Chapter 1

Why think spatially?

In this chapter, you will learn a new approach to thinking spatially about research questions and methods. You will explore the following questions: Why think spatially? What does thinking spatially really mean? Why should I incorporate spatial analysis into my research methods? You will learn about geographic information systems (GIS) and how they are used as a component of research. You will also explore the added value that spatially based research methods bring to enhance scientific investigation and how GIS research methods fit into an overall research framework to provide a more complete picture of the topic under study. This chapter serves as a foundation for later sections of the text.

Learning objectives

- Learn about spatial thinking
- Learn how GIS is useful to various forms of research
- Learn the definitions and relationship between space and place
- Learn about sociospatial, informal, and formal spatial analysis
- Learn the value of a multiple methods approach
- Learn the historic context for spatial thinking

Key concepts

formal spatial analysis
home range
informal spatial analysis
multiple methods
place
policy
sociospatial
space
spatial advantage
spatial analysis
spatial thinking

Using spatial knowledge

A headline on a local news website reads, “Westside Mugger Caught!” Given that you work on the Westside, you feel a great sense of relief as you begin to read the article. The past few weeks have seen a rash of muggings; every couple of days, another victim was attacked, and it seemed as though the assailant was a step ahead of the police. You have always wondered how the police catch up with criminals, and as you read the story, you come across a sentence that piques your interest: “We never would have caught the person behind these attacks without our new CompStat system,” stated the chief of police. The article goes on to explain that CompStat is a computer-based analysis system built around crime statistics mapped in GIS.

Interesting. You begin to wonder exactly what the journalist means by mapping crime statistics. How would that help catch a criminal? You have always found maps to be interesting, and they certainly help you find your way when traveling. You have even heard about those maps to movie stars’ homes you can buy in Hollywood, but you don’t recall ever seeing a map to criminals’ homes (figure 1.1).

It turns out that the GIS behind CompStat wasn’t exactly used to find the home of the criminal, but almost. The police took advantage of a variety of basic information, or data, about the area in which the crimes were occurring (figure 1.2), along with information about the locations of each of the muggings as they were reported. As the locations of the crimes were mapped, some interesting patterns began to develop.

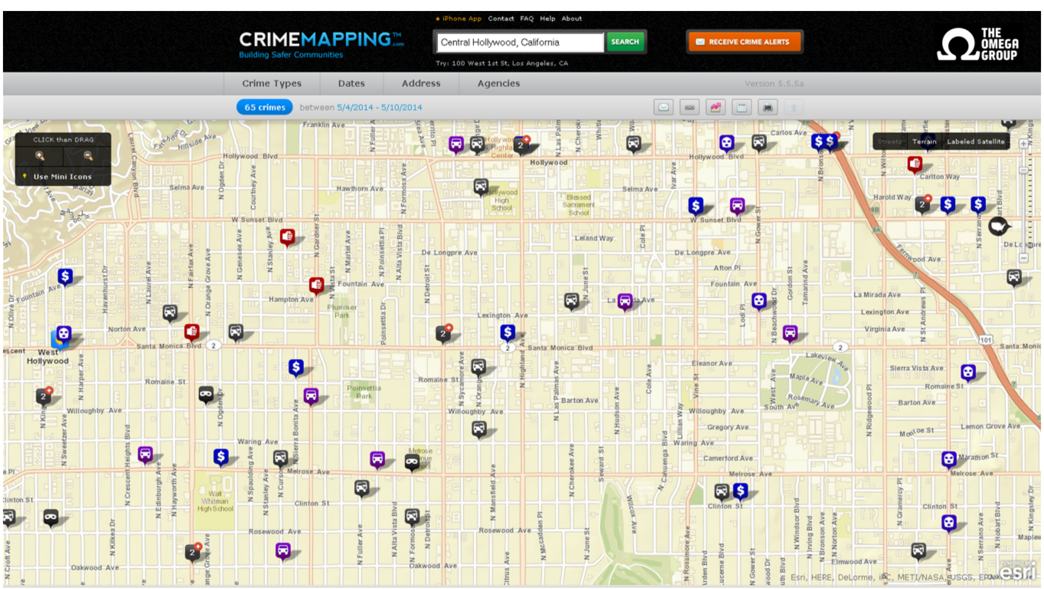


Figure 1.1 **An example of a publicly available crime map from the Hollywood area of Los Angeles, California. This web-mapping site integrates crime data from police departments around the country and is powered by the Esri ArcGIS for Server.** Courtesy of the Omega Group, San Diego, CA. Basemap data from Esri, HERE, DeLorme, IPC, METI/NASA, USGS, EPA.

