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 alumri a broader picture of the current work now going on at Clark.

It is our good fortune to have the assistance of the alumnii. 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.
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 the last year's. I am struck by the fact that much of Monadnock's earlier content was today's concerns—-from the discreetly frantic appeals to 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 1945 issue); to messages by incoming directors (Manuel Van Valkenburg in 1946 and Raymond Murphy in 1961).

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 see 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, 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 tradition.

We have in this past academic year witnessed 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.A. Together with Dr. Shedd, he will assume responsibility for the re-instituted 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 Borden and develop a program in these lines. He has his A.B. from Yale, his A.M. and (Sedding) Ph.D. from the University of Wisconsin. (3) Dr. Terence W. Reed, Visiting Assistant Professor of Urban and Economic Geography. Dr. Reed is currently a visiting professor at the University of Hawai'i. He has his A.B., and Ph.D. from the University of Sydney.

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 $55,000 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 review 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 full field techniques course, coming as a three-week period in either January or June.
Fourth, a new cartography laboratory will be opened by fall (on the first floor of the east wing of the library) and the workroom will be completely remodeled, with private carrels for each graduate student, a lounge, and separate soundproofed typing facilities. The Luby 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 in 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, in 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 Warnock, Robert Eades, Rodman Sheard and Mary Brown—have given unstintingly of themselves in the work of refashioning the School so as to meet today's challenges and opportunities in Geography. To Gay 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 H. 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 Ocean 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 1966. He is, in his words, "still happily single," and is presently working on his doctoral dissertation: "Commercial Recreation in the Urban Environment."

Bollin J. 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.

Sermon 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 estimation of the maximum amount of quantitative data from air photos.

Nicholas Baro is Assistant Professor at the University of Oklahoma. He reports that he has a new son, Peter, who was born on February 3, 1966. Last summer Mr. Baro attended the Vth INQUA Congress and presented a paper on loose topography. He is currently engaged in completing his Ph.D. and will then work on various problems of loose morphology.

George Beilis (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 NGA 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 Besset is now here at Clark (see The Workrooms Today), having obtained leave from Buffalo State, where he is Associate Professor of Geography. He is hard at work on his dissertation.

Gwen Bella is Assistant Editor of EXPLORICA, and in that capacity will travel to Athens for EXPLORICA month, July, 1966. This will include a one-week symposium on urban documentation and renewal 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 1955, 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 a Mayan urban area and has had an article accepted for publication: "Human Organization."

Hans Bosche, who was at Clark in 1954-55, is now Professor of Geography at Zurich University and the Dr. 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 Geography Und Raumwirtschaft. 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
recently completed a year of study at the University of California at Berkeley, under the Distinguished
Professor Program of the National Aeronautics and Space Administration.

David B. Burris (Ph.D. Clark 1956) is in the Department of Geography at the University of
Iowa in Iowa City, Iowa. His recent dissertation was entitled "Some Observations on Industrial
Development and Social Change in the U.S. during the 1930's".

Harry E. Caldwell (Ph.D. Clark 1951) was promoted last year to Professor and Chairman of the
Geography Department at the University of Oklahoma, in Norman. He is the author of "The Physical
Geography of the World".

Clara Campbell (M.A., Clark 1960) is an Assistant Professor of Geography at the University of
California, in Los Angeles. She is the author of "The Political Geography of the Middle East".

Albert S. Cerino is also an Assistant Professor of Geography at the Dartmouth College. He is the
author of "The Political Geography of the Middle East".

Mary L. Carus is an elementary school principal in Rogers, Minnesota, and the author of "The
Political Geography of the Middle East".

Philip M. Cooney is teaching Geography at the University of Minnesota, in Minneapolis. He is the
author of "The Political Geography of the Middle East".

Thomas W. Chamberlin (Ph.D. Clark 1948) is an Academic Dean and Professor of Geography at the
University of Minnesota, in Duluth.

Catherine E. Cox (M.A., Clark 1943) is Assistant Professor of Geography at the University of
Iowa, in Iowa City. She is the author of "The Political Geography of the Middle East".

Catherine J. Freer (Ph.D. Clark 1961) is Professor of Geography at the University of
Southern California, in Los Angeles. She is the author of "The Political Geography of the Middle East".

Clyde K. Crain (Ph.D. Clark 1952) is Professor of Geography at the University of Wisconsin, in
Madison. He has made two trips to South and East Asia, as Chief Advisor for the Upper Indus Regional Plan in
Pakistan and directing contracts on Physical Environment.

Harold F. Creveling (Ph.D. Clark 1951) is a Professor of Geography at the University of North Carolina, in
Chapel Hill. He is the author of "The Political Geography of the Middle East".

Floyd F. Cunningham (Ph.D. Clark 1950) has just been appointed as Chairman of the Depart-
ment of Geography at Southern Illinois University. He is the author of "The Political Geography of the Middle East".

Nadine H. Doses is a part-time lecturer at the University of Toronto and York University (Toronto)
Geography Department. She is the author of "The Political Geography of the Middle East".

Aubrey Van (M.A. Clark 1956) is Associate Professor of Geography at the University of Waterloo.

