Florida TaxWatch

A Rising Tide Sinks All Homes

The Effects of Climate Change on Florida's Economy

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Dear Fellow Taxpayer

With more than 8,400 miles of coastline and a flat, low-lying coastal topography, Florida is especially vulnerable to the effects of sea level rise. Tens of thousands of Florida homes and businesses are at increased risk from sea level rise. Much of Florida's critical infrastructure is at low elevations, designed and built with little consideration of future sea level rise.

The physical effect of changing climate translates into real economic impacts. The long-term economic impacts of climate change will be most severe on Florida's attractiveness as a destination for retirees and seasonal visitors. In the short term, more frequent and severe weather events will have disruptive physical and fiscal consequences for many taxpayers. Florida's favorable climate, attractive waterfronts, and tourist attractions have been the main draws, but increasing storm surges and hurricanes and rising insurance costs could change that. Florida's economy and quality of life depend heavily on preserving and sustaining these valuable resources.

Vulnerability associated with Florida's changing climate is not limited to coastal communities. Rising sea levels and more extreme storm surges make Florida's freshwater underground aquifers vulnerable to saltwater intrusion. Higher evaporation rates contribute to more frequent and intense rainfall events, which make Florida vulnerable to inland and river flooding. Florida is also likely to experience severe health-related impacts resulting from rising temperatures (e.g., lost work time for heat-exposed workers, work-related injuries, and increased healthcare costs, etc.).

Accelerated rates of sea level rise will have profound effects on Florida's coastal ecosystems and will add to Florida's vulnerability to hurricane storm surge, which poses the greatest threat to lives and property. Sustained global warming will likely result in more frequent and intense hurricanes.

Florida's climate is changing. Increasing levels of greenhouse gases in the atmosphere allow the atmosphere to retain more heat energy, which is accompanied by increases in ocean temperatures. As ocean temperatures increase, the great ice sheets melt, ocean water expands, and sea levels rise.

Florida TaxWatch undertakes this independent research project to help taxpayers and policymakers better understand the effects of climate change on each sector of Florida's economy, and to recommend reasonable ways to mitigate those impacts. We greatly appreciate the insights provided by our many partners, which we have tried to capture and present in this report. We look forward to discussing our findings and recommendations with policymakers during the 2022 legislative session and beyond.

Sincerely,

Dominic M. Calabro

Dominic M. Calabro
President & Chief Executive Officer

Contents

Executive Summary	**2**
Florida's Vulnerability to Climate Change	2
Impacts on Florida's Economy	2
Mitigating the Impacts of Climate Change on Florida's Economy	5
Introduction	**7**
Florida's Changing Climate	7
Effects of Climate Change	8
Florida's Economy	10
The Impacts of Climate Change on Florida's Economy	11
Financial Activities	**12**
Trade, Transportation, and Utilities	**18**
Professional and Business Services	**21**
Government	**23**
Education and Health Services	**26**
Leisure and Hospitality	**29**
Manufacturing	**32**
Information	**34**
Construction	**36**
Other Services	**38**
Agriculture	**39**
Climate Change and Florida's Fiscal Sustainability	**42**
Mitigating the Impacts of Climate Change on Florida's Economy	**45**
Conclusions	**51**

Executive Summary

Florida's Vulnerability to Climate Change

Florida's climate is changing. With more than 8,400 miles of coastline and a flat, low-lying coastal topography, Florida is especially vulnerable to the effects of a changing climate. Of the more than 22 million Florida residents in 2020, an estimated 16.1 million (more than 70 percent) live in a coastal county.

By the year 2045, about 64,000 of today's residential Florida properties, valued at more than $26 billion, will be at risk of chronic inundation from sea level rise and from more frequent and severe coastal storms. The flooding of these homes will likely remove almost $350 million from local governments' property tax base. About 2,300 of Florida's current commercial properties, assessed at more than $3 billion, are expected to experience chronic inundation by 2045. By the year 2100, about ten percent of Florida's total residential properties will be at risk of chronic inundation. The flooding of these homes will likely remove almost $5 billion from local governments' property tax base. More than 37,500 of Florida's current commercial properties, assessed at more than $46 billion, are expected to experience chronic inundation by 2100. More than 40 percent of the homes at risk in the U.S., and approximately 35 percent of the country's commercial properties at risk in 2100, will be in Florida.

Much of Florida's critical infrastructure—roads, bridges, airports, seaports, railways, water and sewer systems, power plants, schools, etc.—is at low elevations, designed and built without much consideration of future sea level rise. Although originally built far enough from the water's edge to provide some margin of safety, much of Florida's critical infrastructure will need to be relocated, elevated, replaced, hardened, or abandoned as sea levels rise, at considerable cost to Florida taxpayers.

Sea level rise adds to Florida's vulnerability to hurricane storm surge, which poses the greatest threat to lives and property. Rising sea levels, coupled with greater storm surges, will increase the rate of beach erosion, requiring more frequent restoration of beach and dune fill material. Absent this restoration, beach erosion threatens to damage or destroy beachfront properties, reduce the value of remaining properties, and adversely affect commerce. Rising sea levels and the loss of beaches to erosion will likely have a significant impact on coastal wildlife and habitat. Predicted changes in rainfall will alter freshwater inflow from tidal rivers and in turn will affect estuarine salinity, which will likely alter the communities of aquatic plants and animals that depend on these waters.

Vulnerability associated with Florida's changing climate is not limited to coastal communities. Areas that are connected to the sea by rivers will be subject to greater risks from flooding. The intrusion of saltwater into the aquifers will contaminate Florida's groundwater supplies. As atmospheric temperatures increase, some areas of the state can expect periods of prolonged drought which, in addition to inflicting major damage to crops, livestock, and Florida's food supplies, will increase the risk of wildfires and their related loss of property and lives. Florida's elderly, poor, and children will be especially susceptible to the increased number of dangerously hot days.

Impacts on Florida's Economy

Running parallel to Florida's future development is the growing risk of climate change on all portions of the economy. If only considering three of Florida's sectors—Financial Activities, Professional and Business Services, and Government—which collectively represent the intersection between family, business, and public space, the direct economic risk of climate change quickly rises to more than $175 billion annually by 2050. Not only will Floridians face climate dangers to their residential

structures, but major business operations will be increasingly subject to disruptive climate events with further repercussions for public tax collections. The cascading effects of climate change on all sectors pose a direct threat to Florida's long-term economic longevity and competitive outlook.

For Florida's Financial Activities sector in particular—the state's largest sector by Gross Domestic Product (GDP)—sea level rise, more frequent and severe storms, and other forms of property damage will threaten private, insurable property. Each year, lenders originate billions of dollars in long-term (15 to 30 years) mortgages on coastal properties that are vulnerable to the effects of coastal flooding. Unless appropriate steps are taken to mitigate the effects of climate change, lenders will be more reluctant to write 30-year mortgages on properties in high-risk coastal areas, and the interest rates on those mortgages will likely increase.

The number of mortgage delinquencies, defaults and foreclosures, especially on storm-damaged properties whose value is less than the mortgage balance, is expected to increase, and the sale of properties in high-risk coastal areas and the value of those properties will decline. Property insurance companies will renew fewer annual policies, and those that are renewed will include much higher annual premiums. Even those property owners who have flood insurance through the National Flood Insurance Program (NFIP) will pay much higher premiums.

Trade and transportation are essential parts of Florida's economy, ensuring robust commerce around the state and facilitating the movement of tourists. Ensuring a robust trade network is undermined by a changing climate as growing risks affect infrastructure functionality and performance. Florida has billions of dollars of roads, highways, bridges, railroads, power generating stations, seaports, airports, and spaceports that will be damaged or destroyed unless proper mitigation measures are employed. A flood-damaged transportation network will limit the movement of people and goods from one part of the state to another, and from Florida to other destinations.

For Florida's airports, seaports, and spaceports—which collectively contribute $324.6 billion in output a year—climate disruptions to operations can lead to hundreds of billions in economic losses. For Florida's utilities, higher demand for electricity will result in an additional $5 billion in costs per year by 2050 and $18 billion per year by 2100—even after accounting for natural increases in energy demand due to population growth. Companies involved in wholesale and retail trade can anticipate diminished revenue growth as climate disruptions to supply chains lead to recurrent shortages and increased business costs.

Florida's changing climate will place greater fiscal stress on state and local government budgets. The amount of property, sales, and other taxes and revenues collected can be expected to decline. By 2045, the potential loss of property tax revenue jumps to $350 million, and by the end of the century, the property tax risk escalates to nearly $5.0 billion. The gradual erosion of municipal tax revenue would have an indirect effect on funding for services that local governments typically support, such as schools and public safety programs. Public expenditures for local resilience projects, such as raising roads, constructing sea walls, and retrofitting structures, and for repairing storm-damaged public facilities, can be expected to increase as well. Elsewhere in the Government sector, climate change will damage military installations around the state, endangering nearly $95 billion in annual economic output and putting national security at risk.

As it relates to the Education sector, climate change's economic impact involves the risk of flooding to physical school structures and the potential increase in learning-related disruptions due to extreme weather events. The Health Services sector, will be linked to higher rates of health-related illnesses and mortality, especially among elderly adults, children, and

pregnant women. According to some estimates, the mortality rate due to heat-related illness is expected to climb anywhere from 3.8 to 5.8 per 100,000 Floridians per year, which roughly translates to between 1,000 and 1,400 additional deaths annually by 2035.

Extreme heat risks also pose physical and economic challenges for sectors with outdoor labor. For the Construction sector, there may be as many as 33 fewer workdays per year by 2050 as extreme heat reduces the amount of time workers can safely spend outside. This reduction in safe workdays translates into an annual loss of about $2.0 billion in construction worker earnings, or about $3,874 per worker every year. Similarly, for the Other Services sector, there may be an annual loss of $1.58 billion in earnings for Florida workers involved in installation, maintenance, and repair, which factors to about $4,799 per worker every year by 2050.

Even though heat risks impose economic costs on the Construction sector, capital-intensive projects to develop flood-resilient infrastructure and other facilities can boost construction employment and yield significant economic benefits for the sector, partially offsetting the losses. For every $1 billion invested in flood infrastructure, there may be an associated increase of around 250,000 construction jobs. These projects could generate more sales and payroll tax revenue.

The impact of climate change on Florida's Leisure and Hospitality industry will center on areas where there are high concentrations of both natural attractions and tourism activity, such as in south Florida and elsewhere along Florida's coastline communities. Florida taxpayers can expect to see a dramatic reduction in the number of tourists who visit Florida each year. This translates into billions of dollars in lost business income and state and local government tax revenues. By mid-century, Florida's tourism industry is estimated to bring in $53 billion less annually as climate affects the quantity and quality of the state's natural landscapes and ecosystems. Eventually, by 2100, absent any mitigating factors, Florida's tourism industry would stand to lose $117 billion annually due to climate effects on beaches, the Everglades, coral reefs, and more.

For Florida's Manufacturing sector, businesses will likely experience reduced productivity and increased risk of heat-related worker illness and injury. Manufacturers, especially those that produce large volumes of greenhouse gas emissions (e.g., paper and chemical manufacturers) will be subjected to increased government regulation. Supply chain disruptions from climate-driven events around the world will have a ripple effect on Florida's manufacturers. In the future, supply chain disruptions lasting a month or longer will occur on average every 3.7 years, erasing half a year's profits over a decade. This will limit the availability of goods manufactured in Florida and increase product costs to consumers.

Telecommunications play a vital role in facilitating connectivity within the economy—for consumers and businesses alike—telecommunications are ubiquitous in day-to-day activities. Accordingly, climate-related disruptions, such as extreme weather, can inhibit effective communication and have cascading effects on post-disaster recovery coordination and other economic sectors. The Information sector, however, could benefit from climate change challenges by enabling solutions in other sectors. The COVID-19 pandemic illustrated the significance of telecommunications for remote work, virtual learning, and telemedicine when in-person settings were unavailable. Similarly, future economic disruptions due to climate change can be alleviated, to some degree, by enhancing the telecommunications technologies available in various communities.

For Florida's Agriculture sector, increased temperatures will likely reduce Florida's crop production, valued at around $1.04 billion in annual cash receipts. Crop farmers may also see crop insurance costs and premiums increase anywhere from 3.5 percent to as much as 22 percent as the Federal Crop Insurance Program (FCIP) contends with more risk from climate disruptions around the nation. Florida's livestock is another essential part of the state's agricultural industry that will

experience adverse outcomes from climate change. Higher temperatures will increase the demand for water while also imposing greater heat stress on livestock. The reduction in livestock yield and associated economic impact would be around $25.3 million annually over future years. Major storms and inland flooding may exacerbate economic costs by leading to crop losses, animal deaths, toppled trees, and damaged agricultural infrastructure.

Mitigating the Impacts of Climate Change on Florida's Economy

Climate change is a global phenomenon and, as such, the extent to which Florida can control its effects is limited. Florida can establish itself as a leader in mitigating the effects of climate change on its natural resources, its workforce, and its economy by doing the planning and preparedness necessary to make our low-lying and high-risk areas more resilient to the effects of climate change. To mitigate the effects of climate change on Florida's economy and on the health and safety of Florida residents, Florida TaxWatch offers the following policy considerations (in no particular order):

1. **Develop targeted strategies to reduce regional emissions**—Florida can maximize its use of emerging technologies and other efficiencies to make solar and other forms of "clean" energy cost-effective for everyone.
2. **Slow and managed retreat from the coast**—this will require creative, well-funded programs to assist with retreat and relocation from chronically inundated areas.
3. **A systematic and organized approach to buying down or mitigating risk**—this includes elevating buildings and critical infrastructure above the base flood elevations, waterproofing, levees and seawalls, water storage reservoirs, and other measures that will reduce the risk and limit losses.
4. **End or modify government programs and policies that encourage risky development**—this includes the federally subsidized National Flood Insurance Program and the current cost-share formula for federal disaster funding.
5. **Invest in the protection and restoration of natural buffers**—natural systems such as barrier islands, marshes, coral reefs, and mangroves help absorb wave energy and protect Florida's coastal areas from the devastating effects of storm surge.
6. **Strategic investments in beach nourishment**—since tourism drives the economies of Florida's beachfront communities, strategic investments in beach nourishment provide opportunities to build beach and dune systems higher, thereby helping to protect coastal infrastructure, homes and businesses, marine animals, and helping to sustain local economies.
7. **Invest in strategies to "harden" or "armor" the Florida coast**—coastal property owners often attempt to stabilize coastal land and protect coastal residential and public infrastructure by building shoreline armoring structures (e.g., seawalls, revetments, riprap, etc.) to hold back the sea and prevent erosion and the loss of sediment.
8. **Promote land use and construction practices that improve resiliency**—elevating homes above the base flood elevation, limiting the amount of impervious surfaces, and requiring new development and redevelopment to incorporate building methods and materials designed to reduce wind damage will help to make structures more resilient to the effects of climate change.
9. **Do nothing – maintain the status quo**—doing nothing is no longer an option. The cost of inaction will be too great to do nothing.

Climate change poses an existential and generational threat to Florida. Rising global temperatures and sea levels greatly increase the risks to public health and safety, and to Florida's economy. Florida's continued growth will increase coastal populations and development, which will put still more people and property at risk.

Absent measures to mitigate these risks, rising temperatures and sea levels will result in devastating damages to every sector of Florida's economy. There is no single measure to mitigate the devastating impacts of climate change on Florida's economy, and no region of the state or sector of the economy will be spared. Mitigating these economic impacts will require a comprehensive, multi-faceted strategy which includes a mix of structural (e.g., seawalls, pumping stations, storm surge barriers, elevating and floodproofing buildings, etc.) and non-structural (e.g., beach nourishment, mangrove replanting, coral reef restoration, dune restoration, etc.) measures. It will be expensive, but the costs of inaction will be much greater. Perhaps the most important first step is to stop making the problem worse.

The consequences of climate change will be most severe for those communities that do nothing to prepare for it. By engaging in the policy debate now, Florida TaxWatch hopes to help shape a resilient Florida and a strong and vibrant Florida economy.

Introduction

Florida's Changing Climate

Florida's climate is changing. If no mitigative actions are taken, climate change will have significant impacts on Florida's economy. The long-term economic impacts of climate change will be most severe on Florida's attractiveness as a destination for retirees and seasonal visitors. Florida's favorable climate, attractive waterfronts, and tourist attractions have been the main draws, but increasing storm surges and hurricanes and rising insurance costs would change that.

Some of this change is the result of naturally occurring processes, such as changing ocean currents, global wind patterns, rainfall, fluctuations in the amount of solar energy that reaches the Earth, and other features. Some of this change, however, is the result of human activity. Changes in land use, deforestation, the development of sprawling urban areas, draining of wetlands, and increasing levels of greenhouse gases in the atmosphere all contribute to climate change.[1]

Much of the greenhouse gases released into the atmosphere is the by-product of energy use. Burning fossil fuels releases carbon dioxide (CO_2), which allows the atmosphere to retain more heat energy. Atmospheric CO_2 concentrations have increased from about 280 parts per million (ppm) to nearly 400 ppm over the past 150 years while global average temperatures have warmed about 1.25 degrees Fahrenheit (°F).[2] Computer modeling by the United Nations' Intergovernmental Panel on Climate Change (IPCC) suggests that, averaged over the next 20 years, global temperature is expected to reach or exceed 1.5° Centigrade (C) of warming. Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to close to 1.5°C or even 2°C will be beyond reach.[3]

> *"This report is a reality check… [W]e now have a much clearer picture of the past, present, and future climate, which is essential for understanding where we are headed, what can be done, and how we prepare."*
>
> —Valérie Masson-Delmotte, Intergovernmental Panel on Climate Change

The average global surface temperature in 2020 tied year 2016 as the warmest year on record, according to an analysis by the National Aeronautics and Space Administration (NASA). A separate, independent analysis by the National Oceanic and Atmospheric Administration (NOAA) concluded that 2020 was the second-warmest year on record, trailing only year 2016.[4]

> *"The last seven years have been the warmest seven years on record, typifying the ongoing and dramatic warming trend… [W]hether one year is a record or not is not really that important—the important things are long-term trends. With these trends, and as the human impact on the climate increases, we have to expect that records will continue to be broken."*
>
> —Gavin Schmidt, Director, Goddard Institute for Space Studies[5]

1 Florida State University, "Climate Change," Florida Climate Center, retrieved from https://climatecenter.fsu.edu/topics/climate-change, May 27, 2021.

