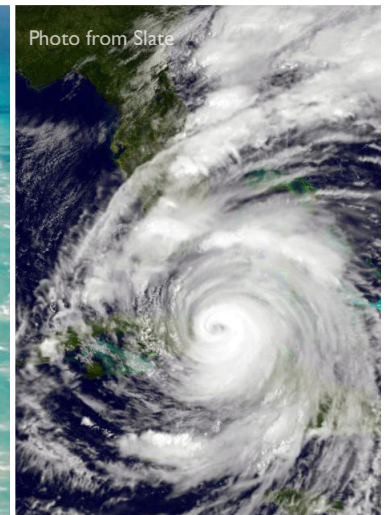


Getting Ahead of the Curve for a Resilient Economy:

An Introduction to Risks and Opportunities of Climate Change for Top Business Sectors in Southeast Florida



Acknowledgements

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Editors: T. Troxler, C. Allouch

Support for this work was provided by The Miami Foundation, Resilience Action Fund, Florida International University's Sea Level Solutions Center, College of Business and Chaplin School of Hospitality Management and Tourism.

This is publication number 8 of the Sea Level Solutions Center in the Institute of Water and Environment at Florida International University.

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In A Nutshell

The purpose of this report is to stimulate discussion and thinking within the Greater Miami business community, in forums such as the Miami Chamber of Commerce and Beacon Council in conjunction with public officials and other community stakeholders, on developing strategies to address future risks and help capture potential opportunities related to sea level rise (SLR) and climate change.

Localities within southeast Florida are considered one of the most vulnerable areas to climate change and impacts of climate change are already present. Sea-level rise is but one effect of a changing climate. Rising temperatures, changes in precipitation and increasing frequencies of intense storms are all consequences of climate change with local to regional impacts that permeate to national impacts, as individual state economies are intricately intertwined. With unabated climate change, specific economic risks for Florida include flooding and storm impacts on coastal property and infrastructure, declines in agricultural and labor productivity, increase in electricity demand and cost, and heat-related health impacts and mortality.

What can we do now to address sea-level rise and climate change to avert these risks to businesses and even create opportunities for our local businesses and economy? We can get ahead of the curve to integrate resilience and sustainability measures into business plans and models to ensure sustained continuity of service and integrate efficiencies that reduce exposures and vulnerability to disruptions.

In this paper, we introduce business risks and opportunities to four major growth areas in the southeast Florida region, focusing on Miami-Dade County: 1) property and real estate development, 2) trade and logistics, 3) healthcare, and 4) tourism and hospitality management. Where information was available for Monroe County, it was also considered as part of this introductory paper.

Since 2012, the Beacon Council (Miami-Dade County's Official Economic Development Partnership) has worked with 145 different businesses looking to expand in or relocate to Miami-Dade County. That work has led to 2,301 jobs being retained, 10,588 new direct and indirect jobs created, and investments of over \$1.2 billion in new capital¹. As such, growth opportunities abound in Miami-Dade County as has been demonstrated by the strong recovery since the economic downturn. The next phase of economic growth is poised to be focused with a resilience lens to ensure that Miami-Dade County's businesses and national and global business partners continue to enable the local and state economy to infuse prosperity. We can position ourselves to sustain the opportunities and high quality of life we enjoy in our southeast Florida community, if we accelerate our work to get ahead of the curve for a resilient economy.

¹Miami-Dade County. 2016. Miami Proposed 2016-2017 Budget and Multi-Year Capital Plan, Vol 1: Strategic Areas: Summaries and Five-Year Plan, Miami-Dade County, Florida.



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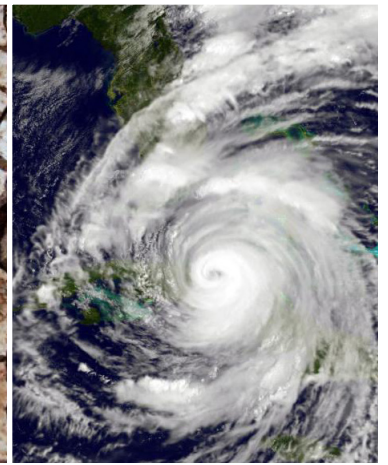


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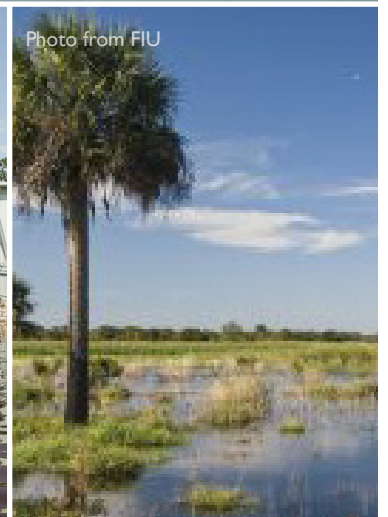


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Introduction

“Florida is considered one of the most vulnerable areas in the country to the consequences of climate change with southeast Florida on the front line to experience the impacts of climate change, especially sea level rise.... Local governments, and the region as a whole, must give significant consideration to adaptation strategies designed to protect public infrastructure, property, water resources, natural areas and native species, and basic quality of life”². Low-lying coastal areas around the world are vulnerable to flooding caused by storm surge and SLR (Figure 1). Global SLR is projected at 0.5-2.0 meters by 2100 according to various scenarios for future climate^{3 4 5 6}, some reporting that these estimates are conservative⁷. In fact, in the last decade, local SLR has increased by three times the global average rate⁸. Miami-Dade County is considered one of the most vulnerable areas to climate change and its effects are already present. During the fall season, Miami experiences “sunny day” flooding which is not just a coastal issue. When the local water table is high and there are heavy rains, this leads to flooding throughout the community. It is projected that up to another six inches of sea level change is expected by 2030⁹. This will increase the number and extent of events with implications for our natural and built environment, including our drinking water, water management, coastal hazard protection, property & business enterprise, and vulnerable populations.

As SLR increases, storm surge impacts worsen¹⁰. More frequent coastal and inland flooding and more intense storms in the future, will greatly exacerbate threats from storm surge, tidal flooding, and freshwater flooding to people, property and livelihoods. However, risk assessment, mitigation, and adaptation strategies are complex undertakings for communities that lack mechanisms to spur public and private investments in building coastal resilience. Despite the significant work of the county to focus on resilience efforts, there is a pressing need to provide entrepreneurs with better information to assess risks and realize the immense business opportunities of resilience efforts in their own business plans and models.



Figure 1: High tide flooding in Miami, Fall 2015

Box 1. Urban resilience adapted from the City Resilience Framework (The Rockefeller Foundation 2015).

Urban resilience describes the capacity of human communities and the environment that sustains them to continue to function well, so that the people living and working in those communities – including the poor and vulnerable – thrive now and into the future no matter what stresses or shocks they encounter.

²Southeast Florida Regional Climate Change Compact (Compact). 2010. Final Regional Compact as ratified by the four party Counties in January 2010. <http://www.south-eastfloridaclimatecompact.org/wp-content/uploads/2014/09/regional-climate-action-plan-final-ada-compliant.pdf>

³Rahmstorf, S. 2007. A semi-empirical approach to projecting future sea-level rise. *Science* 315: 368-370.

⁴Vermeer, M. and S. Rahmstorf. 2009. Global sea level linked to global temperature. *PNAS* 106: 21527-21532.

⁵Church, J.A., P.U. Clark, A. Cazenave, J.M. Gregory, S. Jevrejeva, A. Levermann, M.A. Merrifield, G.A. Milne, R.S. Nerem, P.D. Nunn, A.J. Payne, W.T. Pfeffer, D. Stammer, A.S. Unnikrishnan. 2013. Sea level change in: *Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

⁶National Oceanic and Atmospheric Administration (NOAA). 2013. <https://www.climate.gov/newsfeatures/understanding-climate/2013-state-climate-sea-surface-temperature>, Accessed in March 2016.

⁷Hansen, J., M. Sato, P. Hearty, R. Ruedy, M. Kelley, V. Masson-Delmotte, G. Russell, G. Tselioudis, J. Cao, E. Rignot, I. Velicogna, E. Kandiano, K. von Schuckmann, P. Kharecha, A.N. Legrande, M. Bauer, K.W. Lo. 2015. Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2°C global warming is highly dangerous. *Atmospheric Chemistry and Physics Discussions* 15: 20059-20179.

⁸Wdowski, S., R. Bray, B. P. Kirtman, and Z. Wu. 2016. Increasing flooding hazard in coastal communities due to rising sea level: Case study of Miami Beach, Florida. *Ocean & Coastal Management* 126: 1-8.

⁹Southeast Florida Regional Climate Change Compact Sea Level Rise Work Group (Compact). 2015. Unified Sea Level Rise Projection for Southeast Florida. A document prepared for the Southeast Florida Regional Climate Change Compact Steering Committee. 35 p.

¹⁰Zhang, K., 2011. Analysis of non-linear inundation from sea-level rise using LIDAR data: a case study for South Florida. *Climatic Change* 106: 537-565.

Resilience, Sustainability and the Cost of Doing Nothing

Sea-level rise is but one effect of a changing climate. Rising temperatures, changes in precipitation and increasing frequency of intense storms, are all effects of climate change with local to regional impacts that permeate to national impacts. The economy is intricately linked to climate change and so was created The Risky Business Project. The mission of the project was to quantify the economic risks to the United States from doing nothing about climate change – unmitigated climate change. In a second report released in 2015, the Project focused on the southeastern region of the U.S. including Texas¹¹. With unabated climate change (i.e. maintaining our current emissions path), general trends identified were significant: 1) increasing heat, 2) inundation from higher mean sea levels and high tide lines, 3) changes in precipitation, 4) declines in agricultural productivity, 5) increases in electricity demand and cost, and 6) heat-related health impacts and mortality and a decrease in labor productivity¹². For Florida, specific economic risks identified include risks to coastal property and infrastructure from rising seas and potential storm damage with impacts on Florida’s recreation economy¹³. Increasing heat in terms of number of heat days exceeding 95°F and higher summer temperatures (in terms of heat- and humidity-related human physiological stress) would have significant impacts to people working in the agriculture, construction, utilities and manufacturing industries exposed to outdoor working conditions, with a projected 1.5% drop in labor productivity by 2040-2059. With increasing heat, electricity demand and costs are expected to rise. By 2020-2039, residential and commercial energy expenditures are expected to increase by 9% solely related to climate change¹⁴.

What can we do now to address sea-level rise and climate change to avert these risks to business and even create opportunities for our local businesses and economy? We can get ahead of the curve to integrate resilience and sustainability measures into business plans and model plans to ensure sustained continuity of service and integrate efficiencies that reduce exposures and vulnerability to disruptions. Importantly, but not well appreciated, is that sustainable business practices reduce risks to business and are an integral part of building resilience. For example, if “Business A” reduces the amount of water it needs to create its products, it will be less susceptible to shortages in water supplies than “Business B” that takes no sustainability practices. “Business A” has also reduced its costs of operating its business which can be invested to safeguard against disruptions and ensuring business continuity. Locally, Miami-Dade County has taken the charge and is working hard to abate these risks and realize opportunities in addressing challenges of sea-level rise and climate change. For example, in May 2016, Miami-Dade County, the City of Miami, and the City of Miami Beach joined together to become members of the Rockefeller 100 Resilient Cities global network. As part of 100 Resilient Cities, Miami-Dade is working with innovative cities around the world, as well as local partners, to develop strategies to improve our local economy, provide greater opportunities for our residents, and strengthen our budget to better prepare for storms, sea-level rise, and other natural and man-made threats. To support these efforts, Mayor Gimenez championed establishing an Office of Resilience and appointing a Chief Resilience Officer to lead Miami-Dade County in the development of a comprehensive and cohesive resilience plan for the city’s government and to collaborate with the city’s 34 municipalities and neighboring counties to develop a resilience plan for the region. The Fiscal Year (FY) 2016-17 Proposed Budget for Miami-Dade County is a reflection of this focus on allocating our resources to enhance resilience and enhance our residents’ quality of life. There are four dimensions of resilience that serve as the pillars of the County’s resilience framework: 1) Health & Wellbeing, 2) Economy & Society, 3) Infrastructure & Environment, 4) Leadership & Strategy.

To actuate these goals, a deep understanding of Miami’s local and regional economic sectors and growth areas must align with a strong knowledge of the businesses, business plans and models and business interconnections within and across these sectors to: 1) anticipate exposures that increase risks and 2) develop opportunities for the business community to get ahead of the curve. A resilient economy has the competitive edge to sustain and

¹¹Risky Business. 2015. COME HEAT AND HIGH WATER: Climate Risk in the Southeastern U.S. and Texas. A product of the Risky Business Project, 114p.

