 1937) lives in Alexandria, Virginia, and is a Deputy Office Chief for the Defense Department. He is "processing" his three younger daughters through Virginia Polytechnic Institute, the oldest having graduated from V.P.I. with honors last June.

Benjamin Moulton is Chairman of the Department of Geography and Geology at Indiana State University in Terre Haute and is preparing to operate his Department's second NDEA Institute in Geography this summer.

John M. Moulton is Chairman of the Department of Geography and Geology at Hastings College in Nebraska. He is doing research on pump irrigation on the High Plains of Nebraska and Kansas and did two weeks of field work in western Kansas, Nebraska and eastern Colorado last summer. He hopes to return to Clark in 1966 or 1967 to begin his Ph.D. residency.

C. Josephine Moyer (Ph.D. Clark 1955) lives in Fleetwood, Pennsylvania and has retired after 48 years of teaching in grade school. She is now planning a methods book for college students and to serve as a demonstration teacher and leader of the workshops in her service area. She seems delighted to have free time for writing and traveling and in February took a trip to Mexico and the west coast.

Richard E. Murphy (Ph.D. Clark 1957) has been Chairman of the Geography Department of the University of New Mexico in Albuquerque since the fall of 1965. He spent last year at the Sorbonne on an NSF grant studying Human Geography as it developed in France. He is now working on a revision of the landform classification system which he presented at the IGU meeting in London in July, 1964, parts of which appear in Introduction to Physical Geography, by Arthur Strahler. He plans to use last year's experience for concentration on several aspects of cultural geography.

Natalie E. Nason (M.A. Clark 1948) is Director of Education at Camp Honey, 7th Inf. Division, and Lecturer in Geography at Seoul National University. Last year she traveled to Nepal.

Salvatore J. Natoli is Lecturer in Geography at the University of Connecticut and has written a junior high school text to be published in January, 1968. He is currently working on his dissertation, entitled "Effects and Effectiveness of Zoning Decisions Upon Certain Patterns of Urban Land Use."

Herman L. Nelson (Ph.D. Clark 1954) is Professor of Geography at the State College of Iowa in Cedar Falls.

Norton Nichols, Jr. (M.A. Clark 1950) is Assistant Superintendent of Educational Services, Antelope Valley Union High School District, in Lancaster, California.

Daniel F. Pawling lives in Port Washington, New York and is the Senior Planner for the Tri-State Transportation Commission in New York City. This is both a promotion and a change of assignment for him. He was formerly manager of a land use inventory of the 8,000 square mile Tri-State Region (New York City metropolitan area). He is most pleased to have gotten to the data analysis stage of the inventory and to return to planning activity on such a large scale.

Robert F. Perry, Jr. (Ph.D. Clark 1957) is Chairman of the Department of Geography at Worcester State College. He taught at Harry Caldwell's NDEA summer institute in Idaho last summer and traveled extensively in Washington, Oregon and western Canada. His plans include research, teaching and travel.

Rafael Pico (Ph.D. Clark 1938) lives in Hato-Rey, Puerto Rico. He has been Chairman of the Finance Committee, Banco Popular, since January, 1965 and Senator-at-Large in the Puerto Rican Senate since 1964. In December, 1964, he retired as President of the Government Development Bank. He has just published Part II Geografia de Puerto Rico--Geografia Economica, and in preparation is a book on the Geography of Puerto Rico comprising Parts I and II of Geografia de Puerto Rico, in Spanish.

Theodore S. Pikora (M.A. Clark 1962) is living in Webster, Mass. He has recently changed jobs, from teaching at Masconomet Regional High School in Boxford, Mass. to Instructor at Salem State College.

James Bradford Powers informs us that he will marry Cynthia Bagster-Collins (graduate of Bates College in 1965) on August 20, 1966. He is presently preparing for field work on the American Indian, which will be the topic for his Master's Thesis. His plans are to teach on the college level.

Richard E. Preston (Ph.D. Clark 1964) is Associate Professor of Geography at San Fernando Valley State College in California. He has two children--Richard, Jr., three years old, and Marsha Ann, age 2. He plans to teach this summer in the University of Idaho NDEA Geography Institute. His recent and future publications include: "The Transition Zone: A Study of Urban Land Use Patterns" scheduled for publication in Economic Geography; (as co-author) "A Restatement of the Transition Zone Concept," scheduled for publication in the Annals of the A.A.G.; "The Southern California Metropolis," scheduled for publication in the 1966 Yearbook of the Association of Pacific Coast Geographers.

George B. Priddle (M.A. Clark 1965) is a Lecturer in Geography in Waterloo, Ontario. His plans are to continue doing research for his Ph.D. dissertation.

Louis O. Quam (Ph.D. Clark 1938) is the Director of the Earth Sciences Division of the Office of Naval Research and lives in Falls Church, Virginia.

Yvonne Rebeyrol is a journalist and is employed by Le Monde, in Paris. In connection with her profession, she has traveled in the Kerguelen Islands, New Amsterdam Island and the Crozet Islands (Southern Indian Ocean); Madagascar, Le Reunion, Mauritius, and Kenya; and Jordan.

Ina C. Robertson (M.A. Clark 1924) has retired as Head of the Geography Department at State Teachers College, Valley City, North Dakota. Since an automobile accident six years ago, her activities have been restricted, but she spends summers in Florida with her family and says "Clark friends are always welcome."

J. Lewis Robinson (Ph.D. Clark 1946) is the Chairman of the Department of Geography at the University of British Columbia. He was on a leave of absence during the academic year 1965-66. His article, "The Development and Status of Geography in Canadian Universities," will appear in a Spring issue of The Professional Geographer. He has written a chapter on the "Regional Geography of the Hudson Bay Area," which will appear in the Centennial Volume of essays for the Federal Department of Mines and Technical Surveys. He is also writing a booklet on "The Geography of British Columbia" for the British Columbia school system.

John Kerr Rose is Senior Specialist in Natural Resources and Conservation for Legislative Reference Service at the Library of Congress. He tells us that he has gained grandchildren. Last year he spent five weeks in Germany, Denmark and Sweden as the guest of the respective Parliaments of those countries.

Paul V. Salley (M.A. Clark 1951) is the Chairman of the Geography Department at State College in Salem, Mass. His family now includes seven children--four daughters and three sons.

Barbara Soydam (M.A. Clark 1958) is Assistant Research Officer for the Providence Redevelopment Agency.

Francis J. Schadegg (M.A. Clark 1937) is Chairman of the Department of Geography and Geology at Eastern Washington State College. He is also a part-time planning consultant, having prepared Comprehensive Plans and Zoning Regulations for Lincoln and Adams counties, Washington. He is planning a sabbatical leave during the academic year 1966-67 and will study with Dr. Samailes at the University of London.

Gordon B. Schilz (Ph.D. Clark 1948) is the Chairman of the Geography Department at the University of Omaha. His Department has expanded to six full-time and three part-time teachers.

J.R. Schwendeman (Ph.D. Clark 1941) is head of the Geography Department at the University of Kentucky. He has a grand total of fourteen grandchildren and has written a text on World Geography for college, which will be published by Van Nostrand this year.

Earl B. Shaw (Ph.D. Clark 1933) is Professor of Geography at Assumption College here in Worcester. In June, 1965, his book, Fundamentals of Geography, was published by John Wiley and Sons. During December and January, 1965-66, he took a three-week trip through the Caribbean. He plans on doing research and traveling, and writing and revising textbooks.

Ada M. Shawkey is Chairman of the Geography Department at Framingham State College. She reports that she is "mobile" again, having recovered from a broken hip.

James A. Shear (Ph.D. Clark 1952) is Professor of Geography at the University of Georgia and lives in Athens, Georgia. We may expect his article, "Set Theory and Koeppen's Dry Climates," to appear in Annals toward the end of this year. Another of his articles, "The South Pole's Isothermal Winter," will appear in Arctic.

Victor W. Sim (M.A. Clark 1957) is Assistant Professor of Geography at the University of Western Ontario.

Robert B. Simpson (Ph.D. Clark 1941, M.A. Clark 1934) is Visiting Associate Professor at Dartmouth. He says he is enjoying his return to New England and to teaching, although he is keeping in touch with the Autometric Operation of Raytheon, in Alexandria, Va. He received an "Author's Award" for last year's paper presented at the Columbus, Ohio, meeting of the A.A.G., on the use of side-looking airborne radar for surveys of under-developed countries. His daughter Linda has married a law student (University of Pennsylvania) and son Robert is a student at the University of North Dakota.

Samuel W. Smith is Associate Professor of Geography at Indiana State University in Terre Haute.

Frank J. Sparicio (M.A. Clark 1953-55) is working on Real Estate Research and Acquisition for Stop & Shop, Inc., of Boston. His paper was published in Professional Geographer in the January, 1966, issue. He will continue to work and write in the field of location research and hold seminars in this field. Frank lives in Boston with his wife and three children.

Raymond E. Specht (M.A. Clark 1947) is Associate Professor of Geography at Wisconsin State University in Stevens Point. He is completing his dissertation, "A Functional Analysis of Wood and Portage counties, Wisconsin." He is also completing a bulletin, "The Green Bay Route," for publication in the fall in the Railway and Locomotive Historical Society Journal. He has gotten a Wisconsin State research grant for work on Wisconsin Railway Abandonment. His preliminary findings will be reported in the Spring bulletin of the Council of Wisconsin Geography Teachers.

Susan R. Sprague is a substitute teacher in Danvers, Mass., but will move to Worcester and teach full-time in this area after her marriage May 28 to Henry McCutcheon (See Workroom Today).

Karl Stacey (Ph.D. Clark 1955) is Professor of Geography at Kansas State College in Manhattan, Kansas. He has been traveling widely--in Portugal and Spain during the summer of 1964, and Scandinavia during last summer. He will teach in the Earth Science Institute at Kansas State this summer.

Myron Starbird lives in Farmington, Maine, and is Professor of Geography at the University of Maine.

Robert G. Stone is the Chief of the Scientific Information and Publications Division of the Air Weather Service (USAD). He lives in Belleville, Illinois.

John L. Taylor (Ph.D. Clark 1953) is Consultant on Territorial Affairs for the Committee on Interior and Insular Affairs of the U.S. House of Representatives. He made two visits in the Pacific area last year: in July he represented Congress at the South Pacific Commission Conference in Lae, New Guinea and Noumea, New Caledonia; he also accompanied a Congressional party to Guam, American Samoa, and Trust Territory of the Pacific Islands in November and December.

Charles H. Teller is living in a little adobe hut in Tarija, Bolivia and is an Urban Community Action Peace Corps volunteer. His activities are quite diverse. Daily, he is required to be: public health worker, veterinarian, agricultural extension agent, teacher, library builder, and basketball coach. His plans are to write his Master's Thesis and continue for his Doctorate in Regional Planning.

Ray W. Tobey (M.A. Clark 1954) is retired and pursuing various hobbies at his home in Fairfield, Maine.

Lester Unterberg (M.A. Clark 1960) is Senior Planner for Candeub, Fleissig and Associates, in Allentown, Pennsylvania, where he lives with his wife and three children.

Sister Mary Ursula (Ph.D. Clark 1958) is Chairman of the Social Science Department at Mount Aloysius Junior College in Cresson, Pennsylvania. She is the author of a fourth grade text in geography and coordinating editor of a fifth grade book to be published in January, 1967, by Allyn & Bacon, Inc. These texts are parts of an elementary series of geographies. Sister Ursula is also coordinating editor for the sixth and seventh grade books (author of the latter is Salvatore Natoli), which will appear as part of the same series.

Eugene Van Cleef (Ph.D. Clark 1926) is Professor Emeritus at Ohio State University. He recently traveled to Sardinia and Czechoslavakia, with a few intermediate stops. His recent publications include: "How Banks Can Help Expand International Trade," Banking, April, 1965; and "Morocco: Climate for Business Encouraging," Business Abroad (Dun and Bradstreet), September 6, 1965. In April of this year he presented a paper before the Geography Section of the Ohio Academy of Science: "Seventy-Five Years of Geography--Some Recollections and Comments."

William Van Royen (Ph.D. Clark 1928) is Professor of Geography at the University of Maryland. His articles putting in an appearance this year have dealt with the Appalachian area and population changes in the United States. He spent three months last year gathering data in Europe on changes in the French-Belgian-Dutch coal fields area, for comparison with Appalachia. In addition to working with the Army Scientific Advisory Panel, he expects to do consulting work with the Army Research Office in Durham, North Carolina.

Charles B. Varney (M.A. Clark 1953, Ph.D. Clark 1963) is Professor of Geography at Wisconsin State University in Whitewater and Director of the Honors Program there. He will be Director of this summer's NDEA Geography Institute at W.S.U.

David E. Vincent (M.A. Clark 1963) is Assistant Professor of Geography at State University of New York in Oreonta.

Paul Vouras (M.A. Clark 1952) is Associate Professor of Geography at Paterson State College, in Wayne, New Jersey. He has co-authored Guides for Geographic Studies, Fearon Publishers, 1966.

Lillian Wallace (M.A. Clark 1943) is retired and living in Westfield, Massachusetts.

Seymour West (M.A. Clark 1941) lives in Narberth, Pa., and is an Intelligence Officer for the U.S. Government. He moved to that Philadelphia suburb after nineteen years in Washington and reports that his wife, four sons, and daughter are adjusting quite well.

Katheryne Thomas Whittemore (M.A. Clark 1925, Ph.D. Clark 1936) is Professor Emeritus at State University College in Buffalo, N.Y. and is serving as Historian for the NCGE. She says she will continue to be active professionally in many ways.

Stephen O. Wilson (M.A. Clark 1963) lives in Hamilton, New York and is an Instructor in Geography at Colgate University. This was a change since last year, when he was with the New Hampshire State Planning Project. In February, 1965, his second daughter, Jennifer, was born. During Colgate's January, 1966, Independent Studies he and his students conducted a program of research on ice and snow at Upper Saranac Lake.

Mary Vogt Woodland (M.A. Clark 1943) is working half-time as a research geologist for the U.S. Geological Survey. She has been "lecturing" on the geology of water resources, as a member of the Interleague Water Resources Committee.

A. Joseph Wraight (Ph.D. Clark 1951) lives in Washington, D. C. and is Chief Geographer, U.S. Coast and Geodetic Survey, Environmental Science Services Administration. His World Geography book is completed and will be published by Chilton Books in September, 1966. He has several other books under contract.

