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

By RICHARD J. PIKE


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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**

\(^1\) 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

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0.1 Quantitative Terrain Analysis

*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 1-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; Miliarets and Argialas, 1999a–c; Miliarets, 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; Miliareisis and Argialas, 1999a–c; Schmidt and Dikau, 1999; Verdin and Verdin, 1999; Cronin, 2000).

New Books


Publication of Terrain Analysis: Principles and Applications (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 others—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 nano-
surfaces 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 Miliareis, a former student of Demetre Argialas (Argialas and Miliareis, 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/. Miliareis' 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
   • title of the work, and
   • the name(s) of author(s); surname plus two initials (or, if one given name, then spelled out)
2. year of publication
3. 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.

Address correspondence to:
Richard J. Pike
M/S 975
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA  94025  U.S.A.
FAX [650] 329-4936
e-mail:  rpike@usgs.gov

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Breton de Champ, Paul-Émile, 1854, Note sur les lignes de faîte ou de thalweg (in French; ... ridges and drains): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences / Institut de France, v. 39, p. 647-648. [noted that (Saint-Venant's 1852 implied) math. formulation of topo. ridges & drains had not specified exactly the slope-lines that form the drainage pattern; offered new theorem]

Breton de Champ, Paul-Émile, 1861, Note sur les caractères géométriques des lignes de faîte ou de thalweg (in French; ... geometric char. of ridges or drains): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences / Institut de France, v. 53, p. 808-811. [elaboration on ideas in 1854 paper]

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]

Breton de Champ, Paul-Émile, 1870, Sur les lignes de plus grande pente à déclivité minimum ou maximum (in French; on flow lines of minimum or maximum steepness): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences / Institut de France, v. 70, no. 18, p. 982-985. [no info]

Breton de Champ, Paul-Émile, 1877, Mémoire sur les lignes de faîte et thalweg que l'on est conduit à considérer en topographie (in French; ... on drain and ridge lines that must be addressed in topo.);
Journal de Mathématiques Pures et Appliquées, ser. 3, v. 3, p. 99-114.  [extends descriptive-geometric description of ridges & drains; poses 5 problems]


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]


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]


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.]


Brown, D.G., 1994, Anisotropy in elevation and derivative surfaces as an indication of systematic errors in DEMs, in Congalton, R.G., ed., International Symposium on the Spatial Accuracy of


Bülow, Kurd von, Kranz, Walter, and Sonne, Erich, 1938, Wehrgeologie (in German; with revisions by Prof. Dr. Otto Burre & Prof. Dr. Wilhelm Dienemann): Leipzig, Quelle & Meyer, 178 p. [the German classic on military geology, incl. terrain intelligence & appreciation]


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.]


Cailleux, André, 1947, Caractères distinctifs des coulées de blocailles liées au gel intense (in French; dist. char. of blocky ravines related to intense freezing): Comptes Rendue Sommaire de la Société Géologique de France, 15 Dec., p. 323-324. [slope measurements; early postwar example of French morphometry]

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]


Calvet, Marc, Carozza, J.-M., and Delcaillau, Bernard, 2000, Du bon usage de la morphometrie; a propos de Reponse des bassins versants a l'active tectonique; l'exemple de la terminaison orientale de la chaine pyreneenne; approche morphotectonique (in French; on proper use of morphometry; re Response of drainage basins to active tectonics; example from the eastern Pyrenees; morphotectonic approach; discussion and reply: Geomorphologie, v. 2000, no. 4, p. 267-274. [no info; neo-orometry?]


Carrara, Alberto, Bitelli, G., and Carla', R., 1997, Comparison of techniques for generating digital terrain models from contour lines: International Journal of Geographic Information Science, v. 11, no. 5, p. 451-473.  [set out Q/A criteria: most techniques fail on at least one; ArcTin not so good]


Carroll, Damian, and Morse, Michael, 1996, A national digital elevation model for resource and environmental management: Cartography (Canberra), v. 25, no. 2, p. 43-49.  [GEODATA 9-second DEM of Australia]

Carson, T.M., 1996, Texture-based terrain classification and optimal sampling in support of digital elevation model extraction: West Lafayette, IN, Purdue University, unpublished Ph.D. dissertation, 257 p.  [no info]


Chaplot, V., Walter, C., and Curmi, P., 1999, Sensitivity of a quantitative soil-landscape model to the precision of the topographical input parameters, Ch. 10 in Lowell, Kim, and Jaton, Annick, eds., Spatial Accuracy Assessment—Land Information Uncertainty in Natural Resources: Chelsea, MI, Ann Arbor Press, p. 89-95. [DEM needs < 20m spacing + hi-info-content supplementary elevs.]