2 Ibid.

3 Intergovernmental Panel on Climate Change, "Climate Change 2021: the Physical Science Basis," August 2021.

4 National Aeronautics and Space Administration, "2020 Tied for Warmest Year on Record, NASA Analysis Shows," January 14, 2021, retrieved from https://climate.nasa.gov/news/3061/2020-tied-for-warmest-year-on-record-nasa-analysis-shows/, June 10, 2021.

5 Ibid.

Effects of Climate Change

As global temperatures continue to rise, average sea levels will rise as well. With more than 8,400 miles of coastline and a flat, low-lying coastal topography, Florida is especially vulnerable to the effects of a changing climate. Of the more than 22 million Florida residents in 2020, an estimated 16.1 million (more than 70 percent) live in a coastal county. Eight of Florida's ten largest cities, and 42 of Florida's 50 largest cities, are in relatively high-population density coastal areas.[6] By 2045, the number of Florida residents living in coastal counties is projected to increase to more than 20.1 million.[7]

The scientific community has analyzed the exposure of coastal communities in Florida to chronic inundation[8] under several scenarios. Using the "high sea level rise" scenario, which projects an average of 1.8 feet of sea level rise by the year 2045 and 6.4 feet in 2100, without any additional measures to adapt to rising seas:

- By 2045, about 64,000 of today's residential Florida properties, currently home to more than 100,000 people, are at risk of chronic inundation. Miami, the Florida Keys and the Tampa-St. Petersburg area stand out as being highly exposed within the next 30 years. The total value of at-risk residential properties is about $26 billion. The homes at risk in 2045 currently contribute nearly $350 million in annual property tax revenue.
- By 2100, more than 1 million residential properties (about ten percent of the state's current residential properties and home to approximately 2.1 million Floridians) will be at risk of chronic inundation. The current value of these properties is more than $351 billion. The homes at risk by 2100 currently contribute roughly $5 billion collectively in annual property tax revenue.
- By 2045, about 2,300 of Florida's current commercial properties, assessed at more than $3 billion, are expected to experience chronic inundation. In 2100, this number jumps to more than 37,500 properties assessed at roughly $46 billion today.
- More than 40 percent of the homes at risk in the U.S., and approximately 35 percent of the country's commercial properties at risk in 2100 will be in Florida.[9]

It is important to note that the sea level rise that accompanies climate change is not uniform—not all low-lying areas flood equally. When Florida TaxWatch discusses sea level rise, it is the *average* sea level rise that is being discussed. Accelerated rates of sea level rise will have profound effects on Florida's coastal ecosystems, including barrier islands, bays, estuaries, lagoons, sounds, tidal salt marshes and creeks, mangrove swamps, shellfish beds, seagrass beds, coral reefs, and oyster bars.[10] Florida's economy and quality of life depend heavily on preserving and sustaining these valuable natural resources.

Rising sea levels and storm surge will accelerate beach erosion and the breaching of barrier islands along Florida's Gulf and Atlantic coasts. The Florida Department of Environmental Protection's 2020 list of eroding shorelines includes 422.7 miles of critically eroded beach, 9.1 miles of critically eroded inlet shoreline, 88.7 miles of non-critically eroded beach and 3.2 miles of non-critically eroded inlet shoreline statewide.[11] Rising sea levels, coupled with greater storm surges, will increase the rate of beach erosion, requiring more frequent restoration of beach and dune fill material.

6 World Population Review, "10 Largest Cities in Florida," retrieved from https://worldpopulationreview.com/states/cities/florida, May 278, 2021.

7 Bureau of Economic and Business Research, "Projections of Florida Population by County, 2020–2045, with Estimates for 2018," Volume 52, Bulletin 183, April 2019.

8 Chronic inundation is defined as high tide flooding of 10 percent or more of usable, non-wetland area at least 26 times a year or, on average, every other week.

9 Union of Concerned Scientists, "Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate," June 2018.

10 Florida Oceans and Coastal Council, "Climate Change and Sea Level Rise in Florida: an Update of the Effects of Climate Change on Florida's Oceans & Coastal Resources," December 2010,.

11 Florida Department of Environmental Protection, "Critically Eroded Beaches in Florida," July 2020,

Absent this restoration, beach erosion threatens to damage or destroy beachfront properties, reduce the value of remaining properties, and adversely affect commerce.

Rising sea levels and the loss of beaches to erosion will likely have a significant impact on coastal wildlife and habitat. Tidal wetlands, which help to buffer the impacts of coastal storms, will disappear if sea-level rise exceeds their capacity to accumulate sediment. Other coastal ecosystems, such as sandbars and shoals, estuarine beaches, salt flats, and coastal forests, will be altered. Predicted changes in rainfall will alter freshwater inflow from tidal rivers and in turn will affect estuarine salinity, which will likely alter the communities of aquatic plants and animals that depend on these waters.[12]

The "500-pound gorilla" of climate change is its effects on hurricane frequency and intensity. Sea level rise adds to Florida's vulnerability to hurricane storm surge, which poses the greatest threat to lives and property from tropical cyclones. Although subject to considerable scientific investigation and debate, the current scientific understanding is that sustained global warming will result in more frequent and intense hurricanes, with less intense hurricanes becoming less frequent. As the atmosphere warms, the frequency of the most intense Category 4 and 5 storms is expected to increase by 80 percent by 2080, or by roughly one percent per year. Over the same period the frequency of the less intense Category 1-3 hurricanes will diminish by 38 percent. [13]

Much of Florida's critical infrastructure—roads, bridges, airports, seaports, railways, water and sewer systems, power plants, etc.—is at low elevations, designed and built without much consideration of future sea level rise. Although originally built far enough from the water's edge to provide some margin of safety, much of Florida's critical infrastructure will need to be relocated, elevated, replaced, hardened, or abandoned as sea levels rise, at considerable cost to Florida taxpayers.

Vulnerability associated with Florida's changing climate is not limited to coastal communities. Rising sea levels and more extreme storm surges make Florida's freshwater underground aquifers vulnerable to saltwater intrusion. Surficial aquifers along Florida's coast are already experiencing saltwater intrusion. Rising sea level will increase the hydraulic backpressure on coastal aquifers, reduce groundwater flow toward the ocean, and cause the saltwater to move inland, thereby increasing the risk of contaminating water-supply wells in coastal areas with seawater.[14]

As the atmosphere gets warmer, it can hold more water vapor. Higher evaporation rates contribute to more frequent and intense rainfall events, which make Florida vulnerable to inland and river flooding. Florida is also likely to experience severe health-related impacts resulting from rising temperatures. Floridians typically experience an average of seven "extremely hot days" a year, with temperatures above 95 degrees. The average number of days per year with temperatures above 95 degrees is expected to reach up to 32 by 2039, and up to 76 by 2050.[15] The heat and humidity is a potentially deadly combination for many Floridians, especially Florida's elderly residents. By the end of the century, Florida will likely experience up to 24 days of "extremely dangerous" heat and humidity annually. By 2039, as many as 1,840 additional Floridians, many of which will be elderly, are likely to die from extreme heat driven by climate change.[16]

12 Florida Oceans and Coastal Council, "Climate Change and Sea Level Rise in Florida: an Update of the Effects of Climate Change on Florida's Ocea & Coastal Resources," December 2010,

13 Morris A. Bender et al., "Modeled Impact of Anthropogenic Warming on the Frequency of Intense Atlantic Hurricanes," Science; 327: 454-458, January 2010, retrieved from http://www.sciencemag.org/cgi/content/full/327/5964/454, June 9, 2021.

14 Florida Oceans and Coastal Council, "Climate Change and Sea Level Rise in Florida: an Update of the Effects of Climate Change on Florida's Ocea & Coastal Resources," December 2010.

15 The Risky Business Project, "Come Heat and High Water: Climate Risk in the Southeastern U.S. and Texas," July 2015, retrieved from http://riskybusiness.org/site/assets/uploads/2015/09/Climate-Risk-in-Southeast-and-Texas.pdf, May 29, 2021.

16 Ibid.

Florida's Economy

If Florida were an independent country, it would have the 15th largest economy in the world. Prior to the COVID-19 pandemic, Florida had the 17th largest economy; however, Florida's quick recovery after the pandemic has permitted Florida to move ahead of Indonesia and Mexico.[17] CNN and Moody's Analytics maintain a "Back-to-Normal" index that measures how close states are to their pre-pandemic (March 2020) economic levels and that serves as a basic proxy for economic recovery to date. As of the beginning of April 2021, Florida ranked number one on the list and had a score of 97.4 percent, suggesting Florida is close to pre-pandemic economic levels.[18]

Florida lost almost 1.3 million jobs from February 2020 to April 2020; however, about 75 percent of those lost jobs (+953,400) have been recovered. The number of jobs in Florida was 8,756,300 in July 2021, up 356,700 jobs compared to July 2020.[19] As shown in Table 1, nine of the ten major industries experienced positive over-the-year job growth in July 2021. The one major industry losing jobs was Government (-23,200 jobs, -2.1 percent). All 24 metropolitan statistical areas (MSA) had over-the-year job gains, with the largest gains occurring in the Orlando-Kissimmee-Sanford MSA (+71,300 jobs, +6.2 percent), the Tampa-St. Petersburg-Clearwater MSA (+71,000 jobs, +5.4 percent), the Miami-Miami Beach-Kendall MSA (+56,700 jobs, +5.2 percent), and the Jacksonville MSA (+35,300 jobs, +5.1 percent).[20] A summary of Florida's economy is presented in Table 2.

Table 1. Non-Agricultural Job Growth: July 2020 to July 2021

	Job Growth	
Sector	Number	Percentage
Financial Activities	22,000	3.7%
Trade, Transportation & Utilities	58,000	3.3%
Professional & Business Services	63,200	4.7%
Government	(23,200)	-2.1%
Education & Health Services	41,100	3.2%
Leisure & Hospitality	137,800	14.6%
Manufacturing	9,600	2.6%
Information	6,700	5.3%
Construction	12,400	2.2%
Other Services	30,900	9.9%

Source: Florida Department of Economic Opportunity

17 Florida Chamber of Commerce, "Florida's Economy Grows to 15th Largest in the World, Up From 17th," July 15, 2021, retrieved from https://www.flchamber.com/floridas-economy-grows-to-15th-largest-in-the-world-up-from-17th/, August 20, 2021.

18 Florida TaxWatch, "State COVID-19 Restrictions & the Road Back to Economic Normal," Economic Commentary, April 2021.

19 Florida Department of Economic Opportunity, "Florida's July Employment Figures Released," retrieved from http://lmsresources.labormarketinfo.com/library/press/release.pdf, August 20, 2021.

20 Ibid.

Table 2. Florida's Economy (2020)

Sector	GDP Contributions (Billions $)	Percent of Total GDP	Employment	Percent of Employment
Financial Activities	$214.6	22.9%	590,165	7.0%
Trade, Transportation & Utilities	$184.8	19.7%	1,791,400	21.2%
Professional & Business Services	$129.5	13.8%	1,362,914	16.2%
Government	$98.4	10.5%	463,941	5.5%
Education & Health Services	$89.9	9.6%	1,808,885	21.4%
Manufacturing	$54.1	5.8%	376,148	4.5%
Information	$48.0	5.1%	131,443	1.6%
Construction	$45.1	4.8%	566,563	6.7%
Leisure & Hospitality	$42.1	4.5%	1,022,278	12.1%
Other Services	$20.8	2.2%	255,343	3.0%
Agriculture	$8.8	0.9%	68,668	0.8%
TOTALS	**$936.1**	**100.0%**	**8,438,748**	**100.0%**

Source: Bureau of Economic Analysis (BEA); Florida Department of Economic Opportunity (DEO) – Quarterly Census of Employment and Wages (QCEW) program

The Impacts of Climate Change on Florida's Economy

The adverse impacts of global climate change on Florida's low-lying coastal and flood-prone inland areas cannot be overstated. No region of the state will be immune from these impacts, which will dramatically affect many aspects of society and Florida's economy, both directly and indirectly.

Florida TaxWatch undertakes this independent analysis to analyze the potential impacts of a changing climate on each of the 11 sectors that make up Florida's economy[21] and to recommend appropriate policy changes to mitigate these impacts.

21 The chosen list of economic sectors is not exhaustive but follows the industry classification system used by Florida's Department of Economic Opportunity and the U.S. Bureau of Labor Statistics.

Financial Activities

The Financial Activities sector is part of the service-providing industries group and consists of two specific sub-sectors:

- Finance and Insurance—includes establishments primarily engaged in financial transactions (creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions. Entities include banks, credit unions, monetary authorities, financial investment companies, and insurance carriers.
- Real Estate and Rental and Leasing—includes establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets. The assets may be tangible, as in the case of real estate and equipment, or intangible, as is the case with patents and trademarks.

Climate change has important implications for the financial sector. Sea level rise, more frequent and severe storms, floods, droughts, excessive heat, wildfires, and other forms of climate change increase the risk of property damage and destruction. Florida has the greatest risk of private, insurable property being inundated by rising sea levels than any other state. By 2030, as much as $69 billion in coastal property will be at risk of inundation that is not at risk today. An estimated $15 billion in coastal property will likely be flooded statewide. By 2050, the value of private property that is below local high tide levels is estimated to increase to $152 billion. The value of property below sea level is expected to increase to as much as $23 billion.[22]

An October 2020 study by the University of Pennsylvania's Wharton School[23] looked at the relationship between sea level rise and changes in Florida's real estate and mortgage markets over the past 20 years and found that, up until 2012, there was little difference in the volume of home sales in census tracts that were more exposed to sea level rise and the volume of home sales in census tracts that were less exposed.[24] The vulnerability of a census tract to the effects of sea level rise had little effect on the number of homes sold there.

After 2013, however, sales in these high-risk coastal tracts declined in absolute terms while sales in low-risk coastal tracts rose. Home prices increased similarly in both groups until 2018, when a relative decline in home prices in the high-risk tracts began to emerge. It is estimated that approximately 16,500 (16-20 percent) fewer home transactions took place from 2013-2018 among the 187 census tracts most exposed to sea level rise relative to counterfactual trends. Starting in 2016, home prices in more-exposed census tracts began to decline relative to home prices in less-exposed census tracts, reaching 5-10 percent below trend by 2020.[25]

Data scientists from the First Street Foundation and Columbia University analyzed the impact of increased tidal flooding from sea level rise on property values between 2005 and 2017. Among the 17 states analyzed, Florida has seen the greatest loss in relative home values at $5.4 billion. The 20 "hardest hit" cities along the coast from Maine to Mississippi include Miami Beach (#2), Hollywood (#3), St. Petersburg (#5), Ft. Lauderdale (#8), Key Largo (#12), Jacksonville (#15), and Key West (#17). These seven Florida cities experienced a collective loss in relative home values of more than $1.5 billion.[26]

22 The Risky Business Project, "The Bottom Line on Climate Change," 2015.

23 Benjamin J. Keys and Philip Mulder, "Neglected No More: Housing Markets, Mortgage Lending, and Sea Level Rise," National Bureau of Economic Research, October 2020.

24 "More exposed" is defined to include coastal tracts where more than 70 percent of developed land would be inundated at six feet of sea level rise. "Less exposed" is defined to include coastal tracts where less than 10 percent of developed land would be inundated at six feet of sea level rise.

25 Benjamin J. Keys and Philip Mulder, "Neglected No More: Housing Markets, Mortgage Lending, and Sea Level Rise," National Bureau of Economic Research, October 2020.

26 First Street Foundation, "Rising Seas Erode $15.8 Billion in Home Value from Maine to Mississippi," February 27, 2019, retrieved from https://assets.floodiq.com/2019/02/9ddfda5c3f7295fd97d60332bb14c042-firststreet-floodiq-mid-atlantc-release.pdf, May 29, 2021.

Failure on the part of financial services companies to take appropriate actions in the face of climate change can lead to divestment, damaged credibility with rating agencies, and a loss of credibility with investors. Rising sea levels and a higher incidence of extreme weather events can cause losses for homeowners and diminish their property values, leading to greater risks in mortgage portfolios or lower values of assets on the balance sheet.[27]

In June 2021, President Biden met with the Treasury Secretary, Securities & Exchange Commission, and other leading financial regulators to discuss a requirement that public companies disclose to their investors information about their impact on the environment and other issues related to climate change.[28] Pension funds, endowments, foundations and other institutional backers are responding to calls from their constituents to pay an increasing amount of attention to the sustainability of their investments.

