FLORIDA PORTS COUNCIL

SEAPORTS
RESILIENCY REPORT

FLORIDA PORTS COUNCIL

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PREPARED FOR: Florida Seaport Transportation & Economic Development Council (FSTED) by Littlejohn, Mann & Associates

FPC'S ROLE IS TO PROVIDE LEADERSHIP TO FLORIDA'S SEAPORTS IN THE AREAS OF DATA & RESEARCH, STATE & FEDERAL ADVOCACY AND MARKETING & COMMUNICATIONS.

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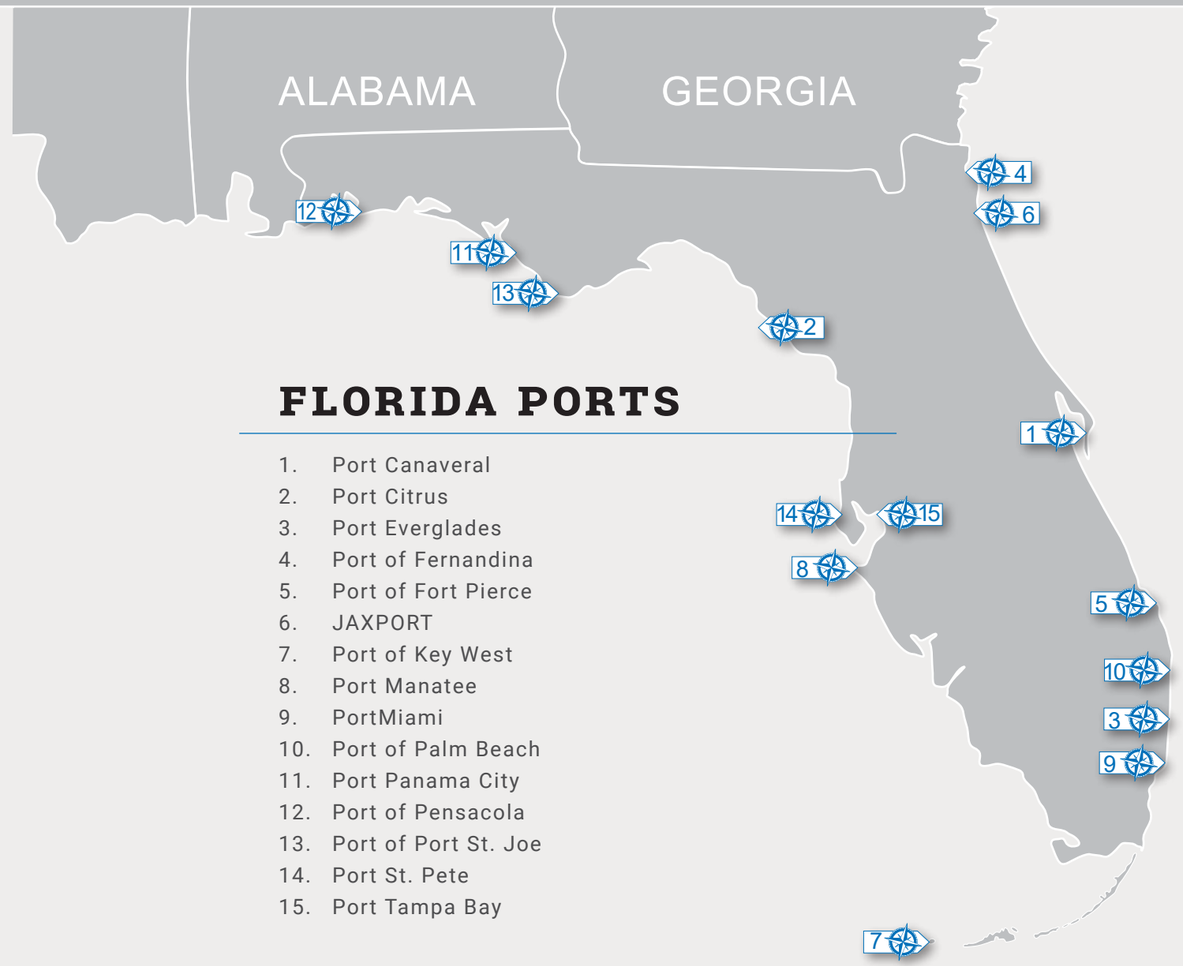
FLORIDA PORTS COUNCIL

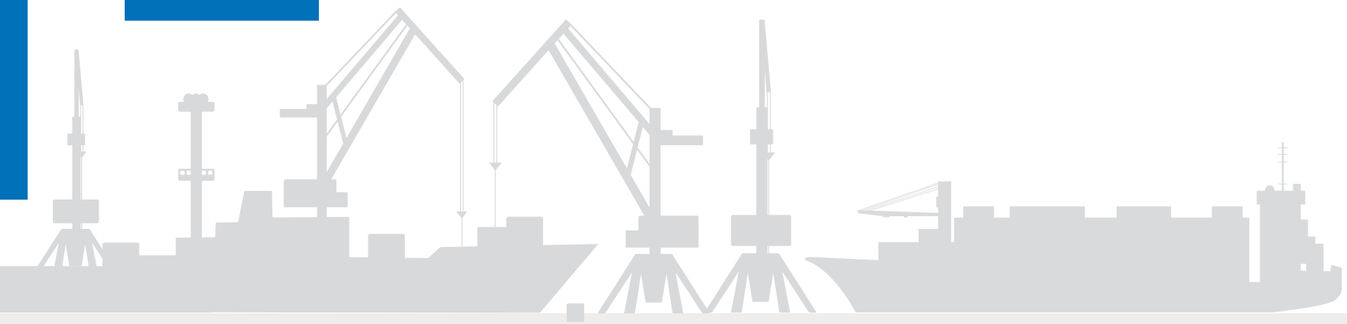
OUR MISSION: Charged with the implementation of seaport capital improvement projects, the Florida Seaport Transportation and Economic Development (FSTED) Council consists of the port directors of the 15 publicly owned seaports and a representative from both the Department of Transportation and the Department of Economic Opportunity. The Florida Ports Council administers the FSTED program and staffs the Council.



FLORIDA PORTS

1. Port Canaveral
2. Port Citrus
3. Port Everglades
4. Port of Fernandina
5. Port of Fort Pierce
6. JAXPORT
7. Port of Key West
8. Port Manatee
9. PortMiami
10. Port of Palm Beach
11. Port Panama City
12. Port of Pensacola
13. Port of Port St. Joe
14. Port St. Pete
15. Port Tampa Bay

EXECUTIVE SUMMARY



What does it mean for a seaport to be resilient? Seaports are not stand-alone facilities, but rather, are integral components of national, regional, and local economies. Seaport resiliency is the ability to coordinate freight movement through ports in times of severe stress on existing infrastructure and operations, including damage to port facilities, highway, rail, or waterway routes leading into and out of the port. In many ways, Florida seaports are leading the nation in resiliency planning and investments to become even more resilient in the face of sea level rise and natural disasters.

What are the potential impacts of sea level rise, and when and how should seaports plan for these anticipated sea level increases? These are complex issues, made all the more challenging due to the significant cost and service-life of maritime infrastructure, including ship berths and cargo handling equipment.

Florida is prepared to evaluate and plan for sea level rise through its master planning process, ongoing commitment to protecting the environment, and predictive modeling. Through the use of tidal gauges, LiDAR and Physical Oceanographic Real-time Systems (PORTS), Florida ports such as Port Everglades and JAXPORT are evaluating the optimization and historical storm surges surrounding the ports. This is taken into account for master planning updates, and while designing new bulkheads. Currently, Florida seaports must have cargo handling equipment that can accommodate approximate 2.5 feet of tidal fluctuations. This is within the range of anticipated sea level increases in 2050, so there is no compelling urgency to update equipment or infrastructure prior to the normal replacement cycle. Wharfs and berths have an approximate lifespan of 20-50 years and a height of 7.5-12.5 feet above water. All port cargo handling equipment is designed based on current ship size, which changes with each new generation of vessel.

Florida seaports are already making significant efforts to minimize the extent and duration of impacts from natural disasters. As a peninsular state, Florida seaports and their surrounding communities face logistical challenges beyond the direct impact of natural disasters. Coastal transportation infrastructure in Florida is especially vulnerable to disruption, and seaports should carefully consider steps to become more resilient. The financial and social impacts associated with temporary seaport closures, reduced cargo capacity, and infrastructure damage can be devastating, and adequate planning and preparation are paramount.

An evaluation of strategies and best practices is provided as a resource for seaports to ensure they can minimize potential threats and maximize opportunities to protect supply chains following natural disasters. The most critical priority for planning is the need to ensure channel and navigable waters are cleared for access to the port post-event. This requires coordination between the seaport, U.S. Coast Guard, U.S. Army Corps of Engineers, and the National Oceanic and Atmospheric Administration prior to and following the storm event. Florida seaports have proactively worked with state and local governments and utility providers to ensure electrical infrastructure leading to seaports is hardened by replacing wooden power poles with concrete poles that can withstand Category 5 winds. Additionally, Florida seaports benefit their surrounding community following a natural disaster if they are properly integrated into resiliency planning efforts at the local or regional level.

The issue of fuel supply and distribution takes on additional importance during hurricane season in Florida. The vital supply lines at fuel terminals located on seaports in Canaveral, Everglades, JAXPORT, Manatee and Tampa are put under enormous constraints before and after any hurricane impact. Florida seaports continue to seek ways to improve the distribution of fuel at these terminals. Florida ports are currently working with the petroleum industry, petroleum marketers/retailers, the U.S. Coast Guard, and state emergency management officials to identify any necessary infrastructure investments. They continue to seek better ways to communicate the status of and access to these fuel terminals after the U.S. Coast Guard has deemed them safe to function.

This report serves as a resource for all seaports as they evaluate methods of improvement, taking advantage of lessons learned from Florida over the years. Resilient seaports, properly integrated into the preparedness plans of the surrounding community, can be a tremendous resource before, during and after a major storm event. Their actions will largely determine the timing and ability to process cargo in an efficient, cost-effective manner and be in a position to support the needs of impacted constituents. This potential role presents opportunities for seaports to expand the range of services provided. Florida seaports view resiliency planning as a long-term investment and ever improving process that requires continuous reappraisal.

SEAPORTS ARE NOT STAND-ALONE FACILITIES, BUT RATHER, ARE INTEGRAL COMPONENTS OF NATIONAL, REGIONAL, AND LOCAL ECONOMIES.

IDENTIFICATION OF VULNERABILITIES TO FLORIDA SEAPORTS

THE COASTAL TRANSPORTATION NETWORK OF FLORIDA SEAPORTS IS A COMPLEX AND DYNAMIC NETWORK OF PRIVATE AND PUBLIC ENTITIES INVOLVING MULTIPLE MODES OF TRANSPORTATION INCLUDING WATERWAYS, TRUCKING, RAIL, AND PIPELINES.

