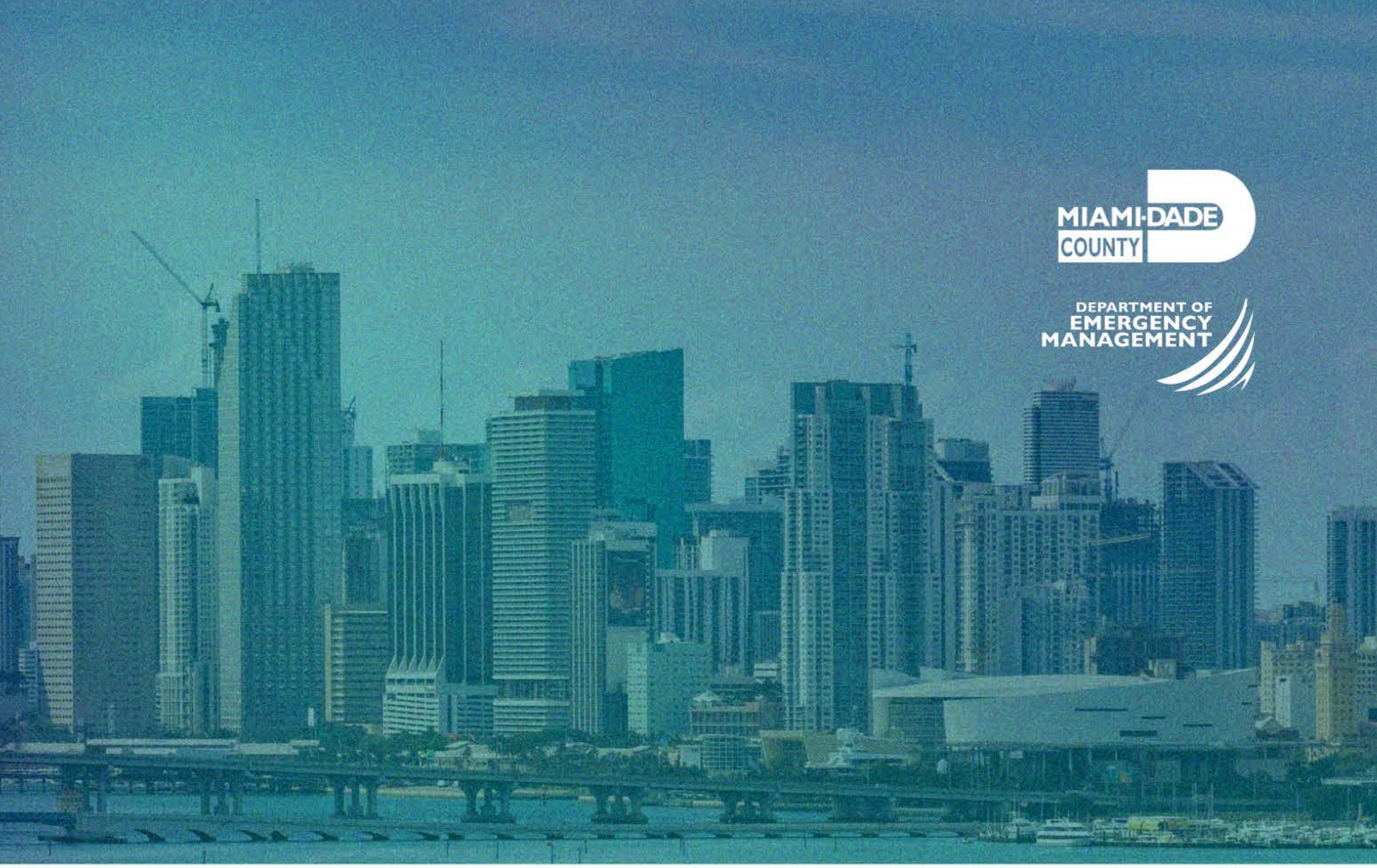

MIAMI-DADE COUNTY

DEPARTMENT OF EMERGENCY MANAGEMENT

LOCAL MITIGATION STRATEGY: LMS 2025

LMS

Miami-Dade County

2025

PART 1:

THE STRATEGY

MIAMI-DADE DEPARTMENT OF EMERGENCY MANAGEMENT

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INTRODUCTION

The Local Mitigation Strategy (LMS) is a comprehensive plan designed to reduce the community's long-term vulnerability to disasters. This plan forms the foundation of Miami-Dade County's approach to mitigation initiatives and establishes the county's eligibility for Hazard Mitigation Assistance (HMA) funding. The mitigation objectives and goals determined in this plan are informed by an assessment of the hazards unique to Miami-Dade County. As a living document, the LMS Plan is revised to integrate necessary changes identified by whole community partners under the direction of Miami-Dade County Department of Emergency Management (DEM).

This plan was published on the DEM website for public review and feedback received was integrated prior to submission to the Florida Division of Emergency Management (FDEM) and Federal Emergency Management Agency (FEMA) for approval. Upon receiving Federal approval, the LMS Plan was presented to the Miami-Dade Board of County Commissioners (BCC) for adoption in 2025.

A review of the changes that have been made to the LMS since its last adoption in 2020 is provided in *Part 4: Appendix A*.

Purpose

The purpose of the LMS is to develop a comprehensive approach to effectively reduce the impact of current and future hazards and risk faced by local communities within Miami-Dade County. [1]

The LMS accomplishes this through the following measures:

- A planning process that encourages whole community participation and input;
- Review and incorporation of community plans, local, state and federal regulations and guidance, studies, reports and technical information;
- Overview of past and present occurrences and projected future hazard events;
- Linkage of mitigation measures and actions to the Threat and Hazard Identification and Risk Assessment (THIRA);
- Identification of measures and actions as LMS Projects are accomplished, are planned for implementation, or identified as potential or future initiatives;
- Identification of potential or actual funding sources;
- Integration of GIS to provide maps to illustrate hazard and risk areas, consequence analysis and mitigation measures;
- Annual reviews and updates;
- Regular meetings, informational messaging, trainings and workshops to engage the mitigation participants;

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[1] EMAP 2016 Standard 4.2.1

- An identified process for monitoring the overall progress of mitigation strategies and documentation of completed initiatives.

This strategy will continuously evolve to address current and future risk and vulnerability.

How to Use This Plan

The LMS is divided into five (5) parts:

Part 1 – The Strategy (LMS-Part 1) – Provides an overview of the LMS and identifies how the plan is implemented, updated, and informed by legal authorities. This part sets forth the goals and objectives for mitigation actions. It also includes the hazards assessment along with rationale for inclusion or omission of hazards in our strategy and information about varying jurisdictional vulnerabilities.

Part 2 – The Projects (LMS-Part 2) – Contains the methodology for how mitigation projects are submitted, prioritized,[2] and tracked. Also includes the list of projects identified by the LMS Working Group members for mitigation actions that are planned, in progress, or completed. This part also highlights case studies of projects completed within the last four years.

Part 3 – Funding (LMS-Part 3) – Identifies potential funding sources for mitigation projects.

Part 4 – Appendices (LMS-Part 4) – This section contains a number of supportive documents including:

- List of Updates made to the plan since the last adoption
- List of LMS members including Steering Committee, Working Group and Sub-Committees
- Miami-Dade Resolution Adopting the LMS
- State Letter approving the LMS
- FEMA Letter approving the LMS
- Local Charter information for the Metropolitan form of Government
- Integration Document
- Municipal Integration of the LMS
- Community and Economic Profile

Part 5 – Flooding NFIP & CRS (LMS-Part 5) – Contains information specific to flood management plans and identifies activities and information in support of the CRS program.

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[2] EMAP 2016 Standard 4.2.3

LMS ORGANIZATIONAL STRUCTURE

The LMS is a compilation of initiatives that are identified and supported by the LMS Chair, LMS Co-Chair, the Steering Committee (LMSSC), the Working Group (LMSWG), sub-committees and ultimately adopted by local governing bodies. A complete list of the participants of the LMS are listed in LMS-Part 4 Appendices B and C.

LMS Chair

The Miami-Dade County Department of Emergency Management (DEM) Mitigation Planner serves as the LMS Chair. The LMS Chair is responsible for updating and maintaining the LMS Plan, coordinating meetings and trainings, reviewing and archiving LMS projects, and disseminating information pertinent to the mitigation goals and objectives set forth in the LMS.

The LMS Chair also serves as the LMSSC Chair. This involves scheduling and presiding over the LMS meetings. The LMS Chair participates in workshops, trainings, and conferences throughout the year to benefit the LMS. Additionally, the LMS Chair maintains a distribution list of individuals interested in mitigation and is responsible for the website updates.

LMS Co-Chair

The LMS Co-Chair is an appointed position by the LMS Steering Committee and assists the LMS Chair by reviewing and developing initiatives as well as providing consultation to the LMS Chair. The LMS Co-Chair is also responsible to stand in for the LMS Chair in case of any unforeseen absences.

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LMS Steering Committee

The LMSSC acts as a “Board-of-Directors” and is responsible for the development of policy guidance. Members of the LMSSC are representative of the organizations found within the larger Working Group (i.e. municipal, county, educational, not-for-profits, private sectors and individuals). The LMSSC acts as a review committee for the establishment of this LMS and the prioritization of the projects therein when a limited funding source is available. Membership on any committee shall be voluntary and subject to the review and approval of the LMSWG. A committee member who fails to attend a reasonable number of committee meetings may be dropped from participation in the committee by a majority vote of the other members of that committee.

Any planning and program development matters are addressed as needed in LMSSC meetings and open forums in the LMS quarterly meetings.

LMS Working Group

The LMSWG is composed of representatives from eight main groups:

- Municipalities
- County Departments
- Colleges and Universities
- Hospitals and Health Care
- Private Non-Profits
- Private Sector/Businesses
- Regional, State and Federal Partners
- Other Stakeholders, including private citizens

The makeup of the LMSWG is not limited to any particular organization or jurisdiction. Numerous others have expressed the desire to participate in the LMS and are welcome to do so. Each organization is encouraged to solicit participation and commentary from its citizens, employees, and members.[3]

To be considered a participant of the LMS and receive the benefits thereof, a municipality, County Department or any other organization must attend at least two (2) of the last four (4) quarterly meetings held. The agencies that are participating in the LMSWG are identified in *Part 4 Appendix B*.

[3] EMAP 2016 Standard 4.4.1(2)

Municipal Participation

Within Miami-Dade County the following municipalities are active participants of the LMS Working Group.

City of Aventura	City of Homestead	City of Opa-locka
Bal Harbour Village	Village of Key Biscayne	Village of Palmetto Bay
Town of Bay Harbor Islands	Town of Medley	Village of Pinecrest
Village of Biscayne Park	City of Miami	City of South Miami
City of Coral Gables	City of Miami Beach	City of Sunny Isles Beach
Town of Cutler Bay	City of Miami Gardens	Town of Surfside
City of Doral	Town of Miami Lakes	City of Sweetwater
Village of El Portal	Miami Shores Village	Village of Virginia Gardens
Florida City	City of Miami Springs	City of West Miami
Town of Golden Beach	City of North Miami	Indian Creek Village
City of Hialeah Gardens	North Bay Village	Miami-Dade County (unincorporated areas)
City of Hialeah	City of North Miami Beach	

For the remainder of this document municipalities will be referred to by only the name and not the full title (e.g. City of Coral Gables will be referred to as Coral Gables).

LMS Sub-Committees

In order to streamline the LMSWG's activities, various sub-committees may be formed as needed to address an area of concern. The formation and disbandment of sub-committees is done in correlation with trending issues that are addressed by the LMSWG members. A list of possible sub-committees can be found in *Part 4 Appendix C*.

Meetings

The LMSWG meets once each calendar quarter and the LMSSC and LMS Sub-Committees meet as needed. Meeting announcements are posted on the LMS webpage, and emails are sent to the LMS Distribution List which is maintained by the LMS Chair.

The representatives are encouraged to notify the public or other interested parties about meeting dates at least 30-days prior to each meeting. Meeting times, dates and locations will be posted on the LMS website: https://www.miamidade.gov/global/emergency/projects-that-protect.page.

Meeting notes and attendance records are kept by the LMS Chair and are available upon request.

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PLANNING PROCESS[4]

The LMS Chair with the assistance of the LMS Steering Committee, and input from the LMSWG, LMS sub-committees, and the public, updates and maintains this plan. Updates are based on factors such as recent disaster events, changes in Local, State, and Federal policies, emerging issues such as aging infrastructure, and new development projects that impact Miami-Dade County communities.

The LMS Chair includes a listing of the revisions made to this plan in relation to these factors, which is documented in the *Part 4 Appendix A: List of LMS Changes*.

Annual Updates

The LMS is updated on an annual basis. These updates are based on reviews from the LMS Chair and input from partners regarding the effectiveness of the plan in reducing the County's vulnerability to hazards and in achieving LMS goals. Any proposed changes are reviewed for integration with the LMS and Comprehensive Emergency Management Plan (CEMP) crosswalks provided by FDEM, the Emergency Management Accreditation Program (EMAP) Standards, the Community Rating System (CRS) Coordinator's Manual, and the Threat Hazard Identification and Risk Assessment (THIRA). An annual update to the LMS is provided to the State by January 31st every year and the documents are subsequently posted on the Miami-Dade County website.

Five-Year Update

A complete State and Federal review and approval of this plan is conducted on a five-year cycle. The plan has undergone review and approval from FDEM and FEMA every five (5) years since 2000. The five-year review process incorporates the annual updates and a review of the FDEM LMS Crosswalk. FDEM notifies the LMS Chair 12-months in advance of the plan expiration date. The LMS Plan is updated and prepared at least eight (8) months prior to its expiration for public review and comments on the plan. Once all comments are reviewed and incorporated, the updated LMS will be submitted to FDEM by the LMS Chair for review no later than six (6) months prior to its expiration date.

FDEM will review the LMS Plan and provide comments, and if needed, the LMS Chair will make revisions to satisfy any State LMS Crosswalk deficiencies. Once the plan has been approved by the State, it is then sent to FEMA for review and approval.

2025 LMS Update Management Plan (LMS-PUMP)

The planning process for the 5-year update for the LMS began at the December 14, 2023 Quarterly Meeting. At this meeting the LMS Chair presented and

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[4] EMAP 2016 Standard 4.2.1.(2)

discussed the LMS Planning Update Management Plan (LMS-PUMP). This plan included the schedule for updating the LMS, the information that would be requested, the schedule for meetings and workshops that would discuss various elements of the plan and the expected roles and responsibilities of the entities involved in the update process.

In the LMS-PUMP, the following major milestones of the update process were presented:

The roles and responsibilities of the entities involved in the update process are as follows:

<u>LMS Chair</u>
Responsible for the overall update process. This includes:
- Ensures that the new plan meets all the policy requirements for a FEMA approved plan
- Provides the LMSWG with a process to update the plan and organizes all the required meetings and discussions
- Documents the meetings, discussions and updates of the plan
- Directs the meetings and discussions
- Implements the approval process

<u>LMSSC</u>
- Participate in all PUC meetings and quarterly LMS meetings
- Reviews plan and provides recommendations for plan updates
- Review draft edits to plan volumes, and approve changes

<u>Plan Update Committee (PUC)</u>
- Participates in the PUC meetings and drafts initial edits to the plan elements
- PUC members may attend all or a selection of the PUC meetings based on expertise and areas of interest

<u>LMSWG</u>
- Participate in all PUC meetings and quarterly LMS meetings

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- Reviews plan and provides recommendations for plan updates
- Review draft edits to plan volumes, and approve changes

<u>Jurisdictions, Special Taxing Districts and Agencies with Boards</u>

- Must provide updates regarding how they implement the mitigation plan in their own planning efforts
- Must submit the approved plan for adoption by their boards and councils

<u>Florida Division of Emergency Management</u>

- Provides support regarding policy, guidance and procedures regarding the development of hazard mitigation plans and their updates
- Reviews and approves hazard mitigation plans through their 5-year cycle updates
- Provides training regarding policy, guidance and procedures regarding the development of hazard mitigation plans and the approval process
- Coordinates the review and approval process between FEMA and local governments

The LMS-PUMP describes the major elements of the LMS Plan that require discussion, collaboration, and input from the community to be updated. These elements require discussion within the Plan Update Committee (PUC) meetings. The PUC is composed of the LMS Steering Committee (LMSSC) and any LMSWG committee members that volunteer to join each individual PUC meeting. The LMS-PUMP also states that FEMA policy requires participating jurisdictions to be part of the development of the hazard mitigation plan to receive FEMA approval and the benefits of that approval.

The following table describes the plan elements and the parties involved in their update:

Plan Element	Collaboration needed	Responsible Parties
(Part 1 – The Strategy) Policies, Ordinances and Programs Affecting Mitigation	Agencies need to provide updates regarding how the plan is implemented locally in their own planning processes	Jurisdictions, Special Taxing Districts and Agencies with Boards
(Part 1 – The Strategy) Analysis of all Hazards from THIRA	Hazards from the most recently updated THIRA need to be reviewed to determine consideration in the LMS	PUC will review section in advance of working meetings, and provide written edits to LMS Chair LMSWG will provide input and consensus of Hazards during quarterly meetings

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Plan Element	Collaboration needed	Responsible Parties
(Part 1 – The Strategy) Mitigation Goals and Objectives	Mitigation goals and objectives will be evaluated to ensure alignment with community needs as well as updated Hazard analysis	PUC will review section in advance of working meetings, and provide written edits to LMS Chair LMSWG will provide input and consensus on goals and objectives during quarterly meetings
(Part 2 – The Projects) Prioritizing Mitigation Initiatives	This element focuses on the criteria for prioritizing mitigation actions and projects. The process will be reviewed to ensure actions and projects are prioritized according to need and benefit. This section also includes the mitigation project list for the county since the last plan update.	PUC will review section in advance of working meetings, and provide written edits to LMS Chair Updated criteria will be presented at quarterly meeting for LMSWG review and discussion LMS Chair will provide survey for input LMSWG members will provide responses and updates regarding their respective completed projects since the last plan update.
(Part 3 – Funding) The Funding	Section will be reviewed to ensure accurate and up to date information on all funding sources and programs, identify any potential new sources of funding, and provide additional guidance on how to navigate these sources to maximize funding opportunities	PUC will review section in advance of working meetings, and provide written edits to LMS Chair
(Part 4: The Appendices) The Appendices – Appendix H: Integration Document	Relevant plans will be listed, plan elements will be identified for each plan, and	PUC members will be assigned a plan/plans in advance. PUC members will review their respective assignment ahead of working

Plan Element	Collaboration needed	Responsible Parties
	reviews will occur to ensure significant elements and priorities from other plans align with LMS Plan. Additionally, any actions needed to bring plans into alignment will be noted.	meetings, and provide written edits to LMS Chair LMS Chair will consult with original plan authors for final consensus prior to adoption of this section.
(Part 4: The Appendices) The Appendices	Existing maps will be updated to current data. Additional mapping needs will be identified based on available research, current hazard analysis, state hazard mitigation plan, and others sources as appropriate.	LMS Chair will meet with County GIS department to make needed updates.

For meetings and discussions scheduled with topics from the LMS-PUMP, relevant materials were forwarded to PUC members ahead of the meetings to provide a better understanding of the elements that were being discussed. PUC members were given an opportunity to provide input during the meetings or in writing via email.

The following table details when the LMS Quarterly and PUC meetings were held to host discussions about the elements of LMS Plan broken down by topic:

Date	Meeting	Topics	Location
December 14, 2023	LMS Q4	• Presentation of LMS PUMP	North Dade Regional Library
February 29, 2024	PUC	• (Part 1 – The Strategy) Analysis of all Hazards from THIRA	Remote: Microsoft Teams
March 14, 2024	PUC	• (Part 1 – The Strategy) Mitigation Goals and Objectives	Remote: Microsoft Teams
March 28, 2024	LMS - Q1	• Presentation and Discussion of Hazards, Goals and Objectives	In person
April 23, 2024	PUC	• (Part 2 – The Projects) Prioritizing Mitigation Initiatives	Remote: Microsoft Teams

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Date	Meeting	Topics	Location
June 27, 2024	LMS – Q2	• Presentation and discussion of Prioritization of Projects • Deadline to provide agency updates (self-reported elements not requiring discussion), Policies, Ordinances and Programs Affecting Mitigation (See Part 1: The Strategy of the LMS Plan) • Deadline to provide survey responses for completed projects (See Part 2: The Projects)	In person
July 30, 2024	PUC	• (Part 4: The Appendices) The Appendices – Appendix H: Integration Document	Remote: Microsoft Teams
August 28, 2024	PUC	• (Part 3 – Funding) The Funding	Remote: Microsoft Teams

Review and Revision Criteria

The LMS will be updated by the LMS Chair with the assistance of the LMSSC and input from the LMSWG. Most revisions made to each section of this document were based upon the LMS-PUMP explained earlier in this document and LMSWG meetings that generally discussed the following questions:

1. Have there been any new mandates from Federal, State or Local agencies that require changes to the LMS? Any new or changing laws, policies or regulations?
2. Are there any societal developments or significant changes in the community that must be added to the current LMS? Does the LMS still reflect the concerns of the community? Are the demographics the same? Has there been any growth or development in hazard areas?
3. Have there been any changes in funding sources or requirements?
4. Should the LMS be updated to include any new forms of hazards or areas of vulnerability within Miami-Dade County communities?
5. Have there been any changes in the Comprehensive Development Master Plan (CDMP), THIRA, or any other planning documents?
6. Have any of the mitigation opportunities been implemented? Are the priorities for implementation the same?
7. What are the recommendations or lessons learned from any major incidents that have occurred during the past five-year update period?

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Public Review and Comment

The latest published version of the LMS Plan is posted on the Miami-Dade County web-site: https://www.miamidade.gov/global/emergency/projects-that-protect.page for public review and commentary. Any comments received through this medium will be incorporated through the revision process identified above. Comments can be sent to the following email address mdlms@miamidade.gov.

DEM will post messages via the different social media platforms and the Miami-Dade County website to encourage Miami-Dade community members to review and comment on the Plan.

Incorporation of Existing Plans and Strategies

As part of the planning process, the LMSWG performed a review of local policies and plans to create an Integration Document (*Part 4 Appendix H*). The LMS Chair, as part of the LMS-PUMP, coordinated a planning meeting facilitated by FEMA contractors through their BRIC Direct Technical Assistance grant program. Opportunities for plan integration of policies, ordinances and programs were discussed so that they could be memorialized in the LMS Plan. Areas for opportunity where mitigation may be better aligned are also notated.

The Integration Document in *Part 4 Appendix H* includes evaluations of the following:

- Miami-Dade County Resilient305 Strategy
- Miami-Dade County Sea Level Rise Strategy
- Miami-Dade County Thrive305 Action Plan
- Miami-Dade County DEM Post Disaster Redevelopment Plan (PDRP)
- 2050 Long Range Transportation Plan (LRTP)
- Miami-Dade County Heat Action Plan 2022
- Miami-Dade County DEM Recovery Support Function (RSF) Mitigation Annex
- Miami-Dade County DEM Flood Response Plan
- Miami-Dade County DEM Recovery Plan (July 2022)
- Southeast Florida Regional Climate Action Plan (RCAP) 3.0

Plan Adoption

Once the plan has been approved by FDEM and FEMA, it will be submitted to the Miami-Dade County Board of County Commissioners (BCC) for adoption. Miami-Dade County has a metropolitan form of government with its own Home Rule Charter (*Part 4 – Appendix G*). Once the BCC passes a resolution, that action automatically includes all the Municipalities within the County. In the event a Municipality does not wish to participate in the action, that Municipality must, through their own resolution, opt out. However, FEMA requires that each jurisdiction, special tax district, institution or agency governed by a board or council adopt the LMS Plan through their own resolution to receive approval and the benefits of approval.

Miami-Dade County communities that wish to utilize the LMS as their Floodplain Management Plan for credit under the CRS Program, must also adopt the LMS. Copies of the local adoption should be sent to the LMS Chair to be incorporated into *LMS-Part 4*.

A copy of the official plan adoption document can be found in *Part 4 Appendix D.*

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POLICIES, ORDINANCES AND PROGRAMS AFFECTING MITIGATION [5]

There are many federal, state and county laws and policies that affect hazard mitigation and all the members of the LMSWG. Some of those are:

Federal

1. The Robert T. Stafford Disaster Relief and Emergency Assistance Act, P.L. 93-288 as amended (The Stafford Act) is interpreted by Title 44 of the Code of Federal Regulation (44 CFR) and governs FEMA and emergency management and sets forth the federal concepts for hazard mitigation. It also defines the Coastal Barriers Resources Act (44 CFR 206 subpart J) and describes floodplain and environmental management (Parts 9 and 10).

2. The Disaster Mitigation Act of 2000 (DMA-2K) has also redefined parts of The Stafford Act and those changes have been incorporated into this document. Much of FEMA has been further redefined by the “Post-Katrina Emergency Management Reform Act of 2006,” which was enacted by Congress and signed into law by the President in the fall of 2006.

3. The National Flood Insurance Program (NFIP) and the Community Rating System (CRS) FLA-15, July 1996, sets up a community rating system for flood insurance offering incentives for communities and credits for identified floodplain management activities.

4. National Fire Code, 1993 and NFPA 101 Life Safety Code define uniform fire safety standards adopted by rule by the State Fire Marshal.

5. Title 15 of the Code of Federal Regulations, which defines the Coastal Zone Management Act (15 CFR Parts 923 and 930).

6. Title 40 of the Code of Federal Regulation which defines the National Environmental Policy Act including such mitigation measures as included in the National Emission Standards for Hazardous Air Pollutants (Part 61), Toxic Substances Control Act (Part 763), the Resource Conservation and Recovery Act and CERCLA (the Superfund).

7. Title 29 of the Code of Federal Regulations that defines the Occupational Safety and Health Act containing many hazard mitigation measures.

8. Presidential Decision Directives 39 and 62 are the authorities directing the development of terrorism response.

[5] EMAP 2016 Standard 4.2.4 (1)

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9. Presidential Policy Directive (PPD) 8: National Preparedness was released in March 2011. The goal of PPD 8 is to strengthen the security and resilience of the U.S. through five (5) preparedness mission areas – Prevention, Protection, Mitigation, Response and Recovery.

    a. National Protection Framework follows the guiding principles of resilience and scalability, a risk informed culture and shared responsibility.

    b. National Mitigation Framework establishes a common platform for coordinating and addressing how the Nation manages risk through mitigation capabilities.

    c. National Response Framework includes establishing a safe and secure environment moving towards recovery.

    d. National Disaster Recovery Framework focuses on how to best restore, redevelop and revitalize the community and build a more resilient Nation.

10. National Infrastructure Protection Plan (NIPP): provides a framework for programs and initiatives for the protection of Critical Infrastructure and Key Resources (CI/KR) and ensures that resources are applied where they offer the most benefit for mitigating risk.

11. PPD – 21 Critical Infrastructure and Resilience establishes a national policy on critical infrastructure security and resilience

State

1. State of Florida Statutes which are pertinent to hazard mitigation include:

    a. Chapter 161 – Beach and Shore Preservation

    b. Chapter 163 – Conservation, Aquifer Recharge and Drainage Element

    c. Chapter 255 – Public Property and Public Buildings

    d. Chapter 373 – Water Resources

    e. Chapter 403 – Environment Controls

2. The South Florida Water Management District is a regional government agency that oversees the water resources in the southern half of the state through managing and protecting water resources including balancing and improving water quality, flood control, natural systems and water supply.

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3. South Florida Fire Prevention Code 1992-93 (adopted by the County Commission) defines standards for fire prevention and allows controlled burns as mitigation.

County

1. Board of County Commission Resolutions

    a. R-572-00, which establishes the Miami-Dade Local Mitigation Strategy as official county policy.

    b. R-710-05, which authorizes the County Manager to apply for, receive, expend and amend applications for projects listed in the Miami-Dade Local Mitigation Strategy.

    c. R-451-14, which requires all County infrastructure projects to consider potential impacts of sea level rise during all project phases.

2. Pertinent Miami-Dade County laws include codes and ordinances that govern the unincorporated and municipal activities, as follows:

    a. Chapter 8(b) of the county code, which deals with emergency management.

    b. Chapter 11(c), covering Development within Flood Hazard Districts.

    c. Chapter 17, i.e. the Housing Code, focused on maintaining the housing stock in decent safe and sanitary conditions.

    d. Chapter 18b covering right-of-way landscaping.

    e. Chapter 24 covering the activities of the Miami-Dade Division Environmental Resources Management (DERM) for permitting hazardous materials.

    f. Chapter 28 of the county code which deals with subdivision regulations.

    g. Chapter 33, covering zoning activities for approval of a development of regional impact.

    h. Floodplain Management Program sets the criteria for elevations and assesses the risks for flooding for different areas of the County.

    i. Miami-Dade County Comprehensive Emergency Management Plan (CEMP) mandates that municipalities have emergency management plans, as well as recommends the performance of hazard mitigation activities.

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   j. Miami-Dade County Comprehensive Land Use Plan dictates current land use and controls future land use and growth throughout the county.

   k. The Public Works Manual, especially Section D5, concerning coastal construction.

   l. Miami-Dade County Environmental Protection Ordinance, Coastal and Freshwater Wetlands Regulations.

3. Miami-Dade County Special Assessment Districts can provide tree-trimming programs that prevent more severe damage during windstorms.

4. On March 1, 2002, the Florida Building Code (FBC), was adopted by Miami-Dade County and all the Municipalities, consequently replacing the South Florida Building Code. The High Velocity Hurricane Zone (HVHZ) portions of the code are applicable to Miami-Dade and Broward Counties only, the HVHZ sections of the FBC in addition to the most current ASCE- 7 standard contains stricter design and construction measures, especially to protect windows, walls, and roof from wind-born debris. In 2012, the FBC was amended to include flood protection measures and use of ASCE-24.

5. The Local Law Enforcement Mutual Aid Agreement with Miami-Dade County designed to coordinate and supplement local resources.

6. The Statewide Mutual Aid Agreement for Catastrophic Disaster Response and Recovery establishes a local resource for all Working Group members that are presently signatories.

7. The Southeast Florida Regional Climate Change Compact set forth an agreement between Miami-Dade, Broward, Palm Beach and Monroe Counties to work in collaboration to address the impacts of climate change on Southeast Florida. The Climate Change Action Plan was subsequently developed to identify and pursue reduction and resiliency measures in the region.

County Programs

<u>Stormwater Management Masterplan</u>

This program has the responsibility of the evaluation of flood protection levels of service. The Stormwater Management (Drainage) Level of Service (LOS) Standards for Miami-Dade County contain both a Flood Protection (FPLOS) and Water Quality (WQLOS) component. The minimum acceptable Flood Protection Level of Service (FPLOS) standard for Miami-Dade County is protection from the degree of flooding that would result for a duration of one day from a ten-year storm, with exceptions in previously developed canal basins, where additional development to this base standard would pose a risk to existing development. All structures shall be constructed at, or above, the minimum floor elevation following the latest version of the Florida Building Code or as specified in Chapter 11-C

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of the Miami-Dade County Code, whichever is higher. The incorporated areas of the county (municipalities) may have adopted stricter elevation standards.

<u>Subdivision and Other Regulations</u>

Miami-Dade County Code imposes certain developmental requirements before land is platted. These relate to the provision of water and sewer facilities, local streets, side-walks, drainage, and open space. Before use permits or certificates of occupancy can be issued, Section 33-275 of the Miami-Dade County Code requires that adequate water, sewage and waste disposal facilities be provided.

<u>Shoreline Review</u>

The Shoreline Development Review Ordinance was adopted in 1985 and prescribes min-imum standards for setbacks, visual corridors and, with its' accompanying resolutions, sets out a flexible review process through which architectural interest, building orientation, landscaping, shoreline use compatibility, access, and other design related elements can be negotiated with the developers and enforced by the local governing jurisdiction.

<u>Area Plan Report</u>

Since 1998, Area Plan Reports have emerged as a preferred planning technique for com-munity visioning and helping to find answers to fundamental planning questions. An Area Plan Report is a practical planning technique, which blends public participation, detailed planning, and the development of implementation tools. Its principal focus is the creation of planning products (instead of processes. Public participation is indispensable for a successful Area Plan Report. The overriding objective is the creation of a detailed plan, which resolves areas of concern identified in the Area Plan Report study area; often these concerns involve capital improvements such as roads, sewers, sidewalks, parks and other community improvements. The Planning and Zoning Divisions of the Department of Regulatory and Economic Resources implements the Area Plan Report process as a collective planning effort that develops a small area plan which incorporates the priorities of a community.

<u>Coastal Management</u>

The Beach Restoration and Management Program is Miami-Dade County's mechanism for initiating and coordinating federal and/or State projects essential to the protection and recreational viability of Miami-Dade's ocean shoreline. Local participation in the determi-nation of activities pertaining to beach restoration and preservation is included in the pro-gram. The County has benefited from large federal and State funding contributions and the expertise obtained because of the program. Most notably, the Miami-Dade County Beach Restoration Project now provides hurricane and erosion control protection for up-land property and a vast recreational resource for public use. This project replaced a significantly eroded shoreline sustained only by bulkheads and seawalls, which offered little protective or recreational value. Implementation of erosion control projects is based on the following criteria:

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1. Need for protection of public safety and property in areas threatened by coastal erosion.

2. To provide enhanced beach-related recreational opportunities for both visitors and Miami-Dade County residents.

3. To provide more effective and efficient long-term management of our natural and restored beach systems.

The Biscayne Bay Restoration and Enhancement Program objectives are to maintain or improve ecological, recreational, and aesthetic values of Biscayne Bay, its shoreline, and coastal wetlands. Projects include shoreline stabilization, mangrove and wetland habitat restoration, and bay bottom community enhancement at parks and other public lands. These contribute to erosion control, water quality, fisheries, and wildlife resources.

Future capital expenditures will be directed primarily towards maintaining and enhancing durability of restored beaches and to environmental improvement of the Biscayne Bay ecosystem. All these projects are developed and carried out based on the best scientific and technical information available to the agencies involved.

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Municipalities

Each of the municipal partners has integrated mitigation into their planning processes, policies, and structures in some capacity. *Part 4 Appendix I* is a review of each municipalities' mitigation policies, ordinances, or plans that integrate Miami-Dade County's LMS. Additionally, each municipality has a designated point of contact which is updated annually utilizing LMS Working Group Contact Update Form. These individuals have the responsibility to coordinate mitigation activities with the relevant municipal agencies.

