CHAPTER 1

# Introduction

## *A Scientific Approach to Geography*

### Learning Objectives:

- What is a scientific approach to geography?
- How is science both an individual and a social activity?
- What are several metaphysical beliefs characteristically held by scientists?
- What are four goals of scientific activity?
- What are the relationships of natural science, social science, and the humanities to the study of geography, currently and throughout its history?

John[1] was pursuing his Masters degree in geography. He was interested in geographical factors that contribute to causing social ills, such as violent crime, in inner cities. Having read some of the literature on this subject, John had discovered the concepts of "associative" and "dissociative" institutions. The first are thought to create community identity and social cohesion; churches might be an example. The second are thought to destroy community identity and social cohesion; crack houses might be an example. John theorized that, "social decay in the inner city is caused by a prevalence of dissociative, rather than associative, institutions." To test his theory, John looked at the city of Milwaukee (it was convenient for him). He got data from the police department on the number of suicides and homicides that had occurred in the previous 10 years in Milwaukee. He also looked in the phone book yellow pages for the Milwaukee Metropolitan Area, which

[1]Although our real experiences over the years inspired John's story, he is fictitious and does not refer to any single real person.

includes suburbs and peripheral areas as well as the urban core of Milwaukee. From the phone book, John counted the number of liquor stores, noting their addresses. He then organized his data into census tract units. Census tracts, created by the U.S. Census Bureau, include regions in cities at about the size of neighborhoods where between 3,000 and 8,000 people reside. John thus assigned each census tract two numbers, the number of "wrongful deaths" and the number of liquor stores. He calculated a Pearson correlation coefficient on these two variables, a statistical index that identifies linear patterns of relationships between two metric-level variables. He found a positive correlation of .31, which suggests that census tracts with more liquor stores in his data set were somewhat more likely to have more wrongful deaths, at least within the previous 10 years. John concluded that he had proven that dissociative institutions cause social decay in inner cities, and he recommended getting rid of liquor stores in inner-city areas.

Should we accept John's conclusions and agree with his recommendation? Probably not. There are numerous problems with the way he conceived, conducted, and interpreted his study. For instance, the yellow pages lists most businesses, but not all. Why look only at liquor stores and not bars? In Wisconsin, people often purchase alcohol in grocery stores and small markets. Shouldn't John have looked at other potentially dissociative institutions, such as adult clubs, gambling parlors, or criminal organizations? His theory is about the presence of dissociative institutions relative to associative institutions, but he didn't even look at associative institutions. What about other indicators of social ills besides murder and suicide, such as assault or rape? Are there other factors that we might expect to be related to the incidence of murder and suicide that vary considerably across census tracts in Milwaukee? Good candidates are socioeconomic status (SES), age, residential density and housing style, housing tenure (ownership status), ethnic makeup, citizenship, and immigration history. John used census tracts as the unit of analysis because of convenience, but are census tracts the proper unit of analysis for the concepts that interested him? And why Milwaukee in the first place? Are there any special characteristics of Milwaukee that make it less representative of cities, including inner cities?

Our story about John's research and its faults and limitations provides a concrete introduction to the topic of this book: **scientific research methods**. Scientific research methods (or methodologies) are the suite of techniques and procedures for empirical scientific investigation, along with the logic and conceptual foundations that tie scientific investigations together and connect them with substantive theory. The topic of research methods clearly touches on many issues important to researchers in all natural- and social-science disciplines, including geography. Research methods concern which problem domains are studied; which specific ideas within the domain are investigated; what entities are studied; what is observed or measured about the entities; how they are observed; where, when, and how many observations are collected; how the observations are analyzed (including graphing, mapping, statistical analysis, or simple tallying); what patterns are in the observations and whether the patterns can be generalized to some larger population of entities, times, or places; what explains the patterns in the observations; and even what the observations say, if anything, about solving practical problems. This is an impressive list. What's more, all of these issues are potentially relevant not only to how we carry out our own research but to how we interpret others' research. The study of research methods is thus central to deciding what conclusions we can draw about the meaning of research, the contexts in which these conclusions hold, and the degree of confidence we have in these conclusions. In other words, you cannot competently carry out or critique scientific research without considerable knowledge of methods.

