

THE COST OF DOING NOTHING



Rising sea levels may submerge many areas of the Tampa Bay region by 2060. A simulated 2.9 foot increase in the sea level may cause thousands of properties to be flooded, thousands of jobs to be lost, lost taxes and lost income from tourism as well as the loss of much of the region's barrier islands. \$160 billion will be lost in Gross Regional Product by 2060.

*Economic Impacts
of Sea Level Rise in
the Tampa Bay Area*

January 2017

Executive Summary

Rising sea levels may submerge many areas of the Tampa Bay region by 2060. While there are varying estimates, one worst case possibility suggests that sea levels may rise as much as 2.95 feet over the next forty years. Such an increase may cause thousands of properties to be flooded, thousands of jobs to be lost, lost taxes and lost income from tourism as well as the loss of much of the region's barrier islands.

Using Geographic Information Systems, economic impact software, county property records and geocoded employment data, the Tampa Bay Regional Planning Council (TBRPC) prepared *The Cost of Doing Nothing: Economic Impacts of Sea Level Rise in the Tampa Bay Region* to consider the potential impacts of year round flooding on the regional economy.

Together these impacts bear cumulative costs of \$162 billion to the region's Gross Regional Product. The direct impacts of sea level rise are summarized in the following table.

When Mean Sea Level Increases by 2.95 Feet	Estimate
Value of Submerged Residential Property in 2015	\$14.9 Billion
Value of Submerged Commercial Property in 2015	\$1.3 Billion
Cumulative loss of Property Taxes (2020-2060)	\$5.4 Billion
Job Losses in submerged areas	17,184

But direct impacts from inundation are only part of the story. Sometimes the most important and longer lasting impacts of large scale events are indirect in nature. As such, *The Cost of Doing Nothing: Economic Impacts of Sea Level Rise in the Tampa Bay Region* assesses the direct and indirect impacts of sea level rise on the regional economy. Because there are many different ways of framing sea level rise as a problem, the Tampa Bay Regional Planning Council prepared a series of computer simulations using REMI PI+, a sophisticated economic modeling tool, to compare different aspects of the issue.

The simulations viewed the same issue—the implications of a sea level rise of 2.95 feet—on different aspects of the economy. In the first simulation, TBRPC examined the stand-alone implications of the loss of some \$16 billion in inundated properties, of lost property taxes and lost access to jobs. This simulation anticipates the loss of \$2 billion of Gross Regional Product to the regional economy in 2060.

The second simulation considered the loss of non-tourism related jobs. This scenario anticipates the loss of \$4.4 billion of Gross Regional Product in 2060 while the third simulation, modeling the loss of tourism jobs, results in the loss of \$1.9 billion in Gross Regional Product. While these three different angles overlap conceptually and are inseparable under actual inundation conditions, the simulation results define the nature of the problem. Even though Sea Level Rise

can flood much of the region's coastal land and its tourist economy, it is the non-tourism related economy that has the most to lose.

Will the events analyzed in this report occur? Probably not. While sea level rise is occurring, it is not yet clear how dramatic that sea level rise will be by 2060. Also, it is likely that if and when flooding occurs, Tampa Bay Area communities will act to mitigate the damage. That mitigation may occur ahead of sea level rise or after its impacts manifest but it is unlikely that nothing will be done to protect property, natural resources and jobs. As such, while reasonable people can disagree about the risks entailed by sea level rise, *The Cost of Doing Nothing: Economic Impacts of Sea Level Rise in the Tampa Bay Region* provides a roadmap for thinking through them.

Introduction

Sea levels are rising around the world¹. In recent years, groups of concerned scientists and economists have convened to study the potential impacts of sea level rise and other climate events and to recommend that governments and industry take action to prevent or mitigate those impacts. Those efforts have resulted in studies such as the [Risky Business project](#) and the [American Climate Prospectus](#) which have raised awareness of the potential risks the American economy and the economies of the fifty states face in the coming years².

As one of the states most affected by sea level rise, Florida's economic outlook is particularly important given its population size and importance to the national economy. Focusing on the Tampa Bay Area, one of the most populous metropolitan areas in Florida in 2060, we ask "what economic impacts are anticipated to occur if nothing is done to mitigate the impacts of sea level rise on the Tampa Bay Area?"

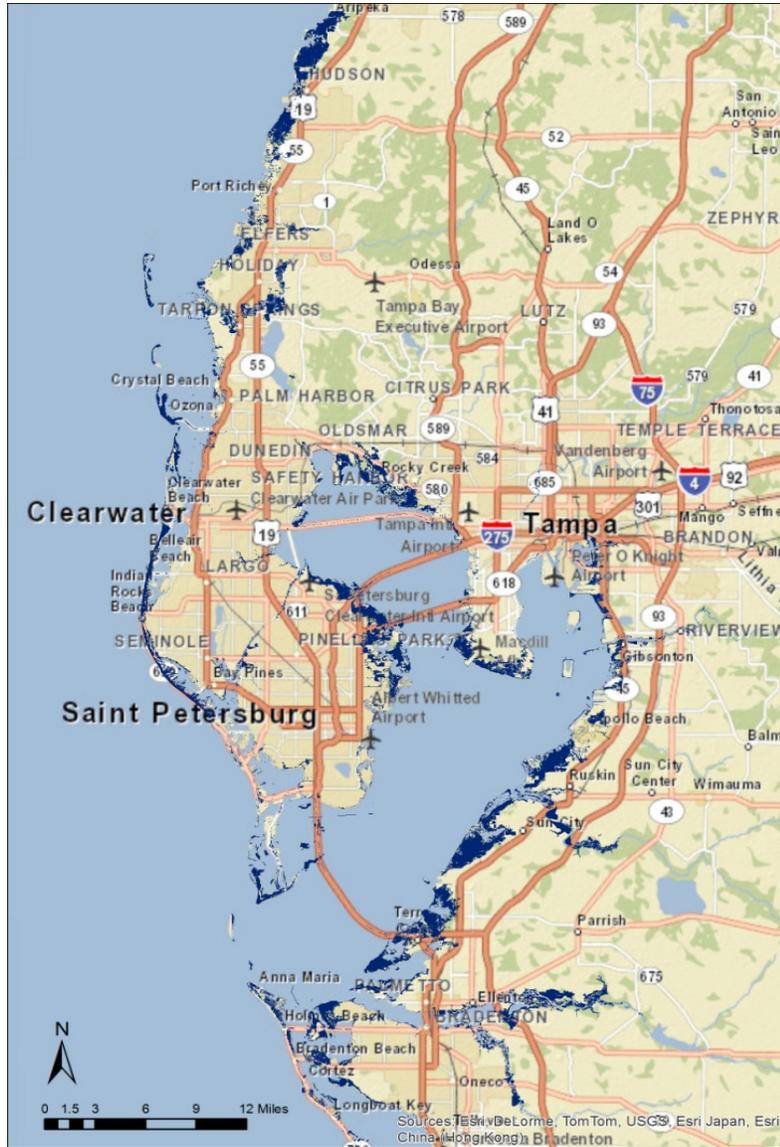
Study Focus: Sea Level Rise in the Tampa Bay Area

Based upon the NOAA High sea level rise projection from the *Recommended Projection of Sea Level Rise in the Tampa Bay Region*, developed by the Tampa Bay Climate Science Advisory Panel (CSAP), the Tampa Bay Regional Planning Council (TBRPC) developed maps depicting a 2.95 foot rise in sea level by 2060. As shown on the map below³ sea level rise may submerge properties along the coastline, including much of the barrier islands in Pinellas County. While the map depicts areas anticipated to be inundated year-round, periodic flooding of other areas further inland may occur as the result of normal storm events. While sea levels will continue to rise, 2060 was chosen as the forecast horizon as this is the last year in the Council's economic impact model, REMI PI+.