The municipal partners either through their designated point of contact or agencies have the responsibility for integrating mitigation into their respective plans and procedures. Common examples of these plans and procedures are:

- Municipal Flood Warning and Response Plans and Procedures
- Municipal Comprehensive Development Master Plans
- Protective Actions Plans and Procedures

Municipal Agencies and their Mitigation Functions

The municipalities of Miami-Dade County each have within their structure certain departments and agencies which affect and promote mitigation. While these agencies may have slightly different names from city to city, the role they perform in the mitigation function remains the same (e.g. public works or public services or community services, etc.). These departments and their functions as it relates to mitigation are listed below.

Municipal Floodplain Manager: Some of the municipalities have a designated floodplain manager. They are responsible for coordinating and directing compliance with the Community Rating System (CRS) and maintaining their municipality's flood warning and response plan.

Municipal Police and Fire Rescue Departments: Each of the municipalities except Miami Lakes, Palmetto Bay and Cutler Bay maintains its own Police Department. The cities of Coral Gables, Hialeah, Key Biscayne, Miami, and Miami Beach maintain their own fire departments, with the rest of the cities using Miami-Dade County Fire Rescue for this service. Emergency responders are essential for alert and notification, lifesaving response, prevention, and protection activities that all contribute to lessening the impact of disasters.

Municipal Code Officials/Departments: the building officials in each municipality, except for some that depend on the county's services, are responsible for interpreting and enforcing all laws, codes, ordinances, regulations, and municipal policies related to the construction, improvement, expansion, or repair of buildings within the municipality. The County Department of Regulatory and Economic Resources (RER) ensures that all new construction complies with the Florida Building Code which is a major factor to hazard mitigation. The department usually is responsible for the management of development in Special Hazard Areas; preservation of open space; general control of land use intensities; and coordination

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between the capacity of public infrastructure in relation to proposals of private development. RER also ensures all proposed development in the municipality conforms to the comprehensive plans as it relates to urban design of public areas and buildings, infrastructure planning and maintenance of flood data and other statistical information.

Municipal Planning and Development Department: This is often a part of the building department and at times, a part of public works. However, several of our municipalities maintain planning and development as a separate entity which interacts with the mitigation strategy in many ways and must be involved in the LMS especially in urban land use.

Public Works Department: In most of our cities this department is responsible for construction and maintenance of roads, bridges, waterways, and storm water management including drainage system development, inspection, and maintenance. All these functions relate in various ways to hazard mitigation. Public works activities are a major component of any mitigation strategy.

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MITIGATION GOALS AND OBJECTIVES[6]

Mitigation initiatives undertaken in Miami-Dade County should be consistent with the goals and objectives set forth in this plan and the individual municipalities' mitigation plans and policies, as well as public safety regulations and citizen welfare.

Goals

1. Reduce Miami-Dade County's vulnerability to natural and man-made hazards

Objectives:

1.1. Incorporate new and more accurate data, studies and maps that demonstrate the evolution of risk in the county
1.2. Utilize a data driven process to measure efficacy of mitigation investments, methods, & techniques
1.3. Identify new and emerging mitigation methods and products for new and retro-fitting construction
1.4. Identify projects that mitigate expected impacts from hazards identified in the THIRA
1.5. Promote mitigation measures to the Whole Community through outreach and education
1.6. Harden building envelope protection – including all openings – and inclusion of a continuous load path from roof to foundation on all structures within the county
1.7. Reduce flooding from rainfall events
1.8. Reduce storm surge hazards and effects by encouraging greater setbacks from shorelines for new developments of waterfront properties, encouraging retrofitting and elevation of structures with high priority consideration for those built on waterfront properties, seeking opportunities to acquire, exchange or otherwise secure limited control of waterfront real estate

2. Minimize future losses from all hazard impacts by reducing the risk to people and property

Objectives:

2.1. Adopt land use policies that limit, prohibit or mandate development and construction standards to promote resilience and reduce risk
2.2. Adopt building codes leading to building design criteria based on site-specific evolving and future risk

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[6] EMAP 2016 Standard 4.2.1.(3)

2.3. Identify mitigation projects that reduce risk to vulnerable populations that are at greater risk from hazards
2.4. Integrate mitigation into existing structures during regular maintenance and replacement cycles
2.5. Consider potential unintended cascading effects of mitigation activities on vulnerable communities

3. Implement mitigation projects that meet or exceed current codes

Objectives:

3.1. Design and develop projects that address both current and future risk
3.2. Identify projects that address cascading hazards from climate change
3.3. Mitigation projects should be sustainable and evidence-based
3.4. Where possible, mitigation projects should utilize nature-based solutions and provide resilience co-benefits
3.5. Identify code amendment opportunities to increase the resilience of the built environment

4. **Prevent flood related repetitive losses from natural disasters**

Objectives:

4.1. Map repetitive and severe repetitive loss (RL & SRL) areas
4.2. Identify and support projects that will mitigate flood risk in these RL and SRL areas and use social vulnerability data to prioritize
4.3. Track mitigation projects by flood basin to see past, current and future projects and compare to flooding data
4.4. Provide RL and SRL education and provide training opportunities
4.5. Support regulations aimed at reducing RL and SRL

5. Promote and support the Community Rating System (CRS) for all communities in Miami-Dade

Objectives:

5.1. Incorporate measures into the LMS to help obtain uniform credit for all CRS communities
5.2. Identify and track projects in the LMS to demonstrate the role of mitigation measures in reducing flood risk
5.3. Provide outreach and educational opportunities that are innovative and coordinated through all levels of government
5.4. Develop and implement a Program for Public Information (PPI) that includes vulnerable populations

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6. Promote mitigation measures for critical facilities

Objectives:

6.1. Continue to invite and work with critical facility stakeholders
6.2. Identify and track mitigation measures for existing critical facilities
6.3. Assess alternate facilities as identified in continuity of operations plans to determine if the sites are appropriately mitigated
6.4. Identify additional sites for emergency sheltering
6.5. Integrate sea level rise modeling to project and characterize expected impacts during the expected service-life of critical facilities Protect expressways, major highways and other thoroughfares and, bridges and causeways to provide for continuous, free flowing traffic and circulation as needed for the effective and unencumbered provision of emergency services and evacuation operations

7. Provide whole community planning

Objectives:

7.1. Engage the whole community in mitigation efforts to maximize coordination and collaboration
7.2. Host mitigation workshops to educate stakeholders and community members
7.3. Initiate organizational, managerial and administrative goals to make mitigation a mainstream function of government affairs; spread the responsibilities throughout many departments and agencies to ensure continuity and a full integration of mitigation management functions in the operations of government
7.4. Enhance public information and engagement to increase awareness of hazards and problems and to educate through a widespread program of general information, media coverage and participatory involvement
7.5. Identify mitigation projects that address gaps in planning, such as technical design, engineering and long-term planning
7.6. Provide support to mitigation partners in pursuing mitigation grant funding by keeping them informed about funding opportunities, connecting them to resources and providing guidance

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HAZARD IDENTIFICATION & VULNERABILITY ASSESSMENT[7]

This section explains the natural, technological, or man-made hazards that have been selected for the LMS based on the potential risks outlined in the Threat and Hazard Identification and Risk Assessment (THIRA) for Miami-Dade County. Each hazard has been described using the following categories:

- **Description:** gives an overarching picture of the hazard.
- **Location:** covers where the hazard is most likely to occur in the county; where possible, maps have been included to support the findings.
- **Extent:** discusses the most damaging effects of the hazard in terms of death, bodily harm, and/or damages. This section also describes the rating scale, if one is available (i.e., Saffir-Simpson scale, Enhanced Fujita scale, etc.).
- **Impact:** describes the potential effects and consequences of the hazard on residents, identified assets and facilities, critical infrastructure, and environment.
- **Previous Occurrence:** lists and describes the historical record of this hazard in the county. The National Climatic Data Center was used to populate this section for many natural hazards. If there were no previous examples of this hazard affecting the county, or the county was only minimally affected, other nearby geographical areas were considered.
- **Vulnerability:** indicates which aspects of the physical environment and which social populations may be impacted by the hazard. In many cases, this section was a judgement call; many different types of populations will be affected by any emergency or disaster in the county. However, some may be more vulnerable than others and those populations have been identified in this section. This category is tied to the Vulnerability Index & Assessment section of the THIRA.
- **Frequency/Probability:** provides information about the probability of future events for the identified hazards.

The updated THIRA was under development during the time of the 5-year LMS update therefore most of the information contained in this section is based on the 2020 THIRA.

[7] EMAP 2016 Standard 4.2.1 (1)

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Rationale for Inclusion or Omission of Hazards in LMS

To determine which hazards would be included in the LMS, each hazard from the THIRA was analyzed using historical and current data and further discussed with LMS partners throughout the PUC meetings. Table 2 below contains this analysis along with information from the discussions which together provide rationale for the inclusion or omission of each hazard. To make these determinations, risk was interpreted as a relative measure of the probability that a hazard event will occur in comparison to the consequences or impacts of that event. Although a hazard is marked as not considered for the LMS, new information or occurrences might necessitate we change this in future revisions.

TABLE 2. ANALYSIS OF ALL HAZARDS FROM THIRA[8]

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	Yes	No		
Animal and Plant Disease		X	Historically, there have not been any occurrences of major animal disease in Miami-Dade County. There have been three new plant disease outbreaks in the last 20 years (15% probability in any one year) that have impacted the agricultural communities but have not had any impact on the physical environment. In 2015, an outbreak of the Oriental Fruit Fly, one of the world's most serious exotic fruit flies that threatens agricultural commodities, was detected in Miami-Dade County farmlands. As a result, 97-square miles of farmland was quarantined in the Redland area and an eradication program was triggered. A state of agricultural emergency was declared in the county by the Florida Commissioner of Agriculture, Adam H. Putman on September 15th, 2015. There were 11 rabies cases in Miami-Dade County in calendar	• For plant diseases pesticides, separation/distancing, eradication of infected plants • For animal diseases, vaccinations, vector control, mosquito control, eradication of breeding grounds (e.g. standing water), public health education • Drain and Cover campaign materials to address mosquito abatement https://www.miamidade.gov/global/solidwaste/mosquito/drain-cover.page

[8] National Oceanic and Atmospheric Administration, National Climatic Data Center, Storm Events Database: https://www.ncdc.noaa.gov/stormevents/

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	**Yes**	**No**		
			year 2018. The cases were comprised of eight raccoons, two cats and one otter. This represented about 10% of all cases statewide, which was a considerable increase from previous years. Since the implementation of Animal Services' Wildlife Rabies Vaccine Distribution, the number of rabies cases reported in Miami-Dade County have decreased significantly, with only two cases in 2019 and one case thus far in 2020. Due to the low occurrence and limited impact, this hazard will not be further evaluated for the LMS at this time.	
Dam / Dike / Levee Failure		X	Miami-Dade County only has one levee that could affect the population, referred to as the 8.5 square mile area. This area has a pump meant to protect it from any failures, but the full required protective measures have not been decided since the levee is relatively new. The U.S. Army Corps of engineers considers all water control structures to be dams but they have confirmed there is no need for emergency plans for any of those control structures in Miami-Dade County after discussion with the County's Department of Regulatory and Economic Resources. There are several water conservation areas that have a berm of about 4 feet around them that are dry most of the year. Historically, there have been no occurrences of dam, dike or levee failures in Miami-Dade County. Modeling performed by Miami-Dade Department of Transportation and Public Works shows that there are no populated areas near these locations that could be negatively impacted if the levees were breached. Due to the low occurrence and limited	• Maintenance of structures • Reduce/minimize construction close to structures, where possible • Fortify structures where risks are identified

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	**Yes**	**No**		
			impact, this hazard will not be further evaluated for the LMS at this time.	
Drought	X		Combined with rising sea level projections, droughts would become a more critical hazard for Miami-Dade County. All agencies involved with managing water supply: SFWMD, Public Works, and Water & Sewer, express concern with droughts and have emergency protocols in place for it. Irrigation becomes particularly complicated by the effects of a drought, even with ordinances already in place to regulate water usage. More specifically, saltwater intrusion would be the greatest risk if canals are too low due to a prolonged drought. Historically, there has been 62 drought events recorded between 1950 and 2024. There have been no reported dollar losses to either physical structures or crops. Although, on July 15, 2015, USDA designated Miami-Dade County as a primary natural disaster area due to the persistent drought conditions between January and July. Additionally, according to NWS, in years when South Florida experiences a drier and warmer winter season due to La Niña, there's an increased likelihood of drought development, especially during the second half of the dry season from February through early May. Each of the previous eight La Niña winters have led to moderate to severe drought by spring over at least parts of South Florida. Droughts in South Florida also typically lead to an increased threat of wildfires peaking during the latter part of the	• Water conservation • Public education and outreach • Regulatory fines • National Drought Mitigation Center http://drought.unl.edu/

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	Yes	No		
			dry season. This hazard is considered further for the LMS due to many partners having a stake in its effects and seeing the need to focus on effective resource management systems, water conservation, and drought preparation and planning.	
Earthquake		X	There have been no earthquakes in Miami-Dade County. South Florida does not have any documented fault lines. The USGS shows there is a 0.279% chance of a major earthquake within 50 kilometers of Miami-Dade in the next 50 years. Therefore, this plan will not include a further evaluation of this hazard at this time.	• No Current Recommendations
Epidemic / Pandemic	X		On March 11, 2020, the Florida Department of Health (FDOH) confirmed the first COVID-19 case in Miami-Dade County. A year into the pandemic, The Florida Department of Health had reported more than 6,000 COVID-related deaths in Miami-Dade County and positive cases were still at a record high of 501,639. Miami-Dade activated its EOC to a level 2 until May 2023 in response. In 2017, Miami-Dade had 113 confirmed cases of the Zika Virus. Out of the total cases, 1 was locally acquired and 112 were travel related. The Zika virus is a disease spread primarily through the bite of an infected *Aedes* species mosquito, the same type of mosquito that spreads other viruses like dengue and chikungunya. A coordinated effort between Miami-Dade County Department of Solid Waste Management and the Florida Department of Health in Miami-Dade County is established to set out a strategic plan in response to the Zika	• Public education and outreach • Vaccinations • Fortify pharmaceutical supplies • Surveillance, monitoring and reporting mechanisms • Quarantine/Isolation measures as needed • Ongoing training for first responders and healthcare providers on mitigating the spread of disease

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	Yes	No		
			Virus. There is consensus among our LMS partners that although the frequency of a pandemic is low, the widespread and compounding effects of this hazard are worth considering further for the LMS.	
Erosion	X		Coastal Erosion is a continuous problem for the Miami-Dade County coastline. It is the county's natural barrier that can help protect us from the impacts of storm surge and sea level rise. The most severe erosion occurs in relation to hurricanes and tropical storm, from June to November. Our SFWMD partners express concern for erosion impacting older roads after a storm and making them impassable as well as affecting structures that are critical to water management. Therefore, they maintain heightened monitoring of this hazard. There are 20.8 miles of beaches in Miami-Dade County that are an important factor to our economy and at risk for erosion. There are also 500 parcels that sit adjacent to the shoreline that could be at risk if erosion became severe. In 2017, Hurricane Irma caused some beach erosion throughout Miami-Dade County with the preliminary assessment estimating a loss of about 170,000 cubic yards of sand. Additionally, our partners have communicated the severity of cascading impacts from erosion. For example, unsecured construction site erosion can aggravate drainage issues and flooding for our county during a storm or rain event. Therefore, this hazard is considered further for the LMS.	• Fortify beaches through re-nourishment • Fortify dunes with vegetation or structural components • Natural barriers such as mangroves and coral reefs • Limit construction close to coastal areas prone to erosion • Limit re-development after disasters in coastal areas prone to erosion • Implement/enforce building code to fortify structures in coastal areas

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	Yes	No		
Extreme Heat	X		In the summer of 2021, the National Weather Service stated that Miami observed 60 days of temperatures at or above 90oF. Due to climate change, Miami-Dade County's minimum temperature has been warming at a rate of +0.6oF per decade since 1985 according to NOAA data. Days with a high heat index in South Florida are also projected to increase with climate change. NOAA's National Weather Service Heat Index is a measure of how the human body feels when air temperature is combined with relative humidity. If greenhouse gas emissions continue to increase, Miami-Dade is projected to have 14 "off the chart" heat index days by late century (2070-2099). "Off the chart" being over 135°F. In 2023, Miami-Dade County also received the first ever heat warning in recorded history and had 42 days that reached a heat index of 105°F or more. As a result, the peaks in heat-related emergency department visits were 100% higher than the peaks in the 5 years prior. Due to the rising concerns associated with extreme heat, especially from health and medical partners, this hazard is considered further for the LMS.	• Public Education, Outreach and emergency notification • Identification, designation and opening of cooling centers for vulnerable populations, as needed. • Implementation of energy redundancy in structures housing vulnerable populations. • Implementation of projects that reduce of the urban heat effect
Flooding	X		Much of Miami-Dade County is susceptible to localized flooding, particularly during the rainy season that runs from mid-May through mid-October. The mean elevation of Miami-Dade County is relatively flat at 11 feet. The County's flat terrain causes extensive "ponding" due to the lack of elevation gradients to facilitate "run-off". Of Miami-Dade's 1,250,287 acres, 44.62% of that is within	• Public education and outreach on FEMA Flood Zones, storm surge planning zones and general flood risks. • Education on Flood Insurance • Participation in NFIP and CRS • Drainage projects to address RL and SRL areas

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	**Yes**	**No**		
			the flood plain (557,871 acres). There have been 101 recorded flood events and 61 flash flood events in Miami-Dade County between 1950 and 2024. Localized flooding and "ponding" occur frequently during the rainy season. Property damages of over $542M and crop damages of over $714M have been recorded from flooding for incidents between 1950 and 2024. LMS partners are also interested in mitigation for compound flooding and groundwater flooding caused by higher tides and sea level rise. There's a heightened awareness within our county of repetitive loss properties and aging infrastructure that continues to be severely affected by these types of flooding. Due to its high frequency and the need for more innovative solutions, this hazard is considered further for the LMS.	• Reinforcing water management structures vital to hospitals • Freeboard requirements for elevation of structures above BFE • Monitoring and coordination for maintenance and mitigation projects along canal areas • Monitoring and maintenance of storm drains • Updating of infrastructure to restore flood protection level of service. • Swale and open space protection • Participation in the development of FEMA FIRM maps to help identify at risk areas and areas that have been mitigated
Hail		X	According to NOAA data, the annual average of hail activity in Miami-Dade County has shown some fluctuation. Between 2000 and 2014, there was an annual average of 9 hail activities in Miami Dade County. Since then, the average number of hail events has decreased. Between 2020 and 2024, there was an average of 5.75 events per year. To date, there has been zero death, injuries, and approximately no property damage associated with hail occurring in Miami-Dade County. Due to the low impacts of this hazard, it will not be considered further for the LMS at this time.	• Alert and notification of public to seek safety inside • No other current recommendations
Hurricane / Tropical Storm	X		In the past 100 years, there have been approximately 340 hurricanes that have impacted the coast of Florida. Of these hurricanes, 70 have impacted Miami-Dade County. Miami-Dade County	• Public education and outreach to match growing population, prioritizing new residents, new homeowners, and visitors • Designation of storm surge risk areas

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	Yes	No		
			has a 1 out of 6 chance of being hit by a hurricane, the highest likelihood in the state. 2017 was the last year that Miami-Dade was impacted by a major Hurricane (Hurricane Irma). Since then, Miami-Dade has received FEMA disaster declarations for hurricanes Dorian, Isaias, Nicole, Ian, and Milton. Due to the high impacts, this hazard is further considered for the LMS.	• Supportive services (evacuation and sheltering) for at risk populations • Nature based solutions and green infrastructure projects based on engineering studies • Structural hardening of structures • See also recommendations under winds and floods.
Landslides		X	Due to Miami-Dade's low average elevation, landslides are not likely to occur. There have been no reported landslides in Miami-Dade. Due to the low probability and low risk this hazard is not further considered for the LMS.	• No current recommendations
Lightning		X	There were 72 reported lightning events in Miami-Dade County between 1950 and 2024 (almost 100% chance of a lighting event occurring every year). Though the probability is high, the recorded impacts of these events is low with the highest single impact being about $80K for an incident in Hialeah Gardens when a lightning struck an apartment building. The lightning strike caused a fire and four apartments suffered significant damage leaving a total of 20 residents displaced. However, due to the low impact of this hazard it will not be considered further for the LMS at this time.	• Surge protection for electrical, computer and phone systems • Lightning detection and warning devices • Public education and outreach
Saltwater Intrusion	X		Saltwater intrusion is a continuous problem that has been occurring ever since the Everglades were drained to provide dry land for urban development and agriculture. Long periods of drought and storm surge inundation are hazards that have been attributed to increases in saltwater intrusion. It poses a threat to the drinking water supply and	• Continue practices of monitoring levels, gauging pumping levels and determining future impacts and need for deeper wells

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	Yes	No		
			requires close coordination of local agencies to continuously monitor intrusion, determine appropriate pumping rates and the coordination with South Florida Water Management District for maintenance of ground water levels. SFWMD, RER, and Public Works already place a lot of effort in mitigating this hazard and have communicated the need to continue doing so. This hazard is included in the LMS for further consideration.	
Sea Level Rise	X		Sea level rise is causing major stress on the entire water management system that we depend on even far inland in our county. Sea level rise also worsens coastal flooding during astronomical high tides and storm surge events. LMS partners from SFWMD, RER, and Public Works have communicated that sea level rise gravely affects the ability of the canals to drain standing water after rainfall events as well as reducing their water storage capacity.. Gravity based outfalls that lie below sea level have already seen impacts when saltwater flows up through the outfall system into the streets of several communities. The Unified Sea Level Rise Projection for Southeast Florida highlights three planning horizons. The first is the short-term projection, that by 2040, sea level is projected to rise 10 to 17 inches above 2000 mean sea level. The second is by 2070, sea level is projected to rise 21 to 54 inches above 2000 mean sea level. The third is that by 2120, sea	• Designation of Adaptation Action Areas • Additional modeling/mapping to determine areas at risk • Build with sea level rise considerations to increase future resiliency as determined by the useful lifespan of a project • Minimize development in future risk areas

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	Yes	No		
			level is projected to rise 40 to 136 inches above 2000 mean sea level.[9]	
Severe Storm	X		A storm is considered severe if it produces a tornado, winds of 50 knots (58 mph) or greater, and/or hail of an inch in diameter or greater. Using heavy rains and thunderstorm wind as indicators, there have been 397 severe storm related events reported in the NOAA data base for Miami-Dade County between 1950 and 2024. Many of our municipalities have been severely affected by localized no name storms and they express necessity to mitigate against this hazard. RER and SFWMD also confirm that these storms often cause more flooding in their water management structures than hurricanes. Due to the high probability and intensity, this hazard is further considered in the LMS.	• Practices to mitigate against hurricanes are also applicable to severe storms. • Also see recommendations under floods • Review Model Storm analyses and identify mitigation initiatives for the hardest impacted areas • Track heavy rain and subsequent flooding to identify areas for potential mitigation measures
Sinkholes		X	There is no official record of all sinkholes in Miami-Dade. The Florida Geological Survey maintains a database of all "subsidence incidents," however this only includes events that have been officially reported and includes many events that are not sinkholes. Between 1948 and 2019, only one subsidence incident was reported in Miami-Dade to the Florida Geological Survey. In 1972, a sinkhole measuring three feet by three feet, was recorded in Miami-Dade County by the Florida Geological	• Assessment, hardening and replacement of aging infrastructure.

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[9] 2019 Unified Sea Level Rise Projection for Southeast Florida: https://southeastfloridaclimatecompact.org/initiative/regionally-unified-sea-level-rise-projection/

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	**Yes**	**No**		
			Survey.[10] Most of the instances reported are small in extent and have not significantly impacted the built environment. Within the State of Florida for insurance claims, Miami-Dade County represented 2% of the total claims in 2010. Additional instances of sinkholes claims have been reported through insurance claim reporting data but the magnitude of each respective claim was not made available. Due to the low impact of this hazard it is not considered further for the LMS at this time.	
Space		X	There have been no space weather events specific to Miami-Dade County that have caused interference with technological components of communication or electrical systems. Due to the low probability of this hazard it is not considered further for the LMS at this time.	• Identifying redundant or alternate systems in case of outages. • Hardening of CI/KR
Tornado	X		There have been 147 occurrences of tornadoes in Miami-Dade County between 1950 and 2024. Recorded damages from tornadoes for property exceeds $202M. Due to the high probability and high impact, this hazard is included in the LMS for further consideration.	• Hardening of structures. • Identification of safe rooms and structures. Follow FEMA Safe Room guidance: https://www.fema.gov/emergency-managers/risk-management/building-science/safe-rooms/resources • Increased public awareness • Signing up for existing alert and notification systems.
Tsunami		X	There have been no tsunamis occurring in Miami-Dade County. The risk of a tsunami striking Florida is considered to be relatively low by the	• Education for risk can be also tied to coastal communities currently at risk for Storm Surge.

[10] Florida Department of Environmental Protection, Florida Geological Survey Division Subsidence Incident Reports Map: https://ca.dep.state.fl.us/mapdirect/?focus=fgssinkholes

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	**Yes**	**No**		
			National Oceanographic and Atmospheric Administration. Due to the low probability of this hazard it will not be considered further at this time.	
Volcano (Ash/Dust)		X	There are no volcanoes in Miami-Dade County and no recorded impacts to the physical environment from volcanoes. Due to our distance to any volcanoes, there is no projected impact. The biggest concern in relation to an active volcano outside of our area would be volcanic ash that may be carried by trade winds that could limit aviation operations or possible compromise the air quality. There are no expected impacts to physical infrastructure. Due to the low probability and low impacts, this hazard will not be considered further for the LMS at this time.	• Implementation of Sheltering in Place as identified in the Miami-Dade All Hazards Protective Measures Plan.
Wildfires	X		There have been 16 wildfires recorded between 1950 and 2024 in Miami-Dade County (21% chance of a wildfire occurring every year). Recorded property damages for wildfires is about $255K. Though historically there has not been a high impact on property, it is estimated that about 613,453 people, or 25% of our area population, live within the Wildland Urban Interface and could be at risk. This hazard is included for further consideration in the LMS.	• Prescribed burning programs. • Cutting brush or other fuel away from structures. • Follow National Fire Protection Association (NFPA) Firewise Communities Program https://www.nfpa.org/education-and-research/wildfire/firewise-usa • Roles in Fire-Adapted Communities http://www.usfa.fema.gov/downloads/pdf/publications/fire_adapted_communities.pdf
Windstorms		X	There were 11 high wind and 6 strong wind events on record from 1950 to 2024 (22% chance of an event occurring every year). Recorded property damages total about $48K. Mitigation strategies that address tropical storms and hurricanes would also help protect the built environment from high	• Building opening and glazing protection. • Hardening of roof structures. • Securing roof top equipment.

Hazard	Further Consideration for LMS		Inclusion/Exclusion Criteria	Mitigation Measures
Natural	Yes	No		
			wind events. Due to the low impact of these events, this hazard will not be considered further for the LMS at this time.	
Winter Storm	X		There have been 27 occurrences of winter storm related events (cold/wind chill, extreme cold, frost/freeze) between 1950 and 2024 (36% chance of an event occurring every year in Miami-Dade County). Though there have not been any recorded property damages, there has been over $300M in crop damages during these events. During these events, a demand for electricity will increase and many homes in South Florida do not have efficient heating systems, unlike their air conditioning systems, and therefore the demand on electricity can be much higher. This hazard is included in the LMS for further consideration.	• Identification, designation, construction of cold weather shelters for homeless and other vulnerable populations and opening of the same during cold weather events. • Public education and outreach • Agriculture Extension works with local growers for educational material for mitigation of crop losses. https://sfyl.ifas.ufl.edu/miami-dade/

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The following non-natural hazards are included in the THIRA and we have included suggested mitigation measures, but they are not currently further considered in the LMS.

Technological	**Mitigation Measures**
Coastal Oil Spill	• Vessel inspections • Compliance with safety regulations
Electric Utility Failure	• Emergency Generators • Alternate energy sources • Hardened utility lines and structures • Emergency Evacuation and Assistance Program run by the DEM to assist vulnerable populations • Public Outreach and Education
Hazardous Materials Release	• Regular onsite inspections of hazardous materials facilities • Hardening of facilities with hazardous materials • Emergency shut off valves • Public Outreach and Education • Implementation of All Hazards Protective Measures Plan
Nuclear Power Plant Release	• Hardened facilities • Public Education, Outreach and Alert and Notification process • Protective Actions to shut down facility • Turkey Point Response Plan and annual exercises
Structural Fire	• Fire suppression safety systems • Alert and notification systems • Regular Fire Drills and Inspections
Transportation Incident (i.e. Highway and/or Rail Incident)	• Inspection and maintenance of transportation corridors • Building infrastructure to future risk and capacity needs • Inspection and maintenance of trains, planes, automobiles and vessels
Water/Wastewater Incident	• Inspection and maintenance of infrastructure • Building infrastructure to future risk and capacity needs
Human Caused Hazards	
Active Shooter	• See Something, Say Something campaign • Security screening procedures
Civil Disturbance/ Civil Unrest	• Intel gathering and sharing • Community gathering points to allow for peaceful demonstrations • Public Outreach and Education

	• Increased law enforcement presence as a deterrence
Electromagnetic Pulse	• Shielding • Backup systems for communications and power • Surge protection
Food Borne Illness Incident	• Follow Public Health guidelines • Reporting systems
Mass Migration	• Intel gathering and sharing
Terrorism – Biological (Category A, B and C Agents)	• Surveillance and reporting • Follow Public Health guidance • Personal Protective Equipment • All Hazards Protective Measures Plan – implementation of Isolation/Quarantine • Public Education and Outreach
Terrorism – Chemical	• Intel gathering and sharing • See Something, Say Something campaign • Surveillance/monitoring of CI/KR sites
Terrorism – Cyber	• Intel gathering and sharing • Security procedures and passwords • Firewalls • Tamper proof infrastructure • Surveillance/monitoring of CI/KR sites • Miami-Dade created a Cyber Security Plan (April 2017)
Terrorism – Explosive	• Protective barriers (bollards, cement barriers, bullet proof glass, metal/chemical detection)
Terrorism – Radiological	• Surveillance/monitoring of CI/KR sites • Intel gathering and sharing • See Something, Say Something campaign
Terrorism – Small Arms	• Intel gathering and sharing • See Something, Say Something campaign • Surveillance/monitoring of CI/KR sites • Security screening procedures

Natural Hazards by Jurisdiction

The following chart depicts the level of overall risk, by jurisdiction, for the twelve natural hazards considered in the LMS. The measure of risk, 0-5, was determined based on a combination of factors including the National Risk Index as a default indicator, discussions with local mitigation professionals, feedback from municipal partners, and known historical impacts of hazards on population and built environment.

The following hazards were rated using the additional data sources described below:

- **Extreme Heat:** Data from Miami Dade County's Heat Vulnerability Assessment study.[11] The heat vulnerability index in this study was created by regression statistics that showed which exposure and sensitivity variables had the strongest relationship with average annual heat related illness hospitalization and emergency department rates from 2015 to 2019.[12]

- **Sea Level Rise:** GIS data gathered from the County's Office of Resilience and NOAA's Sea Level Rise mapping tool. Municipalities already affected by King Tide flooding coupled with a 1 ft sea level rise projection, were rated at very high risk. Municipalities affected by 2-4 ft of sea level rise were given a 3-4 risk level depending on additional feedback provided by municipal partners. Municipalities that were not significantly affected until the 5-6 ft sea level rise mark were rated low risk unless partners expressed particular concerns regarding their vulnerabilities to this hazard.

- **Saltwater Intrusion:** Ongoing USGS studies, which produced an updated map of Miami-Dade County depicting the approximate inland extent of saltwater at the base of the Biscayne aquifer. This map can be found in the section for saltwater intrusion.

- **Epidemic/Pandemic:** The CDC's social vulnerability index shows that Miami-Dade County has a very high susceptibility to the adverse impacts of disease outbreaks when compared to the rest of the U.S.[13] The social vulnerability index is a measure of the demographic and socioeconomic factors such as poverty, lack of access to transportation, and crowded

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[11] Heat Vulnerability Assessment: Understanding Heat Exposure in Miami-Dade County
[12] Miami-Dade Extreme Heart Vulnerability Mapping Report: Vulnerability_Mapping_Deliverable_Final.pdf
[13] CDC Social Vulnerability Index: Social Vulnerability Index | Place and Health - Geospatial Research, Analysis, and Services Program (GRASP) | ATSDR

housing, that adversely affect communities that encounter all kinds of hazards. Additionally, data from the National Institute of Environmental Health Sciences indicates that Miami-Dade County's COVID-19 Pandemic Vulnerability Index (PVI) remains in the top 20% nationally as of March 2023.[14]

TABLE 15. LEVEL OF RISK TO NATURAL HAZARDS BY JURISDICTION

SCALE	
0	Negligible or No Risk
1	Very Low Risk
2	Low Risk
3	Moderate Risk
4	High Risk
5	Very High Risk

Jurisdiction	Drought	Erosion	Flooding	Hurricane/ Tropical Storm	Saltwater Intrusion	Sea Level Rise	Severe Storm	Tornado	Wildfires	Cold Wave	Extreme Heat	Epidemic/ Pandemic
Aventura	3	0	5	5	5	5	5	4	4	4	2	5
Bal Harbour	3	5	5	5	5	5	5	4	4	4	2	5
Bay Harbor	3	5	5	5	5	5	5	4	4	4	2	5
Biscayne Park	3	0	5	5	5	5	5	4	4	4	3	5
Coral Gables	3	3	4	5	5	5	5	3	1	4	4	5
Cutler Bay	2	2	4	5	5	5	3	2	1	4	3	5
Doral	3	3	5	5	4	3	5	4	1	4	5	5
El Portal	3	3	5	5	5	5	5	3	2	4	5	5
Florida City	4	3	5	5	5	5	4	4	4	4	5	5
Golden Beach	3	0	5	5	5	5	5	4	4	4	2	5
Hialeah	3	0	5	5	3	2	5	4	4	4	3	5
Hialeah Gardens	3	0	5	5	3	2	5	4	4	4	2	5
Homestead	3	3	3	5	5	5	3	3	1	4	5	5
Key Biscayne	3	5	5	5	5	5	5	4	4	4	2	5
Medley	3	0	5	5	3	2	5	4	4	4	2	5
Miami	3	0	5	5	5	5	5	4	2	4	5	5
Miami Beach	3	5	5	5	5	5	5	4	4	4	2	5

[14]COVID-19 Pandemic Vulnerability Index: National Institute of Environmental Health Sciences: COVID-19 Pandemic Vulnerability Index Quick Start Guide

Miami Gardens	3	0	5	5	2	3	5	4	4	4	4	5
Miami Lakes	3	0	5	5	2	2	5	4	4	4	2	5
Miami Shores	3	0	5	5	5	4	5	4	4	4	3	5
Miami Springs	3	0	5	5	3	2	5	4	4	4	2	5
North Bay Village	3	0	5	5	5	5	5	4	4	4	2	5
North Miami	3	0	5	5	5	5	5	4	4	4	3	5
North Miami Beach	3	3	5	5	5	5	5	4	3	4	4	5
Opa-locka	2	0	5	5	2	3	5	4	0	4	4	5
Palmetto Bay	4	4	4	5	5	5	3	4	2	4	3	5
Pinecrest	3	3	5	5	5	5	5	4	4	4	2	5
South Miami	3	3	5	5	5	3	5	4	4	4	2	5
Sunny Isles	2	5	4	5	5	5	4	1	0	4	3	5
Surfside	3	5	5	5	5	5	5	4	4	4	2	5
Sweetwater	3	0	5	5	2	2	5	4	4	4	2	5
Virginia Gardens	3	0	5	5	3	2	5	4	4	4	2	5
West Miami	1	0	5	5	3	2	5	3	0	4	3	5
Unincorporated	3	3	5	5	3	4	5	4	4	4	5	5

Drought

<u>Description</u>

A drought is characterized as an extended period with persistent dry weather conditions in a geographic area that typically has rain fall. A drought can however be defined in several different ways depending on the geographical region and situation:

- Meteorological drought: When the normal level of precipitation has a significant measurable drop.
- Agricultural drought: When the level of soil moisture drops below the suitable range for agricultural growth.
- Hydrological drought: When the surface water and underground water supply falls below normal.
- Socioeconomic drought: When water shortages seriously interfere with human activity.

