Loss Avoidance Assessment

Hurricane Matthew (DR-4283)

April 2017

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[1] County reports developed only for those counties with several flood mitigation projects impacted.

DEFINITIONS

The following definitions clarify the use and meanings of certain terms in this Loss Avoidance Assessment.

Area of Impact: Also known as the damage area or damage swath, within which damage is expected to have occurred as the result of a disaster event. The area of impact is dependent upon the type of hazard, and is defined differently for precipitation, storm surge, riverine flooding, and wind.

Building Modification Project: The term "building modification" has been adopted for this report to avoid conflicting terms used by other state and federal agencies. For example, the terms "non-structural" and "structural" are sometimes used to refer to the same projects, depending on the context. Therefore, for clarity, the term "building modification" is used in this report to refer to acquisitions, elevations, flood-proofing, mitigation reconstruction, and wind retrofits.

Current Dollars: Also known as "nominal dollars;" refers to dollars current to the year in which they were spent.

Depth-Damage Function (DDF): The mathematical relationship between the depth of flood water above or below the first floor of a building and the amount of damage that can be attributed due to the water. DDFs are also known as depth damage curves.

Direct Effect: Represents the initial impacts that occur as a result of an economic activity.

Drainage Project: Also referred to as "drainage improvement project;" any project that reduces minor localized flooding or improves the shedding of water from specified project areas. Examples include: installation of new retention areas; improvement or installation of culverts, drain pipes, or pumping stations; or slope stabilization or grading to direct water away from properties.

Employment: All full time equivalent jobs that are created or lost as a result of an economic activity.

Event: The incidence of a hazard that results in damaging impact to an area of the state. An event does not always have to result in a Presidential Disaster Declaration. For the purposes of this report, one event is assessed: Florida Hurricane Matthew (DR-4283).

Geographical Information Systems (GIS): A system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.

IMPLAN: A private company that provides economic impact data and modeling for assessing economic impacts of project decisions in industry sectors.

Indirect Effects: The impact of direct economic effects on supporting industries, such as those that provide equipment and materials.

Induced Effects: The response to a direct effect that occurs through re-spending of income.

Labor Income: The expected combined income of employment in each industry sector generated by project implementation expenditures.

Losses Avoided: Those losses (total dollar value) that would have occurred without the mitigation measure being

implemented. Also known as losses that would have occurred under the "Mitigation Absent" scenario.

Losses Avoided for Building Modification Projects: For the purposes of this assessment, the total of building, content, inventory, and displacement costs that would have occurred had the mitigation measure not been implemented.

Losses Avoided for Drainage / Special Projects: Can be calculated in two ways: 1) based on losses that have been recorded and documented in the project file for similar event return intervals in the past, normalized to present dollar amounts; and 2) the method used for this particular assessment, involves a modeling effort and is described in the *Loss Avoidance Methodology Appendix.*

Losses Avoided for Wind Projects: Similar to "Losses Avoided for Drainage / Special Projects," can be captured in two ways. The first is based on previous losses recorded and documented. The second method uses modeled outcomes based on information input into FEMA's HAZUS Multi-Hazard Loss Estimation software. The methodology used for this assessment can be found and described in the *Loss Avoidance Methodology Appendix.*

Net Present Value (NPV): The sum of losses avoided during all events assessed to date minus dollars spent in 2016 dollars.

Normalization: The process of converting dollar amounts from different years into a value that can be recognized and interpreted consistently. For this report, all dollar values have been normalized to 2016.

Occupancy Type: The use of a structure. Occupancy types used for this report include Agricultural, Commercial, Educational, Government, Hospital, Industrial, Religious, and Residential.

Project: An individual subrecipient award under which a mitigation measure has been implemented. A single project may have multiple project sites and locations. For example, one acquisition grant project may acquire multiple structures in different areas.

Project Cost: The total investment in project implementation; includes both federal and non-federal share at project completion. The project cost includes expected maintenance costs, when available.

Project Site: The location at which a mitigation measure is implemented. For building modification projects that involve multiple structures, project sites are analyzed individually for losses avoided because the same disaster event may have a different impact on different structures.

Real Dollars: Dollars normalized to present day values (2016). Real dollars are different from "current" or "nominal" dollars, which refer to the value of dollars current to the year in which they were spent.

Relative Share of Gross Domestic Product (GDP) Method of Cost Normalization: The cost normalization method used for this report; an appropriate method for normalizing dollars spent on public expenditures because it values public investment based on the size of the economy at the time of the investment. This method clarifies the value of the project at the time of investment as a share of the total amount of money available for investment in the country. It answers the question, "What was the public

investment's value?" with the question "How much of a share of GDP was spent on the public investment?"

Normalization through relative share of GDP can be described as follows:

$$\left(\frac{Cost_n}{Nominal\ GDP_n}\right) x\ Nominal\ GDP_y$$

Where:
n = Year of the cost incurred
y = Year prior to the present year
GDP = Gross domestic product

Recurrence Interval: Also referred to as return periods, defined as the inverse of the probability that the particular intensity of an event will be exceeded in any one year. For the purposes of this report, analysis was based on both flood and wind events. As an example, a 10-year event has a 10 percent chance of its intensity being exceeded in any given year and a 50-year event has a 2 percent chance of being exceeded in any given year. It is important This formula accounts for losses avoided lower than the project cost to avoid a negative ROI.

Special Project: Any project that does not fall within the context of drainage, building modification, or wind retrofit projects. These projects may be highly customized to the mitigation need and typically mitigate certain types of infrastructure. Examples include armoring coastal roadways or culvert retrofits.

to note that in any given 100-year period, a 100-year event may occur once, not at all, or multiple times as each outcome has a probability of occurring in every year.

Return on Investment (ROI): A factor of dollars saved (losses avoided) due to mitigation measures over the life of the investment. Losses avoided are considered an ROI because they represent money that is saved, as opposed to spent, due to the mitigation measure. ROI can help guide decision-making by identifying which investments have been cost-effective. For this report, this formula was used in calculating the ROI:

$$\frac{LA}{PC} = ROI$$

Where:
LA = Losses avoided in terms of any of the above normalization methods.
PC = Project cost
ROI = Return on Investment (%)

Wind Retrofit Project: Any project that that reduces the level of vulnerability of an existing structure to damage from wind and wind-driven rain intrusion during a high-wind event.

Wind Swath: A composite of wind ranges that represent the extent of hurricane, tropical storm, and strong winds.

EXECUTIVE SUMMARY

A loss avoidance assessment is a tool that analyzes the effectiveness of hazard mitigation projects. Projects completed in the past provide a return on investment (ROI). The ROI communicates the value of mitigation measures, and informs future allocation of resources for the highest and best use. Assessing the performance of hazard mitigation measures is critical to substantiate the value of mitigation efforts; evaluating effectiveness of mitigation efforts also helps assure prudent use of future resources.

The loss avoidance assessment demonstrates that mitigating the risk of natural hazards in Florida is a sound investment.

The Florida Division of Emergency Management (FDEM) conducts a loss avoidance assessment after each Presidential Disaster Declaration using real event data to assess the impacts that were prevented by complete mitigation projects. Specifically, the assessment reports dollars saved due to mitigation measures (losses avoided), and calculates a ROI by comparing the cost of the project to actual losses avoided over time.

The Hurricane Matthew Loss Avoidance Assessment considers flood and wind mitigation projects located within the 18 counties included in the DR-4283 Presidential disaster declaration. Projects analyzed were complete as of October 2016 and funded through Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance (HMA) programs and various state-funded mitigation programs, including the Hurricane Loss Mitigation Program.

FDEM evaluated the effectiveness of 136 mitigation projects within the declared counties for Hurricane Matthew, selecting projects based on the event's area of impact. Counties with projects evaluated include Brevard, Broward, Clay, Duval, Flagler, Indian River, Lake, Martin, Orange, Palm Beach, Putnam, Seminole, St. Johns, St. Lucie, and Volusia. It is important to note that Hurricane Matthew may have impacted mitigation projects outside of the declared counties, which may be assessed for future events. Analysts only assessed projects within the declared counties for this assessment; therefore, savings likely exceeded those reported.

40 of the 136 projects analyzed were impacted by Hurricane Matthew, benefitting over 4,400 structures. The 40 projects had a combined capital cost of $19.2 million in 2016 dollars. Without mitigation, damages to the project sites affected by DR-4283 would have cost approximately $81.1 million. The aggregate ROI for the event is 422 percent, with an average project ROI of 97 percent.

The 136 projects evaluated in this assessment benefitted nearly 5,100 structures, with all projects benefitting at least one structure and some projects, particularly drainage, benefitting multiple structures. One project analyzed for Hurricane Matthew was also impacted by Tropical Storm Debby. The analysis integrates

previous results into the overall total of losses avoided to provide a net present value over the lifetime of this project, or a cumulative net present value and return on investment.

Loss avoidance assessments demonstrate the fiscal benefits associated with mitigation activities and support sound decision making related to public funding. Moreover, this assessment provides insight that FDEM and local communities can use to identify effective mitigation, improve mitigation strategies, and increase communities' resilience to natural hazards.

INTRODUCTION TO HAZARD MITIGATION & LOSS AVOIDANCE ASSESSMENTS

Natural hazards such as floods, fires, earthquakes, tornados, hurricanes, and windstorms present a threat to people and property throughout the United States. Hurricanes, in particular, can cause catastrophic damage by bringing storm surge, heavy precipitation, and high winds to coastlines and inland areas. Investing in hazard mitigation measures can reduce the loss of life and property, allow communities to recover more quickly, and lessen the financial impacts of a natural disaster.

An Introduction to Hazard Mitigation

Hazard mitigation is any action, structural or nonstructural, taken to reduce or eliminate long-term risks to life and property from natural disasters. Mitigation projects may be one of a number of measures, examples of which include the following: improving building codes, hardening infrastructure and buildings, acquisition and demolition of structures, outreach and education, land use planning, and legislation (as shown in the panel to the right).