## Overview of the Logic and Philosophy of Science

Let's consider what makes an activity scientific research. What is a **scientific approach**? There is no precise answer to this question. Like art or cheeseburgers (does it count when the "meat" is soy protein?), science is a somewhat vague concept that includes clear central examples but also many examples that most people would agree are more or less scientific, rather than clearly and definitely examples of science or not. That said, we can start with this simple and fairly inclusive definition: *Science is a personal and social human endeavor in which ideas and empirical evidence are logically applied to create and evaluate knowledge about reality.* Let's consider a few components of this definition. Science is a personal and social human endeavor because it is something humans do, as individuals and as social groups. Individual scientists learn from other scientists, work with colleagues and assistants, and act within various cultural and institutional contexts. **Empirical**[2] evidence is derived from systematic observation of the world via the senses, often aided by technology. The systematic nature of scientific empiricism crucially distinguishes it from the observations we all make informally every day. Because science aims for stable and publicly consensual truth, scientific empiricism strives to be repeatable, accumulable, and publicly observable. A necessary reliance on empirical evaluation is, to a large extent, the hallmark of scientific activity, as opposed to other human enterprises that strive to understand the world (more on this below). It helps differentiate science from intuition, authority, anecdote, profitability, physical or political power, the need for happy endings, and other approaches and motivations. Ideally, scientists apply ideas and evidence according to certain formal and informal logical principles in science. It is not possible to give a finite and complete list of these principles, but they certainly include such things as the following: (1) One must avoid contradictions, (2) our confidence in a phenomenon increases as our observations of it increase, and (3) past regularities will probably recur in the future.

The relationship in science between ideas and evidence deserves further comment. Scientists use ideas to design **studies**—units of focused observation or data collection—and to interpret their results. Scientists explain patterns in their empirical observations by reference to ideas about reality. But they also understand that

[2]By the term "empiricism," we are not referring to the philosophical position of Empiricism that holds that all knowledge is ultimately derived from experience after birth.

any empirical observations can potentially be explained not just by ideas about reality but also by ideas about the way they obtained or interpreted the observations. That is, scientists consider that a pattern of observations may reflect such empirical factors as biased instruments, idiosyncratic testing environments, unusual samples, and so on—not just the phenomenon under study.

Notice that our definition does not restrict science to just the physical or biological world. Science is also concerned with the world of human activity, artifact, and institution. There are **natural** (biophysical) **sciences** and **social** (human) **sciences**. This is especially important to recognize in a discipline as broad as geography, which involves both biophysical and human sciences; as we discuss below, it involves humanities, engineering, and craft as well. This text deals with scientific methodology for all of geography, including the biophysical and human domains. Therefore, we always use the generic term "science" inclusively in this text to mean both natural and social sciences.

Our definition also avoids claiming that science restricts itself to one specific approach to logic. The history of debates about the proper way to do science includes numerous claims that, for instance, "real" science applies hypothetico-deductive reasoning, in which scientists use prior hypotheses to deduce observational consequences that they can then compare to empirical evidence. Others have claimed that science is inductive in nature, relying on initial observations to generate hypotheses about reality.[3] But scientists use both **deductive** and **inductive** approaches; we find it misleading to claim that one is generally more common or appropriate than the other.[4] In fact, although our definition highlights logical thinking, it makes no claim that scientists think exclusively in a logical manner. Like artists and other nonscientists, scientists gain insights and create new ideas in any number of different ways that would not be considered strictly logical, including intuition, fantasy, and the like (we look at these further in Chapter 2 when we discuss how to generate research ideas). Clearly, scientists often come to understand a phenomenon through a process of insight, an inferential process that seems to leap from premises to conclusions with no conscious systematic reasoning plan. This form of reasoning is sometimes called **abductive**.

Finally, although our definition points out that science includes both an idea part and an empirical part, it does not claim that every individual scientist or laboratory must engage in both parts equally. Although a science such as physics has become so specialized that some physicists describe themselves as "theoretical" and others as "empirical," all physicists recognize that the full activity of physics includes both theory and empirical observation. Scientists believe that they produce empirical observations in order to evaluate and generate ideas about reality, and they

---

[3]In 17th–19th century philosophical debates, Rationalists and Empiricists championed idea-first and observation-first approaches to science, respectively.