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]


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, Jenő, 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]


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 interpolated contours]


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]


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')]


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]

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]


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(area)/(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]


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]

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]


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 Societá Geolica Italiana, v. 55, p. 411-419.  [relief map; stream orientations; asymmetry & transverse topo. factors]


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]

D


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]


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 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, 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 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]


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


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]


Delazari, L.S., Vieira, A.J.B., and Dalmolin, Quintino, 1998, Extração automática de canais de drenagem utilizando modelos digitais de altitude (in Portuguese; ... 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]


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%]


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.]


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]


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]


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]


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


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]


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., 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 lengths 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]


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,

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]


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]


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?]


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]


Dupuis-Torcy, 1st name unknown, and Brisson, Barnabé, 1808, Sur l'art de projeter 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]


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


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)]


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]


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]


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]


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]


Evans, K.G., and Willgoose, G.R., 2000, Post-mining landform evolution modelling 2. Effects of vegetation and surface ripping: Earth Surface Processes and Landforms: v. 25, no. 8, p. 803-823. [SIBERIA models changes to radioactive tailings pile that must remain undisturbed for 1000s of years]

Everard, C.E., 1956, Erosion platforms on the borders of the Hampshire Basin: Transactions and Papers of the Institute of British Geographers, no. 22, p. 35. [elaborated the height-range diagram of Sparks 1949]


Eyton, J.R., 1991, Rate-of-change maps: Cartography & GIS, v. 18, p. 87-103. [calc. related elev. derivatives from finite differences]


Farabegoli, Enzo, and Agostini, Cecilia, 2000, Identification of Calanco, a badland landform in the northern Apennines, Italy: Earth Surface Processes and Landforms, v. 25, no. 3, p. 307-318. [contour crenulation ratio (LO/LF) = true length/length smoothed; hypso. integral]


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]

Farrenkopf, Dorothee, 1987, Das Relief als steuernder Parameter der Abflußdynamik—ein Beitrag zur fluvialen Prozeßforschung (Relief as controlling parameter of discharge dynamics—a contribution to fluvial process research): Zeitschrift für Geomorphologie, Supplementband 66, p. 73-82. [mean values don't predict high flows well]


Favilli, Massimiliano, Innocenti, Fabrizio, Pareschi, M.T., Pasquarè, Giorgio, Mazzarini, Francesco, Branca, Stefano, Cavarra, Luciano, and Tibaldi, Alessandro, 1999, The DEM of Mt. Etna—geomorphological and structural implications: Geodinamica Acta (Paris), v. 12, no. 5, p. 279-290. [ca. 30X40km; 5m grid @ ± 1m height accuracy; slope map & histogram @ 1° bins; 10^6 input elevs.; shaded relief image]


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]


Fiedler, Bruno, 1890, Vergleich Orometrischer Methoden (Comparison of orometric methods as applied to the Thuringen Forest, in German): Friedrichs-Universität Halle-Wittenberg, Inaugural-Dissertation (Ph.D.), 39 p, 5 plates. [Sonklar, Koristka, Penck, etc. for volume (Simpson's Rule best) & ave. crest height & uplifted mass]

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]

Fiilinskas, Gintautas, 1997, Baltijos Jūros Lietuvos kranto ilgis bei jo nustatymo problemos (in Lithuanian with English summary; length of the lithuanian shore of the Baltic Sea): Geografijos Metrastis (Geographical Yearbook; Vilnius. Lith.), v. 30, paging unknown. [used regression eqns. & data fr maps, airphotos. field, cartometry (Volkov 1950 method); cites Keber 1864]

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 describes each height; 100' contours over hachures]


Fleishmann, Erica, and Mac Nally, R.M., 2002, Topographic determinants of faunal nestedness in Great Basin butterfly assemblages—applications to conservation planning: Conservation Biology, v 16, no. 2, p. 422-429. [no details other than terrain complexity is used]

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Florinsky, I.V., 2000, Relationships between topographically expressed zones of flow accumulation and sites of fault intersection—analysis by means of digital terrain modeling: Environmental Modelling Software, v. 15, no. 1, p. 87-100. [apply Shary 1995 DEM-based technique to better predict soil salinization]


Fournier, F., 1960, Climat et Erosion (in French): Paris, P.U.F., 201 p. [pp. 139-150: 'orographic coefficient'; also, diff. hypso. curves can have same mean elev.]