The frequency and magnitude of natural disasters are increasing, and coupled with growing urbanization, this has resulted in higher costs spent to recover from natural disasters. Communities can implement mitigation measures to prevent or reduce unnecessary losses and alleviate increasing damage costs. Mitigation measures can result in reduced direct property damage, reduced business interruption loss, fewer environmental impacts, reduced human losses, and lower cost of emergency response, among other benefits.

Additionally, a study conducted by the Multihazard Mitigation Council (2005) found that mitigation measures result in significant potential savings to the federal treasury in terms of avoided post-disaster relief costs and future increased federal tax revenues. ***The report estimated that for every $1 spent on mitigation, almost $4 are saved.***[2] Loss avoidance assessments completed by the Florida Division of Emergency Management (FDEM) to date are trending to corroborate a high return on investment for mitigation projects, considering damages avoided alone.

In addition to reducing long-term risk, a 2012 Federal Emergency Management Agency (FEMA) study shows that implementation of mitigation measures can also provide these benefits:

- Increased property values from reducing a structure's vulnerability and, hence, insurance premiums
- Increased property value leading to a strengthened tax base (which also then provides opportunity for continued investment in the local community)
- Increased resiliency and ability for local communities to recover more quickly from a natural disaster
- Improved safety of the neighborhood through building code improvements and reduction of the presence of damaged structures.
- Repetitive flood loss property conversion to additional green space for the community
- Opportunities to use acquired space for improved recreational services
- Added social benefits such as confidence for the future and ease of mind pending a disaster event

[2] Multihazard Mitigation Council. Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities. Located at: https://www.nibs.org/?page=mmc. The report evaluates the benefits of mitigation activities by considering losses to society avoided: reduced direct property damage, reduced business interruption loss, environmental benefits, reduced human losses, and reduced emergency services. This loss avoidance assessment evaluates only direct physical damage and displacement benefits related to hard mitigation activities.

The Hazard Mitigation Process

The hazard mitigation process is a cycle (Figure 1). First, local jurisdictions must perform a risk and vulnerability assessment to identify potential risks to their communities from natural disasters. The risk and vulnerability assessment results in identified mitigation measures that can be implemented to reduce risk. Once mitigation projects are implemented and after a natural disaster occurs, the performance of mitigation efforts should be evaluated to inform future risk and vulnerability assessments and to assess whether public funds were spent wisely. This evaluation ensures mitigation measures effectively protect against hazards and are cost effective and sustainable for local jurisdictions. With substantial investments being made in mitigation, it is important for FDEM to demonstrate the cost-effectiveness of mitigation measures for continued support and funding.

It is important to continually assess whether public funds have been spent wisely.

The loss avoidance assessment fits within the evaluation step of the hazard mitigation process and provides justification for existing and future mitigation action. A loss avoidance assessment demonstrates the effectiveness of mitigation measures by showcasing the benefits of completed mitigation projects, capturing losses avoided, and producing a return on investment. Such an evaluation can aid decision making to appropriately allocate resources in the future. In other words, loss avoidance assessments help answer the question, “Is mitigation worth the cost?”

Figure 1. Mitigation Process

Loss avoidance assessment is one method to substantiate investment in hazard mitigation.

It is important to assess the economic performance of mitigation measures over time to encourage mitigation funding at the local level. The loss avoidance methodology evaluates the performance of implemented mitigation measures during a disaster and characterizes their value through a return on investment (ROI). This methodology uses an actual disaster to validate costs avoided by mitigation measures completed before the disaster event. The assessment compares loss scenarios with and without mitigation and reports money that was saved because of mitigation measures. The losses avoided because of the project are characterized as an ROI because they represent

money saved as a percentage of the money invested in the mitigation project.

Loss avoidance assessments should be integrated into the hazard mitigation process to showcase return on investment.

FDEM can demonstrate a continued ROI if loss avoidance assessments are completed after every natural disaster event. This ROI can be used to improve community resiliency by justifying future investment in mitigation and providing leverage for continued support of mitigation actions. Florida has committed to conducting a loss avoidance assessment after every Presidentially Declared Disaster as part of its Enhanced State status. This allows Florida to receive additional Hazard Mitigation Grant Program (HMGP) funding. This loss avoidance assessment evaluates the performance of mitigation projects that were within Hurricane Matthew's area of impact. Losses avoided during Hurricane Matthew are integrated with the results of previous loss avoidance assessments to demonstrate an overall ROI for those projects.

Since FDEM implemented a loss avoidance system and strategy in 2012, it has completed a loss avoidance analysis after every presidentially declared disaster.

Loss Avoidance Process Overview

As previously stated, the State of Florida maintains a FEMA-approved Enhanced State Hazard Mitigation Plan to receive additional HMGP funding. Part of maintaining the Enhanced State Hazard Mitigation Plan is performing loss avoidance analyses after every Presidentially Declared Disaster. FDEM, in accordance with 44 CFR 201.5(b)(2)(iv), developed a system and strategy by which it will assess and record the effectiveness of each completed mitigation project.

Loss avoidance assessments analyze mitigation projects using funds from HMGP, Pre-Disaster Mitigation program, Repetitive Flood Claims (RFC) program, Severe Repetitive Loss program (SRL), Flood Mitigation Assistance program (FMA), and the State's Hurricane Loss Mitigation Program[3]. The aforementioned programs are not all active at once; for example, the RFC and SRL programs were recently combined into the FMA program. FDEM administers these programs for the State of Florida and maintains project files with all information needed to conduct a loss avoidance assessment; thus, FDEM is the driving force behind loss avoidance assessments in Florida. Mitigation projects implemented with local or private dollars are not assessed in a loss avoidance assessment due to data and time constraints. As such, the results of this analysis can be considered a conservative estimate of mitigation efforts that avoided losses from Hurricane Matthew.

[3] Mitigation programs are often dynamic; not all programs are currently active. In 2014, FEMA combined the RFC and SRL program requirements and funding into the FMA program. Projects awarded under the programs before 2014 are still reported separately.

Limitations of the Loss Avoidance Analysis

Limitations apply to the DR-4283 loss avoidance assessment that likely underestimate both the number of mitigation projects assessed and the ROI of projects that are included. Limitations include:

- Project information for nearly all completed mitigation projects in the state were collected into a geodatabase when the first loss avoidance assessment was conducted in 2012. The geodatabase is updated for each subsequent loss avoidance assessment. Nevertheless, project files are collected for only counties declared under each Presidentially Declared Disaster. Moreover, this limitation coupled with Florida's archiving schedule means there is a chance some mitigation projects completed are not included in this assessment.
- The loss avoidance assessments for Hurricane Matthew and Hurricane Hermine (DR-4280) are the first, other than pilot assessments, to evaluate wind mitigation projects. Thus, there are no previous results for which to integrate DR-4283 results, and it is likely the ROI of wind projects is conservative.
- This assessment is limited to evaluating losses avoided in terms of direct physical damages and displacement costs. It does not include other important benefits (or losses avoided) such as loss of critical services, roadway closures, and human impacts (mental stress and anxiety, lost productivity, and loss of life or injury).

The loss avoidance analysis process can be summarized in four broad pieces, as summarized below. Refer to the *Loss Avoidance Methodology Appendix* for greater detail.

1 – Project and Event Data Collection: Project data needed to conduct a loss avoidance assessment is collected by FDEM Project Managers throughout the grant life-cycle. Loss avoidance analysts obtain FDEM Project Manager files for completed mitigation projects and review them to extract required information. Analysts use event data to identify the DR-4283 area of impact, and may include event precipitation, wind swath, high water marks, gauge height, and event photographs.

Table 1. Event Data and Data Sources

Data Source	Data
National Oceanic and Atmospheric Administration / National Weather Service	Precipitation Data Tide Gauge Data
United States Geologic Survey Flood Event Viewer	High Water Marks Storm Tide Sensor Data (Peak Stage Data)
United States Geologic Survey	Gauge Height
United States Fish and Wildlife Commission	Aerial Imagery
HURREVAC	Wind Swath

2 – Data Review: Analysts review project and event data to ensure accuracy of project file information. Project location, structure information, and elevation are the most critical pieces of information for loss avoidance assessments.

3 – Data Processing and Quality Assurance/Quality Control: Analysts overlay mitigation project and disaster event data in GIS to determine which projects lie within the DR-4283 area of impact for inclusion in the loss avoidance assessment. Analysts estimate impacts to the projects using event data, then confirm them through phone calls, emails, and meetings with local representatives familiar with particular mitigation measures.

Florida's Loss Avoidance Calculators (LACs) quantify the effectiveness of the impacted mitigation projects. Analysts adjust the results to reflect the impacts conveyed by local representatives, as appropriate.

4 – Reporting: Analysts report loss avoidance results and ROI specific to DR-4283. Projects that were included in previous loss avoidance assessments receive an overall ROI, which integrates the DR-4283 results with those of previous disaster events.

This loss avoidance assessment additionally builds upon a 2012 economic impact analysis performed by FDEM, which reveals that hazard mitigation activities provide a positive economic benefit to Floridians in terms of employment and added economic activity, in addition to losses avoided. To further demonstrate the economic benefit of hazard mitigation activities, this loss avoidance assessment includes an update of FDEM's 2012 economic impact analysis. The update evaluates economic output and job creation benefits associated with the implementation of mitigation projects impacted by Hurricane Matthew using the IMPLAN economic impact assessment software system. IMPLAN uses an input-output methodology, in combination with social accounting matrices and economic multipliers, to estimate the result of changes or activities in a study area. To conduct the analysis, analysts allocate project funds to a range of appropriate IMPLAN economic sectors and enter funds per sector into the IMPLAN software as an industry change. IMPLAN reports countywide economic effects of implementing mitigation measures in terms of sales and revenues, value added to GDP, labor income, and employment. Refer to the *Loss Avoidance Methodology Appendix* for greater detail on the economic impact analysis approach

Previous Loss Avoidance Assessments

Florida's previous loss avoidance assessments are summarized in Table 2. Seven projects included in the Tropical Storm Debby Loss Avoidance Assessment are located in Hurricane Matthew's declared counties; however, only one of the seven projects were actually impacted by DR-4283, according to community feedback. Tropical Storm Debby results for this project are integrated with DR-4283 results to demonstrate a cumulative ROI. See the *Detailed Results* section for more information.

