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# ARTICLES

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## The Big Questions in Geography

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In noting his fondness for geography, John Noble Wilford, science correspondent for *The New York Times*, nevertheless challenged the discipline to articulate those big questions in our field, ones that would generate public interest, media attention, and the respect of policymakers. This article presents our collective judgments on those significant issues that warrant disciplinary research. We phrase these as a series of ten questions in the hopes of stimulating a dialogue and collective research agenda for the future and the next generation of geographic professionals. **Key Words:** *geographic ideas, geographic research, geographic thought.*

### Introduction

At the 2001 national meeting of the Association of American Geographers (AAG) in New York City, the opening session featured an address by John Noble Wilford, science correspondent for *The New York Times*. In very candid language, Wilford challenged the discipline to articulate the big questions in our field—questions that would capture the attention of the public, the media, and policymakers (Abler 2001). The major questions posed by Wilford's remarks include the following: Are geographers missing big questions in their research? Why is the research by geographers on big issues not being reported? And what role can the AAG play in improving geographic contributions to address big issues?

First, geographers are doing research on some major issues facing modern society, but not all of them. Geographic thinking is a primary component of the investigation of global warming, for example. Products of that research seen by decision makers and the public often take the form of maps and remote-sensing images that explain the geographic outcomes of climate change. Geographic approaches are at the heart of much of the analysis addressing natural and technological

hazards, with public interaction taking place through the mapping media. Earthquake, volcanic, coastal, and riverine hazards are all subject to spatial analysis that has become familiar to the public. The terrorist attacks of 11 September 2001 have stimulated new interest in geographic information systems that can be used in response to hazardous events and as guidance in emergency preparedness and response (Figure 1).

In addition to these recent challenges, however, there are major issues that geographers are not addressing adequately at the present time, as illustrated by the accounting that follows in this article. A primary reason for the disconnect between capability to help solve problems and the application of those skills for many major issues is the sociology of the discipline of geography. The majority of AAG members, for example, are academicians, and their agendas and reward structures are targeted at specialized research deeply buried in paradigms that are obscure to decision makers and the public. Additionally, this social structure tends to lead geographic researchers into investigations on small problems that can be solved quickly, produce professional publications, and support a drive for promotion and tenure, rather than investigating more



**Figure 1** *Manhattan, New York, before the terrorist attacks of 11 September 2001 (left), and after (right). Photos by S. L. Cutter.*

complex, bigger problems that are not easily or quickly solved and do not necessarily lead to academic publications of a type the genre usually demands.

With few exceptions, those geographers outside the university setting are scattered and work individually, in small groups, or as members of larger interdisciplinary teams for governmental agencies, businesses, or private organizations. Because there are few true "institutes" of geographic research, it is difficult to focus geographic energy on big problems. Many geographers in these settings are responding to immediate and short-term demands on their time and talents, rather than leading the larger-scale investigations.

The work in which many geographers engage to address major problems is not reported for two reasons: it does not fit the classic mold for the research journals where geographers get their greatest career awards, and work related to policy often emerges without attribution to the researchers of origin. A significant example that illustrates this point is the work of the Committee on Geography of the Board on Earth Sciences and Resources in the National Research Council (NRC). The committee oversees study committees, which produce geographic studies and reports to guide the federal government in a wide variety of issues that qualify as big questions. Recent work, contributed to primarily by geographers and accom-

plished from a geographic perspective, includes advice to the U.S. Geological Survey on reformulating its research programs to address geographic issues entangled in urban expansion, hazards, and mapping. In other cases, one study committee is producing direction for the federal government on what decision makers and the general public need to know about the world of Islam, while another is investigating transportation issues related to urban congestion and the development of livability indicators. Other geographers participate in the Water Science and Technology Board of the NRC, with recent contributions including the use of the watershed concepts in ecosystem management and the role of dams in the security of public water supplies. Another example involves a geographer-led multidisciplinary group to investigate spatial thinking, and another geographer led a major effort in global mapping. In all of these cases, geographers play a central role, but the product of their work is ascribed only to an organization (the NRC), and individuals are recognized only in lists of contributors. If the reports successfully influence policy, the decision makers who actuate that policy take credit for the process, rather than the original investigators who made the recommendations.

