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A Bibliography of Terrain Modeling (Geomorphometry), the Quantitative Representation of Topography —*Supplement 4.0*

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Provides over 1600 additions and corrections to the 1993
Bibliography of Geomorphometry and its 1995, 1996,
and 1999 Supplements, with an update
of recent advances

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Abstract This report adds over 1600 annotated references on the numerical characterization of topography, *terrain modeling* or *geomorphometry*, to a 1993 literature review and its first three updates. Erroneous references from the four earlier reports are corrected and many citations of historic interest are included; the cumulative archive is at 6000 entries. An introductory essay cites several hundred of the new entries. These are listed under various topic headings or referenced in brief discussions of several other areas of research, including terrain data and new parameters, neo-orometry, landslide-hazard mapping, Hack's Law, and early work on the mathematical representation of ridges and drainageways.

Introduction

Terrain modeling, the practice of ground-surface quantification, is an amalgam of Earth science, mathematics, engineering, and computer science. The discipline is known variously as *geomorphometry* (or simply *morphometry*), *terrain analysis*, and *quantitative geomorphology.* It continues to grow through myriad applications to hydrology, geohazards mapping, tectonics, sea-floor and planetary exploration, and other fields. Dating nominally to the co-founders of academic geography, Alexander von Humboldt (1808, 1817) and Carl Ritter (1826, 1828), the field was revolutionized late in the 20th Century by the computer manipulation of spatial arrays of terrain heights, or digital elevation models (DEMs), which can quantify and portray ground-surface form over large areas (Maune, 2001). Morphometric procedures are implemented routinely by commercial geographic information systems (GIS) as well as specialized software (Harvey and Eash, 1996; Köthe and others, 1996; ESRI, 1997; Drzewiecki et al., 1999; Dikau and Saurer, 1999; Djokic and Maidment, 2000; Wilson and Gallant, 2000; Breuer, 2001; Guth, 2001; Eastman, 2002). The new Earth Surface edition of the Journal of Geophysical

Research, specializing in surficial processes, is the latest of many publication venues for terrain modeling.

This is the fourth update of a bibliography and introduction to terrain modeling (Pike, 1993, 1995, 1996, 1999) designed to collect the diverse, scattered literature on surface measurement as a resource for the research community. The use of DEMs in science and technology continues to accelerate and diversify (Pike, 2000a). New work appears so frequently that a sampling must suffice to represent the vast literature. This report adds 1636 entries to the 4374 in the four earlier publications[1]. Forty-eight additional entries correct dead Internet links and other errors found in the prior listings. Chronicling the history of terrain modeling, many entries in this report predate the 1999 supplement. Coverage is representative from about 1800 through early–mid 2002. Papers increasingly are published exclusively or in duplicate on the Internet's World Wide Web; the dates given here for Web addresses (URLs) that lack a print publication indicate a Web site's last update or my last access of it.

The bibliography is arranged alphabetically and thus is not readily summarized. This introduction cites about 500 entries, a third of them grouped under 24 morphometric topics, as a guide to the listing's contents. Continuing the practice of previous bibliographies in the series to provide more information on a few applications (see summary of past topics in Pike, 2000a), this report elaborates further on topographic data, putative new parameters, tectonic geomorphology/neo-orometry, biogeography, ice-cap morphometry, results from the Mars Global DEM, landslide-hazard mapping, terrain modeling as physics, Hack's law, and broad-scale computer visualization. The literature of some of these subjects is large, and none of the summaries is intended to more than introduce the topic and comment on some of the current contributions of terrain modeling. Closing the essay is a discussion of pre-1900 papers that trace the evolution of ridge-line and watercourse quantification by descriptive geometry, as well as comments on some new books and an on-line bulletin board.

Revisions in Format

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[1] The few text citations not in the main bibliography are listed at the close of this introduction or in 'Corrections' appended to the main bibliography.

With this report the title of the series incorporates *Terrain Modeling,* in an effort to broaden its readership. According to the Internet-search results illustrated in Table 1, *Terrain Modeling* (plus *Modelling*) is 15 times more frequent than *geomorphometry*. Other alternatives are inapt: *Digital* Terrain Modeling would exclude pre- or non-computer work (Penck, 1894a, b; Hack and Goodlett, 1960); *Terrain Analysis* has military and non-quantitative connotations (Graff, 1997; DARPA, 2002); *Morphometry* is a common practice in biology and paleontology (Cracraft, 1980; MacLeod, 1999); *Surface Rendering, Terrain Rendering*, and *Surface Modeling* have

Table 1

Ranking Descriptors of Surface Quantification

(as keywords on the World Wide Web)

*Index of Hits	*Search Word(s)
100	Surface Modeling**
72	Surface Topography
57	Morphometry
53	Terrain Modeling**
40	Terrain Analysis
24	Surface Rendering
18	Digital Terrain Modeling**
14	Terrain Rendering
11	Topographic(al) Analysis**
6	Surface Metrology
3.5	Geomorphometry
2.4	Digital Elevation Modeling**
2.3	Digital Terrain Analysis
1.6	Quantitative Geomorphology
1.2	Landform Modeling**

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*using the exact-phrase option in the *Google* search engine, 23 September 2002; Index for each term is number of hits / number of hits (28,100) on 'surface modeling' × 100

**includes the British spellings '... Modelling' and 'Topographical ...'

specialized meanings in computer vision and image analysis (Koenderink and van Doorn, 1993, 1994, 1998; López, 1997; Thompson and others, 1998); and *Surface Topography* connotes industrial micro- and nano-morphometry (Thomas and others, 1999; Blunt and Stout, 2000; Scott, 2001).

Another change with this report is the annotation of all entries except the 90 or so that were not seen but whose titles, context, or literature citations insure involvement with terrain modeling (for example, Malyavsky and Zharnovsky, 1974; Brown, 1994; Schneider, 2001). Most remarks are brief, were made hastily, and reflect the author's interest or understanding at the time—commonly descriptive parameters, techniques and data. This informal annotation is not to be construed as a summary of an entry's contents or an appraisal of the work reported—which ranges from trivial to profound. Comments tend to lengthen with the age of the publication, most early work requiring historic context to justify its inclusion. To increase the usefulness of the (eventual) consolidated bibliography, entries in the initial 1993 listing and prior updates are being annotated. Comments have been appended to 61% of the combined 6000 citations, and all entries before 1966.

Topographic Data

Data availability and quality persist as areas of concern in terrain modeling. In the U.S. a new master DEM assembled from all 55,000 1:24,000- and 1:63,360-scale topographic maps eliminates the onerous tiling of multiple 7.5' quadrangles and other data preparation (Gesch and others, 2002). This National Elevation Dataset (NED) is a seamless, continually updated, DEM of uniform horizontal datum (NAD83), unit of height (decimal meters), and projection. Horizontal grid resolution is 1" (nominally 30 m) for the conterminous U.S., Hawaii, and Puerto Rico and 2" for Alaska. Digital filtering during compilation reduces artifacts in the source DEMs (Oimoen, 2000), seamlessly matches adjacent quadrangles, and fills sliver areas of missing data. Because heights for much of the country increasingly are gridded at a spacing of 10 m, a 1/3" (nominally 10 m) DEM is in progress. New national DEMs are not unique to the U.S. For example, Carroll and Morse (1996) describe creation of the GEODATA 9" DEM of Australia and Hutchinson and others (2001) its subsequent upgrading, including discussion of the ANUDEM gridding algorithm to improve data accuracy. In a reversal of conventional experience, contours for the recently completed 1:50,000-scale topographic maps of Ireland were extracted from DEMs generated by digital photogrammetry (Cory and McGill, 1999).

All DEMs are in some respect flawed (Coops, 2000). Most of the error in current DEMs originated in the contour maps from which they were derived and thus cannot be reduced through efforts of the user. Map-accuracy standards vary widely and do not provide a rigorous evaluation. Production standards, moreover, guarantee only a statistical level of quality; locally, accuracy can be low. Contour maps are merely models—of varying fidelity—of topography, just as DEMs are, in turn, imperfect models of the maps (Ollier, 1967). Contour maps never were intended to provide heights of the high density and accuracy increasingly required for terrain modeling. What can be mitigated to some extent by the DEM user is error originating in contour map-to-DEM processing (Duh and Brown, 1999; Holmes and others, 2000; Lane and others, 2000; Lynch, 2002). Most DEMs currently available have been interpolated from contours by sampling designs and computer algorithms that add artifacts and other distortions inherent in the processing (Shortridge, 2001). Various procedures have been applied to repair some of these flaws (Hutchinson and Gallant, 2000; Oimoen, 2000; Hutchinson, 2001; Gesch and others, 2002).

Production methods that bypass map contours as the source of digital heights can improve DEM quality. Two emerging technologies that measure the true ground-surface directly have the potential to reduce some of the current shortcomings in DEM coverage and accuracy (Maune, 2001). Laser altimetry, particularly LiDAR (light distance and ranging), promises DEMs of fine resolution and high accuracy (Ritchie, 1995; DeLoach and Leonard, 2000; Brock and others, 2002), as well as seafloor bathymetry (Sandwell and Smith, 2000). Radar interferometry (InSAR or IfSAR) yields terrain-height accuracies and resolutions comparable with those generated by optical methods (Small, 1998; Gens, 1999; Dowman, 2000; Hanssen, 2001; Smith, 2002). Interferometry also is used to monitor displacements of topography, for example, by subsidence or surface faulting.

LiDAR's aircraft-mounted lasers record 2000-5000 height measurements per second to a vertical precision of ±15 cm. From these voluminous observations DEMs at a horizontal resolution of about a meter can be prepared for large areas (Hill and others, 2000; Carter and others, 2001). While expensive compared to DEMs compiled photogrammetrically or from digitized contours, LiDAR data are decreasing in cost as techniques of acquisition and processing (notably, filtering out vegetation and man-made structures) improve in efficiency and economies of scale make the data more competitive in the marketplace. LiDAR could become the standard procedure, with digital photogrammetry (Gwinner and others, 2000; Lane and others, 2000; Hancock and Willgoose, 2001), for creating fine-scale DEMs of small areas. For representative applications of LiDAR to terrain modeling see Jansma and others (1999), Cowen and others (2000), and Marks and Bates (2000).

Interferometry, which requires simultaneous or repeated signal acquisitions by synthetic-aperture mapping radar, has delivered a near-global DEM at a uniform horizontal resolution of 90 m. Over ten days in February 2000, the Shuttle Radar Topographic Mission (SRTM) system onboard Space Shuttle Endeavour imaged about 80% of Earth's land surface, creating an immense set of terrain heights. The SRTM carried two radar antennas, one aboard the spacecraft, the other at the end of a 60-m mast extending from it. A 3" (nominally 90-m) DEM compiled from mission results (Farr and Kobrick, 2000; NASA, 2002) is taking its place beside the l-km GTOPO30 DEM (Gesch and Larson, 1998; Gesch and others, 1999) that remains the current standard for elevation coverage worldwide. A global 1" (30-m) DEM also is being extracted from the SRTM but only the United States data will be publicly available.

Advanced methods do not assure DEM quality. InSAR, LiDAR, and other remotely-sensed data all contain errors, some of them severe, that are unique to their technologies (Leberl, 1998; Toutin, 1999; Endreny and others, 2000; Ahmadzadeh and Petrou, 2001; Kervyn, 2001; Nuth and others, 2002). The early SRTM results are a cautionary example. Aside from the fact that 1/5 of Earth's land mass (all at high latitudes) was excluded, *relative* vertical accuracy of the new data at the 90% level is expected to average ±10m, a substantial error at the 90-m grid spacing and potentially serious at 30m. Also, because the radar did not penetrate dense vegetation, data in such areas describe the tree canopy rather than bare ground—in which case the new DEM probably reproduces the terrain surface no more faithfully than the NED. NASA (2002) alerts users of SRTM data to "... be aware that the digital ... topographic data are unedited and are intended for scientific use and evaluation. They are outputs directly from the SRTM interferometric radar processor and, for example, may contain numerous voids (areas without data), water bodies may not appear flat, and coastlines may be ill-defined." Currently available, more accurate, DEMs thus are likely to remain the better data for many areas. Slatton and others (2001) have proposed a way to fuse LiDAR with InSAR to get coverage that is at once accurate, dense, and extensive.

New (?) Parameters

While Wolfgang Pauli's "the surface was invented by the devil!" was lamenting complexities of atomic structure at the surface of a solid, the physicist's exasperation applies equally to terrain modeling. Continuous topography is difficult to express, and many new parameters have been proposed to quantify attributes of terrain that existing measures cannot describe. 'New' terrain measures have included mean elevation (Huber, 1825; Sonklar, 1872) and slope gradient (Tillmann, 1915; Bonniard, 1929), relative relief (*relief energy* in European and Japanese practice; Scheer, 1933; Tada, 1937), the hypsometric integral (Hurtrez and others, 1999; Luo, 2000), and most recently the fractal dimension—which briefly revived the old philosopher's-stone fallacy that a single 'magic number' might suffice to express surface form (Evans and Cox, 1998).

Two approaches recently developed to describe *continuous topography*, as distinguished from discrete *landforms*, are the DEM-based 'terrain fabric' of Guth (1999a, b; 2001) and surface 'openness' of Yokoyama and others (1999, 2002). Terrain fabric characterizes the tendency of a surface to be organized into linear ridges rather than isotropic topography, whereas openness expresses dominance (exposure) versus enclosure of a location on an irregular surface. 'New' parameters, however, rarely are; many describe the same basic attribute of surface form and thus are redundant (Pike, 2001e). In geomorphology, for example, the hypsometric integral differs little from elevation skewness (Pike, 2001a). If, or to what extent, the two most recently proposed candidates mimic existing, and perhaps simpler, measures remains to be determined (Guth, 1999b; Pike, 2001d).

Tectonic Geomorphology as Neo-Orometry

Global DEMs of Earth and Mars, as well as coverage of Earth's seafloor and ice caps, have fostered terrain modeling at broad spatial and temporal scales (van der Beek and Braun, 1998; Clayton and Shamoon, 1999; Whipple and others, 1999). In some respects, this trend returns morphometry to its origins in the quantitative generalities sought by von Humboldt (1817, 1843c) and his successors (Sonklar, 1860, 1866; Stange, 1885), but with a sophistication and emphasis on geologic process that were absent from the older work (Hurtrez and others, 1999; Yamada 1999, 2001a, b; Bendick and Bilham, 2001; Bishop and others, 2002). *Orometry*, the 19th-Century measurement of mountains (Penck, 1894b), is echoed today in *tectonic geomorphology*, which interprets landscape evolution from DEM data and assumptions of physical process that reflect the interplay of mountain building and erosion in regions of active deformation (Summerfield, 2000; Burbank and Anderson, 2001; Pazzaglia and Knuepfer, 2001).

By testing theory in controlled experiments (Ahnert, 1966), the broad-scale quantification of topography has helped transform tectonic geomorphology into one of the most active and exciting fields in the Earth sciences (Hovius, 1996; Talling, 1997; Miliaresis and Argialas, 1999a–c; Miliaresis, 2001a, b; Kühni and Pfiffner, 2001a, b; Dietrich and others, 2002). GTOPO30 and other DEM data are being used to model geodynamic and surface processes, rates, and physiographic effects (Whipple and Tucker, 1999; Rice-Snow and Russell, 2000; Montgomery and others, 2001; Montgomery and Brandon, 2002; Azor and others, 2002). In related work requiring large DEMs, classic drainage-basin morphometry has expanded beyond single catchments and fluvial systems (Strahler, 1956, 1958). Current applications include tidal creek systems (Cleveringa and Oost, 1999) and the hydrologic parsing of entire continents (Danielson, 1998; Kumar and others, 2000; Vaughn and others, 1999) and planets (Verdin and Verdin, 1999; Vörösmarty and others, 2000a; Cabrol and Grin, 2001; Smith and others, 2001).

Biogeography

The numerical modeling of terrain is now evident in landscape ecology and wildlife and conservation biology (Meisel and Turner, 1998). These fields traditionally have emphasized spatial over relief attributes of the Earth's surface (Gustafson, 1998; Li, Lu, and others, 2001; Raines, 2002). Although land-surface form affects distribution of plants and the fauna that need them for concealment, food, nesting, and other functions, few habitat models have incorporated topography (Vales, 1996). Even when included, characterization of the ground surface usually is limited to elementary DEM-derived parameters: elevation and slope gradient and aspect—which are insufficient for many field-biological applications.

Such attributes of terrain as roughness, which incorporates both slope steepness and spacing, and site position with respect to the nearest valley bottom or ridge crest are important to local fauna because they influence microclimate, cover from predation, and susceptibility to disturbance by humans. The literature on biogeography is starting to reflect a more complex numerical characterization of topography. Recent examples include topographic determinants of butterfly habitats (Fleishmann and Mac Nally, 2002), ruggedness indices that quantify topographic heterogeneity (Riley and others, 1999) and predict the distribution of musk oxen (Nellemann and Reynolds, 1997), and GIS models such as that by Gustafson and others (2001), which combines hillslope position and its correlation with soil moisture to model the response of salamanders to alternative plans for forest management.

Ice-cap Morphometry

Dating from the pioneering hypsometric curves of Greenland and the Arctic (Meinardus, 1926) and the first DEM of Antarctica (Budd and others, 1984), over two dozen bibliographic entries describe the morphometry of Earth's largest ice-covered surfaces. Topographic measurements are needed to understand the interaction of ice sheets with global climate and sea level. Much of the 10-25 cm rise in sea level over the last 100 years may reflect waning polar ice caps. *Mass balance,* which describes whether an ice sheet is growing, shrinking, or stable, may be estimated from data on the rate of ice thickening or thinning (Krabill and others, 2000). Because polar ice sheets are large, remote, and change slowly, systematic observations on elevation and thickness have been difficult to obtain.

Remote-sensing technology dramatically increased the ease of measurement (Bamber and others, 1998; Bindschadler and others, 1999; Liu and others, 1999; Thomas and others, 1999; Rémy and others, 2001). Not only have accurate DEMs been compiled for the major ice caps (Bingham and Rees, 1999; Bamber and others, 2001), but large 'ice basins' analogous to fluvial catchments have been delimited from the DEMs (Vaughn and other, 1999; Hardy and others, 2000). Other work has quantified subglacial bedrock surfaces and thus estimated ice-cap thickness and volume (Warner and Budd, 2000; Björnsson and others, 2000; Lythe and others, 2001). Not all high-latitude morphometry is of regional extent. Bintanja and others (2001), for example, have quantified fine-scale ripples in polar-cap ice.

The Mars Global DEM

Terrain modeling is indispensable to the investigation of planetary surfaces (Pike, 2001a). Extraterrestrial landforms recently studied from height measurements include impact craters, volcanoes, scarps, and other features on the Moon (Craddock and Howard, 1999), Mercury (Watters and others, 2002), Venus (Bulmer and Wilson, 1999; Herrick and Sharpton, 2000), and the satellites of Jupiter (Schenk and others, 2001; Schenk, 2002). Measurement-driven progress in the quantitative geomorphology of Mars has been spectacular. Over a dozen entries describe morphometric results from topographic data acquired by the Mars Orbiter Laser Altimeter (MOLA), a 10-Hz pulsed infrared-ranging instrument operated in orbit around the planet from 1997 to 2001 aboard the Mars Global Surveyor.

As the mission progressed, a global DEM compiled from range measurements improved in spatial resolution from 59 km to 12 km and to as little as 230 m locally, and in vertical accuracy to ±1 m (Neumann and others, 2001). The resulting global topographic map is the most accurate of any planet in the solar system (Smith and others, 1999; Zuber and others, 1998a, b, 1999, 2001). Geomorphic findings from the MOLA DEM include confirmation of the extraordinary smoothness of the planet's northern hemisphere (Aharonson and others, 1998), regional hypsometry and slope gradients (Head and others, 1999; Kreslavsky and Head, 2000; Aharonson and others, 2001), discovery of a new multi-ring impact basin (Frey and others, 1999), refinement of crater depth/diameter relations (Garvin and Frawley, 1998; Garvin and others, 2000), and delineation and interpretation of valley networks and watersheds (Smith and others, 2001; Williams and Phillips; Stepinski and others, 2002).

Landslide-hazard Assessment

The flurry of activity in mapping landslide susceptibility since its earlier mention in this series (Pike, 1999) warrants revisiting the topic. Because the morphology of landslide source-areas and deposits can be described in geometric terms, slope failure rivals flooding as the geomorphic hazard most amenable to analysis through terrain modeling. The spread of DEMs and GIS technology has shifted emphasis in morphometry from characterizing individual landslides (Collin, 1846; Simonett, 1967; Waltz, 1971) to regional assessment of slope stability (Jäger and Wieczorek, 1994; Montgomery and Dietrich, 1994; Atkinson and Massari, 1998; Dietrich and Montgomery, 1998b). Much of the recent work has involved the spatial modeling of landslide susceptibility, the relative likelihood that a hillside site will fail upon occurrence of a triggering event, such as an earthquake or heavy or persistent rainfall. Two dozen entries in this report sample a small fraction of the current literature on susceptibility mapping, which combines variously slope gradient, curvature, and aspect with geology, evidence of prior failure, and land use (Larsen and Parks, 1998; Mason and others, 1998; Pack and others, 1999; Bucknarn and others, 2001; Coe and Godt, 2001; Gritzner and others, 2001; Pike and others, 2001).

Physics and Terrain Modeling

Recent interest in theoretical aspects of terrain modeling by researchers who are physicists, mathematicians, or engineers rather than Earth scientists may reflect a maturing of the discipline (Arakawa and Krotkov, 1994; Brown and others, 1994; Dodds and Rothman,1999, 2000; Glanz, 1999). Complementing this trend, Earth scientists are beginning to publish on topography in physics journals (Clarke, 1997; Pastor-Satorras and Rothman, 1998a, b; Schörghofer and Rothman, 2001). Much of this new work was prompted by the use of topography in explicating fractal-surface phenomena (Dubuc and Dubuc, 1996; Struzik, 1996) and by recognition of self-organizing properties in the landscape (Bak and others, 1987; Halsey, 2000; Mandelbrot, 2002). More attention has been accorded to planimetric description of river networks (Tokunaga, 1994; Newman and others, 1997; Dodds and Rothman, 2001a, b, c) than to the more complicated problem of characterizing relief, or Z-domain, attributes of continuous topography (Mandelbrot, 1985; Koenderink and van Doorn, 1993, 1994, 1998).

Hack's Law

The post-World War II USGS geomorphologist John Hack combined terrain modeling with a more traditional interpretation of field observations (Hack and Goodlett, 1960; Hack, 1965). His enduring 1957 contribution, known as Hack's Law, is an empirical relation with moderate scatter, $L = 1.4 A^{0.6}$, showing that drainage-basin area *A* increases exponentially with channel length *L.* (see also, Makkaveev, 1955). The significance of the equation was discussed throughout the 1960s and 1970s, centering on debate over the exact value of the exponent—the observed range was 0.47–0.65—and whether it varied regionally and with basin size (Miller, 1958; Mueller, 1972, 1973; Moseley and Parker, 1973; Shreve, 1974). Advances in understanding steady-state scaling of landscape phenomena, resulting from DEM-based analysis of topography in the early 1990s, have revived interest in Hack's Law. Hovius (1996), for example, suggested that the equation was related to the spacing of streams draining mountain belts, while Rinaldo and Rodríguez-Iturbe (1998) considered Hack's Law and basin elongation to be an outgrowth of fractal properties. Among the most recent interpretations are those of Dodds and Rothman (2000, 2001a), Willemin (2000), Birnir and others (2001), and Sivapalan and others (2002).

Broad-scale Visualization

Vigil and others (2000) merged two existing digital images of the lower 48 United States, shaded relief and geologic time (expressed as geologic-map units), into one map, a colored three-dimensional perspective view of the landscape at 1:3,500,000 scale. The resulting digital 'tapestry' is among the more effective combinations of shaded relief with other spatial data and has potential for Earth-science education (Leech and others, 2002). The geologic map, a multi-color, non-uniform vector file, was converted to raster structure and overlaid on the shaded-relief file, a gray-scale raster at a uniform scale. Processing was not routine GIS. Differences between the source maps required various procedures to subdue or remove irregularities in the merged image. Adjusting transparency (opacity), color levels, and contrast of the geologic map to attain an aesthetic and visual balance between shaded relief and geologic-time units was an iterative, trial-and-error process. The final map, occupying a modest 700 MB, did not require high-end hardware or custom programming, but was processed on a PowerMacintosh desktop computer by Adobe Illustrator and Photoshop software. Barton and others (2002, 2003) have created a similar image of the entire North American continent at 1:8,000,000 scale from a later DEM (GTOPO30) and a combined geologic map of Canada, the U.S., and Latin America. Despite the reduced scale, this latest map successfully extends the original tapestry concept.

Other Topics

Terrain modeling has progressed in areas besides those highlighted above. Over 150 references, in 24 of the many subject categories represented in the appended listing, convey the extent of recent developments in morphometry. Most of the following citations touch on several topics:

- ontology, or definition, of terrain and landforms, especially mountains (Agarwal and others, 1996; Mark and Smith, 2002a, b);

- conversion of contour lines to grid DEMs (Gousie, 1998; Gousie and Franklin, 1998; Franklin and Gousie, 1999);

- DEM error and accuracy (Webber, 1995; Giles and Franklin, 1996; Gao, 1997; Gesch, 1998; Duh and Brown, 1999; Lemmens, 1999; Toutin, 1999; Endreny and others, 2000; Gong and others, 2000; Krupnik, 2000; Rees, 2000; López, 2002);

- compression of elevation data (Franklin, 1995; Franklin and Said, 1995; Kidner and Smith, 1997; Ottoson, 2001; Park and others, 2001; Bjørke and Nilsen, 2002);

- impact of DEM error and grid spacing on terrain-modeling applications (Hunter and Goodchild, 1997; Brasington and Richards, 1998; Gesch, 1999; Guth, 1999c; Walker and Willgoose, 1999; Holmes and others, 2000; Wise, 2000; Wolock and McCabe, 2000; Canters and others, 2002);

- the triangulated irregular network, TIN (Brown and others, 1994; Mark, 1997; Ware and Kidner, 1997; Little and Shi, 1998, 2001; Park and others, 2001; Wang and others, 2001; Zhu and others, 2001);

- computing terrain parameters from square-grid DEMs (Weih and Smith, 1996; Jones, 1998; Defourny and others, 1999; Garbrecht and others, 1999; Guth, 1999a, b, 2001; Meyer and others, 2001; Luo, 2002; Shary, 2002; Shary and others, 2002);

- computing terrain parameters from elevation contours and flow lines (Schneider, 1998a, b; Menduni and Riboni, 2000; Mizukoshi and Aniya, 2002);

- visibility analysis and viewsheds (Wang and others, 1996; De Floriani and Magillo, 1999; Franklin, 2000; Messina and Stoffer, 2000; Wang and others, 2000; Kidner and others, 2001; O'Sullivan and Turner, 2001);

- computer visualization of irregular surfaces (Banks and Wickens, 1997; Duchaineau and others, 1997; Valentine and others, 1998, 2001; Eckhardt and others, 2000; Gardner and others, 2000a, b; Malzbender and others, 2001; Mossman, 2001; Yokoyama and others, 2002);

- extracting drainage lines and watersheds from DEMs (Soille and Gratin, 1994; ESRI, 1997; Danielson, 1998; ASCE Task Committee, 1999; Band, 1999; Bertolo, 2000; Djokic and Ye, 2000; Garbrecht and Martz, 2000; Liang and Mackay, 2000; Saunders, 2000; Jones, 2002);

- hillside erosion and slope evolution (Pastor-Satorras and Rothman, 1998a, b; Katsube and Oguchi, 1999; Favis-Mortlock and others, 2000; Iwahashi and others, 2001; Roering and others, 2001);

- fluvial step-pools (Chin, 1999; Chartrand and Whiting, 2000; Duckson and Duckson 2001; Madej, 2001); Jackson and Sturm, 2002);

- self-similar and fractal properties of streams and topography (Tate, 1998a, b; Cleveringa and Oost, 1999; Fagherazzi and others, 1999a–c; Peckham and Gupta, 1999; Pelletier, 1999; Sulebak, 1999; Veneziano and Iacobellis, 1999);

- scaling of river networks and runoff processes (Dietrich and Montgomery, 1998a; Dodds and Rothman, 2000; Schmidt and others, 2000; Veneziano and Niemann, 2000a, b; Fekete and others, 2001; Tang and Day, 2000);

- aeolian dunes (Kar and others, 1998; Wadhawan, 1998; Gay, 1999; Goudie and others, 1999; Jimenez and others, 1999; Sauermann and others, 2000; Bishop, 2001; Al Harthi, 2002);

- glacial landforms (Davis, 1999; Evans, 1999; Etzelmüller and Björnsson, 2000; García-Ruiz and others, 2000; MacGregor and others, 2000; Li and others, 2001a, b);

- volcanic landforms (Rossi, 1999; Stevens and others, 1999; Wichman, 1999; Carn, 2000; Schenk and others, 2001; Stoddard and Jurdy, 2002);

- submarine surfaces and features (Nolan and others, 1999; Adams and Schlager, 2000; Clague and others, 2000; McAdoo and others, 2000; Dunn and others, 2001; Mitchell, 2001);

- karst features (Magdalene and Alexander, 1995; Sykioti and others, 1996; Ferrarese and others, 1998; Whitman and others, 1999; Denizman and Randazzo, 2000);

- relation of ground-surface form to soil properties (Vivas and Paz Gonzalez, 1998; Crawford and others, 1999; Thomas and others, 1999; Bochet and others, 2000; Florinsky and Kuryakova, 2000; Sulebak and others, 2000; Fraisse and others, 2001; Manning and others, 2001; Thompson and others, 2001; Florinsky and others, 2002);

- agricultural fields (Remond and others, 1999; Inamdar and Dillaha, 2000; Fraisse and others, 2001; Takken and others, 2001; Wilson and others, 2001; Planchon and others, 2002; Zobeck and Popham, 2002);

- predicting flood inundation (Cohen and Small, 1998; Ramsey and others, 1998; Small and Cohen, 1999; Bae and others, 2000; Bates and DeRoo, 2000; Marks and Bates, 2000; Nicholls and Small, 2002); and

- numerical classification of terrain, by types and regions (Dikau, 1996; Friedrich, 1996, 1998; Brabyn, 1997; Bivand, 1999; Gimel'farb and others, 1999; Miliaresis and Argialas, 1999a–c; Schmidt and Dikau, 1999; Verdin and Verdin, 1999; Cronin, 2000).

New Books

Book-length publications continue to mark advances in terrain modeling and its supporting technologies. Among recent volumes are those authored by Burbank and Anderson (2001) and edited by Wilson and Gallant (2000), Maune (2001), and Pazzaglia and Knuepfer (2001). Papers from three morphometry-oriented sessions of the 5th International Conference on Geomorphology in Tokyo (2001) are being edited by Evans, Dikau, Tokunaga, Ohmori, and Hirano for a 2003 book provisionally titled <u>Concepts and Modeling in Geomorphology</u>.

Publication of <u>Terrain Analysis</u>: <u>Principles and Applications</u> (Wilson and Gallant, 2000) was a major event. Celebrating the work of Ian Moore (1951-1993), the book began as the proceedings of a 1996 Australian workshop, Creation and Applications of DEMs in Land Resource

Assessment. Much updated from the papers read at the meeting, the book focuses on TAPES (Terrain Analysis Programs for the Environmental Sciences), a set of computer algorithms for quantifying terrain with special reference to hydrology and ecology (for example, Moore and others, 1988). Among the most informative of the 16 chapters are the first five—by Gallant and Wilson, Hutchinson and Gallant, Wilson and Gallant (two), and Wilson and others (all 2000)—which introduce and describe the various TAPES programs. The remaining 11 articles report a variety of applications, some of which illustrate the chronic problem of noisy DEMs.

Digital Elevation Model Technologies and Applications, edited by David Maune (2001) for the American Society for Photogrammetry and Remote Sensing, is subtitled The DEM Users Manual. Prepared by industry specialists in remote sensing rather than by academic scientists, the book is strong on the basics of acquiring and preprocessing square-grid digital elevation data, principally for the U.S. Applications in terrain modeling *per se* are limited to a few examples. After an introduction to DEM terminology and concepts, the remaining 12 chapters address vertical datums, accuracy standards, the USGS National Digital Elevation Program, photogrammetry, IfSAR, Topographic LiDAR, airborne LiDAR bathymetry, Sonar, the various enabling technologies, a sampling of DEM applications, DEM quality assessment, and likely requirements of the DEM user. While useful, much of the material could quickly become dated by advances in techniques of data acquisition and processing.

Quantified topography is essential to the analysis of landscapes shaped by diastrophism. The last two chapters of Burbank and Anderson's (2001) textbook Tectonic Geomorphology draw from published research into the DEM-based modeling of geodynamic and surface process. Illustrated are elevation and slope distributions for highland subregions, drainage spacing as a function of mountain-belt width, valley height/width ratios and other morphometric attributes, and models of landscape evolution constructed from the diffusion equation and a range of assumptions about process and temporal and spatial scale. In addition, five of the eight papers in a special 2001 volume of the American Journal of Science edited by Pazzaglia and Knuepfer, The steady-state orogen: concepts, field observations, and models—by Whipple, Pazzaglia and Brandon, Montgomery, Willett and others, and Stark and Stark—contain DEM-based analyses of erosion and tectonism that contribute to understanding the evolution of mountain topography.

Two books, by Stout and others (2000) and edited by Stout and Blunt (2000), update the three-dimensional quantification of micro- and nanosurfaces from ultra-fine-scale DEMS. This 1990s breakthrough in technique revolutionized the field of industrial-surface metrology, terrain modeling's sister discipline in manufacturing and production engineering. Shorter advances in 3-D metrology include Stout and others (1999); Thomas and others (1999); Blunt and Stout (2001); Wieczorowski (2001); and Assender and others (2002). Among works of historical importance that have come to light are Abbott and Firestone (1933), Kramrisch (1935), and Schmaltz (1936). Pike (2000b, 2001b, c) explored the convergence of Earth-science and industrial practices of surface quantification.

A New Internet Resource

The visibility of terrain modeling on the World Wide Web grew in 2000 with the inauguration of an on-line bulletin board, The Geomorphometry Mailing List. Maintained by Dr. George Miliaresis, a former student of Demetre Argialas (Argialas and Miliaresis, 1997b, 2000, 2001) and now in the Department of Surveying and Regional Planning at the National Technical University of Athens, the English-language list had about 400 subscribers by late 2002. The URL is http://groups.yahoo.com/group/geomorphometry/. Miliaresis' list "... points out information resources for ... geomorphometry and the processing of digital elevation models, related conferences, data availability, algorithms and methods, scientific news, etc. The aim is to promote geomorphometry to new scientists and to integrate advances in geomorphometry and news that are distributed in various fields (remote sensing, geography, geology, surveying, etc.)." Besides serving as a focus for the terrain-modeling community, the list supplements the aging 1999 on-line article Web Resources Compiled For Terrain Modeling, at http://www.agu.org/eos_elec/97260e.html. Other new Internet resources include Discoe (2002), on terrain rendering and animation, and Childs (2002), a repository of current hands-on experience in terrain modeling and digital mapping.

Early Morphometry: Ridges and Watercourses

About 200 of the bibliographic entries listed in this report are over fifty years old and half of them predate 1900. The concepts evolved from 19th-Century orometry and later obsolete work, distant as they are, have shaped much of today's terrain modeling. John Playfair's (1802) explication of the ideas of James Hutton, for example, recognized not only an orderly confluence of streams and their valleys, but also that the upstream angle at which a tributary meets its trunk stream generally is acute (1802, p. 113-114). The latter observation, which was known to Immanuel Kant (1803, v. 3, p. 18) may be even older. A prescient mid-19th Century contribution, although it little affected the science because it was so advanced for the time, is the 1834 paper by Julian Jackson, who devised a primitive—but unmistakable—precursor to the Gravelius-Horton-Strahler system of stream ordering.

Among the best examples of current terrain modeling rooted in early practice is the geometric representation of topographic curvature. Two dozen entries in this report, which elaborate on the historic material discussed in Rieger (1997) and López (1997, 1999) as well as on my translations of short passages from some of the following citations, chronicle the 200-year evolution of mathematical definition of ridges, watercourses, and hillside flow-lines. The 19th-Century context is revealing: While German geographers were quantifying *Küstenentwicklungen*, 'coastal development' or more accurately its degree of planform convolution (Humboldt, 1817, 1835; Nagel, 1835; Reuschle, 1869)—an intricate coastline was thought to favor the rise of 'more advanced', i.e. industrialized, societies)—or calculating the volume and mean height of mountains and continents (Humboldt, 1843c; Koristka, 1858; Sonklar, 1872; Penck, 1886, 1894b), French civil engineers and mathematicians were developing a geometric model to characterize topography's most fundamental features.

Well before Arthur Cayley's 1859 paper "On hills and dales" and Carl Gauss' (1827) paper on curved surfaces, Dupuis de Torcy and Brisson (1808, reprinted in Brisson, 1829) conceptualized topographic ridges and valleys as special cases of downslope flow-lines normal to height contours. (Cayley and Gauss cited neither of these nor their other French predecessors identified below.) This early (the first?) representation of the land surface by descriptive geometry—Barnabé Brisson, a geometer and civil engineer, was a student of Gaspard Monge, the inventor of descriptive geometry—arose from a practical problem. The French had been the first to map height contours regionally, but also were leaders in the engineering of modern canals. The lay of the land and the design compromises it forced upon civil engineers were major considerations in estimating the cost of canals, which could either follow a straight course or trace a sinuous path dictated by the terrain. A canal aligned along relief contours resulted in a longer and less direct course, but required fewer expensive earthworks and locks. Dupuis de Torcy and Brisson proposed applying descriptive geometry to the spot heights indicated on topographic maps, rather than employing the usual field surveys, to locate the divides that separate adjacent large watersheds—thus identifying candidate canal-routes and facilitating cost estimates for cut-and-fill engineering.

This pioneering work in applied surface-geometry was picked up by J.C. Saint-Venant (1852). The French mathematician and civil engineer was perhaps the first to define ridges and valleys explicitly as points of minimum slope—compared to other points at the same elevation—although he did not specify the zero-sloping flow-lines that form the drainage pattern. Shortly thereafter, his countryman P.-E. Breton de Champ (1854) offered a new theorem to redress this shortcoming and elaborated his proposed solution in subsequent papers (1861, 1867, 1870, 1877). Breton de Champs' earliest work precedes the 1858 paper "Démonstration d'une propriété général des surfaces fermées" of Ferdinand (née Frédéric) Reech, the Alsatian thermo- and hydrodynamicist who specified 'critical points' of zero slope on continuous smooth surfaces in descriptive-geometric terms. (A free English translation of Reech's paper was rendered by Warntz, 1967). The hydrodynamicist and mathematical physicist Joseph Boussinesq, a pupil of Saint-Venant, also noted that Saint-Venant's 1852 formulation was incomplete, and developed his own ideas (Boussinesq, 1871, 1872a, b) in a series of exchanges with the French scientist and mathematician M.E.C. Jordan (1872a, b, c). None of the post-1858 works referred to here cite Reech's paper.

The problem of describing slope curvature appears to have attracted little further attention until Müller (1912) cited some of the older French papers in his textbook, wherein he ascribed the earliest descriptive-geometric treatment of ridges and watercourses to Dupuis de Torcy and Brisson (1808). Evidently stimulated by Müller's retrospective, Rothe (1915) further reviewed the French literature, criticizing the formulation of Jordan, and devised yet another geometric definition of ridges and valleys that he claimed solved the problem. Decades lapsed until Rothe's definition was noticed by present-day investigators concerned with the mathematical description of complex surfaces other than topography. Recently, Rothe's work was rediscovered by López (1997, 1999) and by Rieger (1997; pers. comm., e-mail, 09/2001), who disputes the Rothe solution and prefers Jordan's (1872a) definition of ridges and watercourses. Not all contemporary work stems from the foregoing evolution. The characterization of terrain-surface curvature by Shary (2001) and Shary and others (2002), for example, is grounded in the concepts articulated by Gauss (1827) as also, evidently, has been the curvature-based terrain work of Krcho (1983, 1999).

The descriptive-geometric representation of ridge lines and watercourses is powerful and widely applied (Reeb, 1946; Kweon and Kanade, 1994; Brassard, 1998; Rana and Morley, 2002). Terrain-derived concepts have helped shape research in computer vision and image segmentation, much of which characterizes surfaces other than terrestrial landscapes (Burl and others, 1994; López, 1997; Rieger, 1997; Souille, 1999). The most recent development in machine vision, on-the-fly rendering of digital terrain (Duchaineau and others, 1997), brings the descriptive geometry of irregular surfaces full circle, to natural topography, as computer-game developers attempt to create realistic animations of landscapes for commercial video products (Lindstrom and others, 1996; Blow, 2000; Discoe, 2001). This cutting-edge application of terrain modeling to leisure-time mass entertainment probably commands more financial resources than all geomorphic and hydrologic morphometry combined. Most topographic animation employs some variant of the TIN model (Ware and Kidner, 1997). The military follows a similar approach in some of its three-dimensional simulations of battlefield scenarios (Banks and Wickens, 1997; Thompson and others, 1998), although other defense applications are based on square-grid DEMs (Franklin, 1994).

Citation Accuracy and Additions

Incorrect and incomplete citations—through failure to consult original works, careless manuscript preparation, unproofed typesetting, or, recently, computer errors—are an irritating fact of life. The author tried not to perpetuate them here—or worse, create new ones. However, mistakes invariably enter a large and detailed reference list even when, as in this case, all entries were recorded by one individual in a computer file that has been repeatedly checked and updated. Instances of the errors noted above remain and are the author's responsibility. May they be few and not unduly misleading. Mistakes and omissions found by readers should be referred to the author so that corrections can be released in an addendum or in a more formal publication of the bibliography.

Contributions to this archive from its readers would help fill gaps in the terrain-modeling record, improve annotation, and correct mistakes. Especially desired are current and historical morphometric references that are not readily available in the United States, such as non-English-language publications from central and eastern Europe and declassified military reports. Work from France and India also is underrepresented. The earlier bibliographies in this series are available for exchange for copies of contributed papers. To reduce ambiguity and ensure accuracy, please send reprints or photocopies of contributions rather than just the citations, if possible. However, new entries can be added from the following brief information:

1. photocopy of title page, *or*
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    - the name(s) of author(s); surname plus two initials (or, if one given name, then spelled out)
2. year of publication
3. *complete* citation of journal or other form of publication (book, conference proceedings, and so forth), including volume number, issue number, and inclusive pages. For meetings give location and dates; for books the name of city and publisher
4. for publications in languages other than French, German, and Spanish, an English translation of the title and source only.

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Béruber, Dominique, and Jébrak, Michel, 1999, High precision boundary fractal analysis for shape characterization: Computers and Geosciences, v. 25, no. 9, p. 1059-1071. [Euclidean distance mapping (EDM) better than box-counting & dilation methods; dividers meth. not tested]

Béthune, P. de, 1967, On the field survey of hillslopes: Revue de Géomorphologie Dynamique, v. 17, no. 4, p. 152-153. [favors 10m slope-length sampling interval but 15.25 m OK]

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Biasini, Alessandro, 1997, Estimating relief heights from shadows in vertical aerial photographs: Geologica Romana, v. 33, p. 81-87. [Antarctica (poor parallax & no topo); shadows v. clear on snow & ice]

Biasotti, Silvia, 2001, Topological techniques for shape understanding: 10 p., http://www.cg.tuwien.ac.at/studentwork/CESCG-2001/SBiasotti/paper.pdf. [Morse theory, Reeb graphs, height fnc., handles degenerate points]

Bindschadler, Robert, Fahnestock, Mark, and Sigmund, Angela, 1999, Comparison of Greenland ice sheet topography measured by TOPSAR and airborne laser altimetry: IEEE Transactions on Geoscience and Remote Sensing, v. 37, no. 5, p. 2530-2535. [AOL more precise, but TOPSAR covers broader freq. range & has biases]

Bingham, A.W., and Rees, W.G., 1999, Construction of a high-resolution DEM of and Arctic ice cap using shape-from-shading: International Journal of Remote Sensing, v. 20, no. 15 & 16, p. 3231-3242. [photoclinometry of Landsat MSS image; less accurate (14 m RMS) than InSAR]

Bintanja, Richard, Reijmer, C.H., and Hulscher, J.M.H., 2001, Detailed observations of Antarctic blue-ice surfaces: Journal of Glaciology, v. 47, no. 158, p. 387-396. [regular ripples; troughs spaced 20-24 cm & crests 1-2 cm deep; crests deeper in summer]

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Bishop, M.P., Bonk, Radoslav, Kamp, Ulrich Jr., and Shroder, J.F. Jr., 2002, Terrain analysis and data modeling for alpine glacier mapping: Polar Geography, v. 25, no. 3, P. 182-201. [successful object-oriented delineation of glaciers by morphometry; 12 elev & slope attributes fr 20-m DEM; also curvature & aspect; unsupervised clustering]

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Bivand, R.S., 2000, Using the R statistical data analysis language on GRASS 5.0 GIS database files: Computers and Geosciences, v. 26, no. 9-10, p. 1043-1052; http://www.nhh.no/geo/gib/gib1999/gib99-2/durham.pdf. [morphometric example has hypsometric integral & topo types]

Björke, J.T., and Nilsen, Stein, 2002, Efficient representation of digital terrain models—compression and spatial decorrelation techniques: Computers and Geosciences, v. 28, no. 4, p. 433-445. [wavelets slightly better than adapt. triangulation & univ. kriging, but also have other attractive properties for terrain modeling]

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Black, P.E., 1972, Hydrograph responses to geomorphic model watershed characteristics and precipitation variables: Journal of Hydrology, v. 17, p. 309-329. [planform little effects peak magnitude; defines 'basin-eccentricity' param.]

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Beiträge zur internationalen Hangforschung: Göttingen, Vandenhœck und Ruprecht, p. 29-44. [get angle of crests, valley floors & plan-curved slopes fr contour maps]

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Bobrik, A.A., 1916, On the calculation of the 'Küstenentwicklung' or shore-line convolution according to the Berghaus and Nagel methods (in Russian): Izvestiya Russkogo geograficheskogo obshchestva, v. 52, no. 1. [early Russian morphometry addressing the 19th-Century area/perimeter problem]

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Böhm, August, 1887, Einteilung der Ostalpen (in German), *in* Penck, Albrecht, ed., Geographische Abhandlungen: Vienna, E. Hölzel, v. 1, no. 3, p. 243-478. [contains morphometry; no other info]

Böhm, August, 1887, Über Gerbirgsgruppierung (in German; on classification of mountain ranges), *in* Verhandlung des 7 Deutschen Geographentages zu Karlsruhe: Berlin, Reimer, p. 152-158. [a morphologic objective that affected the morphometry of the time; no other info]

Böhm, August, 1889, Über die Genauigkeit der Bestimmung von Gerbirgsvolumen und mittleter Massenerhebung (in German; On accuracy of obtaining mountain volume & center of mass), *in* Verhandlung des 8 Deutschen Geographentages zu Berlin: Berlin, Reimer, p. 214-224. [a concern of morphometry at the time; no other info]

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Bohner, Jürgen, Köthe, Rüdiger, and Trachinow, Christian, 1997, Weiterentwicklung der automatischen Reliefanalyse auf der Basis von Digitalen Reliefmodellen (Advancing automatic relief analysis by means of digital relief models): Göttinger Geographische Abhandlungen, v. 100, p. 3-21. [post-SARA development of Köthe's morphometric pkg.]