Waterborne international trade moving through Florida seaports in 2018 was valued at $87.3 billion and an additional $57.4 billion in containerized cargo.[1] Maritime cargo and cruise activities at Florida seaports support approximately 900,000 jobs and generates $117.6 billion in total economic value.[2] As a key mode in the local, state and national supply chain, it is imperative that Florida seaports be resilient against natural disasters and climate related impacts such as sea level rise.

Recent storm events have revealed the costs of extreme coastal weather events; and due to their coastal locations, seaports are often among the severely impacted infrastructure. With an increase in data and understanding of projected sea level rise, seaports are addressing these potential effects and any necessary and cost-effective infrastructure improvements to become better prepared.

As a peninsular state, Florida seaports face unique and increased risks compared to many other seaports around the country. Florida seaports are likely to encounter tropical storm events each year, with each event having the potential to impact multiple ports throughout the state. Florida seaports have the additional burden of assessing sea level rise impacts and ensuring that present and future cargo handling capabilities needs are not adversely affected. Moreover, these issues should be evaluated together to ensure that actions taken today will improve seaport resiliency for years to come.

In the broadest sense, resiliency is the ability of a system to prepare for, withstand and recover from an impact in a timely and cost-effective manner and to then adapt to future disruptive events.[3] As it relates to seaports, this can include any number of potential events such as environmental threats, global supply chain interruptions, and security threats.

$87.3 B

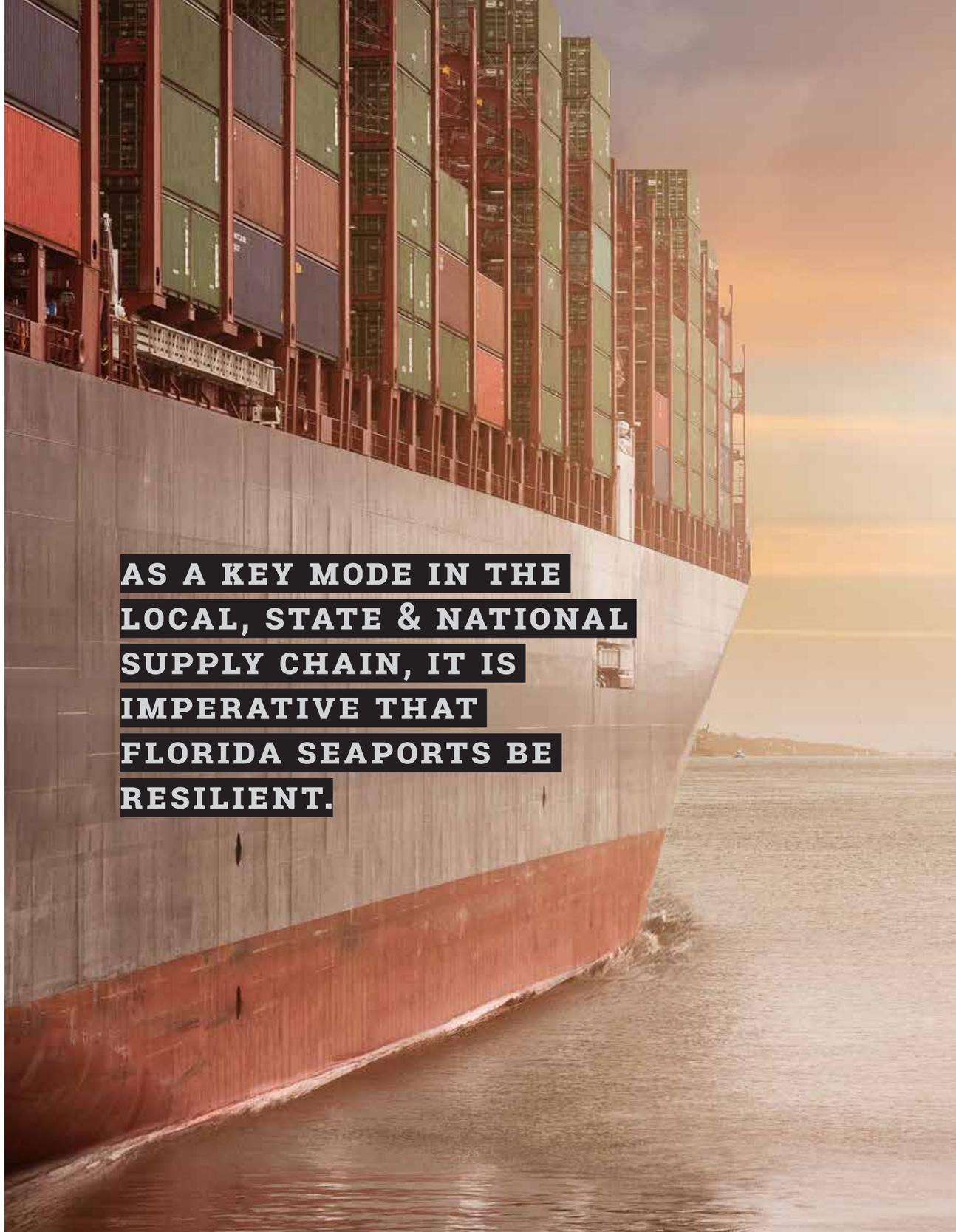
VALUE OF WATERBORNE TRADE MOVED THROUGH FLORIDA SEAPORTS

900,000

JOBS SUPPORTED BY FLORIDA SEAPORTS

$117.6 B

ECONOMIC VALUE GENERATED BY FLORIDA SEAPORTS



DEFINING RESILIENCY FOR FLORIDA SEAPORTS

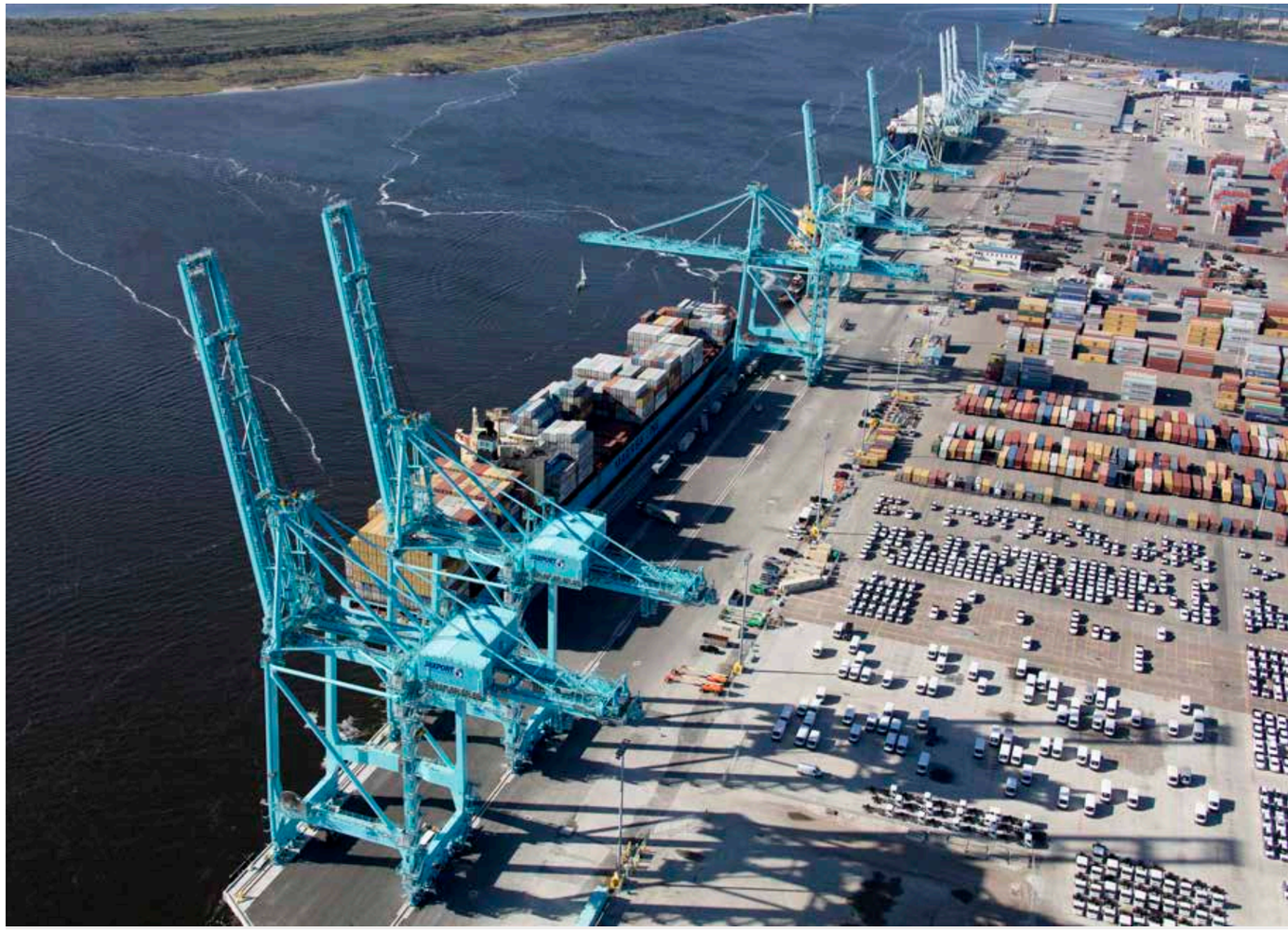
RESILIENCY HAS MANY DIFFERENT MEANINGS, PARTICULARLY WITHIN SEAPORT OPERATIONS.

Seaport resiliency is the ability to coordinate freight movement through ports in times of severe stress on existing infrastructure and operations, including damage to port facilities, the highway, rail, or waterway routes leading into and out of the port.

This report assesses the potential impacts from both hurricanes and sea level rise and describes best practices to address these issues in a cost-effective manner, without impacting ongoing operations. Seaports are integral to the local community and the state and regional supply chain; therefore, seaport resiliency should include the ability to quickly transport necessary supplies to areas that have been impacted by such events. Accordingly, resiliency for Florida seaports can best be defined as the ability to prepare for and withstand future disruptions from environmental impacts with as little damage as possible and bring the seaport's freight movement system back to its prior operating levels quickly in order to support the needs of impacted Floridians.

With regard to hurricanes and severe storm events, this means seaport infrastructure must be capable of withstanding impacts from high winds, storm surge and severe flooding from rain events. It requires systematic coordination among essential personnel to ensure all aspects of a seaport's resiliency plan are effectively put into action. Successful coordination with surrounding local governments to ensure seaports are included as part of the local and state critical infrastructure is paramount. This ensures that access to and from the port and essential utilities such as power, water and sewer are not interrupted, or are available as soon as possible following the event.

