CHAPTER 1

Human Dimensions and Communication of Florida's Climate

Peter J. Jacques[1], Kenneth Broad[2, 3], William Butler[4], Christopher Emrich[5], Sebastian Galindo[6], Claire Knox[5], Keith W. Rizzardi[7], and Kathryn Ziewitz[8]

[1]Department of Political Science, University of Central Florida, Orlando, FL; [2]Abess Center for Ecosystem Science & Policy, University of Miami, Coral Gables, FL; [3]Department of Marine Ecosystems and Society, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL; [4]Department of Urban and Regional Planning, Florida State University, Tallahassee, FL; [5]School of Public Administration, University of Central Florida, Orlando, FL; [6]Department of Agricultural Education and Communication, University of Florida, Gainesville, FL; [7]School of Law, St. Thomas University, Miami Gardens, FL; [8]Sustainability Institute, Florida A&M University, Tallahassee, FL

Florida's climate system, which is nested within regional and global climate systems, cannot be fully understood without including human dimensions that interact with the climate systems in two principal ways: 1) where social systems facilitate or dominate causes of climate change, and 2) where climate change affects social systems. These aspects include complex social interactions and feedbacks, but can be broken down into the impacts, risks, and causes of climate change specific to Florida. Further, communication of these elements can interact with social in/action and facilitate or obstruct adaptive responses. It is important to view the organization of these interactions through social structure, where essential drivers of social forces include the political-economy, demographic, and attitudinal architecture of Florida social systems. In this chapter, we review key social drivers of specific impacts, risks, and causes of climate change within Florida.

Key Messages

Mitigation

- Florida faces a series of threats from climate change that will affect social groups and geographic areas differently. Florida's future depends critically on global reductions of greenhouse gases (GHGs). Florida itself is the 27th largest GHG emitter across all states and other countries. This makes it essential that Florida contribute to global reductions.
- To understand how to reduce GHGs, one needs to be familiar with the development of land and energy in the state that determines sources of power for buildings, transportation infrastructure, and the institutions (rules and laws) that ultimately guide the consumption of hydrocarbon-based energy. Florida has been guided heavily by land and highway development, with almost all the energy consumed in the state coming from sources that directly emit GHGs, with the exception of nuclear power plants.
- There are important macro and micro obstacles to change that must be understood. At the macro level, social structures guide the behavior of large groups, and individuals acting alone are less effective in reducing GHGs than changing these social structures, including institutions. A significant obstacle has been a national organized effort to reject climate change science that some Florida politicians have reproduced at the state level, making policy efforts in this area difficult to even discuss.
- At the micro level (the individual), communication does not necessarily consist of what people say, but instead what is heard. Improvements in reaching out to different target audiences will require engaging creative approaches to communication.

- And providing information is only one step in the process. Sustaining motivation for change remains one of the biggest challenges and will require collaboration among academics, practitioners, and community leaders to ensure that we continue to move forward.

Impacts and Adaptation

- Effective change strategies will require the coordinated collaboration of multiple sectors of society.
- GHG emissions have already exceeded the mid-scenario emission posed by the IPCC 2005 reports and are expected a continued increase in carbon emissions associated with SLR.
- The most realistic SLR estimates place Florida's shoreline 4 ft higher in 2100 than it was in 1990. However, potential impacts from SLR go beyond inundation in coastal and near-coastal areas, and include decreases in potable water for consumption and fresh water for crop growth.
- Sea level hazards have far-reaching implications beyond near-shore areas including loss of tax bases, changes in vector-borne illnesses associated with standing water, and water system failures leading to polluted waters entering the water supply.
- We can identify those areas where populations are least able to adequately prepare for, respond to, and rebound from disasters. When overlaid with potential impacts, we can create a clear path forward for adaptation, mitigation, and resilience building.
- Focusing efforts on those areas designated highly vulnerable will ensure that their respective populations will have more opportunities to increase their resilience to disasters.
- Social vulnerability results from the dynamic interaction of many socio-demographic characteristics and is specific to distinct places, beyond any one factor such as race or economic class. This means that the drivers of vulnerability are different across the landscape and policies for improving resilience need to be aware of what issues and specific drivers exist at the local level.
- Florida has a bipartisan history of funding conservation, a critically important component of both climate mitigation and adaptation efforts so long as funding is used for acquiring land and setting it aside for conservation—which does not always occur in the state.
- Florida has an array of planning tools at its disposal to mitigate imminent future threats but there is significant room for improvement in these plans, which are often incremental and disconnected from other planning documents. Efforts such as the Southeast Florida Climate Change Compact are among the most promising models for regional collaboration geared toward adapting to climate risks.

Keywords

Vulnerability; Adaptation; Governance; Political economy; Institutions; Barriers to communication

Introduction

Florida's population faces some of the most serious threats from climate change in the United States through a series of interconnected changes including but not limited to sea level rise, intensifying tropical storms, severe erosion of the coastline, inland flooding, saltwater intrusion, extreme heat, and changing hydrological and tidal patterns. Direct effects can then give rise to cascading secondary effects such as falling real estate prices and other economic problems, increased costs to government, and social disruption and disorganization. These are but a few examples of how climate change will be felt by society in Florida.

We can think of the human dimensions of climate change as the way humans cause global climate change within a nested hierarchical set of scales, from the local to global, as well as the risks and adaptations to climate-related impacts to human society. Each element is incredibly complex. This chapter can only provide an overview of these issues, treating each element in turn, starting with human causes of climate change specific to Florida and then laying out the social impacts, risks, and adaption to climate change.

Structural Causes of Greenhouse Gas Emissions: Florida's Development, Demographic Change, and Urbanization

Human greenhouse gas emissions are the dominant reason for contemporary global warming and climate change (Pachauri et al. 2014). We must understand the structural social conditions in which emissions are produced to reduce them. Social structures are the political, economic, demographic, and attitudinal forces that contextualize group behavior (Dunlap and Brulle 2015). Individuals may want to reduce their personal emissions, but their behavior is systematically constrained by institutions, social norms, and even available infrastructure. For example, a person may want to reduce their transportation emissions but will have little opportunity to do so without the availability of a robust public transit system; and, public transit is an artifact of political and economic commitments.

Political-Economic Structures and Change

Florida emissions are deeply tied to the political economy of Florida. Political economy refers to the structural components of the economy, such as its composition and the rules that are in place. The political economy of Florida has radically changed over the last 100 years: "Florida went from a small, poor, rural state early in the 20th century to a large state with dense urban areas and average incomes late in the 20th century" (Dewey and Denslow 2014). In that time, the composition of Florida's economy has focused heavily on tourists and retirees. For example, 106 million people visited Florida in 2015; tourism has continued to grow each decade since 1980 and is a major driver of Florida's economy (Bureau of Economic and Business Research 2016), generating an estimated \$65-90 billion. Comparatively, in 2013 there were nearly 50,000 farms in Florida producing \$8.45 billion in receipts (Florida Department of Agriculture and Consumer Services 2016). Unfortunately, jobs tied to tourism and serving retirees tend to be low-wage, and retirees are often less willing to pay taxes for public services such as education and infrastructure; consequently, the 2012 Florida middle-class had a per capita income equal to that seen in 1978 (95% of the US average) (Dewey and Denslow 2014). Since income/poverty is an indicator for vulnerability to hazards (as detailed below), the structure of Florida's economy is partly responsible for this pattern of vulnerability alongside government policies, which have focused on bringing more tourists and retirees, resulting in increased development and subsequent carbon emissions. These dynamics partially guide the rationale and benefits of increased urban and suburban development, as well as the structure of energy production and consumption.

Institutional and Behavioral Change

Effective responses to climate change will require human behavior modifications. However, individual behavior changes are, "… not autonomous: they are constrained by institutional processes such as regulatory structures, property rights and social norms associated with rules in use" (Adger et al. 2005). These larger forces tend to change incrementally or slowly until a breakpoint opens up a cascade of change (Baumgartner et al. 2009). This means that changes *within* social structures are important for climate mitigation and adaptation, and this requires an astute and powerful civil society that is not confused about climate-related public interests -- but unfortunately, civil society is often easily misled by powerful interests (Jacques 2014, 2016; Gramsci 2011).

Often, thoughts about social change are overly focused on getting individuals to "plant a tree, ride a bike, save the world" (Maniates 2001), ignoring social structures that may impede meaningful change. Certainly, individual behavior is important; but institutional, organizational, or governmental change is also required for any real and sustainable environmental outcomes. For example, "adaptation pathways" visualize potential actions in response to changes in climate (Wise 2014), but the Florida Center for Environmental Studies at Florida Atlantic University (Polski 2016) discovered these decision-making tools need to take into account the interaction social sectors to be most effective (Wise 2014). Meanwhile, social and institutional obstacles are the most commonly reported barriers to climate change responses (Biesbroek 2013).

Culture is also important. According to Adger et al. (2013), "society's response to every dimension of global climate change is mediated by culture," which they define as "symbols that express meaning, including beliefs, rituals, art and stories that create collective outlooks and behaviors, and from which strategies to respond to problems are devised and implemented" and culture is "…embedded in the dominant modes of production, consumption, lifestyles and social organization that give rise to emissions of greenhouse gases," (Adger et al. 2013, 112). Thus, the stories we tell ourselves as a culture influence how people identify risk and response (Adger et al. 2013).

Further, information alone does not inspire change. Often, individuals with adequate knowledge and who want to change still fail to actually modify their behavior or practice (Rogers 2003). At the policy level, stakeholders in governments, planners, communities, individuals, industry, and interest groups frequently disagree about the relevance and effectiveness of mitigation and adaptation strategies due to differences in culture and values (Adger et al. 2013). Thus, participatory methods that bring attention to a plurality of vulnerabilities and solutions can more effectively plan for collective risk (Smit and Wandel 2006; van Aalst et al. 2008; Oppenheimer 2013; Susskind et al. 2015).

Many different models of individual and organizational change are available to assist in the design of social interventions aimed at modifying behavior (Rogers 2003; Burke and Litwin, 1992; Burke 2014; Warner et al. 2014). For example, Rogers (2003) developed the Innovation-Decision Process model to explain the process followed by individuals to adopt or reject a technology or idea. The model, consisting of five progressive stages — knowledge, persuasion, decision, implementation, and confirmation — accounts for characteristics of the context, the decision-making unit, and the innovation. Using this model as a guide for the design and implementation of mitigation and adaptation strategies in response to climate change can help us identify the feasibility of the change, the types of information that should be communicated at different stages of the process, the best ways to communicate the required information, the effectiveness of the change process, and the sustainability of the proposed change.

It is imperative that current and future mitigation and adaptation efforts are framed using sound models and methods for planned change. To be effective, adaptation and mitigation responses must connect with what is important to the target population (Adger et al. 2013). Barriers will always be present in any change initiative, but what matters is to ask why and how those barriers emerged (Biesbroek et al. 2013), and what are the best approaches to overcome them. However, the barriers to effective climate change communication are formidable.

Communication of Climate Change in Florida

Another set of challenges to institutional and behavioral change are cognitive barriers to communicating climate change. We like to fancy ourselves a rational species, evolved to a state of consciousness that Descartes described as *cogito ergo sum*: "I think, therefore I am." However, the basis for decisions, from the personal to financial to environmental realms, is more accurately characterized as "I feel, therefore I am" (Damasio 1994; Eakin 2003). We respond to information instinctually, at an unconscious level in fractions of a second and driven by emotions. We often rationalize these snap judgments post hoc, with convenient explanations or selective use of evidence that supports our decisions (i.e., "confirmation bias"). The more uncertain or emotionally charged the situation is, the more we tend to rely on these unconscious processes (Kahneman 1982). Honed by trial and error learning, instincts served us well for survival in the wild and for undertaking tasks for which we have repeated experience or formalized training. We experience "risk as feelings" (Loewenstein 2001). However, as our technological and sociopolitical systems have become more interdependent and complex, we have difficulty comprehending complex multi-causal events or concretely envisioning and accurately planning for the future, resulting in what behavioral economists refer to as "hyperbolic discounting" and social psychologists have described in "construal theory," where distance to an event/value makes it too abstract for prudent decision-making (Trope and Liberman 2010).

In many cases, there are plausible explanations for why these mental shortcuts, or heuristics, may have pro-social benefits regarding fairness, justice, and cooperation (Atran and Henrich 2010; Lind 2001). However, for climate change-related decisions and other environmental risks, these biases lead to suboptimal outcomes for the larger population. Dozens of cognitive biases are known (Figure 1.1) and are increasingly implicated in human decision-making (for an overview of the research history and recent advances, see Kahneman 2011).

Figure 1.1. Known cognitive biases.

The decision sciences have increasingly influenced climate change communication efforts as well (Center for Research on Environmental Decisions 2009). Warnings and subsequent outreach campaigns regarding climate change originated from the scientific community, whose currency is data. Analytical information is presented to the public in hopes that we would act rationally. Such an assumption is naïve and recent work has shown that increased scientific literacy does not increase belief in climate change (Kahan et al. 2012). A cursory look at other realms where there is much less scientific uncertainty (e.g., smoking, obesity, texting while driving) reminds us of the challenges to shifting behavior.

Further, climate change has many of the characteristics that make concerted, coordinated action at the individual and group level difficult. We have not had multiple experiences with global phenomena that have effectively informed learning; in fact, members of the general public often repeat the same suboptimal choices in terms of preparing for hurricanes, which are relatively frequent compared to climate change! (Broad et al. 2007). Unfortunately, climate change is "a slow, creeping and invisible phenomenon" that does not evoke the emotional triggers that drive individual or policy action and that we've seen in response to other threats such as nuclear power or oil tanker spills (Slovic 1987; Beamish 2002). Since climate change is a collective action problem, individual responses are often seen as a drop in the bucket, and responsibility can be deferred. Perhaps most significantly, the impacts are psychologically distant; considered to manifest in the distant future and in far away, remote places (Weber 2006).