Figure 1.2 **The dashboard view provides detailed, specific crime information to police chiefs and precinct commanders.** Courtesy of the Omega Group, San Diego, CA.

For example, all of the muggings occurred within two blocks of an ATM machine. That seems sensible to you; the mugger might well have been targeting people who were getting cash. The attacks were always late in the evening, after ten o'clock, and the victims were always confronted on streets that had little traffic. What streets don't have lots of traffic at that time of night? Perhaps residential areas, where folks are in bed? Maybe. But wouldn't someone hear the commotion? A more likely area is around the financial district, where everything closes at five in the evening and there's not a lot going on at night.

You start to realize that by looking at some basic map information, you might be able to narrow down areas that meet a particular profile that seems to be developing. But as you think about it, you wonder, "Aren't there lots of areas on the Westside where there's little activity in business districts at that time of night? And ATMs? It seems there's one on almost every corner. What else could have helped the police get the bad guy?" It turns out that the crimes were clustered in a ten-block area. Perhaps the mugger lives near that area, or, better still, he probably lives near the middle of that area, so he didn't have to walk too far to find his victims.

Of course, the police knew other things that helped them narrow down the suspect. They knew who in that area had a record for mugging, robbery, burglary, or other similar crimes. They knew if any recent parolees lived nearby. They may have had other clues that matched the modi operandi of known offenders. Odds are this wasn't someone who woke up one day and decided to become a mugger—someone like this probably has a history.

As you ponder all this, you begin to understand how a system like CompStat would be so helpful. Of course, if you could somehow put all of these data together on a map, defining areas that meet the given criteria, you might be able to narrow the search area down to something manageable. Sure, you might not come up with the criminal's home address, but you would certainly know where to put extra police on the beat to catch him. But one thing still bothers you: the complexity of getting all of this information onto a map and doing the analysis to get to this point. Wouldn't that be a major task? It was hard enough for you to draw a readable map for your friends to find their way to your new apartment for your last Super Bowl party! It's much easier to direct your friends to one of the many online mapping tools to find your house.

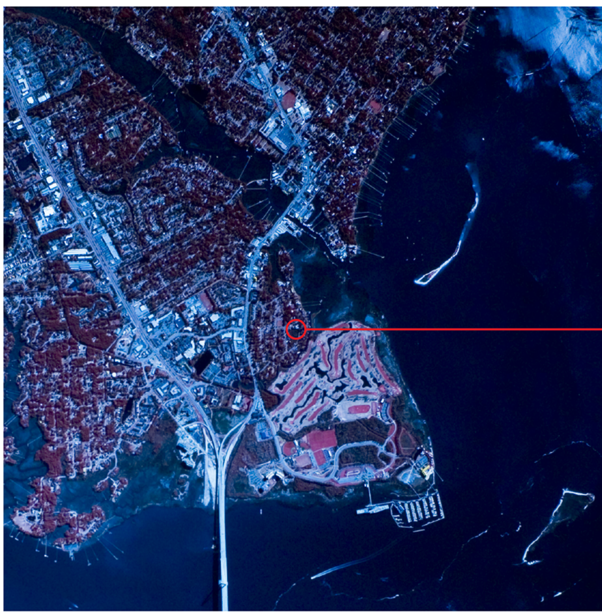
It must be that computer thing the police chief mentioned in the article, that geographic information system, that performs such a complex task. It all sounds very complicated. But you are intrigued and want to find out more about these geographic information systems. Maybe they could be useful in other ways. After all, if you can use them to narrow down locations of criminals, what other kinds of analysis might they be useful for?

What is GIS?