Bonk, Radoslav, 2002, Scale-dependent Geomorphometric Analysis for Glacier Mapping at Nanga Parbat, Pakistan: Master's thesis, Department of Geography-Geology, College of Arts and Sciences, University of Nebraska at Omaha, paging unknown. [TFO (terrain form objects) fr slope, aspect, plan. & profile curv. fr 20-m DEM / details]

Bonk, Radoslav, 2002, Scale-dependent geomorphometric analysis for glacier mapping at Nanga Parbat—GRASS GIS approach, *in* Open source GIS–GRASS users conference 2002, Trento, Italy, 11-13 September, Proceedings: paging unknown; http://dionysos.gssr.sk/ig_home/exchange/ppaudits/trento2002_bonk.pdf. [TFO (terrain form objects) fr slope, aspect, plan. & profile curv. fr 20-m DEM]

Bonniard, F., 1929, Représentation graphique de la pente moyenne d'un bassin-versant (in French): Revue Phys. Géographie Dynamique, v. 2, p. 247-252. [1st publ.? method for clinographic curve, or mean slope betw. paired contours]

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Böttcher, Herr, 1900, Maß für die Dichte der Eisenbahnnetze (index of railroad network density; in German): Geographische Zeitschrift, v. 4, p. 635-639. [adapted to drainage density; x = 2A/L; P = unit-cell area & L = total length]

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Boussinesq, J.V., 1872a, Sur les lignes de faîte et de thalweg (in French; on ridge & drainage lines): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, v. 73, p. 198-201. [see Boussinesq 1871]

Boussinesq, J.V., 1872b, Sur les lignes de faîte et de thalweg (in French; on ridge & drainage lines): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, v. 75, no. 15, p. 835-837. [criticizes Jordan 1872a; see note for Boussinesq 1871]

Bovis, M.J., and Jakob, Matthias, 1999, The role of debris supply conditions in predicting debris flow activity: Earth Surface Processes and Landforms, v. 24, no. 11, p. 1039-1054. [33 basins; pred. d-f attributes fr. basin morphometry by mult. regression]

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Boyell, R.L., and Rushton, H., 1963, Hybrid techniques for real-time radar simulation, *in* Fall 1963 Joint Computer Conference, November, Las Vegas NV, Proceedings: paging unknown. [1st to map contours into arcs & intercontour areas into nodes]

Boyko, A.V., and Limontov, L.Ya., 1980, Digital terrain models and topographic data collection in large-scale mapping (in Russian): Geodesiya i Cartographiya, no. 10, p. 46-53. [no info]

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Brabyn, L.K., 1997, Classification of macro landforms using GIS: ITC Journal, no. 1, p. 26-40. [automates, modifies Hammond system; 1/250K DEM (200-m grid)]

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Brasington, James, and Richards, Keith, 1998, Interactions between model predictions, parameters and DTM scales for TOPMODEL: Computers and Geosciences, v. 24, no. 4, p. 299-314. [depends much on grid size DL (20m≤DL≤500m), esp. @ 100m-200m threshold]

Brassard, Louis, 1998, The Perception of the Image World: Burnaby, BC, Simon Fraser University, unpublished Ph.D. thesis, 409 p. http://www.visionlb.ca/Thesis/Abstract.html. [far-ranging treatise by a computer-vision engineer, focusing on crease detection in greyscale images (among 'creases' are such critical points & lines as peaks, pits, ridges, valleys, saddles, passes)]

Braun, Jean, Zwartz, Dan, and Tomkin, J.H., 1999, A new surface-processes model combining glacial and fluvial erosion: Annals of Glaciology, v. 28, p. 282-290. [exper. results fr CASCADE algorithm modified to include glaciation]

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Breton de Champ, Paul-Émile, 1867, Note sur une propriété de l'équation différentielle des lignes de plus grande pente (in French; ... prop. of diff. eqn. of flow lines): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences / Institut de France, v. 64, p. 407-410. [eqn. describes flow lines, slope lines normal to contours]

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Journal de Mathématiques Pures et Appliquées, ser. 3, v. 3, p. 99-114. [extends descriptive-geometric description of ridges & drains; poses 5 problems]

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Breusing, Dr., 1882, comments (in German) *in* Günther (1882), p. 146. [the area/perimeter problem]

Bribiesca, Ernesto, 1988, Digital elevation model data analysis using the contact surface area: CUGIP - Graphical Models and Image Processing, v. 60, no. 2, p. 166-172. [computer graphics, A.I., simulation, & modeling]

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Brimicombe, A.J., and Tsui, P.H.Y., 2000, A variable resolution, geocomputational approach to the analysis of point patterns: Hydrological Processes, v. 14, nos. 11-12, p. 2143-2155. [compared to nearest-neighbor, quadrat, & L-function approaches]

Brisson, Barnabé, 1829, Un essai sur l'art de projeter les canaux à point de partage par MM. Dupuis de Torcy et B. Brisson (on planning canals *à point de partage* (those linking different drainage basins) ... ; in French), *in* Essai sur le système général de navigation intérieure de la France (On the General System of France's Inland Navigation): Carilian-Goeury, Paris (172 p.), paging of essay unknown. [posthumous re-publ. of Dupuis-Torcy & Brisson 1808 under more explicit title, by Duleau, who edited book & contributed a long intro.; Brisson was a geometer & civil engineer (1777-1828) & student of Gaspard Monge ('father of differential geometry' & 1st to describe lines on curved 3-D surfaces); Brisson applied descriptive geometry to canal engineering & thus improve its cost estimates]

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Brodley, C.E., Lane, Terran, and Stough, T.M., 1999, Knowledge discovery and data mining: American Scientist, v. 87, no. 1, p. 54-61. [improved automated technique for finding small volcanoes on Venus]

Bronstert, Axel, 1999, Capabilities and limitations of detailed hillslope hydrological modelling: Hydrological Processes, v. 13, no. 1, p. 21-48. [uses HILLFLOW; review; soils & climate data needed for best results, etc.]

Brooks, S.M., and McDonnell, R.A., eds., 2000, Geocomputation in Hydrology and Geomorphology: Hydrological Processes, v. 14, nos. 11-12, p. 1899-2206. [7 of the papers deal with some aspect of DEM-based geomorphometry]

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Natural Resource Data Bases, Williamsburg, VA, American Society for Photogrammetry and Remote Sensing, Proceedings: p. 98-107.   [no info]

Brown, D.G., and Olson, J.M., 2001, Integrated teaching of geographic information science and physical geography through digital terrain analysis: Journal of Geography, v. 100, no. 1, p. 4-13. [DEM-based pedagogy emphasizing technology]

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Brunsden, Denys, 1973, The application of systems theory to the study of mass-movement: Geologica Applicata e Idrogeologia (Univ. Bari, IT): v. 8, no. 1, p. 185-207.   [proposes 20 geometric quantities for landslide mass & scar & enclosing hillside, after Varnes 1958 terminology]

Brunsden, Denys, ed., 1971, Slopes, Form and Process: Institute of British Geographers Special Publication no. 3, 178 p.   [11 papers fr. British Geomorphological Research Group; emph. slope profiles, soils]

Brunsden, Denys, 1984, Mudslides, chap. 9 *in* Brunsden, Denys, and Prior, D.B., eds., Slope Instability: London, Wiley, p. 363-418.   [obs. on approx. geometries of mudslide source, track, & accumulation zone]

Brunson, E.B., and Olsen, R.W., 1978, Data digital elevation model collection systems, *in* Digital Terrain Models (DTM) Symposium, May 9-11, St. Louis, MO, American Society of Photogrammetry, Proceedings: p. 72-99.   [explains origin of striped artifacts in USGS manually-profiled DEMs]

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Bucknarn, R.C., Coe, J.A., Chavarria, M.M., Godt, J.W., Tarr, A.C., Bradley, L.-A., Rafferty, S.A., Hancock, Dean, Dart, R.L., and Johnson, M.L., 2001, Landslide susceptibility mapping on the Pueblo Viejo and Río Hondo Quadrangles, *in* Landslides triggered by Hurricane Mitch in Guatemala; inventory and discussion: U.S. Geological Survey Open-file Report 01-0443, p. 26-33, http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-01-0443/.   [map from spatial freq. of elev, slope, and landslides; aspect & plan curv. not signif.]

Budd, W.F., Jenssen, D., and Smith, I.N., 1984, A three-dimensional time-dependent model of the Antarctic ice sheet: Annals of Glaciology, v. 5, p. 29-36. [1st Ant. DEM; constr. fr. digitized 1/6M map; 20m resolution]

Bull, W.B., 1964, Geomorphology of segmented alluvial fans in western Fresno County, California: U.S. Geological Survey Professional Paper 353-E, p. 89-129. [earliest? power functions relating fan area to that of drainage basin]

Bull, W.B., 1964, Alluvial fans and near-surface subsidence in western Fresno County, California: U.S. Geological Survey Professional Paper 437-A, 71 p. [relief/area, % area/altitude (little variance for 3 fan types), slope]

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Burbank, D.W., and Anderson, R.S., 2001, Tectonic Geomorphology: Malden, MA, and Abingdon, UK, Blackwell Science, 274 p. [Ch. 10 & 11 address DEM applics. & landscape-evolution modeling]

Burgkhardt, Johannes, 1888, Das Erzgebirge, eine orometrisch-anthropogeographische Studie: Stuttgart, Engelhorn, Forschungen zur deutschen Landes- und Volkskunde, v. 3, no. 3, p. 84-159. [a 79 p. thesis (Leipzig, 1890)?; relates population, etc. to terrain measures; mean elev., ridge height, area, vol.]

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Caine, Nel, 1982, Toppling failures from alpine cliffs on Ben Lomond, Tasmania: Earth Surface Processes and Landforms, v. 7, no. 2, p. 133-152. [LT/LC ratio critical; respective distances= fr top of topple (LT) & cliff (LC) to base of cliff where it meets topple]

Caine, Nel, 1983, The Mountains of Northeastern Tasmania: Rotterdam, Balkema, 200 p. [var. morphometry; valley width/distance, solution-pan W/D, cliff profiles & PSD, cliff ratio/mt. elev., blockfield size & orientattion & slope/distance]

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Campbell, R.H., and Chirico, Peter, 1999, Geographic information system (GIS) procedure for preliminary delineation of debris-flow hazard areas from a digital terrain model, Madison County, Virginia: U.S. Geological Survey, Open-file Report 99-336, 25 p. [user-specified input = depth of d-f surge rather than its initial volume]

Canters, Frank, De Genst, William, and Dufourmont, Hans, 2002, Assessing effects of input uncertainty in structural landscape classification: International Journal of Geographical Information Science, v. 16, no. 2, p. 129-149. [DEM & classif. error; 4 indices incl. field-of-view 'shape' complexity]

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Carn, S.A., 2000, The Lamongan volcanic field, East Java, Indonesia—physical volcanology, historic activity and hazards: Journal of Volcanology and Geothermal Research, v. 95, nos. 1-4, p. 81-108. [morphometry for 22 maars & 37 cinder/spatter cones]

Carniel, P., and Schiedegger, A.E., 1974, Morphometry of an Alpine scree cone (in Italian): Rivista Italia Geofisica, v. 23, p. 95-100. [measured profiles of talus slopes]

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Chang, K.-T., and Li, Zhaoxing, 2000, Modelling snow accumulation with a geographic information system: International Journal of Geographical Information Science, v. 14, no. 7, p. 693-707. [get 'snow water equivalent' fr location & topo variables fr USGS 3" DEM]

Chang, S.-C., 1992, The Simprecise mapping and evaluation system for engineering geological and landslide hazard zonation, *in* Bell, D.H., ed., Landslides, International Symposium 6th, 10-14 February, Christchurch NZ, Proceedings: Rotterdam, Balkema, v. 2, p. 905-910. [no DEM; terrain facets; variables include slope type & angle]

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Chappelow, J.E., Kieniewicz, J.M., and Sharpton, V.L., 2000, Calculation of crater depths from shadows of arbitrary width (abs.): Eos Transactions of the American Geophysical Union, v. 81, no. 48 (Supplement, P11A-19), p. F803. [by assuming simple crater shape = parabola, shadow need not be at center]

Charleux-Demargne, Julie, and Puech, Christian, 2000, Quality assessment for drainage networks and watershed boundaries extraction from a digital elevation model (DEM), *in* Li, K.-J., Makki, Kia, Pissinou, Niki, and Ravada, Siva, Eds., ACM-GIS 2000, ACM Symposium on Advances in Geographic Information Systems 8th, 10-11 Nov., Washington D.C.: Proceedings, p. 89-94. [see 2001 citation]

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Chartrand, S.M., and Whiting, P.J., 2000, Alluvial achitecture in headwater streams with special emphasis on step-pool topography: Earth Surface Processes and Landforms, v. 25, no. 6, p. 583-600. [channel-bed step L, H, W, slope, & scour-depth]

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Cheng, Qiuming, 1999, Multifractality and spatial statistics: Computers and Geosciences, v. 25, no. 9, p. 949-961. [lacunarity & semivariance for patterns on bands from 6 Landsat TM images]

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Cheng, Y.C., Lee, P.J., and Lee, T.Y., 1999, Self-similarity of the Taiwan Island landscape: Computers and Geosciences, v. 25, no. 9, p. 1043-1050. [40 m DEM; 3-D box-count fractal D > w/ elev. < 1000m; gets D for regions]

Chentsov, V.N., 1940, Morphometric attributes of relief as applied to geomorphological maps (in Russian?), *in* Grigoryev, A.A., ed., Transactions of the Institute of Geography, no. 36: Soviet Academic Press, Moscow, p. 69-71. [no info]

Chertkov, V.Y., and Ravina, I., 1999, Tortuosity of crack networks in swelling clay soils: Soil Science Society of America Journal, v. 63, no. 6, p. 1523-1530. [2-D network char. ~ tort. (connectedness) & spacing of cracks]

Childs, John, 2002, Terrain modeling and mapping using DEM, SDTS, DRG, DLG and DTED Data: Digital Terrain Modeling and Mapping; http://www.terrainmap.com/index.html#top. [excellent hands-on info for DTM, emphasizing "data sources, general technique (as opposed to specific applications), & ... demystification ..." jchilds@terrainmap.com]

Chin, Anne, 1999, The morphologic structure of step-pools in mountain streams: Geomorphology, v. 27, nos. 3-4, p. 191-204. [n=464; height & spacing ≈ particle size & discharge, resp., not slope directly]

Cholnoky, Jenö, 1902, A futóhomok mozgásának törvényei (in Hungarian): Földtani Közlöny (J. Hung. Geol. Soc., Budapest), v. 69, no. 32, p. 6-38. [topo maps & sections of barchan dunes; refs. Hedin & Cornish]

Chorley, R.J., 2000, Classics in physical geography revisited—'Mackin, J.H., 1948, Concept of the graded river: Geological Society of America Bulletin, 59, p. 463-511': Progress in Physical Geography, v. 24, no. 4, p. 563-578. [explains why Mackin's qualitative explication is essential to understanding subsequent quant. developments]

Chorowicz, Jean, Rouis, T., Rudant, J.-P., and Manoussis, S., 1998, Computer aided recognition of relief patterns on radar images using a syntax analysis: Remote Sensing of the Environment, v. 64, no. 3, p. 221-233. [x-band (3,2cm), 2m x 2m pixels, reqd. much filtering & processing]

Chou, Y.-H., Dezzani, R.J., Minnich, R.A,. and Chase, R.A., 1995, Correction of surface area using digital elevation models: Geographical Systems, v. 2, p. 131-151. [for both planimetric maps & scanned images]

Chou, Y.-H., Liu, P.-S., and Dezzani, R.J., 1999, Terrain complexity and reduction of topographic data: Journal of Geographical Systems (Springer), v. 1, p. 179-198. [meas. terrain complexity to reduce data redundancy & applies to two 30-m DEMs]

Christiansen, A.H.J., 2001, Contour smoothing by an eclectic procedure: Photogrammetric engineering and Remote Sensing, v. 67, no. 4, p. 511-517. [splices arcs of quadratic parabolas to use both TIN & its linearly interpolared contours]

Churchill, R.R., 1981, Aspect-related differences in badlands slope morphology: Annals of the Association of American Geographers, v. 71, no. 3, p. 374-388. [stats. & anal. var. for 16 form variables fr segmented slope profiles]

Cipolletti, D.L., 1988, Morphometry of Central American composite cones: New Brunswick, NJ, Rutgers University, unpublished MA thesis, 56 p. [no info]

Clague, D.A., Moore, J.G., and Reynolds, J.R., 2000, Formation of submarine flat-topped volcanic cones in Hawai'i: Bulletin of Volcanology, v. 62, no. 3, p. 214-233. [height/diam., rim/base diam., depth/rim diam.; low & broad]

Clague, D.A., Reynolds, J.R., and Davis, A.S., 2000, Near-ridge seamount chains in the northeastern Pacific Ocean: Journal of Geophysical Research, v. 105, no. B7, p. 16,541-16,561. [3 chains; edifice & summit crater & caldera morphometry; much var.]

Clark, C.D., and Meehan, R.T., 2001, Subglacial bedform geomorphology of the Irish ice sheet reveals major configuration changes during growth and decay: Journal of Quaternary Science, v. 15, no. 5, p. 483-496. [lineaments & variously processed DEM-views of ribbed (Rogen) moraine show ground texture better than satellite images]

Clark, W.A.V. and Gaile, G.L., 1973, The analysis and recognition of shapes: Geografiska Annaler, v. 55 B, p. 155-165. [shape characterization]

Clarke, G.K.C., 1991, Length, width and slope influences on glacier surging: Journal of Glaciology, v. 37, no. 126, p. 236-246. [multivar. analysis of 1754 Yukon glac.: signif. diff. geom.; L is dominant]

Clarke, G.K.C., Schmok, J.P., Ommanney, C.S.L., and Collins, S.G., 1986, Characteristics of surging glaciers: Journal of Geophysical Research, v. 91, no. B7, p. 7165-7180. [univariate analysis of 2356 Yukon glac.: longer glac. more likely to surge]

Clarke, K.C., 1997, Topography, geographical, *in* Trigg, G.L., ed., Testing Equipment—Mechanical to Topological Phase Effects, Encyclopedia of Applied Physics, v. 21: Weinheim, Wiley-VCH verlag, p. 525-531. [includes DEM's, relief depiction, morphometry, topology]

Clayton, Keith, and Shamoon, Nadhim, 1999, A new approach to the relief of Great Britain III. Derivation of the contribution of neotectonic movements and exceptional regional denudation to the present relief: Geomorphology, v. 27, nos. 3-4, p. 173-189. [isostatic uplift fr denudational unloading ≈ 50%; other = river slopes (≈f(rock strength) + misc.]

Cleveringa, Jelmer, and Oost, A.P., 1999, The fractal geometry of tidal-channel systems in the Dutch Wadden Sea: Geologie en Mijnbouw, v. 78, no. 1, p. 21-30. [fractal & Horton analysis; channel systems similar]

Coe, J.A., and Godt, J.W., 2001, Debris flows triggered by the El Niño rainstorm of February 2-3, 1998, Walpert Ridge and vicinity, Alameda County, California: U.S. Geological Survey, Miscellaneous Investigations Series Map MF-2384, 22 p., 1:24,000 scale; http://geopubs.wr.usgs.gov/map-mf/mf2384/. [slope, curvature, upslope contrib. A on 10m DEM for 551 debris-flow source areas]

Cohen, J.E., and Small, Christopher, 1998, Hypsographic demography, the global distribution of human population with altitude: Proceedings of the National Academy of Sciences of the USA, v. 95, November, p. 14,009-14,014; http://www.ldeo.columbia.edu/~small/Pop/HypsoDemo/HypsoDemoMain.html. [Global systematics; As elev. < fr 800 m to 0 m, no. people increase >exponentially while occupied land area increases ~ linearly. Occupied area between 0 & 100 m has disproportionate % of world pop.]

Coleman, Alice, 1952, Some aspects of the development of the lower Stour, Kent: Proceedings of the Geologists' Association, v. 63, part 1, p. 63-86. [modified height-range plot of Sparks 1950; v. detailed (300 'flats')]

Collett, Bernard, Taud, Hind, and Parrot, J.-F., 1999, Anomalies altimétriques de la zone afro-arabe (in French): Eclogae Geol. Helvetica, v. 92, no. 3, p. 275-284. [modeled 'Afar Plume' topo fr. 1 km DEM (DCW) with spline fnc.]

Collin, Alexandre, 1846, Recherches expérimentales sur les glissements spontanés des terrains argileux, accompagnés de considérations sur quelques principes de la mécanique terrestre (in French; ... landslides in clay strata ... soil mechanics): Paris, Carilian-Goeury & Damont, 2 vol., text 168 pages, atlas 21 plates. [early observation & experiment; measured slopes & before & after profiles of slides in embankments; proposed a curved slip face]

Collins, Michael, 1999, The edge of the world—revisiting Earth curvature concerns in terrain modeling: Digital Data Digest (USACE/TEC), v. 5, no. 4, p. 5-7. [line-of-sight calcs. >2000m need correction for curvature]

Cook, A.C., and Robinson, M.S., 1999, Digital elevation models of the lunar surface, *in* Workshop on new views of the Moon II—understanding the Moon through the integration of diverse datasets: Houston TX, Lunar and Planetary Institute, LPI Contribution no. 980, p. 8-10. [fr Clementine UV-VIS images; 1/5 of Moon at 1km/px; maria noisy, uplands best]

Cook, A.C., Watters, T.R., Robinson, M.S., Spudis, P.D., and Bussey, D.J.B., 2000, Lunar polar topography derived from Clementine stereoimages: Journal of Geophysical Research, v. 105, no. E5, p. 12,023-12,033. [new 1 km/pixel DEM + laser altimetry = global topo map of Moon]

Coops, N.C., 2000, Comparison of topographic and physiographic properties measured on the ground with those derived from digital elevation models: Northwest Science, v. 74, no. 2, p. 116-130. [old 90-m DMA DEM; also use to better relocate forest-survey plots]

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, International Symposium 6th, 10-14 February, Christchurch NZ, Proceedings: Rotterdam, Balkema, v. 2, p. 919-924. [field meas. of slide depth/length, slope, height, basin area, etc.; mult. regress. & PCA]

Cory, M.J., and McGill, A., 1999, DTM derivation at Ordnance Survey Ireland: OEEPE Workshop on Automation in Digital Photogrammetric Production, 22-24 June, Ecole Nationale des Sciences Géographiques, Marne la Vallée (France); http://phot.epfl.ch/workshop/wks99/5_2.html. [new national 1:50K map series; contours fr DEMs by digital photogramm., largely automatically]

Court, Arnold, 1972, Heterodox hydrology: Geographical Analysis, v. 4, p. 194-196. [sharp attack on Wong 1963, esp. PCA; Wong reply 197-203]

Cowen, D.J., Jensen, J.R., Hendrix, Chad, Hodgson, M.E., and Schill, S.R, 2000, A GIS-assisted rail construction econometric model that incorporates LIDAR data: Photogrammetric engineering and Remote Sensing, v. 66, no. 11, p. 1323-1328. [3 m DEM from 0.3 m data; considerable tree-canopy cover tolerated]

Cox, E.P., 1927, A method of assigning numerical and percentage values to the degree of roundness: Journal of Paleontology, v. 1, no. 3, p. 179-183. [early work: $R = 4\pi r(\text{area})/(\text{perimeter})^2$]

Cox, R.T., 1994, Analysis of drainage-basin symmetry as a rapid technique to identify areas of possible Quaternary tilt-block tectonics—an example from the Mississippi Embayment: Geological Society of America Bulletin, v. 106, no. 5, p. 571-581. [polar plots of asymmetry vectors (calc. fr transverse topo profiles) for 271 basin segments & streams]

Cracraft, Joel, 1980, Review of The Measurement of Biological Shape and Shape Change, by F.L. Bookstein, F.L., 1978: Systematic Zoology, v. 29, no. 1, p. 102-103. [quant. measurement of shape as the core os systematics; parallels in specific geomorphometry]

Craddock, R.A., and Howard, Alan D., 2000, Simulated degradation of lunar impact craters and a new method for age dating farside mare deposits: Journal of Geophysical Research, v. 105/E8, p. 20,387-20,401. [validates Pike 1974 & 1977 lunar-crater d/D & h/D data]

Crave, Alain, and Davy, Philippe, 1997, Dynamique et géométrie des réseaux hydrographiques (in French), *in* Davy, Philippe, Guillocheau, François, and Hamelin, Bruno, eds., Géomorphologie—Processus et Modélisation: Rennes, Geosciences-Rennes, p. 39-43. [brief examples of analysis of stream networks]

Crave, Alain, and Davy, Philippe, 2001, A stochastic "precipiton" model for simulating erosion/sedimentation dynamics: Computers and Geosciences, v. 27, no. 7, p. 815-827. [based on cellular automata]

Crave, Alain, Lague, D., Davy, Philippe, Kermarrec, J., Sokoutis, D., Bodet, L., and Compagnon, R., 2000, Analogue modelling of relief dynamics: Physics and Chemistry of the Earth (A), v. 25, no. 6-7, p. 549-553. [rain-erosion; parameters fr DEM of scale model @ ±100μ Z & ±500μ XY]

Crawford, J.W., Baveye, Philippe, Grindrod, Peter, and Rappoldt, Cornelius, 1999, Application of fractals to soil properties, landscape patterns, and solute transport in porous media, *in* Corwin, D.L., Loague, Keith, and Ellesworth, T.R., eds., Assessment of non-point source pollution in the vadose zone: Washington, D.C., American Geophysical Union, Geophysical Monograph 108, p. 151-164. [good tips on using fractal D, p. 152-156]

Cronin, Terrence, 1999, A boundary concavity code to support dominant point detection: Pattern Recognition Letters, v. 20, no. 6, p. 617-634. [identifies spurs & draws (small ridges & valleys) from shape of indiv. contours]

Cronin, Terrence, 2000, Classifying hills and valleys in digitized terrain: Photogrammetric Engineering and Remote Sensing, v. 66, no. 9, p. 1129-1137. [fr. containment relations of nested contours, not DEM's; can use open contours at edge of map; good review of prior work]

Cross, Martin, 1998, Landslide susceptibility mapping using the Matrix Assessment Approach—a Derbyshire case study, *in* Maund, J.G., and Eddleston, Malcolm, eds., Geohazards in Engineering Geology: London, The Geological Society, Engineering Geology Special Publication no. 15, p. 247-261. ['MAP'; deep-seated slides; bedrock geol. & slope best; relief, aspect & soils good]

Crosta, G.B., 2000, Detailed report of contractor (DAMOCLES-EVG1-1999-00027P) for first progress meeting: Dept. di Science Geologiche e Geotecnologie, Univ. Milano-Bicocca (UNIBICO), October (for period April-Sept. 2000), 10 p.; http://damocles.irpi.pg.cnr.it/docs/october-2000/mi-october-2000.pdf. [list of 27 morphometric parameters used to describe alluvial fans & catchments in Lombardy]

Crown, D.A., and Baloga, S.M., 1999, Pahoehoe toe dimensions, morphology, and branching relationships at Mauna Ulu, Kilauea Volcano, Hawai'i: Bulletin of Volcanology, v. 61, no. 5, p. 288-305. [445 toes; L, W, thickness, orientation; slope affects aspect ratio, etc.]

Crozier, M.J., Eyles, R.J., Marx, S.L., McConchie, J.A., and Owen, R.C., 1980, Distribution of landslips in the Wairarapa hill country: New Zealand Journal of Geology and Geophysics, v. 23, nos. 5 & 6, p. 575-586. [slope gradient, aspect, & profile location (high, mid, low) of 2206 landslides & parent hillsides]

Cruden, D.M., and Hu, X.-Q., 1999, The shapes of some mountain peaks in the Canadian Rockies: Earth Surface Processes and Landforms, v. 24, no. 13, p. 1229-1241. [slope (cataclinal, anaclinal, dihedral) varies by rock structure; 5 shape types]

Culling, W.E.H., 1960, Analytical theory of erosion: Journal of Geology, v. 68, no. 3, p. 336-344. [by hypothesizing that horizontal flux of eroded material ≈ slope gradient, introduced use of geomorphic 'transport laws' in the conservation of mass to explore controls on landscape form & dynamics; 1st to apply the classical diffusion equation to geomorphology]

Cunit, C., 1855, Études sur les cours d'eau à fond mobile: Grenoble, publisher & paging unknown. [his *courbe de régularisation* = concept of a limiting slope for fluvial transport]

Currado, Claudia, and Fredi, Paola, 2000, Morphometric parameters of drainage basins and morphotectonic setting of eastern Abruzzo: Memorie della Società Geolica Italiana, v. 55, p. 411-419. [relief map; stream orientations; asymmetry & transverse topo. factors]

Currey, D.R., 1964, A preliminary study of valley asymmetry in the Ogototuk Creek area, northwestern Alaska: Arctic, v. 17, no. 2, p. 84-98. [232 map & airphoto slope & azimuth obs. for stream orders 1-4 quantify N (steeper) / S asymmetry]

Curry, A.M., 1999, Paraglacial modification of slope form: Earth Surface Processes and Landforms, v. 24, no. 13, p. 1213-1228. [surveyed gully L, W, depth, vol; nongullied terrain slope & concavity]

Cybulz, Ignatz, 1862, Handbuch der Terrain-Formenlehre, mit einem Anhange über elementar-Unterricht in Terrain-Zeichen nach plastischem unterrichts-Material (in German): Vienna, W. Braumüller, 200 p. [maps & profiles emph. geometry of forms; earliest (?) illustr. (albeit not 3-D) of the 9 slope elements (predates all other refs.); uses Lehmann's (1799) quant. hachure method]

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Da Fontoura Costa, Luciano, and Cesar, R.M. Jr., 2000, Shape Analysis and Classification—Theory and Practice: Boca Raton, FL, CRC Press, 659 p. [comprehensive 2-D computer-based shape recognition & analysis, incl. measures for statistical classification; no Earth-sciences examples!]

Dade, W.B., 2000, Grain size, sediment transport and alluvial channel pattern: Geomorphology, v. 35, nos. 1-2, p. 119-126. [channel sinuosity related to slope, other params.]

Dade, W.B., 2001, Multiple scales in river basin morphology: American Journal of Science, v. 301, no. 1, p. 60-73. [quant. relations among area, relief, & steepness suggest influence of multiple spatial scales]

D'Alessandro, Leandro, Del Monte, Maurizio, Fredi, Paola, Lupia Palmieri, E., and Peppoloni, Silvia, 1999, Hypsometric analysis in the study of Italian drainage basin morphoevolution: Transactions, Japanese Geomorphological Union, v. 20, no. 3, p. 187-202. [mult. regression of H on 5 var.; Adriatic & Tyrrhenian basins differ]

Danielson, J.J., 1998, Delineation of drainage basins from 1 km African digital elevation model, *in* Human Interactions with the Environment-Perspectives from Space, Pecora 13, Sioux Falls, SD, August 20-22, 1996, Proceedings: Bethesda, MD, American Society of Photogrammetry and Remote Sensing, CD-ROM; also <http://www.1.gsi-mc.go.jp/gtopo30/papers/danielson.html>. [DEM-to-watershed transform applied to the GTOPO30 DEM]

DARPA, 2002, Geospatial Terrain Analysis and Representation (Geo*): Defense Advanced Research Projects Agency, Defense Sciences Office: http://www.darpa.mil/dso/future/geo/. [WWW info. & forum on math. representation & analysis of geospatial data for military applics.]

Dausse, M.F.B., 1857, Note sur un principe important et nouveau d'hydrologie: Compte Rendus de l'Academie sed Sciences, Paris, v. 44, p. 756-766. [his *pente de de'équilibre* = concept of a limiting slope for fluvial transport]

Dauteuil, Oliver, Blais, Sylvain, Miau, Delphine, Guille, Gérard, and Maury, R.C., 1988, Apports et limites de l'imagerie SPOT et du modèle numérique de terrain pour l'étude du volcanisme intra-océanique—exemple des îsles de Raiatea et de Tahaa (archipel de la Société, Polynésie française): Géologie de la France, no. 3, 1998, p. 37-50. [20-m DEM @ ±25 m vert. fr 1958 IGN contours; alt. freq., topo profiles]

Davis, P.T., 1999, Cirque morphometry, pp. 34-39, *in* Cirques of the Presidential range, New Hampshire, and surrounding alpine areas in the northeastern United States: Géographie physique et Quaternaire, v. 53, no. 1, p. 25-45; http://216.239.33.100/search?q=cache:FDC2dANUwmUC:www.erudit.org/erudit/gpq/v53n01/davis/davis.htm+W.+F.+Thompson+mountains+morphometry&hl=en&ie=UTF-8. [12 params. on 44 cirques fr 1/20K-1/25K maps, but little stat. analysis; good biblio on prior morphometry]

Davoli, Lina, Del Monte, Maurizio, De Rita, Donatella, and Fredi, Paola, 1999, Geomorphology and tectonics in the Roccamonfina Volcano (Campania - central Italy): Zeitschrift für Geomorphologie, Supplementband 114, p. 11-28. [relief amplitude (i.e. 'relief energy', or local relief) & drainage density on 1km squares]

Davy, Philippe, and Crave, Alain, 2000, Upscaling local-scale transport processes in large-scale relief dynamics: Physics and Chemistry of the Earth (A), v. 25, no. 6-7, p. 533-541. [broad-scale surface model based on DEM-driven erosion dynamics]

De Beauclair Seixas, Roberto, de Figueiredo, L.H., da Silva, C.A., and Carvalho, P.C.P., 2000, Uma metodologia para geração de modelos de elevação a partir de curvas de nível (in Portuguese; a method to generate elevation models from contours): Anais do GeoInfo 2000, p. 82–87. [contour-to-DEM interpolation; after Gousie 1998]

De Berg, M., Bose, P., Dobrint, K., van Kreveld, M., Overmars, M., de Groot, M., Roos, T., Snoeyink, J., and Yu, S., 1996, The complexity of rivers in triangulated terrains, *in* Canadian Conference on Computational Geometry, 8th, Proceedings: p. 325-330. [worst-case edge complexity can be quadratic (i.e., bad) in TIN-to-watershed computations]

De Blasio, F.V., 2002, Note on simulating the size distribution of glacial cirques: Earth Surface Processes and Landforms, v. 27, no. 1, p. 109-114. [narrow size-distr. reproduced fr kinematic stochastic model]

De Chant, L.J., Pease, P.P., and Tchakerian, V.P., 1999, Modelling alluvial fan morphology: Earth Surface Processes and Landforms, v. 24, no. 7, p. 641-652. [diffusive sed. transp. & unsteady radial flow; sed & flow more importand than climate & lithol.?]

De Floriani, Leila, and Puppo, Enrico, 1992, A hierarchical triangle-based model for terrain description, *in* Frank, A.K., Campari, I., & Formentini, U., eds., Theories and Methods of Spatio-Temporal Reasoning in Geographic Space: Lecture Notes in Computer Science, v. 63, no. 9, Berlin & Heidelberg, Springer Verlag. p. 236-251. [define DTM as 1 "a partition of the groundplan, & 2 a family of partially continuous functions, one specified for each part of the partition, & all fncs together form a continuous surface representing the terrain"]

De Floriani, Leila, and Magillo, Paola, 1999, Intervisibility on terrains, ch. 38, *in* Longley, P.A., Goodchild, M.F., Maguire, D.J., and Rhind, D.W., eds., Geographical Information Systems, v. 1, Principles and Technical Issues, 2nd ed.: New York, Wiley, p. 543-556. [reviews geometric modeling of viewsheds etc.]

De Floriani, Leila, Magillo, Paola, and Puppo, Enrico, 2000, VARIANT—a system for terrain modeling at variable resolution: Geoinformatica, v. 4, no. 3, p. 287-315. [storage, manipulation, analysis, & visualizing costs > w/ DEM resolution & accuracy]

De Scally, F.A., Slaymaker, Olav, and Owens, I.F., 2001, Morphometric controls and basin response in the Cascade Mountains: Geografiska Annaler, v. 83 A, no. 3, p. 117-130. [moment stats on 9 params. for 36 debris torr., 79 avalanche, 45 mixed, & 14 stream basins]

De Smet, Roger, 1951, Principles élémentaires de morphométrie (in French): Rev. Cercle des Sciences (Brussels), v. 1, no. 4, p. 13-16. [no info; see his other 1951 paper]

De Villiers, A.B., 1986, A multivariate evaluation of a group of drainage basin variables - a South African case study, *in* Gardiner, V., ed., International Geomorphology 1986, Part II: New York, John Wiley & Sons, p. 21-32. [correl. & Fact. Anal. of 59 var. (167 basins): size (max), relief, soil type, texture, eros. index, circularity]

Debenham, Frank, 1937, Exercises in Cartography: London, publ. unknown, p. 60. [measured contour length by opisometer to calc. clinographic curves]

DeBruin, S., Wielemaker, W.G., and Molenaar, M., 1999, Formalisation of soil-landscape knowledge through interactive hierarchical disaggregation: Geoderma, v. 91, nos. 1-2, p. 151-172. [spatial topologic concepts: containment, adjacency, overlap]

Deffontaines, Benoît, Chotin, Pierre, Aït Brahim, Lahsen, and Rozanov, Michel, 1992, Investigation of active faults in Morocco using morphometric methods and drainage pattern analysis: Geologische Rundschau, v. 81, no. 1, p. 199-210. [maps of summit levels, morphostruct. blocks, comp. w/ drainage net]

Deffontaines, Benoît, 1997, Quelques reflexions en morphometrie et morphostructurale (in French), *in* Davy, Philippe, Guillocheau, François, and Hamelin, Bruno, eds., Géomorphologie—Processus et Modélisation: Rennes, Geosciences-Rennes, p. 99-106. [brief examples of DEM-based analysis of streams & relief; biblio]

Defourny, P., Hecquet, G., and Philippart, T., 1999, Digital terrain modelling—accuracy assessment and hydrological simulation sensitivity, Ch. 7 *in* Lowell, Kim, and Jaton, Annick, eds., Spatial Accuracy Assessment—Land Information Uncertainty in Natural Resources: Chelsea, MI, Ann Arbor Press, p. 61-70. [pt elevs > contours, kriged elevs = best DEM, etc.; hydro models v. sensitive to quality]

DeGraff, J.V., 1978, Regional landslide evaluation—two Utah examples: Environmental Geology, v. 2, no. 4, p. 203-214. [susceptibility based on bedrock (% area), slope (% area), & aspect]

DeGraff, J.V., and Romesburg, H.C.,1980, Regional landslide-susceptibility assessment for wildland management—a matrix approach, *in* Coates, D.R., and Vitek, J.D., eds., Thresholds in Geomorphology: London, George Allen and Unwin, p. 401-414. [large-area mapping by quant. combination of rock type & ground slope & aspect]

Dehn, Martin, Gärtner, Holger, and Dikau, Richard, 1999, Principles of semantic modeling of landform structures, *in* International Conference on GeoComputation, 4th, Fredericksburg VA, Mary Washington College, 25-28 July, GeoComputation 99: http://www.geovista.psu.edu/geocomp/geocomp99/Gc99/067/gc_067.htm. [semantic representation must precede DEMs, tools, implementation]

Del Monte, Maurizio, Fredi, Paola, Palmiere, E.L., and Salvini, Francesco, 1997, Fractal characterisation of drainage network geometry: Geogr. Fis. Dinam. Quat., Suppl. III, v. 1, p. 144-145. [no info]

Del Monte, Maurizio, Fredi, Paola, Palmiere, E.L., and Salvini, Francesco, 1999, Fractal analysis to define the drainage network geometry: Bolletino della Società Geologica Italiana, v. 118, no. 1, p. 167-177. [D rises with > structural control: dendritic-pinnate-parallel-rectangular]

Delazari, L.S., Vieira, A.J.B., and Dalmolin, Quintino, 1998, Extração automática de canais de drenagem utilizando modelos digitais de altitude (in Portugese; ... network drainage from DEMs): Boletim Paranaense de Geociências, no. 46, p. 91-96. [DEM-to-watershed mapping using SKEL pkg. of Meisels et al. 1995]

Delcaillau, B., Ozouf, J.C., Masiee, D., Laville, E., and Coutard, J.P., 1998, Evolution geomorphologique d'un bassin versant cotier; l'exemple de la Touques (Basse-Normandie) (... coastal drainage basin... in French): Comptes Rendus de l'Academie des Sciences, Serie II. Sciences de la Terre et des Planetes, v. 326, no. 9, p. 609-615. [longitudinal profiles & hypsometric integrals related to basin immaturity]

Delclaux, F., and Depraetère, Christian, 2001, Methodological approach for hydrological landscape definition—application of texture measures on West-African watersheds: Actes du 8ème Congrès Européen de Stéréologie et d'Analyse d'Images, Bordeaux, France, (supl 1), p. 590-595. [texture metrics; see other 2001 citation]

Delclaux, F., and Depraetère, Christian, 2001, Quantitative approach for the determination of hydrological landscapes, *in* Falconer, R.A., and Blain, W.R., eds., River Basin Management:

Southampton UK, Boston MA, WITT Press, p. 283-292. [PCA of 9 texture parameters, 1st PC (overall homogeneity) 58%, 2nd (patch clustering) 26%, 3rd (local heterogeneity) 8%]

DeLoach, S.R., and Leonard, Jeff, 2000, Making photogrammetric history: Professional Surveyor, v, 20, no. 4, p. 6, 8, 10. [rather boosterish review of LIDAR as source for topo data]

Demanet, Donat, Pirard, Eric, Renardy, François, and Jongmans, Denis, 2001, Application and processing of geophysical images for mapping faults: Computers and Geosciences, v. 27, no. 9, p. 1031-1037. [math. morphology; gradient images= topo relief; define crest lines]

Demangeot, Jean, 1939, Le relief de la Haute Ubaye (in French): Annales de Géographie, v. 48, p. 343-358. [measured mean elevation, etc.]

Demangeot, Jean, 1943, Notes sur la Haute Vallée de l'Ubaye (in French): Revue de Géographie Alpine, v. 31, no. 4, p. 535-574. [p. 556-563 on mean height & other indices for var. litho-struct. zones]

Demirmen, Ferruh, 1975, Profile analysis by analytical techniques, a new approach: Geographical Analysis, v. 7, no. July, p. 245-266. [defines profile types & proposes params = height, relief, length, slope, curv.]

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Denizman, C., and Randazzo, A.F., 2000, Post-Miocene subtropical karst evolution, lower Suwannee River basin, Florida: Geological Society of America Bulletin, v. 112, no. 12, p. 1804-1813. [sinkhole circularity/elev.; terrace growth ratio/elev.; pitting index/distance]

Denness, B., and Grainger, P., 1976, The preparation of slope maps by the moving interval method: Area, v. 8, p. 213-218. [manual method, not obsoleted by computer where detail needed]

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Denny, C.S., 1967, Fans and pediments: American Journal of Science, v. 265, no. 2, p 81-105. [early fan morphometry; exponential trend (no eqn.) interpr. as steady-state form-process relations]

Densmore, A.L., and Hovius, Niels, 2000, Topographic fingerprints of bedrock landslides: Geology, v. 28, no. 4, p. 371-374. [prob. of >40º slope per horiz. distance from channel normalized by hillslope length, fr 30-m & 50-m DEMs]

Desmet, P.J.J., and Govers, G., 1996, A GIS procedure for automatically calculating the USLE LS factor on topographically complex landscape units: Journal of Soil and Water Conservation, v. 51, no. 5, p. 427-433. [automated unit-contributing-area concept extends Foster & Wischmeier 1974 approach]

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Devdariani, A.S., 1967, The profile of equilibrium and a regular regime (fr Voprosy geografii, Quantitative Methods in Geomorphology, no. 63, 1963, p. 33-48): Soviet Geography, Review and Translation, v. 8, no. 2, p. 168-183. [fit theor. eqn. to longitudinal profile, but had to omit real-world irregularities]

Devdariani, A.S., 1967, A plane mathematical model of the growth and erosion of an uplift (fr Izvestiya Akademii Nauk SSSR, seriya geograficheskaya, 1966, no. 3, p. 7-16): Soviet Geography, Review and Translation, v. 8, no. 2, p. 183-198. [early Russian quant. 2-D model of Davisian landscape evolution]

Develi, K., Babadagli, T., and Comlekci, C., 2001, A new computer-controlled surface-scanning device for measurement of fracture surface roughness: Computers and Geosciences, v. 27, no. 3, p. 265-277. [54 **x** 54mm area, 1.0mm XY & 0.1mm Z resolution]

Di Stefano, C., Ferro, V., Porto, P., and Tusa, G., 2000, Slope curvature influence on soil erosion and deposition processes: Water Resources Research, v. 36, no. 2, p. 607-617. [modeled hydraulic-path correction for topo factors of RUSLE; DEM test]

Diener, Carl, 1890, Generalmajor A. v. Tillo's hypsometrische Karte des europäischen Rußland (in German): Petermanns Geographische Mitteilungen, v. 36, no. 6, p. 156-158. [detailed discussion of Tillo's 1889 map & its construction; small map shows area over 170 m]

Dierking, Wolfgang, 1999, Quantitative roughness characterization of geological surfaces and implications for radar signature analysis: IEEE Transactions on Geoscience and Remote Sensing, v. 37, no. 5, p. 2397-2412. [stationary-radom-process & power-law models for SAR images; several signatures]

Dietrich, W.E., and Montgomery, D.R., 1998a, Hillslopes, channels, and landscape scale, *in* Sposito, Garrison, ed., Scale Dependence and Scale Invariance in Hydrology: Cambridge, UK, Cambridge University Press, p. 0-60. [processes & thus terrain are scale-invariant; drainage density, slope & relief important; DEM's essential]

Dietrich, W.E., and Montgomery, D.R., 1998b, SHALSTAB a digital terrain model for mapping shallow landslide potential: http://socrates.berkeley.edu/~geomorph/shalstab/ (to be published as a technical report by NCASI). [conceptual framework, theory, application, testing, prescriptive use; can download zip file w/ code and documentation for use with ArcView GIS]

Dietrich, W.E., Bellugi, Dino, Heimsath, A.M., Roering, J.J., Sklar, L.S., and Stock, J.D., 2002, Geomorphic transport laws for predicting landscape form and dynamics, *in* Iverson, R.M., and Wilcock, P., eds., Geomorphic Modeling: American Geophysical Union Monograph, in press. [wide-ranging study demonstrates via DEMs how GTLs might model real landscapes]

Dietrich, W.E., Wilson, C.J., and Reneau, S.L., 1986, Hollows, colluvium, and landslides in soil-mantled landscapes, *in* Abrahams, A.D., ed., Hillslope Processes, proceedings of the 16th annual Binghamton symposium in geomorphology: Boston, MA, Allen and Unwin, p. 361-388. [area & gradient inversely log-log related to hollow area & length; leads to basis for formational model]

Dikau, Richard, 1988, Entwurf einer geomorphologisch-analytischen Systematik von Reliefeinheiten (Design of geomorphologic-analytic systematics of relief units, in German): Heidelberger Geographische Bausteine (Heidelberg geogr Contrib.), no. 5, 45 p. [mapping strategy based on work of H. Kugler]

Dikau, Richard, 1994, Computergestützte Geomorphographie und ihre Anwendung in der Regionalisierung des Reliefs (in German): Petermanns Geographische Mitteilungen, v. 138, no. 2, p. 99-114. [quant. landform regions in New Mexico (Hammond method) & SW Germany (flow routing)]

Dikau, Richard, 1996, Geomorphologische Reliefklassifikation und -analyse (in German with english abstract): Heidelberger Geographische Arbeiten, v. 104, p. 15-23. [proposes nested landform hierarchies as multi-scale approach to geomorphometry]

Dikau, Richard, and Friedrich, K., 1999, Digitale Reliefmodellierung (in German), *in* Zepp, H., and Müller, M.J., eds., Landschaftsökologische Erfassungsstandards—Ein Methodenhandbuch: Flensburg, Forschungen zur Deutsche Landeskunde, v. 244, p. 50-68. [another overview of Dikau's systematic approach to terrain representation]

Dikau, Richard, and Saurer, Helmut, eds., 1999, GIS for Earth Surface Systems Analysis and Modelling of the Natural Environment: Stuttgart, Borntraeger, 197 p. [many DEM-based geomorph. applications]

Dikau, Richard, and Schmidt, Jochen, 1999, Georeliefklassifikation (in German), *in* Schneider-Sliwa, Rita, Schaub, Daniel, and Gerold, Gerhard, eds., Angewandte Landschaftsökologie—Grundlagen und Methoden: Berlin, Springer-Verlag, p. 217-244. [restated overview of Dikau's systematic approach to terrain representation]

Dikau, Richard, Hennrich, Kirsten, and Schmidt, Jochen, 1999, Untersuchungen zur computergestützten Regionlisierung von geomorphometrischen Reliefmerkmalen und ihre Parametrisierung in Niederschlags-Abfluß-Modellen in Einzugsgebieten unterschiedlicher Größenordnung (in German with English abstract; ... computer-assisted regionalization of geomorph. relief features & their parameterizing in rainfall-runoff models in catchment areas of different orders ..., *in* Kleeberg, H.-B., Mauser, Wolfram, Peschke, Gerd, and Streit, Ulrich, eds., Hydrologie und Regionalisierung: Deutsche Forschungsgemeinschaft, Forschungsbericht, Wiley-VCH, p. 175-189. [hydro models TOPMODEL & SAKE; 35 dimension, form, & relief params. fr GRASS & ARC/INFO; spatial taxonomy]

Dikau, Richard, Hennrich, Kirsten, Schmidt, Jochen, Flechtner, Iris, Jung, Petra, and Schroeder, Martin, 1997, Untersuchungen zur computergestützten Regionlisierung von geomorphometrischen Reliefmerkmalen und ihre Parametrisierung in Niederschlags-Abfluß-Modellen unterschiedlicher Größenordnung (in German): Abschlußbericht zum Forschungsantrag im Rahmen des DFG-Schwerpunktprogramms 'Regionalisierung in der Hydrologie', Universität Bonn, Geographisches Institut, paging unknown. [see Dikau-Hennrich-Schmidt 1999. *also* same citation, *but* Dikau, Schmidt, Schumacher (Thomas), Hennrich, & Schroeder, 1995, Univ. Heidelberg - no info]

Dirichlet, G.L., 1850, Über die reduction der positiven quadratischen formen mit drei unbestimmten ganzen zalen: J. Reine u. Angew. Math., v. 40, p. 209-227. [landmark in spatial analysis; Dirichlet studied geometric tessellation before Voronoi; thus, diagram is sometimes called *Dirichlet tessellation*]

Discoe, Ben, 2001, The Virtual Terrain Project — "tools for easily constructing any part of the real world in interactive 3D digital form; a set of open-source libraries & applications which enable the rapid construction of interactive 3D scenes from geospatial data for anywhere on the planet": <http://www.vterrain.org/>. [as of 02/20002, a comprehensive site with up-to-date info on digital terrain rendering]

Djokic, Dean, and Maidment, David, eds., 2000, Hydrologic and Hydraulic Modeling Support with Geographic Information Systems: Redlands CA, ESRI Press, 232 p. [5 DEM-related papers fr 1999 ESRI users' conference]

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Djokic, Dean, Ye, Zichuan, and Miller, A., 1997, Efficient watershed delineation using ArcView and Spatial Analyst, *in* 1997 ESRI International User Conference, San Diego, CA, July 8-11, Proceedings: Redlands, CA, Environmental Systems Research Institute, Inc., CD-ROM (can't locate this reference). [ESRI incorporates the DEM-to-watershed transformation into their software]

Dobija, A., 1979, Correlational analysis of morphometric parameters of drainage basins (in Polish): Zesz. Nauk. Univ. Jagiellon., p. 540ff. [no info]

Dodds, P.S., and Rothman, D.H., 1999, Unified view of scaling laws for river networks: Physical Reviews E, v. 59, no. 5, p. 4865-4877. [more direct descr. of XY river structure than Horton laws, based on Tokunaga scaling (T & H laws are equivalent if their drainage densities are similar)]

Dodds, P.S., and Rothman, D.H., 2000, Scaling, universality, and geomorphology, *in* Jeanloz, Raymond, Albee, A.L., and Burke, K.C., eds., Annual Review of Earth and Planetary Sciences, v. 28: Palo Alto CA, Annual Reviews, p. 571-610. [pedagogic rev.; advoc. simple models to expl. steady-state scaling laws for river networks XY & statistical structure of topo. Z; lists 15 scaling laws (Hack's law central; they find exponent = 0.5, not 0.6, for v. large basins); good biblio]

Dodds, P.S., and Rothman D.H., 2001a, Geometry of river networks—scaling, fluctuations, and deviations: Physical Review E, v. 63, 016115, 13 p. [generalize Hack's Law to a joint PDF & use to reveal that fluctuations fr it > w/ basin size]

Dodds, P.S., and Rothman D.H., 2001b, Geometry of river networks II—distributions of component size and number: Physical Review E, v. 63, 016116, 15 p. [Horton's laws extended to include fluctuations in scaling; distr. of stream segment lenghts are exponential]

Dodds, P.S., and Rothman D.H., 2001c, Geometry of River Networks III—characterization of component connectivity: Physical Review E, v. 63, 016117, 10 p. [self-similar scaling of drainage density implies Tokunaga's law, the scaling of side branch abundance along a stream, & a scaling law for stream lengths]

Dombrowski, Pierre, 1979, 150 Years After Gauss' "Disquisitiones Generales Circa Superficies Curvas" (2nd ed., 1981): Paris, Société Mathématique de France, ser. Astérisque, No. 62, 153 p. [translation of this seminal 1827 work on the geometry of curves surfaces is from Hiltebeitel & Morehead 1902 (reprinted 1965)]

Domogalla, P., Mair, G., and Schmidt, R.-G., 1974, Ein Beitrag zur quantitativen Erfassung des Reliefs für die Darstellung in geomorphologischen Karten (A contribution to the quantitative use of relief-representation in geomorphologic maps): Kartographische Nachrichten, v. 24, no. 3, p. 99-104. [no info]

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Dornbusch, W.K., Jr., 1963, Quantitative terrain mapping in the humid tropics, Puerto Rico and the Canal Zone, *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. 73-81. [applies the 4-param. USWES model: plan-profile, slope, spacing, relief]

Doucette, Peter, and Beard, Kate, 2000, Exploring the capability of some GIS surface interpolators for DEM gap fill: Photogrammetric Engineering and Remote Sensing, v. 66, no. 7, p. 881-888. [splining rather better than kriging, inv. dist. weighting, & sfce trend analysis]

Dougherty, D.A., and Moellering, Harold, 1996, Using the 2-dimensional Fourier transform for numerical terrain analysis, *in* ASPRS/ACSM Annual Convention & Exposition, 22-25 April, Bethesda, MD, ACSM Technical Papers: v. 3, Surveying & Cartography, p. 268-277. ['signatures for numerical terrain types'; no other info]

Douglas, D.H., 1983, The XYNIMAP family of programs for geographic information processing and thematic map production, *in* Wellar, B.S., ed., Auto-Carto Six, International Symposium on Automated Cartography 6th, Ottawa Canada, Proceedings: v. II, p. 2-14. [interpolates contours; run 8 rays fr each unknown point until hit known pts, then postprocess to smooth surface; basis of CONSURF contour-to-grid algorithm]

Douglas, D.H., 2000, CONSURF—the Douglas contour to grid methodology: http://www.hig.se/~dds/research/consurf/consur1.htm. [intersection of slope line thru a point & relevant contour lines intractable (both lines are curved); sol'n (based on 1983 XYNIMAP paper) uses slope lines; illustr. by animations]

Dowman, I.J., 2000, *Review of* Generation of Digital Elevation Models Through Spaceborne SAR Interferometry, by D. Small: Photogrammetric Record, v. 16, no. 95, p. 870-871. [hybrid text/Ph.D. thesis; mixed praise & limits; good on DEM analysis]

Doytsher, Yerahmiel, and Hall, J.K., 2001, Simplified algorithms for isometric and perspective projections with hidden line removal: Computers and Geosciences, v. 27, no. 1, p. 77-83. [includes brief review of older hidden-line software]

Drzewiecki, Wojciech, Mularz, Stanislaw, and Pirowski, Tomasz, 1999, Generating slope and aspect maps using different GIS packages (in Polish with English abstract): Geodezja, v. 5, no. 1, p. 101-122. [IDRISI, SURFER, ARC/INFO GRID, ERDAS, MGE GRID & TERRAIN ANALYST, PC RASTER; results not in English]

Dubois, R.N., 2001, Using a quadratic model to theoretically describe the nature of equilibrium shorerise profiles: Journal of Coastal Research, v. 17, no. 3, p. 599-610. [relief = ax^2+bx+c, (x= distance); r^2= 0.95-0.99 for 74 profiles]

DuBuat, P.L.G., 1779, Principes d'Hydraulique, vérifiés par un grand nombre d'Expériences faites par ordre du Gouvernement (2nd ed. 1786, 3-vol. 3rd ed. 1816): Paris, De l'imprimerie de Monsieur, v. 1, 453 p., v. 2, 402 p. [landmark; many quant. experiments suggest dynamic adjustment of form to process re. hydraulic geometry; influenced De La Noë 1888?]