The AAG plays a role in stimulating the research that addresses big questions of importance to modern society by recognizing such work and publicizing it. It may be that

individual researchers will be more willing to undertake such research if their work is recognized by their colleagues in the discipline as being important and worthy of praise. The AAG can influence the National Science Foundation, the National Endowment for the Humanities, the National Institutes of Health, the National Geographic Society, and other funding sources to channel attention and resources to individuals or teams examining the big questions. Individual geographers are not likely to be able to exert much influence, except when they serve on review panels for these organizations, but the AAG can exert its influence from its steady and visible presence in Washington.

In trying to identify those issues that might qualify as big questions (Table 1), we have included wide-ranging concepts that encompass some conceptual issues (such as scale), but also point out specific topical areas that seem to demand particular attention at the moment. We argue that such diverse big ideas belong in this accounting because, in the end, they are related to each other and mutually supportive. Some of these big questions may be obscure to the public, but most of them are familiar to researchers and policymakers alike, who have already begun to address them. There is little hope that any collection of big questions can identify problems of equal “bigness,” but the ones we have identified all seem to warrant teams of researchers and significant funding rather than following the discipline’s usual mode of a single or small group of investigators with funding limited to one or two years in duration. The communication of geographic research findings to the public in thoughtful, useful ways

represents a major challenge. This challenge, by itself, can also be regarded as yet another big problem facing the discipline. With these introductory comments in mind, we now turn to those questions that we feel are important for the geographic community to address.

### **What Makes Places and Landscapes Different from One Another and Why Is This Important?**

This first question goes to the core of the discipline—the relevance of similarities and differences among people, places, and regions. What is the nature of uneven economic development and what can geography contribute to understanding this phenomenon? More specifically, how can national and global policies be implemented in a world that is increasingly fragmented politically, socially, culturally, and environmentally?

To elaborate on this question, we accept an assumption that the human mind is not constructed to handle large-scale continuous chaos. Nor does it function optimally when dealing with large-scale perfect uniformity. Between these two extremes there is variability, which is the dominant characteristic of both the natural world and the human world. To understand the nature of physical and human existence, we need to examine the occurrence and distribution of variability in various domains. For geographers, this examination has involved exploring the nature of spatial distributions, patterns, and associations, examining the effects of scale, and developing modes of representation that best communicate the outcomes of these explorations. In the course of this search for understanding of the essentials of spatial variation, geographers have attempted to comprehend the interaction between physical and human environments, how people adapt to different environments, and how knowledge about human-environment relations can be communicated through appropriate representational media.

Even in the absence of humans, the earth and the phenomena found on this planet are incredibly diverse. Variability is widespread; uniformity is geographically restricted. Determining the nature and occurrence of variability and uniformity are at the heart of the discipline of geography. No other area of inquiry has, as its

**Table 1** *Big Questions in Geography*

1. What makes places and landscapes different from one another, and why is this important?
2. Is there a deeply held human need to organize space by creating arbitrary borders, boundaries, and districts?
3. How do we delineate space?
4. Why do people, resources, and ideas move?
5. How has the earth been transformed by human action?
6. What role will virtual systems play in learning about the world?
7. How do we measure the unmeasurable?
8. What role has geographical skill played in the evolution of human civilization, and what role can it play in predicting the future?
9. How and why do sustainability and vulnerability change from place to place and over time?
10. What is the nature of spatial thinking, reasoning, and abilities?

primary goal, discovering, representing, and explaining the nature of spatial variability in natural and human environments at scales beyond the microscopic and the figural (body space) such as vista, environmental, or gigantic and beyond (Montello 1993). Most geography has been focused on vista, environmental or gigantic scales, but some (e.g., cognitive-behavioral) emphasizes figural scale. Finding patterns or trends towards regularity at some definable scale amidst this variability provides the means for generalizing, modeling, and transferring knowledge from one spatial domain to another. Law-like and theoretical statements can be made, and confidence in the relevance of decisions and policies designed to cope with existence can be determined.