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]


Franz, J., 1899, Hohenschichten-Karte des Mondes (in German; contour map of the Moon): Astron. Beobacht. d. Königsburg, Sternwarte, v. 38, no. 75, paging unknown. [five 1200-m intervals; last such map until that of Ritter in 1934]


Frey, Herbert, Sakimoto, S.E.H., and Roark, J.H., 1999, Discovery of a 450 km diameter, multi-ring basin on Mars through analysis of MOLA topographic data: Geophysical Research Letters, v. 26, no. 12, p. 1657-1660. [2km deep; fit rings to slope breaks in profiles; est. diams est. 350, 455, & 670 km]


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]


Fujita, Takashi, 1984, Slope analysis of landslides of the soft rock type in Kinki, southwest Japan, in International Symposium on Landslides, 4th, 16-21 September, Toronto, Proceedings: Rexdale, Ont., Canadian Geotechnical Society, v. 2, p. 75-80. [spatial freq. of inventory rel. to slope; most deposits at 5°-20°]


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]


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. [7km≤ D ≤ 100km; complex, d=0.33D^{0.53±0.03}]

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., 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]


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]


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]


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]


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 tachometry, using theodolite & staff; need common test areas]


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]


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)]


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]


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]


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?]


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]


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): Grunert 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]


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]


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]
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); rekd to drainage density & veg.]


Hann, R.A., 1943, Statistical methods for delineation of regions applied to data on agriculture and population: Social Forces, v. 7, no. 12, p. 448-452. [need for roughness QC for machined wood surfaces & conformance to prescribed standards, as on metals]


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]


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, 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]


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 cm² resolution]


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]


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]


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


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]


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]


Hevelius, Johannes, 1647, Selenographia, sive Lunae descriptio, atque accurata tam macularum ejus, quam motuum diversorum, aliarumque omnium vicissitudinum phasiumque telescopi ope deprehensurarum, 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]


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]


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]


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]


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]


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]


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?]


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, 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']


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']


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]


Humboldt, Alexander von, 1808, et ann. suiv., Nivellement baromérique fait dans les régions équinoxeiales 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 équinoxeiales 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
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]


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.]


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


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?]


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]


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]


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]

Jezek, K.C., Liu, Hongxing, Zhao, Zhiyuan, and Li, Biyan, 1999, Improving a digital elevation model of Antarctica using radar remote sensing data and GIS techniques: Polar Geography, v. 23, no. 3, p. 185-200. [successful upgrade, but more remains to be done]


Jimenez, J.A., Maia, L.P., Serra, Jordi, and Morais, Jader, 1999, Aeolian dune migration along the Ceará coast, north-eastern Brazil: Sedimentology, v. 46, no. 4, p. 689-701. [h/W & L/W relations (largest barchans yet) are linear]


Johansson, Magnus, Olvmo, Mats, and Söderström, Mats, 1999, Application of digital elevation and geological data in studies of morphotectonics and relief—a case study of the sub-Cambrian...


Johns Hopkins University, 1955, Limitations imposed by topography on line-of-sight surveillance and communication (CLASSIFIED): Operations Research Office, Technical memorandum ORO-T-332, paging unknown. [LOS; no details]


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]
Jordan, M.-E.-C., 1872b, Sur les lignes de faîte et de thalweg; réponse aux observations de M. Boussinesq (in French; on ridge & drainage lines; reply to ... M. B.): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, v. 75, no. 11, p. 625-627. [response to Boussinesq's 1872b criticism; see remarks for Jordan 1872a]

Jordan, M.-E.-C., 1872c, Nouvelles observations sur les lignes de faîte et de thalweg (in French; new obs. on ridge & drainage lines): Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, v. 75, p. 1023-1025. [see remarks for Jordan 1872a]


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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]


Kane, Phillip, 1978, Origins of valley asymmetry at Sarah Canyon, California: Yearbook of the Association of Pacific Coast Geographers, v. 40, p. 103-115. [microclim. & veg. type & density; topo. diffs. incl. drainage area, density, bifurc. ratio, max. slope gradient, mean slope & channel gradient]

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
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.]


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' = \( P/(4\pi A)^{0.5} \) for 538 craters]


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]


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]


Kaufuss, W., 1975, Darstellungsmethode und Anwendungsbeispiele eines Kartogramms der Relieffenergie 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 'relieffenergie']

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


Kerenyi, A., 1977, Kulonbozo reliefenergia-abrazolasok es az erozio kapesolata a tokaji Kopaszhegy peldajan (in Hungarian; Methods for presentation of relative relief and erosion on the example of the Kopasz Mt. in Tokaj: Foldrajzi Ertesito (Geographical Bulletin; Budapest), v. 26, nos. 3-4, p. 289-304. [no info]


Kertész, Ádam, 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)]


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. [DEM fr ASTER stereo coverage will quantify glacier topo. changes]


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Kirkby, M.J., 1984, Modelling cliff development in South Wales—Savigear re-reviewed: Zeitschrift für Geomorphologie, v. 28, no. 4, p. 405-426. [continuum eqn. for mass-balance model, incl. landsliding; results agree w/ Savigear 1952]


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 km²) 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:
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.]