Dubuc, B., and Dubuc, S., 1996, Error bounds on the estimation of fractal dimension: SIAM Journal of Numerical Analysis, v. 33, no. 2, p. 602-626. [re surface roughness; diff. methods, scale ranges & resolutions yield v. diff. estimates]

Duchaineau, Mark, Wolinsky, Murray, Sigeti, D.E., Miller, M.C., Aldrich, Charles, and Mineev-Weinstein, M.B., 1997, ROAMing terrain—Real-time Optimally Adapting Meshes: ACM Symposium Volume Visualization '97, IEEE, 19-24 October, Phoenix AZ, Proceedings: p. 81-88; <http://www.llnl.gov/graphics/ROAM/>. [important paper on terrain rendering using ROAM, a complex TIN-based algorithm using continuous triangle-bintree meshes to achieve dynamic on-the-fly visualization; good biblio]

Duckson, D.W. Jr., and Duckson, L.J., 2001, Channel bed steps and pool shapes along Soda Creek, Three Sisters Wilderness, Oregon: Geomorphology, v. 38, nos. 3-4, p. 267-279. [no lithologic var. by step height h/slope, (L/h)/slope, etc.]

Duh, J.-D., and Brown, D.G., 1999, Local reduction of systematic error in 7-1/2 minute DEMs by detecting anisotropy in derivative surfaces, Ch. 34 *in* Lowell, Kim, and Jaton, Annick, eds., Spatial Accuracy Assessment—Land Information Uncertainty in Natural Resources: Chelsea, MI, Ann Arbor Press, p. 281-292. [fix DEM 'stripes'; use semivariograms & fractal D; local better than global smoothing; some info loss]

Dumoulin, C., Doin, M.P., and Fleitout, L., 2001, On the interpretation of linear relationships bwteen seafloor subsidence rate and the height of the ridge: Geophysical Journal International, v. 146, no. 3, p. 691-698. [bathymetric spectrum; age/depth; ridge height/seafloor depth autocorrel.]

Dunn, Matthew and Hickey, R.J., 1998, The effect of slope algorithms on slope estimates within a GIS: Cartography (Canberra), v. 27, no. 1, p. 9-15; http://www.mappingsciences.org.au/journal.htm. [tried 4 techniques; max. downhill gradient calcs. are best]

Dunn, R.A., Scheirer, D.S., and Forsyth, D.W., 2001, A detailed comparison of repeated bathymetric surveys along a 300-km-long section of the southern East Pacific Rise: Journal of Geophysical Research, v. 106, no. B1, p. 463-471. [spectral analysis, depth differences, size/height threshold]

Dupuis-Torcy, 1st name unknown, and Brisson, Barnabé, 1808, Sur l'art de projecter les canaux de navigation (in French; on locating canals): Journal de l'Ecole Polytechnique, cah. 14, no. 7, p. 262-288; republished 1829 *as* Un essai sur l'art de projeter les canaux à point de partage (planning canals linking different drainage basins) *in* Brisson, B., Essai sur le système général de navigation intérieure de la France, paging unknown. [remarkable paper; defined watercourses geometrically as lines of steepest descent which are asymptotically approached by other lines of steepest descent; cited by Müller 1919 (also 1908/12?), & later Rieger 1997 (& thence López 1997) as possibly defining drainage lines analytically (altho no math shown) before their mention by Saint-Venant 1852. Shows how best line for any summit level may be laid out from topographic maps (then in infancy), particularly those of Cassini (?), rather than ground surveying. N.B. France pioneered the engineering of modern canals, which could follow either terrain contours (earlier in the 1760-1840 Canal Age) or a straight line (later); if contours, few expensive earthworks & locks were needed, but resulting route was longer & less direct; the descriptive work reported here led to more accurate cost estimates for cut-&-fill of canals linking different watersheds. See Brisson 1829; Dupuis-Torcy was a civil engineer; a canal he designed in 1804 in Cayenne (Fr. Guyana, where died ca. 1808) is named for him]

Durheim, C.J., 1850, Sammlung trigonometrischer oder barometrisch-bestimmter absoluter Höhen der Schweiz und ihrer näheren Umgebung. Hypsométrie de la Suisse et des Etats voisins: Bern, Haller, 706 p. [big compilation of trig. & barom. heights; hypso. of Switzerland & adjoining States]

Dutton, G.H., 1999, A hierarchical Coordinate System for Geoprocessing and Cartography: Berlin, Springer, Lecture Notes in Earth Sciences 79, 231 p. [monograph on digital map-generalization; 1997-98 Ph.D. diss., U. Zürich]

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East, T.J., 1978, Mass movement landforms in Baroon Pocket, south-east Queensland—a study of form and process: Queensland Geographical Journal, ser. 3, v. 4, July, p. 37-67. [L, W, d, d/L, vol., & slope gradient differ among 5 types (99 landslides); slope map]

Eastman, Ronald, 1992, IDRISI version 4.0, User's Guide: Worcester, MA, ClarkLabs, Clark University, 178 p. [world's most-used GIS]

Eastman, Ronald, 2002, idrisi32: Worcester, MA, ClarkLabs, Clark University; http://www.clarklabs.org/IdrisiSoftware.asp?cat=2. [major upgrade of world's most-used GIS, $600-$1500]

Ebert, Hermann, 1890, Über die Ringgebirge des Mondes (in German): Sitzungsberichte der Physikalische-Medizinische Soc., Erlangen, p. 171-191. [major pub. on 'Ebert's Rule'; measured crater diams. & depths; computed Schröter's ratio for 92 craters 13 km < D < 150 km (most rim vol. < bowl)]

Ebisemiju, F.S., 1976, Morphometric work with Nigerian topographical maps: Nigerian Geographical Journal (Ibadan), v. 19, no. 1, p. 65-77. [air photos, drainage patterns, methods, slopes]

Ebisemiju, F.S., 1986, Environmental constraints on the interdependence of drainage basin morphometric properties, *in* Gardiner, V., ed., International Geomorphology 1986, Part II: New York, John Wiley & Sons, p. 3-20. [correl. & PCA of 30 var.: texture (max), size, relief, link length ratio, shape, bifurcation ratio]

Eckhardt, F.D., Wilkinson, M.J., and Lulla, K.P., 2000, Using digitized handheld Space Shuttle photography for terrain visualization: International Journal of Remote Sensing, v. 21, no. 1, p. 1-5. [70mm color pic (Namib inselberg) draped on GTOPO30 DEM; res = 50 m ± 5.3m]

Eckis, Rollin, 1928, Alluvial fans of the Cucamonga District, southern Arizona: Journal of Geology, v. 36, no. 3, p. 224-247. [early quant. obs., concavity & slope diminish w/ increasing fan size]

Economic Planning Agency, 1969, Topographic relief of Japan (in Japanese): map scale 1/1,160,000. [relief energy defined on 1' x 1.5' lat.-lon. grid]

Edwards, R., and Durkin, J., 1969, Computer prediction of service areas for V.H.F. mobile radio networks: Proceedings of the Institution of Electrical Engineers (IEE, UK), v. 116, no. 9, p. 1493-1500. [early advocates of regular-grid DEMs fr topo maps for intervisibility & radio-path loss algorithms]

Edwards, S.F., and Wilkinson, D.R., 1982, The surface statistics of a granular aggregate: Proceedings of the Royal Society of London, v. A381, no. 1780, p. 17-31. [acc. to Pastor-Satorras & Rothman 1998a, adds uncorrel. noise to diffusion eqn. to get true self-affine surface]

Ehrenburg, Karl, 1891, Studien zur Messung der horizontalen Gliederung von Erdräumen (in German; ... measuring spatial arrangement of areas on the Earth): Würzburg, Verhandlungen der Physikalisch-Medicinischen Gesellschaft zu Würzburg, v. 25, no. 2, 44 p. [reviews the problem fr Ritter 1828 to C. Rohrbach 1890; considers geometry of var. shape-meas. in great detail]

Elkie, P.R., Rempel, R.S., and Carr, A.P., 1999, Patch Analyst User's Manual—a tool for quantifying landscape structure: Thunder Bay, Ontario, Ontario Ministry of Natural Resources, Northwest Science and Technology, Technical Manual TM–002, 16 p. +Appendix; http://sevilleta.unm.edu/technology/reference/esri/patch_habitat/nwtm002.pdf. [program can implement FRAGSTATS in grid format; http://flash.lakeheadu.ca/~rrempel/patch/]

Ellenberg, Ludwig, 1969, Versuch der numerischen Erfassung des Reliefcharakters (in German; Attempt at numerical expression of relief character): Geographica Helvetica (Bern), v. 24, no. 1, p. 13-15. [slope, relief energy, stream density, contour density]

Elliott, F.E., 1953, A technique of presenting slope and relative relief on one map: Surveying and Mapping, v. 13, no. 4, p. 473-477. [G-H Smith relief on 2.5' squares & 3 Raisz-Henry slope bins]

Elorza, M.G., and Martínez, V.H. Sesé, 2001, Multiple talus flatirons, variations of scarp retreat rates and the evolution of slopes in Almazán Basin (semi-arid central Spain): Geomorphology, v. 38, nos. 1-2, p. 19-29. [math. fcns. for 12 concave slope profiles at 5 diff. evol. stages]

Embleton, Clifford, and Hamann, C., 1988, A comparison of cirque forms between the Austrian Alps and the Highlands of Britain: Zeitschrift für Geomorphologie, Supplementband 70, p. 75-93. [n= 302 fr 1/25K maps; L/h, wall/floor & closure angles, azimuth; results not clear-cut]

Emery, K.O., 1958, Shallow submerged marine terraces of southern California: Bulletin of the Geological Society of America, v. 69, no. 1, p. 39-60. [chart (Plate I) stores/displays depths for discontinuous terrace profiles]

Endreny, T.A., and Wood, E.F., 2001, Representing elevation uncertainty in runoff modelling and flowpath mapping: Hydrological Processes, v. 15, no. 12, p. 2223-2236. [var. sensitivity of D8, MF, DEMON-e & -b, D-Infinity, & DEMON-bl to DEM error]

Endreny, T.A., Wood, E.F., and Lettenmaier, D.P., 2000, Satellite-derived digital elevation model accuracy—hydrogeomorphological analysis requirements: Hydrological Processes, v. 14, no. 1, p. 1-20. [overall SPOT/USGS' differences <3%, but USGS 7.5' better at scales <100m]

Endreny, T.A., Wood, E.F., and Hsu, Ann, 2000, Correction of errors in SPOT-derived DEM's using GTOPO30 data: IEEE Transactions on Geoscience and Remote Sensing, v. 38, no. 3, p. 1234-1241. [coarser GTOPO30 useful in error-analysis of finer satellite-derived DEM]

Engelen, G.B., and Huybrechts, Willy, 1981, A comparison of manual and automated slope maps: Catena, v. 8, no. 2, p. 239-249. [made a DEM; manual (moving interval) method better where detail required]

Environmental Systems Research Institute (ESRI), Inc., 1997, Watershed Delineator Application — User's Manual: Redlands, CA, ESRI, paging unknown. [the DEM-to-watershed transformation is incorporated into ESRI software]

Etzelmüller, Bernd, and Björnsson, Helgi, 2000, Map analysis techniques for glaciological applications: International Journal of Geographical Information Science, v. 14, no. 6, p. 567-581. [calc. basal shear stress, vel., drains, & water vol. fr DEM of Iceland ice cap]

Etzelmüller, Bernd, Ødegård, R., Berthling, I., and Sollid, J.L., 2001, Terrain parameters and remote sensing data in periglacial research: Permafrost and Periglacial Processes, v. 12, no. 1, p. 79-92. [if spatial relations scale-independent within certain range, info can be scaled up & down]

Evans, I.S., 1999, Was the cirque glaciation of Wales time-transgressive or not?: Annals of Glaciology, v. 28, p. 33-39. [no; regression eqns. show floor altitude increases to N or NE, as expected fr present conditions]

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Eyles, R.J., 1971, Mass movement in Tangoio Conservation Reserve, northern Hawkes Bay: Earth Science Journal (NZ), v. 5, no. 2, p. 79-91. [52 valley-side profiles & 29 landslide scars; profile relief, L, slope gradient (3-m segments), concavo-convexity]

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Fardin, N., Stephansson, and Jing, Lanru, 2001, The scale dependence of rock joint surface roughness: International Journal of Rock Mechanics and Mining Sciences, v. 38, no. 5, p. 659-669. [fractal ***D*** & amplit. ***A*** vary over 3-D laser-scanned windows 100mm-1000mm]

Farr, Tom, and Kobrick, Mike, 2000, Shuttle radar topography mission produces a wealth of data: Eos, Transactions, American Geophysical Union, v. 81, no. 48, p. 583 & 585. [how the SRTM data were gathered]

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Fatale, L.A., 1992, DCAC examines impact of DTED Levels 1- and 2 resolution on terrain visualization: U.S. Army Corps of Engineers, Topographic Engineering Center, Digital Data Digest, v. 2, no. 4, p. 1-4. [field photo/DEM images compared; Level 1 useless in gentle terrain, OK in many rough areas]

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Favis-Mortlock, D.T., Boardman, John, Parsons, A.J., and Lascelles, Bruce, 2000, Emergence and erosion—a model for rill initiation and development: Hydrological Processes, v. 14, nos. 11-12, p. 2173-2205. [improved self-organizing DEM model, *Rillgrow 2*, applied to 4 soil surfaces]

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Feldner, Hermann, 1902, Die Flussdichte und ihre Bedingtheit im Elbsandsteingebirge (drainage density & its limitations ... ; in German): Mitteilungen des Vereins für Erdkunde zu Leipzig, p. 1-55. [early dd work post-Neumann 1900; describes 3 methods; x = A/n; A = basin area & n = number of segments]

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Fielder, Gilbert, 1962, The measurement of lunar altitudes by photography—I. Estimating the true lengths of shadows: Planetary and Space Science, v. 9, p. 917-928. [discusses all known error sources]

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Fils, A.W., 1859, Die Centralgruppe des Thüringer Waldes oder die Gegend zwischen Ilmenau and Oberhof (in German): Petermanns Geographische Mitteilungen, v. 5, no. 6, p. 256-271, & plate 10 (1/60,000 scale). [typical of Major Fils many careful surveys; detailed list describs each height; 100' contours over hachures]

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for Applications of Remote Sensing, LARS Technical Report 062879, paging unknown. ['best method' (K.H. Jones, 1998) for computing slope fr DEM]

Flint, J.J., 1974, Stream gradient as a function of order, magnitude and discharge: Water Resources Research, v. 10, no. 5, p. 969-973. [link slope = 1/link magnitude]

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Florinsky, I.V., Eilers, R.G., Manning, G., and Fuller, L.G., 2002, Prediction of soil properties by digital terrain modelling: Environmental Modelling and Software, v. 17, p. 295–311. [DEM slope, aspect, curv., basin A, topo. & stream power indices & correl. of soil and topo.]

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Flückiger, Otto, 1919, Morphologische Untersuchungen am Napf (in German), article 6, *in* Geologische Struktur der Schweizeralpen, Sammelband von 7 Schriften from 1889-1919: Zürich, 34 p. [calculated relative relief for (topographic) basins?]

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Fok, Yu-Si, 1971, Law of stream relief in Horton's stream morphological system: Water Resources Research, v. 7, no. 1, p. 201-203. [mean relief = semilog fnc. of stream order; eval. for 4 rivers]

Foster, G.R., and Wischmeier, W.H., 1974, Evaluating irregular slopes for soil loss prediction: Transactions of the American Society of Agricultural Engineers, v. 17, no. 2, p. 305-309. [attempts to adapt LS factor in USLE to irreg. topo; segments w/ diff. slope]

Foufoula-Georgiou, Efi, and Sapozhnikov, Victor, 2001, Scale invariances in the morphology and evolution of braided rivers: Mathematical Geology, v. 33, no. 3, p. 273-300. [philosophy, methods, & examples from 4 rivers]

Fourneau, R., 1960, Contribution à l'étude des versants dans le sud de la Moyenne Belgique et dans le Nord de l'entre Sambre et Meuse. Influence de la nature du substratum (in French): Annales Société Géologique de Belgique, v. 84, p. 123-151. [10 areas; correl. valley depth & mean slope; 5m slope-sampling interval]

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Fraisse, C.W., Sudduth, K.A., and Kitchen, N.R., 2001, Delineation of site-specific management zones by unsupervised classification of topographic attributes and soil electrical conductivity: Transactions, American Society of Agricultural Engineers, v. 44, no. 1, p. 155-166. [TAPES-G pkg.; elev., slope (D8), plan & profile curv., CTI; mapped PCs]

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Francou, Bernard, and Manté, Claude, 1990, Analysis of the segmentation in the profile of alpine talus slopes: Permafrost and Periglacial Processes, v. 1, no. 1, p. 53-90. [35 slopes at 0.5 deg. precision, 10-m segments; new bi-phase model]

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Franklin, W.R., 2000, Applications of analytical cartography: Cartography and Geographic Information Systems, v. 27, no. 3, p. 225-237; http://www.ecse.rpi.edu/Homepages/wrf/research/gisapps/gisapps.pdf. [examples include terrain visibility, map overlay, mobility, interpol. & approx. of curves & terrain, etc.]

Franklin, W.R., 2000, Approximating visibility: International Conference on Geographic Information Science 1st, GIScience 2000, Savannah, GA, 28-31 Oct., Abstracts, p. 126; http://www.ecse.rpi.edu/Homepages/wrf/research/approxvis/index.html. [rel. importance of var. factors in visibility computation; vis. index sensitive to radius of interest & is Poisson distr.; test on 24 USGS DEMs]

Franklin, W.R., 2002, GeoSpatial terrain—algorithms and representations: unpublished paper; http://www.ecse.rpi.edu/Homepages/wrf/research/geospatial.pdf; & http://www.ecse.rpi.edu/Homepages/wrf/research/geospatial-talk-402/index.html. [explores var. grid DEM processing & attempts at a unified philosophy]

Franklin, W.R., 2002, Siting observers on terrain: Spatial Data Handling 2002 Symposium, Ottawa, July 9, http://www.ecse.rpi.edu/Homepages/wrf/research/sitetalk/index.html; text at http://www.ecse.rpi.edu/Homepages/wrf/research/site.pdf. [new algorithm synth. fast viewshed & LOS visibility index for mult. observers on level-1 DEM]

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(ICA) 11th, Ottawa, Canada, Proceedings: v. 2, p. 1011-1020; http://www.ecse.rpi.edu/Homepages/wrf/research/ica99/. [several programs; grid-TIN, visibility, compression, contour-grid interp.]

Franklin, W.R., and Said, Amir, 1996, Lossy compression of elevation data, *in* Kraak, M.-J., Molenaar, Martien and Fendel, E.M., eds., International Symposium on Spatial Data Handling, 7th, Delft, Neth., Proceedings: Edinburgh, Taylor & Francis, v. 2, p. 519-531; http://www.ecse.rpi.edu/Homepages/wrf/research/p/compress.pdf. [image compr. algorithm may be better & simpler for DEMs than TIN; test on 24 USGS DEMs]

Franklin, W.R., Ray, C.K., and Mehta, Shashank, 1994, Geometric algorithms for siting of air defense missile batteries: Columbus OH, Battelle Inc., Contract no. DAAL03-86-D-0001, Technical Report, 129 p.; http://www.ecse.rpi.edu/Homepages/wrf/research/p/tec_report.pdf. [eval. 3 viewshed algorithms & 4 visibility indices; algorithm for viewsheds better than simplistic sightline analysis]

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Friesz, R.R., 1963, Desert terrain effects on vehicle performance, *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. 60-72. [params. for test courses: cell size, relief, slope, elongation, parallelism, profile area, peakedness]

Frisch, W., Székely, Kuhlemann, J., and Dunkl, I., 2000, Geomorphological evolution of the Eastern Alp in response to Miocene tectonics: Zeitschrift für Geomorphologie, v. 44, no. 1, p. 103-138. [elev. mean & freq., slope map & freq., R map (10km window) for diff. domains fr DEM]

Fu, Bojie, and Chen, Liding, 2000, Agricultural landscape spatial pattern analysis in the semi-arid hill area of the Loess Plateau, China: Journal of Arid Environments, v. 44, no. 3, p. 291-303. [patch size, fractal D, elong., diversity, dominance, relative richness, & fragm. fr. land-use map]

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Gallant, J.C., and Wilson, J.P., 2000, Primary topographic attributes, *in* Wilson, J.P., and Gallant, J.C., eds., Terrain Analysis—Principles and Applications: New York, Wiley, p. 51-85. [var. elev, aspect, slope, area, length, curv. fr DEMS & TAPES software]

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Gandolfi, C., and Bischetti, G.B., 1995, Il valore dell'area di supporto nella generazione automatica della rete di drenaggio dai DEM: Idrotechnica, v. 3, p. 157-174. [criticizes DEM-to-watershed algorithms that use constant threshold area]

Gannett, Henry, collator & arranger, 1877, Lists of Elevations Principally in That Portion of the United States West of the Mississippi River, 4th ed.: U.S. Department of the Interior, Miscellaneous Publications no. 1, Washington, D.C., 167 p. + map. [topo. results of the western surveys; large folding hypsometric map of U.S.]

Gao, Jay, 1997, Resolution and accuracy of terrain representation by grid DEMs at a micro-scale: International Journal of Geographic Information Science, v. 11, no. 2, p. 199-212. [spatial res. affects DEM's kriged from contours < threshold]

Garbrecht, Jurgen, Goodrich, D., and Martz, L.W., 1999, Methods to quantify distributed subcatchment properties from digital elevation models, *in* American Geophysical Union Annual Hydrology Days, 19th, 16-20 August, Fort Collins, CO: Proceedings, p. 149-160. [est. basin length & slope directly fr DEM, not maps]

Garbrecht, Jurgen, and Martz, L.W., 2000, Digital elevation model issues in water resources modeling, paper 1 *in* Djokic, Dean, and Maidment, David, eds., Hydrologic and Hydraulic Modeling Support with Geographic Information Systems: Redlands CA, ESRI Press, p. 1-28, also http://www.esri.com/library/userconf/proc99/proceed/papers/pap866/p866.htm. [reviews DEM-to-watershed transformation state-of-art, esp. data quality & sub-catchment properties]

Garbrecht, Jurgen, Ogden, F.L., DeBarry, P.A., and Maidment, D.R., 2001, GIS and distributed watershed models. I—data coverages and sources: Journal of Hydrologic Engineering, v. 6, no. 6, p. 506-514. [1st of 2-part GIS tutorial for practicing engineers]

Garcia-Castellanos, Daniel, 2002, Interplay between lithospheric flexure and river transport in foreland basins: Basin Research, v. 14, no. 2, p. 89-104. [3-D quant. model of various processes along drainage net]

García-Ruiz, J.M., Gómez-Villar, Amelia, Ortigosa, Luis, and Martí-Bono, Carlos, 2000, Morphometry of glacial cirques in the central Spanish Pyrenees: Geografiska Annaler, v. 82 A, no. 4, p. 433-442. [elev., aspect, lithology A, W, L, L/W. etc.; elev. explains most of variance]

Garcia-Zuniga, F., and Parrot, J.-F., 1998, Tomomorphometric analysis of a recent volcanic cone—Misti (Peru): C.R. Acad. Sci. (Paris), v. 327, p. 457-462. [pattern-recognition extraction of a surface feature from DEM]

Gardner, J.V., Mayer, L.A., and Hughes Clark, J.E., 2000, Morphology and processes in Lake Tahoe: Geological Society of America Bulletin, v. 112, no. 5, p. 736-746. [L, W, H, & dist. fr headwall of 113 avalanche blocks on & off debris apron]

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Gardner, J.V., Dartnell, Peter, Mayer, L.A., Hughes Clarke, J.E., and Stone, J.C., 2000b, Bathymetry and selected perspective views of central San Francisco Bay, California: U.S. Geological Survey, Water-resources Investigations Report 00-4146, map scale 1/15,000, <http://walrus.wr.usgs.gov/outreach/seamap/>. [superb visualization detail at 4 m/pixel]

Gardner, W.H., 1948, Determination of the critical stream for various slopes: Soil Science, v. 66, no. 3, p. 205-215. [experiments confirm soil erosion = fcn (irrigating stream size & surface slope)]

Gardoll, S.J., Groves, D.I., Knox-Robinson, C.M., Yun, G.Y., and Elliott, N., 2000, Developing the tools for geological shape analysis, with regional- to local-scale examples from the Kalgoorlie Terrane of Western Australia: Australian Journal of Earth Sciences, v. 47, no. 5, p. 943-953. [general *XY* shape analysis, also applic. to landforms]

Garnett, Alice, 1935, Insolation, topography, and settlement in the Alps: Geographical Review, v. 25, no. 4, p. 601-617. ['intensity maps' fr terrain, Sun, & Sun/valley-axis angles fr 4 mm grid on topo map]

Garrison, W.L., and Marble, D.F., eds., Quantitative Geography, Part I—Economic and Cultural Topics, and Part II—Physical and Cartographic Topics: Evanston, Ill., Northwestern University Studies in Geography, nos. 13 and 14, 288 p. and 324 p. [unconscionably delayed publication of 17-paper proceedings of seminal ONR/NAS/NRC-sponsored May 1960 symposium that should have had far greater impact than it did. (this meeting closely followed the AAAS-sponsored Dec. 1959 symposium on Quantitative Terrain Studies, which failed to result in a proceedings)]

Garvin, J.B., and Frawley, J.J., 1998, Geometric properties of Martian impact craters—preliminary results from the Mars Orbiter Laser Altimeter: Geophysical Research Letters, v. 25, no. 24, p. 4405-4408. [n=98; simple/complex: $d=0.14D^{0.90}$ & $d=0.25D^{0.49}$; also X-sect.]

Garvin, J.B., Sakimoto, S.E., Frawley, J.J., and Schnetzler, C., 2000, Geometric properties of Martian impact craters—an assessment from the Mars Orbiter Laser Altimeter (MOLA) digital elevation model (abs.): Lunar and Planetary Science XXXI, Abstract 1619, CD-ROM. [$7\text{km} \leq D \leq 100\text{km}$; complex, $d=0.33D^{0.53\pm0.03}$]

Gasparini, N.M., Tucker, G.E., and Bras, R.L., 1999, Downstream fining through selective particle sorting in an equilibrium drainage network: Geology, v. 27, no. 12, p. 1079-1082. [simulations with GOLEM model of landscape evolution (Tucker & Slingerland, 1997)]

Gatto, Francesco, and Marocco, Ruggero, 1994, Morfometria e geometria idraulica dei canali della Laguna di Grado (Friuli-Venezia Giulia) (in Italian; Morphometry and hydraulic geometry of channels of the Grado Lagoon, Friuli-Venezia Giulia): Geografia Fisica e Dinamica Quaternaria (Torini), v. 16, no. 2, p. 107-119. [channel geometry, drainage pattern, lagoons, morphometry]

Gay, S.P., 1962, Origen, distribucíon y movimiento de las arenas eólicas en el área de Yauca a Palpa: Boletin de la Sociedad Geologica del Perú, v. 37, p. 37-58. [good early quant. obs. on airphotos. buried in obscure journal]

Gay, S.P., Jr., 1999, Observations regarding the movement of barchan sand dunes in the Nazca to Tanaca area of southern Peru: Geomorphology, v. 27, nos. 3-4, p. 279-293. [transl. 1962 paper; quantified Bagnold's size/speed deduction. etc.; 3 h meas.: h/w not 1/10]

Gee, M.D., 1992, Classification of hazard zonation methods and a test of predictive capability, *in* Bell, D.H., ed., Landslides, International Symposium 6th, 10-14 February, Christchurch NZ, Proceedings: Rotterdam, Balkema, v. 2, p. 947-952. [18 types of zonation; quant. index for 9 diff. schemes finds similar susceptibilities in test]

Geikie, Archibald, 1868, On denudation now in progress: Geological Magazine, v. 5, p. 249-254. [used Humboldt's mean continental heights; argued landforms were recent; see Vacher 1999]

Geldern-Crispendorf, Günther von, 1932, Reliefenergie, *in* Geisler, W., ed., Wirtschafts- und Verkehrsgeogr. Atlas von Schlesien: Breslau, 1/750K map. [map of relief 'energy'; 8 relative-relief intervals]

Gens, Rüdiger, 1999, SAR interferomtry—software, data format, and data quality: Photogrammetric Engineering and Remote Sensing, v. 65, no. 12, p. 1375-1378. [helpful state-of-art summary, esp, on DEM quality]

Gerber, Paul, 1927, Morphologische Untersuchungen am Alpenrand zwischen Aare und Saane (Freiburger-Stufenlandschaft) (in German): Univ. Freiberg (Switz.), Dissertation, 66 p., Mitteilungen der Naturforschenden Gesellschaft des Kantons Freiberg, Série Géologie et Géographie, v. 10, no. 2, p. 125-197. [char. valley shape using incremental surface curves (elev. vs area), or Flächenzuwachskurve, for 41 areas betw 570m & 2160m]

Gerrard, A.J. and Gardner, R.A.M., 2000, The role of landsliding in shaping the landscape of the Middle Hills, Nepal: Zeitschrift für Geomorphologie, Supplementband 122, p. 47-62. [maps of slope (6 classes), & slope-morphology (the 9 classes); failure V, W, slope]

Gesch, D.B., 1998, Accuracy assessment of a global elevation model using Shuttle Laser Altimeter data, *in* IEEE International Geoscience and Remore Sensing symposium (IGARSS), Seattle WA, July 6-10, Proceedings: Piscataway NJ, Institute of Electrical and Electronic Engineers, CD-ROM. [365,000 SLA points; overall vertical RSME = (only) 70 m for GTOPO30]

Gesch, D.B., 1999, The effects of DEM generalization methods on derived hydrologic features, Ch. 31 *in* Lowell, Kim, and Jaton, Annick, eds., Spatial Accuracy Assessment—Land Information Uncertainty in Natural Resources: Chelsea, MI, Ann Arbor Press, p. 255-262. [breakline emphasis helps preserve topo structure when generalizing]

Gesch, D.B., and Larson, K.S., 1998, Techniques for development of global 1-kilometer digital elevation models, *in* Pecora Thirteen, Human Interactions with the Environment-Perspectives from Space, 13th, Sioux Falls, SD, August 20-22, 1996, Proceedings: Bethesda, MD, American Society of Photogrammetry and Remote Sensing, CD-ROM; also

<http://edcwww.cr.usgs.gov/landdaac/gtopo30/papers/geschd3.html>. [details on GTOPO30 source datasets and processing]

Gesch, D.B., Oimoen, M.J., Greenlee, S.K., Nelson, Charles, Steuck, Michael, and Tyler, Dean, 2002, The National Elevation Dataset: Photogrammetric Engineering and Remote Sensing, v. 68, no. 1, p. 5-11; http://gisdata.usgs.net/ned/default.htm. [NED, seamless & continually upgraded 30m DEM fr all 1:24K USGS quads eliminates tiling & preprocessing]

Gesch, D.B., Verdin, K.L., and Greenlee, S.K., 1999, New land surface digital elevation model covers the Earth: Eos, Transactions, American Geophysical Union, v. 80. no. 6, p. 69-70; http://edcdaac.usgs.gov/gtopo30/README.html#h9. [GTOPO30, @ ~1km grid spacing, replaces ETOPO5]

Gessler, P.E., 1996, Statistical soil-landscape modelling for environmental management: Centre for Resource and Environmental Studies, Australian National University, unpublished Ph.D. thesis, 228 p. [no info]

Ghosh, Parthasarathi, 2000, Estimation of channel sinuosity from paleocurrent data—A method using fractal geometry: Journal of Sedimentary Research, v. 70, no. 3, p. 449-455. [meander-pattern sinuosity related to dispersion of segment orientations]

Giese, B., Oberst, J., Roatsch, T., Neukum, G., Head, J.W., and Pappalardo, R.T., 1998, The local topography of Uruk Sulcus and Galileo Regio obtained from stereo images: Icarus, v. 135, no. 1, p. 303-316. [Ganymede fr. Galileo mission: DEMs @ 0.5 &1.0 km; topo profiles; primitive simple-crater d/D]

Giglierano, J.D., 1999, Shaded relief map of Iowa: Iowa Geology, no. 24, p. 14-15. [color; quite good portrayal of putatively 'flat' state]

Gilbert, G.K., 1877, Land Sculpture, p. 99-150 *in* Report on the Geology of the Henry Mountains: U.S. Geographical and Geological Survey of the Rocky Mountain Region, Washington, D.C., U.S. Govt. Printing Office, 160 p.; p. 93-144 *in* 2nd ed., 1880 (170 p.). [seminal; establishes what to measure; Gilbert's 'law of divides' (116-17,110-11)—'... profile of a river (is) a curve concave upward with the greatest curvature at the upper end' Fig. 54 is logarithmic-like profile; 'declivity bears an inverse relation to quantity of water' (113-14,108)—i.e., not sediment size as asserted by Sternberg 1875]

Gilbert, G.K., 1914, The transportation of debris by running water: U.S. Geological Survey, Professional Paper 86, 263 p. [measured slope of sediment in flume & related it to other data]

Giles, P.T., 2001, Remote sensing and cast shadows in mountain terrain: Photogrammetric engineering and Remote Sensing, v. 67, no. 7, p. 833-839. [algorithm to delineate shadows automatically is 86% effective]

Giles, P.T., and Franklin, S.E., 1996, Comparison of derivative topographic surfaces of a DEM generated from stereoscopic SPOT images with field measurements: Photogrammetric Engineering and Remote Sensing, v. 60, no. 10, p. 1165-1171. [raw DEM not good; test used slope, incidence (from aspect), & profile curvature]

Gilg, A.W., 1973, A note on slope measurement techniques: Area (London), v. 5, no. 2, p. 114-117. [inclined-angle tacheometry, using theodolite & staff; need common test areas]

Gimel'farb, G.L., Schmidt, Jochen, and Braunmandl, A., 1999, Gibbs fields with multiple pairwise interactions as a tool for modelling grid-based data, *in* Hergarten, St., and Neugebauer, H.J., eds., Process Modelling and Landform Evolution, Lecture Notes in Earth Sciences 78: Berlin, Springer-Verlag, p. 47-73. [complex DEM processing reproduces Hammond types in 2 areas; inconclusive]

Giusti, E.V., and Schneider, W.J., 1965, The distribution of branches in river networks U.S. Geological Survey Professional Paper 422-G, p. G1-G10. [found unexpected variability in analysis of bifurcation ratios]

Glagolev, A.A., 1933, On geometrical methods of quantitative mineralogic analysis of rocks (in Russian): Transactions of the Institute of Econ. Mineralogy, Moscow, v. 59, p. 1-47 (not p. 147?). [simplifies Rosiwal 1898 approach to area sampling by replacing lines with grid points]

Glanz, James, 1999, Physicists invading geologists' turf: New York Times SCIENCE, November 23, p. D1, D4. [layman's summary of math./theor. approach to geomorph. by Rinaldo, Rodriguez-Iturbe etc.]

Glazyrin, G.Ye., 1978, Identification of surging glaciers by morphometric characteristics: Mater. Glyatsiologicheskikh Issled. Khronika, v. 33, p. 136-138. [univariate analysis only]

Glezer, V.L., 1988, Development of methods and techniques for derivation and application of digital terrain model to generation of special agricultural maps (abs, Ph.D. thesis; in Russian): Moscow Institute of Engineers for Land Management, Moscow, 24 p. [no info]

Glock, W.S., 1931, The development of drainage systems—a synoptic view: The Geographical Review, v. 21, no. 4, p. 475-482. [uniform drainage density implies constant mean river-spacing, which suggests channel network has reached max. extension into an area]

Gloriod, A., and Tricart, Jean, 1952, Étude statistique de vallées asymétriques sur la feuille Saint-Pol au 1/50 000 (in French): Revue de Géomorphologie Dynamique, v. 3, no. 2, p. 88-98. [constructed rose diagram showing valley asymmetry]

Goldie, H.S., and Cox, N.J., 2000, Comparative morphometry of limestone pavements in Switzerland, Britain and Ireland: Zeitschrift für Geomorphologie, Supplementband 122, p. 85-112. [freq. of clint (block) L & W & L/W, grike (pit) W & d & d/W]

Goller, A., Gelautz, M., and Leberl, F., 1999, Parallel image processing applied to radar shape-from-shading: Photogrammetric Engineering and Remote Sensing, v. 65, no. 3, p. 259-267. [handles large images; 14 processors speed up s-f-s by 13X]

Gong, Jianya, Li, Zhilin, Zhu, Qing, Sui, Haigang, and Zhou, Yi, 2000, Effects of various factors on the accuracy of DEMs—an intensive experimental investigation: Photogrammetric Engineering and Remote Sensing, v. 66, no. 9, p. 1113-1117. [accuracy = f(sampling interval, specific features, relief, data model, capture method)]

Gönnenwein, M.-L., 1931, Untersuchungen über die Flußdichte schwäbischer Landschaften: Erdgesch. u. landeskdl. Abh. aus Schwaben u. Franken, Öhringen, Schwend, v. 13, 66 p. [drainage density, calc. fr. topo maps, shown by density of dot patterns]

Goodchild, M.F., Steyaert, L.T., Parks, B.O., Johnston, Carol, Maidment, D.R., Crane, Michael, and Glendinning, Sandi, eds., 1996, GIS and Environmental Modeling—Progress and Research Issues: New York, Wiley, 504p. [many brief applications papers, some incorporating morphometry]

Goovaerts, P., 1999, Using elevation to aid the geostatistical mapping of rainfall activity: Catena, v. 34, nos. 3-4, p. 227-242. [DEM helps materially; good results from cokriging]

Goovaerts, P., 2000, Geostatistical approaches for incorporating elevation into the spatial interpolation of rainfall: Journal of Hydrology. v. 228, nos. 1-2, p. 113-129. [DEM, multivariate geostatistics, Kriging]

Gordon, D.L., 1960, A morphometric analysis of selected Iowa drainage basins: Iowa City, IA, University of Iowa, unpublished MA thesis, 193 p. [drainage basins, patterns, var. morphometry]

Goudie, A.S., 1978, Colonel Julian Jackson and his contribution to geography: Geographical Journal, v. 144, p. 264-270. [more on the J.R. Jackson 1834 stream ordering, etc.]

Goudie, Andrew, Stokes, Stephen, Cook, James, Samieh, S., and El-Rashidi, O.A., 1999, Yardang landforms from Kharga Oasis, south-western Egypt: Zeitschrift für Geomorphologie, Supplementband 116, p. 97-112. [L, W, H, azimuth, V stats & histogr.; H/w, L/H, V/H, V/W eqn.]

Gousie, M.B., 1998, Contours to digital elevation models—grid-based surface reconstruction methods: Ph.D. thesis, Electrical, Computer, and Systems Engineering Dept., Rensselaer Polytechnic Institute, Troy, NY, paging unknown. [improves representation over 'thin-plate' model?]

Gousie, M.B., and Franklin, W.R., 1998, Converting elevation contours to a grid, *in* Spatial Data Handling '98 Conference, 11-15 July, Vancouver, BC, Proceedings: p. 647-656; http://www.ecse.rpi.edu/Homepages/wrf/research/p/contour.pdf. [new methods; 1st repeatedly interpolates lines betw. orig. contours; 2nd starts w any interp. or approx. surface, gets gradient lines, & does spline interp.]

Gout, Christian, and Komatitsch, Dimitri, 2000, Surface fitting of rapidly varying data using rank coding—application to geophysical surfaces: Mathematical Geology, v. 32, no. 7, p. 873-888. [scale transformation w/ pre- & post-processing = superior to splines; volcano DEM]

Grabau, W.E., 1958, Derivation of a numerical description of the generalized plan and profile: office memorandum *to* Chief, Geology Branch, U.S. Army Engineer Waterways Experiment Station, Vicksburg, unpublished manuscript, 14 July, 7 p. [the char. PPL (here GPPL) was defined in Dec. 1957 'Resumé' doc.; this memo revised as appendix to Van Lopik & Kolb 1959]

Graff, L.H., 1997, State-of-the-art terrain analysis capabilities for today's army: ACSM/ASPRS Annual Convention and Exposition, Seattle, WA, 7-10 April, Technical Papers, v. 3, p. 716-725. [no info]

Graham, L.C., 1980, Stereo radar for mapping and interpretation, *in* Radar geology—an assessment, report of the Radar Geology Workshop, Snowmass, CO, 16-20 July 1979, Jet Propulsion Laboratory Publication 80-61, p. 336-350. [introduction to radargrammetry for terrain heights]

Graham, S.E., and Pike, R.J., 1998a, Elevation maps of the San Francisco Bay region, California—a digital database: U.S. Geological Survey Open-File Report 98-625, 17 p., scale 1:125,000; http://wrgis.wr.usgs.gov/open-file/of98-625/index.html. [data & printer plots fr new DEM of ca. 24 M elevs spaced at 30 m & mosaicked from 1:24K quad. DEMs]

Graham, S.E., and Pike, R.J., 1998b, Slope maps of the San Francisco Bay Region, CA: U.S. Geol. Survey, Open-file Report 98-766, 17 p.; http://wrgis.wr.usgs.gov/open-file/of98-766/. [data & printer plots computed fr ca. 24 M elevs spaced at 30 m]

Graham, S.T., Famiglietti, J.S., and Maidment, D.R., 1999, Five-minute, 1/2°, and 1° data sets of continental watersheds and river networks for use in regional and global hydrologic and climate modeling studies: Water Resources Research, v. 35, no. 2, p. 583-587. [ult. DEM-to-watershed; fr. TerrainBase 5' Global DTM & CIA World Data Bank II]

Graniero, P.A., and Price, J.S., 1999, The importance of topographic factors on the distribution of bog and heath in a Newfoundland blanket bog complex: Catena, v. 36, no. 3, p. 233-254. [DEM params.—esp. substrate area, slope & plan curv—explain 22% variance]

Granö, J.G., 1929, Relative height classification, *in* Reine Geographie: Acta Geographica, v. 2, no. 2 (202 p.), p. 70-72. [0-5m flat, 5-10m hillocks, 10-20m etc.; 1st Finnish quant. work?]

Grayman, W.M., Males, R.M., Gates, W.E., and Hadder, A.W., 1975, Land-based modeling system for water quality management studies: Journal of the Hydraulics Division, ASCE, v. 101, p. 567-580. [TIN system, ADAPT, developed independently of Peucker's concept]

Grayson, R.B., and Blöschl, Günter, 2000, Spatial modelling of catchment dynamics, Chap. 3, *in* Grayson, R.B., and Blöschl, Günter, eds., Spatial Patterns in Catchment Hydrology: Cambridge (UK) Univ. Press, p. 51-81. [pp. 56-70 good on model structure, discretisation, element size & linkage]

Grayson, R.B., Moore, I.D., and McMahon, T.A., 1992, Physically based hydrologic modelling, I. A terrain-based model for investigative purposes: Water Resources Research, v. 28, no. 10, p. 2639-2659. [parses terrain by steepest upslope lines search; yields better ridges than channels]

Green, J.F.N., Bull, A.J., Gossling, F., Hayward, H.A., Turner, E.A., and Wooldridge, 1934, The river Mole—its physiography and superficial deposits: Proceedings of the Geologists' Association, v. 45, part 1, p. 35-69. [measured long. profiles of trunk & tributaries; fit eqn. to upstream data & terraces to est. former profile]

Griffin, M., Beasley, D., Fletcher, J., and Foster, G., 1988, Estimating soil loss on topographically nonuniform field and farm units: Journal of Soil and Water Conservation, July/August, p. 326-331. [making slope-length calc. biggest problem in applying USLE]

Gritzner, M.L., Marcus, W.A, Aspinall, Richard, and Custer, S.G., 2001, Assessing landslide potential using GIS, soil wetness modeling and topographic attributes, Payette River, Idaho: Geomorphology, v. 37, nos. 1-2, p. 149-165. [Bayes model; small slides; slope & elev. best predictors; aspect, plan & profile curv., upslope A, flowpath L, moisture index not significant]

Grout, B.W., Jr., 1994, A history of digital elevation model production at RMMC: Rocky Mountain Benchmark (USGS Rocky Mountain Mapping Center, Denver Federal Center, CO), v. 3, no. 3, paging unknown. [incl. description of manual profiling technique that generated striped artifacts in early (Level 1) USGS DEMs]

Günther, S., 1875, Die Küstenentwicklung, ein mathematischer Beitrag zur vergleichenden Erdkunde (coastal convolution, a mathematical contribution to comparative geography, in German): Grunerts Archiv der Math. und Physik, v. 57, p. 277-284. [the area/perimeter relation; quoted by Rohrbach, 1890]

Günther, S., 1882, Die wahre Definition des Begriffes 'Küstenentwicklung' (the true definition of the term 'coastal convolution', in German): Verh. d. II, Deutschen Geograpentages zu Halle, p. 141-146, plus comments on the lecture by Keber, Zöppritz, & Breusing on p. 146. [the area/perimeter relation; see review by Rohrbach, 1890]

Gupta, V.K., and Mesa, O.J., 1988, Runoff generation and hydrologic response via channel network geomorphology—recent progress and open problems: Journal of Hydrology, v. 102, no. 1-4, p. 3-28. [must add terrain height to planimetric network models]

Guráu, Lidia, 2000, The Correlation of Sanded Wood Surface Roughness to Wood Structure and Finish Quality: Dept. of Forest Products Technology, Buckinghamshire Chilterns University College, UK, Ph.D. thesis; for research proposal, see http://www.bcuc.ac.uk/technology/FPRC/TRAINING/LidiaGurau.htm. ["to improve understanding of how process variables influence surface roughness of sanded solid wood"; excellent intro & biblio on morphometry of finished wood]

Gustafson, E.J., 1998, Quantifying landscape spatial pattern—what is the state of the art?: Ecosystems, v. 1, p. 143-156. [indices, spatial heterogeneity, patchiness, scale, geostatistics, autocovariation, spatial models]

Gustafson, E.J., Murphy, N.L., and Crow, T.R., 2001, Using a GIS model to assess terrestrial salamander response to alternative forest management plans: Journal of Environmental Management, v. 63, p 281-292. [position on slope between ridge crest and valley bottom fr 30 m DEM]

Guth, P.L., 1999a, Quantifying topographic fabric—eigenvector analysis using digital elevation models, *in* Merisko, R.J., ed., Advances in Computer-Assisted Recognition: Applied Imagery Pattern Recognition (AIPR) Workshop, 27th, Washington DC, 14-16 October 1998, Proceedings: SPIE (Intl. Soc. Optical Engrg.) v. 3584, p. 233-243. [adapts Woodcock's 1977 eigenvector method; ln(S1/S2) or 'flatness' & ln(S2/S3) or 'organization' to DEMs]

Guth, P.L., 1999b, Quantifying and visualizing terrain fabric from digital elevation models, *in* Diaz, J., Tynes, R., Caldwell, D., and Ehlen, J., eds., International Conference on GeoComputation, 4th, Fredericksburg VA, Mary Washington College, 25-28 July, GeoComputation 99: CD-ROM ISBN 0-9533477-1-0; http://www.geovista.psu.edu/geocomp/geocomp99/Gc99/096/gc_096.htm. [DEM-based classific. on elev., 'ruggedness', & topo fabric (fr. eigen-analysis)]

Guth, P.L., 1999c, Contour line 'ghosts' in USGS Level 2 DEMs: Photogrammetric Engineering and Remote Sensing, v. 65, no. 3, p. 289-296. [3 ways to show bias in contour-to-grid comp.; Lev. 2 still better than Lev. 1]

Guth, P.L., 2001, Quantifying terrain fabric in digital elevation models, *in* Ehlen, Judy, and Harmon, R.S., eds., The environmental legacy of military operations: Geological Society of America Reviews in Engineering Geology, v. 14, p. 13-25. [continues work on terrain fabrics in two 1999 papers to automate the SSO diagram of Chapman 1951 & 52]

Guzzetti, Fausto, Malamud, B.D., Turcotte, D.L., and Reichenbach, Paola, 2000, Power-law correlations of Italian landslide areas (abs.): Eos Transactions of the American Geophysical Union, v. 81, no. 48 (Supplement, NG62C-19), p. F566. [area/freq. scaling statistics independent of trigger mech.]