Among other things, geographers have repeatedly found, at some scales, spatial regularity in distributions of occurrences that seem random or indeed chaotic at other scales. Sometimes this results from selecting an appropriate scale and format for summarizing and representing information. Examples include using very detailed environmental-scale data to discover the topologic properties of stream networks, or establishing the regular and random components of human settlement patterns in different environments.

Realizing the spatial variability in all phenomena is a part of the naïve understanding of the world. Being able to explain the nature of variability is the academic challenge that drives the discipline of geography. Like other scientists, geographers examine variability in their search for knowledge and understanding of the world we live in, particularly in the human-environment relations and interactions that are a necessity for our continued existence.

### **Is There a Deeply Held Human Need to Organize Space by Creating Arbitrary Borders, Boundaries, and Districts?**

Humans, by their very nature, are territorial. As human civilizations grew from hunter-gatherers to more sedentary occupations, physical manifestation of the demarcation of space ensued. Hadrian's Wall kept the Scots and Picts out, the Great Wall of China protected the Ming Dynasties from the Mongols, and the early walled cities of Europe protected those places

from barbarians and other acquisitive sociocultural groups.

At a more limited scale, internal spaces in cities were also divided, often based on occupation and/or class. As civilizations grew, space was organized and reorganized into districts that supported certain economic activities. City-states begat nation-states, and eventually most of the world was carved up into political spaces. Nation-states required borders and boundaries (all involving geography), as land and the oceans (and the resources contained within) were carved up into non-equal units. Within nations, land partitioning has been a factor in the decline of environmental quality. For example, the erection of barbed-wire fencing on the Great Plains to separate farming and ranching homesteads from each other did more to hasten the decline of indigenous species and landscape degradation than any other invention at the time (Worster 1979, 1993).

The modern equivalent of the human need and desire for delineating space is the notion of private property. Suburban homes with tall fences between neighbors, for example, help foster the ideal of separation from neighbors and disengagement from the community, both predicated on the need to protect "what's mine" (and of course the ubiquitous property value) as well as providing a basic need for privacy. The tendency for the rich to get richer and the poor to get poorer also applies to the values of these divided properties. The diffusion of democratically controlled, market-based economies to much of the globe increases the significance of research that explores why we divide space. Pressing research questions include, for example: Are ghettos bursting with poverty-level inhabitants an inevitable consequence of democratic capitalist societies? Are such societies amenable to concerns for social justice? And how would such concerns influence the patterns and distributions of living activities?

We also lack some of the basic understanding of how the physical delineation of space affects our perception of it. Furthermore, we need better knowledge of how perceptions of physical space alter social, physical, and environmental processes. Finally, has globalization changed our view of the social construction of space? Does physical space still support spatial relations and spatial interactions, or are they

becoming somewhat independent, as may be the case in social space, intellectual space, and cyberspace? How will the interactions between people, places, and regions change as our view of space (and time, for that matter) changes?

### How Do We Delineate Space?

Once we understand *why* we partition space, we face a closely related issue: *how* do we do it? The definition of regions by drawing boundaries is deceptively simple. The criteria by which we delineate space have far-reaching consequences, because the resulting divisions of space play a large role in determining how we perceive the world. A map of the United States showing the borders of the states, for example, evokes a very different perception of the nation than a similar scale map showing the borders of the major river basins. A further difference in perception is created if the map shows major rivers as networks rather than as basins, and the resulting difference between perception of networks and perception of regions can direct knowledge and its application in divergent ways (National Research Council 1999, x). For example, should we conduct pollution-oriented research on rivers or on watersheds, or on the state administrative units that potentially might control pollution? What are the implications of our choice of geographic framework?