Cheng-tsu Wu (Ph.D. Clark 1958) lives in Bronx, New York. He is currently doing research on the agricultural development on the tropical island of Hai-nan, China.

FACULTY NEWS

Saul B. Cohen

Since coming to Clark from the Association of American Geographers in September, Dr. Saul B. Cohen has been busy in a variety of endeavors within and without the University. Duties as Chairman of the Commission on College Geography have taken him to meetings in New York, Boca Raton, Ann Arbor and Washington. A consulting schedule for various Office of Education projects on Geography has involved visits to Denver, Washington and New York to deal with institute and fellowship programs. One of these projects has culminated in the establishment of a Consortium of Professional Associations to study Special Instructional Improvement Programs in American Education, in which he represents the field of Geography. Some other activities include those as Geography Consultant to the Social Science Division of the National Science Foundation and membership on the U.S. National Delegation to the International Geographical Union.

Outside lectures this year included a series of five delivered at the U.S. Naval War College, papers at the annual meetings of the National Council of Social Studies Teachers and the National Council for Geographic Education, and lectures at Dartmouth and Rhode Island State College. Other appearances were before the Clark alumni of Washington, D.C. and the New England Graduate Council Conference at Clark.

For the summer of 1966, Dr. Cohen will direct the Clark Geography Institute for Students and Faculty of Small Southern Colleges and then plans to attend the regional I.G.U. meetings in Mexico City.

Publications this year include a chapter on Geopolitical Equilibrium and the Sino-Soviet World (in Issues of World Communism, ed. by Geography); a chapter on the Geographer in Business (in Geography As A Professional Field); editing of the NDEA Geography Institutes Evaluation Program Report; and preparation of two chapters for the A.A.G.-N.G.S. monograph on the Geography of the New England Region. He has also completed the editing of a volume on Essays in American Geography, which will be the published version of a series on Geography that has just been completed for the Voice of America under his direction.

Robert W. Kates

Dr. Kates has made a number of speaking trips this year. Among the colleges he visited were Pennsylvania State University, the University of Toronto, the University of North Carolina, the University of Hawaii, and the University of Chicago.

Dr. Kates served on a Technical Advisory Committee to the Housing and Home Finance Agency and has been an active member of the National Academy of Sciences Committee on the Alaska Earthquake.

With Professor Joachim Wohlwill, of the Clark Psychology Department, Dr. Kates edited a set of papers for The Journal of Social Issues, on "Man's Response to the Physical Environment." Moreover, he wrote two papers with Derrick Sewell on economic and social aspects of research and development, one related to weather modification and the other to oceanography. In addition, Dr. Kates prepared two papers on the study of human behavior vis-a-vis the environment: "Comprehensive Environmental Planning" and "Stimulus and Symbol: The View from the Bridge."

His plans are to continue work on a book on natural resources and to pursue his commitment to the National Academy of Sciences Committee on the Alaska Earthquake. He is also planning new studies of environmental perception and natural hazards.

Rodman E. Snead

In October, 1965, Dr. Snead presented a paper on "Weather Types and Patterns as an Aid to Teaching the Climate of Southwest Asia in College" at the National Council for Geographic Education in New York.

In December, he went to Puerto Rico to study pleistocene sand dunes and beach rock along the north shore of the island. Later he visited James Blout on St. Thomas, Virgin Islands and discussed possible field research in the Caribbean.

In January, Dr. Snead took a group of 20 undergraduates and three graduate students to Florida as part of the undergraduate Independent Study Program at Clark. The group worked on field problems on Sanibel Island and Key Largo. Tours were made through Everglades National Park and to the museums and research institutes in the Miami area.

In February, Dr. Snead made a study of three NASA space photographs of Iran for the Geographic Intelligence Division of GIMRADA at Fort Belvoir, Virginia. A paper describing the physical features found on these photographs was prepared by Dr. Snead and will be incorporated into the new space atlas which is being prepared for the Army.

In March, Dr. Snead received a new contract with the Office of Naval Research for study of desert coastal morphology. This contract is in preparation for field work along the Mahran Coast of West Pakistan in the spring and summer of 1967. Laboratory research during 1966 includes a study of Pleistocene sand samples taken along the Pakistan and Puerto Rican coasts, plus a detailed study of air photographs of Pakistan desert regions.

In May, Dr. Snead presented a paper on "Storm Damage and Coastal Changes on the New England Coast" at the spring meetings of the New England-St. Lawrence Valley Geographical Society (AAG) and the National Council for Geographic Education in Salem, Massachusetts.

During the summer of 1966, Dr. Snead plans to analyze Pakistan air photos, visit geomorphologists in Mexico and do research at Coastal Studies Institute, Louisiana State University. At the end of the summer he hopes to return to the Virgin Islands along with Dr. Anderson and set up a field camp for January, 1967.

Publications in 1965: with Ian Burton and Robert Kates, "The Shores of Megalopolis: Coast Occupance and Human Adjustment to Flood Hazard." C. W. Thornwaite Associates, Publications in Climatology, Vol. XVIII, No. 3, Elmer, New Jersey. In press: "Vegetation Types in the Las Bela Region of West Pakistan," Ecology; "Physical Geography Reconnaissance: Las Bela Coastal Plain, West Pakistan," Louisiana State University Press; and "Recent Morphological Changes Along the Coast of West Pakistan," Annals of the A.A.G.

Martyn J. Bowden

The major event in the Bowden household was the addition of Marc Kirkland on November 2. Research was largely restricted to completion of the dissertation, but a three-week time-out was taken in the Virgin Islands in January, from which a report entitled "Towards a Hydroclimatology of St. Croix, Virgin Islands," resulted, among other things. Contribution was made to the Clark University Conference on the New Conservation in a paper entitled: "The Future Cityscape: Form and Function."

Henry J. Warman

During the academic year of 1965-66 and the summer preceding, Dr. Warman completed some projects, continued work on others, and remained active on several committees and institutes. Of course, the teaching of three courses filled in the spare time!

Projects completed included sets of transparencies for use in overhead projectors, on the World and South America. The accompanying text material and art specifications involved a total of 66 different topics and maps, 33 to a set. Another completed project was the first in a series of textbooks, a fourth-grade book entitled The Changing Earth and Its People. The series is called "Living in Our Times."

Work continued on the revision of the White-Renner College Geography; the fifth and sixth grade books in the above-named series, and, in cooperation with Dr. Robert Perry, a set of overlays on North America.

Probably the most intriguing work included the preparation for the 1966-67 year-long NDEA Geography Institute. This institute will have 25 teachers from the northeastern states working full-time on the most modern aspects of Geography for secondary schools. Regular staff members will cooperate in the program, offering their specialties.

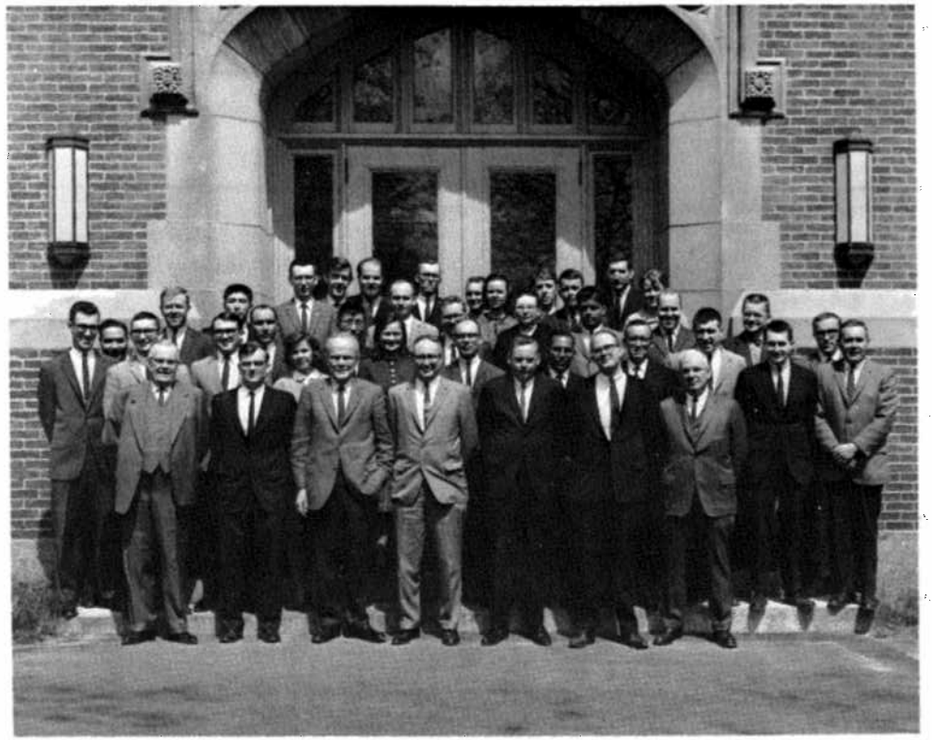
Raymond E. Murphy

Dr. Murphy taught two graduate courses this year--Problems in Economic Geography the first semester, Urban Geography the second--and has supervised a number of dissertations. He has also edited Economic Geography, which is constantly growing in circulation. But, most of all, he performed last rites on his book, The American City: An Urban Geography, and anxiously awaited, with much floor-pacing, its publication by McGraw-Hill. At long last the first copies appeared--in mid-March.

Guy H. Burnham

"Sir Guy," who was formally retired from Clark in June, 1965, was later asked to return to teach a course in Cartography for this academic year. This work will end on May 31--a date which also happens to mark the forty-fourth anniversary of his joining the staff of the School of Geography.

At present, Mr. Burnham is also busy in assisting the Alumni Office in making arrangements for the fiftieth reunion of his 1916 class. After commencement he and his wife are going to have a summer of rest and relaxation before making any plans for the future.



THE GROUP

First Row: (Staff, l. to r.) Guy H. Burnham, Martyn J. Bowden, Raymond E. Murphy, Saul B. Cohen, Director of the School of Geography, Rodman E. Snead, Robert W. Kates, Henry J. Warman.

Second Row: Wallace O'Brien, Merlin Lawson, John Allen, Maryann Johnston, Mary Alice Ealer, Paul Beaudet, Shyam Sharma, Frank Hodges, Ralph Lennon, Robert Thompson, Fred Kinch.

Third Row: Farouk El Gammal, Robert Adams, Ali Pourrabas, Suk-Han Shin, Donald Jellerson, Jane Knepler, Ranganathan Ramachandran, Fred Oxtoby, Thomas Madigan, Thomas Gledhill.

Fourth Row: Susumu Takeuchi, Lawrence Lewis, Henry McCutcheon, Elizabeth Johnson, Lee Phillips, Nora Gildemeister.

Last Row: Rowan Andrews, Niels West, Gary Whiteford, Roger Kasperson, director of the High School Geography Project at Clark, Bryan Thompson, Michael Schwartz.

The Workroom Today

NAME UNDERGRADUATE INSTITUTION	PROGRAM	GRADUATE MAJOR	OBJECTIVES
Merlin P. Lawson University of Buffalo	Ph.D.	Historical Geography	University Research and Teaching
Susumu Takeuchi Waseda University (Tokyo)	M.A.	Historical-Cultural Geography	Teaching
Wallace E. O'Brien Farmington State College	M.A.		Teaching
Robert L. A. Adams Williams College	Ph.D.	Resource Management	Teaching
John L. Allen University of Wyoming	Ph.D.	Cultural-Historical Geography	Teaching
Rohan Stewart Andrew University of Nottingham	M.A.	Urban Geography	Teaching
David G. Arey Denison University	Ph.D.	Resource Management	Academic-research
Paul R. Beaudet Fitchburg State Teachers College	Ph.D.	Urban Geography	Teaching
Mary Alice Ealer Shippensburg State College	M.A.	Geomorphology	Teaching
Farouk M. M. El Gammal Cairo University, Ain Shams University	Ph.D.	Urban Geography	Teaching
Nora A. Gildemeister University of Geneva, Switzerland	M.A.	Historical-Cultural Geography	Research
Thomas Edward Gledhill Rhode Island College	M.A.	Human Geography	Teaching
Jerry Alan Hall University of Buffalo	Ph.D.	Physical Geography, Geomorphology	Teaching, research
Larissa M. Hanuszczak Hunter College, CCNY	M.A.	Historical-Cultural Geography	Teaching, secondary level

NAME UNDERGRADUATE INSTITUTION	PROGRAM	GRADUATE MAJOR	OBJECTIVES
Donald C. Jellerson Gorham State Teachers College, Maine	M.A.	Urban Geography	Teaching or research
Elizabeth E. Johnson Southern Connecticut State College	M.A.	Historical-Cultural Geography	
Maryann M. Johnston Keene State College, New Hampshire	M.A.	Urban Geography	Teaching
Jane E. Knepler Illinois State University	Ph.D.	Economic	Teaching
Bruce L. La Rose Holy Cross	M.A.	Historical Geography	Teaching
Ralph A. Lennon, Jr. University of Massachusetts	M.A.	Political Geography	Teaching
Lawrence T. Lewis Worcester State College	Ph.D.	Urban Geography	Teaching
Henry R. McCutcheon McMaster University, Ontario, Canada	Ph.D.	Resource Management	
Nathan H. Meleen San Jose State College, Clark University	Ph.D.	Geomorphology	Teaching
Fred Oxtoby University of British Columbia	M.A.	Political Geography	
Jesse Louis Scott Pendleton, Jr. Central State of Ohio	Ph.D.	Urban-Economic Geography	Planning
Lee E. Phillips Dartmouth College	M.A.	Economic Geography	Planning
Ali-Asghar-Pourabbas Tehran University, Iran	M.A.	Physical Geography	
R. Ramachandran University of Madras, India	Ph.D.		