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]

Koch, Helge von, 1905, Une méthode géométrique élémentaire pour l'étude de certaines questions de la théorie des courbes planes (in French; simple geometric method to study certain theoretical issues on planar curves): Acta mathematica (Stockholm), v. 30, Octobre, p. 145-174. [origin of fractal theory; not content with the geometric formulation of Weierstrass]


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]


Koristka, Karel, 1861, Bericht über einige im niederen Gesenke und im Marsgebirge ausgeführte höhenmessungen (... on height meas. in the low sinks (sic) & the Marsgebirge; in German): Vienna, F.B. Geitler, 20 p.  [obtaining elev. data; no other info]

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


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): Arbeitshfte Geologie (Hannover), v. 1, p. 31-37.  [DEM-based package for terrain modeling & mapping]


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 & apps. esp. carto/viz.]


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]

Kramrisch, F., 1935, Zur Rauhigkeitsbestimmung von Gesteinbruchsflächen (in German; roughness grading of stone aggregate surfaces): Geologie und Bauwesen, v. 7, no. 2, p. 33-59.  [industrial morphometry; profiles from sectioned casting; roughness = length of fine-scale profile / length of coarse-scale profile; see Wright 1955]


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)]


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 %, \( e = \frac{(100/U)(U-K)}{K} \); 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 & mountains; ref. DEM 1-2m elev. acc.]

Krzysztkowski, Dariusz, and Stachura, Renata, 1993, Morphologic effects of neotectonic movements in the Walbrzych foothills, Middle Sudety Mountains, SW Poland (in Polish with English summary & figure captions): Folia Quaternaria, v. 64, p. 71-81. [relative-relief & slope maps]

Kudrnovská, O., 1975, Morfometrice metody a jejich aplikace pri fizickogeograficke regionalizaci (in Czech; morphometric methods & their application to physico-geographical regionalization): Studia Geographica (Brno), v. 45, 182 p. [86 refs, landform description, quant. geomorph.]


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]


Kusumayudha, S.B., Zen, M.T., Notosiswoyo, Sudarto, Gautama, R.S., 2000, Fractal analysis of the Oyo River, cave systems, and topography of the Gunungsewu karst area, central Java, Indonesia: Hydrogeology Journal, v. 8, no. 3, p. 271-278. [D (Oyo r.) = 1.0-1.5, cave rivers = 1.04-1.08, topo. = 1.5-1.7]


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]


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]


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. apps. per se]


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]


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]


Lessing, Peter, Kulander, B.R., Wilson, B.D., Dean, S.L., and Woodring, S.M., 1976, Landslide correlations and statistics, pp. 31-40, in West Virginia Landslides and Slide-prone Areas: Morgantown, WV, West Virginia Geological and Economic Survey, Environmental Geology Bulletin No. 15, 64 p. & 28 landslide-susceptibility maps, scale 1:24,000. [slope concavity & proximity to other slides assoc. w/ slides, no preferred azimuth; analysis of R- & Q-mode clustering of 39 variables & 100 slides not well handled]


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, Xin, Lu, Ling, Cheng, Guodong, and Xiao, Honglang, 2001, Quantifying landscape structure of the Heihe River Basin, north-west China using FRAGSTATS: Journal of 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]


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]


Little, J.J., and Shi, Ping, 1998, Structural lines, TINs, and DEMs, in International Symposium on Spatial Data Handling 8th, 11-15 July, Vancouver BC, Proceedings: p. 627-636. [structural lines, based on local curvature not water flow, are skeleton for TIN]

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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]


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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Lynn, Greg, 1993, Probable geometries—the architecture of writing in bodies: Any (New York, the Anyone Corp.), May-June, v.1 no. 0. p. 44-49; www.lcc.gatech.edu/~xinwei/classes/lcc/6310_ExpressiveMedium/readings/Lynn/LynnProbableGeometries.pdf. [theoretico-philosoph. views on geometry & shape measurement, re architecture but describes stereological 'random section model' (Buffon-Delesse-Rosiwal-Glagolev area sampling)]


Macar, Paul, 1957-58, Compte rendu de la session extraordinaire de la Société Géologique de Belgique (in French): v. 81, p. 8-13. [more alt.-freq. using only geomorph. signif. 'bench' elevs. from large-scale maps]


MacGregor, D.R., 1957, Some observations on the geographical significance of slopes: Geography, v. 42, p. 167-173. [links 7 intervals of slope to perceptual cues & observer position]


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]


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]

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Majdanowski, Stefan, 1947, Distribution, density and directions of lake-channels of the Polish lowlands (in Polish with long English summary: Przeglad Geograficzny (Polish Geographical Review), v. 21, nos. 1-2, p. 47-69. [300 100K maps sampled w/ squares; 7 map intervals; density > to E.]


