Whither Physical Geography?

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Worry about the place of physical geography seems to be a specifically American problem rather than a world-wide one. —(Ahnert 1962, 1)

The one-hundredth anniversary of the Association of American Geographers (AAG) is an appropriate occasion to reflect on the future of geography in the U.S. During the past hundred years, American geography has been haunted by various dichotomies—none more pronounced than the distinction between human and physical geography. Although the dichotomy can be viewed as invalid (James 1967), it is nevertheless real. Since the founding of the AAG, mutual accommodation of human and physical sides of the discipline has proven difficult. The two sides have coexisted, but have not cooperated. Inclusion of physical geography as a distinct theme in this compilation on geography in the twenty-first century confirms that the human–physical distinction persists.

Physical geography, although a minority component of contemporary American geography, currently is very much alive and well. In fact, it appears to be healthier than ever before. The purpose of this essay is to examine where physical geography has been and may be headed as the AAG moves into its second century as a professional organization. This look to the future begins with a glance at the past to discern the overall development of physical geography over the past hundred years. It then identifies emergent trends that are likely to grow and evolve as physical geography moves forward in the twenty-first century. Finally, the extant breach between human and physical geography is examined in the light of probable trends in physical geography.

A Glance at the Past

What is done is done, and cannot be undone. Yet we can learn from past events in planning the future. —(Orme 1980, 141)

At the founding of the AAG in 1904, physical geography was a prominent component of a nascent American geography. The forty-eight founding members included nineteen geologists and thirteen other natural scientists (James and Martin 1978). The profound influence of William Morris Davis on the scope and content of geographic thought in the early twentieth century is well documented (Chorley, Beckinsdale and Dunn 1973; Martin and James 1993). Davis’s perspective merely reflected the prevailing attitude that largely equated geography as a whole with physical geography in general and geomorphology in particular (Norton 1901).

The composition of the early AAG largely accounts for tentacles of physical geography reaching into human studies in the guise of environmental determinism. Certainly, for natural scientists, the notion that the physical environment could exert a strong influence on human behavior was unlikely to cause serious concern (Rhoads forthcoming). The embarrassment of environmental determinism became apparent to a new generation of geographers less heavily influenced by Davis’s perspective on geographical inquiry. Especially important in this regard was the group of geographers trained in the Department of Geography at the University of Chicago headed by Rollin Salisbury, a physical geographer/geologist who was not a strong advocate of Davis’s ideas (Platt 1957). By the 1920s this group, which included Carl Sauer, Harlan Barrows, Charles Colby, Wellington Jones, Derwent Whittlesey, Robert Platt, Stanley Dodge, and Richard Hartshorne, was steering geography in a new direction. Environmental determinism, already in disrepute within the social sciences (Leighly 1955), was soon cast aside, along, to some extent, with physical geography. Barrows (1923) argued that geographers should not be engaged in explaining the origin, characteristics, and occurrence of landforms, soils, climate, and biota or their relations to one another. Instead, the features of physical geography should be considered only in regard to interaction with human activity. Between the 1920s and early 1950s, physical geography nearly faded from geography. Within the context of Richard
Hartshorne’s (1939) regionalism—it became the hand-maiden of human geography—useful only for defining the biophysical context of human activity (Butzer 1989). The training of physical geographers suffered (Bryan 1944), and Russell (1949) complained that there were not enough papers to hold a half-day session in physical geography at the annual meeting. By the early 1950s, physical geography in the U. S. was in crisis (Leighly 1955). Overviews of climatology (Leighly 1954), geomorphology (Peltier 1954), hydrology (Meigs 1954), biogeography (Küchler 1954), and zoogeography (Stuart 1954), for the AAG’s semicentennial reveal a strong emphasis on qualitative studies involving classification and mapping. Only a handful of references in these overviews come from geographic publications, including the Annals, and many are by individuals who were not trained as geographers or who held positions in academic departments of geography.

Physical geography was gradually resuscitated as part of the quantitative revolution in geography and the earth sciences during the 1950s and 1960s. In climatology (Hare 1955; Court 1957), geomorphology (Strahler 1950, 1952, 1954), and, eventually, biogeography (Morgan and Moss 1965; Fosberg 1976; Gersmehl 1976), a new type of physical geography began to emerge that accentuated a concern with dynamic processes of earth systems. This new approach, which has evolved to the present, is founded on basic physical, chemical, and biological principles and employs statistical and mathematical analysis. It has become known as the “process approach” to physical geography (Gregory 2000).