There are numerous potential areas of analysis in studying the impacts of sea level rise. The Hillsborough County Metropolitan Planning Organization (MPO) has already investigated the effects of sea level rise on parts of the transportation network. That study found that disruptions would result in the loss of \$109 million in Gross Regional Product by 2035 just from increased travel delays during storm events⁴.

Of course, travel delays are just one of many potential negative outcomes of sea level rise. Changes in the cost of homeowner insurance, physical damage to utility and transportation infrastructure, exacerbated nuisance flooding and an increased threat from polluted stormwater runoff into Tampa Bay and the Gulf of Mexico are just a few examples.

Regional Map Depicting Inundated Areas (Dark Blue) in 2060



Quantifying Sea Level Rise Impacts

With many potential areas of analysis, the TBRPC narrowed the study’s focus to model three different aspects of the key sea level rise impact, submerged lands. These three aspects are the loss of property value and consequent loss in government property tax revenue, the loss of jobs on those lands, and the loss of tourism dollars stemming from the loss of beachfront property.

Using County property assessor data and geocoded employment data from Florida Agency for Workforce Innovation, TBRPC identified the key quantitative inputs of the modeling process resulting from a mean sea level increase of 2.95 feet by 2060. Those inputs are summarized below.

When Mean Sea Level Increases by 2.95 Feet	Estimate
Value of Submerged Residential Property in 2015	\$14.9 Billion*
Value of Submerged Commercial Property in 2015	\$1.3 Billion*
Cumulative loss of Property Taxes (2020-2060)	\$5.4 Billion*
Job Losses in submerged areas	17,184

*all currency figures are fixed and local 2015 dollars

A REMI PI+ Model

TBRPC maintains economic impact analysis software to help estimate the impacts of various conjectural policy questions—what would happen if taxes were to increase, or if a new industry began in the Tampa Bay Area—in order to see how those events would affect the regional economy. One of those models, REMI PI+, is a powerful desktop economic simulation tool that can forecast the impacts of thousands of variables across a fifty year time horizon. Its outputs, however, are based on the assumption that inputs are firm when in fact new information will help refine our understanding of future sea level rise. As such, the unambiguous numbers (and maps) that TBRPC presents should be understood as estimates and that actual outcomes will vary.

Assessing the Costs of Inundated Land in the Tampa Bay Area

TBRPC segregated the potential impacts of inundated land in the region into three separate simulations on the regional economy⁵. Under each of the following scenarios, sea levels will be 2.95 feet over 1992 levels. The scenarios are:

1. Simulation 1(Property Value and Tax Revenue Loss) is the impact of the economy from the economic losses stemming from submerged property. In this case 31,800 parcels lose all economic value.
2. Simulation 2 (Direct Job Loss) refers to the combined effects of direct and indirect job loss to sea level rise on the rest of the economy.
3. Simulation 3 (Tourism Loss) is the loss of tourism spending to the economy.

Property Value and Tax Revenue Loss: Simulation 1

Property Value and Tax Revenue loss in the Tampa Bay Area will be gradual in the coming decades and its impacts subtle until higher sea levels inundate coastal lands. The following table summarizes the impacts to submerged land in Hillsborough, Manatee, Pasco and Pinellas County.

Land Use	Acres	Parcels	Value	Est. 2015 Taxes
Residential	72,048	29,297	\$14.9 Bil	\$241.8 Mil
Commercial	4,226	2,316	\$1.2 Bil	\$20.3 Mil
Industrial	296	186	\$94.5 Mil	\$2.1 Mil
Total	76,570	31,799	\$16.2 Bil	\$264.2 Mil

The economic impact of submerged lands was modeled in Policy Insight by simulating the loss of land in the model. As there is no direct way to do this in the model, TBPRC created a simulation where land costs for residential and commercial land uses increase by the same percentage that the acreage lost represents of all land. If eight percent of the land is submerged by 2060 according to the GIS model, the Council modeled an increase in housing and land costs by eight percent in the REMI PI+ model⁶.

Without compensating increases to residential and commercial capital stock, increasing costs of land and housing will induce out-migration, increasing job-loss and the loss of personal income and Gross Regional Product. In addition to increases to the cost of existing land, government spending is reduced by the amount of taxes paid by owners of the affected properties. This impact alone represents a cumulative loss of \$5.4 billion through 2060.

The following table summarizes the impacts of the simulation. Twelve thousand jobs are lost from the region, while nearly 40,000 people leave the region *from the loss of land and the taxes paid on it alone*. Because of the gap between optimal residential capital stock and actual residential capital stock grows due to the loss of land when demand for it is on the rise, this is the only simulation with a positive impact on the Price Index.

Property Value and Taxes		Hills	Manatee	Pasco	Pinellas	Tampa Bay
Category	Units	In 2060 for all counties				
Total	Thousands	-1.292	-2.240	-0.545	-8.404	-12.481
Employment	(Jobs)					
Population	Thousands	-2.400	-9.634	-3.262	-24.461	-39.757
Labor Force	Thousands	-0.787	-4.120	-1.564	-12.522	-18.993
Gross Regional Product	Billions of Fixed (2009) Dollars	-0.302	-0.304	-0.070	-1.355	-2.031
Personal Income	Billions of Current Dollars	0.300	-1.436	-0.386	-3.996	-5.518
PCE-Price Index	2009=100 (Nation)	0.180	0.352	0.136	0.587	0.323

Job Losses: Simulation 2

17,184 jobs currently exist on properties anticipated to be submerged by 2060. Assuming existing job densities and the spatial distribution of employment by industry persists through 2060, that many jobs were modeled as being removed from the economy.

The following table estimates the number of jobs lost by industry in areas that are submerged by 2060.

Industry	Jobs
Accommodation/Food	5,568
Health Care	4,344
Financial Services	2,221
Professional Services	1,674
Retail	1,479
Construction	548
Wholesale/Transportation	539
Education	82
Manufacturing	51
Other	678
Total	17,184

For this simulation, the Council modeled the loss of the jobs in the table above from the regional economy. Because jobs in the accommodation and food services industries are so closely tied to tourism spending, Simulation 2 does not account for the loss of those jobs. Instead, in order to avoid double counting, those job losses and their secondary effects are modeled in the third simulation.