[4]Although deduction is sometimes defined as deriving specific truth from general truth, and induction as deriving general truth from specific truth, the distinction actually refers to the certitude of inferences one makes with each type of logic—deduction definitely leads to true conclusions, whereas induction only probably leads to true conclusions.

believe that someone, eventually, needs to empirically evaluate the ultimate truth of ideas about reality. To look at it another way, ideas about reality suggest studies to conduct and ways to explain the observations that result from those studies. "Theoretical" scientists may not collect and analyze empirical observations, but they believe it is important that someone does. In other words, as we stated above, the dual components of science describe a *social* activity, not just an individual enterprise.

## Characteristic Metaphysical Beliefs of Scientists

In addition to our short definition of science, we believe it is useful to identify a set of **characteristic metaphysical beliefs** or intellectual preferences held by most scientists. As we said above, it is probably impossible for anyone to give a strict definition of the scientific enterprise that actually succeeds at including all instances of scientific activity (past, present, future) while excluding all activities that are not scientific. Delimiting the meaning of a concept like science depends on the nature of human conceptualization, not just the actual reality to which the concept refers. Furthermore, the human activity called science has evolved over the centuries (if not longer) in a somewhat haphazard way—no overarching "creator of science" defined and implemented it. Thus, over time, fairly different activities have been considered better or worse examples of scientific activity. However, we believe that we can identify characteristic beliefs that help us understand what is more scientific than not, and when someone probably is or is not carrying out science. These are metaphysical because they concern beliefs about the ultimate nature of reality (**ontology**) and how a scientist can know about it (**epistemology**). We think a majority of practicing scientists hold these beliefs but don't consider them essential to the definition of science. For example, we would not claim that a person who does not believe in the existence of a world independent of sentient minds could not be doing scientific research. We also call these beliefs "preferences" because they are just that—personal preferences or intuitions. They are unproven, and they are unlikely to be provable, to be the best possible avenues to truth; that is, they are elements of faith!

***1. Realist philosophy.*** Nearly all scientists at least implicitly accept a philosophy of *realism*. They believe the universe actually exists, independently of *sentient* (thinking, feeling) beings, as matter and energy patterned in space and time. The matter and energy coheres into meaningful pieces (entities and events) but is also organized into meaningful pieces by the sentient beings.

***2. Only continuously connected and forward causality.*** This might be thought of as an extension of the belief in realism, but we find it valuable to note it separately. Scientists tend to insist that causes and effects are continuously connected in space and time, and only in a temporally forward direction. That is, cause A can only bring about effect B if A's influence can move forward "densely" in space and time; the space and time between A and B is continuously filled with causal connections that transmit the cause to the effect. Put another way, the patterned matter and energy that is the physical instantiation of causal influence cannot get from A to B without traveling continuously between the space and time separating the two. In Chapter 2, we discuss philosophical and scientific ideas about causality in greater detail, including issues surrounding its forward and continuously connected nature.

***3. Simplicity.*** Scientists prefer the simplest explanation that is adequate. This is often called the principle of **parsimony**[5]; it is also largely captured by the notion that scientists like ideas that are "elegant." Because of their preference for simplicity, scientists prefer general-purpose truths to idiosyncratic truths. We return to this issue in Chapter 7 in our discussion of "nomothetic" (general, lawlike) versus "idiographic" (specific, idiosyncratic) approaches, but we note here that extremely idiographic approaches are essentially nonscientific, however true they may be. We must stress that parsimony still requires explanations to be adequate, in terms of fitting with observations and other ideas that are already accepted. Some people mistakenly believe that a preference for parsimony is a blind requirement to pick the simplest idea in all cases. We also note that although relative simplicity is often fairly obvious (a model with three parameters is simpler than one with five parameters), in other cases it may be a deep intellectual question as to what constitutes greater simplicity.

***4. Skepticism.*** Although scientists are searching for truth, they doubt they will find it in absolute form. Theories, for instance, are considered provisional even when widely and repeatedly supported by empirical evidence. Partially because of their skepticism, scientists dislike ideas that cannot potentially be falsified by evidence or inconsistency with other ideas.[6] Also in line with their skepticism, scientists typically entertain *chance* as a first explanation for patterns in their observations; they must first discard chance before more substantive explanations warrant attention. This logic of falsification and the entertainment of chance are fundamental to the statistical analysis of data, to which we return in Chapter 9.