Table 2. Previous Loss Avoidance Assessment Results

Disaster Assessed	Project Cost	Losses Avoided	ROI
Tropical Storm Fay (2008), North Florida Flood Event (2009), Unnamed June Flood Event (2012), Tropical Storm Debby (2012)	50 projects cost $18.9 million	Approximately $21.9 million in expected losses	16%
Hurricane Isaac (2012)	5 projects cost $8.3 million to protect 842 structures	Approximately $44 million in expected losses, with over $35 million avoided	435% return on project capital investment, due to the high proportion of drainage projects analyzed and the nature of the event
Severe Storms and Flooding (2013)	32 projects cost $4.2 million	Approximately $5.4 million in expected losses, with over $1 million avoided	29%
Florida Severe Storms, Tornadoes, Straight-Line Winds, and Flooding (2014)	33 projects cost $18.4 million	Approximately $24.1 million in expected losses, with $5.6 million in losses avoided	54%

EVENT DETAILS

On October 7, 2016, Hurricane Matthew brushed the eastern coast of Florida before making its final landfall in South Carolina. Although Florida escaped a direct hit, numerous counties were impacted by Matthew's high winds and storm surge. Eighteen counties between Broward County and Nassau County were declared by the President of the United States as major disaster DR-4283, under the Governor's request for Individual Assistance and Public Assistance. Over 1.5 million people were under evacuation orders along the coastline, and more than one million lost power. On October 8, 2016, the federal government approved the declaration, which covered emergency protective measures and debris removal in 18 counties under DR-4283 (FEMA 2016): Bradford, Brevard, Broward, Clay, Duval, Flagler, Indian River, Lake, Martin, Nassau, Orange, Osceola, Palm Beach, Putnam, Seminole, St. Johns, St. Lucie, and Volusia (see Map 1). This declaration also made HMGP assistance available for hazard mitigation procedures throughout the state of Florida.

Hurricane Matthew storm surge impacts. Source: The St. Augustine Record

Details of Hurricane Matthew

October 2016

Eastern Coast of Florida

18 FL counties

affected by the disaster

107 mph

top wind gusts

6+ inches

of total rainfall

9+ foot

storm surge heights

On the morning of October 7, 2016, Hurricane Matthew skirted the east-central Florida coastline, weakening to a Category 3 hurricane after reaching its peak status as a Category 5 storm in the Caribbean. Hurricane Matthew never hit land in Florida, but continued its northern motion along the eastern shoreline; the nearest approach was at 6 AM when the edge of the eyewall touched Brevard County and impacted the area with sustained high winds. All other coastal east-central Florida locations observed tropical storm force sustained winds, with rainfall amounts totaling between 3 to 5 inches. Additional locations experienced higher rainfall amounts as well as storm surge heights that reached up to 7 feet at Fernandina Beach. Table 3 provides the counties that reported the greatest impacts, while Maps 2 through 5 present Hurricane Matthew's hazard impact areas with project location overlays.

Table 3. Summary of Hurricane Matthew Impacts by County

County	Impact
Bradford	Hurricane Matthew impacts within Bradford County appear to be wind and debris-related: 21% of customers were reported without power after the storm.[4]
Brevard	Mandatory evacuations were called for barrier islands in Brevard County. High winds caused damage to homes and businesses and resulted in over 600,000 people without power. Per the Melbourne National Weather Service, Brevard County experienced over 5 inches of rainfall in areas, with a peak wind gust measured at 107 miles per hour (mph) in Cape Canaveral. No severe damage to the space station occurred. Other sustained wind speed measurements averaged around 74 mph.[5]
Broward	Broward County and other areas in south Florida avoided severe impacts due to Matthew's eyewall replacement. The County issued voluntary evacuations for mobile homes and low-lying areas. Minimal beach erosion was reported.[6]
Clay	Tropical storm force winds, heavy rain bands, and significant flooding along the St. Johns River impacted Clay County after Hurricane Matthew. Approximately 85 homes throughout the County experienced varying levels of damage from the storm. Preliminary damage assessments estimate the recovery cost in Clay County at $3 million.[7]
Duval	High wind caused damage in many areas within the county, with wind gusts over 60 mph measured. Storm surge along the coastline overtook dunes and inundated emergency vehicle beach access to extend inland three blocks to 3rd Street in Jacksonville Beach.

[4] Florida Division of Emergency Management. "Hurricane Matthew Information Updates." Last updated November 16, 2016. http://www.floridadisaster.org/eoc/matthew2016/
[5] Bonanno, C. "Hurricane Matthew: 107 mph gusts, 5+ inches of rain." Florida Today October 13, 2016. http://www.floridatoday.com/story/news/local/2016/10/12/nws-melbourne-releases-stats-matthew/91978498/
[6] Olmeda, R. "South Florida returns to normal, spared from Hurricane Matthew's worst." Sun Sentinel. October 7, 2016. http://www.sun-sentinel.com/news/weather/hurricane/fl-hurricane-matthew-story.html
[7] Alonso, R. "Clay looking at roughly $3 million in damages from Hurricane Matthew." WOKTV. October 10, 2016. http://www.wokv.com/news/news/local/clay-looking-roughly-3-million-damages-hurricane-m/nsntK/

County	Impact
	Tidal gauge at Mayport measured over 5 feet of storm surge, recorded as the 2nd highest level on record. Officials in Jacksonville reported that strong winds and high water had impacted almost 500 homes and businesses, severely damaging or destroying over 300 homes.[8]
Flagler	Residents were under mandatory evacuation orders in advance of Matthew in Flagler County, which experienced over $72 million worth of damages. Eleven homes were destroyed in addition to infrastructure such as roadways and public buildings. Significant portions of State Road A1A in Flagler Beach were damaged by water, with almost 1 mile of road collapsed. Peak wind gusts reached 83 mph with rainfall reaching almost 6.5 inches, according to the National Weather Service out of Jacksonville. Storm surge depth was measured at 6 feet in the Palm Coast Saltwater Canal.[9]
Indian River	Winds and storm surge impacted Indian River County, with almost $13 million in damages to the shoreline alone. There were many reports of downed power lines, and minor water damage to structures. Indian River County officials estimate that Hurricane Matthew will cost at least $15 million.[10]
Lake	Impacts from Hurricane Matthew include downed trees and power lines, debris, and minor flooding from the St. Johns River. Approximately 17,000 homes were without power after the storm.[11]
Martin	Few structures in Martin County sustained serious damage from Hurricane Matthew, mostly from falling trees and limbs. The preliminary debris estimate for the County was $1 million.[12]
Nassau	Nassau County was affected by tropical storm force sustained winds as well as storm surge damage, especially in the Fernandina Beach area. Damage estimates for the Fernandina Beach Marina were as high as $3 million. The initial recovery efforts for Matthew cost the County upwards of $10 million, and 700 homes and businesses were reported as damaged. Surge heights reached close to 7 feet, which was the third highest water level recorded at that specific gauge at Fernandina Beach.[13]
Orange	Like other inland counties, Orange County suffered from power outages from downed trees and power lines, impacting about 110,000 residents. It is expected that minimal property damage occurred; preliminary reports showed that most damage is related to roofs, fencing, manufactured homes, and carports.[14]

[8] National Weather Service Jacksonville Blog. "Quick Review of Major Hurricane Matthew." October 9, 2016. http://nws.weather.gov/blog/nwsjacksonville/

[9] Sparvero, J. "Cleanup from Hurricane Matthew in Flagler continues, beaches closed." News 6 Orlando. October 10, 2016. http://www.clickorlando.com/weather/hurricane-matthew/recovery-cleanup-continue-in-flagler-county-after-matthew.

[10] Shainman, J. "Hurricane Matthew will cost Indian River County at least $15 million." WPTV. October 12, 2016. http://www.wptv.com/news/region- indian-river-county/hurricane-matthew-will-cost-indian-river-co-at-least-15m

[11] Fallstrom, J. "17k in Lake lose power but Hurricane Matthew impact less than expected. Orlando Sentinel. October 7, 2016. http://www.orlandosentinel.com/news/lake/

[12] Andreassi, G. "Much of Martin County experienced minimal damage from Hurricane Matthew." TCPalm. October 7, 2016. http://www.tcpalm.com/story/weather/hurricanes/2016/10/08/much-martin-county-experienced-minimal-damage-hurricane-matthew/91784410/

[13] Calloway, E. "700 Nassau County homes, businesses damaged by hurricane." News4Jax. October 10, 2016. http://www.news4jax.com/weather/hurricane-%20matthew/nassau-county-recovering-from-hurricane

[14] Orange County Government, Florida. "Hurricane Matthew Veers East of Orange County." October 12, 2016. http://www.orangecountyfl.net/Newsroom/NS-HurricaneMatthewVeersEastofOrangeCounty.aspx#.WFwb5hsrKUk