Some of these biases are not solely a result of our evolutionary heritage, but are initiated and exacerbated by external forces such as misinformation campaigns (Jacques et al. 2008) put forth by so-called skeptics and those with large financial stakes in the oil and gas industry, which serve to exacerbate an ideological divide in the U.S. (Jacques et al. 2008; McCright and Dunlap 2000; Oreskes and Conway 2010). All of these factors combine to make effective climate change communication extremely challenging (Moser 2010).

While Florida is among the most economically-vulnerable states to climate change, Floridians are also particularly vulnerable to some of these cognitive biases. Our population, especially around the coasts, is highly transient with many recent immigrants from other parts of the U.S. or internationally who may lack a strong sense of place or connective history to Florida (LiPuma and Koelble 2012) or the development of multigenerational knowledge and close interactions with nature that would allow for the perception of subtle changes (Marlen et al. in review). This might relieve one obstacle to inland migration (as discussed later in this chapter). That said, humans cannot perceive subtle, slow changes in a statistically-accurate manner. But just because we are not skilled at picking up these subtle changes or comprehending complex causal relationships does not mean that we do not do it heuristically, as noted above. For example, Zaval et al. (2014) found a strong correlation between the local daily temperature and peoples' belief in climate change.

Floridians associate impacts of climate change with increased heat and storms, two threats that they are relatively well-adapted to (Leiserowitz and Broad 2008). The largest threat by most accounts, sea level rise (SLR), however, is imperceptible to the eye. A critical impact of SLR is on our groundwater supply, and most residents are not even aware of where our potable water comes from or the mechanisms through which saltwater can make its way underground. Relatedly, our limestone geology does not lend itself to the barrier adaptations that have been implemented in other SLR-prone areas such as The Netherlands. These "out of sight, out of mind" interlinked impacts are not unique to Florida's land. For example, ocean acidification can negatively impact reefs, which can hurt fisheries and related tourism as well as the shoreline buffer that the reefs provide, increasing coastal erosion (Ferrario et al. 2014). Yet, most residents are not aware of these coastal processes.

That said, the information on cognitive bias is being incorporated into creative initiatives in the arts to produce unique creative approaches to gain attention and motivate behavioral change (Levin 2015). But there is no silver bullet for information presentation, and the grand challenge is shifting behavior from being reactive to proactive. Alternate framings of the climate issue are well underway and what was once pitted as environmental versus economic choices is increasingly framed as a moral imperative (e.g., the "What would Jesus drive?" campaign).

Creative uses of shaming have also been employed (Jacquet 2015) and advances in computer technology hold promise for "information acceleration" (Meyer et al. 2013). For example, researchers are now using computers and augmented/virtual reality to observe people's decision-making in realistic scenarios, which has the potential to advance decision research in ways that will facilitate a shift from simple information provision to behavioral motivation. These problems not only inform individual behavior, but the context for civil society preferences and the legitimacy of social forces such as social stratification and institutions that will be crucial for mitigating and adapting to climate change (see Adger 2010 and Agrawal 2010).

Demographic Change and Urbanization

Demography is another structural force that provides opportunities and barriers to change. At the start of the 20th century, Florida's population was 528,000 with almost 80% of the population residing in rural areas (US Bureau of the Census 1995). After World War II, Florida's population growth escalated, especially in the central and southern portions of the state. The advent of air conditioning and easy highway travel were crucial in making Florida an appealing destination, attracting full-time and seasonal residents, as well as tourists (Mormino 2005). In the decades from 1950 to 2000, Florida was the fastest-growing state in the nation (Smith 2005), rising from a population of 2.8 million in 1950 to almost 16 million in 2000, and with decadal growth rates ranging from 20-80% (Smith 2005). In the latter half of the 20th century, the majority of Florida's population shifted from residing within city boundaries to living in more dispersed, unincorporated suburban locations (Mormino 2005).

More and more people choose to make Florida their home (Smith 2005). Immigrants to the state have long included retirees; retiring baby boomers continue to move to Florida (Smith and House 2006). In addition, younger newcomers are migrating to take jobs in Florida as the economies and cultures diversify (Florida Trend 2015). The housing crisis and recession caused a brief decline in population from 2008 to 2009 (University of Florida Bureau of Economic and Business Research 2010); however by 2010, the state's population was growing again.

More recently, Florida's population growth has continued to be among the strongest nationwide, and real estate development is still a major driver of the state's economy (US Bureau of Labor Statistics 2015). In 2015, the Miami-Ft. Lauderdale-West Palm Beach Metropolitan Statistical Area (MSA) ranked as the 8th most populous in the nation, followed by the Tampa-St. Petersburg-Clearwater MSA, which was 18th, and the Orlando-Kissimmee-Sanford MSA, which was 26th (Bureau, U.C. 2015).

Residential growth has included the building of many subdivisions spanning large acreages. Housing development consists of primary residences as well as second homes for seasonal residents and domestic or international affluent buyers (Smith and House 2006). Citrus, cattle ranching, forestry, and crop land uses continue to diminish, giving way to development of urban, suburban, and exurban developments (Mulkey 2006). While Florida's earliest towns and cities were founded along coasts and rivers accessible by water transportation, wetland drainage and roadway construction increased the areas easily accessible and suitable for development, allowing urbanization to proceed from the coastal to interior lands (Mormino 2005; Derr 1989). This shifting land use sets the preconditions for transportation and other sources of emissions.

Historic Development in Florida

Development does not occur in a vacuum, but rather is somewhat path-dependent —what came before affects what can happen in the future. For example, roads are often precursors to future development, providing easier access to previously unavailable interior areas.

Evidence of ancient human habitation has revealed that in the distant past, Florida's first peoples adapted to a changing climate: prehistoric residents exploited the larger land mass that was available during the "ice age" of the late Pleistocene and, over time approximately 5,000 to 10,000 years ago (Faught 2004). *[Cf: Ch. 2]*, retreated when shorelines assumed configurations close to the present ones Since those prehistoric times, subsequent Florida settlements have reshaped large portions of the state's landscape (see Chapter 2). As the built environment has expanded, the proportion of land in forests, wetlands, prairies, and other natural areas has diminished; urbanization in the last century also reduced the amount of land in pastures and farmlands. These changes in land cover affect how the chief greenhouse gas, carbon dioxide, cycles through various reservoirs including soil, vegetation, and the atmosphere. Reductions in vegetated landscapes serve to diminish the rate of photosynthesis taking place and thus the land's overall capacity to absorb carbon dioxide (DeFries et al. 1999). As a result, greenhouse gas emissions from human activities have increased. In Florida, as globally, humans have become important driving agents of geologic change (Steffen et al. 2007) including climate change (Pachauri et al. 2014), emitting 218 million metric tons of CO_2 equivalent in 2013, ranking sixth among the US states (US Energy Information Administration 2014).

Land-use change in Florida is strongly tied to residential real estate development, which has transformed vast areas of the state from natural and agricultural areas into housing subdivisions of varying densities (Derr 1989; Zwick and Carr 2006).

Energy Use and Greenhouse Gas Emissions in Florida

The state's energy use and policies bear heavily upon how Florida addresses its role in climate change. Forging effective and complementary climate and energy policies is complicated by conflicts between economic growth and development goals, missions of government bodies and utilities, political will, and varied perspectives on climate change.

Use of fossil fuels has enabled growth and development in Florida, supplying the vast majority of fuel used to generate electricity to heat, light, and, very importantly, to cool buildings. When ranked globally with all US states and nations in a 2004 study, Florida was the 27th largest global emitter of greenhouse gases, outstripping emissions of entire nations including Turkey, Taiwan, and the Netherlands (Peterson and Rose 2006).

In Florida, electric power generation is the chief source of carbon dioxide emissions, responsible for more than half of the emissions in 2015. Residences use more than 50% of this electricity. Transportation was the next largest source of carbon dioxide emissions, contributing almost nine times more than Florida's relatively small industrial sector (US Energy Information Administration 2016).

Florida's energy profile is characterized by a high proportion of residential and commercial customers and a low proportion of industrial ones; the state also experiences the highest number of cooling degree days of any state and the lowest number of heating degree days of any continental state (Florida Public Service Commission 2014). Supplying energy to meet peak demand is driven by the weather-imposed demand for cooling.

Development and Climate Impacts: Transportation and Vegetated Areas

The layout of urban structures affect climate in multiple and complex ways. Scientists are seeking to better understand these impacts separately and in concert with one another. One important consideration is the extent to which urban forms reduce or increase dependence upon private transit (e.g., passenger vehicles, motorbikes, etc.). Urbanization also affects the distribution and extent of vegetative land cover, influencing the degree to which green areas mediate urban "heat island" impacts through the cooling effects of evapotranspiration (Stone and Rodgers 2001). In addition, the presence or absence of vegetation determines how much carbon is sequestered (i.e., taken up in plant growth), which affects the overall carbon balance for a chosen geographic area (Imhoff et al. 2004).

The relationship between transportation and greenhouse gas emissions is well known. Each gallon of gasoline burned emits just under 20 pounds of carbon dioxide when combusted in the atmosphere (US Energy Information Administration 2014) and the vast majority of greenhouse gas emissions in the US result from fossil fuel combustion from passenger vehicles, light trucks, sports utility vehicles, and minivans, which contribute more than half of transportation emissions nationwide (U.S. Environmental Protection Agency 2014).

Globally, the shape into which urban areas evolve is dependent upon the interaction of transportation pathways with the locations of residences, workplaces, and other typical destinations (Hillier 2008). Roadway placement influences the location of residential developments and workplaces, and vice versa, thus influencing the creation of a growing urban structure.

Since the majority of Florida was developed after the automobile age, most of the built environment has been laid with car travel in mind. This has fostered a sprawling land use pattern. Private vehicular travel is the default mode of travel in Florida, exacerbated by conventional zoning that separates land uses — dividing residential from commercial, industrial, and civic activities. Low-density sprawling land-use configurations with separately zoned land uses, typical in Florida, are associated with heavy dependence on fossil fuel-powered personal automobiles and high rates of vehicle miles traveled (VMT), ultimately contributing a greater share of greenhouse gas emissions from transportation than what occurs in compact cities with mixed land uses (Ewing et al. 2007; Steiner et al. 2010). In 2014, approximately 80% of Florida workers drove alone, compared to 76% nationally, and just over 2% used public transportation compared to a national rate of 5% (U.S. Bureau of the Census 2016). Florida ranks third among states for the VMT, with a collective 192,702 million miles traveled in 2013 (US Energy Information Administration 2016).

Transportation is the state's largest "end use" of energy at 36% (US Energy Information Administration 2016). Use of motor fuel by residents and jet fuel to move visitors and cargo via air travel makes Florida one of the nation's leading consumers of motor gasoline and jet fuel (US Energy Information Administration 2016). Consequently, the transportation sector accounts for the state's second highest source of carbon dioxide emissions following electric power generation (US Energy Information Administration 2016), mirroring national trends.

While options for mass and alternative transportation are improving in many communities, lack of comprehensive mass transit services and poor infrastructure for non-motorized travel discourages alternative modes of transit in many Florida cities and counties. Lack of adequate mass transit options has social as well as environmental impacts, as it disproportionately impacts employment and life choices for lower-income residents (Bullard 2003).

Climate is affected by how the expanding built environment changes vegetated areas. Loss of green space in urban regions drives up temperatures, increasing the demand for cooling and negatively impacting human health through the effects of heat stress and impaired air quality (Stone and Rodgers 2001). Addressing the "urban warming" effect is a pressing need as the process of urbanization continues to expand. A study of Atlanta's urban area found that compact- to high-density development contributed less radiant heat energy to surface "heat island" formation than lower-density patterns, prompting policy suggestions to favor compact development in combination with urban tree planting (Church et al. 2013).

As for the relationship between urban form and carbon sequestration, relative to its pre-development status, the overall loss of forests, inland and coastal wetlands, and agricultural landscapes has indisputably reduced the rate of primary productivity and thus carbon uptake in Florida. At a finer scale, changes from human impacts are more complex. Sequestration rates vary according to the types of developed areas and the previous land use of an area that was converted (Zhao et al. 2012). One analysis of Florida's carbon balance showed that residential carbon emissions from energy and transportation fuel consumption were compensated by carbon sequestration in exurban and rural areas, with the state still functioning as a net carbon sink. However, the study did not consider the commercial sector or embodied carbon associated with products created from emissions in distant locations (Zhao et al. 2011).

Understanding of the relationships between population density, land use and cover, and carbon impacts is incomplete; some authors find countervailing positive and negative effects for urban densification when factors extending to distant consumption are considered (Elliott and Clement 2014). It appears that striving for lower-carbon cities will require further attention to reconciling goals for density to support more fuel-efficient transportation with goals for configuration of urban areas that include adequate green and treed spaces to sequester carbon and moderate local and regional climate.

Into the future, human development will not only affect the state's carbon balance, but also its ability to provide other ecosystem services needed to sustain Florida's unique natural and human ecosystems. For example, Florida lost an estimated 84,000 acres of wetlands between 1990-2003, despite the US Clean Water Act requirement for "no net loss" of wetlands to development — this represents a clear policy failure, and perhaps even a corruption (Pittman and Waite 2009). Future "build out" scenarios show vastly different possibilities, with varying portions given to development, conservation, and agriculture depending on the efficacy of growth management efforts to alleviate sprawl (Zwick and Carr 2006; University of Central Florida 2007). Historically, market forces have been strongly influential in driving development. Growth management efforts are tempered by strong "home rule" tendencies and property rights legislation, and Florida's approach to growth management in the past had little effect on the amount, more so on the location and timing of development, ironically facilitating rapid housing construction and increasing population in suburban areas (Boarnet et al. 2011).