Each year, lenders originate billions of dollars in long-term (15 to 30 years) mortgages on coastal properties that are vulnerable to the effects of coastal flooding. If climate change creates new costs in the form of repetitive damage repair, the borrower becomes more likely to default on the mortgage loan, especially if the value of the home is less than the balance on the loan. Two Government Sponsored Enterprises (GSEs)[29]—Fannie Mae and Freddie Mac—guarantee these mortgage loans against default and the taxpayers end up "footing the bill."

In 2016, Freddie Mac, the federally-backed mortgage company, cautioned that sea level rise would eventually destroy billions of dollars' worth of property. The resulting inevitable decline in coastal property values could ripple throughout local economies, and homeowners might decide to stop paying off their mortgages if their home values drop below the balance they owe the bank.[30]

Research by the National Bureau of Economic Research (NBER) shows that mortgage lenders are selling mortgage loans for homes in high-hazard coastal areas to Fannie Mae and Freddie Mac.[31] Lenders are able to choose which mortgages to sell; however, Fannie Mae and Freddie Mac are required to purchase mortgages that meet certain criteria, which do not factor in the risks from climate change. This allows commercial lenders to bundle and transfer their riskiest mortgage loans to Fannie Mae and Freddie Mac with no "negative market signals." Lenders are thus able to shift risk from their balance sheets to the balance sheets of Fannie Mae and Freddie Mac, at the taxpayers' expense. NBER looked at 15 natural disasters that caused at least $1 billion in damages between 2004 and 2012 and found that:

- Natural disasters significantly raise the number of delinquencies, defaults and foreclosures; and
- Immediately following these disasters, lenders issued more mortgages for properties in coastal areas. These mortgage loans were then "securitized" (bundled and sold to other financial institutions). Those sold to Fannie Mae and Freddie Mac are guaranteed by the federal government.[32]

27 Pierpaolo Grippa, Jochen Schmittmann, and Felix Suntheim, "Climate Change and Financial Risk," International Monetary Fund, Finance & Development, December 2019.

28 Kevin Dowd, "The SEC Sets its Sights on Climate Change," Forbes, June 27, 2021, retrieved from https://www.forbes.com/sites/kevindowd/2021/06/27/the-sec-sets-its-sights-on-climate-change/?sh=7a4cf92e532b, June 29, 2021.

29 A government-sponsored enterprise (GSE) is a quasi-governmental entity established to enhance the flow of credit to specific sectors of the American economy

30 Nicholas Kusnetz, "Coastal Flooding Is Erasing Billions in Property Value as Sea Level Rises. That's Bad News for Cities.," Inside Climate News, February 28, 2019, retrieved from https://insideclimatenews.org/news/28022019/coastal-flooding-home-values-sea-level-rise-climate-change-ocean-city-miami-beach/, May 28, 2021.

31 Amine Ouazad and Matthew E. Kahn, "Mortgage Finance and Climate Change: Securitization Dynamics in the Aftermath of Natural Disasters," Bureau of Economic Research, September 2019, revised February 2021.

32 Ibid.

As natural disasters and other forms of climate change increase mortgage delinquencies, defaults, and foreclosures, investors in GSE-backed securities will pay higher prepayment rates.[33] In 2019, GSEs began issuing Uniform Mortgage-Backed Securities (UMBS), large mortgage pools designed to assure investors that they would receive the national average prepayment rate on the securities they purchased.[34] This allows the impacts of geographically-specific natural disasters (e.g., hurricanes along Florida's low-lying coastline) to be averaged with the performance of all loans originating outside the affected areas.

Climate change will likely increase insurance premiums and loan interest rates, which will increase the cost of housing. Prospective insurance purchasers fall into one of four groups.[35] The first group resides in areas where insurance faces no unusual challenges or where those challenges have not yet been realized. The second group includes a significant number of homeowners who live in areas that require more, or more expensive, insurance. There is evidence to suggest that the market may not be incorporating the impact of the risk into the prices of homes, largely because the insurance is mispriced. The third group is made up of those who have become uninsurable as a result of climate change. This group has a higher risk of mortgage default and fewer foreclosure alternatives. The final group includes "climate migrants," who may be forced to move because, even though their house has no realistic flood risk, the surrounding community may not be able to provide sufficient employment opportunities or local services.

As Florida's climate continues to change, renewal of annual residential and commercial insurance policies should continue for the foreseeable future. At some point, and that point is difficult to project, annual premiums will start to increase. Insurance companies will begin to limit coverage or decline to renew some policies. Even if Florida's Office of Insurance Regulation (OIR) mandates that existing policies be renewed, insurance companies can still choose not to write new policies, which effectively makes some properties unsellable.

With more than five million policies in 22,000 communities nationwide, the National Flood Insurance Program (NFIP) is the primary source of flood insurance coverage in the U.S. In October 2021, the Federal Emergency Management Agency (FEMA) changed the way flood insurance premiums are calculated for new NFIP policies. Known as "Risk Rating 2.0," premiums for individual properties will be tied to their actual risk of flooding. New rates for existing NFIP Policies will take effect in April 2022.

Under the previous rating system, properties with the same NFIP flood risk were charged the same rates. Two properties rated as having the same NFIP risk were charged the same rate per $100 of insurance, even though they may be located in different states, or they have differing flood histories. Two properties located in the same flood zone were charged the same rate, regardless of their location within the zone.[36] Under Risk Rating 2.0, however, NFIP premiums will be based upon an individual property's flood risk. Although flood zones will still be used for floodplain management purposes, they will no longer be used in calculating flood insurance premiums.

33 Prepayment is the paydown of principal of a mortgage pass-through in a given month that exceeds the amount of its scheduled amortization for that month. The rate of prepayment is the excess paydown in a given month as a percentage of the outstanding principal balance at the beginning of the month.

34 Research Institute for Housing America, "The Impact of Climate Change on Housing and Housing Finance," September 2021.

35 Ibid.

36 Congressional Research Service, "National Flood Insurance Program: The Current Rating Structure and Risk Rating 2.0," June 4, 2021.

There are limitations on annual NFIP premium increases, which are set in federal statute,[37] and Risk Rating 2.0 will not increase rates annually beyond these caps. Under the Homeowner Flood Insurance Affordability Act (2014), rate increases for primary residences may not exceed 18 percent. There are other types of property (e.g., non-primary residences, non-residential properties, business properties, and properties that have experienced severe repetitive losses, etc.) that are required to have their premium increased by 25 percent annually until they reach full risk-based rates.

Table 3 shows how the maximum statutory increase affects a Standard Flood Insurance Policy (SFIP) subject to an 18 percent increase and a 25 percent increase, respectively. This is based on a national average for policies subject to 25 percent rate increases of $5,878.15, and a national average for all other policies (i.e., not subject to the 25 percent rate increase requirement) of $730.34.[38]

Table 3. Maximum Increases on Average NFIP Premiums

Premiums, Fees, or Surcharges	Policies Subject to 18% Increase	Policies Subject to 25% Increase
Premium Subject to Statutory Cap	$730.34	$5,878.15
Federal Policy Fee (FPF) for SFIP	$50.00	$50.00
HFIAA Surcharge	$25.00	$250.00
Total Due to NFIP Before Increase	**$805.34**	**$6,178.15**
18% Increase on Premium	$131.46	
Total Premium After 18% Increase	$861.80	
Total Due to NFIP after 18% Increase (Includes FPF and HFIAA)	**$936.80**	
25% Increase on Premium		$1,469.54
Total Premium After 25% Increase		$7,347.69
Total Due to NFIP after 25% Increase (Includes FPF and HFIAA)		**$7,647.69**

Source: Congressional Research Service. National average NFIP premium provided by FEMA Congressional Affairs staff, January 19, 2021.

FEMA has released estimates of percentage increases in NFIP premiums for each state. With Risk Rating 2.0 in place:

- 342,142 (20 percent) of Florida's 1,727,900 NFIP policyholders will experience an immediate decrease in annual premiums;
- 1,178,074 (69 percent) of Florida's 1,727,900 NFIP policyholders will experience an annual increase in premiums of $0 to $120;
- 134,572 (8 percent) of Florida's 1,727,900 NFIP policyholders will experience an annual increase in premiums of $120 to $240; and
- 73,113 (4 percent) of Florida's 1,727,900 NFIP policyholders will experience an annual increase in premiums greater than $240.[39]

Annual increases will eventually stop under Risk Rating 2.0 once a property's full-risk rate (i.e., when the rate is tied to the property's actual risk of flooding) is realized.

37 42 U.S.C. §4015(e).

38 E-mail from FEMA Congressional Affairs staff, January 19, 2021.

39 Federal Emergency Management Agency, "Florida – Risk Rating 2.0," retrieved from https://www.fema.gov/sites/default/files/documents/fema_florida-state-profile_03-2021.pdf, June 29, 2021.

Relative to the NFIP, the private flood insurance market is small. Under Risk Rating 2.0, more than 1.3 million Florida NFIP policy holders will pay more for flood insurance. This will afford opportunities for the private flood insurance market to be more competitive, offering broader coverage options at more competitive rates. Adapting to climate change will create new business opportunities for private insurers. New industries, such as wind and solar farms, create opportunities to insure new technologies and products and their associated liability.

Lawsuits may be filed against a business for actions (or inactions) that resulted in harm to the environment. The need to reduce the impacts of global warming has spurred the creation of insurance policies that provide incentives to policyholders who contribute to this effort. As an example of how this is applied elsewhere, usage-based auto insurance (pay-as-you-drive) gives drivers an incentive in the form of lower premiums in exchange for driving less. With "green" commercial building construction expected to rise significantly over the next few years, a growing number of insurers are offering green commercial property insurance policies (at reduced premiums) and endorsements.[40]

It is a common industry practice for companies that insure homeowners against catastrophic losses to buy reinsurance as a way to limit or "hedge" their risk. The amount of property located in Florida's low-lying coastal areas, coupled with the uncertain probability of losses, makes it expensive to insure against catastrophic losses. When a property owner buys a homeowners insurance policy, the insurance company buys reinsurance to hedge their risk.[41] A provision in the Made in America Tax Plan (MATP) would, if passed by the U.S. Congress, increase the cost of reinsurance in two ways: increasing the corporate tax rate from 21 percent to 28 percent; and imposing a global minimum tax with proposed rates from 15 percent to 28 percent. A recent study by the R Street Institute estimates that annual Florida insurance rates will increase by $864 million to $1.62 billion.[42]

These increases will be passed down to property insurance companies and then to property owners, increasing premiums for homeowners and businesses.[43] Because so many Floridians live and operate businesses in low-lying coastal areas and are exposed to catastrophic losses from hurricanes, the MATP provision is essentially a "hurricane tax" on Florida taxpayers.

40 Insurance Information Institute, "Background on: Climate Change and Insurance Issues," November 1, 2019, retrieved from https://www.iii.org/article/background-on-climate-change-and-insurance-issues, June 29, 2021.

41 Florida Politics, "Dominic Calabro: 'Hurricane Tax' – Wrong Idea at the Wrong Time for Florida Homeowners," retrieved from https://floridapolitics.com/archives/460021-dominic-calabro-hurricane-tax-wrong-idea-at-the-wrong-time-for-floridians/, September 28, 2021.

42 Lars Powell, "Estimating Potential Effects of the Global Minimum Tax on Catastrophe Insurance Markets," R Street Institute, September 2021.

43 Florida Politics, "Dominic Calabro: 'Hurricane Tax' – Wrong Idea at the Wrong Time for Florida Homeowners," retrieved from https://floridapolitics.com/archives/460021-dominic-calabro-hurricane-tax-wrong-idea-at-the-wrong-time-for-floridians/, September 28, 2021.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Billions of dollars of property in low-lying coastal areas will be damaged or destroyed by floods and coastal storms.
- The sale of properties in high-risk coastal areas will decline.
- Home prices in high-risk coastal areas will decline.
- Greater risk in lender mortgage portfolios and lower asset values on balance sheets.
- Increased mortgage delinquencies, defaults and foreclosures, especially on storm-damaged properties whose value is less than the mortgage balance.
- Lenders will shift much of risk from their balance sheets to GSEs like Fannie Mae and Freddie Mac, at considerable taxpayer expense.
- Lenders will be more reluctant to write 30-year mortgages on properties in high-risk coastal areas.
- Increased interest rates on mortgage loans.
- Investors in GSE-backed securities will pay higher prepayment rates.
- Property insurance companies will renew fewer annual policies.
- Increased property insurance premiums, even for those who have flood insurance through the National Flood Insurance Program.
- If the MATP passes as written, companies that insure properties against catastrophic losses will pay more for reinsurance.

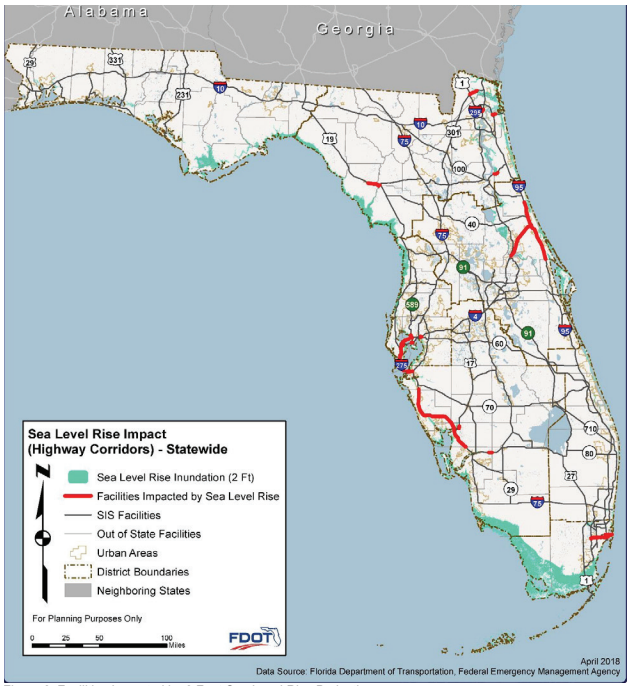
Trade, Transportation, and Utilities

The Trade, Transportation, and Utilities sector is one of several service-providing industries and is comprised of four primary sub-sectors:

- Wholesale Trade—includes establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.
- Transportation and Warehousing—includes establishments that provide transportation of passengers and cargo, warehousing and storage for goods, or scenic and sightseeing transportation.
- Retail Trade—includes establishments engaged in retailing merchandise at the end of the distribution process. Retailers are organized to sell merchandise in small quantities to the general public for personal or household consumption.
- Utilities—includes establishments which provide utility services, such as electric, water, and sewage.

Transportation is an essential part of Florida's economy, ensuring the delivery of goods and services for consumers, providing companies with access to global supply chains, and facilitating the movement of tourists across the state. Ensuring a robust trade and transportation network, however, is undermined by a changing climate when heavy precipitation, sea level rise, and coastal flooding affect infrastructure functionality and performance. Further, hotter temperatures create an increase in demand for water and electricity among various end users, placing an added burden on Florida's utility systems.

Figure 1. Facilities Impacted by 1 Foot Sea Level Rise Projections



Most of Florida's critical infrastructure—including roads, railways, airports, and seaports—sit at low elevations prone to flooding.[44] Continued sea level rise would progressively damage coastal transportation networks, and water inundation during major storm events would introduce substantial risk for inland areas.[45] According to the Florida Department of Transportation (FDOT), a two-foot rise in sea level, expected by 2050, would endanger around 252 miles of Florida's most high-traffic highways (See Figure 1 areas highlighted in red).[46]

Storm surge from a Category 5 hurricane would be even more extensive, flooding one-fifth—around 915 miles—of Florida's most high-traffic highways.[47] When including the impact of sea level rise on smaller state and local roads, the number of

44 Risky Business Project, Climate Risk in the Southeastern U.S. and Texas, July. 2015.

45 U.S. Global Change Research Program (USGCRP), Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment Vol. 2, 2018.

46 Florida Department of Transportation (FDOT), Risk Assessment on SIS Facilities, May 2018. http://floridatransportationplan.com/pdf/FDOT-SIS_ResiliencePhase1-TechMemo_wApp_8-22-18.pdf.

47 Ibid.

flooded roads would grow by an additional 445 miles by 2040 and 1,600 miles by 2060.[48] Flooded and damaged roads incur several economic costs—primarily the capital cost to repair damages and the loss of economic value when workers cannot access roads. In aggregate, the economic loss could amount billions of dollars.[49]

Similar to roads and highways across the state, climate change can affect other transit systems, such as Florida's airports and seaports, by disrupting operations and damaging infrastructure. Florida's airports are responsible for nearly $175 billion in economic output in an average year;[50] however, major hurricanes can disrupt daily airport operations with economic consequences. For example, in the month following Hurricane Irma, total airplane passenger counts decreased 11.6 percent across the state with most decreases occurring in south Florida.[51] The gradual threat of sea level rise also endangers coastal airport infrastructure, which may require ongoing maintenance or repair from flooding and costly capital investments for mitigation. As identified in the National Climate Assessment, Miami, Tampa, and Fort Lauderdale International Airports are three of the nation's largest airports with a runway within twelve feet of sea level, making them extremely at risk for coastal storm surge and flooding.[52]

Florida seaports are also economic drivers, accounting for $117.6 billion in economic output annually; however, they are susceptible to daily tidal fluctuations, major storm events, and gradual sea level encroachment.[53] The cost of repairing or replacing large portions of seaport infrastructure—including wharfs, cranes, and warehouses—would be hundreds of millions of dollars, excluding the reduced cargo efficiency during the process of repair. Disruptions to operations during extreme weather events would reduce the value of waterborne trade moving through Florida seaports, which averages $87.3 billion per year.[54]

For decades, Florida has served as the primary hub for the country's space program due to its ideal location. The state has benefitted from the economic activity generated by space exploration, highlighted in recent years by the burgeoning commercial space industry. Yet despite the prospect of continue economic growth, climate change poses a long-term risk to launch pads and buildings, which collectively represent around $32 billion in infrastructure.[55] Models project the ocean by the Kennedy Space Center (KSC) to rise between five and eight inches by the 2050s and between nine to fifteen by the 2080s.[56] Closing launch sites due to extreme weather or chronic flooding would delay launches and create an economic cost for the space companies that rely on the launch pads to send equipment into space. Furthermore, at the KSC, around 1.5 million of roads will need to be raised by one foot to avoid degradation; by 2060, the figure grows to 20 miles of roadway that will need two feet of higher elevation.[57] The capital cost to raise these roads, along with the loss of access during construction, further present additional economic costs.