County	Impact
Osceola	Osceola County was mostly impacted by winds from Hurricane Matthew. At one point, nearly 6,000 people throughout the County were left without power, but it was quickly restored. Preliminary assessments yielded little significant damage: no roads were closed during or after the storm, and no flooding was reported in flood-prone areas.[15]
Palm Beach	Hurricane Matthew brought powerful winds and heavy rain to Palm Beach County; damage, however, was minimal. Vegetative debris and downed power lines resulted in power loss to approximately 6,000 people throughout Palm Beach County. Minimal structural damage was reported.[16]
Putnam	Putnam County was left with fallen trees, flooded yards, blocked roadways, structural damage, and other damage after Hurricane Matthew. The greatest damage was concentrated in southern areas of Putnam County, including areas along the St. Johns River and Dunns Creek. Approximately 17,000 residents were without power.[17]
Seminole	Hurricane Matthew caused major flooding and road obstructions from debris in over 400 locations in Seminole County. Other damages included fallen trees and power lines. In Altamonte Springs, the lake at Cranes Roost Park swelled, causing the water level to rise. Raised walkways that typically surround the lake were completely submerged October 7, 2016. Nearly 70,000 residents were without power during the height of the storm. Damages are estimated to be $15 million.[18]
St. Johns	Residents were issued mandatory evacuations for the approaching storm. Many coastal areas in St. Johns County were impacted by Matthew's storm surge, which also damaged bridges and roads. A surge peak height was recorded on the St. Johns River at Racy Point, measuring 5 feet. In addition, wind gusts as high as 85 mph were experienced in St. Johns County at the St. Augustine Pier.[19]
St. Lucie	Most damages throughout St. Lucie County were due to downed trees from high winds. However, three fatalities were reported in the county.[20]
Volusia	Matthew's timing over Volusia County coincided with high tide, creating 6 foot storm surge. Preliminary damage assessments in Volusia County set a record: $452.4 million, with the greatest concentration located in Daytona Beach. There were numerous reports of downed power lines and flooded homes throughout the County; in total, nearly 7,000 properties were impacted in some way by the hurricane. At one point, more than 90% of people were without power in Volusia County.[21]

[15] Osceola County. "Osceola County Assesses Effects of Hurricane Matthew." October 7, 2016. http://www.osceola.org/news/2051832-osceola-county-assesses-effects-of-hurricane-matthew.stml

[16] Afshar, P. "Palm Beach County slammed by outer bands of Hurricane Matthew." Local 10 News. October 7, 2016. http://www.local10.com/weather/hurricane-matthew/palm-beach-county-slammed-by-outer-bands-of-hurricane-matthew

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[18] Dunham, E. "Hurricane Matthew Weather Summary for Eastern Central Florida." Central Florida Hurricane Center. October 16, 2016. http://flhurricane.com

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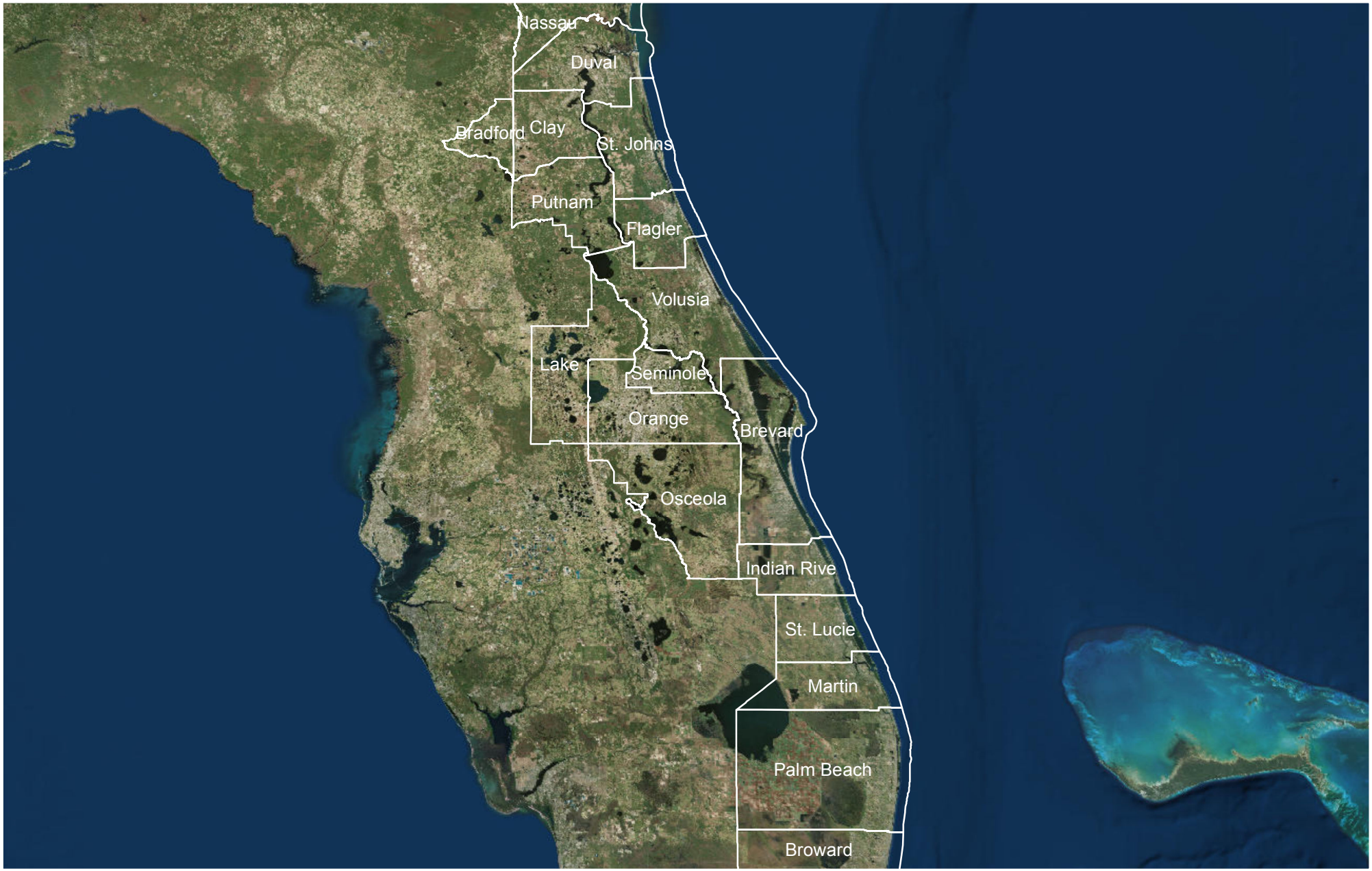
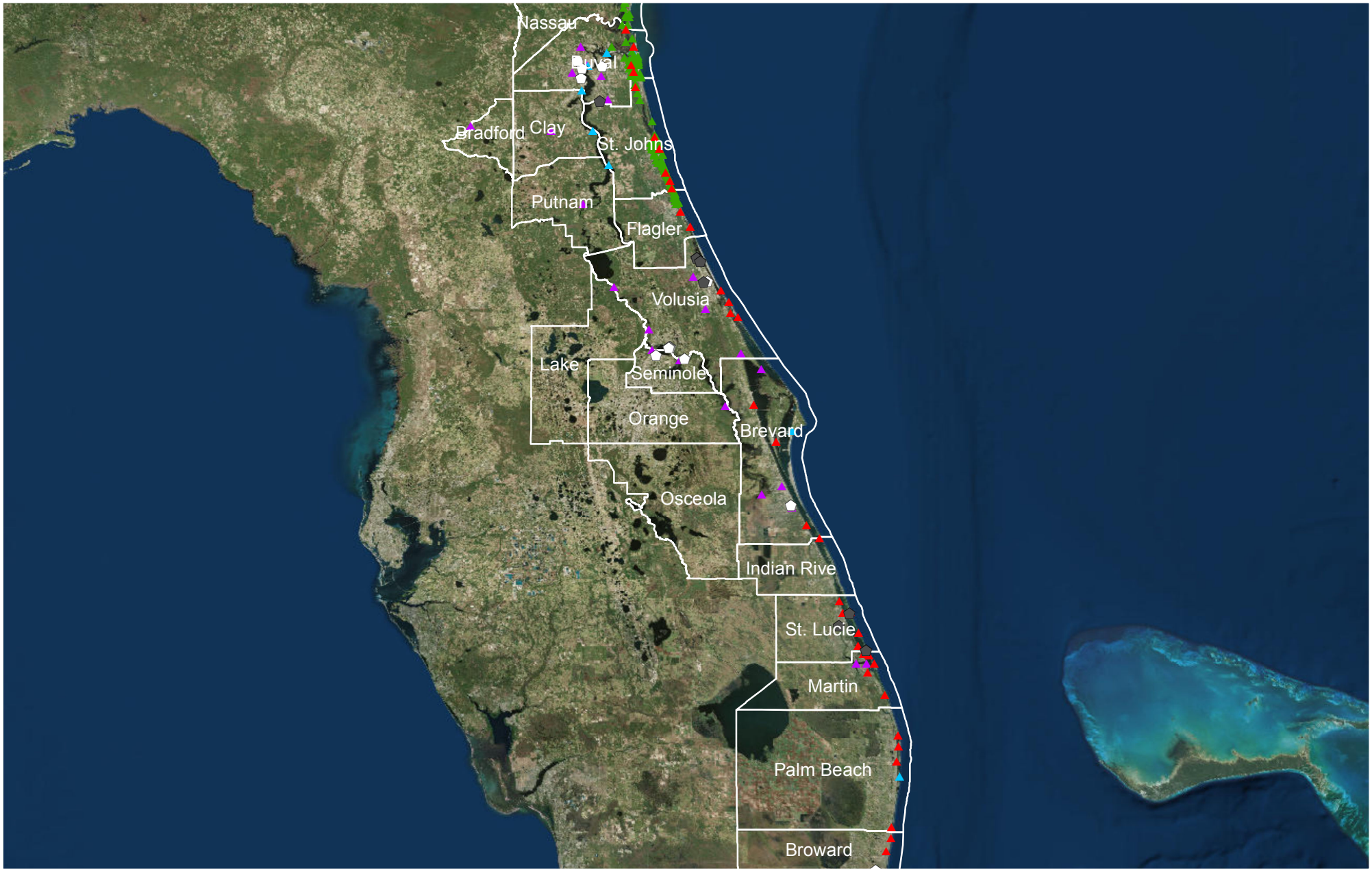