Florida Energy Sources

Florida's energy sources are mainly carbon-based fuels, natural gas (mostly used by power plants), and coal. Natural gas has displaced coal as the primary fuel for electricity generation (US Energy Information Administration 2016). In addition to these carbon-based energy sources, two nuclear power plants on the Atlantic Coast supplied approximately 12% of the state's needs for electricity generation in 2014 (Florida Public Service Commission 2016).

Renewable resources accounted for just over 2% of Florida's net electricity generation in 2015, mostly supplied by biomass, including municipal, forestry, and agricultural waste. Solar energy provided less than 10% of the state's renewable net generation as of 2016 (meaning solar energy provided only 0.002 percent of generation). The potential for continued expansion of solar power is strong because of Florida's bountiful solar thermal and photovoltaic resources (US Energy Information Administration 2016). A small fraction of the state's energy comes from hydroelectric power generated in the Florida Panhandle, and the state's wind resources are considered to be limited with no commercial wind facilities currently in existence (Chamlee-Wright and Storr 2009).

As prices of solar technology have dropped, Florida's capacity in this arena has expanded; in 2015, Florida installed 41 megawatts of solar electric capacity, nearly doubling its prior capacity

(Solar Energy Industries Association 2016). Large utility projects include Florida Power and Light's 75 -megawatt solar power plant in Martin County and the 12-megawatt Jacksonville Solar photovoltaic facility. Businesses and homeowners are increasing solar use, but by 2016 that amounted to just one-tenth of 1% of Florida utility customers (Klas 2016); and, while Florida has the nation's third highest potential for rooftop solar (Solar Energy Industries Association 2016), it ranked 14th in installed solar capacity in the US in 2016.

Florida Energy Policy

As of 2016, Florida lacked overarching climate change and greenhouse gas reduction (climate mitigation) policies, as well as a comprehensive energy policy at the state level. Florida has standards for energy efficiency in buildings and a net metering policy that allows onsite electricity generators to offset energy they consume, but it lacks other more assertive policy tools that other states use to reduce greenhouse gases and promote renewable energy (e.g., performance-based programs to reward mitigation of carbon emissions or a renewable energy portfolio mandating a minimum level of supply by renewable energy sources). The state supports conservation programs through utilities, as mandated by a 1980 plan, however these were dramatically scaled back in 2014.

In Florida, lawmakers discussed a state energy and climate policy in 2007 and 2008, including a reduction of greenhouse gas emissions from state utilities, but the proposals failed. A 2007 executive order (Florida Public Service Commission 2014) mandated state agencies track and reduce greenhouse gas emissions. Other initiatives included on that prohibited idling heavy-duty vehicles in 2008 and a 2009 law that adopted California's motor vehicle emission standards, but both were repealed in 2012 (FS Chapter 62-285). A 2009 clean diesel rebate program remains in effect, and a 2011 provision in the Community Planning Act that allows for regional-scale planning for Adaptive Action Areas (targeted areas for investment specifically aimed at SLR adaptation) allows the Southeast Regional Climate Compact to coordinate its climate action plan (Bolstad 2016). Meanwhile, energy efficiency in buildings substantially improved as a result of a state energy code enacted in 2007 and updated in 2009, but home sizes increased, which reducing savings (Florida Solar Energy Center 2009).

The Florida Energy Efficiency and Conservation Act of 1980 directs the state's utility regulatory body, the Public Service Commission (PSC), to conserve and reduce peak energy demand. It required investor-owned utilities to submit demand-side management (DSM) proposals for approval by the PSC every five years. PSC approval considers efficiency measures, including energy audits and incentive programs, and a popular solar rebate program. Over the years, the PSC estimates that the utility DSM programs eliminated the need for 45 150-megawatt power plant equivalents (Florida Public Service Commission 2014).

However in 2014, the PSC approved a major reduction in utility conservation programs, and in 2015 the PSC ended solar rebates. Utilities argued that availability of affordable natural gas countered the need for conservation programs (Klas 2016). Although natural gas produces fewer carbon emissions per units of energy than coal, the rising use of natural gas consumption has resulted in natural gas-related CO_2 emissions surpassing those from coal nationally (US Energy Information Administration 2014).

Mitigation policies in other states include renewable energy portfolios requiring providers to use a minimum percent of renewable sources by target dates and power purchase agreements that allow third-party businesses to install solar systems and sell the power to customers independent of the utility (Solar Energy Industries Association 2012). Other states have also used market-based incentives and performance-based programs to mitigate carbon use (U.S. Environmental Protection Agency 2014) because states are likely to shoulder the costs of climate-related impacts (Peterson and Rose 2006). Successful policies are based on input from key stakeholders to tailor effective measures suited to the state's unique situation (U.S. Environmental Protection Agency 2014). Minimization of conflicts can be achieved by working in "an open and self-determined policy process" to reduce mitigation costs and promote equity across regions, socioeconomic groups, and generations (Peterson and Rose 2006).

Florida Conservation Policy

Conservation of ecosystems is among the most important strategies for both climate change mitigation and adaptation because, in addition to their intrinsic value, natural resources support the major tourist industries of Florida and conserved ecosystems preserve options and ecosystem services critical to the lives of Floridians. Conservation is mainly achieved through governmental institutions, including Adaptive Action Areas (above). Institutions are rules and decision-making procedures that guide large-scale behaviors and action. Conservation protects areas such as forests, mangrove swamps, and salt marshes that absorb carbon (Chmura et al. 2003). Biodiverse ecosystems promote ecosystem stability (Ives and Carpenter 2007), and coastal ecosystems reduce vulnerability where intact coral reefs, dunes, and wetlands all absorb water and energy that reduce coastal vulnerability (e.g., wetlands provide $23 billion/year in storm protection alone, and every lost hectare adds about $33,000 in storm damage (Costanza et al. 2008)). A thorough analysis of institutions focused on conservation should start at the global level and move incrementally to the local level, but space in this chapter forces us to focus only state institutions.

Relatively open rules for development in the earlier part of the 20th century led to serious environmental problems. In 1972, Florida passed a raft of environmental legislation (Carter 2013) to help Floridians handle climate-related threats such as changes to the water cycle. Among the laws passed were the Florida Water Resources Act, the Land Conservation Act, the Environmental Land and Water Management Act, and the Comprehensive Planning Act. Each of these acts worked at different levels to ensure better science, flexibility, and enforcement of land and water conservation, including the establishment of funds to purchase sensitive and valuable lands. Funding the purchase of select lands started in 1964 with the Land Acquisition Trust Fund. Since then, Florida voters and legislatures have passed multiple conservation programs, including the 1989 "Preservation 2000," which spent $3 billion and purchased the most land of the conservation programs. In 2014, a voter-approved constitutional amendment passed that allocated 33% of taxes on real estate sales to raise Florida's conservation funding to ~$10 billion over 20 years. But, the Florida Legislature and Administration refused to use the money to purchase lands as intended, instead using the funding for operating costs normally paid by the state's general fund, probably because it interfered with the pro-development political agenda that has long been a major driver of Florida politics (Staletovich 2016). Clearly, however, Florida voters have a bipartisan history of supporting conservation, and civil society support is critical to legitimizing government conservation policy.

The 1972 Water Resources Act created the water management districts organized around watersheds, designating regulatory authority at the regional level. This regional approach was intended to empower water management districts to make fast-moving decisions as conditions change and provide the expertise to understand how water systems work, since the districts have researchers on staff and collaborate with the various research universities across the state. The promise of this design was that it was a science-based, watershed-specific approach. However, in practice, the districts have heavily favored growth and development to the point that within the first decade of the 21st century the St. John's Water Management District had reached its "sustainable maximum," exhausting the amount of water available for growth and leaving very little for conservation of critical seeps and springs.

Finally, growth management is critical to conservation efforts to avoid low-density development (sprawl) that fills in an area's available green space and habitats. The 1985 Local Government Comprehensive Planning and Land Development Regulation Act dictated coordinated regional planning through the Florida Department of Community Affairs. However, in 2011 the act was replaced with the Community Planning Act, which removed strict state oversight for "expedited" reviews handled through the state's Department of Economic Opportunity (DEO). This change was meant to open development and remove government obstacles.

Overall, there is a substantial history of institutions for conservation in place in Florida that can be effective, but often these institutions end up favoring development for political reasons.

Paths Forward in Climate Mitigation in Florida

As Florida continues to grow, opportunities exist to improve land-use planning for climate mitigation and improve land conservation. This will increase the resilience of ecological conditions that provide critical life support for Floridians (e.g., more sustainable hydrological conditions) and keep options on the table for the future.

As the "Sunshine State," Florida's energy policy certainly has enormous room for growth in the area of solar energy. For example, solar panels could be a requirement for all new home and business construction. This would provide increased energy independence, lower energy bills for homeowners, and added employment for solar panel installation and maintenance.

Regardless of the specific strategies adopted, attention to disparate impacts on disadvantaged populations should always remain a priority, and efforts toward creating "green" cities (e.g. better mass transit, that mitigate carbon emissions) have the added benefit of resulting in many other sustainability benefits to residents. As with past efforts to manage growth, large challenges exist to obtaining funding, affecting intergovernmental cooperation, and achieving equity in infrastructure spending and policies. Innovative collaborative community involvement and effective communication will be invaluable in addressing collective risk and opportunity (Susskind et al. 2015).

Impacts of Climate Change on Florida's Human Population

We now turn to the impacts of climate change that Florida, specifically, will need to adapt to including SLR, social vulnerability, economic impacts, and the loss/damage for which governments, businesses, and residents will be unable to prepare for. Then, we discuss the planning obstacles and initiatives, including emergency management, to climate-related impacts in Florida.

Sea Level Rise (SLR)

Developing a spatial understanding of SLR is not a new scientific endeavor. Many have modeled potential rising water impact areas from the scientific perspective (Allison et al. 2011; Camber 1992; Hoffman et al. 1983; Rahmstorf 2007) as well as hypotheses and theories on global (Awosika et al. 1992, Stocher et al. 2010), national (Dunbar et al. 1992; FEMA 1991; Smith and Tirpak 1989; Titus 1986; Yohe 1990; Yohe 1996), and more localized (Kana et al. 1984, 1986, 1988) levels (Diaz and Murnane 2008). Fortunately, the geospatial processes required to understand the spatial relationship between estimated water height and potential areas of inundation are very sound (Engelen et al. 1995) and have been used widely over the past two decades to describe the physical impacts of SLR (Dasgupta et al. 2009; Li et al. 2009; Neumann et al. 2010). Titus and Narayanan (1995) described probabilities (by 2010) associated with non-anthropogenic climate change SLR ranging from 55cm to 120 cm. More recent projections range from a .5- to a 1.4-meter rise from 1990 levels by 2100 (Rahmstorf 2007). Planning for the possible effects of a changing climate first requires an understanding of the spatial "footprint" of adverse impacts. One way to understand this is through a geospatial assessment of areas at or below suggested sea level rise estimates.

Florida's vulnerability to sea level rise hazards is represented through a combination of quality digital elevation models (DEM) derived for the entire state using Light Detection and Ranging (LIDAR) systems. This DEM product, available from the Florida Geographic Data Library (FGDL), represents the best available statewide elevation data. FGDL cites four sources for this mosaic dataset of elevation:

1. Northwest Florida Water Management District (NWFWMD) DEM. Reported vertical accuracy ranges from 13 to 30 centimeters.
2. NOAA LIDAR Coastal DEM. Produced using Federal Emergency Management Agency (FEMA) accuracy standards from the Guidelines and Specifications for Flood Hazard Mapping Partners (Federal Emergency Management Agency 2013).
3. Florida Fish and Wildlife Conservation Commission (FWC) Florida Statewide 5-Meter DEM. Produced using U.S. National Map accuracy standards (U.S. National Map 2013).
4. Contour Derived DEM. Based on 2 ft contours from the coastal LiDAR project. The biggest portion of this source data is for the area around Lake Okeechobee, where LIDAR data was from provided by Merrick & Company.

Potential inundation zones were identified spatially through a standard "bathtub" fill flood modeling approach similar to those used in other studies (Rowley et al. 2007; Poulter and Halpin 2008; Mazria and Kershner 2007). Specifically, the DEM was classified as flooded/not flooded based on the value of each grid cell in relation to a given sea level rise scenario. Here, we present the "intermediate-high" scenario from the National Climate Assessment in Table 1.1 and Fig. 1.2 (Parris et al. 2012). We chose to highlight this scenario because lower scenarios primarily take into account the ocean warming, but not ice sheet loss in Antarctica, Greenland, and glaciers; thus, these lower estimates are not realistic (DeConto and Pollard 2016). Florida should plan for at least the SLR presented here, which are based on predictions by Rahmstorf (2007) and imply 126.3 cm SLR by 2100 compared to 1990 levels.

The resulting grid representations show all areas in the state with elevations at or below each scenario threshold, regardless of their situation to the coast. A spatial cost distance algorithm (McCoy et al. 2001) was used to remove those grid cells that met the elevation criteria but were "disconnected" from the coastline.

Caveats: Sea Level Rise Measurement Complexity

Hypothesizing about the potential impacts of possible sea level rise across the coast of Florida is not an exact science. Not only do projections of sea levels in 10, 20, 50, or 100 years continue to be moving targets, but methods, tools, data, and processes for measuring such changes are continuously evolving. Changes in any one of these can have a dramatic effect on the resulting "knowledge" about sea level rise inundation, especially when looking at very small scales. We can, however, with some regional certainty, begin to identify by census tracts those areas where environmental threats such as SLR will interfere with the current human use system. Census tracts are subdivisions of a county that are fairly permanent over time, monitored and delineated by the U.S. Census Bureau. We can also overlay discrete entities on the ground, such as critical facilities, with representations of SLR inundation areas to map specific possible impacts. However, spatial differences between elevation and potential SLR could produce spatial inaccuracies at the local level and these generalized results should not be employed beyond simple visual display.