¹²American Climate Prospectus. 2014. Economic Risks in the United States, V.1.2. Prepared by Rhodium Group for the Risky Business Project, 206p.

¹³Risky Business. 2015. COME HEAT AND HIGH WATER: Climate Risk in the Southeastern U.S. and Texas. A product of the Risky Business Project, 114p.

¹⁴Risky Business. 2015. COME HEAT AND HIGH WATER: Climate Risk in the Southeastern U.S. and Texas. A product of the Risky Business Project, 114p.

catalyze businesses that thrive within it and continue to succeed together. In this paper, we introduce some risks and opportunities in some of the most important industries in southeast Florida: 1) property and real estate development, 2) trade and logistics, 3) healthcare, and 4) tourism and hospitality management and highlight areas of immediate research needs.

Southeast Florida Business Sectors and Projected Growth Areas

Encompassing Miami-Dade and Monroe Counties, the Workforce Development Area (WDA) 23 is the largest of the State of Florida's local workforce development boards and is one of the most dynamic areas in the nation in terms of its ethnic diversity as well as its vibrant financial, commerce, tourism, international trade, culture, media, arts and entertainment sectors¹⁵. With a population of over five million, Miami's metro area is the seventh most populous and fifth-largest urban area in the United States¹⁶.

In 2014, the Gross Regional Product in Miami-Dade County grew to \$137.8 billion. The leading industries in the region contributing to this growth included real estate, wholesale trade, retail trade and accommodations and food services. In 2015, total private employment grew nearly 3.6 percent, with the fastest growing sectors including construction, professional and business services, leisure and hospitality, education and health services, financial activities, and retail trade. The top three trade partners in 2014 were Brazil, Colombia, and China and other countries in the top 25 included Costa Rica, Singapore, and the United Arab Emirates. When comparing the total value of goods traded between 2013 and 2014, there was a 6.9 percent decline. Projected economic weakness in Europe, South America, and Central America, coupled with a slow-down in China, instability in the Middle East and Eurasia, and a stronger dollar is projected to suppress exports in the coming year¹⁷.

The Beacon Council (Miami Dade County's Economic Development Council), local businesses, education and civic leaders in collaboration with CareerSource South Florida (CSSF) have identified seven industries that will be the points of focus in the Council's efforts to diversify Miami-Dade's economy. Through the "One Community, One Goal" (OCOG) strategy, these targeted industries include: Aviation, Banking & Finance, Creative Design, Hospitality & Tourism, Information Technology, Life Sciences & Healthcare, and Trade & Logistics. An analysis of current and emerging industries in WDA 23 identifies six industries that project significant growth over the next seven years. These six industries are directly targeted under the OCOG strategy as a primary industry or as a first level sub-industry. The industries include 1) Trade, Transportation and Utilities, 2) Education and Health Services, 3) Professional, Scientific and Technical Services, 4) other significant industries (Figure 2).

Overall, Labor Market Information, Economic Development Reports for Miami-Dade and Monroe Counties and in house data analyses were used to project current and future employment needs of the seven targeted industries, subindustries and related occupations. In recent analyses, CSSF identified the top five sub-industries of the OCOG targeted industries with the fastest projected growth as well as the top five that will be gaining most new jobs. Those industries include: 1) Professional, Scientific, and Technical Services, 2) Local Government, 3) Food Services and Drinking Places, 4) Administrative and Support Services, and 5) Ambulatory Health. Collectively, the aforementioned industries represent over 57,000 new openings in multiple occupations. By analyzing these occupations and the required skills/educational requirements, CSSF projects future training requirements that will be needed to provide a ready workforce¹⁸. It is unknown to what extent these important job force growth projections consider the changing landscape of adaptation and mitigation that will be required to address increasing effects of stresses and shocks brought by climate change.

¹⁵Career Source South Florida. 2016. Local Plan Submitted under the Workforce Innovation and Opportunity Act, Local Workforce Development Area 23, Career Source South Florida.

¹⁶U.S. Census Bureau. 2015. <https://www.census.gov/>.

¹⁷Miami-Dade County. 2016. Miami Proposed 2016-2017 Budget and Multi-Year Capital Plan, Vol 1: Strategic Areas: Summaries and Five-Year Plan, Miami-Dade County, Florida.

¹⁸Career Source South Florida. 2016. Local Plan Submitted under the Workforce Innovation and Opportunity Act, Local Workforce Development Area 23, Career Source South Florida.

In Miami-Dade County, top ten member business organization types of the Greater Miami Chamber of Commerce (GMCC), in order of most member organizations per type, include non-profit organizations, attorney’s offices, banks, real estate firms, hotels, accounting firms, schools and academic institutions, engineering firms, insurance firms and construction firms. Of the total, the top five business organizations represent over 50% of the total member organizations of the GMCC. A key factor in addressing risks and opportunities in terms of local and broader economic productivity pertains to key sectors and sub-industries both now and projected into the future. The focus of this initial report is to identify risks and opportunities for four of those key growth sectors: 1) property and real estate development, 2) trade and logistics, 3) healthcare, and 4) tourism and hospitality management.

- **Trade, Transportation, and Utilities** projected growth of 7.9 percent with an estimated 27,664 new job openings, growing to an estimated 314,712 jobs in 2023
- **Education and Health Services** projected growth of 18.3 percent with an estimated 31,234 new jobs, growing to an estimated 201,569 jobs in 2023
- **Professional, Scientific, and Technical Services** projected growth is 16.1 percent with an estimated 11,892 new jobs, growing to an estimated 85,869 jobs in 2023
- **Other significant industries** included Leisure and Hospitality (9.7% increase to 161,033 jobs in 2023) and Financial Services (6.1% increase to 81,480 jobs in 2023).

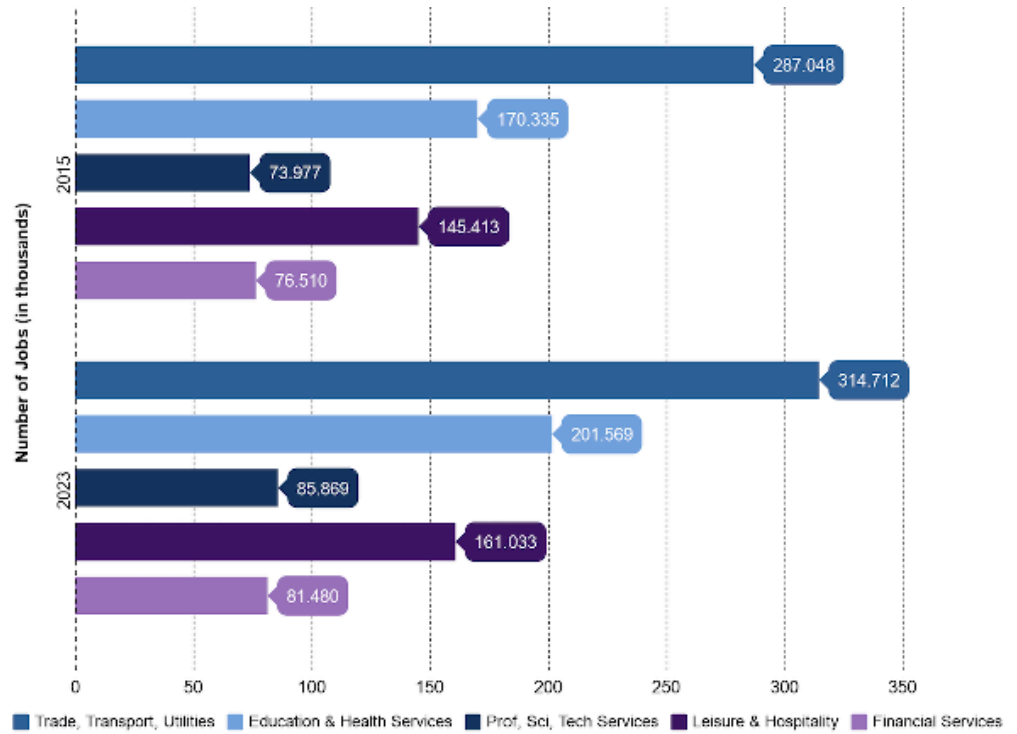


Figure 2. Projected Job Growth of Emerging Industries in WDA (2015-2023)

Rank	Business		Employment		2015-2023 % Change
	Sector	Type	2015	2023	
1	Property and Real Estate	Construction, Sale and Maintenance of Buildings	10,512	14,525	38%
2	Life Sciences and Healthcare	Nursing and Residential Care Facilities	16,933	21,047	24%
3	Life Sciences and Healthcare	Ambulatory Health Care Services	59,121	73,405	24%
4	Hospitality and Tourism	Museums, Historical Sites and Similar Institutions	1,536	1,900	24%
5	Trade and Logistics	Electronics and Appliance Stores	7,889	9,574	21%
6	Multiple	Educational Services	31,124	37,539	21%
7	Multiple	Waste Management and Remediation Services	1,931	2,317	20%
8	Multiple	Specialty Trade Contractors	24,961	29,926	20%
9	Multiple	Social Assistance	17,786	21,002	18%
10	Multiple	Management of Companies and Enterprises	10,177	12,009	18%

Table 1. Fastest growing Sub-industries 2015-2013 in WDA 23 (CareerSource South Florida 2016).

Guiding Framework

In the context of the most vital business productivity issues, this report addresses: 1) value-chain, 2) external stakeholder, and 3) social risks and opportunities (Figure 3) in some of the most important industries in southeast Florida: 1) property and real estate development, 2) trade and logistics, 3) healthcare and 4) tourism and hospitality management. Value chain risks and opportunities were areas of consideration including physical assets, products and services, and supply chain and logistics. For instance, damages due to flooding, resilience measures, tools and techniques, market growth and changes in demand for core products, disruptions in services and shortages in supplies. External stakeholder risks and opportunities were areas of consideration including regulations and ratings and reputations and changing standards. For instance, how governments have changed regulations to reduce emissions or how companies are developing internal climate change strategies, were among those considerations included. Social risks and opportunities were areas of consideration including business continuity, occupational and community considerations. For instance, emergency preparedness and response procedures, health and safety of business employees, access to utilities, facility design and work conditions, and health and safety of customers and clients fell within social risks and opportunities.

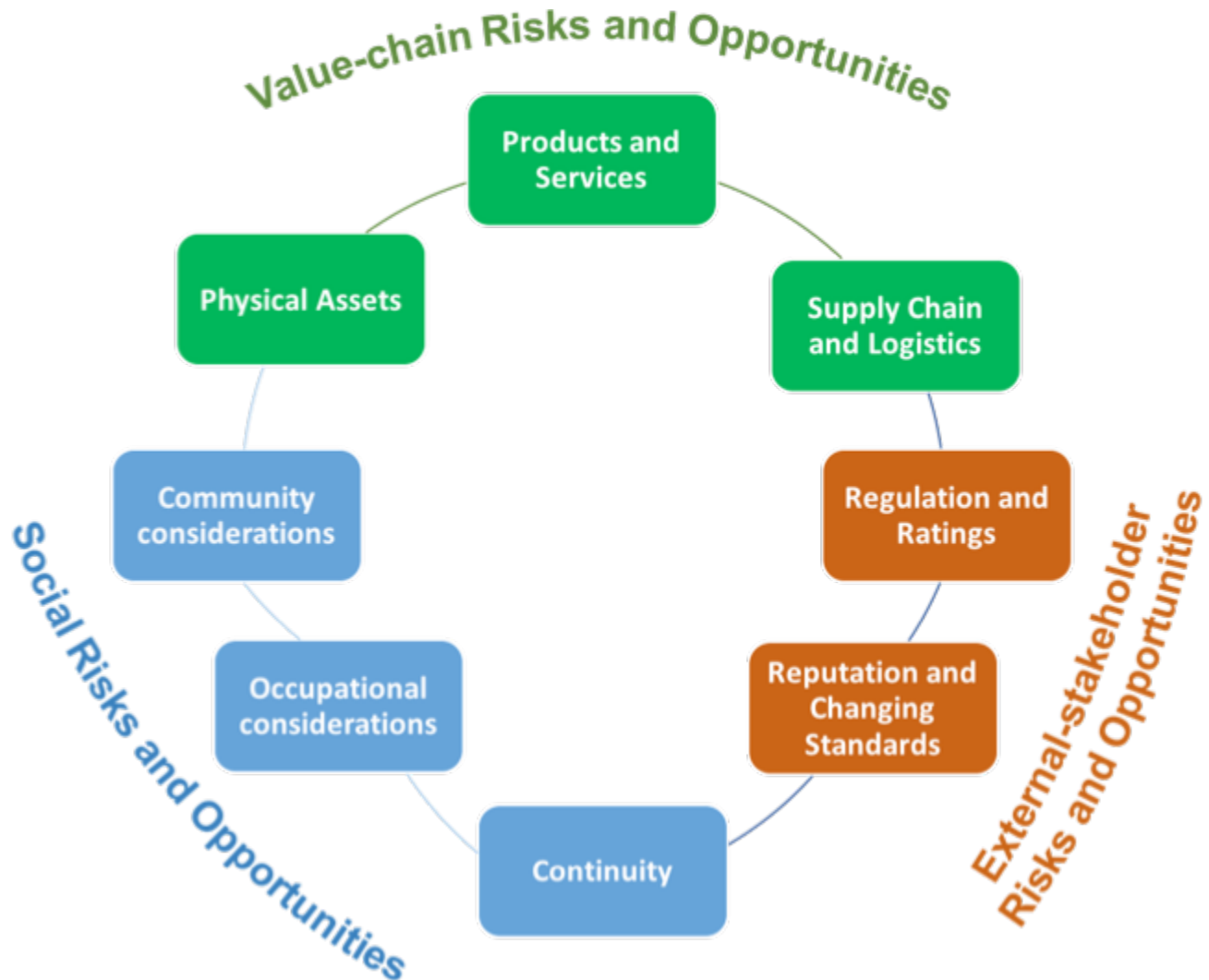


Figure 3. Guiding Framework to address business risks and opportunities in southeast Florida.

