



# CHAPTER 1

## Conceptualizing spatial resilience

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### INTRODUCTION

How do populations react when they encounter unexpected changing environmental conditions? People around the globe frequently experience unexpected situations. Consider the coronavirus disease 2019 (COVID-19) pandemic that emerged in late 2019 and rapidly affected the entire world, while at the local level differentially impacting communities and limiting mobility across various environments. Spatial resilience is built around the keen ability for people to adapt to changes in a positive manner. For example, when a community experiences an extreme winter, heat wave, or unprecedented wildfires or storm surge, it may quickly raise an alarm. When physical environments are constantly changing, communities face a variety of challenges and stress. However, recognizing and responding to such changes and taking action to positively respond can result in spatial resilience.

The earth is a dynamic planet where physical environmental norms are in flux daily. As the physical environment around us begins to change, the social and environmental experiences of individuals fluctuate, resulting in changing places and spaces. One day you may be living in a community by the coast, and the next day your home is washed away by a tsunami. Powerful storms occur at times of year when they are not typically anticipated, which can have disastrous results for people and place. Erosion occurs, lives are lost, and settlement patterns experience disruption.

Large regions of the globe are experiencing major drought and fires, while others are overwhelmed by excessive precipitation, landslides, or coastal flooding.

Almost daily, extreme weather happens, with many record-setting statistics. Regardless of the underlying cause, alternations in weather, climate, and physical environment represent a change from what has been considered normal to create a new reality. When environmental change occurs, social change naturally follows. Such environmental and social changes demand a sociospatial response. For instance, if you live in an area that experiences storm surge now more than in the past and your home floods (or, for example, if you live in the city of Venice, Italy), you may need to move to higher ground. Or in the case of Venice, perhaps the city needs to be raised or flood control mechanisms need to be installed. Spatial resilience is a skill that populations who live in such areas must develop as part of their survival and adaptation to changing environmental conditions.

## ENVIRONMENTAL CHANGES

Environmental changes are visible across a variety of geographies: mountains, deserts, coastal areas, and urban and rural environments. Shifting weather patterns create major changes in the environment, presenting numerous challenges. For communities that experience these environmental changes, there is often no clear prescription or plan for how to react. This book provides a foundation for individuals, communities, governments, and agencies to explore such changes by harnessing spatial data and analysis approaches as they plan for long-term resilience of their communities and environments.

Human communities organize themselves around an established sense of our destiny and our future. When unexpected changes interrupt our plans, it is not a welcome change— why? Because addressing these major environmental and social interruptions requires change on our part— often change for which we do not have the resources to enact. This is especially true when these unexpected changes require major alterations to the way some people lead their everyday lives. But the reality is that environmental change is happening more frequently and extremely today than ever before, and it is wreaking havoc on many geographies. The question is, how are communities going to cope with this across different geographies?

We chose to write this book focused on the application of geographic information system (GIS) technology for spatial resiliency analysis and planning because we recognize that traditional physical environments (ocean, coastal, mountain, desert, urban, and rural) are experiencing previously unknown and unprecedented environmental changes. The socioenvironmental changes are coming quickly, unexpectedly,

and with great intensity. Events over the past several years have spurred us to think in an interdisciplinary fashion (as a team of physical and social scientists) about these changes and to consider what might be done to be better prepared and, ultimately, more resilient.

Additionally, the changing nature of ethnicity in certain environments needs to be considered. So often the names associated with place are determined by communities of a historic origin. When the people who populate a certain area change, the place-names may stay or may also be altered. Perhaps no group is more original for a particular location than its Indigenous peoples. Throughout our book, we focus on Indigenous populations and their interaction with place and space. GIS is examined and used as an important tool for helping Indigenous communities maintain resilience in the face of changing physical and structural environments. We focus on how GIS can maximize Indigenous groups' connection to and use of the resources in their environments.

In addition to Indigenous groups, we focus on the important role that ethnicity plays in mediating other cultural groups, such as Latino interaction with surrounding natural environments and communities. The intricate layers of interaction and community can vary across places, often depends on the cultural norms and practices of the people who live there. Some might say that the surrounding physical environment impacts local social interaction in a particular place. We would say that interaction can indeed be impacted by physical environmental structures but is mediated by the cultural background of a particular group.