Jobs		Hills	Manatee	Pasco	Pinellas	Tampa Bay
Category	Units	In 2060 for all counties				
Total Employment	Thousands (Jobs)	-6.365	-2.803	-1.108	-16.041	-26.318
Population	Thousands	-8.491	-3.657	-0.837	-21.456	-34.442
Labor Force	Thousands	-4.998	-2.086	-0.644	-12.335	-20.064
Gross Regional Product	Billions of Fixed (2009) Dollars	-1.365	-0.502	-0.17	-2.371	-4.408
Personal Income	Billions of Current Dollars	-1.934	-0.933	-0.504	-4.717	-8.088
PCE-Price Index	2009=100 (Nation)	-0.21	-0.307	-0.187	-0.617	-0.34

As with the first simulation, thousands of jobs are lost, and 34,442 people move out of the region. Of the three simulations, direct and secondary job losses are the most impactful to the economy.

Tourism Losses: Simulation 3

Tourism is one of the pillars of the region's economy and with much of the region's attractive beaches modeled to be underwater, the impact to the recreation economy could be enormous. Since there are no prior region specific studies of the loss of coastal land to sea rise, staff made several assumptions about changes to existing conditions for the purposes of the simulation.

Visitors to the region spent about \$12 billion a year between 2013 to 2015⁷. Using industry standards for revenue per hotel employee, the Council modeled the loss of tourism spending by the estimated number of hotel employees in inundated areas, proportionately scaled over 40 years to reflect the slow increase in mean sea level. While this approach likely underestimates the true amenity value of the beach front property, those values are highly subjective in comparison to more directly estimated revenue losses.

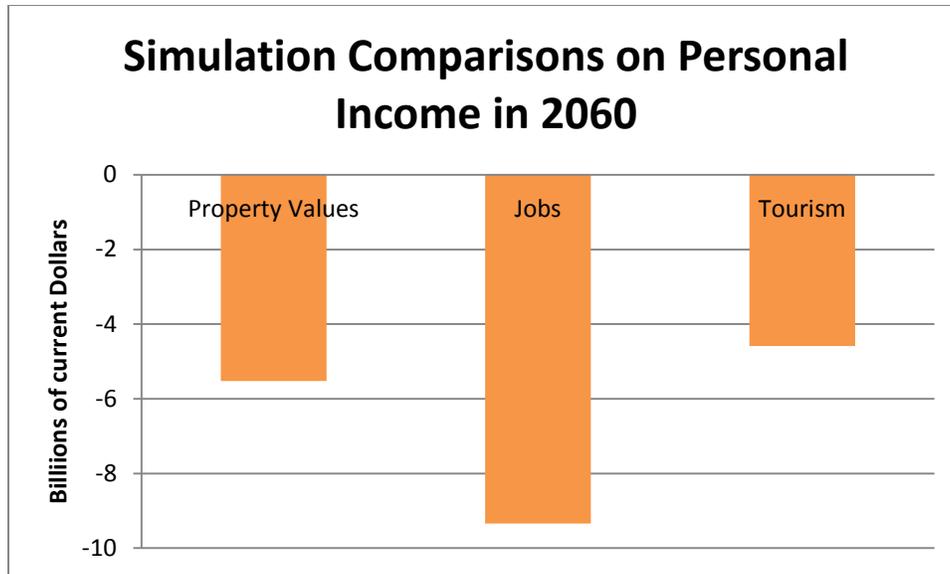
Tourism Losses		Hills	Manatee	Pasco	Pinellas	Tampa Bay
Category	Units	In 2060 for all counties				
Total Employment	Thousands (Jobs)	-3.934	-2.306	-1.969	-8.727	-16.937
Population	Thousands	-5.060	-4.176	-5.538	-12.300	-27.074
Labor Force	Thousands	-2.900	-2.129	-2.908	-6.959	-14.896
Gross Regional Product	Billions of Fixed (2009) Dollars	-0.584	-0.223	-0.176	-0.898	-1.881
Personal Income	Billions of Current Dollars	-0.811	-0.715	-0.831	-2.227	-4.584
PCE-Price Index	2009=100 (Nation)	-0.113	-0.215	-0.190	-0.312	-0.202

Composite Simulation

The final step in the REMI PI+ analysis was re-running all three simulations as a single set of events in a Composite Simulation. That Composite Simulation is not the sum of all of the other simulations. Instead, some factors cancel each other out or represent the same kinds of effects which REMI PI+ accounts. For example, Price Index increases due to the loss of land are overwhelmed by the impacts of the loss of jobs and tourism dollars, leading to an overall decline in the Price Index through the forecast. In other cases, the figures reported in the table below are similar to the sum of all of the other simulations, but not necessarily the same because of interaction effects between the different variables of each simulation.

All Simulations		Hills	Manatee	Pasco	Pinellas	Tampa Bay
Category	Units	In 2060 for all counties				
Total Employment	Thousands (Jobs)	-11.579	-7.332	-3.609	-33.065	-55.585
Population	Thousands	-15.974	-17.355	-9.605	-57.746	-100.68
Labor Force	Thousands	-8.69	-8.297	-5.102	-31.578	-53.666
Gross Regional Product	Billions of Fixed (2009) Dollars	-2.472	-1.128	-0.455	-5.057	-9.112
Personal Income	Billions of Current Dollars	-1.102	-1.35	-0.731	-4.902	-8.084
PCE-Price Index	2009=100 (Nation)	-0.15	-0.176	-0.246	-0.355	-0.214

As such, the Composite Simulation is a useful means to compare different simulations. For example, the following graphic compares how each aspect of submerged lands influences change in Personal Income. In this case, Job losses are the biggest drag on personal income (48%), followed by submerged property values (28%) and then the effects of lost tourism dollars (24%).



Cumulative Effects of Composite Simulation

In any given year of the slow increase in the mean sea level, economic impacts on the region are significant but not overwhelming. In this table, the Council presents 40 years of cumulative pecuniary impacts to the Tampa Bay region’s economy.

All Simulations		Hills	Manatee	Pasco	Pinellas	Tampa Bay
Category	Units	Cumulative 2020-2060				
Gross Regional Product	Billions of Fixed (2009) Dollars	-43.115	-20.244	-8.219	-88.926	-160.503
Personal Income	Billions of Current Dollars	-19.009	-22.103	-12.411	-80.755	-134.28

Conclusion

This report considers the economic implications of the unlikely event that rising sea levels will be ignored by policymakers. Some Florida communities, such as Miami Beach, are already investing millions of dollars to retrofit existing buildings and infrastructure to handle sea level rise. Instead, we ask what would happen if no action is taken to prepare for sea level rise. With a sense of the scale of costs, individual communities or the region as a whole can weigh the benefits of acting and investing early or waiting to see what happens and adjust later.