The “new” physical geography was characterized by several developments. First, it initially brought physical geography and human geography close together, at least methodologically, as the two sides of the discipline embraced quantification and modeling (e.g., Chorley and Haggett 1967). Second, physical geography divided into distinct specializations, such as climatology, geomorphology, and biogeography that separately increased greatly in number, but at the same time became increasingly isolated from one another intellectually. Third, the subfields of physical geography overlapped considerably with process-based specializations in related disciplines larger than geography—a situation that led to some insecurity about the distinctiveness of these subfields relative to research on biogeography (Vale and Parker 1980), geomorphology (Robinson 1963; Graf et al. 1980; Bauer 1996), and climatology (Williams 1961; Terjung 1976; Mather et al. 1980; Yamal et al. 1987; Carleton 1999) in other disciplines of earth science.

Within geography as a whole, separation between physical and human sides of the discipline began to grow when human geography became increasingly disenchanted with quantitative, “positivist” methodologies during the 1970s (Johnston 1997). Whereas Pattison (1964) saw fit to include earth science as a tradition of geography, Taaffe (1974) eliminated this component and tried awkwardly to accommodate physical geography within the domain of human–environment relations—a throwback to Barrows (1923) and Hartshorne (1939). The failure to include any papers on physical geography in the 1979 special issue of the Annals on seventy-five years of American geography provoked a strong response from then AAG president Melvin Marcus (1979), who argued it was time for the discipline to come full circle and realize its promise as an integrative discipline. Unfortunately, this promise has yet to be fulfilled. In fact, polarization was perhaps at its most extreme during the 1980s and early 1990s, when many physical geographers derided what was characterized as the “touchy feely” trend in human geography, and physical geography was cast by relativist, Marxist, and postmodern human geographers into the positivist mold (Harvey 1969; Gregory 1985; Johnston 1997) and tolerated as long as it steered wide of human concerns. More recently, some rapprochement has occurred as geographers wrestle with the inconsistency between geography’s external image as an integrative discipline and the internal reality of a substantive human–physical divide (Rhoads 1999; Gober 2000; Turner 2002).

The history of published papers in the Annals provides a gauge of the “place” of physical geography in American geography (Ahnert 1962). In the period 1911–1923 articles on physical geography often accounted for 50–100 percent of the total number of published papers, which albeit was usually less than seven papers per year (Figure 1). Since that time, the overall number of papers has climbed, and the percentage of papers in physical geography has fluctuated around a long-term mean of 21 percent—a figure roughly consistent with the percentage (19 percent) of the total AAG membership in the biogeography, climate, coastal and marine, geomorphology, and water resources specialty groups in 2001 (Association of American Geographers 2003). The secondary set of large peaks between 1940 and 1950 is somewhat surprising, but two of these peaks are associated with complete issues of the journal devoted to retrospectives on Walter Penck in 1940 and William Morris Davis in 1950. Moreover, few papers from this period have had any lasting impact on research in physical geography. Perhaps most telling is that until the 1999 Forum on Methodology in Physical Geography (Bauer 1999), no thematic set of articles on physical geography was published in the Annals besides the retrospectives on Penck and Davis.
Emerging Trends

We are not very good at predicting futures.
—(Barrow 1998)

The future of science is an enigma. Innovation is the very name of the game.
—(Rescher 1996)

What is the future of physical geography? Specifically, how will it evolve in the twenty-first century? Although we can be certain that major change will occur in future physical geography, we cannot specify what will occur or when and how it will occur because, otherwise, the change would already be occurring. Only two options are available—engage in wild speculation or conjecture about the persistence and future influence of changes already underway. Here I will pursue mainly the latter strategy. One need only reflect on whether geographers in the 1940s could have anticipated developments like GIS, desktop computers, 1960s environmentalism, the fall of the Soviet Union, and the rise of international terrorism to embrace a sober perspective on the perils of prognostication.

Complexity and Nonlinear Behavior

The systems perspective is a hallmark of the process-based approach to physical geography (Strahler 1980). A key aspect of this perspective is the recognition that many systems of concern in physical geography are open, that is, matter and energy flow through these systems. Initial work in the 1950s and 1960s emphasized steady-state behavior of open systems in physical geography, whereby system dynamics maintain a form or structure that remains constant, at least on average, over time. Mathematically, steady state occurs when a response variable has, or closely approximates, the value it would attain if the input variable(s) were constant over an infinite amount of time (Howard 1982). This concept provides the basis for statistical analysis of time-invariant functional relations between spatial covariates (Rhoads 1992).