Property and Real Estate Development

Introduction

Property development, construction, renovation, sales, maintenance and related services are a major component of southeast Florida's economy, representing trillions of dollars in underlying asset value and employing hundreds of thousands of people. The property sector affects other business sectors, such as tourism, trade, education and finance. Property values are a major revenue source for local governments that support public investment and community services. Key property asset segments include physical and infrastructure, residential, commercial and industrial. Table 2 presents sector-specific risks and opportunities based on the guiding framework. These are further discussed below.

Sector-specific Risks and Opportunities

	Risks	Opportunities
Value Chain	<ul style="list-style-type: none"> • Shortage of developable land • Decline in new property investment • Decline in property values • Decline in property sales • High cost of construction • High cost to mitigate existing properties • Decline in public investment 	<ul style="list-style-type: none"> • Materials for land/building elevation and flood defenses • Engineering services • Construction services • Property information services • Adaptation/mitigation products for existing properties
External Stakeholder	<ul style="list-style-type: none"> • High cost of insurance • Decline in infrastructure functionality • Decline in local tourism (i.e. beach loss) • Decline in road-based transport activity 	<ul style="list-style-type: none"> • Water transport facilities • Floating structures technologies • Eco-tourism • Adaptable utility, power and water services • Drone transport services • Adaptation/mitigation maintenance services • Shared land transport services • Distressed property workout services
Social	<ul style="list-style-type: none"> • Decline in local government revenues • Decline in local government investment and services • Decline in local government debt rating and capacity • Increase in local taxes • Decline in local economic activity • Abandoned properties • Decline in quality of living • Decline in affordability • Population migration • Displacement of vulnerable and low-income populations 	<ul style="list-style-type: none"> • Return of land to nature • Reduced impact on Everglades to sustain recreational and water resources • Development on new skills • Sustainable transportation • Learning center for other cities • Doing more with less

Table 2. Property sector risks and opportunities

Discussion

Materials for land/building elevation and flood defenses. Flood mitigation solutions include flood defenses, water pumping and land elevation. Of these, land elevation is the most sustainable (low in maintenance and energy use), but requires large quantities of aggregate materials. Transporting aggregates by land over long distances is costly. Almost all of southeast Florida aggregates are currently produced at local quarries bordering the eastern Everglades (Lakebelt Area). The current capacity of Lakebelt aggregate production is about 40 million tons/year,

most of which is locally used in concrete and asphalt construction applications, as well as railed along Florida’s east coast. An estimated 10 million tons/year of capacity could be available for land elevation¹⁹. Ten million tons of aggregate material amount to approximately four filled Empire State Buildings.

Miami-Dade County with 34 municipalities covers an area of 2000 square miles (half of which is Everglades). More than 80% of the county’s developed land is estimated to be below 10 feet in elevation. Approximately 10 million tons of aggregates are needed in order to elevate one square mile of land by 9 feet. The cities of Miami and Miami Beach are 55 and 40 square miles, respectively. At present capacity it would take 50 years just to raise half of these two municipalities. Total capacity could be doubled to 80 million tons/year in 5-10 years. This would provide 50 million tons/year of land elevation material, allowing 100 square miles of land to be raised over 20 years. Aggregates cost alone would approximate \$20-30 billion²⁰. It would take **160 filled Empire State Buildings and 15 years to elevate the City of Miami Beach; 220 Empire State Buildings and 18 years to elevate the City of Miami; and 380 filled Empire State Buildings and 26 years to elevate both cities concurrently** (Figures 4 and 5).

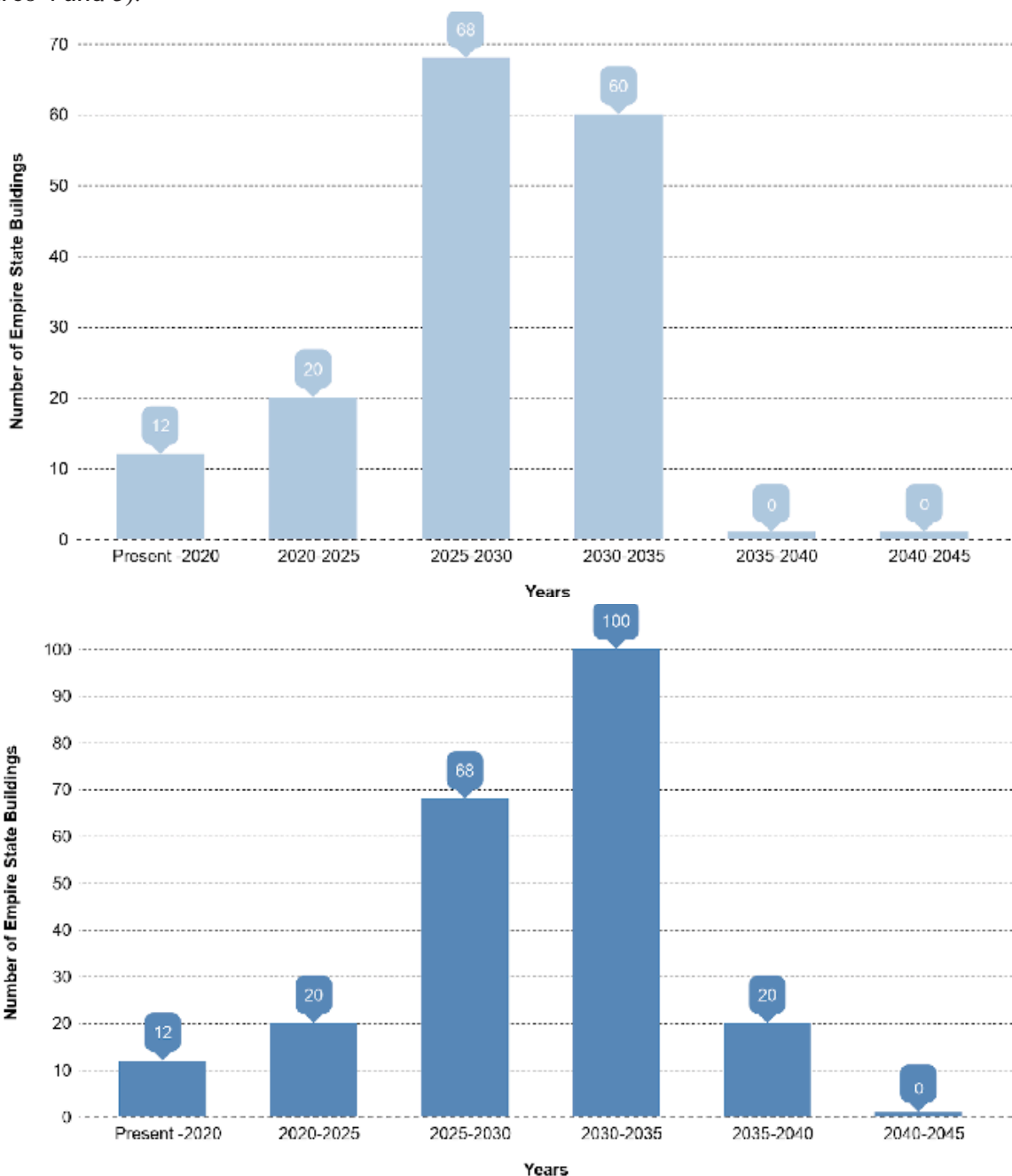


Figure 4. Number of Empire State Buildings/Year to Elevate City of Miami Beach (top) and City of Miami (bottom)

¹⁹Based on author’s industry experience

²⁰Based on author’s industry experience

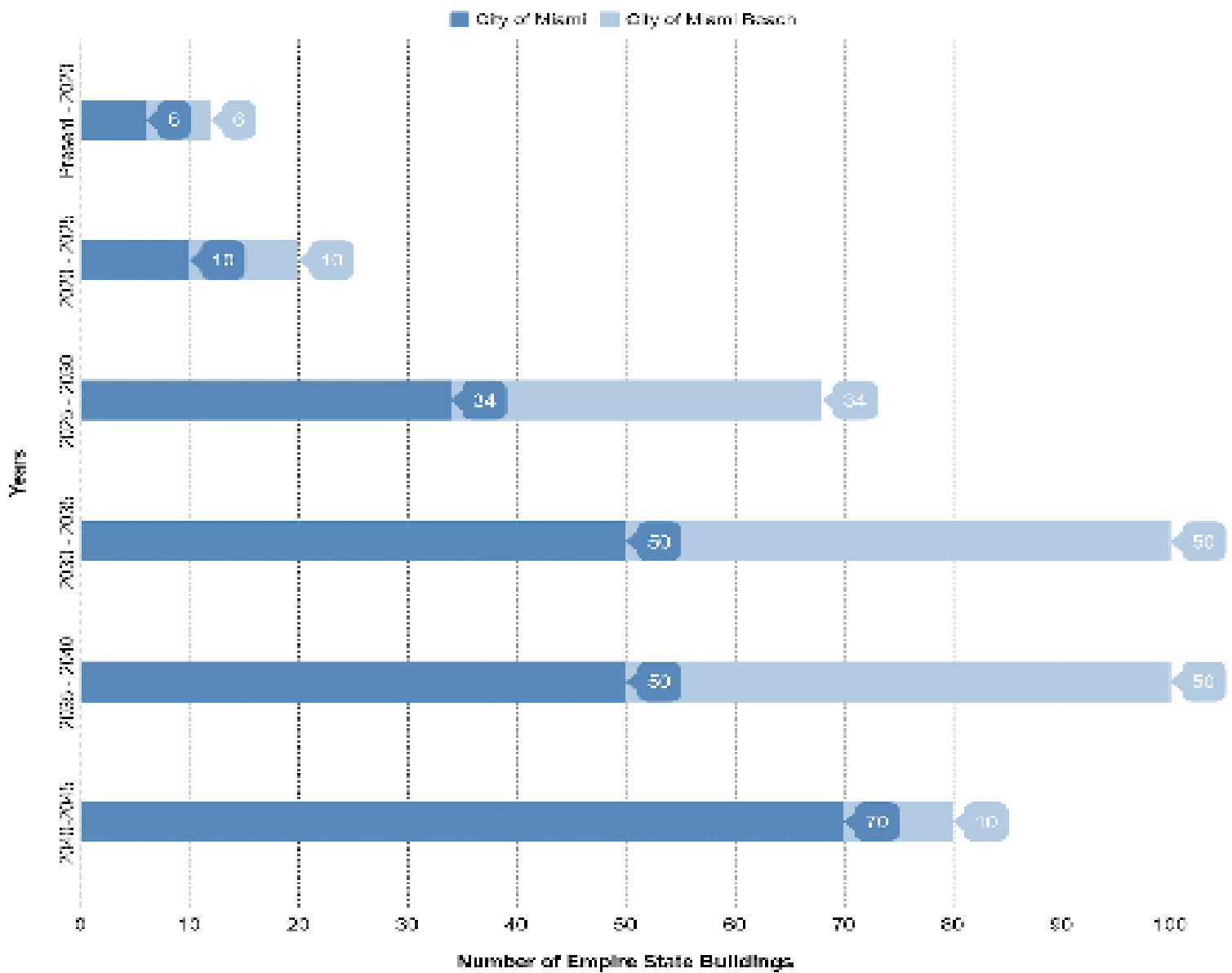


Figure 5. Number of Empire State Buildings/Year to Elevate Both City of Miami and City of Miami Beach Concurrently
 Note: These calculations use the current annual capacity for aggregate production until 2028 (40 million tons per year, where 10 million tons per year are available for land elevation), then the total capacity is doubled (80 million tons per year, where 50 millions tons are per year are available for land elevation).