For Florida's various utility systems, climate change will directly affect the consumption of electricity and water. Higher temperatures will increase demand for electricity, primarily to support greater air conditioning needs throughout the year. Based on prior research, higher demand for electricity will result in an additional $5 billion in costs per year by 2050 and $18 billion per year by 2100—even after accounting for the natural increase in energy demand due to population growth.[58]

48 WGCU Public Media, "Miles of Florida roads face 'major problem' from sea rise. Is state moving fast enough?" Mar. 22, 2021.

49 Ibid, and Consideration of FDOT's Macroeconomic Analysis of Florida's Transportation Investments: Fiscal Year 2019-2023 Work Program, Aug. 2020.

50 Florida Department of Transportation (FDOT), Statewide Aviation Economic Impact Study, 2019.

51 Oxford Economics, The Impact of Hurricane Irma on the Florida Tourism Economy: Prepared for VISIT Florida, Jan. 2018.

52 U.S. Global Change Research Program (USGCRP), Climate change impacts in the United States: U.S. national climate assessment, 2014.

53 Florida Ports Council, Seaports Resiliency Report, 2019.

54 Ibid.

55 NASA, "NASA Watches Sea Level Rise from Space, and Its Centers' Windows," Nov. 5, 2020.

56 NASA, "Sea Level Rise Hits Home at NASA," Aug. 26, 2015.

57 NASA, "NASA Watches Sea Level Rise from Space, and Its Centers' Windows," Nov. 5, 2020.

58 University of Florida – IFAS Extension, "Economic Impacts of Climate Change on Florida: Estimates from Two Studies," March 2018. It should be noted that this calculation assumes that no climate change mitigation efforts are in place.

For every additional degree of Fahrenheit of warming, the study found that electricity consumers in Florida will face an extra $3 billion in costs per year.[59] Furthermore, electricity infrastructure, often located near water for cooling purposes, also faces risk from gradual sea level rise and storm surge. The number of electrical facilities in Florida exposed to flooding from a Category 3 storm could double by 2050 and triple by 2070.[60]

Hotter temperatures and drier conditions have the added effect of intensifying Florida's demand for water among agricultural and household users. For most of Florida, demand for water is expected to increase by more than 50 percent by mid-century as farmers need more water to support plant growth, families use more water for day-to-day activities, and electrical facilities require additional water for cooling.[61] Supplying the rise in demand for water may prove difficult as saltwater intrusion into Florida's permeable aquifers threaten freshwater availability and water systems grapple with heightened user demand.[62] Potential increases in rainfall, as a result of climate change, may partially supply the need for water irrigation among farmers; however, climate variability makes the impact indeterminate.

Businesses within Florida's wholesale and retail trade sub-sectors are connected, in some form or another, to supply chains. Products such as groceries, apparel, pharmaceuticals, and general merchandise depend on well-ordered supply chains to meet consumer demand in a timely manner. As demonstrated throughout the COVID-19 pandemic, disruptions to global and local supply chains can promote inefficiencies by creating bottlenecks and delaying deliveries. This in turn creates significant downstream costs to wholesalers and retailers who are unable to address consumer demand and lose revenue in the process.

Although the COVID-19 pandemic represents the largest and most extreme supply chain shock, in future decades, disruptions will become more commonplace as climate change makes extreme weather more frequent and severe across the world. Across industries, companies can expect supply chain disruptions lasting longer than a month to occur every 3.7 years, on average, due to climate change and other disruptive events.[63] The risk is heightened for trade-oriented industries given their overall exposure to global distribution networks. For example, according to a McKinsey analysis, consumer apparel and petroleum products have the second and third highest exposure to supply chain disruptions, respectively, for their geographic footprint around the world.[64] Higher exposure makes companies that sell those products more susceptible to climate interruptions and more likely to experience financial losses. Though some variation is to be expected, the same risk can be observed for retail and wholesale trade companies that sell other products given their connection to supply chains.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Billions of dollars in damage to roads, highways, bridges, railroads, power generating stations, seaports, airports, and spaceports.
- Disruption to transportation networks, which limits the movement of people and goods from one part of the state to another, and from Florida to other destinations.
- Increased demand for and costs of water, electricity, and other utilities.
- For companies involved in wholesale and retail trade, supply chain shocks can be expected. Prices paid by consumers will increase.
- Diminished economic growth over the coming decades.

59 Ibid.

60 Florida Department of Agriculture and Consumer Services (FDACS), Florida Energy and Climate Plan: Powering Change, Feb. 26, 2019.

61 Columbia University Climate School, "How Climate Change Impacts our Water," Sept. 23, 2019.

62 Florida Atlantic University, Florida Water Management and Adaptation in the Face of Climate Change, Nov. 2011.

63 McKinsey Global Institute, "Risk, resilience, and rebalancing in global value chains," Aug. 6, 2020.

64 Ibid.

Professional and Business Services

The Professional and Business Services sector is part of the service-providing industries group and includes three principal sub-sectors:

- Professional, Scientific, and Technical Services—include establishments that specialize in providing technical expertise for others. Activities include legal advice, accounting, payroll services, engineering, computer services, consulting, and more.
- Management of Companies and Enterprises—include establishments that administer the strategic or organization planning for another company or enterprise.
- Administrative and Support and Waste Management—includes establishments that perform routine support activities for the day-today operations of other organizations. Examples include office administration, clerical services, security and surveillance, janitorial services, and waste disposal services.

For companies within Florida's Professional and Business Services sector, climate change presents both economic opportunity and risk. On the one hand, climate change can pose a direct risk to operations (e.g., major storm shutting down operations) and an indirect risk through regulatory and market forces (e.g., regulatory policies designed to curb carbon emissions). In contrast, climate change affords companies the opportunity to innovate and improve on carbon-reducing efforts, thereby reducing cost and raising resource productivity.[65]

According to Deloitte's 2021 Climate Check report, nearly 30 percent of professional and business executives reported already experiencing the operational impacts of climate change from climate-related events disrupting business models and value chains. Furthermore, around 26 percent responded that scarcity and cost of resources and the regulatory and political uncertainty are impacting their organization.[66] The risk has grown over the last year as many companies have dealt with the COVID-19 pandemic and resulting economic downturn.

In addition to creating risk and uncertainty, climate change also produces opportunities for companies to adapt and innovate to changing conditions. Based on the same Deloitte survey, 49 percent of companies adopted public policy initiatives that promoted sustainability efforts, 48 percent encouraged suppliers and partners to meet specific environmental criteria, and 46 percent are using more sustainable materials and products. In Florida, private company efforts to promote environmental sustainability mirror trends nationwide. At Waste Management, for example, commitments to reduce fleet carbon emissions, upgrade recycling facilities, and invest in green technology have yielded various economic and societal benefits to the community.[67]

For the Professional and Business Services sector, the development of new virtual technologies and the growing reliance on remote work has an additional benefit for climate change efforts. Encouraging the use of telework lowers the amount of daily travel and the amount of energy utilization at office spaces, further reducing carbon emissions. Even though the rapid proliferation of remote work was primarily an outcome of the COVID-19 pandemic, further implementation provides future opportunities for the Professional and Business Services sector to deal with and respond to climate change.

65 Deloitte, "Feeling the heat? Companies are under pressure on climate change and need to do more," Dec. 12, 2019.

66 Deloitte, 2021 Climate Check: Business' Views on Environmental Sustainability" Accessed on June 29, 2021.

67 Waste Management, 2020 Sustainability Report: Building Value Together," Accessed on June 29, 2021.

Remote work enables companies to maintain operations even when the weather prevents access to the physical workplace or displaces workers to other areas. For example, even if storm inundation damages roadways and prevents workers from traveling to an office building, the possibility of working from home minimizes the potential loss to revenue and productivity.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Disruptions in business models and value chains.
- Increased scarcity and cost of resources.
- Regulatory and political uncertainty.

Government

The Government sector comprises establishments of federal, state, and local government agencies that administer, oversee, and manage public programs and have executive, legislative, or judicial authority. These agencies set policy, adjudicate legal cases, and provide for public safety and national defense. These governmental entities oversee programs that are not typically performed in the private sector.

For Florida's Government Sector, continued sea-level rise will impose fiscal stress on municipal budgets by eroding property tax revenue and enlarging expenditures for resilience. On the revenue side, chronic tidal flooding, as a direct result of sea-level rise, can devalue property value over time and reduce property tax revenue.[68] According to one study, by 2030, coastal counties in Florida could lose more than $100 million in property taxes due to chronic flooding. By 2045 the potential loss of property tax revenue jumps to $350 million, and by the end of the century, the property tax risk escalates to nearly $5.0 billion (See Table 4).[69] In Lee and Manatee counties, for example, each could lose more than $22 million in property taxes by 2045 due to repeated flooding.[70] It should be noted, however, that rebuilding or constructing newer, more resilient structures could hypothetically offset some of the expected property tax losses if the new structures are higher in property value. The extent to which chronic inundation diminishes property value or incentivizes homeowners to ultimately abandon properties is an important long-term factor that remains unknown at present.

The gradual erosion of municipal tax revenue would have an indirect effect on funding for services that local governments typically support, such as schools and public safety programs. For example, since local revenue for school support is derived almost entirely from levied property taxes, any long-term reduction in property tax collections would have a negative consequence on many local schools. Other local government expenses that would be affected due to declining revenues include police and fire departments, transportation services, parks and recreation, housing services, and public works projects.

Table 4. Property Tax Risk in Florida

Year	Property Tax At Risk
2020	$55,036,736
2030	$101,267,251
2045	$346,860,157
2060	$1,021,469,604
2080	$2,669,060,666
2100	$4,958,898,111

Source: Union of Concerned Scientists

On the expenditure side, local governments will incur costs to raise and repair roads, retrofit existing water and drainage systems, construct seawalls, and develop other resilience measures. These proactive measures, although designed to reduce the potential long-term risk from sea-level rise, require significant capital investment over time.

68 Shi and Varuzzo (2020), "Surging seas, rising fiscal stress: Exploring municipal fiscal vulnerability to climate change," The International Journal of Urban Policy and Planning.

69 Union of Concerned Scientists, "Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate," Jun. 18, 2018. Note: The results presented in the study are generated based on existing property numbers, property values, and related data from Zillow. The data do not take into account the projected population growth or home appreciation that will occur in future decades.

70 Environmental Defense Fund, "How climate change threatens Floridians' futures," Nov. 9, 2020.

In the Florida Keys for example, county officials plan to spend $1.8 billion over the next two decades to raise around 150 miles of roads in the local community and establishing new drainage systems, pump stations, and vegetation to prevent flooding.[71]

To sustain these new measures, local residents, businesses, and visitors will likely face higher taxes.[72] In Miami, estimates suggest the city will have to spend more than $3.8 billion over the next forty years to adapt the city to rising seas and chronic flooding.[73] Even with all the preventative efforts, however, certain neighborhoods and structures will still be susceptible to damage from daily tidal flooding and storm inundation. The principal challenge for local governments will be deciding how to pay for climate change mitigation efforts, which are expensive in nature. To undergo such efforts, do local residents, businesses, visitors, or the state of Florida ultimately bear the cost for resilience and mitigation? Furthermore, at what point do the long-term costs outweigh the potential benefits from resiliency measures that may not withstand sea level rise forever?

Elsewhere in the Government Sector, climate change will directly affect military installations around the state of Florida with important ramifications for economic output and national security. Florida's twenty military and defense installations provide nearly $95 billion in annual economic output, serving as a powerful economic driver for local economies.[74] In future years, however, recurring flooding, wildfires, and storms—all due to climate change—will endanger these installations. According to the U.S. Department of Defense, eight of Florida's military bases are among the country's most vulnerable bases to climate change.[75] The bases include:

- Eglin Air Force Base
- Hurlburt Field
- Homestead Air Force Reserve Base
- MacDill Air Force Base
- Tyndall Air Force Base
- Patrick Space Force Base
- Key West Naval Air Station
- Marine Corps' Blunt Island Support Facility

By mid-century, Florida's coastal bases may experience ten times the number of floods experienced in 2020.[76] Recurring flooding would damage critical infrastructure and interrupt daily operations at these bases. Severe hurricanes also pose a direct threat by bringing extreme precipitation and high winds. In 2018, Hurricane Michael damaged 95 percent of Tyndall Air Force Base, requiring an estimated $2 billion in capital repair costs and disrupting training, maintenance, and operations for a month.[77] Since military installations are interconnected with the local area, any climate-induced disruption on the military base can magnify the potential economic losses in the broader community. For more information on the future impact of climate change on Florida's military installation, the federal government's *Report on Effects of a Changing Climate to the Department of Defense* represents the most comprehensive report to date.[78]

71 Miami Herald, "Raising Keys roads for sea rise could cost $1.8 billion. Residents may pay much of that bill," Dec. 26, 2020.

72 Ibid.

73 Tampa Bay Times, "Miami's sea-level rise bill - $4 billion by 2060 – still won't keep every neighborhood dry," Apr. 22, 2021.

74 Enterprise Florida, Military and Defense Programs, Accessed Jun. 28, 2021.

75 U.S. Department of Defense, Report on Effects of a Changing Climate to the Department of Defense, Jan. 2019.

76 American Security Project, National Security Implications of Climate Change in Florida, Mar. 2021.

77 Ibid.

78 U.S. Department of Defense, Report on Effects of a Changing Climate to the Department of Defense, Jan. 2019. Readers might also want to reference the recent Department of Defense's DOD Installation and Exposure to Climate Change at Home and Abroad, Released Apr. 2021.

The threat of sea-level rise and amplified storm surge also affects local governments by increasing the demand for hurricane shelters outside of evacuation zones. Shelters serve a crucial role in safeguarding residents who must leave their structures during major hurricanes, but as storm inundation becomes more diffuse due to climate change, the demand for shelter space will subsequently rise. There is also a risk that inland counties will have to accommodate a growing number of residents evacuating from coastal areas, further raising demand for shelter spaces across the state. According to Florida's Division of Emergency Management (DEM), three out of ten regions in Florida are already facing deficits in the number of shelter spaces available to the general population.[79] The Tampa Bay, Southwest Florida, and Central Florida regions have a collective 132,000 space deficit as of 2020 and will continue to rise in coming years.[80] Addressing these deficits while also preparing for future demand growth presents a fiscal cost for many local governments.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Greater fiscal stress on public budgets resulting from declining tax revenues and increasing expenditures for resilience and repair.
- Lower property and other tax collections.
- Increased property and other taxes.
- Increased public expenditures for local projects such as raising roads, constructing sea walls, and retrofitting structures.
- Reduced national security as a result of damage to Florida's key military installations.
- Increased demands to use public facilities for hurricane shelters outside of evacuation zones.

79 Florida Division of Emergency Management (DEM), 2020 Statewide Emergency Shelter Plan, Jan. 31, 2020.

80 Ibid.

Education and Health Services

The Education and Health Services sector is a part of the service-providing industries group and consists of two primary sub-sectors:

- Educational Services—includes establishments that provide instruction and training on a wide variety of subjects. Examples include schools, colleges, universities, test training centers, and more.
- Health Care and Social Assistance—includes establishments providing health care, such as hospitals and residential care facilities, and social assistance, such as child services and community housing services. Although industries in the Health Care and Social Assistance sector may differ in the degree to which they provide medical care exclusively, all industries share the commonality of including trained health practitioners with sufficient medical expertise.

As it relates to the Education Sector, climate change's economic impact involves the risk of flooding to physical school structures and the potential increase in learning-related disruptions due to extreme weather events. As discussed in previous sections, across the state of Florida, projected sea-level rise is expected to flood portions of coastal lands, damaging homes, roads, and other physical structures. Likewise, for schools that are located on low elevation properties, the risk associated with sea-level rise is growing. One study suggests that by 2100, more than thirty schools along Florida's coastline will be at extreme flooding risk due to rising sea levels of at least three feet—without considering the added flooding risk from major storm surge.[81] In Monroe County, as an example, a sea-level rise of one foot would threaten around 65 percent of schools located on low elevation properties.[82] Over time, damaged school structures would incur more capital costs for repair and replacement.

For students, educators, and administrators, environmentally-related disruptions and subsequent school closures can also hurt student outcomes. The influence of disruptions on academic achievement tends to be short-run and often bounce back as school operations resume; however, the influence of natural disasters on students' mental health may be long term in nature and may implicate an economic cost—as documented in longitudinal studies following Hurricane Katrina.[83] The COVID-19 pandemic showed that remote learning was a practical way to maintain learning during periods where in-person learning was not feasible. Similarly, as Florida's education system grapples with future disruptions to learning from climate-induced events, remote formats may mitigate potential learning losses by giving students the ability to learn outside of a classroom. These learning outcomes, however, would likely differ between students in a K-12 setting versus a postsecondary setting since older students would have more experience with virtual technology.