Over the past fifteen years, physical geographers, who have always acknowledged that the systems they study are complex, have turned to emerging ideas in the natural sciences about nonlinear dynamical systems and complexity to explore the relevance of these ideas for understanding physical-geographic phenomena (Gleick 1988; Wolfram 2002). Application of ideas, which began in the 1980s (Malanson et al. 1990), has already occurred throughout physical geography (Richards 2002), including geomorphology (Phillips 1999, 2003), biogeography (Malanson 1999, 2001; Perry 2002) and climatology (Bryson 1997; Washington 2000). From a methodological perspective, attempts to grapple with the complexity of biophysical systems is steering inquiry away from an overemphasis on reductionist investigations toward analyses that holistically consider system dynamics (Harrison 2001). This trend has only begun and is likely to grow over the next several years or decades.

Advances in Measurement Technology

The progress of natural science is intimately linked to the escalation of technology (Rescher 1998), and we live in an age where the rate of technological escalation is unprecedented. Physical geography has benefited greatly from the emergence of new technology and is likely to continue to reap benefits from further technological advances in the foreseeable future. Over the past thirty years, there have been astounding advances in technical capabilities to explore phenomena of interest in physical geography. These advances have substantively improved the capacity to accurately “observe” natural processes through the collection of relevant data (Rhoads and Thorn 1996a). In the field it is now possible to measure the flow in rivers at high frequencies in three dimensions, whereas forty years ago, only one-dimensional,
time-averaged measurements were possible. New field instrumentation has opened up whole new investigative "spaces" in fluvial geomorphology, allowing inquiry into how spatial variation in the three-dimensionality of turbulence and the mean flow influences river dynamics (Rhoads and Sukhodolov 2001; Sukhodolov and Rhoads 2001). Remote sensing has become a standard investigative tool in all areas of physical geography (Fuller 2000; Gao and Liu 2001; Gillespie 2001; Laidler and Treitz 2003) and new technologies such as interferometric synthetic aperture radar (Balzter 2001), differential GPS (Higgitt and Warburton 1999), LIDAR (Woolard and Colby 2002; Lim et al. 2003), and hyperspectral imagery (Treitz and Howarth 1999; Dennison and Roberts 2003; W. A. Marcus et al. 2003) are expanding capabilities for acquiring data on land-surface conditions. Digital elevation model (DEM) data now are widely available for the U. S. and elsewhere to facilitate computer-based analysis of terrain characteristics (Pike 2000). In geohistorical and paleoenvironmental studies, inherently high levels of inferential uncertainty (Rhoads and Thorn 1993) are being overcome through the development and continual refinement of various dating methods (Duller 2000).

**Advances in Computational and Information-Processing Capabilities**

Advances in computational and information-processing capabilities over the past three decades continue to transform physical geography. Innovations in the speed, power, and data-handling capacities of desktop computers, the enormous impact of the Internet on communication and the distribution of data, and the increasing sophistication of software have all fundamentally influenced the practice of research. Nowhere in geography has this impact been more pronounced than in the arena of GIS. What once was the domain only of mainframe computers is now readily available for desktop machines. GIS analysis is now standard in physical geography (Millington et al. 2001; Chapman and Thornes 2003; Walsh et al. 2003), and applications should continue to grow as a new generation of physical geographers is trained to use this rapidly evolving technology to its fullest capabilities. In the computational domain, mathematical software for numerical simulation of natural systems now can be run on desktop computers and increasingly is becoming a common tool in physical geography for exploring the process-based dynamics of geomorphological (Wilcock and Iverson 2003), ecological (Hannon and Ruth 1997), and climatic (Arnfield 2000; Yarnal et al. 2001) systems. The use of sophisticated models, such as those based on computational fluid dynamics (Lane et al. 1999; Rodriguez et al. 2004), and of advanced spatial analysis involving GIS raises concern about adequate training for the twenty-first century physical geographer. To avoid misusing sophisticated models or analytical techniques, physical geographers must be well versed in the basic natural sciences, mathematics, statistics, and computer programming. However, currently, many students are drawn to physical geography for reasons other than scientific rigor (Smith 2001)—a situation at odds with state-of-the-art research.

**Impact of Humans on Biophysical Systems**

Environmental concerns rose to a position of prominence within science and society during the latter part of the twentieth century as the impact of human activity on natural systems became apparent. Geography, as a whole, has been engaged in the study of these concerns, but, as a discipline, it has not been a major player in applied research, which seeks primarily to develop predictive relations of practical utility or to evaluate normative relations for determining a "best" course of action in the light of a desired outcome (Rhoads and Thorn 1996b). For the most part, the development of predictive relations or models can occur independently of societal values; however, the evaluation of normative relations clearly casts the scientist into the domain of public policy (e.g., Graf 2001; Wade et al. 2002). In recent years, physical geographers of all ilks have turned to applied research to demonstrate the relevance of their science for solving contemporary environmental problems (e.g., DeGrand et al. 2000; Malanson 2001; Urban and Rhoads 2003a). This trend has only begun and almost certainly will grow in the near future.