Additional materials demand will be driven by building, road construction and infrastructure mitigation projects. This all creates opportunities for businesses in the materials quarrying, processing, transport and placement activities, as well as suppliers of related equipment and consumables. There will be opportunities as well for innovation, with the advancement of materials with reduced environmental footprints, such as pozzolan-based cements and permeable road pavements that allow uniform water drainage.

Adaptation & mitigation products for existing properties. Products that provide temporary flood defenses for properties, such as inflatable or moveable water barriers are already being marketed, in addition to water pumps and auxiliary equipment. However, raising land that has already been built on will be a challenge. Miami Beach recently invested \$400 million in projects that combine elevating flood-prone roads with water pumping. As a result, many building ground levels now lie below elevated street levels and increasingly depend on pumping defenses. These represent temporary solutions, as pumping will become more difficult and expensive over time.

Longer-term solutions involving general land elevation will require giving up the ground floor of most buildings. It means reconfiguring multistory buildings to make the 2nd floor the new ground floor. This will involve design

modifications and mechanical/electrical equipment relocations. Many of the one to two story structures that cannot economically be placed on stilts will likely be demolished and rebuilt to similar size on higher ground, or replaced with multistory buildings. The rest will be returned to nature. Elevating all small roads for vehicle use may not be economically justified. Instead elevated walk/bike paths may become the access to many properties from disbursed vehicle parking nodes. With fewer roads and limited parking, the private car may become impractical in favor of greater (and more sustainable) shared mobility.

For Miami Beach and the barrier islands private cars may be discontinued totally. As roads are abandoned, they will be replaced by water transport (like in Venice, Italy). A limited number of elevated arterial mass transport/logistics/bike roads may be built. Smaller elevated access walk/supply-cart/bike pathways may branch off from these. Such elevated access may be required as part of future building projects, rather than provided by the city. Opportunities exist for companies that can offer products, solutions and services for such adaptation projects. There may also be opportunities for amphibious vehicles.

Adaptation engineering. Short and long-term adaptation solutions will require engineering services to plan, design and construct. Specialized skills and local experience will need to be developed by these providers. Such firms will need to work with local government to develop and adopt new standards and help manage compliance.

Adaptation construction. Contractors of various sizes and skills will be needed to execute the multitude of public and private mitigation projects over many decades. Specialized equipment, skills and local experience will become a factor for firms that successfully capture this opportunity. Many of these will operate in amphibious environments.

Property risk information and community support. SLR creates buyer, seller, occupant and policymaker/implementer uncertainty that will increase the demand for reliable risk information. To some extent this will become publicly available. However property-specific assessments of near and medium-term flood vulnerability will be sold commercially. Buyers or tenants wishing to compare the relative risk of candidate properties will use it. Also lenders, appraisers and insurers will require greater diligence and disclosure.

Future regulations are expected to require greater flood risk disclosure by real estate agents, which will affect property values. In a 2016 survey of real estate agents sponsored by the Miami Herald, 65% expressed concern regarding the potential impact of SLR on the local real estate market, up from 44% the prior year²¹. In addition, companies that specialize in public and community adaptation education/support will be helping local governments and engineer/contractor implementers to better communicate with and aid affected citizens and local businesses. In many cases, temporary relocation will be required while projects are underway. Already early-mover companies have begun offering information products and support services for these emerging needs.

Lack of master plan and risk of incremental bandaging. Because drastic change is difficult, costly and often painful, the typical reaction is denial, 'wait-and-see' and/or 'lets not scare everyone (yet)'. While this may appear prudent to many, the lack or delay of a master plan concept increases future risk and cost. A series of incremental temporary 'bandage' solutions, while buying time, may eventually be more expensive and resource inefficient compared to following a master plan (even if the latter is evolutionary). It can also make future adaptation efforts more difficult and expensive, as temporary solutions often have to be removed before implementing longer-term

²¹www.miamiherald.com/latest-news/article81966692.ece/binary/Read%20the%20full%20real%20estate%20study

ones (for example, dismantling or reconfiguring underground pumping networks before raising the level of a neighborhood).

Addressing abandoned properties. Future storm events may cause some owners to abandon their unmarketable and value-depressed property, particularly low-rise residential or commercial buildings. Many will discontinue mortgage, tax and insurance payments. Lenders or local governments will eventually foreclose on these properties. Some may be resold and rebuilt to new standards, while others will simply be returned to nature. The process could take many years. Abandoned properties in a semi-marine environment create public safety and environmental issues, as well as degrade the remaining community. Local governments will likely regulate that such properties be demolished within a certain time. If owners/lenders fail to act, local government may proceed to demolish and add the cost to the property lien.

Financing public adaptation projects. The cost of both temporary and longer-term public adaptation projects will vary depending on the elevation of particular areas and distance from water. These represent new and unprecedented multibillion-dollar costs for municipalities, which could undermine their ability to fund other community projects and services. It may occur at a time when property values are already in decline, adding further pressure to their finances. So far, municipalities have in a limited way approached this as a general funding matter, financed through higher taxes/fees across all property owners (independent of location) and/or via general debt issuance. However, as such costs escalate into the billions, it is possible that communities at higher elevations will question why they are subsidizing the adaptation of those at lower elevations.

An alternative could be a ‘special adaptation assessment’ based on property elevation. However, this will more rapidly depress market values of lower elevation communities (including some of today’s wealthier ones, something that may be inevitable). The financing of public adaptation projects could become a topic of considerable social friction as costs enlarge.

In the end municipalities may realize they cannot save (i.e. adapt) all low-lying areas and must focus limited resources on a reduced future footprint. To do otherwise might force them into bankruptcy, which would risk satisfying other deferred obligations, such as unfunded city employee pensions. Another option may be privately funded initiatives that take over ‘sunken areas’ and redevelop them into newly elevated private communities (like the many man-made island-like communities in Dubai).

Finally, a big question is to what extent state and federal monies will be available for such projects. Obviously state and federal revenue benefits by sustaining local economic activity and should therefore justify some support. However much of this may be spent on state and federal facilities (prisons, courthouses, state/federal offices etc).

Financing private adaptation projects. How will owners finance the adaptation of their specific properties? Today an estimated \$350 billion of private home improvements and renovations (mostly cosmetic) are financed annually in the US²². Perhaps in southeast Florida, the future focus of this will become increasing SLR adaptation.

The market value difference between a SLR adapted property and a non-adapted one is expected to grow with time, from an almost indistinguishable difference today²³. Greater awareness, education and information transparency will contribute to this. Studies are already showing that hazard fortification of homes can lead to greater market value. Preserving and enhancing the value of properties should act as an incentive for owners and lenders

²²www.marketwatch.com/story/the-master-bathroom-is-the-new-master-bedroom-2016-07-07

²³<http://aciir.culverhouse.ua.edu/fortifiedstudy/>

to invest in adaptation.

How to incentivize early action. In addition to property regulation, public policymakers will be challenged to develop incentives for private action. Such incentives at the municipal level may include tax incentives (property tax holiday for early movers) and permit incentives (height/size variances for adaptation projects).

Availability of labor. The property sector depends on skilled white- and blue-collar labor. There should be concern that changes in the housing landscape will cause such labor to move further away from southeast Florida. Companies in the sector will be burdened with higher costs to bring in and provide temporary facilities for labor. Some of these accommodations may be floating.

Priority Next Steps

A key research area for property and real estate development is return on investment of resilient adaptation following available case studies, including planning and zoning, retrofits and redevelopment. Further innovative finance mechanisms that reduce the overall financial burden for safeguarding infrastructure as well as deep understanding of low-hanging fruit policy initiatives that can be leveraged to this end are also key areas of research focused at Miami-Dade County and southeast Florida regional level.

Trade and Logistics

Introduction

History. Arguably, few other industries are as old and have been exposed to as many risks as trade and logistics. Findlay²⁴ asserts “that there is abundant evidence of trade in bulk commodities even before the invention of coinage,” and also that since its inception, the industry has been exposed to various sources of risk. Including risk of natural disasters and risk of attacks from hostile parties, both of which lead to losing shipments, compounded by the risk of not being paid in case shipments arrived safely. This means that traders have had more than 30 centuries to find ways to identify and mitigate sources of risk. For example, at the onset of international sea trade, natural disaster risks were reduced by not sailing during winter and/or by staying close to shore²⁵.

In essence, trade and logistics has presented unique challenges to those involved in the industry for a long time. This, in turn has allowed traders to develop, calibrate and curate Standard Operating Procedures (SOPs) and contingency plans that can contend with almost any disruption that they may encounter. Furthermore, the nature of trade and logistics has embedded in those involved the ability to constantly identify and map, as well as devise ways of mitigating, potential sources of risk. In fact, trade and logistics operations are managed based on exceptions to the rule. That is, those involved know that there are so many things that can go wrong in the process, that something will eventually go wrong. And since, sooner or later, something does go wrong, they focus on managing exceptions (or disruptions to the process). This means, value is added to the end customer by effectively and efficiently resolving these disruptions, and offering a resilient process that rapidly recuperates from any disruptions^{26,27}. It is key to recognize that potential disruptions may be encountered at any point in the process, which means that the overall probability of a disruption taking place in Miami is the same as that of encountering one in Los Angeles, or Panama or Hong Kong. Thus, SOPs and contractual agreements in trade and logistics are designed to contend with the possibility of having to bypass (or freezing operations at) any point in the process, this ability is what makes the process adaptive and resilient.

Products and Players. According to IBISWorld Industry Report on Freight Forwarding, Brokerages & Agencies²⁸ in the US, most of the revenues obtained by this industry are associated to domestic freight transportation services (52.2%, see Figure 6), followed by international freight forwarding and customs brokerage services, which account for 35.5% of revenues in 2017. Southeast Florida’s segmentation is likely to have a higher focus on international freight forwarding and customs brokerage services given its “Gateway to the Americas” designation and prominence as a Latin American hub.

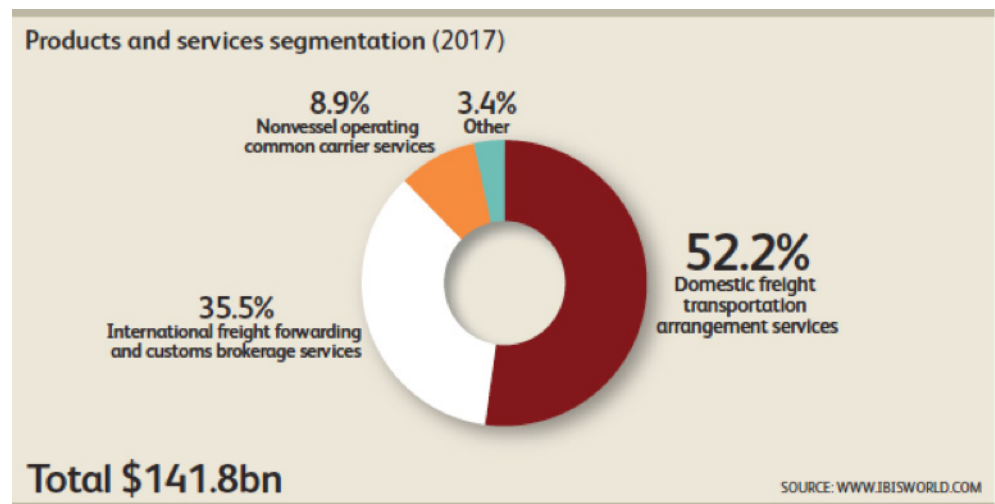


Figure 6.

²⁴Findlay, R. 2006. *Eli Heckscher, International Trade, and Economic History*. MIT Press.

²⁵Duncan-Jones, R. 2002. *Structure and Scale in the Roman Economy*. Cambridge University Press.

²⁶Birke, S. E., Trucco, P., and Fernandez Campos, P. 2017. “Effectiveness of Resilience Capabilities in Mitigating Disruptions: Leveraging on Supply Chain Structural Complexity,” *Supply Chain Management: An International Journal*.