John E. Dornbush is in the Department of Geography at the University of Wisconsin, in Madison. He is the
author of "The Political Geography of the Middle East".

George T. Downey (M.A. Clark 1956) is in the Department of Geography at the University of
Iowa, in Iowa City. He is the author of "The Political Geography of the Middle East".

Matt J. Epstein (Ph.D. Clark 1954) is in the Department of Geography at the University of
Pennsylvania, in Philadelphia. He is the author of "The Political Geography of the Middle East".

Walter Goldenisch (M.A., Clark 1937) is a Professor of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Bradley Fisher (M.A. Clark 1956) is the author of "The Political Geography of the Middle East".

Brian Jackson (Ph.D. Clark 1957) is the author of "The Political Geography of the Middle East".

Roy Jackson (Ph.D. Clark 1956) is in the Department of Geography at the University of
California, in Los Angeles. He is the author of "The Political Geography of the Middle East".

Edward J. Pincus is in the Department of Geography at the University of Wisconsin, in Madison.

James W. Reston (Ph.D. Clark 1953) is a Professor of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Attila Soberan (Ph.D. Clark 1961) is in the Department of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Marilyn Swenson (Ph.D. Clark 1954) is in the Department of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Kathleen M. Gerry (M.A. Clark 1949) is in the Department of Geography at the University of
Wisconsin, in Madison. She is the author of "The Political Geography of the Middle East".

John L. George (M.A. Clark 1954) is in the Department of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Michael A. Clark (M.A. Clark 1957) is a Professor of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Mark A. Clark (M.A. Clark 1957) is in the Department of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Peter G. Kohler (M.A. Clark 1954) is in the Department of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Loren Gould (M.A. Clark 1957) is in the Department of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".

Timothy J. Clark (M.A. Clark 1957) is in the Department of Geography at the University of
Wisconsin, in Madison. He is the author of "The Political Geography of the Middle East".
Donald W. Griffin (Ph.D., Clark 1963) is Assistant Professor of Geography at U.C.L.A. In consultation of the Ph.D. dissertation, he had no family to report to, but his proud owner of a new home. He has traveled in West Africa, doing field work on Planning and Urbanization. Thereafter he went to West Europe to set up from there. In October, 1965, he presented a paper at the African Studies Association. Furthermore he is present to be presented at Riverside, California (the Association of Pacific Coast Geographers), Toronto, and the University of Wisconsin for Urbanization, in June, 1966. He anticipates publication of one of his articles in the APS, and a second in the Jot of the AAAG. In the meantime he is involved in research on Los Angeles and urbanization.

Andrews Crotwell (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 travel.

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

Dorothy Burton Haldy (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.

Robert Hems is Assistant Professor of Geography at East Michigan University. He has joined the Michigan Association of Arts, Sciences, and Letters. He anticipates doing some traveling, with no destinations specified.

William C. Heasman (M.A., Clark 1951) highly recommends his new position as Director of Education at the Tamarac Job Corps Conservation Center: "a fascinating and challenging venture into a new field of education." His two children are "getting old"—Mary Lynn (5) and Gary (3). Willi is living on East Shore Drive, in Detroit, Michigan.

David H. Hoke (M.A., Clark 1950) is a consultant and has been involved in the Pikes Research Project for the Air Force (1942) and private research in northern Labrador and Quebec (1953). His present project is being carried out for the Great Northern Paper Company—glacial deposits in northern Maine. He is living in East Hilden, 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 on an undergraduate major at Southern Connecticut.

Hans J. Jansen, who lives in Brooklyn, New York, is an Adjunct of the Passport Agency of the U.S. State Department, in Radio City. During 1965, he traveled to the Holy Land and Egypt and Istanbul.

Frederick King will leave his position of Geography Department Head at United College (Winipeg, Canada) as of July, 1966. He will then assume the Chairmanship of the Department of Geography at the University of Guelph. In February, 1963, Fred was elected Guelph Fellow of More College, Yale University. His recent publications include: "China and the West," "Business Quarterly," December, 1965 ("Vietnam," "Egoc, December, 1965; Book Review of "Taiwan by Itsself" in "Geographical Review," January, 1966; and Book Review of J. Murray's "Great Chinese Travelers," in "Geographical Review.")

Esther Karchner Hunter (M.A., Clark 1949) is living in Rochester, N.Y.

Gilbert J. Hunter is Assistant Professor of Geography at Katulsk State College. He reports that Department now numbers five and is attracting students of a better caliber. He is writing a re- view of "Urbanization in West Africa for Professional Geographer." He will attend the 1966 NDGA summer institute at Minnesota to study methods of teaching introductory college Geography courses.

Harry K. Ketter (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 was named as Vice President of the Geography Section of the Ohio Academy of Science at Athens, Ohio.

Albert H. Jackson (Ph.D., Clark 1954) is Chairman of the Department of Geography at Western Michigan University in Kalamazoo. He took a week long trip to Bob Marshall Wilderness, South Fork Flathead River in Northwest Montana in July, 1964. For this summer he plans a trip to Europe.


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

Jane J. Johnson (Ph.D., Clark 1949) Assistant Professor of Geography at Wayne State University, is completing her study on "Local-Service Centers in New England." She is now beginning work on a reference volume, "Analytical Techniques for Geographic Research."