Besides calculating direct and indirect costs, parsing and comparing the different categories of potential impacts of sea level rise is helpful in defining the dimensions of the challenges facing policymakers. For example, a public policy approach that rests on a principle that the primary beneficiary of mitigation pays the most to cover mitigation costs might result in higher taxes on commercial property but levies fewer taxes on residential property owners, and fewer still on

accommodation establishments. Analyses such as these can be useful in staking out potential mitigation strategies, while in the private sector insurance premiums will influence future decision making on residential and commercial investment.

Because the problems posed by sea level rise are incremental and grow slowly over time, any discussion of mitigation needs to consider the role of scale in defining the problem. Leaving aside the vast costs of doing nothing over forty years--\$161 Billion of lost Gross Regional Product in 2015 dollars—in each year the impact is relatively small compared to the size of the region’s economy. Even in the peak year of sea level impacts, 2060, the region’s Gross Product is reduced by less than three percent. The benefit of relatively small damage to the economy is that sea level rise will not have catastrophic consequences for the entire region in 2060.

Category	Units	Baseline 2060 Data	Percent Impact of Composite Simulation on Baseline
Total Employment	Thousands (Jobs)	2320	-2.55%
Population	Thousands	4400	-2.50%
Labor Force	Thousands	2141	-3.16%
Gross Regional Product	Billions of Fixed (2009) Dollars	371.51	-2.32%
Personal Income	Billions of Current Dollars	893.7	-2.17%
PCE-Price Index	2009=100 (Nation)	247.63	-0.09%

However, the worst case scenario is not a foregone conclusion. The actual results of sea level rise may be different than 2.95 feet, and it may be even less by 2060. But even lower sea level rise estimates may carry risks for property and infrastructure. The first step in understanding those risks occurs through modeling exercises like this study.

Directions and Need for Future Analysis

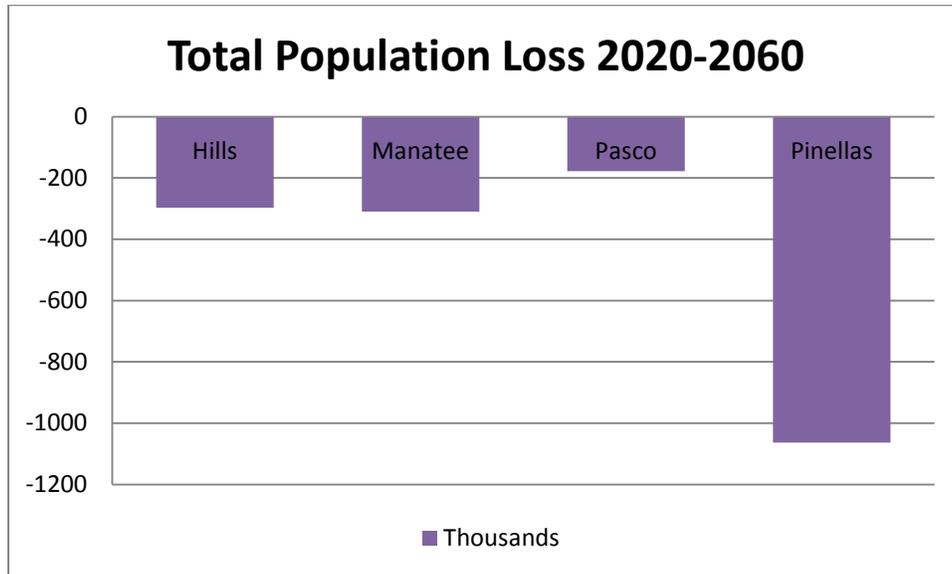
This study focusses on just a few potential impacts of sea level rise because there are many other potential areas of analysis. Potential areas for future study include: how will extreme weather events impact storm drainage and emergency management facilities when they are already compromised by decades of sea level events? How will periodic loss of access through submerged roads affect businesses? How will skyrocketing flood insurance costs shape the housing market, even if the value of homes drop?

Perhaps most important but the most difficult question to answer is how much will it cost to offset sea level rise through technological means or capital investment? From an economic feasibility standpoint, will the investment be worth it?

One potential area of analysis is to refine the overall study and model different sea level rise scenarios, other than the worst case. Generating successively more impactful sea level rise scenarios and their economic effects help to benchmark the rising costs of infrastructure against the concurrently rising sea level.

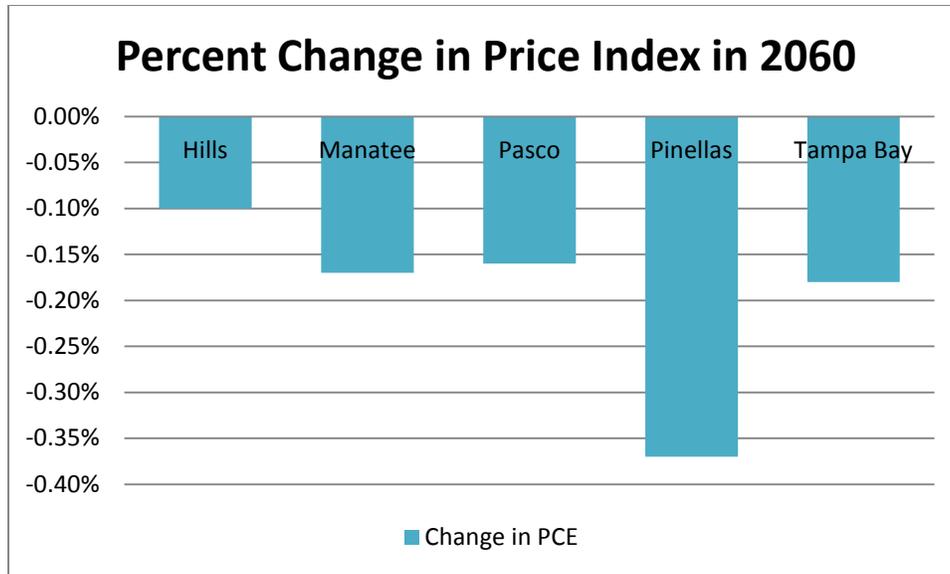
Selected Definitions and Charts

Population: the population of the region totaled by all age cohorts and racial groupings. The Labor Force is the working age subset (15-65) of the population.



