U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

A BIBLIOGRAPHY OF GEOMORPHOMETRY

WITH A TOPICAL KEY TO THE LITERATURE AND AN INTRODUCTION TO THE NUMERICAL CHARACTERIZATION OF TOPOGRAPHIC FORM

by
Richard J. Pike

Open-File Report 93-262-A

1993

Menlo Park
California 94025

CONTENTS

ILLUSTRATIONS

A BIBLIOGRAPHY OF GEOMORPHOMETRY

WITH A TOPICAL KEY TO THE LITERATURE AND AN INTRODUCTION TO THE NUMERICAL CHARACTERIZATION OF TOPOGRAPHIC FORM

by

Richard J. Pike

ABSTRACT

A compilation of over 2100 references provides one-source access to the diverse literature on geomorphometry, the quantification of land-surface form. The report also defines the discipline, describes its scope and practice, discusses goals and applications, and identifies related fields. The bibliography documents the current, computer-driven state-of-art of geomorphometry and furnishes the historical context for understanding its evolution. Most entries address at least one of ten aspects of the science—its conceptual framework, enabling technology, topographic data and their spatial ordering, terrain attributes in vertical and horizontal domains, scale dependence and self-organization of topography, redundancy of descriptive parameters, terrain taxonomy, and the interpretation of land-surface processes. A subset of some 350 references, divided into 49 topics that outline the field of geomorphometry in more detail, guides the reader into the longer, unannotated listing. Lastly, over 100 references trace the development and application of one of the discipline's outstanding new contributions: the DEM-to-watershed transformation.

Topography is perhaps the single most important land surface characteristic that determines the climatic, hydrologic and geomorphic regimes.

Isacks and Mouginis-Mark (1992)

INTRODUCTION

This report is a research bibliography on the numerical representation of topography, or *geomorphometry*, a technical field within the Earth sciences. (I use *topography* in the restricted sense of ground surface or *terrain*, excluding vegetation and the cultural landscape.) Also known simply as *morphometry*, this old and widely practiced specialty has been revitalized over the past 25 years by the digital computer and related developments. Geomorphometry serves both applied and basic ends, supporting society's use of technology as well as contributing to scientific understanding of natural processes (Table 1). The main applications of morphometry to technology include engineering, transportation, public works, and military operations. Morphometry for the interpretation of natural processes and events has two principal functions; it leads not only to new discoveries in Earth science, but also to application of those results for improving the condition of human settlement—most explicitly protection from environmental hazards and the management of natural resources.

I hope to address several issues by compiling a reference resource on geomorphometry. The first, and overriding, purpose is to improve access to the scattered writings of this diverse field. A related goal is to promote scholarship in understanding the development of the discipline and in

Table 1

Some Goals and Applications of Geomorphometry

I. UNDERSTAND NATURAL PROCESSES

A. Pure (primarily Earth) Science—discoveries in:

geomorphology	geophysics	meteorology
geology	soil science	oceanography
hydrology	climatology	planetary science

B. Applied Science—uses of new discoveries (A, above) to:

1. Evaluate natural hazards & reduce their effects:

HAZARDS	*ACTIVITIES*
slope failure	inventory & mapping
wildfire	zoning
earthquake	risk assessment
flood	mitigation
coastal erosion	prediction
volcanic eruption	benefit-cost analysis
severe storm	emergency response
tsunami	restoration

2. Develop & manage natural resources:

RESOURCES	*ACTIVITIES*
water	inventory & mapping
soils & arable land	environmental protection
vegetation & forests	engineering
open space & parks	benefit-cost analysis
minerals & fuels	reclamation
wetlands	commodity extraction
wildlife	depletion-modeling

II. SUPPORT TECHNOLOGICAL NEEDS OF SOCIETY

A. Engineering, Transportation, & Public Works:

cultivation	vehicle design
urbanization & land use	planning, siting & design of:
telecommunications	*bridges, airports, canals, dams,*
navigation	*highways, irrigation, water supply*
waste disposal	planetary-surface exploration

B. Military Operations:

concealment & avoidance	reconnaissance & targeting
cross-country mobility	weapons design & deployment
logistics & engineering	tactical & strategic planning

citing its literature. Third, I have taken the opportunity afforded by this compilation to organize the science of geomorphometry—to identify its components and arrange them in a structure that is consistent with current research directions and applications (Table 2). The fourth objective is to foster a sense of unity within a field that is complex and fragmented and to provide its workers with a focus—a sense of place within science and technology. The fifth goal is to provoke new inquiries into the nature of topography, through the cross-fertilization of ideas that the diversity of this bibliography is intended to create. The sixth aim is to prompt colleagues to investigate the field's related disciplines (Fig. 1) and activities (Table 2) for solutions to operational problems in topographic analysis. Seventh, I want to encourage the continuing development of computer software that implements new approaches and procedures in morphometry (for example, Table 3). My final goal is to call attention to the need for higher standards of accuracy in the mass-produced digital elevation data on which progress in the field depends so critically.

LAND-SURFACE QUANTIFICATION

The Problem

Form has lagged behind process in the quantitative understanding of the Earth's surface and its evolution. Over the past few decades much progress has been made in describing agents of geomorphic change and how they work, even to the extent of modeling physical processes numerically (for example, Anderson, 1988; Phillips and Renwick, 1992). Representation of the topography itself, except for individual drainage basins (Horton, 1945; Stahler, 1964), has been less successful. Reasons for this include the great complexity of terrain, the resulting difficulty in describing it numerically, and some reluctance to abandon the qualitative approach that has long seemed adequate for much research and teaching. Obstacles to quantifying terrain must be overcome, however, for they restrict the role of topographic data in addressing important issues in science and technology that require information on land form. Most recent among such problems is the numerical description, or *parameterization*, of continuous land-surfaces, which is essential to understanding the regional distribution of precipitation (Tarboton, 1992) and other elements that contribute to new knowledge of synoptic meteorology and global climate (Henderson-Sellars and Dickinson, 1992; Isacks and Mouginis-Mark, 1992).

Descriptions of continuous topography tend to be qualitative and subjective, because the prevailing nomenclature is verbal and nonunique. Such adjectives as *hilly, steep, gentle, rough,* and *flat* mean different things to different observers, depending on their experience and the scale of the landscape under scrutiny (Wolfanger, 1941; Frank and others, 1986). The common nouns *mountain, plateau, hill,* and *plain* are equally imprecise—an old shortcoming inherent in applying everyday language to technical questions. One result is that very different landcapes may be characterized in identical terms. *Rolling hills* in North Dakota, for example, does not mean the same thing as *rolling hills* in Tuscany, and neither resembles the *rolling hills* celebrated in songs of the Scottish Border country. Such confusion reflects several underlying issues. For example, just what *are* rolling hills? What makes them *rolling* to the eye and to the mind; what distinguishes them from *non-*rolling hills? How does an observer's location, both on and above the ground surface, affect the perception of hills as *rolling*? And, for that matter, what is a hill and when is it not a hill but rather a ridge or a mountain? These questions, which are of great interest in applied linguistics and the psychology of cognition, are not trivial (Gibson, 1950, 1979; Hoffman, 1990; Graff, 1992).

The different shades of meaning that reside in qualitative terms greatly impede the communication of information about topography. The basic problem, even among experts familiar with landscapes worldwide, is this: language used to represent continuous terrain is not systematically equated with measurable attributes of land form (Frank and others, 1986; Hoffman and Pike, 1992). Without such measures and an orderly taxonomy of form it is impossible, for example, to define *rolling hills* or to specify in exactly what respects the hills of Tuscany differ from those of North Dakota or the Scottish Border. More importantly, it is impossible to incorporate those differences, whatever they might be, into numerical models of terrain that can be related to spatial variation in climate and other natural phenomena, or to use topographic form effectively in related applications. Finally, without precise description of the *what* there can be no meaningful *why*—the operation of geomorphic processes at the Earth's surface cannot be explained convincingly in quantitative terms without measures of the resulting topographic forms. Such measures should be sufficiently comprehensive to provide a signature of process (Pike, 1988a, b), save in cases of *convergence*, or *equifinality*—where different processes and conditions yield similar landforms (Thorn, 1988).

Toward a Solution

The need for repeatable, and thus numerical, description of observations in many sciences has led to the measurement of shape, or *morphometry*. This approach has been particularly successful in such fields as biological systematics (Thompson, 1917; Bookstein, 1978; Warheit, 1992) and sedimentary petrography (Krumbein and Pettijohn, 1938; Marshall, 1987). Application of morphometry to the Earth's surface has come to be known as *geomorphometry*, *geo-* distinguishing this craft from its practice elsewhere, both within and outside of geology and geography. The term, which was simply *morphometry* in the early 20th century and previously *orometry* (Hettner, 1928; Beckinsale and Chorley, 1991), dates back at least to Tricart (1947); it has gained acceptance mainly through the work of Evans (1972) and Mark (1975a). Although a little awkward, the term is no more so than many others in the Earth sciences—for example, paleomagnetism. Lastly, *geomorphometry* is well established and nothing is to be gained by searching out an alternative.

Reduced to its analytic essentials, topography is just geometry and topology. Geometric measures have long been used to describe the three-dimensional form of topographic features that are expressed as points, lines, areas, and volumes in Euclidean space (Smith, 1935; Melton, 1958b; Wood and Snell, 1960a). However, Euclidean geometry vastly oversimplifies so complex a surface as continuous topography (Frank, 1988). Topologic parameters have been introduced more recently to describe sequential order, connectivity, and other non-Euclidean attributes that comprise the spatial arrangement of topographic features (Horton, 1945; Shreve, 1967; Mark, 1979a). Many measures of both types, some of them taken at several spatial scales, are required to effectively represent the shape of a terrain surface (Van Lopik and Kolb, 1959; Hammond, 1964a, b; Pike and Rozema, 1975). The geometry of basic elements—ridges, valleys, slopes, peaks, depressions, and passes—is captured by slope, curvature, and other derivatives of terrain height in both the vertical (Z) domain and in the horizontal (X,Y) domain. The topology of these elements is most frequently expressed as a hierarchy of channel links and nodes, ridges, and watersheds. Nonetheless, parameters of X,Y attributes other than those based on stream order are essential to fully describe the topology of landscapes—particularly where fluvial degradation is not the dominant process.

Two approaches to geomorphometry are often distinguished (Evans, 1972): *specific*—describing discrete features, or *landforms*, and *general*—describing *continuous topography*, or landscapes. Specific morphometry, which directly reflects geomorphic process, is comparatively well developed (Evans, 1987a; Jarvis and Clifford, 1990). Its application is most mature in the study of drainage basins, impact craters and volcanoes, and other landforms that are readily isolated in the landscape. Specific morphometry is less well developed for landforms that can be difficult to identify or delimit, such as drumlins, sand dunes, cirques, and karst features (Evans and Cox, 1974). The practice of morphometry is most primitive for the general case, continuous topography, which least directly reflects geomorphic process and is commonly applied to line-of-sight (viewshed), terrain roughness, and other engineering problems. General geomorphometry today offers many challenges (Pike, 1988a; Pike, Acevedo and Card, 1989; Evans, 1990). Its research agenda includes the problem of nonstationarity (azimuth dependence) of much topography, ambiguity of guidelines for sampling terrain, the unknown degree of scale dependence of land form, and difficulties in describing the organization of continuous topography in the *X,Y* domain.

Morphometry Demystified

Geomorphometry has been defined as the science "which treats the geometry of the landcape" (Chorley and others, 1957, p. 138), but these few words are now inadequate. The computer revolution and related technology, exploration of the planets and Earth's seafloor, and developments in topology and in surface characterization since 1957 warrant an updated definition. The alternatives are many. They range from simply *quantification of topography* to *numerical extraction and expression of the information content of terrain surfaces.* Whatever the definition, geomorphometry is an emerging discipline of land-surface form that transcends method. It is not just a set of approaches and techniques, a toolbox for solving terrain-related problems in science and technology, but a research specialty of its own. Geomorphometry as a science is still immature. Although morphometry has predictive capability (Wood, 1967), it remains highly empirical and—like geomorphology (Cox and Evans, 1987; Rhoads and Thorn, 1993)—lacks unifying theory.

Much work lies ahead before a theory can be formulated for geomorphometry; two possible approaches are noted briefly here. One path is through geomorphology, perhaps the most closely allied discipline (Thorn, 1988). For example, a theory of morphometry might build formal geometric and topologic structures of the Earth's surface for geomorphology, in somewhat the same way that crystallography provides the geometric foundation for mineralogy. Such simple analogies as this would have to be developed much further and incorporate geomorphic processes. Geography offers an alternate path to morphometric theory, which might be based less on physical processes and laws and more on spatial properties and relations derived from graph theory (Bunge, 1962; Mark, 1979a). Such a theory for geomorphometry would require first a general theory of geographical space (King, 1969; Frank and others, 1986; Peuquet, 1988a) that could be implemented by computer (Frank, 1988; Dikau, 1990a).

Geomorphometry is evolving from a vaguely bounded and supportive role between various disciplines into a coherent academic field. However, it is still more derivative and interdisciplinary than primary and independent. Morphometry borrows from, interacts with or feeds back to, and furnishes information for longer-established areas of study, some of them marginal to the Earth sciences (Fig. 1). It is identified with many military and engineering applications (for example, Bekker, 1969). In the United States, morphometry is allied closely with surface hydrology, notably through work starting with that of Horton (1945) and more recently through the computer-partitioning of watersheds from matrices of terrain heights (Table 3; Tribe, 1992b). The field is recognized as a specialty within geology, geography, and geomorphology (Graf, 1988; Richards, 1990), as well as a subfield of digital cartography (Clarke, 1990).

The content of geomorphometry (Table 2) may be more familiar to Earth scientists as *terrain analysis, quantitative geomorphology*, or *terrain modeling.* Although none of these terms is synonymous or entirely correct, all three approaches to land-surface quantification overlap, and morphometry includes much of each field. *Terrain analysis* tends to be applied. Its several connotations—particularly military, engineering, or remote-sensing—often address such problems in general morphometry as the classification of continuous surfaces according to roughness

Figure 1

Some Cognate Disciplines of Geomorphometry

SOURCES FOR APPROACHES AND TECHNIQUES

Artificial intelligence, Automotive engineering, Biological systematics, Cartography, Civil engineering, Computer science, Digital image-processing, Geometry, Geomorphology, Geophysics, Hydrology, Information technology, Machine visualization, Mathematics, Medical imaging, Microscopy, Military terrain-analysis, Pattern recognition, Photogrammetry, Physical geography, Psychology, Remote sensing, Rural-land classification, Statistics, Surveying, Theoretical geography, Topology, Tribology

↓ ↓ ↓ ↓ ↓

GEOMORPHOMETRY

↓ ↓ ↓ ↓ ↓

APPLICATIONS OF ANALYSES AND RESULTS

Agricultural engineering, Cartography, Civil engineering, Communications engineering, Ecology, Economics, Engineering geology, Forestry, Geomorphology, Geotechnical engineering, Hydrology, Land use, Law, Machine visualization, Meteorology & climatology, Military terrain-analysis, Navigation, Oceanography, Physical geography, Planetary science, Planning & zoning, Psychology, Resource management, Risk assessment, Rural-land classification, Soil science, Tectonics, Terrain modeling

(Bekker, 1969). Terrain analysis also can be entirely qualitative and commonly incorporates attributes of landscape other than geometry of the surface—as in the mapping of land systems and similar types of natural units for land-use appraisal (Mitchell, 1973; Way, 1973). *Quantitative geomorphology* is a research discipline with a more strictly scientific focus. It generally interprets physical processes that create discrete features or orderly groups of them, notably drainage basins (Strahler, 1964; Morisawa, 1985) and impact craters (Baldwin, 1963; Pike, 1988c). As a rule, quantitative geomorphology involves specific morphometry and rarely addresses continuous topography, save in the context of regional landscape evolution.

Terrain, or *surface, modeling* describes recent applications of digital-cartographic technology to topographic data (Petrie and Kennie, 1990; Weibel and Heller, 1991). Because the term was rarely used to describe quantitative work predating the computer, it is not synonymous with geomorphometry. Terrain modeling commonly includes relief shading and other means of machine visualization, but it also indicates virtually any spatial ordering and geometric or topologic rendering of the land surface by computer (Dikau, 1990a). Terrain modeling is largely an automated implementation of general geomorphometry. Increasingly, however, such computer-based procedures as the delimitation of watersheds from elevation matrices (Table 3) are blurring the operational distinction between general and specific cases—between landscapes and landforms. Much of the future growth of geomorphometry, including development of its theory, almost certainly lies in what is now termed terrain modeling.

Current Practice

Although long established as a research endeavor, and more recently a discipline in its own right, geomorphometry remains diffuse and ill-defined. Much of the ambiguity arises from an ever-growing and diversifying technology that provides so many new ways to model topography by computer (Fisher and Lindenberg, 1989). To consolidate and more sharply focus the discipline of geomorphometry, I have identified 49 groups of activities or topics that characterize its current state-of-art and suggest a further ten-fold ordering of them (Table 2). This classification is not unique, for the topics could be arranged differently, some topics could be consolidated, and others could be added. I have simply found the structure of Table 2 to be helpful in my own research, in teaching, and in communicating with colleagues. The topics and relations shown in Table 1 and Figure 1, which outline some applications and cognate disciplines of geomorphometry, further aid in this attempt to define the field as it exists today.

The ten general areas in Table 2 are reviewed briefly here; the first four subject headings treat introductory topics and method. *Conceptual framework* sets forth an approach to the numerical representation of both discrete forms and continuous topography; it also addresses such complications of morphometry as its inherently spatial context. *Enabling technology* includes several computer-based techniques for the description of land form. Among these are different approaches to feature measurement as well as the most common means of machine visualization—relief shading. The heading *topographic data* emphasizes the production of information that is used to capture surface form, with special attention to the fidelity of digitized elevations obtained from contour maps. *Spatial ordering of topographic information* is concerned with designs for sampling terrain, often from contour maps, and with structuring the resulting elevations in ways that best describe surface form.

The remaining six topics in Table 2 cover the technical details of terrain representation and the applications of geomorphometry. *Derivatives of elevation in the vertical (Z) domain* include relief and slope angle, and are the most easily generated descriptors of topography. Such *attributes of terrain in the X,Y (horizontal) domain* as spacing and arrangement are more difficult to compute than Z-domain descriptors, but also capture much of the visual perception of surface form.

Table 2

A Topical Key to the Literature on Geomorphometry

INTRODUCTION

1. CONCEPTUAL FRAMEWORK

TOWARD A THEORY OF GEOMORPHOMETRY

Berry, 1968
Dikau, 1990a
Frank, Palmer, and Robinson, 1986
Krcho, 1973, 1990
Kugler, 1974
Mark and Frank, 1989
Thorn, 1988

PERCEPTION & COGNITION OF TOPOGRAPHY

Aloimonos, 1988
Gibson, 1950, 1979
Heinrichs and others, 1992
Hoffman, 1990
Hoffman and Pike, 1992
Hsu, 1974
Lay, 1991
Savitt and others, 1992
Tamura and others, 1978
Young and Yamane, 1992

QUANTIFYING TOPOGRAPHY—NEEDS & CAPABILITIES

Clarke, 1966
Greysukh, 1967
Hammond, 1954a, 1965
Horton, 1945
Mark and Warntz, 1982
Pitty, 1982
Richards, 1990
Strahler, 1954a, 1992
Wolfanger, 1941
Wood and Snell, 1960a

LAND FORM *VS.* LANDFORMS: CONTINUOUS SURFACES *VS.* DISCRETE FEATURES

Evans, 1972, 1987a, 1990
Hammond, 1965
Jarvis and Clifford, 1990
Mark, 1975b
Renwick, 1992
Weaver, 1965

MORPHOMETRY AS ANALYTICAL CARTOGRAPHY

Chervyakov, 1990
Clarke, 1990
Dikau, 1990a, 1992
Frank, Palmer, and Robinson, 1986
Monkhouse and Wilkinson, 1971
Peucker, 1972
Tobler, 1976

METHOD

2. ENABLING TECHNOLOGY

DIGITAL TERRAIN (SURFACE) MODELING

Clarke, 1990
Dikau, 1989,
McCullagh, 1988
Petrie and Kennie, 1990
Weibel, 1992
Weibel and Heller, 1991

GEOGRAPHICAL INFORMATION SYSTEMS

Aronoff, 1989
Burrough, 1986
Carrara and others, 1991
Cowen, 1988
Davis and Dozier, 1990
ESRI, 1992a
Maguire, Goodchild, and Rhind, 1991
Raper, 1989

REMOTE SENSING

Eppler and Farmer, 1991
Franklin, 1991

Haralick and others, 1985
Leberl and others, 1991
Raggam and others, 1989
Sasowsky and others, 1991
Toriwaki and Fukumura, 1978
Wang and others, 1984

DIGITAL IMAGE-PROCESSING

Fabbri, 1984
Jensen, 1986
Ourmazd and others, 1989
Peuquet, 1979
Pike, Acevedo, and Thelin, 1988
Pike and Thelin, 1989

AUTOMATED RELIEF SHADING & PHOTOCLINOMETRY

Batson and others, 1975
Dubayah and Dozier, 1986
Elvhage and Lidmar-Bergström, 1987
Friedhoff and Benzon, 1991
Horn, 1981, 1990
Kennie and McLaren, 1988
Moellering and Kimerling, 1990
Muller and others, 1988
Thelin and Pike, 1991
Yoeli, 1967

AUTOMATED PATTERN RECOGNITION & FEATURE EXTRACTION

Argialas and others, 1988
Buttenfield, 1987
Greysukh, 1967
Haralick and others, 1985
Ivanov and Chalova, 1987
Lay, 1991
Nagao and Matsuyama, 1980
Pao, 1989
Riazanoff and others, 1990
Rosenfeld, 1981
Graff, 1992

EXPERT SYSTEMS & ARTIFICIAL INTELLIGENCE

Argialas and Narasimhan, 1988
Hadipriono and others, 1990
Mackay and others, 1992
Narasimhan and Argialas, 1989
Schenk and Zilberstein, 1990
Usery and others, 1988

COMPUTER ALGORITHMS & SOFTWARE PACKAGES

Barchi and Guzzetti, 1990
Cole and others, 1990
Collins and Moon, 1981
Dozier and Frew, 1990
ESRI, 1991b, 1992b
Evans, 1980
Franklin and Peddle, 1987
Grender, 1976
Guth and others, 1987
Hobson, 1967
Jenson and Domingue, 1988
Nogami, 1985
Peddle and Franklin, 1990
Schaber, Pike, and Berlin, 1980
Thorn and others, 1987
Turner and Miles, 1968
Wolf, 1991b

3. TOPOGRAPHIC DATA

ACCURACY OF CONTOUR MAPS

El-Tahlawi and Rashad, 1991
Fahsi and others, 1990
Gugan and Dowman, 1988
Gustafson and Loon, 1982
Mahoney and others, 1991
Mark, 1983a

DIGITAL ELEVATION MODELS (DEM's) & DIGITAL LINE GRAPHS (DLG's) I—CREATION & AVAILABILITY

Berry and others, 1988
Elassal and Caruso, 1983
Hall and others, 1990
Hutchinson and Dowling, 1991
Kidner and Smith, 1992
McCulloch and Marinaro, 1988
Rinehart and Coleman, 1988
Schut, 1976
Sharif and Makarovic, 1989
Smith and Wessel, 1990
Topographic Science Working Group, 1988
U.S. Defense Mapping Agency, 1992
Wolf and Wingham, 1992
Yoeli, 1986

DEM's & DLG's II—ASSESSMENT OF ERROR & QUALITY

Acevedo, 1991
Carter, 1989, 1992
Ebisch, 1984
Förstner, 1983
Guth, 1992
Hannah, 1981
Li, 1992
Östman, 1987
Pan, 1989
Polidori and others, 1991
Theobald, 1989
Theobald and Goodchild, 1990
USGS, 1988

ADVANCED TECHNIQUES OF DATA ACQUISITION

Björnsson, 1988
Brozena and others, 1992
Evans and others, 1992
Gardner, 1992
Gugan and Dowman, 1988
Krabill and others, 1984
Leberl and others, 1991
Marks and others, 1993
Raggam and others, 1989

4. SPATIAL ORDERING OF TOPOGRAPHIC INFORMATION

SAMPLE DESIGNS TO EXTRACT DATA FROM CONTOUR MAPS

Ansoult, 1989
Carstensen, 1990
Richards, 1990
Maling, 1989
Mark, 1975b
Ming, 1992
Snell, 1961
Strahler, 1956
Wood, 1967
Wood and Snell, 1960a

CARTOGRAPHIC DATA STRUCTURES I—RASTER & QUADTREE

Cebrian and others, 1985
Chen and Tobler, 1986
ESRI, 1991a
Ibbs and Stevens, 1988
Maguire, Kimber, Barry, and Chick, 1991
Samet, 1990
Shaffer, 1988

CARTOGRAPHIC DATA STRUCTURES II—SURFACE-SPECIFIC

Falcidieno and Pienovi, 1990
Frank, Palmer, and Robinson, 1986
Mark, 1979b
Peucker and Chrisman, 1975
Thapa, 1988
Wolf, 1991a

THE TRIANGULATED IRREGULAR NETWORK (TIN)

DeFloriani and others, 1986
ESRI, 1991b
Goodrich and others, 1991
Lee, 1991b
McKenna, 1986
Mirante and Weingarten, 1982
Peucker, Fowler, Little, and Mark, 1978
Plews and Clarke, 1990
Theobald and Goodchild, 1990

CHARACTERIZATION

5. Z-DOMAIN ATTRIBUTES

ELEVATION & SOME OF ITS DERIVATIVES

Clarke, 1966
Evans, 1980
Mark, 1975a
Ohmori and Hirano, 1984
Pike and Wilson, 1971
Stearns, 1967
Strahler, 1952
Tanner, 1959, 1960

LOCAL (RELATIVE) RELIEF

Ahnert, 1984
Drummond and Dennis, 1968
Ohmori, 1978
Pike, Acevedo, and Card, 1989
Wood, 1967
Zakrzewska, 1967

ANGLE OF SURFACE SLOPE

Agopova, 1965
Ahnert, 1970a
Blong, 1975
Mark, Newman, and Brabb, 1988
Moore and Mark, 1986
O'Neill and Mark, 1987a
Pitty, 1968
Speight, 1971
Strahler, 1956
Young, 1972

CURVATURE OF SLOPE IN PROFILE

Carrara and others, 1978
Heerdegen and Beran, 1982
Papo and Gelbman, 1984
Pike, 1988a
Troeh, 1965

6. X,Y-DOMAIN ATTRIBUTES

AZIMUTH (ASPECT) OF TOPOGRAPHIC FEATURES

Abdel-Rahman and Hay, 1981
Dale and Ballantyne, 1980
Evans, 1977b
Gordon, 1981
Jones, 1968
Wadge, 1988
Wadge and Cross, 1988
Williams, 1974

LAND-SURFACE CURVATURE IN PLAN

Chang and Toebes, 1970
Evans, 1972, 1980
Snow, 1989
Troeh, 1965

PLANIMETRIC SHAPE OF TERRAIN FEATURES

Jarvis, 1976
Komar, 1984
LaGro, 1991
McArthur and Ehrlich, 1977
Ongley, 1970
Piotrowski, 1989
Van Lopik and Kolb, 1959
Whalley and Orford, 1989
Williams, 1972a
Woronow, 1981

TERRAIN TEXTURE I—SPACING & FREQUENCY

Dolan and others, 1974
Gregory and Gardiner, 1975
Hallet, 1990
Haralick, 1978
Hill, 1973
Howard, 1992
Lancaster, 1988
Mulla, 1988
Pike and Rozema, 1975
Tarboton and others, 1992

TERRAIN TEXTURE II—ARRANGEMENT (PATTERN)

Anderson, 1987
Eppler and Farmer, 1991
Franklin and Peddle, 1987
He and Wang, 1990
Hsu, 1978
Mark, 1988
Rossbacher, 1986
Trifonov and Shults, 1990
Vincent, 1987

TOPOLOGY OF CHANNELS AND OTHER ELEMENTS OF FORM

Abrahams, 1987
Bras and Rodriguez-Iturbe, 1989
Hadipriono and others, 1989
Haynes, 1977
Howard, 1990a
Mark, 1979a, 1988
Shreve, 1975
Warntz, 1975
Werner, 1991

7. SCALE DEPENDENCY & SPATIAL SELF-ORGANIZATION

VARIATION OF LAND FORM WITH SPATIAL SCALE

Church and Mark, 1980
Frank, Palmer, and Robinson, 1986
Hallet, 1990
Lettau, 1967
Montgomery and Dietrich, 1992

Shaw and Smith, 1990
Wood and Snell, 1957

CARTOGRAPHIC GENERALIZATION & MAP SCALE

Buttenfield, 1989
McMaster, 1989
Scheidegger, 1966
Tobler, 1966
Weibel, 1992
Wolf, 1991b

UNIFORM & NONUNIFORM RELATIONS OF SCALING—ISOMETRY & ALLOMETRY

Bull, 1975
Church and Mark, 1980
Mosley and Parker, 1972
Sprent, 1972
Woldenberg, 1966

SPATIAL AUTOCORRELATION OF TOPOGRAPHY

Mark and Aronson, 1984
Olea, 1977
Oliver and Webster, 1986
Pike, Acevedo, and Card, 1989
Thompson, 1959
Wood and Snell, 1959c
Woodcock and others, II, 1988

PROPERTIES OF THE TOPOGRAPHIC VARIANCE SPECTRUM

Bryson and Dutton, 1967
Ferguson, 1975
Fox and Hayes, 1985
Jaeger and Schuring, 1966
Mark and Aronson, 1984
Pike and Rozema, 1975
Rayner, 1972

FRACTAL DIMENSIONS OF TOPOGRAPHY

Burrough, 1981
Clarke, 1986
Goodchild and Mark, 1987
Liu, 1992
Phillips, 1986
Piech and Piech, 1990
Snow and Mayer, 1992
Xia, Clarke, and Plews, 1991b

8. REDUNDANCY OF TERRAIN PARAMETERS

MEASUREMENT OF COVARIANCE

Engstrom, 1989
Evans, 1972, 1984a
Gordon, 1977
Gray, 1961
Mark, 1975a
Melton, 1958b
Pike and Wilson, 1971

SORTING OUT INDEPENDENT DESCRIPTORS

Ebisemiju, 1979b
Evans, 1984a
Miller and others, 1990
Pike, 1974, 1988b
Wong, 1963

RESULTS & APPLICATIONS

9. TERRAIN TAXONOMY

CLASSIFICATION SCHEMES & THE GEOMETRIC SIGNATURE

Demek, 1972
Hammond, 1954a
Mather, 1972
Parry and Beswick, 1973
Pike, 1988a
Schreier and Lavkulich, 1979
Speight, 1976
Van Lopik and Kolb, 1959

TOPOGRAPHIC TYPES & TOPOGRAPHIC REGIONS

Beckinsale and Chorley, 1991
Dikau, Brabb, and Mark, 1991
Eyles, 1971
Hammond, 1964a, b
Krasnovskaia, 1988
Mather and Doornkamp, 1970
Scott and Austin, 1971
Speight, 1968, 1974
Wood and Snell, 1960a

TERRAIN EVALUATION & LAND SYSTEMS

Burrough, 1989
Isachenko, 1973
Mitchell, 1973
Stewart, 1968
Townshend, 1981
Way, 1973

ENGINEERING CATEGORIZATION OF TOPOGRAPHY

Bekker, 1969
Chiou and others, 1992
Costes and others, 1972
Fisher, 1991b
Goldberg, 1962a
Hibler, 1975
Petrie and Kennie, 1990
Rowan, McCauley, and Holm, 1971
Rozema, 1969
Tsipis, 1975
Tunnard and Pushkarev, 1963
Wentworth, Ellen, and Mark, 1987

10. INTERPRETATION OF SURFACE-SHAPING PROCESSES

SURFACE HYDROLOGY I—DRAINAGE BASIN MORPHOMETRY

Abrahams, 1984
Band and others, 1991
Gardiner, 1982a
Gardiner and Park, 1978
Howard, 1990a, b
Patton, 1988
Strahler, 1964, 1992
Zâvoianu, 1985
Zecharias and Brutsaert, 1985

SURFACE HYDROLOGY II—MODELING CHANGES IN THE GLOBAL ENVIRONMENT

Committee on Global Change, 1990
Davis and others, 1992
Dyer and Vinogradov, 1990
Henderson-Sellars and Dickinson, 1992
Isacks and Mouginis-Mark, 1992
Lettau, 1967
Tarboton, 1992
Young and Pielke, 1983

SURFACE HYDROLOGY III—THE AUTOMATED DEM-TO-WATERSHED TRANSFORMATION

Tribe, 1992b (review paper)
(Table 3 has > 100 more references)

TOPOGRAPHY SHAPED BY NON-FLUVIAL PROCESSES

Carrara and others, 1982
Dolan and others, 1977a
Evans, 1977b, 1987b
Fox and Hayes, 1985
Håkanson, 1978
Lancaster, 1988
Mills and Starnes, 1983
Mock and others, 1972
Morhange, 1992
Pike, 1974
Piotrowski, 1989
Rentsch and others, 1990
Sauchyn and Gardiner, 1983
Silva and others, 1992
Smith, 1988

MODELING & SIMULATION OF PROCESS

Anderson, 1988
Band and others, 1991
Craig, 1980, 1989
Hugus and Mark, 1984
Mayer and others, 1981
McEwen and Malin, 1989
Toppe, 1987
Vertessey and others, 1990

OTHER APPLICATIONS RELATED TO GEOMORPHOLOGY

Aniya, 1985
Brabb, 1987
Burbank, 1992
Carrara and others, 1978
Chorowicz and others, 1991
Colleau and Lenôtre, 1991
Cook and others, 1988
Elmes and others, 1991
Morris, 1991
Norton and Sorenson, 1989
Simpson and Anders, 1992
Tinkler, 1971
Zachar, 1982

These spatial properties do not necessarily require elevation data. Topography differs in shape with level of generalization, or scale, and the degree of *scale dependency and spatial self-organization* is itself a key descriptor of form. Many measures may describe the same attribute of form; such *redundancy of terrain parameters* can be sharply reduced through correlation and multivariate analysis. Systems for *terrain taxonomy*, particularly in continuous topography, are a major goal of geomorphometry. Many classification schemes address numerical problems in the *interpretation of land-surface processes* from land form, including those in surface hydrology and the geomorphology of landforms other than drainage basins.

All ten general categories in Table 2 are active areas of research, but several of them focus on two broad, overlapping activities that have long been central to geomorphometry—developing new techniques of analysis and testing descriptive parameters. Operational techniques often are adapted from allied disciplines (Fig. 1; Table 2, mainly topics 2, 4, and 8). They include roughness analysis, line-of-sight (viewshed) modeling, network analysis, slope-frequency statistics, altimetric analysis, numerical taxonomy, spectral analysis, multivariate statistics, nearest-neighbor analysis, various types of sampling from both profiles and matrices, texture analysis, machine visualization and its complement shape-from-shading (photoclinometry), topologic modeling, signature analysis (fingerprinting), percentage hypsometry, and volumetric analysis. The parameters of form that have been found effective for abstracting natural topography are the subject of much current experimentation (Table 2, mainly topics 5-7). These measures describe various properties of elevation, relief, slope, curvature in plan and profile, spacing, direction and strength of aspect (azimuth), alignment (including parallelism), feature complexity and connectivity, degree of randomness, and scale dependency.

The uses for geomorphometry (Table 1) continue to multiply as computer technology advances and more digital data become available. Applications range from watershed management, measuring road and runway roughness, missile targeting, planetary and deep-sea exploration, and assessing soil erosion to meteorological modeling, quantifying cross-country mobility, mapping eco-regions, planning recreational land-use, and siting installations for microwave transmission. Most recently, morphometry has been adapted to regional tectonics (Burbank, 1992). Combinations of morphometric data with nontopographic information, from remote sensing and other cartographic sources, are especially powerful (Franklin, 1987a). One of the most successful of these combined applications has been the spatially-based study of natural hazards—particularly the recognition, prediction, and risk-assessment of slope failure from digital terrain data (Lied and Bakkehøi, 1980; Carrara, 1983a; Aniya, 1985; Kobashi and Hirano, 1985; Brabb, 1987; Bernknopf and others, 1988; Pike, 1988a, Carrara and others, 1991; Mark, 1992; Ellen and others, 1993).

Implementation

Some of the issues in terrain quantification currently addressed by geomorphometry may be old (Wolfanger, 1941; Bekker, 1969; Chorley, 1972), but the enabling technology is new. The high-speed digital computers, analytical algorithms, input/output and communications devices, and large sets of topographic data that drive current research were unknown just 25 or 30 years ago. The resulting innovations in such related specialties as digital cartography, computer graphics, and geographic information systems (GIS) have revolutionized morphometry. The crucial improvement has been in the speed and volume of data processing. Large tracts of continuous topography can now be described in detail rather than characterized from a few samples; promising techniques and parameters can now be tested and evaluated rapidly, and for virtually any number of terrain types. As a result, progress in specific and especially in general geomorphometry has greatly accelerated. These computer-driven advances have led to new ways to represent topography (Goodchild and Mark, 1987; Clarke, 1990; Moore, 1991) as well as greater variety in the applications of morphometry (Burrough, 1986; Petrie and Kennie, 1990; Maguire and others, 1991b).

Progress in information technology promises to sustain the current vitality of geomorphometry. Through image processing, spatial statistics, machine visualization, and pattern recognition, the digital-computer revolution has laid the necessary foundation for future contributions in the field. New developments in morphometry are being implemented in such allied disciplines as remote sensing (Haralick, 1983), planetology (Leberl and others, 1991), oceanography (Fox and Hayes, 1985), and climatology (Henderson-Sellars, 1992; Tarboton, 1992). One problem at the frontier of current research in geomorphometry is the automated parsing and classification of continuous topography at different scales. Applicable techniques include knowledge-based recognition and extraction of specific features by computer (Chorowicz and others, 1989; Falcidieno and Spagnuolo, 1990). Improved description of spatial patterns and their analysis, notably by fuzzy-set logic or neural networks, promise to contribute to solving this problem and others (Narasimhan and Argialas, 1989; Sui, 1992).

The chief impediment to a wider practice of geomorphometry has always been the slow capture of data through manual measurement of topography, usually on contour maps (Raisz and Henry, 1937; Chapman, 1952; Strahler, 1956). This problem is being eliminated by the mass production of large matrices and networks of terrain heights, *digital elevation models* (DEM's) or *digitial terrain models* (DTM's) (Case, 1978). The square-grid DEM was first implemented by computer in the late 1950's by Charles Miller and his colleagues in the department of civil engineering at MIT (Roberts, 1957), but its early applications were largely military (Noma and Misulia, 1959; Horton and others, 1962; Boehm, 1967). Soon adapted to civilian engineering and Earth science in limited applications (for example, Hobson, 1967; Tobler, 1969a; Pike and Wilson, 1971), the grid DEM was first thoroughly explored for its potential value to morphometry by Evans (1972, 1979, 1980). Today, little morphometric work is attempted without DEM data. Despite much progress, however, shortcomings in the quality of DEM's remain (Theobald and Goodchild, 1990; Acevedo, 1991) and DEM coverage of many parts of the world is either lacking or prohibitively expensive (Wolf and Wingham, 1992). Recent developments in remote-sensing technology should, in time, lead to removal of these obstacles (Evans and others, 1992).

THE BIBLIOGRAPHY

Background

The rapid growth and diversification of geomorphometry have created serious problems of information retrieval. The literature has become so heterogeneous and scattered that it is impossible to command the subject by consulting just a few key serials in geology or geography. Early work, defined here as anything published before World War II, appeared almost exclusively in a few European journals of geography (Smith, 1935; Neuenschwander, 1944). Such ease of access has not prevailed since the war. The still-evolving body of writing on morphometry is shared among increasing numbers of edited collections and symposium volumes, textbooks, technical reports, and scores of serials in the Earth sciences and related areas (Figure 1). Prolific contributors include the rapidly growing fields of digital cartography, remote sensing, spatial modeling, and computer graphics.

Much research on morphometry is inaccessible because its mission-oriented, commonly military, origin was not conducive to publishing in the open literature. This body of material is large because so much of modern geomorphometry is the product of the Cold War (1946-1991) and its offshoot, the Apollo Moon-landing program (1960-1972). (The open literature resulting from such work reveals a virtual who's who in geomorphometry, including Strahler, Melton, Hammond, Wood, Tobler, Evans, Peucker, and David Mark. See Pruitt, 1979.) Major contributions to the field reside in the "gray literature", limited-distribution and in-house documents of military and other governmental agencies (particularly NASA) and their outside contractors (Peltier, 1953 and 1956; Hammond, 1958; Wood and Snell, 1960a; Mays, 1966; Davis, 1969). Most of this material is unclassified but is not well known to the newer students of morphometry and, in any case, is not readily accessible to them. To my knowledge, no interdisciplinary list of these government-sponsored works has been compiled previously.

Bibliographies on various aspects of geomorphometry have been published, but none of them is both current and has the great breadth required for research in the field today. Perhaps the most useful single source is the volume of Goudie and others (1990), in particular the section on morphometry edited by K.S. Richards. However, it is oriented toward geomorphology rather than engineering applications. Once the best, if difficult to find, Neuenschwander (1944) now is useful only as a historical source. The compilations by Carr and Van Lopik (1962, 1963) also are dated and hard to locate, as is the survey of early Russian work by Bocharov and Nikolayev (1957). Helpful reference lists, both on overviews of the subject and on its individual facets, are appended to more recent research papers, literature reviews, or monographs. Among these are Clarke (1966), Zakrzewska (1967), Stewart (1968), Bekker (1969), Salisbury (1971), Hormann (1971), Chorley (1972), Evans (1972, 1979), Mitchell (1973), Speight (1974), Pike and Rozema (1975), Mark (1975a), Horn (1981), Morisawa (1985), Burrough (1986), McCullagh (1988), Thorn (1988), and Petrie and Kennie (1990).

Purpose and scope

The bibliography included in this report addresses the problems of information-retrieval just described. It provides access to the entire field of geomorphometry by collecting representative citations of its dispersed and varied writings into a single source. The alphabetized list of over 2100 entries, dating from the late 18th century, is current through 1992. It emphasizes recent work; 1993 abstracts indicate some of the newest research trends. The need for such a compilation, as well as for the conceptual organization of the various elements of geomorphometry, became especially evident to me in 1988 while preparing the syllabus for a four-week summer course on the subject. The 49 subheadings in Table 2 are the latest iteration of that syllabus, which also served as the outline of a study guide for the course the following year. The literature search culminating in this report began shortly after that second course. It has been a part-time endeavor. The resulting bibliographic entries are cited largely, but not entirely, in the format of the U.S. Geological Survey. Some citations are incomplete and others are irregular in format; these flaws reflect the occasional use of secondary sources and the short time available for the project.

The variety of references reflects the great diversity of geomorphometry. Citations range from abstracts to long books, include routine applications as well as outstanding contributions to technique, and vary from obscure to celebrated and from trivial to profound. To encourage different approaches to problems in morphometry, I have referenced related studies from such peripheral fields as tribology (the study of abraded metal surfaces), meteorology, agricultural and military engineering, planetary-surface exploration, and pyschology (Fig. 1). Basic works from the growing literature on geographic information systems (GIS) and related advances in computer technology and digital cartography also are included. The listing is good on the extraction of digital elevations from contour maps, and other concerns of data capture, although technological advances should soon render much of this material obsolete. Such recent developments in terrain representation as fractal geometry (Mark and Aronson, 1984; Xia and others, 1991b) and harmonic analysis (Pike and Rozema, 1975; Mulla, 1988) are well covered. The listing is biased somewhat toward geomorphology and is perhaps weakest on civilian applications in engineering.

The bibliography includes as much U.S. Government "gray literature" on morphometry as I have been able to locate without a prolonged search. I knew of some of this material from my early work with Walter F. Wood at the U.S. Army Quartermaster Research and Engineering Center (Wood and others, 1962) and at Cornell Aeronautical Laboratory (Pike, 1964). Other references are familiar to me from participation in the NASA Apollo program, during the development of design criteria for the lunar roving vehicle (Pike, 1969). Many documents came from the estate of Walter Wood. Comparable material from other governments is poorly known to me and little of it is included in the bibliography. Although numerous military-sponsored documents are cited, many more applications of terrain intelligence to military doctrine and tactics are not generally available; none of this classified material is given here.

Emphasis of the bibliography is on *general* geomorphometry, the form of *continuous* topography. I have been more selective for *specific* geomorphometry, which addresses the shape of landforms—*discrete* units of topography shaped by known or likely physical processes. The quantification of landforms *per se* is well treated in the literature of geology and geomorphology. Accordingly, only a small fraction of the vast body of writing on hydraulic geometry and the morphometry of drainage basins is included here; that material is well accessed by other recent surveys (Gardiner, 1982a; Zăvoianu, 1985; Howard, 1990a, b). For similar reasons, my referencing of slope-profile analysis only samples the available information (Pitty, 1968; Young, 1972; Cox, 1990). I have ignored much of the large literature on impact craters—the most symmetric and easily measured of all landforms, among the first to be treated quantitatively (Schröter, 1791), and my own area of specialization (Pike, 1974, 1977, 1988c; Pike and Spudis, 1987). The listing is similarly thin on the morphometry of such well defined features as volcanoes (Pike, 1978b), drumlins (Piotrowski, 1989) and sand dunes (Breed and Grow, 1979), although some recent references to the literature on those and other landforms are provided (Table 2).

The bibliography is idiosyncratic in several further respects. English-language publications predominate, although I have attempted a token representation of the large non-English literature (for example, references in Krcho, 1990). I have neither seen nor read many of the obscure sources, especially old works and those in languages other than English, and in such cases I have relied on existing bibliographies (for example, Bocharov and Nikolayev, 1957; Hormann, 1971; Kugler, 1974), even at the risk of perpetuating incomplete or incorrect citations. In this respect I have thought it more helpful to be inclusive than exclusive. Extensive reference lists are already available for some sub-specialties (for example, relief shading; Horn, 1981; Horn and Brooks, 1989), and I have only sampled these. My bibliography includes much historical material, even though it is now technically obsolete, so that students may trace the development of thought and practice in the field. Some entries, such as those on statistics and numerical taxonomy or on evolution of the digital computer and its applications, are not wholly germane to morphometry. However, they contain interesting background, describe provocative analogies to terrain, provide helpful examples or teaching material, or simply offer food for thought. Although I have touched on many facets of geomorphometry and have tried to omit no important works, the listing makes no pretence to completeness. It thus remains something of a browser's choice.

Subsets of the main list

The bibliography is not annotated or subdivided by topic. These shortcomings are partly offset by the stuctured sample of some 350 references in Table 2. This selection provides an up-to-date introduction to each of the 49 sub-fields and activities within geomorphometry as well as guidance in pursuing further study from entries in the main listing. The topics in Table 2 overlap considerably, and few of the references fit comfortably in only one category. A similar

Table 3

Evolution of Research on the DEM-to-Watershed Transformation

1972
Natarajan, 1972
Sprunt, 1972

1975
Collins, 1975
Johnston and Rosenfeld, 1975
Peucker and Douglas, 1975

1978
Moon, 1978

1981
Collins and Moon, 1981

1983
Carroll, 1983
Mark, 1983c
Marks and others, 1983

1984
Hugus and Mark, 1984
Marks and others, 1984
Miller and Goldberg, 1984
O'Callaghan and Mark, 1984
Palmer, 1984
Yoeli, 1984

1985
Chan, 1985
Jenson, 1985
Kobashi and Hirano, 1985
Miller, 1985
Nogami, 1985
Rudyy, 1985

1986
Baglio and others, 1986
Band, 1986a, 1986b
Band and Robinson, 1986
Carrara, 1986
Douglas, 1986
Finsterwalder, 1986
Frank and others, 1986
Palacios-Vélez and Cuevas-Renaud, 1986
Yuan and Vanderpool, 1986

1987
Bevaqua and Floris, 1987
Carla' and others, 1987
Goldberg and others, 1987
Jenson and Trautwein, 1987
Martz and DeJong, 1987
Weibel and others, 1987

1988
Band and Wood, 1988
Beven and others, 1988
Carrara, 1988
Hutchinson, 1988
Jenson and Domingue, 1988
Martz and DeJong, 1988
Morris and Heerdegen, 1988
Riazanoff and others, 1988

1989
Band, 1989a, 1989b, 1989c
Bennett and Armstrong, 1989
Connors and others, 1989
Ehlschlaeger, 1989
Hutchinson, 1989
Seemuller, 1989
Tarboton and others, 1989
Weibel, 1989
Yoshiyama, 1989

1990
Falcidieno & Spagnuolo, 1990
Gardner and others, 1990
Jones and others, 1990
Lammers and Band, 1990
Morris, 1990
Quian and others, 1990
Scarlatos, 1990
Skidmore, 1990
Smith and others, 1990
Soille and Ansoult, 1990
Soille and Vincent, 1990
Theobald, 1990
Theobald and Goodchild, 1990
Tribe, 1990
Van Deursen & Kwadijk, 1990
Zhang and others, 1990

1991
Aumann and others, 1991
Band, 1991
Band and others, 1991
Fairfield and Leymarie, 1991
Freeman, 1991
Hutchinson & Dowling, 1991
Jenson, 1991
Lee and Snyder, 1991
Majure and Eash, 1991
Martz and DeJong, 1991
Moore and Grayson, 1991
Moore and others, 1991
Quinn and others, 1991
Tarboton and others, 1991
Tribe, 1991
U.S. Army, 1991
Vincent and Soille, 1991

1992
Blaszczynski, 1992
Chorowicz and others, 1992
Chou, 1992
Donker, 1992
Ehlschlaeger, 1992
ESRI, 1992
Lozar, 1992
Mackay and others, 1992
Martz and Garbrecht, 1992
Pratson and Ryan, 1992
Rokos and Armstrong, 1992
Sekulin and others, 1992
Smith and Brilly, 1992
Tribe, 1992a, 1992b
Weibel, 1992
White and others, 1992
Wiche and others, 1992

1993
Chorowicz and others, 1993
Garbrecht and Martz, 1993
Helmlinger and others, 1993

ordering of all 2100-odd entries in the main listing would warrant additional, more specialized, topics. Most references in Table 2 are published in the open literature and have good bibliographies that provide further access to the specialized literature and cite important, but older or less available, works. Because Table 2 is deliberately biased toward recent publications in each category, some old classics are absent (Wentworth, 1930; Smith, 1935; Neuenschwander, 1944). Other major contributions to morphometry are excluded from Table 2 because they are unlikely to be found in all but specialized or research collections and large libraries (for example, Hammond, 1958; Mark, 1977; Evans, 1979; Kundert, 1988).

Some elements of geomorphometry are particularly important now, and their literature warrants special attention. These fast-evolving topics include the triangulated irregular network, or TIN (Kumler, 1990; Lee, 1991b), fractal modeling of topography (Polidori and others, 1991; Klinkenberg, 1992), and the automatic extraction of terrain features from DEM's and digital images by such advanced techniques as pattern recognition (Chorowicz and others, 1989; Lee and others, 1992). To exemplify the evolution of one of these topics, I have attempted a comprehensive listing for the automated DEM-to-watershed transformation—an area so active that the resulting list (Table 3) is already dated. Table 3 also omits a few references that describe the automated extraction of drainage networks using digital images instead of DEM's (Toriwaki and Fukumura, 1978; Haralick and others, 1985).

The DEM-to-watershed transformation (Table 3) is a computationally intensive procedure that creates a network of surface-specific lines (ridges and drains) from a matrix of square-grid elevations and delimits areas (drainage basins). Independent, parallel work on the problem converged about 1982 (Marks and others, 1983, 1984). Subsequent enhancements compute a suite of geometric descriptors for each basin (Majure and Eash, 1991). The transformation is important because it fundamentally reorganizes topographic information, from continuous terrain into a mosaic of landforms, thus enabling much topography to be analyzed by the techniques of specific rather than general morphometry. The procedure can yield good results in topography that has sufficient relief to define the fluvial net unambiguously from a DEM. It is less successful in glaciated, eolian, karst, and other landscapes that lack well integrated drainage. To work properly the technique also requires a closely spaced DEM of good quality, particularly in areas of low relief (Martz and Garbrecht, 1992). Over 100 references in Table 3 trace this recent breakthrough in digital cartography from inception (Natarajan, 1972; Sprunt, 1972) to its practical application (Band and others, 1991; Blaszcznski, 1992) and its incorporation into both commercial and public-domain software (U.S. Army, 1991; ESRI, 1992b). Tribe (1992b) offers a good recent review of the procedure and discusses many of the references in Table 3.

Amendments

Incorrect and incomplete citations of the literature—resulting from failure to consult original works, carelessness in manuscript preparation, or typesetting errors—are an irritating fact of life. They are especially annoying in geomorphometry because much of this diverse literature is unfamiliar to specialists. I encountered many such errors in my survey of the discipline and have tried not to perpetuate them. However, mistakes always enter a listing of the size and detail presented here even when, as in this case, all entries were collected by one person and compiled in a computer file that was repeatedly checked and updated. Although effort has been made to assure that the references are correct, instances of the first two types of error cited above certainly remain and are my responsibility. I apologize for them and hope they are not too many or unduly misleading. Mistakes and omissions that are found by readers should be called to my attention so that corrections can be released in an addendum or in a more formal publication of the bibliography. Suggestions for revision or improvement in the arrangement of sub-topics within geomorphometry (Table 2) also are solicited.

Some voids remain in the bibliography and most of them reflect the limited time available for the project. Filling one such gap, on the military applications of morphometry, would also require access to sources that are closed. Although the end of the Cold War may lead to declassification of material from that period, government agencies and their civilian contractors commonly destroy restricted documents as they become obsolete (for example, Cornell Aeronautical Laboratories). However, such outdated writings can be valuable in tracing the history of geomorphometry and should be made public. Even office correspondence may be significant (for example, Groenewood, 1962). Lastly, comparable research in morphometry almost certainly was pursued by military agencies of former Warsaw Pact nations, especially the Soviet Union. This facet of geomorphometry, which would be of historical and probably substantive value, remains unknown to me save for possibly related civilian and academic references in Krcho (1990).

I welcome additions to this bibliography from its users. Again, the emphasis should be on general rather than specific morphometry. Entries in languages other than English are especially wanted, if accompanied by a translation of the citation (particularly for languages in non-Roman characters). To ensure accuracy and reduce ambiguity, please send reprints or photocopies of proposed additions rather than just the citations, if at all possible. However, I can entertain new entries if just the following information is provided:

1. photocopy of title page, or
    - title of the work, and
    - the name(s) of author(s); surname plus two initials (or, if one given name, then spelled out)
2. year of publication
3. the exact *and complete* citation of serial or other form of publication (book, conference proceedings, and so forth), including volume number, issue number, and inclusive page numbers. For meetings give location and dates; for books give name of city and publisher.

Address correspondence to:
Richard J. Pike
M/S 975
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025 U.S.A.
FAX [415] 329-4936

ACKNOWLEDGMENTS

I am grateful to all my colleagues from the CNR-USGS summer courses in hydrogeological hazards held in Perugia, Italy, in 1988 and 1989 for the opportunity to draw together the literature on morphometry and the incentive to compile this bibliography. Discussions with Richard Dikau, University of Heidelberg, expanded my view of the field. Dikau also provided references to the European literature. William Acevedo and Steve Ellen helped clarify and reorganize Table 2 and Figure 1, respectively, and Ellen suggested improvements to the manuscript. Staff at the Menlo Park USGS library were unfailingly helpful. Lastly, I thank Waldo Tobler for Krcho (1990) and other books, and Elaine Wood for the professional archives of her late husband, Walter F. Wood.

BIBLIOGRAPHY OF GEOMORPHOMETRY

A

Abdel-Rahman, M.A., and Hay, A.M., 1981, Sampling and statistical analysis of multi-modal orientation data, in O'Leary, D.W., and Earl, J.L., eds., International Conference on Basement Tectonics, 3rd, Denver Colorado, Basement Tectonics Committee: Proceedings, p. 73-86.

Abers, G.A., Parsons, Barry, and Weissel, J.K., 1988, Seamount abundances and distributions in the southeast Pacific: Earth and Planetary Science Letters, v. 87, no. 2, p. 137-151.

Abler, Ronald, Adams, J.S., and Gould, Peter, 1971, Spatial Organization, the Geographer's View of the World: Englewood Cliffs, New Jersey, 587 p.

Abrahams, A.D., 1980, Divide angles and their relation to interior link lengths in natural channel networks: Geographical Analysis, v. 12, no. 2, p. 157-171.

Abrahams, A.D., 1984, Channel networks, a geomorphologic perspective: Water Resources Research, v. 20, no. 2, p. 161-188.

Abrahams, A.D., 1987, Channel network topology, regular or random, *in* Gardiner, Vincent, ed., International Geomorphology 1986: London, John Wiley and Sons, Part II, p. 145-158.

Abrahams, A.D., and Mark, D.M., 1986, The random topology model of channel networks—bias in the statistical tests: The Professional Geographer, v. 38, no. 1, p. 77-81.

Acevedo, William, 1991, First assessment of U.S. Geological Survey 30-minute DEMs: A great improvement over existing 1-degree data, *in* American Society for Photogrammetry and Remote Sensing—American Congress on Surveying and Mapping, Annual Convention, Baltimore, March 25-29, 1991, Technical Papers, v. 2 (Cartography and GIS/LIS), p. 1-12.

Acevedo, William, and Pike, R.J., 1990, Synoptic maps of southern New England topography from a digital elevation model (abs.), *in* International Symposium on Mapping and Geographic Information Systems, ASTM Committee D-18 and U.S. Geological Survey, San Francisco, June 21-22: Abstract Booklet, p. 40.

Acevedo, William, and Pike, R.J., 1991, Digital representation of morphology in the San Jose 1:100,000 sheet, California (abs.): Geological Society of America Abstracts with Programs, v. 23, no. 2, p. 2.

Ackermann, F., 1978, Experimental investigation into the accuracy of contouring from DTM: Photogrammetric Engineering and Remote Sensing, v. 44, no. 12, p. 1537-1548.

Ackerson, V.B., and Fish, E.B., 1980, An evaluation of landscape units: Photogrammetric Engineering and Remote Sensing, v. 46, no. 3, p. 347-358.

Acreman, M.C., and Sinclair, C.D., 1986, Classification of drainage basins according to their physical characteristics; an application for flood frequency analysis in Scotland: Journal of Hydrology, v. 84, no. 3/4, p. 365-380.

Agopova, G.P., 1965, Quantitative characteristics of bottom slope angles in seas and oceans (translated from the Russian): Oceanology, v. 5, no. 4, p. 135-138.

Ahnert, Frank, 1970a, An approach towards a descriptive classification of slopes: Zeitschrift für Geomorphologie, Supplementband 9, p. 71-84.

Ahnert, Frank, 1970b, Functional relationships between denudation, relief, and uplift in large mid-latitude drainage basins: American Journal of Science, v. 268, no. 3, p. 243-263.

Ahnert, Frank, 1976, ed., Quantitative Slope Models: Zeitschrift für Geomorphologie, Supplementband 25, 168 p.

Ahnert, Frank, 1984, Local relief and the height limits of mountain ranges: American Journal of Science, v. 284, no. 11, p. 1035-1055.

Ahnert, Frank, 1988, Modelling landform change, *in* Anderson, M.G., ed., Modelling Geomorphological Systems: London, John Wiley and Sons, Chapter 13, p. 375-400.

Ahuja, N., and Schachter, B.J., 1983, Pattern Models: New York, Wiley, 309 p.

Akal, Tuncay, and Hovem, Jens, 1978, Two-dimensional space series analysis for sea-floor roughness: Marine Geotechnology, v. 3, no. 2, p. 171-182.

Akima, Hiroshi, 1974, A method of bivariate interpolation and smooth surface fitting based on local procedures; *and* Algorithm 474—bivariate interpolation and smooth surface fitting based on local procedures (E2): Communications of the Association for Computing Machinery, v. 17, no. 1, p. 18-20 and 26-31.

Akima, Hiroshi, 1978, A method of bivariate interpolation and smooth surface fitting for irregularly distributed data points; *and* Algorithm 526—a method &: Association for Computing Machinery Transactions on Mathematical Software, v. 4, no. 2, p. 148-159 and 160-164.

Alderman, P.K., 1991, Automated shaded-relief for medium scale aeronautical charts, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing annual convention, March 24-29, Baltimore, Md., Technical Papers: v. 2 (Cartography and GIS/LIS), p. 13- 20.

Allan, Stuart, 1992, Design and production notes for the Raven Map editions of the U.S. 1:3.5 million digital map: Annals of the Association of American Geographers, v. 82, no. 2, p. 303-304.

Almer, Alexander, Raggam, Johannes, and Strobl, Dieter, 1991, High-precision geocoding of remote sensing data of high-relief terrain, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, annual convention, March 24-29, Baltimore, Md., Technical Papers: v. 4 (GIS), p. 183-192.

Al-nabi, I.M. Gar, 1991, A three dimensional digital elevation data compression procedure: Survey Review (London), v. 31, no. 240 (April), p. 99-106.

Aloimonos, John (Yiannis), 1988, Visual shape computation: Proceedings of the Institute of Electrical and Electronic Engineers, v. 76, no. 8, p. 899-916.