NAME UNDERGRADUATE INSTITUTION	PROGRAM	GRADUATE MAJOR	OBJECTIVES
Roger Roberge Assumption College	Ph.D.	Urban Geography	Teaching
Michael Schwartz Harpur College, Binghamton, New York	M.A.	Political Geography	Foreign Service Work (CARE or Peace Corps)
S. Sharm. Shyam Banaras Hindu University, India	Ph.D.		Teaching, research
Suk-Ham Shin Seoul National University, Korea	M.A.	Resource Management	Teaching
Bryan Thompson University of Toronto	Ph.D.	Urban Geography	Teaching, research
Robert W. Thompson Worcester State College	M.A.	Cultural Geography	Teaching
Niels West Boston University	M.A.		Teaching
Gary Whiteford University of Toronto (York University)	M.A.	Political Geography	Teaching

Thesis and Dissertation Topics

John L. Allen	Dissertation:	"The Changing Geography of the American Northwest, 1803-1815: The Lewis and Clark Expedition"
Rohan Stewart Andrew	Thesis:	"A Centrifugal-Centripetal Force Model of Urban Growth"
David G. Arey	Dissertation:	"Impact of Drought on Municipal Water Supply Planning"
Paul R. Beaudet	Dissertation:	"A Testing of the Concept of Suburbs and Satellites: The Buffalo, New York, Metropolitan Area as a Case Study"
Mary Alice Ealer	Thesis:	Geomorphology--United States; Sand Hook, New Jersey to Deal, New Jersey
Farouk M. M. El Gammal	Dissertation:	"Theory and Reality in the Use of Urban Land for Residential Purposes--the Case of Mobile Home Parks in Massachusetts."
Nora A. Gildemeister	Thesis:	Historical and Cultural. General area: South America
Thomas Edward Gledhill	Thesis:	"Population Geography of Sparsely Settled Rhode Island"
Jerry Alan Hall	Dissertation:	"Problems in Climato-Genetic Geomorphology"
Larissa M. Hanuszczak	Thesis:	"An Historical Geography of Kiev"
Elizabeth E. Johnson	Thesis:	Shaker Communities
Jane E. Knepler	Dissertation:	(tentative) "Shifting Patterns of Park Production in the United States"
Bruce Leo La Rose	Thesis:	"Central Place Study of Vermont, 1609-1803"
Merlin P. Lawson	Dissertation:	"Climate of Great Plains during Incipient Settlement: 1840-1850"
Ralph A. Lennon, Jr.	Thesis:	Political Geography--Africa
Lawrence T. Lewis	Dissertation:	"The Spatial Arrangement of Renter-Occupied Housing in the Suburban Zone of Selected SMSA's"
Nathan H. Meleen	Dissertation:	"General Area of Stream Reversal in New England Pleistocene"
Jesse Louis Scott Pendleton	Dissertation:	"Differential Growth Rates of Worcester and Springfield, Mass."
Ali-Asghar-Pourabbas	Thesis:	The Persian Gulf through the Viewpoint of the Arab Geographer
R. Ramachandran	Dissertation:	"Technological Change and the Spatial Diffusion of Innovations in Rural India"
Roger Roberge	Dissertation:	Innovation and Economic Growth; Their Spatial Implications
S. Sharm. Shyam	Dissertation:	"The Impact of Now-Indigenous Population on the Economy of Assam"
Suk-Ham Shin	Thesis:	Water Resources
Susumu Takeuchi	Thesis:	Historical-Urban--Japan
Bryan Thompson	Dissertation:	(tentative) Settlement Patterns of post-World War II Immigrants into the Metropolitan Toronto Area.
Niels West	Thesis:	Resource Management, with special interest in fishing
Gary Whiteford	Thesis:	Political Geography--Ontario

ARTICLES

With this issue, The Monadnock has been expanded to include a number of papers by M.A. and Ph.D. candidates at the Graduate School. The purpose of this is to acquaint Clark alumni and other members of the profession with the type and variety of graduate student work being carried on at the School.

The articles were submitted for review to the Editorial Board of The Monadnock, composed of students currently at Clark. Five were selected for publication. Although they were concerned with quantitative methods, perception of the environment, and urban geography, the papers do not reflect all of the many interests at Clark. These papers are not intended to be finished pieces of research. Some of them incorporate ideas and suggestions by the staff; many are seminar presentations serving as a focal point for further discussion. With this in mind, it is stipulated that no parts of these papers may be reproduced without the expressed consent of the Clark University Geographical Society and the writer of the article.

Persons wishing to make comments, and/or schools desiring more information or data concerning the published articles, are invited to write directly to the individuals concerned at the Graduate School.

The Editorial Board

MYTH AND PERCEPTION: THE THEME OF UNDERSTANDING THE ENVIRONMENT

John L. Allen

"Men at all times have been influenced quite as much
by beliefs as by facts." -- Ralph Hall Brown, 1948

How indirectly do we know that environment in which we exist and how completely do we function as if that which we believe to be true is the reality of the environment itself. The errors that men hold and have held in beliefs often serve as truth in effect. Virtually the entire history of humanity has been interwoven with the thread of the "terrae incognitae", the unknown lands, as we, as geographers, have been told that the "most fascinating terrae incognitae of all are those that lie within the minds and hearts of men." That which we observe as truth is sometimes nothing more than the shadows of images. This is the basis for the theme of myth and perception. Yet this theme, so important in shaping geographical knowledge, has not been enunciated clearly by geographers. And while all geographical knowledge, as well as the expressions of that knowledge, is influenced by myth, only a very few have recognized the theme as important enough to warrant a separate and distinct study of myth and perception itself. In general, geography has lagged behind most of the other sciences in its refusal to accept studies of behavior and perception as they pertain to the way in which men understand their environment. It is the purpose of this paper to illustrate, first, the nature of these perceptions and how they are modified, and second, how myths have actually influenced the attainment of geographical knowledge.

This, then, is a study in what John K. Wright calls geosophy--"the nature and expression of geographical ideas both past and present...the geographical ideas, both true and false, of all manner of people--not only geographers, but farmers and fishermen, business executives and poets, novelists and painters, Bedouins and Hottentots." (Wright, 1947, p. 12). The discussion will focus upon "the world view"--the notions held collectively and individually at a specific point in time about the nature of the earth's surface and its content--and will adopt as the central theme the relationship between these perceptions or images and the course of exploration and occupation of the earth by man (Wright, 1925a, 1925b, 1925c, 1935, 1942, 1943, 1947, 1953).

There are two general categories of concepts dealing with how men imagine the character of their world and the manner in which it is ordered: that consensual world view which is held by man collectively, and that personal notion of the world which man holds as an individual and which is more complex and transcends reality to a greater degree than the collective world view. The collective notions of the character and arrangement of the world embrace the totality of personal and scientific observations on the aspects of the shared world picture (Lowenthal, 1961, p. 243). This general consensus tends to be cumulative and exists as the result of the combination of a number of smaller collective world views, these being more influenced by particular societal or environmental influences. Thus the collective world view held by Cosmas and many other Christians of the sixth century--a view of the world as a flat parallelogram, twice as broad from east to west as from north to south, surrounded by oceans and vaulted by the heavens--was founded upon the tenets of Christian dogma and varied considerably from the view of the world as a sphere as held by educated pagans of the same time (Beazley, 1897, pp. 273-303). But at this specific point in time, these two divergent opinions might have merged to form the universal world view, at least to persons who were aware of and familiar with both. And as geographical knowledge has expanded, so have the horizons of geography become more familiar until most people today share a common conception of the world.

This is not to say that the universal world view is adhered to by all and is not subject to change. Individuals often tend to accept things as truth which may not be within the scope of the world view and yet may be viewed by them as universal knowledge. And while the general consensus may be fairly common to all people, segments of the consensus may be subject to dispute by selected individuals or groups. Moreover, the world view is highly ephemeral in that the progress of geographical knowledge is in a constant state of flux and as such is liable to rapid and drastic changes. Thus was the world view of 16th century Europe in a highly transitory state resulting from the abrupt expansion of geographical knowledge. But since man always has adhered to the past notions and understandings about his world (as "collective guides to behavior"), the general world view during this period of transition eroded slowly rather than changing all at once and changed at different rates for different individuals and groups, depending upon the extent and reliability of their geographical knowledge. One may speak of "the white light of knowledge" but rainbows playing along the mists

that hid the New World from the view of Europe were there because the components of knowledge had different wave lengths. Geographical knowledge is a spectrum, with wave lengths of varying size and intensity combining to give fact its fullest expression (DeVoto, 1952).

The existence of a universal and shared world view presupposes the further presence of separate or private world views, each of these encompassing certain segments of the shared picture and incorporating private elements which may or may not become a part of or belong to the universal and shared world experience. The consensual world view may contain personal terrae incognitae--lands that are unknown from the standpoint of personal experience but accepted as reality as the result of the a priori acceptance of a common world picture. Thus do all geographers recognize that there is, in fact, a place called Australia--even if they have never observed Australia for themselves. On the other hand, the private world view is based upon personal terrae cognitae or the immediate personal surroundings as viewed and understood by an individual observer (Boulding, 1961). As a result, the personal world view is, according to Lowenthal, "far more localized and restricted in space and time." Furthermore, while some sections of the individual's world view may be accepted within the confines of the general collective notion, most parts of the personal world image are never incorporated into the universal picture and thus remain "less accessible to inquiry and exploration than is the world we all share." (Lowenthal, 1961, p. 249). The world picture as seen by the individual, then, may, as has already been noted, transcend reality to a greater degree than does that world image shared by all.

Each individual is alone in his perception of his private world and in his acceptance or rejection of elements of the collective world view and in being alone, is subject to having his imagination distort what he sees in the landscape. To what extent, for example, were the earliest reports of the English explorers of New England--who looked upon the area as one of great beauty and fertility--based upon fact or upon imagination? Moreover, each individual is subject to the influences of cultural and linguistic differences, to the editing and distortion resulting from personal feelings and emotion, and to the determinations of memory or the individual past (Lowenthal, 1961, pp. 251-260). This is by no means to conclude that the nature of the personal world view diverges greatly from the consensual image, for if the personal view and the shared view were not relatively mutually recognizable, a common world view could not have been constructed. The conclusion that may be drawn, however, is that no two individuals will ever perceive the same phenomenon, at the same point in space and time, in precisely the same manner, nor will the expressions of their perception have the same form or content, although they will probably remain conceptually similar.

These observations on the nature of collective and personal world views may seem to obscure the central theme of this discussion, which is to evaluate the relationships between perception and the course of exploration and occupation of the earth's surface by man. Yet, they are necessary in that any discussion of this nature must embrace some statements regarding the processes of the acquisition of geographical knowledge since the human activities of exploration and occupance are directly influenced by the degree to which men perceive their environment, by the manner in which they understand what they perceive, and by the ways in which they express that understanding. The remainder of the present discussion will be devoted to observations of the roles played by myths and perception in the history of geographical discovery and in the patterns of occupance, as observed and interpreted in the light of the relevant collective and personal world views.

There are several significant approaches that might be used in discussing the history of exploration and occupation but for the purpose of brevity, the dual approach used here is to interpret first "the influence of earlier geographical knowledge and belief upon the course of exploration" and second, to evaluate "the contribution made by exploration to subsequent geographical knowledge" (Wright, 1943, p. 20), particularly as that knowledge influences the pattern of human occupance. That this approach is unique may be illustrated by the fact that only a few geographers, among them J. K. Wright, have attempted to study the world as it appeared to the observers at a specific point in time. Most geographers, rather, have discarded or denied the importance of myths and perception and have directed their studies toward determining the world picture as it should have appeared to these observers.

The number of explorers who have gone forth in search of nothing in particular is few indeed. Most have had definite objectives in mind and these objectives have been gleaned from the information available to them, their world view as formulated in their own minds from the geographical conceptualizations of their own and previous times. These preconceived notions were vitally important in establishing the courses that explorers took and even in the character of their observations about that which they had discovered. "Columbus was constantly seeing things that to him betokened the nearness of Marco Polo's Cathay and the Grand Khan's realms..../ The / doctrine that the polar regions were uninhabitable...colored the thought of certain nineteenth century explorers who described the Arctic lands and seas as lifeless wastes, despite evidence to the contrary that they might have seen had their eyes been open to it (Wright, 1943, p. 21; Nunn, 1924). The strength of the myths and misconceptions upon which these preconceived notions were based was so strong as to reinforce the course of geographical discovery, to the extent that in the event one explorer sought to reach a specific objective and failed, others immediately followed upon his heels until the objective was either reached or realized as illusory. Thus, the history of geographical exploration and discovery is replete with the myths and legends that comprised geographical lore--the kingdom of Prester John, the Golden Land of Quivira, the El Dorado, Terra Australis Incognita--all of which existed only in the minds of men but for which men nevertheless sought, fought, and died.

In order to investigate the manner in which myths may influence the development of geographical knowledge, the myths of the great southern continent of Terra Australis Incognita and of the islands of the Atlantic may be observed as cases in point (Stefansson, 1952; Babcock, 1922). The idea of a great southern continent was given substance by classical geographers, primarily Ptolemy, who produced theoretical arguments to prove its existence. Magellan, in passing through a strait from the Atlantic to the Pacific, was believed to have

confirmed the existence of this southern land, and the presence of a great southern continent was an integral part of the universal world view of the Age of Discovery. Many explorers, including Drake, were sent in search of this mythical land and many returned claiming to have discovered or seen parts of it. The land and peoples of this Southern continent were written about as if they were well known. A 1722 account dealing with Terra Australis Incognita tells that "the southern unknown region, or Terra Australis Incognita, is a vast tract land as we judge by the coasts. I have distinguished parts of it by the several names given it by Pilots and Captains who have sailed by them....The inhabitants are white, of a large stature, strong, industrious, and courageous....Some modern relations tell us that in all that vast country they have neither King nor Prince, all the people being combined together in several factions in the form of a Commonwealth. They choose governors only to make the lazy work, punish offenders, and render justice to every man. They are idolators, and have oratories to pray to their idols in; they observe certain feasts and wash their bodies on certain days every year." (Baker, 1963, pp. 186-187). It is a certainty that parts of Australia and New Zealand and the southern islands had been seen by various explorers, but the presence of a great southern continent was a myth founded upon the constructions of the theoretical geographers. The whole myth of the great southern continent was finally exploded by James Cook and "out of this series of expeditions there came a great wealth of knowledge which not only revolutionized ideas about the Pacific and Australia, but began our modern era of geography." (Baker, 1963, p. 187)

A second influential set of myths were those dealing with the legendary islands of the Atlantic Ocean. (Babcock, 1922). By the beginning of the sixteenth century, following the first reports of Columbus' voyages, the image of the New World was beginning to dawn in the European mind as a few small, delectable islands, bowers of bliss, gardens of eternal youth and spring which could shelter one from the dark wilderness of the world. The Atlantic hid in its misty vastness many wonderful islands, and these island images, compounded of "wonder, terror, wealth, religious perfection, communism, utopianism, or political power," conditioned the European image of America (Jones, 1964, pp. 1-20).