²⁷Chowdhury, M., Hossain, M., Dewan, M. N. A., and Quaddus, M. 2013. “Supply Chain Readiness, Response and Recovery for Supply Chain Resilience to Vulnerabilities: A Study on Ready-Made Garment Industry of Bangladesh,” *The 3rd International Forum and Conference on Logistics and Supply Chain Management (LSCM) 2013*: Institute for Research and Community Service, Petra Christian University.

²⁸In this report we assume that “Trade and Logistics” industry refers to the work of Freight Forwarders and Brokers, which is largely the case in southeast Florida.

Freight forwarders advise clients on the best rates, routes and modes of transportation to or from any area in the world. Forwarders match services to clients, ensuring that products are moved in the most timely and cost-effective way. While, customs brokers advise importers in determining proper classifications and calculating the value of goods being transported. Additionally, importers require information surrounding international quota and tariff regulations. Brokers' operations often go beyond dealing with customs as they must also contact other government agencies, for example: the US Department of Agriculture (USDA) about meat importation; the US Environmental Protection Agency (EPA) on vehicle emission standards; or the US Food and Drug Administration (FDA) on product safety. The development of online application and processing systems has created competition for customs brokerage services in recent years as larger clients have been able to bring customs processing in-house or to outsource it to smaller actors for lower commissions, in effect disintermediating traditional industry players.

Business locations. Out of the approximately 80,000 establishments that belong to this industry in the US, 25.1% are in the southeast region (the largest share of industry establishments nationwide), which also houses many major US ports (including ports in Alabama, Florida and Louisiana). And Florida accounts for 10.1% of establishments nationwide (the largest share of industry establishments in the southeast region, see Figure 7).

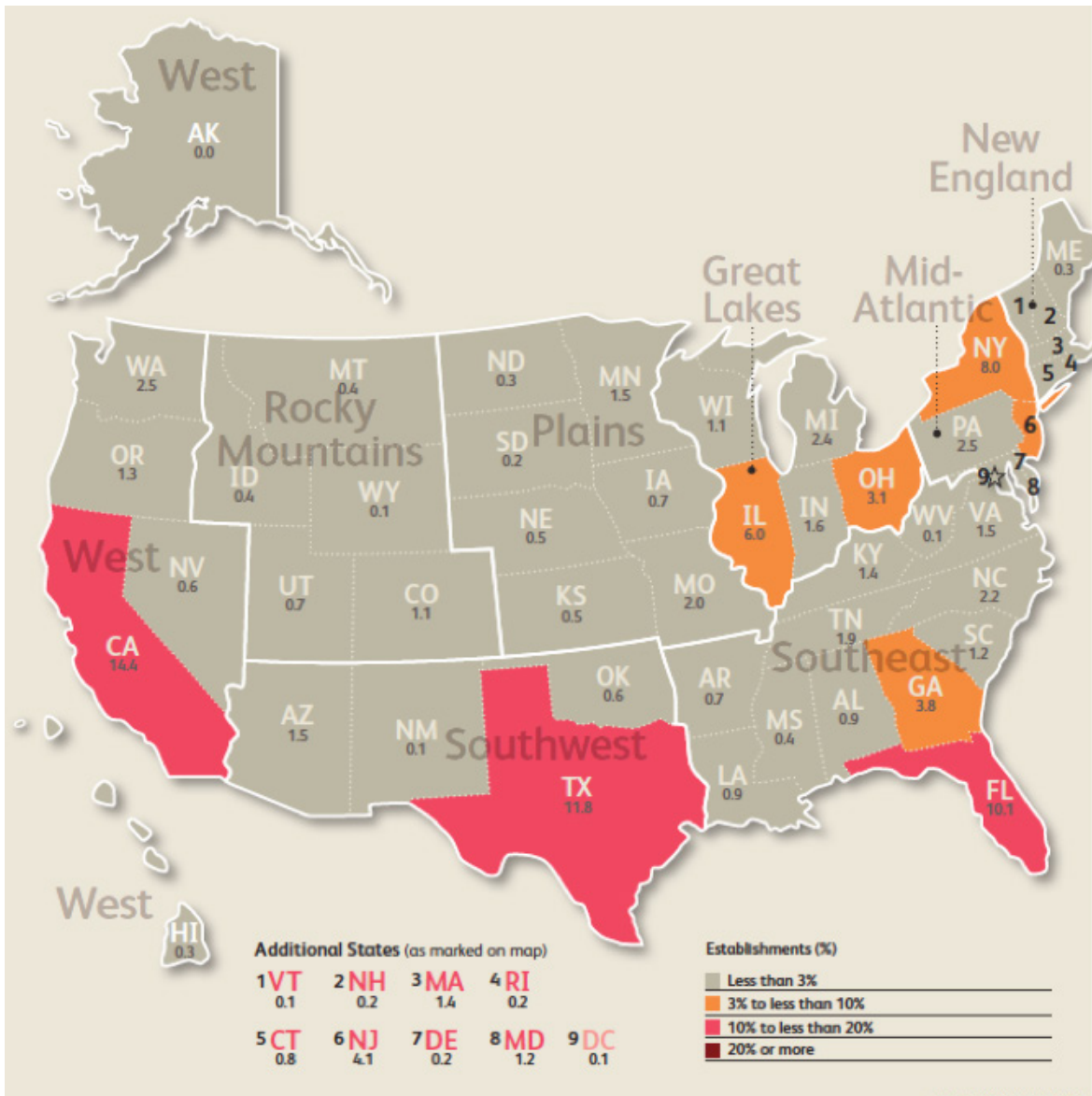


Figure 7.

Sector-specific Risks and Opportunities

Given the industry's inherent characteristics (namely: focus on identifying risks that may lead to disruptions at any point of the process, managing processes based on exceptions, and enhancing process resiliency) and its evolution, large, medium and even very small (one-person) IFFCB firms have moderate exposure to Value Chain Risks (alluding to Physical Assets, Products and Services, and Supply Chain and Logistics). Similarly, Social Risks (alluding to Business Continuity, Occupational and Community Considerations) have been mitigated by allowing employees to work remotely. Finally, in terms External Stakeholder Risks, reputational and regulatory risks are managed through industry dispersion (more than 8000 establishments of all sizes in Florida), along with the continuous need to proactively seek and understand new regulations as well as their business implications (not just in the US but abroad as well). Detailed analysis provided in Table 3 below.

	Risks	Opportunities
Value Chain	<ul style="list-style-type: none"> • Inability to recuperate the flow of basic resources (electricity, gasoline, etc.) • Slow process recovery speed 	<ul style="list-style-type: none"> • Consultancy to help develop and execute contingency plans as well as process resiliency strategies • Consultancy to help increase process recovery speed
External Stakeholder	<ul style="list-style-type: none"> • Compliance issue • Online/cloud data poses a high security threat • Lack of regulator awareness 	<ul style="list-style-type: none"> • Auditing processes • Enhance current and future cybersecurity procedures to avoid risks • Enhance early engagement and commitment (lobbying)
Social	<ul style="list-style-type: none"> • Footprint reduction needs • Conflicts and terrorism • Saturation points • Price gauging for scarce resources 	<ul style="list-style-type: none"> • Increased interest in environment and renewable energy • Security and insurance • Integral development planning • Fines

Table 3. Trade and logistics sector risks and opportunities

Discussion

Contemporary Advances in International Freight Forwarding and Customs Brokerage (IFFCB) Services.

One of the main characteristics of firms offering international freight forwarding and customs brokerage (IFFCB) services, in general, is that business operations and day-to-day activities do not require them to be in close proximity to their clients. But, it does require them to be available at any time, given time differences with clients based in other continents, who wish to inquire about the status of their merchandise/shipments. Since the mid 1990's, and thanks to the arrival of cell phones and the internet, IFFCB firms started developing risk mitigation and business continuity plans that did not require their employees to work from an office, especially given the fact that employees were already required to be available 24/7. Moreover, after Hurricane Andrew, many IFFCB firms based in southeast Florida decided to no longer keep any information or material required for business operations in their offices. Thus, servers, important files, phone lists, contacts, etc. were digitalized and placed in different locations from which they could be accessed remotely by any employee at any time.

Advances in Technology and Regulation. The above situation has been exacerbated with the onset of cloud computing and especially since US Customs and Border Protection launched Automated Manifest System (AMS) to facilitate cargo arrival information and release information between the Steam Ship Lines, Airlines and Rail Car-

riers for shipments destined to or transiting the United States. AMS information works in conjunction with ABI²⁹ to help customs to identify low risk shipments and to allow for faster, electronic customs clearance.

This has allowed many IFFCB firms based in southeast Florida to migrate their systems to the cloud and to leverage the use of mobile applications so that employees can complete all business procedures using their smart phones. In addition, as mentioned above, new smaller actors have emerged that use and take advantage of platforms that consolidate and continuously update customs rules and procedures for more than 80 countries. These platforms also allow small actors to offer customs brokerage services while paying for “one-off” customs clearing transactions, instead of having to develop costly permanent connections in key markets and/or having to keep abreast with all relevant regulatory changes (greatly reducing associated transaction costs).

In sum, IFFCB firms based in southeast Florida have aligned, and continue to align, their business operations with the latest regulatory and technological advances. Mobile applications are becoming must-have tools for operations, logistics, and supply chain professionals as they help them collaborate in real-time with internal and external stakeholders, which in turn has made them essential tools for offering better after-sales services to clients (enhancing responsiveness and accountability) and for creating competitive advantages (reducing delivery times and transaction costs). These mobile applications help companies track inventory, shipments, execute procurement and customs transactions, etc. (Box 2 illustrates some of the most prominent apps used by IFFCB firms).

Box 2. Some of the main applications used by IFFCB firms:

Logistics – Logistics Management, Logistics is a completely free app designed for Android devices that track drivers, vehicles, shipments, and clients in this all-in-one app among the supply chain mobile applications. TomTom WEBFLEET – Telematics Solution, TomTom has developed an app called WEBFLEET, which tracks day-to-day operations for an ever-mobile workforce. Scandit – Advanced Barcode Scanning, it is a supply chain mobile application that extends barcode scanning to the tech savvy inventory manager on the go. EazyStock – Inventory Optimization Software, it is a based inventory optimization tool that systematically reduces excess and obsolete stock levels from the warehouses to reduce costs while increasing the availability of turning more profitable items. Evernote – Online File & Document Storage, this app is one of the best tools for organizing important files, images and documents and is, therefore, a popular app among the supply chain mobile applications. CoPilot Truck– Map & Direction Routing, CoPilot is easy to use app that offers vital turn-by-turn navigation. ServiceMax – Field Service Management the app seamlessly integrates field service contracts, order management, workforce optimization, parts management, social media customer monitoring, customer communities and analytics into a company’s salesforce.com system.

Advances in Insurance Products. The industry has developed a range of sophisticated insurance products that have also helped trigger the institutionalization of risk mitigation and process resiliency strategies in firms of all sizes. For example, “shipping” insurance might include freight forwarder’s liability, customs brokerage and/or warehousing liability, and deal with segmented concerns within a particular shipping route as clients’ request. In addition, there are various types of shipping insurance but one of the most common is a “marine floater” or marine cargo coverage. Despite its reference to sea-going vessels, this usually covers a shipment in all modes of transport from door to door. Furthermore, marine cargo coverage policies not only provide coverage for cargo (or the goods being transported) against damages and perils while being shipped, but also for hull insurance, which covers the personal property of the transporter by covering the damages faced by the vehicle transporting the cargo, significantly reducing the risks of freight forwarders that own fleets. Policyholders have the option to choose the type of policy required, and even the ability to ensure specific routes, trips or voyages, or those undertaken in one full year. Marine cargo insurance (also known as shipping insurance or freight insurance) also

²⁹Automated Brokerage Interface (ABI) - A system available to U.S. Customs Brokers with customs certification to transmit and exchange customs entries and other information via computer to facilitate the prompt release of imported cargo

covers the loss, damage, or theft of commodities while in transit³⁰.

There is All-Risk Cargo Insurance Policies that cover any physical loss/damage from any external cause. An all-risk policy will list any exclusion not covered, but coverage for those exclusions can be added on to the policy as an additional clause. The Perils Cargo Insurance Policy lists what is covered under the policy with anything not directly listed left uncovered by the customer's own policy. These policies do not cover cargo theft. The primary type of named perils policy is Free of Particular Average (FPA), which covers stranding, sinking, burning, collision, fire, lightning, crash. Customers may also insure goods shipment-by-shipment, which do not usually cover: Acts of God - e.g. heavy weather, earthquake, lightning, etc., acts of war - acts of strikes, riots or civil commotions, latent defects in the hull or machinery, criminal acts or negligence by the master or crew including unseaworthiness of the vessel.