We also considered questions such as, How do we get a good sense of a problem or situation? How do we process information? How do we gather data? What data should we consider? And ultimately, how do we assess the current patterns and changes in our surrounding environments that are most important? These represent questions that we explore as the examples in this book. Using information and analysis tools more effectively, we hope communities experiencing these changes will be better able to respond to, react, and plan for future resilience. Failure to do so results in loss of community, tradition, culture, economic viability, and often life itself.

Being prepared to be resilient requires communities to first understand who they are in the context of their own environment and then to thoughtfully prepare for environmental change. Through this book, we provide a methodological framework, case studies, and lessons learned about how such planning and assessment can be effectively applied using the capabilities of GIS as a key tool in the process.

In our own research, we've found it is best to observe a situation, problem, or issue from multiple perspectives, considering both physical and social environmental factors and the characteristics of the place that affect its resilience. Resilience is the ability to manage the shifts between environment and society in a manner that produces balance and harmony. It's of the utmost importance to begin this journey by understanding people in the context of their place and to harness local knowledge, skills, and abilities for how they interact daily with their environment. Using this information as a starting point is necessary before one considers response and action to environmental changes.

## RESPONDING TO VULNERABILITY

The weather, climate, and overall physical environments are in a constant state of flux, perhaps now more than ever. This process creates vulnerability. Weather records are being broken continually, and people are frustrated because much of what they know about the places and environments they inhabit no longer holds true. The ways of life that many communities know and have experience with—including patterns of interaction that they have established over time with their local places—are being severely challenged. Inevitably, such changes create stress through exposing the vulnerabilities of people and places. People become more vulnerable when they live in a city or community that is under the stress of changing environmental conditions that are unfamiliar and unexpected. It becomes an issue of magnitude and frequency.

For instance, if you live in one of the urban cities on the East Coast of the United States, such as Boston, you expect there to be snow, but not two to three feet of snow from one storm. You expect to have big blizzards and storms every now and then, but not the kind of megastorms that have occurred over the last few years. Normal patterns of mobility and action are halted by these major environmental changes, such as unexpected intense snowstorms. The result? People suffer and can't get to work, can't get to the hospital, and are generally snowbound.

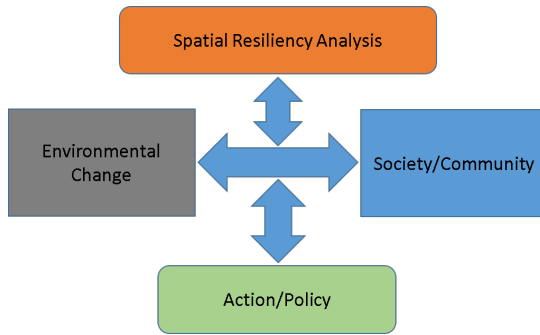
Extreme weather and climatological changes are occurring now on an order of magnitude and with increased frequency and severity that demand attention. This increase demands attention because when major shifts in the physical environment occur, the social community and patterns of interaction shift as well. Reviews of scientific data show that there is more carbon dioxide in the atmosphere now than at any other time in the last 400,000 years (NASA 2015) and that temperatures today

are hitting the highest levels ever recorded. Additionally, issues such as drought or water shortages continue to impact societies in the United States and abroad. Societies are not just sitting by and waiting for disaster to strike; they are assessing the situation and coming up with a plan of action.

Many of the physical environmental changes that are occurring these days are extreme. What is a community to do if the sea level rises and destroys half the town? What if there are severe mudslides due to too much rain and deforestation in a remote mountain community? How should the local residents and natural resource professionals react to increasing mudslides, resulting in increased physical and economic isolation? Another example might be desert communities, where water is the main limiting factor. How about the large cities and places that are supposed to thrive in increased drought? There are only so many resources available, especially when it comes to water, so where do we find these resources, and how do we use them to sustain communities that are in challenging geographies? These are all major questions that illustrate some of the physical environmental shifts that communities increasingly face.