Ancient and medieval maps show the location of various mythical islands, among them St. Brandan's Isle, the island of Brazil, and Antilla, all of which were surrounded by an aura of legend and mystery and referred to in numerous travelers' accounts and geographical documents. The first of these islands to appear on maps was St. Brandan's Isle, so called after the saint of that name who supposedly visited there in the sixth century. As with the other mythical islands of the Atlantic, the facts surrounding the location and nature of St. Brandan's Isle are clouded in mystery and ambiguity, even to the extent that the location never became well enough fixed to appear in the same place on consecutive maps. It is generally assumed that St. Brandan's Isle was located somewhere in the Northland since many of the myths associated with it place it near the iceberg where Judas Iscariot cooled his heels on his annual day's leave from Hell.

Another of the mythical islands was the island of Brazil, appearing on maps in several locations, being placed first just off the coast of Ireland and then shifting westward with the course of exploration as new geographical knowledge altered and transferred the myth from one location to another. The strength of a myth is illustrated in that the notion of the island of Brazil persisted long after geographical knowledge had disproved its mythical location and existence.

The third legendary island is the Island of Antillia, perhaps the most important due to the role it played in the schemes for exploration of the Atlantic. It is possible that Antillia was first associated in the minds of medieval geographers with the Pillars of Hercules beyond which no sailors dared to voyage. The location of Antillia also shifted with the course of exploration and even after the existence of the island had been shown to be legendary, the myth of the place itself persisted, the location being shifted to the mainland of the New World and becoming associated with the Seven Cities of Cibola.

While the importance of the mythical lands of the Atlantic may be exaggerated, they were vital to the cumulative world view, particularly in terms of establishing distances across the Atlantic, and they did stimulate interest in the Atlantic Ocean and lured on explorers who discovered not the islands of mythical conception, but the New World. The point to be made here is of the importance of the European belief in riches and perfection beyond the sunset. In the somber melancholy that hung over Europe at the close of the Middle Ages--as evidenced by the great vogue of the Dance of Death as a theme in literature and art, and by the obsession of various lyric poets with death and misery--the dream world that lay beyond the sunset was welcomed with relief as an imaginative escape (Jones, 1964). And the search for and settlement of this dream world was a geographical phenomenon which has never been equaled in terms of the importance it had for the extension of geographic knowledge.

The foregoing discussion of myth and perception as influencing factors in exploration is, however, only half the picture. The other half deals with the subsequent influences of geographical discovery, the contributions of discovery and exploration to the composite world view of certain peoples. Again it may be noted that this approach is at variance with the main currents in geographical studies, most geographers preferring to study merely the patterns of occupation rather than how myths and misconceptions have developed these patterns. The concern here is specifically with the manner in which the information and misinformation garnered from the reports of journeys of exploration, or retained from the myths of the past, led to the misconceptions which gave impetus to the direction of occupance or circumscribed patterns of settlement, molding to some extent the geographical expansion of nations and the political development of states. The scope of treatment is again topically limited, this time to a discussion of the occupation of the American West.

In the vast hodgepodge of fact and fancy that existed in the minds of men from the discovery of the New World to the date of the Louisiana Purchase, there were five salient features that were central to the complex of myth and mystery that cloaked the American West. Two of these themes, that of symmetrical and interlocking drainage systems, and that of the Great River of the West, were residuals from medieval theoretical geography. The other three, the Northwest Passage, the Western Sea, and the Straits of Anian, were durable

myths that entered the common view as a result of misunderstood or misconstrued observations from the reports of the early explorers of the American West. All of these myths, however, originated in experience of some kind. And whether that experience was incomplete or misunderstood, whether it was distorted by logic or enlarged by fantasy, it had the capacity to invent geography that would influence thought and action quite as much as real geography. When the earlier European image of the New World as a paradise of riches and perfection is added to the five mythical features above, the result is the core of misconception, the core of the view of the American West which came to embody two quite different conceptions. The first of these conceptions utilized the notions of the Northwest Passage, the interlocking drainage patterns, and the Great River of the West and finally became symbolized in the notions of America as a vast empire based on commerce and trade--a highway to India. The second concept was based on the images of the American West as a region of great fertility and vast agricultural possibilities and became effective in embellishing the ideas of America as an empire founded and existing upon the broad foundations of agriculture.

The first concept found expression in the view held by Thomas Jefferson and Thomas Hart Benton, the perception of the American West as a vast highway, traversed by trappers and fur-traders, and providing the nation with easy access to the Pacific Ocean from which the way to India and the Orient lay open. The concept of the vast interior of the North American continent as a highway to the Pacific was probably a holdover from the mercantilist notion and drew upon the long and fabled history of the search for the Northwest Passage. Intimately connected with the dream of manifest destiny, the myth of the great highway played an extremely important role in the first explorations of the interior of the continent, causing Lewis and Clark to be sent forth, not in search of agricultural land for the purposes of expansion, but in search of an easy and accessible route to the Western Ocean, and probably influencing their perceptions and understandings of the nature of the country through which they passed on their journey to the Pacific.

The second great myth which influenced the course of westward expansion was the notion of a vast continental empire based upon the agrarian tradition, an empire occupying an immense region of beauty and fertility, traversed by great rivers beside which "the Nile is but a Rivulet and the Danube a mere ditch," (Smith, 1950, p. 12) a land perceived as "the Garden of the World." The myth of the garden was implicit in the first glimmerings of westward expansion and continued as a dominant factor in American society until near the end of the nineteenth century. The course of human occupancy reflected the influence of this myth, with new communities, devoted neither to trade nor to further expansion but to cultivation, springing up with each westward surge of American civilization, leaving behind them the peripheral coastal and maritime-oriented settlements, and sending forth as their vanguard the frontier settlements. The myth of the garden brought forth the concepts of free men cultivating free soil and of the Agrarian utopia, and eventually was instrumental in such political developments as the sectional conflict which arose over slavery and the partition and parceling out of vast portions of land through the Homestead Act. And as the myth of the garden lured settlers further and further westward, it ran head on into another myth--the myth of the Great American Desert.

Whereas those who adhered to the myth of the garden saw the interior of America as a land of promise, flowing with milk and honey, the travelers and explorers who crossed the Great Plains to the Pacific and the settlers who followed in their wake to take up the land granted them through the Homestead Act found in the lands beyond the Mississippi and lower Missouri valleys no lands of fertile abundance but rather vast plains which they perceived as sterile and sandy wastes (Smith, 1950, pp. 201-213). The furthermost extensions of the agrarian tradition were assumed to be anchored in the eastern portions of Kansas and Nebraska, for beyond that point, the rainfall upon which the myth of the garden depended so heavily diminished rapidly. This was the limit of agricultural settlement, the frontier of Frederick Jackson Turner, whose frontier hypothesis, with its emphasis upon agricultural settlement was spawned by the myth of the garden (Smith, 1950, pp. 291-305). And this myth of the garden was strong enough to Turner's frontier settlers to allow them to discount the myth of the desert--a myth which led early observers to perceive the Great Plains as distinctly Asiatic in character, limiting the future expansion of agriculture and fit only for the occupance of bands of nomadic tribesmen, akin to the Mongol hordes of Central Asia (Brown, 1948, pp. 369-387). The myth of the garden achieved control over men's perceptions and imaginations and was projected into the High Plains, causing one observer to remark upon the plains of Nebraska as "a museum of wonder and value" rather than "an expanse of hot, dry sand; sometimes...veiled by long coarse grass." Thus did Americans occupy the interior of their continent, lured by the glimmering image of an agricultural paradise, based partially on reality and partially on conjecture, but assuming mythical proportions and as such, directly influencing the manner in which men perceived and understood their environment. The myth of the garden has been illustrated not only in America but may have played an important role in the recent Soviet attempt to expand their cultivated lands into Central Asia through the implementation of the "Virgin Lands" program. While it is not the intent here to pursue this concept further, mention of it is worthwhile in that it demonstrates how a myth may transcend boundaries of space and time.

In retrospect, it has been seen that men are indeed influenced as much by beliefs as by facts and that they do function as if that which they perceive as fact is, in truth, reality. J.K. Wright has compared the mind of man to a mirror which not only reflects what it perceives but "retains, records and interprets" these reflections. It should be the proper study of geography not only to study these reflections but also to study the mirror that reflects them for the appearance and nature of the reflected images is determined by the condition of the mirror of the mind, whether it is cracked, warped, spotted, or otherwise modified by both collective and personal experiences. For all images are, as Dr. Wright says, somewhat "distorted and discolored by the quality of the minds in which they have been lodged." They have been blurred by accretions of geographical lore, and confused by thoughts. The fact that they are images of the geographical environment should enable us to distinguish between truth as it was and truth as it appeared to the observers. And if we, as geographers, are to study the geographic environment, should we not begin with the study of geographical thought, the manner in which men have perceived and understood that environment?

BIBLIOGRAPHY

Books

Babcock, William H., Legendary Islands of the Atlantic. American Geographical Society Research Series, No. 8, New York, 1922.

Baker, J.N.L., The History of Geography, Chapter 7. Oxford University Press, 1963.

Beazley, Cr. R., The Dawn of Modern Geography, 3 Volumes. London, 1897.

Boulding, Kenneth E., The Image. University of Michigan, 1961.

Brown, Ralph H., Historical Geography of the United States. Harcourt, Brace and Company, New York, 1948.

_____, Mirror for Americans: Likeness of the Eastern Seaboard in 1810. American Geographic Society Special Publication No. 27, New York, 1943.

De Voto, Bernard, Course of Empire, Houghton-Mifflin, Boston, 1952.

Jones, Howard M., O Strange New World. Viking Press, New York, 1964.

Nunn, G.E., Geographical Conceptions of Columbus. American Geographical Society Research Series No. 14, New York, 1924.

Smith, H.N., Virgin Land: The American West in Symbol and Myth. Harvard University Press, Cambridge, 1950.

Stefannson, Vilhjalmur, Great Adventures and Explorations. The Dial Press, New York, 1947.

Wright, John K., Geography in the Making: The American Geographical Society 1851-1951. American Geographical Society, New York, 1952.

_____, The Geographical Lore of the Time of the Crusades, A Study in the History of Medieval Science and Tradition in Western Europe. American Geographical Society Research Series No. 15, New York, 1925.

Articles

Heathcote, R.L., "Conservation or Opportune Use: The Pastoralist's Problem in Semi-Arid Australia" in The Advancement of Science, Vol. XXI, No. 89, May, 1964, pp. 47-60.

Lowenthal, David, "Geography, Experience, and Imagination: Toward a Geographical Epistemology" in the Annals of the American Association of Geographers, Vol. 51, 1961, pp. 241-260.

Wright, John K., "A Plea for the History of Geography," Isis, VIII, 1925, pp. 477-491.

_____, "Crossbreeding Geographical Quantities" in Geographic Review, Vol. 45, 1955, pp. 52-65.

_____, "Map Makers are Human: Comments on the Subjective in Maps," Geographical Review, XXXII, 1942, pp. 527-544.

_____, "Open Polar Sea," Geographical Review, XLIII, 1953, pp. 338-365.

_____, "Some Broader Aspects of the History of Exploration: A Review," Geographical Review, XXV, 1935, pp. 317-320.

_____, "Terrae Incognitae: The Place of Imagination in Geography," Annals A.A.G., XXXVII, 1947, pp. 1-15.

_____, "The History of Geography: A Point of View," Annals A.A.G., XV, No. 4, 1925, pp. 192-201.

_____, "Where History and Geography Meet, Recent American Studies in the History of Exploration," Proceedings of the Eighth American Scientific Congress, Washington, 1940, IX, (History of Exploration and Cartography), 1943, pp. 17-23.

VARIATIONS IN THE INCIDENCE OF SUICIDE IN THE STATE OF MASSACHUSETTS: AN EXERCISE IN THE USE OF THE POISSON DISTRIBUTION*

Bryan Thompson

Introduction

Maps showing rates can be misleading since the rates usually are derived from widely differing base populations. This paper points out the limitations of using maps to show suicide rates, and outlines an alternative procedure for illustrating areal variations. No attempt is made to account for the differences in suicide rates.

Method

Suicide rates per 100,000 of population were calculated for the fourteen counties of Massachusetts (U.S. Census of Population, 1960) (Figure 1). In comparison with the state average of 8.04 suicides per 100,000 of population, Barnstable and Dukes counties appear to have high rates, and Nantucket and Hampshire counties low rates. However, the above-mentioned counties are among the least populated in the State. The inference was that high and low rates may have resulted from using an expansion factor, and that in terms of actual suicides there was possibly no statistically significant difference between the expected and observed frequencies. Or, in other words, many of the variations could be explained as normal chance occurrences.

Where the probability of events occurring is very small, in this case suicides, the resulting distributions are not normal even when the populations are very large. Observed frequencies of rare events, assuming equal probabilities of occurrence throughout the populations, have been shown to approximate a skewed distribution known as the Poisson distribution (Maxwell, 1961; Dacey, 1964). The underlying assumption in this article was that the probabilities of suicides in 1960 were constant from county to county. The Poisson distribution could not be used to study the number of suicides in any given area over a period of time since the factors determining suicide vary from year to year.

Poisson probability tables were used to determine the probability of obtaining the observed number of suicides for each county. (Table 1). Figures for the expected number of suicides were obtained by assuming that the chances of suicide were the same throughout the State. For example, Barnstable County had 11 suicides when in fact only 5.7 were expected. The probability of 11 or more suicides is 0.031, and thus there was a statistically significant difference at the 0.05 level between the expected and observed results. Similarly, Bristol County had 18 suicides when in fact 32 were expected. In this case the probability of 18 suicides or less is 0.004, and again there was a statistically significant difference. A map was drawn showing the probability of obtaining the observed number of suicides for each county in the State. (Figure 2).

Findings and Conclusion

There were only four counties in the State in which there was a statistically significant difference between the observed and expected number of suicides. Furthermore, only one of the four counties (Barnstable) was included in either the highest or lowest category in Figure 1. Thus the Poisson distribution obviates differences due to random variations. Maps based on probabilities will focus attention on areas where differences are statistically significant. From this point research would be directed at the most important question, namely that of discovering reasons for areal differences in the incidence of suicide throughout the State of Massachusetts.

* This paper is based on an article by Mieczyslaw Choynowski: "Maps Based on Probabilities," American Statistical Association Journal, LIV, No. 286 (June, 1959), pp. 385-389.