**Collaboration with Other Disciplines**

Another recent trend has been an enhanced receptiveness by physical geographers to collaborating with scientists in other disciplines. The impetus for collaboration is interest in complex environmental problems that transcend the domain of a single discipline or subfield of physical geography. Thus, for example, physical geographers are teaming with engineers and biologists both to understand the complex dynamics of environmental systems and to devise appropriate ways of managing these systems (e.g., Wade et al. 2002; Rhoads, Schwartz and Porter. 2003).

The participation of physical geographers in such projects not only directly demonstrates the value of physical geography to practitioners in other disciplines
but also provides opportunities for undergraduate and graduate students to be exposed to the intellectual and cooperative challenges of interdisciplinary research.

In contrast to the move toward interdisciplinarity, barriers between the subfields of physical geography do not appear to have eroded substantially. Intradisciplinary collaboration among physical geographers does occur (e.g., Butler et al. 2003), but it is uncommon. Tremendous potential exists for teams of physical geographers to address important environmental problems. Such collaboration need not involve fundamental restructuring of physical geography (Gregory, Gurnell, and Petts 2002); it depends only on the initiative of physical geographers.

**Philosophical Concerns**

Philosophical discussion within physical geography has been negligible compared to the glut of conceptual debate in human geography. Until recently, physical geographers quietly accepted characterization of their mode of inquiry by human geographers as positivist (Harvey 1969). During the 1990s, however, some physical geographers, particularly geomorphologists, began to show interest in philosophical aspects of their science (Rhoads and Thorn 1993, 1994, 1996a, b; Sherman 1996, 1999; Rhoads 1999; Urban and Rhoads 2003b). Philosophical inquiry can shed light on a variety of issues, including the epistemological nature of knowledge in physical geography, the way in which this knowledge is connected with processes of inquiry and reasoning, the metaphysical assumptions and moral valuations underlying inquiry and reasoning, and important commonalities and differences among these factors between human and physical geography and between geography and other domains of knowledge (Rhoads 1999). Exploration of the scientific nature of biogeography (Spencer and Whatmore 2001) and climatology (Bryson 1997) is beginning to emerge, and pursuit of philosophical inquiry within these subfields should help to illuminate similarities and differences among various parts of physical geography.

**Interaction between Human and Physical Geographers**

Indeed, the “two cultures” are not really distinct. They merge into one another in many disciplines, such as . . . geography. —(Ziman 2000, 181)

The reality in U.S. geography at the beginning of the twenty-first century is that physical geography and human geography, for the most part, are separate and unconnected. Claims within the discipline, and perceptions without, that geography integrates inquiry in the natural and social sciences are useful propaganda, but essentially a ruse. Geography encompasses the human and the physical, but does not combine these ingredients.

Uncomfortable with the presence of a “positivist” physical science component within their discipline, human geographers often cast physical geography into the domain of geography’s human–environment interaction tradition. However, many physical geographers investigate problems that do not consider the influence of humans on natural systems. Environmental research will continue to receive strong emphasis, but the human–environment tradition is too narrow to encompass all research in physical geography. Pattison (1964) got it right when he included within geography the earth science tradition—the foundation for contemporary American geography. The research frontier in physical geography is demanding that the next generation of physical geographers be trained as physical scientists with advanced skills in the basic sciences, mathematics, statistics, and spatial analytical techniques, such as GIS and remote sensing. Without such training, physical geography will truly languish, and research by physical geographers will fail to garner recognition from other natural scientists—a primary audience for this research.

That said, any hope for achieving at least some meaningful integration of physical and human sides of the discipline almost certainly must be centered within the human–environment tradition (Rhoads 1999; Turner 2002). Here, at least in the broadest conceptual terms, is where the common ground will be, should it exist. Thus far, it has proven elusive. The two cultures of the humanities and natural science (Snow 1993), a legacy of Cartesian dualism (Urban and Rhoads 2003b), haunt contemporary geography. Many geographers have busied themselves with efforts to construct “circumferences” (Fenneman 1919) or Venn diagrams (Taaffe 1974) to define the integrative nature of geography. This top-down normative approach has failed to achieve integration of any sort. In fact, it has only moved us farther apart. An alternative is to forget about conceptualizing how an integrative geography should work and get on with the business of trying to make it work. Such a bottom-up approach eschews the need for integrative theory and adopts the perspective that integration, if it is achievable at all, will emerge only by engaging the struggle without much a priori guidance. Specialization demands rigorous training, and it is probably beyond the scope of any individual geographer, no matter how talented, to devise a grand unifying theory for our
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