***5. Quantitative thinking.*** Scientists apply observations and logical thought in order to achieve understanding. To this end, they like precision, of both ideas and observations (we define and compare precision and accuracy in Chapter 2). To increase

[5]The principle of parsimony is often referred to by the charming name "Occam's Razor." William of Ockham was a medieval English philosopher and Franciscan monk who favored minimalism in life, a view expressed in his famous dictum that "plurality should not be posited without necessity."

[6]The 20th-century philosopher Karl Popper offered extensive arguments for why we need to rely on falsifying wrong ideas and not on confirming true ones. His work is part of a larger tradition of philosophical debate about scientific epistemology. As a point of history, however, we do not believe scientists have ever or will ever stick only to falsification or disconfirmation as an epistemological strategy, nor do we believe they need to. Nonetheless, whatever logical value falsification has over confirmation, we believe their preference for skepticism leads scientists to focus more on disproving than proving.

the precision of ideas and observations, scientists often turn to mathematics and computation. When feasible, they often express theories as mathematical equations. They also attempt to carry out observations of the world very carefully, avoiding distorting effects as much as possible. One way they satisfy these preferences is to develop new technologies of observation (procedures, tools) that can extend the ability of the senses to observe the world. Such new technologies have historically extended the reach of scientific observation and hence advanced scientific ideas; they include the telescope, the computer, the chromatograph, and the methods of psychophysics (by which one can quantify people's perceptual responses). We note, however, that although the use of mathematics and technology is desirable to scientists, it is not required in order to classify something as scientific. Less-developed disciplines or those whose problem domains are more complex may still be scientific even if they rely on relatively little sophisticated mathematics and technology.

## Nonscientific Ways of Knowing

We can contrast our definition of science and list of characteristic beliefs of scientists with various nonscientific ways of knowing. At most liberal arts colleges or universities, the major nonscientific approaches to knowing are applied in the **humanities**, traditionally including history, philosophy, languages and literature, art history, and so on; below, we discuss the fact that much geographic research is carried out in the tradition of the humanities. The humanities are like science in their logical application of ideas in order to understand reality, specifically the reality of human existence, but for the most part they do not employ systematic empirical observation of reality as does science; instead, they often informally analyze texts and other symbolic artifacts of human thought, activity, and culture (unlike the systematic coding of archives discussed in Chapter 5). The humanities are thus rarely mathematical in their work.[7] Perhaps scholarship in the humanities is even more distinctive because of a difference in the type of understanding for which it strives. Scientists want general truth, as reflected in their faith in simplicity as a guiding principle, whereas scholars of the humanities want specific truth about people or societies in particular places and times. In addition, humanities scholars are often concerned with promoting ideas about human values and morality that they cannot easily justify objectively or measure quantitatively. We return to these stylistic differences in Chapter 7.

A variety of other approaches to knowing are nonscientific because they do not pursue general knowledge of reality, do not apply systematic empiricism, or strongly oppose one or more of the characteristic beliefs of scientists. Artists (in the visual arts, music, dance) arguably aim for general knowledge but are not systematically empirical in their methods, nor are they likely to endorse many of the characteristic

[7]The huge exception is mathematics itself, which in traditional form is quantitative logic rather than science. Mathematics is a common language of science but is itself primarily a branch of the philosophy of logic (some recent approaches in mathematics are empirical, however).

metaphysical beliefs of scientists. Various crafts and vocations do not have general knowledge as their aim; they are typically about doing something or producing tangible products, rather than knowing something. As with the arts, a variety of approaches to knowing that might be called *spiritual* (religion, mysticism) do not typically employ systematic empiricism, nor do they embrace the characteristic beliefs of scientists. In particular, they tend to take explicit issue with the realist philosophy and skepticism of most scientists. Finally, practitioners of the "paranormal" (astrology, tarot, extrasensory perception) often eschew systematic empirical evidence, but even when they welcome it, they tend to lack skeptical attitudes about their beliefs. However, psychic phenomena have been the subject of genuine scientific research. Evaluations of the meaning of this research are mixed, and skepticism about it is quite strong, perhaps mostly because many paranormal ideas so clearly violate principles of forward connected causality.