Gvin, V.Ya., 1963, Application of morphometry in structural studies of the Upper and Middle Volga and Kama Regions (in Russian), *in* Problems of Geography, no. 63, Quantitative Methods in Geomorphology: Geographizdat, Moscow, p. 64-80. [no info]

Gwinner, Klaus, Hauber, Ernst, Jaumann, Ralf, and Neukum, Gerhard, 2000, High-resolution, digital photogrammetric mapping—a tool for Earth science: Eos, Transactions, American Geophysical Union, v. 81, no. 44, p. 513, 516, & 520. [state-of-art technique to get DEMs & ortho-images]

H

Haas, C., Liu, Q., and Martin, T., 1999, Retrieval of Antarctic sea-ice pressure ridge frequencies from ERS SAR imagery by means of *in situ* laser profiling and usage of a neural network: International Journal of Remote Sensing, v. 20, no. 15 & 16, p. 3111-3123. [large area; 30% error; Fisher-K stats + half width & tail-to-mean ratio]

Hack, J.T., 1965, Geomorphology of the Shenandoah Valley Virginia and West Virginia and origin of the residual ore deposits: U.S. Geological Survey Professional Paper 484, 84 p. [map of relief / sq. mi.; hypso. curves; quant. slope-profile analysis; long. stream profiles; azimuthal asymmetry of slope]

Hack, J.T., and Goodlett, J.C., 1960, Geomorphology and forest ecology of a mountain region in the Central Appalachians: U.S. Geological Survey Professional Paper 347, 66 p. [early postwar USGS quant.; var. relations, long. profile, slope asymmetry, etc.; recaps G.K. Gilbert concepts; 1st? assoc. of concave-straight-convex slopes w/ var. in vegetation & moisture content]

Hadley, R.F., 1961, Some effects of microclimate on slope morphology and drainage basin development, *in* Geological Survey research 1961, short papers in the geologic and hydrologic sciences, articles 1-146: U.S. Geological Survey Professional Paper 424-B, art. 16, p. 32-34. [Slope/aspect rose diagram (n= 50); rekated to drainage density & veg.]

Hagen, J.O., Etzelmüller, Bernd, and Nuttall, A.-M., 2000, Runoff and drainage pattern derived from digital elevation models, Finsterwalderbreen, Svalbard: Annals of Glaciology, v. 31, p. 147-152. [surging glacier; difference 1970 & 1990 DEMs; flowpaths fr DEM]

Hagood, M.J., 1943, Statistical methods for delineation of regions applied to data on agriculture and population: Social Forces, , v. 21, p. 287-297. [early use of principal-components analysis in regional classification]

Hann, R.A., 1957, A method of quantitative topographic analysis of wood surfaces: Forest Products Journal, v. 7, no. 12, p. 448-452. [need for roughness QC for machined wood surfaces & conformance to prescribed standards, as on metals]

Hall, D.B., 1998, Using digital elevation models to calculate a time-averaged landscape denudation rate: Physical Geography, v. 19, no. 4, p. 341-349. [subtr. pre- fr. post-erosion surface to get basin vol. (age interval known]

Halsey, T.C., 2000, Diffusion-limited aggregation—a model for pattern formation: Physics Today, v. 53, no. 11, p. 36-41. [topologic scaling of rivers = one example; shows importance of geomorph. processes in the physical sciences]

Hamilton, G.S., and Dowdeswell, J.A., 1996, Controls on glacier surging in Svalbard: Journal of Glaciology, v. 42, no. 140, p. 157-168. [univariate analysis of 615 glac.: signif. diff. geom.; L is dominant]

Hancock, G.R., and Willgoose, G.R., 2001, The production of digital elevation models for experimental model landscapes: Earth Surface Processes and Landforms, v. 26, no. 5, p. 475-490. [slope/A plots fr 6.0mm±2.0mm-grid DEM of mini-terrain]

Hancock, G.R., and Willgoose, G.R., 2001, Use of a landscape simulator in the validation of the SIBERIA catchment evolution model—declining equilibrium landforms: Water Resources Research, v. 37, no. 7, p. 1981-1992. [model OK, but DEM error critical to derived statistics]

Hankley, Chip, 1999, Quaternary landforms in Wisconsin—how hillshading can be used to accentuate topographic features, *in* Soller, D.R., ed., Digital Mapping Techniques '99, Workshop Proceedings: U.S. Geological Survey Open-File Report 99-386, p. 205-209, http://pubs.usgs.gov/of/of99-386/hankley.html. [adapts Haugerud/Greenberg color Arc/Info AML algorithm to WI 30m DEM]

Hansen, M.F., 1984, Strategies for classification of landslides, chap. 1 *in* Brunsden, Denys, and Prior, D.B., eds., Slope Instability: London, Wiley, p. 1-25. [reviews morphometric approaches of Skempton 1953, Brunsden 1973, Blong 1973, Crozier 1973]

Hanssen, R.F., 2001, Radar Interferometry—data interpretation and error analysis: Dordrecht/Boston/London, Kluwer, 308 p. [useful historical background & review]

Hardy, R.J., Bamber, J.L., and Orford, S., 2000, The delineation of drainage basins on the Greenland ice sheet for mass-balance analyses using a combined modelling and geographical information system approach: Hydrological Processes, v. 14, nos. 11-12, p. 1931-1941. [10 'ice basins' by Arc/Info GIS from 2.5-km DEM (ERS-1 data) & 'balance flux']

Harrison, A.R., and Dunn, R., 1993, Problems of sampling the landscape, *in* Haines-Young, R.H., Green, D.R., and Cousins, S.H., eds., Landscape Ecology and Geographic Information Systems: London, Taylor and Francis, p. 101-109.   [spatial sampling must accommodate 2D & 3D variables]

Harrison, K., and Thackeray, A.D., 1940, On the direction of certain valleys: Geological Magazine, v. 77, no. 2, p. 82-88.   [azimuth-freq. diagrams (25-ft river segments; $150<n<1110$) related to joints, not glaciation]

Hartshorne, James, 1997, Assessing the influence of digital terrain model characteristics on tropics slope stability analysis, *in* Kemp, Z.A., ed., Innovations in GIS 4: London, Taylor and Francis, p. 198-214.   [DEM resolution & quality significantly affect hazard-zonation models]

Haruyama, M., and Kitamura, R., 1984, An evaluation method by the quantification theory for the risk degree of landslides caused by rainfall in active volcanic area, *in* International Symposium on Landslides, 4th, 16-21 September, Toronto, Proceedings: Rexdale, Ont., Canadian Geotechnical Society, v. 2, p. 435-440.   [Eigenvector analysis of elev., contour & stream density, rel. relief, slope form, geology, & land use]

Harvey, C.A., and Eash, D.A., 1996, Description, instructions, and verification for BASINSOFT, a computer program to quantify drainage-basin characteristics: U.S. Geological Survey, Water-Resources Investigations Report 95-4287, 25 p.   [27 morphometric parameters fr Arc/Info AML macro compare well w/ manually derived measures]

Hasbargen, L.E., and Paola, Chris, 2000, Landscape instability in an experimental drainage basin: Geology, v. 28, no. 12, p. 1067-1070.   [lab analog model 1 m across; ridge density @ 1 cm^2 resolution]

Hassan, M.M., 1988, Filtering digital profile observations: Photogrammetric Engineering and Remote Sensing, v. 54, no. 10, p. 1391-1394.   [low-pass filtering of white noise to reduce error in level-1 USGS DEMs]

Haxby, W.F., 1985, Gravity field of world's ocean (color map): Boulder, CO, National Geophysical Data Center, NOAA, Reporty MGG-3.   [Seasat radar altimetry; important precursor to Smith & Sandwell 1997 map & DEM]

Hayakawa, N., et al. (no author info), 1995, Study on extracting drainage network from square-grid DEM (in Japanese): Annual Journal of Hydraulic Engineering, JSCE, v. 39, p. 127-132.   [pits in DEM & flat areas pose big problems]

Hayashi, M., and van der Kamp, G., 2000, Simple equations to represent the volume-area-depth relations of shallow wetlands in small topographic depressions: Journal of Hydrology, v. 237, nos. 1-2, p. 74-85.   [also profiles & % hypsometric curves]

Hayes, Brian, 2000, Dividing the continent: American Scientist, v. 88, no. 6, p. 481-481.   [computer scientist discovers terrain—watersheds, divides, Cayley & Maxwell, DEMs, & image analysis]

Haynes, V.M., 1968, The influence of glacial erosion and rock structure on corries in Scotland: Geografiska Annaler, v. 50A, no. 4, p. 221-234.   [curves y= of form $k(1-x)e^{-x}$ better fit longitudinal profiles of cirques than circles]

Head, J.W. III, Hiesinger, Harald, Ivanov, Mikhail, Kreslavsky, M.A., Pratt, Stephen, and Thomson, B.J., 1999, Possible ancient oceans on Mars—evidence from Mars Orbiter Laser Altimeter data: Science, v. 286, no. 5447, p. 2134-2137.   [elev & slope maps, relief shading, flooding-vol. est.]

Head, J.W. III, Kreslavsky, Mikhail, Hiesinger, Harald, Ivanov, Mikhail, Pratt, Stephen, and Seibert, Nicole, 1998, Oceans in the past history of Mars—test for their presence using Mars Orbiter Laser

Altimeter (MOLA) data: Geophysical Research Letters, v. 25, no. 24, p. 4401-4404. [Elev. & slope; poss. shoreline @ lowland plains; slope/scale-length relation]

Head, J.W. III, Yuter, S.E., and Solomon, S.C., 1981, Topography of Venus and Earth—a test for the presence of plate tectonics: American Scientist, v. 69, no. 6, p. 614-623. [topo profiles & whole-planet % hypso. curves for both; Venus elevs (Pioneer altimetry) not bimodal]

Heikkinen, Olavi, 1975, A trend-surface analysis of relief in Sipoo, southern Finland: Fennia, v. 141, p. 1-54. [valley, mean, & summit heights fr. 1/20K & 50K topo maps]

Hemenway, D.D., 1995, An efficient analytical approach for generating digital elevation models: Alberta, University of Edmonton, M.Sc. thesis, paging unknown. [DEM fr digitized random elevs by a multiquadric technique, QSURF]

Henkel, L., 1900, Berechnung der Dichte des Eisenbahnnetzes (calc. density of railroad networks; in German): Geographische Zeitschrift, v. 6, p. 220-221. [adapted to drainage density; x = 2A/L; P = unit-cell area & L = total length]

Hennrich, Kirsten, Schmidt, Jochen, and Dikau, Richard, 1999, Regionalization of geomorphometric parameters in hydrological modelling using GIS, *in* Diekkrüger, Bernd, Kirkby, M.J., and Schröder, Ulrich, eds., Regionalization in Hydrology: Conference, Technical University of Braunschweig, Germany, 10-14 March, 1997, Proceedings: IAHS Publication no. 254, p. 181-191. [morph params correl. w/ hydro indices is scale dependent & better at fine scales]

Herrick, R.R., and Lyons, S.N., 1998, Inversion of crater morphometric data to gain insight on the cratering process: Meteoritics and Planetary Science, v. 33, p. 131-143. [complex crater d, d/D threshold, onset D for peaks, terraces, & peak rings.; acoustic fluidization model (Melosh 1982) & nonproportional growth (Schultz 1988) in published forms do not reproduce morph. data. Most data consistent w/ linear dependence on crustal strength / hydrostatic pressure, c/rg.]

Herrick, R.R., and Sharpton, V.L., 2000, Implications from stereo-derived topography of Venusian impact craters: Journal of Geophysical Research, v. 105/E8, p. 20,245-20,262. [Venusian craters 50% deeper than complex craters on Earth; other quant. results]

Herzfeld, U.C., and Overbeck, Christoph, 1999, Analysis and simulation of scale-dependent fractal surfaces with application to seafloor morphology: Computers and Geosciences, v. 25, no. 9, p. 979-1007. [methods capture roughness & anisotropy, & extrapolate to other scales & locations]

Herzfeld, U.C., Kim, I.I., Ocutt, J.A., and Fox, C.G., 1993, Fractal geometry and seafloor topography—theoretical versus data analysis for the Juan de Fuca Ridge and the East Pacific Rise: Annales Geophysicae, v. 11, no. 6, p. 532-541. [seafloor fractal, but neither self-similar, self-affine, nor multifractal in usual sense]

Hevelius, Johannes, 1647, Selenographia, sive Lunae descriptio, atque accurata tam macularum ejus, quam motuum diversorum, aliarumque omnium vicissitudinum phasiumque telescopi ope deprehensarum, delineatio. Addita est nova ratio lentes expoliendi, telescopia construendi, et horum adminiculo varias observationes exquisite instituendi (in Latin): Danzig, Hünefeld for the author, 563 p. + 111 engravings. [1st good atlas of Moon, not surpassed for 100 yrs.; a few relative-height determinations from shadow lengths were later compared by Schröter (1791) with his]

Hickey, R.J., 2000, Slope angle and slope length solutions for GIS: Cartography (Canberra), v. 29, no. 1, p. 1-8. [updates 1994 Hickey et al. computations for USLE]

Hill, J.M., Graham, L.A., and Henry, R.A., 2000, Wide-area topographic mapping and applications using airborne LIght Detection and Ranging (LIDAR) technology: Photogrammetric Engineering and Remote Sensing, v. 66, no. 8, p. 908-909, 911-914, 927. [nontechnical intro./review; good biblio]

Hilley, George, and Arrowsmith, Ramon, 2001, Santa Cruz Mountains and San Francisco Bay Peninsula Morphometry: http://activetectonics.la.asu.edu/scm/morphometry/morphometry.html. [envelope, sub-envelope, & elev. residuals maps fr 1/24K DEMs by Arc/Info macro]

Herdt, K.N., Rodhe, Allan, Seibert, Jan, and McDonnell, J.J., 1998, Testing DTM-based spatial soil moisture predictions with peat mapping in forested central Sweden (abs.), Transactions of the American Geophysical Union, v. 79, no. 45, supplement, p. F249. [new 'drainage efficiency index' outperformed TOPMODEL by 20%]

Hochstöger, F., 1995, Verwaltung landesweiter Geländehöhendaten (in German; Administration of country-wide land-height data): Salzburger Geographische Materialien, no. 22, p. 98-106; http://www.ipf.tuwien.ac.at/veroeffentlichungen/fh_p_agit95.html#ZF. [managing the Austrian 250-m DEM; oblique relief-shaded image]

Hodgson, M.E., and Gaile, G.L., 1996, Characteristic mean and dispersion in surface orientations for a zone: International Journal of Geographical Information Systems, v. 10, no. 7, p. 817-830. [circ. stats.]

Hodgson, M.E., and Gaile, G.L., 1999, A cartographic modeling approach for surface orientation-related applications: Photogrammetric Engineering and Remote Sensing, v. 65, no. 1, p. 85-95. [bi-directional angles in DEMs as Hemisph. vectors using linear algebra]

Hoffmann, Klaus, Fleck, W., Gündra, H.I., and Dikau, Richard, 1993, Computergestützte Modellierungen zu Relief-Bodenbeziehungen in Lößgebieten Nord-Baden-Württembergs (computer-aided modelling to resolve relief-soil relations in no. Bavaria & Wurtt.): Mitteilungen der Deutschen Bodenkundlichen Gesellschaft, v. 72, p. 935-938. [10 params.: slope; aspect; plan & prof. curv.; up- & downslope flowlengths, height diffs.; upslope area & slope]

Holmes, K.W., 1999, Calculation of error in a USGS 30-meter digital elevation model and its effects on terrain attributes and environmental modeling: Santa Barbara, University of California, M.A. thesis, 91 p. [see Holmes et al. 2000]

Holmes, K.W., Chadwick, O.A., and Kyriakidis, P.C., 2000, Error in a USGS 30-meter digital elevation model and its impact on terrain modeling: Journal of Hydrology, v. 233, nos.1-4, p. 154-173. [used GPS data; several params. eval.; geostat. modeling; propagation error worst in drains & along streamlines]

Hook, J.C., 1954, The quantification of Landform Characteristics: Iowa City, State University of Iowa, mimeographed, unpublished, 17 p. [discusses 18th German & later morphometry (fr Neuenschwander 1944); seminar paper and/or part of 1955 thesis?]

Hooke, R.LeB., 1968, Steady-state relationships on arid-region alluvial fans in closed basins: American Journal of Science, v. 226, no. 8, p. 609-629. [log-log fan/basin area; basin slope/area; fan slope/basin area]

Hooke, R.LeB., 2000, Toward a uniform theory of clastic sediment yield in fluvial systems: Geological Society of America Bulletin, v. 112, no. 12, p. 1778-1786. [elev., relief, slope angle & length]

Horton, R.E., 1941, Sheet erosion—present and past: Transactions, American Geophysical Union, v. 22, pt. 2, p. 299-305. [measured large river-basins are 'pear-shaped ovoids' in plan, as are basins modeled fr parabolic cross & long. sections]

Hoss, H., 1996, DTM Derivation with laser scanner data: Geomatics Information Magazine, v. 10 , no, 10, p. 28–31. [addresses caveats & quality control as well as flow of procedural steps]

Hoss, H., 1997, Einsatz des Laserscanner-Verfahrens beim Aufbau des digitalen Geländehöhenmodells DGM in Baden-Württemberg (in German): Photogrammetrie Fernerkundung Geoinformation, v. 2, p. 131–142. [a procedure for DEM generation from laser-scanned heights]

Houbolt, J.C., Walls, J.H., and Smiley, R.F., 1955, On spectral analysis of runway roughness and lads developed during taxiing: Washington, D.C., NACA Technical Note 3484, 9 p. [summarizes PSD material, e.g. Walls et al. 1954]

Hovius, Niels, 1996, Regular spacing of drainage outlets from linear mountain belts: Basin Research, v. 8, no. 1, p. 29-44. [important neo-orometry! char. stream spacing (n= 205, 1/250K-1/1000K topo maps) for 10 orogens = 2.07±0.16 the half-width of the mtn. belt (median= 2.13); Himalayas the exception (spacing ratio= 1.17); no explanation; related to Hack's law?]

Howard, Alan D., 1989, Morphometry of planimetric landforms: Reports of Planetary Geology and Geophysics Program - 1988: NASA Technical Memorandum 4130, p. 313-315. ['path-cutting' & 'convex-stepping' metrics for scarps & fluvial systems]

Howarth, P.J., and Bones, J.G., 1972, Relationships between geometric form and process on high Arctic debris-slopes, southwest Devon Island, Canada, *in* Price, R.J., and Sugden, D.E., eds., Polar Geomorphology: Institute of British Geographers, Special Publication 5, p. 139-153. [measured profiles of talus slopes]

Hrnciarová, Tatiana, and Miklós, Ladislav, 1991, Morphometric indices in the interpretation of water and material motion dynamics illustrated on the example Dolná Malanta: Ecology (CSFR), v. 10, no. 2, p. 187-221. [no info]

Hsia, J.-S., and Newton, Ian, 1999, A method for the automated production of digital terrain models using a combination of feature points, grid points, and filling back points: Photogrammetric Engineering and Remote Sensing, v. 65, no. 6, p. 713-719. [digital photogrammetry]

Hsu, M.-L., and Robinson, A.H., 1970, The fidelity of isopleth maps, an experimental study: Minneapolis, University of Minnesota Press, 92 p. [depends on character of source distribution (i.e. topo), size & shape of mapping units (pixels), & the number of control points]

Huang, C., 1998, Quantification of soil microtopography and surface roughness, *in* Baveye, Phillipe, Stewart, B.A., and Parlange, J.-Y., eds., Fractals in Soil Science: Berlin, Springer Verlag, p. 153-168. [used 2-D laser scanner to make DEM]

Huang, Y.D., 2000, Evaluation of information loss in digital elevation models with digital photogrammetric systems: Photogrammetric Record, v. 16, no. 95, p. 781-791. [uses rms differences betw. candidate DEM & a much denser DEM 'standard']

Hubbard, Bryn, Siegert, M.J., and McCarroll, Danny, 2000, Spectral roughness of glaciated bedrock geomorphic surfaces—implications for glacier sliding: Journal of Geophysical Research, v. 105, no. B9, p. 21,295-21,303. [micro- & macro-profiles combine in 5-order PSD's that yield 2 bed-roughness indices]

Huber, William, 1825, Considérations générales sur les Alpes centrales (in French): Bulletin de la Société Géographique de Paris, v. 5, p. 105ff. [refined Humboldt's quant. comparison of ridge & summit mean heights by averaging all summits rather than just a sampling]

Huggett, R.J., 1975, Soil landscape systems—a model of soil genesis: Geoderma, v. 13, no. 1, p. 1-22. [added flow lines to Troeh's 1964 four concave-convex elements to segment land-surface form by slope & curvature; 4 block diagrams; crude computer result]

Huggins, K.H., 1935, The Scottish Highlands—a regional study: Scottish Geographical Magazine, v. 51, p. 296-306. [delimited by relief (> 700') on 2-mi. grid (O.S. maps); used 800' contour & summits >1500']

Huggins, L.F., and Monke, E.J., 1966, The mathematical solution of the hydrology of small watersheds: Purdue University, W. Lafayette, IN, Water Resources Research Center, Technical Report No. 1, 130 p. [one of 1st true distributed-parameter hydrologic models; basis of ANSWERS model]

Hughes, D.A., 1981, An approach to the quantification of floodplain form: Area (London), v. 13, no. 4, p. 285-291. [no info]

Hughes, L.A., Smith, D.H., and Ryley, A., 2001, Robust data compression for digital elevation models (ext. abs.), *in* Kidner, D.B., and Higgs, G., eds., GIS Research UK 9th, Annual Conference (GISRUK 2001), University of Glamorgan, Wales, 18-20 April 2001, Proceedings: p. 462-467. [no info]

Hughes, R.J., Jr., 1959, Volume estimates from contours: Economic Geology, v. 54, no. 4, p. 730-737. [exemplified by cut-and-fill grading of an area]

Humâ, Io., and Râdulescu, D., 1978, Automatic production of thematic maps of slope stability: Bulletin of the International Association of Engineering Geology, no. 17, p. 95-99. [early computer map fr quant. coding of variables incl. slope & aspect]

Humboldt, Alexander von, 1808, et ann. suiv., Nivellement barométrique fait dans les régions équinoxiales du Nouveau Continent 1799-1804 (in French; barometric surveying in equatorial regions of the Americas), published as a separate *from* Recueil d'observations astronomiques, d'opérations trigonométriques et de mesures barométriques, Partie 4, 2 vol. (v. 21 & 22) Paris, F. Schoell, Treuttel & Würtz, *in* Alexandre de Humboldt et Aimé Bonpland, 1805-34, Voyage aux régions équinoxiales du nouveau continent fait en 1799, 1800, 1801, 1802, 1803 et 1804, 30 v., paging unknown. [500 heights calculated by Jabbo Oltmanns fr Humboldt's measurements, Laplace's formula, & Ramond's barometric coeff. It may have been here (otherwise in an unspecified 1807 work) where Humboldt complained that heights of only 62 of the world's mountains were measured and he had accounted for half]

Humboldt, Alexander von, 1817, De distributione geographica plantarum secundum coeli temperiem et altitudinem montium, Prolegomena (in Latin; on the geogr. distr. of plants in the new world, temperatures, & heights of mountains): Lutetiae Parisiorum, Paris & Lubeck, 250 p., hand-colored engraved foldout map. [footnote to p. 112 *in* Edinb. New Phil. Jour., (1845, v. 39) says p. 81 & 182 (82?) of the 1817 work mention 'the distinction which is so important to climatology & human civilization, of continents having uniform, and those having indented coasts; .... the relation of the extent of coasts to the area of the continent, which is ... *the measure of the accessibility of the interior*' This is the (later) much-pursued quantification of continental area/perimeter, or 'coastal development' (*Küstenentwicklungen* i.e. 'convolution'). The concept, attributed by Humboldt to Strabo & evidently 1st quantified by Ritter (1826, 1828), claims that highly indented coasts, e.g. Europe, lead to more advanced cultures]

Humboldt, Alexander von, 1835, article title unknown: Berghaus' Annalen der Erdkunde, v. 12, p. 490ff. [contains material on '... the relation of the extent of coasts to the area of the continent, which is ... *the measure of the accessibility of the interior* ...' (ref. = Edinb. New Phil. Jour., 1845, v. 39, p. 112 footnote is early mention in English of the (later) much-pursued quantification of continental area/perimeter, or 'coastal development' (i.e. *Küstenentwicklungen* or 'convolution'). The concept, attributed by Humboldt to Strabo & evidently 1st quantified by Ritter (1826, 1828), claims that highly indented coasts, e.g. Europe, lead to more advanced cultures]

Humboldt, Alexander von, 1843c, An attempt to determine the height of continents: Edinburgh New Philosophical Journal, v. 34, art. 12, p. 326-337. [measured heights refute Laplace's 1825 deduced mean height of Earth's continents of 1000 m (3028'); see several other A. von H. refs. to this work]

Hunt, C.B., 1950, Military geology, *in* Paige, Sidney, ed., Application of Geology to Engineering Practice: Geological Society of America, p. 295-327. ['scopograph' instrument projected contour maps into landing-craft-level visualizations of terrain; basic descr. of terrain (incl. map units) for observation, concealment, cover, trafficability; WW II experience]

Hurtrez, J.-E., Lucazeau, F., Lavé, J., and Avouac, J.-P., 1999, Investigation of the relationships between basin morphology, tectonic uplift, and denudation from the study of an active fold belt in the Siwalik Hills, Nepal: Journal of Geophysical Research, v. 104, no. B6, p. 12,779-12,796. [of 27 params (17 basins), only basin elev & hyps. int. correl signif. w/ uplift rate; re-derives hypsometric integral (no ref. to Pike & Wilson 1971)]

Hutchinson, M.F., 2001, ANUDEM version 4.6.3: Canberra, Centre for Resources and Environmental Studies, Australian National University; http://cres.anu.edu.au/outputs/anudem.html. [successful software package; yields accurate DEMs with sensible drainage properties fr ~small, but well chosen, elev. & stream line data]

Hutchinson, M.F., and Gallant, J.C., 1999, Representation of terrain, ch. 9, *in* Longley, P.A., Goodchild, M.F., Maguire, D.J., and Rhind, D.W., eds., Geographical Information Systems, v. 1, Principles and Technical Issues, 2nd ed.: New York, Wiley, p. 105-124. [state-of-art review of DEMs & modeling, supplants Weibel & Heller, 1991]

Hutchinson, M.F., and Gallant, J.C., 2000, Digital elevation models and representation of terrain shape, *in* Wilson, J.P., and Gallant, J.C., eds, Terrain Analysis—Principles and Applications: New York, Wiley, p. 29-50. [review, emphasizing ANUDEM software package]

Hutchinson, M.F., Stein, J.L., and Stein, J.A., 2001, Upgrade of the 9 second Australian digital elevation model—A joint project of CRES and AUSLIG: CRES, ANU, http://cres.anu.edu.au/dem/index.html. [intro, sample images, purchase, GEODATA 9" DEM hist & descr, revised source data, ANUDEM gridding algorithm, accuracy est., refs]

I

Ibbit, R.P., Willgoose, G.R., and Duncan, M.J., 1999, Channel network simulation models compared with data from the Ashley River, New Zealand: Water Resources Research, v. 35, no. 12, p. 3875-3890. [250-m DEM; OCN & SIBERIA tested-neither satisfactory; used hypso. int.]

Ijjasz-Vasquez, E.J., Rodriguez-Iturbe, Ignacio, and Bras, R.L., 1992, On the multifractal characterization of river basins: Geomorphology, vol. 5, nos. 3-5, p. 297-310. [develops multifractal spectra of various parameters]

Inamdar. S.P., and Dillaha, T.A., 2000, Relationships between drainage area, slope length, and slope gradient for riparian slopes in Virginia: Transactions of the American Society of Agricultural Engineers, v. 43, no. 4, p. 861-866. [contributing areas computed fr 1-m DEMs; infer fine-scale A fr coarser-scale params.]

Inbar, M., and Risso, C., 2001, A morphological and morphometric analysis of a high density cinder cone volcanic field—Payun Matri, south-central Andes, Argentina : Zeitschrift fur Geomorphologie, v. 45, no. 3, p. 321-343. [summ. 120 cones & 8 groups; params. Hco, Wco, ratio, slope, Dcr]

Inkpen, R.J., Collier, Peter, and Fontana, Dominic, 2000, Close-range photogrammetric analysis of rock surfaces: Zeitschrift für Geomorphologie, Supplementband 120, p. 67-81. [DEMs & variograms of weathered vs. unweathered surfaces]

Iri, M., Shimakawa, Y., and Nagai, T., 2000, Extraction of invariants from digital elevation data with applications to terrain topography (in Japanese): Symposium on Integrated Geographical Information Systems, Proceedings: v. 5, p. 33-46. [peaks, bottoms (pits), & cols (passes) = critical points]

Ivanov, S.S., 1994, Global relief—evidence of fractal geometry, *in* Kruhl, J.H., ed., Fractals and Dynamic Systems in Geoscience: Berlin, Springer-Verlag, p. 221-230. [1975 revised Scripps topo data on 1° global grid; gets $D = 1.37$]

Ivanov, M.A., and Head, J.W., 2001, Altitude distribution of units, §3.4 *in* Geology of Venus—mapping of a global geotraverse at 30ºN latitude: Journal of Geophysical Research, v. 106, no. E8, p. 17,544-17,546. [hypsograms suggest 3 groups of geologic units]

Iwahashi, Junko, and Kamiya, Izumi, 1995, Landform classification using digital elevation model by the skills of image processing—mainly using the Digital National Land Information: Joho Chishitsu (Geoinformatics; Osaka), v. 6, no. 2, p. 97-108. [no info; probably related to Iwahashi 1994?]

Iwahashi, Junko, Watanabe, Shiaki, and Furuya, Takahiko, 2001, Landform analysis of slope movements using DEM in Higashikubiki area, Japan: Computers & Geosciences, v. 27, no. 7, p. 851-865. [spatial freq. ≈ failure proclivity; slope dist. ~ normal on slides, but not stable terrain]

J

Jackson, C.R., and Sturm, C.A., 2002, Woody debris and channel morphology in first- and second-order forested channels in Washington's coastal ranges: Water Resources Research, v. 38, no. 9, p. 16-1 to 16-14. [step-pool freq., step height / channel slope; streams probl. 'step-riffle' not 'step-pool']

Jäger, Stefan, 1993, Computergestützte Erzeugung und Anwendung umweltrelevanter Basisdaten der Reliefgeometrie (Computer-assisted production and use of environmentally relevant basic data of relief geometry), *in* Barsch, Dietrich, and Karrasch, Heinz, eds. Geographie und Umwelt: Tagungsbericht und wissenschaftl. Abhandlungen, 48, Deutscher Geographentag 1991, Wiesbaden, Steiner Verlag, p. 153-158. [no info]

Jäger, Stefan, and Wieczorek, G.F., 1994, Landslide susceptibility in the Tully Valley area, Finger Lakes region, New York: U.S. Geological Survey, Open-file report 94-615, one sheet, 1/50,000 scale. [fr. logistic regr. of 90-m DEM slope, old lake levels & pres./abs. of clays]

Jakobsson, Martin, Cherkis, Norman, Woodward, John, Macnab, Ron, and Coakley, Bernard, 2000, New grid of Arctic bathymetry aids scientists and mapmakers: Eos, Transactions, American Geophysical Union, v. 81, no. 9, p. 89, 93, & 96; http://www.ngdc.noaa.gov/mgg/bathymetry/arctic.html. [new standard: IBCAO (2.5km DBM grid), compiled fr diverse sources, incl. declassified & Russian]

Jakobsson, Martin, 2002, Hypsometry and volume of the Arctic Ocean and its constituent’s seas: Geochemistry Geophysics Geosystems, v. 3, 10.1029/2001GC000302. [2.5km Intl. Bath. Chart Arct. Oc. DBM reveals broad shallow shelves]

Jankowski, D.G., and Squyres, S.W., 1991, Sources of error in planetary photoclinometry: Journal of Geophysical Research, v. 96, no. E4, p. 20,907-20,922. [quant. anal. of at least 7, fr spacecraft image, the planet imaged, & scan-line orientation; good biblio]

Janoo, V.C., 1998, Quantification of shape, angularity, and surface texture of base course materials: Hanover, NH, US Army Corps of Engineers Cold Regions Research & Engineering Laboratory, CRREL Special Report 98-1, 22 p.; http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/SR98_01.pdf. [reviews direct & indirect morphometric methods, incl. Wright 1955]

Jansma, Pamela, Mattioli, Glen, Matias, Audeliz, and Harding, David, 1999, Northeastern Caribbean topography gets a digital upgrade from laser altimetry: Eos, Transactions, American Geophysical Union, v. 80, no. 43, p. 511. [SLICER (Scanning LIDAR Imager of Canopies by Echo Recovery) data corrects DEMs by removing vegetative cover]

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Jayko, A.S., 2000, Digital analysis, p. 7-8 *in* Bonilla, M.G., Jachens, R.C., Jayko, A.S., Wentworth, C.M., and McGarr, A.F., The demise of the San Bruno Fault: California Geology, v. 53, no. 2, p. 4-19. [15-m DEM from 4 mid-19th C. topo maps; shaded relief, curv., profiles]

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Jenco, Marián, 1993, The morphometric analysis of georelief in terms of a theoretical conception of the complex digital elevation model of georelief: Universitas Comeniana, Univerzita Komenského, Bratislava, Geographica Nr. 33, p. 133-153. [Krcho-type analysis of topo. as a random field]

Jennings, P.J., and Siddle, H.J., 1998, Use of landslide inventory data to define the spatial location of landslide sites, South Wales, UK, *in* Maund, J.G., and Eddleston, Malcolm, eds., Geohazards in Engineering Geology: London, The Geological Society, Engineering Geology Special Publication no. 15, p. 199-211. [shallow slides: slope >24°, nr. coal, 1 ha, 90 m long; deep-seated harder to char.; >10ha, whole hillside, longer than 250m]

Jet Propulsion Laboratory, 1997, DEM auxiliary datasets preparation plan—digital elevation mapping support to the EOS/AM-1 platform: Pasadena, CA, California Institute of Technology, JPL D-13508, release 2. 65 p. [30' GTOPO30 spacing met requirements set up here]

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Jiskoot, Hester, Boyle, Paul, and Murray, Tavi, 1998, The incidence of glacier surging in Svalbard—evidence from multivariate statistics: Computers and Geosciences, v. 24, no. 4, p. 387-399. [logit regr. on 13 var. n= 504; glacier length, sfce slope & lithology best pred.]

Johansson, Magnus, 1999, Analysis of digital elevation data for paleosurfaces in south-western Sweden: Geomorphology, v. 26, no. 4, p. 279-295. [3 surfaces interpr. fr. DEM trend-srfce & rel & abs relief]

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Jomelli, Vincent, 1999, Dépôts d'avalanches dans les Alpes Françaises—géométrie, sédimentologie et géodynamique depuis le Petit âge Glaciaire (in French w English abstract & fig. captions): Géographie Physique et Quaternaire, v. 53, no. 2, p. 199-209. [longitud. profiles, slope, concavity index, distance from apex; 20 deposits]

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Jones, C.B., 1997, Surface modeling and spatial interpolation, Chapter 12 *in* Geographical Information Systems and Computer Cartography: Harlow, UK, Addison Wesley Longman, p. 197-213. [textbook; DEM-based examples; good summary]

Jones, C.B., Kidner, D.B., and Ware, J.M., 1994, The implicit triangulated irregular network and multiscale databases: The Computer Journal, v. 37, no. 1, p. 43-57. [can retrieve contours & form lines from multi-scale line tree (MSLT) edge file]

Jones, J.A.A., 1978, The spacing of streams in a random-walk model: Area (London), v. 10, no. 3, p. 190-197. [no info]

Jones, K.H., 1998, A comparison of algorithms used to compute hill slope as a property of the DEM: Computers and Geosciences, v. 24, no. 4, p. 315-323. [Fleming-Hoffer (1979) & Horn (ARC/INFO GRID) best of 8 methods; max. slope = worst]

Jones, N.L., Kennard, M.J., and Zundel, A.K., 2000, Fast algorithm for generating sorted strings: Computers and Geosciences, v. 26, no. 7, p. 831-837. [randomly sorts contour segments; faster than contour tracing]

Jones, Richard, 2002, Algorithms for using a DEM for mapping catchment areas of stream sediment samples: Computers and Geosciences, v. 28, no. 9, p. 1051-1060. [efficient 'priority-first-search weighted-graph' algorithm enforces drainage continuity for both pits & flat terrain & improves on others (reviewed)]

Jordan, M.-E.-C., 1872a, Sur les lignes de faîte et de thalweg (in French; on ridge & drainage lines): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, v. 74, no. 23, p. 1457-1459. [mathematician; his contribution, a series of discussions with Boussinesq, summarized by López 1997: at a valley bottom, the only way to identify the terrain slope-line where others converge is to observe its origin—at a saddle point or a double inflection point of the level curves, taking into account channels along ravines; see also Rieger 1997, who prefers Jordan's def. to Rothe 1915]

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Journel, A.G., Kyriakidis, P.C., and Mao, Shuguang, 2000, Correcting the smoothing effects of estimators—a spectral postprocessor: Mathematical Geology, v. 32, no. 7, p. 787-813. [results from DEM verify theory of spatial interpolation by autocovariance]

Jovanovíc, P.-S., 1940, Les profils fluviatiles en long, leurs formes et leurs génèses. Essai de méthodes morphogénétiques nouvelles (in French): Skopje and Paris (Armand Colin), 196 p. [statistical study of longitudinal stream profiles]

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Junkins, J.L., Jancaitis, J.R., and Miller, G.W., 1972, Smooth Irregular Curves: Photogrammetric Engineering, v. 38, p. 565-573. [probably still the best method to interpolate along a line past simple linear interpolation]

K

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Kammerer, Peter, 1986, Verbesserung der morphometrischen Erfassung des Reliefs mit Hilfe des Digitalen Geländemodells (in German; Improved morphometric understanding of relief with the aid of DEMs): Mitt. der Geographischen Gesellschaft in München, v. 71, p. 57-79. [no info]

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Kanisawa, Satoshi, and Yokoyama, Ryuzo, 1999, Extraction of geologic information from digital elevation map of 50m-mesh—application of slope and openness maps to the Kitakami Mountains (in Japanese): Chisitsu News, no. 542, p. 31-38. [reticulate structure of joint pattern revealed clearly for 1st time by 'openness']

Kant, Immanuel, 1802, Physische Geographie (in German), F.T. Rink, ed.: Königsberg, Göbbels & Unzer, v. 1, 312 p., v. 2, 248 p.; republished 1923 *as* Kant's Gesammelte Schriften, *in* Akad. der Wissenschaften zu Berlin, v. 9, p. 151-436. [among earliest quant. geomorph., see notes for Kant 1803; the only edition authorized by Kant; contents of lectures date to 1775 (v. 1) and 1759 (v. 2)]

Kant, Immanuel, 1803, Physische Geographie (in German): Mainz & Hamburg, ed. Gottfried Vollmer, v. 3 (of 6, v. 1 in 1801), section 1, p. 18. [one of earliest morphometric observations, namely, tributaries normally meet main river at 45° (p. 18); cf Playfair 1802, p. 113-14; Kant among 1st to advocate land quantification beyond mere listing surface extent, height, & depth; Kant never traveled but his collected geographic observations by others (he constantly entertained intellectual guests) were highly influential. Kant also infl. J.H. Schröter 1791, 1802. Defects of Vollmer's edition of Kant (only Rink 1802 ed. is authoritative; see Hartshorne 1939, The Nature of Geography, Annals AAG, 29/3 & 4, p. 38-39) do not necessarily invalidate attribution of the 45° 'rule' (angle is variable) to Kant; lectures on which books were based date to mid-1700's.]

Kao, R.C., 1963, The use of computers in the processing and analysis of geographic information: Geographical Review, v. 53, p. 530-547. [early advocate of automated spatial data handling]

Kar, Amal, 1998, Present-day mobile crescentic dunes in the Thar desert, India, *in* Alsharhan, A.S., Glennie, K.W., Whittle, G.L., and Kendall, C.G.St.C., eds., Quaternary Deserts and Climatic Change: Balkema, Rotterdam, p. 155-164. [1 barchan; shape changes w/ season & degree of development]

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Kargel, J.S. 1986, Morphologic variations of Martian rampart crater ejecta and their dependencies and implications, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 17th, March, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XVII, p. 410-411. [the old area/perimeter relation (see Woronow & Mutch 1980); calc. 'lobateness' = $\mathbf{P}/(4\pi\mathbf{A})^{0.5}$ for 538 craters]

Karlekar, S.N., 1995, Keskar, Umesh, The quantitative assessment of a few landslides around Chiplun and Sangameshwar (Maharashtra): Geographical Review of India, v. 57, no. 1, p. 1-19. [PCA: 26 attributes & 15 sites; major var.= height, 'spread' & 'ground length']

Kastrop, J.E., 1949, Sun Oil Company's mobile elevation meter: World Oil, v. 128, no. 13, p. 76-80. [3-wheel trailer; electro-mechanical slope integratin system; elev. accuracy is fraction of a foot over several miles; less acc. in rough terrain]

Kasugaya, Nobumasa, 1981, A method of the morphometry by the application of the mechanical quadratures (in Japanese with English abstract): Transactions, Japanese Geomorphological Union, v. 1, no. 2, p. 135-149. [8-point terrain-ruggedness index: true area/map area?]

Kasugaya, Nobumasa, and Chikatsu, Hirofumi, 1981, Some examples of the application of the mechanical quadratures to morphometry (in Japanese with English abstract): Transactions, Japanese Geomorphological Union, v. 1, no. 2, p. 151-164. [n=10; ruggedness index: landform volume, evenness]

Katsube, Keiichi, 2000, Morphometry of mountains based on a 50-m DEM (in Japanese), *in* Sugimori, H., Aoki, T., Suzuki, Y., and Oguchi, T., eds., Integration of digital measurement methods for the GIS analyses of hilly lands: Nagoya, Chunichi Shinbun, p. 35-37. [similar height/slope relations for diff. rock types in diff. ranges]

Katsube, Keiichi, and Oguchi, Takashi, 1999, Altitudinal changes in slope angle and profile curvature in the Japan Alps—a hypothesis regarding a characteristic slope angle: Geographical Review of Japan, v. 72 (Ser. B), no., 1, p. 63-72. [50m DEM; 3 alt. zones in 3 ranges:<1 km, 1-2.8 km, >2.8 km]

Kaufmann, Victor, 1998, Geomorphometric monitoring of active rock glaciers in the Austrian Alps (in German), *in* International Symposium on High Mountain Remote Sensing and Cartography 4th (HMRSC-4), 19-29 August 1996, Proceedings: University of Karlstad, Austria, Research Report 97/3 Natural Sciences / Technology, p. 97-113. [chapter 6 is on morphometry]

Kaulfuss, W., 1975, Darstellungsmethode und Anwendungsmoeglichkeiten eines Kartogramms der Reliefenergie fuer den Bezirk Dresden (in German; Representation methods & applicability of a relative-relief map of the Dresden area: Petermanns Geographische Mitteilungen, v. 119, no. 4, p. 317-319. [no info; late use of obsolete term 'reliefenergie']

Kavouras, Marinos, 1989, Vectorization of scanned contour data: Technical Chronicles Á (in Greek), v. 9, no. 3, p. 127-149. [no info]

Kawabata, Daisaku, Oguchi, Takashi, and Katsube, Keiichi, 2001, Effects of geology on slope angles in the southern Japanese Alps—a GIS approach: Transactions, Japanese Geomorphological Union, v. 22, n5. 3, p. 827-836. [height/slope relations for 24 rock types fr 55m DEM; some rel. to landsliding]

Kawakami, H., and Saito, Y., 1984, Landslide risk mapping by a quantification method, *in* International Symposium on Landslides, 4th, 16-21 September, Toronto, Proceedings: Rexdale, Ont., Canadian Geotechnical Society, v. 2, p. 535-540. [weighted freqs. of valley density, elev., slope, formation, geol. structure]

Keane, C.M., 1997, Terrain texture and its potential for landform classification in western Piedmont of Maryland: College Park, University of Maryland, unpublished Ph.D. dissertation, 222 p. [no info]

Keber, Dr., 1882, comments (in German) *in* Günther (1882), p. 146. [the area/perimeter problem]

Keefer, D.K., 1984, Rock avalanches caused by earthquakes—source characteristics: Science, v. 223, no. 4642, p. 1288-1290. [source slope-height (min.= 150 m) vs. gradient (min.= 25°) for n= 23]

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Kennedy, F.E., Brown, C.A., Kolodny, J., and Sheldon, B.M., 1999, Fractal analysis of hard disk surface roughness and correlation with static and low-speed friction: Transactions of the ASME, v. 121, no. 4, p. 968-974. [2 parameters (by patchwork method) sensitive to surface-finishing processes]

Kenny, F.M. (compiler), 1998, Digital elevation model of the Greater Toronto and Oak Ridges Moraine areas, southern Ontario (chromo-stereo enhancement): Geological Survey of Canada, Open-File Report 3423, 1 sheet, map scale 1:200,000. [paper map from DEM released on CD-ROM a year later]

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Kertész, Àdam, and Szilárd, Jenö, 1979, Some problems of slope development reflected in slope-profile investigations: Geographia Polonica, v. 41, no. 1, p. 21-26. [geomorph. interpr. of detailed field slope-profile char.]

Kervyn, François, 2001, Modelling topography with SAR interferometry—illustrations of a favourable and less favourable environment: Computers and Geosciences, v. 27, no. 9, p. 1039-1050. [obtained usable InSAR DEM from one area but not another (vegetation too dense)]

Kheyfets, B.S., 1958, The use of polynomials for mathematical characterization of topographic complexity (in Russian): Izvestiya Vysshikh Uchebnyh Zavedeny, Geodesiya i Aerophotosyemka, no. 1, p. 79-86. [no info]

Kidner, D.B., 1991, Digital terrain models for radio path loss calculations: Ph.D. Thesis, The Polytechnic of Wales, 269 p. [results differ by type of DEMs & its accuracy]

Kidner, D.B., Eynon, Christopher, and Smith, D.H., 2001, Multiscale terrain databases (ext. abs.), *in* Kidner, D.B., and Higgs, G., eds., GIS Research UK 9th, Annual Conference (GISRUK 2001), 18-20 April 2001, University of Glamorgan, Wales, Proceedings: p. 151-153. [hierarch. encodes 131-million-point Great Britain DEM by implicit quadtree pyramid]

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Kidner, D.B., and Smith, D.H., 1997, Storage-efficient techniques for representing digital terrain models, *in* Kemp, Z.A., ed., Innovations in GIS 4: Edinburgh, Taylor and Francis, p. 25-41. [large datasets are forcing efficiencies in storage]

Kidner, D.B., and Smith, D.H., 1998, Storage-efficient techniques for handling terrain data, *in* Spatial Data Handling '98 Conference, 11-15 July, Vancouver, BC, Proceedings: p. 373-385. [large datasets are forcing greater efficiencies in storage]

Kidner, D.B., Dorey, M.I., and Smith, D.H., 1999, What's the point? Interpolation and extrapolation with a regular grid DEM, *in* International Conference on GeoComputation, 4th, Fredericksburg VA, Mary Washington College, 25-28 July, GeoComputation 99: http://www.geovista.psu.edu/geocomp/geocomp99/Gc99/082/gc_082.htm. [high-order techniques > linear ones; bicubic interpol. = min. for DEMs]

Kidner, D.B., Sparkes, A.J., Dorey, M.I., Ware, J.M. and Jones, C.B., 2001, Visibility analysis with the multiscale implicit TIN: Transactions in GIS, v. 5, no. 1, p. 19-37. [storage-reduction method applied to viewsheds]

Kidner, D.B., Ware, J.M., Sparkes, A.J. and Jones, C.B., 2000, Multiscale terrain and topographic modelling with the implicit TIN: Transactions in GIS, v. 4, no. 4, p. 361-378. [reduces size needs a lot by storing only vertices & constraining features at var. scales]

Kieffer, Hugh, Kargel, J.S., and 40 others, 2000, New eyes in the sky measure glaciers and ice sheets: Eos, Transactions of the American Geophysical Union, v. 81, no. 24, p. 265, 270-271. [DEMs fr ASTER stereo coverage will quantify glacier topo. changes]

Kieniewicz, J.M., Chappelow, J.E., and Sharpton, V.L., 2000, Properties of Martian surfaces from the morphology of small impact craters (abs.): Eos Transactions of the American Geophysical Union, v. 81, no. 48 (Supplement, P62B-03), p. F780. [use depth/diam. ratios to infer substrate character]

Killian, K., and Kraus, K., 1992, Punkte in topographischen Flächen mit gleicher Geländeneigung (in German; points in topographic surfaces with same slope (?)): Österreichische Zeitschrift für Vermessungswesen und Photogrammetrie, v. 80, no. 1, p. 20-24. [technique to assess & model contour accuracy]

Kim, Sanghyun, Kim, Kyunghyun, and Jung, Sunhee, 2001, A digital elevation analysis—spatially distributed flow apportioning algorithm (in Korean with English abstract): Journal of Korea Water Resources Association, v. 34, no. 3, p. 241-251. [spatially varied flow-apport. to accomm. A fr upslope cells; channel init. threshold; topography index]

King, D., Bourennane, H., Isambert, M., and Macaire, J.J., 1999, Relationship of the presence of a non-calcareous clay-loam horizon to DEM attributes in a gently sloping area: Geoderma, v. 89, nos. 1-2, p. 95-111. [20X20m DEM; gradient & aspect dominant; wind, not H2O, = major process]

King, G.Q., 1982, Morphometry of Great Basin playas: Salt Lake City, UT, University of Utah, unpublished Ph.D. dissertation, 137 p. [drainage basins, morphometry, statistical analysis]

Kirby, Eric, and Whipple, Kelin, 2001, Quantifying differential rock-uplift rates via stream profile analysis: Geology, v. 29, no. 2, p. 415-418. [differences in channel concavity (Nepal) match predictions of stream-power model]

Kirkby, M.J., 1971, Hillslope process-response models based on the continuity equation, *in* Brunsden, Denys, ed., Slopes, Form and Process: London, Institute of British Geographers, Special Publication no. 3, p. 15-30. [formal introduction of the continuity eqn. into geomorp. modeling]

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Kirkby, M.J., 1993, Long term interactions between networks and hillslopes, *in* Beven, Keith, and Kirkby, M.J., eds., Channel Network Hydrology: New York, Wiley, p. 255-293. [state-of-art progress report, esp. flood forecasting]

Kirkby, M.J., 1997, TOPMODEL—a personal view: Hydrological Processes, v. 11, no. 9, p. 1087-1098. [future variants may have to sacrifice simplicity for added realism]

Kirkby, M.J., 1999, Translating models from hillslope (1 ha) to catchment (1000 km^2) scales, *in* Diekkrüger, Bernd, Kirkby, M.J., and Schröder, Ulrich, eds., Regionalization in Hydrology, Conference, Technical University of Braunschweig, Germany, 10-14 March, 1997, Proceedings:

IAHS Publication no. 254, p. 1-12. [current methods primitive; uses DEM elev. in 'flowstrips' to scale up all other params.]