Alpha, T.R., and Winter, R.E., 1971, Quantitative physiographic method of landform portrayal: Canadian Cartographer, v. 8, no. 2, p. 126-136.

Alster, C.J., 1960, Checking vertical accuracy of topographic maps: Surveying and Mapping, v. 20, p. 446-448.

American Association of State Highway Oficials, 1954, A Policy on Geometric Design of Rural Highways: paging unknown.

Andah, Kodwo, Rosso, Renzo, and Taramasso, A.C., 1987, The role of quantitative geomorphology in the hydrological response of river networks, *in* Water for the Future: Hydrology in Perspective (Proceedings of the Rome symposium, April 1987): IAHS Publication no. 164, p. 93-110.

Anderle, R., and Abrahams, A.D., 1989, Fractal techniques and the surface roughness of talus slopes: Earth Surface Processes and Landforms, v. 14, no. 2, p. 197-209. [see also,1990, Reply, ESPL, v. 15, no. 3, p. 287-290]

Anderson, D.P., 1982, Hidden line elimination in projected grid surfaces: Association of Computing Machinery Transactions, Graphics, v. 1, no. 4, p. 274-291.

Anderson, H.W., 1957, Relating sediment yield to watershed variables: Transactions of the American Geophysical Union, v. 38, no. 6, p. 921-924.

Anderson, M.G., ed., 1988, Modelling Geomorphological Systems: New York, Wiley, 458 p.

Anderson, M.G., and Burt, T.P., 1978, The role of topography in controlling throughflow generation: Earth SurfaceProcesses, v. 3, no. 4, p. 331-334. [*see also* 1980, Reply: ESP, v. 5, no. 2, p. 193-195]

Anderson, R.S., 1990, Eolian ripples as examples of self-organization in geomorphological systems: Earth-Science Reviews: v. 29, Nos. 1-4, p. 77-96.

Anderson, V.N., 1987, Automated texture analysis on landscape maps: Mapping Sciences and Remote Sensing, v. 24, no. 4, p. 330-340.

Andrews, D.J., and Hanks, T.C., 1985, Scarp degraded by linear diffusion—inverse solution for age: Journal of Geophysical Research, v. 90, no. B12, p. 10,193-10,208.

Andrews, D.J., and Bucknam, 1987, Fitting degradation of shoreline scarps by a nonlinear diffusion model: Journal of Geophysical Research, v. 92, no. B12, p. 12,857-12,867.

Andrews, D.S., Kaley, K.W., and Hodge, R.D., 1992, Integration of photogrammetry with multiple data sources for upper Tennessee River navigation lock feasibility studies, *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 2 (Photogrammetry and Surveying), p. 235-243.

Andrews, J.T., and Estabrook, G.F., 1971, Applications of information and graph theory to multivariate geomorphological analyses: Journal of Geology, v. 79, no. 2, p. 207-221.

Andrle, Robert, 1992, Estimating fractal dimension with the divider method in geomorphology, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 131-141.

Aniya, Masamu, 1985, Landslide-susceptibility mapping in the Amahata River basin, Japan: Annals of the Association of American Geographers, v. 75, no. 1, p. 102-114.

Anonymous, 1963, Computer production of terrain models: Communications of the Association for Computing Machinery, v. 6, no. 4, p. 190-191.

Anonymous, 1968, Photometric techniques for mapping Lunar Orbiter site II S-2: St. Louis, MO, U.S. Air Force Aeronautical Chart and Information Center, NASA Defense Purchase Request T-55866, NASA/MSC, Houston, TX, Final Report, 32 p.

Ansoult, M.M., 1989, Circular sampling for Fourier analysis of digital terrain data: Mathematical Geology, v. 21, no. 4, p. 401-410.

Ansoult, M.M., and Soille, P.J., 1990, Mathematical morphology, a tool for automated GIS data acquisition from scanned thematic maps: Photogrammetric Engineering and Remote Sensing, v. 56, no. 9, p. 1263-1271.

Argialas, D.P., 1985, A structural approach towards drainage pattern recognition: Columbus, Ohio State University, unpublished Ph.D. dissertation, paging unknown.

Argialas, D.P., 1989, A frame-based approach to modeling terrain analysis knowledge, *in* American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping, Annual Convention, Baltimore, Maryland, April 2-7, 1989, Technical Papers, v. 3, p. 311-319.

Argialas, D.P., and Harlow, C.A., 1990, Computational image interpretation models, an overview and a perspective: Photogrammetric Engineering and Remote Sensing, v. 56, no. 6, p. 871-886.

Argialas, D.P., Lyon, J.G., and Mintzer, O.W., 1988, Quantitative description and classification of drainage patterns: Photogrammetric Engineering and Remote Sensing, v. 54, no. 4, p. 505-509.

Argialas, D.P., and Narasimhan, Ravi, 1988, TAX, prototype expert system for terrain analysis: Journal of Aerospace Engineering, v. 1, no. 3, p. 151-170.

Armand, D.L., 1965, The logic of geographic classifications and regionalization schemes: Soviet Geography Review and Translation, v. 6, no. 9, p. 20-38.

Armstrong, Marc, and Hopkins, L.D., 1983, Fractal enhancement for thematic display of topologically stored data, *in* Wellar, B.S., ed., Auto-Carto Six, 6th International Symposium on Automated Cartography, Ottawa Canada, 1983, Proceedings, v. II, p. 309-318.

Aronoff, Stanley, 1989, Geographic Information Systems—A Management Perspective: Ottawa, Canada, WDL Publications, 294 p.

Arvidson, R.E., Guinness, E.A., Strebeck, J.W., Davies, G.F., and Schulz, K.J., 1982, Image-processing applied to gravity and topography data covering the continental U.S.: Eos, American Geophysical Union Transactions, v. 63, no. 18, p. 257, 261-265.

Asada, Akira, 1988, Contour processing and 3-D image processing of Sea Beam bathymetric data: International Hydrographic Review (Monaco), v. 65, no. 1, p. 65-80.

Asada, Akira, 1993, New bathymetric surveying and processing system based on Sea Beam 2000 (in English): Report of Hydrographic Researches (Tokyo), no. 29 (March), p. 1-32.

Ashley, G.M., and others (the SEPM Bedforms and Bedding Structures Panel), 1990, Classification of large-scale subaqueous bedforms—a new look at an old problem: Journal of Sedimentary Petrology, v. 60, no. 1, p. 160-172.

Attneave, Fred, 1954, Some informational aspects of visual perception: Psychological Review, v. 61, no. 3, p. 183-193.

Attneave, Fred, and Arnoult, M.P., 1956, Quantitative study of shape and pattern perception: Psychological Bulletin, v. 53, no. 6, p. 452-471.

Aumann, G., Ebner, Heinrich, and Tang, Liang, 1991, Automatic derivation of skeleton lines from digitized contours: ISPRS Journal of Photogrammetry and Remote Sensing, v. 46, no. 5, p. 259-268.

Autometric Corporation, 1963, Applicability of Certain Multifactor Computer Programs to the Analysis, Classification, and Prediction of Landforms: New York, N.Y., *prepared for* Geography Branch, Earth Sciences Division, U.S. Office of Naval Research, Final Report, ONR Task 387-030, Contract Nonr 4145(00), paging by section.

Autometric Facility, the Raytheon Co., 1964, Expanded Study of the Applicability of Multifactor Computer Programs to Terrain Analysis: Alexandria, VA, *prepared for* Geography Branch, Earth Sciences Division, U.S. Office of Naval Research, Final Report, ONR Task 387-030, Contract Nonr 4523(00), 78 p.

Avouac, J.-P., 1993, Analysis of scarp profiles—evaluation of errors in morphologic dating: Journal of Geophysical Research, v. 98, no. B4, p. 6745-6754.

Ayeni, O.O., 1978, Automated digital terrain models, *in* Digital Terrain Models (DTM) Symposium, May 9-11, 1978, St. Louis, Missouri, American Society of Photogrammetry—American Congress on Surveying and Mapping, Proceedings, p. 516-540.

Ayeni, O.O., 1982, Optimum sampling for digital terrain models—a trend towards automation: Photogrammetric Engineering and Remote Sensing, v. 48, no. 11, p. 1687-1694.

Ayres, J.E., and Drummond, S.E., eds., 1992, Special issue—ocean mapping: Marine Geodesy, v. 15, nos. 2-3, p. 63-222. [13 papers]

B

Baglio, J.V., Pick, T.A., and Jenson, S.K., 1986, Topographic characterization using digital elevation models for simulating runoff from watersheds with surface depressions (abs.): Eos, Transactions of the American Geophysical Union, v. 67, no. 44, p. 931.

Bailey, A.I., 1975, A method of analyzing polymodal distributions in orientation data: Mathematical Geology, v. 7, no. 4, p. 285-293.

Bailey, G.B., 1992, Topographic data, *in* Land Processes Distributed Active Archive Center (LPDAAC) moves ahead: The Earth Observer (Greenbelt, MD., NASA, EOS Project Science Office), v. 4, no. 6, p. 21-22.

Bailey, R.G., Zoltai, S.C., and Wiken, E.B., 1985, Ecological regionalization in Canada and the United States: Geoforum, v. 16, no. 3, p. 265-275.

Baker, V.R., 1986, Introduction, regional landforms analysis, *in* Short, N.M., and Blair, R.W. Jr., eds., Geomorphology From Space: National Aeronautics and Space Administration, Special Publication 486, p. 1-26.

Bakhtin, V., 1930, On the determination of the mathematical characteristics of a topographic relief (in Russian): Geodezist (Moscow), no. 2-3.

Bakker, J.P., and Le Heux, W.N., 1947, 1950, Theory on central rectilinear recession of slopes I-IV: Nederlandsche Akademie van Wettenschappen, Proceedings, v. 50, p. 959-966 and 1154-1162, v. 53, p. 1073-1084 and 1364-1374.

Balce, A.E., 1987, Determination of optimum sampling interval in grid digital elevation models (DEM) data acquisition: Photogrammetric Engineering and Remote Sensing, v. 53, no. 3, p. 323-330.

Balce, A.E., 1987, Quality control of height accuracy of digital elevation models: ITC Journal (Enschede, Neth.), p. 327-332.

Baldwin, R.B., 1949, The Face of the Moon: Univ. Chicago Press, 239 p.

Baldwin, R.B., 1963, The Measure of the Moon: Univ. Chicago Press, 488 p.

Band, L.E., 1986a, Topographic partition of watersheds using digital elevation models: Water Resources Research, v. 22, no. 1, p. 15-24.

Band, L.E., 1986b, Analysis and representation of drainage basin structure with digital elevation data, *in* International Symposium on Spatial Data Handling, 2nd, Seattle, Washington, July 5-10, 1986, Proceedings: p. 437-450.

Band, L.E., 1989a, A terrain-based watershed information system: Hydrological Processes, v. 3, no. 2, p. 151-162.

Band, L.E., 1989b, Automating topographic and ecounit extraction from mountainous, forested areas: Artificial Intelligence Applications in Natural Resource Management, v. 3, no. 4, p. 1-12.

Band, L.E., 1989c, Spatial aggregation of complex terrain: Geographical Analysis, v. 21, no. 4, p. 279-293.

Band, L.E., 1991, Distributed parameterization of complex terrain: Surveys in Geophysics, v. 12, nos. 1-3, p. 249-270.

Band, L.E., Nemani, R.R., and Running, S.W., 1992, Effect of land surface representation on simulated evapotranspiration and net carbon assimilation (abs.): Eos, Transactions of the American Geophysical Union, v. 73, no. 14, supplement, p. 109.

Band, L.E., Peterson, D.L., Running, S.W., Coughlan, Joseph, Lammers, Richard, Dungan, Jennifer, and Nemani, Ramakrishna, 1991, Forest ecosystem processes at the watershed scale—basis for distributed simulation: Ecological Modelling, v. 56, nos. 1-4, p. 171-196.

Band, L.E., and Robinson, V.B., 1986, Automated construction of a hydrologic information system from digital elevation data, *in* EPA Workshop on Geographic Information Systems for Environmental Protection, Las Vegas, NV, January 1986, Proceedings: p. 99-112.

Band, L.E., and Wood, E.F., 1988, Strategies for large-scale distributed hydrologic simulation: Applied Mathematics and Computation, v. 27, no. 1, p. 23-37.

Barberi, J.F., 1986, Contour-to-grid methods for the ARAC system, *in* Opitz, B.K., ed., Geographic Information Systems in Government: Workshop on GIS in Government, Springfield, VA, 10-13 December, 1985, Proceedings, v. 2, Hampton, VA, A. Deepak Publishing, p. 531-542.

Barchi, Massimiliano, and Guzzetti, Fausto, 1990, STRANA, a Macintosh computer program for the representation and statistical analysis of orientation data in structural geology, *in* Hanley, J.T., and Merriam, D.F., eds., Microcomputer Applications in Geology, II, Oxford, Pergamon Press, p. 13-23.

Barenblatt, G.I., Zhivago, A.V., Neprochnov, Yu.P., and Ostrovskiy, A.A., 1984, The fractal dimension—A quantitative characteristic of ocean-bottom relief (translated from the Russian): Oceanology, v. 24, no. 6, p. 695-697.

Barlow, H.B., Narasimhan, R., and Rosenfeld, Azriel, 1972, Visual pattern analysis in machines and animals: Science, v. 177, no. 4049, p. 567-575.

Barnaby, Frank, 1993, The role of the navies in the 1990's and beyond, *in* Borgese, E.M., Ginsburg, Norton, and Morgan, J.R., eds., Ocean Yearbook 10: University of Chicago Press, p. 229-239.

Barnett, H.F., Jr., and Finké, P.G., 1971, Morphometry of landforms—drumlins: Natick, Mass., U.S. Army Natick Laboratories, Earth Sciences Laboratrory, Technical Report 71-43-ES, 34 p.

Barr, D.J., and Rockaway, J.D., 1980, How to decrease erosion by natural terrain sculpturing: Weeds, Trees, and Turf, January, p. 31*ff*.

Barret, J.P., 1964, Correction for edge effect bias in point-sampling: Forest Science, v. 10, no. 1, p. 52-55.

Barsch, Dietrich, 1990, Geomorphology and geoecology: Zeitschrift für Geomorphologie, Supplementband 79, p. 39-49.

Barsch, Dietrich, and Mäusbacher, Roland, 1979, Geomorphological and ecological mapping: GeoJournal, v. 3, no. 4, p. 361-370.

Barsch, Dietrich, and Dikau, Richard, 1989, Entwicklung einer digitalen geomorphologischen Basiskarte (DGmBK) (in German with English abstract): Geo-Informations-Systeme, v. 2, no. 3, p. 12-18.

Bartlett, D.F., and Tew, W.L., 1990, Terrain and geology near the WTVD tower in North Carolina, implications for non-Newtonian gravity: Journal of Geophysical Research, v. 95, no. B11, p. 17,363-17,369.

Bartlett, M.S., 1947, The use of transformations: Biometrics, v. 3, no. 1, p. 39-52.

Bassett, K., and Chorley, R.J., 1971, An experiment in terrain filtering: Area (UK), v. 3, no. 2, p. 78-91.

Batchelder, R.B., 1950, Application of two relative relief techniques to an area of diverse landforms—a comparative study: Surveying and Mapping, v. 10, no. 2, p. 110-118.

Batson, R.M., 1987, Digital cartography of the planets—new methods, its status, and its future: Photogrammetric Engineering and Remote Sensing, v. 53, no. 9, p. 1211-1218.

Batson, R.M., Edwards, Kathleen, and Eliason, E.M., 1975, Computer-generated shaded-relief images: U.S. Geological Survey Journal of Research, v. 3, no. 4, p. 401-408.

Batson, R.M., Edwards, Kathleen, and Eliason, E.M., 1976, Synthetic stereo and LANDSAT pictures: Photogrammetric Engineering and Remote Sensing, v. 42, no. 10, p. 1279-1284.

Bauhuber, F., Erlacher, V., and Gunther, P., 1975, A programming system for the manipulation of digital terrain models (in German): Organ der Deutschen Gesellschaft für Photogrammetrie, v. 43, p. 104-107.

Baulig, Henri, 1959, Morphométrie (in French): Annales de Géographie, v. 68, no. 369, p. 385-408.

Beard, M.K., 1991, Theory of the cartographic line revisted—implications for automated generalization: Cartographica, v. 28, no. 4, p. 32-58.

Beard, M.K., and Chrisman, N.R., 1988, Zipper: a localized approach to edgematching: The American Cartographer, v. 15, no. 2, p. 163-172.

Becker, G.F., 1885, The geometrical form of volcanic cones and the elastic limit of lava: American Journal of Science, Ser. 3, v. 30, Art. XXXVII, p. 283-293.

Beckett, P.H.T., 1969, Terrain evaluation for off-road mobility—criticism and models of terrain evaluation procedures for large areas: Oxford University, UK, U.S. Army European Research Office, Contract No. DAJA37-C8-C-0031, Final Technical Report, 120 p. [p. 38, 'variogram']

Beckinsale, R.P., and Chorley, R.J., 1991, The history of the study of landforms, or the development of geomorphology, volume 3—historical and regional geomorphology 1890-1950: London, Routledge, 496 p. [chapter 11, regional classification, p. 379-419; also p. 136-139 on morphometry]

Beer, Tom, and Borgas, Michael, 1993, Horton's laws and the fractal nature of streams: Water Resources Research, v. 29, no. 5, p. 1475-1487.

Bekker, M.G., 1956, Theory of Land Locomotion, the mechanics of vehicle mobility: Ann Arbor, University of Michigan Press, 522 p.

Bekker, M.G., 1960, Off-The-Road Locomotion, research and development in terramechanics: Ann Arbor, University of Michigan Press, 220 p.

Bekker, M.G., 1969, Introduction to Terrain-Vehicle Systems: Ann Arbor, The University of Michigan Press, 846 p. [see, especially, Part I—the terrain, p. 1-378]

Bell, S.A., 1983, Attributes of drainage basin topography—an evaluation of profile and matrix approaches and their hydrological relevance: Durham, UK, University of Durham, unpublished Ph.D. thesis, 397 p.

Bell, T.H. Jr., 1975, Statistical features of sea-floor topography: Deep-Sea Research, v. 22, no. 12, p. 883-892.

Bell, T.H. Jr., 1979, Mesoscale sea floor roughness: Deep-Sea Research, v. 26A, no. 1, p. 65-76.

Benn, B.O., and Grabau, W.E., 1968, Terrain evaluation as a function of user requirements, *in* Stewart, G.A., ed., Land Evaluation: Melbourne, Macmillan of Australia, p. 64-76.

Bennet, D.A., and Armstrong, M.P., 1989, An inductive bit-mapped classification scheme for terrain feature extraction, *in* GIS/LIS '89, Orlando, FL, Proceedings, v. 1, p. 59-68.

Beran, M.A., 1982, Hydrology and automatic cartography: Cartographica, v. 19, no. 2, Monograph 28, p. 56-61.

Berger, J.O., and Berry, D.A., 1988, Statistical analysis and the illusion of objectivity: American Scientist, v. 76, no. 2, p. 159-165.

Berkovich, K.M., Zaytsev, A.A., Novakovskiy, and Sventek, Yu.V., 1986, Remote sensing in the morphometric analysis of channels and floodplains (in Russian): Geomorfologiya, No. 4, p. 51-57. [translated 1987, *in* Mapping Sciences and Remote Sensing, v. 24, no. 3, p. 209-217]

Berkson, J.M., and Mathews, J.E., 1983, Statistical properties of sea-floor roughness, *in* Pace, N.G., ed., Acoustics and the Sea-Bed: Bath, UK, Bath University Press, p. 215-223.

Berlyant, A.M., Koshel', S.M., Musin, O.P., and Suyetova, I.A., 1992, Constructing a global digital data base using a world hypsometric map at 1:15,000,000 scale—preliminary results: Mapping Sciences and Remote Sensing, v. 29, no. 2, p. 146-154.

Berlyant, A.M., and Pastushkova, S.A., 1992, Relief as an indicator in engineering studies and mapping of loess deposits: Mapping Sciences and Remote Sensing, v. 29, no. 2, p. 103-110.

Bernknopf, R.L., Campbell, R.H., Brookshire, D.S., and Shapiro, C.D., 1988, A probabilistic approach to landslide hazard mapping in Cincinnati, Ohio, with applications for economic evaluation: Bulletin of the Association of Engineering Geologists, v. 25, no. 1, p. 39-56.

Berry, B.J.L., 1958, A note concerning methods of classification: Annals of the Association of American Geographers, v. 48, no. 3, p. 300-303.

Berry, B.J.L., 1962, Sampling, coding, and storing flood plain data: Washington, D.C., Department of Agriculture, Handbook No, 237, 27 p.

Berry, B.J.L., 1964, Approaches to regional analysis, a synthesis: Annals of the Association of American Geographers, v. 54, no. 1, p. 2-11. [reprinted *in* Berry and Marble, eds., 1968, p. 24-34]

Berry, B.J.L., 1967, Grouping and regionalization, an approach to the problem using multivariate analysis, *in* Garrison, W.L., and Marble, D.F., eds., Quantitative Geography, Part I, Economic and Cultural Topics: Evanston, Ill., Northwestern University Studies in Geography no. 13, p. 219-251.

Berry, B.J.L., 1968, A synthesis of formal and functional regions using a general field theory of spatial behavior, *in* Berry, B.J.L., and Marble, D.F., eds., Spatial Analysis, A Reader In Statistical Geography: Englewood Cliffs, N.J., Prentice-Hall, p. 419-428.

Berry, B.J.L., and Baker, A.M., 1968, Geographic sampling, *in* Berry, B.J.L., and Marble, D.F., eds., 1968, Spatial Analysis, a reader in statistical geography: Englewood Cliffs, NJ, Prentice-Hall, p. 91-100.

Berry, B.J.L., and Marble, D.F., eds., 1968, Spatial Analysis, a reader in statistical geography: Englewood Cliffs, NJ, Prentice-Hall, 512 p.

Berry, J.K., 1987, A mathematical structure for analyzing maps: Environmental Management, v. 11, no. 3, p. 317-325.

Berry, J.K., 1987, Computer-assisted map analysis, potential and pitfalls: Photogrammetric Engineering and Remote Sensing, v. 53, no. 10, p. 1405-1410.

Berry, M.V., and Hannay, J.H., 1978, Topography of random surfaces: Nature, v. 273, no. 5663, p. 573.

Berry, R.D., Moreland, D.K., and Doughty, E.F., 1988, Production of hypsography digital line graphs from the U.S. Geological Survey's 7.5-minute map series, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, annual convention, March 13-18, 1988, St. Louis, Missouri, Technical papers, v. 2 (Cartography), p. 262-271.

Besicovitch, A.S., 1929, On linear sets of points of fractional dimension: Mathematische Annalen, v. 101, p. 161-193.

Beuerman, D.R., 1968, Mathematical analysis of geomorphic relations: Buffalo, N.Y., Cornell Aeronautical Laboratory Report No. 152, 33 p.

Beucher, S., and Lantuejoul, C., 1979, Use of watersheds in contour detection, *in* International Workshop on Image Processing, Real-time Edge and Motion Detection/Estimation, Rennes, France, September 17-21, Proceedings, paging unknown.

Bevacqua, G., and Floris, R., 1987, A surface-specific line tracking and slope recognition algorithm: Computer Vision, Graphics and Image Processing, v. 40, p. 219-227.

Beven, K.J., and Kirkby, M.J., 1979, A physically based, variable contributing area model of basin hydrology: Hydrological Sciences Bulletin, v. 24, no. 1, p. 43-69.

Beven, K.J., and Moore, I.D., eds., 1992, Terrain Analysis and Distributed Modelling in Hydrology: West Sussex, UK, Wiley Ltd., 256 p. [reprinted papers from first two special issues of Hydrological Processes]

Beven, K.J., Wood, E.F., and Sivapalan, Murugesu, 1988, On hydrological heterogeneity—catchment morphology and catchment response: Journal of Hydrology, v. 100, no. 1/3, p. 353-375.

Beyer, A., 1972, Zur Erfassung flächen Geländes durch willkürlich verteilte Höhenpunkte (in German): Vermessungstechnik, v. 20, no. 6, p. 204-207.

Bickmore, D. P., ed., 1982, Perspectives in the alternative cartography, cartographic computing technology and its applications—papers from the Euro-Cart I seminar, New College, Oxford, Dec. 13-16, 1981: Cartographica, v. 19, no. 2, Monograph 28, 191 p.

Birkoff, G., and Mansfield, L., 1974, Compatible triangular finite elements: Journal of Mathematical Analysis Applications, v. 47, p. 531-553.

Björnsson, Helgi, 1988, Surface and bedrock topography of the ice caps Hofsjökull and Vatnajökull mapped by radio echo sounding, *in* Hydrology of Ice Caps in Volcanic Regions: Reykjavik, Visindafelag Islendinga, Societas Scientarium Islandica, Rit 45, p. 31-54.

Blair, J.B., Harding, D.J., and Bufton, J.L., 1993, Measurement of ground topography and vegetation height by laser altimetry (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 194-195.

Blais, J.A.R., Chapman, M.A., and Lam, W.K., 1986, Optimal interval sampling in theory and practice, *in* International Symposium on Spatial Data Handling, 2nd, July 5-10, Seattle, Washington: Williamsville, New York, International Geographical Union Commission on Geographical Data Sensing and Processing, Proceedings, p. 185-192.

Blaszcznski, Jacek, 1992, Regional soil loss prediction utilizing the RUSLE/GIS interface, *in* Johnson, A.I., Pettersson, C.B., and Fulton, J.L., eds., Geographic Information Systems (GIS) and Mapping—Practices and Standards (selected papers from a symposium, San Francisco, CA, June 12-22, 1990): Philadelphia, PA, American Society for Testing and Materials, Special Technical Publication 1126, p. 122-131.

Blinn, J.F., 1977, Models of light reflection for computer synthesized pictures: Computer Graphics, v. 11, no. 2 , p. 192-198. [also published in Proceedings of SIGGRAPH '77]

Blong, R.J., 1973, Relationships between morphometric attributes of landslides: Zeitschrift für Geomorphologie, Supplementband 18, p. 66-77.

Blong, R.J., 1973, A numerical classification of selected landslides of the debris slide-avalanche-flow type: Engineering geology, v. 7, no. 2, p. 99-114.

Blong, R.J., 1975, Hillslope morphometry and classification—a New Zealand example: Zeitschrift für Geomorphologie, v. 19, no. 4, p. 405-429.

Bobrik, A.A., 1916, On the determination and mathematical measurement of landforms and of the volumetric size of geographic objects on the earth (in Russian): Izvestiya Russkogo geograficheskogo obshchestva, v. 52, no. 1.

Bobrow, D.C., and Stefik, M.J., 1986, Perspectives on artificial intelligence programming: Science, v. 231, no. 4741, p. 951-957.

Bocharov, M.K., and Nikolayev, S.A., 1957, Methods of Mathematical Statistics in Cartography (in a translation from the Russian): Moscow, Publishing House of Geodetic Literature, 227 p.

Boehm, B.W., 1967, Tabular representations of multivariate functions with applications to topographic modelling, *in* National Conference of the Association for Computing Machinery, 22nd, Proceedings, p. 403-415. [also 1967, Santa Monica, Calif., The RAND Corporation Memorandum RM-4636-PR, 67 p.]

Bogdanoff, J.L., and Kozin, F.J., 1961, On the statistical properties of the ground contour and its relation to the study of land locomotion, *in* Mechanics of Soil-Vehicle Systems, 1st International Conference, Turin, Italy, Proceedings, p. 224-240. [also 1962, Land Locomotion Laboratory, Ordnance Tank-Automotive Command, Detroit Arsenal, Report n, 7823, LL 78, 37 p.]

Bogdanoff, J.L., Cote, L.J., and Kozin, F.J., 1965, Introduction to a statistical theory of land locomotion: Journal of Terramechanics, v. 2, no. 3, p. 17-27.

Böhme, Rolf, compiler, 1989, Inventory of World Topographic Mapping, Volume I, Western Europe, North America, and Australasia: London, Elsevier Applied Science Publishers, for The International Cartographic Association, 196 p.

Böhme, Rolf, 1991, The generation and design of hill shading on the basis of raster relief data (in German): Kartographische Nachrichten, v. 41, no. 4, p. 129-136.

Böhme, Rolf, 1991, Geomorphologische Bearbeitungen von digitalen Reliefmodellen mit Methoden der Rasterbildverarbeitung (in German with English summary): Petermanns geographische Mitteilungen, v. 135. no. 4, p. 273-282.

Bonner, W.J., and Schmall, R.A., 1973, A photometric technique for determining planetary slopes from orbital photographs: U.S. Geological Survey Professional Paper 812-A, 16 p.

Bookstein, F.L., 1978, The Measurement of Biological Shape and Shape Change: Berlin, Springer-Verlag, Lecture Notes in Biomathematics 24, 191 p.

Boulton, A.G., 1965, Morphometric analysis of river basin characteristics: United Kingdom Water Resources Board, TN2, 10 p.

Bourke, R.H., and McLaren, A.S., 1992, Contour mapping of Arctic basin ice draft and roughness parameters: Journal of Geophysical Research, v. 97, no. C11, p. 17,715-17,728.

Bowden, K.L, and Wallis, J.R., 1964, Effect of stream-ordering technique on Horton's laws of drainage composition: Geological Society of America Bulletin, v. 75, no. 8, p. 767-774.

Bowyer, A., 1981, Computing Dirichlet Tessellations: Computer Journal, v. 24, p. 162-166.

Boyce, R.B., and Clark, W.A., 1964, The concept of shape in geography: Geographical Review, v. 54, no. 4, p. 561-572.

Boyell, R.L., 1963, The method of successive grids for reduction of function storage requirements: Computer Journal, v. 5, no. 4, p. 320-321.

Boyko, A.V., 1980, Metody i sredstva avtomatizatsii topograficheskikh s"yemka (Methods and means for automated topographic analysis, in Russian): Moscow, paging unknown.

Boyle, R.D., and Thomas, R.C., 1988, Computer Vision, a First Course: Brookline Village, MA, Blackwell Scientific Publications Ltd., 210 p.

Brabb, E.E., 1987, Analyzing and portraying geologic and cartographic information for land-use planning, emergency response, and decisionmaking in San Mateo County, California, *in* American Society for Photogrammetry and Remote Sensing—American Congress on Surveying and Mapping, International Conference, Exhibits, and Workshops on Geographic Information Systems, 2nd, GIS '87-San Francisco, October 26-30, 1987, Proceedings: v. 1, p. 362-374.

Bradshaw, Stuart, Martin, Mary, Kos, Chester, and Tweddale, Scott, 1991, GRASS 4.0 tutorial—DTED and DEM elevation data extraction: Champaign, IL, U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, 13 p.

Brandstätter, L., 1957, Exakte Schichtlinien und Topographische Geändedarstellung (in German): Vienna, Österreichische Zeitschrift für Vermessungswesen, Special volume 18, 90 p.

Bras, R.L., and Rodriguez-Iturbe, Ignacio, 1989, A review of the search for a quantitative link between hydrologic response and fluvial geomorphology, *in* Kavvas, M.L., ed., New Directions for Surfacc Water Modeling, proceedings of the IAHS Symposium, Baltimore, MD, May 1989: IAHS Publication no. 181, p. 149-163.

Brass, Andrew, Wadge, Geoffrey, and Reading, A.J., 1991, Designing a geographical information system for the prediction of landsliding potential in the West Indies *in* Cosgrove, John, and Jones, Mervyn, eds., Neotectonics and Resources: London, Belhaven Press, p. 220-230.

Brassel, K.E., 1974, A model for automatic hill-shading: American Cartographer, v. 1, no. 1, p. 15-27.

Brassel, K.E., Little, James, and Peucker, T.K., 1974, Automated relief representation: Annals of the Association of American Geographers, v. 64, no. 4, map supplement number 17, p. 610-611 and map.

Brassel, K.E., and Reif, D.F., 1979, A procedure to generate Thiessen polygons: Geographical Analysis, v. 11, no. 3, p. 289-303.

Brassel, K.E., and Weibel, Robert, 1988, A review and conceptual framework of automated map generalization: International Journal of Geographical Information Systems, v. 2, no. 3, p. 229-244.

Breed, C.S., and Grow, Teresa, 1979, Morphology and distribution of dunes in sand seas observed by remote sensing, *in* McKee, E.D., ed., A Study of Global Sand Seas: U.S. Geological Survey Professional Paper 1052, Chapter J, p. 253-302.

Breme, H.J., 1970, Contour map and terrain intervisibility processing—a literature survey: University Heights, Bronx, NY, New York University Department of Electrical Engineering, grant AF-AF)SR-70-1854, *for* Air Force Office of Scientific Research, Technical Report 403-11, 34 p. [31 annotated references]

Breyer, S.P., and Snow, R.S., 1992, Drainage basin perimeters; a fractal significance, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 143-157.

Brice, James, 1973, Meandering pattern of the White River in Indiana—an analysis, *in* Morisawa, M.E., ed., Fluvial Geomorphology, proceedings of the 4th annual geomorphology symposium: Binghamton, N.Y., SUNY, Publications in Geomorphology, p. 179-200.

Bridge, B.J., and Beckman, G.G., 1977, Slope profiles of cycloidal form: Science, v. 198, no. 4317, p. 610-612.

Briggs, I.C., 1974, Machine contouring using minimum curvature: Geophysics, v. 39, no. 1, p. 39-48.

Bronowski, Jacob, and Long, W.M., 1951, Statistical methods in anthropology: Nature, v. 168, no. 4279, p. 794.

Bronguleyev, V.Vad., and Bronguleyev, V.V., 1987, A map of the averaged relief of the Russian plain (in Russian): Geomorfologiya, No. 1, p. 22-29. [translated 1987, *in* Mapping Sciences and Remote Sensing, v. 24, no. 3, p. 193-201]

Brooks, W.F., 1985, The Use of the Fractal Dimension to Characterize Landforms and Their Drainage Networks: Ithaca, New York, Cornell University, unpublished Ph.D. dissertation, paging unknown.

Brosch, F.J., Pölsler, P., and Riedmüller, G., 1992, The use of fractal dimension in engineering geology: Bulletin of the International Association of Engineering Geology, no. 45 (April), p. 83-88.

Broscoe, A.J., 1959, Quantitative analysis of longitudinal stream profiles of small watersheds: Office of Naval Research, Geography Branch, Technical Report No. 18, Project 389-042, Department of Geology, Columbia University, New York, NY, 104 p.

Brown, D.G., 1991, Topoclimatic models of an alpine environment using digital elevation models within a GIS, *in* GIS/LIS '91, Atlanta, Georgia, October 28-November 1, 1991, Proceedings, v. 2, p. 835-844.

Brown, S.R., 1987, A note on the description of surface roughness using fractal dimension: Geophysical Research Letters, v. 14, no. 1, p. 1095-1098.

Brown, S.R., and Scholz, C.H., 1985, Broad bandwidth study of the topography of natural rock surfaces: Journal of Geophysical Research, v. 90, no. B14, p. 12,575-12,582.

Brozena, John, Chalona, Marc, Forsberg, Rene, and Mader, Gerry, 1992, New technology allows remote areas to be probed: Eos, Transactions of the American Geophysical Union, v. 74, no. 2, p. 18.

Bruno, B.C., Taylor, G.J., and Lopes-Gautier, R.M.C., 1993, Quantifying the effect of rheology on plan-view shapes of lava flows, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 207-208.

Brunsden, Denys, and Lin, Jiun-Chuan, 1991, The concept of topographic equilibrium in neotectonic terrains, *in* Cosgrove, John, and Jones, Mervyn, eds., Neotectonics and Resources: London, Belhaven Press, p. 120-143.

Bryson, R.A., and Dutton, J.A., 1967, The variance spectra of certain natural series, *in* Garrison, W.L., and Marble, D.F., eds., Quantitative Geography Part II—Physical and Cartographic Topics: Evanston, Ill., Northwestern University Department of Geography, Studies in Geography no. 14, p. 1-24.

Buchanan, Rex, and Steeples, Don, 1990, On-demand map publication: Geotimes, v. 35, no. 4, p. 19-21.

Buchheim, M.P., and Lillesand, T.M., 1989, Semi-automated training field extraction and analysis for efficient digital image classification: Photogrammetric Engineering and Remote Sensing, v. 55, no, 9, p. 1347-1355.

Bull, W.B., 1962, Relation of alluvial-fan size and slope to drainage-basin size and lithology in western Fresno County, California: U.S. Geological Survey Professional Paper 450-B, p. 51-53.

Bull, W.B., 1975, Allometric change of landforms: Geological Society of America Bulletin, v. 86, no. 11, p. 1489-1498.

Bunge, William, 1962, Theoretical Geography: Lund, Sweden, C.W.K. Gleerup, Lund Studies in Geography, Series C, General and Mathematical Geography no. 1, 210 p. [2nd ed., 1966]

Burbank, D.W., 1992, Characteristic size of relief: Nature, v. 359, no. 6395, p. 483-484.

Burl, M.C., Fayyad, U.M., and Smyth, P., 1993, A pattern recognition system for locating small volcanoes in Magellan SAR images of Venus, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 227-228.

Burrough, P.A., 1981, Fractal dimensions of landscapes and other environmental data: Nature, v. 294, no. 5838, p. 240-242.

Burrough, P.A., 1984, The application of fractal ideas to geophysical phenomena: Institute of Mathematics and its Applications, v. 20, no. 3-4, p. 36-42.

Burrough, P.A., 1986, Principles of geographical information systems for land resources assessment: Oxford, Clarendon Press, 193 p. [corrected reprinting, 1987]

Burrough, P.A., 1989, Fractals and geochemistry, *in* Avnir, D., ed., The Fractal Approach to Heterogeneous Chemistry: London, John Wiley and Sons, p. 383-405.

Burrough, P.A., 1989, Fuzzy mathematical methods for soil-survey and land evaluation: Journal of Soil Science, v. 40, no. 3, p. 477-492.

Burrough, P.A., and De Veer, A.A., 1984, Automated production of landscape maps for physical planning in The Netherlands: Landscape Planning, v. 11, p. 205-226.

Bursik, Marcus, 1991, Relative dating of moraines based on landform degradation, Lee Vining Canyon, California: Quaternary Research, v. 35, no. 3, p. 451-455.

Burton, Ian, 1963, The quantitative revolution and theoretical geography: The Canadian Geographer, v. 7, no. 4, p. 151-162. [reprinted 1968 *in* Berry and Marble, eds., p. 13-23]

Busalayev, I.V., 1960, Application of the methods of statistical description of random fields to a characterization of landforms (in Russian): Izv. AN Kazakhskoy SSR, seriya energeticheskaya, No. 2 (18).

Busalayev, I.V., 1964, The use of generalized harmonic analysis in characterizing the surface relief of watersheds (in Russian): Probl. gidroenergetiki i vodnogo khozyaystva (Problems of Waterpower and Water Management), No. 2.

Butler, D.R., Walsh, S.J., and Brown, D.G., 1991, Three-dimensional displays for natural hazards analysis, using classified Landsat thematic mapper digital data and large-scale digital elevation models: Geocarto International, v. 6, no. 4, p. 65-69.

Buttenfield, B.P., 1984, Line structure in graphic and geographic space: Seattle, University of Washington, unpublished Ph.D. dissertation, 302 p.

Buttenfield, B.P., 1985, Treatment of the cartographic line: Cartographica, v. 22, no. 2, p. 1-26.

Buttenfield, B.P., 1987, Automating the identification of cartographic lines: The American Cartographer, v. 14, no. 1, p. 7-20.

Buttenfield, B.P., 1989, Scale-dependence and self-similarity in cartographic lines: Cartographica, v. 26, no. 1, Monograph 40, Numerical Generalization in Cartography, p. 79-100.

Buttenfield, B.P., and McMaster, R.B., eds., 1991, Map generalization—making rules for knowledge representation: New York, Wiley, 256 p.

C

Cadigan, R.A., Ormsbee, L.R., Palmer, R.A., and Voegeli, P.T., 1972, Terrain classification—a multivariate approach: Washington, D.C., U.S. Geological Survey, unpublished report No. USGS-GD-72-024, 61 p. [NTIS No. PB 211 090]

Cailleux, André, and Tricart, Jean, 1950, Pour une meilleure géométrie des formes du relief (in French): Revue de Géomorphologie Dynamique, v. 1, no. 4, p. 194-195.

Calef, Wesley, 1950, Slope studies of northern Illinois: Illinois Academy of Science, Transactions, v. 43, p. 110-115.

Calef, Wesley, 1952, A relative relief map of Illinois: Illinois Academy of Science, Transactions, v. 45, p. 70-72.

Calef, Wesley, and Newcomb, Robert, 1953, An average slope map of Illinois: Annals of the Association of American Geographers, v. 43, no. 4, p. 304-316.

Cannon, R.L., Dave, J.V., Bezdek, J.C., and Trivedi, M.M., 1986, Segmentation of a thematic mapper image using the fuzzy c-means clustering algorithm: IEEE Transactions on Geoscience and Remote Sensing, v. GE-24, no. 3, p. 400-408.

Carla', R., Carrara, Alberto, Detti, R., Federici, G., and Pasqui, V., 1987, Geographical information systems in the assessment of flood hazard, *in* International Conference on the Arno Project (research on a monitoring system for the Arno basin flashflood forecast), Florence, Italy, November 24-25, 1986, Records, p. 149-173.

Carla', R., Carrara, Alberto, and Federici, G., 1987, Generazione di modelli digitali del terreno ad alta precisione (in Italian): Florence, Italy, Quad. Dip. Ing. Civile, Univ. Firenze, 0/87, 30 p.

Carla', R., Carrara, Alberto, Federici, G., and Maugliani, V., 1984, Modelli digitali del terreno nell' indagine geomorfologica e idrologica (in Italian): Milan, Italy, Atti Conv. Aicographics, Milano, November 12-15, 1984, Proceedings, p. 221-241.

Carlston, C.W., and Langbein, W.B., 1960, Rapid approximation of drainage density—line intersection method: U.S. Geological Survey, Water Resources Division Bulletin, 10 Feb., 1960, p. 11.

Carman, G.J., and Welch, Leslie, 1992, Three-dimensional illusory contours and surfaces: Nature, v. 360, no. 6404, p. 585-587.

Carr, D.D., Becker, R.E., and Van Lopik, J.R., 1963, Terrain Quantification Phase II, Playa and Miscellaneous Studies: Texas Instruments Co., *for* U.S. Air Force Cambridge Research Laboratories, Report No. 63-793 (Contract No. AF 19(628)-2786 Project No. 7628 Task no. 762805), 73 p. + appendices (including 154-entry annotated bibliography).

Carr, D.D., and Van Lopik, J.R., 1962, Terrain Quantification Phase I, Surface Geometry Measurements: Dallas, Texas Instruments Co., *for* U.S. Air Force Cambridge Research Laboratories, Report No. 63-208 (Contract No. AF 19(628)-481 Project No. 7628 Task No. 762805), 85 p. + appendices (including 348-entry annotated bibliography).

Carr, J.R., and Benzer, W.B., 1991, On the practice of estimating fractal dimension: Mathematical Geology, v. 23, no. 7, p. 945-958.

Carrara, Alberto, 1983a, Multivariate models for landslide hazard evaluation: Mathematical Geology, v. 15, no. 3, p. 403-426.

Carrara, Alberto, 1983b, Geomathematical assessment of regional landslide hazard, *in* International Conference on Applications of Statistics and Probability in Soil and Structural Engineering, 4th: Università di Firenze, Pitagora Editrice, Proceedings, p. 3-27.

Carrara, Alberto, 1984, Landslide hazard mapping aims and methods, *in* Mouvements de Terrains, Communications du Colloque, Caen, France, 22-24 March, 1984: Centre de recherches en géographie physique de l'environment association Française de géographie physique, Série Documents du BRGM no. 83, p. 141-151.

Carrara, Alberto, 1988, Drainage and divide networks derived from high-fidelity digital terrain models, *in* Chung, C.F. and others, eds., Symposium on Quantitative Analysis of Mineral and Energy Resources, NATO Advanced Study Institute, Il "Ciocco", Lucca, Italy, June 22-July 4, 1986: Dordrecht, Neth., D. Reidel Publ. Co., Series C, Mathematical and Physical Sciences, v. 223, p. 581-597.

Carrara, Alberto, Cardinali, Mauro, and Guzzetti, Fausto, 1992, Uncertainty in assessing landslide hazard and risk: ITC Journal (Enschede, Neth.), no. 1992-2, p. 172-183.

Carrara, Alberto, Cardinali, Mauro, Detti, R., Guzzetti, Fausto, Pasqui, V., and Reichenbach, Paola, 1991, GIS techniques and statistical models in evaluating landslide hazard: Earth Surface Processes and Landforms, v. 16, no. 5, p. 427-445.

Carrara, Alberto, Catalano, E., Sorriso-Valvo, M., Reali, C., and Osso, I., 1978, Digital terrain analysis for land evaluation: Geologica Applicata e Idrogeologica, v. 13, p. 69-127.

Carrara, A., Detti, R., Federici, G., and Pasqui, V., 1988, Reticoli idrografici e parametri morfologici di bacino da modelli digitali del terreno: Bologna, CNR Gruppo Nazionale per la Difesa dalle Catastrofi Idrogeologiche, Linea 3, 60 p.

Carrara, Alberto, and Merenda, L., 1976, Landslide inventory in northern Calabria, southern Italy: Geological Society of America Bulletin, v. 87, no. 8, p. 1153-1162.

Carrara, Alberto, Pugliese-Carratelli, E., and Merenda, L., 1977, Computer-based data bank and statistical analysis of slope instability phenomena: Zeitschrift für Geomorphologie, v. 21, no. 2, p. 187-222.

Carrara, Alberto, Sorriso-Valvo, M., and Reali, C., 1982, Analysis of landslide form and incidence by statistical techniques, southern Italy: Catena, v. 9, no. 1/2, p. 35-62.

Carroll, Roberta, 1983, Automated gully delineation using digital elevation data: Annual Meeting of the American Society of Photogrammetry, 49th, Washington, D.C., March 13-18, 1983, Technical Papers, p. 144-151.

Carrozzo, M.T., Chirenti, A., Luzio, D., Margiotta, C., and Quarta, T., 1981, Realizzazione di un archivio delle quote medie (in Italian): Atti I conv., GNGTS, Roma, p. 223-247.

Carrozzo, M.T., Chirenti, A., Luzio, D., Margiotta, C., Quarta, T., and Zuanni, F., 1982?, Realizzazione di un archivio delle quote medie (in Italian with brief English summary): serial unknown, p. 117-127.

Carrozzo, M.T., Chirenti, A., Luzio, D.m, Margiotta, C., Quarta, T., Tundo, A.M., and Zuanni, F., 1985, Data base of mean height values for the whole Italian landmass and surrounding areas—determining and statistical analysis: Boll. Geod. e Sc. Aff., v. 44, no. 1, p. 37-56.

Carson, M.A., 1975, Threshold and characteristic angles of straight slopes, *in* Yatsu, E., Ward, A.J., and Adams, F., eds., Mass Wasting, Proceedings of the 4th Guelph Symposium on Geomorphology, 1975, Norwich, UK, Geo Abstracts Ltd., p. 19-34.

Carson, M.A., and Kirkby, M.J., 1972, Hillslope Form and Process: London, Cambridge University Press, 475 p.

Carstensen, L.W., Jr., 1990, Angularity and capture of the cartographic line during digital data entry: Cartography and Geographic Information Systems, v. 17, no. 3, p. 209-224.

Carter, J.R., 1983, Bringing the digital elevation model into the classroom, *in* American Society for Photogrammetry—American Congress on Surveying and Mapping, 34rd Annual Meeting, Proceedings/ Technical Papers: p. 474-482.

Carter, J.R., 1984, Computer Mapping, Progress in the '80s: Washington, D.C., Association of American Geographers, 86 p.

Carter, J.R., 1988, Digital representations of topographic surfaces: Photogrammetric Engineering and Remote Sensing, v. 54, no. 11, p. 1577-1580.

Carter, J.R., 1989, Relative errors identified in USGS gridded DEMs, *in* Auto-Carto 9, Ninth International Symposium on Computer-Assisted Cartography, Baltimore, Maryland, April 2-7, 1989, Proceedings, p. 255-265.

Carter, J.R., 1992, The effect of data precision on the calculation of slope and aspect using gridded DEMs: Cartographica, v. 29, no. 1, p. 22-34.

Caruso, V.M., 1987, Standards for digital elevation models, *in* American Society for Photogrammetry and Remote Sensing-American Congress on Surveying and Mapping, annual convention, March 29-April 3, Baltimore, Maryland, Technical Papers, v. 4 (Cartography), p. 159-166.

Case, J.B., ed., 1978, Digital Terrain Model (DTM) Symposium, American Society of Photogrammetry, St. Louis, MO, May 9-11, 1978: Photogrammetric Engineering and Remote Sensing, v. 44, no. 12, p. 1477-1586.

Castleman, K.R., 1979, A history of digital image processing at JPL, *in* Digital Image Processing: Englewood Cliffs, N.J., Prentice-Hall, p. 383-400.

Castner, H.W., and Wheate, Roger, 1979, Re-assessing the role played by shaded relief in topographic scale maps: Cartographic Journal, v. 16, no. 2, p. 77-85.

Catlow, D.R., 1986, The multi-disciplinary applications of DEMs, *in* Blakemore, Michael, ed., Auto Carto London, ICA symposium, September 14-19, 1986, 1986,: Proceedings, v. I, p. 447-454.

Catlow, D.R., and Daosheng, Du, 1984, The structuring and cartographic generalisation of digital river data: Annual Meeting of the American Congress on Surveying and Mapping, 44th, Proceedings, p. 511-520.

Cavadias, G., 1962, Line-of-sight investigation based on quantitative terrain analysis: Montreal, Canadair Limited, Advanced Systems Planning Report ASP-1022, 20 p.

Cayley, Arthur, 1859a, On contour lines and slope lines: The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, v. 18, 4th Series, July-Dec., p. 264-268. [reprinted 1891*in* Collected Mathematical Papers: Cambridge, University Press, v. 4, paging unknown]

Cayley, Arthur, 1859b, On the analytical forms called trees: The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, v. 18, p. 374-378. [reprinted 1891 *in* Collected Mathematical Papers: Cambridge, University Press, v. 4, p. 112-115]

Cebrian, J.A., Mower, J.E., and Mark, D.M., 1985, Analysis and display of digital elevation models within a quadtree-based geographic information system, *in* Auto-Carto 7, Seventh International Symposium on Computer-Assisted Cartography, Washington, D.C., March 11-14, 1985, Proceedings, p. 55-64.

Centeno, J.D., Pedraza, J., Gonzales, S., Acaso, E., and Ortega, L.I., 1987, Small scale physiographic maps in the "Comunidad de Madrid" Spain, *in* Wolff, F.C., ed., International Symposium "Geological mapping in the service of environmental planning," Trondheim, Norway, 6-9 May 1986, Proceedings: Geology for environmental planning, Norges Geologiske Undersoekelse, Special Publication 2, p. 77-81.

Chan, K.K.L., 1985, Locating "lakes" on digital elevation models, *in* American Congress on Surveying and Mapping, fall convention, Indianapolis, IN, September 8-13, 1985, Technical Papers, p. 68-77.

Chandler, J.H., and Cooper, M.A.R., 1989, The extraction of positional data from historical photographs and their application to geomorphology: Photogrammetric Record, v. 13, no. 73, p. 69-78.

Chang, Kang-Tsung, and Tsai, Bor-wen, 1991, The effect of DEM resolution on slope and aspect mapping: Cartography and Geographic Information Systems, v. 18, no. 1, p. 69-77.

Chang, T.P., and Toebes, G.H., 1970, A statistical comparison of meander planforms in the Wabash Basin: Water Resources Research, v. 6, no. 2, p. 557-578.

Chapman, C.A., 1951, Applications of the statistical slope orientation diagram: Illinois Academy of Sciences Transactions, v. 44, p. 129-136.

Chapman, C.A., 1952, A new quantitative method of topographic analysis: American Journal of Science, v. 250, no. 6, p.428-452.

Chase, C.G., 1992, Fluvial landsculpting and the fractal dimension of topography, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 39-57.

Chebotarev, A.S., 1927, The study of local topography from maps by means of statistical methods (in Russian): Trudy Moskovskogo instituta inzhenerov transporta (Moscow), v. 4.

Chen, C.S., 1990, A numerical study of the terrain effects on a squall line: Terrestrial Atmospheric and Oceanic Sciences (Taiwan), v. 1, no. 1, p. 73-90.

Chen, S.P., 1947, The relative relief of Tsunyi, Kweichow: Geographical Society of China Journal, v. 14, no. 2, p. 5.

Chen, Z.-T., 1988, Breaklines on terrain surface, *in* GIS/LIS '88 conference, San Antonio, Texas, Nov. 30-Dec. 2, 1988, Proceedings: v. 2, p. 781-790.

Chen, Z.-T., 1989, A spatial low-pass filter working for triangular irregular network (TIN) and restricted by break lines, *in* Auto-Carto 9, Ninth International Symposium on Computer-Assisted Cartography, Baltimore, Maryland, April 2-7, 1989, ASPRS/ACSM, Proceedings: p. 138-145.

Chen, Z.-T., and Guevara, J.A., 1987, Systematic selection of very important points (VIP) from digital terrain model for constructing triangular irregular networks, *in* Chrisman, N.R., ed., Auto-Carto 8, Eighth International Symposium on Computer-Assisted Cartography, Baltimore, Maryland, March 29-April 3, 1987, ASPRS/ACSM, Proceedings: p. 50-56.

Chen, Z.-T., and Tobler, Waldo, 1986, The multi-disciplinary applications of DEMs, *in* Blakemore, Michael, ed., Auto Carto London, ICA symposium, September 14-19, 1986, 1986,: Proceedings, v. I, p. 475-484.

Cheng, G.C., Ledley, R.S., Pollock, D.K., and Rozenfeld, Azriel, eds., 1968, Pictorial Pattern Recognition—Symposium on automatic photointerpretation, Washington, May 31-June 2, 1967, sponsored by the Office of Naval Research, the University of Maryland, and the Pattern Recognition Society, Proceedings: Washington, D.C., Thompson Book Co., 521 p.

Chentsov, V.N., 1948, Morphometric indices on small-scale geomorphological maps (in Russian): Trudy instituta geografii AN SSSR (Moscow), no. 39.

Chervyakov, V.A., 1990, The role of modern cartography in the formation and development of geographical morphometry (in Russian): Geografiya i prirodnyye resursy, No. 2, p. 120-126. [translated 1990, *in* Mapping Sciences and Remote Sensing, v. 27, no. 4, p. 314-322]

Chiarini, V., Crucilla, U., Onorati, G., Poscolieri, M., and Ventura, R., 1990, Analysis of a digital elevation model of the Italian peninsula for quantitative geomorphology and structural geology: typescript, 20 p. + illustrations.

Chiou, Chyi-Rong, Thomas, V.L., and Hoffer, R.M., 1992, Comparison of four techniques for topographic normalization of LANDSAT TM data, *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 4 (Remote Sensing & Data Acquisition), p. 184-196.

Choate, Raoul, 1966, Lunar slope angles and surface roughness from Ranger photographs, *in* Symposium on Remote Sensing of Environment, 4th, Ann Arbor, The University of Michigan, Proceedings, p. 411-432.

Cholnoky, J., 1938, On slopes: International Review of the Hungarian Geographical Society, p. 77-89.

Chorley, R.J., 1957, Illustrating the laws of morphometry: Geological Magazine, v. 94, no. 2, p. 140-150.

Chorley, R.J., 1957, Climate and morphometry: Journal of Geology, v. 65, no. 6, p. 628-638.

Chorley, R.J., 1958, Group operator variance in morphometric work with maps: American Journal of Science, v. 256, no. 3, p. 208-218.

Chorley, R.J., 1959, The shape of drumlins: Journal of Glaciology, v. 3, no. 25, p. 339-344.

Chorley, R.J., 1962, Geomorphology and General Systems Theory: U.S. Geological Survey Professional paper 500-B, 10 p.

Chorley, R.J., 1969, The drainage basin as the fundamental geomorphic unit, *in* Chorley, R.J., ed., Water, Earth, and Man: London, Methuen, p. 77-99.

Chorley, R.J., ed., 1972, Spatial Analysis in Geomorphology: New York, Harper and Row, 393 p. [also an article, same title, *in* this reference, p. 3-16]

Chorley, R.J., and Dale, P.F., 1972, Cartographic problems in stream channel delineation: Cartography (UK): v. 7, p. 150-162.

Chorley, R.J., and Kennedy, B.A., 1971, Physical Geography, A Systems Approach: London, Prentice-Hall International, 370 p.

Chorley, R.J., Malm, D.E.G., and Pogorzelski, H.A., 1957, A new standard for estimating drainage basin shape: American Journal of Science, v. 255, no. 2, p. 138-141.

Chorley, R.J., and Morley, L.S.D., 1959, A simplified approximation for the hypsometric integral: Journal of Geology, v. 67, no. 5, p. 566-571.

Chorley, R.J., Dunn, A.J., and Beckinsale, R.P.,1964, The History of the Study of Landforms, or the development of geomorphology, volume 1—Geomorphology before Davis: London, Methuen. [chapter 8, the first quantitative work on landscape processes, p. 86-90; chapter 15, early quantitative geomorphology, p. 280-290; Chapter 23, quantitative and morphometric advances, p. 418-440; and p. 603-610 *in* chapter 31, quantitative, dynamic, and chronological advances]

Chorowicz, Jean, Kim, J., Manoussis, S., Rudant, J.-P., Foin, P., and Veillet, I., 1989, A new technique for recognition of geological and geomorphological patterns in digital terrain models: Remote Sensing of the Environment, v. 29, no. 3, p. 229-239.

Chorowicz, Jean, Breard, J.-Y., Guillande, Richard, Morasse, C.-R., Prudon, Didier, and Rudant, J.P., 1991, Dip and strike measured systematically on digitized three-dimensional geological maps: Photogrammetric Engineering and Remote Sensing, v. 57, no. 4, p. 431-436.

Chorowicz, Jean, Ichoku, Charles, Riazanoff, Serge, Kim, Youn-Jong, and Cervelle, Bernard, 1992, A combined algorithm for automated drainage network extraction: Water Resources Research, v. 28, no. 5, p. 1293-1302.

Chorowicz, Jean, Ichoku, Charles, Riazanoff, Serge, Kim, Youn-Jong, and Cervelle, Bernard, 1993, Reply (*to* Garbrecht and Martz, 1993): Water Resources Research, v. 29, no. 2, p. 537-539.

Chou, Yue Hong, 1991, Slope-line detection in a vector-based GIS: Photogrammetric Engineering and Remote Sensing, v. 58, no. 2, p. 227-233.

Christiansen, A.H.J., 1987, Fitting a triangulation to contour lines, *in* Auto-Carto 8, Eighth International Symposium on Computer-Assisted Cartography, Baltimore, Maryland, March 29-April 3, 1987, ASPRS/ACSM, Proceedings, p. 57-67.

Christofoletti, A., 1979, A análise da densidade de drenagem e suas implicações geomorfológicas: Geografia, v. 4, no. 8, p. 23-42.

Christou, Nikolaos, Vaníçek, Petr, and Ware, Colin, 1989, Geoid and density anomalies: Eos, Transactions of the American Geophysical Union, v. 70, no. 22, p. 625 and 631.

Church, Michael, 1981, Horton's slope function: Earth Surface Processes and Landforms, v. 6, no. 2, p. 199-201.

Church, Michael, 1984, On experimental method in geomorphology, *in* Burt, T.P., and Walling, D.E., eds., Catchment Experiments in Fluvial Geomorphology: meeting of the IGU Commission on Field Experiments in Geomorphology, Exeter and Huddersfield, UK, August 16-24, 1981, Proceedings, Norwich, Geo Books, p. 563-580.

Church, Michael, and Mark, D.M., 1980, On size and scale in geomorphology: Progress in Physical Geology, v. 4, no. 3, p. 342-390.

Churchland, P.M., and Churchland, P.S., 1990, Could a machine think?: Scientific American, v. 262, no. 1, p. 32-37.

Chutha, Promchinavongs, and Dooge, J.C.I., 1990, The shape parameters of the geomorphologic unit hydrograph: Journal of Hydrology, v. 177, no. 1-4, p. 81-97.

Ciccacci, Sirio D'Alessandro, Leandro, Fredi, Paola, and Lupia Palmieri, Elvidio, 1992, Relations between morphometric characteristics and denudational processes in some drainage basins of Italy: Zeitschrift für Geomorphologie, v. 36, no. 1, p. 53-67.

Cintala, M.J., 1979, Mercurian crater rim heights and some interplanetary comparisons, *in* Lunar and Planetary Science Conference 10th, Houston, Texas, Proceedings: Oxford, Pergamon Press, p. 2635-2650.

Civco, D.L., 1989, Topographic normalization of LANDSAT thematic mapper digital imagery: Photogrammetric Engineering and Remote Sensing, v. 55, no. 9, p. 1303-1309.

Clark, Isobel, 1979, The semivariogram—part I: Engineering and Mining Journal, v. 107, no. 7, p. 90-94.