The Palmer Index, developed by Wayne Palmer in the 1960s, uses temperature and rainfall information to formulate dryness. It has become the semi-official drought index. The index is effective in determining long-term drought conditions of several months. The index sets normal conditions at 0 with drought conditions in negative values. The index can also be reversed showing the excess of precipitation where the normal conditions at 0 and positive values for amount of rainfall. The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions.

TABLE 3. NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM ALERTS FOR DROUGHTS

Alert	Criteria	Palmer Drought Index
D0 Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.9
D1 Moderate Drought	Some damage to crops, pastures, streams, reservoirs, or wells low, some water shortages developing or imminent, and voluntary water-use restrictions requested.	-2.0 to -2.9
D2 Severe Drought	Crop or pasture losses are likely, water shortages common and water restrictions imposed.	-3.0 to -3.9
D3 Extreme Drought	Major crop and pasture losses with widespread water shortages or restrictions.	-4.0 to -4.9
D4 Exceptional Drought	Exceptional and widespread crop and pasture loss, shortages of water in reservoirs, streams, and wells creating water emergencies.	-5.0 or less

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Source: U.S. Drought Monitor Classification Scheme, from the United States Drought Monitor

Location

The entire County is vulnerable to drought conditions.

Extent

The worst drought in Miami-Dade County, according to the National Climatic Data Center, was in 2011 when the Palmer Drought Index peaked at D4.

Impact

Impact to Miami-Dade County Residents
A drought will most likely affect those migrant farm workers who are employed by the agricultural community. Although not exhaustive, the following is a list of potential social populations that may be more heavily affected by this hazard than other groups. Although not exhaustive, the following is a list of potential social populations that may be more heavily affected by this hazard than other groups.

- Residents with limited or no English
- Low-Income/Poor
- Transient

Impact to Essential Facilities and Other Property
Farms and farmers may feel the impact of a drought before the general population. The consequence of such an incident will be dependent upon the location, scale, magnitude and extent of the incident.

Consequences related to essential facilities and property following a drought may include:

- Business/service interruption, causing an impact to the local economy as well as individual households

Impact to Critical Infrastructure
Droughts typically do not affect physical structures but may affect essential services and other key community assets, including water services.

Consequences related to critical infrastructure following a drought may include:

- Limiting usage of water for recreational/extracurricular activities such as watering lawns and washing cars

Impact to Environment
Droughts play a significant role on the impact of the environment. Dead and dry vegetation caused by droughts provide ample fuel for wildfires. Heavy accumulation of fuels, lack of strategic management programs, and inadequate fire-fighting infrastructure has further complicated Miami-Dade County's risk to wildland urban interface fires.

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Consequences related to the environment following a drought may include:

- Reduced crop, rangeland, and forest productivity
- Increased fire hazards
- Reduced water levels
- Increased livestock and wildlife mortality rates
- Damage to wildlife and fish habitat
- Increased problems with insects and diseases to forests and reduced growth

Previous Occurrences

April – May 2020 – A very dry March and beginning of April led to severe drought conditions which developed over interior and western sections of southern Florida by the 3rd week of April. Several wildfires were reported in these areas. Less than three-quarters of an inch of rain fell during the first half of May across inland portions of Miami-Dade County, leading to the continuation of severe drought conditions. Surface and underground water levels dropped to around 10% of normal in some areas. Rainfall increased significantly during the second half of May, putting an end to the severe drought conditions by the end of the month.

April – mid-May, 2018 – A prolonged dry spell since February continued through the middle of May, leading to lingering severe drought conditions over interior portions of South Florida. The dry conditions coupled with near-record low groundwater levels contributed to the spread of wildfires, including the Avian Complex in eastern Collier County which burned over 82,000 acres. This prolonged period of below normal rainfall led to low groundwater levels across this area, including at Water Conservation area 3, before the onset of the rainy season in mid-May put an end to the severe drought by May 22nd.

January – September 2015 – A combination of decreased rainfall and higher than normal temperatures through Miami-Dade County resulted in drought conditions throughout the county between January and September. A persistent high-pressure system in the upper levels of the troposphere restricted cold fronts to move southward through South Florida and delivered warm subtropical air to the region during the spring months (March-May). During the summer months (June-August), this high-pressure system brought warm and dry easterly winds steering most of the typical South Florida afternoon thunderstorms to the west of the peninsula. A three-month deficit of 10-15 inches of rainfall across the County and temperatures between 0.5 and 1.5 degrees Fahrenheit above normal resulted in drought conditions throughout this period. Miami-Dade County had its peak drought condition in late July 2015 when the Palmer Drought Index peaked to extreme drought (D3) in the eastern part of the County. As a result of this event, USDA

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designated Miami-Dade County as a primary natural disaster area due to the damages and losses caused to the agriculture community.[15]

March – early April, 2012 –Very dry conditions continued into early April over all of South Florida as high pressure continued to provide stable atmospheric conditions.

January – August 2011 –Rainfall totals in January were near to below normal over most of southeast Florida. This resulted in the expansion of severe drought (D2) conditions over inland sections of Miami-Dade County. Rainfall deficits since October over these areas ranged anywhere from 8 to 11 inches. Most wells across the area were running at around 10 percent of normal water levels. The level of Lake Okeechobee remained steady at about 12.5 feet, which is 2.2 feet below normal. The Keetch-Byram Drought Index (KBDI) was in the 500 to 600 range, which reflects a high fire danger and low soil moisture values.

February was a very dry month over South Florida as a high pressure dominated the region's weather pattern. Over most of Miami-Dade, February rainfall totals were less than a tenth of an inch. As a result, February 2011 was among the top 10 driest Februarys on record at Miami and Miami Beach. This led to severe drought conditions over most of South Florida, with extreme drought conditions over portions of the southeast coast. The level of Lake Okeechobee fell about a half-foot during February, from around 12.5 feet to near 12 feet. Forestry officials reported double the number of wildfires during the winter months of 2010-2011 compared to the previous year. The period of October 2010 to February 2011 was the driest on record in the 80-year history of the South Florida Water Management District's records.

Conditions remained dry and by the end of May, most of southern Florida was in an extreme (D3) drought status, except for an area of exceptional (D4) drought over eastern Palm Beach and Broward counties. This is the first time in well over a decade that any part of south Florida has been designated as being under exceptional drought conditions.

June continued the streak of below normal rainfall over most of South Florida. Little rain fell during the first 10 days of the month, with the rainy season not starting until around June 8th. Almost all the rain across the area fell in the last 2 weeks of the months. Total rainfall were only in the 2 to 4 inch range over the east coast metro areas as well as the Gulf coast areas. Miami Beach recorded its driest June on record with only 1.15 inches of rain. Inland areas of South Florida received about 6 to 8 inches, with isolated 9 to 11 inch amounts south and west of Lake Okeechobee.

The level of Lake Okeechobee dropped from around 10 feet at the beginning of June to a minimum of around 9.6 feet in late June before recovering by the end of the month. Wells and underground reservoirs remained at the lowest 10 percent of normal levels.

[15] USDA Designates 2 Counties in Florida as Primary Natural Disaster Areas, 2015: https://southeastagnet.com/2015/07/15/usda-designates-2-counties-in-florida-as-primary-natural-disaster-areas/

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Exceptional (D4) drought conditions extended over most of Palm Beach and Broward counties as well as far northern Miami-Dade County. Extreme (D3) drought conditions extended all the way to the southwest Florida Coast of Collier County, with severe (D2) drought conditions elsewhere over South Florida. Several wildfires broke out over South Florida in June, including a large wildfire in the Everglades of Miami-Dade County near the Miccosukee Resort and several wildfires in north-central Palm Beach County and eastern Collier County. July and August brought much needed rains. Overall, rainfall averaged near to above average over most areas, leading to gradually improving drought conditions. Lake Okeechobee remained over 3 feet below the normal level for this time of year. Underground water levels remained below normal over much of South Florida, especially over the metro east coast sections.[16] No data was available to determine the economic impacts of this event.

November 2008 – May 2009 – The driest winter on record over many locations in Southeast Florida led to the onset of severe drought (D2) conditions. At Miami International Airport, winter season rainfall was only 0.74 inches, making it the driest winter on record. The drought continued into the spring as most of South Florida was still under severe drought (D2) conditions. April rainfall was less than an inch at most locations. Then a very dry start to the month of May prompted the issuance of extreme drought (D3) conditions over virtually all of South Florida. The onset of the rainy season around May 11 brought copious rainfall to the region as a low pressure trough in the upper levels of the atmosphere set up near South Florida, effectively ending the drought by the last week of May..[17]

Vulnerability

[16]National Oceanic and Atmospheric Administration, National Climatic Data Center, Storm Events Database: https://www.ncdc.noaa.gov/stormevents/
[17] Miami-Dade 2015 Threat and Hazard Identification and Risk Assessment

Drought			
Category		Vulnerability*	Risk*
Social (People, etc.)	Special Populations	Minimally Vulnerable	Low
	Cultural Conditions	Minimally Vulnerable	Low
	Socioeconomic Conditions	Somewhat Vulnerable	Medium
Physical (Property, etc.)	Critical Infrastructure	Somewhat Vulnerable	Medium
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Minimally Vulnerable	Low
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Somewhat Vulnerable	Medium
	Social Conditions	Minimally Vulnerable	Low
	Environmental Conditions	Vulnerable	Medium
	Governmental Conditions (inc. Operations)	Minimally Vulnerable	Low
	Insurance Conditions	Somewhat Vulnerable	Medium
	Community Organizations	Minimally Vulnerable	Low

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

<u>Physical Vulnerabilities</u>

Drought is not anticipated to have any impact on the built environment (Critical Infrastructure, Key Resources, and Building Stock). It may cause economic losses to agriculture and aquaculture due to loss of crops or water restrictions that inhibit normal operations. Crops most vulnerable to drought are the ones that are grown during the winter months, our dry season, and harvested in the spring months including cantaloupe, carambola, celery, cucumbers, dragon fruit, eggplant, fennel, guava, green beans, herbs, jackfruit, longyan, lychee, mushrooms, onions, papaya, passion fruit, plantains, radishes, sapodilla, spinach, squash, strawberries, sweetcorn, thyme, tomatoes and zucchini. Drought conditions can also impact the Miami-Dade County Water and Wastewater Treatment system.

<u>Social Vulnerabilities</u>

This hazard may impact persons employed by the agricultural community including migrant farm workers. In terms of the general population, it does not tend to affect one population over another.

<u>Frequency/Probability</u>

With the onset of Climate Change, Miami-Dade County may begin to see more severe droughts. As of the 2018 State of Florida Enhanced Hazard Mitigation Plan, Miami-Dade County is ranked as “medium,” one occurrence every 5-7 years, for drought compared to other counties in Florida.

Erosion

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Description

Erosion is the wearing-away of land or the removal of beach or dune sediments by wave action, tidal currents, wave currents, or drainage; the wearing-away of land by the action of natural forces; on a beach, the carrying away of beach material by wave action, tidal currents, littoral currents or by deflation. Waves generated by storms cause coastal erosion, which may take the form of long-term losses of sediment and rocks, or merely in the temporary redistribution of coastal sediments.

Riverine and canal erosion are minimal within Miami-Dade County and will not be further analyzed. Coastal erosion is of greater concern and is expanded upon next.. Long-shore currents move water in a direction parallel to the shoreline. Sand is moved parallel to most beaches in Florida by long-shore drift and currents. Ideally the movement of sand functions like a balanced budget. Sand is continually removed by long-shore currents in some areas but it is also continually replaced by sand carried in by the same type of currents. Structures such as piers or sea walls, jetties, and navigational inlets may interrupt the movement of sand. Sand can become “trapped” in one place by these types of structures. The currents will, of course, continue to flow, though depleted of sand trapped elsewhere. With significant amounts of sand trapped in the system, the continuing motion of currents (now deficient in sand) results in erosion. In this way, human construction activities that result in the unnatural trapping of sand have the potential to result in significant coastal erosion.

The ability of waves to cause erosion depends on a number of factors, which include:

- The hardness or “erodibility” of the beach, cliff, or rocks, including the presence of fissures, fractures, and beds of non-cohesive materials such as silt and fine sand.
- The rate at which sediment is eroded from the foreshore is dependent on the power of the waves crossing the beach, and this energy must reach a critical level or material will not be removed from the debris lobe.
- Beaches actually help dissipate wave energy on the foreshore and can provide a measure of protection to cliffs, rocks, and other harder formations, as well as any area upland
- The lowering of the beach or shore platform through wave action is a key factor controlling the rate of erosion. A beach is generally lowered when its profile changes shape in response to a change in the wave climate. If the beach is not lowered, the foreshore should widen and become more effective at dissipating the wave energy, so that fewer and less powerful waves affect the area.
- The near shore bathymetry controls the wave energy arriving at the coast and can have an important influence on the rate of erosion.

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Beach Erosion – Beach erosion occurs when waves and currents remove sand from the beach system. The narrowing of the beach threatens coastal properties and tourism revenue in coastal counties throughout the United States.

Dune Erosion – Dune erosion occurs when waves attack the front face of the sand dune, reducing the volume and elevation of the dune. Erosion of the sand dune leaves coastal properties more vulnerable to future storms.

Overwash – When waves exceed the elevation of the dune, sand is transported across the island in a process known as overwash. When overwash occurs, it often results in significant damage to coastal property.

Inundation and Island Breaching – Inundation occurs when the beach system, or the sandy profile located between the most seaward (primary) dune and the shoreline, is completely submerged under the rising storm surge. Strong currents may carve a channel in the island in a process known as island breaching.

<u>Location</u>

The coastal areas indicated in the map are at highest risk for coastal erosion. This includes the municipalities of Key Biscayne, Miami, Miami Beach, Biscayne Park, Bay Harbor Islands, Bal Harbour, Sunny Isles Beach and Golden Beach.

<u>Extent</u>

Erosion is a major concern for all beaches in Miami-Dade County and has been identified in many areas along the coast of the county. Erosion can happen at any time throughout the year. Large pieces of land may erode more quickly during storms, and therefore, more erosion may take place during stormy seasons. Erosion is often a slow onset disaster and can be a concern for many years. Unless action is taken to stop the erosion or replenish areas (such as beaches), erosion is a permanent fixture. Coastal erosion is expected to increase with sea level rise and storm frequency and severity, however, Miami-Dade County's Division of Environmental Resources Management has a program for monitoring and renourishment of the severely eroded areas.

<u>Impact</u>

Impact to Miami-Dade County Residents
Certain population groups may be impacted and/or more vulnerable based on any number of social or economic factors, including those who may unknowingly purchase a home in a high-risk area for erosion. Residents who live on the coast, will most likely be affected by a reduction in their property value. Like all hazards, the actual consequence of such an incident will be dependent upon the location, scale, magnitude and extent of the incident.

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Although not exhaustive, the following is a list of potential social populations that may be more heavily affected by this hazard than other groups.

- Children
- Disabled
- Elderly
- Residents with limited or no English

Consequences towards the public as a result of erosion may include:

- Temporary/permanent loss of residence, causing an increased need for shelter, short-term or long-term housing
- Temporary/permanent loss of transportation, causing a need for replacement or alternative forms of transportation
- Temporary/permanent loss of employment/business income, causing an increased need for loans
- Temporary loss of services/utilities, requiring alternate means to address immediate needs

Impact to Essential Facilities and Other Property

All essential facilities along the coastline of Miami-Dade County are vulnerable to erosion. An essential facility will encounter many of the same impacts as any other building on the shoreline. These impacts will vary based on the magnitude of erosion with exposure of foundation of buildings, destruction of buildings, coastal roads, harbors, jetties and beaches.

Consequences related to essential facilities and property by erosion may include:

- Loss of building function (e.g., damaged home will no longer be habitable, causing residents to seek shelter)
- Business/service interruption, causing an impact to the local economy as well as individual households

Impact to Critical Infrastructure

Impacts to critical infrastructure include broken, failed, or impassable roadways, bridges could fail or become impassable, causing risk to traffic, and possible washing away of jetties due to erosion.

Consequences related to critical infrastructure following erosions may include:

- Disruption in the transportation of goods
- Disruption in the public transportation
- Loss of tourism industry

Impact to Environment

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Erosion can impact the environment greatly in Miami-Dade County. Plants and wildlife that depend on the coastal ecosystem will begin to decline with loss of habitat, as coastal ecosystems will deteriorate. Additionally, erosion can also impact the fishing industry as damage to areas of fish spawning will cause a major waning in commercial fishing.

Consequences related to the environment following erosion may include:

- Loss of habitat for plants and animals dependent on the coastal ecosystem
- Decline in the fish population

Previous Occurrences

Erosion is an on-going threat, and although certain events like a hurricane or strong storm may increase erosion for a period, erosion continues to occur during calm periods.

September 2017 – Hurricane Irma caused some beach erosion throughout Miami-Dade County. The preliminary damage assessments estimated a loss of 170,000 cubic yards of sand. The money amount in damages has not been determined.

October 2016 – Hurricane Matthew caused minor beach erosion, as it travelled northward parallel to Florida's east coast. Miami-Dade County agencies and municipalities estimated close to $1M in damages due to coastal erosion.

October 2012 – Hurricane Sandy never made landfall, but paralleled the coast causing moderate to major beach erosion from central Florida southward to Miami-Dade County. There were reports of waves up to 10 feet in Miami-Dade. Hurricane Sandywas estimated to cause over $2M in damages to beaches including the following:

- Miami Beach 26th – 29th Street – approximately 10,000 cubic yards
- Miami Beach 44th – 46th Street – approximately 2,500 cubic yards
- Miami Beach 53rd – 56th Street – approximately 3,000 cubic yards
- Miami Beach 63rd – 66th Street – approximately 5,000 cubic yards
- Bal Harbour 99th – 103rd Street – approximately 2,600 cubic yards
- Key Biscayne – unknown cubic yards estimated at $1.2M [18]

October 2005 – Hurricane Wilma, caused in general only minor beach (Condition I) erosion to the majority of beaches in Miami-Dade but dune erosion (Condition II) occurred at

[18] Miami-Dade Emergency Operations Center Damages Report

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the Bill Baggs Cape Florida State Park.[19] Picture at right shows damage to Bill Baggs. No major structural damage was observed seaward of the Coastal Construction Control Line (CCCL) or within the Coastal Building Zone (CBZ). Most of the damage near the coast occurred north of Bakers Haulover Inlet. At Cape Florida, a concrete seawall and rock revetment sustained level three damage.

September 2005 – Hurricane Rita, caused only minor beach erosion (Condition I) north of Government Cut from Miami Beach to Broward County. Virginia Key also had minor beach erosion (Condition I) but also experienced overtopping, resulting in a wash over deposit of sand. Portions of Key Biscayne experience moderate beach and dune erosion (Condition III) and south of Sonesta Beach Resort had minor dune erosion (Condition II). No structural damages were sustained along the Miami-Dade County coast seaward of the CCCL or within the CBZ during the passage of Hurricane Rita.

August 2005 – Hurricane Katrina caused minor beach erosion (Condition I) to the northern beaches in Miami-Dade. No structural damages were sustained along the Dade County coast seaward of the CCCL or within the CBZ; however, a number of single-family dwellings were flooded on Key Biscayne forcing their evacuation.

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[19] Florida Department of Environmental Protection Post-Storm Reports

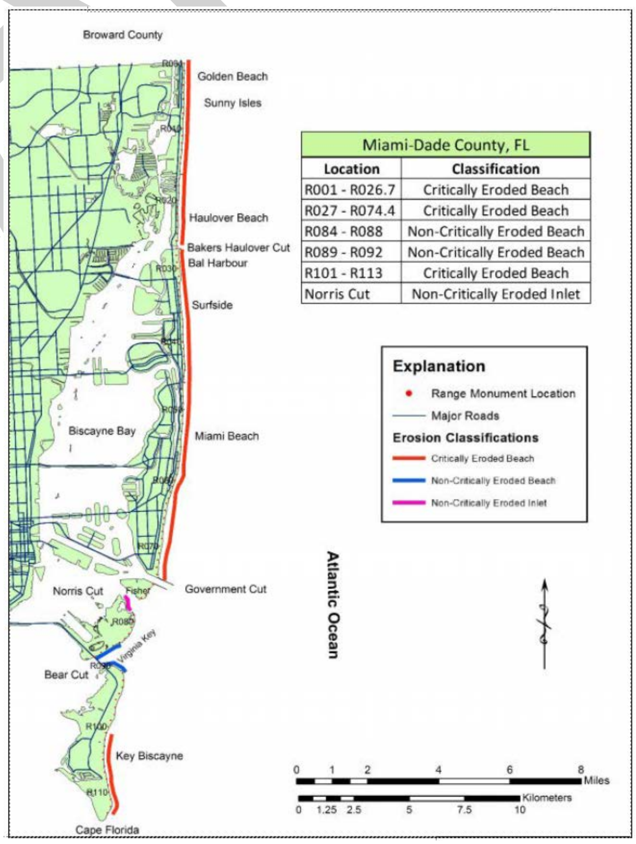
Vulnerability

Erosion			
Category		**Vulnerability***	**Risk***
Social (People, etc.)	Special Populations	Minimally Vulnerable	Low
	Cultural Conditions	Minimally Vulnerable	Low
	Socioeconomic Conditions	Somewhat Vulnerable	Medium
Physical (Property, etc.)	Critical Infrastructure	Vulnerable	Medium
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Somewhat Vulnerable	Medium
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Somewhat Vulnerable	Medium
	Social Conditions	Minimally Vulnerable	Low
	Environmental Conditions	Vulnerable	Medium
	Governmental Conditions (inc. Operations)	Minimally Vulnerable	Low
	Insurance Conditions	Minimally Vulnerable	Low
	Community Organizations	Minimally Vulnerable	Low

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

Physical Vulnerabilities

The entire built environment (Critical Infrastructure, Key Resources, Building Stock) and natural environment (beaches) are vulnerable to erosion primarily along coastal areas. According to a GIS analysis there are approximately 500 parcels in the property appraiser database that intersect with the CCCL. Though the beaches have been fortified over the years and are much wider than they used to be, constant erosion could put structures in these areas at risk. The map to the right shows the status of erosion classifications for Miami-Dade County's coastal areas. Severe erosion can exacerbate storm surge inundation by minimizing the protection offered by beaches and seawalls as they are compromised. Structures such as boardwalks or piers that have pilings in coastal areas may suffer collapse or complete destruction. Beaches in Miami-Dade, such as South Beach and Biscayne National Park, are cited as the number one reason tourists come to Miami-Dade.



There are two piers in Miami-Dade County that extend into the Atlantic Ocean and Government Cut, the Newport Beach Fishing Pier in Sunny Isles Beach and the South Pointe Pier in Miami Beach. The Newport Beach Pier was rebuilt and reopened in 2013 after being destroyed by Hurricane Wilma in 2005 and the South Point Pier was rebuilt and reopened in 2014 after being closed in 2004 due to deterioration.

Social Vulnerabilities

This hazard does not tend to affect one population over another.

Frequency/Probability

Erosion is an ongoing threat in Miami-Dade County. Hurricanes and other strong storms increase the risk of erosion. However, erosion can occur at any time. Projected erosion rates in Miami-Dade County's coastline to increase, as beaches north of the Government Cut are already critically eroded.

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Flooding

<u>Description</u>

Global statistics show that floods are the most frequently recorded destructive events, accounting for about 30% of the world's disasters each year. Flooding is a complicated hazard because there are many different factors that contribute to flooding. Also, there are several different types of flooding. Flooding is an overflowing of water onto land that is normally dry. It can happen during heavy rains or when ocean waves come onshore. Flooding may happen with only a few inches of water, or it may happen with several feet of water. A single flooding incident can affect many different communities covering several states.

TABLE 4. COMMON FLOOD TYPES

Category	Criteria
River or Canal Overbank Flooding	When water levels rise in a river due to excessive rain from tropical systems making landfall, persistent thunderstorms over the same area for extended periods of time.
Ponding	When water levels rise in a land locked area, lake or detention basin due to excessive rain from tropical systems making landfall, persistent thunderstorms over the same area for extended periods of time. In South Florida, some of the severe localized thunderstorms frequently exceed 3 inches/hour, exhausting the storage and infiltration capacity of the drainage system.
Coastal Flooding	When a hurricane, tropical storm, or tropical depression produces a deadly storm surge that overwhelms coastal areas as it makes landfall. Storm surge is water pushed on shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the average water level, 15 feet or more. The greatest natural disaster in the United States, in terms of loss of life, was caused by a storm surge and associated coastal flooding from the great Galveston, Texas, hurricane of 1900. At least 8,000 people lost their lives.
Inland or Riverine Flooding	When tropical cyclones move inland, they are typically accompanied by torrential rain. If the decaying storm moves slowly over land, it can produce rainfall amounts of 20 to 40 inches over several days. Widespread flash flooding and river flooding can result. In the 1970s, '80s, and '90s, inland flooding was responsible for more than half of the deaths associated with tropical cyclones in the United States. The state of Florida has nearly 121,000 census blocks potentially threatened by riverine flooding, translating to nearly $880 billion in property.
Flash Flooding	A rapid rise of water along a stream or low-lying urban area. Flash flooding occurs within six hours of a significant rain event and is usually caused

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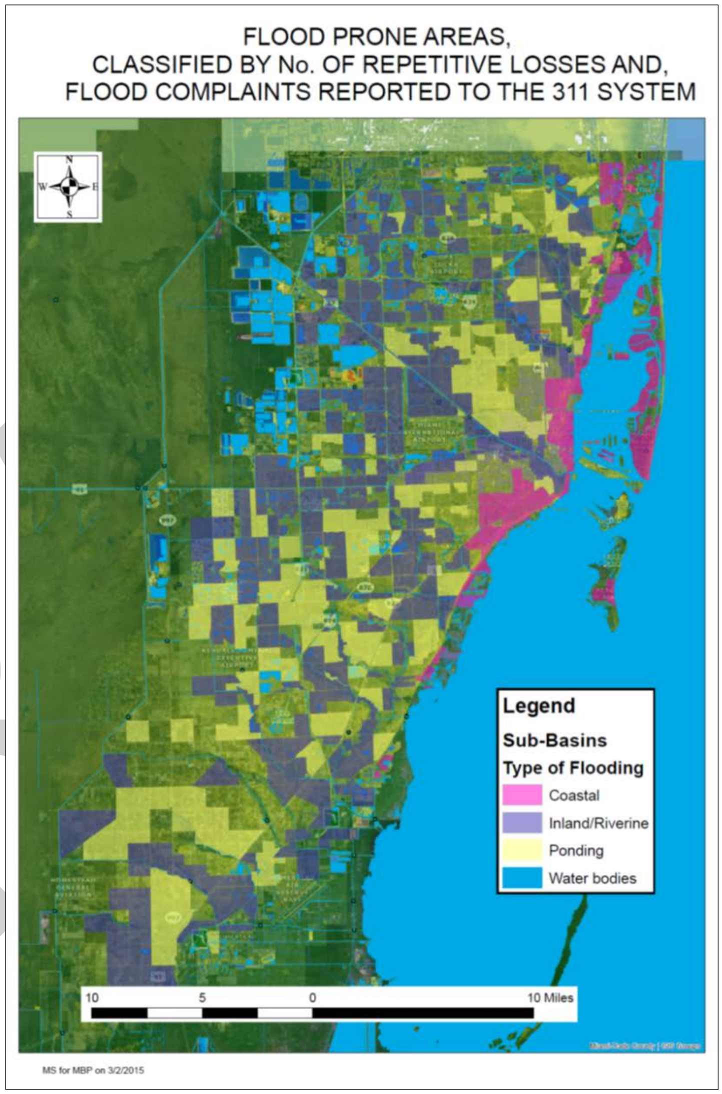
Category	Criteria
	by intense storms that produce heavy rainfall in a short amount of time. Excessive rainfall that causes rivers and streams to swell rapidly and overflow their banks is frequently associated with hurricanes and tropical storms, large clusters of thunderstorms, supercells, or squall lines. Other types of flash floods can occur from dam or levee failures.

Much of Miami-Dade County is susceptible to localized flooding, particularly during the rainy season from June through October, see the map on next page. The mean elevation of Miami-Dade County is relatively flat at 11 feet. The county's flat terrain causes extensive "ponding" due to the lack of elevation gradients to facilitate "run-off". Of Miami-Dade's 1,250,287 acres, 44.62% of that is within the flood plain (557,871 acres). One area in particular experiences flooding on a regular basis. Known as the 8½ square mile area, it is located west of the L-31N Levee, between SW 104th Street on the north and SW 168th Street on the south.



Our community is interlaced with an intricate system of canals that play an integral role in our groundwater saturation levels. When the levels are too high or the canal structures cannot be opened, this can lead to localized flooding during rain events. Agricultural interests can be impacted by levels that are too high or too low. If the control structures release the fresh water at a rapid rate this can also lead to environmental concerns where the fresh water is released. When the control structures fail or are damaged and cannot be operated, alleviation of any localized flooding may require pumping until the canal structures can be re-opened or fixed. Inability to be able to close the salinity structures within the canals could also increase the risk of saltwater intrusion during high tide and storm surge. Part 5 of the LMS provide greater detail as to the canal system within the county and the relation to drainage basins.

The most predominant type of flood hazard is Inland/Riverine. Table 6A-21 shows the percentage of the drainage system service areas subject to the different types of flooding.

TABLE 6A-23 FLOOD CATEGORIES IN MIAMI-DADE COUNTY

Type of Flooding	Area, Acres	%
Coastal	18,314	10%
Inland/Riverine	103,960	57%
Ponding	60,993	33%
Total Service Area	183,267	100%

Source: Miami-Dade County

Considering that the most widespread type of flooding is Inland/Riverine, followed by Ponding, Miami-Dade County began the development of a countywide storm water management program in 1992 for all Primary Canal Basins (see Map 6A-16). The Storm water Utility Planning Division of the Public Works and Waste Management Department administers Miami-Dade County's Storm Water Management Master Plan (SWMMP), which is an essential step towards identifying and solving the current and future storm water drainage, flooding, and water quality problems in the service area, with discharges to Biscayne Bay.

<u>Location</u>

The entire county is vulnerable to flooding. Map 6A-15 below shows the flood prone areas in Miami-Dade County.