2016 Loss Avoidance Assessment
DR-4283: October 3 to 19, 2016

0 35 70 140 Miles



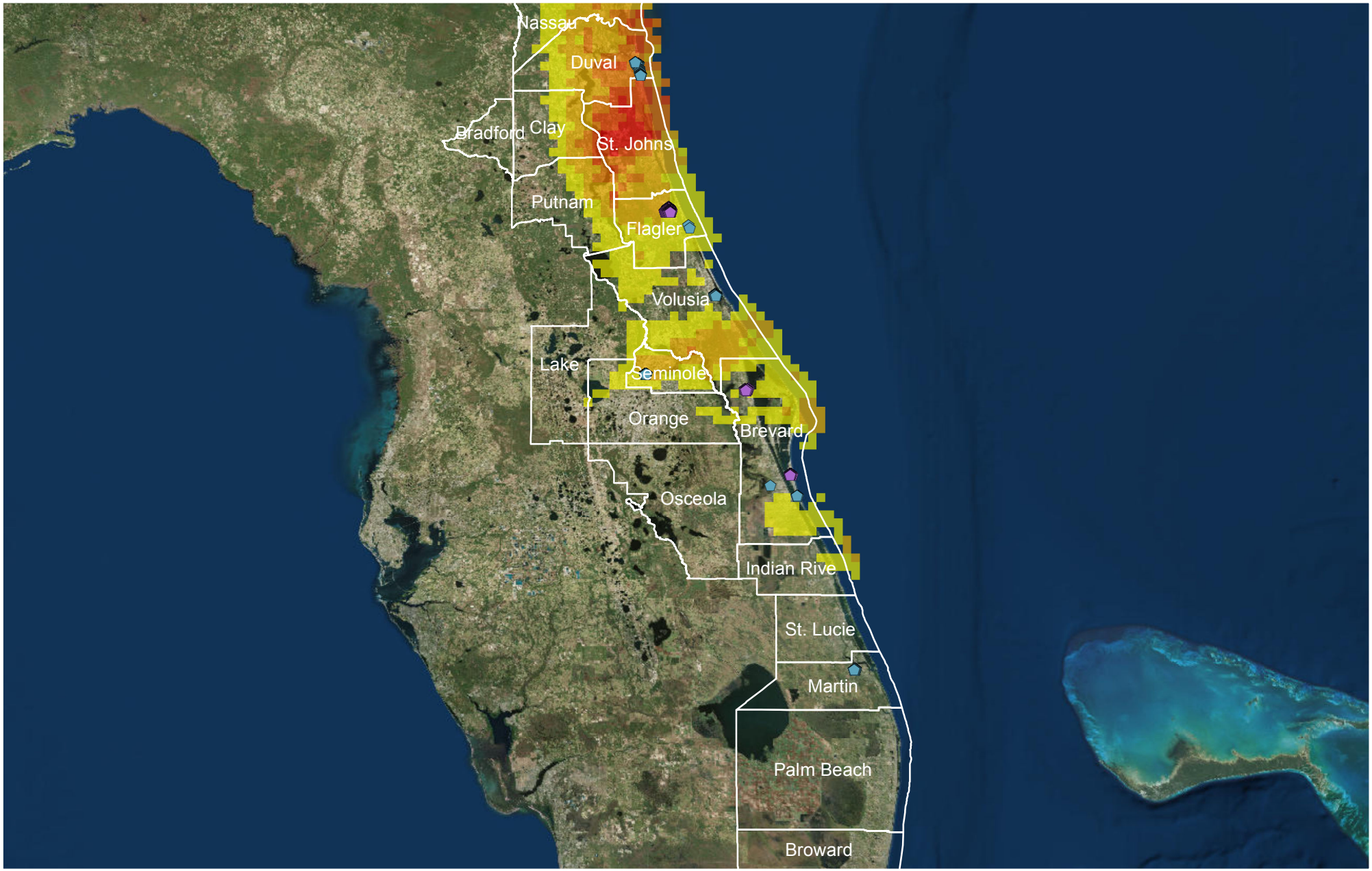
2016 Loss Avoidance Assessment
DR-4283: October 3 to 19, 2016

Flood Projects

- With Results
- In Hazard Area

USGSHWMs · NOAACoopsGages · Gauges · Peak Summaries

0 35 70 140 Miles



2016 Loss Avoidance Assessment
DR-4283: October 3 to 19, 2016

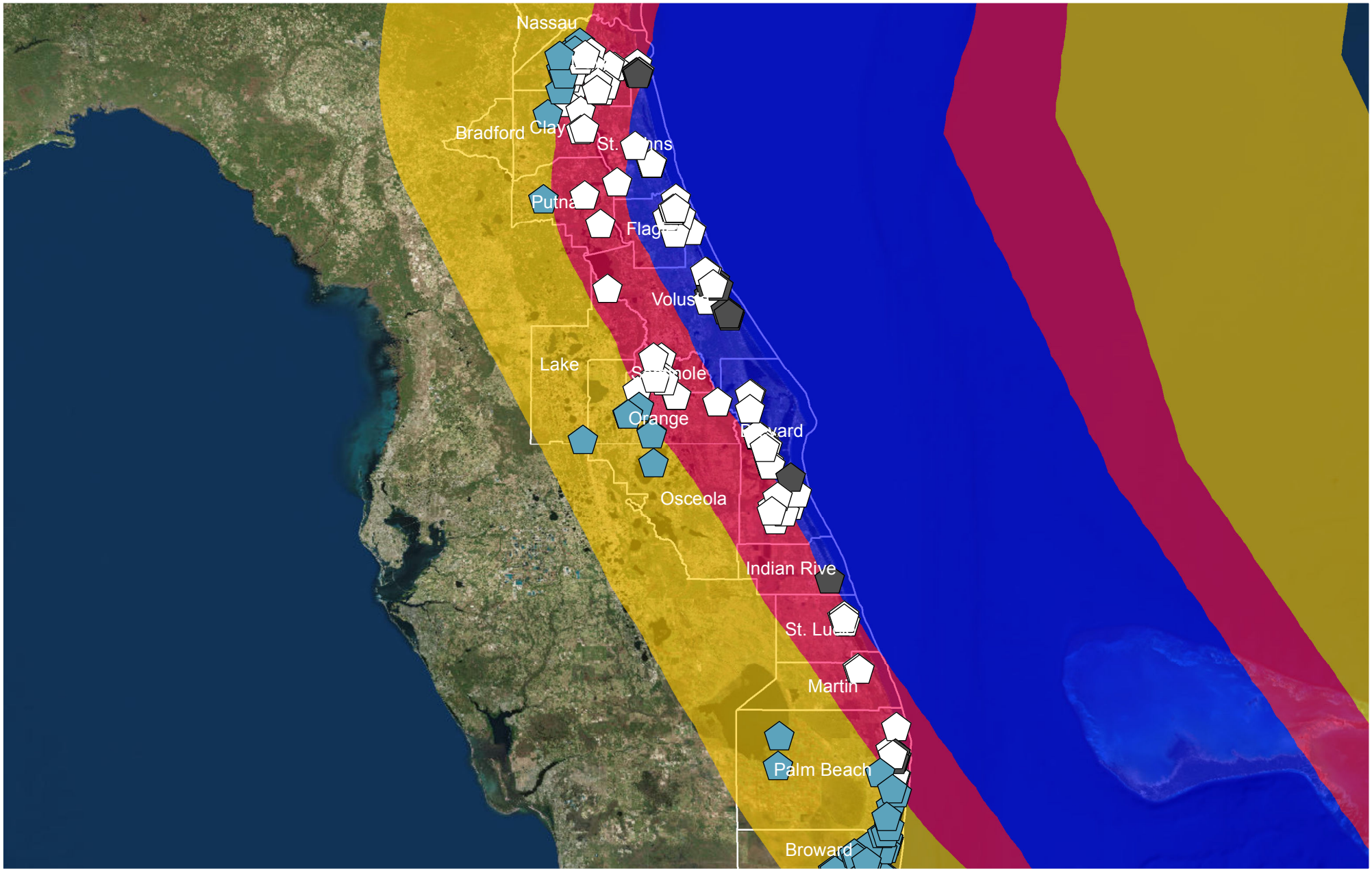
Drainage Projects

- With Results
- In Hazard Area

Precipitation Inches

5 - 7 | 7 - 9 | 9 - 10 | 10 - 12 | 12 - 14

0 35 70 140 Miles



2016 Loss Avoidance Assessment
DR-4283: October 3 to 19, 2016

Wind Speed

- Heavy Wind (30-50 mph)
- Tropical Storm (50-64 mph)
- Hurricane (>64 mph)

Results | In Hazard Area | All Wind

0 35 70 140 Miles

PROJECT HIGHLIGHTS

Hurricane Matthew impacted 40 of the 136 mitigation projects within the storm's area of impact, meaning the storm was great enough to cause damage had the community not implemented the project. Two important results emerge from the data:

Volusia County has the most mitigation projects impacted.[22]

According to analysis results, 22 building modification and wind projects in Volusia County avoided $3.3 million in damage and relocation costs, mitigating losses at 51 structures. Considering that these projects are made of wind retrofit, acquisition, elevation, and second-story conversion projects, this is a high number of residences protected by mitigation. In fact, 75 percent of the County's impacted mitigation projects are acquisition efforts, which eliminate risk by removing structures from the flood zone. Volusia County's average ROI for projects that avoided damages for DR-4283 is 30 percent, due to the expense of acquiring and demolishing structures.

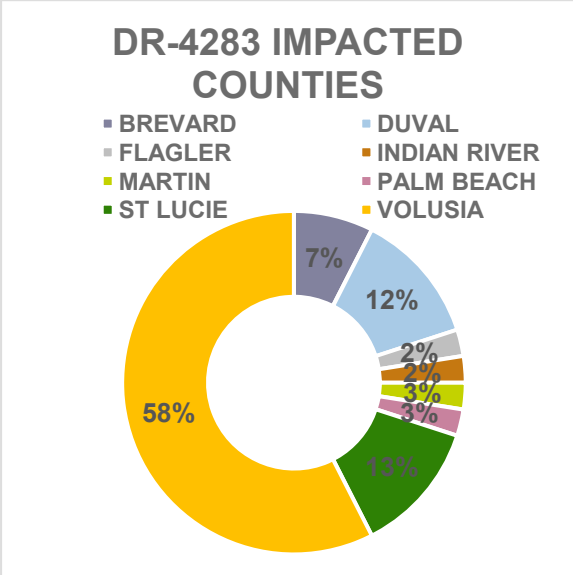


Figure 2. Percentage of mitigation projects impacted per county, DR-4283

4,407 structures
mitigated by losses from Hurricane Matthew

28 projects
mitigated flood damages

12 projects
mitigated wind damages

$81.1 million
in total losses avoided by mitigation projects for Hurricane Matthew

[22] This analysis considers the impacts of Hurricane Matthew on mitigation projects. Counties and other locations without mitigation projects also experienced significant damage from the event.