But the question remains: With all the data that is floating around, what is the best way to be ready to respond to changes in a productive manner? This can be a difficult question to answer, but one can begin by adopting a theoretical approach as to how to conceptualize people in the context of such environmental changes.

Figure 1.1 presents the spatial resilience model to illustrate the major factors that should be considered as we think about people, environmental change, and how communities are impacted. The model consists of four concepts: environmental change, society/community, action/policy, and resilience. In the model, you see that we begin with environmental change, which impacts society/community, and similarly, society/community also impacts and influences environmental change. This two-way flow highlights the reciprocal relationship that exists between these concepts. The point of this analysis is to result in action and policy. The orange box at the top of the model represents resilience. Resilience is the overarching component of the model that positively impacts the two-way flow relationship between environmental change and society/community. This implies that those communities or places that are resilient will be able to better weather and respond to the physical environmental shifts and changes than those communities that are less resilient. Furthermore, there will be a direct relationship between spatial resiliency analysis and action policy. Why?



**Figure 1.1.** A model for spatial resilience.

In essence, the heart of the model is in the spatial resiliency analysis. If communities are able to know, understand, and react to or take charge of their destiny through analyzing their environments, they are on the path toward being resilient. Our approach is based on the idea that the most effective action/policy will derive from the environment where people know their strengths, understand their weaknesses, and therefore geographically have a better sense of where to target their action and efforts. That is what spatial resiliency analysis is all about. Throughout this book, we will explore the various aspects and features of spatial resiliency analysis using GIS.

Societies and communities that successfully adapt to changing conditions will grow and prosper. For example, the Ancient Pueblo people (often known as the Anasazi) were once a very sophisticated society centered on the four corners area of New Mexico, Arizona, Colorado, and Utah. However, around AD 1200, their society disappeared (Roberts 2003). No one really knows exactly what happened, but some researchers have postulated that changing access to food, perhaps due to drought and changing climatological conditions, may have played a role in their disappearance. Additionally, other scientists have argued that their disappearance was due to warfare and political encroachment by other tribes. In any case, the lesson to be learned from the Anasazi societal disappearance example is that there can be societies that are very well and clearly established in a particular geography, and then something occurs to change that. In fact, when we witness the disappearance of a society, clearly a particular vulnerability of that society—whether it be environmental, social, or political—occurred.

The ability of a people to respond to change, especially when it threatens their vulnerabilities or weaknesses, is especially important. In this book, we explore how effective data analysis, planning, and assessment have led to smart policy action on

the part of leaders and decision makers to bolster the strengths of the community. In other words, we explore how societies can be truly resilient and become active in their response to change versus being vulnerable and negatively impacted by these changes.

There are many such examples throughout history that highlight the importance that being adaptive or resilient to change can play. One could say that the Anasazi people faded out or disappeared because they lacked resilience (or the ability to productively adapt and successfully bounce back) to the physical environmental changes that occurred around them. They were not adaptive enough as a society to successfully make their way through the changes that occurred.

## GIS AND SPATIAL VIEWPOINT

The idea for this book emerged from our experience with spatial analysis and particularly GIS. GIS is a computerized mapping technology that has a great capacity to be used in data capture, analysis, and visualization. For many years, GIS has been an effective tool used in the military, planning, and natural resources fields to take stock of resources and situations and prepare for action. Today, GIS has made its way into almost any field that you can think of: health, medicine, sociology, planning, natural resources, business, and marketing, just to name a few. The application of spatial thinking around the globe has burgeoned because people realize the usefulness of thinking spatially.

GIS allows people to actually see data, sometimes even in three-dimensional formats. When you can see data as a readily accessible information product that makes the information visual, it can help to enable a better understanding and comprehension of patterns. But more than just allowing you to visualize data, GIS is a highly sophisticated tool for data analysis and integration. GIS is a means for groups to capture the story of people in a particular place. It enables the charting of environmental change and connecting it to sociodemographic change. When a major hurricane is about to strike, who has the ability to pick up and to move out of its path? GIS enables one to put multiple layers together to look for patterns in data. Through assessment of these patterns, we begin to understand how people engage with place along with unique coping strategies and reactions to change that we can term *resilience*. Assessment and understanding of a problem or issue will be much better if that process is triangulated—meaning measured from various angles and not just one perspective. When one uses GIS, one can clearly see resources or lack of resources.