The logical, rational delineation of spaces on the globe depends on the criteria to be used, but geographic research offers few established, widely accepted rules about what these criteria should be or how they might be employed. The designation of political boundaries without respect to ethnic cultures has wrought havoc in much of postcolonial Africa and central Europe, for example, but geographers have not yet offered workable alternatives that account for the complexities of multicultural populations. In natural-science research and management, a major issue is the establishment of meaningful regions that can be aggregated together to scale up, or that can be disaggregated to scale down. Natural scientists also experience significant difficulty in designing compatible regions across topical subjects. For example, the blending of watersheds, ecosystems, and ranges of particular species poses significant problems in environmental management. Adding to the complexity from a management

and policy perspective is the tangle of administrative regions, whose boundaries are often derived from political boundaries rather than natural ones. Recognition of these problems is easy but offering thoughtful geographic solutions to them is not.

Geographers have much to contribute to the delineation of space by developing new knowledge and techniques for defining subdivisions of earth space based on specific criteria, including economic efficiency, compatibility across applications, ease of aggregation and disaggregation, repeatability, and universality of application. Geographers need to develop methods for delineating space that either resist change over time or accommodate temporal changes smoothly.

A continuing example of delineating space that has important political implications is the process of defining American congressional districts once each decade based on the population census. The need for fair representation, relative uniformity in population numbers in each district, recognition of traditional communities, and accommodation of changing population distributions comprise some of the criteria that need not equate to partisan politics in constructing at least the first approximation of redrawn district boundaries (Monmonier 2001). Some states have nonpartisan commissions to delineate the districts, yet geography provides very little substantive advice on the subject to guide such groups.

### Why do People, Resources, and Ideas Move?

One of the fundamental concepts in geography is the understanding that goods, services, people, energy, materials, money, and even ideas flow through networks and across space from place to place. Although geography faces questions about all these movements, one of the most pressing questions concerns the movement of people. We have some knowledge about the behavior of people who move their residences from one place to another, and we can observe obvious economic forces leading to the migration of people toward locations of relative economic prosperity. However, we have much less understanding about the episodic movements of people in cities. In most developed countries, the congestion of vehicular traffic has become a significant negative

feature in assessing the quality of life, and in lesser-developed countries the increasing number of vehicles used in the context of inadequate road networks results in frustrating delays. Geography can and should address fundamental issues such as the environmental consequences of the decision to undertake laborious journeys to work (e.g., contributions of vehicle exhaust to air pollution, the possible environmental changes induced by telecommuting, and the need for alternative-fuel, low-pollution vehicles). In addition to understanding the environmental consequences of daily moves, the discipline has much to offer in describing, explaining, and predicting the sociocultural consequences of these decisions.

The flow of vehicles on roadways involves obvious physical networks, but there are other flows demanding attention that operate through more abstract spaces. The diffusion of culture—particularly “Western” culture, with its emphasis on materialism and individualism—is one of the leading edges of globalization of the world economy. Geographers must begin to address how these social, cultural, and economic forces operate together to diffuse, from a few limited sources, an extensive array of ideas and attitudes that are accepted by a diverse set of receiving populations. Even if such diffusion takes place through digital space, it probably does so in a distinctive geography that we should understand if we are to explain and predict the world in the twenty-first century.

The electrical energy crisis of 2001 made us aware, quite vividly, of the finiteness of nonrenewable resources such as oil and gas and of the difficulties in their distributions. We have already consumed more than 50 percent of the world’s known reserves of these resources. Historically, as one energy source has replaced another (as when coal power replaced water power), there have been changes in the locational patterns, growth, importance of settlements, and significance of regions. Examples include the decline of heavy industrial areas into “rust belts” and their replacement with service- and information-based centers that have more locational flexibility. As current energy sources change, what will happen to urban location and growth? Will the geopolitical power structure of the world change markedly? For example, will the countries that are part of the Organization of the Petroleum Exporting

Countries (OPEC) retain their global economic power and political strength? Will existing populations and settlements decline, or relocate to alternative sources of energy? What will be the geographic configuration of the economic and political power that goes with such changes?