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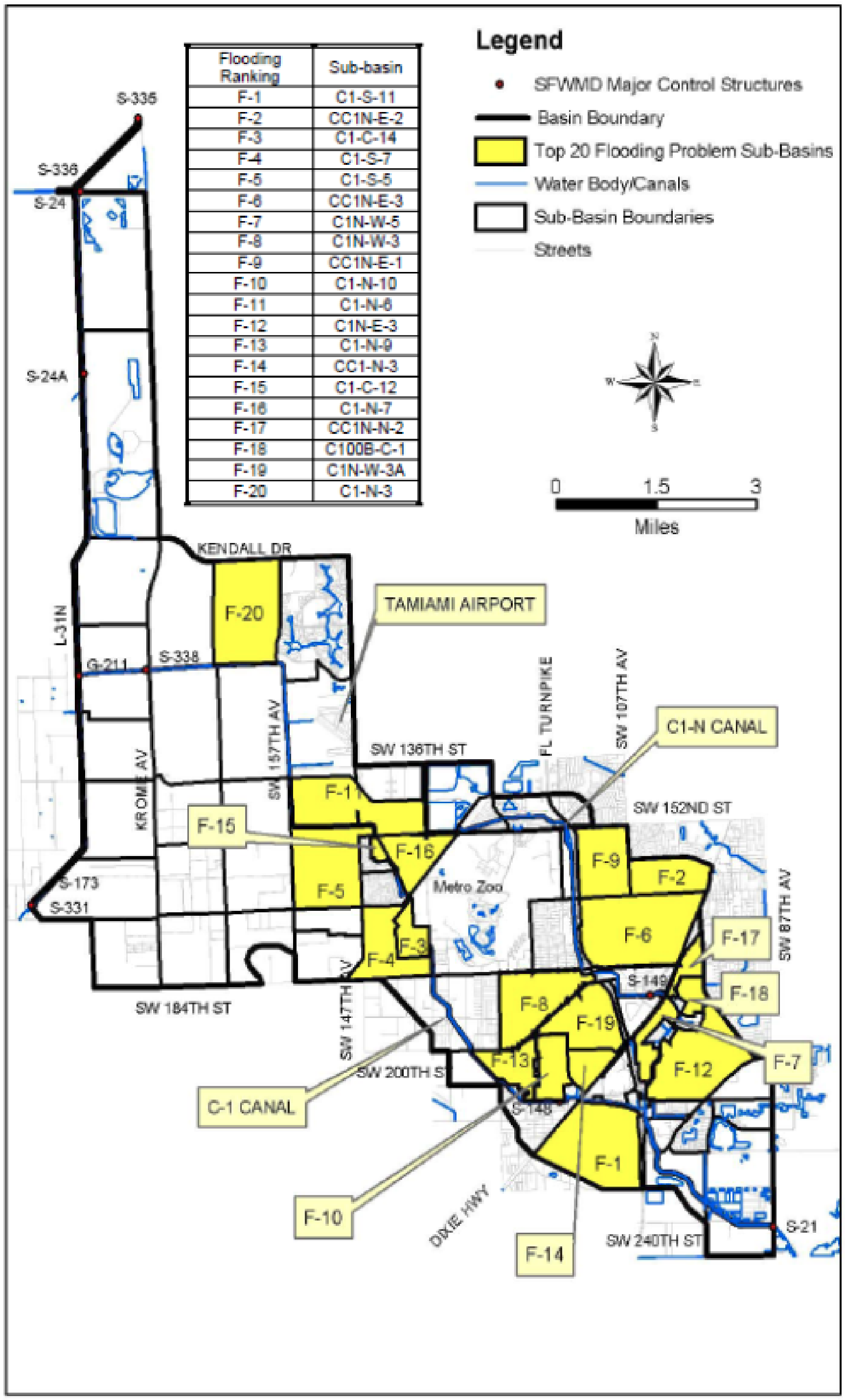
MAP 6A-15 – C-1 BASIN
TOP 20 FLOODING PROBLEM SERVICE AREAS (SUB-BASINS), BASED ON THE FPLOS



Flooding Ranking	Sub-basin
F-1	C1-S-11
F-2	CC1N-E-2
F-3	C1-C-14
F-4	C1-S-7
F-5	C1-S-5
F-6	CC1N-E-3
F-7	C1N-W-5
F-8	C1N-W-3
F-9	CC1N-E-1
F-10	C1-N-10
F-11	C1-N-6
F-12	C1N-E-3
F-13	C1-N-9
F-14	CC1-N-3
F-15	C1-C-12
F-16	C1-N-7
F-17	CC1N-N-2
F-18	C100B-C-1
F-19	C1N-W-3A
F-20	C1-N-3

Source: Storm water Management Masterplan

<u>Extent</u>

Flooding, especially flash flooding, can occur any moment during any time period or season. Flooding and storm surge from hurricanes and tropical storms is likely to occur during hurricane season (June 1 - November 30 in the Atlantic). Strong thunderstorms can also produce heavy flooding in a short period of time. Although storm surge presents the potential for loss of life, a study conducted from 1970 to 1999 by the National Hurricane Center found that freshwater flooding accounted for more than half (59%) of the tropical cyclone deaths in the United States. FEMA estimates that about 41% of Florida is flood prone, which is the highest percentage of all 50 states. Because of the potential for flood damage, Florida has the most flood insurance policies required by the National Flood Insurance Program than any other state.

During large meteorological storms the term "100-year flood" may be used in an attempt to simplify the definition of a flood that statistically has a 1-percent chance of occurring in any given year. Likewise, the term "100-year storm" is used to define a rainfall event that statistically has this same 1-percent chance of occurring. But, just because it rained 10 inches in one day last year doesn't mean it can't rain 10 inches in one day again this year. However, a 100-year storm doesn’t necessarily cause a 100-year flood. Flooding magnitude varies extensively depending on region, soil conditions, weather, and a large host of manmade factors such as dams and levees among others. Several factors can independently influence the cause-and-effect relation between rainfall and stream flow.

<u>Impact</u>

Impact to Miami-Dade County Residents
A flooding event will most likely affect the disabled, elderly, homeless, transient, and low-income communities that reside in areas prone to flooding. Residents may be displaced depending on location and severity of the flooding. The elderly and disabled population may need evacuation assistance from flooding due to mobility issues. Transient groups may experience delays in travel and may not be aware of flooded areas.

Although not exhaustive, the following is a list of potential social populations that may be more heavily affected by this hazard than other groups.

- Low-Income/Poor
- Transient
- Children
- Elderly

Consequences for the public as a result of a flooding incident may include:
- Temporary/permanent loss of employment/business income, causing an increased need for loans.
- Temporary loss of water services/utilities, requiring alternate means to address immediate needs.

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- Temporary/permanent loss of residence, causing an increased need for shelter, short-term or long-term housing.
- Temporary/permanent loss of transportation, causing a need for replacement or alternative forms of transportation.

Impact to Essential Facilities and Other Property

Essential facilities may experience an interruption in daily operations due to flooding causing economic losses. For example, medical facilities, banks, and grocery stores may temporarily close due to flooding, which can even cause some electrical issues as well. Any physical structure located in a flooded area is likely to sustain some amount of damage.

Consequences related to essential facilities and property following a flooding event may include:

- Business/service interruption, causing an impact to the local economy as well as individual households.
- Loss of building function (e.g., damaged homes will no longer be habitable, causing residents to seek shelter).

Impact to Critical Infrastructure

All structures in flood prone areas are vulnerable to flooding. Critical Infrastructure including airports, waterways, utility services, police and fire operations all are impacted by flooding. The consequence will be dependent upon the location, scale, magnitude and extent of the incident in addition to the existing vulnerabilities and community conditions.

Consequences related to critical infrastructure following a flooding event may include:

- Disruption in the transportation of goods
- Disruption in the public transportation
- Shortage of fuel or other essential materials
- Loss of power due to power outage

Impact to Environment

Flooding can significantly impact the environment. It can uproot trees, kill plants, and erode sediment. Floodwater running into bodies of water can affect water quality, create algae, and damage ecosystems. Farms may feel the impact of flooding before the general population, depending on where the crops are located in a flood zone.

Consequences related to the environment following a flooding event may include:

- Reduced crop, rangeland, and forest productivity
- Contaminated drinking water
- Alter landscapes leading to unhabitable locations
- Increased livestock and wildlife mortality rates
- Damage to wildlife and fish habitat

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Previous Occurrences

September 13, 2020 – A low pressure system, turned tropical disturbance, moving across the western Atlantic and over the Bahamas abruptly formed into Tropical Depression Nineteen on September 11th. Tropical Depression Nineteen gradually continued westward and the center passed about 10 to 20 miles SSE of Miami, Florida during the morning of September 12th. As Tropical Depression Nineteen moved westward over the South Florida peninsula, it continued to strengthen into a Tropical Storm known as Tropical Storm Sally. Rainfall flooding impacts were moderate to significant across South Florida with around 3 to almost 8 inches across portions of Miami-Dade County. Several broadcast media reports of significant street flooding from Coconut Grove to Brickell and Downtown Miami, and possibly extending into Little Havana. U.S. Highway 1 in Coconut Grove and Brickell was covered in water up to knee-high in places, leading to a number of stalled vehicles.

August 15, 2019 – Thunderstorms produced very heavy rainfall that measured over 7 inches in about 3 hours across portions of Kendall. This heavy rainfall resulted in flash flooding which resulted in water intrusions in numerous structures and impassable roadways.[20]

October 3-7, 2017 – A combination of high tide and heavy rainfall led to flooding across portions of Miami-Dade County. There were reports of coastal and street flooding in the vicinity of Biscayne Blvd from I-395 to NE 30th Street.

August 24-27, 2017 – A tropical wave (Invest 97L) was located near the central Bahamas on August 21st, 2017 and forecast to move northwestward over Florida. Wind shear and dry air hindered further development of this system, but the National Weather Service forecast an excessive rainfall threat for the remainder of the week. Rainfall amounts of 2 to 4 inches, with locally higher amounts possible, were forecast for the region. As a result, a Flood Watch was in effect for Miami-Dade County from August 24th through the 27th.

Between August 24th and 26th, rainfall amounts ranged between 1 and 4 inches through the county. Rainfall amounts of up to 4.5 inches were recorded in the northeast portion of the county between August 26th and 28th. The only significant report received by the National Weather Service was of Okeechobee Road flooded in Hialeah and a spotter in the area recorded 6.62 inches of rain in a single afternoon on August 27th.

August 1, 2017 – Tropical Storm Emily formed west of Tampa Bay on July 31st, and moved across central Florida, just north of Lake Okeechobee. On August 1st, Tropical Storm Emily was located over the Atlantic and moving away from Florida. Although no direct impacts were reported for Miami-Dade County, a trough extending from the tropical

[20] National Oceanic and Atmospheric Administration, National Climatic Data Center, Storm Events Database: https://www.ncdc.noaa.gov/stormevents/

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system was over southeastern Florida. A combination of the frontal boundary and day-time heating, a band of thunderstorms developed off the coast and moved west. At around 2 pm, the band became nearly stationary over Miami Beach, Key Biscayne and Downtown Miami. A Flash Flood Warning was issued at 3:47pm until 9:45pm. Later in the afternoon, the same band of thunderstorms redeveloped over The Redland, Kendall, Palmetto Bay and Pinecrest area. Rainfall amounts in these areas ranged between 4 and 6 inches with isolated amounts between 7 and 8 inches. The rainfall rates of 2 to 4 inches an hour lasted 2 to 3 hours, and around the same time as high tide.

Significant flooding was reported in Miami Beach and the Brickell area in the City of Miami. Vehicles were stalled in streets with up to 2 feet of water and some streets had to be closed due to deep standing water. In Miami Beach, 1 to 2 feet of water was reported on streets in South Beach including Purdy Avenue, West Avenue, Alton Road, Pennsylvania Avenue, Meridian Avenue, Collins Avenue, Washington Avenue and Indian Creek Drive. Water entered business, homes, apartment lobbies and parking garages. In Mary Brickell Village, more than 10 businesses and buildings had 1 to 4 inches of water inside the structures. The picture to the right, shows the 24-hour rainfall estimates between August 1^{st} and 2^{nd}.

June 7, 2017 – An area of low pressure over the Gulf of Mexico, brought tropical moisture across South Florida during the week of June 5^{th}. Widespread showers and thunderstorms, with the potential of heavy rainfall was forecast for the rest of the week. On June 7^{th}, a Flood Watch was issued for Miami-Dade County until 8 pm. Aside from minor flooding on roadways, no significant issued were reported.

December 2015 – A cold front moved into South Florida during on December 3^{rd}, and stalled across the far southern end of the peninsula and upper Florida Keys on December 4^{th} and 5^{th}. Several rounds of heavy rainfall fell across Southern Miami-Dade County. Rainfall amounts near 15 inches fell across Homestead, the Redlands, and western Kendall, with four (4) to eight (8) inches reported across the remainder of Miami-Dade County, most of which occurred on December 5^{th}. This rainfall led to significant flooding in Miami-Dade County with numerous road closures and cars stalling in flood waters. An estimated $1 Million in damage impacted the County's fall and winter crops and also resulted in multiple day closures at Zoo Miami.[21]

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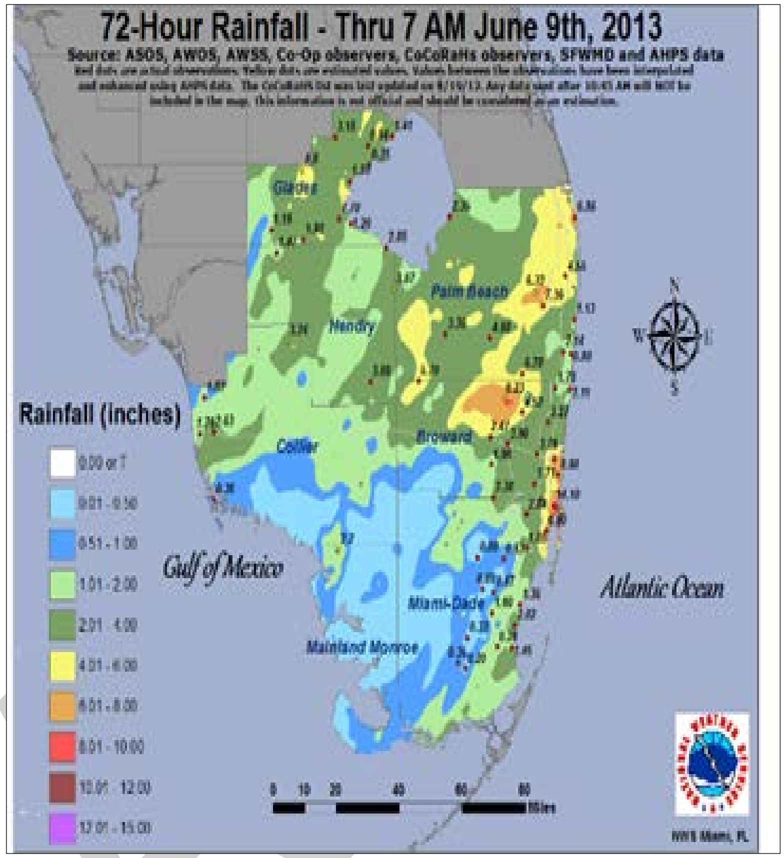
[21] National Oceanic and Atmospheric Administration, National Climatic Data Center, Storm Events Database: https://www.ncdc.noaa.gov/stormevents/

June 7-8, 2013 – On June 6th, Tropical Storm Andrea made landfall in northern Florida, but southern Florida received torrential rain from the tail of the storm. A South Florida Water Management District rain gauge recorded 13.15 inches of rain in North Miami Beach at 5:53 PM EDT with storm total at the same gauge by 9 PM EDT recording 13.94 inches. Other rainfall reports received were 11.71 inches at the FIU Biscayne Campus in North Miami Beach and 9.89 inches at North Miami/Keystone Point. Over 50 vehicles were reported as being stranded in impassable roads in Aventura and additional roads had similar problems in North Miami and Golden Beach. The picture to the right, shows 72-hour rainfall amounts ending on the morning of June 9th, 2013.



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Vulnerability

Flooding			
Category		**Vulnerability***	**Risk***
Social (People, etc.)	Special Populations	Vulnerable	High
	Cultural Conditions	Somewhat Vulnerable	Medium
	Socioeconomic Conditions	Vulnerable	High
Physical (Property, etc.)	Critical Infrastructure	Somewhat Vulnerable	Medium
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Somewhat Vulnerable	Medium
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Vulnerable	High
	Social Conditions	Somewhat Vulnerable	Medium
	Environmental Conditions	Vulnerable	High
	Governmental Conditions (inc. Operations)	Somewhat Vulnerable	Medium
	Insurance Conditions	Somewhat Vulnerable	Medium
	Community Organizations	Somewhat Vulnerable	Medium

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

<u>Physical Vulnerabilities</u>

The entire built environment (Critical Infrastructure, Key Resources, Building Stock) may be vulnerable to flooding especially in low lying, storm surge planning zones, areas close to canals and structures that were built prior to flood plain regulations. Structures in areas where there has been repetitive losses and no mitigation may also be at a higher risk but past flooding events do not necessarily indicate future flooding problems. Part 5 provides additional analysis of residential structures by date of flood regulations within Miami-Dade County.

On the following page is a chart showing how many structures within each jurisdiction are within FEMA Flood Zones.

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TABLE 5. NUMBER OF BUILDINGS BY JURISDICTION IN FEMA FLOOD ZONES

Jurisdiction	A	AE	AH	D	VE	X
Aventura		24,861				172
Bal Harbour		642				3,192
Bay Harbor		2,906				
Biscayne Park		1,116				93
Coral Gables		2,977	1,414		65	16,097
Cutler Bay		8,902	2,009			4,343
Doral		166	7,311			19,729
El Portal		10	111			755
Florida City	2	21	1,899			2,072
Golden Beach		269				136
Hialeah		4,478	21,569			40,678
Hialeah Gardens		139	429			5,895
Homestead		770	12,137			9,556
Indian Creek Village		51				20
Key Biscayne		7,298				
Medley		9	456			1,159
City of Miami		51,416	7,084		3,864	84,868
Miami Beach		51,701				3,939
Miami Gardens		14,024				20,227
Miami Lakes		8,934				1,341
Miami Shores		843			24	3,277
Miami Springs		48	2,338			2,486
North Bay Village		3,659				
North Miami		8,579			139	8,580
North Miami Beach		6,458				8,285
Opa-Locka		951	569			3,104
Palmetto Bay		4,802			44	3,857
Pinecrest		2,260	67			4,618
South Miami		1	825			3,977
Sunny Isles Beach		11,971			1	7,719
Surfside		1,562				1,767
Sweetwater		11	3,410			1,103
Virginia Gardens			132			592
West Miami						1,823
Unincorporated	921	53,113	113,619	1	100	217,268
TOTAL	**923**	**233,368**	**164,534**	**1**	**4,172**	**438,347**

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Heavy rainfall events tend to be measured by the amount of rain during a certain duration to give you what would equate to the chances of this type of storm which is typically categorized by terminology such as a 100 year or 500-year storm.

To help local communities determine if a rain event is considered significant the following site and chart from the National Oceanic and Atmospheric Administration (NOAA) Hydro meteorological Design Studies Center maintains the Precipitation Frequency Data Server (PFDS) which is a point-and-click interface developed to deliver NOAA Atlas 14 precipitation frequency estimates and associated information. To determine the amounts and rates of rain that could create a various internal rain event (e.g. 100 year or 500 year) this website provides local information.
http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=fl

Social Vulnerabilities

People who live in areas prone to flooding and who may be uninsured or underinsured are at greatest risk. The cost of insurance may be prohibitive and people who live outside of a flood zone may believe they are not at risk. People who rent properties may not be aware of their flood risk as it may not be disclosed by the owner or they may not know the history of the area.

Frequency/Probability

There have been 47 recorded flooding events in Miami-Dade County since 2015, averaging out to approximately six and a half per year. Each flooding event lasted for multiple days.

As a result of sea level rise, flooding from just high tide events is becoming more common and has even caused the National Weather Service to issue a coastal flood warning from a 2013 high tide event in Miami-Dade.

A warmer atmosphere holds more water vapor and, therefore, can result in heavier and more long-lasting rainfall events. The expected global pattern is for arid areas to get drier and moist areas to get wetter. Where precipitation is enhanced, strong storms are expected to get stronger with the result that rainfall events with a given recurrence frequency, e.g. the 25-year storm, will happen more often.

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Hurricanes and Tropical Storms

Description

A tropical cyclone is a collection of weather systems classified by the varying wind speeds and intensities, including tropical depression, tropical storm, and hurricane. Tropical weather systems form over subtropical or tropical waters with lowered pressure and the combination of wind circulation at the center. A tropical depression is a weather system with a defined surface circulation and maximum sustained surface winds between 23 mph – 38 mph. A tropical storm develops from a tropical depression, and has a well-defined surface circulation and maximum sustained surface winds of 39 mph – 73 mph.

A hurricane develops from a tropical storm. The term hurricane is used for tropical cyclones in the Northern Hemisphere and east of the International Dateline. A hurricane is a weather system with well-defined surface circulation and maximum sustained surface winds of 74 mph or higher.

Hurricanes are considered one of the most damaging and deadly weather events that occur in the United States, with violent winds, waves reaching heights of 40 feet, torrential rains, and flooding. According to the National Oceanic and Atmospheric Administration (NOAA) there are an average 11 tropical storms that form over the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico regions each year, and on average 6 of the tropical storms develop into hurricanes. The United States experiences a hurricane strike on land about once every year and a half. The strike zone can potentially extend anywhere from Maine to South Texas.

Hurricanes are classified according to the strength of the winds using the Saffir-Simpson Hurricane Scale. The scale is a ranking system from 1 – 5, with 5 being the most severe. The scale also provides examples of the type of damage and impacts in the United States. It is important to recognize that the Saffir-Simpson scale is solely based on wind speed, and not storm surge. The following table shows the Saffir-Simpson Scale:

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TABLE 6A-34 SAFFIR-SIMPSON SCALE

Category		Sustained Winds	Criteria
Pre Saffir-Simpson	Tropical Depression	38 mph or less	A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) is 33 knots (38 mph or 62 km/hr.) or less.
	Tropical Storm	39-73 mph	A tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 knots (39 mph or 63 km/hr.) to 63 knots (73 mph or 118 km/hr.).
Saffir-Simpson Scale	Category 1	74-95 mph	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
	Category 2	96-110 mph	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
	Category 3	111-129 mph	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
	Category 4	130-156 mph	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
	Category 5	157 mph or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Hurricane Center

Storm Surge

From a hurricane, storm surge is often the greatest threat to life and property along the coast. Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tide. Storm surge is produced when the force of the winds moving around the storm push water towards the shore and this surge can travel several miles inland.[22] Predictions for storm surge are made through a variety of means, including the Sea, Lake and Overland Surges from Hurricanes (SLOSH) models.

[22] National Hurricane Center, Storm Surge Overview

Storm surge inundation is modeled in two zones: the high-velocity zone where wave action and debris can severely damage structures, and farther inland, where the primary concern is flooding as opposed to structural damage. Storm surge can create flooding that can destroy buildings and carry debris miles inland, into canals and rivers, the intercostal waterways and out to sea. The water can also pool in low-lying areas impeding response and recovery activities.

Damages associated with storm surge include but are not limited to:

- Extreme flooding in coastal areas
- Inundation along rivers and canals
- Beach erosion
- Undermining of foundations of structures or roadways along the coastline (erosion or scour)
- In confined harbors and rivers, severely damaged marinas and boats
- Sunken vessels or underwater hazards in navigable waterways

<u>Location</u>

The entire County is vulnerable to hurricanes and tropical storms. In 2010 The State of Florida provided new Sea Lake Overland Surge from Hurricanes (SLOSH) data to Miami-Dade County that included higher resolution basin data and grid configurations. Faster computer speeds allowed additional hypothetical storms to be run for creation of the maximum potential storm surge values for each category of storms. The State also mapped the areas using remote-sensing laser terrain mapping (Light Imaging Detection and Ranging) (LIDAR).

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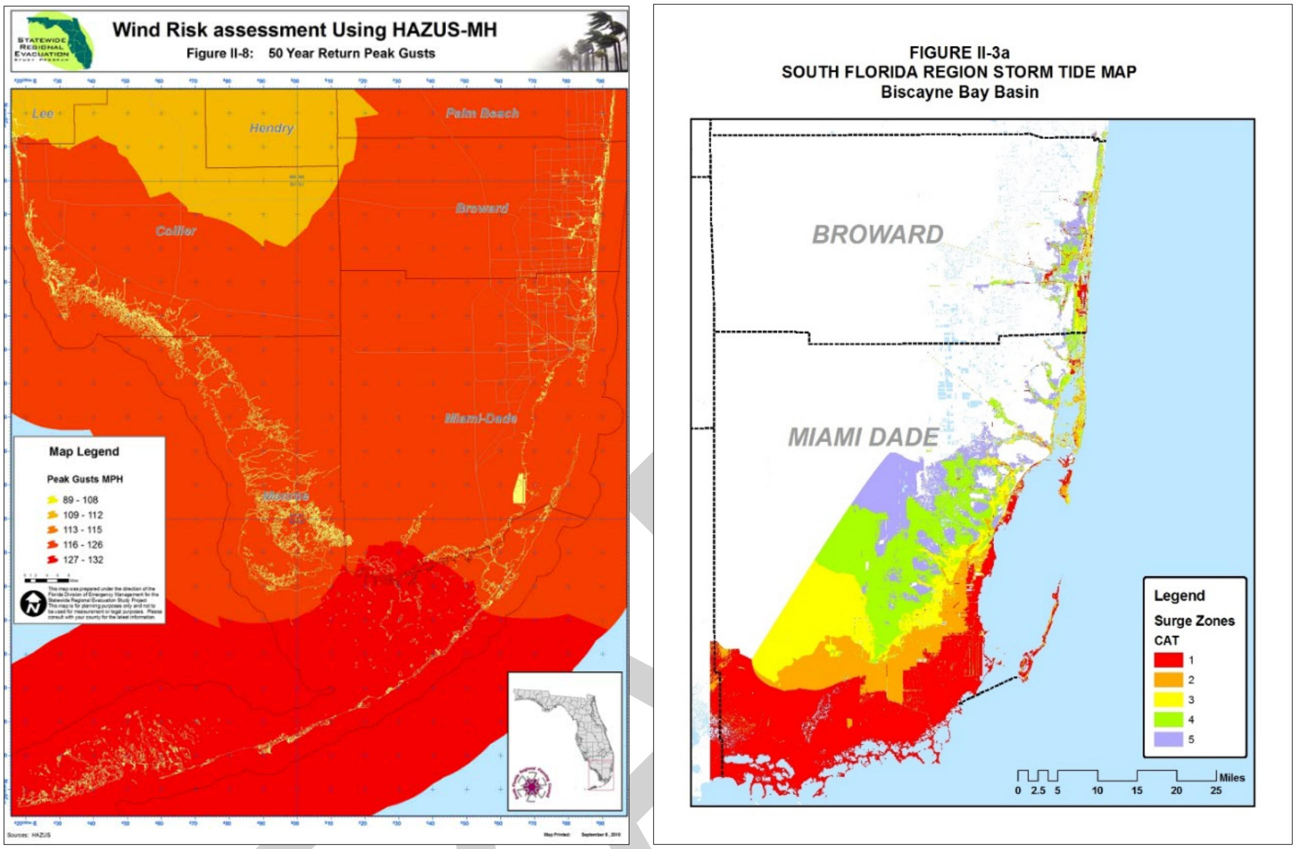
Figure 5. 50 year return for maximum sustained winds (Left) & Potential storm surge for storms modeled within the Biscayne Bay basin (right)



Extent

The most recent Category 5 hurricane to hit Miami-Dade County was Hurricane Andrew in 1992.

The Atlantic hurricane season is June 1 – November 30; the peak of the season is from mid-August to late October. The majority of hurricanes and tropical storms occur during this time period, however storms can form before or after the season. Most hurricanes live no more than a few weeks. They will break apart within a few days upon traveling over cold water or land.

Hurricanes and tropical storms can usually be predicted several days before making land-fall. A tropical storm or hurricane watch is issued 48 hours in advance of anticipated onset of tropical storm or hurricane force winds; dangerous conditions are possible within the specified area. A tropical storm or hurricane warning is issued 36 hours in advance of anticipated tropical storm or hurricane force winds; dangerous conditions are expected within the specified area. This advance warning time allows for the community to prepare for the potential event and engage in protective measures to reduce the impact.

Impact

Impact to Miami-Dade County Residents

Because Miami-Dade County has the highest likelihood in the state for being hit by a hurricane, the entire county population is vulnerable. Specifically, mobile/manufactured home residents, electric dependent, functional needs and persons who may not have adequate resources to protect their homes or access to evacuation resources are at greatest risk for this hazard. Visitors and persons who are new to this area may also be more vulnerable as they may not be familiar with what to do in case an evacuation order is given. Prolonged power outages and gas shortages cause additional challenges to businesses and service providers and can disproportionately impact persons who rely upon regular home services such as medical services or food delivery.

Consequences related to the public following a hurricane or tropical storm may include:

- Temporary/permanent loss of employment/business income, causing an increased need for loans
- Temporary loss of water services/utilities, requiring alternate means to address immediate needs
- Increased need for medical care, causing a potential surge at local hospitals
- Temporary/permanent loss of residence, causing an increased need for shelter, short-term or long-term housing

Impact to Essential Facilities and Other Property

The entire built environment (Critical Infrastructure, Key Resources, and Building Stock) may be vulnerable to hurricanes and tropical storms due to wind, rain and/or storm surge damages. Structures that do not have impact resistant features or protection that can be installed may be more vulnerable to winds. Mobile/manufactured homes and high-rise buildings may also be more vulnerable to wind impacts. Coastal areas and areas along canals and rivers, as depicted in the storm surge map, may be more vulnerable to surge. Coastal areas are at greater risk for high velocity surge and erosion. Low lying areas are more vulnerable to flooding if a storm brings a lot of rain. Uprooted trees can cause damages to underground and overhead utilities. Hurricanes and tropical storms may also cause flying debris that cause additional damages. These storms can also impact natural and agricultural resources as well, causing severe coastal erosion and flooding or wind damage to agricultural assets. The extent of debris and infrastructure outages and restoration times can complicate and increase response and recovery timelines.

Consequences related to essential facilities and property following a hurricane or tropical storm may include:

- Business/service interruption, causing an impact to the local economy as well as individual households.
- Loss of building function (e.g., damaged homes will no longer be habitable, causing residents to seek shelter).

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Impact to Critical Infrastructure

During a hurricane or tropical storm, the types of infrastructure that could be impacted include roadways, utility lines/pipes, railroads, and bridges. Because the county’s entire infrastructure is equally vulnerable, it is important to emphasize that any number of these structures could become damaged during a hurricane or tropical storm. The impacts to these structures include broken, failed, or impassable roadways, broken or failed utility lines (e.g., loss of power or gas to community), and railway failure from broken or impassable railways. Bridges could fail or become impassable, causing risk to traffic.

Consequences related to critical infrastructure following a hurricane or tropical storm may include:

- Disruption in the transportation of goods
- Disruption in the public transportation
- Shortage of fuel or other essential materials

Impact to Environment

Hurricanes and tropical storms play a significant role on the impact of the environment. The strong winds and flooding that this natural hazard produces can uproot plants, harm wildlife, and devastating natural landscape. These storms can damage or destroy energy, chemical, gas facilities, and other businesses that can cause a release of harmful contaminants.

Consequences related to the environment following a hurricane or tropical storm may include:

- Trees and plants can be uprooted and diseases in the soil are spread, impacting wildlife and their habitat.
- Polluted waters cause unsafe drinkable water.
- Increased livestock and wildlife mortality rates.

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Previous Occurrences

August 2020 – A low pressure system moving across the tropical Atlantic into the eastern Caribbean Sea formed into Tropical Storm Isaias on July 28th. While the system briefly became a hurricane near Great Inagua Island on July 30th, it was downgraded back to a Tropical Storm as it moved over Andros Island on August 1st with a minimum central pressure of 993 mb. Isaias gradually turned to the N-NW and the center passed about 30-40 miles east of the Palm Beach County coast during the morning of August 2nd with a minimum central pressure of 995 mb and maximum sustained winds of 65 to 70 mph. Sustained Tropical Storm force winds were felt across portions of Palm Beach, Broward, and Miami-Dade Counties. Rainfall flooding impacts were minor across South Florida with 2 to 2.6 inches measured mainly across Miami-Dade and Broward counties. Almost 3,000 customers lost power during the event, almost all of them in Palm Beach County.

October 2017 – Tropical Storm Philippe was a disorganized storm as it moved across the Florida Straits on October 28th, making landfall in extreme South Florida along the Florida Bay on October 29th as a minimal tropical storm.

The storm brought widespread rainfall across all South Florida, with average amounts of 2 to 4 inches across the region. The wind impacts of Philippe were limited to the east coast of South Florida. This storm produced maximum sustained winds generally between 25 and 35 mph across Miami-Dade County on October 28th. A peak gust of 41 mph was measured at Miami International Airport. Minor tree damage was reported across the area, with no significant property damage reported.[23]

September 2017 – On August 30th, Tropical Storm Irma formed over the eastern Atlantic Ocean with maximum sustained winds of 50 mph. As the day progressed, Tropical Storm Irma continued strengthening and was expected to become a hurricane the following day. Irma's rapid intensification began in the early morning of August 31st, when the maximum sustained winds increased from 70 mph to 115 mph in less than 12 hours. Hurricane Irma, now a category 3 storm, continued its track across the Atlantic Ocean, as it headed towards the Leeward Islands. In the afternoon of September 4th, Miami-Dade County was within the 5-day forecast cone of a major hurricane. Due to the potentially catastrophic hurricane heading to Miami-Dade County, Miami-Dade DEM initiated preparations and activated the Emergency Operations Center (EOC) on September 5th. By the evening, Miami-Dade County was within the 3-day forecast cone.

In the morning of September 5th, less than 300 miles east of the Leeward Islands, Irma became a category 5 hurricane with maximum sustained winds of 175 mph. Catastrophic Hurricane Irma reached its peak strength later that day, with maximum sustained winds

[23] National Oceanic and Atmospheric Administration, National Climatic Data Center, Storm Events Database: https://www.ncdc.noaa.gov/stormevents/

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of 185 mph. For the next couple of days, Hurricane Irma wreaked havoc in Barbuda, Saint Barthélemy, Saint Martin, Anguilla and the Virgin Islands at its peak intensity causing catastrophic damage. Hurricane Irma continued its course through the Caribbean causing widespread damage in Puerto Rico, Hispaniola, Turks and Caicos, the Bahamas and Cuba. At 11pm on September 7th, Miami-Dade County was under a Hurricane Warning and Storm Surge Warning.

On Sunday, September 10th, category 4 Hurricane Irma made its first Florida landfall at Cudjoe Key in the lower Florida Keys at 9:10am. Hurricane Irma continued its northward track and made its second Florida landfall at Marco Island at 3:35pm as a category 3 hurricane. Widespread wind damage, heavy rainfall and storm surge was reported throughout Miami-Dade County. Hurricane and tropical storm force sustained winds were measured throughout the county and resulted in mostly tree damage. Rainfall amounts from September 9th through September 11th were between 5 and 10 inches. Recorded storm surge on Biscayne Bay (from south of Miami to Homestead) was between 4 and 6 feet, and on the east coast was between 2 and 4 feet. Also, an estimated $255 M in agricultural damage was reported in the county. Hurricane Irma was the first hurricane to make landfall in South Florida since Hurricane Wilma in 2005.

October 2016 – In the morning of September 28th, 2016, Tropical Storm Matthew formed over the Windward Islands with a high potential of strengthening. Matthew continued a westward track through the Caribbean and strengthening into a hurricane the next day on September 29th. On the forecast track, Hurricane Matthew would move west followed by a northwest turn and a then continue a northward track through western Haiti and eastern Cuba. On the evening of September 30th, Miami-Dade County was within the 5-day forecast cone of Category 5 Hurricane Matthew. Two days later, Miami-Dade County was not within the cone, but Miami-Dade DEM continued to be vigilant due to the storm's track potential to shift west. On Monday, October 3rd, the forecast track took a drastic westward shift putting Miami-Dade County within the 3-day forecast cone of a major hurricane. The following day, Miami-Dade County was under a Tropical Storm Warning.