TABLE I

Suicides in the Counties of Massachusetts (1960)

County	Population in thousands	Number of Suicides per 100,000	Number of Suicides Expected	Number of Suicides Observed	Probability
Barnstable	70	15.7	5.7	11	.031
Berkshire	142	9.1	11.4	13	N.S.*
Bristol	398	4.5	32.0	18	.004
Dukes	6	34.3	0.5	2	N.S.
Essex	569	8.8	45.7	50	N.S.
Franklin	55	12.8	4.4	7	N.S.
Hampden	429	10.2	34.5	44	N.S.
Hampshire	103	3.9	8.3	4	N.S.
Middlesex	1,239	6.5	99.6	80	.021
Nantucket	4	0	0.3	0	N.S.
Norfolk	510	7.5	41.0	38	N.S.
Plymouth	248	8.1	20.0	20	N.S.
Suffolk	792	7.1	63.7	56	N.S.
Worcester	583	12.2	49.9	71	.003

State Average: 8.04 per 100,000
*N.S. -- Not Significant (probability greater than 0.05)

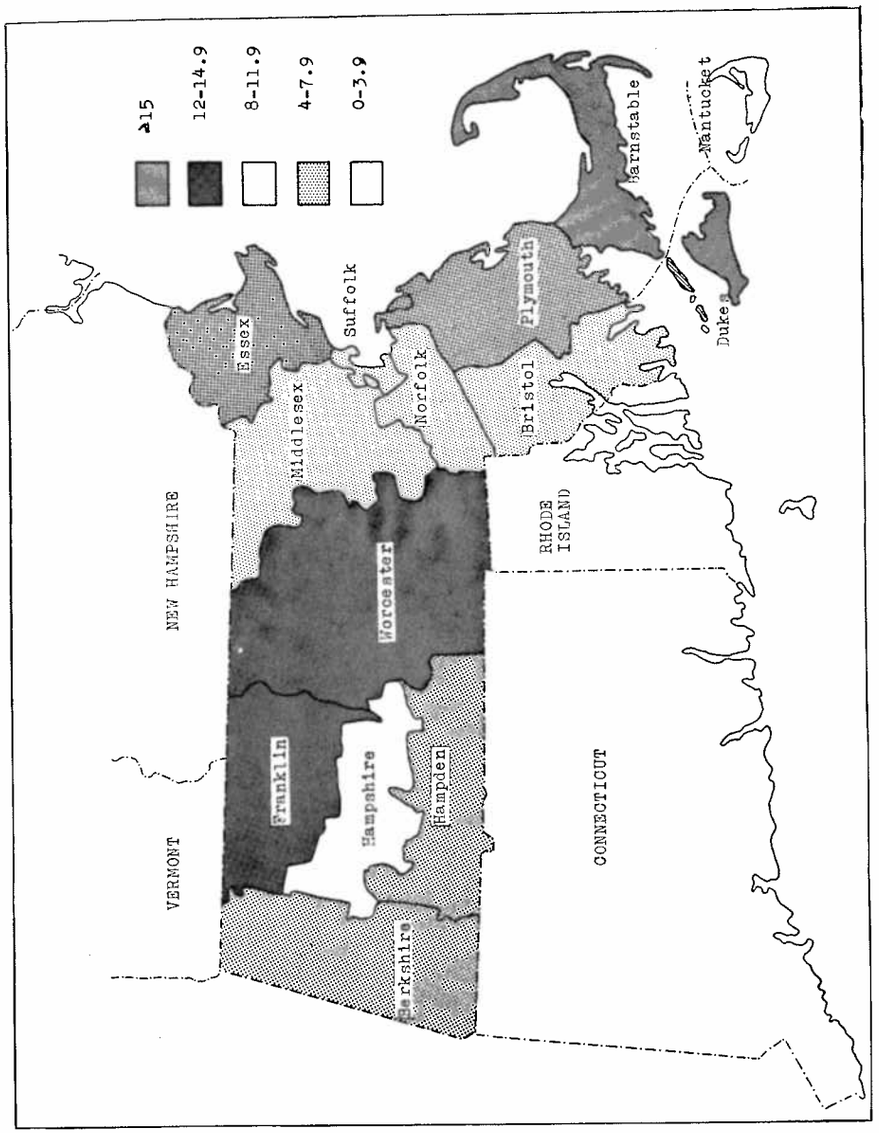


Figure 1. Rates of suicides per 100,000 of population in the counties of Massachusetts (1960)

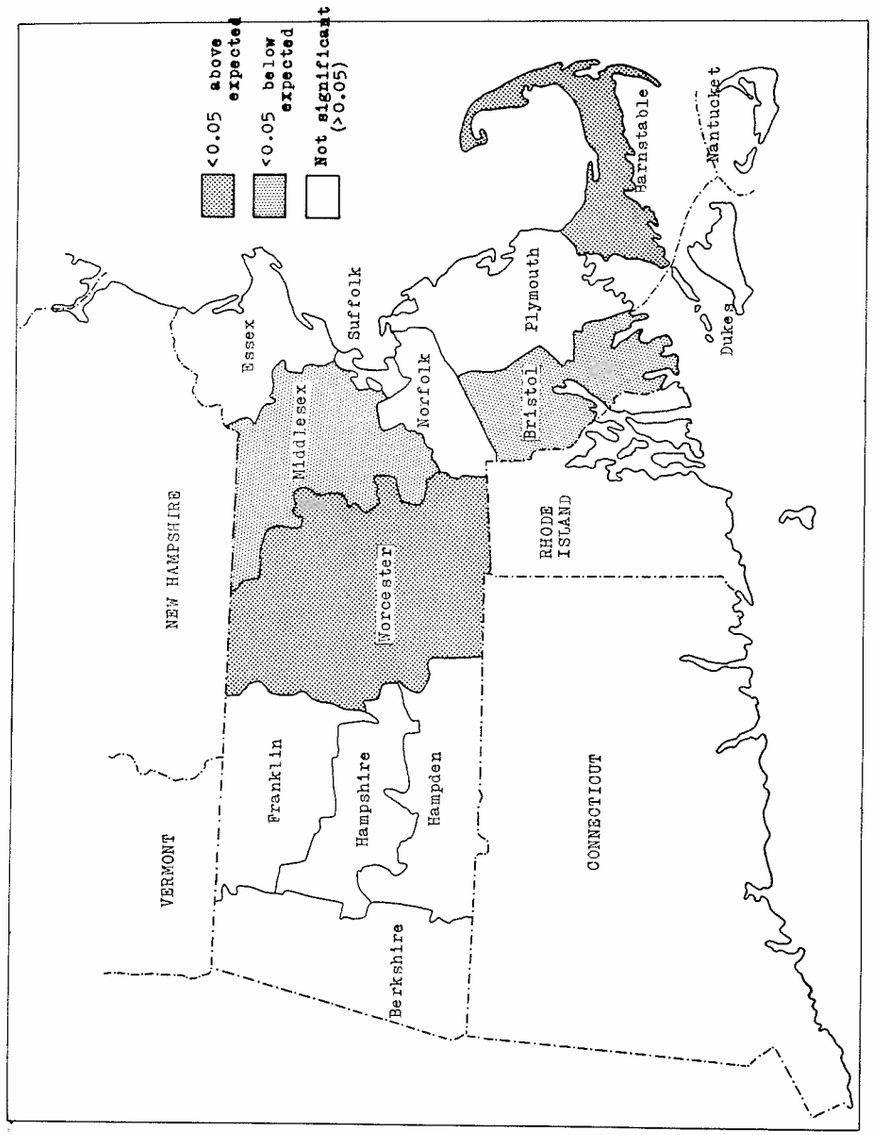


Figure 2. Probability of observed number of suicides in the counties of Massachusetts

BIBLIOGRAPHY

Choynowski, Mieczyslaw, 1959.
Maps based on probabilities, American Statistical Association Journal, 54, pp. 385-389.

Dacey, Michael F., 1964.
Modified Poisson probability law for front pattern more regular than random, Annals, Association of American Geographers, 54, pp. 559-565.

Maxwell, A.E., 1961.
Analyzing Qualitative Data, John Wiley and Sons, New York.

United States Bureau of the Census, Census of Population: 1960, Vol. 1, Part A, pp. 23-11 -- 23-12; United States Department of Health, Education and Welfare, Vital Statistics of the United States 1960, Vol. 11, Mortality, Part B, pp. 9-459 -- 9-461.

INTER-URBAN VARIATIONS IN RESIDENTIAL MOBILITY

Paul R. Beaudet

Americans have become increasingly mobile in terms of place of residence in the past decade. According to the 1960 Census, 49.9% of all Americans over five years of age lived in a different house in 1960 than in 1955 (Census of Population, Table I). Although such mobility has included moving from central cities to suburban rings, from one metropolitan area to another, and from rural to urban locations, it has not been uniform. For example, a low of 26% and a high of 99% population mobility were registered in the areas sampled for this study. (See Table I)

Purpose of the Study

The purpose of this study is to investigate briefly selected factors believed to be associated with variations in residential mobility. There are certainly more factors associated with such variations, but this paper is a preliminary attempt to explain the pattern. The following questions will be emphasized: (1) Are variations in residential mobility throughout the United States related to variations in occupations of the resident labor force; age of the resident male population; median income; educational level; and renter-occupied units as a percent of all occupied units? (2) How much of the total variation in residential mobility may be explained by the combination of these factors?

There seems to be very little research effort concerning the subject of residential mobility. Duncan and Reiss (1956, p. 256) devoted a chapter to mobility, and concluded that residential mobility is higher in non-manufacturing than in manufacturing communities. Their study, however, was different from this one. First, Duncan and Reiss' was a much more inclusive study; secondly, concerning mobility, their findings were based on 1950 Census figures, in which mobility was defined as the proportion of the population over five years of age that lived in a different house in the United States or abroad in 1950 than in 1949; the 1960 definition of residential mobility was substantially different in terms of span of years (see below). Finally, Duncan and Reiss dealt with all incorporated areas of 10,000 or more in the United States as their areal unit of study, rather than with individual census tracts.

Study Design

Census tracts were used as the areal unit of study; tract data are available from the U.S. Census of Population and Housing, Census Tracts, for most cities of 50,000 or more, and most Standard Metropolitan Statistical Areas in the United States. Census tracts are relatively homogeneous in terms of population and socio-economic characteristics, thus they would seem to be a practical unit on which to base the research. The entire United States was selected as the area of study. Ninety cities were chosen by means of a systematic aligned sample, which assured a more even coverage of the country than a simple random sample (see Figure 1). Despite the type of sampling design chosen, the number of samples was greater east of the Mississippi River because of the greater number of cities of 50,000 or more east of it. Two tracts were selected within each city of 50,000 or more, or S.M.S.A., by means of a table of random numbers. A total of 180 tracts were thus sampled, including tracts within central cities, suburban rings, and incorporated and unincorporated placed in the remainders of S.M.S.A.'s.

The Pearson product-moment correlation was calculated to obtain the degree of association between residential mobility and each of the independent variables: education, income, etc. (see Table II). Since the variables are not really independent, but rather are related to one another, a step-wise regression analysis was then calculated in order to determine how much of the total variation of residential mobility might be explained statistically by the combination of the independent variables.

Limitations of the Study

The choice of cities is not strictly representative of all cities in the United States. Unincorporated urban areas, and cities of less than 50,000 outside of S.M.S.A.'s are not included because they are not tracted. The conclusions applicable to the areal units utilized in this study are not necessarily applicable to other types of areal units, such as corporate cities, urbanized areas, etc.

TABLE I
Maximum and Minimum Recorded Observations, By Census Tract

	Maximum	Minimum	Range
Residential mobility	99.0%	26.0%	53.0%
White collar workers as a percent of total resident labor force	80.6%	6.2%	74.4%
Renter-occupied housing as a percent of all dwelling units	95.1%	1.0%	94.1%
Median age	54.8	16.8	38.0
Median number of years of education	14.8	4.2	10.6
Median income	$21,517	$2,348	$19,169

Definition of terms

1. Residential mobility: Percent of the population over five years of age that lived in a different house in 1960 than in 1955, in the U.S. or abroad. (Census tracts, Table P-1).
2. White-collar occupations: Those persons, generally salaried, which include professional, technical, and kindred workers; managers, officers, and proprietors; clerical and kindred workers; and sales workers. (Barry, 1961, p. 11). White-collar workers as a percent of the total resident labor force will be used (Census Tracts, Table P-3).
3. Age of the resident male population: Median age of all males (Census tracts, Table P-2).
4. Educational level: Median school years completed of persons 25 years old or over (Census tracts, Table P-1).
5. Renter-occupied housing: Total non-white and white renter-occupied units as a percent of all housing units (Census tracts, Table H-1).
6. Income: Median income of families. (Census tracts, Table P-1).

TABLE II
Results of Correlations Between
Residential Mobility and Five Independent Variables

	Age	Income	Education	White-collar workers	Renter-occupied housing
Residential Mobility	-.25**	.12	.12	.15*	.39**

* Significant at the .01 level
** Significant at the .001 level

Testing of the hypotheses:

1. There is a high degree of association between residential mobility and proportions of the resident labor force in white-collar occupations.

It was assumed that persons in white-collar occupations might be more mobile than those in the blue-collar labor force. However, on the basis of the correlation results, the hypothesis may be refuted. There is scarcely any such association. It may be that residential mobility is characteristic of certain groups within the white-collar category rather than with white-collar workers as a whole, or more varied within areas of a metropolitan region.

2. There is an inverse relationship between age and residential mobility.

The assumption that the lower the median age the greater the degree of residential mobility holds true in the sense that there is a negative correlation, but it is quite low. Thus, this assumption is not borne out. If data were available for the median age of the entire population (by census tract), a different result may have been obtained; however, this is considered doubtful. Regional variations may be more important.