Finally, the more physically oriented flows, such as those of energy and materials, present a demanding set of questions for geographers. While geochemists are deriving the magnitudes of elemental fluxes of such substances as carbon and nitrogen, for example, it is incumbent on geographers to point out that these fluxes do not take place in aspatial abstract ways, but rather in a physically and socially defined landscape that has important locational characteristics. In other words, although there may very well be an understanding of the amounts of nitrogen circulating from earth to oceans to atmosphere, that circulation is not everywhere equal. How does human management affect the nitrogen and other elemental cycles? What explains its geographic variability? How does that variability change in response to controls not related to human intervention? This leads to our next big question.

### **How Has the Earth Been Transformed by Human Action?**

Humans have altered the earth, its atmosphere, and its water on scales ranging from local to global (Thomas 1956; Turner et al. 1990). At the local scale, many cities and agricultural landscapes represent nearly complete artificiality in a drive to create comfortable places in which to live and work, and to maximize agricultural production for human benefit. The transformations have also had negative effects at local scales, such as altering the chemical characteristics of air and water, converting them into media that are toxic for humans as well as other species. At regional scales, human activities have resulted in wholesale changes in ecosystems, such as the deforestation of north-west Europe over the past several centuries, a process that seems to be being replicated in many tropical regions today. At a global scale, the introduction of industrial gases into the atmosphere plays a still emerging role in global climate change. Taken together, these transformations have had a geographically variable

effect that geographers must better define and explain. Dilsaver and Colten (1992, 9) succinctly outlined the basic questions almost a decade ago: How have human pursuits transformed the environment, and how have human social organizations exerted their control over environments? Graf (2001) recently asked how we can undo some of our previous efforts at environmental change and control.

In many instances, this explanation of variation might emphasize the physical aspects of changes, or understanding the underlying dynamics of why the changes occur (Dilsaver, Wyckoff, and Preston 2000). Wide-ranging assessments of river basins, for example, must rely on a plethora of controlling factors ranging from land use to water, sediment, and contaminant movements. Geographers must employ more complicated and insightful approaches, however, to truly understand why transformations vary from place to place, largely in response to the connection between the biophysical environment and the human society that occupies it. Understanding this delicate interplay between nature and society as a two-way

connection can lead us to new knowledge about social and environmental landscapes, but it can also help us make better decisions on how to achieve future landscapes that are more often transformed in nondestructive ways.

One of the primary issues facing many societies in their relationship with their supporting environments is how much of the biophysical world should be left unchanged, or at least changed to the minimal degree possible. The amount of remaining “natural” landscape in many nations is small—probably less than 5 percent of the total surface—so time is growing short to decide what areas should be set aside and preserved (Figure 2). Not only do these preservation decisions affect land and water surfaces; they also profoundly affect non-human species that use the surfaces for habitat. If human experience is enriched by diverse ecosystems, then the decline in biodiversity impoverishes humanity as well. Which areas should be preserved and why? How should preserved areas be linked with one other? How can public and private property productively coexist with nearby preserved areas?



**Figure 2** A local example of transformations brought about in the natural world by humans. The lower Sandy River of western Oregon appears to be a pristine river, but it has radically altered water, sediment, and biological systems because of upstream dams. Photo by W. L. Graf.

## What Role Will Virtual Systems Play in Learning about the World?

Stated another way, what will virtual systems allow us to do in the future that we cannot do now? What new problems can be pursued (Golledge forthcoming)? Providing an answer opens a Pandora's box of questions concerning the geographic impacts of new technologies (Goodchild 2000). What new multimodal interfaces for interpreting visualized onscreen data need to be developed in order to overcome current technological constraints of geographic data visualization? Can we produce a virtual geography? Do we really want to?