The economic impact of climate change on the Health Care Sector is largely driven by the changing climate's influence on adverse health outcomes, which raises health care expenditures in the process. Warming temperatures, changes in precipitation patterns, and increased severity of extreme weather are all natural outcomes of climate change that have the potential to endanger the underlying health conditions of vulnerable populations with pronounced effects on health care utilization.

Prolonged exposure to hotter temperatures is linked to higher rates of health-related illnesses and mortality, especially among elderly adults, children, and pregnant women.[84] Health risks include cardiovascular disease, respiratory complications, renal

81 Resources for the Future, Florida Climate Outlook: Assessing Physical and Economic Impacts through 2040, Jan. 30, 2020.

82 World Resources Institute, "Sea-Level Rise and Its Impact on Florida," Accessed on June 23, 2021.

83 Brookings Institute, "Learning from Katrina to care for Hurricane Harvey's youngest victims," Sept. 6, 2017.

84 U.S. Global Change Research Program, Ch. 2: Temperature-Related Death and Illness, The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment, 2016.

failure, preterm birth, electrolyte imbalances, and other physiological responses. Because Florida's summer temperatures are hotter than most parts of the U.S., especially during the summer, rising temperatures magnify these risks for Florida residents.[85]

According to some estimates, the mortality rate due to heat-related illness is expected to climb anywhere from 3.8 to 5.8 per 100,000 Floridians per year, which roughly translates to between 1,000 and 1,400 additional deaths annually by 2035.[86] Mortality risk will also vary across the state with south Florida counties, such as Miami-Dade, Palm Beach, and Martin counties facing higher mortality risks than other portions of the state.[87] For example, in Miami-Dade County, median estimates suggest excess deaths due to heat may reach 420 additional deaths per year by 2035.[88] It should be noted that rising temperatures due to climate change may potentially lower the risk of exposure to extreme cold during winter months, partially offsetting the mortality risk associated with hotter temperatures.

More than just increasing the risk of heat exposure, climate change can also lead to adverse health outcomes by affecting air quality, water quality, and vector-borne diseases. Rising carbon dioxide levels and hotter temperatures can help spread airborne allergens, making respiratory issues, such as asthma, more prevalent.[89] Increased water temperatures can alter the seasonality of harmful algal growth and coastal pathogens, threatening sources of clean drinking water for portions of the state.[90] As it relates to vector-borne disease, projected increases in rainfall coupled with extreme weather can increase the geographical range and transmission of mosquito-borne viruses, such as Zika, dengue, and chikungunya.[91]

Quantifying the exact economic cost of climate-related health complications is difficult given the various illnesses and severity levels, along with the uncertainty surrounding exact health care needs. Using the U.S. Environmental Protection Agency's Value of a Statistical Life (VSL), which is often used in cost-benefit analyses for environmental policies, each excess death due to climate change is associated with an economic cost of $7.4 million.[92] The economic impact of climate change is also unequally felt across populations, as some populations are more vulnerable and disproportionately affected. Low-income communities of color, in particular, are often more prone to heat risks and may be less likely to have access to quality care for heat-induced illness.[93] Older populations and children are also more prone to complications, making the potential economic cost higher for these groups.

Climate change can also have a direct impact on health care access and delivery during extreme weather events, such as powerful hurricanes. Especially for hospitals that must stay operational during powerful storms, the potential disruption to healthcare infrastructure, communication networks, and transportation systems can quickly turn deadly. For populations in need of rapid medical attention, these disruptions can prevent access to critically needed services and further exacerbate mortality risks. As an example, in the aftermath of Hurricane Maria in 2017, only three of Puerto Rico's 95 hospitals were

85 Resources for the Future, Florida Climate Outlook: Assessing Physical and Economic Impacts through 2040, Jan. 30, 2020.

86 Ibid. The estimates of additional deaths in 2035 are based on population estimates up to 2035, and the authors assume no demographic changes from 2012 to 2035.

87 Ibid.

88 Ibid.

89 Environmental Protection Agency (EPA), Climate Impacts on Human Health, Jan. 19, 2017.

90 U.S. Global Change Research Program (USGCRP), Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment Vol. 2, 2018.

91 Environmental Protection Agency (EPA), Climate Impacts on Human Health, Jan. 19, 2017.

92 Environmental Protection Agency (EPA), Mortality Risk Valuation, Accessed on June 23, 2021.

93 Health Affairs, "Adding A Climate Lens to Health Policy in the United States," Dec. 2020.

operational, and 30 percent of households reported problems accessing health care services and medication.[94] For these reasons, hospitals will likely need to bolster contingency plans in the future to adapt to the growing dangers of climate change.

For the entire health care sector, the specific challenges that climate change presents largely differ depending on the health care provider and setting. Physicians who see patients in medical offices for routine checkups may face more subtle effects of climate change over the long term, such as having more patients with cardiovascular complications due to continued heat stress. Hospitals, on the other hand, may experience more sudden effects of climate change during major storms when disruptions affect emergency health care services. Although the challenges are not exclusive, the variation suggests that calculating economic costs is difficult to accomplish for the sector as a whole.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Increased flood and storm damage to educational and health care facilities located in low-lying areas.
- Disruptions to learning resulting from school damage and closures. Remote learning can mitigate these losses but only to a certain extent.
- Increased frequency and severity of heat-related illnesses and fatalities, particularly for older and low-income Floridians.
- Increased costs of and decreased access to quality health care.

94 University of Minnesota, "Lessons from a Hurricane: Supply Chain Resilience in a Disaster: An Analysis of the US Disaster Response to Hurricane Maria," Sept. 9, 2020.

Leisure and Hospitality

The Leisure and Hospitality sector is one of several service-providing industries and is comprised of two sub-sectors:

- Arts, Entertainment, and Recreation—includes a wide range of establishments that provide services to meet cultural, entertainment, and recreation interests of their patrons. Examples include theme parks, bowling alleys, golf courses, and spectator sports; and
- Accommodation and Food Services—includes establishments providing customers with lodging and/or prepared meals, snacks, beverages for consumption. Examples include hotels, motels, full-service restaurants, and bars.

Florida's natural environment and Leisure and Hospitality industry are fundamentally connected—every year, millions of visitors from around the world visit the Sunshine State for its theme parks, beaches, nature trails, and waterways, generating economic activity in the process. As climate change threatens coastal and in-land ecosystems—either from largescale events, such as major hurricanes, or slow gradual processes like sea-level rise—physical changes to the environment will disrupt tourism to the state. Over time, these changes and disruptions will yield negative economic consequences as fewer prospective tourists translates into fewer dollars spent on local communities and businesses. Furthermore, the state's Leisure and Hospitality industry relies heavily on transportation, infrastructure, and connectivity to move residents and tourists around the state. As such, any direct impacts of climate change on trade and transportation networks will have important secondary effects for tourism-focused industry in Florida.

As the past few years have demonstrated, Florida's tourism is highly sensitive to sudden large-scale events like major hurricanes. In 2017, Hurricane Irma disrupted travel into the state as the massive storm shut down transportation hubs, including major airports and seaports. The hurricane resulted in 1.8 million fewer out-of-state visitors over the following four months and $1.5 billion in lost visitor spending throughout the state's economy.[95] At large theme parks, such as Disney World, Universal Studios, and SeaWorld, Hurricane Irma forced park closures for a few days as the storm passed through. According to some estimates, Disney World lost $100 million due to the closure and lack of visitors—a financial cost witnessed at other theme parks.[96] For other businesses in the sub-sector, the massive storm compelled many arts, entertainment, and recreation venues across the state to shutter, foregoing millions in revenue.

In future years, economically costly events like major hurricanes will occur with more frequency and severity as climatic factors drive conditions conducive for development.[97] Intense hurricanes—such as the storms that permeated the 2017 and 2018 hurricane seasons—will become more destructive due to warmer ocean temperatures in the Atlantic Ocean basin. These major storms will directly disrupt travel operations and dissuade potential travelers from visiting the state immediately after a storm.[98] With fewer visitors, local arts, entertainments, and recreation businesses will face falling revenues with some regularity during Florida's unpredictable hurricane season.

Excessive heat due to climate change may also prevent individuals from taking part in outdoor recreation, negatively impacting businesses that provide outdoor activities to patrons, such as golf courses, shooting ranges, fitness centers, and spectator venues. Outdoor recreation is a powerful driver in the U.S. economy, accounting for around $887 billion in annual

95 Oxford Economics, The Impact of Hurricane Irma on the Florida Tourism Economy: Prepared for VISIT Florida, Jan. 2018.

96 Orlando Sentinel, "Disney's Cost from Hurricane Irma is $100M," Nov. 9, 2017.

97 Union of Concerned Scientists, "Florida: Ground Zero in the Climate Crisis," May. 2019.

98 Ibid.

spending.[99] In Florida, residents spend an average of $1,351 annually on outdoor recreation activities, equipment, and companies.[100] As excessive heat waves become more prevalent—especially during the hottest summer months—Florida's outdoor recreation businesses may receive less revenue as fewer customers decide to go outside into the extreme heat.[101] Quantifying the exact economic loss is tenuous, however, given the fact some recreational activities are not easily captured in economic transactions (e.g. a personal hike). Some customers may also opt for indoor activities instead, further complicating calculations.

Businesses within Florida's Accommodation and Food Services sub-sector are also highly susceptible to major climatic events. Just as Hurricane Irma led to a decline in visitors to art, entertainment, and recreation establishments, the storm also reduced the number of tourists who used hotels or other lodgings. The hardest-hit Florida Keys experienced a 44 percent decrease in hotel room demand compared to the previous September.[102] Similarly, hotel room demand fell by more than 10 percent in Naples and Miami.[103] A similar pattern can be expected for more frequent major hurricanes in the future; however, displaced residents who use hotels and other lodgings can partially offset the economic losses to accommodation businesses.[104]

For food-service-oriented businesses, the impact of major hurricanes on operations is another clear and direct outcome of climate change. Besides hurricanes, Florida's harmful algal blooms (HABs or "red tide") are another direct and damaging outcome.[105] Red tide can have an outsized impact on the local fishing and restaurant industry since released toxins make it dangerous to consume contaminated shellfish and other seafood. This health risk subsequently lowers demand for seafood in many local areas. Waterfront and other coastal restaurants often face the most economic consequences given their proximity to the water. In 2018, excessive red tide led to more than $130.6 million in economic damages with pronounced losses for southwest Florida's restaurant industry.[106] Historically, major red tide blooms have been accompanied by declines in monthly sales revenue; between 2006 and 2018, monthly sales for Florida's restaurant industry decreased by up to 2.5 percent when red tide was present.[107] Although red tide is a naturally occurring event, climate exacerbates them since red algae and cyanobacteria thrive in warmer waters. Additionally, research finds that increased rainfall from storms washes nitrogen and phosphorous-rich nutrients into waterways, further fueling algal growth.[108]

Overall, environmental impacts due to climate change produce an implicit economic cost for the Leisure and Hospitality industry by reducing the quantity and quality of natural features around the state and increasing the likelihood of economically costly events. Fewer visitors traveling to popular destinations contribute less spending in local communities. Research on past hurricanes has found that on average, Florida counties lose approximately $10 million in gross sales during a hurricane-impacted month, $12 million the following month, and $7 million in the second post-storm month.[109] There is an inherent difficulty, however, in determining an exact economic impact in future years since many climate change-driven outcomes can vary by scale (i.e. statewide vs. localized) and time (i.e. short-lived vs. gradual over the long-run).

99 Outdoor Industry Association, "The Outdoor Recreation Economy," Apr. 2017.

100 Florida Department of Environmental Protection (DEP), "Economic Impact of Outdoor Recreation Activities in Florida," Aug. 2017.

101 Journal of Applied Meteorology and Climatology, "Heat Waves in Florida: Climatology, Trends, and Related Precipitation Events," Mar. 1, 2019.

102 VISIT Florida, "The Impact of Hurricane Irma on the Florida Tourism Economy," Jan. 2018.

103 Ibid.

104 Ibid.

105 A harmful algal bloom (HAB) occurs when toxin-producing algae grow excessively in a body of water. The excessive algal growth, or algal bloom, becomes visible to the naked eye and can be green, blue-green, red, or brown, depending on the type of algae.

106 Tampa Bay Regional Planning Council. The Economic Ripple Effects of Florida Red Tide, Jan. 2019.

107 UF-IFAS, "Quantifying the Socio-Economic Impacts of Harmful Algal Blooms in Southwest Florida in 2018," July 2021.

108 Ibid.

109 Brown et. al. (2021), "The Economic Impacts of Tropical Cyclones on a Mature Destination, Florida, USA," Journal of Destination Marketing & Management.

For example, a largescale hurricane that affects the entire state over a few days stretch has substantially different economic effects than the slower process of red tide off southwest Florida, even though both would have negative consequences.

Despite these estimating challenges, a prior research study conducted by Tufts University[110] estimated the economic cost of climate change on Florida's Leisure and Hospitality industry by analyzing two scenarios: a "rapid stabilization case," where global emissions are reduced by 50 percent by 2050, and a "business-as-usual case" where emissions steadily increase throughout the 21st century. The dollar difference between the two scenarios represented the "cost of inaction," or the cost of climate change to Florida tourism without any mitigating efforts in place.

The report finds that by 2050, Florida's tourism industry would bring in $40 billion less in annual revenue if emissions steadily climb. Adjusting for inflation, this estimate would be about $53 billion using 2021 U.S. dollars (See Table 5).[111] Eventually by 2100, absent any mitigating factors, Florida's tourism industry would stand to lose $117 billion due to climate effects on beaches, the Everglades, coral reefs, and more.

Table 5. Revenue from Leisure and Hospitality Industry in Two Climate Scenarios (in 2021 Billion $)

Climate Scenario	2050	2075	2100
Rapid Stabilization Case	$213	$420	$609
Business-as-Usual Case	$201	$367	$493
Cost of Inaction (Scenario Difference)	$12	$53	$117

Source: Stanton and Ackerman (2007) and University of Florida (2018) Note: The numbers presented in the table have been updated using 2021 US Dollar values to adjust for inflation. The original report used 2006 Dollar values to estimate the costs. Since the underlying data may not incorporate newer emission projections, these figures can be viewed as conservative lower-bound estimates for future costs.

Looking beyond the aggregate statewide impacts, there will also be significant regional variation across the state. The impact of climate change on Florida's Leisure and Hospitality will center on areas where there are high concentrations of both natural attractions and tourism activity, such as in south Florida and elsewhere along Florida's coastline communities. These coastal counties lose $12.5 million in sales, on average, during hurricane-impacted months.[112] Recent research has also found, however, that inland rural areas are extremely susceptible to climate impacts. Analyzing data from 2002 to 2018, one study found that rural counties that experienced hurricanes saw a sizeable decrease in sales tax revenue compared to other rural counties that did not face storm impacts.[113] Since rural counties tend to have smaller revenue streams, economic losses can be substantial and slow the progress of economic recovery over time.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- A dramatic reduction in the number of tourists who visit Florida each year.
- Billions of dollars in lost business income and state and local government tax revenues.
- Increased closures of Leisure and Hospitality-related businesses and industries.
- Dramatic increases in unemployment of Leisure and Hospitality sector employees.
- Reduced outdoor activity (e.g., golf, tennis, hiking, boating, etc.) as a result of increased temperatures.

110 Stanton and Ackerman, Tufts University, "Florida and Climate Change: The Costs of Inaction," Nov. 2007. Referenced in 2018 by the University of Florida, "Economic Impacts of Climate Change on Florida: Estimates from Two Studies."

111 Since the calculation in the study uses 2006 U.S. dollars as a benchmark for inflation, the present analysis adjusts for inflation using updated 2021 U.S. dollars figures. For example, $1 in 2006 is worth $1.32 in 2021 due to inflation.

112 Brown et. al. (2021), "The Economic Impacts of Tropical Cyclones on a Mature Destination, Florida, USA," Journal of Destination Marketing & Management.

113 Huang and Medeiros (2020), "How Do Hurricanes Impact The Tourism Economy?" International Journal of Tourism and Hospitality Research.

Manufacturing

The Manufacturing sector is part of the goods-producing group and comprises establishments engaged in mechanical, physical, or chemical transformation of materials, substances, or components into new products. These establishments are most often described as plants, factories, or productions mills that incorporate machines and other heavy equipment. Examples of businesses in this sector are largely diverse and include firms producing goods including food and beverages, aerospace equipment, communications, pharmaceuticals, batteries, and transportation vehicles. Florida is also home to numerous advanced manufacturing companies which specialize in high-skill, high-wage jobs and develop nanotechnology and other digital technologies.

Nationwide, manufacturing accounts for 23 percent of direct carbon emissions.[114] This is a significant footprint, which makes Florida's manufacturing companies likely to be subject to future climate change regulations. Extremely high temperatures associated with climate change will affect manufacturing productivity. In 2017, a single day with temperatures higher than 90 degrees costs a manufacturing plant more than $10,000 in output.[115] Extremely high temperatures will not just affect productivity; extremely high temperatures place workers at risk and threaten the temperature sensitive electronic devices (e.g., cell phones and high-tech sensors) we use every day.