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

Cartographiya, no. 6, p. 31-38. [no info]

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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
new w annotations & guest contrib.]

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Geophysical Research Letters, v. 28, no. 3, p. 407-410. [topographic profiles, topo. params of
debris aprons & scars]

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’]

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Geographici Universitatis Turkuensis, v. 52, p. 16-32. [new method for degree & quality of
sinuosity]

Mansikkaniemi, Hannu, 1972, Regional differences in the sinuosity of rivers in Finland: Fennia, v.
118, p. 1-33. [method. critique; applies new index to 81 rivers; 5 gen'l. types]

 crater: Journal of Geophysical Research, v. 104, no. E5, p. 11,875-11,882. [200-m XY/30-m Z
res. from radar interferometry; crater dimensions unchanged]

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[150-m XY/50-m Z res. of hard-to-see terrain]

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triangulated irregular networks (TINS): GIS/LIS’97, Cincinnati, OH, October 28-30, Proceedings:
CD-ROM, p. 267-272. [‘multiple invention’; precursors (Hormann &), T. Poiker, ADAPT, & C. Gold]

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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]

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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]


Masoud, Alaa, Masumoto, Shinji, Raghavan, Venkatesh, Kajiyama, Atsushi, and Shiono, Kiyoji, 2002, Landscape modeling and analysis based on digital elevation models generated from topographic maps—algorithm and application 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]


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]


Meinardus, Wilhelm, 1926, Die hypsographischen Kurven Grönlands und der Antarktis und die Normalform der Inlandeisoberfläche (in German): Petermanns Geographische Mitteilungen, v. 72, no. 5/6, p. 97-105.  [gross morphometry of Earth's two largest areas of continental ice]


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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]

Miliaresis, G.Ch., 2000, Recognition of landforms from DEMs and satellite imagery with expert systems, pattern recognition and image processing techniques (in Greek with English abstract &
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]


Miliaresis, G.Ch. and Argialas, D.P., 1999a, Fuzzy pattern recognition of compressional mountain ranges in Iran, in Annual Conference 5th, International Association for Mathematical Geology, Trondheim, August 6-11, Proceedings: p. 227-232. [region-growing fr. ridge & valley seed pixels? same 6 parameters as Basin & Range]


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]


Miller, O.M., 1951, Relief on maps and models—some conclusions and a proposal: Columbus OH, Ohio State University, Mapping and Charting Research Laboratory, Technical Paper no. 151. [the slope-zone technique of Miller & Summerson 1960]


Mino, Yokichi, 1942, Study on peneplains viewed from rock floor theory (Chikei Genron; in Japanese): Kokon-shoin, Tokyo, p. 393-408. [unspecifed geomorphometry]


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]


Monmonier, M.S., Pfaltz, J.L., and Rosenfeld, Azriel, 1966, Surface area from contour maps: Photogrammetric Engineering and Remote Sensing, v. 32, no. 3, p. 476-482. [processes digitized contours; Surface area related to projected area]


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]


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]


Mora C., Sergio, and Vahrson, W.-G., 1994, Macrozonation methodology for landslide hazard determination: Bulletin of the Association of Engineering Geologists, v. 31, no. 1, p. 49-58. [unusual in that uses relative relief on 1 km as slope parameter]

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

Morawetz, Sieghard, 1957, Fragen der Talnetz- und Kammentwicklung insbesondere in den Ostalpen und einigen Nachbargebieten (in German; ... on valley network & ridge development esp. in eastern Alps & contiguous areas), in Neef, Ernst, ed., Geomorphologische Studien (the Machatschek Festschrift): Gotha, VEB Hermann Haack, Ergänzungsheft (supplement volume) no. 262 to Petermanns Geographischen Mitteilungen, p. 91-101. [drainage density (same 12 Flußdichte refs as 1937 paper) & geomorphic process]

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]


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]


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]


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, Besondere 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 between a fan and its surrounding mountains: Geographical Review of Japan, v. 7, no. 8, p. 649-663. [not seen; geometric relations?]