Seaports face a unique challenge for long-term planning. While certain measures can immediately be implemented to increase seaport resiliency to weather events; immediately addressing sea level rise by raising infrastructure heights, such as docks, railways, and roads, would have significant adverse effects on present-day cargo handling efficiency. Resiliency to potential sea level rise is a complex issue for seaports given the significant costs and service life of maritime infrastructure and that much of this infrastructure will require repair or replacement before projected sea levels will have measurable impacts upon them. As seaports are required to address potential environmental issues, including sea level rise, within their master plans, current and ongoing analysis of sea level rise projections should be included in the master planning process, along with necessary upgrades to infrastructure to improve long term resiliency.



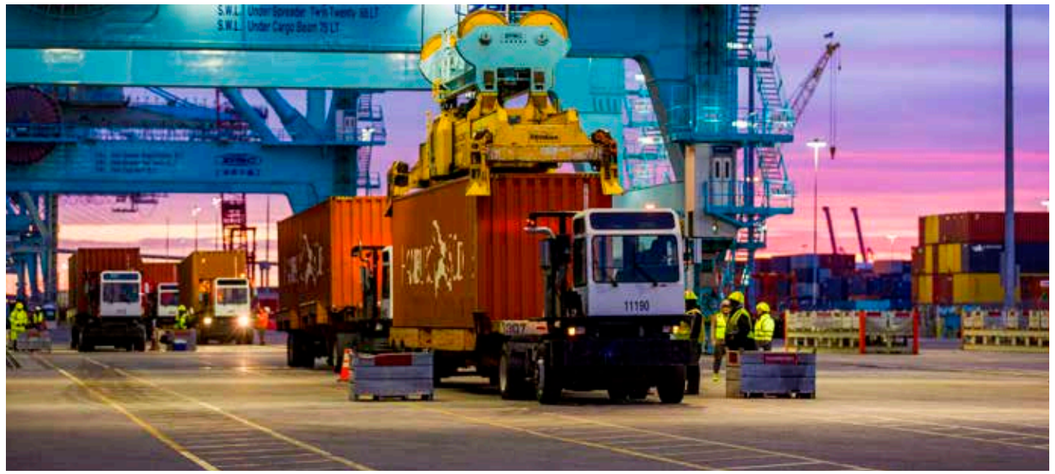
SEAPORT RESILIENCY IS THE ABILITY TO COORDINATE FREIGHT MOVEMENT THROUGH PORTS IN TIMES OF SEVERE STRESS ON EXISTING INFRASTRUCTURE AND OPERATIONS.

BEST PRACTICES FOR CREATING MORE RESILIENT SEAPORTS

Seaports are not stand-alone facilities, but rather are an integral component of the national, regional, and local economies. Florida seaports are essential for the movement of goods and services within a domestic and global marketplace. Their operations influence and depend heavily upon their associated landside and deep-water transportation networks, and on the efficiency of the intermodal transfers that take place within or in close proximity to the port itself. Seaports also play a key role in the recovery of the surrounding region after disruption, facilitating the mobilization of response and recovery assets and the delivery of life-sustaining commodities for impacted communities. Implementing the best practices and recommendations identified can help to minimize the impact from future storms and sea level rise, thus increasing resiliency of Florida seaports and surrounding coastal regions and, in turn, supporting a stronger, more resilient Florida.

BEST PRACTICES TO ADDRESS THE POTENTIAL IMPACTS OF SEA LEVEL RISE IN FLORIDA

Increasing Florida seaport resiliency against the potential impacts from sea level rise is a complex issue requiring the balancing of a port's need for efficient and safe transportation of people and goods, the potential economic and disruptive impacts from immediately replacing infrastructure to meet predicted sea levels, and the need to plan for such impacts in the near and long-term. Each Florida seaport is unique in the people and goods they transport, the infrastructure to conduct operations, the design and age of that infrastructure, and the effects, if any, potential sea level rise may have on an individual seaport.



BEST PRACTICE

Florida seaports are invested in the efficient handling of people and products at the interface of land and sea, which requires a careful assessment of the present and future needs of cargo handling in a changing sea level.

Research provides two main reasons for sea level rise, expansion of the ocean volume due to the increased water temperatures and the melting of land-based glaciers and ice sheets adding water to the oceans.[4] [5] From the 1970s through the last decade, melting and thermal expansion were contributing roughly equally to the observed sea level rise, but over the past decade, the amount of sea level rise due to melting has been nearly twice the amount of sea level rise due to thermal expansion.[6]

The planet's average surface temperature has risen about 1.62 degrees Fahrenheit (0.9 degrees Celsius) since the late 19th century.[7] Most of the warming occurred in the past 35 years, with the five warmest years on record taking place since 2010.[8] The oceans have absorbed much of this increased heat, with the top 2,300 feet (about 700 meters) of ocean showing warming of more than 0.4 degrees Fahrenheit since 1969.[9] The global sea level rose about 8 inches in the last century, with nearly half of that rise occurring in the last two decades with slight acceleration every year.[10] Glaciers are retreating around the world, including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.[11] It is uncertain whether that acceleration will continue or whether internal glacier and ice sheet dynamics (along with natural climate variability) will lead to slow downs or pulses of melting.[12]

Sea level is measured by tide gauges and satellite laser altimeters. Tide gauge stations from around the world have measured the daily high and low tides for more than a century. Since the early 1990s, sea level has been measured from space using laser altimeters, which determine the height of the sea surface by measuring the return speed and intensity of a laser pulse directed at the ocean.[13] NOAA and USACE have used this data to calculate a global average, adjusting for seasonal differences. At the request of the U.S. Climate Change Science Program, NOAA scientists conducted a review of the research on global sea level rise projections, and concluded that there is very high confidence (greater than 90% chance) that global mean sea level will rise at least 8 inches (0.2 meter) but no more than 6.6 feet (2.0 meters) by 2100. The USACE and NOAA created an interactive sea level rise calculator with predictions up to the year 2100,[14] which shows predicted moderate global sea level rise to be between 1.65 and 3.95 feet. [15] [16]

CASE STUDY: PORT EVERGLADES

It is important to keep in mind that every port has different needs. For the internal analyses of Port Everglades' susceptibility to storm surge or sea level rise, the Port held a meeting with leaders from their harbormaster, operations, public works, engineering and security divisions to identify which low elevation infrastructure could cause the greatest disruption if impaired due to water intrusion. All agreed the underground security and data communications network was the most sensitive, and they are currently surveying the elevations of the connection boxes, where water intrusion would likely first occur. The surveyed elevations will be plotted on a topographic relief map of the Port created from 2" vertical resolution LiDAR data obtained from the City of Fort Lauderdale and the Florida Department of Transportation, and a geographic analysis will be performed to determine the storm surge or sea level rise elevation at which water intrusion would likely first occur in the connection boxes. To the extent practicable, these connection boxes will be waterproofed, and the topographic relief map will then be used to identify the next lowest elevation infrastructure that could cause the greatest disruption if impaired due to water intrusion. In addition, during design of new infrastructure the Port evaluates measures that can be practically implemented to optimize adaptation to storm surge and sea level rise, and 6' of additional vertical height has been added to the design cap elevation of the bulkhead for their upcoming Slip 1 Expansion Project.

BEST PRACTICE

Raising current infrastructure heights to meet 20 year plus sea level rise projections may be implausible considering current and even 10 year planned efficiencies of vessel and cargo handling. A careful analysis of infrastructure changes is required to ensure that efficient operations are maintained.

Each seaport in Florida is uniquely able to evaluate and plan for sea level rise through its master planning process, which is required to take place every five years.[17] Florida seaports take advantage of evaluating how to address and plan for sea level rise in the statutorily required port master planning process, which requires updates every five years to qualify for Florida Seaport Transportation and Economic Development Program (FSTED) funding. Section 163.3178(2)(K), F.S., requires that port master plans be included in the local government's coastal management element and requires that port master plans identify existing port facilities and any proposed expansions. To the extent applicable, port master plans must also address the impacts of sea level rise due to the obligation to plan for environmental impacts and protect the coastal environment. The general lifespan of seaport infrastructure, the relatively predicted slow rise of sea levels, and the five-year master plan requirement creates a good roadmap for Florida seaports to assess and plan for the potential impacts of predicted sea level rise on their waterfront operations and infrastructure.

Most seaport waterfront infrastructure, such as wharfs, berths, cranes, warehouses and other large cargo handling equipment are costly to replace but also have limited life spans. For a seaport to replace large portions of its wharf would cost hundreds of millions of dollars along with the supplemental costs of reduced cargo efficiency during replacement. Wharfs and berths have an approximate lifespan of 50 years and have an average wharf/berth height between 7.5-12.5 feet above water. Port cargo handling equipment is designed based on current ship size, which changes with each new generation of vessels. This waterfront infrastructure, and the ships they are designed to service, will undergo life cycle changes at a typical frequency of 20-50 years. This is a critical element Florida seaports evaluate when determining how to address potential sea level rise. It is not efficient or practical for a seaport to expend significant resources in the near term to address the potential impacts of sea level rise beyond the predicted service life of the infrastructure.

CASE STUDY: JAXPORT

As part of JAXPORT's ongoing commitment to protecting the environment, the Port partners with the City of Jacksonville and the Jacksonville Electric Authority to continue to fund the Physical Oceanographic Real-Time System (PORTS), which offers monitoring data from 15 stations comprised of dozens of sensors located along the St. Johns River and its tributaries in Northeast Florida. The system monitors salinity and other river conditions, and provides critical information for projecting storm surge.

Florida seaports must continue to assess the data on sea level rise and its potential implications on the efficient movement of people and cargo through their ports. With an understanding of the causes and projections of sea level rise, Florida seaports must evaluate when to address and plan for those impacts. Seaports are uniquely set apart from cities, counties, state agencies or other entities evaluating and planning for sea level rise. As coastal transportation infrastructure, seaports' infrastructure is costly to replace and engineered for efficient cargo handling for present-day sea level conditions taking into account tidal fluctuations. Each Florida seaport evaluates their current infrastructure and remaining lifespan, the costs of replacing that infrastructure, and the projected sea level rise trends when evaluating for resiliency against sea level rise.

When evaluating predictive maps and planning for sea level rise, a port should take preemptive measures to conduct asset management inventories of its infrastructure and plan to address any needed modifications to address sea level rise when it makes the most economic sense. If the predicted high global

sea level in 2050 is approximately 2 feet, and a seaport's infrastructure will be due for replacement near that time, it is more economical and less disruptive to current cargo handling efficiency to address infrastructure modifications to accommodate sea level rise at that time. Another benefit to this approach is the additional time to allow data to test the accuracy of predictive models and be able to better plan for potential future sea level rise. Florida seaports already must have cargo handling equipment that can accommodate approximately 2.5 feet of tidal fluctuation. This is within the range of the anticipated sea level increases in 2050, so there is no compelling urgency to update equipment or infrastructure prior to the normal replacement cycle.