Drainage projects had positive outcomes in mitigating stormwater flooding during DR-4283.

Drainage projects by nature have high ROI because projects benefit so many structures. Six drainage projects effectively mitigated precipitation flooding from Hurricane Matthew: two projects in Brevard County, and one project each in Duval, Flagler, Martin, and Volusia counties. Together, the six projects protect 4,338 structures and avoid $77 million in damage and displacement costs. The average ROI for the six drainage projects is over 400 percent for Hurricane Matthew alone, and does not evaluate additional rain events experienced.

Drainage projects are intended to mitigate stormwater flooding caused by precipitation; impacts by additional flood sources likely exceed system capacity and render the mitigation project inoperable. For this reason, drainage projects impacted by coastal surge or riverine flooding are not evaluated in this assessment. Nevertheless, many local officials reported that ***drainage projects impacted by surge or riverine flooding during Hurricane Matthew helped convey water more swiftly than it would have receded on its own; this is also considered a mitigation success.***

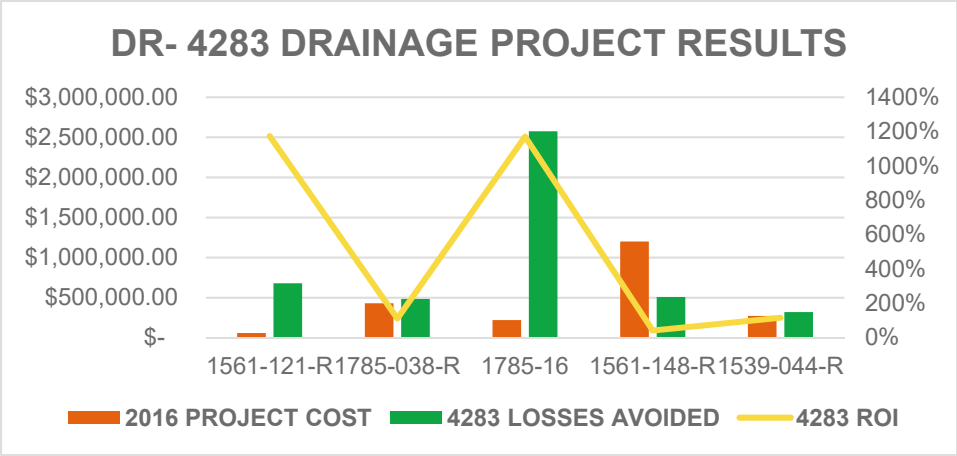


Figure 4. Project Cost, Losses Avoided and ROI for DR-4283-impacted Drainage Projects.
Results for 1545-082-R not represented in graphic.

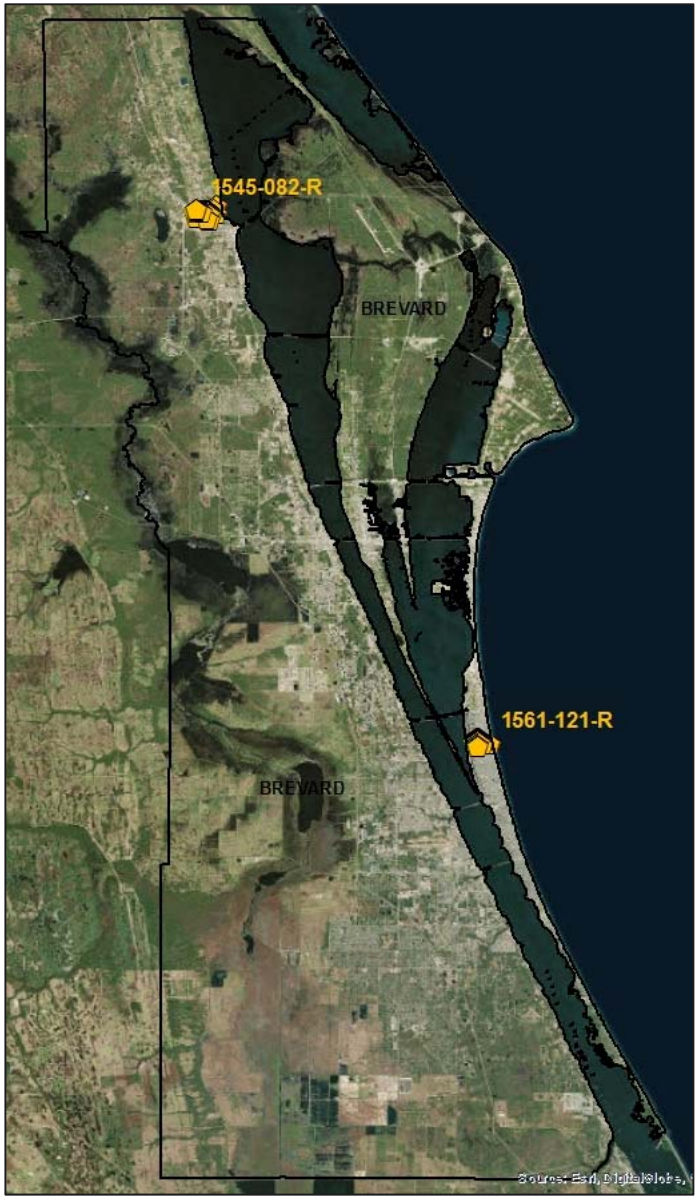


Figure 3. DR-4283 Impacted Drainage Projects, Brevard County

DETAILED RESULTS

The Hurricane Matthew Loss Avoidance Assessment reports analysis results in terms of the number and type of projects analyzed, losses avoided, and ROI realized during DR-4283. This report also integrates DR-4283-specific results with previous Florida loss avoidance assessments to demonstrate a cumulative ROI for projects that have been impacted multiple times. Seven projects within Hurricane Matthew's area of impact were also impacted by Tropical Storm Debby; however, only one project experienced impacts during Matthew.

DR-4283 Results

Projects within Hurricane Matthew's impact area are split fairly even between wind mitigation projects and flood mitigation projects. However, flood mitigation projects are the majority (70 percent) of projects which experienced impacts great enough to calculate losses avoided. Event data and local officials informed analysts that Hurricane Matthew wind speeds were not great enough to cause substantial impacts to wind retrofit projects; however, had the storm been stronger and followed its forecasted track to make landfall in northern Brevard County, much more damage would have occurred. Analysts developed this event scenario to assess expected wind damage if Matthew continued along its projected track. The *Hurricane Matthew Forecasted Track* section provides results of this analysis.

The 40 impacted projects cost more than $19 million to implement, and performed to avoid more than $81 million in structural, contents, and displacement losses for DR-4283, with an average project ROI of 97 percent for Hurricane Matthew alone.

$19.2 million

in mitigation project costs for those impacted by DR-4283.

$81.1 million

in losses expected for DR-4283 without mitigation projects in place (losses avoided).

422 percent

Aggregate ROI for DR-4283 alone.

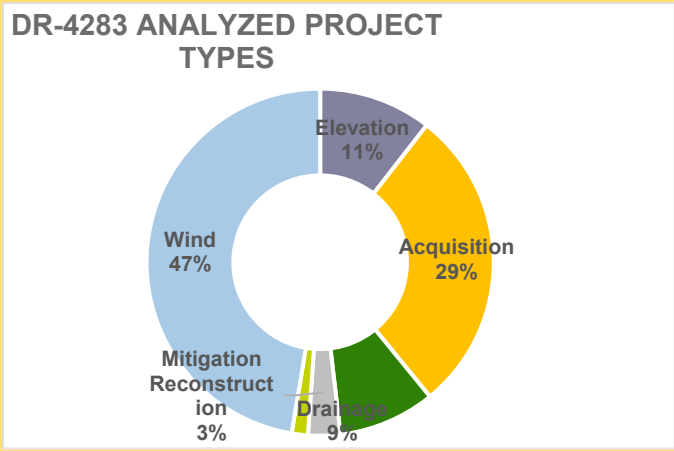


Figure 5. Distribution of Project Types Evaluated within DR-4283 Impact Area

Results by Project Type

Drainage projects protected over 3,200 structures from damage and displacement costs. As discussed in the *Project Highlight* section, drainage projects reap the greatest return on investment for any project type due to the amount of benefitting structures (over 400 percent on average). Although these projects are costly to implement, the cost is relatively low when considering cost of construction per structure benefitting. However, drainage projects are not intended to mitigate storm surge and riverine flooding, and may not effectively reduce risk in coastal flood situations.

Acquisition and elevation projects produced the second highest average ROI per project: 34 percent. Acquisition projects are also the most common project type impacted by DR-4283. Several communities included multiple parcels in a single acquisition project, hence why 14 acquisition projects benefit 42 structures. Grouping contiguous parcels into one mitigation project can help single parcels meet eligibility requirements for FEMA grants, and it also provides an opportunity to maximize greenspace for community use. The acquisition projects impacted by DR-4283 cost $10.7 million to implement, and avoided $3.5 million in losses.