N


Nagel, Dr., 1835, Über die Küstengestaltung der Erde (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√F[]: U = coast perimeter, F = area enclosed; see Rohrbach, 1890]


Neumann, Ludwig, 1889, Die mittlere Kammhöhe der Berner Alpen (in German, mean crest levels of the Bernese Alps): Berichte der Naturforschenden Gesellschaft zu Freiberg im Br., v. 4, no. 1, p. 45-50. [definition of 'mean crest-level'—height 'longitudinal crest profile would take if limited to consistently even portions parallel to sea level', as cited by Fiedler 1890]

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


Neumann, Ludwig, 1900, Die Dichte des Flußnetzes im Schwarzwald (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]


Nice, Bruno, 1948, Energia del rilievo, in La fittezza del reticolato idrografico nell'Appennino tosco-emiliano: Riv. Geog. 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.]


Nogami, Michio, 1999, Effects of geology on geomorphometric characteristics analyzed by a 50-m digital elevation model (in Japanese with 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]


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Nowak, Hans, 1944, Die Relieffenergie 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]


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]


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]


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. [appl. of morphometry; correl. basin discharge w/ mean elev., etc.; esp. ch. VI, p. 75-103]


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]


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, using JERS-1 SAR interferometry: Polar Geoscience, no. 12, p. 227-239. [50m grid; 23 control pts. for 45km x 55km area; better than GTOPO30]


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]


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.]


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 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]


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 DTM (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]


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 Gesellschaft in München, p. 119-155.  [tests formulae given in 1894 book; shallow lake differs in form from 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]


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 possess an importance only when compared with the corresponding ones for other forms of the surface ..."]


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., 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]


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 = ?]


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).]


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]


Raasch, W., 1979, Photometric measurement of terrain roughness: Journal of Terramechanics, v. 16, no. 2, p. 87-111. [no info]


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]


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']

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]

Reeb, Georges, 1946, Sur les points singuliers d’une forme de Pfaff completamente integrable ou d’une fonction numerique (in French; On the singular points of a completely integrable Pfaffian form or of a numerical function): Paris, Comptes Rendus de L’Acad. des Sciences, v. 222, p. 847-849. [proposed topological graph (a critical-point graph) that defines the skeleton of a surface]


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.]


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 l/100K 5-class slope map; correl. w/ veg. & soils]


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 exponential or quadratic]


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]


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]


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)]


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. [exhaustive system for relief char. in plan & profile, 'what is to be descr.' Kugler, Demek infl.]


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]


Rosu, Al, and Balteanu, D., 1969, Caracterezarea 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.]


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]


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., 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]


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 parallèles, sur celles qu'on peut appeler anti-parallèles, et sur les lignes de falte et de thalweg des surfaces courbes en général (in French; on surfaces of greater constant slope as well as curved parallel lines, anti-parallel, and ridge & thalweg lines of curved surfaces in general): Bulletin de la Société Philomatheque 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]


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]


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]


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%]


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]


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]


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 apps.]

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 apps]


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]


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)]


Schumann, Dr., 1864, comments (in German) in Bothe (1864a), p. 406. [the area/perimeter problem; 'coastal development' = U/2\sqrt{F}/\Pi: U = perimeter of coast, F = area enclosed; and r1 = \sqrt{F}/\Pi; see Rohrbach, 1890]


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]


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]

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
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
3”x3” samples; same range, diff. freq. distr.]

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]

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
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
of 3-D object from surface contours]

Shinagawa, Yoshihisa, Kunii, T.L., and Kergosien, Y.L., 1991, Surface coding based on Morse
(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
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., 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., 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, 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.]


Smart, J.S., 1972, Channel networks: Advances in Hydroscience, v. 8, p. 305-346. [Melton's law: channel freq./sq (ch. density) = 0.69]

Smith, D.D., and Whitt, D.M., 1948, Evaluating soil losses from field areas: Agricultural Engineering, v. 29, no. 9, p. 394-396.  [derived eqn for soil loss (corn-belt slope-practice); uses data fr. uniform slopes]


Sobolev, S.S., 1936, Map of erosion depth in the Ukranian SSR and related problems (in Russian): Problemy sovetskogo pochvovedeniya, no. 1: Moscow-Leningrad, AN SSSR, paging unknown.  [no info]


Soille, Pierre, 1988, Modèles numériques de terrain et morphologie mathématique—délimitation automatique de bassins versants (in French): Mémoire de fin d'études (Master's Thesis), Louvain-la-Neuve, Belgium, Université catholique de Louvain, paging unknown.  [DEM's-to-watershed using mathematical morphology]