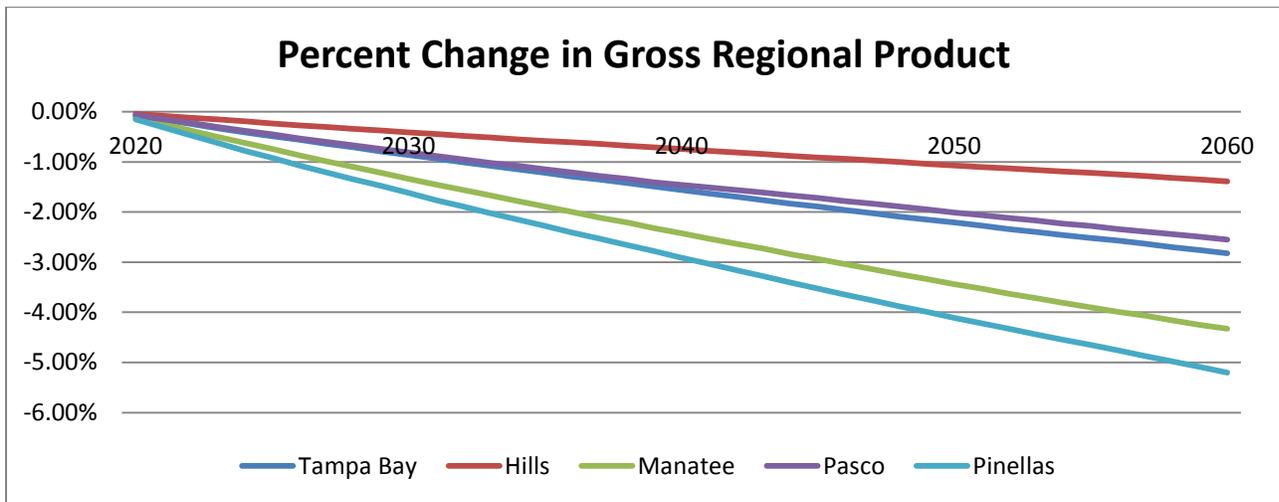
Total Employment: Employment for both private and public sectors across all industries in a given year. Total Employment is the same as Full Time Equivalents of jobs.

PCE-Price Index. An index of all consumer prices scaled to 100. An index of 104 indicates a four percent increase of a basket of goods over the control forecast.



Personal income is wages and all transfer payments.

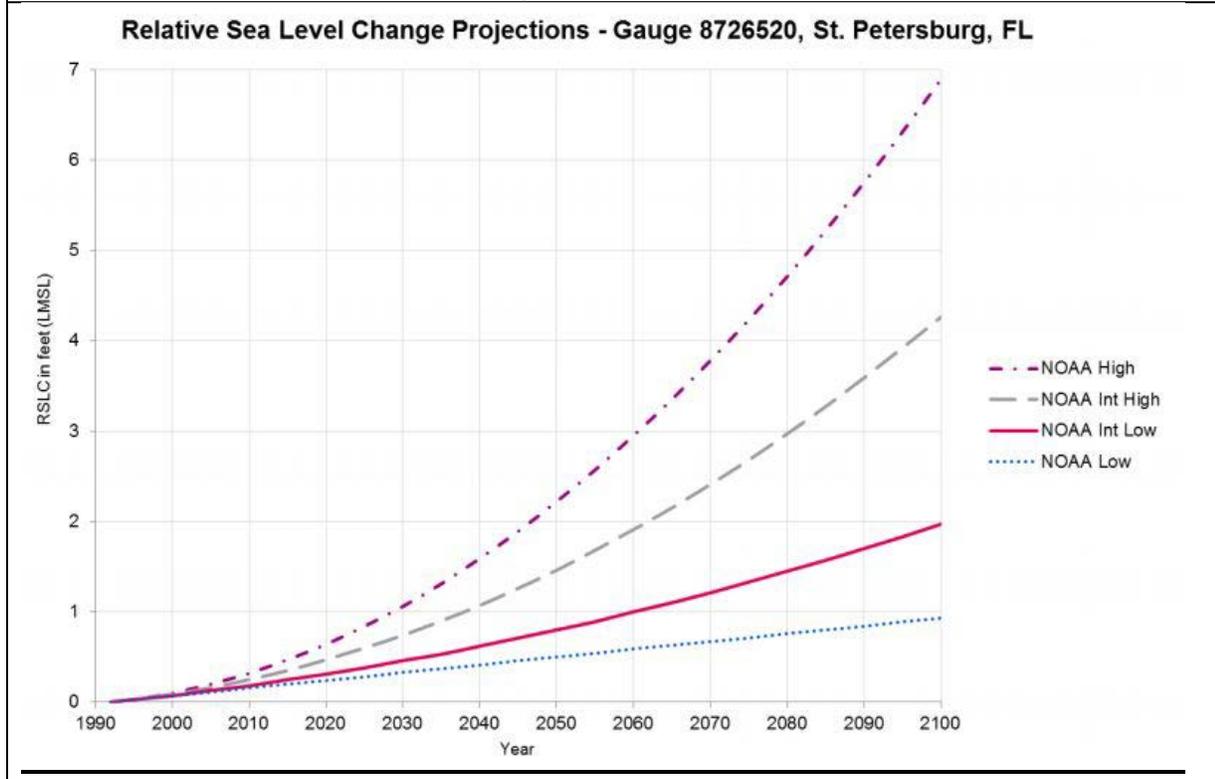
Gross Regional Product is the value of all goods and services produced in the region.



SLR Methodology

The 2060 sea level rise inundation areas for the Tampa Bay region were selected using the NOAA High sea level rise simulation from the *Recommended Projection of Sea Level Rise in the Tampa Bay Region*. The Tampa Bay CSAP recommends that local governments and regional agencies use the set of four regionally adjusted sea level rise projections, shown below⁸. Using the regionally-adjusted NOAA High projection, local mean sea level in the Tampa Bay region in 2060 is estimated to be 2.95 feet above local mean sea level in 1992, the midpoint of the present National Tidal Datum Epoch (NTDE).

Illustration 1: Relative Sea Level Change in Feet



TBRPC’s SLR Assessment Tool, an extension used in conjunction with geospatial analysis software, was employed to determine the land areas that are projected to be frequently inundated in the Tampa Bay region under the regionally-corrected NOAA High simulation for the year 2060. The SLR Assessment Tool uses a LIDAR-based digital elevation model (DEM) of land surfaces in the Tampa Bay area, current (NTDE) tidal datums, and user-input sea level rise values to create a geographic information system (GIS) layer that depicts inundation areas under increased sea level conditions.

The SLR Assessment Tool creates an inundation surface by determining the water surface elevation for a given point under the increased sea level simulation, using NOAA’s interpolated mean higher high water (MHHW) dataset for the present NTDE as the base elevation. The elevation of the land surface at the same point with respect to the North American Vertical Datum of 1988 (NAVD 88) is determined from the DEM. The DEM elevation value is subtracted from the water surface elevation for all coastal locations throughout the region, and

locations where the water surface value is greater than the DEM elevation are shown to be inundation areas. In this analysis, all sea level rise inundation areas have surface hydrologic connectivity to the sea under the increased sea level conditions. Areas in the model where the land elevation is greater than the projected 2060 water surface elevation act as barriers that seawater may not cross. However, seawater may circumvent these barriers if the water surface elevation is high enough to inundate lower elevation land areas nearby.

The 2060 inundation analysis considers projected tidal levels at the MHHW tidal datum. Since MHHW is the average of the higher of the high tide levels each day, the inundation areas determined in this analysis would be expected to frequently experience sunny-day flooding at the highest high tide of the day in 2060. This analysis does not consider heavy precipitation events, where the stormwater drainage system may not be effective in removing excess rainwater from dry land areas. Backflow of seawater through the subsurface stormwater drainage system is not accounted for in this analysis. Also, storm surge from tropical cyclones and other weather systems is not considered. Heavy precipitation, backflow, and storm surge would all be expected to increase the geographic coverage of the inundation areas, though typically on a temporary basis and with lower frequency than sunny day tidal flooding.