Building modification projects refer to projects that reduce flood risk by way of acquisition and demolition, elevation, second-story conversion, or reconstruction. ***Twenty-three building modification projects in the declared counties would have been exposed to flooding during Hurricane Matthew had mitigation not occurred.*** Building modifications for flood risk reduction represent $13.3 million in mitigation investment made between the early 2000s and 2016. These specific projects avoided a total of $4 million in damages from Hurricane Matthew, with an average ROI of 31 percent**.**

Twelve wind retrofit projects protecting 18 structures were impacted by Hurricane Matthew. Due to the event's low windspeeds, the 18 structures avoided a cumulative $19,638; the projects cost nearly $1.2 million to implement, with an average 3 percent ROI. ***Impacted wind retrofit projects are non-residential structures; it is possible that smaller residential sizes are the reason for a lack of residential results.***

Table 4. Average Costs and Benefits per Project Type, DR-4283

Project Type	Number of Projects	Average Project Cost	Average Project Benefit	Average Project ROI
Elevation	8	$279,850	$72,320	34%
Acquisition	14	$717,470	$230,710	34%
Drainage	6	$781,600	$12,840,540	917%
Mitigation Reconstruction	1	$343,220	$35,210	10%
Wind	12	$97,110	$1,640	3%
Total				

Results by County

Brevard, Flagler, and Volusia counties experienced the most flood impacts from Hurricane Matthew, as demonstrated in Table 5. ***Volusia County had the highest number of impacted projects (23), followed by St. Lucie (5) and Duval counties (5).*** Mitigation projects in St. Lucie County averaged nearly a 50% ROI from Hurricane Matthew alone. Brevard County reaped the greatest benefits because over 300 structures benefitted from two drainage projects. Flagler County's drainage project has 2,800 benefitting structures, but due to the expected flood elevations and topographical variation, not every one of them was impacted. Analysts coordinated with local officials from every county to present the preliminary results and verify impacts at project locations. The results presented herein have been adjusted based on community feedback. Individual county reports for counties with multiple flood projects impacted are presented in *Appendix D.*

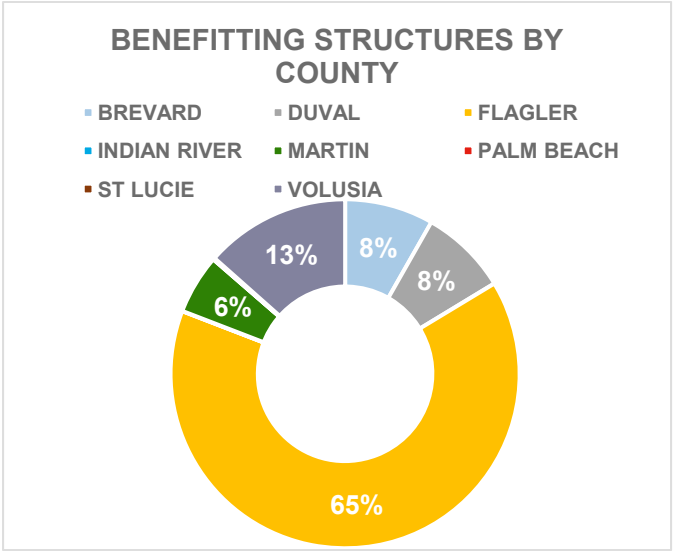


Figure 6. Benefitting Structures by County, DR-4283

Results by Occupancy

Residential structures comprise the vast majority of structures benefitting from mitigation activities (97 percent). The loss avoidance assessment evaluates direct physical damages and displacement costs, but does not capture avoided human impacts (mental stress and anxiety, lost productivity, and loss of life or injury) for mitigated residential structures. As such, results for residential structures are considered conservative. Similarly, the assessment does not account for avoided business interruption impacts for commercial structures, therefore results for non-residential structures may also be conservative.

Table 5. DR-4283 Results by County

County	Number of Projects	Total Project Cost	Losses Avoided	Net Present Value	Average Project ROI
Brevard	3	$2,573,420	$73,156,740	$70,583,330	1,357%
Duval	5	$2,500,780	$803,520	-$1,697,260	19%
Flagler	1	$220,030	$2,575,180	$2,355,160	1170%
Indian River	1	$10,480	$180	$10,300	2%
Martin	1	$1,199,420	$508,530	-$690,890	42%
Palm Beach	1	$33,400	$3,940	-$29,460	14%
St. Lucie	5	$1,370,950	$434,120	-$936,830	45%
Volusia	23	$11,290,550	$3,655,030	-$7,678,300	30%
Total	**40**	**$19,199,030**	**$81,137,250**	**$61,916,050**	**97%**

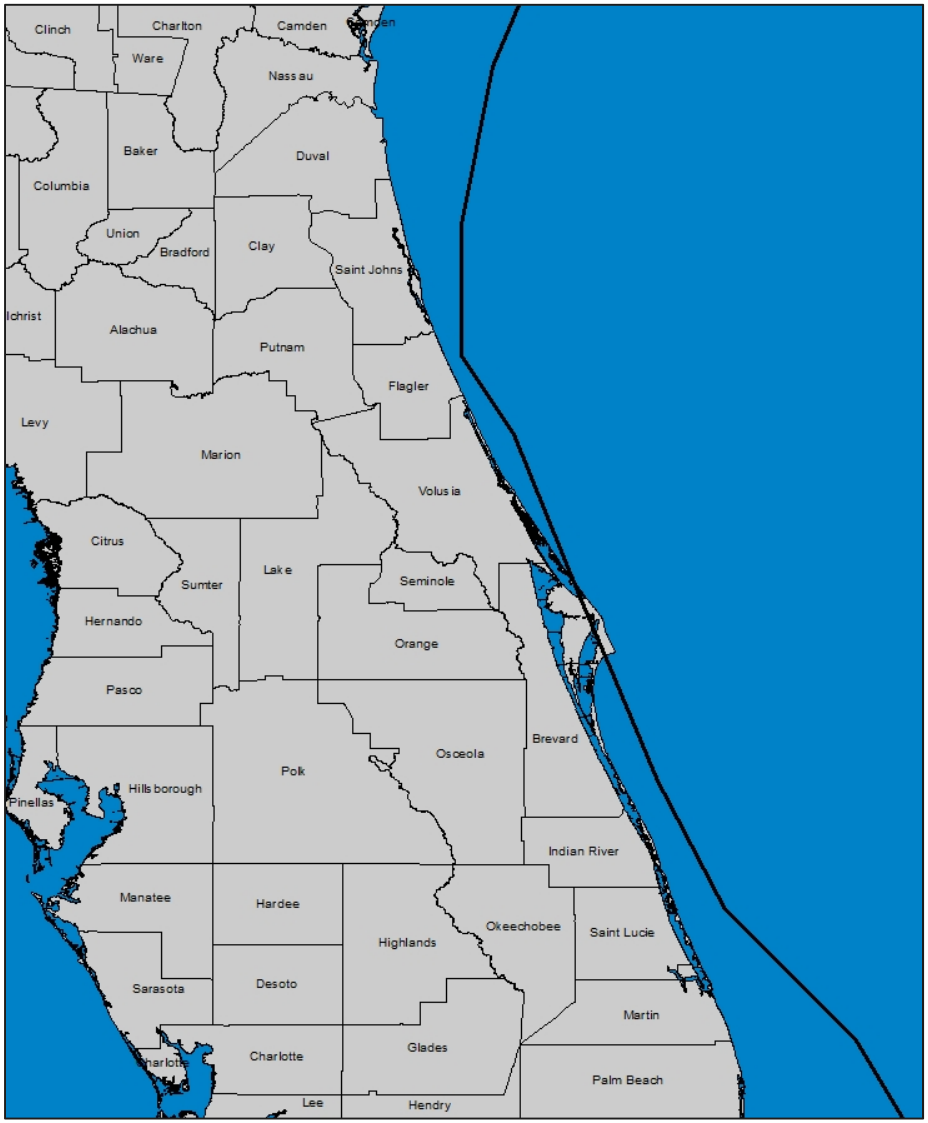


Figure 7. Matthew Forecasted Track. Analysts adjusted actual track 30 miles inland and increased wind speed to 130 mph.

Hurricane Matthew Forecasted Track

Matthew's wind speeds did not cause great impacts at wind retrofit projects sites; losses avoided for all wind retrofits are nearly $20,000. Analysts created a probabilistic scenario to re-evaluate wind retrofit projects in DR-4283's area of impact. This probabilistic scenario is based on Hurricane Matthew's predicted track, which was approximately 10 miles off Florida's east coast with 130 mile-per-hour wind speeds. This scenario is presented in Figure 7.

If Matthew aligned with the predicted track, nearly 230 retrofitted structures would have been protected from wind impacts. These projects would have resulted in $104.3 million in losses avoided, producing an average 336 percent ROI. Actual event impacts resulted in $20,000 in losses avoided and an average 3 percent ROI.

Integrated Results

Tropical Storm Debby also impacted one project with results from DR-4283. The project is an elevation type in Duval County, and experienced $156,110 in losses avoided from Tropical Storm Debby (normalized to 2016 dollars). Hurricane's Matthew's impact on the project was $116,200 in damages and a 25 percent ROI. ***By combining the results of Tropical Storm Debby and Hurricane Matthew, the total losses avoided for this project equate to $272,310, and the cumulative ROI is 58 percent, meaning over half of the project's initial investment has been realized in four years.***

Economic Impact Analysis

Mitigation measures have additional economic benefits beyond losses avoided. Implementing mitigation activities requires engagement with various economic industries such as technical services, construction, State employment, and office administration services. Mitigation projects boost sales and revenues (economic output) in these industries, increasing GDP contributions from Florida and generating jobs. As an addition to the DR-4283 loss avoidance assessment, FDEM identified economic output and job creation benefits based on project expenditures of mitigation measures impacted by Hurricane Matthew.

Results show that mitigation measures impacted by Hurricane Matthew created 180 full-time equivalent (FTE) jobs[23], generated $28.9 million in sales and revenues, and contributed $15.3 million to national GDP.

The IMPLAN analysis software evaluates the relationships between employment, labor income, economic output, and value added to GDP three ways: 1) direct impacts, which include industries that are directly related to mitigation activities; 2) indirect impacts for industries which support those that are directly impacted; and 3) induced impacts, or benefits created through employee spending.