However, we must appreciate these claims about the nature of nonscientific ways of knowing in the context of certain limits we see to scientific understanding. First is that our description of science is an ideal that we rarely attain in practice. Scientists are human beings acting within social, institutional, and cultural contexts. They have imperfect personalities and are sometimes motivated by greed, egotism, or prejudice. Although scientists as a group endorse skepticism, individual scientists sometimes fail to apply adequate skepticism to their own ideas. But here again is where the social nature of science is critical. Social mechanisms, such as peer review of scientific reports (see Chapter 13), serve to blunt the distorting effects of individual human fallibilities on scientific research.

However, we see another limit to scientific understanding as more fundamental. That is simply that one can accept the value of a scientific approach without believing that science is the *only* valid and useful way of knowing. Being nonscientific does not mean that an approach to knowing is necessarily wrong or useless or irrelevant. Many of the most important questions of interest to humans cannot or should not be answered scientifically, although in some cases scientific results may inform them. What is the meaning of human existence? Why is it wrong to hurt people? What is beauty? Is there a God? What is the best form of government? Why should I get out of bed in the morning? Do I want chocolate or vanilla? We believe that some overzealous promoters of a scientific approach might occasionally fail to stress this adequately. We also believe that some critics of scientific approaches, especially when applied to the study of humans, fail to appreciate that reasonable promoters of a scientific approach recognize that it has limits. We think of science as an interesting and useful way to grasp some truth about reality, including human reality, and we recognize that we pursue it in part because we personally enjoy scientific thinking. We do not, however, consider it the royal road to all truth and enlightenment.

## Goals of Science

According to our definition, the purpose of science is "to create and evaluate knowledge about reality." We can elaborate on this purpose in terms of four goals toward which different sciences and scientists strive, to various degrees. The goals are intellectually progressive, in that goals lower on the list presuppose some mastery of those above them. The goals have also largely been historically progressive, in that scientific disciplines have tended to focus more on goals farther down the list as their ideas and empirical techniques developed over time; more mature sciences thus tend to focus more on "lower" goals. The four goals, ordered progressively, are

***1. Description.*** Whatever their domain of interest, scientists must distinguish and describe the basic phenomena (entities and events) within that domain. This is essentially the intellectual act of classification (categorization) common to all sentient creatures, but scientists often carry it out especially systematically.

***2. Prediction.*** Given that they know something of the content of their domain, scientists want to be able to predict phenomena about which they cannot learn simply by direct observation. These predictions are often about the future, but can also concern facts about phenomena from the present or the past that are as yet unknown. The most powerful tools for prediction available to scientists are inferences (both extrapolations and interpolations) from patterns of observations; these inferences take advantage of mathematical precision while exploiting the logical principle that observed regularities will probably hold in other situations not yet observed. We discuss the logic of prediction further in Chapter 9.

***3. Explanation.*** Once scientists can describe and then predict, they want to explain *why* some described and predicted pattern exists. This requires the explication of causal relations among entities and events. As we mentioned above, we discuss the logic and philosophy of causality more in Chapter 2; in Chapter 9, we consider the relation of causality to prediction in the context of data analysis; in Chapters 7 and 11, we discuss how research designs and techniques strengthen or weaken conclusions about causality in empirical studies.

***4. Control.*** Finally, being able to describe, predict, and explain phenomena within their domain of interest, scientists (and those who fund scientists) typically want to apply this knowledge in order to control the phenomena—to bring about desired changes in the phenomena. Now that I understand erosion, can I prevent it? Now that I understand the development of a globalized economy, can I make sure it happens in a way that preserves economic fairness and environmental health?

A distinction is often made between **basic** and **applied** scientific research. Basic research focuses on understanding reality for its own sake; it is primarily an expression of human curiosity and the desire for intellectual mastery. In terms of the goals of science, basic research is very concerned with description, prediction, and explanation, but less with control. In contrast, applied research focuses on control, in addition to the first three goals, for the purpose of making some object or procedure that will help meet specific practical needs or solve specific problems. Although engineering is often contrasted with science, because it is concerned more with making something work (or work better) than with understanding how something works, we can see that engineering might accurately be considered applied science. Similarly, much medical and educational research is applied science. Both basic and applied foci are prevalent in geographic research. Like the definition of science itself, however, the distinction between basic and applied science is somewhat vague and should not be overstressed. Many scientists work in both arenas to various degrees. Optimally, there is interplay between basic and applied science in which the results and needs of each inform and motivate the other.