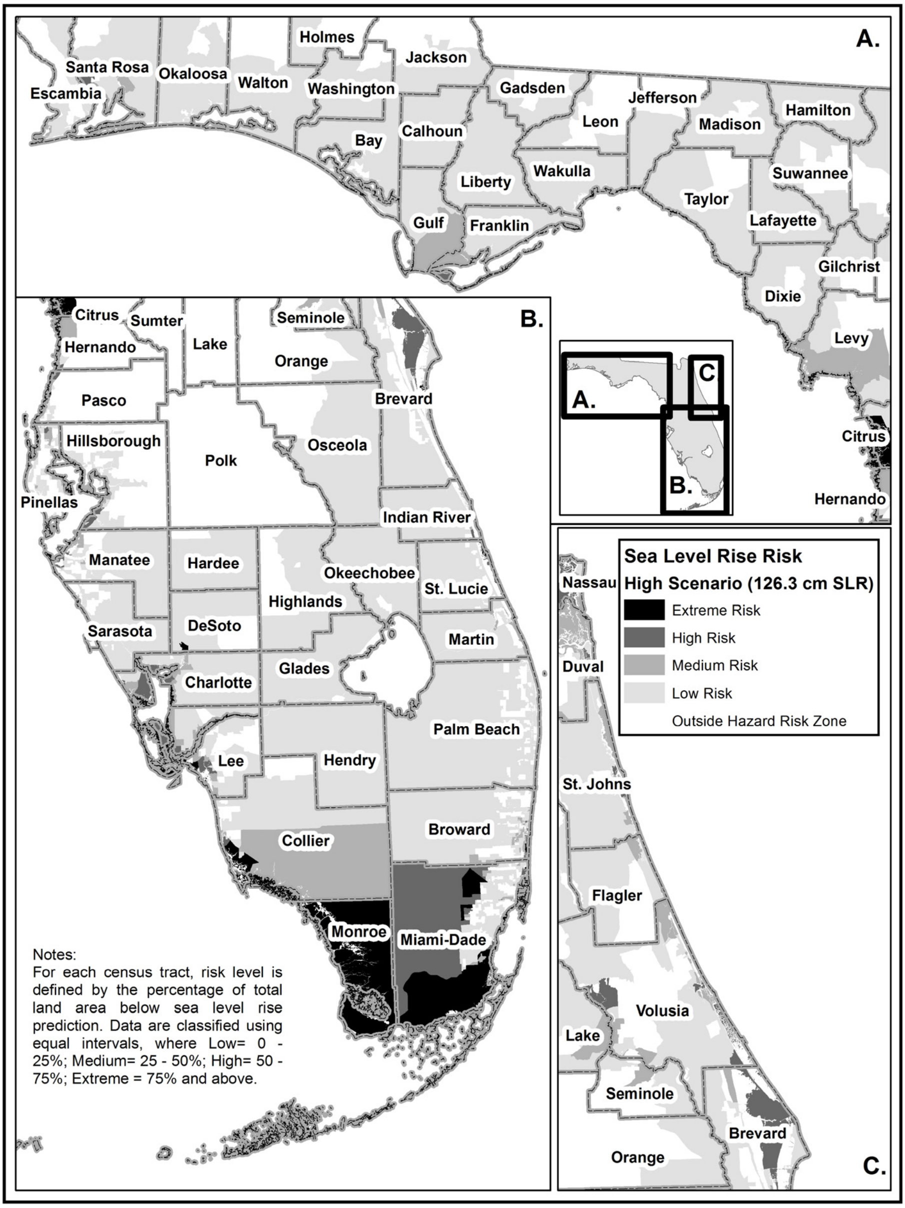

Figure 1.2. Sea level rise risk in Florida (126.3cm by 2100). Areas included are contiguous from the shore.

Table 1.1. Sea level rise (SLR) estimated risk by census tract within counties.

County Name	SLR - High Estimate (Connected Area Under 126.3 cm) Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Alachua	0	0	0	16,164	231,172
Baker	0	0	0	0	27,115
Bay	0	0	6,946	133,878	28,028
Bradford	0	0	0	0	28,520
Brevard	3,300	23,025	25,929	296,824	194,291
Broward	8,638	26,566	147,664	940,949	624,249
Calhoun	0	0	0	14,625	0
Charlotte	0	18,010	24,122	115,936	1,910
Citrus	9,092	0	0	21,077	111,067
Clay	0	0	13,596	154,992	22,277
Collier	11,601	11,861	23,527	159,380	115,151
Columbia	0	0	0	24,177	43,354
DeSoto	1,218	0	0	22,672	10,972
Dixie	0	0	0	11,432	4,990
Duval	0	6,261	70,385	413,209	374,408
Escambia	0	0	3,978	136,281	157,360
Flagler	0	3,217	3,986	35,001	53,492
Franklin	0	1,690	2,804	7,055	0
Gadsden	0	0	0	26,582	19,807
Gilchrist	0	0	0	10,510	6,429
Glades	0	0	0	12,884	0
Gulf	0	0	4,450	11,413	0
Hamilton	0	0	0	14,799	0
Hardee	0	0	0	26,772	959
Hendry	0	0	0	39,140	0
Hernando	0	3,027	5,516	3,686	160,549
Highlands	0	0	0	26,792	71,994
Hillsborough	15	4,547	16,947	377,145	830,572
Holmes	0	0	0	5,544	14,383
Indian River	0	3,212	19,765	88,621	26,430
Jackson	0	0	0	25,398	24,348
Jefferson	0	0	0	4,380	10,381
Lafayette	0	0	0	8,870	0
Lake	0	0	1,634	21,594	273,824

County Name	SLR - High Estimate (Connected Area Under 126.3 cm) Hazard Risk				
	Extreme (75%)	High (50%-75%)	Medium (25%-50%)	Low (<25%)	Out
Lee	8,607	39,046	72,318	320,537	178,246
Leon	0	0	0	18,183	257,304
Levy	0	0	3,289	10,867	26,645
Liberty	0	0	0	8,365	0
Madison	0	0	0	10,553	8,671
Manatee	4,849	14,032	20,278	171,894	111,780
Marion	0	0	0	45,980	285,318
Martin	0	0	17,752	95,554	33,012
Miami-Dade	89,865	137,904	168,936	1,167,648	928,774
Monroe	49,345	14,453	3,548	5,744	0
Nassau	0	12,311	7,980	48,964	4,059
Okaloosa	0	0	0	141,294	39,528
Okeechobee	0	0	0	30,627	9,369
Orange	0	0	0	24,945	1,121,011
Osceola	0	0	0	7,194	261,491
Palm Beach	0	1,683	14,521	956,024	347,234
Pasco	1,487	8,141	16,134	50,114	388,821
Pinellas	0	27,854	95,871	377,269	415,548
Polk	0	0	0	0	602,095
Putnam	0	0	9,421	49,578	15,365
Santa Rosa	0	4,266	4,996	127,972	14,138
Sarasota	0	6,331	8,425	253,376	111,316
Seminole	0	0	7,396	77,961	337,361
St. Johns	0	6,822	17,256	142,915	23,046
St. Lucie	5,841	3,686	4,520	198,634	65,108
Sumter	0	0	0	0	87,023
Suwannee	0	0	0	25,419	16,132
Taylor	0	0	0	13,097	9,473
Union	0	0	0	0	15,535
Volusia	0	15,470	53,573	180,162	245,388
Wakulla	0	0	0	30,776	0
Walton	0	0	0	34,262	20,781
Washington	0	0	0	16,682	8,214

State Summary

Eight Florida counties have residents at some extreme risk (i.e., census tracts with > 75% land below specified elevation to even the lowest prediction of sea level rise being investigated here), with Desoto, Lee, and Monroe counties exhibiting the highest levels of risk to even the lowest predicted sea level rise of 28.5cm (not shown) of SLR. In these counties, at least 50% of the land area in some census tracts is below this elevation. However, the lowest predicted risk is not realistic. Using a middle estimate of 66.9 cm of sea level rise, shows that 16 counties contain tracts with greater than 50% of their land area (affecting more than 168,000 people) in a high risk zone, with immense flooding and erosion risks to coastal and inland areas.

Extreme Events

Here we discuss, albeit briefly due to space limitations, Florida's most important climate-related extreme events — hurricanes. From 1871-1993, there were almost 1,000 hurricanes in the Florida Atlantic, Gulf of Mexico, and Caribbean Sea; 74 made landfall in Florida with hurricane force winds (74 mph) and 105 with tropical storm force winds (up to 73mph) (Doehring et al. 1994). Warming sea surface temperatures from climate change are expected to increase the strength, but not necessarily the frequency, of hurricanes in the Atlantic (Elsner et al. 2008; Webster et al. 2005; Emanuel 2005).

Florida has suffered more than $450 billion in hurricane-related damage since the beginning of the 20th century, and the average loss continues to increase given that "Florida hurricanes are getting more powerful over time" (Malmstadt et al. 2009, 121). The extent of this damage is expected to worsen, not just because there is increasing value of assets on the coast, but also because the effects of hurricanes will likely be more severe, as well. For example, together with SLR, the increases in storm intensity may increase storm surge 25-47% (Balaguru et al. 2016). In places like Miami-Dade, Broward, and Palm Beach where more than 5 million people reside, damage from strong storms will likely be in the tens of billions of dollars unless measures are taken to protect these areas.

Hurricanes present many human dimension problems. At the individual level, they can cause post-traumatic stress disorder or depression (Fullerton et al. 2015), induce pre-term labor and delivery (Grabich et al. 2016), or result in direct or indirect injury. Hurricanes can damage energy infrastructure such as power lines, and infrastructure damage is expected to increase (Grabich et al. 2016). Hurricanes press the government entities charged with managing community risks (see the section on Emergency Management later in this chapter) as well as vulnerable social groups in those communities, necessitating public engagement to adequately and fairly adapt to collective risks (Susskind et al. 2015).

Determinants of Social Vulnerability in Florida's Population

Measures of vulnerability, or the potential for harm, help us understand how social and ecological systems interact and how such interactions might lead to disastrous consequences for people (O'Keefe et al. 1976). Understanding social vulnerability facilitates preparation, response, and recovery in the face of environmental threats and has been widely addressed in literature about global climate change, risks, hazards, and disasters to describe and understand differential impacts on lives and livelihoods (Birkmann 2006; Eakin and Luers 2006; Füssel 2007; Pelling 2003; Polsky et al. 2007; Wisner et al. 2004).

The Social Vulnerability Index (SoVI®) is an empirical measure of pre-event social vulnerability to environmental hazards in the U.S. Initially applied at the county level, SoVI® is a comparative measure for the entire United Statesthat uses a long history of disaster case studies to understand socioeconomic and demographic characteristics that obstruct adequate disaster response (National Research Council 2006; Cutter et al. 2003; Heinz Center 2002). The index combines these population characteristics into a single score for each unit through factor analysis. The measure is closely related to concepts of social well-being, but is focused on characteristics that specifically hinder adequate disaster response. For example, economic status (poverty or wealth) influences a community's ability to absorb losses. On one hand, wealthier communities are better prepared, live in better-constructed homes, and often the residents have "rainy day" funds to cope with unexpected setbacks or catastrophe; whereas, communities in poverty deal with a constant lack of access to resources, safe and secure homes, insurance, and other basic necessities (Table 1.2).

Understanding how social vulnerability manifests across the state provides planners and decision-makers with detailed, geographic information about who and, more importantly, where pockets of the most marginalized people reside. Coupling this information with an empirical understanding of present and future hazards creates opportunities to address deficiencies in social support, identifies targets for governmental and non-governmental disaster preparedness initiatives, and provides a scientific basis for real hazard mitigation aimed at protecting more than just buildings and other infrastructure. Identifying vulnerabilities prior to a disaster can protect lives and livelihoods.

Twenty-seven variables were used in the SoVI-FL 2010-2014 computation (Table 1.2). To facilitate comparisons across counties, all data were from the US Census rolling five-year American Community Survey (ACS) (2010-2014). Each variable was standardized and input into a principal components analysis (PCA) to 1) determine which variables were the most important and 2) condense the number of variables to a smaller set of multi-dimensional attributes or components. Positive values are associated with increasing vulnerability, and negative values associated with decreasing vulnerability.

Six distinct components explain 67.73% of the variances in the data (i.e., the extent of vulnerability) for the SoVI-FL2010-14 (Table 1.3). These components include: 1) Class and race (driven by % in poverty, % black, and % with no access to an automobile); 2) Age (dominated by % social security beneficiaries, % an age-dependent populations); 3) Wealth (characterized by median house value, % earning more than $200K, and per capita income); 4) Ethnicity (represented by % speaking English not well or not at all and % Hispanics); 5) Gender (described by % female an % female labor force participation); and 6) People Per House(hold).

In Fig. 1.3, we see the social vulnerability scores, ranging from + 8.88 (indicating the most vulnerable tract, which is located in Broward County) to – 18.21 (the least vulnerable tract, which is located in Brevard County), mapped by five statistically-created categories (using standard deviation). The darker shades represent the more extreme ends of the scale and tells us where the least and most social vulnerability exists in Florida.

