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What is This?
Theory and quantitative methods in geomorphology

Paul M. Mather

Techniques are the offspring of prevailing philosophical orientations; it is only within the context of a particular framework of thought that they acquire meaning and relevance. The contemporary paradigm (or framework of thought) suggests questions which are to be considered significant, and outlines a methodological approach via which answers to these questions are to be sought. Techniques of measurement and manipulation are then seen to be either relevant or irrelevant within this particular structure.

A change in attitude within geomorphology, dating from around 1950, saw a movement away from the descriptive method associated with denudation chronology towards the ideas of systems. The relationships among the elements of the system were expressed statistically in terms of correlations, or mathematically in terms of analytical models. Chorley (1978) has given a lucid account of the various phases through which geomorphology has passed in the last two centuries; the definitions which are of concern here are:

**Functional.** The basis of theory relying on the mainstream logical positivist thesis that real world phenomena can be explained by showing them to be instances of repeated and predictable regularities in which form and function can be assumed to be related. Theory of this type derives from the view that science is empirically based, rational, objective and aimed at providing explanation and prediction on the basis of observed regular relationships.

**Realist.** This is a philosophical extension of the functional approach to logical positivism, which accepts many of the tenets of the latter. It is based on the view that explanation involves something more than prediction based on observed regularities. It thus seeks to penetrate 'behind' the external appearances of phenomena to the essences of mechanisms which necessitate them as the result of chains of causal connection. The realist is concerned with the identification and investigation of detailed causal mechanisms and of the underlying structures of which the external forms are the artifacts (Chorley, 1978, 2).

In terms of the techniques associated with these two approaches, it is possible to identify a tentative relationship between the functional approach and the use of correlation and regression statistics and their multivariate extensions, while the realist approach can be associated with the use of analytical models.

Despite the simple and appealing way in which the development of
geomorphology can be shown to fall into various phases, each having its associated techniques, it is nevertheless important to realize that things are not as simple as they may at first appear. For example, objections to the point of view which is often loosely called 'logical positivism' have been voiced—with increasing volume—among human geographers (see D. Gregory, 1978); alternative philosophies have been proposed and doubts have been cast on the validity of much of what is called 'the scientific method', as described by Harvey (1969) for example. Do practising scientists actually have any methodological or philosophical views? One eminent scientist, at least, doesn’t think so:

The scientist is not in fact conscious of acting out a method. If a scientist is more or less successful in the enterprise he is engaged on, he attributes it to having enjoyed more or less of luck or learning of perceptiveness or flair, never to the use or misuse of a formal methodology (Medawar, 1969, 8–9).

and later (p. 12):

Science, broadly considered, is incomparably the most successful enterprise human beings have engaged upon, yet the methodology which has made it so, when propounded by learned laymen is not attended to by scientists, and when propounded by scientists is a mis-representation of what they do.

It is perhaps somewhat naive, then, to divide geomorphologists into groups depending on whether they best fit the definitions of ‘functionalist’ and ‘realist’ cited above, for I suspect that the true situation is more subtle and fluid.

A third group of geomorphologists, fitting neither of the above categories, can be recognized. These are the applied geomorphologists, whose work is represented in the publications by Hails (1977) and Cooke and Doornkamp (1974), although much attention has been devoted to applied research in the closely associated field of hydrology (see, for instance, Overton and Meadows, 1976). Some academic geomorphologists see the applied work of their colleagues as disconcerting—Chorley (1978, 11) for example, says: ‘... utilitarian approaches to geomorphology will result either in large-scale work of which the intellectually-sterile taxonomic morphological mapping is the most depressing precursor, or in a piecemeal concentration on small-scale realist systems’. He sees geomorphology becoming ‘increasingly committed to a role involving human well-being and aspirations’ with ‘... an increasing gulf between the theoretical bases dictated by the scientific methods of logical positivism and those prompted by utilitarian and social doctrinaire theories’. He concludes with the warning that ‘... the wheel of theory may be coming full circle from one teleology to another, from an old religious, to a new social orthodoxy’. It is surprising to find that Chorley identifies ‘the scientific method’ with ‘logical positivism’ for alternative scientific philosophies have been expounded—not least the critical rationalist approach of Popper (1972; 1975). Even if this oversimplification is not considered important, it is tempting to identify this move away from the allegedly objective, value-
free methodology of the so-called logical positivists (I feel that this over-used epithet has become meaningless through misuse) with a similar move in human geography (D. Gregory, 1978; Ley and Samuels, 1978). The association between the political establishment and the scientific community during the disturbing period of the 1960s and early 1970s in the United States led some to question the claims made by the scientific establishment to be above ethical considerations in the name of neutrality, objectivity and detachment (Ley and Samuels, 1978, 1-2). This viewpoint was not, of course, restricted to human geographers (see, for example, Shaffer (1978), for a lucid justification of humanistic psychology). Hails (1977, vii) is less outspoken, but equally committed when he states: 'Unfortunately, there are still too many university and college courses which are outdated and divorced from the problems of everyday life'. This is not the place to become more deeply involved in the debate between academic and applied geomorphology, although the view that over-concentration on pressing immediate problems of direct economic and social relevance will reduce the output of basic research, on which applications are based, is an attractive one (it has been put forward as one reason for the decline of the Greek civilization!). For the purpose of this essay it is sufficient to note that methods of large-scale data collection and processing have wide application in such fields as terrain classification, biogeography and hydrology, and that specific techniques have been developed or modified to deal with such data.