Clark, M.W., 1981, Quantitative shape analysis—a review: Journal of Mathematical Geology, v. 13, no. 4, p. 303-320.

Clark, N.N., 1987, A new scheme for particle shape characterization based on fractal harmonics and fractal dimension: Powder Technology, v. 51, no. 3, p. 243-249.

Clark, P.J., and Evans, R.C., 1954, Distance to nearest neighbors as a measure of spatial relationships in populations: Ecology, v. 35, no. 4, p. 445-453.

Clarke, A.L., Gruen, A., and Loon, J.C., 1982, The application of contour data for generating high fidelity grid digital elevation models, *in* ACSM/ASP Conference, Crystal City, VA, Auto-Carto 5th, Proceedings, p. 213-222.

Clarke, J.I., 1966, Morphometry from maps, *in* Dury, G.H., ed., Essays in Geomorphology: London, Heinemann (also New York, American Elsevier), p. 235-274.

Clarke, J.I., and Orrell, K., 1958, An assessment of some morphometric methods: Durham, UK, Department of Geography, University of Durham, Occasional Papers series, no. 2, paging unknown.

Clarke, K.C., 1986, Computation of the fractal dimension of topographic surfaces using the triangular prism surface area method: Computers and Geosciences, v. 12, no. 5, p. 713-722.

Clarke, K.C., 1987, Scale-based simulation of topography, *in* AutoCarto 8, International Symposium on Computer-Assisted Cartography, 8th, Baltimore, MD, March 29-April 3, 1987, Proceedings, p. 680-688.

Clarke, K.C., 1988, Scale-based simulation of topographic relief: The American Cartographer, v. 15, no. 2, p. 173-181.

Clarke, K.C., 1990, Terrain Analysis, p. 204-237 (Chapter 11) *in* Analytical and Computer Cartography: Englewood Cliffs, NJ, Prentice-Hall, 290 p.

Clarke, K.C., ca. 1992, One thousand Mount Everests?, *in* Lam, Nina, and DeCola, Lee, eds., Fractals in Geography, New York, Prentice-Hall, in press.

Clarke, K.C., and Schweizer, D.M., 1991, Measuring the fractal dimension of natural surfaces using a robust fractal estimator: Cartography and Geographic Information Systems, v. 18, no. 1, p. 37-47.

Claus, Michael, 1984, Digital terrain models through digital stereo correlation: Photogrammetria, v. 39, no. 4, p. 183-192.

Clerici, D., 1980, A method for drawing slope maps from contour maps by automatic data acquisition and processing: Computers and Geosciences, v. 6, no. 3, p. 289-297.

Cliff, A.D., and Ord, J.K., 1981, Spatial Processes—models and applications: London, UK, Pion.

Cloud, P.E. Jr., 1966, Beach cusps—response to Plateau's Rule?: Science, v. 154, no. 3751, p. 890-891.

Coates, D.R., 1959, Influence of scale in geomorphic map analysis (abs.): Geological Society of America Bulletin, v. 70, no. 12, part 2, p. 1801.

Coffman, D.M., and Turner, A.K., 1971, Computer determination of the geometry and topology of stream networks: Water Resources Research, v. 7, no. 2, p. 419-423.

COGS letter, 1990, What's DEM data?: The Computer Oriented Geological Society (Denver), August / September, p. 1, 12, and 13.

Cole, Gregory, MacInnes, Scott, and Miller, James, 1990, Conversion of contoured topography to digital-terrain data: Computers and Geosciences, v. 16, no. 1, p. 101-109.

Cole, J.P., and King, C.A.M., 1968, Quantitative Geography, techniques and theories in geography: London, John Wiley and Sons, 692 p.

Colleau, A., and Lenôtre, N., 1991, A new digital method for analysis of neotectonics applied to the Bonnevaux-Chambaran area, France: Tectonophysics, v. 194, no. 3, p. 295-305.

Collett, D., Outliers in circular data: Applied Statistics, v. 29, no. 1, p. 50-57.

Collins, S.H., 1975, Terrain parameters directly from a digital terrain model: The Canadian Surveyor, v. 29, no. 5, p. 507-518.

Collins, S.H., and Moon, G.C., 1981, Algorithms for dense digital terrain models: Photogrammetric Engineering and Remote Sensing, v. 47, no. 1, p. 71-76.

Colman, S.M., and Watson, Kenneth, 1983, Ages estimated from a diffusion equation model for scarp degradation: Science, v. 221, no. 4607, p. 263-265.

Committee on Global Change, 1990, Research Strategies for the U.S. global change research program: Washington, D.C., National Research Council, National Academy Press, 291 p. [see *topographic data*, p. 137]

Committee on Opportunities in the Hydrologic Sciences, 1991, Opportunities in the Hydrologic Sciences: Washington, D.C., Water Science and Technology Board, Commission on Geosciences, Environment, and Resources, National Research Council, National Academy Press, 348 p. [see data: *Topography*, p. 240-242; applications: chapters 3 & 4]

Condit, C.D., and Chavez, P.S., Jr., 1979, Basic Concepts of Computerized Digital Image Processing for Geologists: U.S. Geological Survey Bulletin 1462, 16 p.

Connelly, D.S., 1968, The coding and storage of terrain height data, an introduction to numerical cartography: Ithaca, New York, Cornell University Graduate School, unpublished M.S. thesis, 141 p.

Connelly, D.S., 1972, Geomorphology and information theory, *in* Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, p. 91-108.

Connors, K.F., Gardner, T.W., and Day, R.L., 1989, Deriving stream parameters for hydrologic modeling from digital elevation data, *in* New Directions for Surface Water Modeling, International Association for Scientific Hydrology Symposium, Baltimore Maryland, May 1989, Proceedings: Publication no. 181, p. 397-406.

Conradsen, Knut, Nilsson, Gert, and Thyrsted, Tage, 1986, Statistical lineament analysis in south Greenland based on LANDSAT imagery: IEEE Transactions on Geoscience and Remote Sensing, v. GE-24, no. 3, p. 313-321.

Cook, B.G., Laut, P., Austin, M.P., Body, D.N., Faith, D.P., Goodspeed, M.J., and Srikanthan, R., 1988, Landscape and rainfall indices for prediction of streamflow similarities in the Hunter valley, Australia: Water Resources Research, v. 24, no. 8, p. 1283-1298.

Cook, H.R., 1976, (Operating Systems Panel remarks on data collection systems at the U.S. Army Defense Mapping Agency Topographic Center), *in* International Conference on Automation in Cartography, Auto-Carto I, Reston, VA, December 9-12, 1974, ACSM, Falls Church: Proceedings, p. 268-283.

Cook, H.R., 1976, Accuracy/quality control of digital data in the digital topographic information bank, *in* Annual meeting, 36th, February 22-28, 1976, Washington, D.C., American Congress on Surveying and Mapping, Proceedings, p. 483-488.

Cooper, A.K., 1988, Temporal terrain shading, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, annual convention, March 13-18, 1988, St. Louis, MO, Technical papers, v. 2 (Cartography), p. 282-290.

Corominas, J., Baeza, C., and Salueña, I., 1992, The influence of geometrical slope characteristics and land use on the development of shallow landslides, *in* Bell, D.H., ed., Landslides: Rotterdam, A.A. Balkema, International Symposium on Landslides, 6th, February 10-14, 1992, Christchurch, N.Z., Proceedings, v. 2, p. 919-924.

Costes, N.C., Farmer, J.E., and George, E.B., 1972, Mobility performance of the Lunar Roving Vehicle; terrestrial studies—Apollo 15 results: Marshall Space Flight Center, Alabama, NASA Technical Report TR R-401, 78 p.

Coulson, R.N., Folse, L.J., and Loh, D.K., 1987, Artificial intelligence and natural resource management: Science, v. 237, no. 4812, p. 262-267.

Cowan, D.J., 1988, GIS versus CAD versus DBMS, what are the differences?: Photogrammetric Engineering and Remote Sensing, v. 54, no 11, p. 1551-1555.

Cox, N.J., 1983, On the estimation of spatial autocorrelation in geomorphology: Earth Surface Processes, v. 8, no. 1, p. 89-93.

Cox, N.J., 1990, Hillslope profiles, *in* Goudie, Andrew (with the assistance of six others), ed., Geomorphological Techniques (second edition): London, Unwin Hyman, *for* the British Geomorphological Research Group, p. 92-96.

Cox, N.J., and Evans, I.S., 1987, Introduction, *to* Special Issue on Theoretical Geomorphology—Hillslopes and Rivers: Earth Surface Processes and Landforms, v. 12, no. 1, p. 1-2.

Craig, R.G., 1980, A computer program for the simulation of landform erosion: Computers and Geosciences, v. 6, no. 2, p. 111-142.

Craig, R.G., 1982, Criteria for constructing optimal digital terrain models, *in* Craig, R.G., and Craft, J.L., eds., Applied Geomorphology, Annual Binghamton Geomorphology Symposium, 11th, Kent State University, Ohio, October 2-5, 1980, Proceedings: London, Allen and Unwin, p. 108-130.

Craig, R.G., 1982, Evaluation of terrain complexity by autocorrelation: Kent State University, Kent, Ohio, Geology Department, *for* the National Aeronautics and Space Administration, Contract NAG 5-165, Final Report, 208 p.

Craig, R.G., 1989, Computing Appalachian geomorphology: Geomorphology, v. 2, no. 2, p. 197-207.

Crain, I.K., 1970, Computer interpolation and contouring of two-dimensional data—a review: Geoexploration, v. 8, p. 71-86.

Cressie, Noel, 1991, Statistics for Spatial Data: New York, Wiley, 928 p.

Crosley, K.R. (with Don Boucher), 1991, Quality control of data through scientific visualization: Scientific Computing and Automation, v. 7, no. 11, p. 45-48.

Croswell, P.L., and Clark, S.R., 1988, Trends in automated mapping and geographic information system hardware: Photogrammetric Engineering and Remote Sensing, v. 54, no. 11, p. 1571-1576.

Croxton, F.E., Cowden, D.J., and Klein, Sidney, 1967, Applied General Statistics, 3rd ed.: Englewood Cliffs, N.J., Prentice-Hall, 754 p.

Crozier, M.J., 1973, Techniques for the morphometric analysis of landslips: Zeitschrift für Geomorphologie, v. 17, no. 1, p. 78-101.

Crozier, M.J., 1975, On the origin of the Peterborough drumlin field—testing the dilatancy theory: The Canadian Geographer, v. 19, no. 3, p. 181-195.

Crumpler, L.S., and Head, J.W., 1988, Bilateral topographic symmetry patterns across Aphrodite Terra, Venus: Journal of Geophysical Research, v. 93, no. B1, p. 301-312.

Culling, W.E.H., 1986, On Hurst phenomena in the landscape: Transactions, Japanese Geomorphological Union, v. 7, no. 4, p. 221-243.

Culling, W.E.H., and Datko, Mark, 1987, The fractal geometry of the soil-covered landscape: Earth Surface Processes and Landforms, v. 12, no. 4, p. 369-385.

Curl, Rane, 1986, Fractal dimensions and geometries of caves: Mathematical Geology, v. 18, no. 8, p. 765-783.

Curray, J.R., 1956, The analysis of two-dimensional orientation data: Journal of Geology, v. 64, no. 2, p. 117-131.

Curtis, L.F., Doornkamp, J.C., and Gregory, K.J., 1965, The description of relief in field studies of soils: Journal of Soil Science, v. 16, no. 12, p. 16-30.

D

Dacey, M.F., 1967, Description of line patterns, *in* Garrison, W.L., and Marble, D.F., eds., Quantitative Geography, Part I, Economic and Cultural Topics: Evanston, Ill., Northwestern University Studies in Geography no. 13, p. 277-287.

Dacey, M.F., 1973, Some questions about spatial distributions, *in* Chorley, R.J., ed., Directions in Geography: London, Methuen, p. 127-151.

Dacey, M.F., and Krumbein, W.C., 1976, Topological properties of disjoint channel networks within enclosed regions: Mathematical Geology, v. 8, no. 4, p. 429-461.

Dale, M.L., and Ballantyne, C.K., 1980, Two statistics for the analysis of orientation data in geography: The Professional Geographer, v. 32, no. 2, p. 184-191.

Dalrymple, J.R., Blong, R.J., and Conacher, A.J., 1968, A hypothetical nine unit landsurface model: Zeitschrift für Geomorphologie, v. 12, no. 1, p. 60-76.

Dangermond, Jack, 1984, Geographic data base systems, *in* American Society for Photogrammetry—American Congress on Surveying and Mapping, Fall Convention, Sept. 9-14, 1984, San Antonio, TX: Technical Papers, p. 201-211.

Dangermond, Jack, 1986, The software toolbox approach to meeting the users' needs for GIS analysis, *in* American Society for Photogrammetry and Remote Sensing, Geographic Information Systems Workshop, Atlanta, Georgia, April 1-4, 1986: Proceedings, p. 66-75.

Daniels, R.B., Nelson, L.A., and Gamble, E.E., 1970, A method of characterizing nearly level surfaces: Zeitschrift für Geomorphologie, v. 14, no. 2, p. 175-185.

Darling, E.M. Jr., and Joseph, R.D., 1968, An experimental investigation of video pattern recognition, *in* Cheng, G.C., Ledley, R.S., Pollock, D.K., and Rozenfeld, Azriel, eds., Pictorial Pattern Recognition—Symposium on automatic photointerpretation, Washington, May 31-June 2, 1967, sponsored by the Office of Naval Research, the University of Maryland, and the Pattern Recognition Society, Proceedings: Washington, D.C., Thompson Book Co., p. 457-469.

Darlington, R.B., 1970, Is kurtosis really 'peakedness'?: American Statistician, v. 24, no. 1, p. 19-22.

Davis, C.M., 1932, The hydrologic regions of Michigan: Papers of the Michigan Academy of Science, Arts and Letters, v. 16, 1931, p. 211-215.

Davis, C.M., 1969, A study of the land type: Ann Arbor, Department of Geography, The University of Michigan, *for* U.S. Army Research Office (Durham) Contract No. DA-31-124-ARO-D-456, ORA Project 08055, Final Report, 86 p.

Davis, D.M., Downing, J.A., and Zoraster, Steven, 1982, Algorithms for Digital Terrain Modeling: Fort Belvoir, VA, U.S. Army Engineering Topographic Laboratory, Report ETL-0302, paging unknown.

Davis, F.W., and Dozier, Jeff, 1990, Information analysis of a spatial database for ecological land classification: Photogrammetric Engineering and Remote Sensing, v. 56, no. 5, p. 605-613.

Davis, F.W., Schimel, D.S., Friedl, M.A., Michaelson, J.C., Kittel, T.G.F., Dubayah, Ralph, and Dozier, Jeff, 1992, Covariance of biophysical data with digital topographic and land use maps over the FIFE site: Journal of Geophysical Research, v. 97, no. D17, p. 19,009-19,021.

Davis, J.C., 1986, Statistics and Data Analysis in Geology (2nd edition): New York, John Wiley and Sons, 646 p.

Davis, J.C., 1987, Contour mapping and SURFACE II: Science, v. 237, no. 4815, p. 669-672.

Davis, J.H., 1976, Critical values for a measure of contiguity of anomalous points in a grid survey: Mathematical Geology, v. 8, no. 1, p. 89-94.

Davis, P.A., and Soderblom, L.A., 1984, Modeling crater topography and albedo from monoscopic Viking orbiter images, I—methodology: Journal of Geophysical Research, v. 89, no. B11, p. 9449-9457.

Davis, P.A., and Tanaka, K.L., 1993, Small volcanoes in Tempe Terra, Mars—their detailed morphometry and inferred geologic significance, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 379-380.

Dawson, B.M., 1987, Introduction to image processing algorithms: BYTE, v. 12, no. 3, p. 169-186.

Dawson, B.M., 1989, Changing perceptions of reality (image editing in the microcomputer environment): BYTE, v. 14, no. 13, p. 293-297, 300, 302, & 304.

Day, M.J., 1979, Surface roughness as a discriminator of tropical karst styles: Zeitschrift für Geomorphologie, Supplementband 32, p. 1-8.

De Cola, Lee, 1992, Multiscale characterization of topographic complexity in Colorado (abs.), *in* Balthrop, B.H., and Baker, E.G., compilers, U.S. Geological Survey national computer technology meeting, Norfolk, Va., May 17-22, 1992, Proceedings: U.S. Geological Survey Open-file report 92-64, p. 10.

De Cola, Lee, 1992, Multiscale interactions between topography and vegetation in Colorado, *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 5 (Resource Technology 92), p. 16-27.

Deffontaines, Benoit, and Chorowicz, Jean, 1991, Principles of drainage basin analysis from multisource data—Application to the structural analysis of the Zaire Basin: Tectonophysics, v. 194, no. 3, p. 237-263.

De Floriani, Leila, Falcidieno, Bianca, Pienovi, Caterina, and Nagy, George, 1985, Efficient selection, storage, and retrieval of irregularly distributed elevation data: Computers and Geosciences, v. 11, no. 6, p. 667-673.

De Floriani, Leila, Falcidieno, Bianca, Pienovi, Caterina, Allen, David, and Nagy, George, 1986, A visibility-based model for terrain features, *in* International Symposium on Spatial Data Handling, 2nd, Seattle, WA, July 5-10, 1986, International Geographical Union Commission on Geographical Data Sensing and Processing, International Cartographic Association: Proceedings, p. 235-250.

De Hon, R.A., 1981, Selenographic distribution of apparent crater depth, *in* Lunar and Planetary Science Conference, 12th, Houston, Texas, March 16-20, 1981, Proceedings: New York, Pergamon, v. 12B, p. 639-650.

DeJong, Eric, Saunders, Steve, Hall, Jeff, and McAuley, Myche, 1991, Visualization techniques—Magellan scientists use computer-simulated flights to explore Venus: OSSA Information Systems Newsletter, NASA Office of Space Science and Applications, Issue 23, October, p. 1-4.

Delaunay, B., 1934, Sur la sphère vide (in French): Bulletin de l'Académie Des Sciences de USSR, Classes des Sciences Mathématiques et Naturelles, v. VII, no. 6, p. 793-800. [also listed *as* Izvestiia Akademiia Nauk SSSR, Otdelenie Matematicheskikh i Estestuennykh Nauk]

Dell'Orco, Pietro, and Ghiron, Marco, 1983, Shape representation by rectangles preserving fractality, *in* Wellar, B.S., ed., Auto-Carto 6, International Symposium on Automated Cartography, 6th, Ottawa Canada, 1983: Proceedings, v. II, p. 299-308.

DeLotto, J.S., 1989, The role of scale in automated terrain classification: Buffalo, N.Y., Department of Geography, SUNY-Buffalo, unpublished M.A. thesis, paging unknown.

Demek, Jaromir, ed., and Embleton, C., Gellert, J.F., and Verstappen, H.Th., co-eds., 1972, Manual of Detailed Geomorphological Mapping: International Geographical Union Commission on Geomorphological Surveying and Mapping, Prague, Academia Press, 344 + 24 p. [for morphometry: p. 50-75]

Demek, Jaromir, Embleton, Clifford, and Kugler, Hans, 1982, eds., Geomorphologische Kartierung in mittleren Massstäben: Gotha, Geographische-Kartographische Anstalt, VEB Hermann Haack, Ergänzungsheft Nr. 281 zu Petermanns Geographischen Mitteilungen, 225 p.

Denning, P.J., 1985. What is computer science?: The American Scientist, v. 73, no. 1, p. 16-19.

Denning, P.J., 1986, Expert systems: The American Scientist, v. 74, no. 1, p. 18-20.

Denning, P.J., 1989, Bayesian learning: The American Scientist, v. 77, no. 3, p. 216-218.

Denning, P.J., 1992, Neural networks: The American Scientist, v. 80, no. 5, p. 426-429.

Depraetere, Christian, 1987, Exemples d'analyse géomorphométriques dans les Appalaches à partir des Modèles Numériques de Terrain (in French): Physio-Géo, v. 17, no. 1, p. 49-76.

Depraetere, Christian, 1989, Etude Géomorphométrique du bassin-versant de Booro-Borotou à partir d'un modèle numérique de terrain—Structure et fonctionnement hydropédologique d'un petit bassin-versant de savanne humide (in French): Montpellier, France, Equipe HYPERBAV, Collection Etudes et Thèses, journée hydropédologique, Inst. Fr. de Rech. Sci. pour le Dével. en Cooperation, ORSTOM, paging unknown.

De Smet, Roger, 1951, Problèms de morphométrie (in French): Bull. Société Belge d'Études Géographie, v. 20, p. 111-132.

De Smet, Roger, 1954, Courbe hypsographique et profile moyen de l'Ardenne (in French): Bull. Société Belge d'Études Géographie, v. 23, p. 143-167.

DeVantier, B.A., and Feldman, A.D., 1993, Review of GIS applications in hydrologic modeling: Journal of Water Resources Planning and Management, v. 119, no. 2, p. 246-261.

Diamantides, N.D., and Horowitz, M., 1957, Autocorrelation of the Earth's crust* with analog computers: Review of Scientific Instruments, v. 28, no. 5, p. 353-360. [* *i.e.*, ground surface]

DiBiase, David, 1990, Visualization in the earth sciences: Earth and Mineral Sciences, v. 59, no. 2, p. 13-18. [abridged 1991, *in* Geotimes, v. 36, no. 7 (July), p. 13-15]

Dietrich, W.E., Wilson, C.J., Montgomery, D.R., McKean, James, and Bauer, Romy, 1992, Erosion thresholds and land surface morphology: Geology, v. 20, no. 8, p. 675-679.

Dietrich, W.E., Wilson, C.J., Montgomery, D.R., and McKean, James, 1993, Analysis of erosion thresholds, channel networks, and landscape morphology using a digital elevation model: Journal of Geology, v. 101, no. 2, p. 259-278.

Dikau, Richard, 1988, Case studies in the development of derived geomorphic maps: Geologische Jahrbuch, v. A 104, p. 329-338.

Dikau, Richard, 1989, The application of a digital relief model to landform analysis in geomorphology, *in* Raper, Jonathan, ed., Three dimensional applications in geographical information systems: London, Taylor and Francis, p. 51-77.

Dikau, Richard, 1990a, Geomorphic landform modelling based on hierarchy theory, *in* International Symposium on Spatial Data Handling, 4th, Zürich, Switzerland, July 23-27: 1990, Proceedings, v. 1, p. 230-239.

Dikau, Richard, 1990b, Derivatives from detailed geoscientific maps using computer methods: Zeitschrift für Geomorphologie, Supplementband 80, p. 45-55.

Dikau, Richard, 1992, Aspects of constructing a digital geomorphological base map, *in* Vinken, Renier, ed., Geologisches Jahrbuch (Hannover): v. 122, p. 357-370.

Dikau, Richard, Brabb, E.E., and Mark, R.K., 1991, Landform classification of New Mexico by computer: U.S. Geological Survey Open-file Report OF 91-634, 15 p.

Dillon, W.R., and Goldstein, Matthew, 1984, Multivariate Analysis Methods and Applications: New York, John Wiley and Sons, 587 p.

Diment, W.H., and Urban, T.C., 1981, Average elevation map of the conterminous United States (Gilluly averaging method): U.S. Geological Survey Geophysical Investigations Map GP-933, scale 1:2,500,000.

Ding, Yuemin, 1992, An improved method for shadow modeling based on digital elevation models, *in* GIS/LIS '92, annual conference and exposition, November 10-12, 1992, San Jose, CA: Proceedings, v. 1, p. 178-187.

Divenyi, Pal, and Markus, Bela, 1985, Thematic relief mapping by computer: Mapping Sciences and Remote Sensing, v. 22, no. 1, p. 53-62.

Dixon, Robert, 1983, Geometry comes up to date: The New Scientist, v. 98, no. 1356, p. 302-305.

Djokic, Dean, and Maidment, D.R., 1991, Terrain analysis for urban stormwater modelling: Hydrological Processes, v. 5, no. 1, p. 115-124.

Doehring, D.O., 1970, Discrimination of pediments and alluvial fans from topographic maps: Geological Society of America Bulletin, v. 81, no. 10, p. 3109-3116.

Dohrenwend, J.C., 1978, Systematic valley asymmetry in the central California Coast Ranges: Geological Society of America Bulletin, v. 89, no. 6, p. 891-900.

Dohrenwend, J.C., Abrahams, A.D., and Turrin, B.D., 1989, Drainage development on basaltic lava flows, Cima volcanic field, southeast California, and Lunar Crater volcanic field, south-central

Nevada—Reply: Geological Society of America Bulletin, v. 101, no. 7, p. 982-986. [*see* GSAB, 1987, 99/9, 405-413; & GSAB, 1989, 101/4, 595-599]

Dolan, Robert, Hayden, B.P., and Felder, W., 1977a, Systematic variations in inshore bathymetry: Journal of Geology, v. 85, no. 2, p. 129-141.

Dolan, Robert, Hayden, B.P., Heywood, Jeffrey, and Vincent, Linwood, 1977b, Shoreline forms and shoreline dynamics: Science, v. 197, no. 4298, p. 49-51.

Dolan, Robert, Vincent, Linwood, and Hayden, B.P., 1974, Crescentic coastal landforms: Zeitschrift für Geomorphologie, v. 18, no. 1, p. 1-12.

Donker, N.H.W., 1992, Automatic extraction of catchment hydrologic properties from digital elevation data: ITC Journal (Enschede, Neth.), no. 1992-3, p. 257-265.

Doornkamp, J.C., and King, C.A.M., 1971, Numerical Analysis in Geomorphology: New York, St. Martin's Press, 372 p.

Dornbach, J.E.,, 1956, An approach to design of terrain representation: Surveying and Mapping, v. 16, no. 1, p. 41-44.

Douglas, D.H., 1986, Experiments to locate ridges and channels to create a new type of digital elevation model: Cartographica, v. 23, no. 4, p. 29-61.

Douglas, D.H., and Peucker, T.K., 1973, Algorithms for the reduction of the number of points required to represent a digitized line or its caricature: The Canadian Cartographer, v. 10, no. 2, p. 112-122.

Doyle, F.J., 1978, Digital terrain models—an overview: Photogrammetric Engineering and Remote Sensing, v. 44, no. 12, p. 1481-1485.

Dozier, Jeff, Bruno, J., and Downey, P., 1981, A faster solution to the horizon problem: Computers and Geosciences, v. 7, no. 2, p. 145-151.

Dozier, Jeff, and Frew, James, 1990, Rapid calculation of terrain parameters for radiation modeling from digital elevation data: IEEE Transactions on Geoscience and Remote Sensing, v. 28, no. 5, p. 963-969.

Drewry, D.J., 1975, Terrain units in eastern Antarctica: Nature, v. 256, no. 5514, p. 194-195.

Drogue, Claude, and Bidaux, Pascal, 1992, Structural and hydrogeological origin of tower karst in southern China (Lijiang plain in the Guilin region): Zeitschrift für Geomorphologie, v. 36, no. 1, p. 25-36.

Druet, Yves, 1973, L'utilisation de l'ordinateur pour l'analyse morphométrique du bassin versant en vue de la planification du réseau hydrométrique national de base (in French): Revue de Géomorphologie Dynamique, v. 22, no. 4, p. 173-178.

Drummond, R.R., and Dennis, H.W., 1968, Qualifying relief terms: The Professional Geographer, v. 20, no. 5, p. 326-332.

Drungil, C.E.C., McCuen, R.H., and Simanton, J.R., 1990, Application of low altitude photogrammetry to the determination of rangeland hydraulic parameters: Transactions of the American Society of Agricultural Engineers, v. 33, no. 6, p. 1919-1924.

Dubayah, R.O., and Dozier, Jeff, 1986, Orthographic terrain views using data derived from digital elevation models: Photogrammetric Engineering and Remote Sensing, v. 52, no. 4, p. 509-518.

Dubayah, R.O., and van Katwijk, V., 1992, The topographic distribution of annual incoming solar radiation in the Rio Grande river basin: Geophysical Research Letters, v. 19, no. 22, p. 2231-2234.

Duda, R.O., and Hart, P.E., 1973, Pattern Classification and Scene Analysis: New York, Wiley, 482 p.

Dufour, H.M., and Abgrall, F., 1983, Elements remarquables du relief, Définitions numériques utilisables: Bulletin du Comité Français de Cartographie, v. 95, no. 1, p. 57-79.

Duffield, Wendell, Heiken, Grant, Foley, Duncan, and McEwen, Alfred, 1993, Oblique synoptic images, produced from digital data, display strong evidence of a "new" caldera in southwestern Guatemala: Journal of Volcanology and Geothermal Research, v. 55, no. 3/4, p. 217-224.

Dugay, Claude, Holder, Glenn, LeDrew, Ellsworth, Howarth, Philip, and Dudycha, Douglas, 1989, A software package for integrating digital elevation models into the digital analysis of remote-sensing data: Computers and Geosciences, v. 15, no. 5, p. 669-678.

Dunkerley, D.L., 1983, Lithology and micro-topography in the Chillagoe karst, Queensland, Australia: Zeitschrift für Geomorphologie, v. 27, no. 2, p. 191-204.

Dury, G.H., 1951, Quantitative measurement of available relief and of depth of dissection: Geological Magazine, v. 88, no. 5, p. 339-343.

Dury, G.H., 1973, Magnitude-frequency analysis and channel morphometry, *in* Morisawa, M.E., ed., Fluvial Geomorphology, proceedings of the 4th annual geomorphology symposium: Binghamton, N.Y., SUNY, Publications in Geomorphology, p. 91-121.

Dutton, Geoffrey, ed., 1978, International advanced study symposium on topological data structures for geographic information systems, 1st., Dedham, Mass., 1977, Proceedings, v. 5, Data Structures—Surficial and Multi-Dimensional: Harvard Papers on Geographic Information Systems, Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University, individually paginated (8 papers).

Dutton, Geoffrey, 1983, Geodesic modelling of planetary relief, *in* Wellar, B.S., ed., Auto-Carto 6, International Symposium on Automated Cartography, 6th, Ottawa Canada, 1983: Proceedings, v. II, p. 186-201. [republished *in* Cartographica, 1984, v. 21, nos. 2 & 3, p. 188-207]

Dwornik, S.E., and Webb, P.K., 1961, Microrelief studies as a guide to mine detector design: U.S. Army Research and Development Laboratories, Corps of Engineers, Research Report 1692-RR, 83 p.

Dyer, M.I., and Vinogradov, B.V., 1990, The role of biosphere reserves in landscape and ecosystem studies: Nature and Resources, v. 26, no. 1, p. 19-27.

Dymond, J.R., DeRose, R.C., and Trotter, C.M., 1992, DTMs for terrain evaluation: Geocarto International, v. 7, no. 2, p. 53-58.

E

Earth Sciences Division *Ad Hoc* Committee on Geography, 1965, The Science of Geography: Washington, D.C., National Academy of Science—National Research Council, Publication No. 1277, 80 p.

Ebisch, Konrad, 1984, Effect of digital elevation model resolution on properties of contours, *in* American Society on Photogrammetry / American Congress on Surveying and Mapping, 1984 meeting: Technical Papers, p. 424-434.

Ebisemiju, F.S., 1979a, A reduced rank model of drainage basin morphology: Geografiska Annaler, v. 61 A, no. 1-2, p. 103-112.

Ebisemiju, F.S., 1979b, An objective criterion for the selection of representative basins: Water Resources Research, v. 15, no. 1, p. 148-158.

Ebisemiju, F.S., 1988, Canonical correlation analysis in geomorphology with particular reference to drainage basin characteristics: Geomorphology, v. 1, no. 4, p. 331-342.

Ebizuka, Masaaki, and Hirano, Masashige, 1988, Numerical analysis of landform in the western part of the Izumi Mountain Range based on the digital map: Transactions, Japanese Geomorphological Union, v. 9, no.2, p. 179-192.

Ebner, Heinrich, 1987, Digital terrain models for high mountains: Mountain Research and Development (where publ. ?), v. 7, no. 4, p. 353-356.

Ebner, Heinrich, Reinhardt, W., and Tang, Liang, 1989, Beiträge der Rasterdatenverarbeitung zum Aufbau digitaler Geländemodelle (in German): Zeitschrift für Vermessungenswesen, v. 114, p. 268-278.

Ebner, Heinrich, Reinhardt, W., and Hössler, R., 1988, Generation, management and utilization of high fidelity digital elevation models: International Archives of Photogrammetry and Remote Sensing (Kyoto, Japan), v. 27, part B11, p. III/556-III/566.

Ebner, Heinrich, and Reiss, Peter, 1979, Height interpolation by the method of finite elements, *in* Digital Terrain Models (DTM) Symposium, May 9-11, 1978, St. Louis, MO, ASP/ACSM: Proceedings, p. 241-254.

Ebner, Heinrich, and Tang, Liang, 1989, High fidelity digital terrain models from digitized contours, *in* World Conference of the International Cartographic Association, 14th, , Budapest, Hungary, August 17-24, 1989, presentation (no citation for proceedings volume).

Eckert, Max, 1921, Die Kartenwissenchaft (in German): Berlin and Leipzig, Walter De Gruyter and Co., 2 vols. [Punktsystem of relief protrayal: v. 1, p. 535-540]

Edmonds, A.K., and Moellering, Harold, 1988, An analytical cartographic system for modeling geomorphic data, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, annual convention, March 13-18, 1988, St. Louis, MO: Technical papers, v. 2 (Cartography), p. 129-138.

Edwards, Daniel, 1988, Research for reducing the labor intensive nature of high-resolution terrain analysis feature extraction, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, annual convention, March 13-18, St. Louis, MO: Technical papers, v. 6 (General), p. 64-73.

Edwards, D.L., Desmond, G.B., and Schoppmann, M.W., 1988, Terrain data base generation for autonomous land vehicle navigation: Photogrammetria, v. 43, no. 2, p. 101-107.

Edwards, Kathleen, and Batson, R.M., 1990, Experimental digital shaded-relief map of California: U.S. Geological Survey Miscellaneous Investigations map I-1848, scale 1:1,000,000. [Similar maps of Arizona, Nevada, Utah, Wyoming, and Oregon (I-2271) published by the same authors, 1990-1992]

Edwards, Kathleen, and Batson, R.M., 1990, Experimental digital shaded-relief map of Southwestern United States: U.S. Geological Survey Miscellaneous Investigations map I-1850, scale 1:2,000,000.

EEZ-Scan 84 Scientific Staff, 1986, Atlas of the Exclusive Economic Zone, western conterminous United States: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1792, scale 1:500,000, 152 p.

Efford, N.D., 1991, Sources of error in the photoclinometric determination of planetary topography—a reappraisal: Earth Moon and Planets, v. 54, no. 1, p. 19-58.

Ehrlich, Robert, and Weinberg, Bernard, 1970, An exact method for characterization of grain shape: Journal of Sedimentary Petrology, v. 40, no. 1, p. 205-212.

Ehlschlaeger, C.R., 1989, Using the AT Search algorithm to develop hydrologic models from digital elevation data, *in* International Geographic Information Systems (IGIS) Symposium '89, Baltimore, MD, March 18-19, 1989: Proceedings, p. 275-281.

Ehlschlaeger, C.R., 1992, r.watershed <main>, *in* Geographical Resources Analysis Support System (GRASS), Version 4.1—User's Reference Manual: Champaign, IL, U.S. Army Corps of Enginers, Construction Engineering Research Laboratory, 9 p.

Einstein, Albert, 1926, The cause of the formation of meanders in the courses of rivers and of the so-called Baer's law: Naturwissenschaften, v. 14, p. 223.

El Abbass, T., Jallouli, C., Albouy, Y., and Diament, M., 1990, A comparison of surface fitting algorithms for geophysical data: Terra Nova (London), v. 2, no. 5, p. 467-475.

Elassal, A.A., and Caruso, Vincent, 1983, USGS digital cartographic data standards—digital elevation models: U.S. Geological Survey Circular 895-B, 40 p.

Electromagnetic Systems Laboratory, Inc. (ESL), 1983, Interactive digital image manipulation system (IDIMS), User's Guide: v. 1: Sunnyvale, Calif., paging by section.

Elghazali, M.S., and Hassan, M.M., 1986, Performance of surface fitting algorithms using fictitious double Fourier data, *in* American Congress on Surveying and Mapping, fall meeting, Anchorage, Alaska, September 28-October 3, 1986: Technical papers, p. 203-213.

Eli, R.N., Palmer, B.L., and Hamrio, R.L., 1980, Digital terrain modeling applications in surface mining hydrology, *in* Symposium on Mining Hydrology, Sedimentology, and Reclamation, University of Kentucky: Proceedings, p. 445-453.

Eliason, J.R., 1992, Mapping fractures remotely for earthquake hazard assessment by the use of topographic and seismic hypocenter data: Episodes (IUGS), v. 15, no. 1, p. 75-82.

Ellen, S.D., and Mark, R.K., 1988, Automated modeling of debris-flow hazard using digital elevation models (abs.): Eos, Transactions of the American Geophysical Union, v. 69, no. 16, p. 247.

Ellen, S.D., Mark, R.K., and Cannon, S.H., 1992, Digital mapping of debris-flow hazard near Honolulu (abs.): Eos, Transactions of the American Geophysical Union, v. 73, no. 43 (supplement), p. 227.

Ellen, S.D., Mark, R.K., Cannon, S.H., and Knifong, D.L., 1993, Map of debris-flow hazard in the Honolulu District of Oahu, Hawaii: U.S. Geological Survey Open-file report OF 93-0213, scale 1:30,000, in press.

Ellen, Stephen, Peterson, D.M., and Reid, G.O., 1982, Map showing areas susceptible to different hazards from shallow landsliding, Marin County and adjacent parts of Sonoma County, California: U.S. Geological Survey Miscellaneous Field Investigations Map, MF-1406, scale 1:62,500.

Elliot, J.K., ca. 1988, Land Surface Roughness: University of London (UK), unpublished doctoral dissertation, 321 p.

Elliot, J.K., 1989, An investigation of the change in surface roughness through time on the foreland of Austre Okstindbreen, north Norway: Computers and Geosciences, v. 15, no. 2, p. 209-217.

Elmes, G.A., Fugikawa, E.K., and Twery, M.J., 1991, Forest cover type estimated from digital elevation data, *in* ESRI (Environmental Systems Research Institute, Inc.) Annual User Conference 11th, Redlands, Calif., Proceedings, v. 1, p. 389-395.

El-Tahlawi, M.R., and Rashad, M.Z., 1991, Statistical expression for measuring the degree of reliability of contour maps, *in* GIS/LIS, American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, Fall Convention, Atlanta, GA, October 28-November 1, 1991: Technical Papers, p. A-95 to A-103.

Elvhage, Christian, 1983, Terrängåtergivning—En serie svenska experimentkartor (in Swedish): Uppsala Univ. Naturgeogr. Inst. Rapport 59 med kartbilaga, 147 p.

Elvhage, Christian, 1986, Datorstöd vid terrängåtergivning (in Swedish): Tekniska Skrifter-Professional Papers, LMV-Rapport 1986: 3, 21 p.

Elvhage, Christian, and Lidmar-Bergström, Karna, 1987, Some working hypotheses on the geomorphology of Sweden in the light of a new relief map: Geografiska Annaler, v. 69, ser. A, p. 343-358.

Embleton, Clifford, and Verstappen, H. Th., 1988, The nature and objectives of applied geomorphological mapping: Zeitschrift für Geomorphologie, Supplementband 68, p. 1-8.

Endo, R., 1933, Quantitative researches on frequency distribution of surface inclination for areas of different rocks (in Japanese): Tirikyoiku (Tokyo), v. 19, no. 1, p 30-37.

Engstrom, W.N., 1989, Morphometric analysis of mountain drainage basins in the Basin and Range Province, USA: Zeitschrift für Geomorphologie, v. 33, no. 4, p. 443-453.

Environmental Systems Research Institute, (ESRI) Inc., 1991a, Cell-based modeling with GRID (rev. 6.0), ARC/INFO user's guide, Surface analysis and display: Redlands, CA, ESRI, July 1991, variously paged.

Environmental Systems Research Institute, (ESRI) Inc., 1991b, Surface modeling with TIN (rev. 6.0), ARC/INFO user's guide, Analysis, display, and management: Redlands, CA, ESRI, July 1991, variously paged.

Environmental Systems Research Institute, (ESRI) Inc., 1992a, Understanding GIS, the ARC/INFO method (rev. 6.0): Redlands, CA, ESRI, variously paged.

Environmental Systems Research Institute, (ESRI) Inc., 1992b, Cell-based modeling with GRID 6.1, ARC/INFO user's guide, Supplement—hydrologic and distance modeling tools: Redlands, CA, ESRI, May, 1992, variously paged.

Enzmann, R.D., 1966, Introduction to the section on signatures, *in* Planetology and Space Mission Planning: Annals of the New York Academy of Science, v. 140, Art. 2, p. 154-156.

Enzmann, R.D., 1968, Signature theory, *in* Fairbridge, R.W., ed., The Encyclopedia of Geomorphology: New York, Reinhold Book Co., p. 993-994.

Eppler, D.T., Ehrlich, Robert, Nummedal, Dag, and Schultz, P.H., 1983, Sources of shape variation in lunar impact craters—Fourier shape analysis: Geological Society of America Bulletin, v. 94, no. 2, p. 274-291.

Eppler, D.T., and Farmer, L.D., 1991, Texture analysis of radiometric signatures of new sea ice forming in Arctic leads: IEEE Transactions on Geoscience and Remote Sensing, v. 29, no. 2, p. 233-241.

Erickson, R.A., 1961, Empirically determined effect of gross terrain features upon ground visibility from low-flying aircraft: U.S. Naval Ordnance Test Station, Technical Publication 2760, NAVWEPS Report 7779, paging unknown.

Evans, D.L., Farr, T.G., Zebker, H.A., van Zyl, J.J., and Mouginis-Mark, P.J., 1992, Radar interferometry studies of the Earth's topography: Eos, Transactions of the American Geophysical Union, v. 73, no. 52, p. 553, 557, 558.

Evans, I.S., 1963, Map analysis of mean slope: Geographical Articles (Cambridge Univ., UK), v. 2, p. 34-40.

Evans, I.S., 1969, The geomorphology and morphometry of glacial and nival areas, *in* Chorley, R.J., ed., Water, Earth, and Man: London, Methuen, p. 369-380.

Evans, I.S., 1970, The implementation of an automated cartography system, *in* Cutbill, J.L., ed., Data Processing in Biology and Geology: London, Academic Press, Systematics Association Special Volume No. 3, p. 39-55.

Evans, I.S., 1972, General geomorphometry, derivatives of altitude and descriptive statistics, *in* Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, p. 17-90.

Evans, I.S., 1974, The geomorphometry and asymmetry of glaciated mountains, with special reference to the Bridge River District, British Columbia: University of Cambridge, UK, unpublished Ph.D. dissertation, 527 p.

Evans, I.S., 1975, The effect of resolution on gradients calculated from an altitude matrix (Appendix: Stationarity): Durham City, England, University of Durham, Department of Geography, U.S. Army contract DA-ERO-591-73-G0040, Statistical characterization of altitude matrices by computer, Third progress report, 24 p.

Evans, I.S., 1977a, The selection of class intervals: Transactions of the Institute of British Geographers, New Series, v. 2, no. 1, p. 98-124.

Evans, I.S., 1977b, World-wide variations in the direction and concentration of cirque and glacier aspects: Geografiska Annaler, v. 59A, no. 3-4, p. 151-175.

Evans, I.S., 1977c, Frequency distribution of gradient: Durham City, England, University of Durham, Geography Department, U.S. Army contract DA-ERO-591-73-G0040, Statistical characterization of altitude matrices by computer, Fourth progress report, 56 p.

Evans, I.S., with the assistance of Margaret Young and J.S. Gill, 1979, An integrated system of terrain analysis and slope mapping: Department of Geography, University of Durham, England, U.S. Army Contract DA-ERO-591-73-G0040, Statistical characterization of altitude matrices by computer, Final Report (Report 6), 192 p.

Evans, I.S., 1980, An integrated system of terrain analysis and slope mapping: Zeitschrift für Geomorphologie, Supplementband 36, p. 274-295.

Evans, I.S., 1981, Analysis of terrain characteristics from digital terrain matrices for parts of Devon, Somerset, Dumfries, Galloway and Caithness (reprinted 1984): Durham Geomorphometry Report 7, Durham City, England, University of Durham, Department of Geography, 57 p.

Evans, I.S., 1984a, Correlation structures and factor analysis in the investigation of data dimensionality, statistical properties of the Wessex land surface, England, *in* International Symposium on Spatial Data Handling, August 20-24 1984, Zürich, Switzerland, University of Zürich-Irchel: Proceedings, v. 1, p. 98-116.

Evans, I.S., 1984b, Properties of the Wessex land surface, an investigation of dimensionality and the choice of key variables: Durham Geomorphometry Report 8, Durham City, England, University of Durham, Department of Geography, 131 p.

Evans, I.S., 1987a, The morphometry of specific landforms, *in* Gardiner, V., ed., International Geomorphology 1986, Part II: New York, John Wiley & Sons, p. 105-124.

Evans, I.S., 1987b, A new approach to drumlin morphometry, *in* Menzies, J., and Rose, J., eds., Proceedings of the Drumlin Symposium, International Conference on Geomorphology, 1st, Manchester, England, 16-18 September 1985: Rotterdam, A.A. Balkema, p. 119-130.

Evans, I.S., 1990, General geomorphometry, *in* Goudie, Andrew, and six others, eds., Geomorphological Techniques (second edition): London, Unwin Hyman, p. 44-56. [revised from 1981, Goudie et al., eds., first edition]

Evans, I.S., and Bain, I., 1974, Statistical characterization of altitude matrices by computer, Report 1 (Spectral analysis): First half-yearly report on U.S. Army Contract DA-ERO-591-73-G0040, Durham City, England, University of Durham, Department of Geography, 16 p.

Evans, I.S., and Cox, N.J., 1974, Geomorphometry and the operational definition of cirques: Area (UK), v. 6, no. 2, p. 150-153.

Evans, I.S., and Cox, N.J., 1979, Hypsometry, statistics, and simplicity—A comment: Mathematical Geology, v. 11, no. 1, p. 85-89.

Eyles, R.J., 1965, Slope studies on the Wellington Peninsula: New Zealand Geographer, v. 21, no. 2, p. 133-144.

Eyles, R.J., 1969, Depth of dissection of the West Malaysian landscape: Journal of Tropical Geography, v. 28, no. 1, p. 23-31.

Eyles, R.J., 1971, A classification of west Malaysian drainage basins: Annals of the Association of American Geographers, v. 61, no. 3, p. 460-467.

Eyton, J.R., 1985, A digital terrain modeling package: University Park, The Pennsylvania State University, Mineral Sciences, v. 54, no. 4, p. 37-39.

Eyton, J.R., 1986, Computer generated templates for the construction of landform relief models: American Cartographer, v. 13, no. 4, p. 345-351.

F

Fabbri, A.G., 1984, Image Processing of Geological Data: New York, Van Nostrand Reinhold Co., 244 p.

Fabbri, A.G., 1986, Promising aspects of geological image analysis, *in* Hanley, J.T., and Merriam, D.F., Microcomputer Applications in Geology: Oxford, Pergamon Press, p. 199-213.

Fahsi, Ahmed, Ulliman, J.J., and Chang, K.-t., 1990, The effect of the source and spatial resolution of digital elevation models on contour map accuracy, *in* GIS/LIS '90 Convention, Anaheim, CA, November 1990: Proceedings, v. 1, p. 335-344.

Faintich, M.B., Simley, Jeffrey, and Fortson, Richard, 1984, Terrain elevation and surface feature data display for mission, land use, and trafficability analysis, *in* American Society for Photogrammetry—American Congress on Surveying and Mapping, 1984 meeting: Technical Papers, p. 411-423.

Faintich, M.B., 1985, Defense mapping undergoes a digital revolution: Computer Graphics World, June, p. 10-12, 16, 18, 20, 24, 26, & 28.

Fairfield, John, and Leymarie, Pierre, 1991, Drainage networks from grid digital elevation models: Water Resources Research, v. 27, no. 5, p. 709-717. [correction: 1991, Water Resources Research, v. 27, no. 10, p. 2809]

Falcidieno, Bianca, and Spagnuolo, Michela, 1990, Automatic recognition of topographic features for digital surface modelling, *in* International Symposium on Spatial Data Handling, 4th, July 23-27, 1990, Zürich: Proceedings, v. 1, p. 35-44.

Falcidieno, Bianca, and Pienovi, Caterina, 1990, A feature-based approach to terrain surface approximation, *in* International Symposium on Spatial Data Handling, 4th, July 23-27, 1990, Zürich: Proceedings, v. 1, p. 190-199.

Falconer, K.J., 1985, The Geometry of Fractal Sets: New York, Cambridge University press, Cambridge Tracts in Mathematics, 85, 162 p.

Farr, T.G., 1992, Topographic evolution of Trail Canyon alluvial fan, Death Valley, CA (abs.): Eos, Transactions of the American Geophysical Union, v. 73, no. 43 (supplement), p. 228.

Feder, Jens, 1988, Fractals, New York, Plenum Press, 283 p.

Felleman, J.P., 1986, Landscape visibility, *in* Smardon, R.C., Palmer, J.F., and J.P. Felleman, J.P., eds., Foundations for Visual Project Analysis: New York, Wiley, p. 47-62.

Fellows, J.D., and Ragan, R.M., 1986, The role of cell size in hydrology oriented geographic information systems, *in* Hydrologic Applications of Space

Technology, International Association for Scientific Hydrology Symposium, Cocoa Beach, FLA, August, 1985, Proceedings: Publication no. 160, p. 453-460.

Fels, J.E., 1990, Bivariant color mapping techniques for topographic visualization and their applications in site appraisal, *in* GIS/LIS '90 Convention, Anaheim, CA, November 1990: Proceedings, v. 2, p. 780-788.

Fels, J.E., and Devine, H.A., 1991, Interactive viewshed mapping using shaded surface displays—A community planning application, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, Annual Convention, Baltimore, Md., March 25-29: Technical Papers, v. 2 (Cartography and GIS/LIS), p. 111-121.

Fenneman, N.M., 1917, Physiographic divisions of the United States: Annals of the Association of American Geographers, v. 6, no. 1, p. 19-98.

Fenneman, N.M., and Johnson, D.W., 1928, Physical divisions of the United States: map at 1:7,000,000 scale and table. [reprinted by U.S. Geological Survey, 1946]

Ferguson, R.I., 1975, Meander irregularity and wavelength estimation: Journal of Hydrology, v. 26, No. 3/4, p. 315-333.

Ferguson, R.I., 1979, River meanders—regular or random?, in Wrigley, N., ed., Statistical Applications in the Spatial Sciences: London, Pion, p. 229-241.

Fielding, E.J., Isacks, B.L., Barazangi, Muawia, and Duncan, C.C., 1993, How flat is Tibet? (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 195.

Finch, V.C., 1933, Geographic surveying, *in* Colby, C.C., ed., Geographic Surveys: University of Chicago Press, The Geographic Society of Chicago Bulletin no. 9, p. 3-11.

Finch, V.C., 1933, Montfort—a study in landscape types in southwestern Wisconsin, *in* Colby, C.C., ed., Geographic Surveys: University of Chicago Press, The Geographic Society of Chicago Bulletin no. 9, p. 15-44 + maps.

Finch, V.C., Trewartha, G.T., Robinson, A.H., and Hammond, E.H., 1957, The elements and types of terrain (Chapter 11): Physical Elements of Geography, New York, McGraw-Hill, p. 208-216.

Fink, J.H., Bridges, N.T., and Grimm, R.E., 1993, Shapes of Venusian "pancake" domes imply episodic emplacement and silicic composition: Geophysical Research Letters, v. 20, no. 4, p. 261-264.

Finkel, H.J., 1959, The barchans of southern Peru: Journal of Geology, v. 67, no. 6, p. 614-647.

Finsterwalder, R., 1986, Zur Bestimmung von Tal- und Kammlinien (in German): Zeitschrift für Vermessungswesen, v. 5, p. 184-189.

Finsterwalder, Sebastian, 1890, Über den mittleren Böschungswinkel und das wahre Areal einer topographischen Fläsche (in German): Sitzungsberichte de Königlichen Bayerischen Akademie der Wissenschaften, Mathematische-Physische Abteilung (Munich), v. 20, p. 35-82.

Fiorentino, Mauro, Claps, Pierluigi, and Singh, V.P., 1993, An entropy-based morphological analysis of river basin networks: Water Resources Research, v. 29, no. 4, p. 1215-1224.

Fisher, P.F., 1991a, Simulation of the uncertainty of a viewshed, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, Annual Convention, Baltimore, Md., March 25-28: Technical Papers, v. 6 (Auto-Carto 10), p. 205-218.

Fisher, P.F., 1991b, First experiments in viewshed uncertainty—the accuracy of the viewshed area: Photogrammetric Engineering and Remote Sensing, v. 57, no. 10, p. 1321-1327.

Fisher, P.F., 1992, First experiments in viewshed uncertainty—simulating fuzzy viewsheds: Photogrammetric Engineering and Remote Sensing, v. 58, no. 3, p. 345-352.

Fisher, P.F., and Lindenberg, R.E., 1989, On distinctions among cartography, remote sensing, and geographic information systems: Photogrammetric Engineering and Remote Sensing, v. 55, no. 10, p. 1431-1434.

Fisher, P.F., Mackaness, W.A., Peacegood, G., and Wilkinson, G.G., 1988, Artificial intelligence and expert systems in geodata processing: Progress in Physical Geography, v. 12, no. 3, p. 371-388.

Flint, J.-J., 1976, Link slope distribution in channel networks: Water Resources Research, v. 12, no. 4, p. 645-654.

Flint, J.-J., 1980, Tributary arrangements in fluvial systems: American Journal of Science, v. 280, no. 1, p. 26-45.

Flood, R.D., and Damuth, J.E., 1987, Quantitative characteristics of sinuous distributary channels on the Amazon deep-sea fan: Geological Society of America Bulletin, v. 98, no. 6, p. 728-738.

Foley, M., Hoover, K., and Heasler, P., 1989, Automated pattern recognition of digital elevation models for geomorphic analysis (abs.): Geological Society of America Abstracts with Programs, v. 21, p. A39.

Fordham, B.G., and Bell, G.D., 1978, An empirical assessment and illustration of some multivariate morphometric techniques: Mathematical Geology, v. 10, no. 2, p. 111-139.

Förstner, Wolfgang, 1983, On the morphological quality of digital elevation models, *in* Torlegard, Kennert, ed., International Colloquium on Mathematical Aspects of Digital Elevation Models, 18-20 April, 1983, Stockholm, Royal Institute of Technology, Department of Photogrammetry, Proceedings, p. 6:1-6:18.

Fournier, Alain, Fussell, Don, and Carpenter, Loren, 1982, Computer rendering of stochastic models: Communications of the Association for Computing Machinery, v. 25, no. 6, p. 371-384.

Fournier, Alain, Fussell, Don, and Carpenter, Loren, 1982, Authors' reply to Mandelbrot, B.B., Comment on computer rendering of fractal stochastic models: Communications of the Association for Computing Machinery, v. 25, no. 8, p. 583-584.

Fowler, R. J., and Little, J.J., 1979, Automatic extraction of irregular network digital terrain models, *in* Proceedings of ACM Siggraph '79, Chicago, Ill., August 1989: Computer Graphics, v. 13, no. 2, p. 199-207.

Fox, C.G., and Hayes, D.E., 1985, Quantitative methods for analyzing the roughness of the seafloor: Reviews of Geophysics and Space Physics, v. 23, no. 1, p. 1-48.

Fox, C.G., 1985, Description, Analysis, and Prediction of Sea-Floor Roughness Using Spectral Methods: Bay St. Louis, Miss., Naval Oceanographic Office, Technical Report No. 279, 218 p.

Fox, C.G., 1989, Empirically derived relationships between fractal dimension and power law form frequency spectra: Pure and Applied Geophysics, v. 131, no. 1/2, p. 211-239.

Frank, A.U., 1988, Towards a spatial theory, *in* International Geographic Information Systems Symposium, Arlington, VA, November 15-18, 1987, Proceedings: Washington, D.C., NASA, v. II, p. 215-227.

Frank, A.U., Palmer, Bruce, and Robinson, V.B., 1986, Formal methods for the accurate definition of some fundamental terms in physical geography, *in* International Symposium on Spatial Data Handling, 2nd, July 5-10, 1986, Seattle, WA, International Geographical Union, Commission on Geographical Data Sensing and Processing: Proceedings, p. 583-599.

Franklin, S.E., 1986, An approach to processing dense grid digital elevation models for use in Landsat terrain classification, *in* American Congress on Surveying and Mapping, fall meeting, Anchorage, Alaska, September 28-October 3, 1986, Technical Papers, p. 214-225.

Franklin, S.E., 1987a, Terrain analysis from digital patterns in geomorphometry and Landsat MSS spectral response: Photogrammetric Engineering and Remote Sensing, v. 53, no. 1, p. 59-65.

Franklin, S.E., 1987b, Geomorphometric processing of digital elevation models: Computers and Geosciences, v. 13, no. 6, p. 603-609.

Franklin, S.E., 1987c, Terrain relief and pattern description using digital elevation and Landsat data, *in* International symposium on remote sensing of environment, 21st, Ann Arbor, The

University of Michigan, October 26-30, 1987: Proceedings, p. 1081-1088.

Franklin, S.E., 1991, Satellite remote sensing of mountain geomorphic surfaces: Canadian Journal of Remote Sensing, v. 17, no. 3, p. 218-229.

Franklin, S.E., and Peddle, D.R., 1987, Texture analysis of digital image data using spatial cooccurrence: Computers and Geosciences, v. 13, no. 3, p. 293-311.

Franklin, S.E., Peddle, D.R., and Moulton, J.E., 1989, Spectral/ geomorphometric discrimination and mapping of terrain, a study in Gros Morne National Park: Canadian Journal of Remote Sensing, v. 15, no. 1, p. 28-42.

Frederickson, Poul, 1981, Terrain analysis and accuracy prediction by means of the Fourier transformation: Photogrammetria, v. 36, no. 4, p. 145-157.

Fredericksen, Poul, Jacobi, O., and Kubik, K., 1984, Modelling and classifying terrain: International Archives of Photogrammetry and Remote Sensing, v. 25, Part A3a, p. 256-267.

Fredericksen, Poul, Jacobi, O., and Kubik, K., 1985, A review of current trends in terrain modelling: ITC Journal (Enschede, Neth.), no. 2, p. 101-106.

Freeman, Herbert, 1974, Computer processing of line-drawing images: Computing Surveys, v. 6, no. 1, p. 57-97.

Freeman, Herbert, and Morse, S.P., 1967, On searching a contour map for a given terrain elevation profile: Journal of the Franklin Institute, v. 284, no. 1, p. 1-25.

Freeman, John, 1975, The modelling of spatial relations: Computer Graphics and Image Processing, v. 4, p. 156-171.

Freeman, T.G., 1991, Calculating catchment area with divergent flow based on a regular grid: Computers and Geosciences, v. 17, no. 3, p. 413-422.

Freiberger, Walter, and Grenander, Ulf, 1977, Surface patterns in theoretical geography: Computers and Geosciences, v. 3, no. 4, p. 547-578. [severely criticized by D. Mark, 1978]

Frey, C., 1965, Morphometrische Untersuchung der Vogesen: Basler Beiträge zur Geographie und Ethnologie, Geographische Reihe, v. 6, 150 p.

Friedhoff, R.M., and Benzon, William, 1991, Visualization—the second computer revolution: New York, Freeman, 215 p.

Friedlander, F., 1987, A sequential algorithm for detecting watersheds on a gray level image, *in* International Congress for Stereology, 7th, September, 1987, Caen, France, Proceedings: Acta Stereologica, v. 6/III, p. 663-668.

Frolov, Yu.S., and Yagodina, L.L., 1970, Autocorrelation function and quantitative character of relief (in Russian): Vestnik Leningradskogo Universiteta, 18, Geologiva-Geografiva 3, p. 115-128.

Frolov, Yu.S., 1974, Quantitative characterization of the shape of geographical features (history of the issue; in Russian): Izvestiya VGO, No. 4, p. 281-?

G

Gâlâbov, Z., 1968, On the application of morphometric analysis in geomorphological investigations (results of a geomorphological study of the middle Stara Planina; in Bulgarian), *in* Problemina na geografijata na Bálgariya, v. 2, Nauka i izkustvo, Sofia, p. 7-40.

Gallant, A.L., Whittier, T.R., Larsen, D.P., Omernik, J.M., and Hughes, R.M., 1989, Regionalization as a tool for managing environmental resources: Corvallis, Oregon, U.S. Environmental Protection Agency document EPA/600/3-89/060, 152 p.

Gambell, Neil, and Lucchitta, B.K., 1968, A limitation of first generation Lunar Orbiter negatives as applied to photoclinometry: Flagstaff, AZ, U.S. Geological Survey, Interagency Report: Astrogeology 11, 11 p.

Ganapathy, S., and Dennehy, T.G., 1982, A new triangulation method for planar contours: Computer Graphics, v. 16, no. 3, p. 69-75.

Gao, Jay, and Lo, C.P., 1991, GIS modeling of the influence of topography and morphology on landslide occurrence in Nelson County, Virginia, *in* GIS/LIS '91, Atlanta, Georgia, October 28-November 1, 1991, Proceedings, v. 2, p. 954-963.