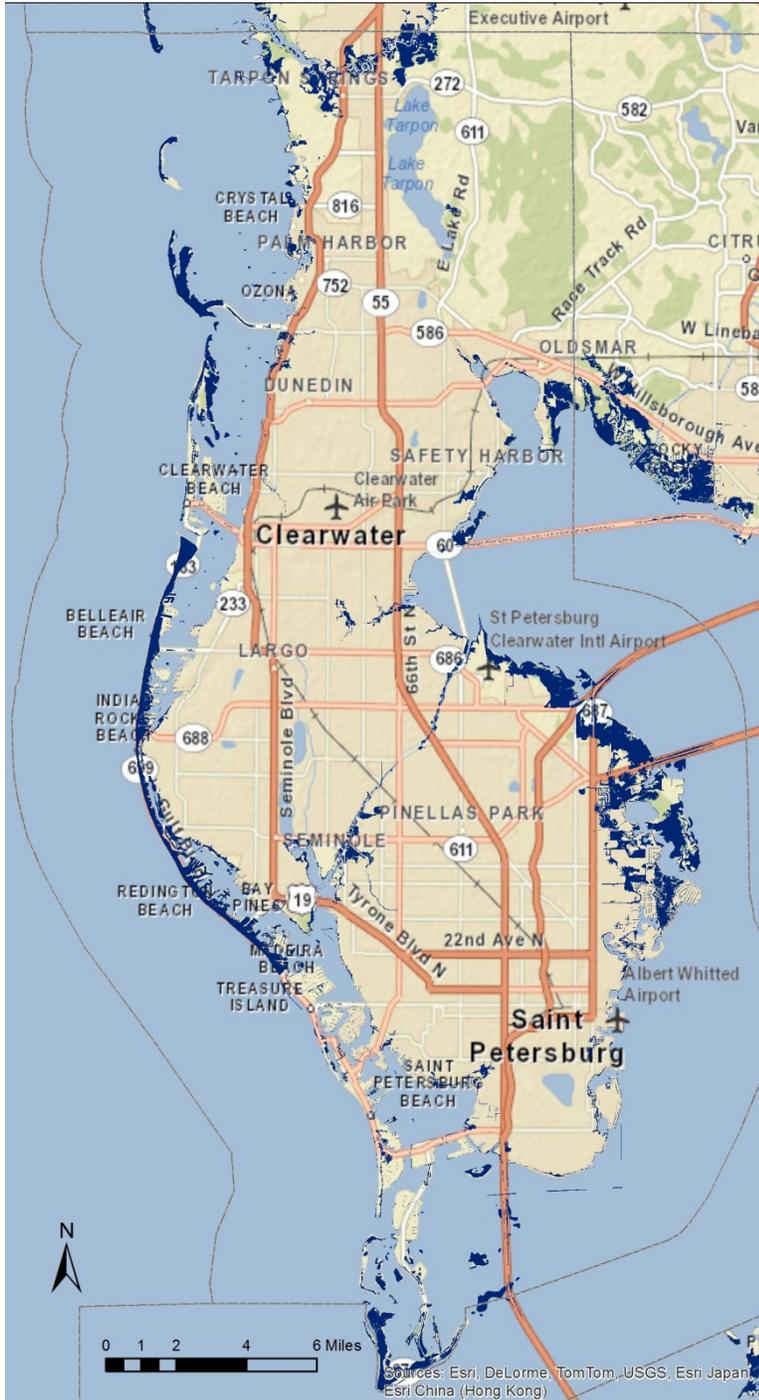
The Quarterly Census of Employment and Wages (QCEW) dataset from the third quarter of calendar year 2015 was used to help determine the impacts of potential future increased sea level conditions. The QCEW dataset, compiled by the State of Florida Bureau of Labor Market Statistics, contains information about geographic location, number of employees, and total wages at each place of employment for businesses/entities that are subject to state Unemployment Insurance (UI) laws. Geocoded location information for each reporting unit was compared with the location of the projected 2060 sea level rise inundation areas for the Tampa Bay region using geographic information system software. Places of employment that intersect the projected 2060 inundation areas are considered to be directly impacted.

Parcel data obtained from the property appraisers' offices in Hillsborough, Manatee, Pasco, and Pinellas Counties were compared with the projected 2060 sea level rise inundation areas for the Tampa Bay region in a geographic information system. Properties that have greater than 20 percent of their total parcel land area in the projected 2060 sea level rise inundation zone are considered to be directly impacted in this analysis.