Florida seaports should begin conducting risk assessments of potential sea level rise, but with the unique conditions imposed upon them as coastal transportation infrastructure. While addressing critical waterfront infrastructure may cause severe disruptions to the efficient transport of goods and people and be economically infeasible, seaports may be planning to construct other infrastructure that has the potential of being impacted by sea level rise. For such infrastructure, ports should use the predictive maps (information to various tools included in Appendix) to determine proper elevations to ensure they are resilient against rising sea levels.

Approaching sea level rise from this bifurcated approach will allow seaports to utilize the master planning process to assess sea level rise on critical waterfront infrastructure and address those impacts in the most economical manner while still accounting for potential impacts to future construction or less critical/costly infrastructure. Due to the complexity of seaport operations and their need for present-day cargo handling efficiency, assessing sea level rise in this manner is the best practice utilized by Florida seaports to ensure their long-term resiliency.

COORDINATION AMONG STAKEHOLDERS IS CRITICAL TO SEAPORT RESILIENCY.

BEST PRACTICES TO PREPARE FOR NATURAL DISASTERS

The 2017 hurricane season was a record year for the U.S. and its territories, with four of six major hurricanes making landfall in the U.S. and impacting coastal communities and their infrastructure.[18] Similarly, 2018 had large storms directly impacting Florida's ports, including Hurricane Michael.[19] All told, 2018 saw the fourth highest total number of significant weather events in the U.S., behind only 2017, 2011, and 2016 respectively, and the fourth highest costs behind 2017, 2005, and 2012, respectively.[20] Hurricanes Michael and Florence accounted for approximately $73 billion in damages, and the total damages from severe storms in 2017 broke all previous records with a reported $306.2 billion in damages nationally.[21]

Due to coastal locations, seaports are vulnerable to the effects of hurricanes and their associated high winds, flooding from storm surge and major rainfall, uncertainty as to exact landfall locations, and crippled energy, water, sewer and transportation infrastructure. Port disruptions affect freight businesses directly involved in maritime operations and the broader regional economies and industrial sectors they support. Therefore, dealing efficiently with such disruptions is a high priority for seaports as well as all levels of state and local government.

A seaport's continuing success during and after such storm events depends on effective coordination of the many aspects of port operations, each involving infrastructure, personnel, technology, communication, and financial resources. As a result, ports are subject to a variety of vulnerabilities including damaged infrastructure, human actions, technological failures, and organizational failures.[22] Compared to other transportation infrastructure, seaports must address additional institutional and physical challenges due to the mixture of privately owned/operated facilities, publicly owned/operated facilities, and publicly owned-privately operated facilities. Each stakeholder has its own set of priorities and constraints that come into play whenever a seaport's cargo movement is disrupted due to storm events, and how these various stakeholders interact with each other varies from port to port.

Although the number and make-up of the stakeholders involved in port operations varies, in general they include the port authorities themselves, private-sector operators doing business within the port, and local, state, and federal government agencies. When a major disruption to a seaport's cargo operations occurs, federal, state, and local government agencies often become involved. Usually, local and state authorities take the lead in responding to emergencies, with federal agency support provided when needed, and especially when local resources become strained or when an event causes problems that extend beyond the physical boundaries of a port.

Coordination among stakeholders is a difficult, but critical element to seaport resiliency. A seaport remains extremely vulnerable if a plan is not in place to ensure personnel and stakeholders perform their necessary tasks following a disruption event and open communication is in place. A lack of coordination not only creates further disruption during a critical time but will likely result in critical infrastructure remaining offline for longer periods leading to additional delays and costs in bringing the seaport to pre-disruption supply chain levels. This is why it is paramount that any seaport resiliency plan not only focuses on preparation, but also considers the critical responses needed after the incident has occurred in order to expedite the return to normal operations.[23]

This coordination effort should fall into three general categories: 1) Preparedness – actions taken before a storm event to avoid or limit a storm's disruptive impact;

PREPAREDNESS
actions taken before a storm event to avoid or limit a disruptive impact

RESPONSE
actions to address immediate impacts of the storm event

RECOVERY
actions taken to get the port to pre-storm event operating levels

2) Response – actions to address immediate impacts of the storm event; and 3) Recovery – actions taken to get the port to pre-storm event operating levels. Collectively, these efforts work to increase seaport resiliency through greater planning, redundancy and flexibility.

In order to increase resiliency against hurricanes or other storm events, seaports should plan for and implement these systems and protocols across key sections of its operations, particularly its infrastructure and technology, personnel and communications, and coordination with outside local, state and federal entities and utilities.[24] Included in this study are examples of lessons learned from disruptions caused by severe storm events and best practices derived from those events.[25] Each storm event presents a unique set of challenges that seaports should consider when evaluating ways to increase their resiliency. While planning for every circumstance is not possible, there are many common factors that can be evaluated from past events and applied prior to the next event on the path to becoming more resilient. This process of continuous improvement requires a thorough and honest after-action review process to identify strengths and weaknesses in a resiliency plan and then a commitment to implementing any needed improvements.

CREATING MORE RESILIENT INFRASTRUCTURE & PREPLANNING

The economic and social impacts by hurricanes and severe storm events demand the continued increase of more resilient infrastructure. This was clearly demonstrated during the 2005 hurricane season. 2005 was a record-breaking year for severe storm events with 27 named storms including 14 hurricanes. Of those, there were eight major hurricanes and an unprecedented three category 5 hurricanes. Seven of these named storms made landfall on the United States leading 2005 to be one of the most destructive years with damages well over $100 billion.[26] In response, several groups engaged in analysis of the impacts from these multiple storm events and recommended best practices to create more resilient seaport infrastructure. Below are some of the lessons learned from past storm events, many of which have been implemented by Florida seaports in evaluating and updating their resiliency plans.

Past lessons have demonstrated that all layers of supply chain considerations, including seaports, airports, railroads, trucking firms, warehouses and distribution centers, can be disrupted by a severe storm event and all play a large role in the immediate response and resumption of operations. As a result, many lessons can be learned across all three categories of resiliency planning (infrastructure and technology; personnel and communications; and coordination with outside agencies/entities). Because each storm is unique and can present multiple threats such as high winds and flooding, it is critical that ports evaluate their infrastructure resiliency from multiple perspectives.

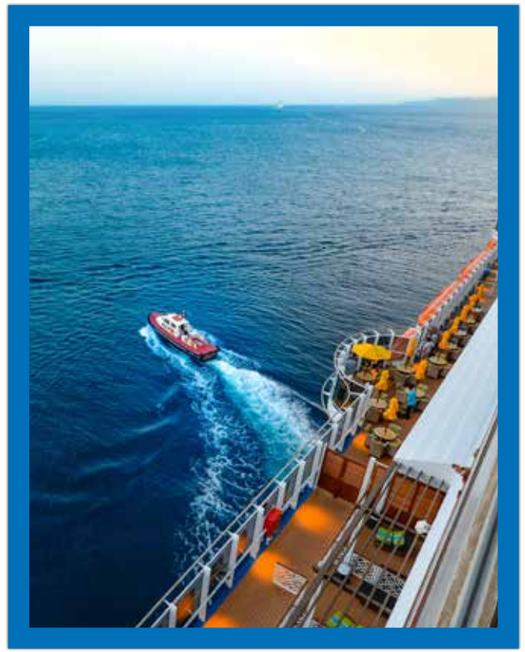
CRITICAL ASSETS

- Navigable channel clearance and depth
- Navigation support vessels
- Terminal storage space and on-dock storage space
- Shipboard and intermodal cargo handling equipment
- Transportation fuels and fueling terminals
- Telecommunications, internet, cell service
- Port servicing trucks
- Pipeline Assets
- Rail
- Vessel, equipment, cargo/container tracking systems
- Vehicles/equipment for debris removal
- Utilities (power, water, sewer)
- Port/terminal access routes
- Electronic/battery operated equipment to operate warehouse doors
- Office structures
- Intermodal connections and capacity to move cargo
- Warehouses and other ancillary structures
- Skilled labor to operate specialized equipment
- Tenant facilities
- Port Security and Access
- Wharves and Berths
- Financial resources (payroll, purchases, accounts payable, insurance)
- Critical records (paper and digital)

A thorough assessment of all required infrastructure and equipment, including technology, for day-to-day operations is necessary. The prior page list of some critical assets impacted from various storm events. As discussed in more detail below, there are now tools available to seaports that assist in evaluating critical infrastructure for resiliency planning.

The most critical priority for planning is the need to ensure channels and navigable waters are cleared for access to the port post-event. This requires coordination prior to and following the storm event between the seaport, the U.S. Coast Guard (USCG), the U.S. Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA). The USACE uses its vessels to survey navigable channels depths, identify submerged obstructions, clear floating debris and to pull and collect obstructions from deep draft channels. Once the channels are clear, the USACE notifies the USCG, who then updates any waiting vessels and port management.

Aids to Navigation (ATON) Verification is another critical component to reopening operational navigation channels for port access. Because the USCG conducts most of these activities, coordination should be maintained between the port and the USCG to ensure buoy tenders as well as spare ATON are pre-positioned in safe areas and ready to deploy quickly. Another tool to assist in surveying and clearing channels is NOAA's mobile integrated survey team (MIST) kits, which can be provided to private vessel operators to help survey channels.[27] A plan should be in place to deploy MIST kits to any vessel of opportunity, such as pilot vessels. Flooding and sea conditions during Hurricane Irma, discussed in more detail below, made it extremely difficult to transport extra ATON to the needed locations and reinstate ATON. As a result, the USCG has used its NAIS infrastructure to broadcast AIS-ATON in affected ports. By working with USCG District Waterways Offices, a pre-defined list of AIS-ATON can be identified and turned on in advance of an approaching storm event. AIS-ATON can be utilized by USCG units charged with port recovery to rapidly triage aids to navigation and prioritize repairs.



As access to the port is critical to resume operations, a plan should be in place prior to a storm event to ensure coordination with the above-identified agencies so that channel surveying and reopening is conducted as swiftly as possible. The USACE has limited resources for surveying vessels and often place them in/near predicted storm paths which, due to the unpredictability of such storms, may not be accurate. Accordingly, many Florida seaports have purchased vessels with necessary surveying equipment and trained crews to assist the USACE in such survey efforts.

While the list of critical assets is broad and intended to address much of a seaport's critical infrastructure, the most important of these in terms of returning to pre-event operational levels are: 1) channel surveying and reopening; 2) restoring electrical power; and 3) resuming fueling terminal operations.

CHANNEL SURVEYING & REOPENING

RESTORING ELECTRICAL POWER

RESUMING FUELING TERMINAL OPERATIONS

BEST PRACTICE

Seaports should make sure they are deemed critical infrastructure with local and state entities to ensure prompt response and have emergency backup generators on standby as necessary.

The second most critical aspect causing delays for reopening a port and resuming normal operations is the loss of power. Most other infrastructure assets rely on electricity and past experience has demonstrated that because utility operations are located outside of a seaport's control, they were unable to address this issue internally thereby causing extensive delays. This was evident following the 2005 hurricane season.