Overall, social vulnerability at the tract level is driven by a combination of socioeconomic and demographic conditions distinct to specific places at the local level. Each county is comprised of a dynamic mix of residents, often with very different demographics. What makes one place vulnerable (e.g. a high number of mobile homes and service sector employment) might not be the same characteristics or variables that influence vulnerability elsewhere (e.g., low educational attainment or unemployment), despite the fact that the resulting SoVI® classification (high) is the same. However, all places with high vulnerability will require additional assistance before, during, and after a shock or stressor such as a hurricane, in order to adequately avoid the long-term effects of the disaster's impact.

The SoVI-FL2010-14 is comprised of the six factor components outlined above. Tract level SoVI® scores by county are detailed in Tables 1.4 and 1.5. Table 1.4 shows the percentage of each county's total population in reference the SoVI® classification of the composite census tracts. For instance, 14.53% of people in Alachua County reside in census tracts with low vulnerability while nearly 20% of Okeechobee County residents reside in tracts with high social vulnerability. Table 1.5 provides an actual count of populations within these same zones for comparative purposes. Using both tables, one can easily see that although nearly 50% of the DeSoto County population resides in areas with elevated vulnerability (medium-high to high), this percentage represents less than 17,000 people; while Miami-Dade's nearly 34% located in the medium-high SoVI® class represents more than 871,000 residents.

Areas with elevated social vulnerability across the state of Florida are concentrated in three main regions. The first is within urban areas located in the southeast part of the state, north from Miami-Dade County, through Broward County, and into Palm Beach County; in these counties, we see that 86%, 28%, and 30% of the respective populations live in areas with elevated vulnerability (Table 1.4 and that social vulnerability is the product of a diverse set of drivers particular to each region. For example, the most vulnerable tracts (medium-high and high SoVI®) within these counties, while primarily driven by ethnicity (component 4) followed closely by class/race (component 1) and gender (component 5), in most cases is not solely an urban vs. rural phenomenon (Table 1.6). Of particular interest is the most vulnerable tract in Miami-Dade, which contains both low and high vulnerability populations, where vulnerability is driven up by age (component 2) and ethnicity (component 4) and down by wealth (component 3) and people per household (component 6).

The second area of elevated SoVI® is comprised of tracts located in south-central Florida, through the I-4 corridor up into the area from Hillsborough County to Orange County and throughout the periphery of Orlando, FL. Here, more than 26% of the population resides in areas with the most extreme vulnerability scores in the state (Table 1.7). In Hillsborough County, nearly 250,000 individuals are situated within 67 census tracts characterized as medium-high to high vulnerability. Nineteen tracts in Osceola County, home to more than 163,000 people, are characterized by at least medium-high vulnerability. Nearly 226,000 people (almost 20%) reside in 69 Orange County census tracts with elevated vulnerability, while Polk County has more than 30% (191,000) of people living in the medium-high to high socially vulnerable tracts. Overall, the I-4 corridor is home to more than 650,000 people within its 152 tracts characterized as high vulnerability. Again, the drivers of social vulnerability are diverse both within each county and between constituent tracts (Table 1.7). Class and Race (component 1), Gender component 5), and People Per Household (component 6) all serve to increase vulnerability in most of the 30 most vulnerable tracts within this zone, while Ethnicity-Hispanic (component 4) and Wealth (component 3) do not serve as major contributors to increased vulnerability.

The third cluster of extreme social vulnerability exists in Central Florida, trending from Pasco County in the south, north to Levy County, and east to Flagler County. Here, 133 census tracts with nearly 613,000 residents are characterized by either medium-high or high vulnerability. One of the main drivers of vulnerability (in 23 of the top 30 census tracts) is the age component. Gender also plays an important role in defining social vulnerability across this area, while class/race and ethnicity are less predictive of high vulnerability. Table 1.8 provides a breakdown of populations for the most vulnerable tracts within each county with respect to an overall social vulnerability score.

Table 1.2. Known correlates of social vulnerability and variables used to compute SoVI-FL2010-14.*

Population Characteristic and Specific Variables	**Influence on Social Vulnerability**
Race and ethnicity % African American % Native American % Asian or Pacific Islander % Hispanic	Imposes language and cultural barriers for disaster preparedness and response; affects access to pre- and post-disaster resources; there is a tendency for minority groups to occupy high-hazard areas; non-white and non-Anglo populations are often most vulnerable.
Socioeconomic Status Per capita income % households earning more than $200,000 % poverty	Affects a community's ability to absorb losses; wealth enables communities to recover more quickly using insurance, personal resources; poverty makes communities less able to respond and recover quickly.
Gender % females in labor force % female population % female headed household, no spouse present	Women often have a more difficult time coping after disasters than men due to role in the employment sector (care taking), lower wages, and family care responsibilities.
Age Age depended populations (% population under 5 years old and % population over 65) Median age	Age extremes (the elderly and very young) increase vulnerability; parents must care for children when daycare facilities are not available; elderly may have mobility or health problems
Renters % renters Median Gross Rent	Renters are often transient populations with limited ties to the community; they often lack shelter options when lodging becomes uninhabitable after disasters or too costly; they typically lack insurance and often lack savings.
Residential property Median value of owner occupied housing % housing units that are mobile homes % Unoccupied Housing Units	The value, quality, and density of residential construction affects disaster losses and recovery; expensive coastal homes are costly to replace; mobile homes are easily damaged
Occupation % employed in farming, fishing, forestry % employed in service occupations	There is a greater likelihood that some occupations, especially those involving resource extraction (fishing, farming), will be adversely affected by disasters; service sector jobs suffer as disposable income declines; infrastructure employment (transportation, communications, utilities) is subject to temporary disruptions post-disaster.
Family Structure Average number of people per household % children in single parent households	Families with a large number of dependents or single-parent households may be more vulnerable because of the need to rely on paid caregivers.
Employment % civilian labor force unemployed	Communities with high numbers of unemployed workers (pre-disaster) can bemore vulnerable, because jobs are already difficult to obtain; this slows the post-disaster recovery.
Education % population over 25 with no high school diploma	Limited educational levels influence ability to understand pre-disaster warning information and likely disaster impacts; knowledge about and therefore access to post-recovery resources

Population Growth % ESL (poorly or not at all)	New immigrant populations often lack language skills and are unfamiliar with state and federal bureaucracies with regards to obtaining disaster relief; may not be permanent or legal residents; unfamiliar with the range of hazards common to an area.
Social Dependency and Special Needs Populations % collecting social security benefits % nursing home residents % no automobile	Residents totally dependent on social services for survival are often economically marginalized; special needs populations (e.g., the infirmed) require more time for evacuation and recovery is often difficult.

*Source: (Cutter et al. 2003; Heinz Center 2002)

Table 1.3. Components of the Social Vulnerability Index-Florida (SoVI-FL2010-2014).

Florida Tract Level 2010-14 Social Vulnerability Component Summary

Component	*Cardinality*	*Name*	*% Variance Explained*	*Dominant Variables*	*Component Loading*
1	+	Class and Race (Black)	16.831	% POVERTY	0.786
				% BLACK	0.784
				% WITH NO AUTOMOBILE	0.720
				% FEMALE HEADED HOUSEHOLDS	0.693
				% EDUCATION LESS THAN 12TH GRADE	0.601
				% RENTERS	0.540
				% EMPLOYED IN SERVICE SECTOR	0.520
				% KIDS IN 2 PARENT FAMILIES	-0.674
2	+	Age (Elderly)	14.586	% SOCIAL SECURITY BENFICIARIES	0.916
				% AGE DEPENDENT POPULATIONS	0.886
				MEDIAN AGE	0.847
				% UNOCCUPIED HOUSING UNITS	0.554
3	-	Wealth	13.087	MEDIAN HOUSE VALUE	0.897
				% EARNING MORE THAN $200k	0.881
				PER CAPITA INCOME	0.828
				MEDIAN GROSS RENT	0.529
4	+	Ethnicity (Hispanic)	8.939	% SPEAKING ENGLISH NOT WELL OR NOT AT ALL	0.914
				% HISPANICS	0.910
5	+	Gender (Female)	7.933	% FEMALE	0.791
				% FEMALE LABOR FORCE	0.756
				% EMPLOYED IN EXTRACTIVE INDUSTRY	-0.519
6	+	People Per House	6.353	PEOPLE PER UNIT	0.730
		Cumulative Variance Explained	**67.729**		

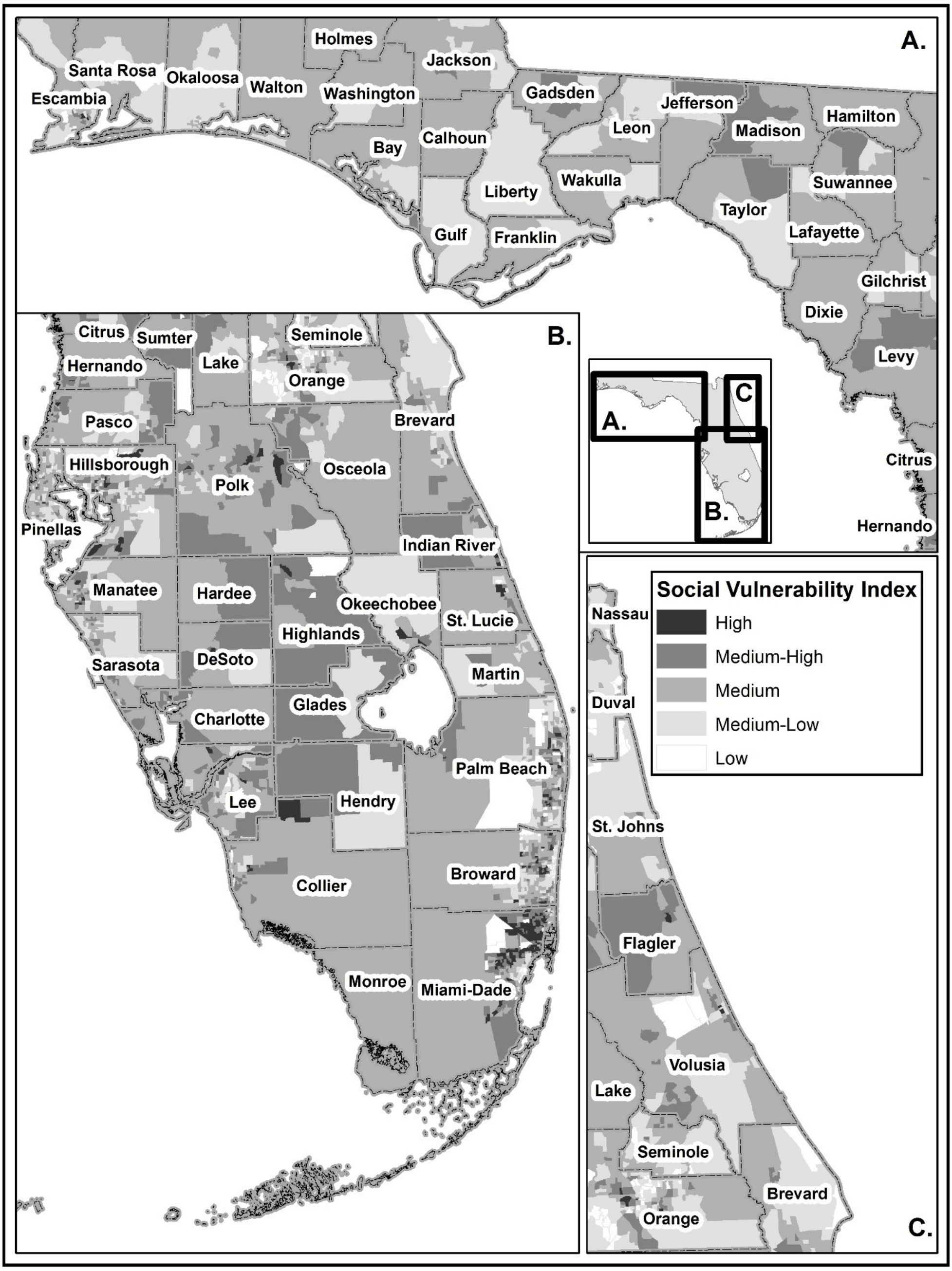

Figure 1.3. SoVI-FL2010-14 Tract-level social vulnerability in Florida.

Table 1.4. Percentage of county population by vulnerability class (SoVI-FL2010-14).