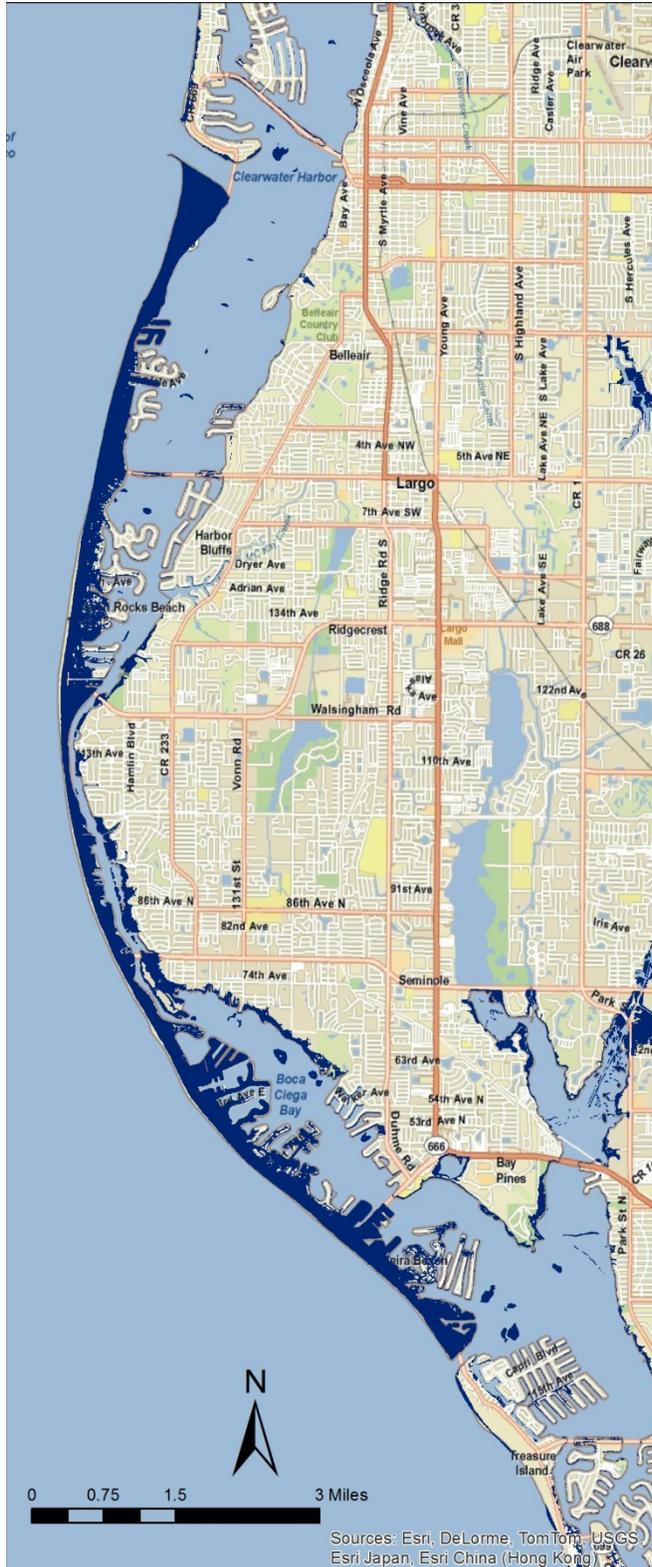
Inundation Maps

The Regional Map and the following larger scale maps indicate the Mean Higher High Water Level in 2060, based on the best currently available data and on the current worst case scenario of a 2.9 foot increase in sea level rise. The following maps highlight areas of interest in the Regional Map and reflect the same assumptions and data.