Although you may already have some familiarity with what GIS is, it is useful to start with a definition. A **geographic information system (GIS)** is a specialized computer database program designed for the collection, storage, manipulation, retrieval, and analysis of spatial data. GIS provides far more than the ability to create maps; although maps are a common output of GIS, they are not the only outcome of analysis, and sometimes not even an essential end product. If this surprises you, consider that GIS technology was originally developed in the 1960s, when computer graphics were virtually nonexistent and output was more often printed on hard copy than displayed on monitors. GIS serves as a powerful data collection, organization, exploration, and analysis tool that can assist the researcher in multiple ways. Perhaps its greatest value lies in its ability to help us understand, draw parallels, and see connections between factors and/or variables with an eye for spatial relationships: understanding any situation, problem, or issue necessitates gaining information, and the best way to gain information is through a variety of channels, not by relying on a single source of information that could be error filled. The next section explores what is meant by the term *GIS*, which facilitates spatial thinking.

In its simplest form, **GIS** is designed to store, manipulate, analyze, and output map-based, or **spatial**, information. In practice, the functions of GIS can be carried out by hand, using only paper, pencil, and a ruler (as a surprising number of people still do). Of course, this is not practical or efficient for many research applications.

When we refer to spatial information or data, we mean that the information is linked to a specific location, such as a street address. Figure 1.3 provides an example of a real-life view of the world, as represented in an aerial photograph. This photograph is tied to associated data about the world similar to what you might collect or analyze in a study. These tabular data are related to the world via their location.



Data Sheet

Survey Number: **294**

Street Address: **325 Burnaby Court**

City, State: **Charleston, SC**

Age of respondent: **37**

Gender of respondent: **Male**

Highest level of education: **B.A.**

Number of adults living in household: **2**

Profession of respondent: **Bank Teller**

Annual Household Income: **$86,000**

Number of children under 18: **3**

Figure 1.3 **On the left is an example of a US Geological Survey (USGS) aerial photograph of a suburban location. This shows the world in much the same manner as if you were looking out the window of an airplane. When collecting data in this area, you could record the area's street address, census block, or neighborhood. These are examples of spatial information. On the right are tabular data associated with one surveyed household, as recorded on a survey form. Used together, spatial and tabular information would be useful in doing GIS-based analysis.** Figure by Steven Steinberg, color infrared imagery, USGS National Aerial Photography Program (NAPP), Charleston, SC, acquired February 6, 2007.

Although no single definition of GIS exists, GIS professionals do agree on some general principles. First, GIS requires a combination of computer hardware and software tools. Second, GIS requires **data**, and these data must possess a spatial or location component. Third, GIS requires knowledgeable individuals to develop the **database** and carry out the data processing. Although GIS software has become much easier to use since the introduction of **graphical user interfaces**, GIS programs, and much of the underlying geographic theory, require people to have a basic understanding of maps and map analysis. Anyone with a little basic computer knowledge, which we discuss in this book, can accomplish most GIS tasks. However, for more complex data and analysis, it is often helpful to work with a GIS analyst with in-depth knowledge of GIS and data.

Last, and perhaps most important, GIS is a system for analysis; that is, GIS is useful for examining, displaying, and outputting information gleaned from the data that are stored and maintained in the system. This book explains the necessary mapping concepts and **spatial analysis** you need to do GIS-based research.

Understanding geographic information systems

To best understand a GIS, you need to understand GIS terminology and how GIS apply to various analysis situations. In particular, how can your area of interest and the associated data be placed into a GIS context? How can GIS technology enhance your analysis and understanding of data? You can use GIS to study issues with real data as well as conceptual data. The concept of space exists in different dimensions: the actual and the perceived. *Space* is defined as distance and time between locations and is often used to determine position. For example, an interview script asking individuals about their homes, communities, relationships, or other interactions inevitably will include phrases such as "in our neighborhood," "around the corner," or "over in the next valley." While investigating social relationships, you might come across examples of conceptual geography. For example, the strengths of social ties between individuals might be represented in statements such as "I'm very close to my younger brother" or, conversely, "We found ourselves drifting further apart with each passing year." These statements, although not tied to physical locations, nonetheless may be mapped and analyzed using many of the same techniques that one might apply in traditional GIS analysis.

A new approach to research methods

The value of spatial relationships, patterns, and connections represented with maps has a long history in many disciplines across the natural and social sciences. However, it is only more recently that we can take this information and put it all into a computer analysis environment using GIS, which can account for and analyze space in meaningful ways.