Garbrecht, Jurgen, and Martz, Lawrence, 1992, An evaluation of drainage parameters extracted from low relief digital elevation models (abs.): Eos, Transactions of the American Geophysical Union, v. 73, no. 43 (supplement), p. 226.

Garbrecht, Jurgen, and Martz, Lawrence, 1993, Comment on "A combined algorithm for automated drainage network extraction" by Jean Chorowicz et al.: Water Resources Research, v. 29, no. 2, p. 535-536.

García-Ruiz, J.M., and Otálora, Fermín, 1992, Fractal trees and Horton's laws: Mathematical Geology, v. 24, no. 1, p. 61-71.

Gardiner, Vincent, 1971, A drainage density map of Dartmoor: Transactions of the Devonshire Association, v. 103, p. 167-180.

Gardiner, Vincent, 1973, Univariate distributional characteristics of some morphometric variables: Geografiska Annaler, v. 54 A, no. 3-4, p. 147-153.

Gardiner, Vincent, 1973, A Morphometric Approach to Land Form Aspects of Land Classification: University of Exeter (UK), unpublished Ph.D. thesis, paging unknown..

Gardiner, Vincent, 1974, Land form and land classification in north west Devon: Transactions of the Devonshire Association, v. 106, p. 141-153.

Gardiner, Vincent, 1975, Drainage Basin Morphometry: London, British Geomorphological Research Group, Technical Bulletin no. 14, 48 p.

Gardiner, Vincent, 1976, Land evaluation and the numerical delimitation of natural regions, *in* Institute of British Geographers / Institute of Geography of the Polish Academy of Sciences Seminar on Applied Physical Geography at Torun, Poland, September 1974, Geographica Polonica: v. 43, no. 1, p. 11-30.

Gardiner, Vincent, 1978, Redundancy and spatial organization of drainage-basin form indices—an empirical investigation of data from northwest Devon: Transactions of the Institute of British Geographers (new series), v. 3, no. 4, p. 416-431.

Gardiner, Vincent, 1982a, Drainage basins morphometry—quantitative analysis of drainage basin form, *in* Sharma, H.S., ed., Perspectives in Geomorphology, V. 2, Quantitative Fluvial Geomorphology: New Delhi, Concept Publishing Co., p. 107-142.

Gardiner, Vincent, 1982b, Stream networks and digital cartography: Cartographica, v. 19, no. 2, Monograph 28, p. 38-44.

Gardiner, Vincent, 1983, The relevance of geomorphometry to studies of Quaternary morphogenesis, *in* Briggs, D.J., and Waters, R.S., eds., Studies in Quaternary Geomorphology, British-Polish Seminar, 6th, Instutute of British Geographers, Sheffield, England, August 1977, Proceedings: Norwich, Geo Books, p. 1-18.

Gardiner, Vincent, and Park, C.C., 1978, Drainage basin morphometry; review and assessment: Progress in Physical Geography, v. 2, no. 1, p. 1-35.

Gardiner, Vincent, and Rhind, D.W., 1974, The creation of slope maps by a photo-mechnical technique: Area (UK), v. 6, no. 1, p. 14-21.

Gardner, C.S., 1992, Ranging performance of satellite laser altimeters: IEEE Transactions on Geoscience and Remote Sensing, v. 30, no. 5, p. 1061-1072.

Gardner, T.W., Sasowsky, K.C., and Day, R.L., 1990, Automated extraction of geomorphometric properties from digital elevation data: Zeitschrift für Geomorphologie, Supplementband 80, p. 57-68.

Garg, P.K., and Harrison, A.R., 1990, Quantitative representation of land-surface morphology from digital elevation models, *in* International Symposium on Spatial Data Handling, 4th, July 23-27, 1990, Zürich, Proceedings, v. 1, p. 273-282.

Garvin, J.B., and Williams, R.S., 1990, Small domes on Venus—probable analogs of Icelandic lava shields: Geophysical Research Letters, v. 17, no. 9, p. 1381-1384.

Garvin, J.B., and Williams, R.S., 1992, Icelandic lava-shield volcanoes—scaling of topography, slopes and morphometry (abs.): Eos, Transactions of the

American Geophysical Union, v. 73, no. 14, supplement, p. 58-59.

Garvin, J.B., and Williams, R.S., 1993, Morphometric comparison of Icelandic lava shield volcanoes versus selected Venusian edifices, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 523-524.

Gassmann, Fritz, and Gutersohn, Heinrich, 1947, Kotenstreuung und Relieffaktor (in German): Geogr. Helvetica (Bern, Switz.), v. 2, no. 1, p. 122-139.

Gates, W.L., and Nelson, A.B., 1975, A new (revised) tabulation of the Scripps topography on a 1° global grid II, Ocean depths: Santa Monica, Calif., RAND Corp. Report R-1277-1-ARPA, 132 p.

Gattrell, Anthony, 1983, Distance and Space—a geographical perspective: Oxford, UK, Clarendon Press, 195 p.

Geary, R.C., 1954, The contiguity ratio and statistical mapping: The Incorporated Statistician, v. 5, p. 115-141. [reprinted 1968 *in* Berry, B.J.L., and Marble, D., eds., Spatial Analysis, a reader in statistical geography: Englewood Cliffs, New Jersey, Prentice-Hall, p. 461-478.]

Gerenchuk, K.I., Gorash, I.K., and Topchiyev, A.G., 1970, A method for establishing some parameters of the morphologic structure of landscapes (translated from the Russian): Soviet Geography, v. 11, no. 4, p. 262-271.

Gerrard, A.J., 1981, Numerical land systems mapping, *in* Soils and Landforms: London, George Allen and Unwin, p. 176-178.

Gerrard, A.J.W., and Robinson, D.A., 1971, Variability in slope measurements—a discussion of the effects of different recording intervals and micro-relief in slope studies: Transactions of the Institute of British Geographers, v. 54, p. 45-54.

Geyl, W.F., 1961, Morphometric analysis and the worldwide occurrence of stepped erosionl surfaces: Journal of Geology, v. 69, no. 4, p. 388-416.

Ghidey, Fessehaie, Gregory, J.M., and Thompson, A.L., 1992, Terrace channel design and evaluation: Transactions of the American Society of Agricultural Engineering, v. 35, no. 5, p. 1513-1520.

Gibson, J.J., 1950, The Perception of the Visual World: Boston, MA, Houghton-Mifflin.

Gibson, J.J., 1979, The Ecological Approach to Visual Perception: Boston, MA, Houghton-Mifflin. [republished 1986, Hillsdale, New Jersey, Lawrence Erlbaum Associates, 322+ p.]

Gilbert, E.N., 1966, Information theory after 18 years: Science, v. 152, no. 3720, p. 320-326.

Gilbert, L.E., 1989, Are topographic data sets fractal?: Pure and Applied Geophysics, v. 131, no. 1/2, p. 241-254.

Gilbert, L.E., and Malinovero, Alberto, 1988, A characterization of the spectral density of residual ocean floor topography: Geophysical Research Letters, v.15, no. 12, p. 1401-1404.

Gilman, C.R., 1981, The manual/photomechanical and other methods for relief shading: American Cartographer, v. 8, no. 1, p. 41-53.

Gimblett, H.R., Fitzgibbon, J.E., Bechard, K.P., Wightman, J.A., and Itami, R.M., 1987, Procedure for assessing visual quality for landscape planning and management: Environmental Management, v. 11, no. 3, p. 359-367.

Glendinning, R.M., 1937, The slope and slope-direction map: Michigan Papers in Geography, v. 7, p. 359-364.

Glock, W.S., 1931, The development of drainage systems—a synoptic view: Geographical Review, v. 21, no. 3, p. 475-482.

Glock, W.S., 1932, Available relief as a factor of control in the profile of a land form: Journal of Geology, v. 40, no. 1, p. 74-83.

Godson, R.H., 1981, Digital terrain map of the United States: U.S. Geological Survey Miscellaneous Investigations Map I-1318, scale 1:7,500,000.

Godson, R.H., Selner, G.I., Rozema, W.J., McMacken, Dennis, and Acosta, A.V., 1970, Topographic data analysis system (computer program documentation): Flagstaff, Arizona, U.S. Geological Survey internal document, Computer Center Division, 100 p.

Goff, J.A., 1991, A global and regional stochastic analysis of near-ridge abyssal hill morphology: Journal of Geophysical Research, v. 96, no. B13, p. 21,713-21,737.

Goff, J.A., and Kleinrock, M.C., 1991, Quantitative comparison of bathymetric survey systems: Geophysical Research Letters, v. 18, no. 7, p. 1253-1256.

Gold, C.M., 1979, Triangulation-based terrain modelling—where are we now?, *in* Auto-Carto 4, International Symposium on Computer-Assisted Cartography, 4th, Proceedings, v. II, p. 104-111.

Gold, C. M., Charters, T.D., and Ramsden, J., 1977, Automated contour mapping using triangular element data structures and an interpolant over each irregular triangular domain: Computer Graphics, v. 11 (Proceedings SIGGRAPH '77), p. 170-175.

Gold, C. M., and Maydell, U.M., 1978, Triangulation and spatial ordering in computer cartography: Canadian Cartographic Association, 3rd annual meeting, Proceedings, p. 69-81.

Goldberg, G.M., 1962a, The derivation of quantitative surface data from gross sources: Surveying and Mapping, v. 22, no. 4, p. 537-548.

Goldberg, G.M., 1962b, Environmental models, a quantitative tool: Western National Meeting of the American Geophysical Union, 2nd, Section of Geology, December 1962, unpublished typescript of presented paper, 18 p.

Goldberg, J.L., Pick, T.A., and Wiche, G.J., 1987, The James River basin project—Digital elevation data supporting a hydrologic study, *in* American Society for Photogrammetry and Remote Sensing-American Congress on Surveying and Mapping, annual convention, March 29-April 3, 1987, Baltimore, MD, Technical papers, v. 4 (Cartography), p. 201-211.

Golubkin, V.M., 1954, The quantitative characterization of the complexity of a terrain and its application to irrigation planning (in Russian): Dissertation for the degree of Candidate (Moscow).

Gomez, D.L., 1978, Tessellation of triangles of variable precision as an economical representation for DTMs, *in* Digital Terrain Models (DTM) Symposium, St. Louis, MO, May 9-May 11, 1978, American Society for Photogrammetry: Proceedings, p. 506-515.

Gomez, D.L., 1979, Digital model for three-dimensional surface representation: Geo-Processing, v. 1, no. 1, p. 53-70.

Goodchild, M.F., 1980, Fractals and the accuracy of geographical measures: Mathematical Geology, v. 12, no. 2, p. 85-98.

Goodchild, M.F., 1982, The fractional Brownian process as a terrain simulation model, *in* Annual Pittsburgh Conference on Modeling and Simulation, 13th, Pittsburgh PA: Proceedings, Part 3, Socio-economic Systems, p. 1133-1137.

Goodchild, M.F., 1988, Lakes on fractal surfaces—a null hypothesis for lake-rich landscapes: Mathematical Geology, v. 20, no. 6, p. 615-630.

Goodchild, M.F., Klinkenberg, Brian, Glieca, M., and Hasan, M., 1985, Statistics of hydrologic networks on fractional Brownian surfaces, *in* Annual Pittsburgh Conference on Modeling and Simulation, 16th, Pittsburgh, PA, Proceedings, v. 16, p. 317-323.

Goodchild, M.F., and Lee, Jay, 1989, The coverage problems and visibility regions on topographic surfaces: Annals of Operations Research, v. 18, p. 175-186.

Goodchild, M.F., and Mark, D.M., 1987, The fractal nature of geographic phenomena: Annals of the Association of American Geographers, v. 77, no. 2, p. 265-278.

Goodrich, D.C., Woolhiser, D.A., and Keefer, T.O., 1991, Kinematic routing using finite elements on a triangular irregular network: Water Resources Research, v. 27, no. 6, p. 995-1003.

Gordon, J.E., 1977, Morphometry of cirques in the Kintail-Affric-Cannich area of northwest Scotland: Geografiska Annaler, v. 59A, no. 3-4, p. 177-194.

Gordon, J.E., 1981, Ice-scoured topography and its relationships to bedrock structure and ice movement in parts of northern Scotland and west Greenland: Geografiska Annaler, v. 63A, no. 1-2, p. 55-65.

Goter, S.K., Thelin, G.P., and Pike, R.J., 1992, Earthquakes in the conterminous United States (1534-1991): U.S. Geological Survey open-file report OF 92-327, 1:3,500,000 scale, 1 sheet.

Gottschalk, Lars, and Krasovskaia, Irina, 1980, Synthesis, processing and display of comprehensive hydrologic information: Norrköping, Sveriges Meteorologiska och Hydrologiska Institut, Report no. RHO 22, 58 p.

Goudie, Andrew, 1969, Statistical laws and dune ridges in southern Africa: Geographical Journal, v. 135, p. 404-406.

Goudie, Andrew (with the assistance of six others), ed., 1990, Geomorphological Techniques (second edition): London, Unwin Hyman, *for* the British Geomorphological Research Group, 570 p.

Gould, S.J., 1966, Allometry and size in ontogeny and phylogeny: Biological Reviews, v. 41, no. 4, p. 587-641.

Govindaraju, R.S., and Kavvas, M.L., 1992, Characterization of the rill geometry over straight hillslopes through spatial scales: Journal of Hydrology, v. 130, no. 1-4, p. 339-365.

Grabau, W.E., 1958, Quantification of the plan profile in landscape classification (abs.): Geological Society of America Bulletin, v. 69, no. 12, part 2, p. 1572.

Grabau, W.E., 1959, Derivation of a numerical description of the characteristic plan-profile, *in* Van Lopik, J.R., and Kolb, C.R., A technique for preparing desert terrain analogs: Vicksburg, Mississippi, Corps of Engineers, U.S. Army Engineer Waterways Experiment Station, Technical Report No. 3-506, Appendix A, p. 1-10.

Grabau, W.E., 1961, The classification of terrain for mobility purposes: Vicksburg Mississippi, Corps of Engineers, U.S. Army Engineer Waterways Experiment Station, Area Evaluation Section, Paper prepared for Third Conference of Tripartite Working Group on Ground Mobility, September 1961, unpublished typescript, 10 p.

Graf, W.L., 1971, Quantitative analysis of Pinedale landforms, Beartooth Mountains, Montana and Wyoming: Arctic and Alpine Research, v, 3, no. 3, p. 253-261.

Graf, W.L., 1988, Fluvial Processes in Dryland Rivers: New York, Springer-Verlag, 347 p. [*see* Sect. 2.4, Spatial Concepts; & 2.5.2., Scale]

Graff, L.H., 1992, Automated classification of basic-level terrain features in digital elevation models: Fort Belvoir, VA, U.S. Army Corps of Engineers Topographic Engineering Center, Report TEC-0013, 49 p. [see also 1991, same title, unpublished M.A. thesis, Univ. Wisconsin, Madison, WI, 192 p.]

Graff, L.H., and Usery, E.L., 1993, Automated classification of generic terrain features in Digital elevation models: Photogrammetric Engineering and Remote Sensing, v. 59, no. ?, in press.

Grassie, D.N.D., 1982, Contouring by computer—some observations, *in* Rhind, David, and Adams, Tim, eds., Computers in Cartography: British Cartographic Society (London), Special Publication No. 2, p. 93-116.

Gravelius, H., 1914, Flusskunde—Grundriss der gesamten Gewässerkunder (in German): Berlin (& Leipzig), Goschensche Verlagshandlung, 176 p. (viii-179)

Gray, D.M., 1961, Interrelationships of watershed characteristics: Journal of Geophysical Research, v. 66, no. 4, p. 1215-1223.

Gray, J.M., 1974, Use of chi-square on percentage orientation data, discussion: Geological Society of America Bulletin, v. 85, no. 5, p. 833-834.

Gray, N.H., Anderson, J.B., Devine, J.D., and Kwasnik, J.M., 1976, Topological properties of random crack networks: Mathematical Geology, v. 8, no. 6, p. 617-626.

Green, P. J., and Sibson, R., 1978, Computing Dirichlet tessellations in the plane: Computer Journal, v. 21, no. 2, p. 168-173.

Greenberg, D.P., 1989, Light reflection models for computer graphics: Science, v. 244, no. 4901, p. 166-173.

Greenlee, D.D., 1987, Raster and vector processing for scanned linework: Photogrammetric Engineering and Remote Sensing, v. 53, no. 10, p. 1383-1387. [also, 1987, *in* Auto-Carto 8, International Symposium on Computer-Assisted Cartography, 8th, Baltimore, MD, March 29-April 3, 1987: Proceedings, p. 640-649]

Gregory, K.J., and Brown, E.H., 1966, Data processing and the study of land forms: Zeitschrift für Geomorphologie, v. 10, no. 3, p. 237-263.

Gregory, K.J., and Gardiner, Vincent, 1975, Drainage density and climate: Zeitschrift für Geomorphologie, v. 19, no. 3, p. 287-298.

Greig-Smith, Peter, 1983, Quantitative Plant Ecology (third edition), Studies in Ecology, Volume 9: Berkeley, University of California Press, 359 p.

Grenander, Ulf, 1975, Dynamic models of geomorphological patterns: Mathematical Geology, v. 7, no. 3, p. 267-278.

Grenander, Ulf, 1976, Lectures in Pattern Theory, Volume 1, Pattern Synthesis: New York, Springer-Verlag, 509 p. [pp. 170-236 most applicable to topography?]

Grender, G.C., 1976, Topo III—a FORTRAN program for terrain analysis: Computers and Geosciences, v. 2, no. 2, p. 195-209.

Greysukh, V.L., 1966, The possibility of studying landforms by means of digital computers (in Russian): Izvestia Akademia Nauk SSR, seria Geograficheskaya 1966, p. 102-110. [published in translation, 1967, *in* Soviet Geography Review and Translation, v. 8, no. 3, p. 137-149]

Greysukh, V.L., and Kosmin, V.V., 1964, The analytical representation of local relief in a digital computer (in Russian): Izv. vyssh. uchebn. zaved., geodeziya i aerofotos"yemka, No. 6.

Grieve, R.A.F., and Garvin, J.B., 1984, A geometric model for excavation and modification at terrestrial simple impact craters: Journal of Geophysical Research, v. 89, no. B13, p. 11,561-11,572.

Griffin, M.W., 1987, A rapid method for simulating three-dimensional fluvial systems: Earth Surface Processes and Landforms, v. 12, no. 1, p. 31-38.

Griffith, D.A., 1987, Spatial Autocorrelation, A Primer: Washington, D.C., Association of American Geographers, 82 p. + appendices.

Griffiths, T.M., 1964, A comparative study of terrain analysis techniques: University of Denver, Department of Geography Publications, prepared for U.S. Army under contract DA-31-124-ARO-D-79, Technical Paper 64-2, paging unknown. [AD-450591]

Grigg, David, 1965, The logic of regional systems: Annals of the Association of American Geographers, v. 55, no. 3, p. 465-491.

Grigg, David, 1967, Regions, models and classes, *in* Chorley, R.J., and Haggett, Peter, eds., Models in Geography: London, Methuen and Co., Chapter 12, p. 461-509.

Grist, M.W., 1969, Digital terrain model: The Consulting Engineer, v. 33, no. 6, p. 46-47.

Grist, M.W., 1972, Digital ground models—an account of recent research: Photogrammetric Record, v. 7, no. 4, p. 424-441.

Groenewoud, Cornelius, 1962, The role of elevation-relief ratio in terrain analysis: Buffalo New York, Cornell Aeronautical Laboratory Inc., Memo For Record, mimeographed typescript CG:jj:65, dated November 15, 1962, 9 p.

Groom, S.L., and Watson, S.H., 1992, Using the Delta for solar system visualization: Information Systems Newsletter, NASA/OSSA, Issue 26 (October, 1992), p. 7-12.

Grumâzescu, H., Stâncâlie, G., and Ungureanu, C., 1990, Remote-sensing techniques for determining the regionally variable characteristics of drainage basins, *in* Beran, M.A., Brilly, M., Becker, A., and Bonaci, O., eds., Proceedings of the symposium

Regionalization in Hydrology, Ljubljana, Yugoslavia, April 23-26, 1990, International Association of Hydrological Sciences, Publication No. 191, p. 3-10.

Gugan, D.J., and Dowman, I.J., 1988, Topographic mapping from SPOT imagery: Photogrammetric Engineering and Remote Sensing, v. 54, no. 10, p. 1409-1414.

Guilcher, André, 1950, Morphologie et morphométrie: Revue de Géomorphologie Dynamique, v. 1, no. 6, p. 288.

Gupta, R.P., and Joshi, B.C., 1990, Landslide hazard zoning using the GIS approach—case study from the Ramganga Catchment, Himalayas: Engineering Geology, v. 28, nos. 1-2, p. 119-131.

Guptill, S.C., and Starr, L.E., 1988, Making maps with computers: American Scientist, v. 76, no. 2, p. 136-142.

Gustafson, G.C., and Loon, J.C., 1982, Contour accuracy and the national map accuracy standards: Surveying and Mapping, v. 42, no. 4 , p. 385-402.

Gutersohn, Heinrich, 1932, Relief und Flussdichte (in German): Universität Zürich, Inagural-Dissertation, 91 p.

Guth, P.L., 1986, TERRANAL: Microcomputer terrain mapping package, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing Annual Meeting, Washington, D.C., March, 1986: Proceedings, v. 1, p. 114-122.

Guth, P.L., 1989, MicroDEM+; comparing digital elevation models on a personal computer: Defense Mapping Agency Systems Center, Symposium '89, Proceedings, p. 389-394.

Guth, P.L., 1990, PC's manipulate large gridded data sets: Federal Digital Cartography Newsletter, Reston, VA, Federal Interagency Coordinating Committee on Digital Cartography, No. 12, p. 12-14.

Guth, P.L., 1992, Spatial analysis of DEM error, *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 2 (Photogrammetry and Surveying), p. 187-196.

Guth, P.L., Ressler, E.K., and Bacastow, T.S., 1987, Microcomputer program for manipulating large digital terrain models: Computers and Geosciences, v. 13, no. 3, p. 209-213.

H

Haan, C.T., and Johnson, H.P., 1966, Rapid determination of hypsometric curves: Geological Society of America Bulletin, v. 77, no. 1, p. 123-125.

Haan, C.T., and Johnson, H.P., 1967, Geometrical properties of depressions in north-central Iowa: Iowa State Journal of Science, v. 42, no. 2, p. 149-160.

Habesch, S.M., 1990, The evaluation of pore-geometry networks in clastic reservoir lithologies using microcomputer technology, *in* Hanley, J.T., and Merriam, D.F., eds., Microcomputer Applications in Geology, II: Oxford, Pergamon Press, p. 91-110.

Hack, J.T., 1957, Studies of longitudinal stream profiles in Virginia and Maryland: U.S. Geological Survey Professional Paper 294-B, p. 45-94.

Hack, J.T., 1965, Postglacial drainage evolution and stream geometry in the Ontonagon area, Michigan: U.S. Geological Survey Professional Paper 504-B, 40 p.

Hack, J.T., 1973, Stream-profile analysis and stream-gradient index: Journal of Research of the U.S. Geological Survey, v. 1, no. 4, p. 421-429.

Hadipriono, F.C., Lyon, J.G., Li W.H., Thomas, and Argialas, D.P., 1989, A drainage pattern knowledge based expert system, *in* American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping, fall convention, 1989, Technical papers, p. 116-124.

Hadipriono, F.C., Lyon, J.G., Li W.H., Thomas, and Argialas, D.P., 1990, The development of a knowledge-based expert system for analysis of drainage patterns: Photogrammetric Engineering and Remote Sensing, v. 56, no. 6, p. 905-909.

Haggett, Peter, 1967, Network models in geography, *in* Chorley, R.J., and Haggett, Peter, eds., Models in Geography: London, Methuen, p. 609-668.

Haines-Young, R.H., and Petch, J.R., 1983, Multiple working hypotheses—equifinality and the study of landforms: Transactions of the Institute of British Geographers, New Series 8, p. 458-466.

Haines-Young, R.H., and Petch, J.R., 1986, Physical Geography, Its Nature and Methods: London, Harper and Row, 230 p.

Håkanson, Lars, 1974, A mathematical model for establishing numerical values of topographical roughness for lake bottoms: Geografiska Annaler, v. 56 A, no. 3-4, p. 183-200.

Håkanson, Lars, 1977, On lake form, lake volume and lake hypsographic survey: Geografiska Annaler, v. 59 A, no. 1-2, p. 1-29.

Håkanson, Lars, 1978, The length of closed geomorphic lines: Mathematical Geology, v. 10, no. 2, p. 141-167.

Håkanson, Lars, 1981, The length of open geomorphic lines: Zeitschrift für Geomorphologie, v. 25, no. 4, p. 369-382.

Hale, W.S., and Grieve, R.A.F., 1982, Volumetric analysis of complex lunar craters—implications for basin ring formation: Journal of Geophysical Research, v. 87, Supplement (Lunar and Planetary Conference, 13th, Houston, TX, March, 1982, Proceedings), p. A65-A76.

Hall, J.K., and Cleave, R.L.W., 1988, The DTM (digital terrain map) project: Geological Survey of Israel Current Research,v. 6, no. 11, p. 79-84.

Hall, J.K., Schwartz, Eric, and Cleave, R.L.W., 1990, The Israeli DTM (digital terrain map) project, *in* Hanley, J.T., and Merriam, D.F., eds., Microcomputer Applications in Geology, II: Oxford, Pergamon Press, p. 111-118, + color plates.

Hallet, Bernard, 1990, Spatial self-organization in geomorphology—from periodic bedforms and patterned ground to scale-invariant topography: Earth-Science Reviews, v. 29, Nos. 1-4, p. 57-75.

Halliday, James, 1964, Photogrammetric contouring of areas covered by evergreen forests, *in* Geological Survey Research 1964: U.S. Geological Survey, Professional Paper 501-C, p. C190-C193.

Hamann, C., 1988, Geomorphologische Karten zur Beurteilung der optischen Qualität von Landschaften (in German): Zeitschrift für Geomorphologie, Supplementband 68, p. 125-141.

Hamilton, C.H., 1930-31, A statistical index of topography: Social Forces, v. 9, p. 204-205.

Hamilton, J.R., 1986, A terrain modeling methodology for use in aircraft and surface-to-air missile encounter models: Applied Geography Conferences, Proceedings, v. 9, p. 228-233.

Hammond, E.H., 1954a, Small-scale continental landform maps: Annals of the Association of American Geographers, v. 44, no. 1, p. 33-42.

Hammond, E.H., 1954b, An objective approach to the description of terrain (abstract): Annals of the Association of American Geographers:, v. 44, no. 2, p. 210.

Hammond, E.H., 1957, On the place, nature and methods of description in the geography of land form: Madison, University of Wisconsin, Department of Geography, Office of Naval Research Contract Nonr 1202(01), Procedures in the descriptive analysis of terrain, Technical Report No. 1, paging unknown.

Hammond, E.H., 1958, Procedures in the Descriptive Analysis of Terrain: Madison, University of Wisconsin, U.S. Office of Naval Research, Geography Branch, Project No. NR 387-015, Contract No. Nonr-1202(01), Final Report, 85 p. + 72 p. of appendices.

Hammond, E.H., 1962, Land form geography and land form description: The California Geographer, v. 3, p. 69-75.

Hammond, E.H., 1964a, Analysis of properties in land form geography—an application to broad-scale land form mapping: Annals of the Association of American Geographers, v. 54, no. 1, p. 11-19.

Hammond, E.H., 1964b, Classes of land surface form in the forty eight states, U.S.A.: Annals of the Association of American Geographers, v. 54, no. 1, Map Supplement Series no. 4, scale 1:5,000,000. [adapted version published as Hammond, E.H., *in* The National Atlas of the United States of America: U.S. Geological Survey, scale 1:7,500,000, p. 62-63.]

Hammond, E.H., 1965, What is a landform? some further comments: The Professional Geographer, v. 17, no. 3, p. 12-13.

Hankley, W.J., and Tou, J.T., 1968, Automatic fingerprint interpretation and classification via contextual analysis and topological coding, *in* Cheng, G.C., Ledley, R.S., Pollock, D.K., and Rozenfeld, Azriel, eds., Pictorial Pattern Recognition—Symposium on automatic photointerpretation, Washington, May 31-June 2, 1967, sponsored by the Office of Naval Research, the University of Maryland, and the Pattern Recognition Society, Proceedings: Washington, D.C., Thompson Book Co., p. 411-456.

Hannah, M.J., 1981, Error detection and correction in digital terrain models: Photogrammetric Engineering and Remote Sensing, v. 47, no. 1, p. 63-69.

Hansel, A.K., 1980, Sinkhole form as an indicator of process in karst landscape evolution: Urbana-Champaign, University of Illinois, unpublished Ph.D. dissertation, paging unknown.

Hansen, J.C., 1963, Map visibility study: U.S. Army ELRDL Technical Report 2347, AD 339-360, paging unknown. [effect of terrain height & type on intervisibility]

Hansen, J.H., and Hurst, M.J., 1986, Digital techniques for terrain simulation, *in* American Congress on Surveying and Mapping, fall meeting, Anchorage, Alaska, September 28-October 3, 1986, Technical papers, p. 226-231.

Hansen, William, 1991, Improved interpolation by inverse distance squared weighting—A comparative quantitative evaluation, *in* GIS/LIS, American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, fall convention, Atlanta, GA, October 28-November 1, 1991, Technical Papers, p. B-67 to B-75.

Hanson-Lowe, J., 1935, The clinographic curve: Geological Magazine, v. 72, no. 4, p. 180-184.

Haralick, R.M., 1978, Statistical and structural approach to texture, *in* Hildebrandt, G., and Boehnel, H.-J., eds., International Symposium on Remote Sensing for Observation and Inventory of Earth Resources and the Endangered Environment, July 2-8, 1978, Freiburg, Germany: Proceedings, v. 1 (Intl. Archives of Photogrammetry, v. 22-7), p. 379-431.

Haralick, R.M., 1983, Ridges and valleys on digital images: Computer Vision, Graphics, and Image Processing, v. 22, no. 1, p. 28-38.

Haralick, R.M., Campbell, J.B., and Wang, S., 1985, Automatic inference of elevation and drainage models from a satellite image: Proceedings of the IEEE, v. 73, no. 6, p. 1040-1053.

Haralick, R.M., and Shanmugam, K.S., 1974, Combined spectral and spatial processing of ERTS imagery data: Remote Sensing of Environment, v. 3, no. 1, p. 3-13.

Haralick, R.M., Shanmugam, K.S., and Dinstein, I., 1973, Textural features for image classification: IEEE Transactions on Systems, Man and Cybernetics, v. SMC-3, no. 6, p. 610-621.

Haralick, R.M., Wang, S., Shapiro, L.G., and Campbell, J.B., 1985, Extraction of drainage networks by using the consistent labeling technique: Remote Sensing of Environment, v. 18, no. 2, p. 163-175.

Haralick, R.M., Watson, L.T., and Laffey, T.J., 1983, The topographic primal sketch: International Journal of Robotics Research, v. 2, no. 1, p. 50-72.

Harary, F., 1969, Graph Theory: Reading, MA, Addison-Wesley, paging unknown.

Hardy, R.L., 1971, Multiquadric equations of topography and other irregular surfaces: Journal of Geophysical Research, v. 76, no. 8, p. 1905-1915.

Hardy, R.L., 1972, The analytic geometry of topographic surfaces, *in* American Congress on Surveying and Mapping, 32nd annual meeting, Washington, D.C.: Proceedings, p. 163-181.

Harlin, J.M., 1978, Statistical moments of the hypsometric curve and its density function: Mathematical Geology, v. 10, no. 1, p. 59-72.

Harlin, J.M., 1979, *Reply to* Hypsometry, statistics, and simplicity—In defense of a second function: Mathematical Geology, v. 11, no. 1, p. 91-92.

Harrison, C.G.A., Miskell, K.J., Brass, G.W., Saltzman, E.S., and Sloan, J.L. II, 1983, Continental hypsography: Tectonics, v. 2, no. 4, p. 357-377.

Harrison, R.E., 1969, Shaded relief, *in* The National Atlas of the United States of America: U.S. Geological Survey, scale 1:7,500,000, p. 56-57.

Hausdorff, Felix, 1919, Dimension und äusseres Mass: Mathematische Annalen, v. 79, no. 2, p. 157-179.

Haverlík, Ivan, and Krcho, Jozef, 1973, Mathematical generalisation of forming isoline thematic maps by computer examplified by morphometric analysis of relief and dynamics of relief insolation: Acta Geographica Universitatis Comenianae, Geographica-physica No. 1, Bratislava, Czechoslovakia, Slovak Pedagogical Publishers, p. 235-424.

Hay, A.M., and Abdel-Rahman, M.A., 1974, Use of chi-square for the identification of peaks in orientation data, comment: Geological Society of America Bulletin, v. 85, no. 12, p. 1963-1966.

Hayden, R.S., ed., 1985, Global Mega-Geomorphology: Workshop sponsored by the National Aeronautics and Space Administration and the International Union of Geological Sciences, Oracle Arizona, January 14-16, 1985, Proceedings, NASA Conference Publication 2312, 134 p.

Haynes, V.M., 1977, The modification of valley patterns by ice-sheet activity: Geografiska Annaler, v. 59A, no. 3-4, p. 195-207

He, D.-C., and Wang, Li, 1990, Texture unit, texture spectrum, and texture analysis: IEEE Transactions on Geoscience and Remote Sensing, v. 28, no. 4, p. 509-512.

Head, C.G., 1984, The map as natural language—a paradigm for understanding: Cartographica, v. 21, no. 1, p. 1-32.

Head, J.W., 1977, Origin of outer rings in lunar multi-ring basins—evidence from morphology and ring spacing, *in* Roddy, D.J., Pepin, R.O., and Merrill, R.B., eds., Impact and Explosion Cratering: New York, Pergamon, p. 563-573.

Heerdegen, R.G., and Beran, M.A., 1982, Quantifying source areas through land surface curvature and *shape: Journal of Hydrology, v. 57, no. 3-4, p. 359-373. [*misprint for "slope"]

Heezen, B.C., and Wilson, Lee, 1968, Submarine geomorphology, *in* Fairbridge, R.W., ed., The Encyclopedia of Geomorphology: New York, Reinhold Book Co., p. 1079-1097.

Heil, R.J., 1979, The digital terrain model as a data base for hydrological and geomorphological analyses, *in* International Symposium on Automated Cartography, 4th, November, 1979, Proceedings, v. II, p. 132-138.

Heil, R.J., and Brych, S.M., 1978a, An approach for consistent topographic representation of varying terrain, *in* American Society of Photogrammetry, Digital Terrain Models (DTM) Symposium, May 9-11, St. Louis, MO, Proceedings, p. 377-411.

Heil, R.J., and Brych, S.M., 1978b, The digital tarrain model—a tool for quantifying terrain characteristics, *in* American Congress on Surveying and Mapping, Fall Convention, October 15-20, 1978, Albuquerque, New Mexico, Proceedings of the Fall Technical Meeting, p. 156-171.

Heinrichs, M.R., Smith, Kip, Pick, H.L., Jr., Bennett, B.H., and Thompson, W.B., 1992, Strategies for localization, *in* Defense Advanced Research Projects Agency (DARPA) Image Understanding Workshop, San Diego, Calif., January 1992, Proceedings, p. 321-325.

Heirtzler, J.R., ed., 1985, Relief of the Surface of the Earth, computer generated shaded relief: Boulder, Colo., U.S. National Oceanic and Atmospheric Administration, National Geophysical Data Center, Report MGG-2, scale 1:39,000,000.

Helmlinger, K.R., Kumar, Praveen, and Foufoula-Georgiou, Efi, 1993, On the use of DEM data for Hortonian and fractal analyses of channel networks: Water Resources Research, v. 29, in-press.

Henderson-Sellars, A., and Dickinson, R.E., 1992, Intercomparison of land-surface parameterizations launched: Eos, Transactions of the American Geophysical Union, v. 73, no. 17, p. 195-196.

Herzfeld, U.C., 1990, Geostatistical software for evaluation of line survey data applied to radio-echo soundings in glaciology, *in* Hanley, J.T., and Merriam, D.F., eds., Microcomputers in Geology, II: Oxford, (UK) Pergamon Press, p. 119-127.

Hettner, Alfred, 1928, Die Oberflächenformen des Festlandes (2nd ed.): Stuttgart, B.G. Teubner Verlag, paging uknown. [republished 1972, as The Surface Features of the Land, Problems and Methods of Geomorphology: (translated and with a preface by Phillip Tilley): New York, Hafner, 193 p.]

Hibler, W.D. III, 1975, Characterization of cold-regions terrain using airborne laser profilometry: Journal of Glaciology, v. 15, no. 73, p. 329-347.

Hibler, W.D. III, Weeks, W.F., and Mock, S.J., 1972, Statistical aspects of sea-ice ridge distributions: Journal of Geophysical Research, v. 77, no. 30, p. 5954-5970.

High, James, 1963, A reappraisal of terrain appreciation: The Professional Geographer, v. 15, no. 1, p. 11-16.

Highway Research Board, 1964, Nuclear Excavation 1963, 5 reports: Annual Meeting, 43rd, January 13-17, 1964, Washington, D.C., NAS-NRC, Highway Research Record, No. 50, 53 p.

Hill, A.R., 1973, The distribution of drumlins in County Down, Ireland: Annals of the Association of American Geographers, v. 63, no. 2, p. 226-240.

Hirano, Masashige, 1977, Preparation of a digital map of the Rokko Mountains as a multi-purpose data-base: Geological Data Processing (Japan), No. 3, p. 33-44.

Hirano, Masashige, 1983, Estimation of the rate of topographic change based on a mathematical model and digital map of the Rokko Mountains (in English): Transactions of the Japanese Geomorphological Union, v. 4, no. 2, p. 241-249.

Hirano, Masashige, and Ishii, Takayuki, 1984, Precise measurement of microforms and fabric of alluvial cones for prediction of landform evolution, *in* Burt, T.P., and Walling, D.E., eds., Catchment Experiments in Fluvial Geomorphology: meeting of the IGU Commission on Field Experiments in Geomorphology, Exeter and Huddersfield, UK, August 16-24, 1981, Proceedings, Norwich, Geo Books, p. 465-475.

Hirsch, F., 1965, Application de la morphométrie à l'hydrologie (In French with English abstract): Revue de Géomorphologie Dynamique, v. 15, nos. 10-11-12, p. 172-175.

Hjelmfelt, A.T. Jr., 1988, Fractals and the river-length catchment-area ratio: Water Resources Bulletin, v. 24, no. 2, p. 455-459.

Hoadley, P.G., and Krenkel, P.A., 1963, A Technique for Macrogeometry Terrain Analysis, Interim report (Contract No. DA-22-079-eng-300) *for* U.S. Army Waterways Experiment Station, Corps of Engineers, Vicksburg Miss. (and Appendix A to Report of meeting of the Board of Consultants for the project Military Evaluation of Geographic Areas, MEGA): Nashville Tenn., Vanderbilt University, Department of Civil Engineering, 45 p.

Hobba, L.J., and Robinson, G., 1972, A suggested new approach to the analysis of drainage basin shapes: Area (UK), v. 4, p. 242-251.

Hobson, R.D., 1967, FORTRAN IV programs to determine surface roughness in topography for the CDC 3400 computer: Lawrence, Kansas Computer Contribution no. 14, 27 p. [republished 1972 *as* Surface roughness in topography: a quantitative approach, *in* Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, p. 221-245]

Hodgson, M.E., 1989, Searching methods for rapid grid interpolation: The Professional Geographer, v. 41, no. 1, p. 51-61.

Hoffman, R.R., 1985, What is a hill? An analysis of the meanings of generic topographic terms: Fort

Belvoir, VA, U.S. Army Engineer Topographic Laboratories, Delivery Order No. 1380, Contract DAAG-29-81-D-0100, Final Report, 61 p., + 30 p. of appendices. [also February 1991 report, AD-A231 413]

Hoffman, R.R., 1987, The problem of extracting the knowledge of experts from the perspective of experimental psychology: AI Magazine, v. 8, no. 2, p. 53-67.

Hoffman, R.R., 1990, What's a hill? Computing the meaning of topographic and physiographic terms, *in* Schmitz, U., Schutz, R., and Kunz, A., eds., Linguistic Approaches to Artificial Intelligence: University of Duisberg, Germany, Duisberg Papers on Research in Language and Culture: Frankfurt, Germany, Peter Lang Verlag, p. 97-128.

Hoffman, R.R., and Pike, R.J., 1992, On the specification of the information available for the perception and description of the natural terrain, *in* Flach, John, and Hancock, P., eds., The Ecology of Human-Machine Interaction: Hillsdale, N.J., L. Erlbaum Assoc., v. 2, in press.

Holroyd, M.T., and Bhattacharyya, B.K., 1970, Automatic contouring of geophysical data using bicubic spline interpolation: Ottawa, Geological Society of Canada, Paper no. 70-55, 40 p.

Hood, Joy, Ladner, Lyman, and Champion, Richard, 1989, Image processing techniques for digital orthophotoquad production: Photogrammetric Engineering and Remote Sensing, v. 55, no. 9, p. 1323-1329.

Hook, J.C., 1955, The Relationship Between Roughness of Terrain and Phenomena Related to Agriculture in Northeastern United States: Iowa City, State University of Iowa, unpublished Ph.D. dissertation, 176 p.

Hook, J.C., 1959, The quantification of landform characteristics—a roughness index: Proceedings of the Indiana Academy of Science, v. 68, p. 277-282.

Hooper, David, 1985, Raster-based contour plotting from digital elevation models using mini- or microcomputers, *in* American Congress on Surveying and Mapping, fall convention, Indianapolis, IN, September 8-13, 1985, Technical Papers, p. 196-202.

Hoover, K.A., Foley, M.G., and Heasler, P.G., 1991, Sub-grid-scale characterization of channel lengths for use in catchment modeling: Water Resources Research, v. 27, no. 11, p. 2865-2873.

Horgan, John, 1990, Claude E. Shannon: The American Scientist, v. 262, no. 1, p. 20-22.

Hormann, Klaus, 1968, Rechenprogramme zur morphometrischen Kartenauswertung (in German): Schriften des Geographischen Instituts der Universität Kiel, v. 29, no. 2, 154 p.

Hormann, Klaus, 1969, Geomorphologische Kartenanalyse mit Hilfe elektronischer Rechenanlagen (in German): Zeitschrift für Geomorphologie, v. 13, no. 1, p. 75-98.

Hormann, Klaus, 1971, Morphometrie der Erdoberfläche (in German): Schriften des Geographische Institut der Universität Kiel, v. 36, 179 p.

Horn, B.K.P., 1981, Hill shading and the reflectance map: Proceedings of the Institute of Electrical and Electronics Engineers, v. 69, no. 1, p. 14-47. [originally released 1979, *in* Workshop on Image Understanding, Palo Alto, CA, April, 1979, Proceedings: p. 79-120; reprinted 1982, *in* Geo-processing, v. 2, no. 1, p. 65-146.]

Horn, B.K.P., 1990, Height and gradient from shading: International Journal of Computer Vision, v. 5, no. 1, p. 37-75.

Horn, B.K.P., and Brooks, M.J., eds., 1989, Shape From Shading: Cambridge, MA, M.I.T. Press, 577 p.

Horton, C.W., Hoffman, A.A.J., and, Hempkins, W.B., 1962, Mathematical analysis of the microstructure of an area of the bottom of Lake Travis: Texas Journal of Science, v. 14, no. 2, p. 131-142.

Horton, R.E., 1926, *in* Jarvis, C.S., Flood flow characteristics: Transactions of the American Society of Civil Engineers, v. 89, p. 1081-1086.

Horton, R.E., 1932, Drainage-basin characteristics: American Geophysical Union, 13th Annual Meeting, April 28 and 29, 1932, Washington, D.C., Transactions, v. 13, p. 350-361.

Horton, R.E., 1945, Erosional development of streams and their drainage basins, hydrophysical approach to quantitative morphology: Geological Society of America Bulletin, v. 56, no. 3, p. 275-370.

Houbolt, J.C., 1961, Runway roughness studies in the aeronautical field: Journal of the Air Transport Division, Proceedings of the American Society of Civil Engineers, v. 87, no. AT 1, p. 12-31.

Hough, S.E., 1989, On the use of spectral methods for the determination of fractal dimension: Geophysical Research Letters, v. 16, no. 7, p. 673-676.

Houssay, Philippe, 1980, Exploitation cartographique de Modèles numériques de terrain en vue de l'Aménagement, *in* Kirschbaum, G.M., and Meine, K.-H., eds., International Yearbook of Cartography, Bonn-Bad Godesburg, Germany, International Cartographic Association, v. 20, p. 98-110.

Howard, Alan D., 1971, Optimal angles of stream junction—geometric, stability to capture, and minimum power criteria: Water Resources Research, v. 7, no. 4, p. 863-873.

Howard, Alan D., 1990a, Theoretical model of optimal drainage networks: Water Resources Research, v. 26, no. 9, p. 2107-2117.

Howard, Alan D., 1990b, Role of hypsometry and planform in basin hydrologic response: Hydrological Processes, v. 4, no. 4, p. 373-385.

Howard, Alan D., 1992, Morphometric definition of drainage density (abs.): Eos, Transactions of the American Geophysical Union, v. 73, no. 14 (supplement), p. 138.

Howard, Alan D., Keetch, M.E., and Vincent, C.L., 1970, Topological and geometrical properties of braided streams: Water Resources Research, v. 6, no. 6, p. 1674-1688.

Howard, Arthur D., and Spock, L.E., 1940, Classification of landforms: Journal of Geomorphology, v. 3, no. 4, p. 332-345.

Howard, Arthur D., 1967, Drainage analysis in geologic interpretation—a summation: American Association of Petroleum Geologists Bulletin, v. 51, no. 11, p. 2246-2259.

Howard, Arthur D., 1973, Modified contour-generalization procedure as applied to the Santa Lucia range, California: Geological Society of America Bulletin, v. 84, no. 10, p. 3415-3428.

Howard, K.A., and Larsen, B.R., 1972, Lineaments that are artifacts of lighting, *in* Apollo 15 preliminary science report: Washington, D.C., U.S. National Aeronautics and Space Administration Special Publication 289, p. 25-58 to 25-62.

Howard, R.B., 1984, The physiographic region in physical geography and geomorphology—historical appraisal and re-evaluation: The California Geographer, v. 24, p. 61-79.

Howard, T.W., 1993, Desert Storm—a focus on terrain analysis support, *in* 1992 ASPRS-ACSM annual convention, Albuquerque, New Mexico, Technical Papers, v. 1, p. 139-145.

Hsu, Shin-Yi, 1974, A mathematical method for measuring visual difference in multiple map comparison, *in* American Congress on Surveying and Mapping, fall convention, September 10-13, 1974, Proceedings: p. 116-132.

Hsu, Shin-Yi, 1978, Texture analysis—a cartographic approach and its applications in pattern recognition: The Canadian Geographer, v. 15, no. 2, p. 151-166.

Hsu, Shin-Yi, 1979, Automation in cartography with remote sensing methodologies and technologies: The Canadian Cartographer, v. 16, no. 2, p. 183-194.

Hsu, Shin-Yi, 1979, The Mahalanobis classifier with the generalized inverse approach for automated analysis of imagery texture data: Computer Graphics and Image Processing, v. 9, no. 2, p. 117-134.

Hsu, Shin-Yi, 1980, The pattern recognition problem / man, machine and their interaction: Cartographica, v. 17, no. 1, p. 101-117.

Huang, Shaoli, Shepherd, W.E., and Johnson, B.C., 1991, Using GIS in powerline route selection—applications for landscape quality assessment, *in* ESRI (Environmental Systems Research Institute, Inc.) Annual User Conference 11th, Redlands, Calif., Proceedings, v. 1, p. 651-660.

Huang, J., and Turcotte, D.L., 1989, Fractal mapping of digitized images—application to the topography of Arizona and comparisons with synthetic images: Journal of Geophysical Research, v. 94, no. B6, p. 7491-7495.

Hugus, M.K., and Mark, D.M., 1984, Spatial data processing for digital simulation of erosion, *in* American Society for Photogrammetry / American Congress on Surveying and Mapping, meeting, 1984, Technical Papers, p. 683-693.

Huijbregts, C.J., 1975, Regionalized variables and quantitative analysis of spatial data, *in* Davis, J.C., and McCullagh, M.J., eds., Display and Analysis of Spatial Data: NATO Advanced Study Institute on Display and Analysis of Spatial Data, Nottingham, England, 1973, Proceedings: London, John Wiley and Sons, p. 38-53.

Humboldt, Alexander von, 1816, Kamm- und Gipfelhöhen der wichtigsten Gebirge (in German): Annalen der Physik und Chemie, v. 13, p. 521.

Humboldt, Alexander von, 1842, Versuch die mittlere Höhe der Kontinente zu bestimmen (in German): Annalen der Physik und Chemie, v. 57, p. 407.

Hunt, B.R., ed., 1981, Special issue on image processing: Proceedings of the Institute of Electrical and Electronics Engineers, v. 69, no. 5, p. 499-654.

Hutchinson, M.F., 1984, A summary of some surface fitting and contouring programs for noisy data: Canberra, Australia, CSIRO, Division of Mathematics and Statistics, Consulting Report 84/6, 24 p.

Hutchinson, M.F., 1986, Fitting surfaces to terrain data, *in* Research Report 1983-85: Canberra, Australia, CSIRO Division of Water and Land Resources, p. 63-64.

Hutchinson, M.F., 1988, Calculation of hydrologically sound digital elevation models, *in* Third International Symposium on Spatial Data Handling, Sydney Australia, August 17-19, 1988: Columbus Ohio, Geography Department, Ohio State University and the International Geographical Union, p. 117-133.

Hutchinson, M.F., 1989, A new procedure for gridding elevation and stream line data with automatic removal of spurious pits: Journal of Hydrology, v. 106, nos. 3/4, p. 211-232.

Hutchinson, M.F., and Dowling, T.I., 1991, A continental hydrological assessment of a new grid-based digital elevation model of Australia: Hydrological Processes, v. 5, no. 1, p. 45-58.

Hutton, R.E. (principal author), 1969, Lunar surface models: Space vehicle design criteria (environment), prepared for Marshall Space Flight Center by TRW SYstems, Redondo Beach, CA, NASA Special Publication SP-8023, 55 p.

I

Ibbeken, Hillert, and Schleyer, Ruprecht, 1979, The morphology of the Aegean Sea—a discussion of morphometrical data: Zeitschrift für Geomorphologie, v. 23, no. 4, p. 396-414.

Ibbs, T.J., and Stevens, A., 1988, Quadtree storage of vector data: International Journal of Geographical Information Systems, v. 2 , no. 1, p. 43-56.

IBM, 1965, Numerical surface techniques and contour map plotting: White Plains, New York, International Business Machines, Data Processing Application, 36 p.

Imamura, G., 1937, Past glaciers and the present topography of the Japanese Alps: Science Reports of Tokyo Bunrika Daiguku, C. 7, 61 p.

Imhof, Eduard, 1965, Kartographische Geländedarstellung: Berlin, Walter de Gruyter, 425 p. [English translation published as Steward, H.J., ed., 1982, Eduard Imhof, Cartographic Relief Representation: New York, Walter de Gruyter, 389 p.]

Inaba, K., Aumann, G., and Ebner, Heinrich, 1988, DTM generation from digital contour data using aspect information: International Archives of Photogrammetry and Remote Sensing (Kyoto, Japan), v. 27, part B9, p. III/101-III/110.

Irons, J.R., 1981, Texture transforms of remote sensing data: Remote Sensing of Environment, v. 11, no. 5, p. 359-370.

Isacks, B.L., and Mouginis-Mark, Peter, 1992, Solid earth sciences in EOS—Report of the Solid Earth Panel: Palaeogeography, Palaeoclimatology, Palaeoecology (Global and Planetary Change Section), v. 98, no. 1, p. 29-35. [see *topography*, p. 33]

Isaacson, D.L., and Ripple, W.J., 1990, Comparison of 7.5-minute and 1-degree digital elevation models: Photogrammetric Engineering and Remote Sensing, v. 56, no. 11, p. 1523-1527.

Isachenko, A.G., 1973, Principles of Landscape Science and Physical-Geographic Regionalization (translated from the Russian edition, Osnovy landsaftovenija fisiko-geograficesko rajonirovanije, 1965, Moscow, and edited by J.S. Massey): Melbourne (Australia) Univ. Press, 311 p.

Iseli, J., 1964, ECAC topographic data processing capability: Annapolis, MD, Electromagnetic Compatibility Analysis Center, U.S. Navy Marine Engineering Laboratory, Report ECAC-TR-64-21, paging unknown.

Ivanov, B.A., Basilevsky, A.T., Kryuchkov, V.P., and Chernaya, I.M., 1986, Impact craters of Venus—analysis of Venera 15 and 16 data, *in* Lunar and Planetary Science Conference, 16th, Houston, TX, March 1985, Proceedings, Part 2 (Journal of Geophysical Research, v. 91, no. B4,), p. D413-D430.

Ivanov, V.V., and Chalova, Ye. P., 1987, An experiment in systematizing the cartographic images of geomorphological features: Mapping Sciences and Remote Sensing, v. 24, no. 4, p. 292-296.

Izmaylova, N.V., 1946-48, The quantitative characterization of the dissection of relief and its application to geomorphological maps (in Russian): Dissertation for the degree of Candidate, Odesskiy gos. in-t im. N.I. Mechnikova (Odessa).

J

Jackson, Julian, 1934, Hints on the subject of geographical arrangement and nomenclature: Journal of the Royal Geographical Society, v. IV, p. 72-88.

Jaeger, R.M., and Schuring, D.J., 1966, Spectrum analysis of terrain of Mare Cognitum: Journal of Geophysical Research, v. 71, no. 8, p. 2023-2028.

Jansson, B., 1964, TERROR—the influence of terrain on optical and radar visibility: Stockholm, Sweden, Research Institute of National Defense, Report, paging unknown.

Jancaitis, J.R., and Junkins, J.L., 1973, Modelling irregular surfaces: Photogrammetric Engineering, v. 39, no. 4, p. 413-420.

Jancaitis, J.R., and Junkins, J.L., 1973, Mathematical Tecniques for Automated Cartography: Fort Belvoir, VA, U.S. Army Engineer-Topographic Laboratories, Contract DAAK 02-72-C-0256, Final Report, paging unknown.

Jarvis, R.S., 1972, New measure of topologic structure of dendritic drainage networks: Water Resources Research, v. 8, no. 5, p. 1265 -1271.

Jarvis, R.S., 1976, Classification of nested tributary basins in analysis of drainage basin shape: Water Resources Research, v. 12, no. 6, p. 1151-1164.

Jarvis, R.S., 1976, Link length organization and network scale dependencies in the network diameter model: Water Resources Research, v. 12, no. 6, p. 1215-1225.

Jarvis, R.S., 1984, Topology of tree-like networks, *in* Gaile, G.L., and Willmott, C.J., eds., Spatial Statistics and Models: Boston, MA, Reidel Publ. Co., p. 271-292.

Jarvis, R.S., and Sham, C.H., 1981, Drainage network structure and the diameter-magnitude relation: Water Resources Research, v. 17, no. 4, p. 1019-1027.

Jarvis, R.S., and Clifford, N.J., 1990, Specific geomorphometry, *in* Goudie, Andrew, and six others, eds., Geomorphological Techniques (second edition): London, Unwin Hyman, p. 63-70.

Jauhiainen, Erkki, 1975, Morphometric analysis of drumlin fields in northern central Europe: Boreas, v. 4, no. 4, p. 219-230.

Jeffery, Tom, 1987, Mimicking mountains: BYTE, v. 12, no. 14, p. 337, 338, 340, 342, 344.

Jenks, G.F., and Caspall, F.C., 1967, Vertical exaggeration in three-dimensional mapping: Lawrence, University of Kansas, Geography Department, NR 389-146, Contract Nonr 583(15), *for* Geography Branch, Office of Naval Research, Technical Report No. 2, 34 p.

Jennings, J.N., 1973, 'Any milleniums today, lady?' the geomorphic bandwaggon parade: Australian Geographical Studies, v. 11, no. 2, p. 115-133.

Jensen, J.R., 1986, Introductory digital image processing—a remote sensing perspective: Englewood Cliffs, N.J., Prentice-Hall, 379 p.

Jenson, S.K., 1985, Automated derivation of hydrologic basin characteristics from digital elevation models, *in* Auto-Carto 7, International Symposium on Computer-Assisted Cartography, 7th, March 11-14, 1985, Washington, D.C.: Proceedings, p. 301-310.

Jenson, S.K., 1988, Help file—DEM drainage software—VAX, UNIX, PRIMOS: Sioux Falls, So. Dak., EROS Data Center, 4 p.

Jenson, S.K., 1991, Applications of hydrologic information automatically extracted from digital elevation models: Hydrologic Processes, v. 5, no. 1, p. 31-44.

Jenson, S.K., and Domingue, J.O., 1988, Extracting topographic structure from digital elevation data for geographic information system analysis: Photogrammetric Engineering and Remote Sensing, v. 54, no. 11, p. 1593-1600.

Jenson, S.K., and Trautwein, C.M., 1987, Methods and applications in surface depression analysis, *in* Auto-Carto 8, International Symposium on Computer-Assisted Cartography, 8th, Baltimore, MD, March 29-April 3, 1987: Proceedings, p. 137-144.

Johnson, Douglas, 1933, Available relief and texture of topography, a discussion: Journal of Geology, v. 41, no. 3, p. 293-305.

Johnson, G.G., and Vand, Vladimir, 1967, Application of a Fourier data smoothing technique to the meteoritic crater Ries Kessel: Journal of Geophysical Research, v. 72, no. 6, p. 1741-1750.

Johnson, George, 1990, New mind no clothes, *review of* Penrose, Roger, The Emperor's New Mind, concerning computers, minds, and the laws of physics, Oxford University Press: The Sciences (New York Academy of Science), v. 30, no. 4 (July/August), p. 45-49.

Johnston, E.G., and Rosenfeld, Azriel, 1975, Digital detection of pits, peaks, ridges and ravines: IEEE Transactions on Systems, Man and Cybernetics, v. SMC 5, p. 472-480.

Johnston, R.J., 1968, Choice in classification—the subjectivity of objective methods: Annals of the Association of American Geographers, v. 58, no. 3, p. 575-589.

Jones, B.W., Rowan, Michael, and Faust, N.L., 1988, The development of small computer geographic analysis systems for military applications, *in* International Geographic Information Systems Symposium, Arlington, VA, November 15-18, 1987, Proceedings: Washington, D.C., NASA, v. III, p. 407-422.

Jones, N.L., Wright, S.G., and Maidment, D.R., 1990, Watershed delineation with triangle-based terrain models: Journal of Hydraulic Engineering, ASCE, v. 116, no. 10, p. 1232-1251.

Jones, T.A., 1968, Statistical analysis of orientation data: Journal of Sedimentary Petrology, v. 38, no. 1, p. 61-67.

Jones, T.A., and James, W.R., 1969, Analysis of bimodal orientation data: Mathematical Geology, v. 1, no. 2, p. 129-135.

Journel, A.G., 1989, Fundamentals of Geostatistics in Five Lessons, short course in geology, volume 8, presented at the 28th International Geological Congress: Washington, D.C., American Geophysical Union, 40 p.

Julesz, Bela, 1965, Texture and visual perception: Scientific American, v. 212, no. 2, p. 38-48.

Julesz, Bela, 1973, Inability of humans to discriminate between visual texture that agrees in second order statistics, revised: Perception, v. 2, p. 391-405.

Julesz, Bela, 1975, Experiments in the visual perception of texture: Scientific American, v. 232, no. 4, p. 34-43.

Jupp, D.L.B., Strahler, A.H., and Woodcock, C.E., 1989, Autocorrelation and regularization in digital images II, simple image models: IEEE Transactions on Geoscience and Remote Sensing, v. 27, no. 3, p. 247-258.

K

Kamalov, B.A., 1965, On the determination of relief of morphometrical features (in Russian): Geod. Kartogr., v. 10, p. 64-65.

Kammerer, Peter, 1987, Möglichkeiten des Einsatzes der Computerkartographie und des Digitalen Geländemodells bei der Herstellung geomorphologischer Karten (in German): Zeitschrift für Geomorphologie, Supplementband 66, p. 135-154.

Kammerer, Peter, 1987, Computergestützte Reliefanalyse unter Verwendung des Digitalen Geländemodells (in German): Münich, Germany, Münchener Geographische Abhandlung, 36 p.

Kangning, Xiong, 1992, Morphometry and evolution of fenglin karst in the Shuicheng area, western Guizhou, China: Zeitschrift für Geomorphologie, v. 36, no. 2, p. 227-248.

Kapoor, Vivek, 1990, Spatial uniformity of power and the altitudinal geometry of river networks: Water Resources Research, v. 26, no. 10, p. 2303-2310.

Kappraff, J., 1986, The geometry of coastlines—a study in fractals: Computers and Mathematics with Applications, v. 12B, p. 655-671.

Karlinger, M.R., and Troutman, B.M., 1989, A random spatial network model based on elementary postulates: Water Resources Research, v. 25, no. 5, p. 793-798.