Klein, Micha, 1981, A quantitative approach to the analysis of slope roughness and effective slope angle: Catena, v. 8, p. 281-284. [3 micro-profiles on 3 gravelly field plots; SDC freq.]

Kling, Johan, 1998, The difference between sorted circle and polygon morphology and their distribution in two alpine areas, northern Sweden: Zeitschrift für Geomorphologie, v. 42, no. 4, p. 439-452. [n=700; circles smaller, width/length higher, & @ higher elev.]

Klinkenberg, Brian, and Clarke, K.C., 1992, Exploring the fractal mountains, *in* Palaz, I., and Sengupta, S.K., eds., Automated Pattern Analysis in Petroleum Exploration: New York, Springer-Verlag, p. 201-212. [fractal modeling of terrain (variogram method); see Clarke, 1993]

Klostermann, Henning, 1970, Zur geomorphometrischen Kennzeichnung kleiner Einzugsgebiete (in German; morphometric characterization of small catchment areas): Petermanns Geographische Mitteilungen, v. 114, no. 4, p. 241-260. [watershed morphometry, German examples]

Knighton, A.D., 2000, Profile form and channel gradient variation within an upland drainage basin - River Noe, Derbyshire: Zeitschrift für Geomorphologie, Supplementband 122, p. 149-164. [7 streams; exponential fcn fits better than linear, log, or power]

Kobrick, Michael, 2002, Planetary phrenology—the lumps and bumps of the Earth: Engineering and Science (California Institute of Technology), v. 65, no. 1, p. 22-31. [the 2000 SRTM presented to a general audience]

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Koenderink, J.J., and Doorn, A.J. van , 1993, Local features of smooth shapes—ridges and courses, *in* Geometric Methods in Computer Vision II, v. 2031, SPIE, p. 2-13. [disputes mathematical correctness of contour-to-watershed algorithms]

Koenderink, J.J., and Doorn, A.J. van, 1994, Two-plus-one-dimensional differential geometry: Pattern Recognition Letters, v. 15, no. 5, p. 439-443. [historical overview of ridge detectors 1st proposed in early 19th C. to define watersheds]

Koenderink, J.J., and Doorn, A.J. van, 1998, The structure of relief, *in* Advances in Imaging & Electron Physics, v. 103, p. 65-150. [review scalar fields on 2D manifolds (relief—contour & fall curves, ridges & courses) for computer vision]

Kok, A.L., Blais, J.A.R., and Rangayyan, R.M., 1987, Filtering of digitally correlated Gestalt elevation data: Photogrammetric Engineering and Remote Sensing, v. 53, no. 5, p. 535-538. [attempt (not wholly successful) to fix striped artifacts in Level-1 USGS DEMs]

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Koristka, Karel, 1863, Hypsometrie von Mähren und Österreichisch Schlesien (hypsometry of Moravia & Austrian Silesia; in German): Brünn, Im commission bei E. Hölzel in Olmütz, 160 p., map. [measurements, quantitative terrain description]

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Kostaschuk, R.A., MacDonald, G.M., and Putnam, P.E., 1986. Depositional process and alluvial fan-drainage basin morphometric relationships near Banff, Alberta, Canada: Earth Surface Processes and Landforms, v. 11, p. 471-484. [found 2 types of fans; relations differ by type]

Köthe, Rüdiger, 1988, Versuch einer computergesteuerten morphographisch-prozeßorientierten Reliefanalyse für die bodenkunliche Kartierung (in German): unpublished Dipl. Arb. Lehrstuhl Phys. Geogr., Univ. Hannover, paging unknown. [SARA software package prototype?]

Köthe, Rüdiger, and Lehmeier, Friedmut, 1993, SARA, ein System zur Automatischen Relief-Analyse (in German): Standort, Zeitschrift für Angewandte Geographie (Köln), v. 4, p. 11-21. [software SARA for DEM-based fluvial modeling]

Köthe, Rüdiger, Gehrt, Ernst, and Böhner, Jürgen, 1996, Automatische Reliefanalyse für geowissenschaftliche Kartierungen—derzeitiger Stand und Weiterentwicklungen des Programms SARA (Automatic relief analysis for geoscientific mapping—present status and progress of SARA): Arbeitshefte Geologie (Hannover), v. 1, p. 31-37. [DEM-based package for terrain modeling & mapping]

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Kraak, M.-J., and Ormelling, Ferjan, 1996, Relief (Sect. 5.5), *in* Cartography—Visualization of Spatial Data: Harlow, UK, Addison-Wesley Longmans, p. 100-108. [textbook; gen'l. info on DEM's & applics. esp. carto/viz.]

Krabill, W., Frederick, E., Manizade, S., Martin, C., Sonntag, J., Swift, R., Thomas, R., Wright, W., and Yungel, J., 1999, Rapid thinning of parts of the southern Greenland ice sheet: Science, v. 283, p. 1522-1524. [1993 & 1998 laser altimetry (70-m planes) differenced; error eval.]

Krabill, W., Abdalati, W., Frederick, E., Manizade, S., Martin, C., Sonntag, J., Swift, R., Thomas, R., Wright, W., and Yungel, J., 2000, Greenland ice sheet—high-elevation balance and thinning, Science, v. 289, p. 428-430. [color map from airborne laser altimetry & GPS]

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Kraus, K., 1994, Visualization of the quality of surfaces and their derivatives: Photogrammetric Engineering and Remote Sensing, v. 60, no. 4, p. 457-462. [graphic means for assessing DEM accuracy & error]

Kraus, K., and Pfeifer, N., 1998, Determination of terrain models in wooded areas with airborne laser scanner data: ISPRS Journal of Photogrammetry and Remote Sensing, v. 53, no. 4, p. 193-203. [better than photogramm., but derived contours not good enough for geomorph.]

Krcho, Jozef, 1983, Theoretical conception and interdisciplinary application of the complex digital model of relief in modelling bidimensional fields (in Slovak with English abstract): Geograficky Casopis., v. 35, p. 265-291. [terrain segmentation by pos. & neg. DEM curvature]

Krcho, Jozef, 1986, Geometric forms of the georelief and their hierarchic levels (in Slovak, with English abstract): Geograficky Casopis, v. 38, p. 210-235. [no info, but undoubtedly related to known works]

Krcho, Jozef, 1987, Mathematical properties of the topographical surface of georelief from the viewpoint of morphometric analysis as well as modelling by means of a complex digital model (in Slovak, with English abstract): Geograficky Casopis, v. 39, p. 169-204. [no info, but undoubtedly related to known works]

Krcho, Jozef, 1989, Mathematical properties of the georelief from the viewpoint of geometric forms and its modelling by approximating functions of two variables (in Slovak, with English abstract): Geograficky Casopis, v. 41, no. 1, p. 23-47. [no info, but undoubtedly related to known works]

Krcho, Jozef, 1999, Landscape as a spatially organized system and georelief as a subsystem of landscape—the influence of georelief on spatial differentiation of landscape proceses: http://www.mpsr.sk/slovak/dok/gn/book/45kap/45kap.htm. [online treatise on his random-field approach to geomorphometry, with illustrations & biblio]

Krebs, Norbert, 1923, Süddeutschland: Leipzig & Berlin, p. 6 (map), 1/4.5M scale. [2nd relative-relief map of So. Germany; 5 intervals]

Krebs, Norbert, 1928, Karte der Reliefenergie, *in* Die Ostalpen und das heutige Österreich, v. 1: Stuttgart, plate 5, 1/2M. [7 relative-relief intervals]

Kreslavsky, M.A., and Head, J.W. III, 1999, Kilometer-scale slopes on Mars and their correlation with geologic units—initial results from Mars Orbiter Laser Altimeter (MOLA) data: Journal of Geophysical Research, v. 104, no. E9, p. 21,911-21,924. [med. slope @ lengths 0.4-25 km; S/L comp. w/ GTOPO30 (slope same)]

Kreslavsky, M.A., and Head, J.W. III, 1999, Morphometry of small shield volcanoes on Venus—implications for the thickness of regional plains: Journal of Geophysical Research, v. 104, no. E8, p. 18,925-18,932. [arithmet. height/diameter stats; small domes; cf Bulwer &]

Kreslavsky, M.A., and Head, J.W. III, 2000, Kilometer-scale roughness of Mars—results from MOLA data analysis: Journal of Geophysical Research, v. 105, no. E11, p. 26,695-26,711. ['differential slope' vs. 0.6-20 km base length]

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Krümmel, O., 1979, Versuch einer vergleichenden Morphologie der Meeresräume (attempt at a comparative morphology of sea areas, in German): Leipzig, publ. & paging unknown.

[area/perimeter relation; Küstengliederung (coastal arrangement) in %, e = (100/U)(U-K); for K see Rohrbach, 1890]

Krupnik, Amnon, 2000, Accuracy assessment of automatically derived digital elevation models from SPOT images: Photogrammetric Engineering and Remote Sensing, v. 66, no. 8, p. 1017-1023. [good overall, some problems in agricultural land & moutains; ref. DEM 1-2m elev. acc.]

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Kuenen, Ph.H., 1935, Geological interpretation of the bathymetrical results, *in* The Snellius Expedition in the Eastern Part of the Netherlands East Indies 1929-1930: Leyden, E.J. Brill, v. 5, Geological Results, pt. 1, p. 62-69. [submarine slopes of composite andesite cones average 25º]

Kugler, Hans, 1965, Aufgaben, Grundsätze und methodische Wege für großmaßstabiges geomorphologisches Kartieren (in German): Petermanns Geographische Mitteilungen, v. 109, no. 4, p. 241-257. [slope & relief as components of large-scale geomorphologic maps]

Kühni, A., and Pfiffner, O.A., 2001a, Drainage patterns and tectonic forcing—a model study for the Swiss Alps: Basin Research, v. 13, no. 2, p. 169-197. [broad-scale SPM (surface-process modeling) of mtn. topography on 100x100 1-km grid cells yields var. relief & drainage patterns]

Kühni, A., and Pfiffner, O.A., 2001b, The relief of the Swiss Alps and adjacent areas and its relation to lithology and structure—topographic analysis from 250-M DEM: Geomorphology, v. 41, no. 4, p. 285-307. [broad-scale neo-orometry fr GTOPO30; rel. to erosion patterns; compare elev., relief, & slope; summit-level map]

Kumar, Muneendra, 2000, A WGS'84 orthometric height of Mount Everest: GPS World, v. 11, no. 10, p. 46-48. [29,028' / 8850m ± 2m, 1 sigma uncertainty]

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Kweon, I.S., and Kanade, Takeo, 1994, Extracting topological terrain features from elevation maps: Computer Vision, Graphics, and Image Processing / Image Understanding, v. 59, no. 2, p. 171-182. [definition of ridges & valleys based on 3 derivatives of elev.; 'topographic change trees' (3 types) descr. surface 'connectability']

Kyriakidis, P.C., Shortridge, A.M., and Goodchild, M.F., 1999, Geostatistics for conflation and accuracy assessment of digital elevation models: International Journal of Geographical Information Science, v. 13, no. 7, p. 677-707. [used higher-resolution DEM as 'ground truth']

L

La Barbera, P., and Lanza, L.G., 2000, Comment on 'A physical explanation of the cumulative area distribution curve' by Hemantha Perera and Garry Willgoose: Water Resources Research, v. 36, no. 3, p. 815-817. [gets different value of phi for CAD based on Tokunaga stream numbering]

La Barbera, P., and Lanza, L.G., 2001, On the cumulative area distribution of natural drainage basins along a coastal boundary: Water Resources Research, v. 37, no. 5, p. 1503-1509. [Horton analysis of independent conterminous basins outlet to the sea]

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Lague, D., Davy, Philippe, and Crave, Alain, 2000, Estimating uplift rate and erodability from the area-slope relationship—examples from Brittany (France) and numerical modelling: Physics and Chemistry of the Earth (A), v. 25, no. 6-7, p. 543-548. [spatially averaged uplift ratio computed fr 250-m DEM]

Lake, Philip, 1928, On hill slopes: Geological Magazine, v. 65, no. 3, p. 108-116. [early detailed slope profiles (n=9) for geomorph.; arcs fit circle or parabola]

Lancaster, Nicholas, 1981, Aspects of the morphometry of linear dunes of the Namib Desert: South African Journal of Science, v. 77, no. 8, p. 366-368. [orientation statistics]

Lancaster, S.T., and Bras, R.L., 2002, A simple model of river meandering and its comparison to natural channels: Hydrological Processes, v. 16, no. 1, p. 1-26. [based on planform sinuosity; more like cellular models; yields compound bends & multibend loops]

Lane, S.N., 2000, The measurement of river channel morphology using digital photogrammetry: Photogrammetric Record, v. 16, no. 96, p. 937-961. [review & progress rept.; now underutilized; data qual. a problem]

Lane, S.N., James, T.D., and Crowell, M.D., 2000, Application of digital photogrammetry to complex topography for geomorphological research: Photogrammetric Record, v. 16, no. 95, p. 793-821. [detailed quality & error analysis, not geomorph. applics. per se]

Langbein, W.B., 1964, Profiles of rivers of uniform change: U.S. Geological Survey, Professional Paper 501-B, 4 p. [concavity = 2A/F; F, fall; A, height diff. of straight line & profile in middle]

Laplace, P.S. de, 1825, no title for entry (in French), *in* Traité du Mécanique Céleste: J.B.M. Duprat, Paris, v. 5, book 11, chap. 1, p. 13, 14, 16 (var. cit.); see also, 4-v Engl. transl. by Nathaniel Bowditch, 1829-39, Boston MA. [Assuming conditions of equilibrium, deduced mean ocean depth = mean height (asl) of continents (3280 ft); this error inspired von Humboldt's (& others') calc. of mean height of continents]

Larsen, M.C., and Parks, J.E., 1998, Map showing landslide susceptibility in the Comerío Municipality, Puerto Rico: U.S. Geological Survey, Open-file Report 98-566, scale 1/20,000. [slope+elev.+aspect+land use+debris-flow meas. = 3 classes]

Lastochkin, A.N., 1987, Morphometrical investigations in geomorphology. I. Classification of morphometric constructs and characteristics (in Russian, v. brief English summary): Vestnik Leningradskogo Universiteta; Geologiia, Geografii, Serie 7, 1987, no. 3, p. 44-53. [proposed classification; long table; 36 refs. incl. Krcho & Pal]

Lastochkin, A.N., 1988a, Morphometrical investigations in geomorphology. II. Studies of morphological features of the Earth's surface (in Russian, v. brief English summary): Vestnik Leningradskogo Universiteta; Geologiia, Geografii, Serie 7, 1988, no. 1, p. 37-50. [reviews range of morph. attributes; cites Krcho; 27 refs.]

Lastochkin, A.N., 1988b, Morphometrical investigations in geomorphology. III. Studies of the morphology of constituent parts of the Earth's surface (in Russian, v. brief English summary): Vestnik Leningradskogo Universiteta; Geologiia, Geografii, Serie 7, 1988, no. 3, p. 50-64. [further? reviews range of morph. attributes; 36 refs.]

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Leberl, F.W., 1980, Application of imaging radar to mapping, *in* Radar geology—an assessment, report of the Radar Geology Workshop: Snowmass, CO, 16-20 July 1979, Jet Propulsion Laboratory Publication 80-61, p. 307-335. [reviews topographic mapping fr. radargrammetry; large biblio.]

Leberl, F.W., 1998, Radargrammetry, Chapter 4 *in* Henderson, F.M., and Lewis, A.J., eds., Manual of Remote Sensing (3rd ed.), v. 2, Principles and Applications of Imaging Radar: New York, John Wiley & Sons, p. 183-269. [state-of-art review; refs occupy p. 252-269]

Leblanc, F., 1842, Observations sur le maximum d'inclinaison des talus dans les montagnes (in French): Bulletin de la Société Géologique de la France, v. 14, p. 85-98. [126 values from var. sources; among earliest systematic measurements of slope]

Lecce, S.A., 1991, Influence of lithologic erodibility on alluvial fan area, western White Mountains, California and Nevada: Earth Surface Processes and Landforms, v. 16, no. 1, p. 11-18. [power functions relating fan to basin area]

Lee, Jay, 1994, Digital analysis of viewshed inclusion and topographic features on digital elevation models: Photogrammetric Engineering and Remote Sensing, v. 60, no. 4, p. 451-456. [defines pixel dominance in intervisibility; contrasts peaks, pits, ravines, ridges]

Lee, J.I., and Kim, S.H., 2000, Application of topographic index calculation algorithm considering topographic properties (in Korean with English abstract): Journal of Korea Water Resources Association, v. 33, no. 3, p. 279-288. [test TOPMODEL by DEM's at 20, 30, 40, 50 m grids]

Leech, M.L., Egger, A.E., and Howell, D.G., 2002, A guided inquiry approach to learning the geology of the U.S. (abs.): Geological Society of America, Annual Meeting, Denver, CO, 27-30 October, paper no. 154-12; http://gsa.confex.com/gsa/2002AM/finalprogram/abstract_37904.htm. [pedagogic applic. of broad-scale computer visualization combining shaded relief & geology]

Legates, D.R., and Wilmot, C.J., 1986 Interpolation of point values from isoline maps: American Cartographer, v. 13, no. 4, p. 308-323. [D.H. Douglas' contour to grid method CONSURF better than prior algorithms]

Legendre, Pierre, and Legendre, Louis, 1998, Spatial analysis, Ch. 13 *in* Numerical Ecology (2nd English ed., 853 p.): Amsterdam, Elsevier, p. 707-785. [statistics, well explained; 'practical handbook & ref. text']

Lehmann, J.G., 1831, On situation, or the guide for correct representation of the landsurface on topographic maps and plans (in Russian, transl. fr. German): St. Petersburg, 74 p. [no info; may be transl. of Lehmann 1799, who invented hachuring, the basis of analytical (i.e. quant.) hill-shading; used slope hachures & later shadow hachures]

Lehmann, Otto, 1934, Über die morphologischen Folgen der Wandwitterung (in German; morph. consequences of cliff weathering): Zeitschrift für Geomorphologie, v. 8, p. 93-99. [refinement of Fisher's 1866 theory; added effects of cliff & scree angles, rock/scree V ratio]

Lehmeier, Friedmut, 1993, Auszug des Symbolschlussels Geomorphologie (DARG) (in German: extract from the Geomorphology Data Code (DARG)): Geologisches Jahrbuch, v. F26, no. 2, p. 47-135. [see Roeschmann & Lehmeier 1993; fleshes out detailed system of relief char. in plan & profile; Kugler, Demek infl.]

Leith, A.C., and McKinnon, W.B., 1991, Terrace width variations in complex Mercurian craters and the transient strength of cratered Mercurian and lunar crust: Journal of Geophysical Research, v. 96, no. E4, p. 20,923-20,931. [after Pearce & Melosh 1986; uses some Pike 1988 D & d data; discusses peak recoil vs rim slumping]

Lemmens, M.J.P.M., 1999, Uncertainty in automatically sampled digital elevation models, Ch. 47 *in* Lowell, Kim, and Jaton, Annick, eds., Spatial Accuracy Assessment—Land Information Uncertainty in Natural Resources: Chelsea, MI, Ann Arbor Press, p. 399-407. [DEM uncertainty poorly known & sources complex; manual capture breaklines best]

Leopold, L.B., 1970, Review of studies of hillslopes – U.S.A.: Zeitschrift für Geomorphologie, Supplementband 9, p. 57-66. [summarizes some 1960's morphometry]

Lessing, Peter, and Erwin, R.B., 1977, Landslides in West Virginia, *in* Coates, D.R., ed., Reviews in Engineering Geology, Geological Society of America, v. 3, Landslides: p. 245-254. [summarizes 1976 work; slope concavity & proximity to other slides assoc. w/ slides, no preferred azimuth]

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Lessing, Peter, Messina, C.P., and Fonner, R.F., 1983, Landslide risk assessment: Environmental Geology, v. 5. no. 2, p. 93-99. [2416 W.VA slides; summary diagram incl. bedrock, dip dir., slope, aspect. area, est. curve., proximity other slides, etc.]

Leverington, D.W., Teller, J.T., and Mann, J.D., 2002, A GIS method for reconstruction of late Quaternary landscapes from isobase data and modern topography: Computers and Geosciences, v. 28, no. 5, p. 631-639. [interpolated isobases subtracted from present topo. & bathymetry]

Lex, Franz, 1925, Karte der relativen Höhen in Kärnten (in German): Vienna, Kärntner Heimatlas, map 4, 1/1.75M. [5-km separation of points; 7 intervals]

Li, Rongxing, Liu, J.-K., and Felus, Yaron, 2001, Spatial modeling and analysis for shoreline change detection and coastal erosion monitoring: Marine Geodesy, v. 24, no. 1, p. 1-12. [computes DEM surfaces of water & lake bottom to get shoreline]

Li, Xin, Lu, Ling, Cheng, Guodong, and Xiao, Honglang, 2001, Quantifying landscape structure of the Heihe River Basin, north-west China using FRAGSTATS: Journal or Arid Environments, v. 48, no. 4, p. 521-535. [6 ecoregions delimited fr 9 metrics; technique could be applied to shaded-relief, other topo data?]

Li, Yingkui, Liu, Gengnian, and Cui, Zhijiu, 2001a, Glacial valley cross-profile morphology, Tien Shan Mountains, China: Geomorphology, v. 38, nos. 1-2, p. 153-166. [quadratic eqns better than power law; Rockies differ fr TS; glac. & fluv. valleys differ quant'ly.]

Li, Yingkui, Liu, Gengnian, and Cui, Zhijiu, 2001b, Longitudinal variations in cross-section morphology along a glacial valley—a case study from the Tien Shan, China: Journal of Glaciology, v. 47, no. 157, p. 243-250. [new, variable width/depth ratio model uses slope & breadth]

Liang, Chaojun, and Mackay, D.S., 1997, Feature-based optimization of flow directions and upslope areas on grid-based digital elevation models, *in* GIS/LIS'97, Cincinnati, OH, October, Proceedings: Bethesda MD, ASPRS, p. 45-52. [refined Mackay & Band 1998 approach by adding rule-based heuristic]

Liang, Chaojun, and Mackay, D.S., 2000, A general model of watershed extraction and representation using globally optimal flow paths and up-slope contributing areas: International Journal of Geographical Information Science, v. 14, no. 4, p. 337-358. ['breadth-first' search + 'feature-based global opt.' gives good DEM-based results in flat terrain]

Lidov, V.P., Setunskaya, L.E., and Khmeleva, N.V., 1956, Study of erosion microforms by quantitative methods, *in* Rihter, G.D., and Dyachenko, A.E., eds., Agricultural Erosion and Its Control: Soviet Academic Press, Moscow, p. 47-69. [no info]

Lindstrom, Peter, Koller, David, Ribarsky, William, Hodges, L.F., Faust, Nick, and Turner, G.A., 1996, Real-time, continuous level of detail rendering of height fields, *in* SIGGRAPH'96 Conference, 4-9 August, New Orleans LA, Proceedings: p. 109-118; <http://www.gvu.gatech.edu/people/peter.lindstrom/papers/siggraph96/>. [important; dynamic DEM display using regular grid; triangular-bintree mesh & bottom-up vertex-reduction; some similarities to later ROAM algorithm]

Link, L.E., 1969, Capability of airborne laser profilometer to measure terrain roughness, *in* Symposium on remote sensing of environment, 6th, Ann Arbor, MI, Proceedings: v. 1, p. 189-196. [12 varied test sites; may be OK if sources of error eliminated]

Linnett, L.M., Clarke, S.J., Graham, C., and Langhorne, D.N., 1991, Remote sensing of the sea-bed using fractal techniques: Journal of Electronics and Communication Engineering, v. 3, no. 5, p. 195-203. [classified images of the seafloor by fractal segmentation]

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Liu, Hongxing, and Jezek, K.C., 1999, Investigating DEM error pattern by directional variograms and Fourier analysis: Geographical Analysis, v. 31, no. 3, p. 249-256. [varies; ± 2-100m at 0.2-5km res.; used their Antarctic data]

Liu, Hongxing, Jezek, K.C., and Li, Biyan, 1999, Development of an Antarctic digital elevation model by integrating cartographic and remotely sensed data—a geographic information system based approach: Journal of Geophysical Research, v. 104, no. B10, p. 23,199-23,213. [best yet; 0.2-5km res. ± 2-100m.; derived shaded relief & flow lines]

Liu, Xi-lin, 2000, Approaches to risk assessment of debris flow (in Chinese): Journal of Mountain Science, v. 18, no. 4, p. 341-345. [basin A & R, channel L, drainage density, active channel proportion]

López, A.M., 1997, Ridge/valley-like structures—creases, separatrices, and drainage patterns, *in* CVonline: On-Line Compendium of Computer Vision, R. Fisher, ed., online Oct. 8, 1997; <http://www.dai.ed.ac.uk/CVonline/LOCAL_COPIES/LOPEZ/cvonline.html>. [review of descriptive-geometric fundamentals of drainage nets, their 19th C. developmental history, & how & why they relate closely to computer vision & (briefly) to the DEM-to-watershed transformation; English translation from the Spanish]

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López, A.M., 1999, Delineation of drainage patterns in gridded DEMs, Ch. 5 *in* Multilocal methods for ridge and valley delineation in image analysis: Ph.D thesis, Universitat Autónoma de Barcelona, p. 125-167; <http://www.cvc.uab.es/shared/staff/all_staff/antonio.htm>. ['free-flow' algorithm uses flowlines rather than pixel-to-pixel routing]

López, A.M., Lumbreras, F., Serrat, Joan, and Villanueva, J.J., 1999, Evaluation of methods for ridge and valley detection: IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI), v. 21, p. 327-335. [descriptive geometry of drainage nets in machine vision; see López 1997]

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Lopéz-Santoyo, A., 1978, Structural relief interpretation through profile analysis, *in* Davis, J.C., ed., Computer Mapping for Resource Analysis, a CoGeoData Conference, Kansas Geological Survey, University of Kansas, and Instituto de Geografía de la UNAM, Mexico, Proceedings: p. 168-182. [no info]

Loveland, T.R., and Ramey, Ben, 1986, Applications of U.S. Geological Survey Digital Cartographic Products, 1979-1983: U.S. Geol. Survey, Bulletin 1583, 44 p. [several use 7.5' DEM's, Digital Terrain Tapes, & Arc-second DEM's]

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Luo, Wei, 2000, Quantifying groundwater-sapping landforms with a hypsometric technique: Journal of Geophysical Research, v. 105, no. E1, p. 1685-1694. [5 parameters of the hyps. curve differentiate fluvial fr. sapping basins]

Luo, Wei, 2000, Review of RiverTools, version 2.0, Research Systems, Inc., 4990 Pearl East Circle, Boulder, CO 80301: Computers and Geosciences, v. 26, no. 2, p. 237-238. [easy to use, excellent visualiz.; needed improvements typical of early version software]

Luo, Wei, 2001, LANDSAP—a coupled surface and subsurface cellular automata model for landform simulation: Computers and Geosciences, v. 27, no. 3, p. 363-367. [based on model of Chase 1992 to model Martian channel devel.]

Luo, Wei, 2002, Hypsometric analysis of Margaritifer Sinus and origin of valley networks: Journal of Geophysical Research. v. 107E, no. E10, 10.1029/2001JE001500. [MOLA data; most basins have hypso. char. of groundwater sapping, some fluvial]

Luoma-Aho, Seppo, 1982, Landforms and morphostructure in Koillismaa, Finland: Fennia, v. 160, no. 1, p. 1-41. [1/20K elevs etc. gridded at 1 & 2km; made maps of elev, relative relief, form density, aspect, geology; correl. matrices]

Lüttig, Gerd, 1953, Eisrand und Reliefenergie: Neues Jahrbuch für Geologie und Palaeontologie Monatshefte (Stuttgart), v. 1, p. 16-20. [position of Saale ice margin determined fr contrast in relative relief]

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M

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Macar, Paul, 1963, Etudes récentes sur les pentes et l'évolution des versants en Belgique: Nachr. Akad. d. Wiss. Göttingen, Math. Phys. Klasse, p. 71-84. [slope-profile analysis from large-scale maps]

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Mackay, J.R., 1954, Arithmetic-square root graph paper: The Professional Geographer, v. 6, no. 1, p. 15-16. [one way to speed up the graphing of ground slope and area curves]

Mackey, B.G., Widdifield, C.A., McKenney, D.W., Lawrence, K.M., Szcyrek, N., and Sims, R.A., 1994, Development of a new digital elevation model for Ontario, *in* Lee, Y. C. (chairperson), Canadian conference on GIS / Conference Canadienne sur les SIG, Ottawa, 6-10 June, Proceedings: p. 633-645. [see 1994 report]

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MacLeod, Norman, 1999, Generalizing and extending the eigenshape method of shape visualization and analysis: Paleobiology, v. 25, no. 1, p. 107-138. [a special case of 'relative warp analysis (Bookstein 1991) defined over broad variety of phenomena & representational strategies; advocates combining 'landmark' with 'outline' techniques; MAC & Wintel software download at http://life.bio.sunysb.edu/morph/]

MacLeod, Norman, 2002, Geometric morphometrics and geological shape-classification systems: Earth-Science Reviews, v. 59, nos. 1-4, p. 27-47. [reviews & discusses new 'conceptual synthesis'; distinguishes 'geometry', 'pattern recognition', & 'morphometrics' approaches; re-do of sed. grain, leaf, & valley shape classifications by eigenshape analysis of 'landmarks'; 8 alpine-valley cross-sections ('V' vs. 'U') fr R.J. Small 1972 geomorph. text]

Madej, M.A., 2001, Development of channel organization and roughness following sediment pulses in single-thread, gravel bed rivers Water Resources Research, v. 37, no. 8, p. 2259-2272. [step spacing & A/channel slope; autocorrel.; thalweg-profile analysis]

Maerz, N.H., Chepur, Poornima, Myers, J.J., and Linz, Justin, 2001, Concrete roughness characterization using laser profilometry for fiber-reinforced polymer sheet application: National Research Council, Washington D.C., Transportation Research Record, no. 1775, p. 132-139; http://www.utc.umr.edu/Publications/Proceedings/2001/TRBconc.pdf. ['laser striping', adapt. of 'shadow profilometry' devel. fr. princ. of the Schmaltz microscope; 3 roughness params. (all same?, i.e., slope); reveals inconsistency in 1 of 9 CSP standard surfaces]

Maerz, N.H., and Franklin, J.A., 1990, Roughness scale effect and fractal dimension, *in* Pinta da Cunha, A., International Workshop on Scale Effects in Rock Masses, 1st, Loen, Norway June 4-6, Proceedings: Rotterdam, Balkema, p. 121-126. [shadow profilometry after Schmalz 1936; rock-joint surfaces not self-similar]

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Malamud, B.D., and Turcotte, D.L., 2001, Wavelet analyses of Mars polar topography: Journal of Geophysical Research, v. 106, no. E8, p. 17,497-17,504. [power-law dependence of WT variance on wavelength, $b \approx 3.5-3.7$]

Maling, D.H., 1955, The geomorphology of the Wear Valley: Durham, UK, University of Durham, Ph.D. thesis, paging unknown. [5000 grid squares minimum req. for stat. signif. sample of topography]

Malthe-Sørenssen, Anders, Walmann, Thomas, Jamtveit, Bjørn, Feder, Jens, and Jøssang, Torstein, 1999, Simulation and characterization of fracture patterns in glaciers: Journal of Geophysical Research, v. 104, no. B10, p. 23,157-23,174. [simple model of scaling relation for circumferential pattern on Iceland cauldron]

Malzbender, Thomas, Gelb, Daniel, and Wolters, Hans, 2001, Polynomial texture maps, in SIGGRAPH 2001, Los Angeles, CA, 12-17 August, Proceedings: p. 519-528; http://www1.acm.org/pubs/articles/proceedings/graph/383259/p519-malzbender/p519-

malzbender.pdf. [enhances photorealism by storing coefficients of biquadratic polynomial in each texel (texture cell); uses images not DEMs]

Malyavsky, B.K., and Zharnovsky, A.A., 1974, On digital terrain modelling (in Russian): Geodesiya i Cartographiya, no. 6, p. 31-38. [no info]

Mandelbrot, B.B., 1985, Self-affine fractals and fractal dimension: Physica Scripta (Sweden), v. 32, no. 4, p. 257-260. [suggests relief profiles are not self-similar, & D of non-fractal objects can be calculated, but it has no theoretical meaning]

Mandelbrot, B.B., 2002, Gaussian Self-Affinity and Fractals—globality, the Earth, 1/F noise, and R/S—selecta (old or new) vol. H: New York, Springer, 663 p. [selected works, reprinted, transl. or new w annotations & guest contrib.]

Mangold, N., and Allemand, P., 2001, Topographic analysis of features related to ice on Mars: Geophysical Research Letters, v. 28, no. 3, p. 407-410. [topographic profiles, topo. params of debris aprons & scarps]

Manning, G., Fuller, L.G., Eilers, R.G., and Florinsky, I.V., 2001, Topographic influence on the variability of soil properties within an undulating Manitoba landscape: Canadian Journal of Soil Science, v. 81, no. 4, p. 439-447. [apply terrain-segmentation (by R, plan/profile curv., slope, catchment) to get 'landform element complexes']

Mansikkaniemi, Hannu, 1970, The sinuosity of rivers in northern Finland: Publicationes Instituti Geographici Universitatis Turkuensis, v. 52, p. 16-32. [new method for degree & quality of sinuosity]

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Margot, J.-L.C., Campbell, D.B., Jurgens, R.F., and Slade, M.A., 1999, Topography of the lunar poles from radar interferometry—a survey of cold trap locations: Science, v. 284, no. 5420, p. 1658-1660. [150-m XY/50-m Z res. of hard-to-see terrain]

Mark, D.M., 1997, The history of geographic information systems—invention and re-Invention of triangulated irregular networks (TINS): GIS/LIS'97, Cincinnati, OH, October 28-30, Proceedings: CD-ROM, p. 267-272. ['multiple invention'; precusors (Hormann &), T. Poiker, ADAPT, & C. Gold]

Mark, D.M., and Smith, Barry, 2002?, A science of topography—bridging the qualitative-quantitative divide, *in* Shroder, J.F. Jr., and Bishop, M.P., eds., Geographic Information Science (GIScience) and Mountain Geomorphology: Chichester UK, Praxis Scientific Publishing / Springer-Verlag, in press. <http://wings.buffalo.edu/philosophy/faculty/smith/articles/topography.pdf>. [some basic underpinnings for morphometry; defining mountains & topo. in the geospatial domain; J.J. Gibson concepts]

Mark, D.M., and Smith, Barry, 2002?, Do mountains exist? Ontology of landforms and topography: Environment & Planning B, in-press. <http://wings.buffalo.edu/philosophy/faculty/smith/articles/Mountains.htm>. [more theoretical background for morphometry; defining mtns. & topo. in geospatial domain'; Gibsonian concepts elaborated]

Marks, Kate, and Bates, Paul, 2000, Integration of high-resolution topographic data with floodplain flow models: Hydrological Processes, v. 14, nos. 11-12, p. 2109-2122. [high accuracy of LIDAR data needed to get good flood-hazard model]

Martinoni, Daria, and Bernhard, Luzi, 1998, A conceptual framework for reliable digital terrain modelling, *in* Spatial Data Handling '98 Conference, 11-15 July, Vancouver, BC, Proceedings: p. 737-750. [approach to DEM error evaluation & prevention]

Martinoni, Daria, and Schneider, Bernhard, 1999, Pluggable terrain module—moving digital terrain modelling to a distributed geoprocessing environment, *in* Vckovski, A., Brassel, K.E., and Schek, H.-J., eds., INTEROP 1999, Interoperating Geographic Information Systems, 2nd, Zürich, Proceedings: Lecture Notes in Computer Science 1580, Springer, Heidelberg & Berlin, p. 315-327. [programming software architecture]

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Mason, D.C., Davenport, I.J., Flather, R.A., and Gurney, C., 1998, A digital elevation model of the inter-tidal areas of the Wash, England, produced by the waterline method: International Journal of Remote Sensing, v. 19, no. 8, p. 1455-1460. [DEM fr. tide-surges on ERS-1 SAR images]

Mason, P.J., Rosenbaum, M.S., and Moore, J.McM., 1998, Digital image texture analysis for landslide hazard mapping, *in* Maund, J.G., and Eddleston, Malcolm, eds., Geohazards in Engineering Geology: London, The Geological Society, Engineering Geology Special Publication no. 15, p. 297-305. [enhance contrast, etc.; fine res. (10m or better) essential; still need DEM]

Masoud, Alaa, Masumoto, Shinji, Raghavan, Venkatesh, Kajiyama, Atsusuhi, and Shiono, Kiyoji, 2002, Landscape modeling and analysis based on digital elevation models generated from topographic maps—algorithm and appliocation on Safaga area, Red Sea coast, Egypt: Journal of Geosciences, Osaka City University, v. 45, art. 6, p. 73-87. [28.5-m-res. DEM min. discretization; curv.-based classif. into ridges, channels, & conv., conc., & planar slopes]

Massari, Remo, and Atkinson, P.M., 1999, Modeling susceptibility to landsliding—an approach based on individual landslide type: Transactions, Japanese Geomorphological Union, v. 20, no. 3, p. 151-168. [generalized linear modeling; logistic regress.; geol., slope & veg. dominant]

Mather, A.E., Harvey, A.M., and Stokes, M., 2000, Quantifying long-term catchment changes of alluvial fan systems: Geological Society of America Bulletin, v. 112, no. 12, p. 1825-1833. [log-log fan & drainage area]

Matmon, A., Zilberman, E., and Enzel, Y., 2000, Determination of escarpment age using morphologic analysis—an example from the Galilee, northern Israel: Geological Society of America Bulletin, v. 112, no. 12, p. 1864-1876. [normalized distance/altitude graphs]

Mattar, K.E., Gray, A.L., Geudtner, D., and Vachon, P.W., 1999, Interferometry for DEM and terrain displacement—effects of inhomogeneous propagation: Canadian Journal of Remote Sensing, v. 25, no. 1, p. 60-69. [atmospheric vagaries a problem; need multiple independent measurements]

Matui, Isamu, 1932, Statistical study of the distribution of scattered villages in two regions of the Tonami Plain, Toyama Prefecture: Japanese Journal of Geology and Geography, v. 9, p. 251-255. [1st use of the quadrat method for spatial analysis in geography?]

Maunder, C.J., 1999, An automated method for constructing contour-based digital elevation models: Water Resources Research, v. 35, no. 12, p. 3931-3940. [uses natural flow lines & contours; no user-defined critical points]

Maune, D.F., ed., 2001, Digital Elevation Model Technologies and Applications, the DEM Users Manual: Bethesda, MD, American Society for Photogrammetry & Remote Sensing, 540 p.; https://eserv.asprs.org/wasprs/staticcontent/staticpages/1067.htm. [13 chapters on DEM operational issues; vert datums, accuracy stds, USGS DEM program, photogramm., IFSAR, LIDAR (incl. airborne bathymetry), SONAR, enabling tech., quality assessment]

Maxwell, J.C., 1955, The bifurcation ratio in Horton's law of stream numbers (abs.): Transactions, American Geophysical Union, v. 36, no. 3, p. 520. [modified to apply to stream segments; in plot of log str. no. & str. order, abs. val. of antilog of slope of linear fit = bifurc. ratio]

Maxwell, J.C., 1967, 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. [publ. of 1960 thesis; of Strahler students the most aware of European morphometry; multiple-regression analysis confirmed Hortonian 'laws' in steep semi-arid terrain]

Mayer, L., 2000, Application of digital elevation models to macroscale tectonic geomorphology, *in* Summerfield, M.A., ed., Geomorphology and Global Tectonics (papers from International Conference on Geomorphology 4th, Bologna, 1999): Chichester UK and New York, Wiley, paging unknown. [no info; presumably *Larry* Mayer, the quant. geomorphologist; see Mayer 1990 & 1994?]

McAdoo, B.G., Pratson, L.F., and Orange, D.L., 2000, Submarine landslide geomorphology, US continental slope: Marine Geology, v. 169, nos. 1-2, p. 103-136. [15 morphometric params. for 83 slides; histograms, correlations]

McAllister, Michael, 1999, A watershed algorithm for triangulated terrains, *in* Canadian Conference on Computational Geometry 11th, Vancouver, BC, University of British Columbia, 15-18 August, Proceedings: p. 103-106 http://www.cs.ubc.ca/conferences/CCCG/elec_proc/fp50.pdf (8 p.). [DEM-to-watershed transformation; vector-based algorithm guarantees one polygon per basin]

McAllister, Michael, and Snoeyink, Jack, 1997, Medial axis generalisation of hydrology networks, *in* Auto-Carto 13, Symposium on Automated Cartography 13th, 5-10 April, Seattle WA, Proceedings: p. 164-173. [from TIN; added benefits from use to depict rivers & lakes; similar to M&S 2000?]

McAllister, Michael, and Snoeyink, Jack, 1999, Extracting consistent watersheds from digital river and elevation data: ASPRS Annual Conference, http://www.cs.ubc.ca/spider/snoeyink/papers/asprs99.pdf. [combine TIN & steepest-descent flow models to identify watershed breaklines]

McAllister, Michael, and Snoeyink, Jack, 2000, Medial axis generalization of river networks: CaGIS, v. 27, no. 2, p. 129-138. [Voronoi quant.-carto. relation of medial axis to riverbank from TIN; similar to M&S 1997?]

McArthur, D.E., Fuentes, R.W., and Devarajan, Venkat, 2000, Generation of hierarchical multiresolution terrain databases using wavelet filtering: Photogrammetric Engineering and Remote Sensing, v. 66, no. 3, p. 287-295. [scale-variant hierarchical triangulations (ca. like a quadtree)]

McBride, E.F., and Picard, M.D., 2000, Origin and development of tafoni in Tunnel Spring Tuff, Crystal Peak, Utah, USA: Earth Surface Processes and Landforms: v. 25, no. 8, p. 869-879. [height, width, depth plots fr field meas.]

McCarroll, Danny, 1992, A new instrument and techniques for the field mesurement of rock surface roughness: Zeitschrift für Geomorphologie, v. 36, no. 1, p. 69-79. [micro-roughness meter; 2 indices: slope std. dev., mean abs. diff adjacent slopes]

McClung, D.M., 2001, Characteristics of terrain, snow supply and forest cover for avalanche initiation caused by logging: Annals of Glaciology, v. 32, p. 223-229. [probl. plot for start-zone slope; cross- & down-slope shape; concave slopes most at risk]

McGill, G.E., 2001, The Utopia Basin revisited—regional slope and shorelines from MOLA profiles: Geophysical Research Letters, v. 28, no. 3, p. 411-414. [topographic profiles, crater size/frequency]

McNamara, J.P., Kane, D.L., and Hinzman, L.D., 1999, An analysis of an Arctic channel network using a digital elevation model: Geomorphology, v. 29, nos. 3-4, p. 339-353. [scaling char. hold only for channels larger than permafrost 'water tracks'; 10-m DEM]

Medler, M.J., and Yool, S.R., 1998, Computer-assisted terrain stratification: Physical Geography, v. 19, no. 5, p. 433-443. [Terrain 'poses' (types?) from combo of elev, slope & aspect by RGB Dig. I-P]

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Melton, M.A., 1965, The geomorphic and paleoclimatic significance of alluvial deposits in southern Arizona: Journal of Geology, v. 73, no. 1, p. 1-38. [alluvial fan slope related to basin relief & area]

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Meyer, Fernand, 1991, Un algorithme optimal de ligne de partage des eaux (in French): 8ème Congrès RFIA, Lyon, France, p. 847-857. [most efficient algorithm for grey scale-to-'watershed' transformation for image segmentation]

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Meyer, T.H., Eriksson, Marian, and Maggio, R.C., 2001, Gradient estimation from irregularly spaced data sets: Mathematical Geology, v. 33, no. 6, p. 693-717. [a generalization of finite-difference methods; uses directional derivatives; see M.E.M. 1997]

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Miliaresis, G.Ch., 1999, Automated segmentation of alluvial fans to regions of high to intermediate flood hazard from Landsat Thematic Mapper imagery, *in* International Symposium on Operationalization of Remote Sensing, 2nd, ITC Enschede, Neth., August 16-20, Proceedings: CD-ROM; abstract = http://www.itc.nl/ags. [Old Army 3' DEM; Death Valley; complex procedure (region-growing), req. Landsat image]

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reference list): National Technical University of Athens, Dept. of Surveying and Regional Planning, unpublished Ph.D. thesis, 267 p.   [Zagros & Great Basin mtns. fr GTOPO30, their extraction, parametric repr., fuzzy repr. & pattern recognition]

Miliaresis, G.Ch., 2001a, Geomorphometric mapping of Zagros Ranges at regional scale: Computers and Geosciences, v. 27, no. 7, p. 775-786.   [mountains delimited by region-growing algorithm]

Miliaresis, G.Ch., 2001b, Extraction of bajadas from digital elevation models and satellite imagery: Computers and Geosciences, v. 27, no. 10, p. 1157-1167.   [bajadas delimited by slope & drainage pixels in region-growing algorithm]

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Miliaresis, G.Ch., and Argialas, D.P., 2000, Extraction and delineation of alluvial fans from digital elevation models and Landsat thematic map images: Photogrammetric Engineering and Remote Sensing, v. 66, no. 9, p. 1093-1101.   [Old Army 3' DEM; Death Valley; complex procedure (region-growing), req. Landsat image]

Miliaresis, G.Ch., and Argialas, D.P., 2002, Quantitative representation of mountain objects extracted from the global digital elevation model (GTOPO30): International Journal of Remote Sensing, v. 23, no. 5, p. 949-964.   [12 mtn. params. classif. by K-means into 4 spatially distinct mtn. clusters]

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Miller, J.P., 1958, High mountain streams—effects of geology on channel characteristics and bed material: Socorro NM, State Bureau of Mines and Mineral Resources, Memoir 4, 53 p.   [Hack's law & other quant. relations verified in Sange de Cristo Range]

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Mitchell, N.C., 2001, Transition from circular to stellate forms of submarine volcanoes: Journal of Geophysical Research, v. 106, no. B2, p. 1987-2003. [n=141; elongation, moment of inertia, perimeter dist.; trans. ca. 3 km edifice height]

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Mizukoshi, Hiroko, and Aniya, Masamu, 2002, Use of contour-based DEMs for deriving and mapping topographic attributes: Photogrammetric Engineering and Remote Sensing, v. 68, no. 1, p. 83-93. [algorithms generate flow (fall) lines and then compute slope gradient & aspect & classify & map slope profile & plan forms]

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http://agile.isegi.unl.pt/Conference/Brno2001/Questions.pdf. [review briefly mentions fractals, TIN, Warntz nets; biblio]

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Montgomery, D.R., Balco, Greg, and Willet, S.D., 2001, Climate, tectonics, and the morphology of the Andes: Geology, v. 29, no. 7, p. 579-582. [broad-scale orometry; cross-range asymmetry, width, hypsometry, & max. elev.]

