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# Climate Change and Sea Level Rise in South Florida

The View of Coastal Residents

# Coastal Research Library

Volume 34

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Risa Palm • Toby Bolsen

# Climate Change and Sea Level Rise in South Florida

The View of Coastal Residents

 Springer

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# Chapter 1

## Introduction



**Abstract** In the United States, a large and influential minority of Americans does not accept that climate change has been exacerbated by human activity. But are residents of at-risk areas more aware of their vulnerability? In late 2018, about 1000 coastal residents of South Florida were surveyed to see if this population, one that is particularly at-risk of flooding associated with sea-level rise, high tides and high intensity hurricanes, was aware of risks to their own communities and their own homes. We also tested whether or not exposure to large-scale maps of likely flooding to the city or county in which the residents live would increase awareness of the reality of the threat of sea-level rise, and its potential impact on real estate values.

**Keywords** Sea-level rise · Climate change · South Florida

Alice is a 45-year-old resident of Miami Beach. She graduated from the University of Miami and is employed in financial services. She and her husband bought their home in 2004, and with the exception of the 2008–2010 economic downturn, they have seen its value steadily rise. She voted for Donald Trump for president in the 2016 election and sees herself as moderately conservative. Although she has seen street flooding in Miami Beach during the time she has lived there, her own home has never been flooded. She has seen headlines such as “Is Miami Beach Doomed to Drown,” but she has her doubts about whether or not the sea level is actually rising. She is not worried about sea-level rise and does not believe that her home is at risk.

Edward is a 68-year-old resident of Clearwater, Florida. He has lived in Florida all his life and retired to his dream home on the coast and close to a golf course. He is a political independent and voted for Hillary Clinton in the 2016 presidential election. He attended college and is very interested in politics. But he doesn’t believe all the hype about climate change or sea-level rise. It is his understanding that the sea level on the Gulf Coast of Florida will rise by one inch every 3 years at most. Since his home is at an elevation of 9 feet above sea-level, it would take 108 years before his home would be at sea-level. To him, the issue of sea-level rise is far from urgent.

Climate change has received an increasing amount of attention over the past decade, particularly with recent reports predicting unprecedented flooding, droughts, and wildfires for the United States, along with new record increases in global temperatures. With warmer ocean temperatures, coastal areas will experience more frequent

and intense storms as well as more flooding associated with sea-level rise. In South Florida, the effects of a combination of land subsidence and sea-level rise are already visible in the form of more frequent street flooding from high tides and from coastal storms. This low-lying area has the deadly combination of population concentrated on the coast, underlying geology that limits the drainage of flood waters, settlement built on land fill, and generally low elevations susceptible to storm surge.

Several scholarly studies have shown the negative impact of coastal location in Florida on housing values (Bernstein et al. 2018; Rao 2017). Newspaper articles declare that “Florida has more to lose with sea rise than anywhere else in the U.S.” and that it is “about to be wiped off the map” (Harris 2018; Rush 2018). But are the residents of South Florida concerned? Are those who live at particular risk from sea-level rise aware of this risk? Do they seek information about their susceptibility to climate change? Do they support policies and laws to mitigate the pace and extent of climate change that would, in turn, slow sea-level rise? Answers to these questions are not only of general interest, but they are also key to our understanding of factors that will affect likely changes in individual behavior and public policy.

The issue of climate change has become so politicized in the United States in recent decades that scientific findings are often interpreted through the lens of political party or ideology. For example, several studies have shown that when those who oppose government regulation are presented with threatening findings about the increasingly likely impacts of climate change, their response is *not* more concern with the issue, but instead resistance and even doubt about the veracity of the science. Do findings such as these that have been noted for the country as a whole also hold for residents of areas that are clearly at risk?

Effective communication about climate change is particularly important in a representative democracy like the United States, because successful public policy can only be enacted and supported with the concurrence of the majority of the population and the advocacy of its leaders. Although surveys show that the majority of Americans accept the idea that human activity has accelerated climate change, a large minority does not, and this minority is not declining in numbers and influence. Further, some national leaders have stated publicly that they doubt the findings of climate scientists and therefore oppose legislation that would cut carbon emissions.

Sea-level rise is one of the effects of climate change that especially threatens the residents of South Florida. Scientists have documented a direct relationship between climate change and sea-level rise through the mechanisms of the expansion of water volume associated with ocean warming and the absorption of more solar energy that accompanies the melting of glaciers and ice sheets (NOAA 2019). Despite this, there is even less consensus about the existence and causes of sea-level rise.