Karlinger, M.R., and Troutman, B.M., 1992, Fat fractal scaling of drainage networks from a random spatial network model: Water Resources Research, v. 28, no. 7, p. 1975-1981.

Kazanskiy, B.A., 1989, A digital terrain model for geomorphological data banks: Mapping Sciences and Remote Sensing, v. 26, no. 1, p. 51-57.

Kazanskiy, B.A., 1989, Quantitative characteristics of the shapes of geographical features (in Russian): Izvestiya Akademii Nauk SSSR, seriya geograficheskaya, No. 6, p. 114-119. [translated 1990, *in* Mapping Sciences and Remote Sensing, v. 27, no. 3, p. 177-184]

Keller, E.A., and Melhorn, W.N., 1973, Bedforms and fluvial processes in alluvial stream channels—selected observations, *in* Morisawa, M.E., ed., Fluvial Geomorphology, proceedings of the 4th annual geomorphology symposium: Binghamton, N.Y., SUNY, Publications in Geomorphology, p. 253-283.

Kelley, A.D., Malin, M.C., and Nielson, G.M., 1988, Terrain simulation using a model of stream erosion, *in* SIGGRAPH '88, Proceedings: Computer Graphics, v. 22, no. 4, p. 263-268.

Kemmerly, P.R., 1982, Spatial analysis of a karst depression population—clues to genesis: Geological Society of America Bulletin, v . 93, no. 11, p. 1078-1086.

Kennedy, B.A., 1978, After Horton: Earth Surface Processes, v. 3, no. 3, p. 219-231.

Kennie, T.J.M., and McLaren, R.A., 1988, Modelling for digital terrain and landscape visualization: Photogrammetric Record, v. 12, no. 72, p. 711-745.

Keppel, E., 1975, Approximating complex surfaces by triangulation of contour lines: IBM Journal of Research and Development, v. 19, no. 1, p. 2-11.

Kesseli, J.E., 1950, Geomorphic landscapes: Yearbook of the Association of Pacific Coast Geographers, v. 12, p. 3-10.

Key, J., Maslanik, J.A., and Schweiger, A.J., 1989, Classification of merged AVHRR and SMMR

Arctic data with neural networks: Photogrammetric Engineering and Remote Sensing, v. 55, no. 9, p. 1331-1338.

Kheoruenromne, Irb, Sharp, W.E., and Gardner, L.R., 1976, Variation of link magnitude with map scale: Water Resources Research, v. 12, no. 5, p. 919-923.

Kheyfets, B.S., 1964, An approximation of a topographic surface by means of Chebyshev's orthogonal polygons (in Russian): Izv. vyssh. uchebn. zaved., geodezia i aerofotos"yemka, No. 2.

Kidner, D.B., 1991, Digital terrain models for radio path loss calculations: University of Wales, Dept. of Mathematics and Computing, unpublished Ph.D. dissertation, 269 p. [available from Defence Research Information Centre, Kentigern House, Brown St., Glasgow, UK]

Kidner, D.B., and Jones, C.B., 1991, Implicit triangulations for large terrain databases: European Conference on GIS (EGIS), 2nd, Brussels, Belgium, Proceedings, v. 1, p. 537-546.

Kidner, D.B., and Smith, D.H., 1992, Compression of digital elevation models by Huffman coding: Computers and Geosciences, v. 18, no. 8, p. 1013-1034.

Kiefer, R.W., 1967, Terrain analysis for metropolitan fringe area planning: Proceedings of the American Society for Civil Engineering, v. 93, Paper 5649, Journal of Urban Planning and Devlopment Division, No. UP4, p. 119-139.

Kilchenmann, Andre, 1971, Statistisch-analytische Landschaftsforschung (in German with English abstract and figure captions): Geoforum, v. 7, no. 1, p. 39-53.

Kim, J.J., 1992, Adaptive mesh in visualization of terrain elevation data, *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 5 (Resource Technology 92), p. 271-276.

King, C.A.M., 1968, An example of factor analysis applied to geomorphological data for six areas in northern England, *in* Cole, J.P., and King, C.A.M., eds., Quantitative Geography: London, Wiley, p. 319-334.

King, L.J., 1969, The analysis of spatial form and its relation to geographic theory: Annals of the Association of American Geographers, v. 59, no. 3, p. 573-595.

King, R.B., 1970, A parametric approach to land system classification: Geoderma, v. 4, no. 1, p. 37-46.

King, R.B., 1972, Relief-stream frequency (R-F) diagram—method of displaying physiographic regions: Journal of Geology, v. 80, no. 6, p. 740-743.

King, R.B., 1975, A comparison of information theory interdependence and product-moment correlation analyses as applied to geomorphic and soils data: Zeitschrift für Geomorphologie, v. 19, no. 4, p. 393-404.

Kiracofe, B., Hutchings, J., Nash, G., Niedzwiadek, H., and Edwards, Dan, 1986, CAPIR/DEM—A collection system for geographically based digital elevation data, *in* Opitz, B.K., ed., Geographic Information Systems in Government: Workshop on GIS in Government, Springfield, VA, December 10-13, 1985, Proceedings, v. 2, Hampton, VA, A. Deepak Publishing, p. 595-603.

Kirk, R.L., 1993, Separation of topographic and intrinsic backscatter variations in biscopic radar images—a "magic airbrush", *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 803-804.

Kirkby, M.J., 1983, *Review of* Mandelbrot, B.B., The fractal Geometry of Nature: Earth Surface Proceses and Landforms, v. 8, no. 4, p. 406.

Klingebiel, A.A., and Montgomery, P.H., 1961, Land Capability Classification: U.S. Department of Agriculture, Soil Conservation Service, Agricultural Handbook No. 210, paging unknown.

Klinkenberg, Brian, 1988, Tests of a fractal model of topography: University of Western Ontario, Canada, unpublished Ph.D dissertation, paging unknown.

Klinkenberg, Brian, 1992, Fractals and morphometric measures; is there a relationship?, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 5-20.

Klinkenberg, Brian, and Goodchild, M.F., 1992, The fractal properties of topography—A comparison of methods: Earth Surface Processes and Landforms, v. 17, no. 3, p. 217-234.

Kobayashi, Sumiji, and Hirano, Masashige, 1985, Sabo-engineering and geomorphic information—data base for controlling disasters on Rokko Mountains, Japan (in Japanese with English abstract and figure captions): Transactions, Japanese Geomorphological Union, v. 6., no. 3, p. 205-224.

Kobayashi, Sumiji, and Hirano, Masashige, 1985, Data-base for controlling disasters on Rokko Mountain region, *in* International Symposium on Erosion, Debris Flow and Disaster Prevention, September 3-5, 1985, Tsukuba, Japan: Proceedings, p. 463-468.

Koehmstedt, J.A., 1993, *review of* Quicksurf ADS [version 4.0 (1991)]: Cartography and Geographic Information Systems, v. 20, no. 1, p. 53-55.

Kolb, C.R., and Dornbusch, W.K., Jr., 1966, Analogs of Yuma terrain in the Middle East desert: Vicksburg Mississippi, Corps of Engineers, U.S. Army Engineer Waterways Experiment Station, Technical Report no. 3-630, report 4, volume I of project No. 1-V-0-25001-A-1 31, 36 p. + appendices. [volume II is 19 map plates; plate I: characteristic plan-profile.]

Komar, P.D., 1983, Shapes of streamlined islands on Earth and Mars—experiments and analyses of the minimum-drag form: Geology, v. 11, no. 11, p. 651-654.

Komar, P.D., 1984, The lemniscate loop—comparisons with the shapes of streamlined landforms: Journal of Geology, v. 92, no. 2, p. 133-145.

Komatsu, G., and Baker, V.R., 1993, Meander properties of Venusian channels, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 815-816.

Konovalov, N.Ye., and Gulenko, V.P., 1963, A numerical model of terrain for plotting alignment by means of a computer (in Russian): Transportnoye stroitel'stvo, No. 1.

Konyha, K.D., and Skaggs, R.W., 1992, A coupled, field hydrology-open channel flow model—theory: Transactions of the American Society of Agricultural Engineering, v. 35, no. 5, p. 1431-1440.

Korvin, G., 1992, Fractal Models in the Earth Sciences: New York, Elsevier, 408 p.

Koshinsky, G.D., 1970, The morphometry of shield lakes in Saskatchewan: Limnology and Oceanography, v. 15, p. 695-701.

Kovar, K., and Nachtnebel, H.P., eds., 1993, Applications of Geographic Information Systems in Hydrology and Water Resources Management, proceedings of conference, HydroGIS 93, Vienna, Austria, April, 1993: Wallingford, UK, IAHS Press, IAHS Publication No. 211, 694 p.

Koz'min, I.P., ca. 1950, Morphological indices of topographic ground relief (in Russian): Dissertation for the degree of Candidate, Nauchno-issledovatel'skiy institut geografii, Kiyevskiy Gosudarstvennyy universitet im. T.G. Shevchenko.

Koz'min, N.N., 1952, A hypsometric method for the determination of the coefficient of prominence of ground relief (in Russian): Nauchnyye zapiski Kiyevskogo Gosudarstvennogo universiteta im. T.G. Shevchenko, v. 11, no. 6.

Kraak, M.J., 1989, Computer-assisted cartographical 3D imaging techniques, *in* Raper, Jonathan, ed., Three Dimensional Applications in Geographical Information Systems: London, Taylor and Francis, p. 99-113.

Kraak, M.J., 1993, Cartographic terrain modeling in a three-dimensional GIS environment: Cartography and Geographic Information Systems, v. 20, no. 1, p. 13-18.

Krabill, W.B., Collins, J.G., Link, L.E., Swift, R.N., and Butler, M.L., 1984, Airborne laser topographic mapping results: Photogrammetric Engineering and Remote Sensing, v. 50, no. 6, p. 685-694.

Krasovskaia, Irina, 1988, A study of mesoscale runoff variability: Geografiska Annaler, v. 70 A, no. 3, p. 191-201.

Krause, D.C., and Menard, H.W., 1965, Depth distribution and bathymetric classification of some sea-floor profiles: Marine Geology, v. 3, no. 3, p. 169-193.

Krcho,, Jozef, 1964, Morphometric analysis of the slope conditions of the Kosice Basin (in Czech): Bratislava, Acta Geol. et Geogr. Univ. Com., Geographica, No. 4, paging unknown.

Krcho, Jozef, 1973, Morphometric analysis of relief on the basis of geometric aspects of field theory: Acta Geographica Universitatis Comenianae, Geographica-physica No. 1, Bratislava, Czechoslovakia, Slovak Pedagogical Publishers, p. 7-233.

Krcho, Jozef, 1990, Morfometrická Analyza A Digitalne Modely Georeliéfu (Morphometric Analysis and Digital Models of Georelief, in Czech): Bratislava, Veda, Vydavatel'stvo Slovenskej Akadémie Vied, 427 p.

Krebs, Norbert, 1922, Eine Karte der Reliefenergie Süddeutschlands (in German): Petermanns Mitteilungen, v. 68, p. 49-53 & plate 3.

Krebs, Norbert, 1930, Mass und Zahl in der physischen Geographie (in German): Hermann Wagner Gedächtnisschrift, Petermanns Mitteilungen, Erganzungsband, 45, no. 209, p. 9-16.

Krenkel, P.A., 1962, Application of terrain descriptive techniques to Fort Knox, Ky (final report for 1961): Vicksburg, Miss., U.S. Army Corps of Engineers, Waterways Experiment Station, unpublished document, paging unknown.

Krenkel, P.A., 1963, A Technique for mMacrogeometry Terrain Analysis: Nashville, Tenn., Vanderbilt University, Department of Civil Engineering, Contract No. DA-22-079-Eng-300, U.S. Army Engineer Waterways Experiment Station, Corps of Engineers, Manual, 45 p.

Krumbein, W.C., 1959, Trend surface analysis of contour-type maps with irregular control point spacing: Journal of Geophysical Research, v. 64, no. 7, p. 823-834.

Krumbein, W.C., and Pettijohn, F.J., 1938, Manual of Sedimentary Petrography: New York, Appleton-Century-Crofts, Inc., 549 p.

Krumbein, W.C., and Shreve, R.L., 1970, Some statistical properties of dendritic channel networks: U.S. Office of Naval Research, Geography Branch, Contract Nonr-1228(36), ONR Task no. 389-150, Northwestern University, Geology Department, Report 13, *and* NSF Grant GA-1137, UCLA, Geology Department, Special Project Report, 117 p.

Kubert, B., Szabo, J., and Giulieri, S., 1968, The perspective representation of functions of two variables: Journal of the Association for Computing Machinery, v. 15, no. 2, p. 193-204.

Kubik, Kurt, and Frederiksen, Paul, 1987, Digital elevation models—review and outlook, *in* American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping, annual convention, Baltimore, Maryland, March 29-April 3, Technical Papers, v. 4 (Cartography), p. 238-240.

Kugler, Hans, 1964, Die geomorphologische Reliefanalyse als Grundlage grossmassstäbiger geomorphologischer Kartierung (in German): Leipzig, Germany, Wiss. Veröff. Dt. Inst. f. Ldk., N.F. 21/22, p. 541-655.

Kugler, Hans, 1974, Das Georelief und seine kartographische Modellierung (in German): Halle/Wittenberg, Martin-Luther Universität, unpublished Doctor of Science dissertation, 517 p. + maps. [part 1, Das Georelief und seine Bedeutung, p. 1-131 & figs. 1-8; part 2, Reliefanalyse, p. 132-366 & figs. 9-57; part 3, Kartographische Modellierung des Georelief, p. 368-452; bibliography, p. 453-517]

Kuhle, Matthias, 1989, Quantificational reductionism as a risk in geography and cartography: GeoJournal, v. 18, no. 4, p. 441-450.

Kuipers, Benjamin, 1978, Modeling spatial knowledge: Cognitive Science, v. 2, p. 129-153.

Kumler, M.P., 1990, A quantitative comparison of regular and irregular digital terrain models, *in* GIS/LIS '90 Convention, Anaheim, CA, November 1990, Proceedings, v. 1, p. 255-263.

Kumler, M.P., and Goodchild, M.F., 1991, A new technique for selecting the vertices for a TIN, and a comparison of TIN's and DEM's over a variety of surfaces (abs.), *in* ACSM-ASPRS annual convention, March 25-29, 1991, Baltimore, MD, Proceedings, v. 2 (Cartography and GIS/LIS), p. 179.

Kundert, Kaspar, 1988, Untersuchungen zur Automatischen Klassifikation von Räumlichen Einheiten (in German): Geographisches Institut Universität Zürich, Geoprocessing Reihe, v. 7, 113 p. + appendices.

L

La Barbera, Paolo, and Rosso, Renzo, 1989, On the fractal dimension of stream networks: Water Resources Research, v. 25, no. 4, p. 735-741.

Laboratoire de Géographie de l'Université de Strasbourg (L.I.G.U.S.), 1952, L'étude statistique des versants (in French): Revue de Géomorphologie Dynamique: v. 3, no. 3, p. 143-147.

Laffey, T.J., Haralick, R.M., and Watson, L.T., 1982, Topographic clasification of digital image intensity surfaces, *in* IEEE Workshop on Computer Vision, Theory, and Control: Proceedings, p. 171-177.

LaGro, James Jr., 1991, Assessing patch shape in landscape mosaics: Photogrammetric Engineering and Remote Sensing, v. 57, no. 3, p. 285-293.

Lam, N.S., 1980, Method and problems of areal interpolation: London, (Canada), Geography Department, The University of western Ontario, unpublished Ph.D. dissertation, paging unknown.

Lamb, A.D., Malan, O.G., and Merry, C.L., 1987, Application of image processing techniques to digital elevation models of southern Africa: South African Journal of Science, v. 83, no. 1, p. 43-47.

Lambiotte, J.J., and Taylor, G.R., 1968, A photometric technique for deriving slopes from Lunar Orbiter photography, *in* Enzmann, R.D., ed., Conference on the use of space systems for planetary geology and geophysics, Boston, Mass., May 25-27, 1967, Proceedings: Annals of American Science and Technology Series, p. 205-224.

Lammers, R.B., and Band, L.E., 1990, Automating object representation of drainage basins: Computers and Geosciences, v. 16, no. 6, p. 787-810.

Lancaster, N., 1988, Controls of eolian dune size and spacing: Geology, v. 16, no. 11, p. 972-975.

Lancaster, N., 1988, A bibliography of dunes—Earth, Mars, and Venus: National Aeronautics and Space Administration, cooperative agreement NCC2-346, Contractor Report 4149, 120 p.

Lanfear, K.J., 1990, A fast algorithm for automatically computing Strahler stream order: Water Resources Research, v. 26, no. 6, p. 977-981.

Langbein, W.B., and others, 1947, Topographic characteristics of drainage basins, Contributions to the hydrology of the United States, 1944 (prepared in 1941): U.S. Geological Survey Water-Supply Paper 968-C, p. 125-158.

Lantuéjoul, Ch., and Maisonneuve, F., 1984, Geodesic methods in quantitative image analysis: Pattern Recognition, v. 17, p. 177-187.

Larson, Magnus, 1988, Quantification of beach profile change: Lund, Sweden, Lund University, Department of Water Resources Engineering, Report No. TVVR-1008, 293 p.

Latty, R.S., 1984, Scene segmentation through region growing: Symposium on Machine Processing of Remotely Sensed Data, 10th, West Lafayette, Indiana, 1984, Proceedings, p. 305-314.

Laurini, Robert, and Thompson, Derek, 1992, Fundamentals of spatial information systems: New York, Academic Press (Harcourt Brace Jovanovich), 680 p.

Laut, Peter, and Paine, T.A., 1982, A step towards an objective procedure for land classification and mapping: Applied Geography, v. 2, no. 2, p. 109-126.

Laut, Peter, Firth, D., and Paine, T.A., 1980, Provisional environmental regions of Australia, a working document towards a framework for Australian environmental statistics, Volume 1 The Regions: Canberra, CSIRO in cooperation with the Department of Science and the Environment, 241 p.

Laut, Peter, Austin, M.P., Body, D.N., Faith, D.P., Goodspeed, M.J., and Paine, T.A., 1982, Hydrologic classification of sub-basins in the Macleay Valley, New South Wales: Canberra, CSIRO Institute of Biological Resources, Division of Water and Land Resources, Technical Memorandum 82/13, 51 p. + illustrations.

Lauzon, J.P., Mark, D.M., Kikuchi, Lawrence, and Guevara, J.A., 1985, Two-dimensional run-encoding for quadtree representation: Computer Vision, Graphics, and Image Processing, v. 30, no. 1, p. 56-69.

Law, D.L., 1984, Sculpturing the surface, *in* Mined-land Rehabilitation: New York, Van Nostrand Reinhold, p. 61-71.

Lawson, C.L., 1977, Software for C-1 surface interpolation, *in* Rice, J.R., ed., Mathematical Software III: New York, Academic Press, p. 161-194. [also Jet Propulsion Laboratory, California Institute of Technology Publication No. 77-30]

Lay, Jinn-Guey, 1991, Terrain feature extraction from digital elevation models—A multi-perspective exploration, *in* GIS/LIS, American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, fall convention, Atlanta, GA, October 28-November 1, 1991, Technical Papers, p. A-191 to A-199.

Leberl, F.W., Maurice, K.E., Thomas, J.K., and Kober, Wolfgang, 1991, Radargrammetric measurements from the initial Magellan coverage of planet Venus: Photogrammetric Engineering and Remote Sensing, v. 57, no. 12, p. 1561-1570.

Leberl, F.W., Maurice, K.E., and Thomas, J.K., 1993, Radargrammetric analysis with Magellan data of planet Venus, *in* 1992 ASPRS-ACSM annual convention, Albuquerque, New Mexico, Technical Papers, v. 1, p. 253-263.

LeBlond, P.H., 1979, An explanation of the logarithmic spiral plan shape of headland-bay beaches: Journal of Sedimentary Petrology, v. 49, no. 4, p. 1093-1100.

Ledley, R.S., 1972, Analysis of cells: IEEE Transactions on Computers, v. C-21, no. 7, p. 740-753.

Lee, Jay, 1989, A drop heuristic conversion method for extracting irregular network for digital elevation models, *in* GIS/LIS '89, Orlando, FL, Proceedings, v. 1, p. 30-39.

Lee, Jay, 1991a, Assessing the existing methods for TIN extraction, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, annual convention, Baltimore, Md., March 25-29: Technical Papers, v. 2 (Cartography and GIS /LIS), p. 194-203.

Lee, Jay, 1991b, Comparison of existing methods for building triangular irregular network models of terrain from grid digital elevation models: International Journal of Geographical Information Systems, v. 5, no. 3, p. 267-285.

Lee, Jay, and Chen, Cheng-Hsiu, 1992, Fractal encoded data bases for simulating terrain surfaces with TIN models, *in* GIS/LIS '92, annual conference and exposition, November 10-12, 1992, San Jose, CA: Proceedings, v. 1, p. 426-435.

Lee, Jay, and Snyder, P.K., 1991, Modelling spatial patterns of digital elevation errors for drainage network analysis, *in* GIS/LIS '91, Atlanta, Georgia, October 28-November 1, 1991, Proceedings, v. 1, p. 71-79.

Lee, Jay, Snyder, P.K., and Fisher, P.F., 1992, Modeling the effect of data errors on feature extraction from digital elevation models: Photogrammetric Engineering and Remote Sensing, v. 58, no. 10, p. 1461-1467.

Lees, G., 1964, A new method for determining the angularity of particles: Sedimentology, v. 3, no. 1, p. 2-21.

Lehmann, J.G., 1799, Darstellung einer neuen Theorie der Bezeichnung der schiefen Flächen im Grundriss oder der Situationzeichnung der Berge (in German): Leipzig, Germany, paging unknown.

Leifer, L.A., and Mark, D.M., 1987, Recursive approximation of topographic data using quadtrees and orthogonal polynomials, *in* Auto-Carto 8, International Symposium on Computer-Assisted Cartography, 8th, Baltimore, MD, March 29-April 3, 1987: Proceedings, p. 650-659.

Leopold, L.B., 1969, Quantitative comparison of some aesthetic factors among rivers: U.S. Geological Survey Circular 620, 16 p.

Leopold, L.B., and Langbein, W.B., 1962, The concept of entropy in landscape evolution: U.S. Geological Survey Professional Paper 500-A, 20 p.

Leopold, L.B., and Langbein, W.B., 1963, Association and indeterminacy in geomorphology, *in* Albritton, C.C., Jr., ed., The Fabric of Geology: Reading, Massachusetts, Addison-Wesley Publ. Co., p. 184-192.

Leopold, L.B., and Maddock, Thomas, Jr., 1953, The hydraulic geometry of stream channels and some physiographic implications: U.S. Geological Survey Professional Paper 252, 56 p.

Leopold, L.B., Wolman, M.G., and Miller, J.P., 1964, Fluvial Processes in Geomorphology: San Francisco, W.H. Freeman, 522 p.

Le Roux, J.P., 1991, Determining the channel sinuosity of ancient fluvial systems from paleocurrent data: Journal of Sedimentary Petrology, v. 62, no. 2, p. 283-291.

Leser, Hartmut, 1985, Incorporation of the GMK 25 BRD in the international development of geomorphological maps, *in* Barsch, Dietrich, and Liedtke, Herbert, eds., Geomorphological Mapping in the Federal Republic of Germany, Contributions to the GMK-priority program IV: Berliner Geographische Abhandlungen, v. 39, p. 9-16.

Lettau, H.H., 1967, Small to large-scale features of boundary layer structure over mountain slopes, *in* Reiter, E.R., and Rasmussen, J.L., eds., Proceedings of the Symposium on Mountain Meteorology, 26 June, 1967, Fort Collins, CO: Colorado State University, Atmospheric Science Paper no. 122, p. 1-74.

Lettau, H.H., 1969, Note on aerodynamic roughness-parameter estimation on the basis of roughness-element description: Journal of Applied Meteorology, v. 8, no. 5, p. 828-832.

Leupin, M.M., 1982, Computer-assisted photogrammetric data capture, *in* II Pan American and VII National Congress on Photogrammetry, Photointerpretation and Geodesy, Mexico: Revista Cartografica, No. 42 (July-December), p. 15-24.

Lewis, B. A., and Robinson, J.S., 1978, Triangulation of planar regions, with applications: Computer Journal, v. 21, p. 324-332.

Lewis, L.A., 1968, Analysis of surficial landform properties—the regionalization of Indiana into units of morphometric similarity: Proceedings of the Indiana Academy of Science, v. 78, p. 317-328.

Ley, R.G., 1986, Accuracy assessment of digital terrain models, *in* Blakemore, Michael, ed., Auto Carto London, ICA symposium, September 14-19, 1986, 1986,: Proceedings, v. I, p. 455-464.

Leymarie, Pierre, Dardel, Jacques, and Renouard, Laurent, 1990, The use of digital elevation models computed from SPOT stereopairs for uranium exploration, *in* Gaal, Gabor, and Merriam, D.F., eds., Computer Applications in Resource Estimation, Prediction and Assessment for Metals and Petroleum: New York, Pergamon Press, p. 225-238.

Li, Deren, and Chen, X.-Y., 1991, Automatically generating triangulated irregular digital terrain model networks by mathematical morphology: ISPRS Journal of Photogrammetry and Remote Sensing, v. 46, no. 5, p. 283-295.

Li, Hungwen, and Kender, J.R., eds., 1988, Special issue on computer vision: Proceedings of the Institute of Electrical and Electronics Engineers, v. 76, no. 8, p. 859-1050.

Li, Rongxing, 1992, Shape from shading—a method of integration of sonar images and bathymetric data for ocean mapping: Marine Geodesy, v. 15, nos. 2-3, p. 115-127.

Li, Zhilin, 1988, On the measure of digital terrain model accuracy: Photogrammetric Record, v. 12, no. 72, p. 873-877.

Li, Zhilin, 1990, Sampling Strategy and Accuracy Assessment for Digital Terrain Modelling: University of Glasgow, unpublished Ph.D. thesis, 299 p.

Li, Zhilin, 1991, Effects of check points on the reliability of DTM accuracy estimates obtained from experimental tests: Photogrammetric Engineering and Remote Sensing, v. 57, no. 10, p. 1333-1340.

Li, Zhilin, 1992, Variation of the accuracy of digital terrain models with sampling interval: Photogrammetric Record, v. 14, no. 79, p. 113-128.

Li, Zhilin, and Openshaw, Stan, 1993, A natural principle for the objective generalization of digital maps: Cartography and Geographic Information Systems, v. 20, no. 1, p. 19-29.

Lidmar-Bergström, Karna, Elvhage, Christian, and Ringberg, Bertil, 1991, Landforms in Skåne, south Sweden. Periglacial and glacial landforms analysed from two relief maps: Geografiska Annaler, v. 73 A, no. 2, p. 61-91. [plate 1 is 1:250,000-scale shaded-relief map]

Liebermann,T.D., 1991, Calculation of daily and instantaneous potential solar radiation and solar angles on sloping surfaces, *in* ESRI (Environmental Systems Research Institute, Inc.), Annual User Conference 11th, Redlands, Calif., Proceedings, v. 1, p. 373-386.

Lied, Karstein, and Bakkehøi, S., 1980, Empirical calculations of snow-avalanche run-out distance based on topographic parameters: Journal of Glaciology, v. 26, no. 94, p. 165-177.

Lied, Karstein, and Toppe, Ronald, 1989, Calculation of maximum snow-avalanche run-out distance by use of digital elevation models: Annals of Glaciology, v. 13, p. 164-169.

Lifton, N.A., and Chase, C.G., 1992, Tectonic, climatic and lithologic influences on landscape fractal dimension and hypsometry; implications for landcape evolution in the San Gabriel Mountains, California, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 77-114.

Linton, D.L., 1951, The delimitation of morphological regions, *in* Stamp, L.D., and Wooldridge, S.W., eds., London Essays in Geography: Cambridge, Mass., Harvard University Press, p. 199-217.

Lipton, A. E., 1992, Effects of slope and aspect variations on satellite surface retrievals and mesoscale analysis in mountainous terrain: Journal of Applied Meteorology, v. 31, no. 3, p. 255-264.

Liu, Tanzhuo, 1992, Fractal structure and properties of stream networks: Water Resources Research, v. 28, no. 11, p. 2981-2988.

Lo, C.P., 1982, Quantitative regional analysis of Chu Chiang Delta area of South China using Landsat images: GeoJournal, v. 6, no. 3, p. 231-240.

Longuet-Higgins, M.S., 1957, The statistical analysis of a random moving surface: Philosophical Transactions of the Royal Society of London, Series A, v. 249, p. 321-387.

Longuet-Higgins, M.S., 1957, Statistical properties of an isotropic random surface: Philosophical Transactions of the Royal Society of London, Series A, v. 250, p. 157-174.

Loon, J.C., 1978, Cartographic Generalization of Digital Terrain Models: Columbus, The Ohio State University, Ph.D. dissertation, 199 p. [Ann Arbor, MI, University Microfilms Int'l , No. 79-02171]

Loon, J.C., and Patias, P.G., 1985, Digital terrain elevation model analysis: Fort Belvoir, VA, U.S. Army Engineer Topographic Laboratories Report no. ETL-0393, paging unknown.

Loughridge, M.S., 1986, Relief map of the Earth's surface: Eos, Transactions of the American Geophysical Union, v. 67, no. 10, p. 121.

Loup, J., 1963, Altitudes moyennes et coefficients d'aération dans la Valais (in French): Revue de Géographie Alpine, v. 51, no. 1, p. 5-18.

Loutit, J.F., 1976, Limiting parameters: Nature, v. 263, no. 5579, p. 634.

Lozar, R.C., 1992, Global climatic change management by watershed basin units, *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 4 (Remote Sensing & Data Acquisition), p. 150-159.

Lubowe, J.K., 1964, Stream junction angles in the dendritic drainage pattern: American Journal of Science, v. 262, no. 3, p. 325-339.

Lucchitta, B.K., and Gambell, N.A., 1970, Evaluation of photoclinometric profile determination, *in* Analysis of Apollo 8 Photographs and Visual Observations: National Aeronautics and Space Administration, Special Publication SP-201, p. 51-59.

Lue, Yan, and Novak, Kurt, 1992, An operational image matching package <MATCH>, *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 2 (Photogrammetry and Surveying), p. 47-56.

Luisi, P.-L., and Thomas, R.M., 1990, The pictographic molecular paradigm: Naturwissenschaften, v. 77, no. 2, p. 67-74.

Lustig, L.K., 1969, Trend-surface analysis of the Basin and Range province and some geomorphic implications: U.S. Geological Survey Professional Paper 500-D, 70 p.

Lüttig, G., 1968, Ist die Reliefenergie ein Mass für das Alter der Endmoränen (in German): Eiszeitalter und Gegenwart, v. 19, p. 197-202.

M

Mabbutt, J.A., 1968, Review and concepts of land classification, *in* Stewart, G.A., ed., Land Evaluation, Papers of a CSIRO Symposium, UNESCO: Melbourne, Macmillan of Australia, p. 11-28.

Macdonald, K.C., Scheirer, D.S., Carbotte, Suzanne, and Fox, P.J., 1993, It's only topography—Parts I and II: GSA Today, v. 3, nos. 1 & 2, p. 1, 24, 25, 29-31, 34, & 35.

MacDonald, T.L., 1931, The distribution of lunar altitudes: Journal of the British Astronomical Association, v. 41, p. 172-183 & 228-239.

MacDonald, R.A., Lebing, Gary, and Hathaway, R.M., compilers, 1992, Joint U.S. Geological Survey/Jet Propulsion Laboratory scientific visualization workshop: Norfolk, VA, May 18-19, 1992, program and abstracts, 27 p.

MacDougall, E.B., 1976, Computer Programming for Spatial Problems: New York, John Wiley and Sons (Halsted Press), 160 p.

MacEachren, A.M., 1982, Map complexity—comparison and measurement: The American Cartographer, v. 9, no. 1, p. 31-46.

Macedonio, G., and Pareschi, M.T., 1991, An algorithm for the triangulation of arbitrarily distributed points—applications to volume estimate and terrain fitting: Computers and Geosciences, v. 17, no. 7, p. 859-874.

Mackay, D.S., 1990, Knowledge-based classification of higher order terrain objects on digital elevation models: Toronto, University of Toronto, unpublished M.Sc. thesis, paging unknown.

Mackay, D.S., Band, L.E., and Robinson, V.B., 1991, An object-oriented system for the organization and representation of terrain knowledge for forested ecosystems, *in* GIS/LIS '91, Atlanta, Georgia, October 28-November 1, 1991, Proceedings, v. 2, p. 617-626.

Mackay, D.S., Robinson, V.B., and Band, L.E., 1992, Development of an integrated knowledgebased system for managing spatiotemporal ecological simulations, *in* GIS/LIS '92, Annual conference and exposition, November 10-12, 1992, San Jose, CA, Proceedings, v. 2, p. 494-503.

Mackin, J.H., 1963, Rational and empirical methods of investigation in geology, *in* Albritton, C.C. Jr., ed., The Fabric of Geology: Reading, Massachusetts, Addison-Wesley, p. 135-163.

Mackintosh, A.R., 1987, The first electronic computer: Physics Today, v. 40, no. 3, p. 25-32.

Maguire, D.J., Kimber, Barry, and Chick, Julian, 1991a, Integrated GIS: the importance of raster, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing Annual Convention, Baltimore, Md., March 25-29: Technical Papers, v. 4 (GIS), p. 107-116.

Maguire, D.J., Goodchild, M.F., and Rhind, D.W., eds., 1991b, Geographical Information Systems—Principles and Applications: New York, Wiley and Sons, 2 vols., 1096 p.

Mahoney, Patricia, Carstensen, L.W., and Campbell, J.B., 1991, Effects of technological change on relief representation on USGS topographic maps: Cartographica, v. 28, no. 4, p. 9-31.

Majure, J.J., and Eash, D.A., 1991, An automated method to quantify physical basin characteristics, *in* Mallard, G.E., and Aronson, D.A., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Monterey, California, March 11-15, 1991, USGS Water-Resources Investigations Report no. 91-4034, p. 558-561.

Makarovic, Branko, 1972, Information transfer in reconstruction of data from sampled points: Photogrammetria, v. 28, no. 4, p. 111-130.

Makarovic, Branko, 1973, Progressive sampling for digital terrain models: ITC (International Institute for Aerospace Survey and Earth Sciences) Journal (Enschede, Netherlands), no. 1973-3, p. 397-416.

Makarovic, Branko, 1975, Amended strategy for progressive sampling: ITC (Intl. Inst. Aerospace Survey and Earth Sciences) Journal (Enschede, Neth.), no. 1975-1, p. 117-128.

Makarovic, Branko, 1976, A digital terrain model system: ITC Journal (Enschede, Neth.), no. 1976-1, p. 57-83.

Makarovic, Branko, 1977, Composite sampling for digital terrain models: I.T.C. Journal (Enschede, Neth.), no. 1977-3, p. 406-433.

Makarovic, Branko, 1978, Digital Terrain Models—a constituent of geo-information systems, *in* Dutton, Geoffrey, ed., Harvard Papers on Geographic Information Systems, Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University: International advanced study symposium on topological data structures for geographic information systems, 1st., Dedham, Mass., 1977, Proceedings, v. 5, Data Structures: Surficial and Multi-Dimensional, p. (Makarovic) 1-19.

Maksimov, G.S., 1953, The measurement of sinuous or meandering lines on maps (in Russian): Uchenyye zapiski Vysshego Arkticheskogo Morskogo uchilishcha im. admirala Makarova, no. 4 (Leningrad-Moscow).

Malcevschi, Sergio, 1987, Lo studio del paesaggio naturale mediante indici ambientali sintetici (in Italian): Terra, Rivista di scienze ambientali e territoriali (Bologna), v. 1, Jan.-March, p. 70-77. [landscape perception and classification]

Males, R.M., and Gates, W.E., 1980, ADAPT—A digital terrain model-based geographic information system, *in* Moore, P.A., ed., Cartographic and Statistical Data Bases and Mapping Software: v. 8, Harvard Library of Computer Graphics, p. 182-195.

Maling, D.H., 1968, How long is a piece of string?: Cartographic Journal, v. 5, no. 2, p. 147-156.

Maling, D.H., 1989, Measurements from Maps, Principles and Methods of Cartometry: Oxford, Pergamon Press, 577 p.

Malinverno, Alberto, 1989, Testing linear models of sea-floor topography: Pure and Applied Geophysics, v. 131, nos. 1/2, p. 139-155.

Malinverno, Alberto, 1991, Inverse square-root dependence of mid-ocean-ridge flank roughness on spreading rate: Nature, v. 352, no. 6330, p. 58-60.

Mandelbrot, B.B., 1967, How long is the coastline of Britain? statistical self-similarity and fractional dimension: Science, v. 156, no. 3775, p. 636-638.

Mandelbrot, B.B., 1975, Stochastic models for the Earth's relief, the shape and the fractal dimension of the coastlines, and the number-area rule for islands: Proceedings of the National Academy of Science, v. 72, no. 10, p. 3825-3828.

Mandelbrot, B.B., 1977, Fractals—Form, Chance and Dimension: San Francisco, California, W.H. Freeman and Company, 365 p.

Mandelbrot, B.B., 1983, The Fractal Geometry of Nature (updated 2nd printing of 1982 edition): San Francisco, California, W.H. Freeman and Company, 460 p.

Mandelbrot, B.B., 1982, Comment *on* Fournier, Alain, Fussell, Don, and Carpenter, Loren, Computer rendering of fractal stochastic models: Communications of the Association for Computing Machinery, v. 25, no. 8, p. 581-583.

Mandelbrot, B.B., 1988, Fractal landscapes without creases and rivers—Appendix A, *in* Peitgen, H.-O., and Saupe, Dietmar, eds., The Science of Fractal Images: New York, Springer Verlag, p. 243-260.

Mandelbrot, B.B., Passoja, D.E., and Paullay, A.J., 1984, Fractal character of fracture surfaces of metals: Nature, v. 308, no. 5961, p. 721-722.

Manokhina, Ye.I., 1939, The coefficient of prominence of topographic relief (in Russian): Trudy po gidrologii. Geografo-ekonomiche skiy nauchno-issledovatel'skiy institut pri LGU (Leningr. gos. un-t, Leningrad), no. 2.

Manson, Vincent, and Imbrie, John, 1964, FORTRAN Program for Factor and Vector Analysis of Geologic Data Using an IBM 7090 or 7094/1401 Computer System: Lawrence, University of Kansas, State Geological Survey, Special Publication 13, 46 p.

Marani, Alessandro, Rigon, Riccardo, and Rinaldo, Andrea, 1991, A note on fractal channel networks: Water Resources Research, v. 27, no. 12, p. 3031-3049.

Marcus, Alan, 1980, First-order drainage basin morphology—definition and distribution: Earth Surface Processes, v. 5, no. 4, p. 389-398.

Mardia, K.V., 1972, Statistics of Orientation Data: New York, Academic Press, 357 p.

Mareschal, J.C., 1989, Fractal reconstruction of sea-floor topography: Pure and Applied Geophysics,v. 131, no. 1/2, p. 197-210.

Marinov, B.D., 1992, Statistic topological segmentation of digital terrain images, *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 2 (Photogrammetry and Surveying), p. 197-206.

Mark, D.M., 1974, Line intersection method for estimating drainage density: Geology, v. 2, no. 5, p. 235-236.

Mark, D.M., 1975a, Geomorphometric parameters—a review and evaluation: Geografiska Annaler, v. 57 A, no. 3-4, p. 165-177.

Mark, D.M., 1975b, Computer analysis of topography—a comparison of terrain storage methods: Geografiska Annaler, v. 57 A, no. 3-4, p. 179-188.

Mark, D.M., 1977, Topological Randomness of Geomorphic Surfaces: Burnaby, British Columbia, Simon Fraser University, unpublished Ph.D. dissertation, 138 p. [also Technical Report #15, "Geographic Data Structures," Office of Naval Research Contract N00014-75-C-0886]

Mark, D.M., 1978, Concepts of "data structure" for digital terrain models: Digital Terrain Models (DTM) Symposium, May 9-11, 1978, St. Louis, Missouri, American Society of Photogrammetry, Proceedings, p. 24-31.

Mark, D.M., 1978, Comments *on* Freiberger and Grenander's "Surface patterns in theoretical geography": Computers and Geosciences, v. 4, no. 4, p. 371-372.

Mark, D.M., 1978, Topological properties of geographic surfaces—Applications in computer cartography, *in* Dutton, Geoffrey, ed., Harvard Papers on Geographic Information Systems, Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University: International advanced study symposium on topological data structures for geographic information systems, 1st., Dedham, Mass., 1977, Proceedings, v. 5, Data Structures: Surficial and Multi-Dimensional, p. (Mark) 1-12.

Mark, D.M., 1979a, Topology of ridge patterns, randomness and constraints: Geological Society of America Bulletin, Part I, v. 90, no. 2, p. 164-172.

Mark, D.M., 1979b, Phenomenon-based data-structuring and digital terrain modelling: Geo-Processing, v. 1, no. 1, p. 27-36.

Mark, D.M., 1979c, Review *of* 'Fractals: Form, Chance and Dimension': Geo-Processing, v. 1, no. 2, p. 202-204.

Mark, D.M., 1980, On scales of investigation in geomorphology: The Canadian Geographer, v. 24, no. 1, p. 81-82.

Mark, D.M., 1980, Scales of investigation in geomorphology, reply: The Canadian Geographer, v. 24, no. 3, p. 314-315.

Mark, D.M., 1981, Topology of ridge patterns—possible physical interpretation of the "minimum spanning tree" postulate: Geology, v. 9, no. 8, p. 370-372.

Mark, D.M., 1982, Digital elevation models and data structuring issues, *in* Douglas, D.H., and Boyle, A.R., eds., Computer-Assisted Cartography and Geographic Information Processing, Hope and Realism: Canadian Cartographic Association, Department of Geography, University of Ottawa, p. 81-84.

Mark, D.M., 1983a, Relations between field-surveyed channel networks and map-based geomorphometric measures, Inez, Kentucky: Annals of the Association of American Geographers, v. 73, no. 3, p. 358-372.

Mark, D.M., 1983b, On the composition of drainage networks containing lakes—statistical distribution of lake in-degrees: Geographical Analysis, v. 15, no. 2, p. 97-106.

Mark, D.M., 1983c, Automated detection of drainage networks from digital elevation models, *in* International Symposium on Automated Cartography, 6th, Ottawa, Canada, 1983, Proceedings, v. II (Automated Cartography): p. 288-298. [republisned 1984, *in* Cartographica, v. 21, no. 2 & 3, p. 168-178.]

Mark, D.M., 1986, Knowledge-based approaches for contour-to-grid interpolation on desert pediments and similar surfaces of low relief, *in* International Symposium on Spatial Data Handling, 2nd, Seattle, Washington, July 5-10, 1986, IGU/ICA, Proceedings, p. 225-234.

Mark, D.M., 1986, Construction of quadtrees and octtrees from raster data, a new algorithm based on run-encoding: The Australian Computer Journal, v. 18, no. 3, p. 115-120.

Mark, D.M., 1988, Network models in geomorphology, *in* Anderson, M.G., ed., Modelling Geomorphological Systems, New York, John Wiley & Sons, p. 73-97.

Mark, D.M., and Aronson, P.B., 1984, Scale-dependent fractal dimensions of topographic surfaces—an empirical investigation, with applications in geomorphology and computer mapping: Mathematical Geology, v. 16, no. 7, p. 671-683.

Mark, D.M., and Church, Michael, 1977, On the misuse of regression in Earth science: Mathematical Geology, v. 9, no. 1, p. 63-75.

Mark, D.M., and Frank, A.U., 1989, Concepts of space and spatial language, *in* International Symposium on Computer-Assisted Cartography, 9th, Baltimore, April 2-7, 1989, American Society for Photogrammetry and Remote Sensing—American Congress on Surveying and Mapping, Proceedings, p. 538-556.

Mark, D.M., and Lauzon, J.P., 1985, The space efficiency of quadtrees, an empirical examination including the effects of 2-dimensional run-encoding: Geo-Processing, v. 2, no. 4, p. 367-383.

Mark, D.M., and Peucker, T.K., 1975, Discussion *of* W. Pillewizer: "Talasymmetrie und Kartometrie:" Zeitschrift für Geomorphologie, v. 19, no. 2, p. 209-212.

Mark, D.M., and Warntz, William, 1982, James Clerk Maxwell, the first quantitative geomorphologist? Discussion: Mathematical Geology, v. 14, no. 2, p. 195-197.

Mark, R.K., 1992, A multidirectional, oblique-weighted, shaded-relief image of the Island of

Hawaii: U.S. Geological Survey Open-file Report 92-422, 3p.

Mark, R.K., 1992, Map of debris-flow probability, San Mateo County, California: U.S. Geological Survey, Miscellaneous Investigations Series, Map I-1257-M, scale 1:62,500, 2 sheets.

Mark, R.K., and Aitken, D.S., 1990, Shaded-relief topographic map of San Mateo County, California: U.S. Geological Survey Miscellaneous Investigations Map I-1257-K, scale 1:62,500.

Mark, R.K., Newman, E.B., and Brabb, E.E., 1988, Slope map of San Mateo County, California: U.S. Geological Survey Miscellaneous Investigations Map I-1257-J, scale 1:62,500.

Mark, R.K., Pike, R.J., Bortoluzzi, Giovanni, and Ligi, Marco, 1991, Mediterranean seabed in digital shaded relief: Eos, Transactions of the American Geophysical Union, v. 72, no. 26, p. 273 & 275.

Mark, R.K., Pike, R.J., Bortoluzzi, Giovanni, and Reichenbach, Paola, 1992, Image from combined land and seafloor DEM's illuminates Tyrrhenian tectonics (abs.): Eos Transactions of the American Geophysical Union, v. 73, no. 14 (Supplement), p. 280.

Mark, R.K., Pike, R.J., and Reichenbach, Paola, 1993, A test for error in digital topography (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 194.

Marks, Danny, Jeff Dozier, and James Frew, 1983, Automated basin delineation from digital terrain data: Greenbelt, MD, Goddard Space Flight Center, NASA Technical Memorandum 84984, 15 p.

Marks, Danny, Jeff Dozier, and James Frew, 1984, Automated basin delineation from digital elevation data: Geo-Processing, v. 2, no. 3 p. 299-311.

Marks, K.M., McAdoo, D.C., and Smith, W.H.F., 1993, Mapping the Southwest Indian Ridge with Geosat: Eos, Transactions of the American Geophysical Union, v. 74, no. 8, p. 81 and 86.

Markus, Bela, 1983, Digital relief modelling (in Hungarian): Geodezia es Kartografia, No. 1, paging unknown.

Markus, Bela, and Molnar, T., 1983, Computerized exploration of relief features (in Hungarian): Geodezia es Kartografia, No. 4, paging unknown.

Marsal, Dieter, 1987, Statistics for Geoscientists: Oxford, Pergamon Press, 175 p. +.

Marsik, Z., 1971, Automatic relief shading: Photogrammetria, v. 27, no. 2, p. 57-70.

Marshall, J.R., ed., 1987, Clastic Particles—scanning electron microscopy and shape analysis of sedimentary and volcanic clasts: New York, Van Nostrand Reinhold, 346 p.

Martin, Mike, 1992, Do-it-yourself visualization: Information Systems Newsletter, NASA/OSSA, Issue 26 (October, 1992), p. 13-15.

Martonne, E. de, 1940, Interprétation géographique de l'hypsométrie française (in French): Comptes Rendues hebdomadaires des Scéances de l'Académie des Sciences, v. 211, p. 378-380 and 426-428.

Martonne, E. de, 1941, Hypsométrie et morphologie, détermination et interpretation des altitudes moyennes de la France et de ses grandes régions naturelles (in French): Annales de Géographie, v. 50, p. 241-254.

Martz, L.W., and DeJong, Eeltje, 1987, Using Cesium-137 to assess the variability of net soil erosion and its association with topography in a Canadian prairie landscape: Catena, v. 14, no. 5, p. 439-451.

Martz, L.W., and DeJong, Eeltje, 1988, CATCH: a FORTRAN program for measuring catchment area from digital elevation models: Computers and Geosciences, v. 14, no. 5, p. 627-640.

Martz, L.W., and DeJong, Eeltje, 1991, Using Cesium-137 and landform classification to develop a net soil erosion budget for a small Canadian prairie watershed: Catena, v. 18, no. 3/4, p. 289-308.

Martz, L.W., and Garbrecht, J., 1992, Numerical definition of drainage network and subcatchment areas from digital elevation models: Computers and Geosciences, v. 18, no. 6, p. 747-761.

Mason, G.L., Dean, T.C., and Farr, J.V., 1990, Engineer model improvement program, Report 1, Standardization of Terrain Data for the Vector-In-Commander and Engineer Functional Area Models: Vicksburg, Miss., U.S. Army Engineer Waterways Experiment Station, Technical Report GL-90-8, paging unknown.

Mason, L.E., 1970, Dynamics analysis report for the LRV (lunar roving vehicle) mobility subsystem: Santa Barbara, CA, General Motors Corp., AC Electronics-Defense Research Laboratories, Report TR70-92, 175 p. + appendices.

Mather, P.M., 1972, Areal classification in geomorphology, *in* Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, p. 305-322.

Mather, P.M., and Doornkamp, J.C., 1970, Multivariate analysis in geography, with particular reference to drainage-basin morphometry: Transactions of the Institute of British Geographers, Publication No. 51, p. 163-187.

Matheron, George, 1965, Les Variables Régionalisées et Leur Estimation—une Application de la Théorie des Fonctions Aléatoires aux Sciences de la Nature: Paris, Masson et Cie, Editeurs, 305 p.

Matsuda, H., 1980, Digital national land information: GeoJournal (Japan), v. 4, no. 4, p. 313-318.

Matthees, R.A., and Danes, Z.F., 1974, Polygonalism of an experimental crater: Northwest Science, v. 48, no. 4, p. 205-210.

Matthews, Neffra, 1991, Interpolating large-scale contour information from digital terrain data, *in* GIS/LIS, American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, Fall Convention, Atlanta, October 28-November 1, 1991, Technical Papers, p. A-120 to A-126.

Matui, Isamu, 1934, The statistical mesh-method of studying geography: Japanese Journal of Geology and Geography, v. 11, no. 4, p. 273-285.

Maxwell, D.A., 1970, Mathematical surface approximation of the terrain: Highway Research Record, p. 319*ff*.

Maxwell, J. Clerk, 1870, On hills and dales: The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, v. 40, 4th Series, Juky-Dec., no. 269, p. 421-427.

Maxwell, J. C., 1960, Quantitative geomorphology of the San Dimas Experimental Forest, California: Office of Naval Research Project NR 389-042, Contract N6 ONR 271-30: Nonr 266 (50), Technical Report No. 19: New York, Columbia University, Department of Geology, 95 p. [revised and published 1967, *as* Quantitative geomorphology of some mountain chaparral watersheds of southern California, *in* Garrison, W.L., and Marble, D. F., eds., Quantitative Geography, Part II, Physical and Cartographic Topics: Evanston, Ill., Northwestern University, Department of Geography, Studies in Geography No. 14, p. 108-226]

Maxwell, J. C., 1962, Test of quantitative terrain description systems at Fort Leonard Wood, Missouri, *for* U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg Mississippi, Contract No. Da 22079 Eng. 303: Rolla, Missouri School of Mines and Metallurgy, Departments of Civil Engineering and Geology and Geological Engineering, 88 p.

Mayer, Larry, Mergner-Keefer, Marcia, and Wentworth, C.M., 1981, Probability models and computer simulation of landscape evolution: U.S. Geological Survey Open-file Report 81-656, 31 p.

Mays, R.R., 1966, Production of numerical maps, *in* Conference-Numerical Topographic Data and Other New Map Products, Fort Belvoir, Va., May 3-5, 1966, Proceedings: Washington, Department of the Army, Office of the Chief of Engineers, p. 38-41K (15 p.).

Mays, R.R., and Noma, A.A., 1970, Automated terrain modeling, *in* American Congress on Surveying and Mapping, annual meeting, March 1-6, 1970, Proceedings, p. 304-337.

Maze, W.H., 1944, The geomorphology of the central eastern area of New South Wales: Journal of the Royal Society of New South Wales, v. 78, p. 28-41.

Mazur, E.R., and Castner, H.W., 1990, Horton's ordering scheme and the generalisation of river networks: The Cartographic Journal, v. 27, no. 2, p. 104-112.

McAdams, H.T., 1969, Computer mapping and data presentation (Off-road mobility research): Buffalo, N.Y., Cornell Aeronautical Laboratory, Inc., Technical Memorandum No. VJ-2330-G-55, 106 p.

McAdams, H.T., Reese, P.A., and Lewandowski, G.M., 1971, Trafficability and visibility analysis of the lunar surface: Buffalo, New York, Cornell Aeronautical Laboratory, Inc., Technical Report VT-2976-D-1, 78 p.

McArthur, D.S., and Ehrlich, Robert, 1977, An efficiency evaluation of four drainage basin shape ratios: The Professional Geographer, v. 29, no. 3, p. 290-295.

McBratney, A.B., Webster, R., and Burgess, T.M., 1981, The design of optimal sampling schemes for local estimation and mapping of regionalized variables—I theory and method: Computers and Geosciences, v. 7, no. 4, p. 331-334.

McCauley, J.F., 1964, Terrain analysis of the lunar equatorial belt: Flagstaff, Arizona, U.S. Geological Survey open-file report, 44 p. (1965).

McCauley, J.F., 1965, Slope frequency distributions as a means of classifying lunar terrain (abs.), *in* Abstracts for 1964: Geological Society of America Special Paper 82, p. 130.

McConnell, Harold, ca. 1962-64, at least five unpublished typescripts on various aspects of morphometry: Department of Earth Science, Northern Illinois University, and Department of Geography, University of Iowa (see Chorley, 1972, for list).

McConnell, Harold, 1966, A statistical analysis of spatial variability of mean topographic slope on stream-dissected glacial materials: Annals of the Association of American Geographers, v. 56, no. 4, p. 712-728.

McCoy, R.M., 1970, Automatic measurement of drainage networks: IEEE Transactions on Geosciences and Electronics, v. 8, p. 178-182.

McCoy, R.M., 1971, Rapid measurement of drainage density: Geological Society of America Bulletin, v. 82, no. 3, p. 757-762.

McCue, G.A., and Green, Jack, 1965, Pisgah Crater terrain analysis: Photogrammetric Engineering, v. 31, no. 9, p. 810-821.

McCullagh, M.J., 1979, Triangular systems in surface representation, *in* Auto-Carto 4, International Symposium on Computer-Assisted Cartography, 4th, Proceedings, v. I, p. 146-153.

McCullagh, M.J., 1988, Terrain and surface modelling systems, theory and practice: Photogrammetric Record, v. 12, no. 72, p. 747-779.

McCulloch, T.M., and Marinaro, R.A., 1988, Producing 1:24,000-scale digital line graphs from scanned data, *in* American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, annual convention, March 13-18, 1988, St. Louis, Missouri, Technical papers, v. 2 (Cartography), p. 243-251.

McCusker, D.E., 1991, Evolution of large format raster scanning at Defense Mapping Agency, *in* American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing annual convention, Baltimore, Md., March 25-29: Technical Papers, v. 4 (GIS),p. 117-122.

McDonald, M.F., and Katz, E.J., 1969, Quantitative method for describing the regional topography of the ocean floor: Journal of Geophysical Research, v. 74, no. 10, p. 2597-2607.

McEwen, A.S., and Malin, M.C., 1989, Dynamics of Mount St. Helens' 1980 pyroclastic flows, rockslide-avalanche, lahars, and blast: Journal of Volcanology and Geothermal Research, v. 37, no. 3/4, p. 205-231.

McGuire, M.J., and Gallagher, J.J., Jr., 1979, Techniques for computer-aided analysis of lineaments, *in* Podwysocki, M.H., and Earl, J.L., eds., International Conference on Basement Tectonics, 2nd, 1978, Proceedings: Denver, Colorado, Basement Tectonics Committee, Inc., p. 528-541.

McHarg, I.L., 1969, Design With Nature: Garden City, N.Y., Natural History Press, 198 p.

McKenna, D.G., 1986, The inward spiral method for the generation of triangulated irregular networks, *in* Optiz, B.K., ed., Geographic Information Systems in Government: Workshop on GIS in Government, Springfield, VA, December 10-13, 1985, Proceedings, v. 2, Hampton, VA, A. Deepak Publishing, p. 945-966.

McKenna, D.G., 1987, The inward spiral method, an improved TIN generation technique and data structure for land planning applications, *in* Chrisman, N.R., ed., Auto-Carto 8, International Symposium on Computer Assisted Cartography, 8th, Baltimore, Maryland, March 29-April 3, 1987, ASPRS/ACSM, Proceedings, 670-679.

McKeown, F.A., Jones-Cecil, Meridee, Askew, B.L., and McGrath, M.B., 1988, Analysis of stream-profile data and inferred tectonic activity, eastern Ozark Mountain region: U.S. Geological Survey Bulletin 1807, 39 p.

McLain, D.H., 1976, Two dimensional interpolation from random data: Computer Journal, v. 19, p. 178-181.

McMaster, R.B., 1989, ed., Numerical Generalization in Cartography: Cartographica, v. 26, no. 1, Monograph 40, 121 p.

Meek, D.S., and Walton, D.J., 1991, Several methods for representing discrete data by line segments: Cartographica, v. 28, no. 2, p. 13-20.

Meier, M.F., 1954, Area-altitude graph of a mature drainage basin (abs.): Bulletin of the Geological Society of America, v. 65, no. 12, part 2, p. 1283-1284.

Meier, Peter, 1969, Numerische Methoden der Relieferfassung: Geographica Helvetica, v. 24, p. 146-151.

Melton, M.A., 1957, An analysis of the relations among elements of climate, surface properties and geomorphology: Office of Naval Research project NR 389-042, New York, Columbia University, Department of Geology, Technical Report 11, 102 p.

Melton, M.A., 1958a, Geometric properties of mature drainage systems and their representation in an E_4 phase space: Journal of Geology, v. 66, no. 1, p. 35-56.

Melton, M.A., 1958b, Correlation structure of morphometric properties of drainage systems and their controlling agents: Journal of Geology, v. 66, no. 4, p. 442-460.

Melton, M.A., 1958c, List of sample parameters of quantitative properties of landforms—their use in determining the size of geomorphic experiments: Office of Naval Research project NR 389-042, New York, Columbia University, Department of Geology, Technical Report 16, 17 p.

Melton, M.A., 1959, A derivation of Strahler's channel-ordering system: Journal of Geology, v. 67, no. 3, p. 345-346.

Melton, M.A., 1962, Methods for measuring the effect of environmental factors on channel properties: Journal of Geophysical Research, v. 67, no. 4, p. 1485-1490. [see *discussion by* Bernard Harris, JGR, v. 67, no. 4, p. 1493-1494]

Melton, M.A., 1989, Drainage development on basaltic lava flows, Cima volcanic field, southeast California, and Lunar Crater volcanic field, south-central Nevada—Alternative interpretation: Geological Society of America Bulletin, v. 101, no. 4, p. 595-599. [*see* GSAB, 1987, 99/9, 405-413; & GSAB, 1989, 101/7, 982-986]

Menard, H.W., and Smith, S.M., 1966, Hypsometry of ocean basin provinces: Journal of Geophysical Research, v. 71, no. 18, p. 4305-4325.

Menzies, John, 1979, A review of the literature on the formation and location of drumlins: Earth Science Reviews, v. 14, no. 4, p. 315-359.

Menzies, John, 1984, Drumlins—A Bibliography: Norwich, UK, Geo Books, 117 p.

Menzies, John, and Rose, James, 1987, Drumlins—trends and perspectives: Episodes, v. 10, no. 1, p. 29-31.

Merlin, P., 1965, A propos des méthodes de morphométrie (in French): Acta Geographica (Paris), v. 56, no. 1, p. 14-20.

Merrill, R.D., 1973, Representation of contours and regions for efficient computer search: Communications of the Association for Computing Machinery, v. 16, no. 2, p. 69-82.

Miller, C.L., and LaFlamme, R.A., 1958, The digital terrain model—theory and application: Photogrammetric Engineering, v. 24, no. 3, p. 433-442.

Miller, D.H., 1948, A terrain sample of the Sierra Crest region (abs.): Yearbook of the Association of Pacific Coast Geographers, v. 10, p. 46-47.

Miller, G., 1986, The definition and rendering of terrain maps: Computer Graphics, v. 20, no. 4, p. 39-48.

Miller, J.R., Ritter, D.F., and Kochel, R.C., 1990, Morphometric assessment of lithologic controls on drainage basin evolution in the Crawford Upland, south-central Indiana: American Journal of Science, v. 290, no. 5, p. 569-599.

Miller, O.M., and Summerson, C.H., 1960, Slope-zone maps: Geographical Review, v. 50, no. 2, p. 194-202.

Miller, S.W., 1985, A spatial data structure for hydrologic applications: Geo-Processing, v. 2, no. 4, p. 385-408.

Miller, S.W., 1988, Automatic production of near-cartographic quality contours, *in* International Symposium on Spatial Data Handling, 3rd, Sydney, Australia, August 17-19, 1988, International Geographical Union, Proceedings, p. 157-184.