Montgomery, D.R., and Brandon, M.T., 2002, Topographic controls on erosion rates in tectonically active mountain ranges: Earth and Planetary Science Letters, v. 201, no. 3-4, p. 481-489. [slope & relief; nonlinear rate w/ relief; GTOPO30 local relief on 10 km circles for 4 continents]

Montgomery, D.R., and Dietrich, W.E., 1994, A physically based model for the topographic control on shallow landsliding: Water Resources Research, v. 30, no. 4, p. 1153-1171. http://socrates.berkeley.edu/~geomorph/shalstab/. [development of software to predict debris flow]

Montgomery, D.R., and Greenberg, H.M., 2000, Local relief and the height of Mount Olympus: Earth Surface Processes and Landforms, v. 25, no. 4, p. 385-396. [valley W/slope L & % local relief (30-m DEM) infer eros. control of high peak location]

Moore, I.D., Burch, G.J., and Mackenzie, D.H., 1988, Topographic effects on the distribution of surface soil water and the location of ephemeral gullies: Transactions, American Society of Agricultural Engineers, v. 31, no. 4, p. 1098-1107. [topo. heterogeneity vital in pred. catchment moisture; TOPO software for terrain analysis formally became TAPES]

Moores, E.A., 1966, Regional drainage basin morphometry: Iowa State University, Ames, IA, unpublished Ph.D. dissertation, paging unknown. [Drainage basin morphometry, fluvial features]

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Morawetz, Sieghard, 1937, Das Problem der Taldichte und Hangzerschneidung (in German; The problem of valley density and slope incision): Petermanns Geographische Mitteilungen, v. 83, no. 12, p. 346-350. [comparative drainage density (12 refs.) & geomorphic process]

Morawetz, Sieghard, 1939, Reliefenergie und Vergletscherung in der Nanga Parbat-Gruppe: Zeitschrift für Gletscherkunde, v. 26, no. 3-4, p. 303-307. [no info]

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Morgen, Herbert, 1940, Die natürlichen Ertragsfaktoren ... in 26 Landkreisen Pommerns. Ein raum-politische Studie (in German; natural yield factors ... in 26 Pomeranian districts. A geo-political study): Berichte über Landwirtschaft, N.F., no. 151, p. 28. [map of relative relief; 1/850K; 8 intervals]

Morisawa, M.E., 1959a, Relation of morphometric properties to runoff in the Little Mill Creek, Ohio, drainage basin: Office of Naval Research Project NR 389-042, Contract N6 ONR 271-30: Nonr 266 (50), Technical Report no. 17: New York, Columbia University, Department of Geology, 10 p. [prelude to thesis; signif. power-fcn. correl. for stream L, relief ratio, & 2 shape ratios]

Morisawa, M.E., 1959b, Relation of quantitative geomorphology to stream flow in representative watersheds of the Appalachian Plateau province: Office of Naval Research Project NR 389-042, Contract N6 ONR 271-30: Nonr 266 (50), Technical Report no. 20: New York, Columbia University, Department of Geology, 94 p. [published in 1962; identified 5 diff. types of difficulty in defining channel networks fr contour maps]

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Mossman, James, 2001, New color system enhances relief mapping: ArcUser (ESRI, Redlands CA), Jan.-March, p. 54-56. [continuous-appearing shaded-relief fr lighter, closer-spaced color palette]

Mostafa, M.E., and Hussein, M.T., 1997, Automated characterization of some morphological features with application to Khor Baraka drainage basin, Sudan: Journal of King Abdulaziz University (Saudi Arabia), Earth Science, v. 9, p. 39-55, 1997. [basin perimeter, total & fractal areas, hypsometric curves, network maps]

Mueller, J.E., 1972, Re-evaluation of the relationship of master streams and drainage basins: Geological Society of America Bulletin, v. 83, no. 11, p. 3471-3473. [Hack's law exponent ~0.47 for 65 mid-to-large basins]

Mueller, J.E., 1973, Re-evaluation of the relationship of master streams and drainage basins—reply: Geological Society of America Bulletin, v. 84, no. 9, p. 3127-3130. [Hack's law exponent ~0.55 for 250 small-to-large basins; stream sinuosity not an influence on ~0.5 exponent]

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Müller, Emil, 1912, Lehrbuch der Darstellenden Geometrie für Technische Hochschulen, v. I (in German; 1st publ. 1908?, v. 2 in 1916): Leipzig & Berlin, Teubner, p. 52. [inspired Rothe 1915?; ascribes earliest descriptive-geometric treatment of ridges & watercourses to Dupuis de Torcy & Brisson 1808, but claims 'a perfectly rigorous geometrical definition ... has not yet been found']

Müller, Emil, 1919, Besondre Punkte und Linien auf der Geländefläche; Verlauf von Schichten- und Fallinien (in German: special points & lines on the ground surface; course of contour and slope lines, § 166 *in* Lehrbuch der Darstellenden Geometrie für Technische Hochschulen, v. I (?) (2nd ed; 1st publ. 1918?): Leipzig & Berlin, Teubner, p. 47-53. [expanded? his 1912 treatment (other earlier editions exist); refs Dupuis de Torcy & Brisson 1808 (1st modern citation?), later French work, Maxwell 1870; credits Rothe 1915 with correctly defining watercourses]

Murata, Teizo, 1931a, Theoretical consideration on the shape of alluvial fans: Geographical Review of Japan, v. 7, no. 7, p. 569-586. [not seen; geometric conceptualization of fan relief and plan form? as equations?]

Murata, Teizo, 1931b, Relation betwen a fan and its surrounding mountains: Geographical Review of Japan, v. 7, no. 8, p. 649-663. [not seen; geometric relations?]

Murphey, J.B., Wallace, D.E., and Lane, L.J., 1977, Geomorphic parameters predict hydrograph characteristics in the Southwest: Water Resources Bulletin, v. 13, no. 1, p. 25-38. [catchment area = best; new shape/size param.]

Murray, John, 1886, Drainage areas of the continents and their relation to oceanic deposits: Scottish Geographical Magazine, v. 2, no. 9, p. 548-555. [watershed planimetry of new Bartholomew global Lambert equal-area maps; land/water (area) = 1/2.5, cf. Penck 1886]

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Musgrave, G.W., 1947, The quantitative evaluation of factors in water erosion, a first approximation: Journal of Soil and Water Conservation, v. 2, no. 3, p. 133-138. [derived equation for soil loss; uses data fr. uniform slopes]

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Naden, P.S., 1993, A routing model for continental-scale hydrology, *in* Symposium on Macroscale Modeling of the Hydrosphere, Yokohama, July, Proceedings: IAHS Publication 214, p. 67-79. [early broad-scale DEM-based model; implicit source-to-sink method]

Nagel, Dr., 1835, Über die Küstengestaltung der Erdteile (on the coastal shape of the continents, in German): Heinrich Berghaus' Annalen der Erd-, Völker-, und Staatenkunde (Berlin), v. 12, p. 490-497. [after Ritter 1826, next work on coast shape?; $K = U/2\sqrt{F\prod}$: U = coast perimeter, F = area enclosed; see Rohrbach, 1890]

Nakano, M., Takagi, A., and Haraguchi, N., 1985, Stochastic simulation of gully networks on eroded land, *in* El-Swaify, S.A., Moldenhauer, W.C., and Lo, Andrew, eds., Soil Erosion and Conservation: Ankeny, Iowa, Soil Conservation Society of America, p. 178-187. [used prior sim. models & Strahler ordering; varied results]

Nakayama, Daichi, 1998, A study of DEM-based drainage basin classification—the case of the Abukuma Mountains (in Japanese with English abstract & figure captions): Geographical Review of Japan, v. 71A, p. 169-186. [54 basins, 5 hyps. & 6 planim. char.; PCA = 3 PC's & 4 types]

NASA, 2002, Shuttle Radar Topography Mission: U.S. National Aeronautics and Space Administration, http://www.jpl.nasa.gov/srtm/. [official online source for SRTM data and information]

Natarajan, Padma, 1999, Intelligent retrieval of ridgelines from digital elevation models: Orono ME, University of Maine, Dept. of Electrical and Computer Engineering, unpublished MSEE thesis, paging unknown. [presented at 1999 ASPRS ANnual Conference]

Nellemann, Christian, and Reynolds, P.E., 1997, Predicting late winter distribution of muskoxen using an index of terrain ruggedness: Arctic and Alpine Research, v. 29, no. 3, p. 334-338. [Indices based on contour characteristics fr topo maps]

Neumann, G.A., Rowlands, D.D., Lemoine, F.A., Smith, D.E., and Zuber, M.T., 2001, Crossover analysis of Mars Orbiter Laser Altimeter data: Journal of Geophysical Research, v. 106, no. E10, p. 23,753-23,768. [error for 5000 orb. profiles modeled by 24 M elev. crossovers; adjusted tracks accuracy < 1 m vert.]

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Neumann, Ludwig, 1888, Orometrische Studien im Anschluß an die Untersuchungen des Kaiserstuhlgebietes (orometric studies after investigations of the Kaiserstuhl area; in German): Zeitschrift für wissenschaftliche Geographie (Weimar), v. 7, no. 1, p. 320-332. [post-Sonklar work; cited elsewhere as 'Untersuchung' & 'Kaiserstuhlgebirges']

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Neumann, Ludwig, 1900, Die Dichte des Flußnetzes im Schwarzwalde (Stream network density in the Black Forest, in German): Gerlands Beiträge zur Geophysik, Leipsig, v. 4, ca. p. 222. [early dd work; defined drainage density = L/A; L = total stream lengths & A = basin area; 1 km squares]

Newman, W.I., Turcotte, D.L., and Gabrielov, A.M., 1997, Fractal trees with side branching: Fractals, v. 5, no. 4, p. 603-614. [more direct descr. of river structure, based on Tokunaga scaling]

Newson, M.D., 1978, Drainage Basin characteristics, their selection, derivation and analysis for a flood study of the British Isles: Earth Surface Processes, v. 3, no. 3, p. 277-293. [>1000 basins]

Nice, Bruno, 1948, Energia del rilievo, *in* La fittezza del reticolato idrografico nell'Appennino tosco-emiliano: Riv. Geogr. Ital., v. 60, p. 11-22, & 65-98. [1/700K relative-relief map; 3x3 samples; 7 intervals]

Nicholls, R.J., and Small, Christopher, 2002, Improved estimates of coastal population and exposure to hazards released: EOS, Transactions, American Geophysical Union, v. 83, no. 28, p. 301, 305. [quant. rel. (graphs & maps) of pop. density to elev. & distance from coast; need LiDAR to improve low-lying elevs.]

Nieuwenhuis, J.D., and van den Berg, J.A., 1971, Slope investigations in the Morvan (Haut Folin area): Revue de Géomorphologie Dynamique, v. 20, no. 4, p. 161-176. [6063 field-profile angles at 10-m length; stat. relation betw. slope & elev. & rock type]

Nikora, V.I., and Goring, D.G., 2001, Extended self-similarity in geophysical and geological applications: Mathematical Geology, v. 33, no. 3, p. 251-271. [structure func. & ESS (extended self-sim.) plots of Martian topo. &]

Nogami, Michio, 1995, Geomorphometry for detailed digital elevation model (in Japanese with English summary): Chishitsu Chosajo Geppo (Bull. Japan. Geol. Survey), v. 46, no. 4, p. 465-474. [DEM's, drainage basins & patterns, math. models]

Nogami, Michio, 1998, An algorithm and a C-program source for automated drainage network extraction (in Japanese with English abstract): Theory and Applications of GIS (J. of GIS Assoc. of Japan), v. 6, no. 1, p. 95-102. [flood-type; random-walk techn. gives good results on flats]

Nogami, Michio, 1999, Effects of geology on geomorphometric characteristics analyzed by a 50-m digital elevation model (in Japanese with English abstract and figure captions): Geographical Review of Japan, v. 72A, no. 1, p. 23-29. [50m DEM; height, slope, convexity, & geology of Japan change through time]

Nogami, Michio, 2000, 50m-DEM and landforms of Japanese Islands (abs.): Transactions, Japanese Geomorphological Union, v. 21, no. 1, p. 69-70. [PCA of morphometric properties of 597 mountain summits]

Noguchi, Naohiko, 1972, Quantitative geomorphology and relative rate of erosion, Pescadero Creek Basin, San Mateo Co., California: University of Santa Cruz, Dept. Earth Sciences, unpublished M.Sc. thesis, 109 p. [only the areal params. correlate highly with environmental variables]

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Nowacki, Gregory, Shephard, Michael, Krosse, Patricia, Pawuk, William, Fisher, Gary, Baichtal, James, Brew, David, Kissinger, Everett, and Brock, Terry, 2001, Ecological subsections of Southeast Alaska and neighboring areas of Canada: USDA Forest Service, Alaska Region, Technical Publication No. R10-TP-75, 306 p. [binned elev., slope, aspect, 'roughness' (std. dev. elev.) & slope & elev. histograms for 73 regions fr 60m DEM (1:63,360 maps)]

Nowak, Hans, 1944, Die Reliefenergie im Grenzsaume der Böhmischen Masse zwischen Donau und Thaya: Mitteilungen Geograph. Ges. Wien, no. 87, p. 16-18. [1/420K relative-relief map; 1 km samples; 7 relief intervals]

Nuth, Van, Pulliam, Jay, and Wilson, Clark, 2002, Migration of radar altimeter waveform data: Geophysical Research Letters, v. 29, no. 10, p. 131-1 to 131-4. [Greenland ice-sheet data reveal one limitation of current radar altmeters]

Nye, J.F., 1965, Flow of a glacier in a channel of rectilinear, elliptic, or parabolic cross-section: Journal of Glaciology, v. 5, no. 41, p. 661-690. [shape factor = (A/h of trimline above thalweg) x trough perimeter]

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O'Donnell, Greg, Nijssen, Bart, and Lettenmaier, D.P., 1999, A simple algorithm for generating streamflow networks for grid-based, macroscale hydrological models: Hydrological Processes, v. 13, no. 8, p. 1269-1275. [gets coarse-scale network from fine-scale DEMs using accumulation-flow file]

O'Sullivan, David, and Turner, Alasdair, 2001, Visibility graphs and landscape visibility analysis: International Journal of Geographical Information Science, v. 15, no. 3, p. 221-237. [applied graph theory yields pixel surface colored by size of visible neighborhoods]

Ochi, Shiro, and Shibasaki, Ryosuke, 1999, Development of 1km drainage model based on GTOPO30 and global data sets, *in* Otsubo, Kuninori, Tsuboi, Kaoru, and Hiromoto (Airies), Misako, eds., 1999 NIES Workshop on Information Bases and Modeling for Land-use and Land-cover Changes Studies in East Asia, 25-27 January, Tsukuba, Japan, Proceedings: p. 201-205. [algorithm for drainage-direction matrix, but fit still inconsistent]

Ochi, Shiro, and Shibasaki, Ryosuke, 1999, Algorithm for generating drainage direction matrix using DEM (GTOPO30) and DCW (in Japanese with English abstract and figure captions): Journal of the Japan Society of Photogrammetry, v. 38, no. 3, p. 60-68. [combines DEM with planimetric stream depiction to get better DDM]

Ochis, Heidi, and Russell, E.C., 1997, Comparison of a piecewise transformation to polynomial-based geometric correction algorithms: Boulder, CO, Computer Terrain Mapping, Inc., 13 p.; http://www.ctmap.com/gis_journal/geotin.pdf. [piecewise technique better, & for all relief types]

Ochis, Heidi, Russell, E.C., and Hoffer, R.M., 1997, A comparison of a triangulation-based piecewise transformation to polynomial-based geometric correction algorithms, *in* ACSM/ASPRS Annual Convention & Exposition, Seattle, WA, April 7-10: Technical Papers, v. 3, p. 215-225. [piecewise technique better, & for all relief types]

Ogden, F.L., Garbrecht, Jurgen, DeBarry, P.A., and Johnson, L.E., 2001, GIS and distributed watershed models. II—modules, interfaces, and models: Journal of Hydrologic Engineering, v. 6, no. 6, p. 515-523. [2nd of 2-part GIS tutorial for practicing engineers; applics.]

Oguchi, Takashi, Tanaka, Yukiya, Kim, Tae-Ho, and Lin, Zhou, 2001, Large-scale landforms and hillslope processes in Japan and Korea: Transactions of the Japanese Geomorphological Union, v. 22, no. 3, p. 321-336. [A/elev., slope map, slope/elev., % slope >15° & % slope < 2°/elev.]

Ohmori, Hiroo, and Sugai, Toshihiko, 1994, Morphometrical characteristics of landslide masses and their geomorphological implications: Transactions, Japanese Geomorphological Union, v. 15, no. 1, p. 1-16. [see 1995 paper by same authors]

Oimoen, M.J., 2000, An effective filter for removal of production artifacts in U.S. Geological Survey 7.5-minute digital elevation models, *in* Conference on Applied Geologic Remote Sensing, 14th, 6-8 Nov., Las Vegas, NV, Proceedings: Ann Arbor, MI, Veridian ERIM International, p. 311-319; http://edcnts12.cr.usgs.gov/ned/filter/; *also* http://gisdata.usgs.net/ned/filter/index.html. ['mean profile filter' at least partially successful in removing 'stripes' from level 1 USGS DEMs]

Okagama, T., 1969, Gipfelflur, *in* Quaternary tectonic map of Japan: National Research Center for Disaster Prevention, map no. 6, 1/2,000,000. [summit-height envelope fr 1.5' x 1.25' grid &1/50,000 maps]

Okayama, T., 1932, Some problems on mountain topographic features (in Japanese): Geography of Iwanamikoza (Geographical course of Iwanami), Iwanamisyoten, Tokyo, 50 p. [among earliest Japanese use of morphometric methods]

Okayama, T., 1953, The geomorphic structure of Japan—as a starting point of regional geomorphology (in Japanese): Sundai Shigaku (Sundai Historical Review), v. 13 (not 3?), p. 28-38. [summit-height envelope fr 1.5' x 1.25' grid &1/50,000 maps]

Okimura, Takashi, and Kawatani, T., 1986, Mapping of the potential surface-failure sites on granite mountain slopes, *in* Gardiner, V., ed., International Geomorphology 1986, Part I: New York, John Wiley & Sons, p. 121-138. [debris flows; incl. slope & slope curvature fr.10m DEM]

Olivera, Francisco, Famiglietti, James, and Asante, Kwanbena, 2000, Global-scale flow routing using a source-to-sink algorithm: Water Resources Research, v. 36, no. 8, p. 2197-2207. [instead of cell-to-cell routing; hydrographs for large basins fr. GTOPO30 seem OK]

Olivera, Francisco, 2001, Extracting hydrologic information from spatial data for HMS modeling: Journal of Hydrologic Engineering, v. 6, no. 6, p. 524-530. [princ. & meth. behind DEM-to-watershed, etc. for input to USACE's modeling system]

Olivier, J., and Valentine, R., 1965, Engineering Lunar Model Obstacles (ELMO): JFK Space Center, Future Studies Branch, Launch Support Equipment Engineering Division, Tech. Report TR-145-D, paging unknown. [to provide pre-real lunar data quant. design criteria for Lunar Roving Vehicle design concepts; synthetic technique used 2 params, terrain obstacle spacing (constant) & size (var.), for var. topo profiles]

Onde, H., 1938, La Maurienne et la Tarentaise, étude morphologique (in French): Revue de Géographie Alpine, v. 26?, p. 663-771; *also* La Maurienne et la Tarentaise. Étude de géographie physique: Thèse Lettres Grenoble / Grenoble, Arthaud, 624 p. [applic. of morphometry; correl. basin discharge w/ mean elev., etc.; esp. ch. VI, p. 75-103]

Onde, H., 1939, L'aération des massifs montagneux et son évaluation (in French): Revue de Géographie Alpine, v. 27, p. 447-453. ['coefficient of aeration' applied to mountains]

Ongley, E.D., 1968, Towards a precise definition of drainage basin axis: Australian Geographical Studies, v. 6, no. 1, p. 84-88. ['basin vectoral axis' = vector resultant of high-order links]

Ore, H.T., and White, E.D., 1958, An experiment in the quantitative analysis of drainage basin characteristics: Compass, Sigma Gamma Epsilon, v. 36, no., 1, p. 23-38. [Horton analysis of 2 Iowa basins supports laws of stream numbers & lengths]

Orlandini, Stefano, and Lamberti, Alberto, 2000, effect of wind on precipitation intercepted by steep mountain slopes: Journal of Hydrologic Engineering, v. 5, no. 4, p. 346-354. [6 basin params. fr DEM combine w/ modeled 3D rainfall field]

Orris, G.J., and Williams, J.W., 1984, Landslide length-width ratios as an aid in landslide identification and verification: Bulletin of the Association of Engineering Geologists, v. 21, no. 3, p. 371-375. [n=153; different l/w for diff. facies of St. Clara fm. in No. CA]

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Otuka, Y., 1933, The Japanese coastline (in Japanese with English summary: Geographical Revue of Japan, v. 9, p. 819-843. [coastline shape = (L-D)/D where D = circle diam & L = shoreline length in circle]

Overbeck, Christoph, 1997, Simulation der Topographie des Meersbodens mit Hilfe fraktaler Prozesse (in German): Universität Trier, Germany, unpublished thesis (Diplomarbeit), 180 p. [found scale-dependent breaks in fractal analyses of seafloor topo form]

Ozawa, Taku, Doi, Koichiro, and Shibuya, Kazuo, 1999, A case study of generating a digital elevation model for the Sôya Coast area, Antarctica, usinbg JERS-1 SAR interferometry: Polar Geoscience, no. 12, p. 227-239. [50m grid; 23 control pts. for 45km x 55km area; better than GTOPO30]

P-Q

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Paillou, Philippe, and Gelautz, Margrit, 1999, Relief reconstruction from SAR stereo pairs—The 'optimal gradient' matching method: IEEE Transactions on Geoscience and Remote Sensing, v. 37, no. 4, p. 2099-2107. [pairs preproc., then filtered to get gradient (brightness?)-amplitude images]

Pal, S., 1972, A classification of morphometric methods of analysis—An appraisal: Geographical Review of India, v. 34, (cited by Lastochkin, 1987). [no info]

Palacios-Vélez, O.L., Gandoy-Bernascon, William, and Cuevas-Renaud, Baltasar, 1998, Geometric analysis of surface runoff and the computation order of unit elements in distributed hydrological models: Journal of Hydrology, v. 211, nos. 1-4, p. 266-274. [new algorithms for kinematic cascade from DEM or TIN]

Palmu, J.-P., 1997, Combining Quaternary geological and digital elevation model data, *in* Autio, Sini, ed., Geological Survey of Finland Current Research 1995-1996: Geological Survey of Finland Special paper 23, p. 109-116. [novel DEM visual. technique; ChromaDepth; depth parallax inmduced by color]

Panin, A.V., and Gelman, R.N., 1997, Experience applying GPS techniques to derivation of large-scale digital terrain models (in Russian): Geodesiya i Cartographiya, no. 10, p. 22-27. [no info]

Papanikolaou, K., and Derenyi, E.E., 1987, GIS in support of remote sensing technology—present applications, future possibilities, *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, Proceedings: v. 1, p. 333-339. [gen'l. info on DEMs, slope & aspect, shadowed area, & ridge extraction]

Pareschi, M.T., Favalli, M., Giannini, F., Sulpizio, R., Zanchetta, G., and Santacroce, R., 2000, May 5, 1998, debris flows in circum-Vesuvian areas (southern Italy)—insights for hazard assessment: Geology, v. 28, no. 7, p. 639-642. [10-m DEM fr. 1/25K TIN: basin slope vs. shape factor, &; superb oblique shaded-relief image of area is on cover of v. 28, no. 8]

Park, Donggyu, Cho, Hwanggue, and Kim, Yangsoo, 2001, A TIN compression method using Delaunay triangulation: International Journal of Geographical Information Science, v. 15, no. 3, p. 255-269. [reviews past methods; near-equiangular triangles.]

Parlow, E., and Schweinfurth, G., 1995, Das Digitale Geländemodell, *in* Fiedler, F., Klimaatlas Oberrhein Mitte-Süd: Textteil, IFG Offenbach, p. 17-18. [no info]

Pastor-Satorras, Romualdo, and Rothman, D.H., 1998a, Scaling of a slope—the erosion of tilted landscapes: Journal of Statistical Physics, v. 93, nos. 3/4, p. 477-500. [propose theory to model erosion; attempt to explain inflected shape of autocorrel. fcn.; var, comparisons w. topo-map data.]

Pastor-Satorras, R., and Rothman, D.H., 1998b, Stochastic equation for the erosion of inclined topography: Physical Review Letters, v. 80, no. 19, p. 4349-4352. [abbreviated version of P-S & R 1998a]

Patel, J.G., Pappalardo, R.T., Head, J.W., Collins, G.C., Hiesinger, Harald, and Sun, Jie, 1999, Topographic wavelengths of Ganymede groove lanes from Fourier analysis of Galileo images: Journal of Geophysical Research, v. 104, no. E10, p. 24,057-24,074. [dominant wavelenths vary w/ location, fr 1-2 km to 5-10 km]

Paulson, M.J., and Tucker, Dean, 1998, Comparison of GIS-based watershed delineation algorithms (abs.), *in* Hallam, C.A., and Salisbury, J.M., eds., GIS Applications in Water Resources Research—American water Resources Annual Meeting, Chicago Ill, November 6-10, 1994: U.S. Geological Survey, Open-file Report 98-751, p. 18. ['several' packages evaluated; no further details on results]

Payer, Julius, 1865, Orometrischer Theil, p. 6-8 *in* Die Adamello-Presanella-Alpen nach dem Forschungen und Aufnahmen (in German): Gotha, Justus Perthes, Ergänzungsheft (supplement volume) no. 17, to Petermanns Geographischen Mitteilungen, 36 p. [measurements of elev., slope, rel. relief, & a ratio for various mountains in the Tyrol]

Pazzaglia, F.J., and Brandon, M.T., 2001, A fluvial record of long-term steady-state uplift and erosion across the Cascadia forearc high, western Washington state, *in* Pazzaglia, F.J., and Knuepfer, P.L.K., eds., The steady-state orogen—concepts, field observations, and models: American Journal of Science, v. 302, nos. 4 & 5, p. 385-431. [elev. & slope / distance profiles; use valley profile, terrace levels & ages, & kinematic model to est. incision & rock uplift across a mtn. range]

Pazzaglia, F.J., and Knuepfer, P.L.K., eds., 2001, The steady-state orogen—concepts, field observations, and models: American Journal of Science, v. 302, nos. 4 & 5, p. 313-512; http://www.geology.yale.edu/~ajs/TableContents.html. [broad-scale work; 'neo-orometry'?; 1st & 5th-8th of 8 papers all have morphometric contributions]

Pearce, S.J., and Melosh, H.J., 1986, Terrace width variations in complex lunar craters: Geophysical Research Letters, v. 13, no. 13, p. 1419-1422. [W < w/ distance fr rim, & largest terrace (nearest rim) > w/ rim D; pre-collapse topo profile most important control on width; see also Leith & McKinnon 1991]

Peckham, S.D., and Gupta, V.K., 1999, A reformulation of Horton's laws for large river networks in terms of statistical self-similarity: Water Resources Research, v. 35, no. 9, p. 2763-2777. [generalizes scaling from means to entire distribtions; supported by Shreve model]

Peeters, L., 1944, De Waarde van Enkele Kartografische Methoden bij de Analyse van een polycyclish Relief (in Dutch): Natuurwetenschnappelyk Tijdschr., v. 26, no. 1, p. 25-35. [Macar (1938) sampling technique; choice of spacing of sampling grid precludes total objectivity]

Pegler, K.H., 1999, TIN random densification—a process to minimize the ridging phenomenon in DTMs (abs.): URISA Annual Conference, Chicago, IL, August 21-25, <http://www.urisa.org/99Conference/database_design_and_maintenance.htm>. [attempt to fix 'stripes' in stereo-profiled DEMs]

Péguy, Ch.P., 1945, Recherches sur les orientations directrices de l'hydrographie dans les chaines plissées (in French): Revue de Géographie Alpine, v. 33, p. 215-237. [index of correl. betw. river orientation & fold axes]

Péguy, Ch.P., 1947, Haute Durance et Ubaye—Esquisse physique de la zone intra-alpine des Alpes françaises du Sud (in French): Thèse Lettres Grenoble / Grenoble, Arthaud, 314 p.; *also* chap. III: Revue de Géographie Alpine, v. 35, no. 3. [elevation statistics, etc.]

Peikert, Ronald, and Roth, Martin, 1999, The "parallel vectors" operator—a vector field visualization primitive, *in* IEEE conference Visualization'99, 24-29 October, San Francisco CA, Proceedings: IEEE Computer Society Press, p. 263-270; <http://www.cg.inf.ethz.ch/~peikert/vis99/slides.pdf>. [descriptive geometry of vortex surfaces in turbomachinery; cites ridge & valley defs. by Saint-Venant, Breton de Champs, Rothe, Haralick]

Pelletier, J.D., 1999, Self-organization and scaling relationships of evolving river networks: Journal of Geophysical Research, v. 104, no. B4, p. 7359-7375. [diffusion-eqn model of landscape evol. fr. overland & channel flow; used RiverTools]

Penck, Albrecht, 1886, Einteilung und mittlere Kammhöhe der Pyranäen (arrangement? & mean crest heights of the Pyrenees; in German): Jahresbericht der Geographischen Gesellschaft in München (1885), v. 11, no. 20, p. 58-75, 64ff. ['calculated profile area by summing trapezoids defined by adjacent contours & the contour interval' (Riedel 1907)]

Penck, Albrecht, 1886, Relative proportion of land and water on the surface of the Earth (transl. from German by J.T. Bealby): Scottish Geographical Journal, v. 2, no. 6, p. 358-362. [history of land area /water area est.; puts it at 1/2.57-1/2.60; discusses the many uncertainties]

Penck, Albrecht, 1894a, Morphometrie des Bodensees (in German; morphometry of Lake Constance): Jahresbericht der Geographischen Gessellschaft in München, p. 119-155. [tests formulae given in 1894 book; shallow lake differs in form fr others in Europe; see Peucker 1894]

Penck, Albrecht, 1894b, Orometrie *in* Morphologie der Erdoberfläche (in German), Stuttgart, J. Engelhorn, v. 2, p. 339-343. [summarizes mountain morphometry; comments on work of Sonklar, others]

Penck, Walther, 1922, Morphologische Analyse (in German): Berlin, Verhandlung des 20 Deutschen Geographentages Leipzig 1921, p. 122-128. [cited by D. Merriam 1981 as having quant. material; Penck's posthumous 1924 book does develop Fisher 1866 theory of slope retreat]

Perez, Albert, 2000, Source Water Protection Project—a comparison of watershed delineation methods in ARC/INFO and ArcView GIS, *in* Djokic, Dean, and Maidment, David, eds., Hydrologic and Hydraulic Modeling Support with Geographic Information Systems: Redlands CA, ESRI Press, p. 53-64; http://www.esri.com/library/userconf/proc99/proceed/papers/pap483/p483.htm. [compares Arcview w Spatial Analyst & Watershed Delineator Extensions with ARC/INFO GRID AMLs]

Perlant, F., 2000, Using stereo images for digital terrain modeling: Surveys in Geophysics, v. 21, nos. 2-3, p. 201-207. [elementary intro to making a DEM from stereo images]

Pernarowski, Leszek, 1960, Application of statistical methods in investigating dune forms: Przeglad Geograficzny (Polish Geographical Review), v. 32, supplement (XIXth IGC, Stockholm), p. 57-66 + errata sheet. [Czekanowski's 'meth. of differ.' on ave. azimuth, windw. & lee slopes, asymmetry, height]

Petzold, Bettina, Reiss, Peter, and Stössel, Wolfgang, 1999, Laser scanning—surveying and mapping agencies are using a new technique for the derivation of digital terrain models: ISPRS Journal of Photogrammetry and Remote Sensing, v. 54, p. 95–104; http://www.fsl.orst.edu/~lefsky/isprs/1130.pdf. [Germany; more accurate & less costly than photogrammetry; some quality caveats]

Peucker, Karl, 1894, Morphometry of the Lake of Constance: The Geographical Journal, v. 4, no. 3, p. 264-266. [English summary of Penck 1894; "... morphometric values posses an importance only when compared with the corresponding ones for other forms of the surface ..."]

Péwé, T.L., Burbank, Lawrence, and Mayo, L.R., 1967, Multiple glaciation of the Yukon-Tanana upland, Alaska: U.S. Geological Survey, Miscellaneous Investigations Map, I-507, one sheet, 1/500,000 scale. [rose diagrams summarize 1088 cirque azimuths (NNE dominate)]

Philip, G.M., and Watson, D.F., 1986, A method for assessing local variation among scattered measurements: Mathematical Geology, v. 18, no. 8, p. 759-764. [surface-roughness metric computes an approx. of surface-normal vector via vector cross-products; slope]

Phillips, J.D., 1999, Divergence, convergence, and self-organization in landscapes: Annals of the Association of American Geographers, v. 89, no. 3, p. 466-488. [reviews 11 definitions of S-O; urges caution in using term]

Pickup, Geoff, and Marks, Alan, 2000, Identifying large-scale erosion and deposition processes from airborne gamma radiometrics and digital elevation models in a weathered landscape: Earth Surface Processes and Landforms, v. 25, no. 5, p. 535-557. [map-based DEMs insuffic.; DEM fr radar altimetry & GPS got ground not trees]

Pike, R.J., 1976, Crater dimensions from Apollo data and supplemental sources: The Moon, v. 15, p. 463-477. [large database of measurements (H, h, D, d, circularity) from spacecraft photogrammetry]

Pike, R.J., 2000a, Geomorphometry—diversity in quantitative surface analysis: Progress in Physical Geography, v. 24, no. 1, p. 1-20. [state-of-art review of a dozen varied topics]

Pike, R.J., 2000b, Nano-metrology and terrain modelling—convergent practice in surface characterisation: Tribology International, v. 33, no. 9, p. 593-600. [redo of Wood & Snell 1960 illustrates potential technique for parsing an engineering surface]

Pike, R.J., 2001a, Scenes into numbers—facing the subjective in landform quantification, *in* Hoffman, R.R., and Markman, A.B., eds., Interpreting remote sensing imagery—human factors: Boca Raton FL, Lewis Publ. (CRC), p. 83-114. [quant. inferential steps & analytic procedures link perception of (mostly planetary) surface form with interpretation]

Pike, R.J., 2001b, Digital terrain modeling and industrial surface metrology—converging realms: The Professional Geographer, v. 53, no. 2, p. 263-274. [automobile cylinder-wall micro-topography exemplifies methods of industrial surfacing as spatial processes]

Pike, R.J., 2001c, Digital terrain modelling and industrial surface metrology—converging crafts: International Journal of Machine Tools and Manufacture, v. 41, nos. 13-14, p. 1881-1888. [2 examples of redundancy in morphometric analysis, fr metrology & geomorphology]

Pike, R.J., 2001d, Geometric signatures—experimental design, first results (abs.): Int'l. Conference on Geomorphology 5th, Chuo Univ., Tokyo, Japan, August 2001; DEMs and Geomorphology, Geographic Information Systems Association (Japan) Special Publication, v. 1, p. 50-51; *and* Transactions, Japanese Geomorphological Union, v. 22, no. 4, p. C-192. [corrected correlations for 91 samples x 49 parameters fr 1/24K topo map DEMs]

Pike, R.J., 2001e, "Topographic fragments" of geomorphometry, GIS, and DEMs (abs): Int'l. Conference on Geomorphology 5th, Chuo Univ., Tokyo, Japan, August 2001; DEMs and Geomorphology, Geographic Information Systems Association (Japan) Special Publication, v. 1, p. 34-35. [misc. observations & recommendations on current state of art]

Pinchemel, Philippe, 1950, L'analyse morphométrique des réseaux hydrographiques (in French; morphom. anal. hydro. networks): Comptes Rendues des Séances de l'Académie des Sciences (Paris), v. 230, 5 Feb., p. 556-557. [presumably Hortonian analysis]

Piper, D.J.W., and Evans, I.S., 1967, Computer analysis of maps using a pencil follower: Geographical Articles (Cambridge Univ., UK), v. 9, p. 21-25. [stored & manipulated digitized versions of contours fr printed maps]

Pitty, A.F., 1969, Some problems in selecting a ground-surface length for slope-angle measurement: Revue de Géomorphologie Dynamique, v. 17, no. 2, p. 66-71. [optimal length = ?]

Pitty, A.F., 1970, A scheme for hillslope analysis, II. Indices and tests for differences: University of Hull (UK), Occasional Papers in Geography, no. 17, 56 p. [fr. Ph.D. thesis; reduces descr. to series of indices: freq. distr., profiles, component shapes, irregularities., position on profile]

Piwowar, A., 1902, Über Maximalböschungen trockener Schuttkegel und Schutthalden (in German): Vierteljahrsschrift d. Nat. forsch. Gesellschaft Zürich, v. 48, p. 43-56. [measured profiles of talus slopes]

Planchon, Olivier, Esteves, Michel, Silvera, Norbert, and Lapetite, J.-M., 2002, Microrelief induced by tillage—measurement and modelling of surface storage capacity: Catena, v. 46, no. 2-3, p. 141-157. [random roughness param. fr 5 cm DEM spacing @ 1 mm vert. accuracy]

Playfair, John, 1802, § 99 & 111, *in* Illustrations of the Huttonian Theory of the Earth: Edinburgh, facsimile reprints 1956, Urbana, Univ. Illinois Press, & 1964, New York, Dover, 528 p. [a geometer, & one of the 1st in Britain to teach modern math. analysis & recent work from Europe, he early recognized key relations (generalized as 'Playfair's Law') quantified only much later—stream size proportional to that of its valley; channels & valleys of streams & tributaries ('... and valley side slopes' implied) meet on same level, p. 102; stream-junction angles are acute upstream of junction, p. 113-14 (see also Kant, 1803, p. 18).]

Plazanet, C., and Spagnuolo, M., 1998, Seafloor valley shape modeling, *in* Spatial Data Handling '98 Conference, 11-15 July, Vancouver, BC, Proceedings: p. 751. [no info]

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Potter, D.M., 1957, Measurements of runway roughness of four commercial airports: Langley Field, VA, Aeronautical Laboratory, National Advisory Committee for Aeronautics, NACA Research Memorandum RM L56126, 86 p. [raw data for elev. profiles surveyed w/ level, rod, & tape at 2' (0.6 m) interval & 0.01" vert. precision interpolated to 0.001"; 2 unlabeled PSD plots for one runway]

Premoze, Simon, Thompson, W.B., and Shirley, Peter, 1999, Geospecific rendering of alpine terrain: Eurographics Workshop on Rendering, 10th, EGWR'99, Grenada, Spain, 21-23 June, (paper not in proceedings); http://www.cs.utah.edu/vissim/papers/snowTerrain/. [adding color aerial imagery, shading & shadowing for time of day, snow cover, & 3-D instancing of trees and brush to DEM much improve visual quality]

Press, Harry, and Tukey, J.W., 1956, Power spectral methods of analysis and their applications to problems in airplane dynamics, *in* Durbin, E.C., ed., Flight Test Manual: North American Treaty Organization AGARD (Advisory Group for Aeronautical Research and Development), Part IVC, p. 1-41; also *in* The Collected Works of John W. Tukey v. I—Time Series, 1949–1964, Wadsworth Advanced Books & Software: Monterey, CA., p. 185-255]. [actual work may date closer to ~1954 (see Walls et al. 1954); many PSD examples; comp. details; introduced 'prewhitening, simplifying choice of window]

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Puppo, E., Davis, L., De Menthon, D., and Teng, Y., 1994, Parallel terrain triangulation: International Journal of Geographical Information Systems: v. 8, no. 2, p. 105-128. [developed & implemented (for 1st time) a parallel algorithm for Delaunay triang.]

R

Raasch, W., 1979, Photometric measurement of terrain roughness: Journal of Terramechanics, v. 16, no. 2, p. 87-111. [no info]

Rachocki, Andrzej, 1981, Alluvial Fans—an attempt at an empirical approach: Chichester & New York, Wiley, 161 p. [intro to quant. p. 23-24, & randon-walk model p. 111-143]

Raczkowski, M., Wojcik, A., and Zuchiewicz, W., 1985, Mloda tektonika Karpat w swietle analizy morfostrukturalnej (in Russian): Zesz Nauk AGH, kwart Geologia, v. 11, no. 2, p. 38-83. [isoline maps of valley height & stream length in the Carpathians; method of Filosofov 1960, 63, 70]

Radebaugh, Jani, and Christiansen, E.H., 1999, Terrestrial pluton and planetary caldera sizes—implications for the origin of calderas (abs.): EOS, Transactions, American Geophysical Union, v. 80, no. 46, Supplement, p. F635. [freq. distr. of plutons based on Pike & Clow 1981 caldera data]

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Raines, G.L., 2002, Description and comparison of geologic maps with FRAGSTATS—a spatial statistics program: Computers and Geosciences, v. 28, no. 2, p. 169-177. [1st Earth-science use? implem. in Patch Analysis extension of ESRI's Arcview by converting polygon files to grids; potential applic. to drainage basins & topo. facets]

Ramsey, E.W. III, Nelson, G.A., Laine, S.C., Kirkman, R.G., and Topham, Willie, 1998, Generation of coastal marsh topography with radar and ground-based measurements: Journal of Coastal Research, v. 14, no. 3, p. 1158-1164. [ERS-1 SAR flood extent + contours; 5-9X better; eval. errors]

Rana, Sanjay, and Morley, Jeremy, 2002, Surface Networks: London, UK, University College, Centre for Advanced Spatial Analysis, Working paper 43, 72 p.; http://www.casa.ucl.ac.uk/working_papers/Paper43.pdf. [reviews surface-specific abstraction of 2-D surfaces, 1859-2000]

Range, Wolfgang, 1961, Morphometrische Untersuchungen in den Einzugsgebieten der Bayerischen Alpenflüsse (Morph. inves. in catchments of Bavarian alpine rivers, in German): Veröffentlichung aus dem Arbeitsbereich der Bayer. Landesstelle für Gewässerkunde in München, 62 p. [defines & calc. area, mean slope & elev, drainage density, etc. fr contour maps]

Rao, L.A.K., Asif, Mohammed, and Ali, S.R., 1997, Quantitative hydrogeomorphic investigation of Kali-Sindh sub-basin within Rajgarh district, Madhya Pradesh, India: Indian Journal of Earth Sciences, v. 24, nos. 3-4, p. 45-50. [Horton/Strahler analysis; geol. structure does not affect stream topology]

Rapp, Anders, 1967, On the field survey of hillslopes: Revue de Géomorphologie Dynamique, v. 17, no. 4, p. 152. [favors 5-m or 10-m slope-length sampling interval]

Rasehorn, F., 1911, Die Flußdichte im Harze und in seinem nördlichen Vorlande (in German; drainage density in the Harz ...): Univ. Halle, dissertation, 58 p., Zeitschrift für Gewässerkunde, v. 9, p. 1-56. [x = A/n, A = basin area & n = number of segments]

Ravenstein, M.A., 1841, Some observations on relief maps: Report of the Tenth Meeting of the British Association for the Advancement of Science—Notices and abstracts of communications, Geology Section, Glasgow, August 1840, v. 9, p. 122-123. [invented raised relief (stamped in plastic); his 1838 'Plastic Atlas']

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Ray, C.K., 1994, A new way to see terrain: Military Review, v. 2, no. 1, p. 81-89. [3D representation much quicker, more accurate & efficient than 2D map]

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Rees, W.G., 1992, Measurements of the fractal dimension of ice-sheet surfaces using Landsat data: International Journal of Remote Sensing, v. 13, p. 663-671. [semivariogram analysis, other]

Rees, W.G., 1998, A rapid method of measuring snow-surface profiles: Journal of Glaciology, v. 44, no. 148, p. 674-675. [photo against portable black back-plate + image-processing = topo profile]

Rees, W.G., 2000, The accuracy of digital elevation models interpolated to higher resolutions: International Journal of Remote Sensing, v. 21, no. 1 p. 7-20. [bilinear or bicubic interp. OK; rms acc. of interp. DEM = 0.2-0.6 std. dev. of height diff. of adj. elevs.]

Remond, Agnès, Beaudoin, André, and King, Christine, 1999, SAR imagery to estimate roughness parameters when modelling runoff risk: International Journal of Remote Sensing, v. 20, no. 13, p. 2613-2625. [six params. of periodic & random roughness for 4 classes of agric. fields]

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Rencz, Andy, Leclerc, Yvonne, Wright, Dan, Bonham-Carter, G.F., and Balma, Rob, 1991, Digital topography for earth sciences (Topographie numerique et sciences de la terre): Geos (Ottawa), v. 20, no. 2, p. 1-6. [no info]

Reniger, Anna, 1954, Significance of land relief for agriculture (in Polish with English summary + fig. & table captions: Przeglad Geograficzny (Polish Geographical Review), v. 26, no. 4, p. 37-47. [data for 6 areas fr I/100K 5-class slope map; correl. w/ veg. & soils]

Renssen, H., and Knoop, J.M., 2000, A global river routing network for use in hydrological modeling: Journal of Hydrology, v. 230, nos. 3-4, p. 230-243. [fr. TerrainBase 30' DEM (NGDC 1997); basin areas test well re publ. data]

Replumaz, A., Lacassin, R., Tapponnier, P., and Leloup, P.H., 2001, Large river offsets and Plio-Quaternary dextral slip rate on the Red River fault (Yunnan, China): Journal of Geophysical Research, v. 106, no. B1, p. 819-836. [drainage area/apparent offset, river spacing, up-downstream correl.]

Reuschle, F., 1869, Kritische Miszellen zur Geographie I. Das Maß der Küstenentwicklung und Grenzentwicklungs-Koeffizienten überhaupt (Critical goal ? of geography I. measuring generalized coefficients of coastal and border convolution): Zeitschrift der Gesellschaft für Erdkunde zu Berlin, v. 4, p. 193-199. [coastal convolution = U/2√F∏: U = perimeter of coast, F = area enclosed; *also* r1 = √F/∏; see Rohrbach, 1890]

Ribolini, Adriano, 2000, Relief distribution, morphology and Cenozoic differential uplift in the Argentera Massif (French-Italian Alps): Zeitschrift für Geomorphologie, v. 44, no. 3, p. 363-378. [R analysis after Burbank 1992, Gilchrist et al 1994, & Fielding et al. 1994]

Rice, R.M., Corbett, E.S., and Bailey, R.G., 1969, Soil slips related to vegetation, topography, and soil in southern California: Water Resources Research, v. 5, no. 3, p. 647-659. [n= 200; slope gradient >80% for all landslides; prox. to streams, veg. type & density important; discrim. analysis]

Rice, R.M., and Foggin, G.T. III, 1971, Effect of high intensity storms on soil slippage on mountainous watersheds in southern California: Water Resources Research, v. 7, no. 6, p. 1485-1496. [topo data incl. aspect, vol., area, length, width; discrim. analysis, slope most important]

Rice, S.P., and Church, Michael, 2001, Longitudinal profiles in simple alluvial systems: Water Resources Research, v. 37, no. 2, p. 417-426. [elev./dist. for stream links are expoential or quadratic]

Rice-Snow, Scott, 1998, Fractal characteristics of drainage basin boundaries in Puerto Rico, *in* Johnson, A.I., and Fernandez-Jauregui, C.A., eds., Hydrology in the Humid Tropic Environment: Symposium, Kingston, Jamaica, 17-23 November, 1996, Proceedings: IAHS Publication no. 253, p. 195-201. [6 large basins; D (1.06-1.11) like that of temperate basins]

Rice-Snow, Scott, and Russell, Joshua, 1999, Long-range persistence of elevation and relief values along the Continental Divide in the conterminous U.S., *in* International Conference on GeoComputation, 4th, Fredericksburg VA, Mary Washington College, 25-28 July, GeoComputation 99: http://www.geovista.psu.edu/geocomp/geocomp99/Gc99/043/gc_043.htm. [both params. robustly self-affine, D = 1.0-1.2, fr. Mex. to Can.]

Richards, K.S., 1978, Yet more notes on the drainage density-basin area relationship: Area (London), v. 10, no. 5, p. 344-353. [w/ discussion by Pethick, Ferguson, & Gerrard]

Riedel, Wilhelm, 1907, Die Einteilung des Odenwaldes in orographische Gruppen—Ein Beispiel für die Verwertung der Ergebnisse orometrischer Untersuchungen zur Einteilung von Gebirgen (in German; dividing the Odenwald into orogr. sections—an example using results of orometric investig. to classify mountains): Univ. Gießen, Dissertation, 54 p. [using 14 ridge params. (4 'improved' over Sonklar's) fr new 1/25K topo map, partitions area into hierarchy of 3 main divs. & 4 divs. containing 17 dominant ridges]

Rieger, J.H., 1997, Topographical properties of generic images: International Journal of Computer Vision, v. 23, no. 1, p. 79-92. [both computer vision (grey values) & Earth science (terrain heights) need geometric descr. of surface features, e.g. watercourses, a non-trivial problem; prefers Jordan 1872a definition of critical lines to Rothe 1915; found 1808 Dupuis de Torcy & Brisson ref. in Müller 1919]

Riitters, K.H., O'Neill, R.V., Hunsaker, C.T., Wickham, J.D., Yankee, D.H., Timmins, S.P., Jones, K.B., and Jackson, B.L., 1995, A factor analysis of landscape pattern and structure metrics: Landscape Ecology, v. 10, no. 1, p. 23-39. [best discussion to consult after the FRAGSTATS manual]

Riley, S.J., DeGloria, S.D., and Elliot, R., 1999, A terrain ruggedness index that quantifies topographic heterogeneity: Intermountain Journal of Sciences, v. 5, no. 1-4, p. 23-27. [no details]

Rinaldo, Andrea, and Rodríguez-Iturbe, Ignacio, 1998, Scaling in river networks, *in* Sposito, Garrison, ed., Scale Dependence and Scale Invariance in Hydrology: Cambridge, UK, Cambridge University Press, p. 61-87. [Hack's Laws = outgrowth of fractality, which exists imperfectly within upper & lower limits]

Rinaldo, Andrea, Fagherazzi, Sergio, Lanzoni, Stefano, Marani, Marco, and Dietrich, W.E., 1999, Tidal networks 2. Watershed delineation and comparative network morphology: Water Resources Research, v. 35, no. 12, p. 3905-3917. [quantify network properties, incl. power-law relations]

Rinaldo, Andrea, Fagherazzi, Sergio, Lanzoni, Stefano, Marani, Marco, and Dietrich, W.E., 1999, Tidal networks 3. Landscape-forming discharges and studies in empirical geomorphic relationships: Water Resources Research, v. 35, no. 12, p. 3919-3929. [simple model predicts local peak ebb & flood Q; tested OK on Venice Lagoon]

Ritchie, J.C., 1995, Airborne laser altimeter measurements of landscape topography: Remote Sensing of the Environment, v. 53, no. 2, p. 91-96. [4000 data/sec. at 5cm-res.; GPS control; microtopo. elevs.]