Ultimately, the county was affected by the outside bands of Hurricane Matthew, as it continued its paralleled track along the Florida east coast. Rainfall amounts of up to 1.5 inches were recorded throughout the County. Although, no significant damage was reported, Miami-Dade agencies and municipalities estimated $10M for public assistance eligible categories.

August 2012 – Tropical Storm Isaac moved across the Florida Keys and Miami-Dade experienced a storm surge measured at 1.3 feet and sustained winds measuring 29 mph at the Miami International Airport. In a 72-hour period portions of the county received between 2-10 inches of rain. Wind damage in southern Florida was minor and mostly limited to downed trees and power lines.[24] Approximately 26,000 customers lost power in Miami-Dade. There was no Presidential Declaration for damages within Miami-Dade.

[24] National Hurricane Center, Tropical Cyclone Report Hurricane Isaac (AL092012)

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Miami-Dade agencies and municipalities estimated $5.5 M for public assistance eligible categories.[25]

October 2012 – Hurricane Sandy never made landfall locally, but paralleled the coast causing coastal erosion with reports of waves up to 10 feet in Miami-Dade. There was no Presidential Declaration for damages within Miami-Dade. It was estimated by the Miami-Dade Regulatory and Economic Resources Department that there was approximately $2M in damages from coastal erosion.[26]

October 2005 – Hurricane Wilma, made landfall in southwestern Florida on October 24th as a Category 3, crossing Florida in less than 5 hours.[27] Wilma caused structural damage from hurricane force winds out to the west and southwest. Widespread light to moderate wind damage was sustained throughout the county. In downtown Miami, numerous high-rise office buildings were severely impacted by hurricane force winds. The Miami Metromover was closed due to falling debris from a neighboring high-rise building. Power outages occurred county-wide for three weeks due to damaged power lines and utility poles. Power losses to service station fuel pumps caused a major but temporary impact on recovery operations. Wind damage to trees and shrubs (native and ornamental) was extensive throughout the county. Ficus trees and Australian Pines sustained most of the tree damage, while palms appeared to fare well. Throughout the Biscayne Bay area there was significant marine damage. Many boats were blown up into bulkheads, docks, and overpasses. Some vessels were freed from their moorings and deposited hundreds of feet from where they were originally docked. The Port of Miami sustained damage to roughly 2,000 feet of bulkheads and a cruise terminal lost a section of its roof. The Sunny Isles Marina dry storage facility collapsed, damaging close to 300 vessels. Numerous docks and pilings throughout the county were severely damaged by the battering of vessels that were moored to them. On the barrier islands, there was sporadic minor to moderate wind damage to ocean front high-rise condominiums, low-rise motels, commercial buildings, and single-family dwellings. The typical wind damages were broken windows, damaged hurricane shutters, and minor roofing losses.

August 2005 – Hurricane Katrina, made landfall in Miami-Dade County on August 25th. Rainfall amounts were excessive across portions of south Miami-Dade County causing flooding of structures, vehicles, crop lands and nurseries. A maximum storm total amount of 16.33 inches, of which 15.10 inches fell in a 24-hour period, was measured by a cooperative observed in Perrine. Other heavy storm total amounts in south Miami-Dade County included 14.04 inches at Homestead Air Reserve Base, 12.25 inches near Florida City and 11.13 inches near Cutler Ridge. Most of the remainder of metropolitan Miami-Dade County generally received rain amounts of two to four inches. Total damage in south Florida was estimated at around $100 million. Between 100 and 200 houses suffered significant damage, mainly in south Miami-Dade County due to flooding. Wind

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[25] Miami-Dade County EOC Activation Archive
[26] Miami-Dade County EOC Activation Archive
[27] National Hurricane Center, Tropical Cyclone Report Hurricane Wilma

damage was mainly to vegetation, signs, and watercraft. Winds and flooding combined caused an estimated $423 million in losses to agriculture and nurseries. A total of six persons are known to have died directly because of the winds and water, all in Miami-Dade County. Three of those were associated with drowning, two on boats and one under unknown circumstances.

August 1992 – Hurricane Andrew, which was reclassified as a Category 5 in 2002, made landfall in Miami-Dade County on August 24th, 1992. Damage was estimated at $25 billion, with 25,524 homes destroyed and 101,241 damaged. 90% of all mobile homes in the southern portion of the county were destroyed. The Miami Herald reported $.5 billion losses for boats. The powerful seas extensively damaged offshore structures, including the artificial reef system.[28]

TABLE 6A-42 PRESIDENTIALLY DECLARED HURRICANE AND TROPICAL STORM EVENTS IN MIAMI-DADE COUNTY

Disaster Type	Disaster Number	Title	Incident Begin Date	Declaration Date	Incident End Date	Disaster Close Out Date
DR	209	HURRICANE BETSY	9/14/1965	9/14/1965	9/14/1965	5/18/1967
DR	955	HURRICANE ANDREW	8/24/1992	8/24/1992	8/25/1992	5/5/2009
EM	3131	HURRICANE GRORGES	9/25/1998	9/25/1998	10/2/1998	5/5/2009
EM	3143	HURRICANE FLOYD EMERGENCY DECLARATIONS	9/14/1999	9/14/1999	9/16/1999	5/15/2012
DR	1306	FL-HURRICANE IRENE-DR-REQ	10/14/1999	10/20/1999	10/24/1999	
EM	3150	TROPICAL STORM IRENE	10/14/1999	10/15/1999	10/19/1999	4/26/2010
DR	1539	TROPICAL STORM BONNIE AND HURRICANE CHARLEY	8/11/2004	8/13/2004	8/30/2004	
DR	1545	HURRICANE FRANCES	9/3/2004	9/4/2004	10/8/2004	
DR	1561	HURRICANE JEANNE	9/24/2004	9/26/2004	11/17/2004	
DR	1602	HURRICANE KATRINA	8/24/2005	8/28/2005	9/6/2005	
EM	3220	HURRICANE KATRINA EVACUATION	8/29/2005	9/5/2005	10/1/2005	7/3/2012
EM	3259	TROPICAL STORM RITA	9/18/2005	9/20/2005	10/23/2005	
DR	1609	HURRICANE WILMA	10/23/2005	10/24/2005	11/18/2005	
EM	3377	HURRICANE MATHEW	10/3/2016	10/6/2016	10/19/2016	
DR	4337	HURRICANE IRMA	9/4/2017	9/10/2017	10/18/2017	
EM	3385	HURRICANE IRMA	9/4/2017	9/5/2017	10/18/2017	
EM	3419	HURRICANE DORIAN	8/28/2019	8/30/2019	9/9/2019	

[28] National Hurricane Center, Preliminary Report Hurricane Andrew

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Disaster Type	Disaster Number	Title	Incident Begin Date	Declaration Date	Incident End Date	Disaster Close Out Date
EM	3533	HURRICANE ISAIAS	7/31/2020	8/1/2020	8/4/2020	
DR	4680	HURRICANE NICOLE	11/7/2022	12/13/2022	11/30/2022	
DR	4673	HURRICANE IAN	9/23/2022	9/29/2022	11/4/2022	
DR	4834	HURRICANE MILTON	10/5/2024	10/11/2024	11/2/2024	

Source: data.gov, FEMA Disaster Declarations Summary

Vulnerability

Hurricane/Tropical Storm			
Category		Vulnerability*	Risk*
Social (People, etc.)	Special Populations	Vulnerable	High
	Cultural Conditions	Somewhat Vulnerable	Medium
	Socioeconomic Conditions	Vulnerable	High
Physical (Property, etc.)	Critical Infrastructure	Somewhat Vulnerable	Medium
	Key Resources	Vulnerable	High
	Building Stock	Vulnerable	High
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Vulnerable	High
	Social Conditions	Vulnerable	High
	Environmental Conditions	Somewhat Vulnerable	Medium
	Governmental Conditions (inc. Operations)	Somewhat Vulnerable	Medium
	Insurance Conditions	Somewhat Vulnerable	Medium
	Community Organizations	Vulnerable	High

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

Physical Vulnerabilities

The entire built environment (Critical Infrastructure, Key Resources, and Building Stock) may be vulnerable to hurricanes and tropical storms due to wind, rain and/or storm surge damages. Structures that do not have impact resistant features or protection that can be installed may be more vulnerable to winds. Homes that were built under older building codes and standards may be more vulnerable to wind damages. Per the HAZUS conducted by the State of Florida in 2018, Miami-Dade has the following physical vulnerabilities.

HAZUS estimates that in 2019 there are 575,844 buildings in the region which have an aggregate total replacement value of $213 billion. Table 8 presents the relative distribution of value with respect to the general types of occupancies.

Coastal areas and areas along canals and rivers, as depicted in the storm surge map, are more vulnerable to surge. Coastal areas are at greater risk for high velocity surge and erosion. Low lying areas are more vulnerable to flooding if a storm brings significant rainfall. Uprooted trees can cause damage to underground and overhead utilities. Hurricanes and tropical storms may also cause flying debris that cause additional damage. These storms can also impact natural and agricultural resources as well, causing severe coastal erosion and flooding or wind damage to agricultural assets. The extent of debris and infrastructure outages and restoration times can complicate and increase response and recovery timelines. Part 5 provides tables that show how many Commercial, Industrial, Residential and Other types of structures are within Storm Surge Planning Zones.

TABLE 8. BUILDING EXPOSURE BY OCCUPANCY TYPE

Occupancy	Exposure ($1,000)	Percent of Total
Residential	140,918,020	66.1%
Commercial	36,916,484	17.3%
Industrial	2,273,279	1.1%
Agricultural	905,243	0.4%
Religious	2,731,747	1.3%
Government	20,608,864	9.7%
Education	8,935,765	4.2%
Total	**213,289,402**	**100.0%**

<u>Essential Facility Inventory</u>
For essential facilities, there are 38 hospitals in the region with a total bed capacity of 10,829 beds. There are 512 schools, 109 fire stations, 67 police stations and 6 emergency operation facilities.[29]

<u>Mobile/Manufactured Homes</u>
There are currently 59 mobile home parks within Miami-Dade County. On an annual basis the Miami-Dade County Office of Emergency Management assesses these sites. This assessment verifies their location and the total number of mobile homes are on-site.

TABLE 9. MOBILE HOME PARKS IN MIAMI-DADE COUNTY[30]

NAME	ADDRESS	CITY	ZIP CODE	PHONE	TOTAL UNITS	TYPE
All Star 36th Street Mobile	3010 NW 36 ST	Miami-Dade	33142	305-557-1122	53	MHP
Americana Village Mobile Home Park	19800 SW 180TH AVE	Miami-Dade	33187	305-253-6025	525	MHP
Aquarius Mobile Home Park	451 SE 8TH ST	Homestead	33030	305-248-9383	190	MHP

[29] 2018 HAZUS Report for Miami-Dade County
[30] Miami-Dade DEM 2019 Mobile Home List

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NAME	ADDRESS	CITY	ZIP CODE	PHONE	TOTAL UNITS	TYPE
Biscayne Breeze Trailer Park	11380 BISCAYNE BLVD	Miami-Dade	33181	786-220-7482	61	MHP
Blue Belle Trailer Park	3586 NW 41ST ST	Miami-Dade	33142	305-635-1755	150	MHP
Boardwalk Mobile Home Park	100 NE 6TH AVE	Homestead	33030	305-248-2487	166	MHP
Carleys Mobile Home Park	4111 NW 37TH AVE	Miami-Dade	33142	305-315-8311	70	MHP
Cocowalk Estates Trailer Park	220 NE 12TH AVE	Homestead	33030	305-246-5867	218	MHP
Colonial Acres Mobile Home Park	9674 NW 10TH AVE	Miami-Dade	33150	305-696-6231	296	MHP
Courtly Manor Mobile Home Park	12401 W OKEECHOBEE RD	Hialeah Gardens	33018	305-821-1400	525	MHP
Gables Trailer Park	825 SW 44TH AVE	Miami-Dade	33134	305-903-2000	95	MHP
Gateway Estates Mobile Home Park	35250 SW 177TH CT	Miami-Dade	33034	305-247-8500	222	MHP
Gateway West Mobile Home Park	35303 SW 180TH AVE	Miami-Dade	33034	305-246-5867	120	MHP
Gator Park RV Campground	24050 SW 8TH ST	Miami-Dade	33194	305-559-2255	30	RV
Goldcoaster Mobile Home Park	34850 SW 187TH AVE	Homestead	33034	305-248-5462	547	MHP
Hibiscus Trailer Park	3131 W 16TH AVE	Hialeah	33012	305-755-3942	34	MHP
Highland Village Park Mobile Home Park	13621 HIGHLANDS DR	North Miami Beach	33181	305-948-2928	500	MHP
Holiday Acres Mobile Home Park	1401 W 29TH ST	Hialeah	33012	305-822-4611	84	MHP
Homestead Trailer Park	31 SE 2ND RD	Homestead	33030	305-247-4021	50	MHP
Honey Hill Mobile Home Park	4955 NW 199TH ST	Miami-Dade	33055	305-625-9255	438	MHP
J Bar J Trailer Ranch	2980 NW 79TH ST	Miami-Dade	33147	305-691-2432	99	MHP
Jones Fishing Camp Trailer Park	14601 NW 185TH ST	Miami-Dade	33018	954-536-7400	52	MHP
Larry and Penny Thompson Memorial Park	12451 SW 184TH ST	Miami-Dade	33177	305-232-1049	240	RV
Lil' Abner Mobile Home Park	11239 NW 4TH TER	Sweetwater	33172	305-221-7174	908	MHP
Little River Mobile Home Park	215 NW 79th ST	Miami-Dade	33150	786-766-9385	76	MHP
Medley Lakeside Mobile Home Park	10601 NW 105TH WAY	Medley	33178	305-888-3322	86	MHP

NAME	ADDRESS	CITY	ZIP CODE	PHONE	TOTAL UNITS	TYPE
Medley Mobile Home Park,	8181 NW SOUTH RIVER DR	Medley	33166	305-885-7070	206	MHP
Miami Everglades Campground	20675 SW 162ND AVE	Miami-Dade	33187	305-233-5300	330	RV
Miami Heights Mobile Home Park	3520 NW 79TH ST	Miami-Dade	33147	305-691-2969	140	MHP
Miami Soar Mobile Home Park	8202 NW Miami CT	Miami-Dade	33150	754-465-5410	352	MHP
Palm Garden Mobile Home Park	28501 SW 152ND AVE	Miami-Dade	33033	305-247-8915	275	MHP
Palm Garden RV Park	28300 SW 147TH AVE	Miami-Dade	33033	305-247-8915	39	RV
Palm Lake Mobile Home Park	7600 NW 27TH AVE	Miami-Dade	33147	305-696-1920	118	MHP
Palmetto Estates Mobile Home Park	3205 W 16TH AVE	Hialeah	33012	754-219-9217	95	RV
Princetonian Mobile Home Park	12900 SW 253RD TER	Miami-Dade	33032	305-257-3251	200	MHP
Redlands Mobile Home Park	17360 SW 232ND ST	Miami-Dade	33170	305-247-7707	80	MHP
Riviera Mobile Home Park	19900 NW 37TH AVE	Miami Gardens	33055	305-624-5888	162	MHP
Rovell Trailer Park	939 NW 81ST ST	Miami-Dade	33150	305-586-7045	138	MHP
Royal Country Trailer Park	5555 NW 202ND TER	Miami Gardens	33055	305-621-2270	864	MHP
Royal Duke Trailer Park	3620 NW 30TH AVE	Miami-Dade	33142	786-719-8990	99	MHP
Shady Oaks Mobile Home Park	14701 NE 6TH AVE	Miami-Dade	33161	305-507-7528	25	MHP
Silver Court Trailer Park	3170 SW 8TH ST	Miami	33135	305-649-8941	236	MHP
Silver Palm Place Mobile Home Park	17350 SW 232ND ST	Miami-Dade	33170	941-202-1484	112	MHP
Sixth Ave Trailer Park	14752 NE 6TH AVE	Miami-Dade	33161	305-582-0867	22	MHP
Southern Comfort RV Resort	345 E PALM DR	Florida City	33034	305-248-6909	300	RV
Sunnyside Trailer Park	6024 SW 8TH ST	West Miami	33144	305-266-1727	105	MHP
University Lakes Mobile Home Park	12850 SW 14TH ST	Miami-Dade	33184	305-226-4251	1153	MHP
Westhaven Court Mobile Home Park	6020 SW 8TH ST	West Miami	33144	305-903-4791	21	MHP
Westland Mobile Home Park	1175 NW 79TH ST	Miami-Dade	33150	305-557-1122	114	MHP

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NAME	ADDRESS	CITY	ZIP CODE	PHONE	TOTAL UNITS	TYPE
Wynken Blynken And Nod Mobile Home Park	2775 W OKEE-CHOBEE RD	Hialeah	33010	305-887-6570	186	MHP

Social Vulnerabilities

Mobile/manufactured home residents, electric dependent, functional needs and persons who may not have adequate resources to protect their homes or access to evacuation resources are at greatest risk for this hazard. Visitors and persons who are new to this area may also be more vulnerable as they may not be familiar with what to do in case an evacuation order is given. Prolonged power outages and gas shortages cause additional challenges to businesses and service providers and can disproportionately impact persons whom rely upon regular home services such as medical services or food delivery.

Frequency/Probability

In the past 100 years, there have been approximately 340 hurricanes that have impacted the coast of Florida. Of these hurricanes, 70 have impacted Miami-Dade County. Miami-Dade County has a 1 out of 6 chance of being hit by a hurricane, the highest likelihood in the state. Florida not only leads the nation in number of hurricanes making landfall, but also the severity of those storms. Since 2015, there have been 4 Tropical Storms, 17 Tropical Depressions, and 2 Storm Surge incidents recorded in Miami-Dade County. This averaged out to approximately 4 and a half per year. Each hurricane and tropical storm event lasted for up to 2 to 6 days.

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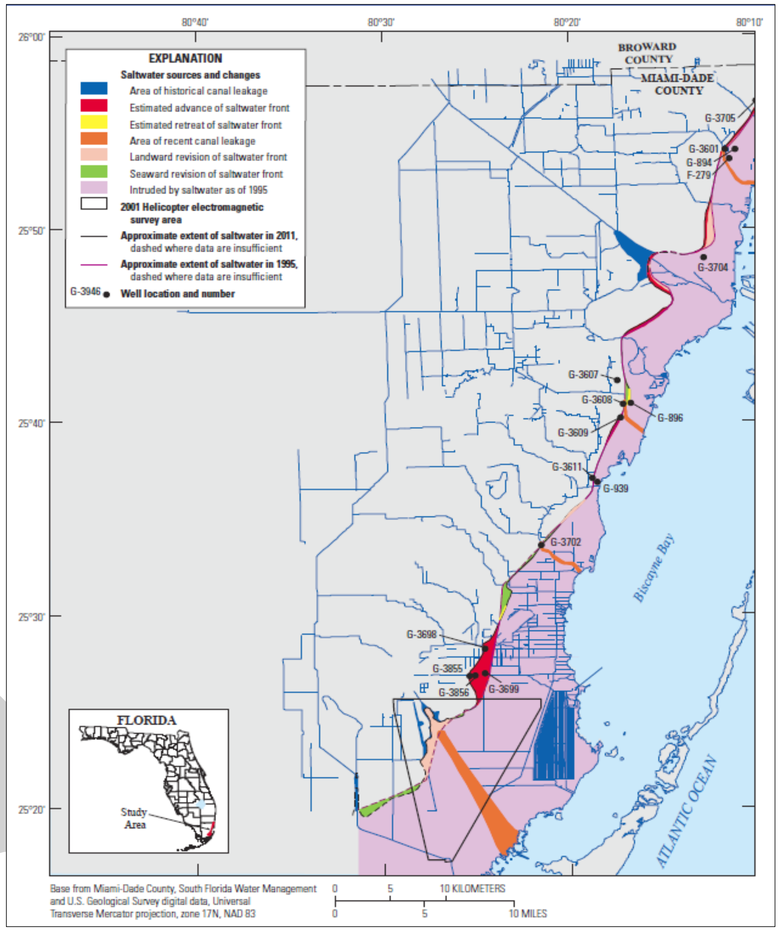
Saltwater Intrusion

Description

According to the United States Geological Survey (USGS), saltwater intrusion is a generic term referring to an influx of saltwater through various pathways into an aquifer. The South Florida Water Management District defines it as chloride concentrations exceeding drinking water standards of 250 mg/1. Saltwater Intrusion is a major threat to the freshwater resources of the coastal areas in southeastern Florida. There are three primary mechanisms by which saltwater contaminates the freshwater reservoir in the unconfined, surficial aquifers of the region: (1) encroachment of saltwater from the ocean along the base of the aquifer; (2) infiltration of saltwater from coastal saltwater mangrove marshes: and (3) the flow of saltwater inland through canals where it leaked into the aquifer.



Saltwater intrusion has been a concern in Miami-Dade County since the early 1930s. The USGS has been monitoring saltwater intrusion in the county since 1939. The salt front was mapped in 1995 and again in 2011 (Prinos et al, 2014). Miami-Dade County is vulnerable to saltwater intrusion because the county "has low land-surface altitude and a low topographic gradient and is bordered to the east and south by sources of saltwater in the Atlantic Ocean, Biscayne Bay, and Florida Bay" (Prinos et al, 2014). The limestone beneath Miami-Dade is part of the unconfined, shallow and highly transmissive Biscayne Aquifer, and is highly vulnerable to contaminants, especially saltwater, along coastal areas and canals.

The inland movement of the saltwater interface into the Biscayne Aquifer is primarily due to the drainage of the Everglades by the canal system, which began in the early 20th century to make way for development, agriculture, and flood control (Leach et al, 1972), however other mechanisms also come into play including: “the upconing of relict or residual saltwater that had been incorporated in relatively impermeable sediments during previous sea-level high stands occurring during interglacial periods; the gradual encroachment of saltwater from the ocean along the base of the aquifer resulting from reductions in freshwater head relative to sea level rise; and the infiltration of saltwater from coastal saltwater mangrove marshes” (Prinos et al, 2014). The combined effects of natural and human factors are resulting in a diminishing freshwater supply and threatening the habitability of this region.

The Biscayne Aquifer supplies 99% of all groundwater withdrawn in Miami-Dade County to support the county’s growing population (Marella, 2009). As the population in Miami-Dade County grew in the 1970s and 1980s, groundwater withdrawals increased. However, beginning in the 1990s, groundwater withdrawals maintained at a constant level even as the population grew. Since the mid-2000s, Miami-Dade County’s population has continued to grow but groundwater withdrawals have actually decreased. This may be due to stricter water use policies that were enacted in May 2007 when water levels in Lake Okeechobee reached record lows.

<u>Location</u>

The salt front is the farthest inland extent of saltwater intrusion in the aquifer. As show in Map 6A-40, the salt front is not equally intruding along the coast of Miami-Dade County.

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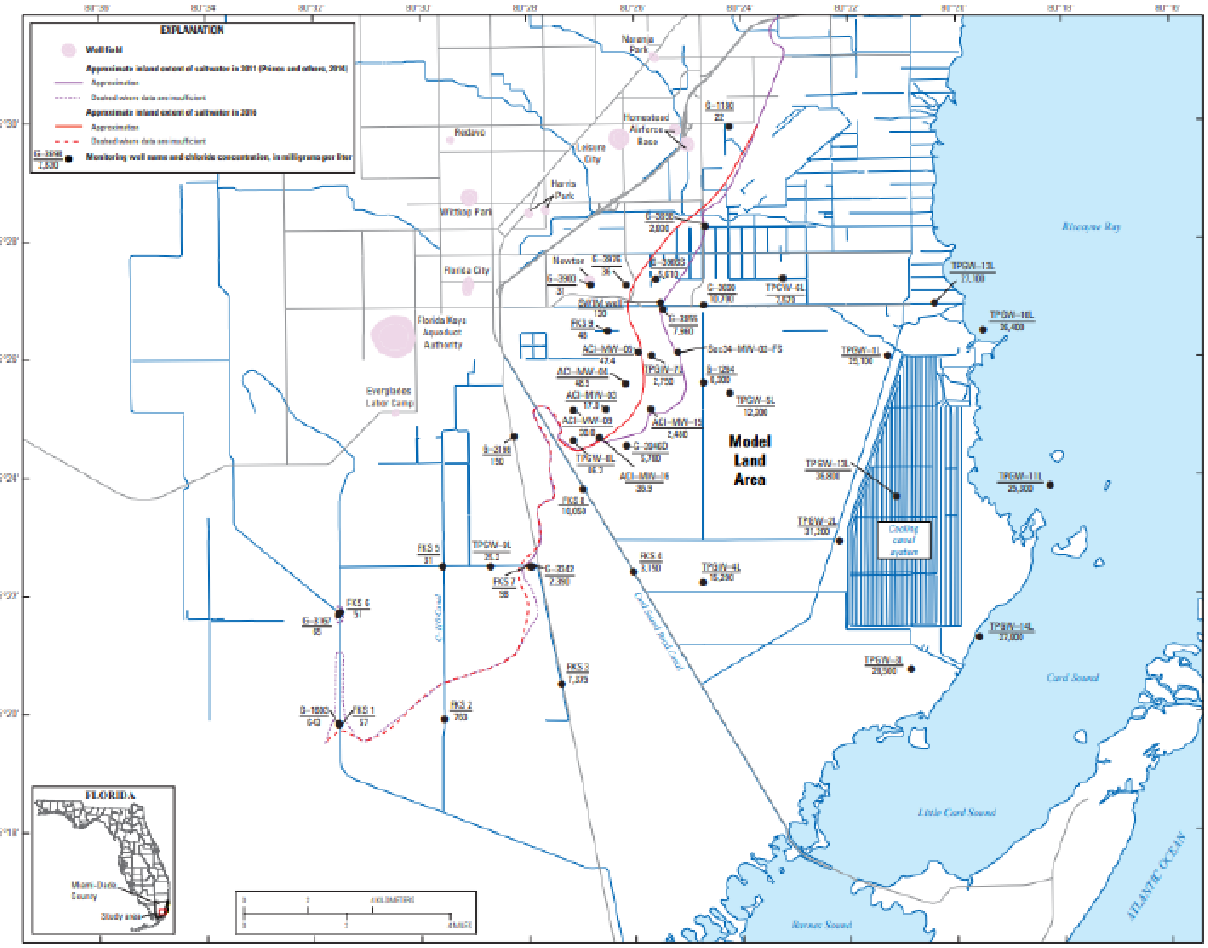
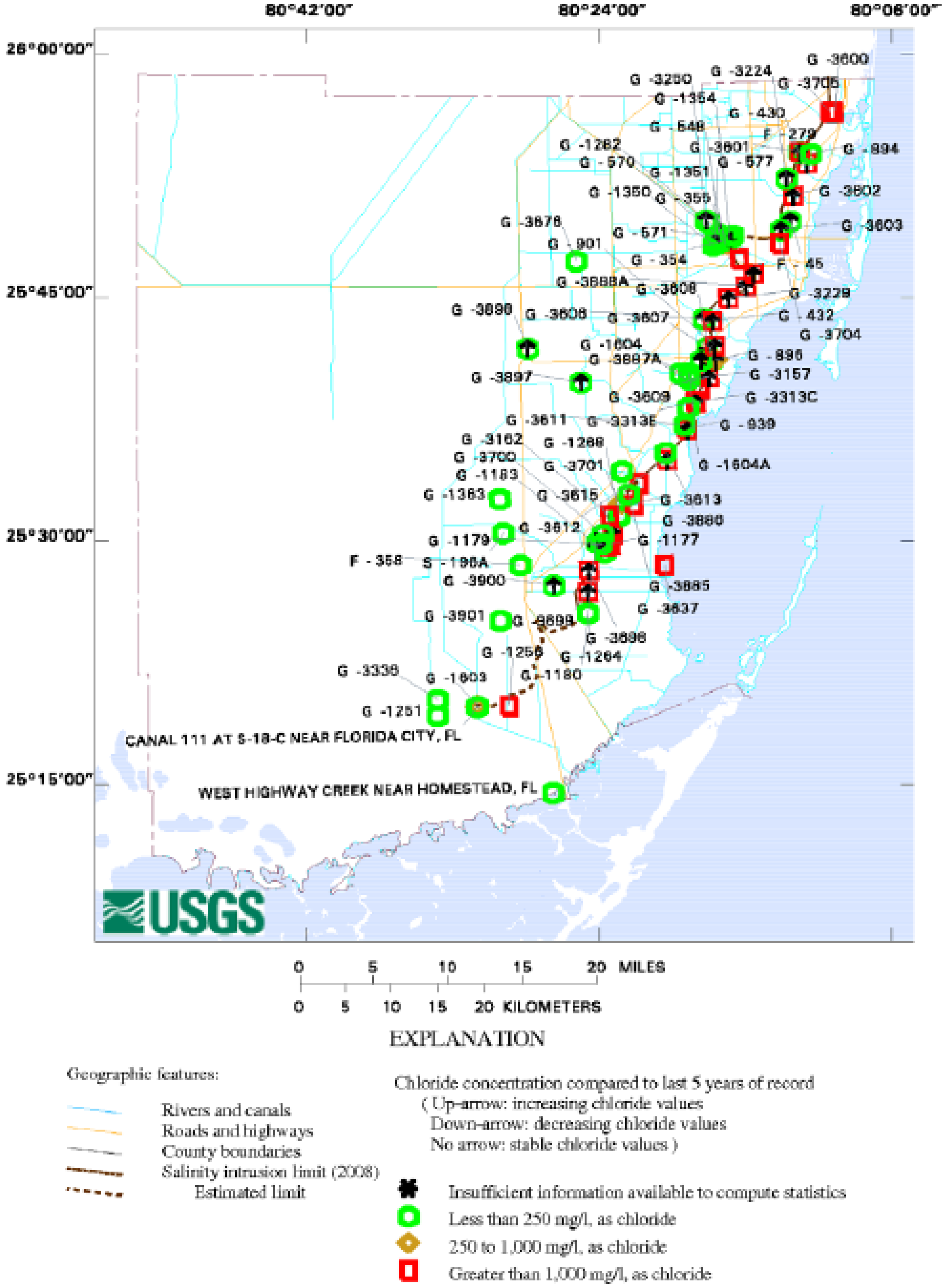
MAP 6A-40 LOCATION OF THE SALT FRONT IN MIAMI-DADE COUNTY



Source: U.S. Department of the Interior, U.S. Geological Survey, 2016

MAP 6A-41 SALINITY AND CHLORIDE DATA IN MIAMI-DADE COUNTY



Chloride data from selected sites in Miami-Dade County, Florida,
Based on PROVISIONAL DATA, as of August 31, 2012.

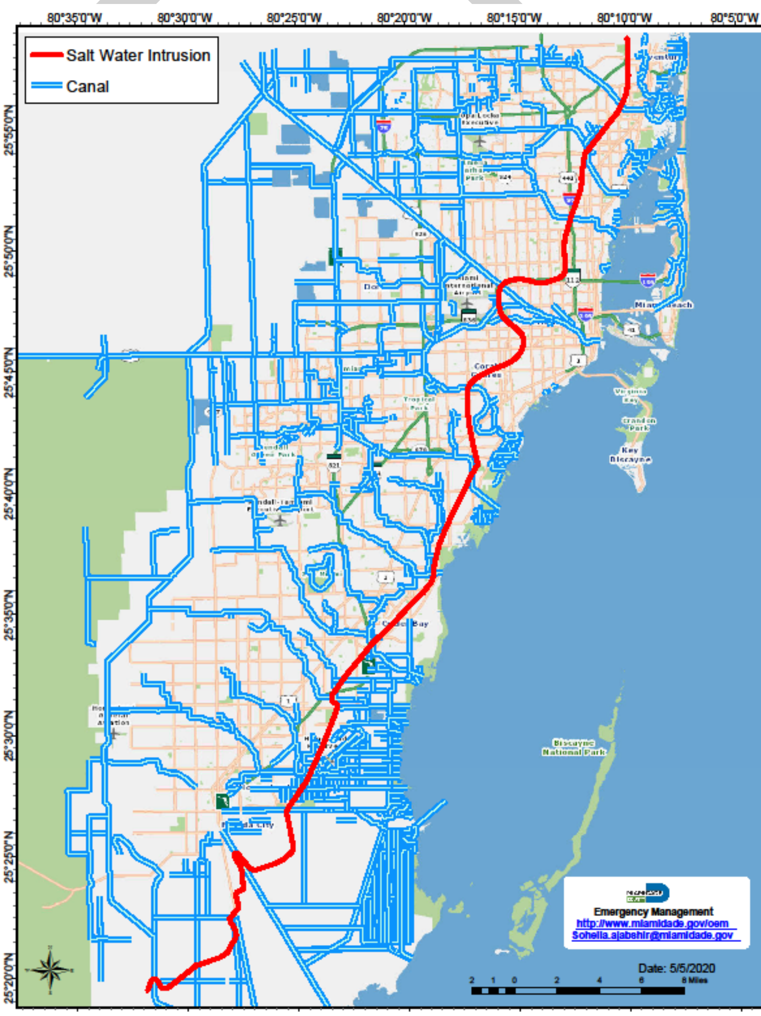
Source: USGS, South Florida Water Management District

<u>Extent</u>

According to a 2011 USGS study, approximately 1,200 square kilometers of the mainland Biscayne aquifer has been intruded by salt water, however this intrusion has not been equally distributed around the county, with some areas experiencing increased intrusion and others receding salinity levels. Increased saltwater intrusion occurs most often during April or early May when water levels are typically at their lowest in Miami-Dade County. Additionally, there is a close correspondence between drought and saltwater intrusion (Prinos et al, 2014).

Since the 2011 USGS study, the saltwater inface continued to move inland and an updated map produced in 2016 depicts the approximate inland extent of saltwater at the base of the Biscayne aquifer. Miami-Dade County and the USGS are working together to monitor the saltwater intrusion extent inland along the east part of the county in order to be able to timely and effectively respond as needed.

<u>Impact</u>



Miami-Dade County is vulnerable to saltwater intrusion because the county "has low land-surface altitude and a low topographic gradient and is bordered to the east and south by sources of saltwater in the Atlantic Ocean, Biscayne Bay, and Florida Bay" (Prinos et al, 2014). Saltwater intrusion can affect the freshwater supply throughout the county dependent on the magnitude of intrusion.