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

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

William T. Kite, 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 Kessel (M.A., Clark 1934) 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 Kessels compiled a workbook in Physical Geography, "Examination in Physical Geography," published by William Brown Company of Dubuque, Iowa, and an outline, "Outline of a Course in World Geography," published by the Phillips-Campbell Publishing Company of Little Falls, N.J.

Louis J. Koller (M.A., Clark 1929) is retired and lives in Covington, England, U.K.

Edward S. Korsch (M.A., Clark 1950) is the senior City Planner for the Detroit City Planning Commission.

Mary S. Kricher (Ph.D., Clark 1965) is Associate Professor of Geography at Southern Illinois University. She is currently engaged in a study of the Central Illinois Valley.

Esther L. Kuhl (M.A., Clark 1930) is retired and lives in Newtongee, Pennsylvania.

William A. Kuechler (M.A., Clark 1953) 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 L. Kues (Ph.D., Clark 1965) is Assistant Professor of Geography at Wayne State University, where he will direct this year's NDGA summer institute. His article "Continuity of the Great Lakes" was published in the "Bulletin of the Michigan Meteorological Society," Vol. 46, No. 1, February, 1965.


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

Minos L. Laskos (Ph.D., Clark 1930) is Chairman of the Department of Geography and Geology and Head of Geography, Pennsylvania State College. He will attend the I.G.T. 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-
Institute's in the Miami area.

In February, Dr. Snead made a study of three NASA space photographs of Iran for the Geographic Intelligence Division of CEMARRA 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 (NAAG & 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.


Marky R. Bowden

The major event in the Bowden household was the addition of Marc Kirkland on November 3. Research was interrupted for a period of the dissertation, but a three-month time out we spent 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 L. Warren

During the academic year of 1965-66 and the summer preceding, Dr. Warren 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 transparents for use in overhead projectors, on the World and Southern America. The accompanying test material and test 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-Berman College Geography: the fifth and sixth grade books in the above-named series, and, in cooperation with Dr. Robert Perry, a set of overviews on North America.

Probably the most intriguing work included the preparation for the 1966-67 year-long NASA 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 semester, 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 Appalachian-Blue Ridge Geography, and anxiously awaited, with much floor-peacing, 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.l Guy H. Burnham, Martyn J. Bowden, Raymond E. Murphy, Saul S. Cohen, Director of the School of Geography, Melman E. Sneed, Robert W. Kates, Henry J. Worman.

Second Row: Wallace O'Brien, Martin Lawson, John Allan, Maryam Johnston, Mary Alice Baier, Paul Banister, Shyam Sharma, Frank Hodges, Ralph凌晨, Robert Thompson, Fred Kinch.