Sokolov, A.A., 1969, Interrelationship between geomorphological characteristics of a drainage basin and stream (in Russian): Soviet Hydrology, Selected Papers, no. 1, paging unknown. [no info]

Sonklar, C.E. von I., 1860, Die Oetzthaler Gebirgsgruppe, mit besonderer Rücksicht auf Orographie und Gletscherkunde, nach eigenen Untersuchungen dargestellte (in German): Gotha, J. Perthes, 306 p. [1st use of some of the morphometric measures (pp. 249 ff.) summarized in full later in his 1873 book (not known if term 'orometrie' coined here); 13 maps]

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]


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]


Squividant, E., 1994, MNTsurf, logiciel de traitement des Modèles Numérique de Terrain: Rennes, ENSAR (Ecole Nationale Supérieure Agronomique de Rennes), internal document, paging unknown.  [calculates such hydro parameters as catchment area]


Steger, Carsten, 1997, Removing the bias from line detection in CVPR '97, IEEE International Conference on Computer Vision and Pattern Recognition, 17-19 June, Puerto Rico, Proceedings: p. 116-122.  [develops explicit model for surroundings of curvilinear structures ('lines') as well as lines themselves]


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]


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]


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]


Stoddard, P.R., and Jurdy, D.M., 2002, Distribution of Io's volcanoes—possible influence on spin axis: Geophysical Research Letters, v. 29, no. 9, 10.1029/2001GL014539, p. 63-1 to 63-4.  [351 volcanoes & ~100 mountains are complementary re longitude]


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]


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., 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]


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]

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, Etude 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 penneplains, 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]


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]


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.]

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.]


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]


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]


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]


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 (~ \( D = 1.71 \))]


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]


Thompson, J.A., Bell, J.C., and Butler, C.A., 2001, Digital elevation model resolution—effects on terrain attribute calculation and quantitative soil-landscape modeling: Geoderma, v. 100, nos. 1-2, p. 67-89. [10m surveyed DEM ± 0.1m precision vs. 30m DEM ± 1.0m prec.]

Thompson, M.M., 1956, How accurate is that map?: Surveying and Mapping, v. 16, no. 2, p. 164-173. [admits U.S. vertical acc. standards lower than those in Europe & that slope gradient needs to be taken into account]


Tillmann, E., 1915, Orometrie der Eifel (in German): Bonn, Univ. Bonn, Ph.D. diss., 92 p. [drainage density, mean slope & height &/or volume]


Tillo, A.A., 1889, Untersuchung über die mittlere Höhe der Kontinente und die mittlere Tiefe der Meere in verschiedenen Breitenzonen (in German): Petermanns Geographische Mitteilungen, v. 35, no. 2, p. 48-49. [discusses Murray's 1888 paper & 1887 Barthol. map; gives tables of elevs. & depths by 10°lat. bins]

Tokunaga, Eiji, 1994, Selfsimilar natures of drainage basins, in Takaki, R., ed., Research of Pattern Formations: Tokyo, KTK Scientific Publishers, p. 445-468.  [fractal D of channel network is same as that of its basin]

Tokunaga, Eiji, 2000, Dimensions of a channel network and space-filling properties of its basin: Transactions, Japanese Geomorphological Union, v. 21, no. 4, p. 431-449.  [basin never filled by its streams; i.e. self-similar networks not space-filling in Tok. Branching Systems I & II]


Treitz, Paul, and Howarth, Philip, 2000, Integrating spectral, spatial, and terrain variables for forest ecosystems classification: Photogrammetric Engineering and Remote Sensing, v. 66, no. 3, p. 305-317.  [fair (k = 61%) result; need more detailed params. than elev, slope, & relief]

Tsukamoto, Yoshinori, and Ohta, Takehiko, 1988, Runoff process on a steep forested slope: Journal of Hydrology, v. 102, no. 1-4, p. 165-178.  [define 3 slope units by combining the 9 basic slope types]


Tylor, Alfred, 1869, Section of surface of Lower Carboniferous series, Hirwain Common, Figure 7 in On Quaternary gravels: Quarterly Journal of the Geological Society of London, v. 25, first part, p. 73.  [illustrates author's thesis (same volume, p. 7) of paper read Nov. 11, 1868 that longitudinal stream profiles are parabolic; see his abstract]