Finally, insurance coverage carried by a warehouse operator is one of the most commonly misunderstood elements of the relationship between the warehouse operator and the customer. If the warehouse operator is negligent in the care of the customer's goods, the insurance carrier directly pays the customer for the loss incurred. Warehouse legal liability insurance is a third-party coverage. It is also important to note that virtually every warehouse legal liability policy excludes liability for loss or damage in instances where the warehouse operator has agreed to take on a higher degree of responsibility for the customer's goods beyond what is legally required (i.e., "reasonable care"). This exclusion is necessary because warehouse legal liability policies are underwritten by insurance carriers on the basis of insuring the risks associated with the warehouse operator's negligence. All these insurance products, developed thanks to the fact that trade and logistics operations are managed based on exceptions, act to expand the flexibility, adaptability and resiliency of IFFCB firms of all sizes³¹.

Additional Advances. Advances in weather forecasting technologies, along with new contracting and collaboration arrangements, have allowed IFFCB firms of all sizes to develop contingency plans in association with IFFCBs based in other locations in Florida (for example in Tampa, Panama City, Pensacola, Jacksonville, etc.) or in South-eastern US (Mobile, AL; Savannah, GA; etc.). These contingency plans contemplate everything from adjusting routes and warehousing, to completing required added-value tasks (such as re-packaging merchandise, etc.) so that jobs can always be completed in a seamless manner to the end customer. Once again, this is accomplished thanks to an inherent ability to recognize that disruptions can occur at any point in the process, along with a disciplined focus on managing based on exceptions and enhancing process resiliency.

Priority Next Steps

There are at least two high impact and high uncertainty areas that should be analyzed and assessed in further detail. The first alludes to connectivity, or trade and logistics businesses' ability to communicate and exchange information/data in order to appropriately monitor the goods they have been charged with moving and thus be able to provide an appropriate service level to end customers. In essence, given the important influence that Information and Communication Technologies (ICTs) have had on this industry's evolution, the level of exposure the industry has to limited connectivity scenarios is significant. Back up connectivity plans need to be developed and maintained based on the estimated level of exposure each business has. Exposure should be estimate using the likelihood of a limited connectivity scenario and the impact it would have on business operations and profits.

The second area related to the impact on service level and costs associated to executing contingency plans for diverted Last Mile Deliveries (LMDs). Freight forwarders having to divert or re-route LMDs because of sea level rise disruptions will need to put in place (as part of their SOPs), and execute, contingency plans. Execution costs and negative impacts on service levels of diverted LMDs should be analyzed and assessed.

³⁰Zhen, X., Li, Y., Cai, G. G., and Shi, D. 2016. "Transportation Disruption Risk Management: Business Interruption Insurance and Backup Transportation," *Transportation Research Part E: Logistics and Transportation Review* (90), pp. 51-68.

³¹Lodree Jr, E. J., and Taskin, S. 2008. "An Insurance Risk Management Framework for Disaster Relief and Supply Chain Disruption Inventory Planning," *Journal of the Operational Research Society* (59:5), pp. 674-684.

Healthcare

Introduction

Florida is home to the nation's second largest medical device manufacturing industry, third largest pharmaceuticals manufacturing industry, and seventh largest biotech R&D industry³². Miami houses the second largest health district in the U.S. after Houston, with three universities, eight hospital facilities with 30,355 beds, and nearly a dozen medical research institutes³³.

In Broward and Palm Beach counties, medical device firms and life science research thrives, facilitated by the opening of Scripps Research Institute in 2004 and the fast growth of Mako. In Miami-Dade and Broward counties alone, there are nearly 1,000 life sciences companies, and not including health-tech companies³⁴.

Sector-specific Risks and Opportunities

	Risks	Opportunities
Value Chain	<ul style="list-style-type: none"> • Damages to physical assets due to extreme weather events • Disruptions and/or shortages in delivery of products and services 	<ul style="list-style-type: none"> • Building strategically to manage flooding and storm damage • Focusing on market growth areas • New pharmaceutical and patient care offerings • Helping customers/patients prevent or mitigate risks
External Stakeholder	<ul style="list-style-type: none"> • Changing rules and regulations around carbon emissions can add costs or impede specific business activities • Poor reputation on climate can hurt revenue through boycotts or local community protests 	<ul style="list-style-type: none"> • Implementing fuel and energy efficient initiatives, and capturing and recycling anesthetic gases resulting in cost savings • Understanding and collaborating with stakeholders for government support and incentives
Social	<ul style="list-style-type: none"> • Damages to human assets due to extreme weather events and lack of preparedness 	<ul style="list-style-type: none"> • Investing in telehealth and telecare to reduce patient travel and improve quality of care • Developing systems to act upon extreme weather advisories and warnings to reduce health risks

Table 4. Health sector risks and opportunities

Discussion

Physical Risks to Assets. In the Health sector value chain, risks to physical assets can be mitigated through adaptation and resilience tools such as building strategically to manage flooding and storm damage. Some examples include, making first floor elevation well above FEMA 500-year flood elevation³⁵, placing all critical infrastructure and patient care functions above the first floor, locating all mechanical and electrical infrastructure (incoming electrical service switchgear and panels, as well as emergency generators) on the roof, minimizing the chance that a flood will disrupt service, and using a gas-fired, on-site combined heat and power (CHP) system that can provide energy-efficiency benefits as well as additional power generation in the event that the grid loses power or

³²<https://www.enterpriseflorida.com/thefutureishere/life-sciences/>

³³<http://www.id8nation.com/life-sciences-expanding-quickly-in-south-florida/#sthash.OMaQCvUu.dpbs>

³⁴<http://www.id8nation.com/life-sciences-expanding-quickly-in-south-florida/#sthash.OMaQCvUu.dpbs>

³⁵<https://toolkit.climate.gov/case-studies/investment-infrastructure-sea-level-hospital-will-pay-reducing-risk>

other backup-generators experience problems³⁶. Installations within health care facilities are among the leading examples of the potential of CHP technology. The United States Department of Energy estimates that the 47.5 MW system installed within Boston's Longwood Medical Area reduced total fuel consumption by 24% and reduced annual CO₂ emissions by 177,500 tons. Gundersen Health System implemented a CHP system fueled by landfill gas which serves the full heating demand of its Onalaska Campus, while also off-setting 7% of Gundersen's total electricity demand and effectively redirecting the emissions from the landfill³⁷. Green roofs also help to reduce storm water discharge during heavy rainfalls³⁸.

Products and Services. In products and services, organizations should consider market growth areas associated with sea level rise that can become accessible to businesses via new and innovative offerings. For example, worsening extreme weather, rising temperatures, and changing precipitation patterns could increase the spread of tropical diseases that are spread by mosquitoes, such as malaria and dengue fever. The pharmaceutical company, Bayer, cites that climate change could result in 40 million to 60 million additional people being exposed to these diseases. A potential growth area for this company may result from increased demand for its mosquito-control products³⁹. GlaxoSmithKline (GSK) also anticipates that climate change could affect demand for its anti-malarial products and notes that if the company's sales rose by 1%, about \$446 million, would be added to their revenue. Additionally, GSK warns that changing precipitation patterns and increased storms could contribute to the spread of water-borne diseases and respiratory and diarrheal illnesses, creating a need for "greater disease prevention and more patient treatments"⁴⁰.

Merck is researching the negative impacts that higher temperatures could have on vaccines so they can be proactive in avoiding potential losses of vaccines or impacts on their efficacy⁴¹. The increasing tendency for extreme storms creates health risks including cholera outbreaks, which can be caused when hurricanes or floods mix wastewater with potable water sources. Healthcare providers and pharmaceutical companies can be proactive in developing and obtaining medicines needed for such illnesses⁴².

Opportunities also lie in helping customers and patients prevent or mitigate risks. In the future, coastal communities may experience increased exposure to algal toxins in aerosols. In Florida, toxic algal blooms release aerosolized brevetoxins into the atmosphere, exacerbating asthma and other existing respiratory diseases in susceptible individuals⁴³. Pharmaceutical treatment of these conditions could serve as a business opportunity. Patient rooms could have key-operable windows, which can reduce the impact of indoor overheating and allow patients to shelter-in-place if the building's cooling or ventilation system is inoperable during an extreme weather event.

Disruptions and Shortages. In supply chain and logistics, disruptions and/or shortages in delivery of products and services can act as risks associated with extreme weather events and sea level rise. However, organizations can secure access to critical back-up supplies and resources (medical equipment, treatment, supplies, required experts, alternative energy supplies) and ensure that coordination and communication mechanisms are in place with external agencies and stakeholders as well as optimize transport carriers and diversify suppliers.

Regulations and Ratings. Risks related to external stakeholders in terms of regulations and ratings concern

³⁶<https://toolkit.climate.gov/case-studies/investment-infrastructure-sea-level-hospital-will-pay-reducing-risk>

³⁷https://noharm-uscanada.org/sites/default/files/documents-files/2704/Health%20Care%20Climate%20Change%20-%20Opportunity%20Transformative%20Leadership_0.pdf

³⁸<https://toolkit.climate.gov/case-studies/retrofitting-childrens-hospital-hurricane-resistant-shell>

³⁹<http://www.motherjones.com/environment/2015/12/climate-change-business-opportunities/>

⁴⁰<http://www.motherjones.com/environment/2015/12/climate-change-business-opportunities/>

⁴¹<http://www.motherjones.com/environment/2015/12/climate-change-business-opportunities/>

⁴²<http://www.motherjones.com/environment/2015/12/climate-change-business-opportunities/>

⁴³<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3756629/> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3756629/>

government agencies that have signed pledges to reduce emissions, and may enact policies such as carbon taxes which can have an immediate impact on cash flow. To reduce these potential risks, organizations can plan for the possibility of higher costs of capital because of climate related exposure such as carbon pricing, supply-chain disruption, or product obsolescence. Changing rules and regulations that can add costs or impede specific business activities, subsidies in support of a competitor, or withdrawal of subsidies. Organizations can also benefit in cost savings by implementing fuel and energy efficient initiatives that reduce carbon emissions. Specifically, most anesthetic gases—including N₂O and halogenated inhalation gases— used in hospital operating rooms escape to the atmosphere during use. Capturing and recycling these gases reduces these emissions and results in cost savings. One study estimates that if U.S. hospitals adopt three types of sustainability interventions (energy use reduction, waste reduction, more efficient purchase of supplies), the five-year national savings of the hospitals' sustainability interventions could be more than \$5.4 billion⁴⁴.

Case study: Pitt County Memorial Hospital in North Carolina was the first hospital in the United States to install an on-site biodiesel fueling station. The 35 diesel vehicles in the hospital's fleet—including ambulances, buses, and service trucks—now run on B20 fuel (a blended fuel containing 20% biodiesel). Such initiatives can work in reducing both greenhouse gas emissions and other harmful pollutants, since biodiesel exhaust is non-toxic and non-carcinogenic⁴⁵.

Case study (see Figure 8): Oregon Health & Science University (OHSU) in Portland installed solar electric panels and a solar thermal water heating system as part of the LEED Platinum design for its Health and Healing Center. The panels will have an annual output of 66,000 kWh. The Center projects \$660,000 per year in electricity savings and a 12% reduction in CO₂ emissions⁴⁶. They received over \$1.5 million in government incentives and tax credits for their energy efficient initiatives. If the OHSU building achieves the expected LEED Platinum certification and qualifies for all available tax benefits and incentives, the net savings of the project will be approximately \$3.2 million. Additionally, annual operating cost savings for energy will add approximately \$6.6 million to the building's value⁴⁷.

Case study (see Figure 8): Providence Health & Services, a regional healthcare system serving the Pacific Northwest and California, exclusively purchases Energy Star-qualified computers. This initiative serves as one component of a highly organized, system wide, energy efficiency program projected to save the healthcare system more than \$3.4 million annually⁴⁸.

Case study (see Figure 8): York Hospital in Maine purchases 90% green energy, drawing from in-state renewable energy sources. The hospital's green energy purchases have qualified it for the EPA's Green Power Partnership and helped it reduce its carbon emissions by 24% between 2000 and 2006; the hospital's green programs save more than \$100,000 in operating expenses annually⁴⁹.