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<tr>
<th>Name</th>
<th>Undergraduate Institution</th>
<th>Program</th>
<th>Graduate Major</th>
<th>Objective</th>
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<tbody>
<tr>
<td>Martin F. Lawson</td>
<td>University of Buffalo</td>
<td>Ph.D.</td>
<td>Historical Geography</td>
<td>University Research and Teaching</td>
</tr>
<tr>
<td>Susumu Takeuchi</td>
<td>Waseda University (Tokyo)</td>
<td>M.A.</td>
<td>Historical-Cultural Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>Wallace E. O'Brien</td>
<td>Farmington State College</td>
<td>M.A.</td>
<td></td>
<td>Teaching</td>
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<tr>
<td>Robert L. Adams</td>
<td>Williams College</td>
<td>Ph.D.</td>
<td>Resource Management</td>
<td>Teaching</td>
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<tr>
<td>John L. Allen</td>
<td>University of Wyoming</td>
<td>Ph.D.</td>
<td>Cultural-Historical Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>Helen Stewart</td>
<td>University of Nottingham</td>
<td>M.A.</td>
<td>Urban Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>David G. Arey</td>
<td>Denison University</td>
<td>Ph.D.</td>
<td>Resource Management</td>
<td>Academic-research</td>
</tr>
<tr>
<td>Paul R. Beaudet</td>
<td>Finchburg State Teachers College</td>
<td>Ph.D.</td>
<td>Urban Geography</td>
<td>Teaching</td>
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<tr>
<td>Mary Alice Eader</td>
<td>Shippenburg State College</td>
<td>M.A.</td>
<td>Geomorphology</td>
<td>Teaching</td>
</tr>
<tr>
<td>Farouk M. M. El Gemmel</td>
<td>Cairo University, Ain Shams University</td>
<td>Ph.D.</td>
<td>Urban Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>Nina A. Gildemeister</td>
<td>University of Geneva, Switzerland</td>
<td>M.A.</td>
<td>Historical-Cultural Geography</td>
<td>Research</td>
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<tr>
<td>Thomas Edward Gledhill</td>
<td>Rhode Island College</td>
<td>M.A.</td>
<td>Human Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>Jerry Alan Hall</td>
<td>University of Buffalo</td>
<td>Ph.D.</td>
<td>Physical Geography, Geomorphology</td>
<td>Teaching, research</td>
</tr>
<tr>
<td>Larissa M. Ranschke</td>
<td>Hunter College, CCNY</td>
<td>M.A.</td>
<td>Historical-Cultural Geography</td>
<td>Teaching, secondary level</td>
</tr>
<tr>
<td>Donald C. Jefferson</td>
<td>Uptown State Teachers College, Maine</td>
<td>M.A.</td>
<td>Urban Geography</td>
<td>Teaching or research</td>
</tr>
<tr>
<td>Elizabeth L. Johnson</td>
<td>Southern Connecticut State College</td>
<td>M.A.</td>
<td>Historical-Cultural Geography</td>
<td></td>
</tr>
<tr>
<td>Maryann M. Johnston</td>
<td>Keene State College, New Hampshire</td>
<td>M.A.</td>
<td>Urban Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>Jane E. Keppler</td>
<td>Illinois State University</td>
<td>Ph.D.</td>
<td>Economic</td>
<td>Teaching</td>
</tr>
<tr>
<td>Bruce L. La Rose</td>
<td>Holy Cross</td>
<td>M.A.</td>
<td>Historical Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>Ralph A. Lennon, Jr.</td>
<td>University of Massachusetts</td>
<td>M.A.</td>
<td>Political Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>Lawrence T. Lewis</td>
<td>Worcester State College</td>
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<td>Urban Geography</td>
<td>Teaching</td>
</tr>
<tr>
<td>Henry L. McCutcheon</td>
<td>McMaster University, Ontario, Canada</td>
<td>Ph.D.</td>
<td>Resource Management</td>
<td></td>
</tr>
<tr>
<td>Nathan H. Melson</td>
<td>San Jose State College, Clark University</td>
<td>Ph.D.</td>
<td>Geomorphology</td>
<td>Teaching</td>
</tr>
<tr>
<td>Fred Ostoby</td>
<td>University of British Columbia</td>
<td>M.A.</td>
<td>Political Geography</td>
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<tr>
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<td>Dartmouth College</td>
<td>M.A.</td>
<td>Economic Geography</td>
<td>Planning</td>
</tr>
<tr>
<td>Alirae M. Pourabbas</td>
<td>Tehran University, Iran</td>
<td>M.A.</td>
<td>Physical Geography</td>
<td></td>
</tr>
<tr>
<td>R. Ramachandran</td>
<td>University of Madras, India</td>
<td>Ph.D.</td>
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<tr>
<td>S. Sharma</td>
<td>Banaras Hindu University, India</td>
<td>Ph.D.</td>
<td>Teaching, research</td>
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</table>
| Sub-Ham Shin                    | Seoul National University, Korea    | M.A.    | Resource Management          | Teaching            | Paul R. Bauedt: "A Testing of the Concept of Suburbs and Satellitias: The Buffalo, New York, Metropolitan Area as a Case Study"
| Bryan Thompson                  | University of Toronto              | Ph.D.   | Urban Geography              | Teaching, research  | Mary Alice Beaver: "Geography—United States; Sandy Hook, New Jersey to Dual, New Jersey"
| Niels West                      | Boston University                  | M.A.    | Teaching                     |                     | Nore A. Gilnetin: "Historical and Cultural. General area: South America"
| Gary Whiteford                  | University of Toronto (York University) | M.A.    | Political Geography          | Teaching            | Thomas Edward Gladhill: "Population Geography of Sperely Settled Rhode Island"
|                                |                                    |         |                              |                     | Jerry Allen Hall: "Problems in Climato-Geographic Geomorphology" |
|                                |                                    |         |                              |                     | Larissa M. Hanusczek: "An Historical Geography of Kier" |
|                                |                                    |         |                              |                     | Elizabeth E. Johnson: "Shaker Communities" |
|                                |                                    |         |                              |                     | Jane E. Knepler: "Experimental Shifting Patterns of Park Production in the United States" |
|                                |                                    |         |                              |                     | Bruce Leo La Rose: "Central Place Study of Vermont, 1609-1803" |
|                                |                                    |         |                              |                     | Morrin P. Lawson: "Climate of Great Plains during Incipient Settlement: 1840-1850" |
| Ralph A. Lemon, Jr.             |                                    |         |                              |                     | Ralph A. Lemon, Jr.: "Political Geography—Africa"
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| Nathan H. Moeleen               |                                    |         |                              |                     | Disertation: "General Area of Stream Reversal in New England Pleistocene" |
| Ali-Asghar Pouzbaz               |                                    |         |                              |                     | Disertation: "The Pesticide Gulf through the Viewpoint of the Arab Geographer"
| R. Ramachandran                 |                                    |         |                              |                     | Disertation: "Technological Change and the Spatial Diffusion of Innovations in Rural India"
| Roger Robert                    |                                    |         |                              |                     | Disertation: "Innovation and Economic Growth: Their Spatial Implications"
| S. Sharma, Shyasa               |                                    |         |                              |                     | Disertation: "The Impact of Non-Indigenous Population on the Economy of Aswan"
| Sub-Ham Shin                    |                                    |         |                              |                     | Disertation: "Water Resources"
| Susumu Takachi                  |                                    |         |                              |                     | Disertation: "Hisorical—Urban—Japan"
| Bryan Thompson                  |                                    |         |                              |                     | Disertation: "(tentative) Settlement Patterns of post-World War II Immigrants into the Metropolitan Toronto Area."
| Niels West                      |                                    |         |                              |                     | Disertation: Resource Management, with special interest in fishing |
| Gary Whiteford                  |                                    |         |                              |                     | Disertation: 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 alumn 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
METH 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 Henry Barron, 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 in held beliefs often serve as truth in effect. Virtually the entire history of humanity has been intertwined with the thread of the "term incomparability", the unknown lands, as we, as geographers, have been told that the "most fascinating term incomparability of all are they 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 examined clearly by geographers. While all geographical knowledge, as well as the expressions of that knowledge, is influenced by myths, only a very few have recognized the theme as important enough to warrant a separate and distinct study of myth and perception itself. It is the purpose of this paper to illustrate, first, the nature of those 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 geography — "the nature and expression of geographical ideas both past and present...geographical ideas, both true and false, of all manner of people—nongeographers as well as geographers, farmers and fishermen, business executives and poets, novelists and painters, Bedouins and motorists." (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 geographical exploration and occupation of the earth by men (Wright, 1952a, 1952b, 1956, 1955, 1954, 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 conceptual 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 reason to a greater degree. The collective world view is the character and arrangement of the world and the totality of personal and scientific observations on the aspects of the shared world picture (Lowenthal, 1961, p. 261). This general notion 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 tenants of Christian dogma and varied considerably from the view of the world as a sphere held by educated peoples of the same time (Beasley, 1937, pp. 271-303). But at this specific point in time, these divergent opinions might have merged to form the universal world view, at least to persons who were seeing both with both. And as geographical knowledge has expanded, we have the horizons of geography become more familiar until people today share a common conception of the world.