One of the challenges for those seeking to generate greater consensus among the public for action is to find better ways to communicate scientific information about climate change. Numerous survey experiments have shown the impacts of exposure to different types of climate change messages varying, for example, in the ways they are presented or in who presents the information. However, little fieldwork has been done in settings where the local effects of climate change are particularly evident

and are currently an immediate threat to property and lives. This is why we have focused *on this issue in this place*: we assessed responses to sea-level rise by residents of coastal Florida, an area within the United States that is likely to suffer the most severe damage over the relatively short-run. We also provide new information about the attitudes of this particular population concerning climate change mitigation policies including land use regulation and carbon taxes.

We surveyed almost 1000 residents of South Florida in late 2018 to see if exposure to large-scale maps of likely flooding would increase acceptance of the reality of human-exacerbated climate change, sea-level rise, and the linkage between the two. We also were interested in knowing whether those who received this kind of information were more likely to believe that their own communities were at risk, and that the values of their own homes might be reduced. Our empirical findings—for example, that provision of specific and relevant visual information caused respondents, particularly Republican respondents, to become *less* interested in the subject—are of urgent importance.

In the next two chapters, we will examine both the scientific foundations for climate change and sea-level rise, and also the politicization of this topic in the United States. We will then describe the South Florida study area, the general characteristics of our respondents, and present an analysis of an experiment in which residents were provided with detailed, visual information about the risk of flooding associated with sea-level rise. We focus on predictive factors that shape beliefs, policy support and behavior. We also provide some detail about five of the respondents, each of whom is convinced his or her home is not at risk despite clear evidence to the contrary. We conclude with an analysis of the types of policy measures that these respondents support that would reduce carbon dioxide emissions or short-term vulnerability.

## References

- Bernstein A, Gustafson M, Lewis R (2018, Forthcoming) Disaster on the horizon: the price effect of sea-level rise. *J Financ Econ*. SSRN: <https://ssrn.com/abstract=3073842>. <https://doi.org/10.2139/ssrn.3073842>
- Harris A (2018) Florida has more to lose with sea rise than anywhere else in the U.S., new study says. In: *Miami Herald*. Available at: <https://www.miamiherald.com/news/local/environment/article213092454.html>. Accessed 18 July 2018
- NOAA National Oceanic and Atmospheric Administration (2019) Is sea-level rising? National Ocean Service. Available at: <https://oceanservice.noaa.gov/facts/sealevel.html>. Accessed 4 June 2019
- Rao K (2017) Climate change and housing: will a rising tide sink all homes? Zillow. Available at: <https://www.zillow.com/research/climate-change-underwater-homes-12890/>. Accessed 16 July 2018
- Rush E (2018) Rising seas: Florida is about to be wiped off the map. In: *The Guardian*. Available at: <https://www.theguardian.com/environment/2018/jun/26/rising-seas-florida-climate-change-elizabeth-rush>. Accessed 26 June 2018

# Chapter 2

## The Science of Climate Change and Sea-Level Rise



**Abstract** Although there is natural variability in climate when measured over millions or billions of years, the speed of climate change has accelerated as a result of human activity. Globally, the impacts of climate change include an increase in the annual mean surface air temperature and changes in rainfall patterns, with some regions getting more rainstorms and others becoming much drier. At a global scale, these rapid changes could result in regional food shortages triggering a massive amount of human migration, putting stress on food production as well as increasing political instability. In Florida, the impacts of climate change are likely to include flooding associated with sea-level rise, an increase in invasive species, damage to the coral reefs, and increased numbers of damaging hurricanes.

**Keywords** Atmospheric models · Carbon dioxide · Sea-level rise · South Florida · Fourth National Climate Assessment

Is the climate actually changing? And if it is, does this affect the sea-level? And how will these changes affect the South Florida region? To understand the context for our study, we will review how the climate system works, how we know that the climate is changing, natural and human forces changing the climate, how climate change affects sea-level rise, and the likely impacts of climate change and sea-level rise on South Florida.

### 2.1 How Does the Climate Work?

Elements of the climate system include the atmosphere, the surface of the land, the surface of the water and ice cover, as well as vegetation and human-made changes to the landscape, such as pavement and buildings. The interaction of these elements to form climate at a particular place is caused by the spinning of the earth on its axis, and the rotation of the earth around the sun, as well as the amount of solar energy released by the sun.