Case study (see Figure 8): The Children's Hospital of Eastern Ontario, in collaboration with Blue-Zone Ltd., installed innovative anesthetic gas capture technology in all of its operating rooms. After capturing, reclaiming, and purifying the gases, the hospital can reuse them. This procedure extends the gases' lifecycle by ten to twenty times, saving money and reducing greenhouse gas emissions. Blue-Zone projects that within two years, hospitals will reduce their anesthesia costs by 25 per cent once they build a stock of recycled gas⁵⁰.

⁴⁴http://www.commonwealthfund.org/~media/files/publications/issue-brief/2012/nov/1641_kaplan_can_sustainable_hosp_bend_cost_curve_ib.pdf

⁴⁵http://www.engr.ncsu.edu/ncsc/transportation/success_stories/Pitt_Co_4_Memorial/AFI_Pitt_County_Memorial_Hospital.html

⁴⁶<https://www.nrdc.org/sites/default/files/ohsu.pdf>

⁴⁷<https://www.portlandoregon.gov/bps/article/437418>

⁴⁸http://www.energystar.gov/index.cfm?c=healthcare.bus_healthcare_providence_health

⁴⁹<http://www.seacoastonline.com/apps/pbcs.dll/article?AID=/20080109/NEWS/801090335/-1/NEWS01&sfad=1>

⁵⁰<https://www.theglobeandmail.com/report-on-business/a-remedy-for-the-operating-room/article1155719/>

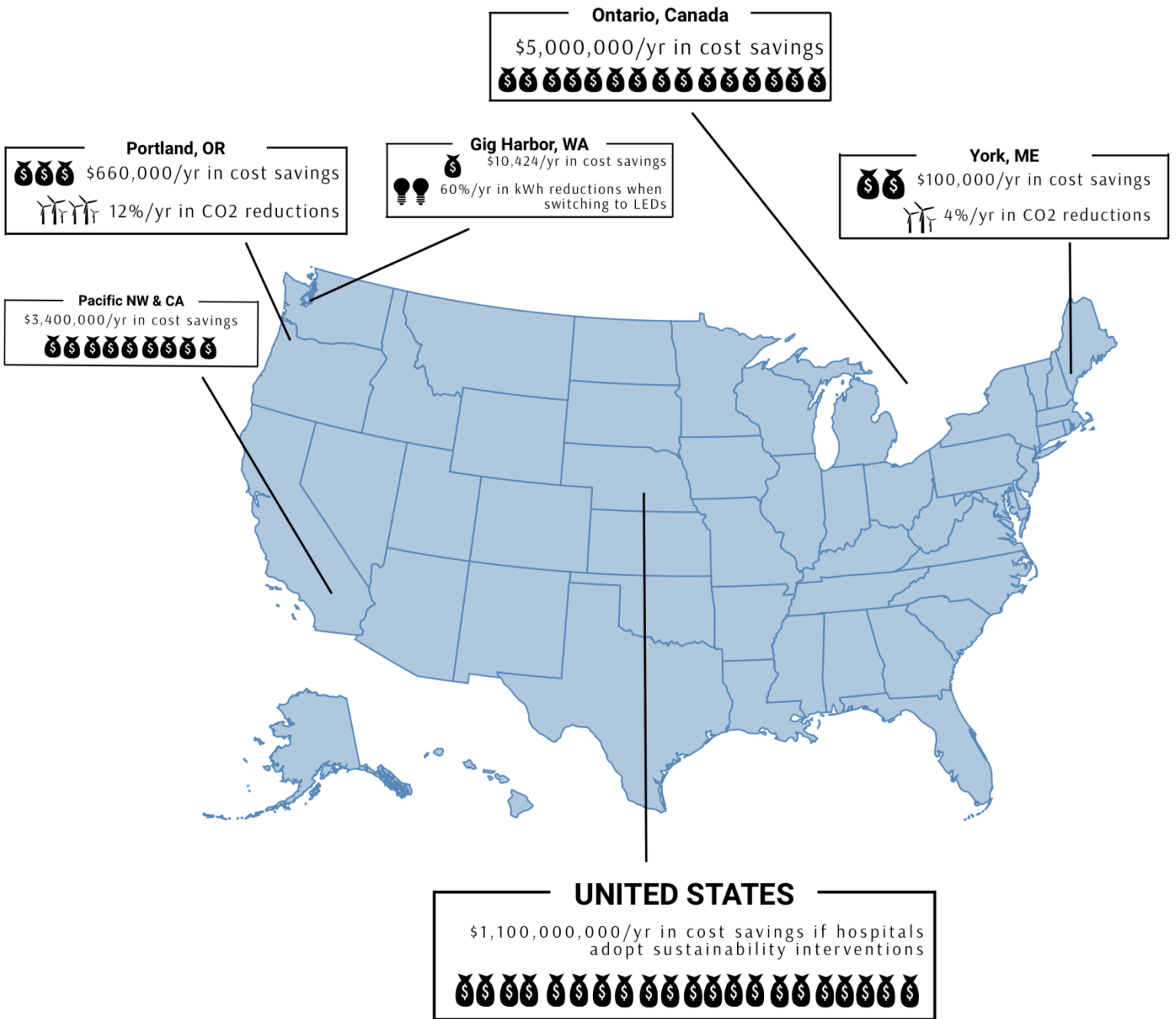


Figure 8. Map of the United States highlighting different case studies in healthcare associated with energy and cost savings.

Government and Public Support. Also, for external stakeholders, organizations can identify initiatives, public/municipal policies and legislation that would support climate change and sea level rise mitigation at their properties, and identify stakeholders within their surrounding community for potential collaboration.

Case study: Nicklaus Children’s Hospital received a grant through Federal Emergency Management Agency’s Hazard Mitigation Grant Program (HMGP), administered by the Florida Department of Community Affairs. The \$5 million HMGP grant was essential to enabling the \$11.3 million project to retrofit the hospital to protect against major storms⁵¹.

⁵¹<https://toolkit.climate.gov/case-studies/retrofitting-childrens-hospital-hurricane-resistant-shell>

Reputations and Changing Standards. Understand and collaborate with stakeholders regarding policy options and initiatives is an important opportunity for mitigating risks. Organizations can collaborate with governments and the World Health Organization to integrate meteorological data and new technologies into disease surveillance and early warning systems related to the effects of climate change and sea level rise⁵². Further, organizations can develop an internal strategy on climate change to react effectively to regulations and policy changes. By proactively developing internal strategies on climate change and related weather events, organizations can save time and resources.

Case study: On September 8, 2016 the Federal Register posted the final rule Emergency Preparedness Requirements for Medicare and Medicaid Participating Providers and Suppliers. The regulation went into effect on November 16, 2016. Health care providers and suppliers affected by this rule must comply and implement all regulations one year after the effective date, on November 16, 2017⁵³.

Developing a credible and trusted reputation on climate can not only improve products but also safeguard their operation during hazard events when energy may be limited. A poor reputation on climate can hurt revenue through consumer boycotts or local community protests. For example, design medical devices with lower power consumption and improved end of product lifecycle recycling and develop and implement improved processes to reduce, reuse and recycle water, raw materials, non-renewable minerals, energy, other inputs, by-products, hazardous waste, non-hazardous waste and packaging. Organizations can demonstrate the connection between climate change, sea level rise, and human health to the community through policy development, written commitment statements, and participation in bioethics committees⁵⁴.

Just as important as continuity of product operation for consumers is business continuity during extreme weather events. Organizations must plan to safeguard continuity. This also gives businesses that have planned ahead the upper competitive edge over those that have not.

Community Considerations. For customer/clients/patients (and their families), in addition to sheltering patients in place, hospital facilities are also responsible for delivering medical services to large numbers of injured people during emergencies. It is imperative that hospitals maintain not only operational infrastructure services, but also vital medical care delivery services. Establish mutual aid/assistance agreements (mutual aid, transfer of patients, sharing of resources and supplies) with other institutions during response and recovery from an extreme weather event or natural disaster. Ensure emergency plans for extreme weather events are consistent with community plans and updated regularly and iteratively based on new information on how climate and vulnerability affect risks. Provide psychological first aid to address mental health impacts of emergencies and disasters on patients, health care facility staff and visitors. Develop systems to act upon extreme weather advisories and warnings to reduce health risks. Develop systems for monitoring injuries and diseases from climate-related hazards including monitoring health outcomes to vulnerable patients (e.g., elderly, immobile, infants, critical care patients) in the event of a climate-related emergency or disaster⁵⁵.

For business owners and employees (and their families), invest in telehealth and telecare to reduce patient travel and improve quality of care. Also, calculate the number of personnel that will not likely report to work due to inability to travel, illness or safety concerns; Hospitals and residential care facilities should have effective personnel recall systems coordinated with local and regional emergency management systems⁵⁶. Identify temporary staffing sources – i.e., Red Cross, Emergency Response Teams, etc. Further, invest in healthcare solutions to mitigate the

⁵²<https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertEmergPrep/Emergency-Prep-Rule.html>

⁵³<https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertEmergPrep/Emergency-Prep-Rule.html>

⁵⁴<https://practicegreenhealth.org/pubs/toolkit/reports/ClimateChange.pdf>

⁵⁵Paterson, J., Berry, P., Ebi, K., & Varangu, L. (2014). Health care facilities resilient to climate change impacts. *International journal of environmental research and public health*, 11(12), 13097-13116.

⁵⁶Paterson, J., Berry, P., Ebi, K., & Varangu, L. (2014). Health care facilities resilient to climate change impacts. *International journal of environmental research and public health*, 11(12), 13097-13116.

impacts of a changing climate for disease prevention including: changing patterns of vector borne, food-borne and water-borne diseases; increased air pollution; undernutrition; and heat-related mortality, exhaustion and stroke. Also, help build resilient health systems able to anticipate, respond to, cope with, recover from and adapt to climate-related shocks and stresses including increased morbidity arising from natural disasters (heatwaves, floods, droughts and storms), conflict and forced migration⁵⁷.

Case study: The Veterans Health Administration (VHA) began introducing telehealth programs in the 1990s in the United States. The annual cost to deploy the telehealth program in 2012 was \$1,600 per patient per year, compared to over \$13,000 for traditional home-based care and over \$77,000 for nursing home care. Telehealth also was associated with a 25 percent reduction in number of bed days of care and a 19 percent reduction in hospital admissions across all VHA patients utilizing telehealth. Overall, the VHA estimates average annual savings of \$6,500 for each patient that participated in the telehealth program in 2012. This sums to nearly \$1 billion in system-wide savings associated with the use of telehealth in 2012⁵⁸.

Priority Next Steps

Health care facilities are among the most complex and energy-intensive in the United States. Hospitals use 836 trillion BTUs of energy annually, producing about 2.5 times the energy intensity and carbon dioxide emissions of traditional office spaces⁵⁹. By engaging in green building, smart landscaping, and other energy-efficient initiatives such as recycling anesthetic gases, healthcare organizations can reduce their energy use and greenhouse gas emissions. Energy efficiency strategies can bring significant cost savings to healthcare organizations, as U.S. hospitals spend over \$5 billion annually on energy, often equaling 1 to 3 percent of a typical hospital's operating budget or an estimated 15 percent of profits⁶⁰. Research suggest that every dollar a hospital in the United States saves on energy is equivalent to generating \$20 in new revenues⁶¹. Strategic site locations, telecare, and telehealth can help contain urban sprawl and lessen auto dependence, helping to reduce pollution across the country and improve patient care, especially during times of flooding or inclement weather.

Organizations can find resources on the integration of advanced energy efficiency and renewable technologies in hospital design, construction, retrofit, operations, and maintenance through the Hospital Energy Alliance (HEA) which was established in 2009 by the U.S. Department of Energy⁶². Through HEA, hospitals have access to the most current information and tools supporting energy-efficiency and renewable energy technologies.

Box 3.

“As hospitals reduce energy costs (and mitigate the risks of future cost volatility), they are in a position to allocate additional resources to life-saving equipment and patient care. Further, energy-efficiency and renewable energy strategies can dramatically increase a hospital’s power reliability, even during times of widespread disaster.” -- U.S. Department of Energy

⁵⁷<https://www.unglobalcompact.org/library/4341>

⁵⁸Healthcare Information and Management Systems Society. The Department of Veterans Affairs #mHealth Case Study. Accessed March 7, 2016. <http://www.himss.org/ResourceLibrary/mHimssRoadmapContent.aspx?ItemNumber=30310>

⁵⁹<https://www.energy.gov/articles/department-energy-announces-launch-hospital-energy-alliance-increase-energy-efficiency>

⁶⁰<https://www.energy.gov/articles/department-energy-announces-launch-hospital-energy-alliance-increase-energy-efficiency>

⁶¹https://www.energystar.gov/ia/business/healthcare/factsheet_0804.pdf

⁶²https://www1.eere.energy.gov/buildings/publications/pdfs/alliances/hospital_energy_alliance_fact_sheet.pdf

Tourism and Hospitality Management

Introduction

Tourism is a vital economic sector of southeast Florida, drawing over 37.8 million international and domestic visitors annually. The largest contributing tourism destination counties for southeast Florida are Greater Miami, Broward and Palm Beach counties⁶³. Employment, and tax revenues are generated by overall visitor spending in the lodging, restaurant, entertainment, attractions and cruise ship direct tourism business sectors. In 2016, 62.5% of visitors responding to exit surveys indicated that the quality of the beach experience was primary to the overall vacation rating and willingness to return, according to the Greater Miami & Beaches 2016 Visitor Industry Overview⁶⁴. Southeast Florida's natural attractions are a key factor in maintaining the growth of the tourism industry and are the most vulnerable of the regions assets to sea level rise impacts.