County Name	Social Vulnerability Rank				
	Low	Medium Low	Medium	Medium High	High
Alachua	14.53%	56.04%	20.75%	6.95%	1.72%
Baker	0.00%	46.18%	53.82%	0.00%	0.00%
Bay	1.84%	45.28%	47.39%	5.49%	0.00%
Bradford	0.00%	0.00%	100.00%	0.00%	0.00%
Brevard	0.23%	30.74%	55.07%	13.96%	0.00%
Broward	6.18%	22.99%	42.70%	22.79%	5.33%
Calhoun	0.00%	0.00%	100.00%	0.00%	0.00%
Charlotte	2.02%	2.07%	50.67%	42.58%	2.65%
Citrus	0.00%	3.55%	55.57%	40.88%	0.00%
Clay	0.00%	37.91%	58.13%	3.96%	0.00%
Collier	2.70%	9.07%	55.94%	21.26%	11.03%
Columbia	0.00%	0.00%	95.11%	4.89%	0.00%
DeSoto	0.00%	13.70%	37.50%	41.71%	7.09%
Dixie	0.00%	0.00%	100.00%	0.00%	0.00%
Duval	7.28%	42.88%	38.45%	7.68%	3.72%
Escambia	5.60%	39.61%	43.12%	10.54%	1.13%
Flagler	0.00%	0.00%	59.57%	34.47%	5.96%
Franklin	0.00%	52.82%	47.18%	0.00%	0.00%
Gadsden	0.00%	9.18%	43.85%	46.97%	0.00%
Gilchrist	0.00%	28.73%	71.27%	0.00%	0.00%
Glades	0.00%	28.20%	0.00%	71.80%	0.00%
Gulf	0.00%	77.23%	22.77%	0.00%	0.00%
Hamilton	0.00%	0.00%	100.00%	0.00%	0.00%
Hardee	0.00%	0.00%	55.46%	44.54%	0.00%
Hendry	0.00%	14.31%	28.13%	57.56%	0.00%
Hernando	0.00%	0.99%	60.91%	37.12%	0.98%
Highlands	0.00%	0.00%	16.52%	77.13%	6.35%
Hillsborough	11.44%	32.04%	36.95%	16.47%	3.10%
Holmes	0.00%	0.00%	100.00%	0.00%	0.00%
Indian River	0.00%	15.16%	46.96%	35.21%	2.67%
Jackson	0.00%	28.62%	58.90%	12.48%	0.00%
Jefferson	0.00%	44.40%	28.66%	26.94%	0.00%
Lafayette	0.00%	32.60%	67.40%	0.00%	0.00%
Lake	0.00%	13.58%	60.28%	24.73%	1.41%

County Name	Social Vulnerability Rank				
	Low	Medium Low	Medium	Medium High	High
Lee	0.17%	15.35%	53.63%	27.34%	3.52%
Leon	10.76%	52.88%	30.45%	5.90%	0.00%
Levy	0.00%	0.00%	66.25%	33.75%	0.00%
Liberty	0.00%	100.00%	0.00%	0.00%	0.00%
Madison	0.00%	31.53%	37.84%	30.63%	0.00%
Manatee	0.00%	25.33%	48.32%	21.09%	5.26%
Marion	0.61%	10.72%	43.88%	42.44%	2.34%
Martin	0.00%	19.05%	75.06%	4.63%	1.26%
Miami-Dade	4.75%	6.33%	18.60%	33.50%	36.82%
Monroe	1.72%	60.70%	35.25%	2.34%	0.00%
Nassau	2.02%	47.21%	50.77%	0.00%	0.00%
Okaloosa	7.07%	67.10%	25.83%	0.00%	0.00%
Okeechobee	0.00%	28.54%	39.78%	12.40%	19.27%
Orange	9.26%	35.01%	36.94%	16.43%	2.37%
Osceola	0.00%	5.12%	38.49%	56.38%	0.00%
Palm Beach	3.03%	26.99%	40.09%	24.44%	5.45%
Pasco	0.00%	20.46%	58.90%	19.80%	0.84%
Pinellas	3.60%	36.79%	46.25%	11.20%	2.16%
Polk	0.01%	11.41%	57.50%	27.20%	3.89%
Putnam	0.00%	9.40%	38.65%	51.95%	0.00%
Santa Rosa	5.07%	68.04%	26.89%	0.00%	0.00%
Sarasota	0.00%	18.92%	62.50%	18.59%	0.00%
Seminole	4.63%	40.53%	51.28%	3.56%	0.00%
St. Johns	7.35%	61.53%	28.94%	2.17%	0.00%
St. Lucie	0.00%	0.79%	79.24%	11.84%	8.14%
Sumter	8.48%	0.00%	23.26%	62.97%	5.29%
Suwannee	0.00%	19.07%	53.05%	27.89%	0.00%
Taylor	0.00%	35.73%	47.17%	17.10%	0.00%
Union	23.51%	48.18%	28.31%	0.00%	0.00%
Volusia	1.14%	13.09%	66.81%	17.51%	1.46%
Wakulla	0.00%	58.19%	41.81%	0.00%	0.00%
Walton	0.00%	30.53%	69.47%	0.00%	0.00%
Washington	0.00%	28.37%	71.63%	0.00%	0.00%
State Total	**7.46%**	**4.20%**	**42.78%**	**21.31%**	**24.25%**

Table 1.5. Total county population by vulnerability class (SoVI-FL2010-14).

County Name	Social Vulnerability Rank				
	Low	Medium Low	Medium	Medium High	High
Alachua	36,591	141,082	52,249	17,509	4,328
Baker	0	12,495	14,562	0	0
Bay	3,190	78,325	81,984	9,489	0
Bradford	0	0	27,552	0	0
Brevard	1,240	168,754	302,258	76,639	0
Broward	112,234	417,368	775,177	413,670	96,820
Calhoun	0	0	14,657	0	0
Charlotte	3,294	3,384	82,673	69,471	4,329
Citrus	0	4,959	77,669	57,143	0
Clay	0	73,867	113,281	7,720	0
Collier	9,026	30,335	187,106	71,119	36,888
Columbia	0	0	64,352	3,310	0
DeSoto	0	4,765	13,044	14,510	2,466
Dixie	0	0	16,137	0	0
Duval	64,077	377,687	338,637	67,619	32,730
Escambia	17,023	120,453	131,116	32,062	3,445
Flagler	0	0	58,877	34,076	5,890
Franklin	0	6,146	5,490	0	0
Gadsden	0	4,302	20,550	22,013	0
Gilchrist	0	4,870	12,078	0	0
Glades	0	3,719	0	9,471	0
Gulf	0	12,187	3,594	0	0
Hamilton	0	0	14,466	0	0
Hardee	0	0	15,278	12,271	0
Hendry	0	5,489	10,792	22,079	0
Hernando	0	1,720	105,863	64,510	1,699
Highlands	0	0	16,232	75,790	6,239
Hillsborough	146,372	409,991	472,810	210,785	39,710
Holmes	0	0	19,741	0	0
Indian River	0	21,367	66,178	49,617	3,756
Jackson	0	14,055	28,923	6,127	0
Jefferson	0	6,365	4,108	3,862	0
Lafayette	0	2,876	5,945	0	0
Lake	0	41,416	183,866	75,417	4,311

County Name	Social Vulnerability Rank				
	Low	Medium Low	Medium	Medium High	High
Lee	1,078	99,404	347,263	177,010	22,799
Leon	30,235	148,543	85,519	16,585	0
Levy	0	0	26,539	13,518	0
Liberty	0	8,302	0	0	0
Madison	0	5,959	7,153	5,789	0
Manatee	0	85,064	162,269	70,841	17,666
Marion	2,052	35,898	146,914	142,083	7,824
Martin	0	28,506	112,330	6,933	1,889
Miami-Dade	123,598	164,624	483,683	871,269	957,687
Monroe	1,292	45,648	26,509	1,759	0
Nassau	1,510	35,372	38,036	0	0
Okaloosa	13,353	126,814	48,817	0	0
Okeechobee	0	11,246	15,674	4,886	7,592
Orange	111,119	420,167	443,325	197,192	28,438
Osceola	0	14,823	111,421	163,205	0
Palm Beach	41,117	366,865	544,838	332,149	74,105
Pasco	0	96,746	278,460	93,588	3,951
Pinellas	33,336	340,306	427,819	103,597	19,972
Polk	31	70,454	354,957	167,881	24,000
Putnam	0	6,879	28,291	38,021	0
Santa Rosa	8,021	107,670	42,549	0	0
Sarasota	0	73,193	241,829	71,922	0
Seminole	20,010	175,137	221,592	15,396	0
St. Johns	14,954	125,163	58,872	4,413	0
St. Lucie	0	2,234	225,024	33,622	23,108
Sumter	8,792	0	24,126	65,302	5,488
Suwannee	0	8,275	23,024	12,105	0
Taylor	0	8,107	10,704	3,879	0
Union	3,587	7,352	4,319	0	0
Volusia	5,665	65,302	333,368	87,382	7,264
Wakulla	0	18,048	12,967	0	0
Walton	0	17,653	40,168	0	0
Washington	0	6,997	17,663	0	0
State Total	**1,444,394**	**812,797**	**8,283,267**	**4,126,606**	**4,694,728**

Table 1.6. Driving forces of the most vulnerable tracts in Southeast Florida.

County	Population	Housing Units	Components of Social Vulnerability						SoVI Score
			Class and Race (Black)	Age (Elderly)	Wealth	Ethnicity (Hispanic)	Gender (Female)	People Per Household	
Miami-Dade	88	66	1.2179	4.5794	-2.4018	4.5935	-2.5372	-1.4099	8.8454
Broward	7,843	6,255	0.8120	3.1029	-0.9002	2.4288	2.5168	-1.4726	8.2882
Miami-Dade	4,469	1,556	0.8128	0.8368	-0.7876	3.9164	0.8990	0.1206	7.3732
Miami-Dade	3,234	1,512	4.1127	0.8009	0.0694	0.4265	1.5747	0.3201	7.1655
Palm Beach	1,193	1,326	1.0047	3.7280	-0.5712	0.0549	2.3042	-0.5413	7.1218
Miami-Dade	4,940	1,541	1.8853	0.2252	-0.2061	1.3642	1.1489	1.9619	6.7916
Miami-Dade	3,801	1,352	4.2050	0.0982	0.3033	-0.7599	1.9085	1.6076	6.7561
Miami-Dade	5,510	1,502	0.3633	0.9087	-0.5276	3.8080	-0.4286	1.1867	6.3657
Palm Beach	1,963	2,313	0.6703	3.5523	-0.7563	0.5058	2.1626	-1.2931	6.3542
Miami-Dade	5,856	1,901	0.7396	0.6810	-0.4642	4.2680	0.2370	-0.0612	6.3285
Miami-Dade	8,289	2,786	0.3599	0.5737	-0.6671	4.1120	0.5118	-0.0154	6.2092
Miami-Dade	3,630	1,715	3.5189	0.4355	0.2544	-0.7202	2.0929	1.1330	6.2057
Palm Beach	1,802	1,779	-0.2285	2.8070	-0.8385	0.6007	3.0698	-0.9569	6.1306
Miami-Dade	4,014	2,138	0.8865	1.4334	-0.6721	4.0492	0.6981	-1.6755	6.0636
Miami-Dade	4,820	1,235	-0.5343	0.8093	0.0774	3.3765	0.3832	2.0479	6.0053
Miami-Dade	6,276	1,773	-0.2156	0.3694	-1.4943	2.9608	-0.2238	1.5954	5.9805
Miami-Dade	5,166	1,492	2.3073	-0.1479	-0.3674	0.7555	1.3845	1.3128	5.9797
Miami-Dade	3,936	1,287	0.3930	0.9913	-0.6135	3.4766	0.5120	-0.0189	5.9675
Miami-Dade	4,432	1,250	1.3060	0.3074	-0.3404	1.9449	-0.3133	2.3503	5.9357
Miami-Dade	5,117	1,455	0.5912	0.3161	-0.3222	3.6855	0.3673	0.6512	5.9335
Palm Beach	3,266	1,201	3.7131	-0.0261	0.1260	-1.1593	1.9815	1.5496	5.9328
Miami-Dade	4,743	2,008	0.2250	0.7563	-0.8020	4.3913	0.5249	-0.8144	5.8851
Miami-Dade	3,813	1,318	4.3339	-0.1709	0.3042	-0.7122	1.5071	1.2079	5.8616
Miami-Dade	5,565	2,257	1.7737	0.5730	-0.4958	4.3141	0.0336	-1.4471	5.7432
Miami-Dade	5,128	1,493	-0.0003	0.7560	-0.3095	3.5597	0.0549	1.0282	5.7079
Palm Beach	1,645	2,320	0.9547	3.7866	-0.7031	-0.1342	1.7208	-1.3246	5.7064
Broward	4,682	1,611	2.5791	-0.0820	-0.0325	-0.4243	2.0231	1.5523	5.6807
Miami-Dade	5,573	1,908	0.6237	0.2449	-0.6297	3.5361	0.9211	-0.3124	5.6432
Miami-Dade	7,879	3,127	0.7526	0.4651	-0.4743	3.9420	0.5395	-0.5416	5.6320
			Vulnerability Driver			Vulnerability Detractor			

Table 1.7. Driving forces of the most vulnerable tracts in south central and central Florida.