This is not to say that the universal world view is held 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 within 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 subject to the influence of changes which are often drastic. This very transient world view of the sixteenth century in Europe is a highly transitory state resulting from the abrupt expansion of geographical knowledge. But since man always has arrived at a certain understanding about his world for "collective" or "social" knowledge, the general world view during this period of transition proceeded slowly rather than changing all at once and changed at different rates for different individuals and groups, depending upon the extent and relativity of their geographical knowledge. One may speak of "the white light of knowledge" but shadows playing along the mists that hid the New World from the view of Europe were there because the components of knowledge had different wavelength lengths. Geographical knowledge is a spectrum, with wave lengths of varying size and intensity combinations to give it its fullest expression (Dorico, 1952).

The existence of a universal and shared world view presupposes the further presence of separate or private worlds which are encompassing certain aspects of the shared picture. These separate or private elements which may or may not become a part of the universal and shared world experience. The consensual world view may contain personal term incomparability—lands that are unknown from the standpoint of personal experience but accepted as reality by the result of the five senses. These are elements that are "real," but acceptance within the confines of the general collective notion, most parts of the personal world image are never integrated into the personal image and thus remain "less accessible to inquiry and exploration than in the world we all share." (Lowenthal, 1961, p. 249). The world picture as seen by the individual, then, may, as has already been noted, transcended reality to a greater degree than does the world image shared by all.

Each individual is alone in his perception of his personal 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 influence of cultural and linguistic differences, to the editing and distortion resulting from personal feeling and emotion, and to the determinations of memory or the personal image (Lowenthal, 1961, p. 251-260). This is by no means to conclude that the nature of the personal world view diverges greatly from the consensual image, for the personal view and the shared view were not relatively mutually incompatible, 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 the expressions of their perception have the same form or content, although they will probably remain conceptually similar.

Those 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 provide an approach necessary for an understanding of the manner in which man perceives his environment, by the manner in which they understand what they perceive, and by the ways in which they act upon that understanding. The remainder of the present discussion will be devoted to the examination of the role played by myths and perception in the history of geographical discovery and in the patterns of occupation, 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 of the earth's surface. The dual approach used here is to integrate the study of the social and cultural aspects of earlier geographical knowledge and boiled upon the course of exploration and second, to evaluate the "contributions" of man to the "subsequent geographical knowledge" (Wright, 1943, p. 210), particularly as that knowledge influences the pattern of human occupation. 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 observer at a specific point in time. The collective notions of the world view may be derived from the importance of myths and perception and have directed their studies toward determining the world picture as it should seem consistent to them.

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 cleared from the information available to them, their world view as formulated in their minds from the geographical conceptions of their own and previous others. These perceived notions were vitally important in establishing the courses that exploration followed and the perspective of their observations. "What we discover," has been constantly seeing things that to him betokened the nearness of Marco Polo's Cathay and the Grand Khan's court. The explorers who concluded that the polar regions were uninhabitable, caused one navigator to plan an expedition to an island in the Arctic seas and see as impossible, despite evidence to the contrary that they might have seen had their eyes been open to it (Wright, 1943, p. 21; Nason, 1942). The voyage of these projects were actively perceived actions upon the course of geographical discovery, to the extent that in the earth one explorer sought to reach the other. Similarly, others immediately following upon his heels until the object was either reached or realized as illusion. Thus, the history of geographical exploration and discovery is replete with examples of how the limited conceived geographical line—"the depopulated lands of the North, the frozen lands of Quivira, the El Dorado, Terra Austra Incompleta—all in which only the minds of men but not men themselves sought, fought, and died.