Due to the interdependence between manufacturers and international suppliers, supply chains serve an integral role in the manufacturing process. As observed throughout the COVID-19 pandemic, severe disruptions in any part of the world can interrupt the entire supply chain process, affecting the timely flow of materials and resulting in a higher cost of production for businesses. Even as Florida's manufacturers move on from the current pandemic, considerations about future disruptions and their economic costs are growing. One particular source of future disruption will be climate change. As an evolving climate increases the frequency and severity of acute weather events around the world and in the U.S., the likelihood of supply chain shocks affecting Florida's manufacturers will rise and have a prominent economic impact.

For Florida's Manufacturing Sector, vulnerability to climate-driven supply chain shocks depends on various factors, such as the diversity of manufactured products and the geographical dispersion of supply chains. Florida's manufacturing is diverse in the set of goods it produces, ranging from computers and batteries to boats and satellites, and more. By economic output, Florida's largest manufacturing sub-sector is computer and electronic products, which accounts for $8.7 billion in annual output, followed by production for chemicals, food and beverages, and aerospace (See Figure 2).[116] Product diversity around the state reduces the reliance on a single supply chain and therefore minimizes risk to potential disruption; however, large enough external shocks on the scale of the COVID-19 pandemic can still be widespread across all manufacturing areas.

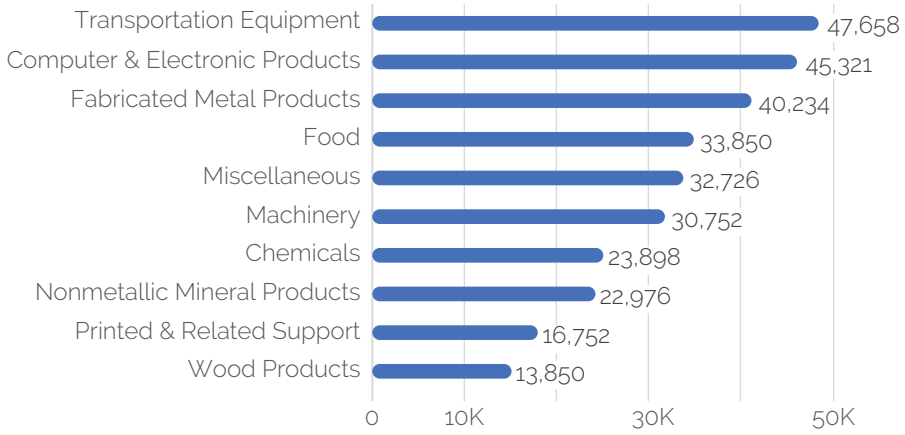
Despite the given product diversity, Florida's manufacturers still face considerable risk to climate-driven disruptions for some areas of production that require supplies from locations outside of Florida. For example, some of Florida's largest manufacturing areas include computer, electronics, and aerospace—which all require semiconductor technology either produced in the U.S. or in Asia. According to McKinsey, however, the probability of a major hurricane with sufficient intensity

114 U.S. Environmental Protection Agency, "Sources of Greenhouse Emissions," retrieved from https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions, October 14, 2021.

115 Scott Huntington, "Is Climate Change Having an Impact on Manufacturing?," retrieved from https://www.altenergymag.com/article/2020/01/is-climate-change-having-an-impact-on-manufacturing/32543, October 14, 2021.

116 National Association of Manufacturers (NAM), 2021 Florida Manufacturing Facts, Accessed June 25, 2021.

Figure 2. Manufacturing Industries' Employment (2020)



Source: "By the Numbers: Florida's Manufacturing Growth," Department of Economic Opportunity, June 2021.

to disrupt global semiconductor supply chains may grow up to four times by 2040.[117] Furthermore, the same study found the probability that an acute weather event may disrupt heavy rare earth production may increase up to three times by 2030.[118] Rare earth metals are ubiquitous in aerospace vehicles, medical devices, and rechargeable batteries—all products manufactured in Florida.

For Florida's manufacturers, disruption due to climate-driven events is a growing reality for the future of global commerce. According to a McKinsey analysis, manufacturers can now expect supply chain disruptions lasting a month or longer to occur every 3.7 years, on average, which would erase half a year's profits over the course of a decade.[119] In future years, supply chain resilience will assist Florida's manufacturers in reducing exposure to acute weather disruptions and minimizing potential economic costs to production. Resilience strategies include proactively identifying critical vulnerabilities in a manufacturer's supply chain and diversifying supplier sources, particularly within Florida. One tool that pursues these two goals is Connex Florida—a supply chain database for the manufacturing industry in Florida. Developed by FloridaMakes, Space Florida, and the Associated Industries of Florida, the Connex Florida platform enables Florida manufacturers to analyze potential risk and diversify supplier bases by connecting with in-state suppliers.[120] Tools like Connex Florida, and other proactive measures, enable Florida manufacturers to navigate global disruptions and lessen long-term costs.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Manufacturers will likely experience reduced productivity and increased risk of heat-related illness and injury.
- Manufacturers, especially those that produce large volumes of greenhouse gas emissions, will be subjected to increased regulation.
- Supply chain disruptions that result from climate change events across the globe will reduce the production of products manufactured in and exported from Florida. This will limit the availability of goods manufactured in Florida and increase their costs.

117 McKinsey Global Institute, "Could climate become the weak link in your supply chain?" Aug. 6, 2020.

118 Ibid.

119 Mckinsey Global Institute, "COVID-19 and climate change expose dangers of unstable supply chains," Aug. 28, 2020.

120 FloridaMakes, Connex Florida: Florida's Supply Chain Solution, Accessed on Jun. 25, 2021.

Information

The Information sector is one of the service-providing industries and comprises establishments engaged in the following: (a) producing and distributing information; (b) providing the means to transmit or distribute these products as well as data or communications; and (c) processing data. Included in this sector are companies that publish material on the Internet, the motion picture and sound industries, broadcasting companies, telecommunications, Web search portals, and information services.

Telecommunications play a vital role in facilitating connectivity within the economy—for consumers and businesses alike—telecommunications are ubiquitous in day-to-day activities. Accordingly, climate-related disruptions, such as extreme weather, can inhibit effective communication and have cascading effects on post-disaster recovery coordination and other economic sectors. Hurricane Michael (2018) is a prime case study. A week after Hurricane Michael had struck Florida's panhandle, more than 46 percent of cell sites in Bay County and 35 percent of cell sites in Gulf County were still down. The lack of cell access hampered recovery efforts and made it difficult for residents to communicate with first responders for help and to receive resources from outside the community. With climate change catalyzing more severe hurricanes, future storms on the scale of Hurricane Michael can interrupt large swaths of communication networks.

Sea-level rise due to climate change can also threaten internet infrastructure, leading to widespread internet outages, further disrupting communications. According to a study by the University of Wisconsin-Madison and University of Oregon, there will be around 4,100 miles of fiber conduit underwater over the next fifteen years with the impacts most pronounced in major coastal cities.[121] Miami is one of the top five cities in the U.S. with the highest risk to internet infrastructure—more than 149 miles of the city's fiber conduit will be submerged following a projected one-foot rise in sea level.[122] To prepare internet networks for sea-level rise, businesses within the Information sector will likely incur successively more capital costs over time.

Given its importance to connectivity in the economy, Florida's Information sector could benefit from climate change challenges by enabling solutions in other sectors. The COVID-19 pandemic illustrated the significance of telecommunications for remote work, virtual learning, and telemedicine when in-person settings were unavailable. Similarly, future economic disruptions due to climate change can be alleviated, to some degree, by enhancing the telecommunications technologies available in various communities. Companies that provide these telecommunications infrastructure or services could derive an economic benefit; however, to maximize the benefit, there must be sufficient attention toward broadband access. Throughout Florida, six percent of residents do not have adequate broadband infrastructure, and 51.1 percent live in areas with only one provider.[123] The disparities are even more apparent in rural areas where households are less likely to have broadband access or sufficient download speeds relative to more urban areas.[124] Considering the fact these rural areas may require more assistance during climate-driven events, advancing broadband capacity in these areas will be an economic priority for both the telecommunications companies and the local communities.

121 The University of Wisconsin-Madison and The University of Oregon, "Lights Out: Climate Risk to Internet Infrastructure," July 16, 2018.

122 Ibid.

123 Herald-Tribune, "In Florida, many still lack broadband access, including in Sarasota and Manatee counties," July 7, 2021.

124 Federal Communications Commission (FCC), Fourteenth Broadband Deployment Report, Jan. 19, 2021.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Acute climate-related disruptions, such as extreme weather, can inhibit effective communication and have cascading effects on post-disaster recovery coordination and other economic sectors.
- Storm and flood-damaged internet infrastructure will cause widespread outages and reduced economic output. Repair costs after major events may present a financial liability for the state and local governments.

Construction

The Construction sector is part of the goods-producing group and includes establishments engaged in the construction of buildings or engineering projects, such as highways or utilities. Construction work may include new work, additions, alterations, or maintenance to existing structures both in residential and nonresidential settings. Jobs within the Construction industry include construction managers, landscape architects, contractors, civil engineers, electricians, construction workers, and more.

Given the particular vulnerabilities of Florida's real estate market and infrastructure to sea-level rise and storm inundation, the state's Construction Sector will play a key role in mitigating against and responding to broader climatic changes affecting the state of Florida. In particular, efforts to improve infrastructure resilience, green technology, and post-hurricane reconstruction boost construction employment and yield positive economic contributions to the local economy.

Flood-related damages are a costly outcome of climate change for many communities, especially along Florida's coastline. As flooding risks become more elevated due to sea-level rise and extreme precipitation, investments in flood-resilient infrastructure become more crucial to mitigate future risk. Some of these infrastructure projects include elevated properties, raised roadways, wetlands restoration, seawalls, beach renourishment. Not only do these projects improve safety for people and property, but they also serve as an economic stimulus for the local community.[125]

Capital-intensive projects to develop flood-resilient infrastructure can boost employment and yield significant economic benefits for the Construction Sector. According to Johns Hopkins University's 21st Century Cities Initiative, every $1 million increase in funding for flood infrastructure at the metropolitan statistical area (MSA) level increases construction employment by 25 jobs.[126] Aggregating this figure across the state, for every $1 billion invested in flood infrastructure, there is an associated increase of around 250,000 construction jobs.[127] Furthermore, since this investment would stimulate local economies, most of the economic benefits would support local contractors and spur new construction businesses. The study finds that investing $1 million in an MSA would create, on average, four new construction businesses in the local area.[128] Local spending also creates a multiplier effect, meaning money trickles throughout the community and indirectly supports job creation in other industries.

In addition to flood-resilient infrastructure projects, construction efforts by various private companies and municipal utilities to promote renewable energy sources also derive an economic benefit for the Construction Sector. Florida Power & Light's '30-by-30' plan, for example, seeks to install more than 30 million solar panels by 2030, which is projected to create around 2,800 construction jobs throughout the process and supply renewable energy across the state.[129] Disney's Solar Farm is another example, creating more than 300 construction jobs to develop a solar field that powers two Disney parks.[130] On a municipal level, the Florida Municipal Solar Project is a joint project consisting of sixteen municipal utilities that will power cities like Orlando, Kissimmee, and Ocala in the future. The project is also expected to promote local construction jobs across the central Florida region.[131]

125 Johns Hopkins and American Flood Coalition, "The Local Economic Impact of Flood-Resilient Infrastructure Projects," Johns Hopkins University's 21st Century Cities Initiative, Dec. 8, 2020.

126 Ibid

127 Ibid

128 Ibid

129 Florida Power & Light (FPL), News Release "FPL makes history with 14 new solar energy centers under construction across Florida," Oct. 26, 2020.

130 EHS Daily Advisor, "How Climate Change is Affecting Constructions Jobs," Jan 8. 2020.

131 Orlando Sentinel, "2 new solar farms to deliver power to 6 Florida cities, including Orlando and Kissimmee," Jun. 22, 2020.

Climate change not only impacts the Construction Sector on the front-end through mitigation projects, but it can also impact the sector on the back-end through recovery efforts following major weather events. When major storms damage various residential and commercial properties, often the Construction Sector becomes essential to the recovery effort, repairing and rebuilding structures in the community. The poignant examples of Hurricane Andrew (1992) and Hurricane Michael (2018) illustrate the destructive potential a major hurricane can have on local areas and the ensuing need for reconstruction.

According to research from Dodge Data & Analytics on various hurricanes over the past few years, new residential construction often slows immediately following major hurricanes as most attention shifts toward assessing damage and relief efforts.[132] New construction and remodeling often pick up after a few months as recovery progresses. In the year after Hurricane Irma, for example, residential remodeling increased by 20.3 percent in Florida compared to a national average of 6.1 percent.[133] Although these post-hurricane trends may boost construction employment, economic challenges may also appear. These challenges include the material scarcity that may result when certain construction materials are in high demand after a storm and the labor shortage that may occur when contractors require more skilled labor to meet increased consumer demand. The presence of these factors may minimize the potential economic benefit to the Construction Sector after storms.[134]

Even though the Construction sector will benefit from more resiliency and recovery projects, extreme heat poses a physical and economic challenge for many construction companies. Outdoor workers are 35 times more likely to die from heat exposure than the general population, and with climate change making extremely hot days more likely, the amount of time construction workers can spend outside will gradually decline. By midcentury in Florida, there may be as many as 33 fewer workdays per year as extreme heat reduces the amount of time workers can safely spend outside.[135] This reduction in safe workdays translates into an annual loss of about $2.0 billion in construction worker earnings, or about $3,874 per worker every year.[136]

Overall, the economic impact of climate change on the Construction Sector is likely positive in direction but indeterminate in magnitude. Construction efforts to bolster flood-resilient infrastructure, along with private sector initiatives to promote green energy, help create construction jobs and local spending. After major hurricanes, which are increasing in frequency due to climate change, construction may also benefit from post-storm needs for repairing and rebuilding structures, although these benefits are tempered by time and may not manifest right away. The reduction in safe working days for construction workers is another factor that will moderate the potential economic benefit from climate change.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Capital-intensive projects to develop flood-resilient infrastructure can boost employment and yield significant economic benefits for the Construction sector.
- There is a potential for construction projects to provide state and local government entities with more tax revenue as projects spur spending and raise the value of some property; however, this association is tempered by ongoing climate risks that can potentially destroy new structures.
- Even though the Construction sector will benefit from more resiliency and recovery projects, extreme heat poses a physical and economic challenge for many construction companies by limiting the amount of time workers can safely spend outside. This reduction in safe workdays translates into lost construction worker earnings.

132 Dodge Data & Analytics, "Hurricane Irma's Wide Path to Impact Outlook for Florida Construction," Sept. 18, 2017.

133 Business Wire – Berkshire Hathaway, "BuildFax Finds Residential Remodeling Increased Substantially in Florida, Potentially Impacting Reinsurance Negotiations for Carriers," Nov. 27, 2018.

134 Nationwide, "The Impact of Extreme Weather Patterns on Construction," Sept. 2020.

135 Union of Concerned Scientists, Too Hot to Work: Assessing the Threats to Climate Change Poses to Outdoor Workers, Aug. 17, 2021.

136 Ibid.

Other Services

The Other Services sector is one of several in the service-providing industries group and includes establishments engaged in providing services not explicitly defined elsewhere in the NAICS classification system. Companies in this sector are primarily engaged in activities such as repairing equipment, promoting religious activity, social advocacy, laundry services, personal care services, and more.[137] Given the diversity of companies and organizations with Florida's Other Services, determining the economic impact of climate change on the sector is difficult. Nonetheless, some potential effects are highlighted.

For Other Services companies that primarily operate outdoors, excessive heat due to climate change can have a negative economic impact by reducing the amount of time workers can spend outside. According to one report, by 2050 there may be an annual loss of $1.58 billion in earnings for Florida workers involved in installation, maintenance, and repair, which factors to about $4,799 per worker every year.[138] Excessive heat would impose a physical risk on many workers who face continued heat exposure and lead to financial and productivity losses for many employers.

Climate change can also impact businesses that rely on international supply chains to sell product and services. Automotive and consumer electronic businesses, for example, require internationally and domestically sourced materials to provide their services to customers. Supply chain disruptions due to acute climate events can prevent the timely delivery of needed parts. Based on a risk analysis, automotive repair companies can expect to lose more than 56 percent of one year's earnings over a decade due to supply chain disruptions.[139] Similarly, for businesses that offer services to repair computers and electronics, the disruption-induced losses are around 39 percent of one year's earnings over a decade.[140] In general, Other Services companies that source products from elsewhere will experience the negative effects of climate change disruptions on basic operations.

For organizations that are involved in some form of advocacy, especially dealing with the natural environment, climate change may prompt more environmental advocacy efforts around the state of Florida. Since many of these organizations may involve volunteers and may differ in their size and outreach, capturing an exact economic impact is difficult.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Lost wages and a negative economic impact as a result of the reduced amount of time workers can safely spend outside.
- Supply chain disruptions can affect operations, reduce output, and affect economic activity for a local region. There may be inadequate supply to meet increased consumer demand.

137 Florida TaxWatch, "Bringing the Sunshine State Back: The Impact of COVID-19 Across Florida's Economy & Options for Recovery," January 2021.

138 Union of Concerned Scientists, Too Hot to Work: Assessing the Threats to Climate Change Poses to Outdoor Workers, Aug. 17, 2021.

139 McKinsey Global Institute, "Risk, resilience, and rebalancing in global value chains," Aug. 6, 2020. Note: The projected losses are in Net Present Value (NPV) which discounts future cash flows according to some discount factor. Additionally, the losses are presented before any interest, taxes, or amortization is factored in.