County	Population	Housing Units	Components of Social Vulnerability: Class and Race (Black)	Age (Elderly)	Wealth	Ethnicity (Hispanic)	Gender (Female)	People Per Household	SoVI Score
Hillsborough	3,749	1,282	5.5028	-0.0159	0.2392	0.0778	1.5443	0.3552	7.2250
Orange	1,597	549	4.5859	-0.1379	0.3820	-0.7103	2.1612	1.0722	6.5890
Hillsborough	3,547	1,202	3.5645	-0.2142	0.0495	-0.8347	2.1604	1.7238	6.3503
Highlands	5,079	1,842	2.2010	0.7052	-0.3365	0.3124	-0.2242	2.1511	5.4819
Orange	4,268	1,622	3.5390	0.2234	0.0320	-0.9335	1.5974	0.9827	5.3771
Lee	6,903	1,812	2.2318	-0.6297	-0.2523	1.5480	0.1694	1.6941	5.2659
Orange	4,355	1,637	2.3729	0.1808	0.0036	-0.8126	1.8225	1.5804	5.1405
Hillsborough	4,252	1,626	1.0956	0.4405	-0.4032	2.1935	0.7362	0.2000	5.0690
Hillsborough	3,273	2,402	-0.1722	2.9633	-0.2489	0.3772	2.0890	-0.5678	4.9384
Polk	3,284	1,283	2.2267	0.3987	-0.5189	-0.0576	0.2108	1.5705	4.8679
Polk	4,239	2,965	-0.6859	2.3720	-1.8200	-0.2855	0.8241	0.7307	4.7753
Hillsborough	4,055	1,752	3.2071	0.0539	0.0563	-0.8651	1.2306	1.1308	4.7011
Orange	5,167	1,937	-0.0736	0.7876	-1.6029	1.0978	-0.0498	1.2908	4.6558
Hillsborough	2,414	1,844	-0.0114	2.9158	-0.7606	-0.2088	1.7467	-0.5721	4.6308
Hillsborough	2,528	1,957	0.1497	3.4625	-0.3644	-0.1049	1.3907	-0.6374	4.6249
Lee	4,701	1,514	3.2213	-0.1851	0.0489	-0.8772	0.5037	1.8280	4.4418
Hillsborough	2,205	1,681	0.7211	3.3791	0.0487	0.8741	1.2246	-1.7498	4.4004
Lee	3,951	1,259	2.3066	-0.0201	-0.1127	0.5615	-0.2570	1.5958	4.2995
Hillsborough	3,461	1,438	2.8186	-0.3909	-0.2217	-0.4322	1.7687	0.2772	4.2630
Lee	4,414	2,932	-0.9073	3.1801	-1.1557	-0.3881	0.0890	1.0829	4.2123
Hillsborough	54	26	-1.3027	1.3280	-1.7727	-0.9094	3.1393	0.1758	4.2037
Polk	6,382	1,883	1.1911	-0.0714	-0.8297	2.1336	-1.1291	1.1824	4.1362
Hillsborough	1,528	1,137	-0.6433	2.2920	-1.9926	-0.5360	0.3012	0.6820	4.0886
Lee	2,830	1,220	3.3533	0.3663	-0.1391	-0.9024	0.8571	0.2723	4.0856
Hillsborough	2,579	1,139	3.4869	-0.3645	0.4230	-1.1463	1.6308	0.8217	4.0054
Hillsborough	820	550	-0.0260	3.3768	0.3217	0.1805	1.2906	-0.5189	3.9813
Orange	7,046	2,727	2.6517	-0.8453	-0.0532	-0.4778	1.7117	0.8439	3.9374
Orange	6,005	2,416	2.3273	-0.5481	-0.1450	-0.0463	1.0965	0.9344	3.9088
Hillsborough	5,172	1,929	0.6797	-0.1728	-0.3851	1.1672	0.9417	0.8227	3.8236

Vulnerability Driver | Vulnerability Detractor

Table 1.8. Driving forces of the most vulnerable tracts in Central Florida.

County	Population	Housing Units	Components of Social Vulnerability						SoVI Score
			Class and Race (Black)	Age (Elderly)	Wealth	Ethnicity (Hispanic)	Gender (Female)	People Per Household	
Hernando	1,699	1,288	0.2864	3.5500	-0.5571	-0.4180	1.6437	-0.0993	5.5198
Sumter	4,533	3,235	0.0903	3.3919	-0.5514	0.0208	1.8602	-0.4580	5.4565
Marion	1,484	792	4.5145	0.5212	0.2639	-1.4485	0.5967	1.2996	5.2197
Pasco	1,636	1,465	1.0979	2.3097	-1.4662	-0.8829	0.5196	0.2222	4.7327
Marion	6,340	4,526	0.0901	3.2195	-0.6428	-0.1093	1.2391	-0.4918	4.5904
Pasco	2,315	1,704	-0.4419	2.6609	-1.3033	-0.6072	1.1174	0.4387	4.4712
Lake	4,311	3,609	0.0526	3.6739	-1.2826	-0.4053	0.2493	-0.6315	4.2216
Sumter	955	400	3.5249	-0.4418	0.1597	-1.5814	1.4770	1.3868	4.2059
Flagler	5,890	2,951	-0.4619	1.2459	-0.4608	-0.0266	1.5690	0.9188	3.7060
Putnam	4,412	1,659	2.5998	0.2626	-0.2585	-0.9054	0.6123	0.8415	3.6693
Pasco	1,625	1,620	-1.1043	3.5444	-2.2348	-0.9361	-0.6508	0.5298	3.6177
Pasco	2,923	1,790	0.8256	2.0970	-1.4225	0.3053	0.5561	-1.5900	3.6165
Sumter	10,736	6,687	-0.8232	2.7351	-0.6006	-0.2321	1.2832	-0.0741	3.4894
Marion	14,839	8,866	-0.4982	2.2914	-0.9034	-0.2109	0.9680	0.0346	3.4884
Citrus	5,087	2,897	0.5754	1.0065	-0.9511	0.0718	1.1755	-0.3693	3.4111
Pasco	2,755	1,510	-0.0495	2.0205	-1.6526	-0.2754	-0.7949	0.7495	3.3028
Marion	6,776	2,939	0.2380	0.8337	-0.5015	-0.2170	1.0674	0.8281	3.2518
Hernando	4,750	2,885	-1.1681	2.2436	-1.8801	-0.4512	0.1537	0.5891	3.2472
Sumter	5,186	3,158	-0.7210	2.7810	-0.9187	-0.0893	0.7426	-0.4026	3.2294
Hernando	2,457	1,712	-0.2461	3.1665	-0.2692	-0.0787	0.8523	-0.7437	3.2195
Hernando	1,393	1,075	-0.3955	2.6499	-0.8558	-0.2395	1.2934	-0.9610	3.2029
Citrus	2,927	1,874	-0.2764	1.3940	-1.1696	-0.6701	1.0875	0.4605	3.1651
Hernando	3,467	2,335	-0.4464	2.1977	-1.5732	-0.7456	0.0238	0.5510	3.1537
Pasco	3,536	2,249	-1.0511	2.7709	-1.8268	-0.4926	-0.3353	0.4025	3.1213
Citrus	5,796	3,297	0.1345	1.0962	-0.9458	-0.7428	1.3828	0.2575	3.0739
Pasco	3,801	1,327	0.8291	0.7294	-1.1545	0.6400	-1.3576	1.0715	3.0670
Marion	13,701	5,713	0.5960	0.3076	-0.5528	0.1944	0.6660	0.6598	2.9766
Putnam	2,673	1,397	2.8233	0.0381	0.2469	-1.1383	1.2660	0.2037	2.9459
Marion	6,933	4,082	0.2152	1.8160	-0.6425	-0.5971	0.7077	0.1515	2.9357
Marion	10,495	6,107	-0.6963	2.1008	-0.9606	-0.1564	0.5890	0.1176	2.9152

Vulnerability Driver   Vulnerability Detractor

Economic Impacts

Here, space permits only a very brief outline of the potentially massive economic impacts of climate change on Florida that will affect nearly every economic sector -- from transportation to tourism and agriculture. These impacts will not only cost billions in hurricane damage alone, but also alter economic opportunities throughout the state into the future.

Officials in Miami-Dade County are charged with protecting nearly $9 trillion in infrastructure from climate-related threats including SLR. Thus in the city of Miami Beach, they have planned to spend between $400-500 million to upgrade stormwater drains that allow for saltwater intrusion and cause what is referred to as "sunny day" flooding of low-lying neighborhoods (Cocchiarella 2016). Of course, Florida tourism is deeply tied to beach tourism and the comparative attractiveness of Florida may change with threats such as SLR, storms, or the spread of vector-borne diseases (such as Zika) (Agnew and Viner 2001). Unfortunately, beach erosion increases under even minor SLR and can erode away the barrier islands where so many Florida beaches are located (FitzGerald et al. 2008). Since 1998, the Florida Beach Management Funding Assistance Program has paid approximately $626 million of an estimated $2 billion spent to mitigate beach erosion; that represents about a third of the total cost, with the rest of the funds coming from federal and local governments (Florida Department of Environmental Protection).

More flooding, higher heat extremes, and stronger tropical storms and hurricanes are anticipated across the southeast region of Florida, all of which can have significant economic impacts. Increased CO_2 can aid photosynthesis of tree crops (increasing revenues) as well as weeds (adding costs) (Asseng et al. 2013). Roads engineered to handle SLR exceed typical road construction costs by $2-3 million per lane mile (Bloetscher et al. 2013), adding to the state's transportation costs. And, of course, energy costs will be. For example, much literature already exists to demonstrate that household consumption goes up (studies vary on how severely) with the need for increased use of air conditioning, although it is also the case that such an increase can ultimately lead to the adoption of long-term, energy cost-saving measures such as the purchase of solar panels or energy-efficient appliances (Auffhammer and Mansur 2014). Other climate-related effects such as ozone increases due to warming air, more harmful algae blooms due to warmer waters, and vector-borne diseases such as dengue, which can be affected by warming temperatures (Schramm 2013); all of these will increase health costs for individuals, and potentially affect work productivity.

These are but a few examples of how wide-ranging the economic impacts of climate change will be on Florida, and this does not even include those costs associated with mitigating greenhouse gases. Policies to guard against these trends require investing in programs that increase options, such as coastal conservation, distance people from harm, open discussions, and increase education.

"Loss and Damage"

Loss and damage is an Intergovernmental Panel on Climate Change (IPCC) category for economic and non-economic impacts people cannot adapt to but are forced to pay for, such as the costs of internally displaced residents who must flee their homes for safer ground to areas that are not ready for them. Given the SLR analysis above, some of Florida's coastal areas will ultimately have to be abandoned, which will result in both economic (e.g., infrastructure and buildings) and non-economic losses (e.g., ecological and cultural losses). The options for dealing with SLR range from installation of concrete sea walls that often lead to even worse erosion, to restoring dunes and protecting coastal habitats (e.g. salt marshes) through ecological engineering. Ecosystem restoration may be "the most important for reducing exposure to hazards" (Arkema et al. 2013). — But protecting all of Florida's threatened coastlines is probably not practical. Thus, there will be land and property lost, people displaced, and infrastructure investments "sunk."

On the other end of the spectrum, refugees from climate-vulnerable areas such as the Caribbean and Haiti may choose to relocate to Florida, having been pushed out of their homes due to climate-related events. This is one example of inequities that will affect not only people vulnerable to direct effects but poor people who will not have capital or other resources to adapt. And the cost to Florida for welcoming these affected refugees will be high. As a frame of reference, as of 2000, Florida was paying $250 million a year to assist Haitian refugees, many of whom had been pushed out of their homes as a result of a "grand-scale rundown of the environmental resources — soil, water and trees—that underpin their agricultural economy" (Myers 2002, 610).

Human Dimensions of Adaptation to Climate Risks

Florida is the most susceptible state in the US to tropical cyclones and flooding. Florida is also vulnerable to drought, heat events, storms, vector-borne diseases, wildfires, and SLR, all of which have the potential to become more intense and/or more frequent as climate change unfolds (Melillo et al. 2014). As a result, adaptation must be taken seriously. In fact, if the global community of nations were to aggressively cut emissions, 900 fewer municipalities will be submerged due to SLR. One city in Florida with over 100,000 people in this category is Jacksonville (Strauss et al. 2015). Thus, Floridians are dependent on the global community to cut (mitigate) these emissions lest we experience severe damage in the future. That said, some impacts will occur regardless of actions taken by the local, regional, and global communities, so we must also consider how Florida can adapt to inevitable changes. There are multiple definitions of adaptation (Smit and Wandel 2006), for example, the IPCC (2001) defines it as adjustments in ecological, social, or economic systems aimed at alleviating the negative effects and/or taking advantage of emerging opportunities that result from observed or expected changes in climate.

Certainly, to effectively respond to climate change, Floridians must modify their behavior: Adger, Arnell, and Tompkins (2005) wrote, "Adaptation is made up of actions throughout society, by individuals, groups, and government" across social sectors, from businesses to city councils. Fortunately, Florida does have control over some adaptive strategies at our disposal including coastal development arrangements, inland migration policies, institutions, and conservation. Unfortunately, significant obstacles exist for many of these adaptive measures.

Planning Context for Climate Change Adaptation in Florida

Given that climate change impacts will be felt at multiple scales, federal, state, and local initiatives can help the state adapt to coming changes. This section reviews state, regional, and local responses to climate change adaptation, with a particular focus on SLR adaptation planning at each of these levels.

State Climate Change Planning Initiatives

In 2007, Florida's governor established the Action Team on Energy and Climate Change to develop a climate action plan for the state. The plan, which was completed in October 2008, included recommendations for adapting to temperature changes, SLR, extreme storm events, and precipitation. It called for the creation of an eponymous commission to oversee implementation (Georgetown Climate Center 2014). However, in 2010 the Florida Legislature abolished the commission and the newly-elected governor apparently directed state officials not to use the terms "climate change," "global warming," and "sustainability" (Korten 2015).

Nevertheless, several state agencies continue their work on climate-related specific initiatives funded by federal grants. For example, the Department of Economic Opportunity (DEO) established the Community Resiliency Initiative in 2011 to provide technical support to local governments facing SLR. DEO planning staff have worked with the US Department of Environmental Protection, the National Oceanic and Atmospheric Administration (NOAA), and the US Environmental Protection Agency to inform planning/time horizons for SLR determine the scientific needs for SLR projections, develop a legal framework for action, and implement Adaptation Action Areas under the state's amended land use planning and growth management policy (Butler et al. 2013; Deyle et al. 2013; Markell 2016). The Florida Department of Health (DoH), funded by the US Centers for Disease Control, convened a technical advisory team to conduct climate- and health-related vulnerability assessments throughout the state. Florida State University now oversees this program, funding local efforts to address climate change-related health vulnerabilities. Similar efforts to develop robust data, analyses, and model building to increase our understanding of these vulnerabilities have also been undertaken in Florida's Department of Transportation, Department of Environmental Protection, Division of Emergency Management, and the Florida Fish and Wildlife Conservation Commission among others, along the same lines as the original SoVI® analysis above (Butler et al. 2013).

Sea Level Rise (SLR) Planning at the Local Level

While climate change is a global phenomenon, local and regional areas are differentially impacted and much adaptation depends on local governments' land use planning and policies, locally-relevant education and outreach, and capital investments in infrastructure improvements.