Ritter Carl, 1806, Sechs Karten von Europa mit erkärendem Texte (in German): Schnepfenthal. [map V, 'Die Gebirgshöhen in Europa, ihre Vegetationsgrenzen & verschiedene Luftschichten', altho rather primitive (no contour lines), is perhaps the 1st layer-tint elevation map]

Ritter, Carl, 1826, Über geographische Stellung und horizontale Ausbreitung der Erdteile (Geogr. position & horizontal extent of the continents; in German): Berlin, lecture at Kgl. Akad. d. Wissenschaften, December 14, published 1852 *in* Einleitung zur allgemeinen vergleichenden Geographie, und Abhandlungen zur Begründung einer mehr wissenschaftlichen Behandlung der Erdkunde: Berlin, Sammlung der Abhandlungen Ritters, p. 103-128. [calculated circularity index for the continents; related cont. area to square of perimeter or area of smallest circumscribed circle; the 1st-ever spatial morphometry? see 1861 Gage transl.]

Ritter, Carl, 1828, Bemerkungen über Veranschaulichungsmittel räumlicher Verhältnisse bei graphischen Darstellungen durch Form und Zahl (Illustrative methods for spatial properties using diagrams of form & number; in German): Berlin, lecture at Kgl. Akad. d. Wissenschaften, January 17, published 1852 *in* Einleitung zur allgemeinen vergleichenden Geographie, und Abhandlungen zur Begründung einer mehr wissenschaftlichen Behandlung der Erdkunde: Berlin, Sammlung der Abhandlungen Ritters, p. 129-150. [early spatial morphometry; includes 1826 calc. of circularity index of the continents; see 1861 Gage transl.]

Robison, E.G., Mills, K.A., Paul, James, Dent, Elizabeth, and Skaugset, Arne, 1999, Digital elevation models (DEMs) and ground-slope comparisons, pp. 32-39 *in* Storm impacts and landslides of 1996—Final Report: Oregon Department of Forestry, Forest Practises Technical Report no. 4, 145 p. [30-m DEM slopes (fr 40' CI map) poorly correl. w/ site slope (smaller scale length & better source maps)]

Rodda, J.C., 1970, A trend-surface analysis trial for the planation surfaces of north Cardiganshire: Transactions of the Institute of British Geographers, Publ. no. 50, p. 107-114. [early applic. of T-S technique to topo.]

Roering, J.J., Kirchner, J.W., and Dietrich, W.E., 1999, Evidence for nonlinear, diffusive transport on hillslopes and implications for landscape morphology: Water Resources Research, v. 35, no. 3, p. 853-870. [back to Davis & Gilbert; transport law ≈ slope angle; field agreement (2-m DEM)]

Roering, J.J., Kirchner, J.W., and Dietrich, W.E., 2001, Hillslope evolution by nonlinear, slope-dependent transport—steady state morphology and equilibrium adjustment timescales: Journal of Geophysical Research, v. 106, no. B8, p. 16,499-16,513 (minor correction *in* 106, B11, 26,787). [simulations; suggest hilltop curvature, not relief & slope, indicates tectonic forcing]

Roeschmann, Günter, and Lehmeier, Friedmut, 1993, Vorschläge zur morphographischen Kennzeichnung des Oberflächenreliefs für punktbezogene geowissenschaftliche Profilaufnahmen (REPA) (in German: proposals for the morphographic characterization of surface relief for geoscientific data acquisition at drilling sites and exposures): Geologisches Jahrbuch, v. F26, no. 1, p. 3-46. [exhautive system for relief char. in plan & profile, 'what is to be descr.' Kugler, Demek infl.]

Rogers, C.A., 1993, Describing landscapes—indices of structure: Burnaby, BC, Simon Fraser University, unpublished M.Sc. thesis, 170 p. [landscape ecology; used metrics now in FRAGSTATS]

Romieux, A., 1890, Relations entre la déformation actuelle de la croûte terrestre et les densités moyennes des terres et des mers (in French;): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences / Institut de France, v. 111, p. 994-996. [tries to reconcile mean land & sea elevs. with geophysics in light of *Challenger* Expedition data]

Romstad, Bård, 2001, Improving relief classification with contextual merging, *in* ScanGIS'2001, Scandinavian Research Conference on Geographical Information Science 8th, Ås, Norway, 25-27 June, Proceedings: p. 3-13; <http://www.nlh.no/conf/scangis2001/papers/15.pdf>. [more uniform, less 'noisy' terrain types; 10m DEM of Spitzbergen]

Rosiek, M.R., Kirk, R., and Howington-Krause, A., 1999, Lunar south pole topography derived from Clementine imagery, *in* Workshop on new views of the Moon II—understanding the Moon through the integration of diverse datasets: Houston TX, Lunar and Planetary Institute, LPI Contribution no. 980, p. 52-53. [fr Clementine altimetry; 90°-65° S at 1km/px; color map]

Rosiwal August, 1898, Über geometrische Gesteinsanalysen. Ein einfacher Weg zür ziffermassigen Feststellung des Quantitätsverhältnisses der Mineral-Bestandteile gemengter Gesteine (in German; Geometric rock analysis. A simple method for numerical determination of quant. ratios of mineral fractions of mixed rocks; transl. H.G. Ranson, 1960, Royal Aircraft Establ., Farnborough, U.K., Lib. Trans. #871): Verhandl. der Kaiserlich-Koeniglichen Geologischen Reichsanstalt, Vienna, 5/6, p. 143-175. [parallel-line sampling to obtain area (& thus volume, after stereological principle of Achille Delesse 1847) of mineral constituents in rocks fr microscope analysis of thin sections; directly adapts to area measurement on maps]

Rossi, M.J., 1999, Plan-curvature effect on the formation of tumuli on shield volcanoes—an example from Leitin lava flow field in Iceland: Zeitschrift für Geomorphologie, Supplementband 114, p. 1-10. [tumuli freq., plancurv., & slope / dist. fr vent; freq. of tumulus H, W, & A]

Rosu, Al, and Balteanu, D., 1969, Caracterizarea cantitativa si clasificarea unitatilor geomorfologice din Romania, pe baza varietatii reliefului (Quantitative characterization and classification of geomorphic units in Romania based on relief variations): Terra (Helsinki), v. 1, no. 1, p. 28-31. [defined 18 units on relief energy & dissection]

Rothe, Rudolf, 1915, Zum problem des talwegs (in German; on the drainage-line problem): Sitzungsberichte der Berliner Math. Gesellschaft, v. 14, p. 51-69. [key to older French refs.; citing math. definition (Saint-Venant 1852) & theorem (Breton de Champ 1854), Rothe criticizes Jordan 1872a & rather vaguely defines valley (& ridge) lines (flow-lines where other flow-lines converge & join to form a stream channel) as points where slope is locally minimal re/ other points at same elev.]

Roubal, J., and Poiker, T., 1985, Automated contour labeling and the contour tree, *in* Auto-Carto 7, International Symposium on Computer-Aided Cartography, 7th, Washington, D.C., March 11-14, Proceedings: p. 472-481. [data structure evolved into Kweon & Kanade 1994 'topographic change tree']

Rouse, W.C., 1984, Flowslides, chap. 12 *in* Brunsden, Denys, and Prior, D.B., eds., Slope Instability: London, Wiley, p. 491-522. [obs. on approx. geometries of ~20 flowslide (e.g. Gros Ventre, Blackhawk, Sherman, Madison Cyn.) rupture surfaces, tracks, & deposits]

Rowbotham, D.N., and Dudycha, Douglas, 1998, GIS modelling of slope stability in Phewa Tal watershed, Nepal: Geomorphology, v. 26, nos. 1-3, p. 151-170. [creates irreg. 'terrain units' fr DEM maxs & mins fr elev. & curvature surfaces]

Rowland, S.K., and Garbeil, Harold, 2000, Slopes of oceanic basalt volcanoes, *in* Mouginis-Mark, P.J., Crisp, J.A., and Fink, J.H., eds., Remote Sensing of Active Volcanism: Washington, DC, American Geophysical Union, Geophysical Monograph 116, p. 223-247. [DEMs & slope for 15 shields in 4 regions; plot slope vs. elev. & % total elev.]

Rowland, S.K., MacKay, M.E., Garbeil, H., and Mouginis-Mark, P.J., 1999, Topographic analyses of Kíluea volcano, Hawai'i, from interferometric airborne radar: Bulletin of Volcanology, v. 61, no. 1-2, p. 1-14. [10-m DEM, vert. accuracy 1-2 m; compare w/ USGS DEM & ground truth survey]

Rubey, W.W., 1952, Final stages in development of present topography, p. 122-136 *in* Geology and mineral resources of the Hardin and Brussels quadrangles (in Illinois): U.S. Geological Survey, Professional Paper 218, 179 p.   [eqn. relates stream-surface slope to channel depth/width, load, particle size, & discharge; used many results from G.K. Gilbert's 1914 flume experiments]

Rudenko, M.V., Dzhumaylo, N.A., and Berezhnyy, B.V., 1983, A computer method for the statistical analysis of bottom relief data: Oceanology, v. 22, no. 5, p. 630-632.   [morphometry, relief, statistical analysis]

Ruffin, B.W., 1965, Lunar heights from shadows automatically: Photogrammetric Engineering, v. 31, no. 5, p. 741-743.   [qual. descript. of quant. processes for getting spot heights for the ACIC lunar charts]

Ruggles, C.L.N., Medyckyj-Scott, D.J., and Gruffydd, A., 1993, Multiple viewshed analysis using GIS and its archaeological application—a case study in northern Mull, *in* Andresen, J., Madsen, T., and Scollar, I., eds., Computing the past—Computer Applications and Quantitative Methods in Archaeology, CAA92 Aarhus: Aarhus, Denmark, Aarhus University Press, p. 125-131.   [used to solve historico-archeological problems]

Ruhe, R.V., 1967, Geomorphic surfaces and surficial deposits in southern New Mexico: Socorro NM, State Bureau of Mines and Mineral Resources, Memoir 18, 65 p.   [eqns. of profiles & contours on fans, pediments, & piedmonts; fits ellipse to plan of mtn. range]

Ruhe, R.V., and Walker, P.H., 1968, Hillslope models and soil formation, I, *in* International Congress of Soil Science, 9th, Adelaide, Australia, Transactions: v. 4, p. 551-560.   [parsed geomorph. units fr concavo-convexity & slope gradient, length, & width; proposed quant. descr. but did none]

Russell, E.C., Kumler, Mark, and Ochis, Heidi, 1995, Identifying and removing systematic errors in USGS DEMs, *in* Conference, GIS in the Rockies, Denver, CO, 25-27 Sept., Proceedings: paging unknown; http://www.ctmap.com/gis_journal/destripe.pdf.   [row-by-row DEM power-spectrum estimates better than low-pass filtering]

Russell, E.C., and Ochis, Heidi, 1995-96?, Mitigation methods for systematic errors in USGS DEMs: Boulder, CO, Computer Terrain Mapping, Inc., 8 p.; http://www.ctmap.com/gis_journal/filtering_wp.pdf.   [good review of Level 1 7.5' problem; improvements fr power-spectrum (manual profiling) or global + local filtering (Gestalt Photomapper II)]

Rutkis, Janis, 1971, Tables on relative relief in middle and western Europe: Uppsala Universitet, Naturgeografiska Institutionen, Uppsala, Sweden, UNGI Rapport 9, 22 p.   [+ 2 appendices with 69 pages of tables of elevation; see William-Olssen, 1975]

Ruxton, B.P., 1958, Weathering and subsurface erosion in granite at the piedmont angle, Balo, Sudan: Geological Magazine, v. 95, no. 5, p. 353-377.   [quant. data on slope profiles suggest correl. betw. slope & lithology]

Rzhanitsky, N.A., 1960, Morphological and hydrological regularities of the structure of the river net (translated from the Russian by D.B. Krimgold): U.S. Agricultural Research Service, 380 p.   [quant. drainage analysis applied to USSR hydro. problems; big. Engl. biblio]

S

Sadahiro, Yukio, 2001, Analysis of surface changes using primitive events: International Journal of Geographic Information Science, v. 15, no. 6, p. 523-538.   [modify 'structural graph' (Warntz topology; critical points & integral curves)]

Sagar, B.S.D., 2002, Qualitative models of certain discrete natural features of drainage environment: New Delhi, India, Allied Publishers Ltd., ca. 225 p, in-press. [a morphometric monograph ('qualitative' a misnomer) on spatial fractal char. of rivers, math. morphology, '1-D maps']

Sagar, B.S.D., and Murthy, K.S.R., 2000, Generation of a fractal landscape using nonlinear mathematical morphological transformations: Fractals, v. 8, no. 3, p. 267-272. [fr 3r-order Koch quadric fractal; 'resembles landscape (w/) alluvial fans, of interest to theoretical geomorphologists']

Sagar, B.S.D., Murthy, M.B.R., Rao, C.B., and Raj, Baldev, 2002, Morphological approach to extract ridge and valley connectivity networks from digital elevation models: International Journal of Remote Sensing, v. 23, in press, 9 p. [math. morph. transform. of grey-scale image of DEM; Gaussian blurring technique]

Sagar, B.S.D., and Rao, B.S.P., 1995, Fractal relation on perimeter to the water body area: Current Science (Bangalore, India), v. 68, no. 11, p. 1129-1130. [the old (mid 19th Cent.) area/perimeter problem yet again]

Sagar, B.S.D., and Srinivas, D., 1999, Estimation of number-area-frequency dimensions of surface water bodies: International Journal of Remote Sensing, v. 20, no. 13, p. 2491-2496. [math. morph.; set theory-based transform, the 'cascade of erosion-dilation' for 1700 lakes]

Sagar, B.S.D., Venu, M., and Murthy, K.S.R., 1999, Do skeletal networks derived from water bodies follow Horton's laws?: Mathematical Geology, v. 31, no. 2, p. 143-154. ['yes', acc. to Melton's law, tested on Nizamsagar Reservoir]

Sagar, B.S.D., Venu, M., and Srinivas, D., 2000, Morphological operators to extract channel networks from digital elevation models: International Journal of Remote Sensing, v. 21, no. 1 p. 21-29. [mathematical morphology simplifies DEM-to-network transf. from a simulated DEM]

Saint-Venant, A.J.C.B. (Adhémar Jean-Claude Barré) de, 1852, Sur les surfaces à plus grande pente constante ainsi que sur les lignes courbes parallèls, sur celles qu'on peut appeler anti-parallèls, et sur les lignes de faîte et de thalweg des surfaces courbes en général (in French; on surfaces of greater constant slope as well as curved parallel lines, anti-parallels, and ridge & thalweg lines of curved surfaces in general): Bulletin de la Société Philomathématique de Paris, March 6 session, p. 24-29. [mathematician & civil engineer; 2 theorems here; this possibly 1st identify of ridges & drains as points of minimum slope—compared to other points at same elevation, altho did not specify flow-lines (slope = zero) that form drainage pattern (see Haralick 1983)]

Sakaguchi, Yukata, 1968, On mountain-forming processes: Geographical Review (Japan), v. 77, p. 284-310. [used relative relief & summit altitude]

Salisbury, N.E., 1980, Thresholds and valleys widths in the South River basin, Iowa, *in* Coates, D.R., and Vitek, J.D., eds., Thresholds in Geomorphology: London, George Allen and Unwin, p. 103-129. [problem of valley widening approached by regression analysis of basin area, reach length, slope, etc.]

Sallenger, A.H. Jr., Krabill, William, Brock, John, Swift, Robert, Jansen, Mark, Manizade, Serdar, Richmond, Bruce, Hampton, Monte, and Eslinger, David, 1999, Airborne laser study quantifies El Niño-induced coastal change: Eos, Transactions, American Geophysical Union, v. 80, no. 8, p. 89, 92, 93. [Airborne Topo. Mapper (ATM): 2-m spacing & 14-cm rms vert. error show erosion]

Sandwell, D.T., and Smith, W.H.F., 2001, Bathymetric estimation, *in* Fu, L.-L., and Cazenave, eds., Satellite Altimetry and Earth Sciences—A handbook of techniques and applications: New York, Academic Press, p. 441-457. [state-of-art overview]

Sapozhnikov, V.B., and Foufoula-Georgiou, Efi, 1999, Horizontal and vertical self-organization of braided rivers: Water Resources Research, v. 35, no. 3, p. 843-851. [dynamic scaling emerges as critical state approached; braided rivers are S-O systems]

Sauermann, G., Rognon, P., Poliakov, A., and Herrmann, H.J., 2000, The shape of the barchan dunes of Southern Morocco: Geomorphology, v. 36, nos. 1-2, p. 47-62. [h/W; n=8; claim shape not necessarily size-invariant]

Saunders, William, 2000, Preparation of DEMs for use in environmental modeling analysis, *in* Djokic, Dean, and Maidment, David, eds., Hydrologic and Hydraulic Modeling Support with Geographic Information Systems: Redlands CA, ESRI Press, p. 29-52; http://www.esri.com/library/userconf/proc99/proceed/papers/pap802/p802.htm. [integrates vector hydro layer into DEM prior to watershed delineation ('stream burning')]

Savigear, R.A.G., 1967, On surveying slope profiles: Revue de Géomorphologie Dynamique, v. 17, no. 4, p. 153. [see also de Béthune, & Rapp, same source]

Savigear, R.A.G., 1967, The analysis and classification of slope profile forms, *in* Macar, Paul, ed., L'evolution des versants: Liége, p. 271-287. [last (?) Savigear paper on slope profiles (1st in 1952)]

Schaber, G.G., Pike, R.J., and Berlin, G.L., 1979, Terrain-analysis procedures for modeling radar back-scatter: U.S. Geological Survey Open-file Report 79-1088, 20 p. + 41 p. appendix. [the Pike et al. 1968-70 software package; appendix has entire FORTRAN code & worked example]

Scheer, Roderich, 1933, Die zahlenmäßige Erfassung der Reliefenergie und ihre Darstellung (numerical capture of relief energy and its representation, in German): Geogr. Wochenschrift (Breslau), v. 1, no. 17, p. 463-464. [brief note on relative-relief technique]

Scheidegger, A.E., 1967, A stochastic model for drainage patterns into an intermontane trench: Bulletin of the International Association of Scientific Hydrology, v. 12, no. 1, p. 15-20. [introduced the directed random network, the simplest possible reasonable flow model]

Scheidegger, A.E., 1968, Horton's law of stream numbers: Water Resources Research, v. 4, no. 3, p. 655-658. ['law' math. consistent only for structurally Hortonian networks, which are rare in nature]

Scheidegger, A.E., and Langbein, W.B., 1966, Probability concepts in geomorphology: U.S. Geological Survey Professional Paper 500-C, p. C1-C14. [var. examples of randomness concepts in understanding landforms & rivers]

Schenk, P.M., 2002, Thickness constraints on the icy shells of the galilean satellites from a comparison of crater shapes: Nature, v. 417, no. 6887, p. 419-421. [d/D plots for Callisto, Ganymede, & Europa fr stereo DEMs, photoclinometry, & shadow lengths]

Schenk, P.M., Hargitai, Henrik, Wilson, Ronda, McEwen, Alfred, and Thomas, Peter, 2001, The mountains of Io—global and geological perspectives from Voyager and Galileo: Journal of Geophysical Research, v. 106, no. E12, p. 33,201-33,222. [L, W, A, h (mean h= 6.3 km) for 115 mtns. & 541 volcanoes (mean h= 17.5 km); h fr shadow lengths, twilight illum., limb profiles, & stereo elev. mapping)]

Schick, A.P., 1964, Accuracy of the 1/20,000 topographic maps of Israel for morphometric studies: Bulletin of the Israel Exploration Society, v. 28, no. 1, p. 43-54. [1/2500 maps better than 1/20K maps, by ~10%]

Schilling, S.P., 1998, LAHARZ—GIS programs for automated mapping of lahar-inundation hazard zones: U.S.Geological Survey, Open-file Report 98-638, 80 p. [based on Iverson & (1998); menu-driven ARCINFO GRID software uses DEM]

Schlager, Wolfgang, and Adams, E.W., 2001, Model for the sigmoidal curvature of submarine slopes: Geology, v. 29, no. 10, p. 883-886. [STRATA pkg. consis. w/ upper-planar / lower-concave-upward model of shelf-slope break]

Schloss, Milton, 1965, Quantifying terrain roughness on lunar and planetary surfaces: American Institute of Aeronautics and Astronautics 2nd Annual Meeting, July 26-29, San Francisco CA, Paper no. 65-389 (separate), 22 p. *also abstracted* 1966, Journal of Spacecraft and Rockets (AIAA), v. 3, p. 283-285. [PSD-like log-log plots fr slope & curvature deviations extended to 1.25'-grid DEM fr USGS map of Ranger 7 (Mare Cognitum) site]

Schmaltz, Gustav, 1929, Über Glätte und Ebenheit als physikalisches und physiologisches Problem (smoothness & parallelism as a physical & physiological problem, in German): Zeitschrift des Vereines deutscher Ingenieure, v. 73, no. 41, p. 1461 ff. [engineering-surface measurements fr microscopic study of profile sections]

Schmaltz, Gustav, 1936, Technische Oberflächenkunde—Feingehalt und Eigenschaften von Grenzflächen technischer Körper insbesondere der Maschinenteile (in German; Technical surface science—smoothness & characteristics of exterior surfaces of workpieces, esp. machine parts): Berlin, Springer Verlag, 286 p. [review of industrial surface metrology, earlier work; profile quantification using the Schmaltz microscope]

Schmid-McGibbon, Gesche, and Eyton, J.R., 1996, Frequency-based contextual landform classification: Geomatica, v. 50, no. 3, p. 287-299. [freq. counts fr. classified DEM's of relief, slope & curvature]

Schmidt, Jochen, 1996, Untersuchungen zum Einfluß geomorphologischer Variabilität und Struktur auf den Niederschlag-Abfluß-Prozeß in kleinskaligen Einzugsgebieten (in German, Studies on influence of geomorphologic variability & structure on rainfall-discharge process in small-scale catchments): Ruprecht-Karls-Universität Heidelberg, Geographisches Institut, unpublished Diplomarbeit, 183 p. [hydrologic terrain modelling]

Schmidt, Jochen, and Dikau, Richard, 1999, Extracting geomorphometric attributes and objects from digital elevation models—semantics, methods, future needs, *in* Dikau, Richard, and Saurer, Helmut, eds., GIS for Earth Surface Systems Analysis and Modelling of the Natural Environment: Stuttgart, Borntraeger, p. 153-173. [overview in GIS context; extends previous work w/ GRASS & ARC/INFO examples]

Schmidt, Jochen, Hennrich, Kirsten, and Dikau, Richard, 2000, Scales and similarities in runoff processes with respect to geomorphometry: Hydrological Processes, v. 14, nos. 11-12, p. 1963-1979. [framework overview for detailed work in Schmidt et al. 1998 & Hennrich et al. 1999]

Schmidt, Jochen, Merz, Bruno, and Dikau, Richard, 1998, Morphological structure and hydrological process modelling: Zeitschrift für Geomorphologie, Supplementband, 112, p. 55-66. [basin morphometry & rainfall-runoff related using SAKE model]

Schmidt, Jürgen, 2000, Oberflächenabfluß und erosion, Möglichkeiten und Grenzen der mathematischen Prozeßbeschreibung (in German; runoff & erosion, potentialities & limitations on math. desc. of process: Zeitschrift für Geomorphologie, Supplementband, 123, p. 1-12. [reviews SLOP 3D, EROSION 2D/3D, RillGrow (Ahnert, etc.); newer models finer scale]

Schmidt, K.M., and Davidson, J.G., 1999, Using geomorphic features to constrain tectonic activity near Pahrump Valley, Nevada and California, *in* Conference on Status of Geologic Research and Mapping in DeathValley National Park, Las Vegas, NV, April 9-11: U.S. Geological Survey, Open-file report 99-153, p. 154-155. [mountain-front sinuosity, valley H/W, & drainage area x slope]

Schmidt, K.M., and Montgomery, D.R., 1996, Rock mass strength assessment for bedrock landsliding: Environmental and Engineering Geoscience, v. 2, no. 3, p. 325-338. [quantifies relief, slope, & bedding-plane properties]

Schneider, Bernhard, 1995, Adaptive interpolation of digital terrain models, *in* International Cartographic Conference, 17th, Barcelona, Proceedings: v. 2, p. 2206-2210. [no info; probably like his 1998 work]

Schneider, Bernhard, 1998a, Geomorphologisch plausible Rekonstruktion der digitalen Repräsentation von Geländeoberflächen aus Höhenliniendaten (in German; geomorph. plausible rec. of terrain surfaces fr contour data): Geographisches Institut Universität Zürich, Geoprocessing Reihe, v. 35 (Inaugural dissertation), 226 p. + appendices; http://www.geo.unizh.ch/~benni/b_3.html. [surface directly fr contours via TIN better than contour-to-grid; several applics.]

Schneider, Bernhard, 1998b, Geomorphologically sound reconstruction of digital terrain surfaces from contours, *in* International Symposium on Spatial Data Handling 8th, 11-15 July, Vancouver BC, Proceedings: p. 657-667. [thesis work; gets surface directly from contours via TIN; several applics]

Schneider, Bernhard, 2000, Uncertainty propagation in digital terrain modelling with Taylor methods and interval arithmetic, *in* Accuracy 2000, July 2000, Amsterdam, Proceedings: p. 561-568. [no info]

Schneider, Bernhard, 2001, Phenomenon-based specification of the digital representation of terrain surfaces: Transactions on GIS, v. 5, no. 1, p. 39-52. [no info]

Schneider, Bernhard, 2001, Uncertainty of local form in digital terrain modelling (extd. abs.), *in* GIS Research UK 9th Annual Conference (GISRUK 2001), Proceedings: p. 336-340. [no info]

Schneider, Bernhard, and Martinoni, Daria, 2001, A distributed geoprocessing concept for enhancing terrain analysis for environmental modeling: Transactions on GIS, v. 5, no. 2, p. 166-178. [no info]

Schneider, Hans, 1932, Maximal Reliefenergie, *in* Morphologie des Buntsandsteinodenwaldes: Frankf. Geogr., v. 6, no. 2, plate 6, 1/800K map. [map of relief 'energy' on 5km squares; 7 relative-relief intervals]

Schoorl, J.M., Sonneveld, M.P.W., and Veldkamp, A., 2000, Three-dimensional landscape process modelling—the effect of DEM resolution: Earth Surface Processes and Landforms: v. 25, no. 9, p. 1025-1034. [5 DEM spacings for hillslope & basin; erosion & sedimentation rates over- & underpred.]

Schörghofer, Norbert, and Rothman D.H., 2001, Basins of attraction on random topography: Physical Review E, v. 63, no. 2, p. 132-137. [ability to collect water ≈ contour curv. / local slope, so hillslope & drainage area statistically related, even in random topography; Gaussian surfaces model random topography]

Schrepfer, Hans, 1933, Karte (2) der Reliefenergie, *in* Der Kaiserstuhl: Bad. Landeresverein f. Naturkunde und Naturschutz, Freiburg i B., p. 5, 1/133K map, and p. 7, 1/120K map (Taleintiefung). [maps of relief 'energy'; resp. 7 and 4 relative-relief intervals]

Schröder, Florian, and Roßbach, Patrick, 1994, Managing the complexity of digital terrain models: Computers and Graphics, v. 18, no. 6, p. 775-783. [create TINs from DEMs (an off-line process, due to its complexity)]

Schroeder, Martin, 1995, Computergestützte Reliefmodellierung der Erde (in German, computer-assisted relief modelling of the Earth): Diplomarbeit im Fach Geographie, Ruprecht-Karls Univ. Heidelberg, Fakultät für Geowissenschaften Geographisches Institut, 84 p. and 4 fold-out color maps. [Hammond classif. of New Mexico, US (lower 48), & world (GTOPO30)]

Schruben, P.G., 1998, Color shaded-relief map of the conterminous United States: U.S. Geological Survey, Open-file Report 99-0011, CD-ROM (ESRI ArcView 3.0 reqd.), and http://pubs.usgs.gov/openfile/of99-011/ (Adobe Photoshop reqd.). [15 arc-sec fr. old Arny data; uses Mark's multi-directional shading]

Schuller, D.J., Rao, A.R., and Jeong, G.D., 2001, Fractal characteristics of dense stream networks: Journal of Hydrology, v. 243, nos. 1-2, p. 1-16. [self-affine, not self-similar; ***D*** varies widely by technique]

Schultze, C., 1864, Flächeninhalt und Küstenlänge. Notiz, betr. den Schumannschen Vorschlag. (Area & coastal length. Note, Schumann's suggestion considered, in German): Petermanns Geogr. Mitteilungen, v. 10, no. 3, p. 92. [the area/perimeter problem; 'coast devel.' = U/K, U = coast length, for K see Rohrbach, 1890]

Schulz, Karsten, Huwe, Bernd, Wörlen, Christine, and Eiden, Reiner, 1999, Wind speed regionalization and its influence on areal evapotranspiration prediction, *in* Diekkrüger, Bernd, Kirkby, M.J., and Schröder, Ulrich, eds., Regionalization in Hydrology: Conference, Technical University of Braunschweig, Germany, 10-14 March, 1997, Proceedings: IAHS Publication no. 254, p. 97-104. [distributed DEM data much improve ET estimates over those based on central station topo only]

Schumann, Dr., 1864, comments (in German) *in* Bothe (1864a), p. 406. [the area/perimeter problem; 'coastal development' = U/2√F∏: U = perimeter of coast, F = area enclosed; and r1 = √F/∏; see Rohrbach, 1890]

Schumm, S.A., 1954, Evolution of drainage systems and slopes in badlands at Perth Amboy, New Jersey: Office of Naval Research Project no. 389-042, Contract N6 ONR 271-30, Technical Report no. 8, New York, Columbia University, Department of Geology, 86 p. + illustrations. [most prominent Strahler student; extended Horton work on topologic & geometric variables]

Schumm, S.A., 1954, The relation of drainage basin relief to sediment loss, *in* International Association of Hydrology, IUGG, General Asembly 10th, Rome, Proceedings: v. 1, p. 216-219. [defined relief ratio, Rh, as total basin relief / max. basin length parallel to main trunk]

Schwartz, P.M., Levine, D.A., Hunsaker, C.T., and Timmins, S.P., 1995, TERRAIN, a computer program to process digital elevation models for modeling surface flow: U.S. Department of Energy, National Laboratories, Oak Ridge TN, 73 p. [software calculates overland flow paths, watershed boundaries, slope, & aspect; US$22.95]

Scott, P.J., 2001, An algorithm to extract critical points from lattice height data: International Journal of Machine Tools and Manufacture, v. 41, Nos. 13-14, p. 1889-1897. [satisfies Euler Criterion & other topological properties that always must apply to continuous data]

Seibert, Jan, 1999, On TOPMODEL's ability to simulate groundwater dynamics, *in* Diekkrüger, Bernd, Kirkby, M.J., and Schröder, Ulrich, eds., Regionalization in Hydrology: Conference, Technical University of Braunschweig, Germany, 10-14 March, 1997, Proceedings: IAHS Publication no. 254, p. 211-220. [basic assumptions obstruct correct simulation of spatial & temporal dynamics]

Serra, Jean, 1995, (online) Course on mathematical morphology: Centre de Morphologie Mathématique, Fontainebleau, France. <http://cmm.ensmp.fr/~serra/cours.htm>. [chapter 9, 'Skiz and Watershed', describes grey scale-to-elevation transformation; standard text on subject = Serra Jean, 1982, Image Analysis and Mathematical Morphology: London, Academic Press]

Serrat, Joan, López, A.M., and Lloret, David, 2000, On ridges and valleys, *in* International Conference on Computer Vision 15th (ICPR'00), IEEE Computer Society, 3-8 September, Barcelona: Proceedings, v. 4, p. 59-66. [intro. to descriptive geometry of ridges & drains in machine vision; taxonomy; see López 1997 & 1999]

Seymour, M., and Cumming, I., 1998, Improving DEMs using SAR interferometry, *in* IEEE International Geoscience and Remore Sensing symposium (IGARSS), Seattle WA, July 6-10, Proceedings: Piscataway NJ, Institute of Electrical and Electronic Engineers, CD-ROM. [work with GTOPO30]

Sharma, H.S., 1986, Climate and drainage basin morphometric properties - a case study of Rajasthan, *in* Gardiner, V., ed., International Geomorphology 1986, Part II: New York, John Wiley & Sons, p. 69-87. [maps of stream freq. & dissection index; 5 climate types contrasted]

Sharpton, V.L., and Head, J.W. III, 1985, Analysis of regional slope characteristics on Venus and Earth: Journal of Geophysical Research, v. 90, no. B5, p. 3733-3740. [Pioneer/Venus data; 3°x3° samples; same range, diff. freq. distr.]

Shary, P.A., 2001, Analytical GIS "Eco": <http://members.fortunecity.com/eco4/giseco/>. [software package for digital terrain modeling & display, by Peter Shary, for Windows 95/98/2000/NT; 23 land surface attributes; $US 900/1200 as of 05/02; emphasis on soils analysis by the curvature measures in Shary 1995 & Shary et al. 2002]

Shary, P.A., Sharyara, L.S., and Mitusov, A.V., 2002, Fundamental quantitative methods of land surface analysis: Geoderma, v. 107, nos. 1-2, p. 1-32. [DEM-based random-field parameterization of surface curvature after Gauss 1827, Evans & Young 1978, Krcho 1973 & 83; formulae for 12 curvatures & 7 other local parameters]

Shepard, F.P., 1970, Lagoonal topography of Caroline and Marshall Islands: Geological Society of America Bulletin, v. 81, no. 7, p. 1905-1914. [4-fa contours reveal irreg. floors; 10-20-m-relief knoll-&-basin topo]

Shiiba, Michiharu, Ichikawa, Yutaka, Sakakibara, Tetsuyoshi, and Tachikawa, Yasuto, 1999, A new numerical representation form of basin topography (in Japanese with English abstract & figure captions): Transactions of the Japanese Society of Civil Engineers, n. 621/II-47, p. 1-9. [gets both concentration & divergence of flow fr grid DEM]

Shimazu, Hiroshi, 2001, Relief condition and sediment transport processes in Japanese and Korean mountain river basins: Transactions of the Japanese Geomorphological Union, v. 22, no. 3, p. 307-320. [R/elev., R components by river type; elev. & slope/stream distance]

Shinagawa, Yoshihisa, and Kunii, T.L., 1991, Constructing a Reeb graph automatically from cross sections: IEEE Computer Graphics and Applications, v. 11, no. 6, p. 44-51. [topological skeleton of 3-D object from surface contours]

Shinagawa, Yoshihisa, Kunii, T.L., and Kergosien, Y.L., 1991, Surface coding based on Morse theory: IEEE Computer Graphics and Applications, v. 11, no. 5, p. 66-78. [extends Morse theory (for abstracting shape of a surface) to sections of 3-D objects]

Shinagawa, Yoshihisa, Kunii, T.L., Belyaev, A.G., and Tsukioka, Taketo, 1996, Shape modeling and shape analysis based on singularities: The International Journal of Shape Modeling, v. 2, no. 1, p. 85-102. [define fcn. on object & use its singularities to abstract object shape; Reeb graph, wavelets]

Shortridge, A.M., 1997, Characterizing the relationship between 7.5' and 1 degree digital elevation models: Santa Barbara, University of California, M.A. thesis, 70 p. [the "old Army" 1 degree data are poor by comparison]

Shortridge, A.M., 2001, Characterizing uncertainty in digital elevation models: ch. 11, *in* Hunsaker, C.T., Goodchild, M.F., Friedl, M.A., Case, T.J., eds., Spatial Uncertainty in Ecology—Implications for Remote Sensing and GIS Applications: New York, Springer, p. 238-257. [2 causes; diffs. betw. data model & real surface, and poor capture by production methods]

Shortridge, A.M., and Clarke, K.C., 1999, On some limitations of square raster cell structures for digital elevation data modeling, Ch. 41 *in* Lowell, Kim, and Jaton, Annick, eds., Spatial Accuracy Assessment—Land Information Uncertainty in Natural Resources: Chelsea, MI, Ann Arbor Press, p. 341-347. [identified resampling problems that need to be addressed by GIS users]

Shrestha, R.L., and Carter, W.E., 2000, Bare earth digital terrain model from airborne laser swath mapping (abs.): Eos Transactions of the American Geophysical Union, v. 81, no. 48 (Supplement, G72A-01), p. F323. ['ground clutter' (structures, vegetation, etc.) filtered out of DEMs]

Shreve, R.L., 1963, Horton's "Law" of stream numbers for topologically random drainage netwirks (abs.): Transactions, American Geophysical Union, v. 44, no. 1, p. 44-45. [1st publ. by Shreve on randomness, rather than orderly development, in river patterns]

Shreve, R.L., 1974, Variation of main stream length with basin area in river networks: Water Resources Research, v. 10, no. 6, p. 1167-1177. [Systematic deviation of observations (n = 461) from Hack's Law]

Shulits, Samuel, 1955, Graphical analysis of trend profile of a shortened section of river: Transactions of the American Geophysical Union, v. 36, no. 4, p. 649-654. [cutoffs on the Rhine; slope & sediment size closely related]

Siakeu, Jean, and Oguchi, Takashi, 2000, Soil erosion analysis and modelling—a review: Transactions, Japanese Geomorphological Union, v. 21, no. 4, p. 413-429. [USLE & alternatives; includes caveats on DEM-based work]

Siegburg, Werner, 1987, Talasymetrien in der Umgebung von Bonn (Valley symmetry around Bonn): Decheniana, v. 140, p. 204-217. [no info]

Siegburg, Werner, 1988, Multivariate statistische Untersuchungen zur Hanggenese am Beispiel des Siebengebirges (multivariate statistical studies of slope genesis exemplified by the Sieben mountains): Zeitschrift für Geomorphologie, v. 32, no. 4, p. 481-497. [correl. slope, conc., conv. w/ geology, aspect, sed. cover, etc.]

Siegmund, Mike, and Hall, Kevin, 2000, A study of valley-side slope asymmetry based on the application of GIS analysis—Alexander Island, Antacrtica: Antarctic Science, v. 12, no. 4, p. 471-476. [slope & aspect of polygons of TIN-DEM fr map contours]

Sigle, M., 1985, Das digitale Höhenmodell für das Land Baden-Württemberg (in German): Nachr. Karten-und Vermessungswesen, Series I, v. 95, p. 143-154. [the Baden-Württemberg provincial DEM]

Sigle, M., Hellwich, O., and Köstli, A., 1992, Intersection and combination of digital elevation models—methods and applications: International Archives of Photogrammetry and Remote Sensing, v. 29, pt. B4, Commission IV, p. 878-882. [DEM analysis pkg SCOP]

Simonett, D.S., 1967, Landslide distribution and earthquakes in the Bewani and Torricelli Mountains, New Guinea, a statistical analysis, *in* Jennings, J.N., and Mabbutt, J.A., eds., Landform Studies from Australia and New Guinea: Canberra, Australian National University Press, p. 64-84. [L/S elev., slope angle & length, area, vol.; mult. regression eqns.; denudation est.]

Singh, R.L., 1967, Morphometric analysis of terrain, Part 2: Indian Sci. Congr. Ass., 54th Sess., Proc. p. 115-134. [Relative relief, dissection indexes, drainage texture or density, slope]

Sinha-Roy, S., 2002, Hypsometry and landform evolution—a case study in the Banas drainage basin, Rajasthan, with implications for Aravalli uplift: Journal of the Geological Society of India, v. 60, no. 1, p. 7-26. [10 basins; tectonic history interpr. fr shape of % hypsom. curves & relation to several other basin measures]

Sirotkin, M.P., 1961, Calculation of topographic volume by approximate integration techniques (in Russian): Izvestiya Vysshikh Uchebnyh Zavedeny, Geodesiya i Aerophotosyemka, no. 6, p. 39-46. [no info]

Sitnikov, V.K., 1964, Calculation of mean river slope and valley side slope (in Russian): Meteorol. Gidrol., no. 3, paging unknown. [no info]

Sivapalan, M., Jothityangkoon, C., and Menabde, M., 2002, Linearity and nonlinearity of basin response as a function of scale—discussion of alternative definitions: Water Resources Research, v. 38, no. 2, p. 4-1 to 4-5. [Hack's law arises from linear network response & a purely geometrical property of the basin]

Sjogren, D.B., and Rains, R.B., 1995, Glaciofluvial erosional morphology and sediments of the Coronation-Spondin Scabland, east-central Canada: Canadian Journal of Earth Science, v. 32, no. 5, p. 565-578. [1/20K DEMs & altimetric surveys of v. low-relief features; 1-2-m CI]

Skempton, A.W., 1953, Soil mechanics in relation to geology: Proceedings of the Yorkshire Geological Society, v. 29, pt. 1, no. 3, p. 33-62. [1st distinction of landslides by D/L, where D= depth of moving mass & L= length upslope; also slope gradient vs. slope height]

Skidmore, A.K., 1997, GIS applications and use of digital terrain modelling, *in* Hodgson, S., Rumor, and Harts, J.J., eds., Joint European Conference on Geographical Information, 3rd, Vienna, Austria, Proceedings: Amsterdam, IOS Press, v. 1, p. 442-463. [reviews DEM's in GIS; DEM accuracy, quality, role in modeling; big biblio heavy on applic.]

Skinner, H., and Moore, A.J., 1997, Digital elevation model of the Oak Ridges Moraine, southern Ontario (hillshade enhanced): Geological Survey of Canada, Open-File Report 3297, 1 poster. [Oak Ridges Moraine NATMAP Project; see Kenny 1998 & Kenney et al. 1999]

Slatton, K.C., Crawford, M.M., and Evans, B.L., 2001, Fusing interferometric radar and laser altimeter data to estimate surface topography and vegetation heights: IEEE Transactions on Geoscience and Remote Sensing, v. 39, no. 11, p. 2470-2482. [one way to get accurate, dense, and broad coverage]

Small, D., 1998, Generation of Digital elevation Models Through Spaceborne SAR Interferometry: Department of Geography, Univ. Zurich, Remote Sensing Series, v. 30, 150 p. [hybrid text/Ph.D. thesis; thorough on DEM analysis fr. 2 test areas]

Small, Christopher, and Cohen, J.E., 1999, Continental physiography, climate and the global distribution of human population, *in* International Symposium on Digital Earth, Beijing, Proceedings: Beijing, China, Science Press, p. 965-971; http://www.ldeo.columbia.edu/~small/population.html. [graphs show how world pop. density diminishes rapidly w/ elev. & distance fr sea & permanent rivers]

Smalley, I.J., and Unwin, D.J., 1968, The formation and shape of drumlins and their distribution and orientation in drumlin fields: Journal of Glaciology, v. 7, p. 377-390. [applied nearest-neighbor test]

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Smart, J.S., 1973, The random model in fluvial geomorphology, *in* Morisawa, M.E., ed., Fluvial Geomorphology, *in* annual geomorphology symposium, 4th, Binghamton, N.Y., SUNY, Proceedings: Publications in Geomorphology, p. 27-49. [introduces 3rd postulate to Shreve's 2; finds topol. random model better than Horton's laws]

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Smith, D.E., Zuber, M.T., and 17 others, 1999, The global topography of Mars and implications for surface evolution: Science, v. 284, no. 5419, p. 1495-1503. [26-million-elev MOLA DEM at 1° (~59 km) res. & ±13-m accuracy]

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Soille, Pierre, 1999, Morphological Image Analysis: Berlin, Springer-Verlag, 316 p. (English edition of Morphologische Bildverarbeitung, 1998). [math. morphology; a few DEM applics.; p. 230-39, 'the watershed transformation' (grey scale to elevation)]

Soille, Pierre, 1999, Processing of digital elevation maps, Chapter 19 *in* Jähne, B., Haußecker, H., and Geißler, P., eds., Handbook of Computer Vision and Applications, v. 3: San Diego, Academic Press, p. 411-428. [no info; see other articles]

Soille, Pierre, 2002, Advances in the analysis of topographic features on discrete images: Lecture Notes in Computer Science, no. 2301, p. 175-186. [math. morphology; imposition of minima, lower complete transf., hit-or-miss transform, extracting crest lines by skeletonisation]

Soille, Pierre, and Gratin, C., 1994, An efficient algorithm for drainage networks extraction on DEMs: Journal of Visual Communication and Image Representation, v. 5, no. 2, p. 181-189. [improved DEM-to-watershed transformation]

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Sokolov, A.A., 1962, Interrelations between the morphological features of basins and of river networks (in Russian): Meteorol. Gidrol., no. 2, paging unknown. [no info]

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Sonklar, C.E. von I., 1862, Die Gebirgsgruppe der Hohen Tatra (in German): Petermanns Geographischen Mitteilungen, v. 8, no. 4, p. 121-125. [compares Ötzthaler Alps & Hohen Tatra across 7 of the 12 parameters later summarized in 1873 book]

Sonklar, C.E. von I., 1866, Die Gebirgsgruppe der Hohen-Tauern, mit besonderer Rücksicht auf Orographie, Gletscherkunde, Geologie und Meteorologie, nach eigenen Untersuchungen dargestellt (in German): Vienna, Beck'sche Universitäts-Buchhandlung, 408 p. [Pt. 1, Orographie, Orometrie, Topographie; further use of some of the morphometric measures later summarized in his 1873 book]

Sonklar, C.E. von I., 1872, Die Zillerthaler Alpen, mit besonderer rücksicht auf orographie, gletscherkunde und geologie nach eigenen untersuchungen dargestellt (in German): Gotha, Justus Perthes, Ergänzungsheft (supplement volume) no. 32, to Petermanns Geographischen Mitteilungen, 61 p. [many mean heights of ridges & other forms in chap. VI-VII, pp. 39-54ff.]

Sowter, M.J., and Talling, P.J., 1998, Topographic fingerprinting of erosional processes in mountainous regions (abs.): Eos, Transactions of the American Geophysical Union, v. 79, no. 45, supplement, p. F366. [suite of DEM params. ; relief, slope, plan. arrangement of ridges, valleys, spurs]

Sparks, B.W., 1949, The denudation chronology of the dip-slope of the South Downs: Proceedings of the Geologists' Association, v. 60, no. 3, p. 165-215. [devised the height-range diagram; plotted 283 field-surveyed flat areas]

Sparks, B.W., 1952, Stages in the physical evolution of the Weymouth Lowland: Transactions and Papers of the Institute of British Geographers, no. 18, p. 21. [elaborated the height-range diagram of Sparks 1949]

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Squividant, E., 1994, MNTsurf, logiciel de traitment des Modèles Numérique de Terrain: Rennes, ENSAR (Ecole Nationale Supérieure Agronomique de Rennes), internal document, paging unknown. [calculates such hydro parameters as catchment area]

Srinivasan, Raghavan, and Engel, B.A., 1991, Effect of slope prediction methods on slope and erosion estimates: Applied Engineering in Agriculture, v. 7, no. 6, p. 779-783. [compared 4 square-grid-DEM slope-calc. techniques against field meas.; found neighborhood & quadratic best. & max. slope poorest]

Srinivasan, Raghavan, Engel, B.A., Wright, J.R., Lee, J.G., and Jones, D.D., 1994, The impact of GIS-derived topographic attributes on the simulation of erosion using AGNPS: Applied Engineering in Agriculture, v. 10, no. 4, p. 561-566. [refinement of their 1991 experiment; neighborhood method best]

Stange, Paul, 1885, Orometrie des Thüringerwaldes (in German): Friedrichs-Universität Halle-Wittenberg, Inaugural-Dissertation (Ph.D.), 44 p.; *also* 1885, in Petermanns Geographische Mitteilungen, v. 31, no. 7?, p. 250-254. [Sonklar's volume method for mountains = mean dimensions for Thur. Forest block; 12 meas. for 36 valleys, 17 N & 19 SW (sloping?)]

Stark, C.P., and Hovius, Niels, 2001, The characterization of landslide size distributions: Geophysical Research Letters, v. 28, no. 6, p. 1091-1094. [power-law scaling, but small failures are strongly undersampled]

Stark, C.P., and Stark, G.J., 2001, A channelization model of landscape evolution, *in* Pazzaglia, F.J., and Knuepfer, P.L.K., eds., The steady-state orogen—concepts, field observations, and models: American Journal of Science, v. 302, nos. 4 & 5, p. 486-512. [sub-grid scale parameterization aggregates channel properties of roughness, srfce morph., cross-sect.]

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Steger, Carsten, 1998, An unbiased detector of curvilinear structures: IEEE Transactions on Pattern Analysis and Machine Intelligence, v. 20, no. 2, p. 113-125. [similar to Steger 1997 (& unpubl. 1997 Ph.D. dissertation)]

Steger, Carsten, 1999, Subpixel-precise extraction of watersheds, *in* IEEE International Conference on Computer Vision 7th (ICCV'99), 20–25 September, Corfu, Greece, Proceedings (CD-ROM): p. 884-890. [critical points & flowlines fr Gaussian filter derivatives superior to pixel-by-pixel routing]

Steiner, N., Harder, M., and Lemke, P., 1999, Modelling sea ice roughness in the Arctic, *in* Wettlaufer, J.S., Dash, J.G., and Untersteiner, Norbert, eds., Ice Physics and the Natural Environment: NATO ASI Series (1997 meeting), v. I 56, Berlin, Springer, p. 341-345. [model fr statistics of observed pressure-ridge geometry; use to verify remote sensing]

Steinhauser, Dr., 1864, comments (in German) *in* Bothe (1864a), p. 406. [the area/perimeter problem; 'coastal convolution' = ((U/4)^2)/F, U = coast length, F = land area]

Stelford, Mark, 1998, Sources of error in morphometrically defined hydrologic source areas (abs.), *in* Hallam, C.A., and Salisbury, J.M., eds., GIS Applications in Water Resources Research—American water Resources Annual Meeting, Chicago Ill, November 6-10, 1994: U.S. Geological Survey, Open-file Report 98-751, p. 19. [problem = 'sinks' in glaciated & karst terrain on 7.5' DEM's not real]

Stepinsky, T.F., Marinova, M.M., McGovern, P.J., and Clifford, S.M., 2002, Fractal analysis of drainage basins on Mars: Geophysical Research Letters, v. 29, no. 8, p. 30-1 to 30-4. [4-point network descriptor fr Tarboton algorithm on 0.5 km DEMs of old mtn. terrain fr MOLA data]

Sternberg, H., 1875, Untersuchungen über Längen- und Querprofil geschiebeführender Fluss (study of the longitudinal & transverse profile of the most (?) prominent river; in German): Zeitschrift für Bauwesen, v. 25, no. 11-12, p. 483-506. [the Rhine; 1st to suggest long. profile = exponential curve; related slope to sediment size—*see* Gilbert 1877]

Stevens, N.F., Wadge, G., and Murray, J.B., 1999, Lava flow volume and morphology from digitised contour maps—a case study at Mount Etna, Sicily: Geomorphology, v. 28, nos. 3-4, p. 251-261. [differences 10-m DEM's fr 1969 & 1991 1/25K maps, 25-m CI; not OK for thin flows]

Stewart, E.M., and Head, J.W., 2001, Ancient Martian volcanoes in the Aeolis region—new evidence from MOLA data: Journal of Geophysical Research, v. 106, no. E8, p. 17,505-17,513. [parabolic curves fit to flank topo. of candidate stratocone MOLA 'Feature A' suggest original h ~3 km]

Stewart, Ian, 1991, A Swift trip over rugged terrain: Scientific American, v. 264, no. 6, p. 123-125. ['critical points' theorem; H+V-P=2, where H= no. of local maxima, V= min., P= saddles]

Stocks, J., 1939, Neues zur Morphometrie des Atlantischen Ozeans: Annaler der Hydrographie und Maritimen Meteorology, v. 67, p. 1-13. [see Stocks, 1938; (NB, author's initial Th.?)]