In October 2005, Wilma, began developing rapidly in the Caribbean Sea, growing from a tropical storm to a Category 5 hurricane in just 24 hours.[28] After crossing the Yucatán Peninsula of Mexico, Wilma crossed the Gulf of Mexico and made landfall in Florida as a Category 3 hurricane with an eyewall nearly 60 miles in diameter and producing multiple tornados across several counties. Due to the large size of Wilma's core and sustained winds impacting much of the peninsula, southern Florida encountered widespread damage, including the largest disruption of electrical services ever experienced in Florida with nearly 98-percent of south Florida losing power. Florida Power and Light reported outages in 42 counties. Wilma remains one of the more destructive and costliest storms with damages estimated at approximately $21 billion.[29] Lacking pre-existing agreements with utility companies, and having no other redundancies in place, many ports were unable to restore power to critical areas.

Some best practices for storm preparation include proactive engagement with local utility providers, as well as procurement of emergency generators and other emerging micro-grid technologies. Many Florida seaports now have agreements with local governments and utility providers to ensure that they receive priority treatment in power restoration. This requires pre-storm season coordination to ensure local prioritization with county officials and utility providers. Florida seaports have proactively worked with state and local governments and utility providers to ensure the electrical infrastructure leading to a seaport is hardened by replacing wooden power poles with concrete poles that can withstand Category 5 winds. Another way Florida seaports are leading the way on resiliency is by coordinating with utilities for additional power supply for critical infrastructure that operates on a different sector of the utility company's grid. This offers redundancy should one sector of the grid sustain greater damage than the other or be capable of coming back online faster.

In addition, the purchase of generators and sufficient fuel to operate them for at least three to five days ensures that critical infrastructure will be available while the power grid is being restored. Generators should also be located in areas well above historic and projected storm surge heights.[30] This is critical as many seaports have installed backup generators only to have them destroyed by higher than predicted storm surge.

Directly related to power supply is the need to ensure fueling terminals and distribution stations are resilient and able to quickly restore to operating status following disruptions. This was another lesson learned from Hurricane Wilma and quickly addressed by Florida seaports following that event. While the majority of seaport infrastructure requires electricity, an equally large portion of seaport infrastructure requires fuel, particularly vehicles and equipment required to respond to hurricane damage and resume cargo operations. Additionally, Florida seaports support fuel distribution for much of the state, which is a critical need following severe storm events.

Port Everglades, one the state's largest fuel distributors, went nearly four days without power to their fueling terminals following Hurricane Wilma due to aging utility infrastructure leading to the port. Port Everglades subsequently worked with utlity provider Florida Power and Light to substantially harden that infrastructure and to ensure that it is identified as a priority area for power restoration. Similarly, Port Tampa Bay, another large fuel

distributor in Florida, has worked to ensure their fueling terminals are resilient with similar agreements with utility providers. Additionally, seaports should ensure that all fueling stations and terminals have sufficient backup power through generators (and fuel to operate the backup power) that is located well above potential storm surge levels. Staging and storage areas should be pre-identified for response and recovery equipment and fuel.

In addition to these key elements of a seaport's infrastructure, it is imperative to increase resiliency to all other areas of infrastructure. As past storms have demonstrated, lack of water and sewer utilities are another issue that severely impacts a port's response following a hurricane. Without running water, toilets, and showers available to essential staff and emergency personnel, recovery efforts can be greatly impaired. To address this, seaports should have agreements in place with portable water, shower, and toilet providers to deliver this equipment to a safe location before a storm event to ensure it is immediately accessible and not delayed due to damaged roads or flooding. Additionally, having bedding supplies, bottled water, food reserves and places for personnel to sleep/rest during the extended working hours after a hurricane is another best practice as it may be difficult to travel to/from the port. Such supplies should account for the pre-identified number of essential personnel.

Another major issue is the need for infrastructure to support port operations and recovery efforts, including office space, security assets, and access to port information systems and records. The primary hub for all these activities is the main operations center, and best practices should be implemented to ensure essential port personnel have a place to conduct activities to bring the port back to pre-storm operating levels. An operations center must have backup power, a functioning communications network, internet access to coordinate with emergency agencies and personnel through online systems, and necessary supplies such as food, water and restroom facilities. Because this

BEST PRACTICE CONTINUED

is the main base of operations before, during, and after any disruptive event, annual inspections should be conducted to ensure all necessary equipment is working properly and supplies are in place. One issue several seaports have encountered is failure of cellular devices due to cell tower damage. Satellite phones or two-way radios should be available as a backup form of communications, and they should be tested for functionality before a storm event. Another consideration is to have an offsite location fully equipped and capable of conducting recovery and day-to-day operations and informing any emergency personnel and state and federal agencies of the offsite location.

Another critical aspect of seaport resiliency is pre-prioritized placement of cargo handling and heavy equipment and port response vehicles to protected areas so that they are immediately available following the storm event. One of the major issues following a hurricane that causes extended delays is the loss of on-dock storage space as containers and cargo cannot be transported due to damaged cargo handling equipment and intermodal transportation vehicles. Moving truck, rail, and other cargo handling equipment to temporary safe locations, even if it is off port property, should be considered.

Storm-related vessel and cargo surges can be just as disruptive to supply chains and freight movement as port closures. Logistics plans and protocols should be considered to handle surges of diverted shipments. Florida seaports are again leading the nation in this regard having entered into a Memorandum of Agreement to assist impacted Florida ports with necessary equipment for the processing of diverted shipments following a hurricane or other disruptive event. The Memorandum is reviewed after each significant event to determine if any additional protocols are necessary for continued increase in Florida seaport resiliency.

Likewise, plans should be in place for expected labor interruptions following a hurricane and necessary security protocols to address this. Many employees are likely to be directly impacted or may be having difficulty returning to the port following a severe storm. Seaports should have a plan in place to bring additional labor into the port to handle disruptions in cargo movement. This can include truck drivers, longshoremen, vessel/vehicle repairmen, debris removal crews, law enforcement, fire departments or hazmat teams. Bringing these additional personnel on port property requires planning, including addressing the need for proper credentials. Truck drivers entering a port must have a Transportation Worker Identification Credential (TWIC) card, and most U.S. seaports also have their own local registration system for drivers. In some cases following severe storms, port officials and laborers had difficulty entering affected ports because they lacked the required credentials.[31] Ports should also have a plan for extending gate hours, along with plans/agreements with truck and railroad companies for extended operating hours, to ensure the efficient movement of cargo and resolve any backlogs. Lastly, security fencing and gates may need to be repaired prior to the resumption of port operations.

Additional elements of a seaport infrastructure that should be included in a resiliency plan is coordination of tenant infrastructure and equipment as well as their resiliency and/or business continuity plans. There should be a plan to ensure that any tenant infrastructure or equipment that, due to high winds or flood waters, could cause damage to critical seaport infrastructure is moved to a safe location. Likewise, any tenant infrastructure that is essential for cargo movement or to assist in the resumption of normal seaport operations should be moved to pre-identify protected areas to ensure availability immediately after the storm passes. Seaports should also request copies of their tenants' resiliency or business continuity plans and work to coordinate planning efforts with port personnel to respond and recover as quickly as possible.

ENSURING RESILIENT PERSONNEL & COMMUNICATIONS

Coordination and communication between essential personnel to maintain the flow of logistics information throughout the supply chain, from truckers to suppliers to carriers to key federal agencies, is one of the single most important elements of returning a seaport to normal operations following a hurricane or severe storm event. The ability to maintain the flow of information before, during, and after a hurricane directly affects recovery time. Florida seaports have always been on the leading edge of hurricane resiliency and many of the best practices identified in this study have been implemented throughout Florida seaports. However, as stated, every hurricane and seaport are unique and can present unanticipated challenges and new learning opportunities.

Seaport information systems, including computers, network equipment and electronic document storage, may not typically be considered as seaport infrastructure. However, these systems are absolutely critical to seaport resiliency. Seaports should develop backup systems for all critical information technology functions. Backup systems should be located in areas that are not likely to be impacted by the storm event, with copies located in an off-site location if possible. Cloud-based technology to backup necessary information systems and ensure that essential personnel are able to access that information remotely should also be utilized as an additional precautionary step. Ports should consider requiring employees to enroll in direct deposit so payroll can be processed from anywhere with an internet connection. An additional related practice is to have hard copies for all executive staff of important insurance documents, personnel records, contacts, and the broker/claims agent contact information immediately available for recovery efforts. Pre-event planning should include annual video/photo inventory of seaport assets to assist with damage assessment and insurance claims after an event.

BACKUP SYSTEMS

Develop backup systems for all critical information technology functions.

DIRECT DEPOSIT

Require employees to enroll in direct deposit so payroll can be processed from anywhere with an internet connection.

HARD COPIES

Have hard copies for all executive staff of important documents immediately available for recovery efforts.

VIDEOS/PHOTOS

Take annual video/photo inventory of seaport assets to assist with damage assessment and insurance claims.

In 2017, the Gulf of Mexico encountered category 4 Hurricanes Harvey and Irma only weeks apart from one another. These two storms had very different effects on the seaports they impacted and, due to the short time period between the storms, communication and personnel resiliency were key to swift response and recovery.

Hurricane Harvey was the second costliest hurricane in U.S. history (after inflation), behind only Hurricane Katrina in 2005, costing approximately $125 billion.[32] On August 25, 2017, Hurricane Harvey made landfall along the Texas coast near Port Arkansas as a Category 4 storm with sustained winds of 130mph.[33] Harvey also brought a large storm surge of 9.5 feet and was the most significant tropical cyclone rainfall event in U.S. history with total rainfall reported of 60.8 inches. FEMA estimated that more than 19 trillion gallons of rainwater fell on parts of Texas, causing widespread, catastrophic flooding.[34]

Hurricane Irma made landfall on September 6, 2017, on the Virgin Islands as a Category 5 hurricane with reported wind gusts of 131 mph and four days later made landfall on the Florida Keys as a Category 4.[35] While Irma did not cause catastrophic impacts by the time it reached the southeast coast near Marco Island, it did cause significant power outages, widespread flooding, and forced the closure of many Florida seaports. One of the more difficult issues caused by Irma was coordinating key port and interagency personnel due to the incredibly close proximity to Hurricane Harvey.