Three separate strands in geomorphological work have been identified in the preceding paragraphs. These are the functional, the realist and the applied; specific techniques can be associated with each view, and these techniques will be examined in the remainder of this paper. In practice the threefold division is not by any means watertight, but it serves the purposes of this essay.

I Statistical methods

The most common reaction of the new wave of geomorphologists of the 1950s to a scatter plot was to draw a straight line on it. The hydraulic geometry of Leopold and Maddock (1953) and the morphometric analysis of Strahler (1950; 1952) are based on curve-fitting, or more specifically, straight-line fitting. Melton's (1958) influential paper was also based on empirical measures of drainage basin properties, but he used correlations rather than the regression approach of other workers. The idea of correlations among drainage-basin characteristics was an appealing one, especially as the concept of systems was entering geomorphological thought (Chorley, 1962; Chorley and Kennedy, 1971, Figure 2.27).

The curve-fitting approach is typified by the work of Wolman (1955), who related width, depth, velocity, water surface slope and channel rough-
ness to discharges equalled or exceeded 50 per cent of the time for stations along Brandywine Creek, Pennsylvania. Similar work is so widespread that it scarcely needs listing. That it is still an attractive method of summarizing data is shown in the recent work of Anderson and Burt (1978) and Gregory and Ovenden (1979); the latter authors attempt to relate drainage network volumes and precipitation in 11 drainage basins in England. Like Wolman, they use curve-fitting methods to display relationships between variables thought to be significant.

In these studies the significant variables are, generally speaking, surrogates or composites. It is considered implicitly that the individual relationships between the various components of the sequence of events leading from the initial input to the system response are so complex that it would be impossible to unravel them in a finite time. A variable such as drainage density is selected because it reflects or summarizes a number of processes operating on the drainage system. As Gregory and Ovenden remark:

> The parameter used most frequently to express the character of the drainage network has been drainage density. It has been argued that drainage density should represent precipitation character and Melton derived an inverse relation between drainage density and Thornthwaite's P/E index. More recently, Madduma Bandara has demonstrated that this relationship becomes positive above a critical level of effective precipitation (1979, 1).

Thus, drainage density reflects not only precipitation effectiveness but also the degree of development of the drainage network as reflected by characteristics such as '... vegetation density, transpiration, moisture retention and other factors' (Gregory and Ovenden, 1979, 1).

The use of graphical methods to relate composite variables is frequently used in conjunction with statistical methods. Straight line relationships (including those which can be linearized by logarithmic transformations) are conveniently summarized by the use of regression analysis, although the assumptions underlying the classical regression model are not always met (Mark and Church, 1977; Till, 1973) due to confusion between the nature of the difference between a functional relationship and a regression relationship. (Mark and Church (1977, 74) report that '... In a review of 24 papers on morphometry, only two used regression analysis correctly'.)

The use of two-dimensional surface-fitting as a method for summarizing spatially distributed variables is a well-established procedure in the earth sciences. It use is well-documented (Agterberg, 1974; Davis, 1973; Mather, 1976) and so little comment is needed here. As in the one-dimensional case of curve-fitting, the intention is to extract a simple description of the behaviour of a variable, whose variation over space is thought to be the sum of two components—one deterministic (the 'trend') and the other stochastic, representing error, randomness, and the effects of locally important processes. Frequency-domain, as opposed to spatial-domain, techniques such as filtering (see below) can also be used with similar aims.