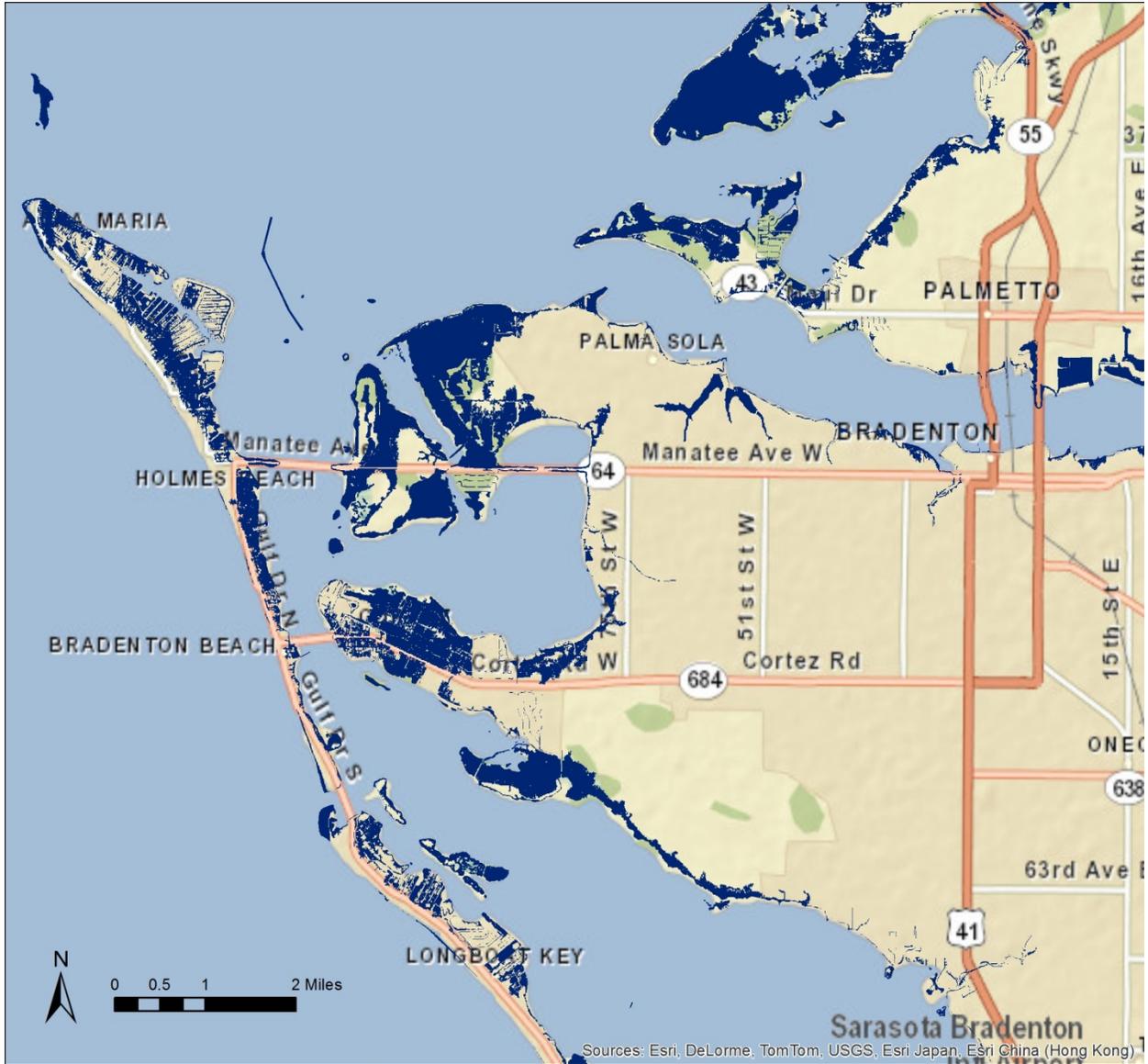
Pinellas County



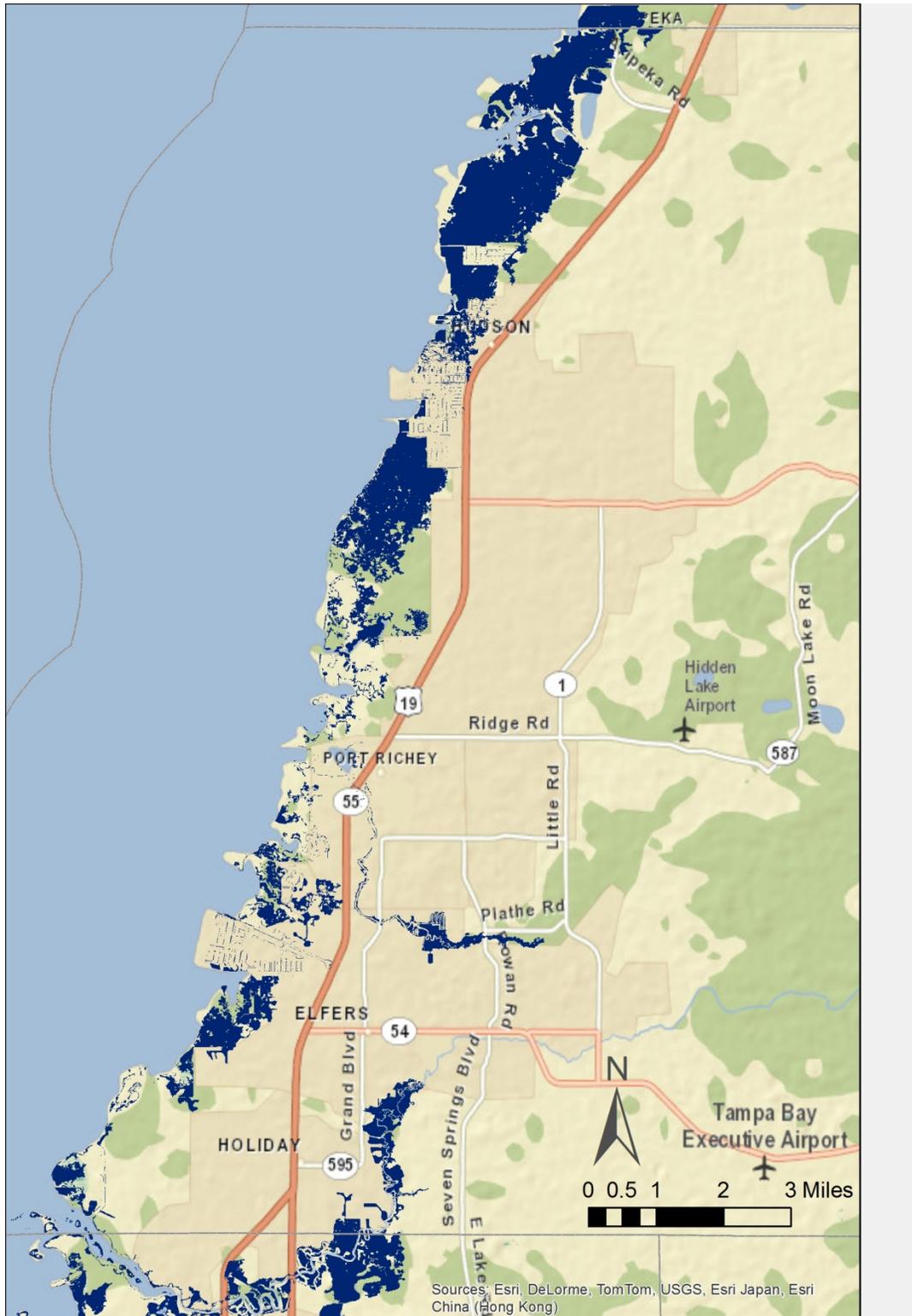
Pinellas Beaches



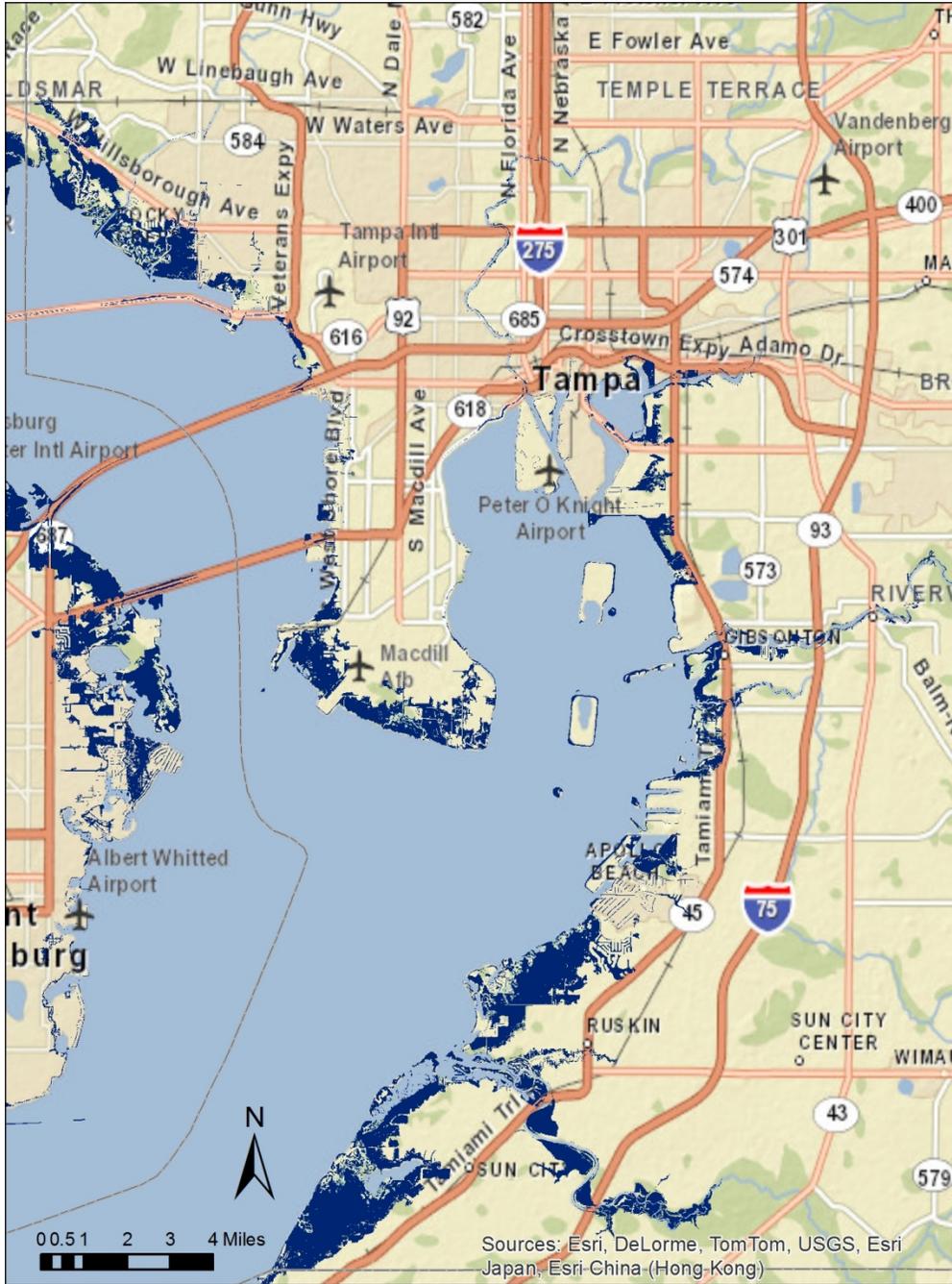
Bradenton and Beaches



Pasco



Hillsborough



¹ <http://oceanservice.noaa.gov/facts/sealevel.html>

² <http://riskybusiness.org> and <http://climateprospectus.org/>

³ Dark blue indicates inundation areas at Mean Higher High Water (MHHW) based upon the regionally-corrected NOAA High SLR Simulation for 2060 (+2.95 ft over the 1992 MHHW level).

⁴ Hillsborough County. Vulnerability Assessment and Adaptation Pilot Project. October 2014. P. 32.

⁵ Due to the timing of the original grant terms, the region refers to Hillsborough, Manatee, Pasco and Pinellas Counties.

⁶ Since there is no true equivalence between the percentage of acres lost and the resulting percentage increase in costs, the assumed precise trade-off between the two variables is intended to ensure that the impacts are roughly on the same magnitude even as there no existing studies that account for the permanent loss of a primary factor of production to sea level rise.

⁷ Visit Tampa Bay and Visit St Pete/Clearwater, 2015.

⁸ Tampa Bay Climate Science Advisory Panel. 2015. *Recommended Projection of Sea Level Rise in the Tampa Bay Region*