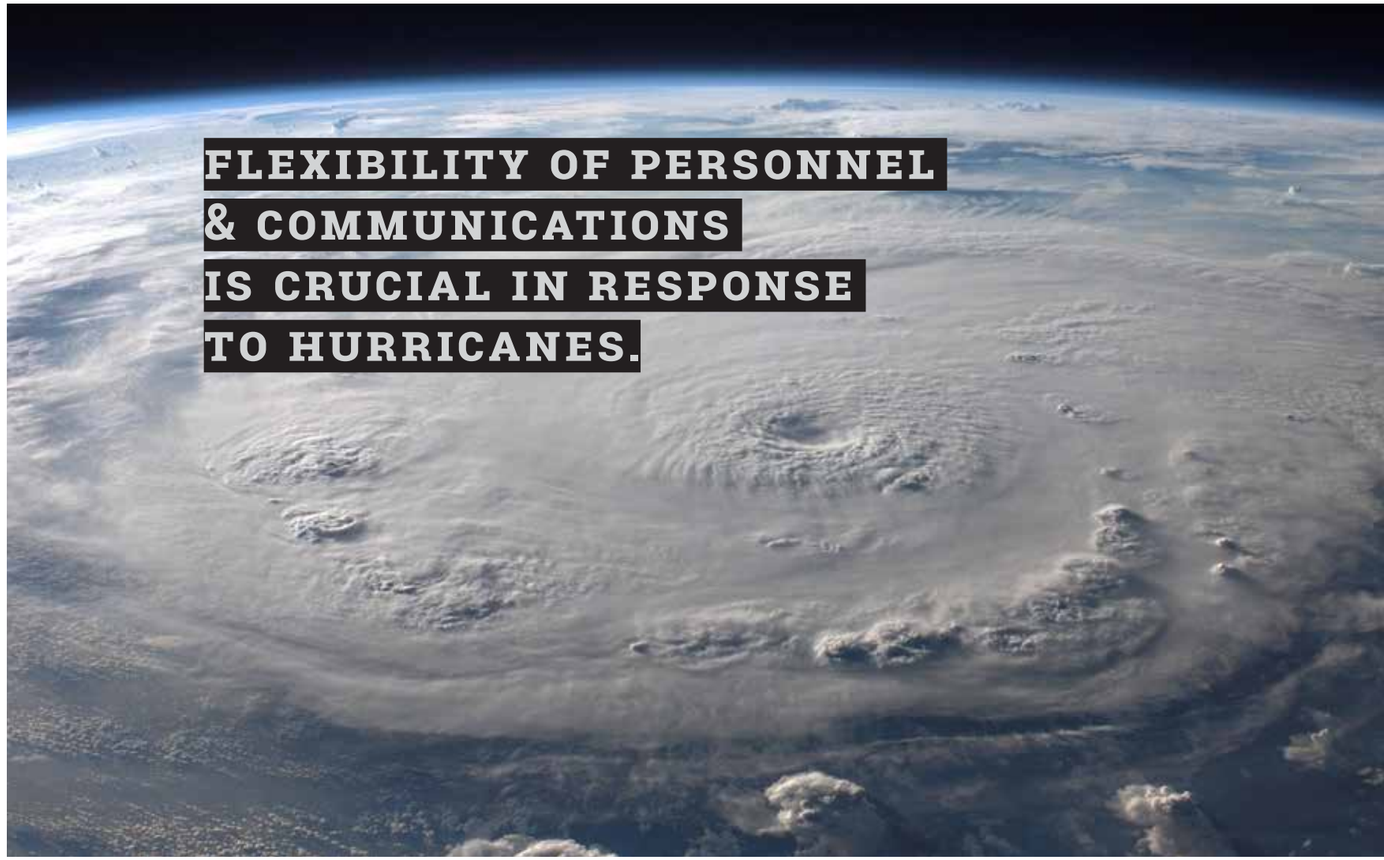
Key pre-storm communication actions included the establishment of clear chains of communication between field units and decision makers. Two-way communication from units in the field and reporting back up through the chain of command ensured responders could manage issues quickly. Using a centralized information distribution center further assisted with the early transmission of information and reporting out to the field in the days leading up to the arrival of Hurricanes Harvey and Irma. This was not only beneficial to internal agency communications but provided a forum for most agencies involved with preparation to communicate and share their own information.

Even with the robust pre-event planning and communication, the unprecedented rainfall and flooding caused by Hurricane Harvey severely impacted recovery times across Texas seaports. The limited availability of port condition or status information impacted knowledge management and opportunities for collaboration. Essential port personnel and first responders had difficulty balancing their immediate duties with continuous information requests which resulted in a bottleneck of communications regarding the status of the Port.[36]

Responses and recovery operations through both of these storms faced challenges related to communications with essential personnel and federal agencies. These challenges prompted discussions at multiple levels on how to mitigate and overcome future communications disruptions, as well as alleviate the impact on response and recovery.[37] Communications among essential port personnel, first responders, media, and the public was a consistent problem and identified as one that must be addressed in any resiliency plan.

The use of regionalized reporting from a common source, such as the USCG's Common Assessment and Reporting Tool (CART) system, has proven helpful to ensure responders are operating with the same information. Florida seaports recognized the need to fill information sharing gaps and communication disruptions by utilizing a single information reporting software and, once again leading the nation on resiliency, purchased the ARES CommandBridge CARRT system. This allows all Florida seaports to be connected to the same information sharing system as well as multiple state and federal agencies, to ensure all critical personnel are receiving the most up to date information and can coordinate resources as necessary in support of response actions.

Communication and coordination among essential port personnel, public agencies, public and private organizations, and along the entire supply chain is critical to ensure swift response and recovery. Ports should have a designated, suitably trained, and qualified emergency manager who plans for, coordinates activities and communications, and monitors disruptive events. Due to the need for both operational communications and public information sharing during storm events, one suggested approach is to assemble the port executive director, public affairs officer, and emergency manager in the emergency operations center. This ensures the personnel responsible for critical decision-making and communicating those decisions are in one place and can efficiently relay



that information to other essential personnel and first responders. Additionally, designated essential personnel should participate in National Incident Management Systems (NIMS) training.[38]

Outside of the need for clear and rapid communication with essential port personnel and federal agencies, communication with the media has proven successful in providing the public with regular status updates as well as preventing or reducing speculation. Regular media updates can provide information to all stakeholders and facilitate a smoother and faster recovery process. Communications with customers is crucial to let them know where their shipments are and in what condition. It is important to get this information out to the customers quickly. In addition, maintaining an emergency hotline to provide information on evacuation and return-to-work procedures for employees can assist in ensuring essential personnel and necessary labor for cargo movement have up-to-date information on how to safely and quickly return to the port.

There also must be clear communication between the seaport emergency manager and state and federal agencies. As discussed above, there are multiple agencies involved in helping seaports respond to hurricanes, and there should be a main contact at the port to coordinate these efforts. The plan should also detail the categories of essential personnel and their responsibilities before, during, and after a hurricane and that such personnel communicate with the emergency manager. The port should also send a list of the essential personnel to the sheriff's department and local emergency departments to help facilitate getting back into the port after an event, even if the surrounding areas remain closed.

Seaports should also designate thresholds for restarting port operations and a person in charge of such decision-making. Typically, the thresholds include assessment of the condition of the transportation assets in the port, its infrastructure, as well as health, safety, and damage assessments.

Cargo prioritization planning should be considered, along with acceptable cargo flow rates, to avoid bottlenecks in cargo transportation. This plan should address the potential issues surrounding cargo movement in times of disaster, including what roles will the government (local, state, and federal) play in this process, how will labor availability affect such planning, and how may security issues affect the movement of cargo. It is recommended that an advisory unit be created to include necessary executive staff, the emergency manager, seaport security personnel, and other personnel that are essential to the port's cargo management and transportation functions.

BEST PRACTICE

Flexibility of personnel and communications is also crucial in response to hurricanes.

It is nearly impossible to plan for every contingency given the unique characteristics of an individual storm's impacts and a seaport's ability to tolerate those impacts. While flexibility and potential improvisation may be difficult to plan for, conducting simulations, scenario planning or table-top exercises each year will help reveal potential weaknesses in both personnel and communication networks and methods to improvise should those events occur. While these exercises may require significant time to plan and execute, they could save a seaport significant time and money when a disaster hits. Another best practice to both help train personnel and reveal unknown weaknesses (either in personnel, communications, or a resiliency plan) is to coordinate with other ports, local governments or surrounding states to deploy essential personnel to disaster sites to gain firsthand experience of operating in the aftermath of a hurricane or severe storm event.

COORDINATION WITH SURROUNDING COMMUNITIES & REGIONS

Each of the best practices described in this study relate to seaport's infrastructure, personnel or communications. However, to further increase a seaport's resiliency, these same considerations must be evaluated outside of the port's boundaries and incorporated into the resiliency planning process.

While a seaport cannot control all aspects of emergency response outside its perimeter, efforts should be made to coordinate with local governments, utilities and surrounding communities to ensure that restoring access to/from the port, necessary utilities, and access to emergency personnel are a top priority. It is critical that decision makers in each of these sectors understand the vital role that ports play in recovery efforts, such as supplying fuel and relief supplies to the impacted communities. It is also critical that ports understand the role inland modes of transportation have on increasing their resiliency by ensuring cargo can efficiently be transported from terminals and docks and reduce the potential for backlog.

Seaports should engage with local decision makers and utilities and consider executing written agreements to ensure that the port receives priority treatment from off-port emergency personnel to assist in clearing the routes into the port. This may include selecting a preferred route ahead of time and building in flexibility for additional routes to account for severe road or debris damage. Ports should also strive for agreements between local governments and utility providers identifying the port as a top priority for restoration of utilities including power, water and sewer – with power restoration being the top priority. A practice that may help foster collaboration and provide for a better understanding of the importance of resuming port operations and cargo flow after a hurricane is to provide port and logistics training for first responders and other stakeholders such as utility companies and local governments.

In addition to coordinating to ensure port operations can resume as soon as possible, ports can also coordinate with their local governments and surrounding communities to provide emergency operations facilities, staging areas for emergency supplies, or even temporary office buildings for government services.

CASE STUDY: PORT PANAMA CITY

IN THE AFTERMATH OF HURRICANE MICHAEL, PORT PANAMA CITY DONATED THE USE OF SEVEN ACRES OF SPACE AT A BULK TRANSFER FACILITY, AND TEN ACRES AT AN INDUSTRIAL SITE, AS A STAGING AREA FOR HURRICANE RELIEF.[39]

By providing these staging areas, cell phone companies were able to expedite the restoration of cellular service, utility companies had staging areas to store materials and coordinate power restoration, and mobile banking systems were set up for cash withdrawal and other bank transactions. Some staging areas were still being used five months after the hurricane due to the degree of damage to the surrounding area. Achieving resiliency in seaports and near-port communities involves an understanding of the interdependency and interconnectedness between ports, local governments and communities. A resilient seaport requires hardened physical and technological infrastructure, coordination of personnel and communication, and organizational and operational resilience beyond its perimeter.

RESOURCES TO ASSIST PORTS IN RESILIENCY PLANNING EXECUTION

The increased number of hurricane and severe storm events over the past decade, along with the models predicting the potential impacts of sea level rise, has encouraged the advancement of various resources to assist in resiliency planning. Among these resources is funding and technical support for the creation and implementation of resiliency plans. Below are some resources available to Florida seaports in their resiliency planning and execution.