Miller, S.W., and Goldberg, J.L., 1984, Integrating digital map data from the national topographic map series with other digital data sets for land and water resource assessment, *in* American Society for Photogrammetry—American Congress on Surveying and Mapping, conference, 1984, Technical Papers, p. 486-500.

Miller, V.C., 1953, A quantitative geomorphic study of drainage basin characteristics in the Clinch Mountain area, Virginia and Tennessee: Office of Naval Research Project No. 089-042, Contract N6 ONR 271-30, Technical Report No. 3, New York, Columbia University, Department of Geology, 30 p. + illustrations.

Millett, J.A., and Barnett, H.F. Jr., 1972, Morphometry of landforms—quantification of slope gradients in glaciated terrain: Fort Belvoir, VA, U.S. Army Engineer Topographic Laboratories, Report ETL-RN-72-3, 12 p.

Mills, H.H., 1982, Piedmont-cove deposits of the Dellwood quadrangle, Great Smoky Mountains, North Carolina, U.S.A.—morphometry: Zeitschrift für Geomorphologie, v. 26, no. 2, p. 163-178.

Mills, H.H., and Starnes, D.D., 1983, Sinkhole morphometry in a fluviokarst region—eastern Highland Rim, Tennessee, U.S.A.: Zeitschrift für Geomorphologie, v. 27, no. 1, p. 39-54.

Mills, H.H., 1987, Morphometry of drumlins in the northeastern and north-central USA, *in* Menzies, J., and Rose, J., eds., Proceedings of the Drumlin Symposium, First International Conference on Geomorphology, Manchester, England, 16-18 September 1985: Rotterdam, A.A. Balkema, p. 131-148.

Mills, H.L., 1963, Quantitative environmental studies, south Florida, *in* Military Evaluation of Geographic Areas reports on activities to April 1963: Vicksburg, Mississippi, U.S. Army Corps of Engineers Waterways Experiment Station, Miscellaneous Paper No. 3-610, p. 147-167.

Mills, Kim, Fox, Geoffrey, and Heimbach, Roy, 1992, Implementing an intervisibility analysis model on a parallel computing system: Computers and Geociences, v. 18, no. 8, p. 1047-1054.

Milne, B.T., 1988, Measuring the fractal geometry of landscapes: Applied Mathematics and Computing (UK), v. 27, p. 67-79.

Ming, Tan, 1992, Mathematical modelling of catchment morphology in the karst of Guizhou, China: Zeitschrift für Geomorphologie, v. 36, no. 1, p. 37-51.

Mintzer, Olin, and Messmore, J.A., 1984, Terrain analysis procedural guide for surface configuration: Fort Belvoir, VA, U.S. Army Engineer Topographic Laboratories, Geographic Sciences Laboratory, Report No. 12 in the ETL

Series on Guides for Army Terrain Analysis, 244 p.

Mirante, Anthony, and Weingarten, Nicholas, 1982, The radial sweep algorithm for constructing triangulated irregular networks: IEEE Computer Graphics and Applications, v. 2, no, 3, p. 11-13, 15-21.

Mitchell, C.W., 1973, Terrain Evaluation: London, Longman, 221 p.

Miyazaki, K., 1930, A statistical study of distribution of altitude in the Kii mountains (in Japanese): Geographical Review of Japan, v. 6, p. 1371-1384.

Mock, S.J., 1971, A classification of channel links in stream networks: Water Resources Research, v. 7, no. 6, p. 1558-1566.

Mock, S.J., Hartwell, A.D., and Hibler, W.D. III, 1972, Spatial aspects of pressure ridge statistics: Journal of Geophysical Research, v. 77, no. 30, p. 5945-5953.

Moellering, Harold, and Kimerling, A.J., 1990, A new digital slope-aspect display process: Cartography and Geographic Information Systems, v. 17, no. 2, p. 151-159.

Mohr, P.A., and Wood, C.A., 1976, Volcano spacings and lithospheric attenuation in the eastern rift of Africa: Earth and Planetary Science Letters, v. 33, p. 126-144.

Moik, J.G., 1980, Digital Processing of Remotely Sensed Images: U.S. National Aeronautics and Space Administration Special Publication, SP-431, 330 p.

Monkhouse, F.J., and Wilkinson, H.R., 1971, Maps and Diagrams (3rd ed.): London, Methuen, 522 p. [1st ed, 1952; 2nd ed, 1964]

Monmonier, M.S., 1974, Measures of pattern complexity for choroplethic maps: The American Cartographer, v. 1, no. 2, p. 159-169.

Monmonier, M.S., 1979, Estimates of trend direction—vagueness and bias in map reading: The Canadian Cartographer, v. 16, no. 1, p. 45-60.

Monmonier, M.S., 1982, Computer-Assisted Cartography—Principles and Prospects: Englewood Cliffs, NJ, Prentice-Hall.

Montgomery, D.R., and Dietrich, W.E., 1992, Channel initiation and the problem of landscape scale: Science, v. 255, no. 5046, p. 826-830.

Montgomery, D.R., and Foufoula-Georgiou, F., 1993, Channel network source representation from digital elevation models (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 152.

Moon, G.C., 1978, Digital terrain representation as applied to water resources: Guelph, Ontario, Canada, School of Engineering, University of Guelph, unpublished master's thesis, paging unknown.

Moore, E.D., Panuska, J.C., Grayson, R.B., and Srivastava, K.P., 1988, Application of digital topographic modelling in hydrology, *in* Modelling Agricultural, Forest, and Rangeland Hydrology, ASAE, St. Joseph, Michuigan, Publication No. 07-88, p. 447-461.

Moore, G.A., 1968, Automatic scanning and computer processes for the quantitative analysis of micrographs and equivalent objects, *in* Cheng, G.C., Ledley, R.S., Pollock, D.K., and Rozenfeld, Azriel, eds., Pictorial Pattern Recognition—Symposium on automatic photointerpretation, Washington, May 31-June 2, 1967, sponsored by the Office of Naval Research, the University of Maryland, and the Pattern Recognition Society, Proceedings: Washington, D.C., Thompson Book Co., p. 275-326. [see especially, '1. nature of the problem', p. 275-279]

Moore, H.J., Lugn, R.V., and Newman, E.B., 1974, Some morphometric properties of experimentally cratered surfaces: U.S. Geological Survey Journal of Research, v. 2, no. 3, p. 279-288.

Moore, I.D., ed., 1991, Digital terrain modelling in hydrology, special issue: Hydrological Processes, v. 5, no. 1, p. 1-124.

Moore, I.D., and Burch, G.J., 1986, Modeling erosion and deposition—topographic effects: Transactions of the American Society of Agricultural Engineers, v. 29, no. 6, p. 1624-1630, & 1640.

Moore, I.D., and Grayson, R.B., 1991, Terrain-based catchment partitioning and runoff prediction using vector elevation data: Water Resources Research, v. 27, no. 6, p. 1177-1191.

Moore, I.D., Grayson, R.B., and Ladson, A.R., 1991, Digital terrain modelling—a review of hydrological, geomorphological and biological applications: Hydrological Processes, v. 5, no. 1, p. 3-30.

Moore, I.D., O'Loughlin, E.M., and Burch, G.J., 1988, A contour-based topographic model for hydrological and ecological applications: Earth Surface Processes and Landforms, v. 13, no. 4, p. 305-320.

Moore, J.G., and Mark, R.K., 1986, World slope map: Eos, American Geophysical Union Transactions, v. 67, no. 48, p. 1353 & 1360-1362.

Moore, J.G., and Mark, R.K., 1992, Morphology of the island of Hawaii: GSA Today, v. 2, no. 12, p. 257-259, & 262.

Moore, R.F., and Thornes, J.B., 1976, LEAP—a suite of FORTRAN IV programs for generating erosional potentials of land surfaces from topographic information: Computers and Geosciences, v. 2, no. 4, p. 493-499.

Moore, R.F., and Simpson, C.J., 1982, Computer manipulation of a digital terrain Model (DTM) of Australia: BMR Journal of Australian Geology and Geophysics, v. 7, no. 1, p. 63-67.

Morehouse, Scott, 1985, ARC/INFO: a geo-relational model for spatial information, *in* Auto-Carto 7, International Symposium on Computer-Aided Cartography, 7th, Washington, D.C., March 11-14, 1985, Proceedings, p. 388-397.

Morhange, Christophe, 1992, Essai de quantification de l'évolution géomorphologique d'un archipel volcanique tropical né d'un point chaud—Le cas des îles de la Société en Polynésie française: Zeitschrift für Geomorphologie, v. 36, no. 3, p. 307-324.

Morisawa, M.E., 1957, Accuracy of determination of stream lengths from topographic maps: Transactions, American Geophysical Union, v. 38, no. 1, p. 86-88.

Morisawa, M.E., 1958, Measurement of drainage-basin outline form: Journal of Geology, v. 66, no. 5, p. 587-591.

Morisawa, M.E., 1962, Quantitative geomorphology of some watersheds in the Appalachian Plateau: Bulletin of the Geological Society of America, v. 73, no. 9. p. 1025-1046.

Morisawa, M.E., 1985, Development of quantitative geomorphology, *in* Drake, E.T., and Jordan, W.M., eds., Geologists and Ideas, A history of North American geology, Centennial Special Volume 1: Boulder, Colorado, Geological Society of America, p. 79-107.

Morisawa, M.E., 1988, The Geological Society of America Bulletin and the development of quantitative geomorphology: Geological Society of America Bulletin, v. 100, no. 7, p. 1016-1022.

Morris, D.G., and Heerdegen, R.G., 1988, Automatically derived catchment boundaries and channel networks and their hydrological applications: Geomorphology, v. 1, no. 2, p. 131-141.

Morris, Kevin, 1990, Evaluating digital elevation models for the identification of geological features in remotely-sensed imagery, *in* Annual Conference of the Remote Sensing Society, 16th, Nottingham, England, Proceedings, p. 90-101.

Morris, Kevin, 1990, The automatic detection of three-dimensional features from remotely-sensed imagery and digital terrain models, *in* Remote Sensing: An Operational Technology for the Mining and Petroleum Industries, October 8-10, 1990, London, England, Institute of Mining and Metallurgy, Proceedings, p. 59-74.

Morris, Kevin, 1991, Using knowledge-base rules to map the three-dimensional nature of geological features: Photogrammetric Engineering and Remote Sensing, v. 57, no. 9, p. 1209-1216.

Morse, M., 1925, Relations between the critical points of a real function of *n* variables: Transactions of the American Mathematical Scoiety, v. 27, p. 345-396.

Morse, S.P., 1965a, Computer storage and analysis of contour map data: Air Force Office of Scientific

Research, Report 400-106 (AFOSR 65-0592), paging unknown. [published1968, *as* Computer storage of contour map data: Association for Computing Machinery, national conference 23rd, Proceedings, p. 45-51]

Morse, S.P., 1965b, A mathematical model for the analysis of contour-line data: University Heights, Bronx, NY, New York University, Department of Electrical Engineering, Technical Report 400-124, paging unknown. [published 1968: Journal of the Association for Computing Machinery, v. 15, no. 2, p. 205-220]

Morse, S.P., 1966, Generalized computer techniques for the solution of contour-map problems: University Heights, Bronx, NY, New York University, Department of Electrical Engineering, unpublished Ph.D. dissertation, paging unknown.

Morse, S.P., 1969, Concepts of use in contour map processing: Communications of the Association for Computing Machinery, v. 12, no. 3, p. 147-152.

Mosley, M.P., and Parker, R.S., 1972, Allometric growth—A useful concept in geomorphology?: Geological Society of America Bulletin, v. 83, no. 12, p. 3669-3674.

Moss, Dorian, 1985, An initial classification of 10-km squares in Great Britain from a land characteristic data bank: Applied Geography, v. 5, no. 2, p. 131-150.

Mouginis-Mark, P.J., and Garbeil, H., 1993, Use of TOPSAR digital topographic data for volcano studies—geometry of valleys on Mt. Somma, Italy (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 193.

Mouginis-Mark, P.J., and Wilson, Lionel, 1981, MERC—a FORTRAN IV program for the production of topographic data for the planet Mercury: Computers and Geosciences, v. 7, no. 1, p. 35-45.

Mueller, J.C., 1979, Problems in the definition and measurement of stream length: The Professional Geographer, v. 31, no. 3, p. 306-311.

Mulla, D.J., Distribution of slope steepness in the Palouse region of Washington, Soil Science Society of America Journal, v. 50, no. 6, p. 1401-1406.

Mulla, D.J., 1988, Using geostatistics and spectral analysis to study spatial patterns in the topography of southeastern Washington State, U.S.A.: Earth Surface Processes and Landforms, v. 13, no. 5, p. 389-405.

Muller, J.-C., 1976, Numbers of classes and choropleth pattern characteristics: The American Cartographer, v. 3, no. 2, p. 169-175.

Muller, J.-P., Day, Tim, Kolbusz, John, Dalton, Mike, Richards, Sam, and Pearson, James, 1988, Visualization of topographic data using video animation, *in* Muller, J.-P., ed., Digital Image Processing in Remote Sensing: London, Taylor and Francis, p. 21-38.

Mullins, L.E., 1961, Terrain analysis for cross-country movement: The Military Engineer, no. 351 (January-February, 1961), p. 35-36.

Musgrave, F.K., Kolb, C.E., and Mace, R.S., 1989, The synthesis and rendering of eroded fractal terrains, *in* SIGGRAPH '89, Proceedings: Computer Graphics, v. 23, no. 3, p. 241-50.

Musgrave, G.W., 1947, The quantitative evaluation of factors in water erosion: Journal of Soil and Water Conservation, v. 2, no. 3, p. 133-138.

Musin, O.R., Novakovskiy, B.A., and Serbenyuk, S.N., 1987, Automated mapping of slope angles and orientation from aerial photographs (in Russian): Geomorfologiya, no. 4, p. 30-36. [translated 1988, *in* Mapping Sciences and Remote Sensing, v. 25, no. 3, p. 201-209]

Myklestad, E., and Wagar, J.A., 1977, PREVIEW—computer assistance for visual management of forested landcapes: Landscape Planning, v. 4, p. 313-332.

N

Nagao, Makoto, and Matsuyama, Takashi, 1980, A Structural Analysis of Complex Aerial Photographs: New York, Plenum, 199 p.

Nagao, Makoto, Mulai, Y., Ayabe, K., Arai, K., and Nakazawa, T., 1988, A study of reducing abnormal elevations in automatic computation of elevations from satellite data: International Archives of Photogrammetry and Remote Sensing, v. 27, No. B4, p. 280-288.

Nagy, George, 1984, Advances in information extraction techniques: Remote Sensing of Environment, v. 15, no. 2, p. 167-175.

Nakayama, Ken, and Shimojo, Shinsuke, 1992, Experiencing and perceiving visual surfaces: Science, v. 257, no. 5075, p. 1357-1363.

Nakano, T., 1983, A "fractal" study of some Rias coastline in Japan, *in* University of Tsukuba, Japan, Institute of Geoscience, Annual Report for the Academic Year 1982, No. 9, p. 75-80.

Narasimhan, Ravi, and Argialas, D.P., 1989, Computational approaches for handling uncertainties in terrain analysis, *in* American Society for Photogrammetry and Remote Sensing—American Congress on Surveying and Mapping Annual Convention, Baltimore Maryland, April 2-7, 1989, Technical Papers, v. 3 (Remote Sensing), p. 302-310.

Nash, D.B., 1980, Forms of bluffs degraded for different lengths of time in Emmet County, Michigan, USA: Earth Surface Processes, v. 5, no. 4, p. 331-345.

Natarajan, Thyagarajan, 1972, Digital Terrain Analysis: University of Toronto, Department of Civil Engineering, unpublished Ph.D. dissertation, 302 p.

Nathan, Robert, 1966, Digital video-data handling: Pasadena, Calif., Jet Propulsion Laboratory Technical Report no. 32-877. [published 1968, *as* Picture enhancement for the Moon, Mars, and man, *in* Cheng, G.C., Ledley, R.S., Pollock, D.K., and Rosenfeld, Azriel, eds., Pictorial Pattern Recognition: Washington, D.C., Thompson Book Co., p. 239-266.]

Nathan, R.J., and McMahon, T.A., 1990, Identification of homogeneous regions for the purpose of regionalisation: Journal of Hydrology, v. 121, no. 4, p. 217-238.

National Geographic Society, 1976, Portrait U.S.A. the first color (Landsat) photomosaic of the 48 contiguous United States: Washington, D.C., scale 1:4,560,000.

National Geophysical Data Center, 1988, ETOPO-5 bathymetry/topography data: Data Announcement 88-MGG-02, Boulder, Colorado, National Oceanic and Atmospheric Administration, U.S. Dept. Commerce.

Natrella, M.G., 1963, Experimental Statistics: United States Department of Commerce, National Bureau of Standards Handbook 91, paging by section.

Nayak, P.R., 1971, Random process models of rough surfaces: Transactions of the American Society of Mechanical Engineers, Journal of Lubrication Technology, v. 93F, p. 398-407.

Neel, E.E., Stultz, S.J., and Tyszka, R.J., 1982, Digital terrain analysis data—a critical element in future tactical C31: Signal (UK), March 1982, p. 52-54.

Neibling, W.H., and Thompson, A.L., 1992, Terrace design affects inter-terrace sheet and rill erosion: Transactions of the American Society of Agricultural Engineering, v. 35, no. 5, p. 1473-1481.

Neuenschwander, Gustav, 1944, Morphometrische Begriffe, eine kritische Übersicht auf Grund der Literatur (in German): Universität Zürich, Inaugural-Dissertation, 135 p.

Neuland, Herbert, 1976, A prediction model of landslips: Catena, v. 3, no. 2, p. 215-230.

Neumann, Jan, 1991, The topological information content of the map—a means for resolving certain problems in theoretical cartography (in Russian): Izvestiya AN SSSR, seriya geograficheskaya, No. 2, p. 122-131. [translated 1992, *in* Mapping Sciences and Remote Sensing, v. 29, no. 2, p. 111-124]

Neumann, L., 1886, Orometrie des Schwarzwaldes (in German): Geographische Abhandlungen (Penck, ed.), Vienna, v. 1, no. 2, p. 189-238.

Neumyvakin, A.Yu., and Yakolev, A.F., 1986, Construction of a digital terrain model: Mapping Sciences and Remote Sensing, v. 23, no. 3, p. 227-232.

Newell, W.L., 1970, Factors influencing the grain of the topography along the Willoughby Arch in northeastern Vermont: Geografiska Annaler, v. 52A, no. 2, p. 103-112.

Newman, E.B., Paradis, A.R., and Brabb, E.E., 1978, Feasibility and cost of using a computer to prepare landslide susceptibility maps of the San Francisco Bay region, California: U.S. Geological Survey Bulletin 1443, 27 p.

Newman, W.I., and Turcotte, D.L., 1990, Cascade model for fluvial geomorphology: Geophysical Journal International, v. 100, no. 3, p. 433-439.

Nicholas, F.W., and Lewis, J.E. Jr., 1980, Relationships between aerodynamic roughness and land use and land cover in Baltimore, Maryland: U.S. Geological Survey Professional Paper 1099-C, 36 p.

Nikolayev, S.A., 1955, On the quantitative characterization of the sinuosity of a shore line (in Russian): Sbornik statey po kartografii (Moscow), no. 8.

Nikora, V.I., 1991, Fractal structures of river plan forms: Water Resources Research, v. 27, no. 6, p. 1327-1333.

Nir, Dov., 1957, The ratio of relative and absolute altitudes of Mt. Carmel—a contribution to the problem of relief analysis and relief classification: Geographical Review, v. 47, no. 4, p. 564-569.

Nogami, Michio, 1985, A processing system for digital terrain analysis (in Japanese with English abstract and figure captions): Transactions, Japanese Geomorphological Union, v. 6, no. 3, p. 245-264.

Nogami, Michio, 1988, Processing system of digital elevation data for morphometry (in Japanese), *in* Yamaguchi, Takeshi, ed., Research on Intensive Utilization of Geographic Information: Report of Grant-in-Aid from the Ministry of Education and Culture of Japan in 1987, p. 77-112.

Nogami, Michio, 1989, Numerical land information [e.g., DEM] in Japan: Transactions, Japanese Geomorphological Union, v. 10-A, p. 147-156.

Nogami, Michio, 1991, A method and computer program for preparation of DEM from contour map (in Japanese): Map, v. 29, no. 3, p. 20-26.

Noma, A.A., 1966, Current AMS computer processing of numerical topo data, *in* Conference-Numerical topographic data and other new map products: Fort Belvoir, Va., May 3-5, 1966, Department of the Army, Office of the Chief of Engineers, Proceedings, p. 42-48.

Noma, A.A., and Misulia, M.G., 1959, Programming topographic maps for automatic terrain model construction: Surveying and Mapping, v. 19, no. 3, p. 355-366.

Nordbeck, Stig, 1965, The law of allometric growth: Ann Arbor, Michigan Inter-university Community of Mathematical Geographers, Discussion Paper No. 7, 28 p.

Norman, P.E., 1969, Out-of-this-world photogrammetry: Photogrammetric Engineering, v. 35, no. 7, p. 693-701.

Norton, Denis, and Sorenson, Steve, 1989, Variations in geometric measures of topographic surfaces underlain by fractured granitic plutons: Pure and Applied Geophysics, v. 131, no. 1/2, p. 77-97.

Norvelle, F.R., 1991, Interactive digital correlation techniques for automatic compilation of elevation data: Fort Belvoir, VA, U.S. Army Engineer Topographic Laboratories, Report No. ETL-0272, paging unknown.

Norvelle, F.R., 1992, Using iterative orthophoto refinements to correct digital elevation models (DEM's), *in* ASPRS/ACSM/RT '92 Convention, Washington, D.C., August 3-8, 1992, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Technical Papers, v. 2 (Photogrammetry and Surveying), p. 27-35. [also 1993, *in* 1992 ASPRS-ACSM annual convention, Albuquerque, New Mexico, Technical Papers, v. 1, p. 347-355

Noskov, V.F., 1969, A mathematical model of relief, and the connection of its parameters with geomorphological characteristics (in Russian): Vestnik Moskovskogo Universiteta, Geografiva, v. 1, p. 105-110.

Numan, N.M.S., Awda, G.J., and Thannoon, H.A., 1992, Topographic map revision in northern Iraq using DTMs and orthophotos: ITC Journal (Enschede, Neth.), no. 1992-3, p. 244-248.

Nutter, Robert, and Vincent, D.M., 1991, Line Trace Plus—an enhanced process for digital elevation model production, *in* GIS/LIS, American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, fall convention, Atlanta, October 28-November 1, 1991, Technical Papers, p. A-127 to A-132.

Nystuen, J.D., 1963, Identification of some fundamental spatial concepts: Papers of the Michigan Academy of Science, Arts, and Letters, v. 48, p. 373-384. [reprinted 1968, *in* Berry, B.J.L., and Marble, D.F., eds., Spatial Analysis, A Reader In Statistical Geography: Englewood Cliffs, N.J., Prentice-Hall, p. 35-41.]

Nystuen, J.D., 1966, Effects of boundary shape and the concept of local convexity: Ann Arbor, Michigan Inter-University Community of Mathematical Geographers, Discussion Paper 10, paging unknown. [Univ. Microfilms No. OP-33067, Ann Arbor, MI]

O

O'Callaghan, J.F., and Mark, D.M., 1984, The extraction of drainage networks from digital elevation data: Computer Vision, Graphics and Image Processing, v. 28, no. 3, p. 323-344.

Ochocka, Janina, 1931, Krajobraz Polski w swietle mapy wysokosci wzglednych (Cartes des hauteurs relatives de la Pologne; in Polish): Trav. Géogr. Publiés sous la Direction de E. Romer, no. 13, ca. 45 p.

Odeh, I.O.A., Chittleborough, D.J., and McBratney, A.B., 1991, Elucidation of soil-landform interrelationships by canonical ordination analysis: Geoderma, v. 49, no. 1, p. 1-32.

Oden, N.L., and Sokal, R.R., 1986, Directional autocorrelation—an extension of spatial correlograms to two dimensions: Systematic Zoology, v. 35, no. 4, p. 608-617.

Ohmori, Hiroo, 1978, Relief structure of the Japanese mountains and their stages in geomorphic development: Bulletin of the Department of Geography, University of Tokyo, v. 10, p. 31-85.

Ohmori, Hiroo, 1981, Simulation of change of landform from a geomorphometric method (in Japanese with English abstract and captions): Transactions, Japanese Geomorphological Union, v. 2, no. 1, p. 95-100.

Ohmori, Hiroo, 1983, A three-dimensional model for the erosional development of mountains on the basis of relief structure: Transactions, Japanese Geomorphological Union, v. 4, no. 1, p. 107-120.

Ohmori, Hiroo, 1985, Numerical data and computer graphics in geomorphology (in Japanese with English abstract and figure captions): Transactions, Japanese Geomorphological Union, v. 6, no. 3, p. 225-244.

Ohmori, Hiroo, and Hirano, Masashige, 1984, Mathematical explanation of some characteristics of altitude distributions of landforms in an equilibrium state: Transactions, Japanese Geomorphological Union, v. 5, no. 4, p. 293-310.

Ohmori, Hiroo, and Sohma, Hidehiro, 1983, Landform classification in mountain region and geomorphic characteristic values (in Japanese with English summary and figure captions): Japanese serial, title unknown, v. 21, no. 3, p. 1-12

Okimura, Takashi, 1989, Prediction of slope failure using the estimated depth of the potential failure layer: Journal of Natural Disaster Science, v. 11, no. 1, p. 67-79.

Olea, R.A., 1977, Measuring Spatial Dependence with Semivariograms: Lawrence, University of Kansas, Kansas Geological Survey Series on Spatial Analysis No. 3, 29 p.

Olea, R.A., 1984, Systematic sampling of spatial functions: Lawrence, University of Kansas, Kansas Geological Survey Series on Spatial Analysis No. 7, 48 p.

Olender, H.A., 1980, Analysis of a triangulated irregular network (TIN) terrain model for military applications: Stanford Research Institute Project 6726, Office of Naval Research, Contract N00014-77-C-0698, Final Report, 90 p.

Oliver, M.A., and Webster, R., 1986, Semi-variograms for modelling the spatial pattern of landform and soil properties: Earth Surface Processes and Landforms, v. 11, no. 5, p. 491-504.

Olivier, R., 1971, Digitalisation du Relief de la Suisse Romande (in French): Bull. Soc. Vaud. Sci. Nat., v. 70, no. 12, p. 1-12.

Ollier, C.D., 1963, Contour map accuracy and analysis: Australian Geographical Studies, v. 1, no. 1, p. 96-99.

Ollier, C.D., 1967, Landform description without stage names: Australian Geographical Studies, v. 5, no. 1, p. 73-80.

Ollier, C.D., 1967, Geomorphic indications of contour map accuracy: Cartography, v. 6, p. 121-124.

Ollier, C.D., 1977, Terrain classification—methods, applications and principles, *in* Hails, J.R., ed, Applied Geomorphology: Amsterdam, Elsevier, p. 277-316.

O'Loughlin, E.M., 1986, Prediction of surface saturation zones in natural catchments by topographic analysis: Water Resources Research, v. 22, no. 5, p. 794-804.

Olsen, R.W., 1981, Analysis of digital terrain profile data: Menlo Park, CA, U.S. Geological Survey Western Mapping Center, Memorandum dated June 1981, 5 pages + tables.

Olson, Judy, 1972, Autocorrelation as a measure of map complexity, *in* American Congress on Surveying and Mapping annual meeting, March 12-17, 1972, Proceedings: p. 111-119.

Omernik, J.M., 1987, Ecoregions of the conterminous United States: Annals of the Association of American Geographers, v. 77, no. 1, p. 118-125.

O'Neill, M.P., and Mark, D.M., 1985, The use of digital elevation models in slope frequency analysis, *in* Annual Pittsburgh Conference on Modeling and Simulation, 16th, April 25-26, 1985, Proceedings, v. 16, no. 1, p. 311-315.

O'Neill, M.P., and Mark, D.M., 1987a, On the frequency distribution of land slope: Earth Surface Processes and Landforms, v. 12, no. 2, p. 127-136.

O'Neill, M.P., and Mark, D.M., 1987b, The *Psi-s* plot—a useful representation for digital cartographic lines, *in* Auto-Carto 8, International Symposium on Computer-Assisted Cartography, 8th, Baltimore, MD, March 29-April 3, 1987: Proceedings, p. 231-240.

Ongley, E.D., 1970, Drainage-basin axial and shape parameters from moment measures: Canadian Geographer, v. 14, no. 1, p. 38-44.

Onorati, Giuseppe, and Poscolieri, Maurizio, 1988, The Italian mean heights archive, a digital data set useful for thematic mapping and geomorphological units analysis, *in* Eighth Symposium EARSel, Capri (Italy), 18-20 May, 1988, p. 451-466.

Onorati, Giuseppe, and Poscolieri, Maurizio, 1990, Uso dei dati delle quote medie del territorio italiano per studi di geomorfologia quantitativa nei Monti Simbruini-Ernici e nei Monti del Matese (in Italian): Servizio Geologico Nazionale (Roma), Memorie Descrittive della Carta Geologica D'Italia, v. 38, p. 251-275.

Onorati, G., Poscolieri, M., Ventura, R., Chiarini, V., and Crucilla, U., 1992, The digital elevation model of Italy for geomorphology and structural geology: Catena, v. 19, no. 2, p. 147-178.

Onstad, C.A., and Brakensiek, D.L., 1968, Watershed simulation by stream path analogy: Water Resources Research, v. 4, no. 5, p. 965-971.

Openshaw, Stan, 1981, The modifiable areal unit problem, *in* Wrigley, N., and Bennett, R.J., eds., Quantitative Geography, A British View: Routledge and Kegan Paul, London, p. 60-69.

Openshaw, Stan, 1984, The Modifiable Areal Unit Problem: Norwich, UK, Geo Books, paging unknown.

Orlov, P.M., 1936, The mathematical characterization of relief using contour maps (in Russian): Nauchnyye zapiski MIIVKh (Moscow Institute of Water Engineers im. V.R. Vil'yams, Moscow), no. 2.

Östman, Anders, 1986, A graphical editor for digital elevation models: Geo-Processing, v. 3, no. 2, p. 143-154.

Östman, Anders, 1986, A PC-based editor for digital terrain models, *in* Blakemore, Michael, ed., Auto Carto London, ICA symposium, September 14-19, 1986, 1986,: Proceedings, v. I, p. 465-474.

Östman, Anders, 1987, Quality control of photogrammetrically sampled digital elevation models: Photogrammetric Record, v. 12, no. 69 , p. 333-341.

Ostrowski, J.A., Benmouffok, D., He, D.C., and Horler, D.N.H., 1989, Geoscience applications of digital elevation models, *in* Agterberg, F.P., and Bonham-Carter, G.F., eds., Statistical Applications in the Earth Sciences: Ottawa, Geological Survey of Canada, p. 33-37.

Oswald, H., and Raetzsch, H., 1984, A system for generation and display of digital elevation models: Geo-Process (Germany), v. 2, p. 197-218.

Ouchi, Shunji, 1990, Self-affinity of landform and its measurement: Geographical Reports of Tokyo Metropolitan University, no. 25, p. 67-79.

Ouchi, Shunji, and Matsushita, Mitsugu, 1992, Measurement of self-affinity on surfaces as a trial application of fractal geometry to landform analysis, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 115-130.

Ourmazd, A., Taylor, D.W., Bode, M., and Kim, Y., 1989, Quantifying the information content of lattice images: Science, v. 246, no. 4937, p. 1571-1577.

Outcalt, S.I., 1974, Gradient mapping of pattern ground characteristics from a photomosaic of the IBP tundra biome site near Barrow, Alaska: Mathematical Geology, v. 6, no. 3, p. 235-244.

Outcalt, S.I., and Melton, M.A., 1992, Geomorphic application of the Hausdorff-Besicovich dimension: Earth Surface Processes and Landforms, v. 17, no. 8, p. 775-787.

P

Pachauri, A.K., and Pant, Manoj, 1992, Landslide hazard mapping based on geological attributes: Engineering Geology, v. 32, no. 1,2, p. 81-100.

Palacios-Vélez, O.L., and Cuevas-Renard, B., 1986, Automated river-course, ridge, and basin delineation from digital elevation data: Journal of Hydrology, v. 86, no. 3/4, p. 299-314.

Palmer, Bruce, 1984, Symbolic feature analysis and expert systems, *in* International Symposium on Spatial Data Handling, Zürich, Switzerland, August, 1984, Proceedings, v. 2, p. 465-478.

Pan, J.-J., 1989, Spectral analysis and filtering techniques in digital spatial data processing: Photogrammetric Engineering and Remote Sensing, v. 55, no. 8, p. 1203-1207.

Pannekoek, A.J., 1967, Generalized contour maps, summit level maps, and streamline surface maps as geomorphological tools: Zeitschrift für Geomorphologie, v. 11, no. 2, p. 169-182.

Panov, B.P., 1938, On the methodology of the compilation of river-network-density maps (in Russian): Izvestiya Gosudarstvennogo gidrologicheskogo instituta (Leningrad), no. 56.

Pao, Yoh-Han, 1989, Adaptive Pattern Recognition and Neural Networks: Reading, MA, Addison-Wesley, 309 p.

Papo, H.B., and Gelbman, E., 1984, Digital terrain models for slopes and curvatures: Photogrammetric Engineering and Remote Sensing, v. 50, no. 6, p. 695-701.

Pappas, T.N., 1992, An adaptive clustering algorithm for image segmentation: IEEE Transactions on Signal Processing, v. 40, no. 4, p. 901-914.

Paradise, T.R., and Yin, Zhi-Yong, 1993, Weathering pit characteristics and topography on Stone Mountain, Georgia: Physical Geography, v. 14, no. 1, p. 68-80.

Park, C.C., 1978, Allometric analysis and stream channel morphometry: Geographical Analysis, v. 10, no. 3, p. 211-228.

Park, C.M., Lee, Y.H., and Scheps, B.B., 1971, Slope measurement from contour maps:

Photogrammetric Engineering, v. 37, no. 3, p. 277-283..

Parks, J.M., 1966, Cluster analysis applied to multivariate geologic problems: Journal of Geology, v. 74, no. 5, Part 2, p. 703-715.

Parks, J.M., 1970, FORTRAN IV program for Q-mode cluster analysis on distance function with printed dendrogram: Lawrence, The University of Kansas, State Geological Survey, Computer Contribution 46, 32 p.

Parrot, J.-F., and Taud, Hind, 1992, Detection and classification of circular structures on SPOT images: IEEE Transactions on Geoscience and Remote Sensing, v. 30, no. 5, p. 996-1005.

Parry, J.T., and Beswick, J.A., 1973, The application of two morphometric terrain-classification systems using air-photo interpretation methods: Photogrammetria, v. 29, no. 5, p. 153-186.

Parsons, A.J., 1976, A Markov model for the description and classification of hillslopes: Mathematical Geology, v. 8, no. 6, p. 597-616.

Parsons, A.J., 1977, Curvature and rectilinearity in hillslope profiles: Area (UK), v. 9, p. 246-251. [and two comments, by A.J.W. Gerrard and by N.J. Cox, in next volume, p. 129-131]

Partsch, Joseph, 1911, Schlesien—eine Landeskunde für das deutsche Volk, v. II (in German): Breslau, Verlag Ferdinand Hirt, 690 p. [relative-relief map on p. 587 and text on p. 586]

Parvis, Merle, 1950, Drainage pattern significance in airphoto identification of soils and bedrocks: Photogrammetric Engineering, v. 16, no. 3, p. 387-409.

Paschinger, Viktor, 1934, Die relativen Höhen von Kärnten (in German): Petermanns Mitteilungen, v. 80, p. 331-333 and 367-368.

Passarge, Siegfried, 1919, Die Grundlagen der Landschaftskunde, v. I—Beschreibende Landschaftskunde: Hamburg, Friederichsen, de Gruyter & Co., 210 p.

Patton, P.C., 1988, Drainage basin morphometry and floods, *in* Baker, V.R., Kochel, R.C., and Patton, P.C., eds., Flood Geomorphology, New York, Wiley, p. 51-64.

Pavlidis, T., 1977, Structural Pattern Recognition: New York, Springer Verlag, 302 p.

Pavlidis, T., 1978, A review of algorithms for shape analysis: Computer Graphics and Image Processing, v. 7, p. 243-258.

Pavlidis, T., 1980, Algorithms for shape analysis of contours and wave-forms: IEEE Transactions on Pattern Analysis and Machine Intelligence, v. 2, no. 4, p. 301-312.

Peddle, D.R., and Franklin, S.E., 1990, GEDEMON, a FORTRAN-77 program for restoration and derivative processing of digital image data: Computers and Geosciences, v. 16, no. 5, p. 669-696.

Peddle, D.R., and Franklin, S.E., 1991, Image texture processing and data integration for surface pattern discrimination: Photogrammetric Engineering and Remote Sensing, v. 57, no. 4, p. 413-420.

Péguy, Ch.P., 1942, Principes de morphométrie alpine (in French): Revue de Géographie Alpine (Grenoble, France), v. 30, p. 453-486.

Péguy, Ch.P., 1948, Introduction à l'emploi des méthodes statistiques en géographie physique (in French): Revue de Géographie Alpine (Grenoble, France), v. 36, no. 1, p. 5-101.

Peled, Ammatzia, Loon, J.C., and Bossler, J.D., 1989, Producing intermediate contours from digitized contours: The American Cartographer, v. 16, no. 3, p. 191-200.

Peleg, M., 1985, Characterisation of the ruggedness of instant coffee particle-shape by natural fractals: Journal of Food Science, v. 50, no. 3, p. 829-831.

Peltier, L.C., 1953, Quantitative Geomorphology, A Progress Report: U.S. Department of the Army, unpublished draft typescript, 29 p. + maps, diagrams, and appendices dated April 1953.

Peltier, L.C., 1954, Some properties of the average topographic slope (abs.): Annals of the Association of American Geographers, v. 44, p. 229-230.

Peltier, L.C., 1955, Landform analysis in operational research (abs.): Geological Society of America Bulletin, v. 66, no. 12, part 2, p. 1716-1717.

Peltier, L.C., 1956, Terrain Components in Operational Research: U.S. Geological Survey, Military Geology Branch, Report prepared for the U.S. Army Office of the Chief of Engineers (for use in Signal Corps Contract DA-36-039-SC-64562), ASTIA No. AD124803, 55 p. + maps.

Peltier, L.C., 1959, Area sampling for terrain analysis (abs.): Bulletin of the Geological Society of America, v. 70, p. 1809.

Peltier, L.C., 1962, Area sampling for terrain analysis: The Professional Geographer, v. 14, no. 2, p. 24-28.

Peltier, L.C., 1980, Events in the development of geomorphology, *in* Coates, D.R., and Vitek, J.D., eds., Thresholds in Geomorphology: London, George Allen and Unwin, p. 25-42.

Pelton, Colin, 1987, A computer program for hill-shading digital topographic data sets: Computers and Geosciences, v. 13, no. 5, p. 545-548.

Penck, Albrecht, 1894, Morphologie der Erdoberfläche (in German), Stuttgart,v. 1, 471 p. [average slope calculation: p. 47]

Pennock, D.J., Zebarth, B.J., and De Jong, E., 1987, Landform classification and soil distribution in hummocky terrain, Saskatchewan, Canada: Geoderma, v. 40, nos. 3/4, p. 297-315.

Penney, Walt, 1989, Images (image processing on a microcomputer): BYTE, v. 14, no. 13, p. 248, 250, 252-254, 256.

Pennsylvania Research Associates, Inc., 1969, Digitally controlled video displays for helicopter avionics simulation—initial design study: Final Engineering Report, *for* U.S. Army Electronics Command, Technical Report ECOM-0246-F, paging unknown. [terrain visibility]

Penteado, M.M., and Hulke, S.D., 1974, A computer method for quantitative drainage basin analysis: Notícia Geomorphológica, Campinas, v. 14, no. 27/28, p. 61-75.

Pentland, A.P., 1984, Fractal-based description of natural scenes: IEEE Transactions on Pattern Analysis and Machine Intelligence, v. PAMI-6, no. 6, p. 661-674.

Perkal, Julian, 1956, On the epsilon-length: Bulletin of the Polish Academy of Science, Cl III, v. 4, no. 7, p. 399-403.

Perkal, Julian, 1958a, Proba Obiektywnej generalizacji (An attempt at objective generalization; in Polish): Geodézja és Kartográfia, v. 7, no. 2, p. 130-142. [translated by W. Jakowski, 1966, *as* An attempt at objective generalisation, *in* Nystuen, John, ed., Ann Arbor, Michigan Inter-University Community of Mathematical Geographers, Discussion Paper 10B, 32 p. Univ. Microfilms No. OP-33067, Ann Arbor, MI]

Perkal, Julian, 1958b, O Dtugosci Krzywych Empirycznych; in Polish): Zastosowania Mathematyki, v. 3, nos. 3-4, p. 258-283. [translated by W. Jakowski, 1966, *as* On the length of empirical curves, *in* Nystuen, John, ed., Ann Arbor, Michigan Inter-University Community of Mathematical Geographers, Discussion Paper 10B, 32 p. Univ. Microfilms No. OP-33067, Ann Arbor, MI]

Peterson, R.H., 1958, A statistical model for describing and comparing the routes taken by tanks across terrain: Aberdeen Proving Ground, Maryland, U.S. Department of the Army, Ballistic Research Laboratories, Memorandum Report No. 1155, 24 p.

Petrie, G., and Kennie, T.J.M., 1987, Terrain modeling in surveying and civil engineering: Computer-Aided Design, v. 19, no. 4, p. 171-187..

Petrie, G., and Kennie, T.J.M., eds., 1990, Terrain Modelling in Surveying and Civil Engineering, Caithness (UK), Whittles Publ., 351 p.

Peucker, Karl, 1890, Beiträge zur orometrischen Methodenlehre (in German): Dissertation, Breslau, 45 p.

Peucker, T.K., 1969, Some thoughts on optimal mapping and coding of surfaces: Cambridge, Massachusetts, Graduate School of Design, Harvard Papers in Theoretical Geography,

"Geography and the properties of surfaces" series, No. 34, 14 p.

Peucker, T.K., 1972, Computer Cartography: Washington, D.C., Association of American Geographers, Commission on College Geography, Resource Paper No. 17, 75 p.

Peucker, T.K., 1978, Data structures for digital terrain models—discussion and comparison, *in* Dutton, Geoffrey, ed., Harvard Papers on Geographic Information Systems, Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University: International advanced study symposium on topological data structures for geographic information systems 1st., Dedham, Mass., 1977, Proceedings, v. 5, Data Structures: Surficial and Multi-Dimensional, p. (Peucker) 1-15.

Peucker, T.K., 1979, Digital terrain models, an overview, *in* Auto-Carto 4, International Symposium on Computer-Aided Cartography 4th, Proceedings, v. I, p. 97-107.

Peucker, T.K., 1980, The impact of different mathematical approaches to contouring: Cartographica, v. 17, no. 2, Monograph 25, p. 73 -95.

Peucker, T.K., and Chrisman, Nicholas, 1975, Cartographic data structures: The American Cartographer, v. 2, no. 1, p. 55-69.

Peucker, T.K., and Douglas, D.H., 1975, Detection of surface-specific points by local parallel processing of discrete terrain elevation data: Computer Graphics and Image Processing, v. 4, no. 4, p. 375-387.

Peucker, T.K., Fowler, R.J., Little, J.J., and Mark, D.M., 1976, Digital representation of three-dimensional surfaces by triangulated irregular networks (TIN): Burnaby, B.C., Canada, Simon Fraser University, Geography Department, *for* Office of Naval Research, Geography Programs, Contract N00014-75-C-0886, Technical Report No. 10 (revised), 63 p..

Peucker, T.K., Fowler, R.J., Little, J.J., and Mark, D.M., 1978, The triangulated irregular network: Digital Terrain Models (DTM) Symposium, St. Louis, Missouri, May 9-11, 1978, American Society of Photogrammetry, Proceedings, p. 516-540.

Peucker, T.K., Fowler, R.J., Little, J.J., and Mark, D.M., 1979, The triangulated irregular network, *in* Auto-Carto 4, International Symposium on Computer Assisted Cartography 4th, Proceedings, v. II, p. 96-103. [abridged *from* PFL&M, 1978]

Peucker, T.K., Fowler, R.J., Little, J.J., and Mark, D.M., 1980, TIN: Triangulated Irregular Network, *in* Marble, D.F., ed., Computer Software for Spatial Data Handling, v. 3, Cartography and Graphics, International Geographical Union Commission on Geographical Data Sensing and Processing, U.S. Geological Survey, Reston, VA., p. 646-648.

Peuquet, D.J., 1979, Raster processing, an alternative approach to automated cartographic data handling: The American Cartographer, v. 6, no. 2, p. 129-139.

Peuquet, D.J., 1988a, Representations of geographic space—toward a conceptual synthesis: Annals of the Assocation of American Geographers, v. 78, no. 3, p. 375-394.

Peuquet, D.J., 1988b, Toward the definition and use of complex spatial relationships, *in* International Symposium on Spatial Data Handling, 3rd, Sydney, Australia, August 17-19, 1988, International Geographical Union, Proceedings, p. 211-223.

Peuquet, D.J., 1988c, Issues involved in selecting appropriate data models for global databases, *in* Mounsey, Helen, and Tomlinson, Roger, eds., Building Databases for Global Science: London, Taylor and Francis, p. 66-78.

Pfaltz, J.L., 1976, Surface networks: Geographical Analysis, v. 8, no. 1, p. 77-93.

Pfeifer, P., 1984, Fractal dimensions as a working tool for surface-roughness problems: Applications of Surface Science, v. 18, no. 1-2, p. 146-164.

Phillips, J.D., 1986, Spatial analysis of shoreline erosion, Delaware Bay, New Jersey: Annals of the Association of American Geographers, v. 76, no. 1, p. 50-62.

Phillips, J.D., 1990, Relative importance of factors influencing fluvial soil loss at the global scale:

American Journal of Science, v. 290, no. 5, p. 547-568.

Phillips, J.D., and Renwick, W.H., 1992, eds., Geomorphic Systems, proceedings of the Binghamton Symposium in Geomorphology, 23rd, September 25-27, 1992: Geomorphology, v. 5, nos. 3-5, p. 195-487.

Phillips, R.J., 1984, Experimental method in cartographic communication, research on relief maps: Cartographica, v. 21, no. 1, Monograph 31, p. 120-128.

Phong, B.-T., 1973, Illumination for computer-generated images: Salt Lake City, University of Utah, Department of Computer Science, Report No. UTEC-CSc-73-129, paging unknown. [abridged 1975, *in* Communications of the ACM, v. 18, no. 6, p. 311-317]

Piech, M.A., and Piech, K.R., 1990, Fingerprints and fractal terrain: Mathematical Geology, v. 22, no. 4, p. 457-485.

Pielke, R.A., and Kennedy, Elaine, 1980, Mesoscale terrain features: Charlottesville, VA, University of Virginia, unpublished report UVA-ENV SCI-MESO-1980-1, 19 p.

Pierce, K.L., and Colman, S.M., 1986, Effect of height and orientation (microclimate) on geomorphic degradation rates and processes, late-glacial terrace scarps in central Idaho: Geological Society of America Bulletin, v. 97, no. 7, p. 869-885.

Pieri, D.C., 1984, Junction angles in drainage networks: Journal of Geophysical Research, v. 89, no. B8, p. 6878-6884.

Pike, R.J., 1961, The order of valley depth: The Monadnock (Journal of the Clark University Geographical Society, Worcester, MA), v. 35, no. 2, p 12-19.

Pike, R.J., 1963, Landform regions of southern New England, a quantitative delimitation: Worcester, Mass., Clark University, unpublished M.A. thesis, 80 p.

Pike, R.J., 1964, Some Morphometric Properties of the Lunar Surface—A Preliminary Investigation from Lunar Aeronautical Charts: Buffalo, N.Y., Cornell Aeronautical Laboratory Report No. VS-1985-C-1, 112 p.

Pike, R.J., 1969, Lunar surface geometry, *in* Moore, H.J., Pike, R.J., and Ulrich, G.E., eds., Lunar terrain and traverse data for lunar roving vehicle design study: unpublished U.S. Geological Survey internal report, Section B, p. B1-B46.

Pike, R.J., 1971, Preliminary quantitative terrain-analysis results from three Apollo 10 photographs, *in* Analysis of Apollo 10 Photography and Visual Observations: NASA Special Publication SP-232, p. 5-12.

Pike, R.J., 1972, Q-mode landform regions of southern New England, *in* Adams, W.P., and Helleiner, F.M., eds., International Geography 1972, Papers Submitted to the 22nd International Geographical Congress, Montreal, Canada, Univ. Toronto Press, p. 365-367.

Pike, R. J., 1972, Geometric similitude of lunar and terrestrial craters, *in* International Geological Congress, 24th, Montreal, Canada, August 1972, Section 15, Planetology: Proceedings, p. 41-47.

Pike, R.J., 1972, Preliminary slope-frequency distributions on Mars, *in* NASA Viking Data Analysis Team (VDAT), Langley Research Center, VA, Report M75-144-0, p. 4-5 to 4-20.

Pike, R.J., 1974, Craters on Earth, Moon, and Mars—multivariate classification and mode of origin: Earth and Planetary Science Letters, v. 22, no. 3, p. 245-255.

Pike, R.J., 1975, Slope analysis of the martian equatorial belt at 30 km resolution, *in* Masursky, H., and Strobell, M.H., eds., Geologic Maps and Terrain Analysis Data for Viking Mars '75 landing sites considered in December 1972, U.S. Geological Survey Interagency Report: Astrogeology 59, p. 55-61.

Pike, R.J., 1977, Size-dependence in the shape of fresh craters on the Moon, *in* Roddy, D.J., Pepin, R.O., and Merrill, R.B., eds., Impact and Explosion Cratering: New York, Pergamon Press, p. 489-509.

Pike, R.J., 1978a, Lunar Landscape Morphometry: U.S. Geological Survey open-file report no. 78-812, Menlo Park, CA, 142 p.

Pike, R.J., 1978b, Volcanoes on the inner planets—some preliminary comparisons of gross topography, *in* Lunar and Planetary Science Conference 9th, March 1978, Houston, TX, Proceedings, New York, Pergamon Press, p. 3239-3273.

Pike, R.J., 1980, Apollo 15-17 Orbital Investigations—geometric interpretation of lunar craters: U.S. Geological Survey Professional Paper 1046-C, 77 p.

Pike, R.J., 1986a, Mapping geomorphic provinces on solid planets—a quantitative example from Earth, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 17th, March 1986, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XVII, p. 664-665.

Pike, R.J., 1986b, Scale dependence of planetary surface slope is curvilinear, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 17th, March 1986, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XVII, p. 666-667.

Pike, R.J., 1986c, Variance spectra of representative 1:62,500-scale topographies—a terrestrial calibration for planetary roughness at 0.3 km to 7.0 km, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 17th, March 1986, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XVII, p. 668-669.

Pike, R.J., 1987, Toward geometric signatures for planetary terrain—an assessment of Earth at 1:24,000 scale, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 18th, March 1987, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XVIII, p. 780-781.

Pike, R.J., 1987, Information content of planetary terrain—varied effectiveness of parameters for the Earth, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 18th, March 1987, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XVIII, p. 778-779.

Pike, R.J., 1988a, The geometric signature—quantifying landslide-terrain types from digital elevation models: Mathematical Geology, v. 20, no. 5, p. 491-511.

Pike, R.J., 1988b, Toward geometric signatures for geographic information systems, *in* International Geographic Information Systems Symposium, Arlington, VA, November 15-18, 1987, Proceedings: Washington, D.C., NASA, v. III, p. 15-26.

Pike, R. J., 1988c, Geomorphology of impact craters on Mercury (*with a section on* Calculation of crater dimensions from oblique images, by G.D. Clow and R.J. Pike), *in* Vilas, Faith, Chapman, C.R., and Matthews, M.S., eds., Mercury: Tucson, Univ. Arizona Press, p. 165-273.

Pike, R.J., 1991, Surface features of central North America—A synoptic view from computer graphics: GSA Today, v. 1, no. 11, p. 241, 251-253.

Pike, R.J., 1992, Standards for digital topographic data, *in* Johnson, A.I., Pettersson, C.B., and Fulton, J.L., eds., Geographic Information Systems (GIS) and Mapping—Practices and Standards (selected papers from a symposium, San Francisco, CA, June 12-22, 1990): Philadelphia, PA, American Society for Testing and Materials, Special Technical Publication 1126, p. 316-317.

Pike, R.J., 1992, Machine visualization of synoptic topography by digital image processing, *in* Wiltshire, D.A., ed., Selected Papers in the Applied Computer Sciences, 1992, U.S. Geological Survey Bulletin 2016, Chapter B, p. B1-B12.

Pike, R.J., 1993, How to improve digital topographic data (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 195.

Pike, R.J., and Acevedo, William, 1988, Image-processed maps of southern New England topography (abs.): Geological Society of America Abstracts with Programs, v. 20, no. 1, p. 62.

Pike, R.J., and Rozema, W.J., 1975, Spectral analysis of landforms: Annals of the Association of American Geographers, v. 65, no. 4, p. 499-516.

Pike, R.J., and Spudis, P.D., 1987, Basin-ring spacing on the Moon, Mercury, and Mars: Earth Moon and Planets, v. 39, no. 2, p. 129-194.

Pike, R.J., and Thelin, G.P., 1989, Cartographic analysis of U.S. topography from digital data, *in* Auto-Carto 9, International Symposium on Computer-Assisted Cartography, 9th, Baltimore, April 2-7, 1989, American Society of Photogrammetry and Remote Sensing and American Congress on Surveying and Mapping, Proceedings, p. 631-640.

Pike, R.J., and Thelin, G.P., 1989, Shaded relief map of U.S. topography from digital elevations: Eos, Transactions of the American Geophysical Union, v. 70, no. 38, cover and p. 843 & 853.

Pike, R.J., and Thelin, G.P., 1990-91, Mapping the nation's physiography by computer: Cartographic Perspectives (bulletin of the North American Cartographic Information Society, University Park, Pennsylvania), No. 8, Winter, p. 15-24.

Pike, R.J., and Thelin, G.P., 1992, Visualizing the United States in computer chiaroscuro: Annals of the Association of American Geographers, v. 82, no. 2, p. 300-302 (see also, p. 289-300).

Pike, R.J., and Wilson, S.E., 1971, Elevation-relief ratio, hypsometric integral, and geomorphic area-altitude analysis: Geological Society of America Bulletin, v. 82, no. 4, p. 1079-1084.

Pike, R.J., Acevedo, William, and Card, D.H., 1989, Topographic grain automated from digital elevation models, *in* International Symposium on Computer-Assisted Cartography, 9th, Baltimore, April 2-7, 1989, American Society for Photogrammetry and Remote Sensing—American Congress on Surveying and Mapping, Proceedings, p. 128-137.

Pike, R.J., Acevedo, William, and Showalter, P.K., 1992, Mapping topographic form by digital image-processing in the San Jose 1:100,000 sheet, California: U.S. Geological Survey open-file report OF92-420, 56 p.

Pike, R.J., Acevedo, William, and Thelin, G.P., 1988, Some topographic ingredients of a geographic information system, *in* International Geographic Information Systems Symposium, Arlington, VA, November 15-18, 1987, Proceedings: Washington, D.C., NASA, v. II, p. 151-164.

Pike, R.J., Guzzetti, Fausto, Mark, R.K., Bortoluzzi, Giovanni, Ligi, Marco, Bennett, Brian, Acevedo, William, and Thelin, G.P., 1989, Synoptic maps of Italy's topography from a digital elevation model: First workshop 'Informatica e Scienze della Terra', Sarnano, Italy, October 18-20, 1989, Proceedings, Napoli, DeFrede, p. 27/1-27/7.

Pike, R.J., Thelin, G.P., and Acevedo, William, 1987, A topographic base for GIS from automated TINs and image-processed DEMs, *in* American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping, International Conference, Exhibits, and Workshops on Geographic Information Systems, 2nd, GIS '87-San Francisco, October 26-30, 1987, Proceedings, v. 1, p. 340-351.

Piotrowski, 1989, Relationship between drumlin length and width as a manifestation of the subglacial processes: Zeitschrift für Geomorphologie, v. 33, no. 4, p. 429-441.

Pitty, A.F., 1968, Some comments on the scope of slope analysis based on frequency distributions: Zeitschrift für Geomorphologie, v. 12, no. 3, p. 350-355.

Pitty, A.F., 1968, A simple device for the field measurement of hillslopes: Journal of Geology, v. 76, no. 6, p. 717-720.

Pitty, A.F., 1982, The Nature of Geomorphology: London, Methuen, 161 p.

Pizer, S.M., Zimmerman, J.B., and Staab, E.V., 1984, Adaptive grey level assignment in CT scan display: Journal of Computer Assisted Tomography, v. 8, no. 2, p. 300-305.

Plews, R.W., and Clarke, K.C., 1990, Problems in implementing the TIN data structure, *in* American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, annual convention, Denver, Colorado, March 18-23, Technical Papers, v. 2 (Cartography), p. 11-18.

Plunkett, Gordon, and Schanzer, Dena, 1989, The use of synthetic solar illumination for visualizing digital elevation models, *in* American Society for Photogrammetry and Remote Sensing—American Congress on Surveying and Mapping, fall convention, Technical papers, p. 471-481.

Podmore, T.H., and Huggins, L.F., 1980, Surface roughness effects on overland flow: Transactions of the American Society of Agricultural Engineers, v. 23, no. 6, p. 1434-1439, 1445.

Poggio, T., Gamble, E.B., and Little, J.J., 1988, Parallel integration of vision modules: Science, v. 242, no. 4877, p. 436-440.

Poiker, T.K., and Griswold, L.A., 1985, A step towards interactive displays of digital elevation models, *in* Auto-Carto 7, International Symposium on Computer-Aided Cartography, 7th, Washington, D.C., March 11-14, 1985, Proceedings, p. 408-415.

Polidori, Laurent, and Chorowicz, Jean, 1993, Comparison of bilinear and Brownian interpolation for digital elevation models: ISPRS Journal of Photogrammetry and and Remote Sensing, v. 48, no. 2, p. 18-23.

Polidori, Laurent, Chorowicz, Jean, and Guillande, Richard, 1991, Description of terrain as a fractal surface, and application to digital elevation model quality assessment: Photogrammetric Engineering and Remote Sensing, v. 57, no. 10, p. 1329-1332.

Pollack, H.N., 1968, On the interpretation of state vectors and local transformation operators, *in* Merriam, D.F., and Cocke, N.C., eds., Computer Applications in the Earth Sciences, colloquium on simulation: Lawrence, University of Kansas, State Geological Survey, Computer Contribution 22, p. 43-46.

Pollack, H.N., 1969, Dynamic modeling, *in* Models of Geologic Processes—an Introduction to Mathematical Geology: American Geological Institute short course, 7-9 November, 1969, Philadelphia, PA, Lecture Notes, p. HP-1 to HP-33.

Porter, S.C., 1972, Distribution, morphology, and size frequency of cinder cones on Mauna Kea volcano, Hawaii: Geological Society of America Bulletin, v. 83, no. 12, p. 3607-3612.

Posey, C.J., 1946, Measurement of surface roughness: Mechanical Engineering, v. 68, p. 305, 306, and 338.

Poscolieri, Maurizio, and Onorati, Giuseppe, 1988, A quantitative geomorphology study of main carbonate massifs of central and southern Apennines based on a digital elevations archive, *in* IGARSS '88 Symposium, Edinburgh, Scotland, 13-16 September 1988, Proceedings, ESA SP-284 (IEEE 88CH2497-6), p. 1653-1654.

Powell, M.J.D., and Sabin, M.A., 1977, Piecewise quadratic approximations on triangles: American Society for Computing Machinery Transactions on Mathematical Software, v. 3, p. 316-325.

Powers, P.S., Varnes, D.J., and Savage, W.Z., 1992, Digital elevation models for Slumgullion Landslide, Hinsdale County, Colorado, based on 1985 and 1990 aerial photography: U.S. Geological Survey Open-file Report 92-535A, 5 p.

Pratson, L.F., and Ryan, W.B.F., 1992, Application of drainage extraction to NOAA gridded bathymetry of the U.S. continental margin, *in* Lockwood, Millington, and McGregor, B.A., eds., Exclusive Economic Zone Symposium on Mapping and Research, November 5-7, 1991, Portland, Oregon, Proceedings: U.S. Geological Survey Circular 1092, p. 110-117.

Press, W.H., Teukolsky, S.A., Vetterling, W.T., and Flannery, B.P., 1992, Numerical Recipes in FORTRAN, The Art of Scientific Computing (2nd ed.): Cambridge University Press, 963 p. ['C' version has 1024 p.]

Preusser, Albrecht, 1984, Bivariate Interpolation über Dreieckselementen durch Polynome 5. Ordnung mit c_1-Kontinuität (in German): Zeitschrift für Vermessungswesen, v. 109, no. 6, p. 292-301.

Preusser, Albrecht, 1984, Computing contours by successive solution of quintic polynomial equations (Algorithm 626): ACM Transactions on Mathematical Software, v. 10, no. 4, p. 463-475.