While SLR is already evident, we still must and can plan for future SLR because we understand the basic mechanics and are familiar with how to deal with the related impacts such as coastal erosion, coastal flooding, and saltwater intrusion into both surface and groundwater (Church et al. 2013; Butler et al. 2016; Nicholls and Cazenave 2010; Wong et al. 2014). However, many of Florida's coastal communities have been slow to respond to this inevitable threat. As discussed earlier, the topic of SLR remains rife with uncertainty and complexity. This has led to what Butler et al. (2016) characterized as a "low-regrets incrementalism" approach to adaptation planning in Florida's coastal communities, where only around half of Florida coastal counties and 15% of coastal municipalities addressed SLR in their planning documents, often in non-binding planning documents such as sustainability or adaptation plans. Of those communities that did include SLR in their binding policy documents, the majority called for tentative planning in future community infrastructure, development regulations, land use amendments, or beach and inlet management. A few communities, mostly in South Florida, called for establishing Adaptation Action Areas, investing in storm water infrastructure, or raising sea wall height restrictions.

Interviews with planners in communities with more progressive responses revealed that political will to act could be influenced by high quality information and SLR models from reputable sources, along with visible impacts that could obviously be attributed to SLR (such as sunny day flooding) (Butler et al. 2016). Community attitudes to under-adaptation, tolerance of economic opportunity costs, and tolerance of uncertainty seem to determine how aggressive a community will choose to be in developing responses to SLR (Deyle et al. 2013), and most localities have not overcome the political barriers to action.

Regional Collaboration in Adaptation Planning

Where locals seem to be hesitating in many parts of the state, regional agencies and collaborative groups in the Southeast, Northeast, Southwest and Tampa Bay regions are leading the way by calculating regional sea level rise projections, supporting or developing local scale and regional scale vulnerability assessments, and convening local, regional, state and federal agencies and stakeholders to determine appropriate paths forward. An exemplar regional effort is the Southeast Florida Climate Change Compact (SEFCCC), an agreement and commitment to work together among Monroe, Broward, Palm Beach and Miami-Dade counties (Southeast Florida Regional Climate Change Compact 2016), see http://www.southeastfloridaclimatecompact.org/. This collaborative approach is important because many local governments lack the capacity to develop the complex models necessary to guide robust and adequately flexible actions that allow learning and continuous adaptation (Deyle and Butler 2013). Also, communities need to coordinate their actions — for instance, a sea wall in one community can undermine nature-based restoration of dunes or mangroves in another. A recent analysis of the SEFCCC (Vella et al. 2016) found that while it has no regulatory authority or funding to offer, it is well-regarded in the region and has influenced the policies, investments, and initiatives of many of the communities in the area. In particular, the counties involved in the SEFCCC worked with regional, state, and federal agencies, as well as other scientists and experts, to develop a Unified Sea Level Rise Projection (SEFCCC 2015) and a Regional Climate Action Plan (SEFCCC 2012) that contains 110 mitigation and adaptation action items for implementation, many of which have been undertaken by local governments in the region. Moreover, compact members share technical expertise among high level public officials in the counties and municipalities throughout the region. All of the counties and many municipalities have adopted climate adaptation elements into their comprehensive plans, relying on the Unified Sea Level Rise Projection for setting adaptation policies. Moreover, the exchange of information among key professionals from government, nonprofit and private sectors has generated new ideas for policy experimentation and adoption in many communities. This voluntary regional collaborative approach holds promise for a state where state-level planning and action has largely stalled (Vella et al. 2016).

Inland Migration and Managed Retreat

In 2015, over 20 million people were estimated to live in Florida, most of them in counties directly on the coast. Since the 1970s, the proportion of Florida population on the coast has ranged between 75-80% (U.S. Bureau of the Census 2008).

However, the threats to coastal residents from SLR are so serious that the Swiss RE Group, the largest company in the world that insures other insurance companies, official testified before the US Senate that parts of Florida may not be insurable by 2100 (Staletovich 2014). Inland migration from the coast and "managed retreat" are two important options. Managed retreat is the removal of buildings and infrastructure while also restoring the ecosystem to allow these ecosystems to protect areas from threats such as coastal flooding. Policy tools include fixed setbacks (how close a building is allowed to be to the shoreline), land acquisition, zoning options for hazardous areas, conservation easements, and immanent domain; but each of these face serious opposition from property owners (Dyckman et al. 2014), which means these tools require just and thoughtful community engagement (Susskind et al. 2015).

Inland migration faces several related challenges. Because inland areas are limited, they create what biologists call a "coastal squeeze" (i.e., as the tide rises, organisms typically move inland, but cannot if they are blocked by inland development) (Doody 2004). For plants and animals, this can cause local and regional extinctions (Luisa Martínez et al. 2014). For people, the impacts are pressures on inland land use (and prices), infrastructure, and services such as schools and first responders.

Beyond that, there are psycho-social reasons that inland migration will face resistance despite its obvious practical utility. People develop an allegiance to the place they live, as evidenced by the fact that very vulnerable places such as coastal Louisiana are continually re-inhabited after devastating storms (see for example Chamlee-Wright and Storr 2009). Furthermore, individuals and groups are often resistant to abandoning a doomed project when they have "sunk costs" into the project. Sunk costs – costs already incurred that cannot be recovered – are a prime example of how irrational decision-making should not be underestimated. For example, Janssen et al. (2003) showed empirically that pre-Columbian Pueblo societies in the southwest failed to adapt to existential civilization threats even when threats become known, including a changing climate that affected agriculture, because they had invested in the construction of buildings.

Emergency Management Response

Federal Initiative

Since the terrorist attacks of September 11, multiple policy and program efforts have focused on restructuring the Federal Emergency Management Agency (FEMA) mission and organizational structure to build capacity of local jurisdictions to prepare for, respond to, recover from, and mitigate all hazards (see Hu et al. 2014 for summary of policy changes and implementation efforts). One of the most recent efforts involves planning for future hazard risks, including climate change, at the state and local levels.

As of March 6, 2016, FEMA requires states to include these risks in the state hazard mitigation plans in order to qualify for federal disaster funding (e.g., Hazard Mitigation Assistance Mitigation Project and Public Assistance Grants Categories C-G), though states do not need to use the exact words "climate change" In their mitigation plans. Under Title 44 Code of Federal Regulation Part 201, FEMA requires all states to include a risk assessment of future hazard events and changing conditions, which aligns with the original intent of the Stafford Act. The Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121-5207; Public Law 93-288) is the largest source of federal funding to state and local governments for disaster recovery. Signed into law on November 23, 1988, the act provides up to 75% reimbursement to local and state governments recovering from a disaster. FEMA started reviewing the state hazard mitigation plans (SHMP) (as per State Guide Appendix A) for these future events and conditions. Plans need to include: …a summary of the probability of future hazard events that includes projected changes in occurrences for each natural hazard in terms of location, extent, intensity, frequency, and/or duration and considerations of changing future conditions, including the effects of long-term changes in weather patterns and climate on the identified hazards (Hazard Mitigation Planning 2016, ¶ 11).

Most states have not included climate risks in their SHMP because FEMA had not previously required it and the agency only mandates plan updates once every five years to remain eligible for this mitigation funding (Bagley 2015).

FEMA has provided approximately $1 billion annually for state and territory hazard mitigation efforts since 2010, of which Florida has received nearly $52 million annually. Between 2010 and 2014, Florida ranked sixth in the nation for obtaining FEMA's mitigation funding. Governors of states who either do not approve a plan with climate risks or who approve a plan without including these risks are ineligible for this funding (Bagley 2015).

State Plan

Currently, Florida has begun collecting information about SLR and climate change per Appendix K of the 2013 State Enhanced Hazard Mitigation Plan. Climate change is directly referenced in: Objective 2.4 of that and the 2016 plan, "Assist in the integration of climate change and SLR research into state, local and regional planning efforts;" and, Objective 4.5, "Participate in climate change and SLR research that will further the state and local government's ability to plan for and mitigate the impacts of future vulnerability." (State of Florida Enhanced Hazard Mitigation Plan 2016, objective 4.5).

Local Hazard Mitigation Strategies

Federal or state requirements to create, adopt, and implement local land use plans increases the likelihood of compliance and higher quality plans (Peacock et al. 2009; Berke 1996; Berke and French 1994; Berke et al. 2014; Burby 2006; Burby and May 1997).

Many coastal jurisdictions in the US have begun to include climate change in local hazard mitigation plans; however, these plans are not typically included in comprehensive land use plans, even though communities incorporating hazard reduction mechanisms in their land use plans experience less damage from a disaster (e.g., Nelson and French 2002). Still, not all hazards are included in land use plans equally (Srivastava and Laurian 2006). Without this link to land use plans, a hazard mitigation plan lacks regulatory power. As a stand-alone plan, there is no legal requirement for implementation or compliance and local jurisdictions allowing, at times even incentivizing, planning in hazards areas can *increase* a disaster's damaging effects by making development in these areas less expensive through government hazard reduction subsidies (Burby 2006).

Conclusion

Florida faces multiple serious threats from climate change dominated by human-emitted greenhouse gasses (GHGs). Florida is a major economy in the world and is likewise a significant emitter of GHGs. In order to reduce these emissions, it is important to address the structural causes and not simply individual behaviors that can result in GHG emissions. Structural determinants are things that organize a society. These include economic sectors, institutions, infrastructure, social stratification, and political-economic architecture, which all guide the behavior of large numbers of individuals and groups. Often these structures hinder behavioral changes. For example, individuals in Florida who wish to reduce their GHG footprint may not have access to the tools to do so, such as effective and reliable mass transit. Other structural elements, such as the state's pro-development stance that has favored land development, has reduced the primary production that allows for CO_2 sequestration and is also a precursor to highways and other features of the built-environment that provide future pathways for GHG emissions. Meanwhile, at the individual level, communicating the dynamics of climate change is not merely a matter of informing citizens of the problem, partly because there is an organized effort to cast doubt on well-established climate science basics thus confusing members of the general public, and also because many people carry varied cognitive biases that make it very difficult for them to think and act rationally to avoid climate change risks that evolve slowly, are fairly invisible, and may contradict individual beliefs or sense of reality. For example, we are far more prone to believe a risk is real if it is consistent with our preexisting beliefs, but to believe otherwise even when that risk (e.g., slowly rising seas) is a serious threat to our well-being and active behavioral change would protect our welfare.

Meanwhile, the impacts of climate change will not affect everyone equally. This chapter has detailed the geographic organization of areas most vulnerable to SLR as well as the most socially vulnerable areas throughout Florida. Eight Florida counties have census tracts where 75% of the land is under the submergence elevation – the elevation level that would flood and be inundated – even in a case of the smallest, and quite frankly unrealistic, SLR projections. DeSoto, Lee, and Monroe counties have the most extreme exposure to this risk. Worse yet, under more realistic SLR scenarios, 16 counties have census tracts where more than half of the land is under the submergence elevation (with the potential to affect more than 168,000 people living in these high risk zones), with the potential for immense SLR impacts to coastal and inland areas. Florida is arguably the state most likely to be affected by SLR in the US and with the most to lose. SLR threatens our state's revenue-generating beaches, trillions of dollars in coastline infrastructure, the income and investments of residents who may be forced to migrate inland (putting pressure on the inland areas, as well), insurance losses and the designation of more areas as uninsurable, as well as the need for massive government expenditures to solve problems such as erosion, relocation, and "sunny day flooding" in areas such as Miami-Dade County. In short, SLR in Florida has the potential to be a powerful force toward social disorganization and instability.

Unfortunately, some members of Florida's population are especially vulnerable to the risks associated with climate change, such as the effects of extreme storm events. Using the Social Vulnerability Index (SoVI®), this chapter shows that vulnerability is clustered geographically and driven by different demographic components in different areas. For example, in the I-4 corridor, components 1 (Class and Race), five (Gender), and 6 (Persons Per Household) of the

SoVI® influence the vulnerability of most of the 30 most-vulnerable tracts. Among the most vulnerable areas in Florida, 86% of Miami-Dade residents live with elevated risk to the impacts of climate change. Understanding how risk is distributed across Florida provides decision-makers with critical information to inform how they can plan ahead and spend resources most effectively.

Planning efforts that address climate change in Florida has been mixed across the state. Federal programs and resources for emergency management planning already exist, but local level planning for climate change has been slow and incremental. At the same time, Florida boasts the Southeast Florida Climate Change Compact, which has earned national attention for its effective use of science and local-regional coordination. Further, other regional efforts are underway in Florida at various stages of assessment and planning for climate change adaptation. Still, some planning for climate change has been scuttled for political reasons, as have critical conservation efforts. For example, the 2014 Land and Water Conservation Amendment ("Amendment 1") passed with more than 60% of the vote (2.8 million votes), indicating a strong bipartisan majority preference of voters to invest in critical conservation; but, it was derailed by the state's Governor who won re-election by only 1%, (Jones 2015). The prior administration had been more proactive on climate issues, but many of these previous efforts were also aborted. This demonstrates the power of state leadership. Meanwhile, climate has become a polarizing issue in the state and nationwide, sharply dividing Democrats who tend to see climate as real and as an important threat to act on, and Republicans who are more likely to see climate change science as exaggerated or even as a fabrication and scientific deception. Research indicates some of the climate change sceptics' beliefs are fueled not by an understanding of climate science basics, but by fears of governmental abuse of power, loss of traditional energy sources, and increased taxes (Dunlap 2016; Jacques and Knox 106). If and as climate denial is normalized, state leadership will have an increasingly heavy hand in determining how proactive Florida will be on mitigating and adapting to climate change.

There are many resources in Florida to approach the problems of climate change in the state, from a robust scientific infrastructure in the university system and networks of federal agencies to the genuine commitment to conservation of land and coastline by the public. All of these resources will need to be employed to overcome the serious macro and micro obstacles that challenge our ability to address a warming world in the coming century.

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