140 McKinsey Global Institute, "Risk, resilience, and rebalancing in global value chains," Aug. 6, 2020.

Agriculture

The Agriculture sector comprises establishments involved in growing crops, raising animals, harvesting timber, and harvesting fish from a farm, ranch, or other natural habitats. Examples of establishments in this sector include farms, ranches, greenhouses, nurseries, orchards, and more.

Over the coming decades, climate change poses a direct challenge to Florida's agriculture due to the dependence of crop and livestock production on environmental factors, such as temperature, precipitation, and CO_2 concentration. A higher incidence of extreme weather events due to climactic changes will also negatively affect crop and livestock yields while also worsening pest and disease prevalence. For crop production specifically, changing climate conditions may lead to some positive effects in the short-term as increased atmospheric CO_2 and moderate temperatures in the winter may be conducive for growth; however, these benefits would diminish over time. Overall, the interdependence between agriculture and climate makes Florida's agriculture especially susceptible to climate change.

Florida's diverse and moderate climate makes the state ideal for growing a broad variety of crops, including oranges, grapefruit, cucumbers, tomatoes, watermelons, strawberries, and more throughout the year. According to the U.S. Department of Agriculture, the orange fruit is Florida's main agricultural product by market value, totaling around $1.04 billion in annual cash receipts and equating to more than 59 percent of the total U.S. value.[141] Sugarcane, tomatoes, and strawberries, are the next three largest crops in Florida by cash receipts and range in value from $307 million to $569 million (See Table 6).[142]

Table 6. Market Value of Florida's Crops

Crops	Market Value (Million $ Dollars)/Year	Percent of U.S. Value
Oranges	$1,041	59.0%
Sugarcane	$569	49.8%
Tomatoes	$426	26.6%
Strawberries	$307	12.1%
Bell Peppers	$235	42.1%
Watermelon	$162	28.8%
Sweet Corn	$141	21.6%
Cucumbers	$91	32.6%
Grapefruit	$81	39.9%
Source: U.S. Dept. of Agriculture-Economic Research Service (2019)		

Rising temperatures due to global warming present a threat to crop production in Florida since most crops possess optimal temperature ranges for growth. Citrus, sugarcane, and tomatoes—the top three crops in Florida—have optimal growing ranges of 68-86°F, 79-81°F, and 66-77°F, respectively.[143] Temperatures outside these optimal ranges decrease crop growth by adversely impacting crop life cycles, natural resource uptake, photosynthesis, and reproduction. The same is observed for other crops in Florida even though optimal ranges may differ. In the short-term, there may be some benefit to crop production

141 U.S. Department of Agriculture: Economic Research Service, Cash Receipts by State for 2019, Updated: Feb. 5, 2021. https://data.ers.usda.gov/reports.aspx?ID=17843#P7a6dc7f6ee394054910a9b592a28f220_7_17iT0R0x9

142 Ibid.

143 Young Gu Her et al. (2017), Climate Change Impacts and Adaptation in Florida's Agriculture. Florida's Climate: Changes, Variations, & Impacts. Retrieved on May 19, 2021.

if warming temperatures prevent a number of crop freezes during winter months; however, this benefit dissipates in the long-term as hotter temperatures ultimately lead to reduced crop viability, crop failure, and a net loss to production.[144]

Elevated CO_2 concentration in the atmosphere, another natural outcome of climate change, can also impact crop production. Past studies find that heightened CO_2 can increase the rate of photosynthesis and reduce the amount of water crops lose due to transpiration, resulting in more crop production.[145] The exact magnitude of crop yield increase depends on the features of the particular crop, however. For most of the crops in Florida, including citrus, crop yield improvement will occur at a diminishing rate as the beneficial effects gradually decline.[146] Thus, even though CO_2 may help in some ways, the benefit is not as sizeable as the negative effect on production due to higher temperatures.

For Florida's crop farmers, growing climate risk may drive up crop insurance costs over the coming decades. The Federal Crop Insurance Program (FCIP) provides insurance to compensate for crop losses due to natural causes, such as floods, freezes, and storms. In Florida, there are more than 14,000 federal crop insurance policies covering around $4.2 billion in crop value.[147] With climate-related disruptions becoming more common in the future, the total cost to maintain the FCIP will likely rise, passing on higher premiums to Florida's farmers. The U.S. Department of Agriculture estimates that overall crop insurance costs and premiums could increase from 3.5 percent to as much as 22 percent higher due to climate change.[148]

Florida's livestock is another essential part of the state's agricultural industry that will experience adverse outcomes from climate change. Cattle, other livestock, and dairy comprise 12.7 percent of Florida's farm sales in 2019, amounting to $987.7 million in cash receipts.[149] Higher temperatures, as a result of climate change, will induce greater heat stress on livestock. Research finds that hotter conditions can disrupt basic metabolic and reproductive processes in animals, yielding increased mortality and decreased breeding.[150] Heat stress also negatively affects milk and meat production and can diminish the quality of products for end consumers.[151] Looking at the major livestock industries across the U.S., one study found that the aggregate economic losses for dairy and beef industries due to heat stress were $897 million and $369 million per year, respectively.[152] Since Florida's dairy and beef industries constitute only two percent of the total U.S. market,[153] the associated economic impact in Florida would be around $25.3 million annually over future years.[154]

Common to both crop and livestock production, climate change has the potential to increase water demand and the incidence of disease. Florida's farms consumed more than 3.2 billion gallons of fresh water per day before 2020, and this demand is expected to rise to 3.7 billion per year by 2035.[155] The increased demand will place stress on water supply systems and worsen competition for water resources among farmers. Climate change will also increase the likelihood of citrus greening, a bacterial

144 Borisova et al. (2018), "Economic Impacts of Climate Change on Florida: Estimates from Two Studies," Retrieved on May 19, 2021.

145 NASA, "NASA Study: Rising Carbon Dioxide Levels will Help and Hurt Crops," May 3, 2016.

146 Young Gu Her et al. (2017), Climate Change Impacts and Adaptation in Florida's Agriculture. Florida's Climate: Changes, Variations, & Impacts. Retrieved on May 19, 2021.

147 Florida Department of Agriculture and Consumer Services (FDACS), "Commissioner Nikki Fried & U.S. Dept. of Agriculture Hold Crop Insurance Town Hall," Feb. 17, 2021.

148 U.S. Department of Agriculture, Climate Change and Agricultural Risk Management Into the 21st Century, Jul. 2019.

149 U.S. Department of Agriculture: Economic Research Service, Cash Receipts by State for 2019, Updated: Feb. 5, 2021.

150 Bernabucci (2019), "Climate Change: Impact on Livestock and How Can We Adapt," Animal Frontiers, Accessed May 20, 2021.

151 Ibid.

152 Summer (2018), "Impact of Heat Stress on Milk and Meat Production," Animal Frontiers, Accessed May 20, 2021.

153 U.S. Department of Agriculture: Economic Research Service, Cash Receipts by State for 2019, Updated: Feb. 5, 2021.

154 To find this Florida economic impact, we take 2% of the $897 million and $369 million. (0.02x$1266 million=$25.3 million).

155 Resources for the Future, Florida Climate Outlook: Assessing Physical and Economic Impacts through 2040, Jan. 30, 2020.

disease that destroys citrus products in Florida. Citrus greening transmission is most prevalent around 77°F but can occur between 61°F and 91°F.[156] Transmission may rise during warmer winter months but may be offset by hotter summer months; however, the net effect is indeterminate. For livestock, combined changes in temperature and rainfall can promote the spread of vector-borne diseases with deadly consequences.[157]

Florida's forestry industry is another integral part of the state's overall Agriculture sector, responsible for $719 million in revenue for forest production.[158] Timber products provide the necessary inputs for many items, including toilet paper, towels, medicine, carpet, paints, and many other consumer products. Despite this central importance, Florida's forestry is at risk to several climate factors. Climate change alters the frequency and intensity of disturbances, such as wildfires, storms, and insect outbreaks which can all destroy acres of forest. Already being witnessed in other portions of the country, large forest disturbances lead to massive economic costs.[159] For example, during Oregon's 2020 wildfire season, persistent wildfires over a few weeks led to a cost of $1.15 billion in damage.[160]

Lastly, climate change can affect agriculture in Florida by increasing the frequency and severity of major weather events, such as major hurricanes. Hurricanes affect crops primarily through high wind, rainfall, and flooding. Winds can have lasting effects on tree orchards by defoliating leaves and toppling trees, while flooding can inundate roots and reduce oxygen availability, leading to crop deaths. Furthermore, for farms near the coast, hurricane storm surges can present the added problems of high salinity and saltwater intrusion into subsurface aquifers.[161] The economic impacts of more frequent and severe hurricanes on agriculture can be profound and long-term, growing in scale as hurricanes destroy more agricultural land used for production. Past major hurricanes, such as Hurricane Irma in 2017, led to $2.5 billion in damages to the agricultural industry due to crop losses, animal deaths, debris cleanup, and damaged infrastructure.[162] Hurricane Michael in 2018 created more than $1.3 billion in economic damages for northwest Florida's timber industry, disrupting and destroying production in many affected areas.[163] For future storms like Hurricanes Irma and Michael, damages may be even more exponential as climate change intensifies hurricane development.

Key Takeaways

Unless appropriate steps are taken to mitigate the effects of climate change, Florida taxpayers can expect to see:

- Reduced crop production in Florida since most crops possess optimal temperature ranges for growth.
- Reduced livestock yield.
- Increased demand for water.
- Negative impacts on Florida's forestry industry due to wildfires, storms, and insect outbreaks that can destroy acres of woodland.
- More frequent and severe hurricanes can potentially destroy crop fields, kill livestock, and topple trees, magnifying the economic costs for the sector.

156 Resources for the Future, Florida Climate Outlook: Assessing Physical and Economic Impacts through 2040, Jan. 30, 2020.

157 Ibid.

158 Florida Forestry Association, 2017 Economic Impact Study, Accessed Aug. 25, 2021.

159 Environmental Protection Agency (EPA), Climate Impacts on Forests, Jan. 19, 2017.

160 Governor's Wildlife Economic Recovery Council, Recovering & Rebuilding from Oregon's 2020 Wildires, Jan. 4, 2021.

161 UF-IFAS, "Hurricane Impacts on Florida's Agriculture and Natural Resources," Nov. 2018.

162 Florida Department of Agriculture and Consumer Services, "The Effects of Hurricane Irma on Florida Agriculture," Oct. 4, 2017.

163 UF-IFAS, "UF/IFAS Economists: Hurricane Michael Caused $1.58 Million in Florida Agricultural Production Losses," Nov. 2, 2018.

Climate Change and Florida's Fiscal Sustainability

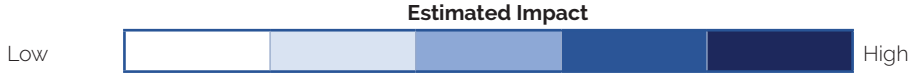
Climate change will have complex consequences for Florida's economy, spanning across all economic sectors with varying degrees of severity. From affecting daily operations to interrupting the timely flow of goods and services, every sector will have to contend with the growing obstacles that climate change will create. Sea-level rise and frequent extreme weather events also pose a long-term risk to the health and well-being of millions of Florida residents along the coast and inland, further worsening outcomes for the overall economy.

In view of these economic consequences, climate change is anticipated to challenge Florida's fiscal sustainability over the long run. Fiscal sustainability is a crucial policy objective as there must be a sufficient balance between tax revenues and public expenditures for governments to confront the unique challenges that climate change presents. To fund resiliency projects and mitigative measures, governments must possess adequate revenue streams to sustain construction. The ongoing threat of climate change, however, diminishes public revenue as fewer tourists and lower property values reduce tax bases. The result is a fiscal imbalance for the state. These fiscal consequences can quickly spill over into Florida's ability to remain economically competitive and may serve as a significant barrier to growth for decades to come.

Given the diversity of economic impacts for each sector and their subsequent influence on fiscal sustainability and competitiveness, Table 7 provides a snapshot view for each Florida sector.

Table 7. Climate Change Impact Across Different Sectors

	Impact on Output and Productivity	Impact on Public Tax Revenue	Impact on Public Expenditures	Impact on Economic Competitiveness
Financial Activities				
Trade, Transportation, Utilities				
Professional & Business Services				
Government				
Education & Health Services				
Leisure & Hospitality				
Construction				
Manufacturing				
Information				
Other Services				
Agriculture				



To explain in greater detail the differences and gradations between low and high for each column (e.g., impact on output and productivity, public tax revenue), the following provides a more descriptive explanation for Table 8.

Impact on Output and Productivity

- Low: There is a negligible impact on business operations as workers can perform their daily responsibilities with little to no disruptions from climate-related conditions or events.
- High: The number of goods and services that businesses can provide is greatly reduced as major climate-related events and conditions disrupt business operations multiple times in a year. Workers cannot perform their responsibilities in a timely or efficient manner without experiencing disruptions to their health or well-being.

Impact on Public Tax Revenue:

- Low: Climate change will have no discernible impact on the businesses' ability to transact goods or services that are taxed. For residential or commercial structures, there will be little to no impact on property value due to the climate.
- High: The amount of income, sales, property, or other assets subject to taxation will rapidly shrink due to climate change disruption and damage, leading to smaller local and state government collections. Tax revenue impacts will likely exceed $5 billion annually by mid-century.

Impact on Public Expenditures:

- Low: There will be little effect on the sector's physical structures or other assets that would require public expenditure to repair, recover, and mitigate against future dangers.
- High: As a result of risk and impacts on the particular sector, state and local governments will have to spend tens of billions annually on disaster relief, reconstruction of damaged infrastructure, healthcare expenses, and mitigation/adaption measures.

Impact on Economic Competitiveness:

- Low: Businesses in the sector will be able to effectively recruit talent and expand operations in Florida without experiencing any higher costs due to climate change.
- High: Climate change will severely raise the cost of doing business in Florida by affecting infrastructure, insurance costs, utilities, supply chains, talent acquisition, and other factors. A higher cost of doing business will potentially lead many companies to move out of the state.

From a revenue perspective, challenges in the Financial Activities and Leisure & Hospitality sectors have a significant share of the overall impact on tax revenue. Rising sea levels endanger Florida's coastal properties and severely limit the amount of property tax revenue that can be collected. By 2100, the amount of property tax at risk in Florida is expected to climb to nearly $5 billion. Annual tourism—an important source of sales tax revenue—will also take a significant hit as severe weather, excessive heat, and natural environment changes reduce inbound tourism. By the end of the twenty-first century, the amount of sales tax at risk may reach $117 billion annually. For other economic sectors, a decline in output and productivity has an indirect effect on state and local tax bases as declining economic activity equates to fewer taxable transactions. These indirect impacts are harder to quantify, but directionally, they will likely harm Florida's fiscal picture.

From an expenditure perspective, capital investments in the Trade, Transportation, and Utilities; Financial Activities, and Government sectors will be required for resiliency projects. Measures such as raising roads and fortifying coastal properties will entail hundreds of billions of dollars for the state government and many localities. The ability to pay for these projects,

however, evidence the great strain on public budgets as many local governments may be unable to pay for these capital projects over time. On the back end, governments will also expend large payments to provide relief and repair following major hurricanes, which are becoming more frequent and severe due to climate change. Furthermore, climate change will have an indirect impact on public expenditures as health expenses progressively climb due to heat-related illnesses within vulnerable populations.

Although the connection is not readily apparent at times, challenges with fiscal sustainability have an important bearing on the state's economic competitiveness. As more public expenditures are allocated to deal with climate change, this focus detracts from strategic investments in other portions of the economy that may advance the state's diversification goals. Raising the cost of doing business in the state may further minimize the ability to recruit talent and businesses from other locations. Florida is often heralded as a prime destination to work and live given its attractive climate and popular destinations; however, climate change has the potential to tarnish the Sunshine State's reputation thereby disadvantaging talent acquisition, business recruitment, and economic development for the entire state.

Mitigating the Impacts of Climate Change on Florida's Economy

Climate change is a global phenomenon and, as such, the extent to which Florida can control its effects is limited. Florida can establish itself as a leader in mitigating the effects of climate change on its natural resources, its workforce, and its economy by doing the planning and preparedness necessary to make our low-lying and high-risk areas more resilient to the effects of climate change.

As shown in this analysis, the impacts of a changing climate on Florida's economy can be devastating. To mitigate the effects of climate change on Florida's economy and on the health and safety of Florida residents, Florida TaxWatch offers the following policy considerations (in no particular order):

1. Develop targeted strategies to reduce regional emissions

As global temperatures continue to warm, sea level will continue to rise. How much it will rise depends mostly on the rate of future carbon dioxide emissions and future global warming. Global warming is a global phenomenon and, as such, is beyond Florida's sole control. Florida can, however, maximize its use of emerging technologies and other efficiencies to make solar and other forms of "clean" energy cost-effective for everyone. Florida Power & Light (FPL), for example, is implementing its "30-by-30" plan[164] to install more than 30 million solar panels by the year 2030, making Florida a world leader in affordable, reliable, and clean solar energy (Figure 3).