Risks to economy through risks to the tourism industry in southeast Florida can be primarily quantified by Tourism Arrival Numbers; Tourism Spending and Tourism Related Employment. In 2016 these values were reported by the three largest counties; Miami-Dade, Broward and Palm Beach (Figure 9).

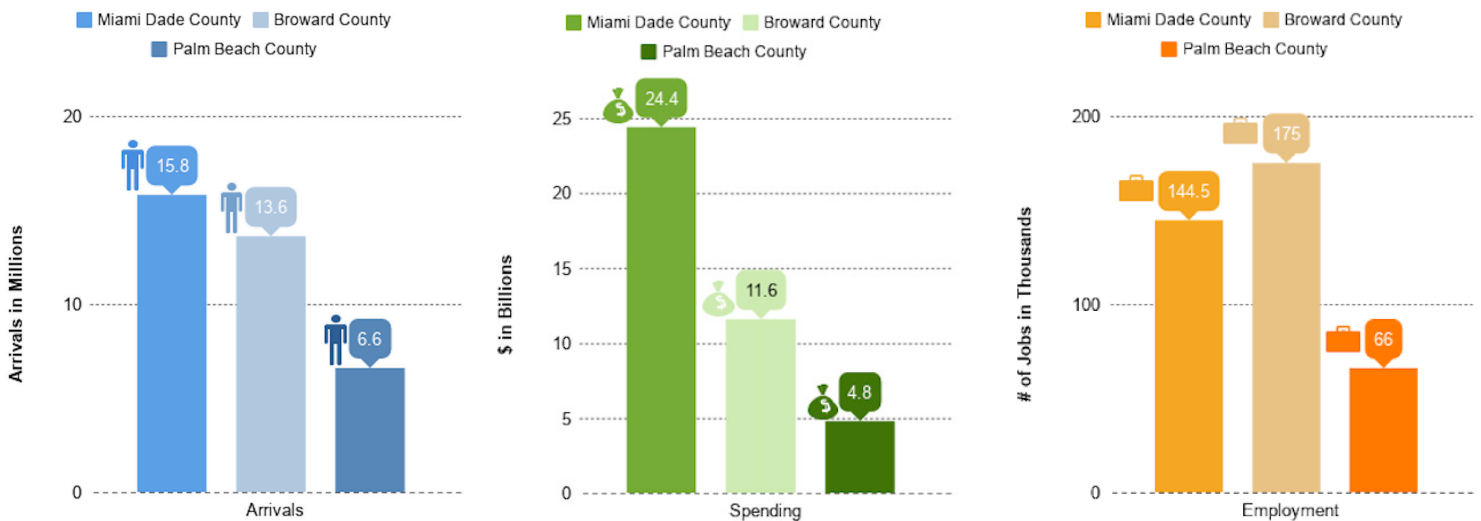


Figure 9. The overall economic value of the tourism industry to southeast Florida^{63, 64}

Note: The total number of tourism arrivals was 37.8 million, total tourism spending was \$43.4 billion, and total jobs attributed to tourism employment was 385,500 jobs.

Sector-specific Risks and Opportunities

Some of the asset segments in the tourism sector include lodging, food and beverage services, cruise ship industry, theme parks, attractions (beach and water-based activities, and meetings and conventions). Risks that affect tourism can also be common to other sectors like property and real estate development. Like all sectors, there are cascading impacts associating with these risks for the local economy and tax base.

Discussion

Case Study: City of Miami Beach. The risk to the economic infrastructure provided by the tourism industry to the City of Miami Beach represents over eleven billion dollars in visitor spending by fifteen and a half million visitors annually to the one-mile wide and nineteen square mile area. The threats the stability of the tax base repre-

⁶³2016 Comprehensive Annual Financial Report (PDF). - Broward County www.broward.org/Accounting/Documents/2016CAFR.pdf accessed November 17, 2017

⁶⁴Greater Miami and the Beaches 2016 Visitor Industry Overview partners.miamiandbeaches.com/-/media/files/gmcbv/partners/.../annual-report-2016 accessed November 17, 2017

	Risks	Opportunities
Value Chain	<ul style="list-style-type: none"> • Decline in visitor arrivals and spending • Decline and shortage of developable land • Decline in new property investment • Decline in property values • High cost of construction • High cost to mitigate existing properties • High cost of insurance • Decline in infrastructure functionality • Decline in local government investment and services • Availability of local labor 	<ul style="list-style-type: none"> • Implementation of flood mitigation strategies that reduce flood impacts results in positive media coverage and improved perceptions by both inbound tourism and business travelers • Working with local and state agencies to collaborate on initiatives by businesses to reduce climatic impacts puts local businesses ahead of other tourism-based coastal economies
External Stakeholder	<ul style="list-style-type: none"> • Rising water levels impede transportation to events, entertainment facilities, recreational activities, and other tourism-related businesses • Poor reputation on climate and climate action can impact inbound tourism to the Greater Miami Area. <p>The challenge of climate unreliability for specific times of the year during which tourism arrivals expect certain climate conditions for recreation and beach related activities can impact future tourism</p>	<ul style="list-style-type: none"> • Shared land transport services • Water transport services • Floating structures technologies • Adaptable utility, power and water facilities • Eco-tourism • Pumping station installation and mitigation technology
Social	<ul style="list-style-type: none"> • The presence of climate-related diseases, such as Zika, can significantly impact inbound tourism and business revenues in the short term • Businesses can be impacted by reducing employment. The subsequent multiplier effect of lost income creates financial stress. 	

Table 5. Tourism sector risks and opportunities

mented by hotel, restaurant and retail use and sales taxes with reductions in visitor spending bring into question the ongoing stability of the City's public infrastructure if the detailed threats of sea level rise become reality.

The economic impact of Miami Beach as a tourism destination are identified in the 2016 Miami Beach Economic Indicator Report: 48% of the 15,496,300 million visitors to Greater Miami stayed in Miami Beach and spent \$11,221,884,000 in the year 2014 . This spending is supported by 185 hotels in the City of Miami Beach representing 19,545 hotel rooms in 2014, and \$1,609,274,622 in total room sales generating \$16,181,700 in hotel and restaurant sales tax for the City of Miami Beach⁶⁵. Ongoing construction of renovated and new hotels is projected to grow the number of hotel rooms to 22,000 in Miami Beach by 2017.

The multiplier effect from a loss of tourism visitors due to rising sea waters would include the loss of jobs in hotels, restaurants and retail establishments in proportion to declines in visitor expenditures. In addition the transportation sector and tourism services would see a decline in income from tourism related expenditures. Total tourism related taxes collected for Miami Dade County in 2016 was \$240,695, of which the City of Miami Beach accounted for \$82,402,364 or 34.2%⁶⁶.

⁶⁵Greater Miami and the Beaches 2016 Visitor Industry Overview partners.miamiandbeaches.com/-/media/files/gmcbv/partners/.../annual-report-2016 accessed November 17, 2017

⁶⁶Greater Miami and Beaches 2016 Visitor Industry Overview

During heavy rains, high tides and storms, the streets of Miami Beach currently flood from the back-flow of the storm sewer system as the run off pipes are covered by water from Biscayne Bay. The streets become flooded, to varying degrees, making walking and driving difficult. A pumping station installation effort includes sixty new pumping stations with back-flow preventers to mitigate flooding, which are being installed to maintain transportation connectivity and protect residential and commercial property. Sea wall upgrades for Miami Beach and the canals that make up the waterways system, will incorporate natural solutions for storm surge control reincorporating the natural environment to this island that was once a mangrove swamp⁶⁷.

Case Study: Cruise Ship Industry. Growth for southeast Florida is not limited to land based projects. Cruise ships with capacities of over 6,000 passengers and crew have established Miami and Fort Lauderdale as their home ports. 5% of total visitor arrivals in Greater Miami as causers ship passengers. One of the largest passenger cruise ships in the world, Royal Caribbean's 'Allure of the Sea', carries a maximum of 6,437 passengers. The Miami River Harbor will accommodate six million cruise ship passengers annually by the year 2,035⁶⁸. The majority of these passengers arrive by air into Miami Airport requiring a transportation infrastructure to accommodate groups from 2,000 to 6,000 people during specific time periods to arrive and depart from Miami, as arriving groups disembark a ship while departing groups wait to board. Year-round over the three-day weekend period, 12 to 16 cruise ships and 48,000 to 64,000 passengers will impact the Port of Miami facilities.

Demands for better access to the Port of Miami for both cargo and cruise ships have resulted in dredging efforts to create a deeper harbor. The Port of Miami will be the closest U.S. port when the newly widened and deepened Panama Canal is completed to accommodate mega size cargo vessels that require minus 50-52 foot harbor depth when loaded to full capacity. Deep dredge efforts are deepening the main Miami harbor channel from a minus 42 foot depth to the minus 50/52 foot depth required by these cargo ships. More than one billion dollars of capital infrastructure improvements are being completed to meet the 2017 deadlines for Port of Miami improvements⁶⁹.

The project to deepen the Port of Miami channel by ten feet is moving six million cubic yards of sediment from the bottom of the channel. The sediment raised and spread out through the mouth of the river channel into the ocean is forecast to cover seven acres of now exposed coral reef. By removing a source of oxygen to the reef and its marine life this major component of stabilizing marine life in the area directly off of the coast of Miami Beach will die⁷⁰. This natural underwater barrier for ocean surge coming onto the beaches will be rendered ineffective, increasing the risk of flooding over the dunes and into the community of Miami Beach. With the loss of this barrier comes the risk of elevating water levels in Biscayne Bay, the Miami River and the densely populated upstream areas built to the rivers' edge whose only protection are aging sea walls.

Priority Next Steps

Quantifying return on investment for case studies for flood mitigation projects like those being undertaken in Miami Beach in terms of tourism-generated dollars is a key research need. Other recreational assets like the Everglades and Biscayne Bay and market research to identify environment-based services on which local businesses depend (i.e. water, waterfront rental properties and hotels) would ensure that private, local, state and federal investments achieve the highest return for supporting the tourism industry and tax base.

⁶⁷Margarita Wells, personal communication, March 5, 2014

⁶⁸Miami-Dade County 2011

⁶⁹Greater Miami and the Beaches 2016 Visitor Industry Overview partners.miamiandbeaches.com/-/media/files/gmcbv/partners/.../annual-report-2016 accessed November 17, 2017

⁷⁰Staletovich, 2014



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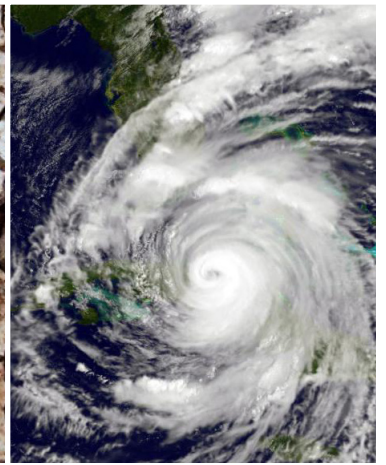


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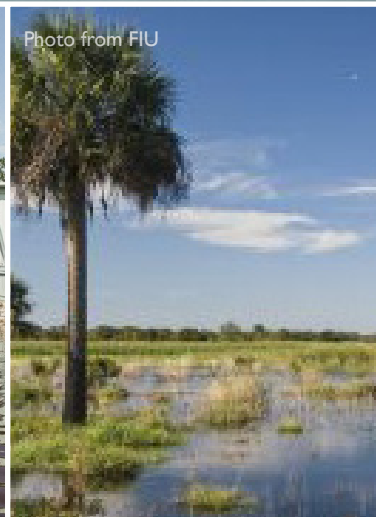


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Resilience Action Fund

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Built Environment