STATE & FEDERAL AGENCY RESOURCES & TOOLS

Multiple agencies at the state and federal level are available to partner with Florida seaports in their resiliency planning process and in the implementation of those plans. Coordinating with these agencies during the planning phase will improve communication and response activities during and following storm events and may expedite the availability of emergency funding. Florida seaports have their designated emergency manager and coordinate regularly with appropriate agency representatives and prior to the start of each hurricane season.

The U.S. Committee on the Marine Transportation System created the Resilience Integrated Action Team (MTS R-IAT) to focus on cross-Federal agency knowledge and governance in order to incorporate the concepts of resilience into the operation and management of the U.S. Marine Transportation System.[40] MTS R-IAT works with the USCG and NOAA to coordinate among multiple federal agencies and assist seaports in their resiliency planning against hurricanes and other severe storm events. They evaluate pre- and post-storm actions in search of improved best practices for resiliency planning. Through this coordinated effort, annual summaries are created with new best practices to consider based on experiences from recently impacted seaports.

In the event of a major disaster, it is the responsibility of Federal Emergency Management Agency (FEMA) to coordinate federal agency responses and to ensure the deployment of necessary federal assistance. FEMA support includes financial assistance to states, tribes, and local governments and individuals, and coordinating the efforts of other Federal agencies to protect life and property. As the lead Federal agency, FEMA authorizes the USCG and the USACE to perform dredging activities to expedite the reopening of navigation channels and other response and recovery operations.

The USCG is the responsible agency for addressing Marine Transportation System (MTS) recovery efforts. Coordination of recovery activities is facilitated through the local USCG Captain of the Port, Marine Transportation System Recovery Units and FEMA emergency support functions. Following a hurricane, the USCG stands up an Incident Command System to support the response and recovery of impacted port, including coordinating recovery efforts between the Coast Guard, Federal and state/local agencies and organizations.
As briefly described previously, to assist in this process, the USCG created the Common Assessment Reporting Tool (CART) to identify pre-storm status of waterways and navigation systems, port area critical infrastructure, port area vessels, offshore energy infrastructure, and monitoring systems to aid in identifying storm-related impacts. CART is updated several times daily throughout the response and recovery phases of each major storm to make that information available to seaports and other involved stakeholders. Florida seaports have led the way in the nation with their implementation of the ARES CommandBridge CARRT system for all seaports. This system is an excellent tool, but could be improved by increased interagency integration, especially with the USCG.

NOAA supports the federal response and recovery mission by providing critical data and expertise including maritime-specific navigation, observation, and positioning services. NOAA also provides pre-storm aerial imaging which is crucial in conducting flood and damage assessment.

The USACE assists response and recovery operations undertaken and initiated by the Department of Homeland Security (DHS) and FEMA. USACE has the responsibility to maintain and ensure the return to operational status of federal navigation channels at their authorized depths following storm events. They also maintain other types of navigation projects, such as locks, dams, port turning basins, and coastal structures. The USACE also works in close coordination with the USCG to facilitate the removal of marine debris that poses an obstruction to vessels transiting through federal navigation channels. Following a hurricane, the USACE provides these services on an expedited timeframe.

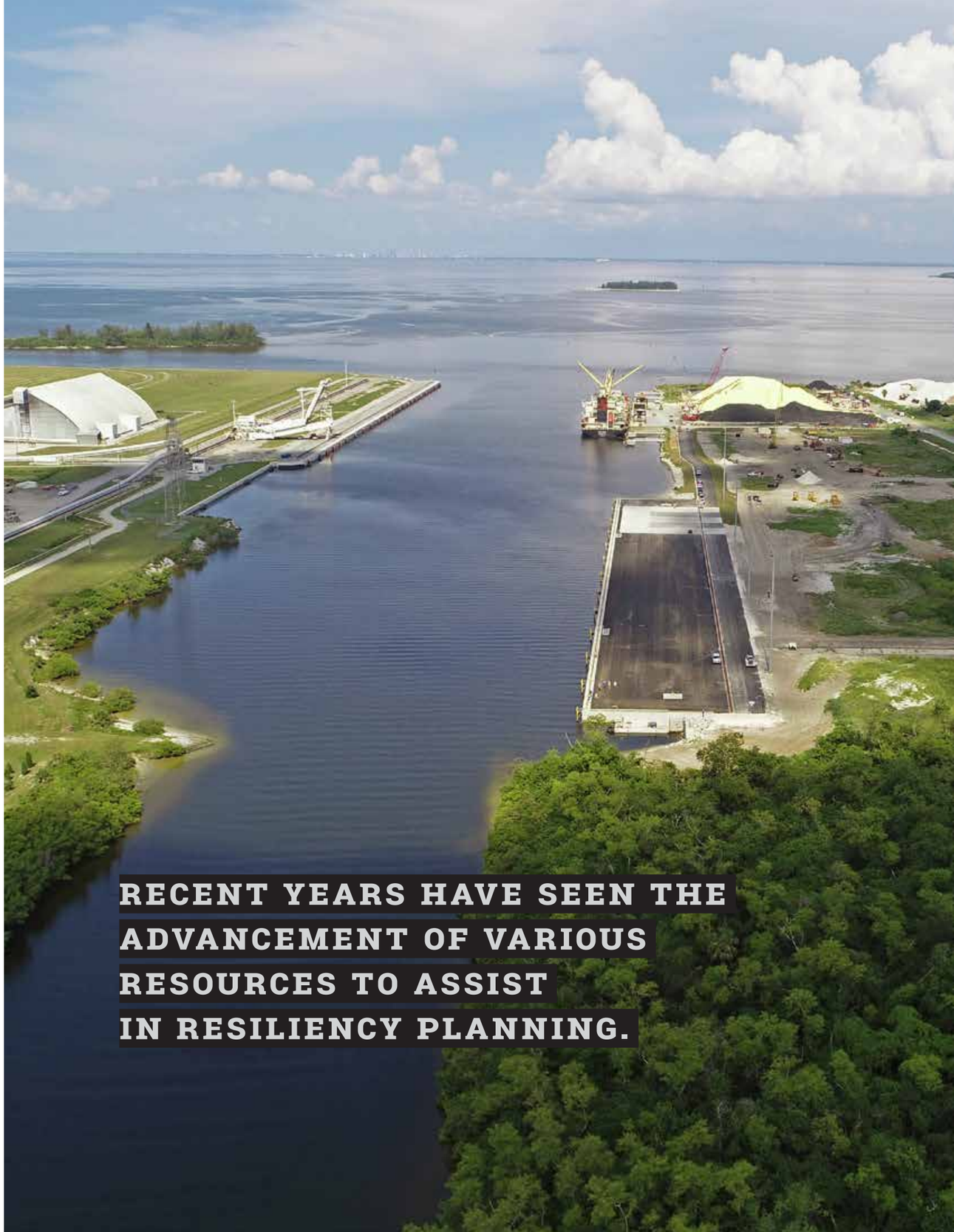
The Department of Transportation Maritime Administration (MARAD) maintains a Ready Reserve Fleet of government vessels to serve as command and control platforms during and after hurricanes. MARAD provides support for communication, berthing, housing, feeding, and medical support during emergencies. Subject to the availability of Federal funds, MARAD can also charter commercial vessels or procure other resources to assist in recovery efforts. MARAD can also provide seaports with technical assistance and grants to improve port infrastructure when Congress appropriates relief funding.

The Department of Homeland Security's Office of Infrastructure Protection (DHS IP) leads and coordinates national programs and policies on critical infrastructure security and resilience. DHS IP's Infrastructure Development and Recovery Program (IDR) facilitates responsibilities under the National Disaster Recovery Framework to support FEMA, USACE, and local communities in recovering infrastructure. IDR deploys trained personnel to impacted areas to assist with recovery and rebuilding decisions that promote long-term resilience by rebuilding "better than before." This effort is intended to reduce future costs and vulnerabilities across many types of industry sectors and facilities.

Another resource for resiliency planning available to Florida seaports is the Port Resiliency Index created by NOAA and the Gulf of Mexico Alliance.[41] Some Florida seaports have utilized this tool to evaluate their current plans and help increase their resiliency by implementing suggested best practices.

In addition to the agencies and tools identified above regarding hurricane resiliency, other agencies and resources are available to assist in planning for sea level rise. The University of Florida created the Geo Planning Center Florida Sea Level Sketch Planning Tool, which is a free program to review estimated sea level rise scenarios for any area in the state.[42] Florida seaports use this tool to evaluate projected sea levels at a specified date in the future and include those in design plans for future infrastructure projects.

NOAA also created the Sea level Rise Viewer - Coastal Inundation Toolkit, which provides valuable training, data, and tools for addressing sea level rise. Additionally, their website features a sea level rise viewer for coastal communities, which allows for visualization of coastal flooding at various heights of sea level rise.[43] The USACE has another sea level rise tool which uses live NOAA data to graph actual, current sea level rise alongside predicted points from models.[44] This tool can be helpful in the validation of sea level rise models. Climate Central, a non-profit research organization, created the Surging Sea Map Viewer, which allows the viewing of side-by-side maps of various sea level rise scenarios to determine the most critical potential areas of impact in one map view.[45] Finally, the Florida Department of Environmental Protection (FDEP) recently published a Florida Adaptation Planning Guidebook to help communities create a framework to develop or update existing resiliency plans to address sea level rise.[46] While aimed towards cities and counties, there are several resources and best practices that can be adapted to Florida seaports.



POTENTIAL FUNDING SOURCES FOR CREATION & IMPLEMENTATION OF RESILIENCY PLANS

There are a number of funding opportunities available at the federal and state level to assist Florida seaports in resiliency planning and response actions. In addition to grants, funding opportunities may exist in the form of partnerships with local communities or other interested stakeholders to share resources to support vulnerability assessments and integrate best practices into resiliency plans.

Recently, FDEP's Office of Resiliency and Coastal Protection, Florida Resilient Coastline Program, received $2.6 million in funding from the Florida Legislature to assist in resiliency planning and implementation actions in Florida coastal communities. As coastal transportation infrastructure is critical to Florida's economy and recovery efforts, Florida seaports are eligible to access these grant funds to assist in their resiliency planning. FDEP also has the Clean Water State Revolving fund which provides low interest loans for planning, designing and construction of water pollution control facilities. These low interest loans may be able to assist in the design and construction of more resilient stormwater management or other water control infrastructure on seaport property.

The Florida Department of Economic Opportunity's (DEO) Office of Disaster Recovery supports communities following disasters by addressing long-term recovery needs for housing, infrastructure and economic development, including funding needs that remain after other federal or private insurance assistance has been exhausted. The Florida Department of Transportation (FDOT) also has funding available through the Florida Seaport Transportation and Economic Development Council. Such funding requests would go through the normal SeaCIP application process.