This hazard typically does not affect essential facilities or critical infrastructure and other properties, however it may impact the amount and types of water control structures in the area to prevent saltwater intrusion.

Impact to Environment

According to the EPA, saltwater intrusion can and may diminish drinking water sources. Saltwater intrusion can lead to groundwater degradation, causing water utilities to increase water treatment.

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Consequences related to the environment following saltwater intrusion may include:

- The hazard may diminish the availability or quality of water sources for drinking water.

Previous Occurrences

Saltwater intrusion has been monitored by the USGS since 1939. Per the USGS "in 1904 (prior to any human-induced drainage), the saltwater interface was estimated to be at or near the coast because of the very high-water levels which occurred naturally in the Everglades. Freshwater was reported to seep from the Biscayne aquifer offshore into Biscayne Bay in sufficient quantities to be used as a supply of freshwater for ships. Beginning in 1909 with the extension of the Miami River and continuing through the 1930's, construction of drainage canals (with no control structures) and pumpage from coastal well fields resulted in the lowering of water levels in the Biscayne aquifer, thereby inducing the inland movement of saltwater into the aquifer. Additionally, seawater driven by tides flowed inland in the drainage canals, resulting in the seepage of saltwater into the Biscayne aquifer from the canals. By 1946, salinity-control structures had been installed in all primary canals as far seaward as possible. These controls prevented saltwater driven by tidal changes from moving upstream in the canals beyond the controls. The controls also served to backup freshwater which maintained higher water levels in the Biscayne aquifer near the coastline. These water levels are higher than those that occurred during the period of uncontrolled drainage. The inland migration of saltwater in northern Miami-Dade County slowed or reversed in some areas because of the effects of these controls on water levels.

In the early 1960's, the existing canal system in southern Miami-Dade County was expanded to provide flood control. The canals were equipped with flow-regulation structures both near the coast and inland, allowing water levels to be stepped down from structure to structure to prevent excessive drainage. However, the design and operation of this system lowered freshwater levels in the Biscayne aquifer, especially near the coast, allowing for the inland movement of saltwater during the drought years of 1970 and 1971. In 1976, additional water was routed to southern Miami-Dade County, raising water levels along the coast and slowing or reversing the inland movement of the saltwater interface.

Since 1984, additional events have occurred which have affected water levels in the Biscayne aquifer and, hence, the movement of the saltwater interface. Among these events are the initial operation of the Northwest Well Field and a consequent reduction in pumping from the Hialeah-Miami Springs Well Field, expansion of the Southwest Well Field, and changes in the delivery schedule of water to southern Dade County and Everglades National Park. Future changes in water levels might occur as a result of changes in the management of the ecosystem of south Florida. These changes will be based on the

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results of studies being conducted as part of the U.S. Geological Survey South Florida Ecosystem Program and other studies.

Per the USGS paper referenced below, “some saltwater likely leaked from canals prior to the installation of water control structures. Near the Miami Canal northwest of the water control structure S-26, this saltwater is gradually mixing with the groundwater and salinity is gradually decreasing. Modern leakage of saltwater likely is occurring along the Card Sound Road canal and upstream of salinity control structures in the Biscayne, Black Creek and Snapper Creek Canals. Saltwater also may have leaked from the Princeton Canal and the canal adjacent to well G-3698, although this leakage could not be confirmed or refuted with available information.”

<u>Vulnerability</u>

The eastern part of Miami-Dade County is most vulnerable; however the salt front is not equally intruding along the coast of Miami-Dade County.

Saltwater Instrusion			
Category		Vulnerability	Risk
Social (People, etc.)	Special Populations	Somewhat Vulnerable	Medium
	Cultural Conditions	Minimally Vulnerable	Low
	Socioeconomic Conditions	Minimally Vulnerable	Low
Physical (Property, etc.)	Critical Infrastructure	Minimally Vulnerable	Low
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Minimally Vulnerable	Low
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Minimally Vulnerable	Low
	Social Conditions	Minimally Vulnerable	Low
	Environmental Conditions	Vulnerable	Medium
	Governmental Conditions (inc. Operations)	Minimally Vulnerable	Low
	Insurance Conditions	Minimally Vulnerable	Low
	Community Organizations	Minimally Vulnerable	Low

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

<u>Physical Vulnerabilities</u>

The SFWMD has identified “Utilities at Risk” for salt water intrusion, which include utilities with well fields near the saltwater/freshwater interface that do not have an inland well field, have not developed adequate alternative sources of water, and have limited ability to meet user needs through interconnects with other utilities; and “Utilities of Concern”, which include utilities having well fields near the saltwater/freshwater interface, the ability to shift pumps to an inland well field, or an alternative source that is not impacted by the drought (SFWMD, 2007). Miami-Dade WASD well fields included as “Utility at Risk” are South Miami-Dade Well fields (Newton, Elevated Tank, Naranja, Leisure City, Roberta

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Hunter Park and Caribbean Park). MDWASD Utilities of Concern include the North and Central Miami-Dade Well fields (Hialeah-Preston and Alexander Orr).

Well fields are at risk and as such protection areas have been delineated and are monitored. Saltwater intrusion can impact the rates at which groundwater is pumped to supply drinking water supplies and may require deeper wells to be drilled. Agricultural crops may be impacted by the salinity levels. Saltwater intrusion can also displace the fresh groundwater thereby impacting the water-table elevations in urban areas levels that could increase localized flooding.

Social Vulnerabilities

This hazard does not tend to affect one population over another.

Frequency/Probability

Since 2016, the inland extent of saltwater at the base of the Biscayne aquifer continues to move inland. Increased saltwater intrusion occurs most often during April or early May when water levels are typically at their lowest in Miami-Dade County.

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Sea Level Rise

Description

Sea Level Rise refers to the increase currently observed in the average Global Sea Level Trend, which is primarily attributed to changes in ocean volume due to two factors: ice melt and thermal expansion. Melting of glaciers and continental ice masses, such as the Greenland ice sheet, which are linked to changes in atmospheric temperature, can contribute significant amounts of freshwater input to the Earth's oceans. Additionally, a steady increase in global atmospheric temperature creates an expansion of saline sea water (i.e., salt water) molecules (called thermal expansion), thereby increasing ocean volume.

Sea level rise is occurring due to three main factors, all of which are occurring due to global climate change:

- Thermal Expansion: As with all water, when the ocean heats up, it expands. About 50% of the sea level rise in the past 100 years is because the ocean is warmer, and therefore takes up more space.
- Glacier and Polar Ice Cap Melting: Although glaciers and polar ice caps naturally melt a little each summer, they usually regain lost area during the winter. However, warmer winters have meant less opportunity to regrow this ice, resulting in more melted water remaining in the oceans, contributing to sea level rise.
- Greenland and West Antarctic Ice Loss: Similar to what is happening with glaciers and the polar ice cap, the huge ice sheets that cover Greenland and Antarctica are melting.

Sea level rise hazards include:

- Increased risk of tidal flooding in coastal areas. In addition, tropical systems may become stronger because of climate change. This could lead to increased storm surge and wave heights during hurricanes. As South Florida drainage systems are gravity based and reliant upon the ability of South Florida Water Management District to release water from the canals into the bay this could compromise the ability to drain low-lying interior areas.
- Higher storm surge, increased evacuation areas, reduced shelter capabilities and increased evacuation time frames.
- Destruction of natural resource habitats that could impact ecosystems and agriculture and challenge the adaptive capabilities of flora and fauna.
- Increased potential for saltwater intrusion. If saltwater migrates farther inland, higher salinity could impair both ground and surface water, affecting ecosystems, agricultural land and the Biscayne Aquifer, the primary source of drinking water for Southeast Florida.

- Impacts on the growth and productivity of crops. Prolonged periods of drought, severe weather or potential for saltwater intrusion could negatively impact the local agricultural economy.
- Increased shoreline erosion and inundation of land. Increased sea levels can lead to increased shoreline erosion from intense storms and higher storm surges.
- Loss of infrastructure and existing development. As sea level continues to rise, deeper water near the shore will translate to higher storm surge, faster flow, higher waves, greater hydro-dynamic pressure, and wave impact loads on buildings near the shoreline which may increase infrastructure damage.

According to the Environmental Protection Agency (EPA) sea level is rising faster in certain parts of the world due to natural events such as wind patterns, ocean currents, and other factors. Florida, particularly Southeast Florida, is vulnerable to sea level rise given its extensive shoreline and low elevation. The so-called "relative sea level" that is measured by a tide gauge at a particular location, is a function of both changes in the elevation of the sea's surface due to changes in the volume of water in the ocean (eustatic sea level) and vertical movement of the land upon which the tide gauge sits due to subsidence or tectonic movement of the earth's crust.

Based on past and current emissions, all projection curves assume a growing greenhouse gas emission concentration scenario, in which emissions continue to increase until the end of the century, consistent with the IPCC Fifth Assessment Report's (AR5) Representative Concentration Pathways (RCP 8.5). Estimates of sea level rise are provided from a baseline year of 2000, and the planning horizon has been extended to 2120, in response to the release of climate scenarios extending beyond the year 2100 by federal agencies (NOAA and the U.S. Army Corps of Engineers) and the need for planning for infrastructure with design lives greater than 50 years.

In the short-term, sea-level rise is projected to be 10 to 17 inches by 2040 and 21 to 54 inches by 2070 (above the 2000 mean sea level in Key West, Florida). In the long-term, sea-level rise is projected to be 40 to 136 inches by 2120. Projected sea level rise, especially beyond 2070, has a significant range of variation because of uncertainty in future greenhouse gas emissions reduction efforts and resulting geophysical effects.

<u>Location</u>

The entire County is being affected by rising sea levels. Low-lying areas, both urban and undeveloped wetland areas, are being impacted. The potential extent of impact is widest in the Southern portion of the County, but all areas, including inland areas, are being impacted by changing water levels.

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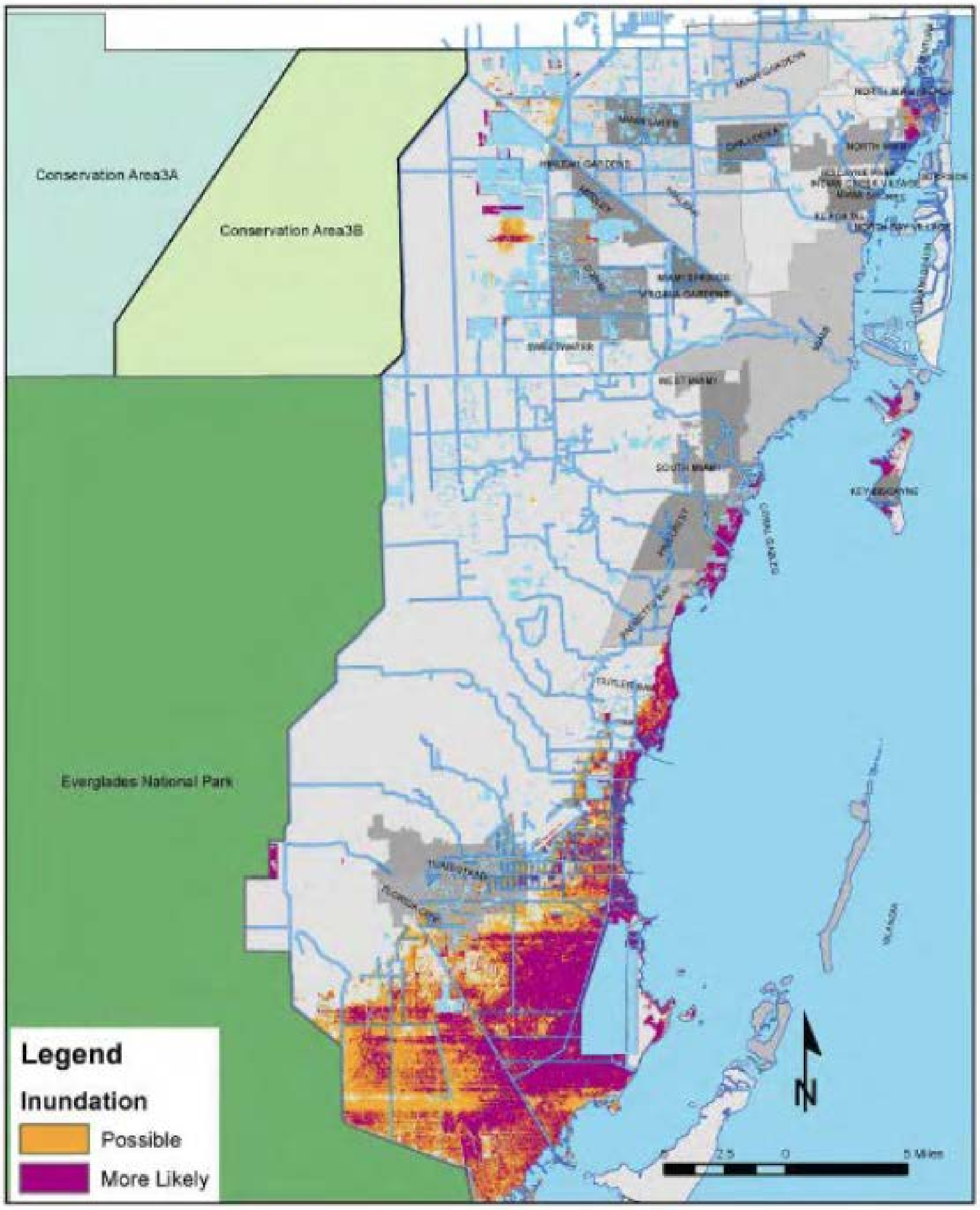
MAP 6A-42 1-FOOT SEA LEVEL RISE IN MIAMI-DADE COUNTY



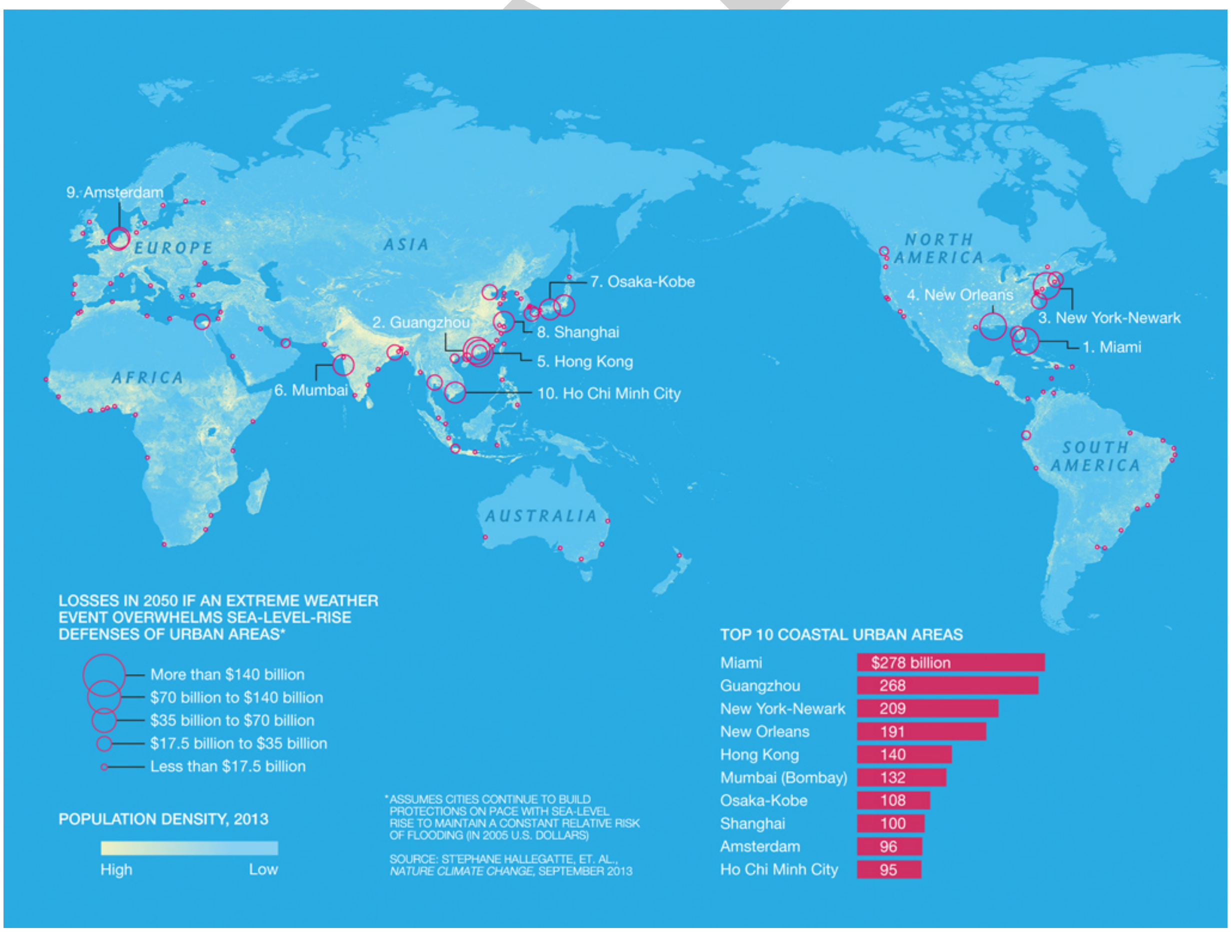
Source: Miami-Dade County Local Mitigation Strategy/Southeast Florida Regional Climate Change Compact

Extent

According to the IPCC, the sea level rise gradually rose in the 20th century and has been rising at an increased rate in the 21st century. According to the World Resources Institute, the sea level in South Florida has increased by 12 inches since 1870. By 2100, greenhouse gas concentrations are predicted to reach levels greater than or equal to those observed during the last interglacial period when sea levels were between 13.1' and 19.7' higher than present levels (Rhode Island, 2014 Hazard Mitigation Plan).

Rising sea levels, coupled with potentially higher hurricane wind speeds, rainfall intensity, and storm surges are expected to have a significant impact on coastal communities. More intense heat waves may mean more heat-related illnesses, droughts, and wildfires. As climate science has evolved and improved, compared to past updates this plan considers climate change as a parameter in the ranking or scoring of natural hazards and respective mitigation actions rankings.

If sea levels rise by just 16 inches, flood damages in port cities around the world could cost one trillion dollars per year. In a recent National Geographic publication (see Map below), the cost to Miami in 2050 if an extreme weather event overwhelmed the city's sea level rise defenses would be the most expensive of all coastal urban areas in the world at $278 billion. The Miami metropolitan region has the greatest amount of exposed financial assets and 4th-largest population vulnerable to sea level rise in the world. The only other cities with a higher combined (financial assets and population) risk are Hong Kong and Calcutta. The county alone has more people living less than 4 feet above sea level than any state in the nation except Florida itself and Louisiana (Broward County's population is comparable as well).



<u>Impact</u>

Impact to Miami-Dade County Residents

Sea level rise can affect an entire population in the county. Because sea level rise is so encompassing and long-term, this hazard has the potential to affect major changes in the county, and not only the few populations identified here. Certain population groups may be impacted and/or more vulnerable based on location/proximity to the incident or other social vulnerability conditions.

Homeowners would be at greater risk if they own a home in a low elevation area. Homeowners would lose their home or have trouble selling their home knowing it lies in a low elevation area and will most likely experience the direct impacts of sea level rise. Because of sea level rise, county residents would have to move to a location above sea level, those who are part of the low-income/poor community may be unable to afford housing.

Consequences related to the public following severe sea level rise impact over time may include:

- Temporary/permanent loss of residence, causing an increased need for shelter, short-term or long-term housing.

Impact to Essential Facilities and Other Property

All essential facilities are vulnerable to a one-foot sea level depth scenario. As mentioned above, a portion of the properties at Homestead Air Reserve Base, the Turkey Point Nuclear Power Plant, and the Cutler Power Plant are at elevations below sea level. Most of these potentially inundated areas on these properties are existing storm water management ponds and ditches and the cooling canals at Turkey Point. The cooling canal system at Turkey Point is extremely critical to the function and safety of the plant and additional analysis is necessary in order to fully understand potential impacts to all components of the facility.

Building Inventory: Impacts to buildings within the county can be expected due to saltwater corrosion over time which could lead to possible loss of the entire building.

Consequences related to essential facilities and property following sea level rise may include:

- Loss of building function (e.g., damaged homes will no longer be habitable, causing residents to seek shelter).
- Business/service interruption, causing an impact to the local economy as well as individual households.

Impact to Critical Infrastructure

Due to sea level rise, the types of infrastructure that could be impacted include roadways, utility lines/pipes, railroads, and bridges, dependent on the sea level rise depth. Because the county's entire infrastructure is equally vulnerable, it is important to emphasize that any number of these structures could become damaged by sea level rise over time.

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Consequences related to critical infrastructure sea level rise impact may include:

- Disruption in the transportation of goods
- Disruption in the public transportation
- Shortage of fuel or other essential materials

Impact to Environment

Sea level rise can impact the environment dependent on the sea level rise depth. As stated earlier, under a one-foot sea level rise scenario, 12% of the county is impacted with conservation lands being the major land use type inundated. At the two-foot scenario, 16% of the land is impacted with agricultural lands added to the conservation lands. At the three-foot scenario, 18% of the total land mass of the county is impacted including inland areas around the Northwest Municipal Drinking Water Well field. Low lying inland areas like the well field are more likely subject to future drainage issue associated with rain events rather than saltwater impacts. In terms of acres inundated, wetland hardwood forest (mangrove) and vegetated non-forested wetlands are among the major habitats impacted.

Consequences related to the environmental impacts of sea level rise may include:

- Trees and plants can be uprooted and diseases in the soil are spread, impacting wildlife and their habitat.
- Marine plant and animal habitats may be impacted.
- Wetland hardwood forest (mangrove) and vegetated non-forested wetlands are among the major habitats impacted.

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Vulnerability

Sea Level Rise			
Category		Vulnerability*	Risk*
Social (People, etc.)	Special Populations	Vulnerable	High
	Cultural Conditions	Somewhat Vulnerable	High
	Socioeconomic Conditions	Vulnerable	High
Physical (Property, etc.)	Critical Infrastructure	Vulnerable	High
	Key Resources	Vulnerable	High
	Building Stock	Vulnerable	High
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Vulnerable	High
	Social Conditions	Somewhat Vulnerable	High
	Environmental Conditions	Very Vulnerable	Extreme
	Governmental Conditions (inc. Operations)	Somewhat Vulnerable	High
	Insurance Conditions	Vulnerable	High
	Community Organizations	Minimally Vulnerable	Medium

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

Physical Vulnerabilities

The built environment (Critical Infrastructure, Key Resources, and Building Stock) and natural environment are vulnerable to sea level rise and though some preliminary mapping shows southern portions of the county at highest risk there is risk to other portions as well. Coastal communities, such as Miami Beach, have already begun to experience sunny day flooding in relation to high and king tides that limit the gravitational drainage that drains to the bay. Additional mapping is being done to determine all areas that may be at risk.

Social Vulnerabilities

Homeowners would be at greater risk if they own a home in a low elevation area. Homeowners would lose their home, or have trouble selling their home knowing it lies in a low elevation area and will most likely experience the direct impacts of sea level rise. Due to the effects of sea level rise, county residents would have to move to a location above sea level, and those who are part of the low-income/poor community may be unable to afford housing.

Although not exhaustive, the following is a list of potential social populations that may be more heavily affected by this hazard than other groups. For more information on the different categories indicated here, please refer to their respective sections in the Vulnerability Index & Assessment:

- Low-Income/Poor
- Homeownership

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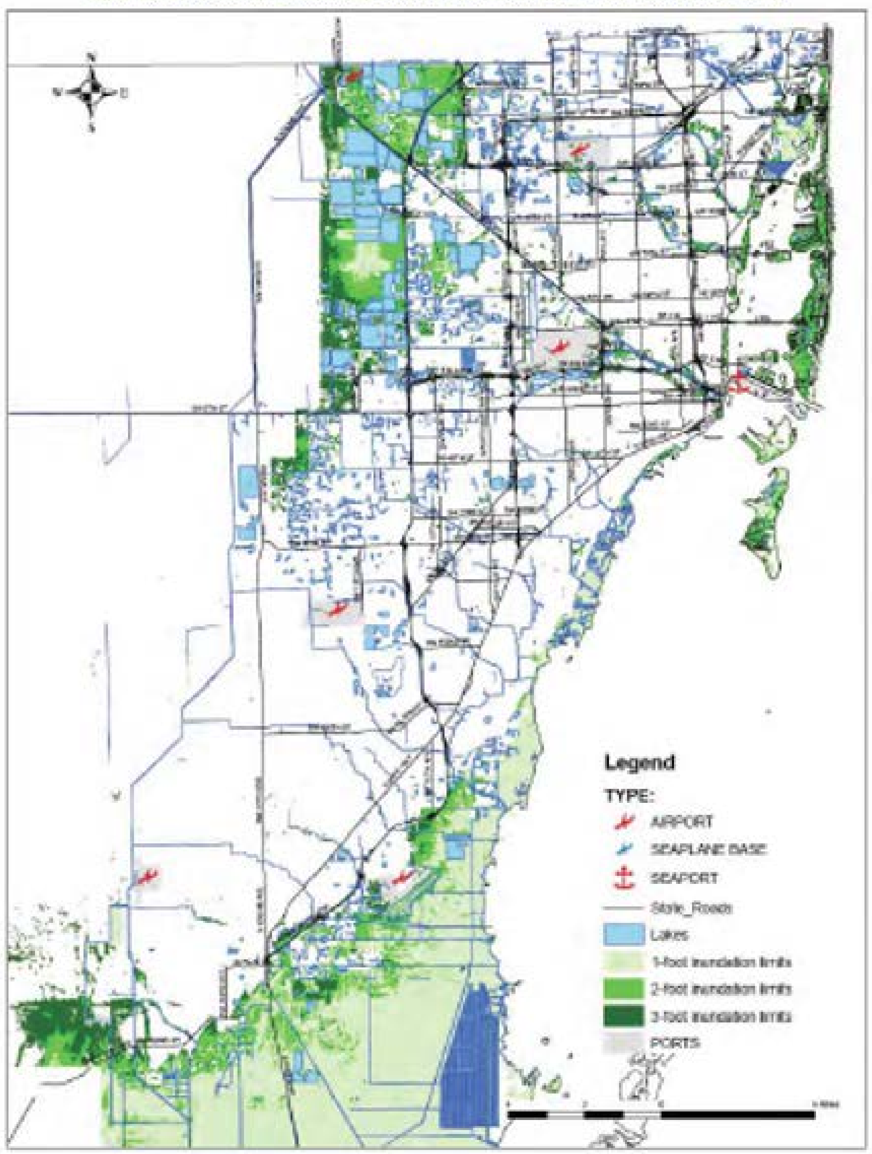
Analysis of Physical Features

Ports and Airports

One area determined by the group to be critical is Homestead Air Reserve Base. The County has already met with planners developing the long-term use of the base and provided input on sea level rise. Opa-Locka West is vulnerable, but this airport is only a landing strip used for training and so is not considered critical. Below are tables that represent the area that may be below mean high-high water sea level with a 1-, 2-, or 3-feet sea level rise.

MAP 6A-46 SEAPORTS AND AIRPORTS VULNERABILITY TO SEA LEVEL RISE



Source: Miami-Dade County Local Mitigation Strategy/Southeast Florida Regional Climate Change Compact

1-Foot Sea Level Rise

Facility Name	More Likely	Possible	Total Inundation	Total Area of Facility (Acres)	Percent Inundation
Homestead General Aviation	0	4.92	4.92	770.71	0.6%
Kendall-Tamiami	22.86	2.37	25.23	1,428.48	1.8%
Miami International	36.01	2.38	38.39	2,731.06	1.4%
Opa Locka Executive	16.87	4.71	21.58	1,640.89	1.3%
Opa Locka West	12.08	1.46	13.54	412.03	3.3%
Port of Miami (Seaport)	0.61	0.16	0.77	534.5	0.1%
Port of Miami (River Port)	2.32	1.26	3.58	136.23	2.6%
USA Homestead Air Base	195.43	80.4	275.83	1,970.96	14.0%

2-Feet Sea Level Rise

Facility Name	More Likely	Possible	Total Inundation	Total Area of Facility (Acres)	Percent Inundation
Homestead General Aviation	5.6	0.66	6.25	770.71	0.8%
Kendall-Tamiami	26.87	1.6	28.47	1,428.48	2.0%
Miami International	42.34	5.63	47.97	2,731.06	1.8%
Opa Locka Executive	30.58	15.93	46.51	1,640.89	2.8%
Opa Locka West	24.2	68.55	92.75	412.03	22.5%
Port of Miami (Seaport)	0.89	0.22	1.11	534.5	0.2%
Port of Miami (River Port)	4.63	3.61	8.24	136.23	6.0%
USA Homestead Air Base	327.73	119.27	447	1,970.96	22.7%

3-Feet Sea Level Rise

Facility Name	More Likely	Possible	Total Inundation	Total Area of Facility (Acres)	Percent Inundation
Homestead General Aviation	6.58	0.83	7.41	770.71	1.0%
Kendall-Tamiami	31.01	2.82	33.83	1,428.48	2.4%
Miami International	57.47	24.24	81.71	2,731.06	3.0%
Opa Locka Executive	65.51	76.22	141.73	1,640.89	8.6%
Opa Locka West	212.09	96.59	308.68	412.03	74.9%
Port of Miami (Seaport)	1.63	0.5	2.13	534.5	0.4%
Port of Miami (River Port)	14.73	11.47	26.2	136.23	19.2%
USA Homestead Air Base	573.64	202.52	776.16	1,970.96	39.4%

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Power Plants

Miami-Dade County has one nuclear power and one coal generation power plant. The generation facilities are not directly impacted. This data below includes impact to the Turkey Point Nuclear Power Plant cooling canals, the coastal wetlands at the Cutler Plant, and some scattered power transfer stations throughout western Miami-Dade County.

Power Plant	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Area of Facility (Acres)	Percent Inundation
1-foot Sea Level Rise	4,812	247	5,059	7,228.77	70%
2-foot Sea Level Rise	5,259	233	5,492	7,228.77	76%
3-foot Sea Level Rise	5,707	233	5,940	7,228.77	82%

Railroads

Railroads did not seem to be particularly affected, perhaps because most of the rail beds in Miami-Dade County are elevated above the road and surrounding surfaces. The impact reported is limited to FEC Railroad in the northeast coast of Miami-Dade County and to the portion of the CSX railroad serving the rock mine lakes along NW 12 ST in the western portion of the County. This data is reported in miles.

FEC and CSX Railroads	More Likely (miles)	Possible (miles)	Total Inundation (miles)	Total Length of Rail (miles)	Percent Inundation
1-foot Sea Level Rise	0.71	0.09	0.8	320.9	0.1%
2-foot Sea Level Rise	0.91	0.23	1	320.9	0.4%
3-foot Sea Level Rise	1.65	0.79	2	320.9	0.7%

Water and Wastewater Treatment Plants

Miami-Dade has three major water and three major wastewater treatment plants within the County boundary. The analysis was performed by land use category as provided by the Department of Planning and Zoning. The results, therefore, do not include the names of the facilities, only the area possibly or more likely affected by the inundation scenario. Since this original analysis was completed Miami-Dade County Water and Sewer Department has invested significantly in understanding the vulnerability of their assets and investing in protecting them from future flooding.

Water Treatment Plants	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Area within Land Use Category (acres)	Percent Inundation
1-foot Sea Level Rise	0.38	0.16	0.54	210.37	0.26%
2-foot Sea Level Rise	0.85	0.64	1.49	210.37	0.71%
3-foot Sea Level Rise	2.58	1.6	4.18	210.37	1.99%

Wastewater Treatment Plants	More Likely (acres)	Possible (acres)	Total Inundation (acres)	Total Area within Land Use Category (acres)	Percent Inundation
1-foot Sea Level Rise	11.1	5.32	16.42	460.14	3.57%
2-foot Sea Level Rise	19.91	6.15	26.06	460.14	5.66%
3-foot Sea Level Rise	36.47	8.33	44.8	460.14	9.58%

Landfills

Inundation for all levels of sea level rise were primarily in areas surrounding landfills. The South Dade Landfill, Munisport, and Dade Recycling are surrounded by low-lying areas. Below ground components such as leachate collection systems will also be impacted by sea level rise.

South Dade Landfill, Munisport, & Dade Recycling	More Likely (acres)	Possible (acres)	Total Inundation (acres)
1-foot Sea Level Rise	154	80	234
2-foot Sea Level Rise	266	33	299
3-foot Sea Level Rise	333	30	363

Hospitals

No hospitals in Unincorporated Miami-Dade County were projected to be permanently inundated by 3 feet of sea level rise. Of the 34 total hospitals within the county boundaries, only three hospitals were affected in municipalities in the 3-foot sea level rise scenario.

- Selected Specialty Hospital, 955 NW 3rd ST, City of Miami, 33128
- Mount Sinai Medical Center, 4300 Alton Road, City of Miami Beach, 33140
- South Beach Community Hospital, 630 Alton Road, City of Miami Beach, 33139

Schools

No schools in Unincorporated Miami-Dade County were projected to be permanently inundated by sea level rise of 3 feet. Only three of the 867 schools were affected in municipalities in the 3-foot sea level rise scenario. However, more specific survey information on all affected schools, such as elevation certificates and topographic survey is needed to determine if those would be impacted.

- Student Services & Attendance, 489 East Drive, Miami Springs 33166
- School Board Administrative – Annex, 1500 Biscayne Boulevard, Miami 33132
- Biscayne Elementary, 800 77th Street, Miami Beach 33141

Emergency Evacuation Centers

None of the 69 emergency evacuation centers in Miami-Dade County were impacted.[31] However, more specific survey information and finished floor elevation certificates on all shelters are needed to determine actual impacts.