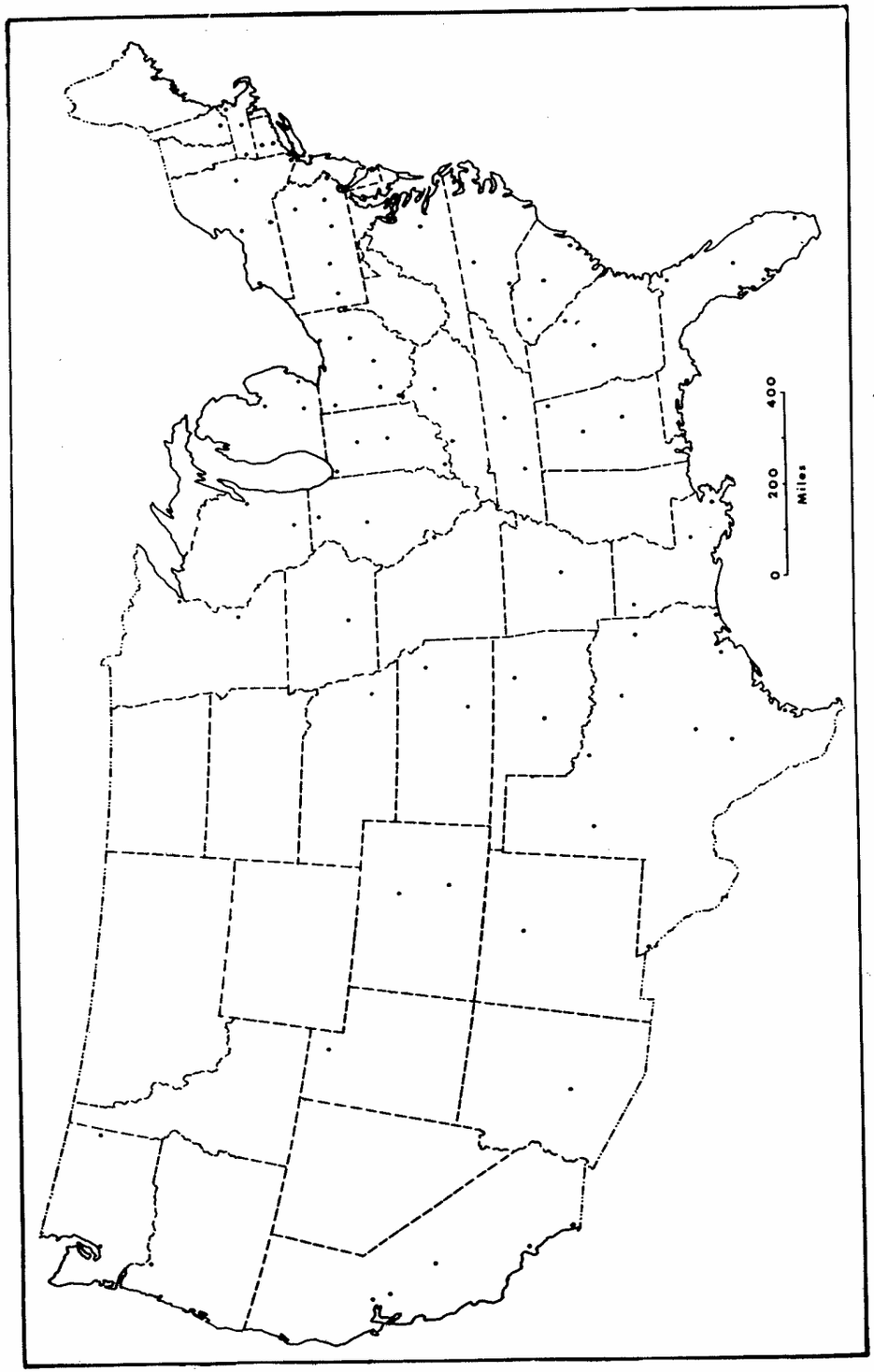


Figure 1. Location of Study Areas (one dot equals two census tracts)

3. Persons with a higher educational level tend to be more mobile than those with a lower educational level.

No attempt was made to define precisely "higher" or "lower" educational level, but the results of the correlation fail to support the assumption on a national level. It may be, however, that there are significant differences between cities of different functions, or between central cities and their suburban rings.

4. Persons living in renter-occupied housing are more mobile than home-owners.

Implied in this assumption was that home-owners tend to remain more settled than persons who rent. The results of the correlation failed to support the assumption, although this was the highest correlation recorded. There is a weak relationship between residential mobility and renter-occupied housing, though it may be stronger regionally; between zones in a metropolitan area; or between different socio-economic groups.

5. There is a positive relationship between increase in income and residential mobility.

It was assumed that the higher the income, the greater the degree of residential mobility. Again, as in the above results of correlation, the assumption was not supported. The correlation between residential mobility and income is identical to that for educational level, and similar to that for occupation. Undoubtedly, these factors are related, but where is there a greater association: on the corporate city level, or urbanized area level, or regionally?

TABLE III
Results of Stepwise Multiple Regression
And Multiple Correlation Coefficients

Final regression equation: $Y = .44 + .09x_4 - .08x_5 + .07x_1 + .03x_2 - .001x_3$

$R = .059$
$R^2 = .003$

x_1 = white-collar occupations; x_2 = renter-occupied housing; x_3 = income; x_4 = median age; x_5 = educational level.

Areal Associations of Residential Mobility

How does the combination of the independent variables, considered simultaneously, explain the variations in residential mobility throughout the United States? A step-wise multiple regression was undertaken to answer this question. Results are to be found in Table III. The final regression equation yielded an r^2 of .003. In other words, the combination of the independent variables explained almost nothing of the variations of residential mobility in the United States.

Conclusion

It was found that none of the hypotheses tested were strongly correlated with residential mobility, and the combination of the independent variables explained almost none of the variations.

The use of a different areal unit than the census tract may prove more fruitful. However, other aspects of residential mobility remain to be investigated: (1) Is residential mobility related to an entirely different set of factors than those presented here? (2) Are there regional variations, i.e., is mobility greater in the Northeast than in the South? (3) Is mobility greater among certain ethnic groups than others? (4) Are variations in mobility related to areas within a metropolis, such as the suburban rings or central cities? (5) Are variations in residential mobility related to functions of cities, or metropolitan areas?

This investigation has barely touched upon the many questions concerning mobility. It is hoped that one result of the study is stimulation toward further research.

REFERENCES

Barry, Charles, "White-collar Employment--Trends and Structure," Department of Labor, Bureau of Labor Statistics, Vol. 84, January, 1961.

Duncan, Otis, and Reiss, Albert, Social Characteristics of Urban and Rural Communities, 1950. Wiley and Sons, New York, 1956.

U.S. Census of Population, 1960, National Summary, Table I, "Mobility for States and State Economic Areas."

A STOCHASTIC MODEL OF FLUVIAL PATTERNS

Merlin Lawson and George Downey

In 1962, Luna B. Leopold and Walter B. Langbein published a paper entitled "The Concept of Entropy in Landscape Evolution," which contains a theoretical statement on the development of landscape morphology. With the concept of entropy, or least work, which is essentially the second law of thermodynamics, they have created an adequate stochastic model for probabilistically describing landscapes and river systems (which in themselves are inherently interlocked). Their work represents the contemporary thinking on this subject, which has gradually evolved from the Davisian geographical cycle, through modifications by such researchers as Makin, Horton, and Wolman.

Leopold and Langbein were the first geomorphologists to use the probabilistic techniques of the "gambler's ruin" and the "drunkard's walk" as models to compare the compatibility of their theoretical notions with realistic stream patterns in accordance with Horton's statistical laws and computations of drainage basins.

By using a Fortran program written by Hildert Schenck and explicitly designed to simulate drainage basin models, it was hoped that the following purposes could be attained: first, to find what type of drainage patterns could be simulated by the use of the computer; and second, to analyze the quantitative structure of the generated patterns with regard to the natural patterns.

As previously mentioned, the basis of the simulation model rests on the probabilistic techniques of the "drunkard's walk" and the "gambler's ruin." The following is a brief resume of these.

The "Drunkard's Walk"

It is assumed that a drunk standing on a uniform and level surface has an equal probability of taking his first step in any direction. Having taken the first step, and having arrived at his destination, he again has an equal probability of taking his next step in any direction, and so on. The analogue to this in drainage simulation is that a drop of water, falling on a level, homogeneous surface, has an equal probability of flowing in any direction. With this idea extended to every designated unit area on the surface, it is quite easy to visualize the random generation of the direction flow of a stream.

The "Gambler's Ruin"

This is a probabilistic statement that sadly reveals the fact that if you continually bet against the "house," you will eventually lose. The "gambler's ruin" is a statistical statement, which gives the probable duration of the game, having the knowledge of the capital of the gambler and the "house." That is: $D=Z(A-Z)$, where D is the duration of the game, Z is the gambler's capital, and A is the total capital (gambler's capital plus the "house's" capital).[1] In applying this formula, then, if two gamblers each had $100 and were to toss a coin until one had won all of the other's money, the contest would last an average duration of 100,000 tosses. If, however, one contestant had $199 and his opponent had $1.00, the average duration of the game would be 199 tosses, even though the total capital is equal in each case.

The physical analogue to this, as far as drainage basins are concerned, is that two streams, flowing in juxtaposed basins, will deviate from the mean or orthogonal path, until such a time that they flow into one another, thus forming a single stream. The above formula can be used to find the duration (length) of the stream, starting at a given distance from a stream and flowing until it meets that stream. This is analogous to the gambler and the "house" starting out with equal sums. In this case:

$$Z=1/2A \qquad \text{and} \qquad D=1/2A^2$$

It will be noted that this condition infers a stream with fixed boundaries. In any case, the distance traveled would have to increase by at least the first order of the separation distance. Thus, we have established two limits:

$$D \propto A^2 \qquad \text{and} \qquad D \propto A$$

This is a probabilistic statement, which confirms and agrees with Horton's laws.

[1] Feller, (1950, pp. 286-290) presents a rigorous statistical proof of this formula using the method of generating functions.

The Method of Drainage Basin Simulation

Originally this project sought to utilize the Fortran program written by Schenck, which purported to produce random numbers resulting in simulated stream flows within a rectangular drainage matrix. The matrix dimensions of 20 x 30 consistently generate streams of the fourth order. Following major difficulties with the syntax in Schenck's program, it was finally established that the random number generator produced invalid arrays. The program, consequently, had to be almost entirely rewritten. The most significant change was the formation of a function sub-routine as a random number generator, which, by a series of floating point multiplications and alternate fixed point truncations, produced a satisfactory array of random numbers.

Each of the 600 matrix cells was given an address M(I,J). For example, the address of the cell in the seventh row and the nineteenth column would be $M_{7,19}$. The address of each cell was punched on IBM program cards, and the resulting pack of 600 cards was shuffled to assure a random input of data. At the start of the program each matrix position was assigned a value of zero. By making use of Read statements and a dummy matrix card, it was possible to assign a value, in this case 9, to cells which would allow drainage out of the basin.

It was hypothesized that variations in the position of out-drainage cells (ex. an ocean or base level) would produce differences in the resulting drainage patterns. For instance, if the cells at the top of the matrix are assigned as out-drainage cells, the authors theorized that a dendritic pattern would evolve; if drainage is only allowed out of the cells at the center of the matrix, a centripedal pattern would develop; and if drainage out is only allowed at the four corners, a radial drainage pattern would be produced.

For an explanation of the program procedure, the discussion will be limited to the dendritic type of positioning. The computer receives the 600 data cards. All the cells in the first row are assigned the value of 9, meaning that ultimate drainage will flow "north" as in a continental-divide situation. The computer then accepts its first random data card with the address $M_{I,J}$ and a value of zero. The random generator sub-routine produces a random number from one to four and assigns the number to the cell, then proceeds to an adjacent cell which has been designated by the random number selection. Because the program warrants the use of two constraints, that the flow sequence cannot double back on itself or loop into itself, a value of 50 is added to the generated number in each cell until the flow is terminated by the confluence with a drainage outlet or a previously generated stream. When such a termination occurs the value of 50 is subtracted, leaving the random numbers of that flow. A series of Do statements allows this procedure to be repeated with each cell and each card until all the cells of the matrix have been assigned a random flow sequence. Sense switches can introduce commands for the computer to type out generated random numbers, the count of the cells filled by random numbers at any given time, and the exact address of filled cells. On the termination of the run, the matrix is punched out and converted to print (Figure 1).

Trellis Drainage Pattern

A decided change in the program was necessary to produce a stochastic model for a trellis drainage pattern. Essentially, this was accomplished by interjecting further constraints on the randomness of flow direction. On input, the drainage outlets were positioned along the top of the matrix, similar to the dendritic simulation. The ridges of the basin were produced by assigning values of 10 to rows $M_{13,J}, M_{27,J}$. The program was rewritten to allow the ridge values of 10 to be replaced only by the generation of a 3, meaning that superimposed consequent streams were the only streams that could flow through a ridge. The a priori reasoning for this stems from the belief that obsequent streams (of value 1) would become beheaded by streams on the consequent side of the ridge. Flow directions on the top of ridges (value 2 and 4) was rejected by axiomatic reasons, inasmuch as streams cannot flow on the top of ridges. The resulting possibility of a stream crossing a ridge is slightly less than 1/4, because no two streams were allowed to flow through the same gap. All other facets of the program remained the same.

Quantification of Simulation Models

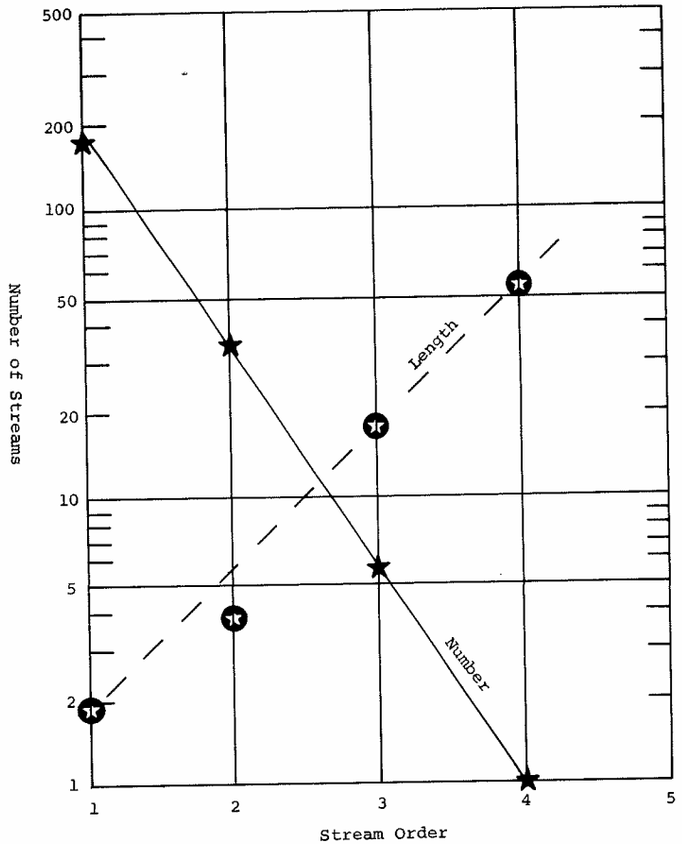
The individual matrices resulting from the various constraints of the program enables theoretical examination, quantification, and comparison with the natural patterns. Figure 2 expresses the nearly orthogonal relationship that results when the length of streams per stream order are plotted against the number of streams per stream order. Other quantitative comparisons established the reproduction of bifurcation ratios between stream orders (Table I).