The multivariate extension of the techniques mentioned above was a
natural consequence of the growing organization of thought along systems lines (Chorley, 1962; Chorley and Kennedy, 1971; Bennett and Chorley, 1978) and the import of computer-oriented methods from other disciplines (Harman, 1960; Cooley and Lohnes, 1962). These multivariate methods were, in general, developed by behavioural scientists, and their effect was felt initially in those areas of geography which were closest to behavioural sciences. Multivariate methods, of which factor analysis, principal components analysis and canonical correlation analysis are the best known, appear to have been more readily adopted in the geological sciences (Joreskog et al., 1976; Davis, 1973) and in areas such as sedimentology (Orford, 1978) compared to geomorphology and hydrology. This is possibly a consequence of the greater emphasis on process among geomorphologists, while some geologists are concerned with taxonomy. To a certain extent, biogeographers and ecologists are also more closely associated with the taxonomic approach (Frenkel and Harrison, 1974; Pritchard and Anderson, 1971). A comprehensive review of the use of statistical methods in physical geography has appeared in a recent issue of this journal (Unwin, 1977).

The use of statistical methods in geomorphology and hydrology is not confined to the application of curve-fitting or correlation methods and their multivariate counterparts. It was pointed out above that the users of these methods rely on composite variables, such as drainage density, which conveniently summarize (the cynic would say disguise) the effects of a complex of causal variables. Where a number of variables interact dynamically their behaviour can also be represented by a stochastic model. Lawrance and Kottegoda (1977, 2) state this clearly in their introduction to their valuable review of stochastic modelling of riverflow time series; they identify the processes which generate riverflow at a point, and contribute to its temporal variation, and conclude:

The combination of all these factors makes river-flow a highly complex process, and one which can to good effect be treated stochastically.

The stochastic model is a statistical system of the 'black box' variety. The parameters defining its inner form and workings need not have any physical interpretation, for its aim is to generate riverflow data which resemble historical riverflow series in respect of hydrologically important properties. Simple models of this type are the subject of a monograph by Fiering and Jackson (1971); the techniques reviewed by Lawrance and Kottegoda (1977) are more complex and are divided into two types. The first set are the short-memory models (including Markov autoregressive models, higher order autoregressive models and daily flow models based on shot-noise processes), while the second set consists of long-memory models (fractional noise models, broken-line models and autoregressive moving-average (ARMA) models. One application of geomorphological significance is given by Nillson and Sundblad (1975). Time-series models,
based on the Box-Jenkins approach, have also been utilized by Thornes and
Clark (1975; 1976) in their Non-Sequential Water Quality Project, in
which an interesting study involving a one-dimensional application of
Matheron’s theory of regionalized variables is reported. This ‘theory’ is
more generally used in a two or three-dimensional context, under the name
of kriging or geostatistics. An extensive bibliography of this subject can be
found in Alldredge and Alldredge (1978).

The term ‘stochastic model’ has also been used to cover methods of
descriving, in probability terms, the development over time of geo-
morphological phenomena. The first description of these methods is
Leopold and Langbein’s (1962) account of the use of random walks to
simulate the development of drainage networks. The random walk is, in
fact, a memory-less stochastic model; it is useful in defining a most probable
outcome or state. Its value lies in the fact that attention is drawn to the
conclusion that, even in the absence of variation in major controlling
factors, the final outcome of a sequence of operations is not predeter-
minable. A simple random walk is also used by McCullagh and King (1970) in
their model of the development of coastal spits, and other pertinent
references are Scheidegger and Langbein (1966) and Scheidegger (1970).

In summary, then, it can be stated that the statistical approach has as its
aim the development of empirical relationships between, on the one hand,
composite variables which summarize aspects of process and, on the other
hand, variables which either reflect some measure of the response of a
system or which represent an aspect of the geometrical form of the
landscape. These aims have been most clearly realized in studies in which
prediction rather than explanation has been the aim. Geomorphological
studies have tended to founder on the reefs of equifinality; similarity of
form does not imply that those forms have been produced by similar
processes. More recent efforts in quantitative geomorphological research
have been concentrated on the study of processes of transfer of mass and
energy within geomorphological systems. As Chorley puts it: ‘... there
has been a growing conviction among geomorphologists over the past 15
years or so that they must penetrate behind the appearances of external
form to the essential physical and chemical mechanisms which are assumed
to sustain and transform them’ (1978, 9). Following Chorley, this will be
termed the realist viewpoint and it will be related here to conceptual or
analytical modelling.