In general, myths may influence the development of geographical knowledge, the myths of the greater southern continent of Terra Australis Incompleta and of the islands of the Atlantic (Navahoan, 1812, 1813; Bradan, 1922). The idea of a great land was given substance by classical geographers, primarily Ptolomy, 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 theory of the Age of Discovery. Many explorers, including Christopher Columbus, had ventured south 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 so as if they were well known. A 1712 map of Europe’s imaginative image of the South World as a paradise of riches and perfection was added to the five mythical features above, the result is the core of misconception, the core of the image of the American West which came to embody the mythic features and the Western form of the American mind. Two exceptions utilized the notions of the Northwest Passage, the interlocking drainage patterns, and the Great River of the West. The second concept was an amalgamation of the American West as a region of great fertility and vast agricultural possibilities and became effective in embellishing the myths of American freedom and nationhood

The first concept found expression in the view held by Thomas Jefferson and Thomas Hart Benton, the perception of the American West as a paradise of natural beauty and resources of particular interest to westerners and to the nation, as is evident in the first glimmerings of westward expansion and continued as a dominant factor in American society until the end of the nineteenth century. The concept 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 western surge of American civilization, leaving behind them the perpetual coastal and territorial-oriented settlements, and seeking for their way up the frontier the myth of the garden found both in the concept of free men cultivating free soil and in the agrarian utopia, and eventually was instrumental in the growth of the American agricultural empire, the result being the out of vast areas of land for the purposes of expansion, but in search of an easy and accessible route to the Westerns, 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, the concept of the exploration of the Northwest Passage, 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 and hills which "the File is but a Rivulet and the Danube a mere ditch," (Smith, 1901, p. 12) a land perceived as "the Garden of the World." The myth of the garden was utilized in the first glimmerings of westward expansion and continued as a dominant factor in American society until the end of the nineteenth century. The concept 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 western surge of American civilization, leaving behind them the perpetual coastal and territorial-oriented settlements, and seeking for their way up the frontier the myth of the garden found both in the concept of free men cultivating free soil and in the agrarian utopia, and eventually was instrumental in the growth of the American agricultural empire, the result being the out of vast areas of land for the purposes of expansion, but in search of an easy and accessible route to the Westerns, and probably influencing their perceptions and understandings of the nature of the country through which they passed on their journey to the Pacific.
BIBLIOGRAPHY

Books


Articles


**VARIATIONS IN THE INCIDENCE OF SUICIDE IN THE STATE OF MASSACHUSETTS:**
**AN EXCISE 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 Hampden and Hampshire counties low rates. However, the above-mentioned counties are among the least populated in the State. The inference 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; Day, 1954). 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 0.051, 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 22 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 death in the State of Massachusetts.

*This paper is based on an article by Miezakewicz Chyorsniak, "Maps Based on Probabilities," *American Statistical Association Journal*, LV, No. 288 (June, 1959), pp. 391-399.*
### Table 1

Suicides in the Counties of Massachusetts (1966)

<table>
<thead>
<tr>
<th>County</th>
<th>Population in thousands</th>
<th>Number of Suicides per 100,000</th>
<th>Number of Suicides</th>
<th>Probability</th>
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<tr>
<td>Barnstable</td>
<td>70</td>
<td>15.7</td>
<td>5.7</td>
<td>11</td>
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<tr>
<td>Berkshire</td>
<td>142</td>
<td>9.1</td>
<td>11.4</td>
<td>13</td>
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<tr>
<td>Bristol</td>
<td>390</td>
<td>4.5</td>
<td>32.0</td>
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<tr>
<td>Dukes</td>
<td>6</td>
<td>34.3</td>
<td>0.5</td>
<td>2</td>
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<td>Essex</td>
<td>569</td>
<td>8.9</td>
<td>45.7</td>
<td>50</td>
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<tr>
<td>Franklin</td>
<td>55</td>
<td>12.8</td>
<td>4.4</td>
<td>7</td>
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<tr>
<td>Hampden</td>
<td>429</td>
<td>10.2</td>
<td>34.5</td>
<td>44</td>
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<tr>
<td>Hampshire</td>
<td>103</td>
<td>3.9</td>
<td>9.3</td>
<td>4</td>
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<tr>
<td>Middlesex</td>
<td>1,239</td>
<td>6.5</td>
<td>99.6</td>
<td>89</td>
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<tr>
<td>Nantucket</td>
<td>4</td>
<td>0</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>Norfolk</td>
<td>510</td>
<td>7.3</td>
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<td>Plymouth</td>
<td>248</td>
<td>8.1</td>
<td>20.0</td>
<td>20</td>
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<td>Suffolk</td>
<td>792</td>
<td>7.1</td>
<td>63.7</td>
<td>56</td>
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<tr>
<td>Worcester</td>
<td>583</td>
<td>12.2</td>
<td>49.9</td>
<td>71</td>
</tr>
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</table>

State Average: 8.94 per 100,000

*N.S. -- Not Significant (probability greater than 0.05)

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**Figure 1**: Map of suicides per 100,000 of population in the counties of Massachusetts (1966).
Figure 2. Probability of observed number of suicides in the counties of Massachusetts.
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 28% and a high of 98% population mobility were registered in the areas sampled for this study (see Table D).