[31] 2020 Florida Emergency Shelter Plan

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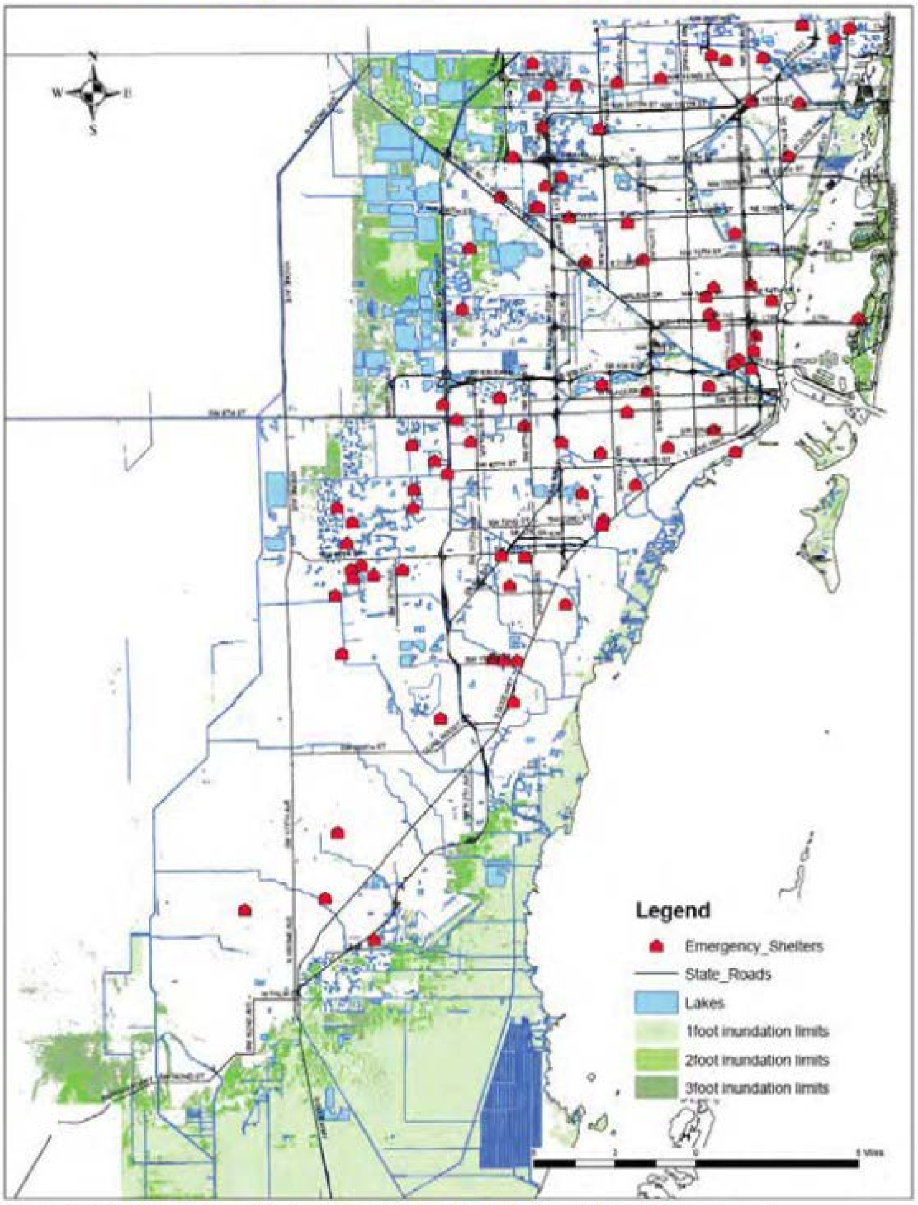
MAP 6A-47 VULNERABILITY OF EMERGENCY SHELTERS TO SEA LEVEL RISE

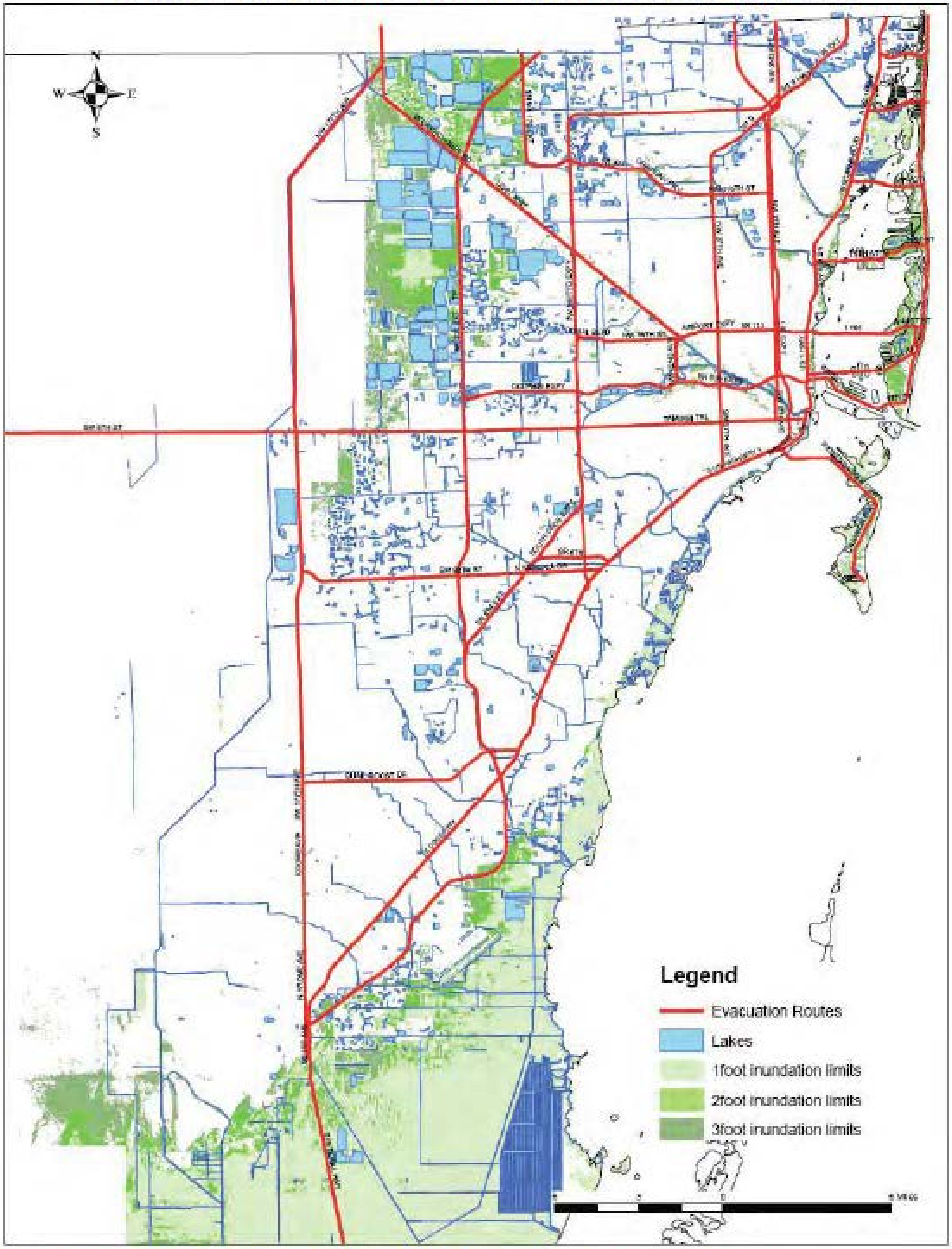


Source: Miami-*Dade County Local* Mitigation Strategy/*Southeast Florida Regional Climate Change Compact*

Evacuation Routes

Miami-Dade County determined there are at most four miles of evacuation routes that would be permanently inundated by a three-foot rise in sea levels. These routes are designed to provide service in a 100-year storm. US1 Overseas Highway to the Florida Keys and the Rickenbacker Causeway to Key Biscayne have been improved. The concern for the evacuation routes is flooding of the local access roads leading to them.

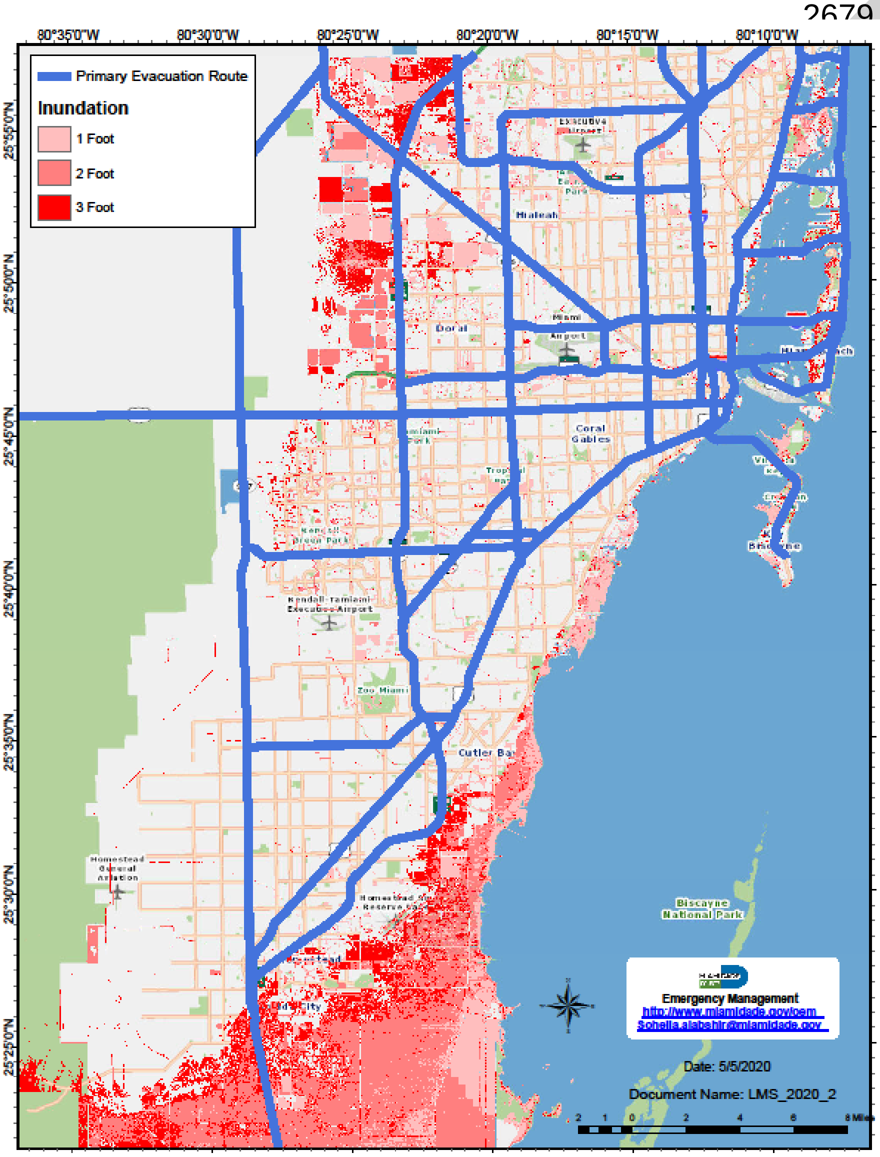
MAP 6A-48 VULNERABILITY OF EVACUATION ROUTES TO SEA LEVEL RISE



Source: Miami-Dade County Local Mitigation Strategy/Southeast Florida Regional Climate Change Compact

Marinas

Marine facilities were analyzed using land use category maps provided by the Department of Planning and Zoning. Marine complexes and marine commercial land uses were combined. All marina facilities are located on or next to water features, east of all salinity control structures to give easy access to the ocean. The assumption is that all will be affected in some way, although the extent is only estimated by this current analysis. It is assumed that those docks with fixed infrastructure will be inundated while floating docks will rise with sea levels.



Marine Facilities	Total Inundation (acres)
1-foot Sea Level Rise	31
2-foot Sea Level Rise	75
3-foot Sea Level Rise	150

Results of Analysis

Geographic analysis was done based on the following criteria:

- Miles of road by Florida Department of Transportation category
- Future Land Use
- Habitat/Land Use Land Cover

Taxable Value of Property

Miami-Dade County has chosen not to estimate the taxable value of potentially impacted property until such time as the mapping and analytical methods are more robust. Miami-Dade, through the Stormwater Master Planning Process, has determined that the current assessment tools probably underestimate potential impacts.

Roads by FDOT Category

Roadways are summarized by Functional Class in miles. High volume categories include sections of roadway where bridges were removed from the LiDAR data and represented bare earth rather than the actual roadways.

1-Foot Sea Level Rise – Assumption: 50% Percent Inundation = Whole Segment Affected

Functional Class	Total Inundation (Miles)	Total Coverage (% impacted)
1 – high volume, maximum speed	3	0.08%
2 – high speed, channels traffic to FC1	4	
3 – high speed, lower mobility, connects to FC2	3	
4 – moderate speed, through neighborhoods	62	
5 – low volume, i.e. access roads, parking lanes	Not assessed	
Total	72	

2-Foot Sea Level Rise – Assumption: 50% Percent Inundation = Whole Segment Affected

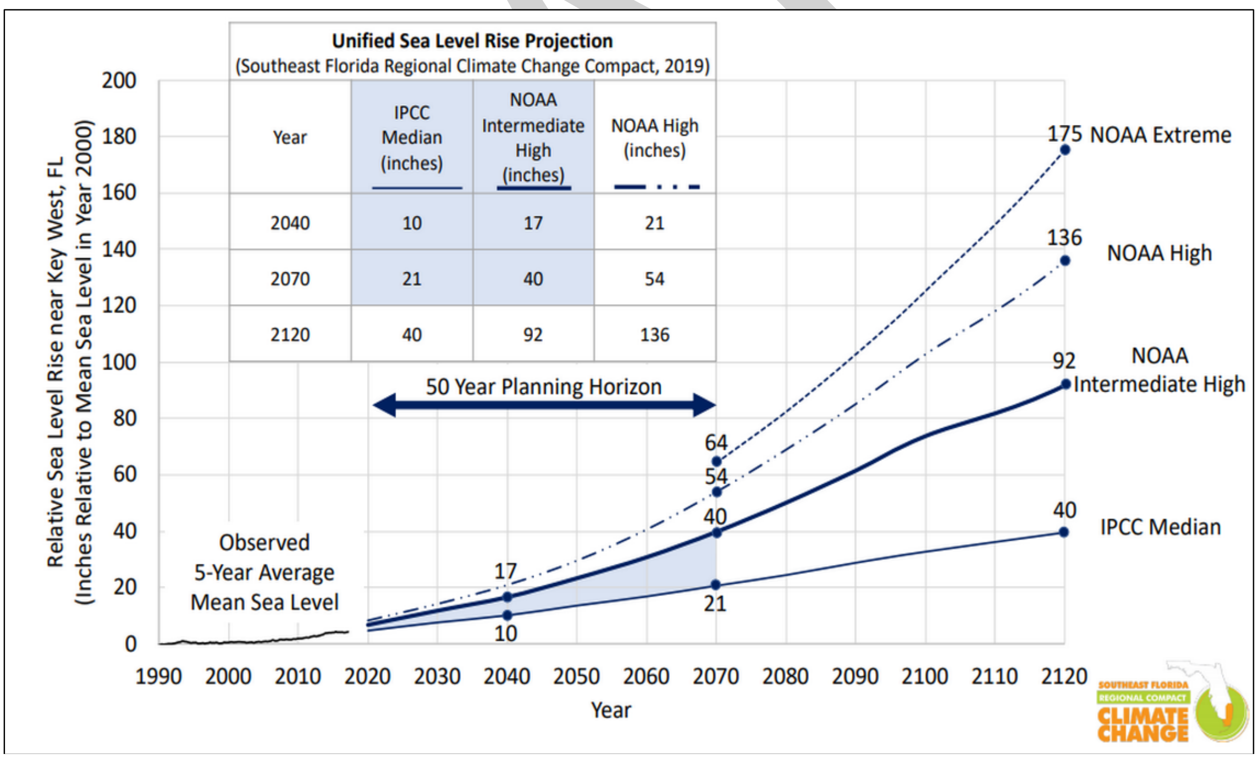
Functional Class	Total Inundation (Miles)	Total Coverage (% impacted)
1 – high volume, maximum speed	6	3%
2 – high speed, channels traffic to FC1	11	
3 – high speed, lower mobility, connects to FC2	8	
4 – moderate speed, through neighborhoods	232	
5 – low volume, i.e. access roads, parking lanes	Not assessed	
Total	257	

3- Foot Sea Level Rise – Assumption: 50% Percent Inundation = Whole Segment Affected

Functional Class	Total Inundation (Miles)	Total Coverage (% segments impacted)
1 – high volume, maximum speed	12.18	6%
2 – high speed, channels traffic to FC1	26.33	
3 – high speed, lower mobility, connects to FC2	21.22	
4 – moderate speed, through neighborhoods	496.21	
5 – low volume, i.e. access roads, parking lanes	Not assessed	
Total	**555.94**	

Frequency/Probability

According to the World Resources Institute, the sea level in South Florida has increased by 12 inches since 1870. Miami-Dade County continues to experience sea level rise, see projection below from the Southeast Florida Regional Climate Change Compact 2019.



Severe Storm

<u>Description</u>

Severe storms often combine several meteorological events, including lightning, hail, tornadoes, and flooding. Each of these are covered in their own hazard profile. This profile will focus on what qualifies as a thunderstorm and heavy rain.

A thunderstorm is a meteorological event generated by atmospheric imbalance and turbulence caused by unstable warm air that rises rapidly, heavy moisture, and upward lift of air currents that can bring a combination of heavy rains, strong winds, hail, thunder, lightning, and tornadoes.

The National Weather Service classifies a severe storm as a thunderstorm that can produce 1 inch or larger hail, wind gusts greater than 58 mph and/or a tornado. Although lightning and/or excessive rainfall may occur during a severe thunderstorm and have severe consequences, these are not considered primary elements of a severe thunderstorm. Severe thunderstorms, flood threats and lightning are handled through difference sets of warnings and watches by the National Weather Service.

Types of thunderstorms:

- Single-cell storm: Grow and die within an hour; brief heavy rain and lightning
- Multi-cell storm: Individual cells last 30-60 minutes, but the entire storm may last for hours; may produce hail, strong winds, brief tornadoes, and flooding
- Squall Line: Group of storms in a line that passes quickly, with high winds and heavy rain
- Supercell: Highly organized storm that lasts for more than an hour; produces the most violent tornadoes
- Bow Echo: Squall line that bows outward
- Mesoscale Convective System (MCS): Collection of thunderstorms that act as a system, can last more than 12 hours
- Mesoscale Convective Complex: Long lived cluster of showers and thunderstorms
- Mesoscale Convective Vortex: MCS with low pressure center that pulls winds into vortex pattern
- Derecho: Long lived windstorm with rapidly moving band of showers or thunderstorms; can produce as much damage as a tornado, but the damage is all in one direction (straight line wind damage)

There are an average of 72 thunderstorm days in the Miami-Dade County area, according to the monitor at the Miami International Airport. Thunderstorms are most frequent

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during July and August when afternoon storms are a near daily experience. Severe thunderstorms and lightning strikes are traditionally responsible for the most frequent damage in Miami-Dade County. Windstorm damage resulting from downbursts and squall lines frequently knock down trees and power lines.

Location

The entire county is vulnerable to severe storms.

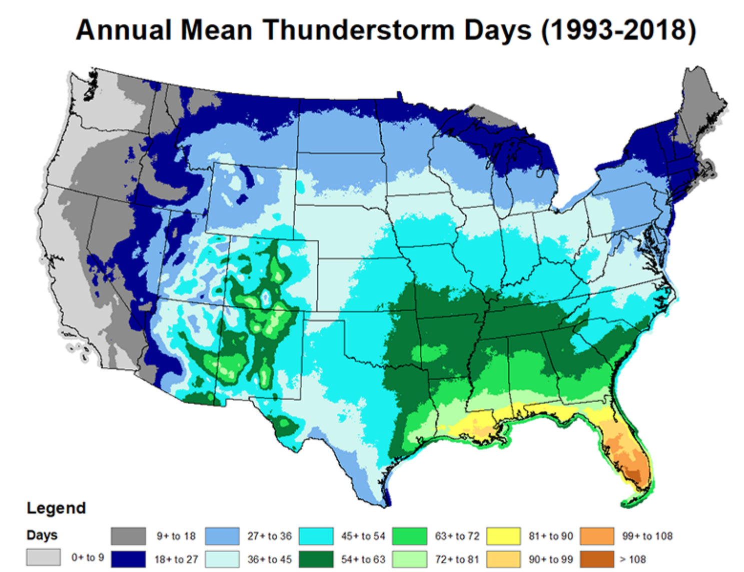
Extent

Winds of up to 100 mph, F3 tornado and 4-inch hail during a severe storm. The most expensive severe storm to take place in Miami-Dade County occurred in 1995 and left $5 million in damages. Only 1 person has been killed and 4 injured in heavy rain and thunderstorm wind events, according to the National Climatic Data Center (NCDC).

Thunderstorms are most likely during the spring and summer months, in the afternoon and evening, however they can occur year-round and at all hours. Winter thunderstorms are rare, but they do occur when conditions are right.

Most thunderstorms last around an hour, but some can last for several hours. The duration depends on the type of storm, as described above.

There are over 16 million thunderstorms worldwide each year. At any given time, there are about 2,000 thunderstorms happening around the world. There are about 10,000 severe thunderstorms each year in the U.S. Many thunderstorm aspects, including flooding, lightning and hail, are very dangerous, and are described further in their respective hazard profiles.



Annual number of thunderstorm days in the U.S. From: Koehler, Thomas L., 2019: Cloud-to-Ground Lightning Flash Density and Thunderstorm Day Distributions over the Contiguous United States Derived from NLDN Measurements: 1993-2018. Under review at Monthly Weather Review. Used by permission.

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<u>Impact</u>

Impact to Miami-Dade County Residents

A severe storm would affect an entire population within the area most severely, but power outages and street closures have the potential to impact many more. Because severe storms are categorized as having winds more than 58 mph, those most at risk from severe storms include people living in mobile homes, campgrounds, and other dwellings without secure foundations or basements. The disabled population are also considered to be most vulnerable because of the lack of mobility to escape the impacted area. Additionally, those residents who are electric dependent are vulnerable as severe storms tend to cause power outages.

Consequences related to the public following a severe storm may include:

- Increased need for medical care, causing a potential surge at local hospitals.
- Temporary/permanent loss of residence, causing an increased need for shelter, short-term or long-term housing.
- Temporary/permanent loss of transportation, causing a need for replacement or alternative forms of transportation.
- Temporary/permanent loss of employment/business income, causing an increased need for loans.
- Temporary loss of services/utilities, requiring alternate means to address immediate needs.

Impact to Essential Facilities and Other Property

All essential facilities and buildings are vulnerable to severe storms. An essential facility will encounter many of the same impacts as any other building within the jurisdiction. These impacts will vary based on the magnitude of the severe storm, but can include structural failure, damaging debris (trees or limbs), roofs blown off, windows broken by debris, hail, high winds, and loss of facility functionality (e.g., a damaged police station will no longer be able to serve the community).

Consequences related to essential facilities and property following a severe storm may include:

- Loss of building function (e.g., damaged homes will no longer be habitable, causing residents to seek shelter).
- Business/service interruption, causing an impact to the local economy as well as individual households.

Impact to Critical Infrastructure

During a severe storm, the entire built environment is vulnerable due to wind or rain damage. As mentioned earlier, structures that were built prior to any 1957, before any building codes related to flooding were implemented in Miami-Dade may be at higher risk and buildings built from 1958 to1972 that are considered pre-FIRM may also be at higher risk.

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Consequences related to critical infrastructure following a severe storm may include:
- Disruption in the transportation of goods
- Disruption in the public transportation

Impact to Environment
Agricultural areas are vulnerable to heavy rains which may flood the farmlands. Flooding of farmlands may lead to a decrease in crop yielding. Severe storms can also cause water contamination, impacting local flora and fauna. If a high wind hits power lines or causes gas leaks, fires or contamination can also result.

Consequences related to the environment following a severe storm may include:
- Trees and plants can be uprooted and diseases in the soil can spread, impacting wildlife and their habitat.
- Crop yielding may substantially decrease dependent on the severity of flooding.

Previous Occurrences

August 24, 2020 – A low pressure system moving across the tropical Atlantic into the Bahamas formed into Tropical Storm Laura near Puerto Rico and Hispaniola. As Laura continued across the northern Caribbean Sea, making landfall along southern Cuba, the outer rain bands extended across the South Florida bringing minor impacts. Tropical Storm force wind gusts reached across Miami-Dade, a few strong enough to become severe gusts.

April 30, 2020 – A line of thunderstorms developed over loop current in the Gulf of Mexico ahead of an approaching cold front. As the line progressed eastward, strong daytime heating allowed for an Atlantic Sea breeze to develop across, which resulted in several rounds of thunderstorms that produced damaging wind gusts and hail across South Florida.

May 6, 2019 – Thunderstorms caused damage across Miami-Dade County that resulted in downed trees, power poles, fences and street signs. A tractor trailer was also overturned on the Florida Turnpike.

January 23, 2017 – A strong squall line ahead of a cold front produced a tornado near the Palmetto Expressway and NW 48th Street at 3:45am. The tornado continued a northeast track and moved over Miami Springs and the City of Hialeah producing between EF-0 and EF-1 damage. Damage consisted of an overturned tractor trailer, about 24 empty cargo containers were moved, downed trees and power lines, and damage on roofs. No injuries or fatalities were reported, but 13 families were displaced in Hialeah and required assistance by the American Red Cross.

July 18, 2016 – This thunderstorm produced gusty winds which resulted in property damage in Cutler Bay. This damage, estimated at $5,000 occurred in the vicinity of SW 200th Street between Old Cutler Road and Cutler Ridge Park.

June 18, 2016 – A severe thunderstorm over Miami-Dade County led to wind damage. Power lines, trees, fences, and store signs were knocked down in Westchester. There was also damage in Downtown Miami to furniture being blown off high rise balconies into the streets due to the high winds.

February 16, 2016 – On February 15th, a strong squall line developed ahead of a cold front over the Gulf of Mexico and as it moved over the warm waters, it intensified. An unstable environment and strong low level rotation was in place over South Florida ahead of the line. In the overnight hours of February 16th, another squall line developed ahead of the first line. Both of these lines merged over southeast Florida before daybreak. As the squall line moved across Florida, it produced a number of severe thunderstorms throughout. A total of 6 tornadoes were confirmed across southern Florida, including an EF-0 in Northeast Miami-Dade. No injuries or fatalities were reported.

June 29, 2015 – Afternoon showers and thunderstorms caused sporadic tree damage in an area from Doral to Florida International University campus, then east to Fontainebleau. A total of 12,940 customers reported power outages in Miami-Dade County.

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Vulnerability

Since severe storms can occur within any area in the county, the entire county population and all buildings are vulnerable to severe storms.

Severe Storms			
Category		**Vulnerability***	**Risk***
Social (People, etc.)	Special Populations	Somewhat Vulnerable	Medium
	Cultural Conditions	Minimally Vulnerable	Low
	Socioeconomic Conditions	Minimally Vulnerable	Low
Physical (Property, etc.)	Critical Infrastructure	Somewhat Vulnerable	Medium
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Somewhat Vulnerable	Medium
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Minimally Vulnerable	Low
	Social Conditions	Minimally Vulnerable	Low
	Environmental Conditions	Minimally Vulnerable	Low
	Governmental Conditions (inc. Operations)	Minimally Vulnerable	Low
	Insurance Conditions	Minimally Vulnerable	Low
	Community Organizations	Minimally Vulnerable	Low

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

Physical Vulnerabilities

The entire built environment (Critical Infrastructure, Key Resources, and Building Stock) may be vulnerable to severe storms due to wind or hail damages. These types of events could cause power outages or some structural damages to mobile/manufactured homes (see Hurricanes/Tropical Storms for a listing), communications towers, or damage trees and overhead utilities. Underground utilities could be impacted if trees topple and uproot these systems. Severe weather may also cause flying debris to cause additional damage. Structures in areas where there have been repetitive losses and no mitigation may also be at higher risk but past flooding events do not necessarily indicate future flooding problems. Areas with ongoing construction or drainage problems may also be at greater risk. Parks and open spaces where people congregate outside are vulnerable to severe weather that may roll in with little notice, this includes coastal beaches, Crandon Park, all County and State parks, large venues such as the Homestead-Miami Speedway, Hard Rock Stadium, and Marlins Park.

Social Vulnerabilities

People who live in areas prone to flooding and may be uninsured or underinsured are at greatest risk. The cost of insurance may be prohibitive and people who live outside of a flood zone may believe they are not at risk. People who rent properties may not be aware of their flood risk as they may not be disclosed by the owner or they may not know the

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history of the area. Electric dependent and people living in mobile/manufactured homes may be at greater risk when it occurs in their areas.

Frequency/Probability

There have been 50 recorded severe storm (heavy rain and thunderstorm wind) events in Miami-Dade County from January 2015 to December 2020, averaging out to approximately ten per year. 41 thunderstorm wind events, and 9 heavy rain events in the past five years. According to the monitor at the Miami International Airport, there is an average of 72 thunderstorm days in the Miami-Dade County area.

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Tornado

<u>Description</u>

Tornadoes are one of nature's most violent storms. A tornado is a violently rotating column of air extending from a thunderstorm to the ground. The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 mph or more. Damage paths can be more than one mile wide and 50 miles long. Most tornadoes, however, have wind speeds of 112 mph or less.

Tornadoes occur as part of strong thunderstorms that develop in unstable atmospheric conditions. The strongest tornadoes form with supercells, rotating thunderstorms with a well-defined radar circulation called a mesocyclone. One in three supercells experience a decent of clouds or funnel cloud. These thunderstorms can also produce damaging hail and severe straight-line winds even without a tornado occurrence.

Tornadoes develop under three scenarios: (1) along a squall line ahead of an advancing cold front moving from the north; (2) in connection with thunderstorm squall lines during hot, humid weather; and (3) in the outer portion of a tropical cyclone. Because the temperature contrast between air masses is generally less pronounced in the state, tornadoes are typically less severe in Florida than in other parts of the country.

Florida tornadoes occur in the greatest number during June, July and August. These are typically small, short-lived events that can produce minor damage and seldom take lives. Florida's most deadly tornado outbreaks occur in the spring. Most of the nation's large killer tornadoes tend to occur in the late afternoon and early evening hours, due to the afternoon buildup of heat in the lower atmosphere that lingers into the early nighttime hours. However, Florida is different. Tornado climatology shows that strong to violent tornadoes are just as likely to occur after midnight as they are in the afternoon. This unique feature makes these tornadoes more dangerous, because most people are asleep after midnight and do not receive warnings relayed by commercial radio or television.

Waterspouts, tornadoes that occur over bodies of water, are common along the southeast U.S. coast, especially off Southern Florida and the Keys. They are smaller and weaker than the most intense tornadoes, but still can be quite dangerous. Waterspouts can overturn small boats, damage ships, create significant damage when hitting land, and kill people.

The impact of a tornado is relative to its intensity and location. Even a weak tornado can cause significant damage if it strikes a densely developed area. Comparing Florida to other states that are affected by tornadoes is only a point of reference as it only takes one large tornado or a series of smaller tornadoes to truly devastate a community. The East Central Florida Tornado Outbreak of 22-23 February 1998 clearly demonstrates this fact. In under four hours it caused: almost half the fatalities, 42; close to one-tenth the injuries,

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260; and almost one-fifth the cost (approximately $100 million) as the preceding statewide totals for tornado damage over a thirty-five-year period.

<u>Location</u>

The entire county is equally vulnerable to tornadoes.

<u>Extent</u>

The strongest tornado to affect Miami-Dade County was an EF3 in 1959. Florida has two tornado seasons: summer and spring. The summer tornado season runs from June until September and has the highest frequencies of storm generation, with usual intensities of EF0 or EF1 on the Enhanced Fujita Scale. This includes those tornadoes associated with land-falling tropical cyclones. These tend to be more common and usually the least destructive.

The spring season, from February through April, is characterized by more powerful tornadoes because of the presence of the jet stream. When the jet stream digs south into Florida and is accompanied by a strong cold front and a strong squall line of thunderstorms, the jet stream's high-level winds of 100 to 200 mph often strengthen a thunderstorm into what meteorologists call a “supercell” or “mesocyclone.” These powerful storms can move at speeds of 30 to 50 mph, sometimes occur in groups of six or more, and produce dangerous downburst winds, large hail, and usually the deadliest tornadoes. They generally move in an easterly direction.

Strong to violent tornadoes in Florida are just as likely to occur after midnight as they are during the afternoon. This unique feature makes Florida tornadoes very dangerous because most people are asleep and do not receive adequate weather warnings.

Most tornadoes last less than 10 minutes, however on rare occasions, they can last long enough to affect areas in multiple states (the longest tornado in history was likely an EF5 in 1925, which lasted for 3.5 hours and traveled 219 miles). They often form with little warning; recent reports show there is an average warning time of 13 minutes before tornadoes hit.

Most tornadoes are below the EF-3 scale.

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TABLE 6A-73 TORNADO STRENGTH

Tornado Strength	% of Tornadoes	% of Deaths	Lifetime	Winds
Weak (EF-0 or EF-1)	69%	3%	5-10 minutes	< 110 mph
Strong (EF-2 or EF-3)	29%	27%	20 minutes +	110-205 mph
Violent (EF-4 or EF-5)	2%	70%	can exceed 1 hour	> 205 mph

Source: National Oceanic and Atmospheric Administration, Tornado Classifications, Louisville, KY Forecast Office

Enhanced Fujita (EF) Scale

On February 1, 2007, the National Weather Service adopted the “Enhanced Fujita (EF) Scale”. The EF Scale evaluates and categorizes tornado events by intensity. Both the original Fujita Scale and the EF Scale estimate the intensity of a tornado (3-second gust speed) based on the magnitude of damage. The original scale had a lack of damage indicators and with the increasing standards for buildings, rating of tornadoes was becoming inconsistent. The EF Scale evaluates tornado damage with a set of 28 indicators (see NOAA website). Each indicator is a structure with a typical damage description for each magnitude of a tornado.

TABLE 6A-74 FUJITA VS. ENHANCED FUJITA SCALE

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-206	162-209	3	138-167	3	136-165
4	207-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Source: National Oceanic and Atmospheric Administration

<u>Impact</u>

Impact to Miami-Dade County Residents

A tornado would affect the entire population in the tornado's path most severely, but power outages and street closures have the potential to impact many more. Those most at risk from tornadoes include people living in mobile homes, campgrounds, and other dwellings without secure foundations or basements. People in automobiles are also very vulnerable to tornadoes. The elderly, very young, and the physically and mentally handicapped are most vulnerable because of the lack of mobility to escape the path of destruction. Currently, approximately 5.8% and 2.4% of Miami-Dade County residents are under 5 or over 85 years of age, respectively . People who may not understand watches and warnings due to language barriers are also at risk. Approximately 76% of Miami-Dade County residents 5 and over speak a language at home other than English, although basic familiarity with English is likely. Additionally, emergency notifications are translated into Spanish and Haitian Creole. As of 2020, approximately 3,472 people resided in an emergency shelter or were found to be sleeping in places not meant for human habitation, such as on the streets, under a bridge or in a car.