This capability is especially useful for leaders of countries, the military, city managers, and policy makers to be able to know and understand the lay of the land. In other words, GIS can simultaneously provide a bird's-eye view of a situation or problem along with a more specific analysis of a particular geographic location or area.

## RESILIENCE

*Resilience* means being able to account for the change that occurs between physical environmental change and societal/community change patterns in a positive and proactive manner. Resilience is not only an ideal but also something that people and communities can actively strive to reach through careful planning and assessment. The thesis underlying this book is that if people have solid data about their communities, they can use it to spatially understand the strengths and weaknesses of their local geographies and the various environmental challenges that exist.

The spatial resilience process means taking stock of what you have, trying to target and understand vulnerabilities, and then moving forward to ready your community to account for change. If you successfully read the data, you can identify weaknesses and areas that need bolstering before disaster strikes. If you are aware of past context and history of environmental changes, including how people responded to changes, you can successfully respond to these changes in the future. A major part of achieving resilience is understanding people in the context of their geographic place.

## PEOPLE IN THE CONTEXT OF PLACE

People are always tied to a particular place or geography. As they establish themselves in a particular physical geography and climate, they establish ways of interacting with that environment. A community's patterns of interaction with its environment are going to be influenced by a number of things in the physical environment, such as weather, stability of the land, nature of the topography, and proximity of the geographic area. These factors will in turn be mediated by social factors, including politics, culture, social structure, and power. For instance, major environmental shifts could result in further isolation for a particular place or could change the season of an entire industry (such as agriculture) that is dependent on certain climatic conditions to achieve production goals.



Given all the environmental shifts that are happening both locally and globally, as scientists and authors, we wanted to share information about how using the spatial perspective can lead to successful resilience. The responses will be holistic in nature because spatial analysis gives a larger, more realistic view of major environmental changes that occur in various geographies. The best way to establish useful plans for action and response to change is to first gain a solid understanding of your environment through gathering baseline information about physical geography using various types of data; analyzing that data to identify strengths, weaknesses, and patterns; and developing action plans based on the analysis. This book focuses on change and the ability to successfully plan for and adapt to change in a manner that works or is successful. Resilience is defined as an ability to recover from or adjust easily to misfortune or change (Merriam-Webster, n.d.).

## INTERDISCIPLINARY PERSPECTIVE

This book is unique because we incorporate an interdisciplinary approach to looking at the issues of resilience. The fields that are covered in this book include geography, social sciences, planning, landscape architecture, urban and rural sociology, economics, migration, community development, meteorology, and oceanography. But the main distinctive feature of our book is that we encourage, recognize, and highlight the integration of various types of data (quantitative, qualitative, and spatial) to produce a holistic view of a challenge. We encourage communities to achieve resilience through an integrated, thoughtful, spatial approach. That is where GIS technology emerges as a leader in the field of spatial resilience, because it enables this data integration and the consideration of various pieces of the story that create a holistic view.

This book is a hybrid of theory and action, consisting of background and practical steps for how to achieve resilience. Each chapter was contributed by experts who have used GIS as part of their work on resilience in their respective fields. This book is structured to provide the reader with both theory and applied examples supporting and illustrating this theory. We hope to take you on a journey through a variety of environments and applications to illustrate resilience in context of a particular environment and community that incorporates a spatial perspective and uses GIS technology in the approach. While GIS is not always the primary focus of the cases presented, in each of these examples it provides essential tools and capabilities

necessary to assess, explore, and develop policies or solutions that address aspects of resilience in the particular case.