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 Bennis (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 Bennis was a more comprehensive 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 during 1950 than in 1940; the 1960 definition of residential mobility was substantially different in terms of span of years (see below). Finally, Duncan and Bennis dealt with all incorporated areas of 10,000 or more in the United States as their unit of study, rather than with individual census tracts.

Study Design

Census tracts were used as the area 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 sampling plan, which assured a more even coverage of the country than a simple random sample (see Appendix D). 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 to represent each city of 50,000 or more, or 3,500,000 people, by means of a table of random numbers. A total of 890 tracts were thus sampled, including tracts within central cities, suburban rings, and incorporated and unincorporated places in the remainder of S.M.A.

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 III). Since the variables are not really independent, but rather are related to one another, a stepwise 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.A.'s, are not included because they are not treated. The conclusions applicable to the rural units utilized in this study are not necessarily applicable to other types of rural units, such as corporate cities, urbanized areas, etc.

| TABLE I | Maximum and Minimum Recorded Observations, By Causal Factor |
| --- | --- | --- | --- |
| | Maximum | Minimum | Range |
| Residential mobility | 99.0% | 26.0% | 53.0% |
| White-collar workers as a percent of total resident labor force | 80.5% | 6.2% | 74.4% |
| Renter-occupied housing as a percent of all dwelling units | 95.1% | 1.0% | 94.1% |
| Median age | 54.0 | 16.8 | 88.0 |
| Median years of education | 14.0 | 15.1 | 16.0 |
| 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 (see census tracts, Table P-1).
2. White-collar occupations: Those persons, generally salaried, which include professional, technical, and kindred workers; managers, officials, and proprietors; clerical and kindred workers; and sales workers (see census tracts, Table P-6).
3. Age of the resident male population: Median age of all males (see census tracts, Table P-2).
4. Educational level: Median school years completed of persons 25 years old or over (see census tracts, Table P-10).
5. Renter-occupied housing: Total non-white and white renter-occupied units as a percent of all housing units (see census tracts, Table H-1).
6. Income: Median income of families (see census tracts, Table P-10).

| TABLE II | Results of Correlations Between Residential Mobility and Five Independent Variables |
| --- | --- | --- | --- | --- |
| Mobility | Age | Income | Education | Renter-occupied housing |
| Residential | .25** | .12 | .12 | .15* |
| Mobility | .39** |

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

Testing of 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. Residential variations may be more important.
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

<table>
<thead>
<tr>
<th>Final regression equation: $Y = 0.44 + 0.09x_1 + 0.06x_2 + 0.06x_4 - 0.01x_3$</th>
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</thead>
<tbody>
<tr>
<td>$r = 0.09$</td>
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<tr>
<td>$R^2 = 0.003$</td>
</tr>
<tr>
<td>$x_1$ = white-collar occupation; $x_2$ = renter-occupied housing; $x_3$ = income; $x_4$ = educational level.</td>
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**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 0.003. 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 area 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**


U.S. Census of Population, 1960, National Summary, Table I, "Mobility for States and State Economic Areas."
A STOCHASTIC MODEL OF FLUVIAL PATTERNS

Merlin Lewin and George Downey

In 1962, Lotus B. Leopold and Walter B. Langbein published a paper entitled "The Concept of Entropy in Landscape Evolution" in which contains a theoretical statement of the development of landscape morphology. The concept of entropy, or heat 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 Darwinian geographical cycle, through modifications by such researchers as Malin, 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 explore 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 Schonh 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 pattern 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 review 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 oddly 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, leaving the knowledge of the capital of the gambler and the "house." That is: D=D/2, where D is the duration of the game, is the gambler's capital, and is the total capital (gambler's capital plus the "house" capital. 1) Applying this formula, then, if two gamblers each had $100 and were to take a coin until one had all of the other's money, the contest would last an average duration of 100,000 trials. If, however, one contestant had $199 and his opponent had $1,001, the average duration of the game would be 199,000 trials, even though the total capital is equal in each case.

The physical analogy 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:

\[ D = \frac{1}{2}A \]

and

\[ D = \frac{1}{2}A \]

It will be noted that this condition refers 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:

\[ D = A \]

\[ D = A \]

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

1) Feller, (1960, pp. 288-629) 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 Schonh, which purposed 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 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 subroutine as a random number generator, which, by a series of firing 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, N, J). For example, the address of the cell in the seventeenth row and the sixteenth column would be M = 17, N = 6, J = 16. The address of each cell was put 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 head 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 (i.e., 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 streams modeled would evolve; if drainage is only allowed out of the cells at the center of the matrix, a centripetal pattern would develop; and if drainage is allowed to all the surface rivers, 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 and generates 10 random numbers in the first five rows assigned the value of 9, meaning that ultimate drainage will flow "north" as in a continental-drainage situation. The computer then accepts its first random data card with the address (M, N, J) and a value of zero. The random number subroutine 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 5 is added to the generated number in each cell until the flow is terminated by the discharge with a drainage outlet or a previously generated stream. When such a termination occurs the value of 5 is subtracted, leaving the number of the total flow. A series of the 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 control the sequence 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

Deciding change in the program was necessary to produce a stochastic model for a trellis drainage pattern. Essentially, this was accomplished by interpreting 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. Each of the main streams were designated by assigning values of 10 to each of the 20 drainage outlets. The program was rewritten to allow the ridge streams to be replaced only by the generation of a 1, meaning that superposed consequent streams were the only streams that could flow through a ridge. A stream residing for this stream from the belief that oblique streams (of value 1) would become beheaded by streams on the consequent ridge of the ridges. Flow directions on the top of ridges (values 2 and 4) were rejected by assigning these values to the stream (i.e., as streams cannot flow on the top of ridges). The remaining 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 of the statistical properties of the models. 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 information ratios between stream orders (Table 1).