II Analytical methods

The study of the relationship between process and response (which is taken
to include geometrical form) has, as we have seen, been conducted in an
empirical manner and at a meso-scale by users of statistical methods (section
I above). The difficulties experienced by the practitioners of this approach
have led to the philosophical orientations of research geomorphologists moving away from empirical methods towards a more deductive approach, involving the specification of relationships derived from physical theory and then deduction of the observable consequences of these relationships.

Because our knowledge of the nature and rates of operation of geomorphological processes is inadequate, it is often impossible to specify even approximately the relationships among the components of the system under study, and empirical relationships such as those described above (section I) are frequently used. It is rather salutary to read the opinion of two eminent mathematicians on this topic:

Judging from the literature it seems that today, after much work has been done and much has been learned about the crust of the earth, there is little evidence concerning the forces and their effects upon the shape of the surface. For this reason, we have chosen to postulate a rather arbitrary, but a priori not unreasonable, mechanism of generation (Freiberger and Grenander, 1977, 548).

The assumptions underlying the mathematical model which these authors describe can be summarized as:

(i) the total mass of the landform remains constant. Hence, the vertical displacements are related to the horizontal displacements by an equation of continuity.
(ii) The horizontal displacements are governed by a two-dimensional diffusion equation, with forcing terms made up of (a) additive random noise, and (b) a tangential force field, the systematic component.
(iii) The tangential force field acts in the following manner. At any given time, the initial point of application of the force is selected from a two-dimensional Poisson distribution with given intensity \( m \), and its initial signed amplitude \( A \) from another distribution with symmetry around zero. . . . The point of application (and thus the influence) of this force will move with given constant speed \( V \) in a random direction . . . with the amplitude of the force decaying exponentially (Freiberger and Grenander, 1977, 548).

The lack of knowledge of the forces governing horizontal transfers of material over the earth’s surface is demonstrated by the use of assumptions (i) and (ii) while assumption (iii) is described as a highly speculative method of taking into account the drag forces acting on the surface from the interior of the earth. The mathematical development of these statements is impressive; beginning with a flat surface, the computer program based upon the model produces maps of height fields of which Figures 1 and 2 are examples. This model is based on speculation rather than theory or observational evidence, but—as its authors point out—‘it is true that at the moment we lack empirical support . . . but to provide such support is not our aim now’ (Freiberger and Grenander, 1977, 547).

The use of conceptual or analytical models by earth scientists tends to be on a much more limited scale than that discussed in the preceding paragraphs. For example, Freeze (1978) describes a mathematical model of hillslope hydrology in which he states his aim as being to develop ‘. . . a fully-illuminated white-box approach selected from the class of conceptual
models' (Freeze, 1978, 178). The type of model used by Freeze requires the specification of initial and boundary conditions, the size and shape of the region of flow, the equation of flow within the region, and the spatial and temporal distribution of the hydraulic of hyrogeologic parameters that control the flow. Consideration of geomorphological and hydrological factors, as well as the mathematical tractability of the proposed model, leads to the specification of a partial differential equation of a form similar to those used in physics to deal with the two-dimensional diffusion of heat through solids. Freeze's approach, which he considers '... will find its greatest value in the examination of flow mechanisms on hypothetical hillslopes or on small instrumented research watersheds rather than as a large-scale engineering tool for hydrologic prediction' (Freeze, 1978, 223),
stands in sharp contrast to the increasingly widespread use of mathematical modelling in catchment hydrology as described and practised by such authors as Fleming (1975), Overton and Meadows (1976), Betson (1976) and Betson and Ardis (1978).

These authors implicitly or explicitly begin from the premise that nature is complex rather than, as Newton would have it, simple. Betson and Ardis (1978, 298) view the boundary-value approach of Freeze (discussed above) as suspect, since functional relationships are, in general, not clearly known nor are boundary conditions capable of being specified accurately. The class of models described by Betson and Ardis (1978) as parametric mathematical models basically comprise a package of empirical findings. The relationships among causative independent variables and the characteristics of

Figure 2
elements within the system are defined using rational empirical parametric expressions ... The parametric approach has value in complex systems where the relationships cannot be explicitly expressed' (Betson and Ardis, 1978, 297). As knowledge of these relationships increases, the parametric models evolve towards the ideal, but essentially unattainable, deterministic model.