## WHY RESILIENT COMMUNITIES?

We selected the case studies presented in this volume to highlight a variety of ways resilience, and the analysis of resilience using GIS, can be applied across multiple environments and communities. A theme carried throughout these narratives is that community members, decision makers, and researchers working across varied geographies can effectively use spatial analysis as a component of their efforts and plan to adapt to changing natural and cultural environments in a productive manner to produce more resilient communities. Regardless of the underlying causes, change will happen in spaces and places where people interact with their environment. Sometimes these changes are rapid or unanticipated, while other times changes may occur in the long term. Some may be influenced by the very changes made by humans as they alter the physical and natural environments to serve the needs of their changing world, communities, and economies. These changes may be subtle or fairly significant due to an alteration in a physical ecosystem. Communities interact with their environments in many ways, fine-tuning these spaces and places to adjust to or influence changing relationships and patterns.

Communities around the globe work toward resilience on a regular basis, and a goal of resilience—or more simply, an ability to sustain a community and its standard of living—is something that is common to all communities. All societies seek to maintain and enhance their environment, in whatever manner this is defined in their own culture. Everybody in an existing locality can be involved in contributing key data essential to understanding people and their context in a place. A strong community arises from the local assets that exist in a given geography. Throughout this book, we share stories of resilience and the successful navigation of challenges that emerge across a variety of contexts.

Living and working in a community necessitate navigation around the local spaces and places, being aware of anything that is happening in the local ecology. The awareness and familiarity that local people have with a place too often go unnoticed and unrecognized. What we have highlighted here is that people who care about a locality often possess the will and skill to engage in sociospatial ecological thinking. This means that communities can situate themselves into larger contexts or surroundings. They have the keen ability to visualize the environment and to see

their position, role, or place in the larger ecosystem. GIS can play an important role in that process, as we see in the various spatial case studies presented in this book. GIS is a powerful tool because it facilitates the overlaying and visualization of different types of data. When you can see data portrayed, it makes it easier to see the patterns of where certain features occur.

For any society, the ability to manage and adjust to changes in the physical, social, economic, and political environments is powerful. Throughout history, societies have consistently encountered changing surroundings in their social and physical environments. For instance, there is the mystery of the Anasazi, who had well-developed and complex societies and seemingly disappeared without a clear explanation. According to science journalist George Johnson in *The New York Times*, “Like people today, the Anasazi (or Ancient Puebloans, as they are increasingly called) were presumably complex beings with the ability to make decisions, good and bad, about how to react to a changing environment. They were not pawns but players in the game” (Johnson 2008, 1). Some scientists hypothesize that the seeming disappearance of the Anasazi was due to drought or other changes in the climate. Other explanations suggest the onset of a plague or sickness. The bottom line is that when societies fail to adapt to major environmental or social changes, they suffer the consequences of these changed ecosystems or social constructs in their world. As a result, many societies fade away, sometimes for well-understood reasons, or, in other cases, without any clear explanation.

People live in various neighborhoods, districts, villages, and towns for reasons that can be teased out of the data. These reasons may relate to the availability (or historical availability) of specific resources in the surrounding physical environment, including natural resources essential to the function of the society or secondary values such as access to transportation or trade routes. Sometimes societies develop in environments that are less hospitable, often the result of social or political influences that force a population into places they might not otherwise choose, for example, the forced resettlement of Native Americans to reservations.

Patterns of local social interaction and engagement are often driven by the physical geography of where people live. This environmentally driven, site-specific social interaction is not something that we discuss enough. However, when people have meaningful knowledge about local places and geographies that can be included in the data collection and mapping process (for example, by incorporating public participation GIS methods), communities have a better chance to achieve resilience in part by maintaining control of their own local knowledge.

## SPATIAL ECOLOGY OF PEOPLE AND PLACES

What is spatial ecology? It is the established social and spatial connections between people, space, and place in an ecosystem. As we think about people and place, a valuable lens through which to view change and the resulting adaptive responses is sociospatial ecology. Sociospatial ecology means holistically considering the spatial and environmental connections between and among entities in a bounded area.

Tobler's First Law of Geography states, "Everything is related to everything else. But near things are more related than distant things" (Tobler 1970). According to this line of thought, entities that exist proximate to one another will have more in common with one another than those that are farther away. In other words, the objects within a physical boundary are going to be more in line with one another than those not located within the same physical boundary. Perhaps less known is Tobler's Second Law, stating, "The phenomenon external to an area of interest affects what goes on inside" (Tobler 1998). In other words, while the factors within an area, perhaps within a community, possess important internal relationships, these things do not exist in a vacuum. People and places are also affected by factors external to them, such as natural, social, or political events.