---

TABLE 1

<table>
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<tr>
<th>order</th>
<th>number of streams</th>
<th>bifurcation ratio</th>
<th>average length ratio</th>
</tr>
</thead>
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<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
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<tr>
<td>4</td>
<td>6</td>
<td>9.0</td>
<td>9.0</td>
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</tbody>
</table>

*Not complete

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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 stream 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 analog 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 models. However, more importantly, a corridor has been paved to facilitate further studies along these frontier horizons. The mapping of an intuitive and mechanistic 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 may offer extensive and refined interpretive information in other scholarly geographical pursuits. One such application could involve the quantification of street patterns, that is, cities may exhibit significant 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 gridspaced 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 qualitative spatial generalizations for urban or traffic studies. In the long run, the final evaluation of statistical models rests upon the resultant diversity of applications.

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


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 conglomerations. The factual aspect ranges from the severe water shortages 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 1969 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 re-election of the incumbent president as Vice President of the United States.

The synopsis of the cover of this paperback describes New York as "the Concrete Wasteland" and asks the following questions: "Death Valley? Garstmano? 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 novel, 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, 1954, 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 demand 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 135 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 355 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 60 to 125 miles. The Catskill System contains two watersheds -- the Esopus and the Schoharie covering a total of 371 square miles, a capacity of 110 billion gallons and a dependable yield of 555 mgd. The Rondout and Neversink watersheds have a total area of only 91 and 93 square miles respectively. They are the smallest of the watersheds with a combined capacity of less than 85 billion gallons and a dependable yield of 335 mgd. Both of these reservoirs act as storage for diverted water from the Delaware System 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 695 mgd. The Peepskonk Dam of the East Branch was completed in 1952. The Camarena 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 1,863 mglp.

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 network 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 an average of sixty-four in recent years, is shown in Table 1. The average annual rainfall for the period 1906 to 1963 was calculated to be 41.34 inches. In addition, one standard deviation from this mean was found to be 7.91 inches.
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, which have a rainfall of 0.37 inches, the fifth driest year of record, is approximately 0.183. This probability was determined by the following formula:

\[ P(b) = \frac{n!}{b!(n-b)!} \times p^b \times (1-p)^{n-b} \]

\[ P(a) = \frac{b}{1+(b/n)(a-1)} = 0.183 \]

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年度 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 complex factors which affect runoff. This model operates upon the past record of runoff. The model 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 release required by law from several reservoirs which drain the metropolitan area 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 1,100 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 indicates that this amount is insufficient to establish a definite quantity of water, but that it was assured 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 other releases as directed by the River Master at Mountain, New Jersey. In the simulation model a constant amount of diversion of 150 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, 10% capacity and the actual amount now in the reservoirs, 20% capacity or 169 billion gallons. By random selection, however, 1965 turned out to be an exceeding-wet year and thus, by the end of 1965 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 back to its present level, the year 1965, 1970, and 1975. The Cannonsville Project is an extension of the history of the New York's water supply controversy and the Cannonsville reservoir has been included in the project since it has been proposed. This project has been completed by the beginning of the year 1975. The Board of Water Supply has not yet criticized the argument that with this project water is assured.

Table 2 shows the annual input and output of the model minus Cannonsville. This system remains essentially the same as the remainder of this present decade. However, in 1970 a modest decrease in population and thus, by the end of 1970 a daily per capita consumption combined with a decrease in normal or below normal rainfall begins to create some problems. These problems are temporarily alleviated in 1975 by a series of wet years. By 1985, even with very high per capita consumption and the possible age of Cannonsville, the system appears to be quite adequate. For 1991 the reservoirs at the end of the year, under the assumed conditions of 1,710 mgd, as compared to the year 1965, shows a total of 1,650 mgd at the same point in time. All of this water is provided by the reservoirs of the New York water supply system by the Byrd Water Supply Company. It also puts an end to the problem of science-fiction.
TABLE 3
SIMULATED MODEL
ANNUAL RUNOFF, STORAGE AND CONSUMPTION
FUTURE SYSTEM (Canonsville included)

<table>
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<tr>
<th>YEAR</th>
<th>RUNOFF</th>
<th>STORAGE</th>
<th>TOTAL</th>
<th>CONSUMPTION</th>
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Watershed area: 1,969 square miles
Maximum storage capacity: 604 billion gallons
All figures in billion gallons

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 Canonsville 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 Canonsville, conditions would become quite precarious 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-five 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 hoarders, beard makers 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 disaster. 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 part 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 Thornwell 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