One serious problem that deserves immediate attention is the examination of the geographic implications of the development of economies and societies based on information technology. In particular, the sociospatial implications of an increasing division between the digital haves and have-nots demand attention. Pursuing such a problem will require answering questions about the geographic consequences of employment in cyberspace and its implication for human movements such as

migration, intraurban mobility, commuting, and activity-space restructuring. The current extensive demand for and use of transportation for business purposes may need to be re-examined. It may be argued that, in the world of business communication, geographic distance is a decreasingly important factor, because both digital and visual interaction can take place at the click of a mouse button without the need for person-to-person confrontation. If this is so, what are the longer-term impacts for living and lifestyles, and how could the inhabitation and use of geographic environments be affected? If this is true, why is it that we see dramatic concentrations of cyber-businesses in a few areas, similar to the locational behavior of pre-digital industries? Are Silicon Valley in California and Route 128 in Massachusetts simply the "rust belts" of the future?

Research has shown that the most effective way of learning about an environment is by directly experiencing it, so that all sensory modalities are activated during that experience (Figure 3) (Gale 1984; Lloyd and Heivly 1987; MacEachren 1992). However, many places are distant or inaccessible to most people. The



**Figure 3** Exploring immersive virtual worlds with equipment developed between 1992 and 2001, showing the original and the miniaturized versions of a GPS-driven auditory virtual environment at the University of California, Santa Barbara. The more cumbersome 1992 version is shown on the left, with the reduced 2001 version on the right. Psychologist Jack Loomis and associates developed the system, demonstrated here by author Reginald Golledge. Photos courtesy of R. Golledge.



interior of the Amazon rainforest, the arctic tundra of northern Siberia, Himalayan peaks, the interior of the Sahara desert, Antarctica and the South Pole, the barrios of Rio de Janeiro, and the Bosnian highlands can become much closer to us. Satellite imagery provides detailed digitized imagery of these places. A problem awaiting solution is how to use this extensive digital database to build virtual systems that will allow immersive experiences with such environments. Problems of motion-sickness experienced by some people in immersive systems need to be solved; assuming this will be achieved, virtual reality could become the laboratory of the future for experiencing different places and regions around the world.

Discovering how best to deal with problematic futures, on earth or on other planets, is definitely one of the big problems facing current and future geographers. Many land use planning, transportation, and social policies are made on an “if \_\_\_\_\_ then \_\_\_\_\_” basis. Because we are unable to change the world experimentally, we need to investigate other ways of observing environmental events and changes. Examples include changing a street for vehicles to a pedestrian mall to explore human movement behavior, or experiencing the action and consequences of snow or mud avalanches in tourist-dependent alpine environments. What more can we learn by building and manipulating virtual environments? In a virtual system, we can raise local pollution levels, accelerate global warming, change sea levels by melting icecaps, or simulate the impacts of strictly enforcing land conversion policies at the rural-urban fringes of large cities. In the face of an increasingly international economy and globalization of environmental issues, there is a need to develop a way to explore possible scenarios before implementing policies theoretically designed to deal with global (or more local) problems.

### **How Do We Measure the Unmeasurable?**

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Geography is normally practiced at local to national scales at which we can get a clear sense of the existence or development of patterns and processes. People, landscapes, and resources are not evenly distributed on the earth's surface, so we begin with a palette that is diverse.

How can we accommodate such diversity in policies to avoid winners and losers? Economists, for example, assume away all spatial variability in their economic models. What happens to general models when space is introduced? How can we transform from the local to the global and vice versa? The question of scale transformation, especially the calibration of large-scale global circulation models or the development of climate-impact models globally with local or regional applications is a major area in which geography can contribute and is playing a leading role (AAG GCLP Group forthcoming).