Before leaving our discussion of the goals of science, we need to mention a few caveats. The first is that scientists sometimes violate the progressive quality of the goals. Although later goals presuppose earlier goals, this need only be partially true. For instance, explanation requires prediction, but not anything like perfect prediction—it only has to be at least better than chance prediction. Or to take another instance, a certain amount of practical control can be exerted over phenomena without having a complete explanation for them; applied sciences like engineering often focus on successful control to the point of happily applying trial-and-error approaches that can lead to control without understanding. Our second caveat about the goals is that scientists may be able to predict phenomena at some scale of analysis but not at others that are smaller or larger, despite feeling like they have a fairly complete explanation of the phenomena. This is especially relevant to geography, concerned as it is with phenomena that exist and interact at a wide range of scales (we discuss the concept of scale in Chapter 2 and the problems of analysis related to scale in Chapter 9). Finally, an understanding of the ultimate limits of prediction was one of the great intellectual achievements of the 20th century, when we recognized that very small events have the power to radically alter the future (the "butterfly wing effect"). Thus, prediction in complex systems has ultimate limits because of the possibility the system will enter into "chaotic" states that we cannot predict, even with complete prior knowledge. Our ability to predict weather will apparently always be limited in this way, for example. A related intellectual achievement of the 20th century concerns ideas developed by quantum physicists about limits to the traditional notion of causality (more in Chapter 2).

## History and Philosophical Systems of the Discipline of Geography: Natural Science, Social Science, and Humanities

We finish this chapter with a short overview of the history and philosophical systems of the discipline of geography, and their relation to scientific and other approaches to knowing. Traditionally one might define **geography** as *the study of the earth as the home of humanity* (the word's literal meaning is "earth writing"). A more modern and impressive-sounding definition is that geography is *the study of the distribution of human and natural structures and processes over the earth's surface, and the role of space and place in understanding these human and natural structures and processes.* Like other disciplines, the domain, methods, and philosophical foundations of geography have changed over the centuries. In fact, geography has arguably gone through even more intellectual changes than other traditional disciplines, especially during the 20th century. The result of all this is that geography is an extremely broad and heterogeneous discipline. Many books discuss these changes (see the bibliography at the end of the chapter), and we touch upon them only briefly here. We heartily recommend reading these books and taking a course on the history and philosophical systems of geography.

Geographical thought perhaps began when humans first recognized that different places have different characteristics ("areal differentiation"): The land surface varies, plants vary, people look and sound different, and so on. Surely this occurred long before writing first appeared. A more formal study of geography probably began in the ancient worlds of Africa, the Middle East, and the Far East, as part of astronomy and land surveying. From these early days, military activity was also a major impetus for the development of geographic knowledge of all kinds, including the measurement of the earth (**geodesy**), and the description of its human and natural variation; the military motivation for geography continues to this day. Trade was another early motivation for accumulating geographic knowledge. And the logs and diaries kept by travelers and explorers over the centuries provided a rich source of descriptions (occasionally accurate) of faraway places. These early intellectual endeavors provided the seeds for the diverse approaches of modern geography. Thus, geographers from the beginning applied a mixture of linguistic, graphic (including cartographic), and mathematical approaches as part of their intellectual activity. Although the relative mixture of the three has shifted over the history of the discipline, geographers still apply all three today.

By the time geography emerged as a separate academic discipline in the 19th century, it had developed a venerable tradition of characterizing places and regions in terms of the totality of their natural (geomorphological, climatological, botanical, and so on) and human (cultural, economic, political, and so on) characteristics. This approach is called **regional geography**. Regional geography is still a part of the discipline of geography, of course, and it is perhaps what most lay people think primarily constitutes the subject matter of geography; it is sometimes called the "*National Geographic* approach." However, during the 19th century, as academic specialization flowered, a different approach began within geography. This approach focused on particular topical areas or "systems" within the domain of geography, trying to describe and, even more, explain the workings of these systems wherever they found expression on the earth. A practitioner of **systematic geography** might therefore study river systems or urban structure anywhere they occur.

Many scholars who championed the systematic approach during the early 20th century thought it made geography look more like other sciences, which were continuing to develop depth, perhaps at the expense of breadth. A penchant for applying mathematics and the application of a strict interpretation of positivist philosophy also characterized this quest for scientific respectability. It also contributed to the division in geography between those who specialized in the natural aspects of the earth and those who specialized in the human aspects. This all culminated in the so-called quantitative revolution of the mid-20th century. Particular scholars and departments championed statistics, geometry, calculus, computers, airplane and satellite remote sensing, and then (a little later) geographic information systems (GIS) as the "right" way to do geography.