TABLE I

order	number of streams	bifurcation ratio	average length	length ratio
1	140	4.0	1.9	1.8
2	35	5.9	3.5	5.4
3	6	6.0	19.1	3.0
4*	1	---	57.0	---

*Not complete

Figure 2 RELATION OF NUMBER AND AVERAGE LENGTHS OF STREAMS TO STREAM ORDER FOR A DENDRITIC PATTERN



The inherent attractiveness of simulation models is evidenced by the ability to compare quantification attributes among different patterns. For instance, it may be found that the ridge constraints of trellis patterns may lead to the fact that they generate a higher stream order than dendritic patterns of the same drainage area. Other applications may lead to the simulation of identical trellis and dendritic bifurcation ratios by altering the probability of crossing ridges. Consequently, an inference could be drawn as to the association of the original probability of natural streams crossing ridges.

Beneficial Aspects of the Research Project

The associated benefits of the production of probability models manifest themselves in many ways. Just as the importance of an analogue is measured by the number of extensions or applications of that model, so too can one measure the degree of accomplishment related to the present study. It is true that much has been learned with regard to the geomorphic quantification modes. However, more importantly, a corridor has been paved to facilitate further studies along these frontier horizons. The reaping of an intuitive and mechanical knowledge concerning the use of computer systems is an example of the continuing assets related to this study. The authors of this paper suggest that the application of the "random walk" and "gambler's ruin" model dels may offer extensive and ramified interpretive information in other scholarly geographical pursuits. One such application could involve the quantification of street patterns, that is, cities may exhibit identifying street patterns as a result of being influenced by morphologic constraints. Examples of such distinguishable street patterns could be: (1) Cities located on plains may exhibit a centripedal street pattern; (2) Cities built on hills or deltas may display dendritic street patterns. Hierarchies of street dimension, traffic flow, or arterial function can also be studied in seeking quantitative spatial generalizations for urban or traffic studies. In the long run, the final evaluation of statistical models rests upon the resultant diversity of application.

Figure 1 STOCHASTIC SIMULATION OF DENDRITIC DRAINAGE

9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
4	4	3	1	2	3	1	2	3	4	3	1	3	2	4	4	1	2	3	2
3	2	2	2	3	3	2	4	1	2	3	2	4	3	2	2	1	4	4	3
3	2	4	4	1	3	2	2	2	3	2	2	2	2	3	2	2	1	1	2
1	3	3	4	1	3	3	4	3	2	2	3	2	2	2	1	2	4	1	3
4	1	4	1	4	4	4	3	2	2	4	3	4	4	3	4	1	2	1	3
4	4	1	4	4	1	4	4	4	1	3	4	1	2	4	1	1	2	4	1
4	3	4	3	4	4	3	3	4	4	3	2	2	3	1	2	2	3	1	2
3	2	2	1	3	4	4	4	3	4	3	3	2	3	2	2	2	3	2	1
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3	3	1	4	3	3	4	4	3	3	2	3	3	2	1	2	4	3	1	1
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4	3	2	1	3	4	4	4	3	2	1	3	2	1	3	2	3	4	3	1
4	4	3	4	1	4	4	3	1	3	4	4	3	2	3	2	3	2	2	2
4	3	2	2	2	3	4	4	4	3	2	3	2	4	3	4	3	3	2	2

Legend

North at top of matrix

Address of 9 denotes out-drainage cells
Address of 1: flow is south
Address of 2: flow is west
Address of 3: flow is north
Address of 4: flow is east

BIBLIOGRAPHY

Chorley, Richard J. "Geomorphology and General Systems Theory," U.S.G.S. Professional Paper 500-B, 10 pp. (1962).

_____. "Geography and Analogue Theory," Annals, Vol. 54, No. 1, pp. 127-137, (1964).

Feller, William. Probability Theory and Its Applications, Vol. I, New York: John Wiley & Sons, Inc., 419 pp. (1950).

Horton, R.E. "Erosional Development of Streams and Their Drainage Basins," Geol. Soc. Am. Bull., Vol. 56, pp. 275-370, (1945).

Leopold, Luna B. "Rivers," American Scientist, Vol. 50, pp. 511-537, (1962).

_____. and Walter B. Langbein. "The Concept of Entropy in Landscape Evolution," U.S.G.S. Professional Paper 500-A, 20 pp. (1962).

Schenck, Hilbert Jr. "Simulation of the Evolution of Drainage-Basin Networks with a Digital Computer," Jour. of Geophysical Research, Vol. 69, pp. 5739-5745, (1963).

_____. "Simulation of the Creation of a Drainage Network," NSF Grant 23083, pp. 110-125, (1963).

A SIMULATED MODEL OF THE WATER SUPPLY OF NEW YORK CITY 1965 - 2014

Robert S. Weiner

Introduction

Charles Einstein's novel, The Day New York Went Dry, is a story, partially based upon fact and partially fictional, concerning the water problems of one of the world's largest urban agglomerations. The factual aspect ranges from the severe water shortage which occurred in 1949, through the growing needs of the city in the 1950's and early sixties. The fictional part speculates on the increased consumption and a series of drought years culminating in near disaster in 1968 with the metropolis being saved only by the intervention of nature in the form of a hurricane in the fall of that year just before the presidential election, thus assuring the inevitability of the election of the story's hero as Vice President of the United States.

The synopsis on the cover of this paperback describes New York as "The Concrete Wasteland" and asks the following questions: "Death Valley? Guantanamo? No! New York City. Three years from now when the final water shortage has begun to turn the greatest city in the world into a concrete wasteland. It's a crazy science-fiction notion, isn't it? Nothing that could really happen, could it? We don't have to worry, do we? Do we?"

The purpose of this study is to attempt some answers to these questions. In order to do this it is proposed, first, to determine the probability of getting some exact number of critical dry years in the future; and, secondly, to simulate an input-output model of the entire New York water supply system for the next fifty years.

Historical Background

The development of sources of water for New York City has a long and tortuous history. In the latter part of the 18th and the early part of the 19th Century, the City depended upon a financial institution, of all things, to supply it with water from wells located on Manhattan Island. This was the Manhattan Company, whose charter contained the requirement that "unless the Company should furnish a supply of pure and wholesome water sufficient for the use of all citizens who might wish to subscribe, the corporation would be dissolved" (Blake, 1956, p. 101).

This early period was marked by a combination of political intrigue and private-enterprise chicanery. It involved such famous names as Aaron Burr and De Witt Clinton. Unable to meet the demands for water, the Manhattan Company was eventually replaced by a politically-appointed Board of Water Commissioners who, with great difficulty, finally brought the Croton Project into operation in 1842.

The Croton Project was the first step in going beyond the city limits for a supply of water. Through the years since, the sources of supply have expanded as the city has grown. Today, the system contains seven distinct watersheds supplying water to the City from as far away as 125 miles.

Description of the Watersheds

The Croton Watershed, in Westchester and Putnam counties about forty miles north of the City, presently consists of eight major reservoirs (Figure 1). This watershed covers an area of 375 square miles. The reservoirs have a capacity of 97 billion gallons and a dependable yield of 325 million gallons per day (mgd).

The remaining watersheds are located to the west of the Hudson River and their distances from the City range from 80 to 125 miles. The Catskill System contains two watersheds -- the Esopus and the Schoharie covering a total of 571 square miles, a capacity of 150 billion gallons and a dependable yield of 555 mgd. The Rondout and Neversink watersheds have a total area of only 95 and 93 square miles respectively. They are the smallest of the watersheds with a combined capacity of less than 86 billion gallons and a dependable yield of 235 mgd. Both of these reservoirs act as storage for diverted water from the Delaware System farther to the west. The Delaware System also consists of two parts--the East Branch and the West Branch. This is the newest and largest section of the entire source region having a combined area of 822 square miles, a storage capacity of 251 billion gallons and a dependable yield of 685 mgd. The Pepacton Dam of the East Branch was completed in 1955. The Cannonsville Dam of the West Branch is expected to go into operation some time this month (this study was carried out in the Fall of 1964; the dam is now completed).

The total system of watersheds covers almost 2,000 square miles, has a storage capacity of over 604 billion gallons of water and a dependable yield of 1,860 mgd.

Figure 1*

NEW YORK WATER SUPPLY

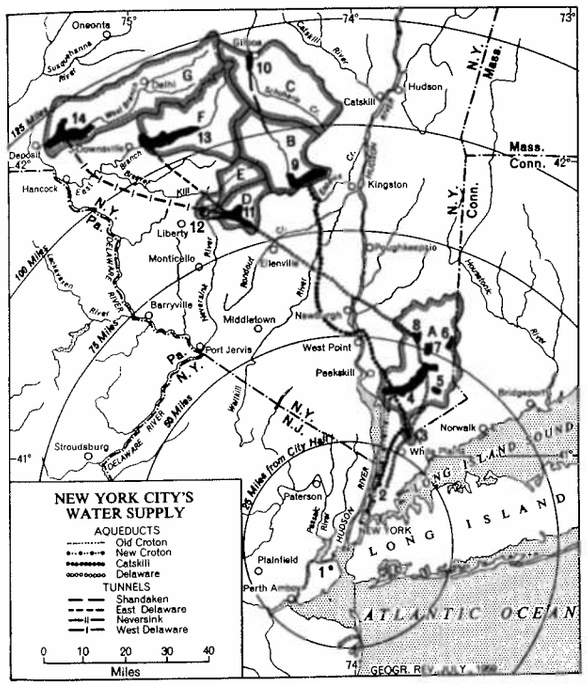

Fig. 1—The sources of New York City's water supply. Watersheds are shown by heavy boundary; key: A, Croton; B, Esopus; C, Schoharie; D, Rondout; E, Neversink; F, East Delaware; G, West Delaware. Reservoirs are shown in black; key: 1, Silver Lake; 2, Hill View; 3, Kensico; 4, Croton; 5, Cross River; 6, East Branch; 7, Middle Branch; 8, West Branch; 9, Ashokan; 10, Schoharie; 11, Rondout; 12, Neversink; 13. Pepacton; 14, Cannonsville (under construction). Adapted from map in "The Water Supply of the City of New York" (see text footnote 13 below), pp. 40-41.

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The Average Annual Rainfall Record

Since 1906, the United States Weather Bureau and the Department of Water Supply, Gas and Electricity of the City of New York have maintained a number of precipitation stations throughout the entire area of the watersheds. The data supplied by these stations, ranging in number from as few as fifteen in 1906 to as many as sixty-four in recent years, is shown in Table 1. The average annual rainfall for the period 1906 to 1963 was calculated to be 45.34 inches. In addition, one standard deviation from this mean was found to be ±5.91 inches.

TABLE I

ANNUAL AVERAGE RAINFALL
CROTON, CATSKILL AND DELAWARE WATERSHEDS
1906 - 1963*

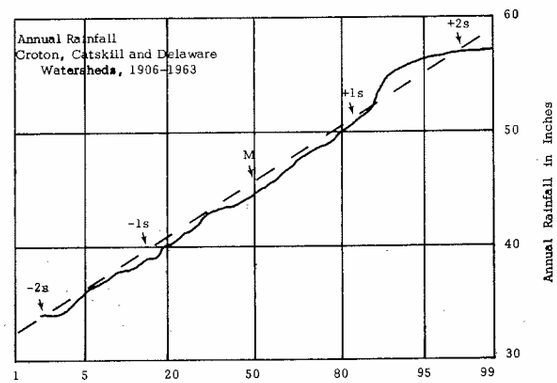
YEAR	NUMBER OF STATIONS	AVERAGE (inches)	YEAR	NUMBER OF STATIONS	AVERAGE (inches)
1963	48	38.07	1934	38	47.65
1962	49	33.39	1933	38	48.73
1961	52	37.36	1932	38	48.12
1960	64	57.06	1931	38	43.25
1959	64	37.76	1930	38	36.67
1958	64	50.16	1929	38	46.59
1957	64	34.19	1928	38	47.91
1956	64	51.45	1927	35	56.01
1955	64	45.51	1926	35	41.70
1954	64	44.26	1925	35	44.37
1953	63	47.41	1924	35	44.58
1952	63	56.67	1923	34	41.45
1951	57	54.70	1922	34	44.63
1950	63	42.85	1921	34	43.24
1949	63	45.22	1920	33	52.08
1948	63	43.25	1919	33	48.99
1947	63	42.73	1918	31	40.30
1946	62	39.98	1917	26	40.17
1945	63	57.56	1916	26	43.23
1944	63	41.41	1915	25	50.01
1943	63	43.55	1914	27	38.66
1942	63	51.90	1913	27	46.48
1941	63	36.50	1912	28	45.14
1940	63	46.48	1911	28	42.85
1939	63	38.66	1910	25	43.56
1938	62	55.49	1909	27	45.56
1937	62	56.29	1908	27	41.25
1936	38	49.14	1907	23	49.98
1935	38	38.91	1906	15	48.86

* Sources: Annual Reports of the Board of Water Supply of the City of New York: 1963, 1961, 1959, 1958, 1956, 1950, 1940-46 and 1939.

Weather Bureau, U.S. Department of Commerce, Climatological Data, New York, Annual Summaries.

In order to determine whether or not the relative frequency of annual rainfall was normally distributed, the mean and two standard deviations were plotted on the accompanying arithmetic probability graph paper as a straight line (Figure 2). Then the rainfall of each of the fifty-eight years was plotted. As can be seen from the graph, the resulting relative frequency curve approximates the straight line closely enough to assume that the fifty-eight-year record is normally distributed.

Figure 2



Probability of Occurrence of Critically Dry Years

Having established that the relative frequency of annual rainfall is normally distributed, it is now possible to determine the probability of occurrence of some critically dry year by use of a binomial distribution. The probability of getting exactly five years, in the next fifty-eight years, as dry or drier than 37.36 inches, the fifth driest year of record, is approximately 0.183. This probability was determined by the following formula:

$$P(r) = {}_{r}^{N} p^{r} q^{N-r}$$

$$P(5) = {}_{5}^{58} (5/58)^{5} (53/58)^{53} = 0.183$$

A Simulated Model

It is also possible to develop a simulated model of the input-output of the reservoir system once the relative frequency of annual rainfall of past history has been found to be normally distributed.