The economic impact analysis reveals mitigation activities mainly benefit the real estate, construction, and architectural/engineering and related services industries. Direct employment within these industries made up over 65% of total jobs created due to mitigation activities impacted by DR-4283. The construction and real estate sectors reap the most benefit because most projects impacted by Hurricane Matthew are acquisition/demolition projects. Top industries with indirect employment benefit from implementation of mitigation measures include retail, building repair services, and restaurants, while industries with the most induced employment impacts include hospitals, educational services, restaurants, and retail. The majority of these industries operate locally, meaning the money is infused into the very communities benefitting from the losses avoided.

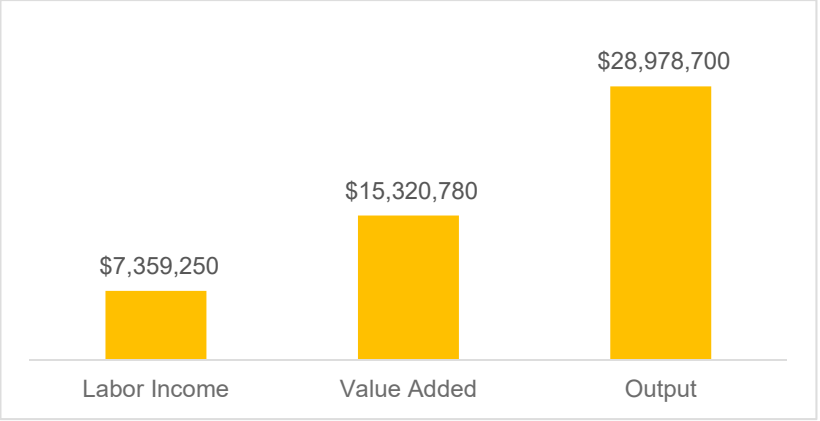


Figure 8. Total economic benefit of implementing mitigation measures, projects impacted by DR-4283 (reported in 2016 dollars)

[23] FTE is a method to standardize workload in order to make comparisons across various contexts or fields of study. Analysts used IMPLAN's methodology to convert full-time, part-time, and temporary employment to FTE jobs. Analysts use a simple ratio for each IMPLAN industry to covert between IMPLAN jobs and FTE jobs.

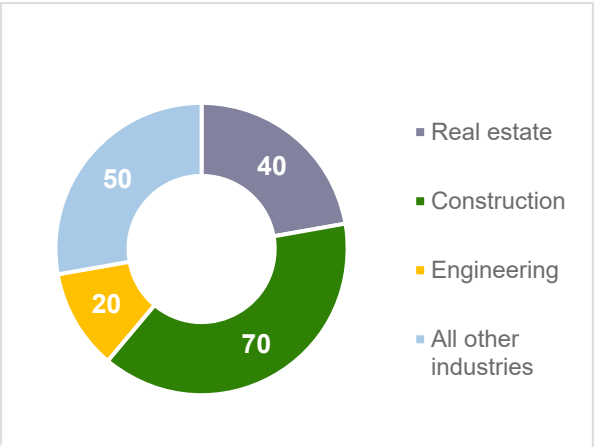


Figure 9. Total employment created by economic industry due to mitigation measures implemented

Economic Benefits of Mitigation Measures impacted by DR-4283

- **110 jobs in directly-impacted industries; 70 jobs from secondary impacts.**
- **$28.9 million generated in economic output, a 51% increase in the initial investment.**
- **180 total jobs created with an average labor income of $40,880.**

Economic impact analysis evaluates more factors than job growth alone. Economic output, labor income, and value added[24] are also important indicators of economic health. displays the 10 top-performing industries for these benefits, which follow trends similar to that of employment: real estate, construction, and architectural/engineering benefit most from mitigation investment. ***These results reveal that two of Florida's top economic industries – real estate and tourism – are supported by FDEM mitigation activities. In addition, industries that benefit most from implementing mitigation measures are those which tend to suffer in times of economic stress.*** Considering these factors, ***mitigation is a sound investment in Florida's economy in both comfortable and demanding economic times.*** Benefits of mitigation are historically limited to post-disaster losses avoided, but FDEM considers implementation of mitigation measures an important economic contribution to Florida when considering job growth and economic output generated.

Table 38. Top 10 industries benefitting from total economic output growth, reported 2016 dollars

Industry	Labor Income	Value Added	Output
Construction	$2,811,726	$46,332,010	$10,984,110
Real estate	$720,920	$5,100,020	$7,826,000
Architectural, engineering, and related services	$1,214,159	$1,243,150	$2,447,920
Retail and Wholesale Trade	$801,775	$1,302,323	$2,086,760
Finance and Insurance Activities	$87,450	$145,550	$572,090
Owner-occupied dwellings	$0	$378,360	$565,200
Local electric utilities and power distribution	$53,081	$202,450	$410,440
Restaurants	$108,501	$177,850	$321,690
Employment services	$165,055	$240,660	$315,770
Hospitals and medical services	$137,879	$156,410	$283,670

[24] Output is sales and revenues for industries; Labor income considers all contribution to GDP.

LESSONS LEARNED

The State of Florida identified mitigation lessons learned while conducting phone calls and meetings with communities to validate analysis results. Communities may use these learning experiences to enhance mitigation initiatives and strategically focus future investments to create a comprehensive approach to resilience. As extreme weather continues to stress and shock the physical and social fabric of our cities, it is imperative we learn from past experiences and adapt to achieve a more resilient future.

Understanding Local Risk

Understanding local risk is critical to developing a mitigation strategy that includes palatable, yet effective mitigation measures. Communities must balance the risk and cost of protecting itself against chronic stresses – frequent events that weaken a community, such as heavy rainfall – with acute shocks – sudden threatening events, such as a hurricane. This balance affects the types of mitigation projects a community invests in. A best management practice shared by an impacted community suggests that an implementation plan for mitigation measures should incorporate a public education component to ensure that residents understand the risk projects intend to mitigate. This can help residents make better decisions to protect health and safety in the event of acute shocks.

Strategic Mitigation Planning

Addressing local risk is accomplished through strategic mitigation planning: prioritizing mitigation projects based on impact and benefit. Local officials from several impacted communities recommend a combined approach to target mitigation: address site-specific issues on a regular basis, and plan for large-scale

- Balance costs and mitigation measures to reduce chronic stresses and protect against acute shocks for a mitigation ‘sweet spot’.
- Pick the low-hanging fruit available in your community: those easiest to mitigate.
- Consider mitigation measures that provide co-benefits: those that protect the environment, provide economic benefit, and improve quality of life.

projects that benefit a wide audience on a longer time frame. Low-hanging fruit, or easily implementable projects, are different for every community: some actively implement building modification projects to address site-specific issues as they are most effective in reducing risk to structures, while some communities take a passive approach to mitigation and use upcoming capital improvements as an opportunity to incorporate resiliency measures on a larger scale. The local risk context, available mitigation options, and community vision are all factors communities may consider when developing strategic mitigation plans.

Comprehensive Resilience through Mitigation

Mitigation projects are known to provide benefits in the form of losses avoided: physical damages, displacement and relocation of residents and businesses, economic interruptions, and casualties as well as other benefits that increase the resiliency of the built environment, its' residents, and the economy. Mitigation projects may also contribute to a community's overall resilience by providing co-benefits: those that protect the environment, improve residents' quality of life, and spur economic investment and diversity. One may refer to these benefits as value-added, as opposed to losses avoided. Co-benefits can contribute to ecological, social, and economic resilience[25], altogether improving a community's overall resilience.

[25] Ecological resilience is an ecosystem's ability to absorb disturbances and still persist; likewise, social resilience is the ability of different social entities to respond, adapt, and transform in the face of shocks or stressors. Many factors contribute to social resilience, but social capital and social networks play a critical role in building and maintaining social resilience. Social capital is the networks and relationships between people in a certain society that enable the society to function effectively. Economic resilience is the economy's ability to be flexible and cope with external shocks.

CONCLUSIONS

Assessing the performance of hazard mitigation measures is critical to substantiate the value of mitigation efforts, and loss avoidance assessment results help assure prudent use of limited public resources. FDEM conducts a loss avoidance assessment after each Presidential Disaster Declaration using actual event data to validate avoided hazard impacts due to completed mitigation projects. These avoided hazard impacts are presented in terms of dollars saved (losses avoided) due to mitigation action, and project ROI.

The Hurricane Matthew loss avoidance analysis results reveal that out of 136 projects within the storm's area of impact: 40 experienced impacts that would have caused damage had the community not implemented the mitigation project. Overall, the 40 projects cost $19.2 million to implement and avoided $81.1 million in potential damage. The average project ROI for DR-4283 is 97 percent. Drainage projects show the greatest ROI because multiple structures benefit from one mitigation action. Acquisition and elevation projects have the second-best ROI, an average of 34 percent, revealing that on average, a third of the initial mitigation investment for such projects was returned during Hurricane Matthew alone.

In addition to evaluating losses avoided and ROI, FDEM analysts estimated additional economic benefits of mitigation actions. Implementing mitigation activities engages various economic industries; in turn, boosting sales and revenues, increasing GDP contributions from Florida, and generating jobs. Results show that a $19.2 million-dollar investment in mitigation actions has created 180 full time equivalent jobs, generated $29 million in sales and revenue, and contributed $15 million to the national GDP.

Loss avoidance assessments demonstrate the fiscal benefits of mitigation projects, and analysis results support sound decision making related to public funding. Chronic stresses and acute shocks related to natural hazards are drastically altering the physical and social fabric of our cities. Increasingly frequent and more intense coastal storms will affect social, economic, and environmental systems and infrastructure that communities rely on every day. As such, loss avoidance analysis provides insight that FDEM and local communities can use to explore strategies for a resilient future

97 percent of initial mitigation investment, on average, was realized during Hurricane Matthew alone.

180 jobs created,

$29 million in sales and revenue generated,

$15 million contributed to the national GDP because **Florida** implemented mitigation actions.