We need to develop more compatible databases that have an explicit geographic component, with geocoded data that permit us to scale up and scale down as the need arises. Data collection, archiving, and dissemination all are areas that require our expertise, be it demographic data, environmental data, or land-use data. The large question is, how do we maintain a global information system that goes beyond the petty tyrannies of nation-states (and the need to protect information for “security” reasons), yet protects individuals’ right to privacy? The selective use of remote-sensing techniques to monitor environmental conditions has been helpful in understanding the linkages between local activities and global impacts. However, can we use advanced technology to support demographic data collection and analyses and still maintain safeguards on privacy protection (Liverman et al. 1998)? For example, recent Supreme Court decisions have placed important legal protections on the use of thermal infrared sensors in public safety.

Another series of issues involves the aggregation of human behaviors. How can we geographically aggregate data along a set of common dimensions to insure its representation of reality and get around the thorny issues of averaging and the mean-areal-center or modified-areal-unit problems? We often use techniques to handle aggregated populations and areas that in fact, depart from reality, creating a type of artificial environment. Unfortunately, public policies all too often are based on these constructed realities, thus further exacerbating the distribution of goods, services, and resources. What new spatial statistical tools do we need to address this concern?

Lastly, in a post-11-September world, how

do we measure the geography of fear? Does the restriction of geographic data (presumably for national security reasons) attenuate or amplify fear of the unknown? The discipline requires the open access to information and data about the world and the people who live there. Data access will be one of the key issues for our community to address in the coming years.

### **What Role Has Geographical Skill Played in the Evolution of Human Civilization, and What Role Can It Play in Predicting the Future?**

Is there a necessary geographic base to human history? If so, how can we improve our ability to predict spatial events and events that have spatial consequences that will fundamentally shape the future? Can we develop the geographic equivalent of leading economic indicators?

From the early cradles of civilization in Africa and Asia, humankind gradually colonized the earth. This process of redistributing people in space (migration) was caused by population growth, resource exhaustion, attractive untapped resources, environmental change, environmental hazard, disease, or invasion and succession by other human groups. But what skills and abilities were required to ensure success in relocation movements? Were the movements random or consciously directed? If they were directed, then what skills and/or abilities were required by explorers, leaders, and followers to ensure success? What criteria had to be satisfied before resettlement was possible? What new geographic skills and abilities have been developed throughout human history, and which ones have deteriorated or disappeared? Have geographic skills and abilities been maintained equally in males and females? If not, what developments in the evolution of human civilizations have mediated such losses or changes?

While we know much about human history, we know little about the geographical basis of world history, and we know little of the extent to which the presence or absence of geographic knowledge played a significant part in historical development. For example, would Napoleon's invasion of Russia been more successful had skilled and knowledgeable geographers counseled him on the route chosen and the

appropriate season for movement? Historians often tell us that understanding the past is the key to knowing the present and to successfully predicting the future. We cannot fully understand the past if we ignore or diminish the importance of environmental diversity and knowledge about those variations that are the result of spatial and geographic thinking and reasoning. A similar argument can be made for predicting future events and behaviors. What geographic knowledge is likely to be important in prediction? Must we rely on assumptions about uniform environments, population characteristics, tastes and preferences, customs, beliefs, and values? Such a procedure is precarious at best. However, we do not currently know *how* to incorporate geographic variability into our models, or indeed what variables should be incorporated into predictive models. Achieving such a goal is a necessary part of increasing our very limited predictive capabilities.

### **How and Why Do Sustainability and Vulnerability Change from Place to Place and over Time?**

Historically, geography was an integrative science with a particular focus on regions. It then switched from breadth to depth, with improvements in theory, methods, and techniques. We are now returning to that earlier perspective as we look for common ground in the interactions between human systems and physical systems. Increasing population pressures, the regional depletion or total exhaustion of resources, environmental degradation, and rampant development are processes that affect the sustainability of natural systems and constructed environments. There is a movement toward the integration of many different social and natural science perspectives into a field called sustainability science (Kates et al. 2001). Understanding what constrains and enhances sustainable environments will be an important research theme in the future. How can we maintain and improve the quality of urban environments for general living (social, economic, and environmental conditions)? How long can the processes of urban and suburban growth continue without deleterious and fundamental changes in the landscape and the escalation in costs of environmental restoration?