Preusser, Albrecht, 1985, Some hidden features and extensions of IMSL Library routine IQHSCV (smooth surface fit): IMSL User Notes, v. 2, no. 3, p. 2, 3, and 12.

Price, Maribeth, and Suppe, John, 1993, Studying Venus using a GIS database, *in* Abstracts of papers submitted to the Lunar and Planetary Science

Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 1183-1184.

Price, W.A., 1968, Oriented lakes, *in* Fairbridge, R.W., ed., The Encyclopedia of Geomorphology: New York, Reinhold Book Co., p. 784-796.

Protod'yakonov, M.M., 1925, Chislovyye kharakteristiki topograficheskikh usloviy mestnosti (Numerical characteristics of topographical detail; in Russian): Moscow.

Proudfoot, M.J., 1942, Sampling with traverse lines: Journal of the American Statistical Association, v. 37, p. 265-270.

Proudfoot, M.J., 1946, Measurement of Geographic Area: Washington, D.C., U.S. Bureau of the Census, 120 p.

Provorov, K.L., and Ivanov, A.M., 1978, Mathematical simulation of terrain relief using cubical and bicubical splines (in Russian): Geodeziya i kartografiya, No. 8, p. 39-44. [translated 1977, *in* Geodesy, Mapping, and Photogrammetry, v. 19, no. 3, p. 163-166.

Pruitt, E.L., 1979, The Office of Naval Research and geography: Annals of the Association of American Geographers, v. 69, no. 1, p. 103-108.

Q

Qian, Jianzhong, Ehrich, R.W., and Campbell, J.B., 1990, DNESYS—an expert system for automatic extraction of drainage networks from digital elevation data: IEEE Transactions on Geoscience and Remote Sensing, v. 28, no. 1, p. 29-45.

Quinn, P.F., Beven, K.J., Chevallier, P., and Planchon, O., 1991, The prediction of hillslope flow paths for distributed hydrological modelling using digital terrain models: Hydrological Processes, v. 5, no. 1, p. 59-79.

Qiu, H.L., 1988, Measuring the Louisiana coastline—an application of fractals, *in* Association of American Geographers, Cartography Specialty Interest Group, Occasional Paper No. 1: p. 33-40.

R

Raggam, J., Buchroithner, M.F., and Mansberger, R., 1989, Relief mapping using nonphotographic spaceborne imagery: ISPRS Journal of Photogrammetry and Remote Sensing, v. 44, no. 1, p. 21-36.

Raisz, E.J., 1931, The physiographic method of representing scenery on maps: Geographical Review, v. 21, no. 2, p. 297-304.

Raisz, E.J., 1939, Landforms of the United States, *in* Atwood, W.W., 1940, The physiographic provinces of North America: New York, Blaisdell, scale about 1:4,500,000. [6th revised edition 1957]

Raisz, E.J., 1948, Land-slope analysis: General Cartography, New York, McGraw-Hill, p. 277-282. [similar material *in* 1st edition, 1938, and Principles of Cartography, 1962]

Raisz, E.J., 1956, Landform maps: Petermanns geographische Mitteilungen, v. 100, no. 2, p. 171-172, & figs. 30, 31.

Raisz, E.J., 1959, Landform maps—a method of preparation: Cambridge, MA, *for* Geography Branch, Office of Naval Research, Contract Nonr 2339(00), Final Report, Part I, p. 1-23.

Raisz, E.J., and Henry, Joyce, 1937, An average slope map of New England: Geographical Review, v. 27, no. 3, p. 467-472.

Ranke, Victor von, 1956, Perspecktive im Ingenieurbau insbesondere im Strassenbau: Wiesbaden, Bauverlag Gmbh., 141 p.

Rao, S.V.L.N., and Rao, B.S. Prakasa, eds., 1992, Applications of Mathematical Morphology for Pattern Studies: Visakhapatnam, India, J.P. Laser Graphics, ca. 100 p.

Raper, J.F. ed., 1989, Three dimensional applications in geographical information systems: London, Taylor and Francis, 189 p.

Raper, J.F., and Maguire, D.J., eds., 1992, GIS design models: Computers and Geosciences (special issue), v. 18, no. 4, p. 387-475.

Rayner, J.N., 1972, The application of harmonic and spectral analysis to the study of terrain, *in*

Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, p. 283-302.

Reams, M.W., 1992, Fractal dimensions of sinkholes, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 159-165.

Reed, Bruce, Galvin, C.J. Jr., and Miller, J.P., 1962, Some aspects of drumlin geometry: American Journal of Science, v. 260, no. 3, p. 200-210.

Reech, M., 1858, Démonstration d'une propriété général des surfaces fermées (in French): Journal de l'Ecole Polytechnique, v. 37, p. 169-178.

Reed, T.B. IV, and Hussong, Donald, 1989, Digital image processing techniques for enhancement and classification of SeaMARC II side scan sonar imagery: Journal of Geophysical Research, v. 94, no. B6, p. 7469-7490.

Reeve, E.C.R., and Huxley, J.S., 1945, Some problems in the study of allometric growth, *in* Clark, W.E. LeGros, and Medawar, P.B., eds., Essays on "Growth and Form" presented to D'Arcy Wentworth Thompson: Oxford, Clarendon Press, paging unknown. [reprinted *in* Huxley, J.S., 1972, Problems of Relative Growth (2nd edition): New York, Dover, p. 267-302.]

Reich, B.M., 1971, Land surface form in flood hydrology, *in* Coates, D.R., ed., Environmental Geomorphology, proceedings of the first annual geomorphology symposium: Binghamton, N.Y., SUNY, Publications in Geomorphology, p. 49-68.

Reichenbach, Paola, Pike, R.J., Acevedo, William, and Mark, R.K., 1992, All Italy portrayed in digital *chiaroscuro* (abs.): Eos Transactions of the American Geophysical Union, v. 73, no. 14 (Supplement), p. 45.

Reichenbach, Paola, Acevedo, William, Mark, R.K., and Pike, R.J., 1992, Landforms of Italy: Perugia, It., Consiglio Nazionale delle Ricerche, Instituto di Ricerca per la Protezione Idrogeologica nell'Italia Centrale, *in collaboration with* U.S. Geological Survey, scale 1:1,200,000.

Reichenbach, Paola, Pike, R.J., Acevedo, William, and Mark, R.K., 1993, A new landform map of Italy in computer-shaded relief: Bolletino di Geodesia e Scienze Affini (Istituto Geografico Militare, Florence, Italy), v. 52, no. 1, p. 21-44, with fold-out 1:2,000,000-scale map.

Reid, M.B., and Hine, B.P., 1992, Terrain tracking for lander guidance using binary phase-only spatial filters: Photogrammetric Engineering and Remote Sensing, v. 58, no. 12, p. 1699-1706.

Rentsch, Hermann, Welsch, Walter, Heipke, Christian, and Miller, M.M., 1990, Digital terrain models as a tool for glacier studies: Journal of Glaciology, v. 36, no. 124, p. 273-278.

Renwick, W.H., 1992, Equilibrium, disequilibrium, and nonequilibrium landforms in the landscape, *in* Phillips, J.D., and Renwick, W.H., eds., Geomorphic Systems, proceedings of the Binghamton Symposium in Geomorphology, 23rd, September 25-27, 1992: Geomorphology, v. 5, nos. 3-5, p. 265-276.

Reyment, R.A., 1991, The study of size and shape, *in* Multidimensional Palaeobiology: Oxford, UK, Pergamon Press, p. 99-157.

Rhind, David, 1975, A skeletal overview of spatial interpolation techniques: Computer Applications (UK), v. 2, no. 3 and 4, p. 293-309.

Rhind, D.W., and Green, N.P.A., 1988, Design of a geographical information system for a heterogeneous scientific community: International Journal of Geographical Information Systems, v. 2, no. 2, p. 171-189.

Rhoads, B.L., and Thorn, C.E., 1993, Geomorphology as science—the role of theory: Geomorphology, v. 6, no. 4, p. 287-307.

Riazanoff, Serge, Cerville, Bernard, and Chorowicz, Jean, 1988, Ridge and valley line extraction from digital terrain models: International Journal of Remote Sensing, v. 9, no. 6, p. 1175-1183.

Riazanoff, Serge, Cerville, Bernard, and Chorowicz, Jean, 1990, Parametrisable skeletonization of binary and multi-level images: Pattern Recognition letters, v. 11, no. 1, p. 25-33.

Riazanoff, Serge, Julien, P., Cerville, Bernard, and Chorowicz, Jean, Extraction et analyse automatiques d'un réseau hiérachisé de talwegs—Application à un modèle numérique de terrain dérivé d'un couple stéreoscopique SPOT: International Journal of Remote Sensing, in-press (ca. 1992).

Ricard, Y., Froidevaux, C., and Simpson, R., 1987, Spectral analysis of topography and gravity in the Basin and Range province: Tectonophysics, v. 133, no. 3/4, p. 175-187.

Rich, John, 1916, A graphical method of determining the average inclination of a land surface from a contour map: Transactions of the Illinois Academy of Sciences, v. 9, p. 195-199.

Richards, K.S., ed., 1990, Part two—form, *in* Goudie, Andrew (with the assistance of six others), ed., Geomorphological Techniques (second edition): London, Unwin Hyman, *for* the British Geomorphological Research Group, p. 31-108.

Richardson, L.F., 1961, The problem of contiguity, *an appendix to* Wright, Quincy, and Lienau, C.C., eds., The statistics of deadly quarrels: Pittsburgh, Boxwood Press, 373 p. [reprinted 1961, *in* General Systems, Yearbook of the Society for General Systems, v. 6, p. 139-187.

Rigney, M.P., and Brusewitz, G.H., 1992, Asparagus shape features for quality assessment: Transactions of the American Society of Agricultural Engineering, v. 35, no. 5, p. 1607-1613.

Rinaldo, Andrea, Rodriguez-Iturbe, Ignacio, Rigon, Riccardo, Bras, R.L., Ijjasz Vasquez, Ede, and Marani, Alessandro, 1992, Minimum energy and fractal structures of drainage networks: Water Resources Research, v. 28, no. 9, p. 2183-2195.

Rindfleisch, Thomas, 1966, Photometric method for lunar topography: Photogrammetric Engineering, v. 32, no. 2, p. 262-276. [also, 1965, *as* A photometric method for deriving lunar topographic information: Pasadena, CA, Jet Propulsion Laboratory, Technical Report No, 32-786]

Rinehart, R.E., and Coleman, E.J., 1988, Digital elevation models produced from digital line graphs, *in* American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, annual convention, March 13-18, 1988, St. Louis, Missouri, Technical papers, v. 2 (Cartography), p. 291-299.

Ripley, B.D., 1981, Spatial Statistics: New York, John Wiley and Sons, 252 p.

Ripley, B.D., 1988, Statistical Inference for Spatial Processes: New York, Cambridge University Press, 148 p.

Rives, J.M., and Besaw, G.A., 1990, Automated terrain inference from digital elevation data, Fort Monmouth, N.J., U.S. Army Communications-Electronics Command: Final Technical Report, 65 p.

Robert, Andre, and Roy, A.G., 1990, On the fractal interpretation of the mainstream length-drainage area relationship: Water Resources Research, v. 26, no. 5, p. 839-842. [see also, Reply, 1991, WRR, v. 27, no. 9, p. 2489-2490]

Roberts, Paul, 1957, Using new methods in highway location: Photogrammetric Engineering, v. 23, no. 3, p. 563-569.

Roberts, P.O., 1963, The digital terrain model approach to railroad route location: Bulletin of the American Railway Engineering Association, v. 63, paging unknown.

Robichaud, P.R., and Molnau, M., 1990, Measuring soil roughness changes with an ultrasonic profiler: Transactions of the American Society of Agricultural Engineers, v. 33, no. 6, p. 1851-1858.

Robinove, C.J., 1979, Integrated terrain mapping with digital Landsat images in Queensland, Australia: U.S. Geological Survey Professional Paper 1102, 39 p.

Robinove, C.J., 1986, Principles of logic and the use of digital geographic information systems: U.S. Geological Survey Circular 977, 19 p.

Robinson, A.H., 1946, A method for producing shaded relief from aerial slope data: Annals of the Association of American Geographers, v. 36, no. 4, p. 248-252. [reprinted 1948, *in* Surveying and Mapping, v. 8, no. 3, p. 157-160]

Robinson, A.H., 1953, Other methods of depicting land surface: Elements of Cartography, New York, John Wiley & Sons, p. 215-218.

Robinson, A.H., 1956, The necessity of weighting values in correlation analysis of areal data: Annals of the Association of American Geographers, v. 46, no. 2, p. 233-236.

Robinson, A.H., and Thrower, N.J.W., 1957, A new method of terrain representation: The Geographical Review, v. 47, no. 4, p. 507-520.

Robinson, Geoffrey, and Joyce, E.B., 1969, *review of* Land Evaluation: Australian Geographical Studies, v. 7, no. 1, p. 74-80.

Robinson, J.E., and Charlesworth, H.A.K., 1975, Relation of topography and structure in south-central Alberta: Mathematical Geology, v. 7, no. 1, p. 81-87.

Roddy, D.J., Pepin, R.O., and Merrill, R.B., eds., 1977, Impact and Explosion Cratering—planetary and terrestrial implications, Symposium on Planetary Cratering Mechanics, Flagstaff, Arizona, September 13-17, 1976, Proceedings: New York, Pergamon, Press 1301 p.

Rodolfi, G., 1988, Geomorphological mapping applied to land evaluation and soil conservation in agricultural planning—some examples from Tuscany (Italy): Zeitschrift für Geomorphologie, Supplementband 68, p. 155-174.

Rodriguez-Iturbi, Ignacio, Rinaldo, Andrea, Rigon, Riccardo, Bras, R.L., Ijjasz-Vasquez, Ede, and Marani, Alessandro, 1992, Fractal structures as least energy patterns—the case of river networks: Geophysical Research Letters, v. 19, no. 9, p. 889-892.

Rokos, D.-Kl., and Armstrong, M.P., 1992, Parallel terrain feature extraction, *in* GIS/LIS '92, Annual conference and exposition, November 10-12, 1992, San Jose, CA, Proceedings, v. 2, p. 652-661.

Rose, Albert, and Weimer, P.K., 1989, Physical limits to the performance of imaging systems: Physics Today, v. 42, no. 9, p. 24-32.

Rose, James, and Letzer, J.M., 1975, Drumlin measurements—a test of the reliability of data derived from 1:25,000 scale topographic maps: Geological Magazine, v. 112, no. 4, p. 361-371.

Rosenfeld, Azriel, 1981, Image pattern recognition: Proceedings of the Institute of Electrical and Electronics Engineers, v. 69, no. 5, p. 596-605.

Rosenfeld, Azriel, 1988, Computer vision, basic principles: Proceedings of the Institute of Electrical and Electronics Engineers, v. 76, no. 8, p. 863-868.

Rosenfeld, Azriel, Fried, Charles, and Orton, J.N., 1965, Automatic cloud interpretation: Photogrammetric Engineering, v. 31, no. 11, p. 991-1002.

Rosenfeld, Azriel, and Kak, A.C., 1982, Digital Picture Processing, 2nd ed., New York, Academic Press, vols. I and II, 435 and 349 p.

Rosenfeld, Azriel, and Pfaltz, J.L., 1966, Sequential operations in digital picture processing: Journal of the Association for Computing Machinery, v. 13, no. 4, p. 471-494.

Ross, R., and Evans, B.M., 1984, The development of visual resources management and computer aided design in the United States Forest Service, in Evans, B.M., ed., Computer-Aided Landscape Design—principles and practice: Scotland, The Landscape Institute, p. 85-105.

Ross, S.G., 1986, Interpolation for contouring—an experiment in weighting functions: Geo-Processing, v. 3, no. 2, p. 179-194.

Rossbacher, L.A., 1985, Quantitative analysis of Martian polygonal ground, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 16th, March 1985, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XVI, p. 710-711.

Rossbacher, L.A., 1986, Nearest-neighbor analysis—a technique for quantitative evaluation of polygonal ground patterns: Geografiska Annaler, v. 68A, no. 1-2, p. 101-105.

Rosso, Renzo, Bacchi, Baldassare, and La Barbera, Paolo, 1991, Fractal relation of mainstream length to catchment area in river networks: Water Resources Research, v. 27, no. 3, p. 381-387.

Roth, L.E., Saunders, R.S., Downs, G.S., and Schubert, Gerald, 1989, Radar altimetry of large Martian craters: Icarus, v. 79, no. 2, p. 289-310.

Rowan, L.C., and McCauley, J.F., 1967, Lunar terrain analysis, *in* Lunar Orbiter—image analysis studies report, May 1, 1965 to January 31, 1966: U.S. Geological Survey open-file report 148, p. 89-129.

Rowan, L.C., McCauley, J.F., and Holm, E.A., 1971, Lunar terrain mapping and relative-roughness analysis: U.S. Geological Survey Professional Paper 599-G, 32 p.

Roy, A.G., Gravel, Ginette, and Gauthier, Céline, 1987, Measuring the dimensions of surfaces, a review and appraisal of different methods, *in* Chrisman, N.R., ed., Auto-Carto 8, International Symposium on Computer-Assisted Cartography 8th, Baltimore, Maryland, March 29-April 3, 1987, Proceedings, p. 68-77.

Rozema, W.J., 1968, The use of spectral analysis in describing lunar surface roughness: U.S. Geological Survey, Interagency report Astrogeology 12, prepared for NASA under Purchase Order No. W-12,388, Amend. No. 2, 34 p.

Rozema, W.J., 1969, The use of spectral analysis in describing lunar surface roughness, *in* Geological Survey Research 1969: U.S. Geological Survey Professional Paper 650-D, p. 180-188.

Rudberg, Sten, 1960, Geology and morphology, *in* Somme, A., A Geography of Norden: Stockholm, p. 27-40 and maps no. 2, 3, and 4.

Rudyy, R.M., 1985, An analytical method for identifying structure lines in topography: Mapping Sciences and Remote Sensing, v. 22, no. 1, p. 82-87.

Ruhe, R.V., 1950, Graphic analysis of drift topographies: American Journal of Science, v. 248, no. 6, p. 435-443.

Ruhe, R.V., 1952, Topographic discontinuities of the Des Moines lobe: American Journal of Science, v. 250, no. 1, p. 46-56.

Russell, R.J., 1949, Geographical geomorphology: Annals of the Association of American Geographers, v. 39, no. 1, p. 1-11.

Rybkin, S.I., 1947, A morphometrical classification of rivers (in Russian): Meteorol. Gidrol., 4.

Ryder, J.M., 1971, Some aspects of the morphometry of paraglacial alluvial fans in south-central British Columbia: Canadian Journal of Earth Science, v. 8, no. 10, p. 1252-1264.

Ryll, Ewald, 1962, Aerial observer effectiveness and nap-of-the-Earth (Project TRACE): Buffalo New York, Cornell Aeronautical Laboratory, *for* U.S. Army Quartermaster Research and Engineering Command, Natick, MA, Report No. VE-1591-G-1, 126 p.

S

Saffari, Bobby, 1989, Putting DSPs (digital signal processors) to work (in the microcomputer environment): BYTE, v. 14, no. 13, p. 259, 260, 262-264, 266, 268-270, and 272.

Salari, E., and Siy, P., 1984, The ridge-seeking method for obtaining the skeleton of digital images: IEEE Transactions on Systems, Man, and Cybernetics, v. SMC-14, p. 524-528.

Salisbury, N.E., 1957, A generic classification of landforms of Minnesota: Minneapolis, University of Minnesota, Department of Geography, unpublished Ph.D. dissertation, 171 p.

Salisbury, N.E., 1962, Relief-slope relations in glaciated terrain (abs.): Annals of the Association of American Geographers, v. 52, no. 3, p. 358-359.

Salisbury, N.E., 1971, Threads of inquiry in quantitaive geomorphology, *in* Morisawa, Marie, ed., Quantitative geomorphology—some aspects and applications: Binghamton, N.Y., Annual Geomorphology Symposia Series, 2nd, October 15-16, 1971, Proceedings, p. 9-60.

Samet, Hanan, 1984, The quadtree and related hierarchical data structures: Association for Computing Machinery, Computing Surveys, v. 16, no. 2, p. 187-260.

Samet, Hanan, 1989, The Design and Analysis of Spatial Data Structures: Reading, Mass., Addison-Wesley Publishing Co., 493 p.

Samet, Hanan, 1990, Applications of Spatial Data Structures—Computer Graphics, Image Processing, and GIS: Reading, Mass., Addison-Wesley Publishing Co., 507 p.

Samet, Hanan, Shaffer, C.A., Nelson, R.C., Huang, Y.-g., Fujimura, Kikuo, and Rosenfeld, Azriel, 1986, Recent developments in quadtree-based geographic information systems, *in* International Symposium on Spatial Data Handling 2nd, July 5-10, 1986, Seattle, Washington, Proceedings, p. 15-32.

Sampson, R.J., 1978, SURFACE II graphics system: Lawrence, Kansas Geological Survey, Series on Spatial Analysis, 240 p.

Sanchez-Azofeifa, A., Jenson, S.K., and VanderZee, D., 1992, Use of digital elevation models as a water resources planning tool on regulated rain forest basins (abs.): Eos, Transactions of the American Geophysical Union, v. 73, no. 43 (supplement), p. 226.

SAS Institute Inc., 1985, SAS descriptive procedures (chapter 20), *in* SAS User's Guide, Basics (Version 5 edition): Cary, North Carolina, SAS Institute Inc., p. 735 & 741. [reinterpretation of kurtosis]

Sasowsky, K.C., Petersen, G.W., and Evans, B.M., 1992, Accuracy of SPOT digital elevation model and derivatives—utility for Alaska's north slope: Photogrammetric Engineering and Remote Sensing, v. 58, no. 6, p. 815-824.

Saucier, R.T., and Broughton, J.D., 1962, A technique for mapping terrain microgeometry: Vicksburg, Mississippi, U.S. Army Corps of Engineers Waterways Experiment Station, Technical Report No. 3-612, 25 p. + 34 pages of appendices.

Sauchyn, D.J., and Gardner, J.S., 1983, Morphometry of open rock basins, Kananaskis area, Canadian Rocky Mountains: Canadian Journal of Earth Science, v. 20, no. 3, p. 409-419.

Sauer, C.O., 1925, The morphology of landscape: Berkeley, University of California Publications in Geography, v. 2, no. 2, p. 19-53. [republished 1969, *in* Leighly, John, ed., Land and Life, a selection from the writings of Carl Ortwin Sauer: Berkeley, University of California Press, p. 315-350]

Savigear, R.A.G., 1965, A technique of morphological mapping: Annals of the Association of American Geographers, v. 55, no. 3, p. 514-538.

Savitt, S.L., Henderson, T.C., and Colvin, T.L., 1992, Feature extraction for localization, *in* Defense Advanced Research Projects Agency (DARPA) Image Understanding Workshop, San Diego, Calif., January 1992, Proceedings, p. 327-331.

Sawatsky, D.L., and Raines, G.L., 1981, Geologic uses of linear-feature maps derived from small-scale images, *in* O'Leary, D.W., and Earl, J.L., eds., Third International Conference on Basement Tectonics, Denver, Colorado, Basement Tectonics Committee, Proceedings, p. 91-100.

Sayles, R.S., and Thomas, T.R., 1978, Surface topography as a nonstationary random process: Nature, v. 271, no. 5644, p. 431-434.

Sayles, R.S., and Thomas, T.R., 1978, Topography of random surfaces, reply: Nature, v. 273, no. 5663, p. 573.

Scarlatos, L.L., 1989, A compact terrain model based on critical topographic features, *in* Auto-Carto 9, International Symposium on Computer-Assisted Cartography, 9th, Baltimore, Maryland, April 2-7, 1989, ASPRS/ACSM, Proceedings, p. 146-153.

Scarlatos, L.L., 1990, An automated critical line detector for digital elevation matrices, *in* American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, annual convention, Denver, Colorado, March 18-23, Technical Papers, v. 2 (Cartography), p. 43-51.

Scarlatos, L.L., 1991, Adaptive hierarchical triangulation, *in* American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, annual convention, Baltimore, Md., March 25-29: Technical Papers, v. 6 (Auto-Carto 10), p. 234-246.

Schaber, G.G., Pike, R.J., and Berlin, G.L., 1980, Terrain-analysis procedures for modeling radar back-scatter, *in* Radar Geology: An Assessment, report of the Radar Geology Workshop, Snowmass, Colo. 16-20 July 1979, Jet Propulsion Laboratory Publication 80-61, p. 168-199. [also 1979, U.S. Geological Survey Open-file Report 79-1088, 20 p. + 41 p. appendix that includes entire FORTRAN code and a worked example]

Schaber, G.G., Strom, R.G., Moore, H.J., Soderblom, L.A., Kirk, R.L., Chadwick, D.J., Dawson, D.D., Gaddis, L.R., Boyce, J.M., and Russell, Joel, 1992, Geology and distribution of impact craters on Venus—what are they telling us?: Journal of Geophysical Research, v. 97, no. E8, p. 13,257-13,301.

Schaefer, Melvin, Elifrits, B., and Barr, D.J., 1979, Scupturing reclaimed land to descrease erosion, *in* Symposium on Surface Mining Hydrology, Sedimentology, and Reclamatioin, 1979, Lexington, KY, The University of Kentucky, Proceedings, p. 99*ff*.

Scheidegger, A.E., 1965, The algebra of stream-order numbers: Geological Survey Research 1965, U.S. Geological Survey Professional Paper 525-B, p. B187-B189.

Scheidegger, A.E., 1966, Effect of map scale on stream orders: Bulletin of the International Association of Scientific Hydrology, v. 11, no. 3, p. 56-61.

Scheidegger, A.E., 1991, Theoretical Geomorphology (3rd revised edition): Berlin, Springer-Verlag, 434 p. [1961, 1st ed., 333 p.; 1970, 2nd ed., 435 p.]

Schenk, Hilbert S. Jr., 1963, Simulation of the evolution of drainage-basin networks with a digital computer: Journal of Geophysical Research, v. 68, no. 20, p. 5739-5745.

Schenk, P.M., 1989, Crater formation and modification on the icy satellites of Uranus and Saturn—depth/diameter and central peak occurrence: Journal of Geophysical Research, v. 94, no. B4, p. 3813-3832.

Schenk, P.M., 1993, Central pit and dome craters—exposing the interiors of Ganymede and Callisto: Journal of Geophysical Research, v. 98, no. E4, p. 7475-7498.

Schenk, Tony, and Zilberstein, Ofer, 1990, Experiments with a rule-based system for interpreting linear map features: Photogrammetric Engineering and Remote Sensing, v. 56, no. 6, p. 911-917.

Schlapfer, Albert, 1938, Die Berechnung der Reliefenergie und ihre Bedeutung als graphische Darstellung (in German): Dissertation, Univ. Zürich, 57 p.

Schloss, J.A., and Rubin, F.A., 1992, A "bottom-up" approach to GIS watershed analysis, *in* GIS/LIS '92, annual conference and exposition, November 10-12, 1992, San Jose, CA: Proceedings, v. 2, p. 672-679.

Schloss, Milton, 1965, Quantifying terrain roughness on lunar and planetary surfaces: American Institute of Aeronautics and Astronautics 2nd Annual Meeting, San Francisco, California, July 26-29, 1965, Paper 65-389, 22 p. [also 1966, *in* Journal of Spacecraft and Rockets (AIAA), v. 3, p. 283-285]

Schneider, William, 1961, A note on the accuracy of drainage densities computed from topographic maps: Journal of Geophysical Research, v. 66, no. 10, p. 3617-3618.

Scholz, D.K., Doescher, S.W., and Hoover, R.A., 1987, Automated generation of shaded relief in aeronautical charts, *in* American Society of Photogrammetry and Remote Sensing / American Congress of Surveying and Mapping, annual convention, Baltimore, March 29-April 3, 1987, Technical Papers, v. 4 (Cartography), p. 212-219.

Schowengerdt, R.A., and Wang, Han-lung, 1989, A general purpose expert system for image processing: Photogrammetric Engineering and Remote Sensing, v. 55, no. 9, p. 1277-1284.

Schreier, H., and Lavkulich, L.M., 1978, A numerical terrain classification scheme for off-road terrain trafficability assessments: Geoforum, v. 9, no. 3, p. 225-234.

Schreier, H., and Lavkulich, L.M., 1979, A numerical approach to terrain analysis for off-road trafficability: Photogrammetric Engineering and Remote Sensing, v. 45, no. 5, p. 635-642.

Schrepfer, Hans, and Kallner, Horst, 1930, Die maximale Reliefenergie Westdeutschlands (in German): Petermanns Mitteilungen, v. 76, p. 225-227 & plate 15.

Schröter, J.H., 1791 & 1802, Selenotopographische Fragmente zur genauern Kenntniss der Mondefläche, ihren erlittenen Veränderungen und Atmosphäre (in German): Lilienthal (v. I), Göttingen (v. II), 676 p. & 565 p.

Schumm, S.A., 1956, Evolution of drainage systems and slopes in badlands at Perth Amboy, New Jersey: Geological Society of America Bulletin, v. 67, no. 5, p. 597-646.

Schumm, S.A., 1960, The shape of alluvial channels in relation to sediment type: U.S. Geological Survey Professional Paper 352-B, p. 17-30.

Schumm, S.A., 1982, Drainage basin morphology, *in* Simons, Li, and Associates, eds., Engineering Analyses of Fluvial Systems, Fort Collins, Colorado, p. 5.15-5.21.

Schut, G.H., 1976, Review of interpolation methods for digital terrain models: The Canadian Surveyor, v. 30, no. 5, p. 389-412.

Schwarcz, H.P., and Shane, K.C., 1969, Measurement of shape by Fourier analysis: Sedimentology, v. 13, no. 2, p. 213-231.

Scott, R.M., and Austin, M.P., 1971, Numerical classification of land systems using geomorphological attributes: Australian Geographical Studies, v. 9, no. 1, p. 33-40.

Searle, J.R., 1990, Is the brain's mind a computer program?: The American Scientist, v. 262, no. 1, p. 26-31.

Searle, R.C., 1983, Submarine central volcanoes on the Nazca plate—high-resolution sonar observations: Marine Geology, v. 53, no. 1, p. 77-102.

Seemuller, W.W., 1989, The extraction of ordered vector drainage networks from elevation data: Computer Vision, Graphics, and Image Processing, v. 47, no. 1, p. 45-58.

Sekulin, A.E., Bullock, Andrew, and Gustard, Alan, 1992, Rapid calculation of catchment boundaries using an automated river network overlay technique: Water Resources Research, v. 28, no. 8, p. 2101-2109.

Selby, M.J., 1968, Morphometry of drainage basins in areas of pumice lithology, *in* New Zealand Geography Conference, 5th, New Zealand Geographical Society: Proceedings, p. 169-174.

Shaffer, C.A., 1988, An empirical comparison of vectors, arrays, and quadtrees for representing geographic data: Geologische Jahrbuch, v. A104, p. 99-115.

Shaffer, C.A., 1989, A full resolution elevation representation requiring three bits per pixel, *in* Buchmann, A., Günther, O., Smith, T.R., and Wang, Y.-F., eds., Design and Implementation of Large Spatial Databases: New York, Springer Verlag, p. 45-64.

Shamos, M.I., 1975, Geometric complexity: Proceedings of the 7th Annual Symposium on the Theory of Computing, p. 224-233.

Shannon, C.L., 1948, A mathematical theory of communication, Parts I and II: Bell System Technical Journal, v. 27, p. 379-423 & 623-656.

Shapiro, L.G., 1985, Recent progress in shape decomposition and analysis, *in* Kanal, L.N., and Rosenfeld, Azriel, eds., Progress in Pattern Recognition 2, Amsterdam, Elsevier, p. 113-123.

Sharif, Massoud, and Makarovic, Branko, 1989, Optimizing progressive and composite sampling for DTMs: ITC Journal (Enschede, Neth.), no. 1989-2, p. 104-111.

Sharpnack, D.A., and Akin, Garth, 1969, An algorithm for computing slope and aspect from elevations: Photogrammetric Engineering, v. 35, no. 3, p. 247-248.

Sharpton, V.L., and Head, J.W. III, 1986, A comparison of the regional slope characteristics of Venus and Earth—implications for geologic processes on Venus: Journal of Geophysical Research, v. 91, no. B7, p. 7545-7554.

Sharpton, V.L., Burke, Kevin, Hall, S.A., Lee, Scott, Marin, L.E., Suarez, Gerardo, Quezada-Muñeton, J.M., and Urritia-Fucugauchi, Jaime, 1993, Chicxulub impact basin—gravity characteristics and implications for basin morphology and deep structure, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993 Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 1283-1284.

Shaw, P.R., and Smith, D.K., 1987, Statistical methods for describing seafloor topography: Geophysical Research Letters, v. 14, no. 10, p. 1061-1064.

Shaw, P.R., and Smith, D.K., 1990, Robust description of statistically heterogeneous seafloor topography through its slope distribution: Journal of Geophysical Research, v. 95, no. B6, p. 8705-8722.

Shelburg, M.C., 1982, The development of a curve and surface algorithm to measure fractal dimensions and presentation of results: Columbus, The Ohio State University, Geography Department, unpublished M.A. research paper, 130 p.

Shelburg, M.C., Moellering, Harold, and Lam, Nina, 1982, Measuring the fractal dimensions of empirical cartographic curves, *in* ACSM/ASP Conference, Crystal City, VA, August 22-28, 1982, Auto-Carto, 5th, Proceedings, p. 481-490.

Shelburg, M.C., and Moellering, Harold, 1983, IFAS—A program to measure fractal dimensions of curves and surfaces, *in* Annual Meeting, 43rd, American Congress on Surveying and Mapping / American Society of Photogrammetry, convention, March 13-18, 1983, Washington, D.C., Technical Papers: p. 483-492.

Shelburg, M.C., Lam, Nina, and Moellering, Harold, 1983, Measuring the fractal dimensions of surfaces, *in* Auto-Carto 6, International Symposium on Automated Cartography, 6th, Ottawa, Canada, ACSM/ASPRS, Proceedings: v. II, p. 319-328.

Sheldon, Ken, 1987, Probing space by camera, the development of image processing at NASA's Jet Propulsion Laboratory: BYTE, v. 12, no. 3, p. 143-148.

Shephard, M.K., Guinness, E.A., and Arvidson, R.E., 1993, The roughness of the Martian surface—a scale dependent model, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 1293-1294.

Shepherd, W.H., 1968, Automatic contour digitizer: Photogrammetric Engineering, v. 34, no. 1, p. 75-82.

Short, N.M., 1982, The Landsat Tutorial Workbook, basics of satellite remote sensing: Washington, D.C., U.S. National Aeronautics and Space Administration, Reference Publication 1078, 553 p.

Short, N.M., 1987, Terranes as terrains—a geomorphic study of the Klamath Mountains (abs.): Geological Society of America Abstracts with Programs, v. 19, no. 7, p. 843.

Shoshany, Maxim, Inbar, Moshe, Begin, Z.B., and Hall, J.K., 1992, Analysis of facet and regional structure relationships in determining digital terrain model (DTM) grid density: Israel Journal of Earth Science, v. 41, Nos. 2-4, p. 217-225.

Shreve, R.L., 1966, Statistical law of stream numbers: Journal of Geology, v. 74, no. 1, p. 17-37.

Shreve, R.L., 1967, Infinite topologically random channel networks: Journal of Geology, v. 75, no. 2, p. 178-186.

Shreve, R.L., 1969, Stream lengths and basin areas in topologically random channel networks: Journal of Geology, v. 77, no. 4, p. 397-414.

Shreve, R.L., 1975, The probabilistic-topologic approach to drainage-basin geomorphology: Geology, v. 3, no. 9, p. 527-529.

Shreve, R.L., 1979, Models for prediction in fluvial geomorphology: Mathematical Geology, v. 11, no. 2, p. 165-175.

Sibson, R., 1978, Locally equiangular triangulations: Computer Journal, v. 21, p. 243-245.

Sibson, R., 1980, The Dirichlet tessellation as an aid in data analysis: Scandinavian Journal of Statistics, v. 7, p. 14-20.

Sibson, R., 1980, A vector identity for the Dirichlet tessellation: Mathematical Proceedings of the Cambridge Philosophical Society, v. 87, p.151-155.

Sieber, René, and Brassel, K.E., eds., 1986, A selected bibliography on spatial data handling—data structures, generalization and three-dimensional mapping: University of Zürich, Department of Geography, Geoprocessing Series, v. 6, 78 p.

Silfer, A.T., Kinn, G.J., and Hassett, J.M., 1987, A geographic information system utilizing the triangulated irregular network as a basis for hydrologic modeling, *in* Chrisman, N.R., ed., Auto-Carto 8, International Symposium on Computer-Assisted Cartography, 8th, Baltimore, Maryland, March 29-April 3, 1987, ASPRS/ACSM, Proceedings, p. 129-136.

Silva, P.G., Harvey, A.M., Zazo, C., and Goy, J.L., 1992, Geomorphology, depositional style and morphometric relationships of Quaternary alluvial fans in the Guadalentin Depression (Murcia, southeast Spain): Zeitschrift für Geomorphologie, v. 36, no. 3, p. 325-341.

Sima, J., 1972, Prinzipien des CS digitalen Geländemodells: Vermessungstechnik, v. 20, no. 2, p. 48-51.

Simaan, Marwan, and Aminzadeh, Fred, eds., 1989, Artificial intelligence and expert systems in petroleum exploration: Greenwich, Connecticut, JAI Press Inc., Advances in Geophysical Data Processing, v. 3, 307 p.

Simkin, Tom, Tilling, R.I., Taggart, J.N., Jones, W.J., and Spall, Henry, 1989, This dynamic planet—world map of volcanoes, earthquakes, and plate tectonics: U.S. Geological Survey, in cooperation with the Smithsonian Institution, scale 1:30,000,000.

Simpson, D.W., and Anders, M.H., 1992, Tectonics and topography of the western United States—an application of digital mapping: GSA Today, v. 2, no. 6, p. 117, 118, 120, and 121.

Simpson, R.W., Jachens, R.C., Blakely, R.J., and Saltus, R.W., 1986, A new isostatic residual gravity map of the conterminous United States with a discussion on the significance of isostatic residual anomalies: Journal of Geophysical Research, v. 91, no. B8, p. 8348-8372.

Singh, L., 1970, Basin circularity ratio as a terrain-type element—A case study of the Hoshiarpur Kangra tract: Deccan Geography, v. 8, nos. 1-2, p. 119-128.

Singh, L., 1971, Ruggedness number as a parameter in terrain regionalization—A case study of Hoshiarpur Kangra tract: Indian Geographical Journal, v. 46, no. 1, p. 17-21.

Sircar, J.K., and Cebrian, J.A., 1986, Application of image processing techniques to the automated labelling of raster digitized contour maps, *in* International Symposium on Spatial Data Handling, 2nd, Seattle, Washington, July 5-10, 1986, Proceedings, p. 171-184.

Sirotkin, M.P., 1937, Mathematical characterization of the complexity of a landform (in Russian): Geodezist (Moscow), no. 6.

Skateborg, J.H.T., 1986, A digital terrain model based on a geomorphologic map for computer assisted mapping: ITC Journal (Enschede, Neth.), v. 4, p. 299-306.

Skidmore, A.K., 1989, A comparison of techniques for calculating gradient and aspect from a gridded digital elevation model: International Journal of Geographical Information Systems, v. 3, no. 4, p. 323-334.

Skidmore, A.K., 1990, Terrain position as mapped from a gridded digital elevation model: International Journal of Geographical Information Systems, v. 4, no. 1, p. 33-49.

Slansky, Jack, 1972, Measuring concavity on a rectangular mosaic: IEEE Transactions on Computers, v. C-21, no. 12, p. 1355-1364.

Slaucitajs, Leonids, 1936, Begriff der Reliefentwicklung und Berechnung des wahren Areals einer topographischen Fläche (in German): Petermanns Mitteilungen, v. 82, no. 4, p. 111-112.

Slaymaker, H.O., ed., 1986, Morphometric analysis of maps, British Geomorphological Research Group Occasional Paper 4, paging unknown.

Smalley, I.J., and Vita-Finzi, Claudio, 1969, The concept of "system" in the Earth sciences, particularly geomorphology: Geological Society of America Bulletin, v. 80, no. 8, p. 1591-1594.

Smart, J.S., 1968, Statistical properties of stream lengths: Water Resources Research, v. 4, no. 5, p. 1001-1014.

Smart, J.S., 1969, Topological properties of channel networks: Geological Society of America Bulletin, v. 80, no. 9, p. 1757-1773.

Smart, J.S., and Moruzzi, V.L., 1972, Quantitative properties of delta channel networks: Zeitschrift für Geomorphologie, v. 16, no. 3, p. 268-282.

Smith, C.S., 1952, Grain shapes and other metallurgical applications of topology, *in* Metal Interfaces: Cleveland, OH, Transactions of the American Society of Metals, p. 65-113.

Smith, D.K., 1988, Shape analysis of Pacific seamounts: Earth and Planetary Science Letters, v. 90, no. 4, p. 457-466.

Smith, D.K., and Shaw, P.R., 1989, Using topographic slope distributions to infer seafloor patterns: IEEE Journal of Oceanic Engineering, v. 14, no. 4, p. 338-347.

Smith, Guy-Harold, 1935, The relative relief of Ohio: Geographical Review, v. 25, no. 2, p. 272-284.

Smith, Guy-Harold, 1938, The morphometry of landscape—an analysis of slope (abs., paper read at 36th Annual Meeting, Ann Arbor, 1937): Annals of the Association of American Geographers, v. 28, no. 1, p. 63-64.

Smith, K.G., 1950, Standards for grading texture of erosional topography: American Journal of Science, v. 248, no. 9, p. 655-668.

Smith, M.B., and Brilly, Mitja, 1992, Automated grid element ordering for GIS-based overland flow modeling: Photogrammetric Engineering and Remote Sensing, v. 58, no. 5, p. 579-585.

Smith, R.B., 1979, The influence of mountains on the atmosphere, *in* Saltzman, Barry, ed., Advances in Geophysics: New York, Academic Press, v. 21, p. 87-230.

Smith, R.B., 1989, Hydrostatic airflow over mountains, *in* Saltzman, Barry, ed., Advances in Geophysics: New York, Academic Press, v. 31, p. 1-41.

Smith, T.R., Zhan, Cixiang, and Gao, Peng, 1990, A knowledge-based, two-step procedure for extracting channel networks from noisy DEM data: Computers and Geosciences, v. 16, no. 6, p. 777-786.

Smith, T.R., Menon, Sudhakar, Star, J.L., and Estes, J.E., 1987, Requirements and principles for the implementation and construction of large-scale geographic information systems: International Journal of Geographical Information Systems, v. 1, no. 1, p. 13-31.

Smith, W.H.F., and Wessel, P., 1990, Gridding with continuous curvature splines in tension: Geophysics, v. 55, no. 3, p. 293-305.

Snell, J.B., 1958, A device and method for analyzing line of sight: Natick, Massachusetts, U.S. Army Quartermaster Research and Engineering Center, Environmental Protection Research Division, Environmental Analysis Branch, Technical Report EP-101, 22 p.

Snell, J.B., 1961, Method for predicting line-of-sight capabilities—preliminary investigations: Geological Society of America Bulletin, v. 72, no. 3, p. 479-484.

Snow, R.S., 1989, Fractal sinuosity of stream channels: Pure and Applied Geophysics, v. 131, no. 1/2, p. 99-109.

Snow, R.S., and Mayer, Larry, 1992, Introduction to special issue—Fractals in geomorphology: Geomorphology, v. 5, nos. 1/2, p. 1-4.

Sohlbach, K.D., 1978, Computergestützte geomorphometrische Analyse von Talformen (in German): Göttinger Geogr. Abh. 71.

Soille, Pierre, 1991, Spatial distributions from contour lines—An efficient methodology based on distance transformations: Journal of Visual Communication and Image Representation, v. 2, no. 2, p. 138-150.

Soille, P.J. and Ansoult, M.M., 1990, Automated basin delineation from digital elevation models using mathematical morphology: Signal Processing, v. 20, no. 2, p. 171-182.

Soille, P.J., and Vincent, Luc, 1990, Determining watersheds in digital pictures via flooding simulations, *in* Kunt, Murat, ed., Symposium on Visual Communication and Image Processing '90, Lausanne, Switzerland, Oct. 1-4, 1990, Proceedings: Bellingham, WA, International Society for Optical Engineering, v. 1360, Part One of Three Parts, p. 240-250.

Sokal, R.R., and Sneath, P.A., 1963, Principles of Numerical Taxonomy: San Francisco, W.H. Freeman, 359 p.

Songklar, K.A. von, 1873, Allgemeine Orographie, die Lehre von den Reliefformen der Erdoberfläche (in German), Vienna, W. Braumüller, 254 p.

Sørensen, P.R., 1984, Simulating reality with computer graphics: BYTE, v. 9, no. 3, p. 106-110, 112, 114, 116, 118, 120, 122, 124, 1 26, 128, 130, 132, and 134.

Speight, J.G., Meander spectra of the Angabunga River: Journal of Hydrology, v. 3, no. 1, p. 1-15.

Speight, J.G., 1967, Spectral analysis of meanders of some Australasian rivers, *in* Jennings, J.N., and Mabbutt, J.A., eds., Landform Studies from Australia and New Guinea: Canberra, Australian National University Press, p. 48-63.

Speight, J.G., 1968, Parametric description of land form, *in* Stewart, G.A., ed., Land Evaluation: Melbourne, Macmillan of Australia, p. 239-250.

Speight, J.G., 1971, Log-normality of slope distributions: Zeitschrift für Geomorphologie, v. 15, no. 3, p. 290-311.

Speight, J.G., 1974, A parametric approach to landform regions, *in* Brown, E.H., and Water, R.S., eds., Progress in Geomorphology: Institute of British Geographers, Special Publication 7, p. 213-230.

Speight, J.G., 1976, Numerical classification of landform elements from air photo data: Zeitschrift für Geomorphologie, Supplementband 25, p. 154-168.

Speight, J.G., 1977, Landform pattern description from aerial photographs: Photogrammetria, v. 32, no. 5, p. 161-182.

Speight, J.G., 1980, The role of topography in controlling throughflow generation—a discussion: Earth Surface Processes, v. 5, no. 2, p. 187-191.

Speight, J.G., and Hatano, S., 1979, Methods and significance of slope mapping: Map (Journal of the Japanese Cartographic Association), v. 17, no. 4, p. 29-30.

Spencer, Rob, 1984, Cluster analysis, a pattern-recognition program in BASIC: BYTE, v. 9, no. 10, p. 129, 130, & 423-426.

Spies, K.P., and Paulson, S.J., 1981, TOPOG—a computerized worldwide terrain elevation data base generation and retrieval system: U.S. Department of Commerce, National Telecommunications and Information Administration, NTIA Report No. 81-61, 214 p.

Sprent, P., 1972, The mathematics of size and shape: Biometrics, v. 28, no. 1, p. 23-37.

Sprunt, B.F., 1970, Geographics—a computer's eye view of terrain: Area (UK), v. 4, p. 54-59.

Sprunt, B.F. 1972, Digital simulation of drainage basin development, *in* Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, p. 371-389.

Spudis, P.D., and Sharpton, V.L., 1993, Impact basins on Venus and some interplanetary comparisons, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 24th, March 1993, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XXIV, p. 1339-1340.

Stäblein, G., 1968, Reliefgenerationen der Vorderpfalz (in German): Würzburger Geogr. Arbeiten, v. 23, p. 1-191.

Stäblein, G., 1972, Modellbildung als Verfahren zur komplexen Raumerfasssung (in German):

Würzburger Geogr. Arbeiten, v. 37 (Gerling-Festschrift), p. 67-93.

Stäblein, G., 1979, Geomorphological models as a tool for environmental studies: GeoJournal, v. 3, no. 4, p. 379-385.

Stakenborg, J.H., 1986, Digitizing alpine morphology, A digital terrain model based on a geomorphologic map for computer-assisted applied mapping: ITC Journal (Enschede, Neth.), v. 4, p. 299-306.

Star, J.L., 1985, Introduction to image processing: BYTE, v. 10, no. 2, p. 163-166, 168, and 170.

Stark, C.P., 1991, An invasion percolation model of drainage network evolution: Nature, v. 352, no. 6334, p. 423-425.

Stearns, R.G., 1967, Warping of the Western Highland Rim peneplain in Tennessee by ground-water sapping: Geological Society of America Bulletin, v. 78, no. 9, p. 1111-1124.

Stefanovic, P., Radwan, M.M., and Tempfli, K., 1977, Digital terrain models—data acquisition, processing and applications: ITC Journal (Enschede, Neth.), no. 1, p. 61-76.

Stefanovic, P., and Sijmons, K., 1984, Computer-assisted relief representation: ITC Journal (Enschede, Neth.), v. 12, no. 1, p. 40-47.

Stein, Arthur, 1959, Terrain mask angles: paper presented at Joint Session of AAAS Section E and Geological Society of America Symposium on Quantitative Terrain Studies, Chicago, December 28, 1959, unpublished typescript, 29 p. [possibly later published in Buffalo, NY, *as* Cornell Aeronautical Laboratories technical report]

Steinhaus, Hugo, 1954, Length, shape and area: Colloquium Mathematicum, v. 3, no. 1, p. 1-13.

Steinhaus, Hugo, 1960, Mathematical Snapshots: London, Oxford University Press.

Stephenson, G.R., and England, C.B., 1969, Digitized physical data of a rangeland watershed: Journal of Hydrology, v. 8, no. 3/4, p. 442-450.

Sterr, Horst, 1985, Rates of change and degradation of hillslopes formed in unconsolidated materials—a morphometric approach to date quaternary fault scarps in western Utah, USA: Zeitschrift für Geomorphologie, v. 29, no. 3, p. 315-333.

Stevens, P.S., 1974, Patterns in Nature: Boston, Little, Brown & Co., 329 p.

Stewart, G.A., ed., 1968, Land Evaluation—Papers of a C.S.I.R.O. symposium organized in cooperation with UNESCO, Canberra, August 26-31, 1968: Melbourne, Macmillan of Australia, 392 p.

Stocking, Michael, Chakela, Qalabane, and Elwell, Henry, 1988, An improved methodology for erosion hazard mapping, Part I—the technique: Geografiska Annaler, v. 70A, no. 3, p. 169-180.

Stoddart, D.R., 1965, The shape of Atolls: Marine Geology, v. 3, no. 4, p. 369-383.

Stone, R.O., and Dugundji, James, 1965, A study of microrelief—its mapping, classification and quantification by means of Fourier analysis: Engineering Geology, v. 1, no. 2, p. 89-167. [also: 1963, Los Angeles, University of Southern California, Contract DA-22-079-Eng.-261, *for* U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg Mississippi, (final report), 161 p.]

Strahler, A.N., 1946, Geomorphic terminology and classification of land masses: Journal of Geology, v. 54, no. 1, p. 32-42.

Strahler, A.N., 1949, Recent developments in quantitative analysis of erosional landforms (abs.): Annals of the Association of American Geographers, v. 39, no. 1, p. 65.

Strahler, A.N., 1950a, Davis' concepts of slope development viewed in the light of recent quantitative investigations: Annals of the Association of American Geographers, v. 40, no. 3, p. 209-213.

Strahler, A.N., 1950b, Equilibrium theory of erosional slopes approached by frequency distribution analysis: American Journal of Science, v. 248, nos. 10 and 11, p. 673-696 and 800-814.

Strahler, A.N., 1952, Hypsometric (area-altitude) analysis of erosional topography: Bulletin of the Geological Society of America, v. 63, no. 11, p. 1117-1142.

Strahler, A.N., 1954a, Statistical analysis in geomorphic research: Journal of Geology, v. 62, no. 1, p. 1-25.

Strahler, A.N., 1954b, Empirical and explanatory methods in physical geography: The Professional Geographer, v. 6, no. 1, p. 4-8.

Strahler, A.N., 1956, Quantitative slope analysis: Bulletin of the Geological Society of America, v. 67, no. 5, p. 571-596.

Strahler, A.N., 1957, Quantitative analysis of watershed geomorphology: Transactions of the American Geophysical Union, v. 38, no. 6, p. 913-920.

Strahler, A.N., 1964, Quantitative geomorphology of drainage basins and channel networks, *in* Chow, V. te, ed., Handbook of Applied Hydrology, New York, McGraw-Hill, p. 4-39 to 4-76.

Strahler, A.N., 1992, Quantitative/dynamic geomorphology at Columbia 1945-60—A retrospective: Progress in Physical Geography, v. 16, no. 1, p. 65-84.

Strahler, A.N., and Koons, E. Donaldson, 1960, Objective and quantitative field methods of terrain analysis: Office of Naval Research, Geography Branch, Project NR 387-021, Contract Nonr 266(50), Final Report, New York, Columbia University, Department of Geology, 51 p.

Strobl, J., 1988, Reliefanalyse mit dem Computer (in German): Geographische Rundschau, v. 40, p. 38-43.

Strong, James, Klasky, Ronald, Haynes, W.P. III, and Withers, Julia, 1989, Scientific visualization technique for 3-D terrain mapping: National Aeronautics and Space Administration Office of Space Science and Applications, Information Systems Newsletter, Issue 16 (April), p. 38-43.

Suga, S., 1985, Geomorphic characteristics of Shikoku Island, Japan, expressed by the statistical analysis of digital terrain model (in Japanese with English abstract): Geographical Review of Japan, v. 58A, p. 807-818.

Sugitani, T., 1988, Development of pc-based water drainage data base system (in Japanese), *in* Yamaguchi, Takeshi, ed., Research on Intensive Utilization of Geographic Information: Report of Grant-in-Aid from the Ministry of Education and Culture of Japan in 1987, p. 113-129.

Sui, D.Z., 1992, An initial investigation of integrating neural networks with GIS for spatial decision making, *in* GIS/LIS '92, annual conference and exposition, November 10-12, 1992, San Jose, CA: Proceedings, v. 2, p. 727-736.

Supan, A.G., 1927-30, Grundzüge der physischen Erdkunde (in German): Berlin, Walter de Gruyter, 551 p.

Surface Analysis Group, 1968, A preliminary analysis of photometric/ computer terrain data for lunar trafficability models: Houston, TX, NASA Manned Spacecraft Center, Science and Applications Directorate, Mapping Sciences Laboratory, Working Paper, 75 p.

Sutherland, I.E., Sproull, R.F., and Schumacker, R.A., 1974, A characterization of ten hidden-surface algorithms: Computing Surveys, v. 6, no. 1, p. 1-55.

Suzuki, Takasuke, Tokunaga, Eiji, Noda, Hiroyuki, and Arakawa, Hiroshi, 1985, Effects of rock strength and permeability on hill morphology: Transactions, Japanese Geomorphological Union, v. 6, no. 2, p. 101-130.

Swan, S.B.St.C., 1967, Maps of two indices of terrain, Johor, Malaya: Journal of Tropical Geography (Singapore), v. 25, no. 1, p. 48-57.

Switzer, P., Mohr, C.M., and Heitman, R.E., 1964, Statistical analyses of ocean terrain and contour plotting procedures: Project Trident, U.S. Department of the Navy, Bureau of Ships Nobsr-8154 SS-050, Technical Report, ix + 79 p. [ref. A.D. 601538]

Szeliga, Tim, Yates, Garner, and Hastings, David, 1993, Optimized digital elevation data—removal of "wedding cake" effect from 3 arc-second DMA digital elevation model data for Colorado, *in* 1992 ASPRS-ACSM annual convention, Albuquerque, New Mexico, Technical Papers, v. 1, p. 473-479.

T

Tamura, Hideyuki, Mori, Shunji, and Yamawaki, Takashi, 1978, Textural features corresponding to visual perception: IEEE Transactions on Systems, Man and Cybernetics, v. SMC-8, no. 6, p. 460-473.

Tanaka, Kitirô, 1930, A new method of topographical hill delineation (in English): Fukuoka, Japan, Kyushu Imperial University, College of Engineering, Memoirs, v. 5, no. 3, p. 121-143.

Tanaka, Kitirô, 1932, The orthographical relief method of representing hill features on a topographical map: The Geographical Journal (UK), v. 79, no. 3, p. 213-219.

Tanaka, Kitirô, 1950, The relief contour method of representing topography on maps: Geographical Review, v. 40, no. 3, p. 444-456. [reprinted 1951, *in* Surveying and Mapping, v. 11, no. 1, p. 27-37]

Tanner, W.F., 1959, Examples of departure from the Gaussian in geomorphic analysis: American Journal of Science, v. 257, no. 6, p. 458-460.

Tanner, W.F., 1960, Numerical comparison of geomorphic samples: Science, v. 131, no. 3412, p. 1525-1526.

Tarboton, D.G., 1989, The analysis of river basins and channel networks using digital terrain data: Cambridge, MA, Massachusetts Institute of Technology, Department of Civil Engineering, Sc.D. Thesis, paging unknown.

Tarboton, D.G., 1992, Precipitation in topographically diverse regions (meeting report): Eos, Transactions of the American Geophysical Union, v. 73, no. 16, p. 185.

Tarboton, D.G., Bras, R.L., and Rodriguez-Iturbe, Ignacio, 1988, The fractal nature of river networks: Water Resources Research, v. 24, no. 8, p. 1317-1322.

Tarboton, D.G., Bras, R.L., and Rodriguez-Iturbe, Ignacio, 1989, Scaling and elevation in river networks: Water Resources Research, v. 25, no. 9, p. 2037-2051.

Tarboton, D.G., Bras, R.L., and Rodriguez-Iturbe, Ignacio, 1991, On the extraction of channel networks from digital elevation data: Hydrological Processes, v. 5, no. 1, p. 81-100.

Tarboton, D.G., Bras, R.L., and Rodriguez-Iturbe, Ignacio, 1992, A physical basis for drainage density, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 59-76.

Tarvydas, Albin, 1984, Terrain approximation by triangular facets, *in* American Congress on Surveying and Mapping, Technical Papers of the 44th Annual Meeting, March 11-16, 1984, Washington, D.C., Proceedings, p. 524-532.

Taylor, C.C., and Norton, S.W., 1983, Information-theoretic surface modeling, *in* American Congress on Surveying and Mapping—American Society of photogrammetry 43rd Annual Meeting, March 13-18, 1983, Washington, D.C., Technical Papers, p. 493-502.

Taylor, D.R.F., 1991, A conceptual basis for cartography/new directions for the information era: Cartographica, v. 28. no. 4, p. 1-8.

Taylor, R.M., 1984, Effects of map scale, complexity and generalisation on terrain-map matching performance: Cartographica, v. 21, no. 1, p. 129-134.

Tempfli, Klaus, 1980, Spectral analysis of terrain relief for the accuracy estimation of digital terrain models: ITC Journal (Enschede, Neth.), no. 1980-3, p. 478-510.

Tempfli, Klaus, and Makarovic, Branko, 1979, Transfer functions of interpolation methods: Geo-Processing, v. 1, no. 1, p. 1-26.

Terada, T., 1930, Statistical method for measuring the degree of surface inclination in topographical maps (in Japanese): Geographical Review of Japan (Tokyo), v. 6, p. 653-661.

Tersky, N.Yu., 1992, Digital terrain modelling based on multibeam echosounder data (abs.): International Geological Congress 29th, Kyoto Japan, 24 August-3 September 1992, Abstract Volume 3, p. 973.

Tesche, T.W., and Bergstrom, R.W., 1978, Use of digital terrain data in meteorological and air quality modeling: Photogrammetric Engineering and Remote Sensing, v. 44, no. 12, p. 1549-1559.

Thapa, K., 1988, Automated line generalisation using zero-crossings: Photogrammetric Engineering and Remote Sensing, v. 54, no. 4, p. 511-517.

Thapa, K., 1988, Critical points detection and automatic line generalisation in raster data using zero-crossings: The Cartographic Journal, v. 25, no. 1, p. 58-68.

Thauer, Walter, 1955, Neue Methoden der Berechnung und Darstellung der Reliefenergie (in German): Petermanns Mitteilungen, v. 99, no. 1, p. 8-13.

Thelin, G.P., and Pike, R.J., 1991, Landforms of the conterminous United States—A digital shaded-relief portrayal: U.S. Geological Survey Miscellaneous Investigations Map, I-2206, scale 1:3,500,000.

Theobald, D.M., 1989, Accuracy and bias issues in surface representation, *in* Goodchild, Michael, and Gopal, Sucharita, eds., Accuracy of Spatial Databases: London, Taylor and Francis, p. 99-106.

Theobald, D.M., 1990, Automated delineation of hydromorphological features on a triangulated irregular network-based digital elevation model: Santa Barbara, University of California, Department of Geography, unpublished M.A. thesis, paging unknown.

Theobald, D.M., and Goodchild, M.F., 1990, Artifacts of TIN-based surface flow modeling, *in* GIS/LIS '90 Convention, Anaheim, CA, November 1990, Proceedings, v. 2, p. 955-967.

Thiemann, R., Fischer, J., Haschek, G., and Kneidl, G., 1989, Visualization of terrain data, *in* Hausmann, W., Hopgood, F., and Strasser, W., eds., Eurographics '89 conference, Hamburg, 1989, Proceedings: Amsterdam, Elsevier, p. 173-195.

Thiessen, A.H., 1911, Precipitation averages for large areas: Monthly Weather Review, v. 39, no. 7, p. 1082-1084.