Almost as soon as the quantitative revolution occurred, however, a counter-revolutionary response criticized the supposed limits of quantitative approaches. To shorten a complicated story, these criticisms charged especially that **positivist** geographers oversimplified human experience and activity to the point of caricature. Instead of the clean and precise abstractions of scientific modeling and analysis, these critics called for approaches that recognized a messier, more subjective, and self-willed geographic reality. Furthermore, according to these critics, geographic reality was often the expression of unequal power relations among various stakeholders. These **post-positivist** critiques came in a large variety of flavors during the later 20th century, including phenomenology, Marxism, feminism, social theory, deconstructionism, and postmodernism. There are important differences among these positions, of course; the bibliography at the end of the chapter provides some relevant readings.

The situation today is that of a pluralistic geography. Both regional and systematic approaches are evident. Geographers apply linguistic, cartographic, and mathematical methods in a bewildering array of combinations. This is especially true within human geography, where the perspectives of a plethora of disciplines, both social science and humanities, inform the study of human experience, activity, society, and culture. Across the breadth of geography, scholars study an enormous assortment of specific topics. Human geographers investigate transportation, migration, population, cultural distribution and diffusion, communication, economic activity (production, consumption, buying and selling), regional development, recreation and tourism, place perception and identification, spatial and environmental thought, urban structure and change, and resources and hazards. Physical geographers investigate landform formation and change, soils and minerals, lakes and rivers, groundwater, climate and atmosphere, plant and animal distribution, glaciers and ice fields, and ocean and coastal processes. Yet other geographers specialize in the refinement and development of new geographic information methods and techniques that cut across the human/physical distinction, including GIS, database design, cartography and visualization, remote sensing, spatial theory and analysis, and geostatistics.

Given its very broad subject matter and pluralistic nature, geography in the early 21st century is remarkably **multidisciplinary** and **interdisciplinary**.[8] Physical geography overlaps with most of the physical and life sciences, especially the earth and environmental sciences of geology, biology, ecology, oceanography, hydrology, climatology, and atmospheric science. Human geography overlaps with most of the social and behavioral sciences, especially sociology, economics, anthropology, psychology, and political science. Alternatively, a great deal of human geography overlaps with the humanities, especially history, literature, philosophy, art, and cultural studies. Various technical specialties within geography overlap with engineering of several kinds, as

[8]The distinction being the degree to which a collection of multiple disciplines, each with its own concepts, vocabulary, and methods, is integrated into a single hybrid "interdiscipline."

well as mathematics and computer science. Last but not least, some areas of geography focus on the expression of "geographic craft." It is still, however, the case today that for many of us, the real promise of the field is the integration of the natural, human, and technical aspects of "the study of the earth as the home of humanity."

## Review Questions

- To what does the phrase "scientific research methods" refer, and why is attention to methods important for conducting and interpreting research?

### Overview of the Logic and Philosophy of Science

- What are some characteristics of a scientific approach to geography? What is scientific empirical observation, and how does it differ from everyday, informal empirical observation?
- What are the following "characteristic metaphysical beliefs" held by scientists: realism, continuously connected and forward causality, simplicity, skepticism, quantitative thinking?
- What are some common types of nonscientific ways of knowing, and how are they nonscientific?
- What are some important limitations of a scientific approach to knowing?

### Goals of Science

- What are the four scientific goals of description, prediction, explanation, and control, and how do they relate to each other?
- What are basic and applied science, and how is this distinction relevant to geographic research?

### History and Philosophical Systems of the Discipline of Geography

- What is the focus of geography as a scholarly discipline, and how has this changed historically? What are the regional and systematic approaches to the discipline of geography?
- What are major developments in ideas and approaches of the discipline of geography during the 20th century?