The part empirical-part analytical structure of many mathematical models is well illustrated by the work of Ahnert (1976; 1977). His theoretical slope development model incorporates mathematical representations of the processes of fluvial downcutting, weathering, splash, viscous and plastic flow, overland flow and wash. These processes are related to material and form by the use of coefficients, the values of which are defined by the user of the computer program.

The accuracy of an analytical model is normally assessed by comparing the performance of the model with the real data. Two points must be borne in mind here. The first is perhaps more relevant to hydrological models which attempt to reproduce the discharge hydrograph of a catchment for even a poor model will reproduce an approximation to the actual hydrograph. The degree to which the model results approach reality is thus no guarantee of the physical validity of the model representation. Even if the model is well structured (in that its components are correctly realized) there are generally a number of free parameters which are fixed so as to minimize some badness-of-fit function. The actual values that are eventually given to these parameters do not, in general, have any physical interpretation. Where automatic function minimization routines are used, for example, the pattern-search method incorporated in the TVA SSAM models (TVA, 1978; Betson, 1976), this danger is increased. With this method, the response surface of the parameter can be easily examined; if similar output results are obtainable for different combinations of parameter values (as revealed by the response surfaces) then the model is suspect. Aspects of model verification are dealt with in a hydrological context by Betson and Ardis (1978), Fleming (1975) and Overton and Meadows (1976).

The separation between statistical and conceptual models, which was made at the beginning of this paper, is thus not a clear one; the conceptual models discussed in this section can be seen to embody relationships resulting from curve-fitting exercises, rather than the conclusions arrived at deductively from a consideration of the physical laws which describe the behaviour of the phenomena concerned. The predictions derived from conceptual models are, furthermore, checked against observational data; as Kirkby comments, in a review of sediment transport models, '... Predictions ... urgently require field observations to back them up' (1978b, 362). Checking of predictions against real data is frequently done statistically, further clouding the distinction between statistical and conceptual models.
III Applied geomorphology

For the most part, applied geomorphology has been concerned with the prediction of events which are of actual or potential concern to the occupants of an area, the description of an area in geomorphological terms, or building up inventories of regional geomorphological data, often in the form of geomorphological maps. The use of remote sensing methods, ranging from conventional aerial photography to the multispectral scanner systems of earth satellites, has helped in the acquisition of data and in the development of terrain classification schemes. In one way the increasing use of remote sensing technology by neighbouring disciplines, such as geology, has led to a growing interest in geomorphology, for it is often the case that geological interpretation of remote sensing imagery is based upon the geomorphological and vegetational features. As Verstappen says in his review of remote sensing in geomorphology: '... Aerial survey has had a second ... impact on geomorphology because it helped form a link with the neighbouring disciplines of geology, soil science, etc. and thus contributed substantially to the transformation of geomorphology from a subject of academic interest merely, into a modern science with numerous applications' (1977, 6; italics added). Thus, the increased availability of data has led not only to the opening-up of possibilities of large-scale process studies (e.g. the study of temporal change in landforms or in processes such as sediment movement patterns in estuaries) but it has also enabled geomorphologists to show themselves to be useful to the community which supports them. Chorley (1978, 10–11) is not convinced that this is a favourable trend (see above).

The philosophical basis of applied geomorphology is straightforward—it has none. Brunsden et al. make this point quite clear: 'As yet, no philosophy of applied geomorphology has emerged except to provide the client with the most accurate information and guidance as quickly as possible. ... sophistication and intellectual stimulation are not necessarily prerequisites for an expertise to be of value to management bodies and commercial organizations. The nature of applied work will be determined by what clients need and not by the fads and fashions of an academic discipline' (1978, 253). Cooke is somewhat more circumspect: 'Applied geomorphology relates to practical problems ... its philosophical basis ... is inevitably dictated by the demands of specific problems' (1977, 184). There is nothing unusual in this attitude; it reflects the well-known distinction between science (the acquisition of knowledge) and technology (the practical use of this knowledge). As long as the technology adequately represents the contemporary scientific achievements, this division need not be harmful. If the application of geomorphological principles is soundly based, then anxieties over its influence on the academic side of the discipline can be quelled. Indeed, as will be outlined below, the needs of the applied geomorphologist may well open up or at least develop new lines of data acquisition and manipulation.
The application of empirical and theoretical results to problems involving the prediction of events or situations of concern to a community has been largely within the province of hydrology, although the modifications in the geomorphological environment also have predictable effects. Quantitative predictions of flood discharges are based on numerous empirical formulae dating back over a century. Thus, Ward (1978, 72) reports a formula used by the railway engineer Major E. T. D. Myers and first published a hundred years ago which relates $Q_{m}$ (maximum discharge) and $A$ (area):