FEMA has a number of funding opportunities that may be available to assist Florida seaports in their resiliency planning. Potential FEMA funding opportunities include: FEMA Community Disaster Loan Program (loans to offset loss of revenue due to natural disasters), FEMA Flood Mitigation Assistance Program (grants to reduce the number of repetitive loss structures insured by the National Flood Insurance Program), and the FEMA Hazard Mitigation Grant Program (grants to reduce loss of life and property due to natural disasters and enable mitigation measures to be implemented).

The Pre-Disaster Mitigation (PDM) program provides annual funding for hazard mitigation planning and implementation. The PDM is a competitive federal grant program designed to assist with the implementation of cost-effective mitigation activities prior to disasters to reduce the overall risk to people and property and minimize the cost of disaster recovery.

The USACE also has a number of potentially available funding opportunities. The USACE Hurricane and Storm Damage Reduction Projects provides funding opportunities for protection of facilities against damages caused by storm-driven waves. Though these funds may not be available for planning, they could potentially be used to repair and improve damaged infrastructure in accordance with adopted resiliency plans. USACE also has a Flood Damage Reduction program to plan, design and construct small flood control projects, which could assist in resiliency planning and implementation. NOAA's Office for Coastal Management offers a competitive Coastal Resilience Grant to fund coastal projects to prepare for and recover from extreme weather events, climate hazards and changing ocean conditions.

The Gulf of Mexico Alliance Gulf Star Funding Program is a public-private partnership to fund projects that are tied directly to Gulf economies, including coastal resilience. The goal of the program is to facilitate partnerships between the Gulf of Mexico Alliance and outside funding partners to strategically achieve measurable results around priority issues common to all five states of the Gulf of Mexico region.

In addition to the preceding list, there are options to assist Florida seaports in their resiliency planning and implementation.[47] There are a number of federal and state grant programs that may offer some form of funding for a particular piece of a resiliency plan. Additionally, creating partnerships with interested stakeholders, as evidenced by the Gulf of Mexico Alliance, assists in offsetting costs by allowing stakeholders to pool resources to fund planning efforts and implement those strategies in each of their plans. Using creative funding techniques such as these assist Florida seaports in creating and implementing robust resiliency plans while significantly reducing the associated costs.

CONCLUSION

TURNING VULNERABILITIES INTO OPPORTUNITIES

Florida seaports view resiliency planning as a long-term investment and continue to lead the nation in implementing resiliency best practices learned from past hurricanes and severe storm events. Florida seaports understand that actions taken now to reduce future risk will reduce the frequency or severity of storm-related supply chain interruptions. By continually increasing resiliency, Florida seaports ensure that their workforce can return safely and quickly after a storm event and provide the labor needed to transport cargo to and from the ports. When port infrastructure is hardened and able to withstand greater storm events without significant damage, this reduces future repair and replacement costs following storms, when such costs can be at their highest. By integrating resiliency plans into the seaport master planning process, implementing the best practices identified in this report, and working with stakeholders at local, state and federal level, Florida seaports can continue to improve their resiliency. In doing so, Florida seaports may also identify opportunities to expand the range of services provided to their customers and surrounding community.

APPENDIX: Seaports Resiliency Report

APPENDIX

1 Florida Ports Council Fast Facts – https://smhttp-ssl-63157.nexcesscdn.net//wp-content/uploads/04_01_19-FastFacts-Seaports.pdf. Accessed July 5, 2019.

2 Id.

3 PIANC Cross-Commission Task Group 193. 2016. Background: Resilience of the Maritime and Inland Waterborne Transport System. [online] http://www.pianc.org/envicomactivewg.

4 Climate Change: Global Sea Level, by Rebecca Lindsey, August 1, 2018, accessed online July 2019, at https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

5 A third, much smaller contributor to sea level rise is a decline in water storage on land – aquifers, lakes and reservoirs, rivers, soil moisture – mostly as a result of groundwater pumping, which has shifted water from aquifers to the ocean. Id.

6 Id.

7 https://www.ncdc.noaa.gov/monitoring-references/faq/indicators.php, accessed July 2019.

8 https://www.giss.nasa.gov/research/news/20170118/, accessed July 2019

9 Levitus, S.; Antonov, J.; Boyer, T.; Baranova, O.; Garcia, H.; Locarnini, R.; Mishonov, A.; Reagan, J.; Seidov, D.; Yarosh, E.; Zweng, M. (2017), NCEI ocean heat content, temperature anomalies, salinity anomalies, thermosteric sea level anomalies, halosteric sea level anomalies, and total steric sea level anomalies from 1955 to present calculated from in situ oceanographic subsurface profile data (NCEI Accession 0164586). Version 4.4. NOAA National Centers for Environmental Information.

10 R. S. Nerem, B. D. Beckley, J. T. Fasullo, B. D. Hamlington, D. Masters and G. T. Mitchum. Climate-change–driven accelerated sea-level rise detected in the altimeter era. PNAS, 2018 DOI: 10.1073/pnas.1717312115) Glaciers are retreating almost everywhere around the world — including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa (National Snow and Ice Data Center)

11 National Snow and Ice Data Center, accessed July 2019, https://nsidc.org/cryosphere/sotc/glacier_balance.html

12 Climate Change: Global Sea Level, by Rebecca Lindsey, August 1, 2018, accessed online July 2019, at https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

13 Climate Change: Global Sea Level, by Rebecca Lindsey, August 1, 2018, accessed online July 2019, at https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

14 Id.

15 http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html

16 Sea level rise at specific locations may be more or less than the global average due to local factors: subsidence, upstream flood control, erosion, regional ocean currents, and whether the land is still rebounding from the compressive weight of Ice Age glaciers.

17 See, §§ 311.07 and 311.09, Florida Statutes; See also, F.A.C. 14B-1.002

18 NOAA 2017 Atlantic Hurricane Season, https://www.nhc.noaa.gov/data/tcr/index.php?season=2017&basin=atl. Accessed ____

19 NOAA 2018 Atlantic Hurricane Season - https://www.nhc.noaa.gov/data/tcr/index.php?season=2018&basin=atl. Accessed _____

20 NOAA, Office for Coastal Management – Fast Facts, Weather Disasters and Costs https://coast.noaa.gov/states/fast-facts/weather-disasters.html. Accessed July 4, 2019.

21 Id.

22 The National Academies Press, "Making U.S. Port Resilient as Part of Extended Intermodal Supply Chains" (2014).

23 ASW, Inc. (2013) Superstorm Sandy: Framing the Discussion of a Supply Chain Disruption and Transportation Outlooks. A. Strauss-Wieder Inc. FHWA Talking Freight Seminar, January 23, 2013.

24 These categories are not rigid but offer three main areas a seaport should address when evaluating ways to increase its resiliency against hurricanes and severe storm events, such as infrastructure and personnel, etc.

25 While every hurricane and severe storm event offers lessons to be learned, the storm events discussed in this report were selected because of the unique and severe impacts they caused leading to the creation of additional best practices from each.

26 NOAA National Centers for Environmental Information, State of the Climate: Hurricanes and Tropical Storms for Annual 2005, published online January 2006, retrieved on August 22, 2019 from https://www.ncdc.noaa.gov/sotc/tropical-cyclones/200513.

27 During the 2017 hurricane season, NOAA successfully used mobile integrated survey team (MIST) kits when operating vessels of opportunity. Quickly providing private operators with everything they need to aid in the channel survey effort helped to quickly in restoring the Port of Miami back to operation following Hurricane Irma.

28 https://www.nhc.noaa.gov/data/tcr/AL252005_Wilma.pdf

29 Id.

30 The predictive storm surge maps indicated that most of the Port of New York and New Jersey would remain dry. However, the surges well exceeded predictions and destroyed the generators that were in place.

31 There may be legal and liability issues with contingency labor. The Infrastructure Security Partnership (TISP) provides the following list of workforce policy issues: "compensation, prolonged absences, social isolation … safe workplace rules, flexible payroll issues, contractual issues, information from/coordination with regulators; privacy issues; ethical issues; union-related issues…" (See, The Infrastructure Security Partnership (2011) Regional Disaster Resilience: A Guide for Developing an Action Plan, p. 30, 2011 Edition.).

32 NOAA (2018): "Harvey, Irma, Maria and Nate retired by the World Meteorological Organization, Destructive hurricanes slammed parts of United States, Caribbean in 2017", accessed July 2019. http://www.noaa.gov/media-release/harvey-irma-maria-and-nate-retired-by-world-meteorological-organization.

33 Blake, E.S., and D.A. Zelinky, (2018): "National Hurricane Center Tropical Cyclone Report Hurricane Harvey" May 9, 2018, accessed July 2019. https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf.

34 Id.

35 NOAA NOS (2018): "Hurricane Irma NOS Fiscal Year 2017 Year in Review", January 10, 2018, accessed July 2019. https://oceanservice.noaa.gov/annualreport17/hurricane-irma.html.

36 Id.

37 U.S. Committee on the Marine Transportation System, The 2017 Hurricane Season: Recommendations for a Resilient Path Forward for the Marine Transportation System, U.S. Department of Transportation, Washington, D.C. (December 2018).

38 The National Incident Management System (NIMS) provides a consistent nationwide framework and approach to enable government at all levels (Federal, State, tribal, and local), the private sector, and nongovernmental organizations (NGOs) to work together to prepare for, prevent, respond to, recover from, and mitigate the effects of incidents regardless of the incident's cause, size, location, or complexity. Accessed online in July 2019, at https://www.fema.gov/pdf/emergency/nims/nimsfaqs.pdf

39 Florida Ports Council, Pathway to Prosperity, 2019-2023 5-Year Florida Seaport Mission Plan, last visited July 2019 at http://scdn.flaports.org/wp-content/uploads/2019-2023-FLPorts_Ports_SMP-web.pdf

40 MTS R-IAT website, accessed July 2019, https://www.cmts.gov/topics/resilience

41 Available online at http://masgc.org/assets/images/Ports_resilience_index.pdf, accessed July 2019.

42 Available online at https://sls.geoplan.ufl.edu/beta/viewer/, accessed July 2019.

43 Available online at https://coast.noaa.gov/slr/#/layer/slr/2/-9177098.289020855/3237960.1302270433/14/satellite/41/0.8/2080/extreme/midAccretion, accessed July 2019.

44 Available onling at https://www.usace.army.mil/corpsclimate/Public_Tools_Dev_by_USACE/sea_level_change/, accessed July 2019.

45 Available online at http://sealevel.climatecentral.org/maps, accessed July 2019. This website also has a number of other sea level rise maps to assist in various resiliency analysis and planning.

46 Available online at https://floridadep.gov/sites/default/files/AdaptationPlanningGuidebook.pdf, accessed July 2019.

47 This is a brief overview of potentially applicable funding opportunities. A more detailed list of other federal, state, and non-profit funding opportunities can be found in Appendix 6.2 of FDEP's Florida Adaptation Planning Guidebook.

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