Suburban sprawl is already a major policy issue. What is the long-term impact on human survival of the constant usurpation of agricultural land by the built environment? How long can we continue slash and burn agriculture in many parts of the tropical world? What triggers the environmental insecurity of nations, and how does this lead to armed conflicts and mass migrations of people? How have these processes varied in time and space? What are the greatest threats to the sustainability of human settlements, agriculture, energy use, for example and how can we mitigate or reduce those threats (NRC 2000)?

Nonsustainable environments enhance the effect of risks and hazards and ultimately increase both biophysical and social vulnerability, often resulting in disasters of one kind or another. When societies or ecosystems lack the ability to stop decay or decline and they do not have the adequate means to defend against such changes, there can be potentially catastrophic results. Examples include the environmental degradation of the Aral Sea, the increasing AIDS pandemic, and the human and environmental costs of coastal living (Heinz Center 2000). Vulnerability can be thought of as a continuum of processes, ranging from the initial susceptibility to harm to resilience (the ability to recover) to longer-term adaptations in response to large-scale environmental changes (Cutter, Mitchell, and Scott 2000). These processes manifest themselves at different geographic scales, ranging from the local to the global. What is the threshold when vulnerability ceases to become something we can deal with and becomes something we cannot? At what point does the built environment or ecosystem extend beyond its own ability to recover from natural or social forces?

### **What Is the Nature of Spatial Thinking, Reasoning, and Abilities?**

Geographic knowledge is the product of spatial thinking and reasoning (Golledge 2002b). These processes require the ability to comprehend scale changes; transformations of phenomena, or representations among one, two, and three spatial dimensions. They also require understanding of: the effect of distance, direction, and orientation on developing spatial knowledge; the nature of reference frames

for identifying locations, distributions and patterns; the nature of spatial hierarchies; the nature of forms by extrapolating from cross-sections; the significance of adjacency and nearest neighbor concepts; the spatial properties of density, distance, and density decay; and the configurations of patterns and shapes in various dimensions and with differing degrees of completeness. It also requires knowing the implications of spatial association and understanding other concepts not yet adequately articulated or understood. What geography currently lacks is an elaboration of the fundamental geographic concepts and skills that are necessary for the production and communication of spatial and geographic information. In the long run, this will be needed before geography can develop a well-articulated knowledge base of a type similar to other human and physical sciences.

### **Conclusion**

In the American Declaration of Independence, Thomas Jefferson wrote that among the most basic of human rights are life, liberty, and the pursuit of happiness. Each of these rights is played out upon a geographic stage, has geographic properties, and operates as a geographical process. Geography, as a field of knowledge and as a perspective on the world, has paid too little attention to these grand ideas, and they are fertile ground for the seeds of new geographic research. How and why does the opportunity for the pursuit of happiness vary from one place to another, and does the very nature of that pursuit change geographically?

In pursuit of answers to the big questions articulated above, we will inevitably need to think about doing research on problems such as:

- What are the spatial constraints on pursuing goals of life, liberty, and the pursuit of happiness?
- What are our future resource needs, and where will we find the new resources that have not, at this stage, been adequately explored?
- When does geography start and finish? Does it matter?
- What are likely to be the major problems in doing the geography of other planets?
- Will cities of the future remain bound to

the land surface, or will they move to what we now consider unlikely or exotic locations (under water or floating in space)?

The big questions posed here are not all-encompassing. They represent our collective judgments (and biases) on what issues are significant for the discipline, and those that should provide a focus for our considerable intellectual capital. Not everyone will agree with us, nor should they. We view this article as the beginning of a dialogue within the discipline as to what are the probable big questions for the next generation of geographers. ■

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