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Stoddart, D.R., ed., 1997, Process and Form in Geomorphology: London & NY, Routledge, 415 p. [not seen; the Chorley Festschrift; a few papers appear to be morphometric]

Stokes, S., Goudie, A.S., Ballard, J., Gifford, C., Samieh, S., Embabi, N., and El-Rashidi, O.A., 1999, Accurate displacement and morphometric data using kinematic GPS: Zeitschrift für Geomorphologie, Supplementband 116, p. 195-214. [h/W data on 20 barchans in SW Egypt]

Stout, K.J., and others, 1999, 14 (+3) parameters for 3D surface roughness: University of Huddersfield, UK, School of Engineering, Center for Ultra Precision Techniques, <http://zeus.plmsc.psu.edu/~manias/MatSc597/roughness/definitions.html>. [details on industrial morphometric measures on Web; see Stout et al., 1993, 2000]

Stout, K.J., and Blunt, Liam, eds., 2000, Three-Dimensional Surface Topography (2nd Ed): London UK and Bristol PA, Penton Press, 308 p. [enlarged ed. of state-of-art review of a major development in metrology]

Stout, K.J., Blunt, Liam, Dong, W.P., Mainsah, Evaristus, Luo, N., Mathia, T.G, Sullivan, P.J., and Zahouani, H., 2000, The development of methods for the characterisation of roughness in three dimensions (2nd ed.): London UK and Bristol PA, Penton Press, 384 p. [revision & enlargement of important 1993 review]

Stover, J.C., 1995, Optical Scattering—Measurement and Analysis, 2nd ed.: SPIE Press, Bellingham WA, 340 p. [full description of power spectral density applied to optical micro-surfaces]

Strahler, A.N., 1952, Dynamic basis of geomorphology: Bulletin of the Geological Society of America, v. 63, no. 9, p. 923-938. [mechanics & fluid dynamnics; 1st mention of general systems theory in geomorph.]

Strahler, A.N., 1954, Quantitative geomorphology of erosional landscapes: 19th International Geological Congress, Algiers, 1952, Comptes Rendues, Section 13, part 3, fasc. 15, p. 341-354. [good summary & intro to the subject]

Strahler, A.N., 1956, The nature of induced erosion and aggradation, *in* Thomas, W.L., Jr., ed., Man's Role in Changing the Face of the Earth: University of Chicago Press, p. 621-638. [introduces 'Horton Number' = runoff intensity + slope + 'erosion porportionality']

Strahler, A.N., 1958, Dimensional analysis applied to fluvially eroded landforms: Bulletin of the Geological Society of America, v. 69, no. 3, p. 279-300. [parameter lists; methodol. statements; descr. of optimal analytic procedures]

Strahler, A.N., 1968, Quantitative geomorphology, *in* Fairbridge, R.W., ed., The Encyclopedia of Geomorphology, New York, Reinhold, p. 898-912. [his last state-of-art summary of Horton-Strahler geomorph.; modified from Strahler 1964]

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Strumbo, D.A.,1963, Surface texture—measurement methods: Forest Products Journal, v. 12, no. 7, p. 299-303. [early surface-roughness analysis on wood]

Struzik, Z.R., 1996, From coastline length to inverse fractal problem—the concept of fractal metrology: University of Amsterdam, Neth., unpublished Ph.D. dissertation, paging unnown. [continued development of the wavelet transform; highly mathematical]

Sulebak, J.R., 1997, Geomorphometric studies of different topographic regions—analysis and applications from Norway and Sweden: University of Oslo, Department of Geography, Sc.D. thesis, 204 p. [see Sulebak 1999 & Sulebak et al. 1997]

Sulebak, J.R., 1999, Fractal analysis of surface topography: Norsk Geografisk Tidsskrift (Norwegian Journal of Geography), v. 53, no. 4, p. 213-225. [topo. scaling; 50m DEM; multiple PSD of 2 areas: not unifractal; good biblio]

Sulebak, J.R., Tallaksen, L.M., and Erichsen, B., 2000, Estimation of areal soil moisture by use of terrain data: Geografiska Annaler, v. 82A, no. 1, p. 89-105. [slope, aspect, plan & profile curv., & wetness index fr 5m DEM; regression model]

Summerfield, M.A., 1976, Slope form and basal stream relationships—a case study in the Westend basin of the southern Pennines, England: Earth Surface Processes, v. 1, no. 1, p. 89-96. [54 field slope-profiles at 5-m segments, convexity index]

Summerfield, M.A., 1991, Sub-aerial denudation of passive margins—regional elevation versus local relief models: Earth and Planetary Science Letters, v. 102, no. 3/4, p. 460-469. [slope/modal elev. & slope/relief fr 1/250K map 15' DEM]

Sun, Tao, Meakin, Paul, and Jøssang, Torstein, 2001, A computer model for meandering rivers with multiple bed load sediment sizes, 1, Theory, 2, Computer simulations: Water Resources Research, v. 37, no. 8, p. 2227-2241 & 2243-2258. [parameter space has 5 geomorph. regions; initial meander is growth controlled by curvature-related instabilities]

Sung, Q.C., Chan, Y.C., and Chao, P.C., 1998, Spatial variation of fractal parameters and its geological implications: Terrestrial, Atmosphere and Oceanic Sciences (TAOS; Taiwan), v. 9, no. 4, p. 655-672. [includes an azimuth-related parameter]

Surell, Alexandre, 1841, Étude sue les torrents des Hautes-Alpes: Paris, Carilian-Goeury and V. Dalmont, 283 p. [his *régime* = 'grade', concept of a limiting slope for fluvial transport; meas. long. profile concave]

Svensson, Harald, 1956, Method for exact characterizing of denudation surfaces, especially peneplains, as to position in space: Lund, Sweden, Lund Studies in Geography, Ser, A, no. 8, paging unknown. [trend-surface analysis to map & distinguish erosional surfaces]

Swan, S.B.St.C., 1966, Stream representation on Malayan maps: Journal of Tropical Geography (Singapore), v. 22, no. 1, p. 1-9. [incomplete patterns pose problem for drainage-density calc.]

Sweeting, M.M., 1955, The land-forms of north-west County Clare: Transactions and Papers of the Institute of British Geographers, no. 21, p. 33-49. [elaborated the height-range diagram of Sparks 1949]

Sykioti, Olga, Deffontaines, Benoît, Chrowicz, Jean, Obert, Daniel, Marsily, Ghislain de, Lauverjat, Jacques, and Carvalho, Jose, 1996, Imagerie numérique de la surface topographie, Application à la géométrie d'un milieu karstique—Verneuil-sur-Avre (Perche) (in French w/ English summary & figure captions): Bulletin de la Société Géologique de la France, v. 167, no. 2, p. 269-284. [synth. incl. drainage net + slope, hillshade, & envelope map fr 50-m DEM]

Szekely, Balazs, 2001, On the surface of the Eastern Alps; a DEM study: Tuebinger Geowissenschaftliche Arbeiten, Reihe A, Geologie, Palaeontologie, Stratigraphie, v. 60, 124 p. [neo orometry; elev. max, mean, range, std dev., autocorrelation, variogram, slope, ruggedness params, regions, etc.]

T

Tada, Fumio, 1937, Relief energy of Jehol (2), *in* Geography of Jehol, Report of the first scientific expedition to Manchuria (in Japanese with German (& English?) summary): Tokyo, p. 121-132, plate 4, 1/2.5M, and plate 5, 1/1.5M (diff. method). [maps of 'relief energy'; resp. 8 & 10 relative-relief intervals, 14 & 5 km spacing of elevs.]

Tahari, D., 1994, Les Modèles Numérique de Terrain—état de l'art: Bulletin trimestriel de la Société Belge de Photogrammétrie-Télédétection et Cartographie, no. 195-196, p. 25-40. [French-language summary]

Taillefer, F., 1948, L'altitude moyenne des régions naturelles des Pyrénées françaises (in French): Revue de Géographie Alpine, v. 36, no. 1, p. 145-160. [mean elev. & 'coeff. of articulation' for 52 & 46 zones, resp.]

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Blackwell Publishers, p. C181-C192. [current definitions of 'critical points' fail to meet the Euler Criteria in DEM representation of terrain features; raster image-processing, filtering]

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Takken, Ingrid, Govers, Gerard, Steegen, An, Nachtergaele, Jeroen, and Guérif, Jérome, 2001, The prediction of runoff flow directions on tilled fields: Journal of Hydrology, v. 248, nos. 1-4, p. 1-13. [logistic regr. eqn using slope, tillage direction, aspect, roughness]

Talling, P.J., Stewart, M.D., Stark, C.P., Gupta, Sanjeev, and Vincent, S.J., 1997, Regular spacing of drainage outlets from linear fault blocks: Basin Research, v. 9, no. 4, p. 275-302. [neo-orometry re/ Hovius 1996; stream spacing (n=551) char. of indiv. blocks (n= 43), but mean ratios var. widely = 1.4-4.1 the half-width of the block]

Tang, Tao, and Day, M.J., 2000, Field survey and analysis of hillslopes on tower karst in Guilin, southern China: Earth Surface Processes and Landforms, v. 25, no. 11, p. 1221-1235. [slope-profile quantification]

Tanner, W.F., 1956, Parallel slope retreat in humid climate: Transactions, American Geophysical Union, v. 37, no. 5, p. 605-607. [3 stat. tests on 1/24K N. GA topo maps all suggest parallel retreat]

Tarboton, D.G., and Shankar, Ude, 1998, The identification and mapping of flow networks from digital elevation data (abs.): Eos, Transactions of the American Geophysical Union, v. 79, no. 45, supplement, p. F248. [3 methods; best = accumulated no. of locally concave grid cells]

Tate, N.J., 1995, The fractal dimension of topography: Norwich, UK, University of East Anglia, unpublished Ph.D. dissertation, 296 p. [details & elab. for Tate 1998]

Tate, N.J., 1998a, Estimating the fractal dimension of synthetic topographic surfaces: Computers and Geosciences, v. 24, no. 4, p. 325-334. [several methods: none 'optimal,' poor reproducibility; big biblio]

Tate, N.J., 1998b, Maximum entropy spectral analysis for the estimation of fractals in topography: Earth Surface Processes and Landforms—Technical and Software Bulletin, v. 23, p. 1197-1217. [MEM introduced; advantages & disadv., tradeoffs w/ other methods]

Taud, Hind, Parrot, J.-F., and Alvarez, Roman, 1999, DEM generation by contour line dilation: Computers and Geosciences, v. 25, no. 7, p. 775-783. [contours dilate until they meet & create intermediate contour lines]

Taylor, T.J., 1851, An Inquiry into the Operation of Running Streams and Tidal Waters, with a view to determine their principles of action, and an application of those principles to the improvement of the River Tyne: London, Longman Brown Green and Longmans, 119 p. [dynamic adjustment of form to process re. hydraulic geometry]

Tebbens, S.F., Burroughs, S.M., Barton, C.C., and Naar, D.F., 2001, Statistical self-similarity of hotspot seamount volumes modeled as self-similar criticality: Geophysical Research Letters, v. 28, no. 14, p. 2711-2714. [cum. freq-vol. distr. is truncated power law, scaling exp. **a** = 0.57 (~ ***D***= 1.71)]

Temple, P.H., and Rapp, Anders, 1972, Landslides in the Mgeta area, western Uluguru Mountains, Tanzania: Geografiska Annaler, v. 54A, nos. 3-4, p. 157-193. [n=34; scar W, d, L; gradient; vol., dist. fr ridge crest; aspect]

Thauer, Walter, 1955, Morphologische Studien im Frankenwald und Frankenwaldvorland: Sonderabdruck aus den Mitteilungen der Fränkischen Geographischen Gesellschaft, no. 1, 232 p.; *also* 1954 dissertation. [relative-relief map by the circle method, published 1955 in Petermanns Geogr. Mitt. as plate 1]

Thieken, A.H., Lücke, Andreas, Diekkrüger, Bernd, and Richter, Otto, 1999, Scaling input data by GIS for hydrological modelling: Hydrological Processes, v. 13, no. 4, p. 611-630. [diff. in DEM resolution (12.5-50m) makes huge diff. in channels & params.; used KINEROS model]

Thom, B.G., 1970, Carolina Bays in Horry and Marion Counties, South Carolina: Geological Society of America Bulletin, v. 81, no. 3, p. 783-814. [A-L-W-ellipt. & orient. stats.; nearest-neighbor tests; inconclusive]

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Tucker, G.E., Catani, Filippo, Rinaldo, Andrea, and Bras, R.L., 2001, Statistical analysis of drainage density from digital terrain data: Geomorphology, v. 36, nos. 3-4, p. 187-202. [hillslope-flowpath length at nonchannel basin sites, fr. DEM, to get texture]

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van Burkalow, Anastasia, 1945, Angle of repose and angle of sliding friction: Bulletin of the Geological Society of America, v. 56, no. 6, p. 669-707. [early attempt to numerically model talus slopes]

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van Deursen, W.P.A., and Wesseling, C.G., 1995, The PCRaster package: University of Utrecht, The Netherlands, Technical Report of the Department of Physical Geography, 198 p. <http://www.geog.uu.nl/pcraster.html>. [includes DEM-to-watershed transformation] van Dijk, W., and Le Heux, J.W.N., 1952, Theory of parallel rectilinear slope recession, I and II: Koninklijke Nederlandsche Akademie van Wettenschappen, Proceedings, v. 55 B, p. 115-122 and 123-129. [relation among non-parallel slope retreat, talus accumulation, & slope shape]

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Veneziano, Daniele, and Iacobellis, Vito, 1999, Self-similarity and multifractality of topographic surfaces at basin and subbasin scales: Journal of Geophysical Research, v. 104, no. B6, p. 12,797-12,812. [in this 1st (?) comparison of Z with XY methods & results, concludes Z-based computations of fractal ***D*** are deficient & misleading, & that fluvial terrain is fundamentally self-similar, not multi-fractal]

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Ventura, S.J., and Irvin, B.J., 2000, Automated landform classification methods for soil-landscape studies, *in* Wilson, J.P., and Gallant, J.C., eds., Terrain Analysis—Principles and Applications, New York, John Wiley and Sons, p. 267-294. [reviews slope-form taxonomy; ARC/INFO, fuzzy, other clustering on TAPES variables]

Verdin, K.L., 1997, A system for topologically coding drainage basins and stream networks, *in* 1997 ESRI International User Conference, San Diego, CA, July 8-11, Proceedings: Redlands, CA, Environmental Systems Research Institute, Inc., CD-ROM; http://www.esri.com/library/userconf/proc97/proc97/to350/pap311/p311.htm. [hydro. modeling using GTOPO30 DEM]

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Verdin, K.L., and Verdin, J.P., 1999, A topological system for delineation and codification of the Earth's river basins: Journal of Hydrology, v. 218, nos. 1-2, p. 1-12. [Otto Pfafstetter's concept; based on topo & thus impl. by DEMs, here NA GTOPO30]

Veregin, Howard, 2000, Quantifying positional error induced by line simplification: International Journal of Geographical Information Science, v. 14, no. 2, p. 113-130. [can find freq. bandwidth that eliminates most vertices for streams, etc.]

Vernon, Peter, 1966, Drumlins and Pleistocene ice flow over the Ards/Strangford Lough area, County Down, Ireland: Journal of Glaciology, v. 6, p. 401-409. [perpendicular & parallel spacing, meas. fr. drumlins center-to-center]

Vertessy, R.A., Hatton, T.J., O'Shaughnessy, P.J., and Jayasuriya, M.D.A., 1993, Predicting water yield from a mountain ash forest catchment using a terrain analysis based catchment model: Journal of Hydrology, v. 150, nos. 2-4, p. 665-700. [describes implementation of TOPOG software pkg. to get network of quadrilateral terrain elements]

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Veverka, Joseph, and 32 others, 2001, Imaging of small-scale features on 433 Eros from NEAR—evidence for a complex regolith: Science, v. 292, no. 5516, p. 484-488. [Near Earth Asteroid Rendezvous; d/D for craters >20m-100m ≈ 0.2]

Vielra, G.T., 2000, Glacial and periglacial data integration in a GIS—methodology used in the Sierra da Estrela, Portugal: Geological Quarterly (Warsaw), v. 44, no. 1, p. 27-31. [var. image maps derived fr. 10-m DEM]

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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. [using the grey scale-to-'watershed' transformation for image analysis]

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Vitek, J.D., and Tarquin, Pamela, 1984, Characteristics of relict stone polygons, Sangre de Cristo Mountains, Colorado, USA: Zeitschrift für Geomorphologie, v. 28, no. 4, p. 455-465. [n=193 mapped @ 1/240; meas. l, w, A, slope, relief, & spacing; veg. growth obscures conclus.]

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Vogt, P.R., 2000, Endoresment of global ocean mapping project: Eos, Transactions of the American Geophysical Union, v. 81, no. 43, p. 498. [more on GOMap DEM, a costly but excellent idea]

Vogt, Peter, and Jung, W.-Y., 2000, GOMap—a matchless resolution to start the new millenium: Eos, Transactions of the American Geophysical Union, v. 81, no. 23, p. 254, 258. [proposes 100-m res. mapping of entire ocean floor to get bathym. DEM]

Voigt, Erika, 1940, Neue hypsographische Kurven im Atlantischen Ozean (in German): Mitteilungen der Gesellschaft für Erdkunde zu Leipsig, v. 55, p. 5-30 & 5 fold-outs. [hypso diagrams fr maps fr recent ship surveys; mid-Atlantic ridge]

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Voronoi, M.G., 1908, Nouvelles applications des parametres continus a la theorie des formes quadratiques (in French): J. Reine u. Angew. Math., v. 134, p. 198-287. [surface tessellation; polygon defined by lines bisecting lines connecting neighboring points]

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Waldrip, D.B., and Roberts, M.C., 1972, The distribution of slopes in Indiana: Proceedings of the Indiana Academy of Sciences, v. 81, p. 251-257. [automated gradient measurement from topo maps]

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Hannover & Leipzig, Hahn, p. 230-240. [review of cartometry complementing that of orometry in same textbook]

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Walker, J.P., and Willgoose, G.R., 1999, On the effect of digital elevation model accuracy on hydrology and geomorphology: Water Resources Research, v. 35, no. 7, p. 2259-2268. ['ground-truth' compared to topo-map and photogram. DEMs: use publ. DEMs w/ caution]

Walschot, L., 1973, De hellingkaart (in Dutch): Natuurwetenschappelijk Tijdschrift, v. 55, p. 210-226. [manual method of slope mapping, not obsoleted by computer where detail needed]

Walton, T.L. Jr., 1999, Shoreline rhythmic pattern analysis: Jouirnal of Coastal Research, v. 15, no. 2, p. 379-387. [low-freq. (12km) non-stationary oscillations fr. time-series analysis]

Waltz, J.P., 1971, An analysis of selected landslides in Alameda and Contra Costa Counties, California: Bulletin of the Association of Engineering Geologists, v. 8, no. 2, p. 153-163. [l.s.-specific measures of plan & profile curvature the only signif. params.]

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Ware, J.M., Kidner, D.B., and Herbert, M.J., 1996, Terrain in perspective—DEMs or TINs, *in* JEC-GI'96, Joint European Conference on Geographical Information, 2nd, 27-29 March, Barcelona, Proceedings: Amsterdam, IOS Press, p. 388-397. [no info]

Warner, R.C., and Budd, W.F., 2000, Derivation of ice thickness and bedrock topography in data-gap regions over Antarctica: Annals of Glaciology, v. 31, p. 191-197. [use DEM & ice distrib. via balance fluxes & assumptions on ice-flow dynamics]

Warntz, William, 1967, Concepts and applications—spatial order, Part I and Part II section G, *in* Warntz, William, and Woldenberg, M.J., Geography and the properties of surfaces series, paper no. 1: Harvard Papers in Theoretical Geography, 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, p. 11-94, 173-184. [11 sections review network, surface topology; 'rediscovery' of concept origins; cites Reech (1858, including a free transl.), Cayley, & Clerk Maxwell]

Warntz, William, and Waters, Nigel, 1975, Network representations of critical elements of pressure surfaces: Geographical Review, v. 65, no. 4, p. 476-492. [applies peak-pit-pass-pale / ridge-course-slope line topology; good discussion of critical lines]

Watson, D.F., 1992, Contouring—a guide to the analysis and display of spatial data: Oxford, UK, Pergamon, 340 p. [comprehensive survey of the various contouring methods]

Watters, T.R., Schultz, R.A., Robinson, M.S., and Cook, A.C., 2002, The mechanical and thermal structure of Mercury's early lithosphere: Geophysical Research Letters, v. 29, no, 11, p. 37-1 to 37-4. [Topo. profile of 1.3-km-high lobate scarp fr DEM fr Mariner 10 stereo pairs]

Weaver, J.D., 1960, Note on higher level erosion surfaces of Puerto Rico: Caribbean Geol. Conf., 2d, Mayagueez, P.R., Jan. 4-9, 1959, Trans., p. 96-98. [altimetric curves fr 38 1/30,000 quads; 5 levels, 2 known]

Webber, B.B., 1995, Testing the vertical accuracy of United States Geological Survey 7.5 minute and 1 degree digital elevation models: Moscow, ID, University of Idaho, unpublished MS. thesis, 73 p. [stat. comp. yields true accuracy & potential problems in diff. terrains]

Weber, Dominique, and Herrmann, Agnes, 2000, Contribution de la photogrammétrie numérique à l'étude spatio-temporelle de versants instables—l'exemple du glissement de terrain de Super-Sauze (Alpes-de-Haute-Provence, France) (in French with English summary & figure captions): Bulletin de la Société Géologique de la France, v. 171, no. 6, p. 637-648. [6 DEMs, difference maps, trace morph. evolution of a complex flow slide]

Wechsler, S.P., 1999, Digital elevation model (DEM) uncertainty—evaluation and effect on topographic parameters: Redlands, CA, ESRI User Conference, http://www.esri.com/library/userconf/proc99/proceed/papers/pap262/p262.htm#_Author_Information; or http://www.csulb.edu/~wechsler/Dissertation/P262/P262.html. [used DEM metadata & spatial char.; Monte-Carlo simulations]

Wechsler, S.P., 2000, Effect of DEM Uncertainty on Topographic Parameters, DEM Scale and Terrain Evaluation: SUNY Syracuse, Ph.D. dissertation, 380 p.; http://www.csulb.edu/~wechsler/Dissertation/Abstract_web.doc. [ArcView-implemented Monte Carlo simulations use random error fields to quantify uncertainty in DEM, slope, upslope contrib. A, & topo. index (TI)]

Weibel, Robert, 1990, Verarbeitung und Anwendung digitaler Geländemodelle im Bereich der Geographie (in German; Processing & applying DTMs in Geography): Geographica Helvetica, v. 45, no. 4, p. 145-153. [no info]

Weibel, Robert, 1997, Digital terrain modelling for environmental applications—a review of techniques and future trends, *in* Hodgson, S., Rumor, and Harts, J.J., eds., Joint European Conference on Geographical Information, 3rd, Vienna, Austria, Proceedings: Amsterdam, IOS Press, v. 1, p. 464-474. [a subsystem of GIS; DEM def., tasks, functions (DEM gen., manip., visual., applic.), trends]

Weih, R.C., and Smith, J.L., 1996, The influence of cell slope computation algorithms on a common forest management, *in* Kraak, M.-J., Molenaar, Martien and Fendel, E.M., eds., International Symposium on Spatial Data Handling, 7th, Delft, Neth., Proceedings: Edinburgh, Taylor & Francis, v. 2, p. 857-875. [compares 8 slope methods, 6 ~ similar, 2 not; large area diffs. result]

Welch, D.M., 1967, Slope evolution on recessional moraines: University of Alberta, unpublished M.SC. thesis, 100 p. [field profiles on 23 dated moraines (86 yrs.) reveal slope converges to 25-30 deg.]

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. [field profiles on recessional moraines; slope dispers. < rapidly w/ time.]

Wells, N.A., 1999, ASTRA.BAS—a program in QuickBasic 4.5 for exploring rose diagrams, circular histograms and some alternatives: Computers and Geosciences, v. 25, no. 6, p. 641-654. [great flexibility, plus less-biased 'corona dot' and 'mean-deviation dot' diagrams]

Werner, B.T., 1995, Eolian dunes—computer simulations and attractor interpretation: Geology, v. 23, no. 12, p. 1107-1110. [simple transport model yields remarkably 'real' barchans, linear & star dunes]

Werner, B.T., 1999, Complexity in natural landform patterns: Science, v. 284, no. 5411, p. 102-104. [theories: self-org. in temp. hierarchy > reductionism & universality]

Werner, B.T., and Hallet, B., 1993, Numerical simulation of self-organized stone stripes: Nature, v. 361, no. 6408, p. 142-144. [std. dev./mean = 1/4 for real & 2D simulated forms; means close]

Werner, B.T., and Kocurek, G., 1997, Bed-form dynamics—does the tail wag the dog?: Geology, v. 25, no. 9, p. 771-774. [orientation of bed-form crests related to 'defects' (l. & r. terminations) in pattern]

Werner, Christian, 1972, Two models for Horton's law of stream numbers: The Canadian Geographer, v. 9, p. 50-68. [relation of str. no. to order of infinite topol. random networks obeys Horton's law for bifurcation ratio 4; proved by combinatorial theory]

Werner, Christian, 1982, Analysis of length distribution of drainage basin perimeter: Water Resources Research, v. 18, no. 4, p. 997-1005. [can't be derived from the random model; descr, model of ridge & channel nets]

Western, A.W., Grayson, R.B., Blöschl, Günter, willgoose, G.R., and McMahon, T.A., 1999, Observed spatial organization of soil moisture and its relation to terrain indices: Water Resources Research, v. 35, no. 3, p. 797-810. [organiz. high in wet season, low in dry; need diff. indices for ea.]

Weverinck, Th., 1936, Beiträge zur Tektonik und Morphologie von Schonen: Adhandl. Geol.-paläont. Inst. Univ. Griefswald, v. 42, 1/200K map. [relative relief map on 2-km squares; 6 relief intervals]

Wheatly, David, 1995, Cumulative viewshed analysis—a GIS-based method for investigating intervisibility, and its archaeological application, *in* Lock, G., and Stancic, Z., eds., Archaeology and GIS—a European Perspective: London, Taylor and Francis, p. 171-186. [summed viewsheds for several sites = 'cumulative viewshed analysis']

Wheeler, D.A., 1979, Studies of river longitudinal profiles from contoured maps: Area (London), v. 11, no. 4, p. 321-326. [profile concavity?]

Wheeler, D.A., 1979, The overall shape of longitudinal profiles of streams, *in* Pitty, A.F., ed., Geographical Approaches to Fluvial Processes: Norwich UK, Geobooks, p. 241-260. [profile concavity increases with total fall for 115 UK rivers]

Whipple, K.X., 2001, Fluvial landscape response time—how plausible is steady-state denudation?, *in* Pazzaglia, F.J., and Knuepfer, P.L.K., eds., The steady-state orogen—concepts, field observations, and models: American Journal of Science, v. 302, nos. 4 & 5, p. 313-512. [model params. fit to measured channels test model in Central Range of Taiwan]

Whipple, K.X., and Tucker, G.E., 1999, Dynamics of the stream-power river incision model—implications for height limits of mountain ranges, landscape response timescales, and reseach needs: Journal of Geophysical Research, v. 104, no. B8, p. 17,661-17,674. [state-of-art review of work on longitudinal stream profiles]

Whipple, K.X., Kirby, Eric, and Brockelhurst, S.H., 1999, Geomorphic limits to climate-induced increases in topographic relief: Nature, v. 401, no. 6748, p. 39-43. [scales of relief; fluvial & glacial relief production; E.E. Small's comments pp. 31-33]

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Wichman, R.W., 1999, Internal crater modification on Venus—recognizing crater-centered volcanism by changes in floor morphometry and floor brightness: Journal of Geophysical Research, v. 104, no. E9, p. 21,957-21,977. [bright- & dark-floored craters diff.; floor/rim diam., elev., etc.]

Wichman, R.W., and Schultz, P.H., 1995, Floor-fractured impact craters on Venus—implications for igneous crater modification and local magmatism: Journal of Geophysical Research, v. 100, no. E2, p. 3233-3244. [arith. floor & peak-ring D for 4 crater types as f(arith. rim D)]

Wieczorek, G.F., Harp, E.L., Mark, R.K., and Bhattacharyya, A.K., 1988, Debris flows and other landslides in San Mateo, Santa Cruz, Contra Costa, Alameda, Napa, Solano, Sonoma, Lake, and Yolo Counties, and factors influencing debris-flow distribution, *in* Ellen, S.D., and Wieczorek, G.F., eds., Landslides, floods, and marine effects of the storm of January 3-5, 1982, in the San Francisco Bay Region, California: U.S. Geological Survey Professional Paper 1434, p. 133-161. [30-m DEM slopes for debris-flow sources contrasted with all slopes]

Wieczorowski, M., 2001, Spiral sampling as a fast way of data acquisition in surface topography: International Journal of Machine Tools and Manufacture, v. 41, Nos. 13-14, p. 2017-2022. [spiral of Archimedes is more efficient than grid sampling]

Wigmosta, M.S., and Lettenmaier, D.P., 1999, A comparison of simplified methods for routing topographically driven subsurface flow: Water Resources Research, v. 35, no. 1, p. 255-264. [DHSVM vs. TOPMODEL: good agreement, but large differences remain]

Wijdenes, D.J., Poesen, Jean, Vandererckhove, Liesbeth, Nachtergaele, Jeroen, and De Baerdemaeker, Jo, 1999, Gully-head morphology and implications for gully development on abandoned fields in a semi-arid environment, Sierra de Gata, southeast Spain: Earth Surface Processes and Landforms, v. 24, no. 7, p. 585-603. [correl. of 9 params on 59 catchments suggest geomorph. conclusions]

Wilbur, S.C., 1988, Surging vs nonsurging glaciers—a comparison using morphometry and balance: Fairbanks, AK, University of Alaska, unpublished M.Sc. thesis, paging unknown. [univariate analysis only]

Willemin, J.H., 2000, Hack's Law—sinuosity, convexity, elongation: Water Resources Research, v. 36, no. 11, p. 3365-3374. [38 hand-digitized perims. & channels, better than DEM data; exponent 0.50-0.60; elongation with > size not general]

Willett, S.D., Slingerland, Rudy, and Hovius, Niels, 2001, Uplift, shortening, and steady-state topography in active mountain belts, *in* Pazzaglia, F.J., and Knuepfer, P.L.K., eds., The steady-state orogen—concepts, field observations, and models: American Journal of Science, v. 302, nos. 4 & 5, p. 455-485. [tectonic/surface-process model compared w/ topo profiles of mountains in WA USA, Taiwan, N.Z.]

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William-Olsson, William, 1975, Relative relief map of the western half of Europe, Figure 1 *in* A prelude to regional geography—two maps of Europe: Stockholm, Esselte Map Service, 19-p. pamphlet, p. 2. [data of Rutkis, 1971 (100 km^2 circles); 1/18M, 8 geometric intervals; originial was in color at 1/4M]

Williams, G.J., 1967, A relative relief map of Sierra Leone: Sierra Leone Geographical Journal, v. 11, no. 1, p. 11-14. [no info]

Williams, G.P., and Guy, H.P., 1971, Debris avalanches—a geomorphic hazard, *in* Coates, D.R., ed., Environmental Geomorphology, proceedings of the first annual geomorphology symposium: Binghamton, N.Y., SUNY, Publications in Geomorphology, p. 25-46. [slope/distance plots, azimuth, slope length]

Williams, R.M.E., and Phillips, R.J., 2001, Morphometric measurements of martian valley networks from the Mars Orbiter Laser Altimeter (MOLA) data: Journal of Geophysical Research, v. 106, no. E10, p. 23,737-23,751. [valley depth (~109m±), width (2km±) & ratios; V- and U-shaped valleys modeled]

Wilson, B.N., Leaf, R.B., and Hansen, B.J., 2001, Microrelief meter for field topography measurements: Transactions, American Society of Agricultural Engineers, v. 44, no. 2, p. 289-295. [portable, automated, non-contact; X, Y, Z accuracy ~ ±0.25mm, ±1.5mm, ±0.5mm, resp.]

Wilson, J.D., Klotz, L.D., and Nagaraj, C., 1997, Automated measurement of aggregate indices of shape: Particulate Science and Technology, v. 15, no. 1, p. 13-35; also 1995, Federal Highway Administration Report FHWA-RD-95-116, paging unknown. [quant. graphs of roundness & angularity fr video-image analysis]

Wilson, J.P., and Gallant, J.C., eds., 2000a, Terrain analysis—Principles and Applications: Chichester UK & NY, Wiley, 479 p. [proc. of 25-29 Nov. 1996 ACLEP workshop, Creation and Applications of Digital Elevation Models (DEMs) in Land Resource Assessment; applic. of TAPES (Terrain Analysis Programs for the Environmental Sciences) algorithms, post-Ian Moore, esp. chapters 1-5, p. 1-161]

Wilson, J.P., and Gallant, J.C., 2000b, Digital terrain analysis, *in* Wilson, J.P., and Gallant, J.C., eds., Terrain Analysis—Principles and Applications: New York, Wiley, p. 1-27. [mostly intro & review, plus summary of book chapters, emph. on DEMS & TAPES algorithms]

Wilson, J.P., and Gallant, J.C., 2000c, Secondary topographic attributes, *in* Wilson, J.P., and Gallant, J.C., eds., Terrain Analysis—Principles and Applications: New York, Wiley, p. 87-131. [topo wetness, stream power, radiation & temp. indices fr DEMs & TAPES software]

Wilson, J.P., Repetto, P.L., and Snyder, R.D., 2000, Effect of data source, grid resolution, and flow routing method on computed topographic attributes, *in* Wilson, J.P., and Gallant, J.C., eds., Terrain Analysis—Principles and Applications: New York, Wiley, p. 133-161. [used USGS 7.5' DEMs of Montana & Idaho]

Wimmer, Christian, Siegmund, Robert, Schwäbisch, Marcus, and Moreira, João, 2000, Generation of high precision DEMs of the Wadden Sea with airborne interferometric SAR: IEEE Transactions on Geoscience and Remote Sensing, v. 38, no. 5, p. 2234-1145. [2.5-m spacing & 5-cm rms elev. accuracy over low-relief area]

Wise, S.M., 2000, Assessing the quality for hydrological applications of digital elevation models derived from contours: Hydrological Processes, v. 14, nos. 11-12, p. 1909-1929. [caveats general

& specific; elev. derivs., incl. TOPMODEL results, are broadly similar, diff. in detail; good biblio (*see also* http://www.shef.ac.uk/geography/staff/wise_stephen/dtm/dtm.htm]

Wise, S.M., 2000, GIS data modelling—lessons from the analysis of DTMs: International Journal of Geographical Information Science, v. 14, no. 4, p. 313-318. [many analysis problems arise fr modeling deficiencies in current GIS packages]

Wohl, E.E., Thompson, D.M., and Miller, A.J., 1999, Canyons with undulating walls: Geological Society of America Bulletin, v. 111, no. 7, p. 949-959. [I-shaped bedrock valleys; systematically varying wall width]

Wohl, E.E., 2000, Basin morphometry, *in* Mountain Rivers: Washington, D.C., American Geophysical Union, Water Resources Monograph 14, p. 44-49. [mountain & lowland rivers differ in relief, valley slope, & relief ratio, but not drainage density]

Wohl, E.E., and Merritt, D.M., 2001, Bedrock channel morphology: Geological Society of America Bulletin, v. 113, no. 9, p. 1205-1212. [9 params. on 41 reaches; substrate heterogen., slope & Selby RMS best descriminants]

Woldenberg, M.J., 1971, The two-dimensional spatial organization of Clear Creek and Old Woman Creek, Iowa, *in* Morisawa, M.E., ed., Quantitative geomorphology—some aspects and applications, Binghamton, NY, Annual Geomorphology Symposia Series, 2nd, October 15-16, Proceedings: p. 83-106. [hexagonal hierarchies at Hortonian orders 5-7 compared to human lung]

Woldenberg, 1972, Relations between Horton's laws and hydraulic geometry as applied to tidal networks: 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. 45, p. 1-39. [no info]

Wolock, D.M., and McCabe, G.J., 2000, Differences in topographic characteristics computed from 100- and 1000-m resolution digital elevation model data: Hydrological Processes, v. 14, no. 6, p. 987-1002. [50 US locales, old 3' DEM; diffs in slope, basin A, & wetness index due to discretization]

Womersley, J.R., and Hopkins, M.R., 1945, Suggestions concernant l'emploi du corrélogramme pour l'interprétation des enregistrements du fini de surface (on using the correlogram to interpret measurements of surface finish, in French): Journées des Etats de Surface, Editions de l'Office Professionnel Général de la Transformation des Métaux, Paris, p. 135-139. [first application of stochastic techniques to describe rough surfaces]

Wood, E.F., Sivapalan, Murugesu, Beven, K.J., and Band, L.E., 1988, Effects of spatial variability and scale with implications to hydrological modeling: Journal of Hydrology, v. 102, no. 1-4, p. 29-47. [apply representative elementary area (REA) concept to hydrol.; ca. 1.0 km2; topog. infl.]

Wood, J.D., 1996, The geomorphological characterisation of digital elevation models: Geography Department, University of Leicester, UK, unpublished Ph.D. dissertation, 456 p., *also* <http://www.geog.le.ac.uk/jwo/research/dem_char/thesis/>. [comprehensive DEM-based terrain modeling; good biblio.]

Wood, J.D., 1998, LandSerf software (Version 1.6): University of Leicester, UK, Geography Dept., computer program for terrain surface DEM analysis. <http://www.geog.le.ac.uk/jwo/research/LandSerf/landserf16/doc/index.html>. [see his 1996 Ph.D. thesis]

Wood, J.D., 1998, Modelling the continuity of surface form using digital elevation models, *in* International Symposium on Spatial Data Handling, 8th, July 11-15, Vancouver, Canada, Proceedings: p. 725-736, *and*

http://www.geog.le.ac.uk/jwo/research/conferences/sdh98/index.html. [quadratic interpolation of continuous surfaces by semi-axes of conic sections]

Woodruff, J.F., 1963, Linear and areal properties of drainage basins as delimiting criteria (abs.): Annals of the Association of American Geographers, v. 53, no. 4, p. 631. [proposes paramaters for regional characterization]

Wooldridge, S.W., 1928, The 200-foot platform in the London Basin: Proceedings of the Geologists Association, v. 39, part 1, p. 1-26. [hypsometric curves fr lengths of intercepts along equidistant parallel lines]

Woronow, Alexander, and Mutch, Patricia, 1980, On the origin of Martian pedestal, lobate, and multilobate ejecta deposits, *in* Abstracts of papers submitted to the Lunar and Planetary Science Conference, 11th, March, Houston, TX, The Lunar and Planetary Institute: Lunar and Planetary Science XI, p. 1282-1284. [the old area/perimeter relation; fr Mandelbrot 1977 they get $\mathbf{P}^{1/H} / \mathbf{A}^{0.5} = \mathbf{K}$, where H & K are constants, H the 'Hausdorff dimension' & equiv. to 'lobateness' in Kargel 1986]

Wright, D.J., Goodchild, M.F., and Proctor, J.D., 1997, GIS—tool or science? Demystifying the persistent ambiguity of GIS as 'tool' versus 'science': Annals of the Association of American Geographers, v. 87, no. 2, p. 346-362. [philosoph. issues relevant to Terrain Modeling; see response by J. Pickles, p. 363-372]

Wu, Fan, 2000, Multi-scale automatic extraction of terrain structure line based on wavelet analysis (abs.): International Conference on Geographic Information Science 1st, GIScience 2000, Savannah, GA, 28-31 Oct., Abstracts, p. 389; http://www.giscience.org/GIScience2000/posters/090-Wu.pdf. [new way to extract ridges & channels fr contours]

Wurm, A., 1936, Morphologische Analyse und Experiment Hangentwicklung, Einebnung, Piedmonttreppen: Zeitschrift für Geomorphologie, v. 9, p. 57-87. [series of experimental topo profiles evolved, systematically, w/ erosion]

X

Xiao, Yanni, 1996, Topographic characterization for DEM error modelling: Vancouver, BC, University of British Columbia, unpublished Ph.D. dissertation, 447 p. [cluster analysis, DEMs, fractals, spatial variations]

Xiaohua, Zhu, and Jian, Wang, 1998, Fractal analysis applied to mountain ridges and faults—A case study of China (in Chinese with English abstract & figure captions): Mountain Research (Shandi Yanjiu), v. 16, no. 2, p. 94-98. [D= 1.63 (all China), but 1.35 in SW China; D of ridges & faults related]

Xu, Jiandong, Qu, Guosheng, and Jacobi, R.D., 1999, Fractal and multifractal properties of the spatial distribution of natural fractures—analyses and applications: Acta Geologica Sinica, v. 73, no. 4, p. 477-487. [uses Cantor's dust theory; western NY sample; D is scale dependent]

Xu, Wei, and Cumming, Ian, 1999, A region-growing algorithm for InSAR phase unwrapping: IEEE Transactions on Geoscience and Remote Sensing, v. 37, no. 1, p. 124-134. [resulting DEM OK re. map heights; good but time-consuming]

Y

Yagi, Shintaro, and Takahashi, Yoshiaki, 1992, Three dimensional expression of the terrain using digital cartographic data: Bulletin of the Geographical Survey Institute, v. 37, p. 39-49. [relief-shading & other output from 50-m and 250-m DEM's; no maps shown]

Yamada, Shuji, 1999, Mountain ordering—a method for classifying mountains based on their morphometry: Earth Surface Processes and Landforms, v. 24, no. 7, p. 653-660. [neo-orometry; defined by closed contours; params resemble Strahler's; number, area, & height plot as power series]

Yamada, Shuji, 2001a, Classification and geomorphometry of Japanese mountains based on mountain ordering: Journal of Geography, v. 110, no. 1, p. 79-93. [applied neo-orometry fr 1/500K maps; relief= $H/A^{0.5}$, where H= height & A= area; rel. $R= \sum h_i/H$, where h_i =height of enclosed lower-order mtn.; perimeter fractal D; all 3 are related in Japan]

Yamada, Shuji, 2001b, Evaluation of topographic naturalness of anthropogenically modified mountains: Geographical Review of Japan, v. 74A, no. 11, p. 643-657. [applied neo-orometry; 3 params. defined in 1999 & 2001a differ for developed & undeveloped mtn areas on 1/25K maps]

Yang, M.-S., and Lee, K.T., 2001, Determination of probability distributions for Strahler stream lengths based on Poisson process and DEM: Hydrological Sciences Journal, v. 46, no, 5, p. 813-824. [streams & Strahler order extracted fr 40-m Taiwan DEM]

Yang, Xiaojun, and Hodler, Thomas, 2000, Visual and statistical comparisons of surface modeling techniques for point-based environmental data: Cartography and Geographic Information Science, v. 27, no. 2, p. 165-175. [DEM test; multiquadric RBF stat. best, min. curv. fastest, inverse-dist. poorest]

Yatsu, Eiju, 1955, On the longitudinal profile of the graded river: Transactions, American Geophysical Union, v. 36, no. 4, p. 655-663. [7 of 9 river profiles consist of two exponential curves, not one]

Yeh, P.A., 1994, Fractal geometry and its implications for the Tatun volcanic area, Taiwan (in Chinese): Chung-Li, National Central University, Department of Applied Geology, M.Sc. thesis, 90 p. [used Clarke's triangular prism surface method for D]

Yemelyanov, O.G., 1984, Determination of slope gradient of a bottom using digital terrain model (in Russian): Geodesiya i Cartographiya, no. 11, p. 37-40. [no info; seafloor?]

Yin, K.L., and Yan, T.Z., 1988, Statistical prediction models for slope instability of metamorphosed rocks, *in* Bonnard, Christopher, ed., International Symposium on Landslides, 5th, 10-15 July, Lausanne, Proceedings: Rotterdam, Balkema, v. 2, p. 1269-1272. [4 classes for polygon units; elev, slope, relief, azimuth, & lithology]

Yin, Z.-Y., and Wang, Xinhao, 1999, A cross-scale comparison of drainage basin characteristics derived from digital elevation models: Earth Surface Processes and Landforms, v. 24, no. 6, p. 557-562. [1/250K vs. 1/24K; elev. & length params. OK, but not slope params.]

Yokoyama, Ryuzo, Shirasawa, Michio, and Kikuchi, Yu, 1999, Representation of topographical features by 'opennesses' (in Japanese with English abstract & figure captions): Journal of the Japanese Society of Photogrammetry and Remote Sensing, v. 38, no. 4, p. 26-34. [image-processing; fits cone to each DEM elev.; brings out streams, ridges, textures]

Yokoyama, Ryuzo, Shirasawa, Michio, and Pike, R.J., 2002, Visualizing topography by openness—a new application of image processing to digital elevation models: Photogrammetric Engineering and Remote Sensing, v. 68, no. 3, p. 257-265. [grey-scale images computed from DEM express degree of dominance or enclosure of locations on any irregular surface]

Yoshida, Takeyoshi, Kanisawa, Satoshi, Yokoyama, Ryuzo, Shirasawa, Michio, and Ohguchi, Takeshi, 1999, Refinement of geological map by referring to high-resolution DEM and the derived digital maps—application to the study of Late Cenozoic caldera swarm in the NE Honshu arc, Japan (abs.): EOS, Transactions, American Geophysical Union, v. 80, no. 46, Supplement, p. F1088. [Yokoyama's 'openness' algorithm (50-m DEM) identifies circular features]

Yoshikawa, Torao, Kaizuka, Sohei, and Ota, Yoko, 1981, Relief energy of Japan (simplified from Economic Planning Agency 1969), *in* The Landforms of Japan: Tokyo, University of Tokyo Press, front endpaper. [4 intervals: >800, 400-799, 200-399, 0-199 m; recent use of term]

Young, Anthony, 1978, Slopes—1970-1975, ch. 5 *in* Embleton, Clifford, Brunsden, Denys, and Jones, D.K.C., eds., Geomorphology—Present Problems and Future Prospects: Oxford, The University Press, p. 73-83. [550 pubs. classified (but not listed); summary of slope mapping, profiles, other areas]

Young, R.A., and Mutchler, C.K., 1969, Effect of slope shape on erosion and runoff: Transactions of the American Society of Agricultural Engineers, v. 12, no. 2, p. 231-233, 239. [experiments on convex, concave (least soil loss), straight slopes; microrelief meas.]

Young, R.A., and Mutchler, C.K., 1969, Soil movement on irregular slopes: Water Resources Research, v. 5, no. 5, p. 1084-1089. [experiments on convex, concave (least soil loss), straight slopes; microrelief meas.]

Yu, Sidi, van Kreveld, Marc, and Snoeyink, Jack, 1996, Drainage queries in TINs—from local to global and back again, *in* Kraak, M.-J., Molenaar, Martien and Fendel, E.M., eds., International Symposium on Spatial Data Handling, 7th, Delft, Neth., Proceedings: Edinburgh, Taylor & Francis, v. 2, p. 829-842; *also* 1996, 7th Symposium on Spatial Data Handling, Proceedings: p. 13A.1-13A.14. [preprocessing to facilitate queries; properties of drainage networks]

Z

Zaitsev, V.M., Lavrova, V.S., and Chigirev, A.A., 1973, Derivation of contour maps using a stereomodel of a terrain and a computer (in Russian): Geodesiya i Cartographiya, no. 4, p. 48-53. [no info]

Zakrzewska, Barbara,1971, Nature of land form geography: Professional Geographer, v. 23, no. 4, p. 351-354. [core of LFG = "recognition of spatial land form problems & analysis of their origin"]

Zâvoianu, Ion, 1972, The relationship between drainage density and stream frequency: Rev. Roum. Géol. Géophys., Géogr., Sér. Géogr., v. 16, no. 2, p. 167-174. [no info]

Zâvoianu, Ion, 1974, Determination of the drainage net average slope in a given hydrographic basin: Rev. Roum. Géol. Géophys., Géogr., Sér. Géogr., v. 18, no. 2, p. 137-152. [no info]

Zebker, H.A., Amelung, Falk, and Jonsson, Sjonni, 2000, Remote sensing of volcano surface and internal processes using radar interferometry, *in* Mouginis-Mark, P.J., Crisp, J.A., and Fink, J.H., eds., Remote Sensing of Active Volcanism: Washington, DC, American Geophysical Union, Geophysical Monograph 116, p. 179-205. [DEMs for 16 edifices; much variance in quality]

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to geodesy & orography; in German): Gotha, Justus Perthes, 107 p., 2 colored contour maps. [his most signif. morphometric work; reviewed *in* Petermanns Geogr. Mitt. 1858, v. 4, no. 12, p. 517; much on method; many heights; 1st mean-slope calculations (p. 96-102), for several valleys (formula later criticized as too complex for any but ridge-&-valley terrain)]

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CD-ROM); http://www.ncgia.ucsb.edu/conf/SANTA_FE_CD-ROM/sf_papers/mueller_dirk/dmwpaper.html. [apply TOPMODEL & WET, models based on the topographic-index concept]

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(NCGIA CD-ROM); http://edcdaac.usgs.gov/gtopo30/papers/santafe3.html. [30 arc-sec. (90 m) global DEM to replace ETOPO5 (5 arc-min, 10km) data]

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