Thoman, Richard, 1952, A method of constructing average slope maps: Illinois Academy of Sciences, Transactions, v. 45, p. 82-84.

Thomas, Barbara, and Tuttle, S.D., 1968, Differentiation of drift topography by statistical analysis of slope data: Iowa Academy of Science 1967, Proceedings, v. 74, p. 147-159.

Thomas, D.S.G., 1986, Dune pattern statistics applied to the Kalahari Desert, southern Africa: Zeitschrift für Geomorphologie, v. 30, no. 2, p. 231-242.

Thomas, J., Kober, W., and Leberl, F., 1991, Multiple image SAR shape-from-shading: Photogrammetric Engineering and Remote Sensing, v. 57, no. 1, p. 51-59.

Thomas, R.W., 1981, Point pattern analysis, *in* Wrigley, N., and Bennett, R.J., eds., Quantitative Geography, A British View: London, Routledge and Kegan Paul, p. 164-176.

Thomas, T.R., ed., 1982, Rough Surfaces: London, Longman, 249 p.

Thomas, T.R., and King, M., 1977, Surface topography in engineering, a state of the art review and bibliography: British Hydromechanics Research Association, Fluid Engineering Series, v. 3, 103 p. (651 entries).

Thompson, D'Arcy W., 1917, On Growth and Form: Cambridge, Cambridge University Press, 793 p. [revised, 2nd ed., 1942, Cambridge, 1116 p.; abridged edition *edited by* J.T. Bonner, 1961, Cambridge, 346 p.]

Thompson, H.D., 1941, Topographic analysis of the Monterey, Staunton, and Harrisonburg quadrangles: Journal of Geology, v. 49, no. 5, p. 521-549.

Thompson, M.M., 1960, A current view of the National Map Accuracy Standards: Surveying and Mapping, v. 20, p. 449-457.

Thompson, W.E., 1958, Measurement of power spectra of runway roughness: Washington, D.C., Langley Aeronautical Laboratory, NACA Technical Note 4303.

Thompson, W.F., 1959, Determination of spatial relationships of locally dominant topographic features (abs.): Geological Society of America Bulletin, v. 70, no. 12, Pt. 2, p. 1814. [also 1964, U.S. Army Natick Laboratories Technical Report, 24 p.]

Thompson, W.F., 1964, How and why to distinguish between mountains and hills: The Professional Geographer, v. 16, no. 6, p. 6-8.

Thorn, C.E., 1988, An Introduction to Theoretical Geomorphology: Boston, Unwin Hyman, 247 p. [Ch. 7, Space in geomorphology, p. 73-89; ch. 8, Morphology: p. 90-113; references: p. 224-237]

Thorne, C.R., Zevenbergen, L.W., Burt, T.P., and Butcher, D.P., 1987, Terrain analysis for quantitative description of zero-order basins, *in* Beschta, R.L., and others, eds., Erosion and Sedimentation in the Pacific Rim: Proceedings of an international symposium held at Oregon State University, Corvallis, August 3-7, 1987, IAHS Publication no. 165, p. 121-130.

Thornes, J.B., 1972, Debris slopes as series: Arctic and Alpine Research, v. 4, no. 4, p. 337-342.

Thornes, J.B., 1973, Markov chains and slope series—the scale problem: Geographical Analysis, v. 5, no. 4?, p. 322-328.

Thornbury, W.D., 1965, Regional Geomorphology of the United States: New York, John Wiley & Sons, 609 p.

Thrower, N.J.W., 1960, Cyprus—a landform study, Map Supplement Number 1: Annals of the Association of American Geographers, v. 50, no 1, one sheet.

Thrower, N.J.W., and Jensen, J.R., 1976, The orthophoto and orthophotomap—characteristics, development and application: The American Cartographer, v. 3, no. 1, p. 39-56.

Tian Chi, Li, 1983, A mathematical model for predicting the extent of a major rockfall: Zeitschrift für Geomorphologie, v. 27, no. 4, p. 473-482.

Tillo, A.A., 1881, The mean elevation of the dry land and the mean depth of the sea in the northern and southern hemispheres (in Russian): Izvestiya Russkogo geograficheskogo obshchestva (Leningrad), v. 25.

Tinkler, K.J., 1971, Statistical analysis of tectonic patterns in areal volcanism—the Bunyaruguru Volcanic Field in West Uganda: Mathematical Geology, v. 3, no. 4, p. 335-355.

Tipper, J.C., 1992, Landforms developing and basins filling—Three-dimensional simulations of erosion, sediment transport, and deposition, *in* Pflug, Reinhard and Harbaugh, J.W., eds., Computer Graphics in Geology—Three-dimensional computer graphics in modeling geologic structures and simulating geologic processes: Lecture Notes in Earth Sciences 41, Berlin, Springer-Verlag, p. 155-170.

Tjia, H.D., 1969, Breaks in slope on strato-volcanoes: Bulletin of National Institute of Geology and Mining (Bandung, Indonesia), v. 2, no. 3, p. 35-40.

Tobler, W.R., 1959, Automation and cartography: Geographical Review, v. 49, no. 4, p. 526-534.

Tobler, W.R., 1963, Geographical ordering of information: The Canadian Geographer, v. 7, no. 4, p. 203-205.

Tobler, W.R., 1966, Numerical map generalization: Ann Arbor, Michigan Inter-University Community of Mathematical Geographers, Discussion Paper No. 8, 24 p. [reprinted 1989, *in* Cartographica, v. 26, no. 1, Monograph 40, Numerical Generalization in Cartography, p. 9-25]

Tobler, W.R., 1967, Of maps and matrices: Journal of Regional Science (supplement), v. 7, no. 2, p. 275-280.

Tobler, W.R., 1969a, An analysis of a digitalized surface, *in* Davis, C.M., A study of the land type: Ann Arbor, University of Michigan Department of Geography, Final Report on Contract No. DA-31-124-ARO-D-456, p. 59-83.

Tobler, W.R., 1969b, Geographic filters and their inverses: Geographical Analysis, v. 1, no. 3, p. 234-253.

Tobler, W.R., 1970, Selected computer programs: Michigan Geographical Publications, Ann Arbor, University of Michigan Department of Geography, variously paged. [18 programs with brief descriptions]

Tobler, W.R., 1976, Analytical cartography: The American Cartographer, v. 3, no. 1, p. 21-31.

Tobler, W.R., 1988, Resolution, resampling, and all that, *in* Mounsey, Helen, and Tomlinson, Roger, eds., Building Databases for Global Science: London, Taylor and Francis, p. 129-137.

Tobler, W.R., 1989, An update to 'Numerical map generalization': Cartographica, v. 26, no. 1, Monograph 40, Numerical Generalization in Cartography, p. 7-8.

Tobler, W.R., and Davis, C.M., 1968, A Digital Terrain Library: Ann Arbor, University of Michigan Department of Geography, U.S. Army Research Office Contract DA-31-124-ARO-D-456, Technical Report 08055-1-T, 23 p.

Tokunaga, E., 1984, Ordering of divide segments and law of divide segment numbers: Transactions, Japanese Geomorphological Union, v. 5, no. 1, p. 71-77.

Tomlinson, R.F., and Petchenik, B.B., eds., 1988, Reflections on the revolution, the transition from analogue to digital representations of space, 1958-1988: The American Cartographer, v. 15, no. 3, p. 245-322.

Topographic Science Working Group, 1988, Report to the Land Processes Branch, Earth Science and Applications Division, NASA Headquarters: Houston, TX, Lunar and Planetary Laboratory, 64 p.

Toppe, Ronald, 1987, Terrain models—a tool for natural hazard mapping, *in* Salm, Bruno, and Gublker, Hansueli, eds., Symposium on Avalanche Formation, Movement and Effects, Davos, Switzerland, September 14-19, 1986, Proceedings: Wallingford, UK, International Association of Hydrological Sciences, Publication No. 162, p. 629-638.

Toriwaki, Jun-ichiro, and Fukumura, Teruo, 1978, Extraction of structural information from grey pictures: Computer Graphics and Image Processing, v. 7, no. 1, p. 30-51.

Torlegård, Kennert, 1972, Digital terrain models—general survey and Swedish experiences: Bildmessung und Luftbildwesen, v. 40, no. 1, p. 21-30.

Torlegård, Kennert, ed., 1983, International Colloquium on Mathematical Aspects of Digital Elevation Models, photogrammetric data acquisition, terrain modelling, accuracy: Stockholm, Royal Institute of Technology, Department of Photogrammetry, Proceedings volume, paging by section.

Torlegård, Kennart, Östman, Anders, and Lindgren, Ralf, 1984, A comparative test of photogrammetrically sampled digital elevation models: International Archives of Photogrammetry and Remote Sensing, v. 25, no. A3b, p. 1065-1082. [reprinted 1986, *in* Photogrammetria, v. 41, no. 1, p. 1-16]

Tou, J.T., and Gonzalez, R.C., 1972, Recognition of handwritten characters by topological feature extraction and multilevel categorization: IEEE Transactions on Computers, v. C-21, no. 7, p. 776-785.

Toussaint, G.T., ed., 1988, Computational Morphology—A computational geometric approach to the analysis of form: Amsterdam, Elsevier, 261 p.

Townshend, J.R.G., 1981, Regionalization of terrain and remotely sensed data, *in* Townshend, J.R.G., ed., Terrain Analysis and Remote Sensing: London, Allen and Unwin, p. 109-132.

Townshend, J.R.G., ed., 1981, Terrain Analysis and Remote Sensing: London, Allen and Unwin, 272 p.

Toy, T.J., 1977, Hillslope form and climate: Geological Society of America Bulletin, v. 88, no. 1, p. 16-22.

Travis, M.R., Elsnes, G.H., Iverson, W.D., and Johnson, C.G., 1975, VIEWIT—computation of seen areas, slope and aspect for land use planning: Pacific Southwest Forest and Range Experiment Station, USDA Forest Service, Geberal Technical Report No. PSW-11, 70 p.

Trefethen, J.M., 1936, A method for geographic surveying: American Journal of Science, 5th Series, v. 32, no. 192, p. 454-464.

Trenhaile, A.S., 1975, The morphology of a drumlin field: Annals of the Association of American Geographers, v. 65, no. 2, p. 297-312.

Trenhaile, A.S., 1976, Cirque morphometry in the Canadian Cordillera: Annals of the Association of American Geographers, v. 66, no. 3, p. 451-462.

Trenhaile, A.S., 1979, The morphometry of valley steps in the Canadian Cordillera: Zeitschrift für Geomorphologie, v. 23, no. 1, p. 27-44.

Trewartha, G.T., and Smith, G.-H., 1940-1941, Surface configuration of the driftless cuestaform hill-land: Annals of the Association of American Geographers, v. 30-31, no. 1, p. 25-45.

Trewartha, G.T., Robinson, A.H., and Hammond, E.H., 1961, The varieties of surface form (Chapter 2): Fundamentals of Physical Geography, New York, McGraw-Hill, p. 28-37.

Trewartha, G.T., Robinson, A.H., and Hammond, E.H., 1968, Characteristics and classes of land-surface form (Chapter 15): Fundamentals of Physical Geography, 2nd ed.: New York, McGraw-Hill, p. 222-234.

Tribe, Andrea, 1990, Towards the automated recognition of landforms (valley heads) from digital elevation models, *in* International Symposium on Spatial Data Handling, 4th, July 23-27, 1990, Zürich, Proceedings, v. 1, p. 45-52.

Tribe, Andrea, 1991, Automated recognitiom of valley heads from digital elevation models: Earth Surface Processes and Landforms, v. 16, no. 1, p. 33-49.

Tribe, Andrea, 1992a, Problems in automated recognition of valley features from digital elevation models and a new method toward their resolution: Earth Surface Processes and Landforms, v. 17, no. 5, p. 437-454.

Tribe, Andrea, 1992b, Automated recognition of valley lines and drainage networks from grid digital elevation models—a review and a new method: Journal of Hydrology, v. 139, Nos. 1-4, p. 263-293.

Tricart, Jean, 1947, Sur quelques indices géomorphométriques (in French): Comptes Rendues hebdomadaires des Séances de l'Académie des Sciences (Paris), v. 225, p. 747-749.

Tricart, Jean, 1952, La géomorphologie et la notion d'échelle (in French): Revue de Géomorphologie Dynamique, v. 3, no. 5, p. 213-218.

Tricart, Jean, 1965, Principes et méthodes de la géomorphologie (in French): Paris, Masson, 496 p. [see p. 159-182]

Tricart, Jean, and Muslin, J., 1951, L'étude statistique des versants (in French): Géomorphologie Dynamique, v. 2, no. 4, p. 173-182.

Trifonov, V.G., and Shults, S.S. Jr., 1990, Geologic applications of space imagery (English translation of 1986 paper): Soviet Journal of Remote Sensing, v. 6, no. 1, p. 32-42.

Troeh, F.R., 1963, Quantitative landform parameters correlated to six soil series in New York State: Ithaca, NY, Cornell University, unpublished Ph.D. thesis, 152 p.

Troeh, F.R., 1965, Landform equations fitted to contour maps: American Journal of Science, v. 263, no. 7, p. 616-627.

Tsipis, Kosta, 1975, The accuracy of strategic missiles: Scientific American, v. 233, no. 1, p. 14-23. ["terrain-matching" principle]

Tunnard, Christopher, and Pushkarev, Boris, 1963, The internal harmony of the freeway—continuity of alignment, three-dimensional coordination, *in* Manmade America, chaos or control? An inquiry into selected problems of design in the urbanized landscape: New Haven, Yale University press, p. 177-201. [p. 455 refs., esp. to German work]

Turcotte, D.L., 1991, Fractals in geology—what are they and what are they good for?: GSA Today, v. 1, no. 1, p. 1, 3-4.

Turner, A.K., and Miles, R.D., 1968, Terrain analysis by computer: Indiana Academy of Science (Geology and Geography), Proceedings, v. 77 (1967), p. 256-270.

Tylor, Alfred, 1875, Action of denuding agencies: Geological Magazine, new series, decade 2, v. 2, no. 9 (no. 135 overall), supplement, p. 433-473.

U

Ullah, W., and Dickinson, W.T., 1979, Quantitative description of depression storage using a digital surface model, I. Determination of depression storage, and II. Characteristics of surface depressions: Journal of Hydrology, v. 42, no. 1/2, p. 63-75 & 77-90.

Unstead, J.F., Myres, J.L., Roxby, P.M., and Stamp, L.D., 1937, Report on "Classification of regions of the world" by the Committee of the Geographical Association: Geography (UK), v. 22, p. 253-282.

Unwin, David, 1989, Fractals and the geosciences, Introduction: Computers and Geosciences, v. 15, no. 2, p. 163-165.

Upton, G.J.G., and Fingleton, Bernard, 1985, Spatial Data Analysis by Example, Volume I—Point pattern and quantitative data: New York, John Wiley and Sons, 410 p.

Upton, G.J.G., and Fingleton, Bernard, 1989, Spatial Data Analysis by Example, Volume II—Categorical and directional data: New York, John Wiley and Sons, 416 p.

U.S. Army, 1963, Military Evaluation of Geographic Areas (MEGA), Reports on Activities to April 1963: Vicksburg, Mississippi, U.S. Army Corps of Engineers, Waterways Experiment Station, Miscellaneous Paper No. 3-610, 237 p.

U.S. Army, 1966, Conference on numerical topographic data and other new map products, U.S. Army Engineer Geodesy, Intelligence and Mapping Research and Development Agency,(GIMRADA), Fort Belvoir, VA, 3-5 May, 1966, Proceedings, 118 p.

U.S. Army, 1991, Geographical Resources Analysis Support System (GRASS), Version 4.0—User's Reference Manual: Champaign, IL, U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, paging unknown.

U.S. Defense Mapping Agency, 1990, Digitizing the Future, 3rd ed.: Fairfax, VA, Defense Mapping Agency, DMA stock No. DDIPDIGI TALPAC, 105 p. [catalog of summary information on DMA digital data and related subjects]

U.S. Defense Mapping Agency, 1992, Digital chart of the World (Edition 1, July; for use with the Disk Operating System), Fairfax, VA. [DCW data base—1500 megabytes of vector data organized in 17 thematic layers, including all 1000-foot elevation contours—on 4 compact disks, VPFVIEW software, and users manual paged by section]

U.S. Geological Survey, 1978, Digital terrain tapes: Reston, VA, National Cartographic Information Center User Guide, 12 p.

U.S. Geological Survey, 1986, Production of shaded-relief products: Reston, VA, U.S. Geological Survey Yearbook 1986, p. 37-38.

U.S. Geological Survey, 1986, Digital line graphs from 1:24,000-scale maps, data users guide 1: Reston, VA, National Mapping Program, Technical Instructions, paging unknown.

U.S. Geological Survey, 1988, Digital elevation model evaluation and testing—procedural manual: Reston, VA, National Mapping Program, Technical Instructions, 18 p.

U.S. Geological Survey, 1990, Digital elevation models, data users guide 5 (2nd printing, revised): Reston, VA, National Mapping Program, Technical Instructions, 51 p. [replaces 1987 ed. of 38 p.]

Usery, E.L., Altheide, Phyllis, Deister, R.R.P., and Barr, D.J., 1988, Knowledge-based GIS techniques applied to geological engineering: Photogrammetric Engineering and Remote Sensing, v. 54, no. 11, p. 1623-1628.

V

Vakhtin, B.M., 1955, A hypsometric equation of local relief (in Russian): Izv. Voronezhskogo gos. pedagogicheskogo in-ta, v. 17.

Van Asch, T.W.J., and Stehn, H., 1973, Computerised morphometric analysis of drainage basins from maps: Utrecht, Neth., Geographical Institute, Rijksuniv. Utrecht, Publ. Ser. B51.

Van Blargan, E.J., Ragan, R.M., and Schaake, J.C., 1989, A hydrologic geographic information system (abs.): Eos, American Geophysical Union Transactions, v. 70, no. 43, p. 1092.

Van Diggelen, J., 1951, A photometric investigation of the slopes and the heights of the ranges of hills in the maria of the Moon: Bull. Astron. Inst. Netherlands, v. 11, p. 283-289.

Van Dijke, J.J., and van Westen, C.J., 1990, Rockfall hazard—a geomorphological application of neighbourhood analysis with ILWIS: ITC Journal (Enschede, Neth.), no. 1990-1, p. 40-44.

Van Driel, J.N., and Davis, J.C., eds., 1989, Digital geologic and geographic information systems: Washington, D.C., American Geophysical Union, Short course presented at the 28th International Geological Congress, v. 10, 62 p.

Van Deusen, B.D., 1966, A statistical technique for the dynamic analysis of vehicles traversing rough yielding and non-yielding surfaces: Detroit, Michigan, Chrysler Corp., prepared for NASA under contract NASW-1287 by Advanced Projects Organization, 178 p. [also 1967, NASA Report No. CR-659]

Van Deusen, B.D., and McCarron, G.E., 1967, A new technique for classifying random surface roughness: New York, N.Y., SAE Paper No. 670032.

Van Deursen, W.P.A., and Kwadijk, K.J., 1990, Using the watershed tools for modeling the Rhine catchment, *in* European Conference on Geographical Informational Systems, 1st, Amsterdam, Neth., 1990, Proceedings, p. 254-262.

Van Lopik, J.R., 1962, Optimum utilization of airborne sensors in military geography: Photogrammetric Engineering, v. 28, no. 11, p. 773-778.

Van Lopik, J.R., and Kolb, C.R., 1959, A technique for preparing desert terrain analogs (handbook): Vicksburg, Mississippi, U.S. Army Engineer Waterways Experiment Station, Technical Report No. 3-506, 70 p. + 19 plates and 20 p. of appendices.

Van Roessel, J.W., 1988, Conversion of cartesian coordinates from ans to generalized balanced ternary addresses: Photogrammetric Engineering and Remote Sensing, v. 54, no. 11, p. 1565-1570.

Van Steijn, Henk, de Ruig, J., and Hoozemans, F., 1988, Morphological and mechanical aspects of debris flows in parts of the French Alps: Zeitschrift für Geomorphologie, v. 32, no. 2, p. 143-161.

Varnes, D.J., 1974, The logic of geological maps with reference to their interpretation and use for engineering purposes: U.S. Geological Survey Professional Paper 837, 48 p.

Vasil'yev, A.S., 1978, An algorithm for forming a digital model from normalized isoline charts (in Russian): Izvestiya vuzov, Geodeziya i aerofotos"yemka, No. 6, p. 91-99. [translated 1977, *in* Geodesy, Mapping and Photogrammetry, v. 19, no. 4, p. 212-216]

Veatch, J.O., 1935, Graphic and quantitative comparisons of land types: Journal of the American Society of Agronomy, v. 27, no. 7, p. 505-510.

Veatch, J.O., 1937, The idea of the natural land type: Proceedings of the Soil Science Society of America, v. 2, p. 499-503.

Veatch, J.O., 1939, Patterns based upon the distribution of swamp land in Michigan: Papers of the Michigan Academy of Science, Arts and Letters, v. 24, Part III, 1938, p. 93-106.

Vergasov, V.A., Vasmut, A.S., and Prugalova, 1971, Tests to obtain a training sample for the problem of recognizing types of topographic forms with a computer (in Russian): Geodeziya i kartografiya, No. 7, paging unknown.

Vergasov, V.A., 1974, Statistical analysis and automatic recognition of the contours of topographic maps (in Russian): Izvestiya vuzov, Geodeziya i aerofotos"yemka, No. 1, p. 103-109. [translated 1974, *in* Geodesy, Mapping and Photogrammetry, v. 16, no. 2, p. 108-111]

Verhoef, J., Roest, W.R., and Srivastava, S.P., 1989, Plate reconstructions and gridded data: Eos, American Geophysical Union Transactions, v. 70, no. 21, p. 609 and 618.

Verhoef, J., Usow, K.H., and Roest, W.R., 1990, a new method for plate reconstructions—the use of gridded data: Computers and Geosciences, v. 16, no. 1, p. 51-74.

Verstappen, H. Th., 1983, Applied Geomorphology—geomorphological surveys for environmental development: Amsterdam, Elsevier, 437 p.

Vertessy, R.A., Wilson, C.J., Silburn, D.M., Connolly, R.D., and Ciesiolka, C.A., 1990, Predicting erosion hazard areas using digital terrain analysis, *in* Ziemer, R.R., O'Loughlin, C.L., and Hamilton, L.S., eds., Symposium on Research Needs and Applications to Reduce Erosion and Sedimentation in Tropical Steeplands, Suva, Fiji, 11-15 June 1990, Proceedings: IAHS Publication No. 192, p. 298-308.

Verts, W.T., and Hill, F.S., Jr., 1990, An error metric for inexact gray-scale quadtrees, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, annual convention, Denver, Colorado, March 18-23, Technical Papers, v. 1 (Surveying), p. 223-229.

Vieux, B.E., 1991, Geographic information systems and non-point source water quality and quantity modelling: Hydrological Processes, v. 5, no. 1, p. 101-113.

Vilborg, Lennart, 1977, The cirque forms of Swedish Lapland: Geografiska Annaler, v. 59A, no. 3-4, p. 89-150.

Vincent, C.L., 1976, A method for the mathematical analysis of the cross-sectional geometry of tidal inlet channels: Mathematical Geology, v. 8, no. 6, p. 635-647.

Vincent, Luc, and Soille, Pierre, 1991, Watersheds in digital spaces—An efficient algorithm based on immersion simulations: IEEE Transactions on Pattern Analysis and Machine Intelligence, v. 13, no. 6, p. 583-598.

Vincent, P.J., 1983, The morphology and morphometry of some arctic trittkarren: Zeitschrift für Geomorphologie, v. 27, no. 2, p. 205-222.

Vincent, P.J., 1987, Spatial dispersion of polygonal karst sinks: Zeitschrift für Geomorphologie, v. 31, no. 1, p. 65-72.

Vincent, P., and Poole, D.J., 1978, Terrain roughness—quo vadis?: Area (UK), v. 10, no. 3, p. 182-184.

Vose, G.M., 1985, *Review of* Allan Turing, the enigma: BYTE, v. 10, no. 2, p. 65-68.

Voss, R.F., 1985, Random fractal forgeries, *in* Earnshaw, R.A., ed., Fundamental Algorithms for Computer Graphics, NATO ASI Series, v. F17: New York, Springer-Verlag, p. 805-835.

Voss, R.F., 1985, Random fractal forgeries—from mountains to music, *in* Nash, S., ed., Science and Uncertainty: IBM Science Reviews, p. 69-88.

Voss, R.F., 1988, Fractals in nature—from characterization to simulation, Chapter 1, *in* Peitgen, H.-O., and Saupe, Dietmar, eds., The Science of Fractal Images: New York, Springer-Verlag, p. 21-69.

W

Wadge, Geoffrey, 1988, The potential of GIS modelling of gravity flows and slope instabilities: International Journal of Geographical Information Systems, v. 2, no. 2, p. 143-152.

Wadge, Geoffrey, and Cross, A., 1988, Quantitative methods for detecting aligned points—An application to the volcanic vents of the Michoacan-Guanajuato volcanic field, Mexico: Geology, v. 16, no. 9, p. 815-818.

Wadge, Geoffrey, and Pearson, Emma, 1991, GIS for geology: Terra Nova (UK), v. 3, no. 1, p. 93-98.

Wald, L., 1989, Some examples of the use of structure functions in the analysis of satellite images of the ocean: Photogrammetric Engineering and Remote Sensing, v. 55, no. 10, p. 1487-1490.

Waldbaur, Harry, 1952, Die Reliefenergie in der morphographischen Karte (in German): Petermanns Geogr. Mitteilungen, v. 96, p. 156-167. [comprehensive bibliography]

Walker, P.A., and Grant, I.W., 1986, Quadtree, a FORTRAN program to extract the quadtree structure of a raster format multicolored image: Computers and Geosciences, v. 12, no. 4A, p. 401-410.

Walker, P.H., Hall, G.F., and Protz, R., 1968, Relation between landform parameters and soil properties: Proceedings of the Soil Science Society of America, v. 32, no. 1, p. 101-104.

Wallis, H.M., and Robinson, A.H., eds., 1987, Cartographical Innovations—an international handbook of mapping terms to 1900: London, Map Collector Publications *in association with* the International Cartographic Association, 353 p. [*see* Topographical map, Hypsometric map, Morphological map, Hachures, Isarithm, Contour, & Isobath]

Walls, J.H., Houbolt, J.C., and Press, H., 1954, Some measurements and power spectra of runway roughness: Washington, D.C., NACA Technical Note 3305, 27p.

Walsh, S.J., 1989, User considerations in landscape characterization, *in* Goodchild, M.F., and Gopal, Sucharita, eds., Accuracy of Spatial Databases: London, Taylor and Francis, p. 35-43.

Walters, R.F., 1969, Contouring by machine—A user's guide: American Association of Petroleum Geologists Bulletin,v. 53, no. 11, p. 2324-2340.

Wang, Li, and He, D.-C., 1990, A new statistical approach for texture analysis: Photogrammetric Engineering and Remote Sensing, v. 56, no. 1, p. 61-66.

Wang, S., Haralick, R.M., and Campbell, J., 1984, Relative elevation determination from Landsat imagery: Photogrammetria, v. 39, no. 4-6, p. 193-215.

Wang, Ze-shen, and Muller, J.C., 1993, Complex coastline generalization: Cartography and Geographic Information Systems, v. 20, no. 2, p. 96-106.

Waragai, T., 1981, The study of mountain topography with compound mesh map in the Boso hills (in Japanese with English abstract): Journal of the Japanese Cartographic Association, v. 19, no. 1, p. 14-20.

Ware, Colin, 1989, Fast hill shading with cast shadows: Computers and Geosciences, v. 15, no. 8, p. 1327-1334.

Warheit, K.I., 1992, *Review of* Proceedings of the (1988) Michigan Morphometrics Workshop, by Rohlf, F.J., and Bookstein, F.L., eds., 1990, Ann Arbor, University of Michigan Department of Zoology, Special Publication no. 2, 380 p. (with analytical software on diskette): Systematic Biology, v. 41, no. 3, p. 392-395.

Warner, T.A., Campagna, D.J., Evans, C.S., Levandowski, D.W., and Cetin, Haluk, 1991, Analyzing remote sensing geobotanical trends in Quetico Provincial Park, Ontario, Canada, using digital elevation data: Photogrammetric Engineering and Remote Sensing, v. 57, no. 9, p. 1179-1183.

Warntz, Willian, 1966, The topology of a socio-economic terrain and spatial flows: Papers of the Regional Science Association, v. 17 , no. 1, p. 47-61.

Warntz, William, 1975, Stream ordering and contour mapping: Journal of Hydrology, v. 25, no. 3/4, p. 209-227.

Warntz, William, and Woldenberg, M.J., 1967, Concepts and applications—spatial order: Harvard Papers in Theoretical Geography, no. 1, Cambridge, MA, Harvard University, Graduate School of Design, Laboratory for Computer Graphics and Spatial Analysis, *for* Geography Branch, Office of Naval Research, Project NR 389-147, Technical Report, 196 p.

Watanabe, Kazuki, 1993, Submarine micro-topography in the western part of Sagami Bay (in Japanese with English figure captions): Report of Hydrographic Researches (Tokyo), no. 29 (March), p. 33-50.

Watson, D.F., 1981, Computing the N-dimensional Delaunay tessellation with application to Voronoi polytopes: The Computer Journal, v. 24, no. 2, p.167-172.

Watson, D.F., and Philip, G.M., 1984, Triangle based interpolation: Mathematical Geology, v. 16, no. 8, p. 779-795.

Watson, G.S., 1966, The statistics of orientation data: Journal of Geology, v. 74, no. 5, part 2, p. 786-797.

Watson, Kenneth, 1968, Photoclinometry from spacecraft images: U.S. Geological Survey Professional Paper 599-B, 10 p.

Watson, L.T., Laffey, T.J., and Haralick, R.M., 1985, Topographic classification of digital image intensity surfaces using generalized splines and the discrete cosine transformation: Computer Vision, Graphics and Image Processing, v. 29, p. 143-167.

Watt, Alan, 1989, Fundamentals of Three-dimensional Computer Graphics, Reading, Mass., Addison-Wesley Publishing Co., 430 p.

Waugh, T.C., 1986, A response to recent papers and articles on the use of quadtrees for geographic information systems, *in* International Symposium on Spatial Data Handling, 2nd, July 5-10, Seattle, Washington: Williamsville, New York, International Geographical Union Commission on Geographical Data Sensing and Processing, Proceedings, p. 33-37.

Way, D.S., 1973, Terrain Analysis, a guide to site selection using aerial photographic interpretation: Stroudsburg, Pennsylvania, Dowden Hutchinson and Ross, 392 p. [2nd ed., 1978]

Weaver, G.D., 1965, What is a landform?: The Professional Geographer, v. 17, no. 1, p. 11-13.

Webring, Michael, 1981, MINC—A gridding program based on minimum curvature: U.S. Geological Survey Open-File Report 81-1224, 12 p.

Weibel, E.R., 1963, Morphometry of the Human Lung: New York, Academic Press, paging unknown.

Weibel, Robert, 1987, An adaptive methodology for automated relief generalization, *in* Chrisman, N.R., ed., Auto-Carto 8, International Symposium on Computer-Assisted Cartography, 8th, 1987, ASPRS/ACSM, Proceedings: p. 42-49.

Weibel, Robert, 1989, Konzepte und Experimente zur Automatisierung der Reliefgeneralisierung (in German with English abstract): Inaugural-Dissertation, Universität Zürich, 218 p. + appendices.

Weibel, Robert, ed., 1989, Contributions to digital terrain modeling and display (revisions of four papers published previously): University of Zürich, Department of Geography, Geoprocessing Series, v. 12, 100 p.

Weibel, Robert, 1991, Design and implementation of a strategy for adaptive computer-assisted relief generalization (in German): Kartographische Nachrichten, v. 41, no. 3, p. 94-103.

Weibel, Robert, 1992, Models and experiments for adaptive computer-assisted terrain generalization: Cartography and Geographic Information Systems, v. 19, no. 3, p. 133-153.

Weibel, Robert, and DeLotto, J.S., 1988, Automated terrain classification for GIS modeling, *in* GIS/LIS '88 Conference, San Antonio, Texas, November 30-December 2, 1988, Proceedings, v. 2, p. 618-627. [revised version published 1989, *in* Weibel, Robert, ed., Contributions to Digital Terrain Modeling and Display, Univ. Zürich, p. 25-50]

Weibel, Robert, and Heller, Martin, 1991, Digital terrain modelling, *in* Maguire, D.J., Goodchiid, M.F., and Rhind, D.W., eds., Geographical Information Systems—Principles and Applications: London, Longman, vol 1, p. 269-297.

Weibel, Robert, Heller, Martin, Herzog, Adrian, and Brassel, K.E., 1987, Approaches to digital surface modeling, *in* First Latin American Conference on Computers in Geography, San Jose, Costa Rica, October 5-9, 1987, Proceedings, p. 143-163. [revised version published 1989, *in* Weibel, Robert, ed., Contributions to Digital Terrain Modeling and Display, Univ. Zürich, p. 1-23]

Weiringa, J., 1986, Roughness-dependent geographical interpolation of surface wind speed averages: Quarterly Journal of the Royal Meteorological Society, v. 112, p. 867-889.

Weissel, J.K., Pratson, L.F., Malinverno, A., and Harding, D.J., 1993, Scaling properties of topographic surfaces (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 194.

Welch, D.M., 1970, Substitution of space for time in a study of slope development: Journal of Geology, v. 78, no. 2, p. 234-239.

Welch, R., Lang, H.R., Kahle, A.B., and Tsu, H., 1993, The Advanced Spaceborne Thermal Emission and Reflectance Radiometer (ASTER) stereo subsystem—a source of digital elevation models (DEMs) for Earth science research (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 194.

Wentworth, C.K., 1930, A simplified method of determining the average slope of land surfaces: American Journal of Science, Series 5, v. 20, no. 9, p. 184-194.

Wentworth, C.M., Ellen, S.D., and Mark, R.K., 1987, Improved analyses of regional engineering geology using geographic information systems, *in* GIS-San Francisco, International Conference, Exhibits, and Workshops on Geographic Information Systems, 2nd, San Francisco, October 26-30, 1987, American Society for Photogrammetry and Remote Sensing / American Congress on Surveying and Mapping: Proceedings, v. 2, p. 636-649.

Werner, B.T., and Fink, T.M., 1993, Beach cusps as self-organized patterns: Science, v. 260, no. 5110, p. 968-971.

Werner, Christian, 1988, Formal analysis of ridge and channel patterns in maturely eroded terrain: Annals of the Association of American Geographers, v. 78, no. 2, p. 253-270.

Werner, Christian, 1991, Several duality theorems for interlocking ridge and channel networks: Water Resources Research, v. 27, no. 12, p. 3237-3247.

Werner, Christian, and Smart, J.S., 1973, Some new methods of topologic classification of channel networks: Geographical Analysis, v. 5, no. 4, p. 271-295.

Werner, Eberhard, 1979, Graphical display of orientation data for visual analysis, *in* Podwysocki, M.H., and Earl, J.L., eds., International Conference on Basement Tectonics, 2nd, 1978, Proceedings: Denver Colorado, Committee on Basement Tectonics, Inc., p. 521-527.

Werritty, A., 1972, Accuracy of stream link lengths derived from maps: Water Resources Research, v. 8, no. 5, p. 1255-1264.

Werritty, A., 1972, The topology of stream networks, *in* Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, p. 167-196.

West, B.J., and Goldberger, A.L., 1987, Physiology in fractal dimensions: American Scientist, v. 75, no. 4, p. 354-365.

Weszka, J.S., Dyer, C.R., and Rosenfeld, Azriel, 1976, A comparative study of texture measures for terrain classification: IEEE Transactions on Systems, Man, and Cybernetics, v. SMC-6, no. 4, p. 269-285.

Whalley, W.B., and Orford, J.D., 1989, The use of fractals and pseudofractals in the analysis of two-dimensional outlines, review and further exploration: Computers and Geosciences, v. 15, no. 2, p. 185-197.

Wheaton, G.E., 1987, Map compilation of bathymetric data gathered within the U.S. Exclusive Economic Zone, *in* American Society for Photogrammetry and Remote Sensing—American Congress on Surveying and Mapping, annual convention, Baltimore, Maryland, March 29-April 3, Technical Papers, v. 3 (Surveying), p. 144-153.

White, D.A., Smith, R.A., Price, C.V., Alexander, R.B., and Robinson, K.W., 1992, A spatial model to aggregate point-source and nonpoint-source water-quality data for large areas: Computers and Geosciences, v. 18, no. 8, p. 1055-1073.

White, E.R., 1985, Assessment of line-generalization algorithms using characteristic points: The American Cartographer, v. 12, no. 1, p. 17-27.

White, J.F., 1966, Convex-concave landslopes—a geometrical study: Ohio Journal of Science, v. 66, no. 6, p. 592-608.

Whitehouse, D.J., and Archard, J.F., 1970, The properties of random surfaces of significance in their contact: Proceedings of the Royal Society of London, Series A, v. 316, no. 1524, p. 97-121.

Whitted, Turner, 1982, Some recent advances in computer graphics: Science, v. 215, no. 4534, p. 767-774.

Whittington, G., Beavon, K.S.O., and Mabin, A.S., 1972, Compactness of shape—review, theory, and application: Johannesburg, South Africa, University of Witwatersrand, Department of Geography and Environmental Studies, Occasional Paper 7, paging unknown.

Wiche, G.J., Jenson, S.K., Baglio, J.V., and Domingue, J.O., 1992, Application of digital elevation models to delineate drainage areas and compute hydrologic characteristics for sites in the James River Basin, North Dakota: U.S. Geological Survey Water-supply Paper 2383, 23 p.

Wiechel, H., 1878, Theorie und Darstellung der Beleuchtung von nicht gesetzmässig gebildeten Flächen mit Rücksicht auf die Bergzeichnung (in German): Civilingenieur, v. 24, p. 335-364.

Wildey, R.L., 1975, Generalized photoclinometry for Mariner 9: Icarus, v. 25, no. 4, p. 613-626.

Wildey, R.L., 1984, Topography from single radar images: Science, v. 224, no. 4645, p. 153-156.

Willgoose, Garry, 1993, Geomorphologic process from digital terrain map analysis (abs.): Eos Transactions of the American Geophysical Union, v. 74, no. 16 (Supplement), p. 152.

Willgoose, Garry, Bras, R.L., and Rodriguez-Iturbe, Ignacio, 1992, The relationship between catchment and hillslope properties—implications of a catchment evolution model, *in* Snow, R.S., and Mayer, Larry, eds., Fractals in Geomorphology: Geomorphology, v. 5, Nos. 1/2, p. 21-37.

Williams, C.M., 1986, The geometric modeling and compression of terrain data, *in* International Symposium on Spatial Data Handling, 2nd, Seattle, Wash., July 5-10, 1986, International Geographical Union, Proceedings, p. 158-170.

Williams, P.W., 1972a, Morphometric analysis of polygonal karst in New Guinea: Geological Society of America Bulletin, v. 83, no. 3, p. 761-796.

Williams, P.W., 1972b, The analysis of spatial characteristics of karst terrains, *in* Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, p. 135-163.

Williams, P.W., 1974, Use of chi-square on percentage orientation data, reply: Geological Society of America Bulletin, v. 85, no. 5, p. 833-834.

Wilson, Lee, 1968, Slopes, *in* Fairbridge, R.W., ed., The Encyclopedia of Geomorphology: New York, Reinhold Book Co., p. 1002-1020.

Wilson, P.M., 1981, Comparing sources of terrain data for a geographical information system, *in* Proceedings of the ASP-ACSM Convention, Washington, D.C., February 22-27, 1981, Technical Papers of the American Congress on Surveying and Mapping, p. 201-210.

Witczak, M.W., 1972, Relationships between physiographic units and highway design factors: Washington, D.C., Highway Research Board, National Academy of Sciences—National Academy of Engineering, National Cooperative Highway Research Program, Report 132, 161 p.

Witzgall, Christoph, and Karalus, Randall, 1991, Terrain modeling—shortest path, drain patterns and interspersed contours: U.S. Army Corps of Engineers, Topographic Engineering Center, Fort Belvoir, VA, TEC Report, paging unknown. [AD A256 655]

Wivell, C.E., Steinwand, D.R., Kelly, G.G., and Meyer, D.J., 1992, Evaluation of terrain models for the geocoding and terrain correction of synthetic aperture radar (SAR) images: IEEE Transactions on Geoscience and Remote Sensing, v. 30, no. 6, p. 1137-1144.

Woldenberg, M.J., 1966, Horton's laws justified in terms of allometric growth and steady state in open systems: Geological Society of America Bulletin, v. 77, no. 4, p. 431-434.

Woldenberg, M.J., 1967, Geography and properties of surfaces: Cambridge, MA, Harvard University, Harvard Papers in Theoretical Geography, v. 1, p. 95-189.

Woldenberg, M.J., 1969, Spatial order in fluvial systems—Horton's laws derived from mixed hexagonal hierarchies of drainage basin areas: Geological Society of America, v. 80, no. 1, p. 97-112.

Woldenberg, M.J., 1972, The average hexagon in spatial hierarchies, *in* Chorley, R.J., ed., Spatial Analysis in Geomorphology: New York, Harper and Row, 323-352.

Woldenberg, M.J., Cumming, Gordon, Harding, Keith, Horsfield, Keith, Prowse, Keith, and Shiam, Singhal, 1970, Law and order in the human lung: Cambridge, MA, Harvard University Graduate School of Design, Laboratory for computer graphics and spatial analysis, Harvard Papers in Theoretical Geography, "Geography and the properties of surfaces" series, No. 41 (ONR Contract No. 00014-67A-0298), 56 p.

Wolf, G.W., 1988, Generalisierung topographischer Karten mittels Oberflächengraphen (n German): Doctoral dissertation, University of Klagenfurt, paging unknown.

Wolf, G.W., 1991a, Characterization of functions representing topographic surfaces, *in* American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing annual convention, Baltimore, Md., March 25-28: Technical Papers, v. 6 (Auto-Carto 10), p. 186-204.

Wolf, G.W., 1991b, A FORTRAN subroutine for cartographic generalization: Computers and Geosciences, v. 17, no. 10, p. 1359-1381.

Wolf, Michael, and Wingham, Duncan, 1992a, A survey of the world's digital elevation data: Dorking, Surrey, UK, Mullard Space Science Laboratory, Global Topography Team Report 4010/04-92-002, 87 p.

Wolf, Michael, and Wingham, Duncan, 1992b, The status of the world's public-domain digital topography of the land and ice: Geophysical Research Letters, v. 19, no. 23, p. 2325-2328.

Wolfanger, L.A., 1941, Landform types: East Lansing, Michigan State College Agricultural Experiment Station, Technical Bulletin 175, 24 p.

Wong, S.T., 1963, A multivariate statistical model for predicting mean annual flood in New England: Annals of the Association of American Geographers, v. 53, no. 3, p. 298-311.

Wood, C.A., 1980, Morphometric evolution of cinder cones: Journal of Volcanology and Geothermal Research, v. 7, no. 3/4, p. 387-413.

Wood, C.A., and Andersson, L.E., 1978, New morphometric data for fresh lunar craters, *in* Lunar and Planetary Science Conference, 9th, Houston, Texas, March 1978, Proceedings: New York, Pergamon Press, p. 3669-3689

Wood, W.F., 1954, The dot planimeter—a new way to measure map area: The Professional Geographer, v. 6, no. 1, p. 12-14.

Wood, W.F., 1955, The relationships of relief (abs.): Annals of the Association of American Geographers, v. 45, no. 3, p. 306-307. [Paper read at 51st annual AAG meeting, Memphis, Tenn., April 11-14, 1955, typescript, 8 p.]

Wood, W.F., 1956, Increasing the value of small-scale maps for landform study by the use of statistical inference (abs.): Annals of the Association of American Geographers, v. 46, no. 2, p. 282-283. [Paper read at 52nd annual AAG meeting, Montreal, April 1-5, 1956, typescript, 12 p.]

Wood, W.F., 1956, Relief, slope, and natural vegetation: Paper read before Section E, AAAS, Annual meeting, New York, Dec. 27, 1956, typescript, 9 p. + figures]

Wood, W.F., 1958, Flat grasslands and hilly forests, why? (abs.): Annals of the Association of American Geographers, v. 48, no. 3, p. 298. [Paper read at 54th annual AAG meeting, Los Angeles, CA, August 18-22, 1958, typescript, 14 p. + tables I-VI]

Wood, W.F., 1959, Prediction in terrain analysis (abs.): Geological Society of America Bulletin, v. 70. no. 12, Pt. 2, p. 1816. [also paper read at AAAS annual meeting, Chicago, Ill., Dec. 27, 1959, typescript, 9 p. + figures]

Wood, W.F., 1961, Ranges of unobstructed ground-to-ground visibility, *in* U.S. Army Ordnance Corps symposium, Environmental Factors Influencing Optimum Operation of Ordnance Materiel, San Antonio, Texas, 27-30 September, 1960, Proceedings, p. 17-29.

Wood, W.F., 1962, Further development of a method to predict line-of-sight capabilities: Fort Eustis, VA, U.S. Army Transportation Command, Air Vehicle Environmental Research Team, Aircraft Environmental Research Study Report AE-5, 18 p.

Wood, W.F., 1963, The relationship of mask angles to terrain geometry and its applicability to military problems: Buffalo, N.Y., Cornell Aeronautical Laboratory, Report No. VT-1810-G-2, 40 p.

Wood, W.F., 1966, Statistical terrain analysis: Reprographics (New York, United Business Publications, Inc.), v. 4, no. 2, p. 8-10, 12, & 39.

Wood, W.F., 1967, Qualitative considerations in quantitative physical geography, *in* Garrison, W.L., and Marble, D.F., eds., Quantitative Geography Part II—Physical and Cartographic Topics: Evanston, Ill., Northwestern University Studies in Geography no. 14, p. 227-242. [also paper read at Symposium, Geography, Division of Earth Science, NRC, Chicago, May 5-6, 1960, typescript, 17 p.]

Wood, W.F., and Lewandowski, G.M., 1965, The optimal human operator method for digitizing a map, *in* Wood, W.F., Magorian, T.R., and Groenewood, Cornelius, Quantitative terrain analysis: Buffalo, N.Y., Cornell Aeronautical Laboratory, Report No. VE-1871-G-1, Appendix III, p. 1-14. [report, but not appendix, classified; submitted for presentation at 1966 AAG meeting, but not read]

Wood, W.F., and Lewandowski, G.M., 1970, Maneuvering the dual mode manned/automated lunar roving vehicle: Buffalo, N.Y., Cornell Aeronautical Laboratory, Report No. VS-2860-D, 73 p.

Wood, W.F., and Snell, J.B., 1957, The dispersion of geomorphic data around measures of central tendency and its application: Natick, MA, U.S. Army Quartermaster Research and Development Center, Research Study Report EA-8, 5 p. + figures. [also, 1957, (abs.): Annals of the Association of American Geographers, v. 47, no. 2, p. 184-185; also paper read at 53rd annual AAG meeting, Cincinnati, Ohio, April 1-4, 1957, typescript, -- p.]

Wood, W.F., and Snell, J.B., 1959a, Predictive methods in topographic analysis I. relief, slope, and dissection on inch-to-the-mile maps in the United States: Natick, MA, U.S. Army Quartermaster Research and Engineering Center, Technical Report EP-112, 31 p.

Wood, W.F., and Snell, J.B., 1959b, Predictive methods in topographic analysis II. estimating relief from World Aeronautical Charts: Natick, MA, U.S. Army Quartermaster Research and Engineering Center, Technical Report EP-114, 19 p.

Wood, W.F., and Snell, J.B., 1959c, Preliminary Investigations of a Method to Predict Line-of-Sight Capabilities: Natick, MA, U.S. Army Quartermaster Research and Engineering Center, Research Study Report EA-10, 16 p.

Wood, W.F., and Snell, J.B., 1960a, A Quantitative System for Classifying Landforms: Natick, MA, U.S. Army Quartermaster Research and Engineering Center, Technical Report EP-124, 20 p.

Wood, W.F., and Snell, J.B., 1960b, A preliminary test of ground-to-air visibility: Fort Eustis, VA, U.S. Army Transportation Command, Air Vehicle Environmental Research Team, Aircraft Environmental Research Study Report AE-2, 19 p.

Wood, W.F., Soderberg, P.G., and Pike, R.J., 1962, A preliminary model of most-severe contour flying: Fort Eustis, VA, U.S. Army Transportation Research Command, Air Vehicle Environmental Research Team, Aircraft Environmental Research Study Report AE-4, 33 p .

Woodcock, C.E., Strahler, A.H., and Jupp, D.L.B., 1988, The use of variograms in remote sensing—I. scene models and simulated images—II. real digital images: Remote Sensing of Environment, v. 25, no. 3, p. 323-348, 349-379.

Woodcock, N.H., 1977, Specification of fabric shapes using an eigenvalue method: Geological Society of America Bulletin, v. 88, no. 9, p. 1231-1236.

Woodruff, J.F., 1964, A comparative analysis of selected drainage basins: The Professional Geographer, v. 16, no. 4, p. 15-19.

Woodruff, J.F., 1965, Frequency distribution of elevations as an index to terrain classification (abs.): Annals of the Association of American Geographers, v. 55, no. 4, p. 1965.

Woodruff, J.F., and Evenden, L.J., 1962, Geomorphic measurements from aerial photographs: The Professional Geographer, v. 14, no. 3, p. 23-26.

Woronow, Alexander, 1981, Morphometric consistency with the Hausdorff-Besicovich dimension: Mathematical Geology, v. 13, no. 3, p. 201-216.

Worth, Christopher, 1978, Determining a vertical scale for graphical representations of three-dimensional surfaces: The Cartographic Journal, v. 15, no. 2, p. 86-92.

Wright, P.J.F., 1955, A method of measuring the surface texture of aggregate: Concrete Research Magazine, November, p. 151-160.

Wright, R.L., 1972, Principles in a geomorphological approach to land classification: Zeitschrift für Geomorphologie, v. 16, no. 4, p. 351-373.

Wu, H.H., 1981, Prinzip und Methode der automatischen Generalisierung der Reliefformen: Nachrichten aus dem Karten- und Vermessungswesen, Series I, v. 85, p. 163-174.

Wu, S.S.C., 1978, Mars synthetic topographic mapping: Icarus, v. 33, no. 3, p. 417-440.

X

Xia, Zong-Guo, 1991, The Fractal Characterization of Land Surface: New York, City University of New York, Department of Geography, unpublished Ph.D. dissertation, paging unknown.

Xia, Zong-Guo, Clarke, K.C., and Huang, J.X., 1991a, An evaluation of algorithms for estimating the fractal dimension of topographic surfaces, *in* GIS/LIS, American Congress on Surveying and Mapping—American Society for Photogrammetry and Remote Sensing, fall convention, Atlanta, October 28-November 1, 1991, Technical Papers, p. A-164 to A-180.

Xia, Zong-Guo, Clarke, K.C., and Plews, R.W., 1991b, The uses and limitations of fractal geometry in terrain modeling, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing annual convention, Baltimore, Md., March 25-29: Technical Papers, v. 2 (Cartography and GIS/LIS), p. 336-352.

Y

Yaguchi, A., 1987, Digital geographic information collection at Geographical Survey Institute in Japan, *in* Kirschbaum, Klaus, and Meine, K.-H., eds., International Yearbook of Cartography: Bonn-Bad Godesberg, Kirschbaum Verlag, p. 253-258.

Yamaguchi, Yasushi, 1985, Image-scale and look-direction effects on the detectability of lineaments in radar images: Remote Sensing of Environment, v. 17, no. 2, p. 117-127.

Yamazaki, Hisao, 1971, Relative relief map of Japan, *in* Arnberger, Erik, and Aurada, Fritz, eds., International Yearbook of Cartography: London, George Philip & Son, International Cartographic Association, v. 11, p. 106-110.

Yang, C.T., and Stall, J.B., 1971, Note on the map scale effect in the study of stream morphology: Water Resources Research, v. 7, no. 3, p. 709-712.

Yazdani, Rostam, 1983, A comparison of regular grid, contour digitization, and the TIN method for the creation of a digital terrain model (DTM): Canada Centre for Remote Sensing, project No. 1-13-808, Project Report, 29 p.

Yefremov, Yu. K., 1949, An attempt at a morphographic classification of landform elements and simple landforms (in Russian): Voprosy geografii, No.11.

Yoeli, Pinhas, 1965, Analytical hill shading (A cartographic experiment): Surveying and Mapping, v. 25, no. 4, p. 573-579.

Yoeli, Pinhas, 1966, Analytical hill shading and density: Surveying and Mapping, v. 26, no. 2, p. 253-260.

Yoeli, Pinhas, 1967, The mechanisation of analytical hill shading: Cartographic Journal (Glasgow), v. 4, no. 2, p. 82-88.

Yoeli, Pinhas, 1971, An experimental electronic system for converting contours into hill-shaded relief, *in* Arnberger, Erik, and Aurada, Fritz, eds., International Yearbook of Cartography: London, George Philip & Son, International Cartographic Association, v. 11, p. 111-114.

Yoeli, Pinhas, 1975, Compilation of data for computer-assisted relief cartography, *in* Davis, J.C., and McCullagh, M.J., eds., Display and Analysis of Spatial Data: London, John Wiley and Sons, p. 352-367.

Yoeli, Pinhas, 1976, Computer-aided relief presentation by traces of inclined planes: The American Cartographer, v. 3, no. 1, p. 75-85.

Yoeli, Pinhas, 1982, Über digitale Geländemodelle und deren computergestützte kartographische und kartometrische Auswertung (in German): Vermess., Photogramm. Kulturtech., no. 2/82, p. 34-39.

Yoeli, Pinhas, 1984, Computer-assisted determination of the valley and ridge lines of digital terrain models, *in* Kirschbaum, Klaus, and Meine, K.-H., eds., International Yearbook of Cartography: Bonn-Bad Godesberg, Kirschbaum Verlag, p. 197-206.

Yoeli, Pinhas, 1984, Error-bands of topographical contours with computer and plotter (program KOPPE): Geo-Processing, v. 2, no. 3, p. 287-297.

Yoeli, Pinhas, 1984, Cartographic contouring with computer and plotter: The American Cartographer, v. 11, no. 2, p. 139-155.

Yoeli, Pinhas, 1985, The making of intervisibility maps with computer and plotter: Cartographica, v. 22, no. 3, p. 88-103.

Yoeli, Pinhas, 1985, Topographic relief depiction by hachures with computer and plotter: Cartographic Journal, v. 22, no. 2, p. 111-124.

Yoeli, Pinhas, 1986, Computer executed production of a regular grid of height points from digital contours: The American Cartographer, v. 13, no. 3, p. 219-229.

Yokoya, N., Yamamoto, K., and Funakubo, N., 1989, Fractal-based analysis and interpolation of 3D natural surface shapes and their application to terrain modeling: Computer Vision, Graphics, and Image Processing, v. 46, no. 3, p. 284-302.

Yoshikawa, T., 1956, Hypsometric analysis of late mature and old mountains in central Korea—an approach to quantitative research of physiographic development of mountains: Japan Journal of Geology and Geography, v. 27, no. 1, p. 67-78.

Yoshiyama, A., 1989, Drainage network generation and measurement based on digital elevation data: Geographical Reports of Tokyo Metropolitan University, v. 24, p. 43-53.

Youden, W.J., and Mehlich, A., 1937, Selection of efficient methods for soil sampling: Contributions from Boyce Thompson Institute, v. 9, no. 1, p. 59-70.

Young, Anthony, 1964, Slope profile analysis: Zeitschrift für Geomorphologie, Supplementband 5, p. 17-27.

Young, Anthony, 1971, Slope profile analysis—the system of best units: Institute of British Geographers, Special Publication 3, p. 1-13.

Young, Anthony, 1972, Slopes: Edinburgh, Oliver and Boyd, 288 p.

Young, Anthony, 1974, Slope Profile Survey: Norwich, UK, GeoAbstracts, British Geomorphological Research Group, Technical Bulletin No. 11, 52 p.

Young, G.S., and Pielke, R.A., 1983, Application of terrain height variance spectra to mesoscale modeling: Journal of the Atmospheric Sciences, v. 40, no.10, p. 2555-2560.

Young, G.S., Pielke, R.A., and Kessler, R.C., 1984, A comparison of the terrain height variance spectra of the Front Range with that of a hypothetical mountain: Journal of the Atmospheric Sciences, v. 41, no. 7, p. 1249-1250.

Young, M.P., and Yamane, Shigeru, 1992, Sparse population coding of faces in the inferotemporal cortex: Science, v. 256, no. 5061, p. 1327-1331.

Young, Margaret, 1978, Terrain analysis, program documentation: U.S. Army Contract DA-ERO-591-73-G0040, Statistical characterization of altitude matrices by computer, Report No. 5: Durham City, England, The University of Durham, Department of Geography, 27 p. [see Evans, I.S.]

Young, R.N., 1954, A Geographic Classification of the Landforms of Puerto Rico: Madison, University of Wisconsin, Department of Geography, unpublished Ph.D. dissertation, 158 p.

Yuan, L.-P., and Vanderpol, N.L., 1986, Drainage network simulation: Computers and Geosciences, v. 12, no. 5, p. 653-665.

Z

Zachar, Dusan, 1982, Relief, *in* Soil Erosion, Developments in Soil Science 10: Amsterdam, Elsevier, p. 281-300. [morphometric methods, p. 185-188.]

Zadeh, L.A., 1977, Fuzzy sets and their application to classification and clustering, *in* Van Ryzin, J., ed., Classification and Clustering,: New York, Academic Press, p. 251-299.

Zakrzewska, Barbara, 1963, An analysis of landforms in a part of the central Great Plains: Annals of the Association of American Geographers, v. 53, no. 4, p. 536-568.

Zakrzewska, Barbara, 1967, Trends and methods in land form geography: Annals of the Association of American Geographers, v. 57, no. 1, p. 128-165.

Zakrzewska Borowiecka, Barbara, 1985, Wisconsin drumlin field and its origin: Zeitschrift für Geomorphologie, v. 29, no. 4, p. 417-438.

Zâvoianu, Ion, 1985, Morphometry of drainage basins: Amsterdam, Elsevier, Developments in Water Science, 20, 238 p.

Zecharias, Y.B., and Brutsaert, Wilfried, 1985, Ground surface slope as a basin scale parameter: Water Resources Research, v. 21, no. 12, p. 1895-1902.

Zebarth, B.J., and DeJong, Eeltje, 1989, Water flow in a hummocky landscape in central Saskatchewan, Canada, I. Distribution of water and soils: Journal of Hydrology, v. 107, no. 1-4, p. 309-327.

Zevenbergen, L.W., 1987, Erosion Modelling using Terrain Analysis: University of London, UK, unpublished Ph.D. thesis, paging unknown.

Zevenbergen, L.W., and Thorne, C.R., 1987, Quantitative analysis of land surface topography: Earth Surface Processes and Landforms, v. 12, no. 1, p. 47-56.

Zhang, M.C., Campbell, J.B., and Haralick, R.M., 1990, Automatic delineation of drainage basins within digital elevation data using the topographic primal sketch: Mathematical Geology, v. 22, no. 2, p. 189-209.

Zhang, Z., and Simaan, Marwan, 1989, Control schemes for SEIS, a rule-based system for segmentation of a seismic section based on texture: Advances in Geophysical Data Processing, v. 3, p. 135-173.

Zharnovskiy, A.A., 1976, Detection of large errors in coordinates and heights during digital modeling of relief: Geodesy, Mapping and Photogrammetry, v. 18, no. 1, p. 33-35.

Zheng, Y.-J., 1993, Digital photogrammetric inversion—theory and application to surface reconstruction: Photogrammetric Engineering and Remote Sensing, v. 59, no. 4, p. 489-498.

Zhou, Qiming, 1992, Relief shading using digital elevation models: Computers and Geosciences, v. 18, no. 8, p. 1035-1045.

Zingg, A.W., 1940, Degree and length of land slope as it affects soil loss in runoff: Agricultural Engineering, v. 21, p. 59-64.

Zoraster, Steven, Davis, D.M., and Hugus, M.K., 1984, Manual and Automated Line Generalization and Feature Displacement: Fort Belvoir, VA, U.S. Army Engineering Topographic Laboratories, Report ETL-0359 (+ETL-0359-1), 184 p.

Zoraster, Steven, 1982, A comparison of two-dimensional interpolation algorithms, *in* II Pan American and VII National Congress on Photogrammetry, Photointerpretation, and Geodesy, Mexico, 1982: Revista Cartografica, no. 42 (July-December), p. 25-35.

Zoraster, Steven, and Ebisch, Konrad, 1988, Contouring using variable density rectangular grids, *in* American Congress on Surveying and Mapping / American Society for Photogrammetry and Remote Sensing, annual convention, March 13-18, 1988, St. Louis, Missouri, Technical papers, v. 2 (Cartography), p. 139-148.

Zusne, L., 1970, Visual Perception of Form: New York, Academic Press, paging unknown.

Zycor, Inc., 1983, User's Manual for Contour-to-Grid Interpolation (CTOG): Austin, Texas, *for* U.S. Geological Survey, Reston, VA, 24 p. + appendices.