Communities are really miniature ecologies that exist at a specific time, space, and place, usually bounded by some sort of loosely defined border. The border serves as an edge or limit on the system, but entities also pass from outside the system to inside the system and back again. Spatial ecology focuses on spatial patterned relationships between entities within a bounded ecological system, allowing you to look at things internal to a community as well as the ebb and flow of physical resources and human and social capital resources in and out of an ecosystem.

## SPATIAL CASE STUDIES

The case studies we compiled for this book exist across a wide variety of physical spaces. We grouped these into four thematic sections to help guide readers to topics that are most relevant to their interests. Nonetheless, each of these case studies includes two common themes: first, an effort or need to adapt to changes in the natural or social environment, and second, a use of GIS technology to help facilitate the collection, visualization, and analysis of this information. Regardless of your own interests, all of the examples presented incorporate multiple methods and

interesting approaches, so we encourage you to explore examples from each section. Many of the methods used to explore these issues of resilience may be transferable to your own area of interest, even if the specific example comes from a different geography from your own.

Given the right tools and data, any community or organization has an opportunity to solve its problems through critical spatial thinking and analysis and, ultimately, is better equipped to make decisions. Of course, communities have managed for resilience long before the development of GIS. Spatial thinking doesn't require technology. However, GIS provides a powerful enabling technology to effectively assess, consider, and communicate options in ways that were not easily accomplished before its availability. GIS enables people, place, and space to interact together as a collective whole to respond to change in an informed, targeted manner versus relying on an incomplete, qualitative awareness of changes here or there in a particular environment. GIS can help communities prepare for change and adapt to changes as they occur in real time. Furthermore, the analytical capabilities of GIS offer valuable predictive capabilities that can be harnessed to help communities achieve the best results possible.

It goes without saying that in most cases, the members of a local community will have the greatest understanding and awareness of their surroundings based on the learned and accumulated knowledge that develops and is passed down over time. As such, local populations can be quick to recognize and respond to changes that occur, especially when these changes relate to core elements of their survival, food, shelter, and the safety of their population. The result is that communities act when needed and adjust themselves.

## CLIMATE CHANGE AND WATER GEOGRAPHIES

Resilience in ocean and coastal areas is highlighted in chapter 2, "Resilience in coastal regions: The case of Georgia, USA," by Rosanna G. Rivero, Alison L. Smith, and Mariana B. Alfonso Fragomeni. The authors explore various factors that impact coastal vulnerability to climate change through adopting a multidisciplinary approach to achieving coastal resilience in Georgia and also explore the use of a unique geodesign framework.

A second water-focused chapter concentrates on safety and access to the Columbia River. Written by Paul Cedfeldt, Jacob Watts, Hans Moritz, and Heidi Moritz, chapter 4, “The mouth of the Columbia River: USACE, GIS and resilience in a dynamic coastal system,” tells the story of how GIS is used to achieve resilience at the mouth of the Columbia River and highlights the history of the river, its people, and how the United States Army Corps of Engineers works with the community to help achieve greater resilience.

## INDIGENOUS ECOLOGIES

We have included two chapters examining the use of GIS by Indigenous and minority communities. These chapters demonstrate how gathering local knowledge of a community and its environments and packaging it using GIS can better preserve, document, and communicate this important cultural knowledge. These chapters highlight the power of Indigenous knowledge and the role that GIS can play.

In chapter 7, “Indigenous Martu knowledge: Mapping place through song and story” by Sue Davenport and Peter Johnson, we see how one Australian Aboriginal community, the Martu people, has worked to rebuild social stability and resilience. The key is a combination of ancient knowledge and practices with modern technologies. This population often leads a traditional desert existence and uses songs and stories to share information and to cope with the modern surrounding physical environment. GIS provides a means to capture and use this oral tradition in new ways.