Everyone thinks spatially on a daily basis. At the beginning of the day, when we navigate our way to work, school, or the grocery store, we think about our destination and how best to reach it. This spatial thinking occurs in our minds, based on our knowledge of the surrounding environment (figures 1.4 and 1.5). We may choose a route to a particular destination based on what is most familiar or what we have found to be the most effective path in the past.

Figure 1.4 **A map of essential landmarks from the perspective of our son at age seven. This map features locations he found important at the time, including our home, his school, parks, and other significant locations. Geography is not accurately represented for either distance or direction from home. However, features closer to home (to which he has personal experience walking or riding his bike) are more accurately represented than those that must be reached as a passenger in a car.** Map courtesy of Joshua Steinberg, 2011.

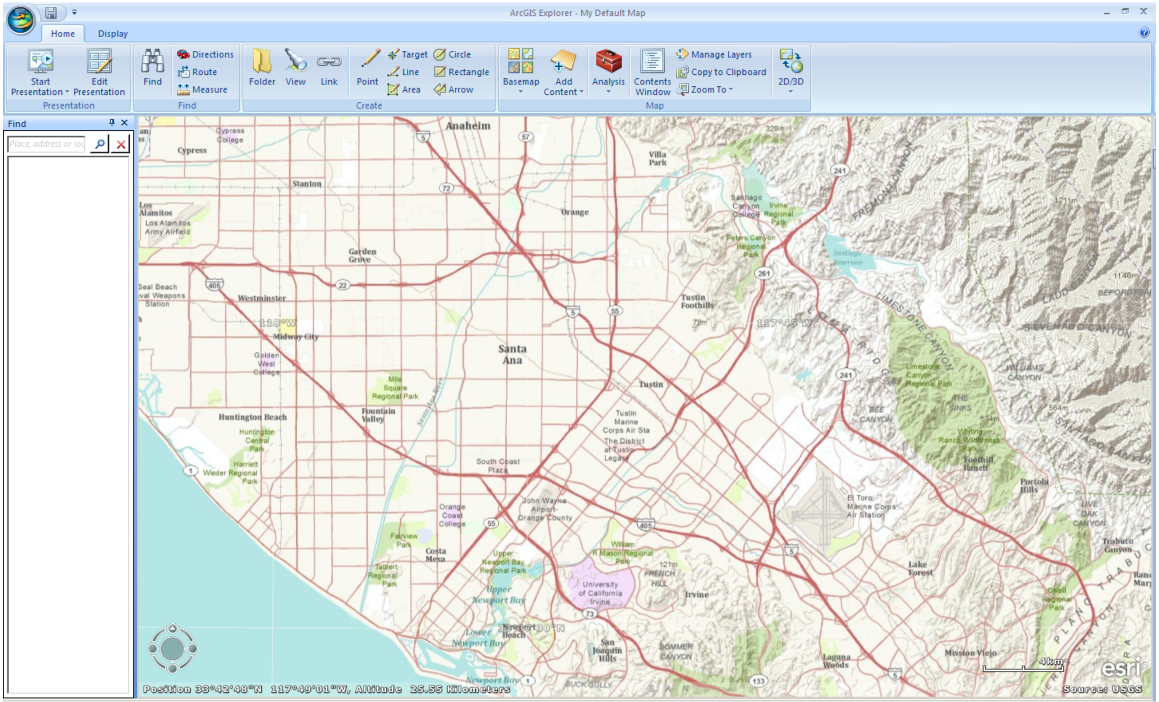


Figure 1.5 **A view of the same region represented in figure 1.4 as a map built with ArcGIS software with USGS basemap data. The landmarks highlighted in our son's map actually stretch across a region in excess of 300 square kilometers.** Map courtesy of Steven Steinberg. Data from USGS.

When you are in a new place or city and do not know where you are, how do you find your way to where you want to go? You could rely on digital technologies, such as Global Positioning System (GPS) (figure 1.6) or web-based mapping tools, to assist you in finding your way to a specific location. You could get there by following a paper map (figure 1.7), although not many people do that anymore. You could find your way by asking local people for directions. Asking for directions will most likely produce a variety of answers, depending on whom you ask and that person's own experience with travel and mobility in the city.