METHODOLOGICAL ISSUES

There are a number of sources of friction within the geomorphological community which the discipline can ill afford given the small number of practitioners. Perhaps foremost among these is methodology and/or technique. In an era of rapidly burgeoning techni-ques, there is a large and increasing burden on the research geomorphologist to master new methods of inquiry and analysis. Many of these methods are quite sophisticated, requiring a considerable investment of time and effort to develop the requisite level of expertise for conducting meaningful scientific research. The net result is that specialists proliferate, generalists are disparaged, and professional exchange within the discipline withers. The personal investment in mastering individual research techniques is now so substantial that loyalty to them is necessarily great and the tendency to view other tech-niques as flawed appealing. It is, perhaps, worth noting the parallel between this situation and the original thrust of the multiple working hypothesis concept with respect to ruling hypotheses (e.g. Chamberlin 1897).

Another important source of both confusion and conflict within geomorphology is the scale of interest. Scale, both spatial and temporal, pervades geomorphology and chal-lenges geomorphologists like few other issues. Successful scale-linkage is a strong candidate for the Holy Grail of geomorphology. In a discipline where it is perfectly acceptable to investigate regional landscapes that are millions of years old or to monitor the response of sand grains on a beach to individual wind gusts, the diverse problems associated with profound scale changes tend to be a source of professional divergence because it is quite apparent that the discipline's body of theory does not reach seamlessly across the entire range of legitimate scales of interest (Rhoads and Thorn 1993). Quite obviously reductionist approaches that provide a fundamental explanation that may be multiplied or scaled up as needed have been attempted. However, such approaches gen-erally have generated more questions than solutions. Geomorphologists are discovering that new conceptual issues emerge at every scale of interest. Faced with this situation, they have begun to recognize the full complexity of the scale problem.

The discipline would benefit greatly if its practitioners had a more comprehensive and profound appreciation of the concepts held, and obstacles faced, by all geomorphologists regardless of specific interests or methodologies. To steal an analogy from Stephen J. Gould's characterization of evolution, we need to view the discipline not as a tree (or alternatively a ladder) with inherent notions of inferiority and superiority, but rather as a shrub with many shoots. In short, we are all entitled to be an individual shoot, but we need to recognize that we all share the same root stock and that different is not inherently inferior or superior. Hopefully, as geomorphologists of different scale and methodological 'persuasions' enter into active collaborations with one another, all will become more appreciative of the advantages and disadvantages of different types of geomorphological research.

Michael Church examines the fundamental relationships between scale and theory building in geomorphology From the small to the large, he sees (1) at very small scales, stochastic processes being described statistically, (2) at the scale of classical mechanics, description by deterministic theories, (3) at even larger scales, systems which are still described deterministically but exhibit 'contingent endogenous effects' that make nonlinear dynamical models appropriate, (4) at the very largest scales, narrative, particularist descriptions of purely contingent landscape evolution.

Keith Richards takes up the scale issue by contrasting research methods which are extensive (large-N) with those that are intensive (small-N). Sampling theory addresses large-N studies comprehensively, but small-N studies lack a comparably well-developed underpinning. In geomorphology, the seeming weakness of 'uniqueness' in detailed (small-N) case studies may be offset by creating a 'web of research' in which at-a-site cross-referencing of many components within a well-established theoretical framework substitutes for the robustness supplied by replication in large-N studies.

Ron Dorn confronts the scale issue in terms of resolution. He takes as his case study the relationship between established geomorphic models of alluvial-fan development in Death Valley and recent changes in the way Quaternary climatic changes are viewed. While this case study focuses on the use of optical varnish microlaminae in relating fan building to such climatic indicators as 'Heinrich events', he raises the much broader issue of the quality of resolution that can be achieved in paleoreconstructions and the ability of geomorphologists to link mixed signals from different environments in a manner that permits acceptable testing of hypotheses.

Jeffrey Peakall, Phil Ashworth, and Jim Best survey the rigorous demands of attempting to construct physical scale models, focusing upon flume experiments ranging from 1:1 replicas, through Froude scale models, to distorted or analog models. Throughout their review they focus on the underlying principles that determine how well the physical model accurately replicates the corresponding real-world prototype.

REFERENCES

Chamberlin, T.C. 1897. The method of multiple working hypotheses, *Journal of Geology,* **5,** 837-848.

Rhoads, B.L. and Thorn, C.E. 1993. Geomorphology as science: the role of theory, *Geomorphology,* **6**, 287-307.