Authors Kevin O’Connor and Bob Sharp wrote chapter 8, “Developing resiliency through place-based activities in Canada.” Their chapter explores how place-based education in a rural, Indigenous community empowered local youth to make a difference in understanding community history, culture, and local traditional ecological knowledge. Students developed a better understanding of themselves situated within the larger community and natural world. The chapter examines the connection to social and spatial place. When students can contribute to the resilience of their community while using new and exciting tools such as GIS, it both empowers them to make a difference in their local communities and offers a new set of knowledge and skills that will benefit their own lives. Helping their community to capture and use local knowledge gives them the power to act to benefit the entire community.

## URBAN ECOLOGIES

Author Jason Douglas focuses on youth in an urban environment in chapter 9, “Engaging youth in spatial modes of thought toward social and environmental resilience.” This chapter highlights how an urban mapping program empowers the community to focus on resilience and various environmental justice issues. Public participation GIS is employed, and students are again the leaders, working with their communities to enable change.

A second urban example comes from chapter 5, contributed by Regan Maas. “Urban resilience: Neighborhood spatial complexity and the importance of social connectivity” explores how poorer communities have a great strength in terms of their social networks. GIS is used to examine cluster analysis and how to identify resilient neighborhoods and individuals. Populations that face adversity can ultimately develop the skill sets necessary to come out on top by becoming adept at adjusting to and fighting their way through challenges.

Chapter 3, “Building resilient regions: Spatial analysis as a tool for ecosystem-based climate adaptation” by Laurel Hunt, Michele Romolini, and Eric Strauss, focuses on creating resilient cities and regions across five similar Mediterranean-climate regions: California, Central Chile, the Western Cape of South Africa, South and South West Australia, and the region bordering the Mediterranean Sea. Despite different geopolitical boundaries, comparisons are drawn across similar Mediterranean ecologies.

## RURAL ECOLOGIES

In chapter 10, “Health, place, and space: Public participation GIS for rural community power,” which we contributed, we examine how GIS can be used for community empowerment in rural Latino communities. We worked with community-based organizations and local residents to examine, document, and address issues related to agricultural pesticides and community health, ultimately leading to new policies for buffer zones preventing the spraying of pesticides near schools. This chapter ties together a number of sociospatial methods, including public participation GIS, use of pesticide application permit data from local government, and information on local weather patterns and crops to assess and communicate information to the local communities. Our analysis provided the basis for developing policies that support the needs of both the local growers and farming communities in California, which

depend on each other to support the economy of these regions and provide fruits and vegetables throughout the country and beyond.

## AS YOU EMBARK ON THIS JOURNEY

We hope you will find the examples embedded in these spatial case studies as a source of inspiration for your own work. Please use and modify the methods and best practices presented in these examples to achieve spatial resilience and effective policy in the communities and geographies where you work. Successful policies to achieve long-term resilience are those that actively consider the strengths of people in the context of their geographies.

## REFERENCES

- Johnson, George. 2008. "Vanished: A Pueblo Mystery." *The New York Times*, April 8, 2008.
- Merriam-Webster. n.d. "Resilience." In *Merriam-Webster.com*. Accessed May 24, 2020.  
[www.merriam-webster.com/dictionary/resilience](http://www.merriam-webster.com/dictionary/resilience).
- NASA. 2015. "The Relentless Rise of Carbon Dioxide." NASA Global Climate Change: Vital Signs of the Planet. Accessed May 23, 2020. [https://climate.nasa.gov/climate\\_resources/24/graphic-the-relentless-rise-of-carbon-dioxide](https://climate.nasa.gov/climate_resources/24/graphic-the-relentless-rise-of-carbon-dioxide).
- Roberts, D. 2003 "Riddles of the Anasazi: What awful event forced the Anasazi to flee their homeland never to return?" *Smithsonian Magazine*, July 2003.
- Tobler, W. R. 1970. A Computer Movie Simulating Urban Growth in the Detroit Region, *Economic Geography* 46 (Supplement): 234–40.
- Tobler, W. R. 1998. Linear pycnophylactic reallocation—Comment on a paper by D. Martin. *International Journal of Geographical Information Science* 13 (1): 85–90.