$$Q_{m} = 10000pA^{0.5}$$

where $p$ is a coefficient expressing the ratio of the estimated flood peak for a particular river to the assumed maximum for all rivers of $10^3$ cumecs. This approach underlies more recent work (NERC, 1975) based on multiple regression:

$$\bar{Q} = cA^{0.27} F^{0.27} S^{0.16} W^{1.23} R^{1.43} (1 + L)^{0.85}$$

where $\bar{Q}$ is mean annual flood; $c$ a coefficient varying regionally; $A$ catchment area; $F$ number of stream junctions per km$^2$; $S$ slope of main channel; $W$ an index of winter rain acceptance rate; $R$ net daily rainfall having a five-year return period, and $L$ the proportion of the catchment draining through lakes. More recent approaches are based on deterministic models of catchment response as mentioned in section II and discussed by Fleming (1975).

The application of geomorphological principles to practical problems is the subject of a review by Schumm (1977). These range from interpretation of imagery from Lunar Orbiter and Mariner 9 spacecraft of features of the lunar and Martian surfaces the prediction of channel adjustment following upstream modifications of the river régime, dams and barrages being the most obvious. Schumm demonstrates the complexity of the interrelationships resulting from reduced sediment load, and reduced peak floods. Empirical relationships are used by Schumm to show how the channel morphology and river pattern can be expected to alter in response to hydrological change.

Remote sensing of the terrestrial and aquatic features of the earth's surface has been widely used over many years in geomorphological investigations, and these methods have been widely used and developed by applied geomorphologists (Verstappen, 1977). Recent developments in spacecraft and sensor technology allied to more widespread and powerful digital methods of image processing have made it possible to build up large-scale geomorphological inventories, using digital, rather than photographic, imagery. Aerial photography still has a major part to play and this role is being enlarged by satellite imagery. The statistical techniques used by geographers to handle large amounts of data are finding a new home in the classification of digital data from earth satellites (Swain, 1978) and new
techniques of image enhancement and analysis are pointing the way to promising lines of geomorphological enquiry (McCullagh and Campbell, 1978; Robinson and Carroll, 1977). Filtering and frequency analysis of digital images, whether they be derived from orbiting scanners or from field observations expressed in map form, are potentially valuable analytical tools (Robinson, 1973). The application of remote sensing methods to geomorphology are discussed by Allan (1978), Mitchell (1975), and Goetz et al. (1975); this last work contains much interesting geomorphological and geological work. General reviews of a wide range of applications are to be found in Barrett and Curtis (1977); Peel et al. (1976); Sabins (1978) and Reeves et al. (1975).

IV Conclusion

The changes of orientation of modern geomorphology are piquantly described by Kennedy, who asks '... Why is it that geomorphologists seem, periodically (cyclically?), to go a little insane and throw over their old gods (or paradigms) in favour of new ones?' (1977, 154). These changes in orientation, which have been mapped by Chorley (1978), can be linked to changes in methodology, as discussed in the main body of this paper. This linkage, and the identification of separable strands in geomorphological research could, with reason, be thought naive, for it is equally possible that the introduction of new techniques has enabled geomorphologists to ask different, possibly more penetrating, questions. Essentially, the various approaches are complementary rather than competitive, as noted by Allen (1977, 15–16). If it is true, as Kennedy (1977) implies, that geomorphologists are not at all sure what they, as a group, should be doing, it is not surprising that the philosophy and methodology of their discipline lack, unanimity. I, for one, do not find this depressing—the encouragement of stimulating research, even if unorthodox, is ultimately to be preferred to the dogmatic rejection of original ideas in the belief that truth is revealed only to a select few who follow a rocky path to their private Elysium.

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