A simulated model of the annual rainfall and the annual runoff expressed as equivalent yield in billions of gallons for each year of the next fifty years was developed. The annual rainfall was determined by randomly selecting normal deviations from a table of Gaussian Deviates. Simulating the annual runoff is somewhat more difficult because of the many and complex factors which affect runoff. This model relies upon the past record of runoff. The record shows that for a given annual rainfall there have been limits within which the runoff varies. For example, when the average annual rainfall has been between forty-one and forty-six inches the record shows that the equivalent yield in millions of gallons per day per square mile has varied from 0.8 to 1.4. Once the rainfall was determined, the yield was selected from a table of random numbers within the limits indicated by the past record. With this information it is then possible to calculate the quantity of water in the reservoirs available for consumption for any given year.

Output consists of two major aspects: the amount of water needed to supply the needs of New York City and the releases required by law from several reservoirs which dam streams that are a part of the Delaware drainage system involving several states.

The present consumption of New York City is about 162 gallons per capita per day for its approximately eight million people. In the model it is assumed that in the next fifty years the population will increase to something over ten million people and a daily per capita consumption of 190 gallons will be reached. In terms of total consumption, this means that the present annual rate of 1,300 billion gallons will reach approximately 2,000 billion gallons in the year 2014.

As for diverted water, the Supreme Court has handed down decisions setting the minimum quantities of water to be released by the Board of Water Supply to the Delaware River in order to maintain flow and provide for sufficient water to the other states involved. At present this minimum amount is about six billion gallons annually, but it will be increased when the Cannonsville Dam goes into operation. The past record of releases is insufficient to establish a definite quantity of water, but it was assumed that in wetter years the Board of Water Supply would be more generous with releases than in drier years. This attitude might create friction between the states involved, however, since the Cannonsville agreement stipulates not only minimum amounts, but also such other releases as directed by the River Master at Montague, New Jersey. In the simulated model a constant amount of diversion of 100 billion gallons annually was arbitrarily set, being reduced only in drier years, but still maintaining the minimum required by law.

In order to test the input-output simulation model, it was decided to start the reservoirs on January 1, 1965 at 100% capacity, 50% capacity and the actual amount now in the reservoirs, 30% capacity or 169 billion gallons. By random selection, however, 1965 turned out to be an exceedingly wet year and, thus, by the end of 1966 this three-way distinction was dropped since even at the lower capacity the reservoirs were full.

The simulation model was calculated twice--once without the Cannonsville Project and once with Cannonsville included. This was done for two reasons. First, it was found that with the addition of the 450 square miles of the West Branch Delaware Watershed the input was increased to such a point that present requirements could easily be met. Secondly, throughout the history of New York's water supply a controversy has surrounded each new reservoir project that has been proposed. The Cannonsville Project has been no exception. The Board of Water Supply has met its critics with the argument that with this additional watershed New York's water requirements can be fulfilled to at least the year 2000. Thus, using the two models provides us with a comparison; each operating under similar rainfall and runoff conditions, although making somewhat more stringent consumption demands when Cannonsville is included.

Table 2 shows the annual input and output of the model without Cannonsville. This system remains adequate through the remainder of this present decade. However, in 1970 a modest increase in population and daily per capita consumption combined with a series of near normal or below normal rainfall begins to create some problems. These problems are temporarily alleviated in 1975 by a series of wet years. By 1982, even by reducing per capita consumption back to its present level, the entire system goes dry and thus Einstein's science-fiction becomes reality.

With Cannonsville included, the story is quite different. Under similar rainfall and runoff conditions the system appears to be quite adequate. Some trouble develops in 1984, but even here, there is some water in the reservoirs at the end of the year, even under an increased consumption of 1,710 mgd as compared to only 1,655 mgd at the same point in Table 2. Also, this system provides 180 gallons per person per day for 9.5 million people. Not until the year 2009 with the system providing almost 2,000 mgd or 190 gallons per person per day to 10.5 million people does it go dry. This point is nine years beyond the claims made for the system by the Board of Water Supply. It also puts Einstein's novel back into the realm of science-fiction.

TABLE 2

SIMULATED MODEL
ANNUAL RUNOFF, STORAGE AND CONSUMPTION
PRESENT SYSTEM (Cannonsville excluded)
1965-2014

Watershed area: 1,519 square miles
Maximum storage capacity: 507 billion gallons
All figures in billion gallons

YEAR	RUNOFF	(STORAGE)	TOTAL	CONSUMPTION	STORAGE Dec. 31	CONSUMPTION CHANGES
1965	776.2	507 (100%)	1283.2	581.8	701.4/507	
1966	776.2	254 (50%)	1030.2	581.8	448.4	
	776.2	169 (30%)	945.2	581.8	363.4	8.0 million people
1966	776.2	507 (100%)	1283.2	581.8	701.4/507	162 gals/day/capita
	776.2	448.4(50%)	1224.6	581.8	642.8/507	100 billion gals.
	776.2	363.4(30%)	1139.6	581.8	557.8/507	diverted
1967	720.8	507	1227.8	581.8	646.0/507	
1968	1497.0	507	2004.0	581.8	1442.2/507	
1969	665.3	507	1172.3	581.8	590.5/507	
1970	499.0	507	1006.0	662.1	343.9	
1971	720.8	343.9	1064.7	662.1	402.6	
1972	499.0	402.6	901.6	662.1	239.5	
1973	443.5	239.5	683.0	662.1	20.9	8.8 million people
1974	831.7	20.9	852.6	662.1	190.5	175 gals/day/capita
1975	998.0	190.5	1188.5	662.1	526.4/507	100 billion gals.
1976	776.2	507	1283.2	662.1	621.1/507	diverted
1977	942.5	507	1449.5	662.1	787.4/507	
1978	831.7	507	1338.7	662.1	676.6/507	
1979	443.5	507	950.5	662.1	288.4	
1980	720.8	288.4	1009.2	755.0	254.2	
1981	499.0	254.2	753.2	578.6	174.6	
1982	332.7	174.6	507.3	578.6	0 (shortage)	
1983	609.9	0	609.9	578.6	31.3	
1984	332.7	31.3	364.0	578.6	0 (shortage)	
1985	720.8	0	720.8	578.6	142.2	
1986	609.9	142.2	752.1	578.6	173.5	
1987	942.5	173.5	1116.0	578.6	537.4/507	9.7 million people
1988	720.8	507	1227.8	578.6	649.2/507	162 gals/day/capita
1989	332.7	507	839.7	578.6	261.1	100 billion gals.
1990	499.0	261.1	760.1	578.6	181.5	diverted
1991	942.5	181.5	1124.0	578.6	545.4/507	
1992	388.1	507	895.1	578.6	316.5	
1993	720.8	316.5	1037.3	578.6	458.7	
1994	720.8	458.7	1179.5	578.6	600.9/507	
1995	443.5	507	950.5	578.6	371.9	
1996	776.2	371.9	1148.1	578.6	569.5/507	
1997	720.8	507	1227.8	578.6	649.2/507	
1998	720.8	507	1227.8	578.6	649.2/507	
1999	720.8	507	1227.8	578.6	649.2/507	
2000	720.8	507	1227.8	656.5	571.3/507	
2001	443.5	507	950.5	656.5	294.0	
2002	720.8	294.0	1014.8	656.5	358.3	
2003	720.8	358.3	1079.1	656.5	422.6	
2004	720.8	422.6	1143.4	656.5	486.9	10.5 million people
2005	609.9	486.9	1096.8	656.5	440.3	170 gals/day/capita
2006	720.8	440.3	1161.1	656.5	504.6	5 billion gals
2007	499.0	504.6	1003.6	656.5	347.1	diverted
2008	609.9	347.1	957.0	656.5	300.5	
2009	332.7	300.5	633.2	656.5	0 (shortage)	
2010	609.9	0	609.9	656.5	0 (shortage)	
2011	776.2	0	776.2	656.5	119.7	
2012	776.2	119.7	895.9	656.5	239.4	
2013	776.2	239.4	1015.6	656.5	359.1	
2014	720.8	359.1	1079.9	656.5	423.4	

TABLE 3

SIMULATED MODEL
ANNUAL RUNOFF, STORAGE AND CONSUMPTION
FUTURE SYSTEM (Cannonsville included)

Watershed area: 1,969 square miles
Maximum storage capacity: 604 billion gallons
All figures in billion gallons

YEAR	RUNOFF	(STORAGE)	TOTAL	CONSUMPTION	STORAGE Dec. 31	CONSUMPTION CHANGES
1965	1006.2	604 (100%)	1610.2	581.8	1028.4/604	
	1006.2	302 (50%(	1308.2	581.8	726.4/604	
	1006.2	169 (30%)	1175.2	581.8	593.4	
1966	1006.2	604 (100%)	1610.2	581.8	1028.4/604	8.0 million people
	1006.2	604 (50%)	1610.2	581.8	1028.4/604	162 gals/day/capita
	1006.2	593.4 (30%)	1599.6	581.8	1017.8/604	100 billion gallons
1967	934.3	604	1538.3	581.8	956.5/604	diverted
1968	1940.7	604	2544.7	581.8	1962.9/604	
1969	862.4	604	1466.4	581.8	884.6/604	
1970	646.8	604	1250.8	662.1	588.7	
1971	934.3	588.7	1523.0	662.1	860.9/604	
1972	646.8	604	1250.8	662.1	588.7	
1973	574.9	588.7	1163.6	662.1	501.5	8.8 million people
1974	1078.0	501.5	1579.5	662.1	917.4/604	175 gals/day/capita
1975	1293.6	604	1897.6	662.1	1235.5/604	100 billion gallons
1976	1006.2	604	1610.2	662.1	948.1/604	diverted
1977	1221.8	604	1825.8	662.1	1163.7/604	
1978	1078.0	604	1682.0	662.1	1019.9/604	
1979	574.9	604	1178.9	662.1	516.8	
1980	934.3	516.8	1451.1	724.2	726.9/604	
1981	646.8	604	1250.8	724.2	526.6	
1982	431.2	526.6	957.8	724.2	233.6	
1983	790.6	233.6	1024.2	724.2	300.0	9.5 million people
1984	431.2	300.0	731.2	724.2	7.0	180 gals/day/capita
1985	934.3	7.0	941.3	724.2	217.1	100 billion gallons
1986	790.6	217.1	1007.7	724.2	283.5	diverted
1987	1221.8	283.5	1505.3	724.2	781.1/604	
1988	934.3	604	1538.3	724.2	814.1/604	
1989	431.2	604	1035.2	724.2	311.0	
1990	646.8	311.0	957.8	775.3	182.5	
1991	1221.8	182.5	1404.3	775.3	629.0/604	
1992	503.1	604	1107.1	775.3	331.8	
1993	934.3	331.8	1266.1	775.3	490.8	10.0 million people
1994	934.3	490.8	1425.1	775.3	649.8/604	185 gals/day/capita
1995	1078.0	604	1682.0	775.3	906.7/604	100 billion gallons
1996	1006.2	604	1610.2	775.3	834.9/604	diverted
1997	934.3	604	1538.3	775.3	763.0/604	
1998	934.3	604	1538.3	775.3	763.0/604	
1999	934.3	604	1538.3	775.3	763.0/604	
2000	934.3	604	1538.3	828.2	710.0/604	
2001	1078.0	604	1682.0	828.2	853.8/604	
2002	934.3	604	1538.3	828.2	710.0/604	
2003	934.3	604	1538.3	828.2	710.0/604	10.5 million people
2004	934.3	604	1538.3	828.2	710.0/604	190 gals/day/capita
2005	790.6	604	1394.6	828.2	566.4	100 billion gallons
2006	934.3	566.4	1500.7	828.2	672.5/604	diverted
2007	646.8	604	1250.8	828.2	422.6	
2008	790.6	422.6	1213.2	828.2	385.0	
2009	431.2	385.0	816.2	828.2	0 (Shortage)	
2010	790.6	0	790.6	828.2	0 (Shortage)	
2011	1006.2	0	1006.2	828.2	178.0	
2012	1006.2	178.00	1184.2	828.2	356.0	
2013	1006.2	356.0	1362.2	828.2	534.0	
2014	934.3	534.0	1468.3	828.2	640.1/604	

Conclusion and Evaluation

This study has attempted to analyze some of the problems of supplying water to New York City, one of the world's largest urban agglomerations. The probability of getting exactly five years as dry or drier than the fifth worse year of record was calculated to be 0.183. Two simulated models covering the next fifty years were produced, one with the new Cannonsville Dam included and one without it. With the new dam it was shown that under similar conditions of rainfall and runoff, New York is assured of an adequate supply of water until the turn of the century, whereas without Cannonsville, conditions would become quite perilous beyond the next decade.

The quantitative methods used here present an interesting and novel approach to the physical aspects of New York's water supply. However, the author is not completely satisfied that the simulated model comes as close to reality as it might. When one reviews the year 1949, further modification of the model seems to be in order.

The average annual rainfall for 1949 was about equal to the fifty-eight-year average, and there were thirty-one years drier than 1949. Yet, New York City faced near disaster similar to that described in Einstein's novel. This was the year of the war on leaky faucets, water holidays, bearded males and other measures aimed at maximum water conservation. In reality, the average annual rainfall failed to tell the whole story. The first part of the year was quite wet. On the critical date of June first, the reservoirs were at 100% capacity. Ideal conditions prevailed. Then disaster struck. The summer and autumn of 1949 were considerably above average in temperature with virtually no rainfall. By December, 1949, the City was on the edge of despair. Fortunately, a wet spring in 1950 brought the reservoirs back to 100% capacity again by June. This incident illustrates the sensitivity of the water supply of a large city which can be overlooked if the prime factors which affect this supply are considered on such a broad period of time as a year.

What might bring this model closer to reality would be to consider this past record of fifty-eight years not just in terms of its annual rainfall, but to approach it on a month-to-month water balance basis using the Thornwaite system for determining the evapotranspiration. The speed and versatility of the modern computer would certainly put such a study well within the realm of possibility.

BIBLIOGRAPHY

Annual Reports of the Board of Water Supply of the City of New York: 1963, 1961, 1959, 1958, 1956, 1950, 1940-46 and 1939.

Blake, Nelson Manfred, Water for the Cities: A History of the Urban Water Supply Problems in the United States (Syracuse, New York: Syracuse University Press, 1956).

Einstein, Charles, The Day New York Went Dry (Greenwich, Connecticut: Fawcett Publications, Inc., 1964).

New York Times: 1949, 1950, 1957, 1963, 1964.

Weather Bureau, U.S. Department of Commerce, Climatological Data, New York, Annual Summaries.