Unbenannt, Maik, 1998, Ableitung und Bewertung morphometrischer Parameter ausgewählter Hangsegmente im Cottonwood Canyon, Colorado, USA mit Hilfe Digitaler Höhenmodelle (in German; Derivation & eval. morph. param. selected slope segments ... DEM): Martin-Luther-University Halle-Wittenberg, Department of Geography, M.A. thesis (unpublished), paging unknown.  [multivariate analysis of slope, aspect, profile & plan convexity]


U.S. Geological Survey, 2001, HYDRO1k Elevation derivative database: Sioux Falls, ND, EROS Data Center; http://edcdaac.usgs.gov/gtopo30/hydro/index.html. [gridded river network at 1km resolution; global coverage planned]


V

Vacher, H.L., 1999, Computational geology 5—if geology, then calculus: Journal of Geoscience education, v. 47, no. 2, p. 166-175. [tutorial; landform examples: Hack's equation; also allometry]


Vakhtin, B., 1931, Experiments to determine mathematical characteristics of relief for the CCR (in Russian): Geodezist, no. 11-12, p. 43-55. [no info]


Vales, D.J., 1996, User's manual for ELKVULN, an elk vulnerability, hunter, and population projection program, version 1.00: Moscow, ID, Department of Fish and Wildlife Resources, University of Idaho, 24 p. [PC software pkg uses mean slope & 'aspect contagion' ('broken' vs continuous)]

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]

van der Beek, P.A., and Braun, Jean, 1998, Numerical modelling of landscape evolution on geological time-scales—a parameter analysis and comparison with the south-eastern highlands of Australia: Basin Research, v. 10, no. 1, p. 49-68. [comprehensive DEM neo-orometry (incl. correl.); roughness amplitude, R, hyps. integral, elev., fractal D; variograms, etc.]


van Remortel, R.D., Hamilton, M.E., and Hickey, R.J., 2001, Estimating the LS factor for RUSLE through iterative slope length processing of DEM elevation data: Cartography (Canberra), v. 30, no. 1, p. 27-35. [updates 1994 Hickey et al. calcs. for RUSLE]


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]


Veneziano, Daniele, and Niemann, J.D., 2000a, Self-similarity and multifractality of fluvial erosion topography 1. mathematical conditions and physical origin: Water Resources Research, v. 36, no. 7, p. 1923-1936. [expressed by topo increments in subbasins; dynamic modeling]


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.]


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]

Veverka, Joseph, and 32 others, 2000, NEAR at Eros—imaging and spectral results: Science, v. 289, no. 5487, p. 2088-2097. [Near Earth Asteroid Rendezvous; d/D for 9 sub-pristine impact craters (0.65km≤D≤5.5km) = 0.12-0.16]

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]

VieIra, 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]

Vieux, B.E., 1993, DEM aggregation and smoothing effects on surface runoff modeling: Journal of Computing in Civil Engineering, v. 7, no. 3, p. 310-338. [low-pass filtering a 7.5' DEM by convolution to reduce spurious pits]


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.]


Vogt, P.R., 2000, Endorsesment 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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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]


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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)


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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.]}


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http://www.geog.le.ac.uk/jwo/research/conferences/sdh98/index.html. [quadratic interpolation of continuous surfaces by semi-axes of conic sections]


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X


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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]
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= ∑ h_i/H, where h_i =height of enclosed lower-order mtn.; perimeter fractal D; all 3 are related in Japan]


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]

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Z


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Zöttl, Josef, 1951, Die Reliefenergie des Waldaist-Gebietes, in Landformung und Talentwicklung in Flußgebiet der Waldaist: Arbeiten a. d. Oberösterr. Musealvereins, v. 96, p. 36. [ca. 1/250K relative-relief map; 500-m samples; 6 relief intervals]

Zuber, M.T., and 14 others, 2000, Internal structure and early thermal evolution of Mars from Mars Global Surveyor topography and gravity Science, v. 287, no. 5459, p. 1788-1793. [crust thickness not correl. w/ topo. dichotomy, but is thin under lg. basins]

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Sonklar, C.E. von I., 1873, Orometrischer Theil (Orometric section) p. 173-192, in Allgemeine Orographie, die Lehre von den Relief-Formen der Erdoberfläche (General orography, the science of relief forms of the earth’s surface, in German): Vienna, W. Braunmüller, 254 p.  [one of the landmarks in 19th C. orometry (a term he evidently coined, possibly in his 1860 book on the Oetzthaler Gebirgsgruppe), these few pages summarize his major contribution, 12 morphometric measures—later criticized (by Penck, Hettner, & others) as too many & not suffiently linked to geomorphic process; was the 2nd to propose a mean-slope formula, but too subjective; book shows influence by Ritter’s concept of ‘comparative geography’]


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