## Key Terms

**abduction:** a type of implicitly logical reasoning that can lead to true conclusions without systematic reasoning from explicit premises

**applied science:** a style of scientific research that focuses on understanding reality in order to control it

**basic science:** a style of scientific research that focuses on understanding reality for the sake of understanding

**characteristic metaphysical beliefs of scientists:** beliefs or intellectual preferences commonly held by scientists about the ultimate nature of reality and how it can be understood; they help to understand the concept of scientific activity

**control:** the most mature of the four goals of science; being able to bring about desired changes in the phenomena within a scientific domain for practical purposes

**deduction:** a type of explicitly logical reasoning in which premises definitely lead to true conclusions

**description:** the least mature of the four goals of science; distinguishing and characterizing the phenomena within a scientific domain, typically by classifying

**empirical:** evidence derived from systematic observation of the world via the senses, often aided by technology

**epistemology:** the philosophical study of how people, including scientists, can acquire knowledge about reality; together with ontology, it makes up the study of metaphysics

**explanation:** the third most mature of the four goals of science, before control; explicating causal relations in order to answer the question of why some phenomenon is the way it is

**geodesy:** the theory and technology of measuring the size and shape of the earth and the distribution of features on its surface

**geography:** the study of the earth as the home of humanity; it literally means "earth writing"

**goals of science:** four specific ways that scientists strive to attain their ultimate goal of understanding reality, including description, prediction, explanation, and control; the goals are intellectually progressive from least to most mature

**humanities:** nonscientific disciplines that study the human world of individual and social activity, artifact, and institution; they include such disciplines as history, philosophy, languages and literature, art history, and much of human geography

**induction:** a type of explicitly logical reasoning in which premises probably lead to true conclusions

**interdisciplinary:** an approach to scholarship that combines two or more traditional disciplines by integrating their concepts, vocabularies, or methods into a new hybrid discipline

**multidisciplinary:** an approach to scholarship that combines two or more traditional disciplines without integrating their concepts, vocabularies, or methods

**natural sciences:** scientific disciplines that study the natural, or biophysical, world; they include such disciplines as atmospheric science, biology, chemistry, geology, oceanography, physics, and physical geography

**ontology:** the philosophical study of the ultimate nature of reality; together with epistemology, it makes up the study of metaphysics

**parsimony:** a belief widely held by scientists that the simplest adequate explanations are the best

**positivism:** a philosophical crystallization in the late 19th and 20th centuries of much of traditional scientific belief, explicitly advocating the rationality of such things as mind-independent reality, publicly observable truths that are objectively measurable, and so on

**post-positivism:** various diverse philosophies developed in the mid and late 20th century that criticize aspects of positivist philosophy as a model of how science is done and should be done

**prediction:** the second least mature of the four goals of science, after description; guessing unknown phenomena within a scientific domain at better than chance level

**realism:** a belief widely held by scientists that the universe actually exists, independently of sentient beings

**regional geography:** a traditional approach to geographic inquiry in which places and regions are studied in terms of the totality of their natural and human characteristics; in contrast to systematic geography

**scientific approach:** a personal and social human endeavor in which ideas and empirical evidence are logically applied to create and evaluate knowledge about reality

**scientific research methods:** the suite of techniques and procedures for empirical scientific investigation, along with the logic and conceptual foundations that tie scientific investigations together and connect them with substantive theory

**sentient:** entities that think and feel, including at least humans and many other animals; sentience has implications in scientific research for how we collect, interpret, and communicate data, and for various ethical considerations

**social sciences:** scientific disciplines that study the human world of individual and social activity, artifact, and institution; they include such disciplines as anthropology, communications, economics, political science, psychology, sociology, and much of human geography

**studies:** units of focused observation or data collection

**systematic geography:** an approach to geographic inquiry that emerged in the 19th century in which geographers study particular topical areas or "systems" within geography wherever they operate on the earth; in contrast to regional geography

## Bibliography

Abler, R. F., Marcus, M. G., & Olson, J. M. (1992). *Geography's inner worlds: Pervasive themes in contemporary American geography.* New Brunswick, NJ: Rutgers University Press.

Craig, E. (Ed.) (1998). *Routledge encyclopedia of philosophy.* London: Routledge.

Geography Education Standards Project (1994). *Geography for life: National geography standards 1994.* Washington, DC: National Geographic Research & Exploration.

Laudan, L. (1977). *Progress and its problems: Toward a theory of scientific growth.* Berkeley: University of California Press.

Martin, G. J., & James, P. E. (1993). *All possible worlds: A history of geographical ideas* (3rd ed.). New York: Wiley.

National Research Council (1997). *Rediscovering geography: New relevance for science and society.* Washington, DC: National Academy Press.