Figure 3. FPL Solar Farm

2. Slow and managed retreat from the coast

Instead of retreating from the coast, Floridians are moving closer to the water's edge. Buyers and tax assessors place a premium on the riskiest and most vulnerable properties (typically those closest to the water). Properties located further inland, which are less vulnerable, typically sell for considerably less. Hurricanes "thin the market" as older, more vulnerable homes are weeded out, which frees up space for new and more-expensive development. Instead of retreating, however, homeowners want to rebuild in the same location. Developers build safer, bigger, and more expensive housing units. Property values soar and local property tax rolls increase. Since coastal properties tend to be more expensive and generate more local property taxes, the idea of removing storm-damaged or flooded properties off the local property tax rolls will be an anathema to many local elected officials.

164 Florida Power & Light, "FPL Solar Plants," retrieved from https://www.fpl.com/energy-my-way/solar/energy-centers.html, June 15, 2021.

Breaking this cycle will require creative, well-funded programs to assist with retreat and relocation from chronically inundated areas. FEMA's Flood Mitigation Assistance Program, Hazard Mitigation Grant Program, and Pre-Disaster Mitigation Program, include provisions that permit the purchase and demolition of chronically inundated properties, and the dedication of the vacated land as "open space." It is unlikely that these programs can be funded at a level that would make a difference. At the pace in which FEMA executed buyouts during the period from 1989 to 2019, FEMA would only be able to purchase an additional 115,000 properties (nationwide) by the end of the century (current projections are that as many as 13 million properties will be inundated by then).[165]

3. A systematic and organized approach to buying down or mitigating risk.

One way to better protect Florida's communities from sea level rise and more frequent and severe coastal storms is by anticipating the threats and taking steps in advance to reduce the risk and limit losses. This includes elevating buildings and critical infrastructure above the base flood elevations, waterproofing, levees and seawalls, water storage reservoirs, and other measures that will reduce the risk and limit losses. The Flood Mitigation Industry Association estimates that Florida has as many as 600,000 older or historic flood vulnerable pre-flood map buildings in FEMA flood zones that are candidates for mitigation.[166]

These are investments with demonstrated returns. The National Institute of Building Sciences reports that every dollar spent on pre-disaster mitigation and preparedness saves six dollars in rebuilding costs after a storm.[167] Mitigation has proven to save lives and property, and to invigorate the economy through increased construction. A 2020 study by the Johns Hopkins University and the American Flood Coalition found that investment in flood resilience projects can lead to significant economic return by creating local jobs, boosting a community's economy, and improving public health outcomes.[168] A $1 million increase in funding for flood infrastructure projects in a metropolitan statistical area creates 40 jobs—25 jobs in the construction industry and 15 jobs in retail trade. A $10 billion dollar investment could be associated with up to 400,000 new jobs across the country.[169]

> *"Invest properly in mitigation, you're going to get your money back—regardless of what your beliefs in climate change are."*
>
> —Bryan Koon, Chairman, Multihazard Mitigation Council, National Institute of Building Sciences[170]

In January 2021, President Trump signed into law the Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) Act[171], which creates a revolving loan fund program designed to help provide funding to local governments to invest in projects that will help to mitigate the impacts of rising sea levels, coastal erosion, and damage from deadlier and more catastrophic coastal storms. Congress has appropriated $100 million in each of fiscal years 2022 and 2023. Low-interest loans

165 Anna Weber and Rob Moore, "Going Under: Long Wait Times for Post-Flood Buyouts Leave Homeowners Underwater," Natural Resources Defense Council, Sept. 12, 2019.

166 June 20, 2021 e-mail from Roderick Scott, CFM, Board Chair, Flood Mitigation industry Association.

167 National Institute of Building Sciences, "Natural Hazard Mitigation Saves: 2017 Interim Report."

168 Johns Hopkins 21st Century Cities Initiative and the American Flood Coalition, "The Local Economic Impact of Flood-Resilient Infrastructure Projects."

169 Ibid.

170 Christopher Flavelle, "Federal Disaster Mitigation Saves $6 for Every $1 Spent," Insurance Journal, January 12, 2018, retrieved from https://www.insurancejournal.com/news/national/2018/01/12/477024.htm, June 2, 2021.

171 Public Law Number 116-284.

will provide state and local governments with necessary capital to invest in mitigation projects that will help reduce property damage and loss of life, the cost of flood insurance, and disaster response and recovery costs.

The 2021 Florida Legislature established within the Department of Environmental Protection (FDEP) the Resilient Florida Grant Program,[172] which provides funding to local governments for resilience planning and for projects to adapt critical assets. FDEP is required to develop and maintain a statewide data set that will be used to determine the risks to inland and coastal communities (including statewide sea level rise projections); and to annually submit a plan proposing up to $100 million in funding for projects that address risks from flooding and sea level rise. Local governments, regional resilience entities, and water management districts are authorized to submit lists of proposed projects to the FDEP for scoring and inclusion in the plan.

4. End or modify government programs and policies that encourage risky development.

Perhaps the best illustration of a government program that encourages risky development is the National Flood Insurance Program (NFIP). Administered by the Federal Emergency Management Agency (FEMA), the NFIP was established in 1968 to provide homebuyers insurance that had proved difficult for the private sector to provide at affordable rates and promote effective floodplain management. In exchange for government-backed insurance, participating communities would be required to adopt innovative land development and building regulations designed to steer new development away from flood-prone areas, thereby reducing future losses.

The predominant source of income for the NFIP is the premiums paid by policyholders; however, the NFIP was not designed to be risk-based and the premiums are not priced to reflect actual risk. A 2017 report by the nonpartisan Congressional Budget Office (CBO) found that 85 percent of the NFIP's 5.1 million coastal properties pay less than the full risk-based rate for coverage, which accounts for a significant portion of the NFIP's projected annual shortfall of $1.4 billion.[173]

Although only three percent of NFIP policies are for properties located in what the NFIP calls the "Velocity Zone", or "Zone V" (coastal areas where tidal surge is projected to add at least three feet to water levels reached in a 100-year flood), more than one-third of all NFIP claims over the past 35 years are storm surge-related.[174] According to the CBO, 29 percent of properties within Zone V receive a discounted rate because they were in place before FEMA created Flood Insurance Rate Maps (FIRMs) for those communities. In addition, 69 percent of properties within Zone V are considered to be "grandfathered" and are charged rates for properties in Zone A (properties within the 100-year floodplain that are not subject to storm surge-related risk).[175]

The NFIP fails to balance public and private risk. Policies on inland properties produce a surplus of $200 million a year[176], and people who build in flood-prone coastal areas are being subsidized by inland taxpayers. Many of these coastal properties are what the NFIP calls "non-primary residences." A 2013 study by the U.S. Government Accountability Office estimated that

172 CS/CS/SB 1954.

173 Congressional Budget Office, "The National Flood Insurance Program: Financial Soundness and Affordability," September 2017.

174 Ray Lehmann, CBO's NFIP Report Makes Clear How We Encourage People to Live at the Coast," Insurance Journal, September 3, 2017, retrieved from https://www.insurancejournal.com/blogs/right-street/2017/09/03/463213.htm, June 19, 2021.

175 Congressional Budget Office, "The National Flood Insurance Program: Financial Soundness and Affordability," September 2017.

176 Ray Lehmann, CBO's NFIP Report Makes Clear How We Encourage People to Live at the Coast," Insurance Journal, September 3, 2017, retrieved from https://www.insurancejournal.com/blogs/right-street/2017/09/03/463213.htm, June 19, 2021.

roughly one out of every three insured houses was a beach house, an investment property, or a second home.[177] The policy question is whether taxpayers should continue to subsidize development in high-hazard areas, or whether only those who can afford the risk of living in flood-prone areas without subsidies live there.

A larger private flood insurance market is needed to take some of the risk off the backs of Florida taxpayers and give property owners more options. Research by the R Street Institute shows that the private flood insurance market grew by more than 50 percent in 2017 and now represents about 15 percent of all flood insurance policies written nationwide.[178] The private flood insurance market is not large enough to absorb all of the NFIP's 5.1 million policies; however, a recent study by the actuarial firm Milliman found that, even in flood-prone states like Florida, 70-90 percent of NFIP policyholders could find cheaper coverage in the private market.[179]

Another example is the cost-share formula for federal disaster funding. Until the late 1980s, the principle that state and local governments should have a financial stake in their recovery was a key tenet of federal disaster assistance programs. The cost-share formula required the federal government to pay 75 percent of the response and recovery costs while state and local governments shared the remaining 25 percent. After hurricanes Hugo (1989) and Andrew (1992), FEMA developed a cost-share formula that loosened the burdens on the states. For Hurricane Andrew, the state of Florida paid 25 percent of the first $132 million (33 million), with FEMA paying 100 percent of the costs above $132 million. With a total of $718 million in assistance provided, the effective federal cost-share for Hurricane Andrew was 95.6 percent.[180] Since then, expectations have shifted such that the federal government will pay for more of the response and recovery. The current expectation is that state and local governments will continue to receive generous cost-shares, and that the federal government will always be there to rescue state and local governments and homeowners.

5. Invest in the protection and restoration of natural buffers.

Natural systems such as barrier islands, marshes, coral reefs, and mangroves help absorb wave energy and protect Florida's coastal areas from the devastating effects of storm surge. Coastal development and efforts to armor or harden the coastline have resulted in the loss of natural coastal features (e.g., beaches, dunes, mangroves, coastal marshes) or have severely impeded the natural flow of sediment that helps to maintain these systems.

Restoring these natural coastal features involves reestablishing the natural processes—sediment movement and improved water quality—that allow these systems to maintain themselves.[181] Mangroves buffer the impacts of waves and storm surge by dissipating wave energy. Mangroves have been documented to reduce surge heights, reduce water flow velocities, and reduce inundation levels caused by coastal storms.[182]

177 Gilbert M. Gaul, "The Geography of Risk," Picador, 2019.

178 R.J. Lehmann, "Testimony of R.J. Lehmann to the Senate Banking Committee: The Case to Reform the NFIP," retrieved from https://laweconcenter.org/resource/testimony-of-r-j-lehmann-to-the-senate-banking-committee-the-case-to-reform-the-nfip/, June 21, 2021.

179 John W. Rollins and Nancy P. Watkins, "What Could Private Flood Insurance Look Like in New Jersey and New York," Milliman, July 24, 2018, retrieved from https://www.milliman.com/-/media/milliman/importedfiles/uploadedfiles/insight/2018/ny-nj-market-feasibility.ashx, June 22, 2021.

180 Congressional Research Service, "FEMA Disaster Cost-Shares: Evolution and Analysis," April 4, 2013.

181 Naturally Resilient Communities, "Solution: Restoring Coastal Features," retrieved from http://nrcsolutions.org/wp-content/uploads/2017/03/NRC_Solutions_Restoring_Coastal.pdf, June 22, 2021.

182 U.S. Army Corps of Engineers, "Miami-Dade Back Bay Coastal Storm Risk Management Draft Integrated Feasibility Report and Programmatic Environmental Impact Statement," Virtual Public Meeting, June 2020, retrieved from https://www.saj.usace.army.mil/Portals/44/siteimages/Shore%20Protection/Dade%20County/Miami-Dade-Back-Bay-Study/Miami_Dade_BB_CSRM_Public_NotesfromPresentation_June_2020.pdf?ver=2020-06-09-064049-217, June 22, 2021.

6. Strategic investments in beach nourishment.

Rising sea levels and man-made structures (i.e., seawalls) accelerate beach erosion. Florida's beaches provide critical habitat for marine life, protect property and infrastructure, and support tourism and state and local economies. Currently, 419.6 of Florida's 825 miles of sandy coastline has been designated by the Florida Department of Environmental Protection as "critically eroded," a designation that reflects a level of erosion that threatens development, recreational, cultural, and environmental interests.[183] Much of Florida's coastal erosion is the result of the construction and maintenance of more than 60 navigation inlets around the state, which interrupts the natural flow of sand along the beach.

Local, state and federal entities are now managing over 200 miles of restored beaches in Florida.[184] Beach nourishment provides a significant level of storm protection benefits for upland properties and infrastructure, has minimal impacts on the coastal system, and helps to quickly restore marine animal habitat. Since tourism drives the economies of Florida's beachfront communities, strategic investments in beach nourishment provide opportunities to build beach and dune systems higher, thereby helping to protect coastal infrastructure, homes and businesses, marine animals, and helping to sustain local economies.

7. Invest in strategies to "harden" or "armor" the Florida coast.

Coastal property owners often attempt to stabilize coastal land and protect coastal residential and public infrastructure by building shoreline armoring structures (e.g., seawalls, revetments, riprap, etc.) to hold back the sea and prevent erosion and the loss of sediment. Seawalls protect the coast from erosion and flooding by reflecting high wave energy back into the sea. Seawalls are not without drawbacks, the most significant of which is their cost. Surveys of seawall contractors by the City of Ft. Lauderdale generated quotes ranging from $650 to $2,000 per linear foot (exclusive of design, permitting, and other fees), depending on the design height, anticipated wave loading, construction materials, and number of construction stages.[185]

Coastal armoring can prevent sandy beaches, wetlands, and other natural areas from moving inland as sea levels rise or as beach erosion continues. By restricting the natural movement of sediments, coastal armoring can also eliminate valuable habitat for marine animals and public beachfront. Seawalls are also subject to failure—if the pressure on the landward side of the seawall is less than the pressure exerted on the seaward side, cracks can form and the seawall can fail. It may be impractical, not to mention cost-prohibitive, to build a seawall along the entire Florida coastline, but that has not prevented the U.S. Army Corps of Engineers from proposing the construction of approximately six miles of seawalls, as high as 13 feet and at a cost of $4.6 billion, along the Miami-Dade County coastline.[186] In August 2021, Miami-Dade County officially rejected this plan.

8. Promote land use and construction practices that improve resiliency.

Through the process of photosynthesis, plants remove carbon dioxide from the air. Discouraging land use activities such as deforestation and clear cutting, and increasing the use of cover crops, will remove more carbon from the atmosphere. Limiting impervious surfaces and requiring development to include stormwater retention ponds will increase the absorption of water into the ground and reduce the likelihood that drainage systems will become compromised.

183 Florida Department of Environmental Protection, "Why Beach Restoration," retrieved from https://floridadep.gov/rcp/beaches-funding-program/content/why-beach-restoration, June 22, 2021.

184 Ibid.

185 Joe Clements, "Sea Wall Guide: What are the Advantages and Disadvantages?," Green Coast, retrieved from https://greencoast.org/sea-wall-advantages-and-disadvantages/, June 21, 2021.

186 U.S. Army Corps of Engineers, "Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study," June 2020.

Elevating homes above the base flood elevation and requiring new development and redevelopment to incorporate building methods and materials designed to reduce wind damage will help to make structures more resilient to the effects of climate change.

9. Do nothing – maintain the status quo.

Doing nothing is no longer an option. The cost of inaction will be too great to do nothing. As sea levels rise, many Florida communities in low-lying coastal areas will eventually be under water. This will force Floridians to move inland in droves. Those who are able to remain in coastal areas will be at greater risk of more frequent and more severe coastal storms and damage from related storm surges.

Even those who do move inland will not be completely spared. Areas that are connected to the sea by rivers will be subject to greater risks from flooding. The intrusion of saltwater into the aquifers will contaminate Florida's groundwater supplies. As atmospheric temperatures increase, some areas of the state can expect periods of prolonged drought which, in addition to inflicting major damage to crops, livestock, and Florida's food supplies, will increase the risk of wildfires and their related loss of property and lives. Florida's elderly, poor, and children will be especially susceptible to the increased number of dangerously hot days.

As Florida TaxWatch has shown in this report, the impact of doing nothing to mitigate the effects of climate change on Florida's economy will be catastrophic.

Conclusions

Climate change poses an existential and generational threat to Florida. Rising global temperatures and sea levels greatly increase the risks to public health and safety, and to Florida's economy. Florida's continued growth will increase coastal populations and development, which will put still more people and property at risk. Absent measures to mitigate these risks, rising temperatures and sea levels will result in devastating damages to every sector of Florida's economy.

There is no single measure to mitigate the devastating impacts of climate change on Florida's economy, and no region of the state or sector of the economy will be spared. Mitigating these economic impacts will require a comprehensive, multi-faceted strategy, which includes a mix of structural (e.g., seawalls, pumping stations, storm surge barriers, elevating and floodproofing buildings, etc.) and non-structural (e.g., beach nourishment, mangrove replanting, coral reef restoration, dune restoration, etc.) measures. It will be expensive, but the costs of inaction will be much greater. Perhaps the most important first step is to stop making the problem worse.

The anticipated erosion of coastal areas and reduction in property values creates a dilemma for coastal communities. On one hand, communities that choose to leave waterfront properties unprotected will find their property tax rolls severely eroded as floods and storm surges destroy their most valuable properties. On the other hand, communities that choose to protect those properties will be encouraging still more high-risk development. The hard choices that will be necessary to deal with the state's many environmental and economic challenges are here, and few people want to face them. Republican lawmakers, who have controlled the Florida Legislature for more than 20 years, acknowledged in late 2019 that they had ignored climate change for so long that the state had "lost a decade." We cannot afford to lose another.

The consequences of climate change will be most severe for those communities that do nothing to prepare for it. By engaging in the policy debate now, Florida TaxWatch hopes to help shape a resilient Florida and a strong and vibrant Florida economy.

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As an independent, nonpartisan, nonprofit taxpayer research institute and government watchdog, it is the mission of Florida TaxWatch to provide the citizens of Florida and public officials with high quality, independent research and analysis of issues related to state and local government taxation, expenditures, policies, and programs. Florida TaxWatch works to improve the productivity and accountability of Florida government. Its research recommends productivity enhancements and explains the statewide impact of fiscal and economic policies and practices on citizens and businesses.

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