Consequences related to the public following a tornado may include:

- Increased need for medical care, causing a potential surge at local hospitals.
- Temporary/permanent loss of residence, causing an increased need for shelter, short-term or long-term housing.

- Temporary/permanent loss of transportation, causing a need for replacement or alternative forms of transportation.
- Temporary/permanent loss of employment/business income, causing an increased need for loans.
- Temporary loss of services/utilities, requiring alternate means to address immediate needs.

Impact to Essential Facilities and Other Property

All essential facilities and buildings are vulnerable to tornadoes. An essential facility will encounter many of the same impacts as any other building within the jurisdiction. These impacts will vary based on the magnitude of the tornado, but can include structural failure, damaging debris (trees or limbs), roofs blown off, windows broken by debris, hail, high winds, and loss of facility functionality (e.g., a damaged police station will no longer be able to serve the community).

Consequences related to essential facilities and property following a tornado may include:

- Loss of building function (e.g., damaged homes will no longer be habitable, causing residents to seek shelter).
- Business/service interruption, causing an impact to the local economy as well as individual households.

Impact to Critical Infrastructure

During a tornado, the types of infrastructure that could be impacted include roadways, utility lines/pipes, railroads, and bridges. Because the county's entire infrastructure is equally vulnerable, it is important to emphasize that any number of these structures could become damaged during a tornado. The impacts to these structures include broken, failed, or impassable roadways, broken or failed utility lines (e.g., loss of power or gas to community), and railway failure from broken or impassable railways. Bridges could fail or become impassable, causing risk to traffic.

Consequences related to critical infrastructure following a tornado may include:

- Disruption in the transportation of goods
- Disruption in the public transportation
- Shortage of fuel or other essential materials

Impact to Environment

Tornado and high wind events can destroy trees, building, and other important infrastructure. Tornados have been known to kill animals, damage farmland, and disrupt the food chain. Tornados can also cause water contamination, impacting local flora and fauna, not to mention humans. If a high wind or tornado hits power lines or causes gas leaks, fires or contamination can also result.

Consequences related to the environment following a tornado may include:

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- Trees and plants can be uprooted and diseases in the soil are spread, impacting wildlife and their habitat.

Previous Occurrences

August 19, 2020 – A robust, stationary trough over the Gulf of Mexico kept deep south/southwest flow and rich tropical moisture over South Florida. Several short waves rotating around the base of the trough enhanced the showers and thunderstorms that produced a tornado over the Golden Beach area in Miami-Dade from a waterspout and flooding from heavy rainfall. Damage consisted primarily of numerous broken/snapped tree branches, including to a large Sea Grape tree, a couple of newly planted trees toppled, several damaged/twisted metal gates, and tossed lawn/patio furniture. Some of the debris ended up in the adjacent Atlantic Ocean. Most of the damage was confined to ocean-facing homes and properties. One home had water blown in through a set of sliding glass doors due to the force of the wind. This damage is mainly consistent with EF-0 intensity, although one or two spots could have experienced winds close to the EF-1 threshold.

January 27, 2019 – Tornado likely began on W 20th Avenue and W 76th Street just east of the Palmetto Expressway, tracking ENE over the Palm Lakes neighborhood of Hialeah. Heaviest damage began a block to the east at the intersection of W 18th Lane and W 76th Street, where two vehicles were overturned. The heavy damage continued at homes in the 1800 block of W 76th Street, where minor roof damage was noted, along with many broken large tree branches, a couple of uprooted trees, awning, and patio damage. The tornado then tracked over a small lake, then over a home at W 16th Court and W 77th Street where a small patio roof was blown across the street. The damage pattern became quite discontinuous and spread-out to the east of W 16th Court, suggesting that the tornadic circulation had lifted. Estimated wind speeds with the section of the tornado from W 18th Lane to W 16th Court is 75-85 mph, in the upper end of the EF-0 range.

January 23, 2017 – During the overnight and pre-dawn hours of January 23rd, a powerful squall line well ahead of a cold front over the Gulf of Mexico moved over South Florida. The line of storms resulted in a tornado touching down several times. The tornado first touchdown was near the Palmetto Expressway and NW 48th Street at 3:45 am. It then touched back down on the east side of the Palmetto Expressway, from NW 50th Street to NW 52nd Street between NW 74th and 69th Avenue. The damage in this area included an overturn tractor trailer, about 24 empty cargo containers were moved and an office building sustained minor roof damage. These were EF-0 borderline EF-1 damages (75-85 mph winds). The tornado continued a northeast track and moved into the Miami Springs area with winds most likely in the EF-1 range (90-95 mph). Loss of roof covering material and downed trees was reported in the “Bird District” between Shadow and Ludlum Avenue and Falcon and Dove Avenue. As it continued its track through Miami Springs, more damage was recorded east of Hammond Drive to Okeechobee Road where downed power lines and trees were reported. Once it crossed Okeechobee Road and entered into the City of Hialeah it caused EF-1 damage from Red Road to W 2nd Avenue between West 10th and 13th Streets. In this area, four apartment buildings sustained roof damage and although the tornado passed very close to a water plant, it did not sustain any damage. The tornado lifted near W 2nd Avenue and W 13th street. 13 families were displaced in Hialeah and required assistance by the American Red Cross.

February 16, 2016 – A squall line moving through Florida produced an EF-0 tornado in NE Miami-Dade. The tornado had an intermittent path of about 3.4 miles and affected the areas between NE 191st Street and Ives Dairy Road, from NW 8th Avenue to NE 23rd Avenue. Damage consisted of uprooted trees, several leaning poles and minimal structural damage, including several structures with roof damage. No injuries or fatalities were reported.

June 24, 2012 – Golden Beach Police reported a waterspout moving onshore moving north. The path was approximately 0.5 miles, and it was estimated as an EF-0. Beach chairs were tossed about 30 feet in the air and there was damage to trees and a hut. One residence also had damage to a metal gate and trees. The estimated amount of property damage was $10,000.

August 14, 2008 – A thunderstorm in Hialeah produced an EF1 tornado with the highest estimated wind speeds near 90 mph. The tornado damaged eight structures. The estimated property damage was $150,000.

March 27, 2003 – An F1 to F2 tornado touched down in East Hialeah, reached maximum intensity in the Brownsville area, and then lifted just before entering Biscayne Bay. The F1 to F2 damage began in an industrial area where several warehouse roofs were damaged and several empty semi-tractor trailers were overturned. The tornado then heavily damaged 60 houses in Brownsville. A total of 343 other structures sustained damage, mostly to roofs and windows. Also, several cars were overturned. Total damage estimates were around $8 million. Numerous trees, utility poles, and signs were uprooted or knocked down.

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Vulnerability

Since tornadoes can occur within any area in the county, the entire county population and all buildings are vulnerable to tornadoes.

Tornado			
Category		**Vulnerability***	**Risk***
Social (People, etc.)	Special Populations	Vulnerable	Medium
	Cultural Conditions	Somewhat Vulnerable	Medium
	Socioeconomic Conditions	Somewhat Vulnerable	Medium
Physical (Property, etc.)	Critical Infrastructure	Somewhat Vulnerable	Medium
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Somewhat Vulnerable	Medium
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Vulnerable	Medium
	Social Conditions	Somewhat Vulnerable	Medium
	Environmental Conditions	Somewhat Vulnerable	Medium
	Governmental Conditions (inc. Operations)	Somewhat Vulnerable	Medium
	Insurance Conditions	Somewhat Vulnerable	Medium
	Community Organizations	Somewhat Vulnerable	Medium

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

Physical Vulnerabilities

The entire built environment is vulnerable to tornadoes depending on where it hits (may be directly or indirectly impacted). Mobile and manufactured homes tend to sustain the most damage from a tornado due to their lighter weight building materials. A list of mobile home parks in Miami-Dade is provided in the Hurricane/Tropical Storm section. Unreinforced concrete buildings and wood structures may be more vulnerable to tornado damage. Power lines and trees may be downed or underground utilities may be uprooted when trees topple.

Social Vulnerabilities

People with disabilities such as decreased vision or hearing may not be aware of the tornado warnings. Electrically dependent individuals may rely on life-sustaining medical equipment and may be at greater risk due to power outages.

Frequency/Probability

There have been 129 recorded tornadoes in Miami-Dade County since 1950, averaging out to approximately two per year (though the frequency has been less than that over the past five-year period). In addition to tornado events, 67 funnel clouds and approximately the same number of waterspouts are noted for the same period.

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Wildfire

Description

Wildfire is defined by the Florida Forest Service (FFS) as any fire that does not meet management objectives or is out of control. Wildfires occur in Florida every year and are part of the natural cycle of Florida's fire-adapted ecosystems. Many of these fires are quickly suppressed before they can damage or destroy property, homes and lives.

A wildfire is a naturally occurring event, often ignited by lightning and fueled by grasses, brush, and trees. Wildfires help to control the buildup of woody debris, improve soil conditions, reduce weedy and invasive plants, reduce plant disease, and maintain the habitat conditions thus providing a healthy ecosystem. However, as Florida communities grow and expand, they push into wildfire-prone areas, aggravating the delicate ecosystem and increasing the risk of fires. The wildland-urban interface describes the area of transition between non-human inhabited areas and the built environment. According to FEMA, a wildland-urban interface fire is a wildfire in a geographical area where structures and other human development meet or intermingle with wildland or vegetative fuels. An urban-wildland interface fire is typically ignited by human activities including campfires, uncontrolled burns, smoking, vehicles, trains, equipment use, and arsonists. People start more than four out of every five wildfires, usually through debris burns, arson, or carelessness.

Wildfire behavior is based on three primary factors: fuel, topography, and weather. The type and amount of fuel, as well as its burning qualities and level of moisture affect wildfire potential and behavior. Fuel is the most important factor in determining fire behavior in Florida, due to the large amounts of vegetative growth from the long growing season, ample sunshine, and significant annual rainfall. The amount dry woody debris fuel dramatically increases following a hurricane. Topography affects the movement of air and fire over the ground surface. Slope and terrain can change the rate of speed at which fire travels. Topography is the least important factor in Florida, because of the generally flat layout of the land. Weather affects the probability of wildfire and has a significant effect on its behavior. Temperature, humidity, and wind (both short and long term) affect the severity and duration of wildfires. Weather phenomena such as El Niño and La Niña events further complicate the delicate balance of these three essential components to wildfire. The deluge of rainfall that occurs during El Niño events creates excessive vegetative growth. El Niño is followed by La Niña, which creates drought conditions and excessive heat. As a result, the abundant vegetative growth dies off and provides ample fuel for wildfires.

According to the State of Florida Enhanced Hazard Mitigation Plan, Miami-Dade County is at a medium risk for wildfires and has an estimated annualized loss of $428,000 (residential buildings, commercial buildings, medical buildings, educational buildings, and governmental buildings).

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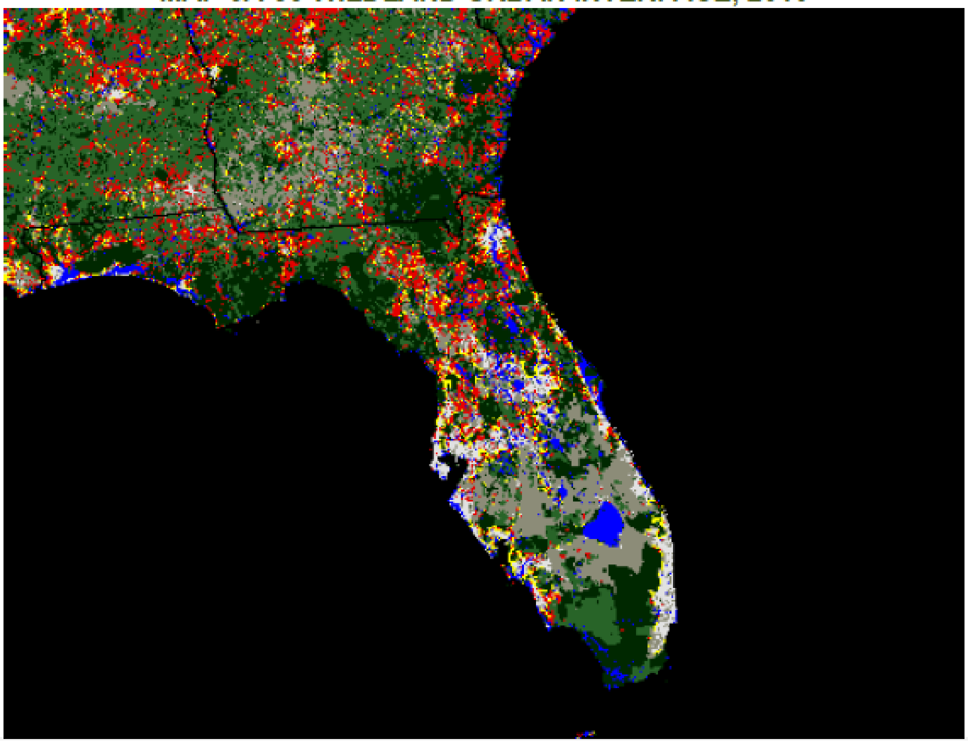
Location

Wildfires are most likely to occur in the western portions of Miami-Dade County. This area includes the Everglades and the Urban Wildland Interface.

MAP 6A-55 WILDLAND URBAN INTERFACE, 2010



WUI	Non-WUI Vegetated	Non-Vegetated or Agriculture
Interface	No Housing	Medium and High Density Housing
Intermix	Very Low Density Housing	Low and Very Low Housing Density
		Water

Source: SILVIS Lab

Extent

The most damaging wildfire in Miami-Dade County according to the National Climatic Data Center caused $100,000 in damages (April, 2000).

Miami-Dade County is most vulnerable to wildfires during the dry season. Wildfires typically occur during periods of high temperature and drought and are often exacerbated by wind. The Fire Weather Outlook issued by NOAA's National Weather Service is a good source to monitor fire forecasts.

Wildfires can last for as long as conditions permit (fuel, heat & oxygen). Wildfires can spread rapidly, traveling up to 14 mph. Factors determining a wildfire's speed of onset include fuel, topography, and weather.

Over 100,000 wildfires burn 4-5 million acres in the United States yearly. Wildfires have become increasingly common in recent years and have burned up to 9 million acres in the most destructive years.

Florida accounts for 5% of the nation's wildfires each year. Since 1998, more than 15,000 Florida wildfires have burned over one million acres destroying over 750 structures. Florida wildfires are an example of the increasing threat of fires from the urban-wildland interface.

Forests that rely on wildfires (including the Everglades) have extremely varied ideal time intervals between fire events. Some low-elevation forests ("dry" forests), thrive on fire intervals of 5-20 years. Surface fires can be low to high intensity. Ground and crown fires are often extremely intense.

Fires in the Everglades tend to happen annually, with rapid wet-season fires, often started by lightning. Dry-season fires are less common but can be more damaging. Additionally, there seems to be a longer 10–14-year cycle that coincides with global climate condition changes.

<u>Impact</u>

Impact to Miami-Dade County Residents

A wildfire would affect an entire population group and/or more vulnerable population based on location/proximity to the incident or other social vulnerability condition(s). Those most at risk from wildfires include people living in mobile homes, campgrounds, and other dwellings without secure foundations or basements. Low-income families could be living in homes or apartments that are vulnerable to wildfires leading to lose of property or death. Children are more vulnerable to smoke inhalation due to their small body size. The disabled and elderly also have more frail bodies than adults. Currently, approximately 5.8% and 2.4% of Miami-Dade County residents are under 5 or over 85 years of age, respectively. People who may not understand watches and warnings due to language barriers are also at risk. Approximately 76% of Miami-Dade County residents 5 and over speak a language at home other than English, although basic familiarity with English is likely. Additionally, emergency notifications are translated into Spanish and Haitian Creole. The actual consequence of such an incident will be dependent upon the location, duration, scale, magnitude and extent of the incident in addition to the vulnerabilities and conditions described above.

Consequences related to the public following a wildfire may include:

- Increased need for medical care, causing a potential surge at local hospitals.

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- Temporary/permanent loss of residence, causing an increased need for shelter, short-term or long-term housing.
- Temporary/permanent loss of employment/business income, causing an increased need for loans.
- Temporary/permanent loss of transportation, causing a need for replacement or alternative forms of transportation.
- Temporary loss of services/utilities, requiring alternate means to address immediate needs.

Impact to Essential Facilities and Other Property

All essential facilities and buildings are vulnerable to wildfire. An essential facility will encounter many of the same impacts as any other building within the jurisdiction. These impacts will vary based on location and duration of the wildfire, but can include structural failure, disrupted communications systems, power outage, and loss of facility functionality (e.g., a damaged police station will no longer be able to serve the community).

Consequences related to critical infrastructure following a wildfire may include:

- Loss of building function (e.g., damaged homes will no longer be habitable, causing residents to seek shelter).
- Business/service interruption, causing an impact to the local economy as well as individual households.

Impact to Critical Infrastructure

All aspects of the built environment are vulnerable to wildfires, especially those within the wildland-urban interface (WUI), or up to 1 mile outside the WUI; approximately 80% of all wildfires in Florida happen within one mile of the WUI.

Consequences related to critical infrastructure following a wildfire may include:

- Loss of building function (e.g., damaged homes will no longer be habitable, causing residents to seek shelter).
- Business/service interruption, causing an impact to the local economy as well as individual households.

Impact to Environment

There can be long-term impacts to the environment because of a wildfire on weather and the climate. The scale of wildfire can release large quantities of carbon dioxide and carbon monoxide into the atmosphere. This chain reaction would then cause increased air pollution. For more information on vulnerabilities to environmental conditions, please refer to the respective section in the Vulnerability Index & Assessment (THIRA Volume II, pages 284 - 292).

Consequences related to the environment following a wildfire may include:

• Increase of air pollution that could cause various types of health issues (e.g. respiratory or cardiovascular problems).

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TABLE 11. FIRE DANGER LEVELS

Level	Criteria
Low	**Ignition**: Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires. **Spread**: Fires in open cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. **Spotting**: There is little danger of spotting. Control: Easy
Moderate	**Ignition**: Fires can start from most accidental causes, but with the exception of light-ning fires in some areas, the number of starts is generally low. **Spread**: Fires in open cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. **Spotting**: Short-distance spotting may occur, but is not persistent. **Control**: Fires are not likely to become serious and control is relatively easy.
High	**Ignition**: All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. **Spread**: Fires spread rapidly. High-intensity burning may develop on slopes or in concentrations of fine fuels. **Spotting**: Short-distance spotting is common. **Control**: Fires may become serious and their control difficult unless they are at-tacked successfully while small.
Very High	**Ignition**: Fires start easily from all causes. **Spread**: Immediately after ignition, spread rapidly and increase quickly in intensity. Fires burning in light fuels may quickly develop high intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels. **Spotting**: Spot fires are a constant danger; long distance spotting likely. **Control**: Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
Extreme	**Ignition**: Fires start quickly and burn intensely. All fires are potentially serious. **Spread**: Furious spread likely, along with intense burning. Development into high in-tensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. **Spotting**: Spot fires are a constant danger; long distance spotting occurs easily. **Control**: Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Source: National Fire Danger Rating System

<u>Previous Occurrences</u>

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June 28, 2019 - A small wildfire developed in the Tamiami Pinelands Park area. The fire quickly spread causing damage to two vehicles. The estimated damage was $75,000.

May 2008 – The Mustang Corner Fire was a large wildfire that burned over the Everglades of western Miami-Dade County. The fire burned 39,465 acres in the Everglades National Park. The fire also prompted the evacuation of some 1,753 prisoners and 250 employees from the Everglades Correctional facility and 535 detainees from the Krome Detention Center as the fire closed within ten miles. The fire prompted dense smoke advisories for the Miami Metropolitan area from May 17th to May 21st as dense smoke moved into the area during the night and early morning hours.

May 7, 2008 – A wildfire broke out near Southwest 227th Avenue and Southwest 232nd Street in the Redland area of western Miami-Dade County, covering about 20 acres and threatening a home before being extinguished. The fire consumed 20 acres of a 30 acre farm, two vehicles, and some farm equipment. The estimated damage caused by this fire was $30,000.

August 7, 2004 – A lightning-initiated wildfire burned 10,000 acres mostly in an area between the Homestead Extension of the Florida Turnpike and Krome Avenue. Smoke from the fire closed down portions of both roads for hours at a time and one person was killed in a vehicle crash likely caused by the restricted visibility. A local health alert was issued for persons mainly in the Doral area.

April 5, 2000 – A 50-acre wildfire occurred in Homestead and destroyed two mobile homes and two boats. The total estimated damage was $100,000.

March 30-31, 1999 – Redland area about a dozen wildfires burned as winds gusting near 30 mph quickly spread the flames. None of the fires exceeded 100 acres but a plant nursery was destroyed, and several homes were threatened. Smoke closed the Florida Turnpike Extension and the Don Shula Expressway for several hours.

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TABLE 6A-86 PRESIDENTIALLY DECLARED WILDFIRE EVENTS IN MIAMI-DADE COUNTY

Disaster Type	Disaster Number	Title	Incident Begin Date	Declaration Date	Incident End Date	Disaster Close Out Date
DR	1223	EXTREME FIRE HAZARD	5/25/1998	6/18/1998	7/22/1998	6/21/2011
FS	2256	FL-FIRES 04/13/99	4/13/1999	4/18/1999		7/26/2002
EM	3139	FL-FIRES 04/15/99	4/15/1999	4/27/1999	5/25/1999	4/14/2004
FS	2359	FL - EVERGLADES FIRE COMPLEX - 04/25/01	4/17/2001	4/25/2001		9/16/2003

Source: data.gov, FEMA Disaster Declarations Summary

<u>Vulnerability</u>

Wildfire			
Category		**Vulnerability***	**Risk***
Social (People, etc.)	Special Populations	Vulnerable	Medium
	Cultural Conditions	Somewhat Vulnerable	Medium
	Socioeconomic Conditions	Somewhat Vulnerable	Medium
Physical (Property, etc.)	Critical Infrastructure	Somewhat Vulnerable	Medium
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Vulnerable	Medium
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Somewhat Vulnerable	Medium
	Social Conditions	Somewhat Vulnerable	Medium
	Environmental Conditions	Vulnerable	Medium
	Governmental Conditions (inc. Operations)	Somewhat Vulnerable	Medium
	Insurance Conditions	Vulnerable	Medium
	Community Organizations	Somewhat Vulnerable	Medium

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

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Physical Vulnerabilities

The built environment (Critical Infrastructure, Key Resources and Building Stock) and natural environment that are closest to the Everglades, agricultural areas or large open spaces are at a higher risk for exposure from wildfires. Critical facilities would include the Homestead Correction Institute, Dade Correctional Institution, Dade Juvenile Residential Facility, Everglades Correctional Institution, Krome North Service Processing Center, South Florida Reception Center, and Metro-West Detention Center. Residential areas of concern would include the Everglades Labor Camp, Gator Park Mobile Home Park, and Jones Fishing Camp Trailer Park. Visibility on roads may be compromised due to smoke, and this may lead to the need for road closures or increased traffic accidents.

Social Vulnerabilities

Populations with respiratory complications may be at greater risk due to air quality issues in relation to wildfires. The social vulnerability section should be reviewed for more information on how these types of circumstances may affect populations differently.

Frequency/Probability

There have been 13 recorded wildfires in Miami-Dade County since 1998, averaging approximately one and a half per year. Miami-Dade County is most vulnerable to wildfires during the dry season. Wildfires typically occur during periods of high temperatures and drought and are often exacerbated by wind.

Cold Wave

Description

A cold wave is a natural hazard defined by FEMA as a rapid fall in temperature within 24 hours and extreme low temperatures for an extended period. The temperatures classified as a cold wave are defined by our local National Weather Service (NWS) weather forecast office as temperatures at or below 50 degrees Fahrenheit. In Miami-Dade County, most winter concerns revolve around protecting crops from cold temperatures and providing shelter for vulnerable populations such as the homeless.

A cold wave poses a threat to the lives and safety of individuals exposed. This hazard is responsible for dozens of deaths a year across the Country due to exposure to the elements. It can lead to complications such as hypothermia and frostbite after prolonged exposure. Hazards such as carbon monoxide poisoning, and household fires are increased in improperly ventilated homes during severe winter weather events. The loss of utilities stress resources and puts vulnerable populations at risk.

Extreme cold events or cold waves consist of long periods of below freezing temperatures that sometimes accompany a winter storm. Since a cold wave is relative to temperatures in the area in question, a universal temperature defining it is not available. However, a significant drop in temperature causing a threat to the safety of the public can be defined as a cold wave. A cold wave is often correlated with the arrival of a cold front. A cold front is a weather system that moves into a region and replaces existing warmer air with cold air. Since cold air is denser than warm air, a cold front will push cold air under warm air causing warm air to rise higher in the atmosphere and subsequently cool. This often produces cloud cover or precipitation. This weather pattern can remain in a region for a few hours or sometimes as long as a couple of weeks. Cold air will eventually be pushed out by another weather front.

Extreme cold temperatures are seasonal in nature and can occur any time from early fall to mid spring. Since extreme cold is defined by colder than normal temperatures for an extended period, it does not necessarily require subzero temperatures and can occur in relatively tepid weather. Extreme cold is associated with the passage of cold fronts. Cold fronts are systems originating in normally colder regions and can remain in an area for periods of time ranging from just a few hours to a couple of weeks. The front will vacate when it is replaced by another weather system. The frequency of extreme cold is dependent on weather patterns within a particular region. Weather patterns are affected by many variables including ocean currents, jet streams, volcanic activity, and man's footprint on the environment. Extreme cold weather is correlated to weather systems that have cold air behind them and can occur several times a season. The magnitude of the cold weather is also affected by many variables including where the cold air weather system originates and whether another system forms that will push the existing system out.

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Winter storms are a rare occurrence in Florida but not improbable. The earliest recorded occurrence of snow or sleet occurred in 1774. The latest occurrence of snow or sleet in the spring fell on January 2010, as a cold front brought scattered snow flurries along with widespread sleet and freezing rain, especially in the northern and central portions of the state. The state record for snowfall is 5 inches, set in northern Florida during January 1800. The earliest date for recorded snow fall was during Late November 2006 Nor'easter on November 21 across central Florida.

As mentioned, severe winter weather can occur during ice and snow events. Ice storms are one of the most dangerous types of winter storms. Ice storms typically occur when precipitation falls from above freezing (32 degrees Fahrenheit) temperatures and comes in contact with air or surfaces that are below freezing. During ice storms, ice accumulates on the ground surfaces, power lines and trees. Ice causes dangerous conditions on the ground reducing traction and rendering slick surfaces. These conditions are dangerous to pedestrians as many injuries occur from falling on the slick surfaces. This is especially dangerous for the elderly as their limited mobility and agility is further reduced on slick surfaces. In addition, the elderly are prone to injuries from tripping accidents as their bone mass diminishes with age.

Ice also creates dangerous conditions for vehicles. Ice can accumulate and blocks sewage runoff grates. Rain, freezing rain, and sleet often accompany ice storms, which increase the risk of floods. As flooding progresses, conditions only become slicker and more dangerous for pedestrian and vehicle travel. In extreme cases, floods can lead to the spillage of hazardous materials that can contaminate water supplies. When ice storms are accompanied by cold temperatures, the homeless and those without adequate heating in their homes are at risk. Although cold temperatures are required for ice storms, they do not have to occur during extreme cold. Temperatures within a few degrees of freezing are sufficient for ice storms to occur.

Temperature changes and extreme cold can be somewhat mitigated by large bodies of water, as water takes longer to cool and warm than land. However, even though water will stabilize temperatures, changes in air pressure associated with water contribute to winds in the area.

<u>Location</u>

The entire county is vulnerable to winter weather, and inland portions tend to see colder temperatures by a just few degrees. These areas tend to be south of Kendall Drive and west of the Florida Turnpike, primarily the Redland area and areas west of Homestead and Florida City.

<u>Extent</u>

Temperatures have dropped as low as the 20s in Miami-Dade County. In January 2010, cold temperatures killed an elderly man and caused $286 million in crop damages.

Extreme winter weather is seasonal in nature and can occur any time temperature and atmospheric conditions are right. Depending on the geographic latitude on the jurisdiction in question, winter weather events can occur anywhere from late September to early May, but it is not necessarily limited to those months.

Although weather patterns are impossible to predict exactly, the National Weather Service tracks weather and provides warnings up to 3 to 7 days in advance. The duration of a winter weather event is also highly variable and can last as long as 3-4 days while others have been over within a period of hours.

Weather is influenced by many factors including man's footprint on the environment, natural climatic cycles, volcanic activity, jet stream and ocean current patterns such as El Niño and La Niña. These factors will vary the atmospheric conditions conducive to winter weather resulting in some winters with multiple storms and others with few or no storms. The exact impact of these factors has yet to be determined.

TABLE 6A-93 NATIONAL WEATHER SERVICE ALERTS FOR WINTER WEATHER

Alert	Criteria
Winter Weather Advisories	Are issued for accumulations of snow, freezing rain, freezing drizzle, and sleet which will cause significant inconveniences and, if caution is not exercised, could lead to life-threatening situations.
Winter Strom Watch	Alerts the public to the possibility of a blizzard, heavy snow, heavy freezing rain, or heavy sleet. Winter Storm Watches are usually issued 12 to 48 hours before the beginning of a Winter Storm.
Winter Storm Warning	Issued when hazardous winter weather in the form of heavy snow, heavy freezing rain, or heavy sleet is imminent or occurring. Winter Storm Warnings are usually issued 12 to 24 hours before the event is expected to begin.

Source: National Weather Service

The National Weather Service posts wind-chill advisories and warnings for communities based on the winter temperatures. Wind chill advisories and warnings are set locally and based on typical and expected temperatures for the region. Periods of extreme cold or high winds may necessitate the declaration of wind chill advisories and warnings. A wind chill warning is the more serious of the two declarations. The NWS maintains a wind chill index to illustrate the effects of different speeds of wind.

TABLE 6A-94 WIND CHILL INDEX

Wind	Temperature																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times	30 Minutes	10 Minutes	5 Minutes

Wind chill is calculated by: Wind chill (ºF) = 35.74 0.6215T - 35.75(V^0.16) 0.4275T(V^0.16) Where: T = Air Temperature (F), V = Wind Speed (mph), ^ = raised to a power (exponential)

Source: National Oceanic and Atmospheric Administration

TABLE 13. AVERAGE FREEZE DATES FOR SOUTH FLORIDA[32]

LOCATION	EARLIEST FREEZE	AVERAGE FIRST FREEZE	AVERAGE LAST FREEZE	LATEST FREEZE
HIALEAH	DECEMBER 15	DECEMBER 21-31	JANUARY 21-31	MARCH 3
HOMESTEAD	DECEMBER 28	DECEMBER 21-31	JANUARY 21-31	JANUARY 31
MIAMI BEACH	DECEMBER 24	DECEMBER 21-31	JANUARY 21-31	MARCH 3
MIAMI	DECEMBER 11	DECEMBER 21-31	JANUARY 21-31	MARCH 3

Impact

Impact to Miami-Dade County Residents

Cold waves or extreme cold weather is a particularly dangerous hazard for at-risk populations. These populations include those who have a difficult time keeping warm or finding a heat source during an extreme cold event. The homeless are particularly at risk. Age groups such as the elderly and infants have limited physiological capability to keep warm. Outdoor animals and pets are also at risk of extreme cold temperatures. Consequences related to the public following a winter storms & freezes may include:

[32] National Weather Service Miami Office

- Increased need for medical care, causing a potential surge at local hospitals
- Temporary loss of water services/utilities, requiring alternate means to address immediate needs
- Temporary/permanent loss of transportation, causing a need for replacement or alternative forms of transportation.

Impact to Essential Facilities and Other Property

Little of the built environment (Critical Infrastructure, Key Resources, and Building Stock) is vulnerable to winter storms. Pipes carrying water to households could freeze and expand causing pipes to burst. Often water will be contaminated during this process. Inadequately heated or insulated homes may resort to heating by kerosene heaters or stoves. These methods of heating are dangerous and contribute to carbon monoxide poisoning and household fires. Agricultural interests are more vulnerable to winter storms and frost can destroy crops.

Consequences related to essential facilities and property following a flooding may include:

- Business/service interruption, causing an impact to the local economy as well as individual households
- Loss of building function (e.g., damaged homes will no longer be habitable, causing residents to seek shelter).

Impact to Critical Infrastructure

Critical infrastructure can be impacted by winter storms and freezes. Transportation vehicles could lose functionality or unable to traverse through roads from winter storms or freezes that could cause sleet to appear on roads. The impacts to these structures include failed or impassable roadways, broken or failed utility lines (e.g., loss of power or gas to a community), and railway failure from broken or impassable railways. Bridges could fail or become impassable, causing risk to traffic.

Consequences related to critical infrastructure following a winter storm and freeze may include:

- Disruption in the transportation of goods
- Disruption in the public transportation
- Shortage of fuel or other essential materials
- Loss of power due to power outage.

Impact to Environment

Winter storms and freezes play a significant role in the impact of the environment. This natural hazard can create blizzards that can result in trees falling and plants dying. Because of that forests will be damaged producing excess carbon dioxide that causes an imbalance in the local ecosystem.

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Consequences related to the environment following a cold wave or extreme freeze may include:

- Reduced crop, rangeland, and forest productivity
- Alter landscapes leading to uninhabitable locations
- Increased livestock and wildlife mortality rates
- Damage to wildlife and fish habitat

<u>Previous Occurrences</u>

January 2012 – Temperatures dropped to the freezing mark over parts of inland Miami-Dade County on the night of January 3rd and early morning of January 4th, with temperatures at these values for 2-4 hours. Areas most affected were the Redland and Homestead areas. Damage to most sensitive crops (beans, herbs, squash, and Asian vegetables) was about 15-20%. A few wind-protected fields suffered near-total losses.

January 2010 – A strong artic cold front moved through South Florida in the early part of January. This cold front produced freezing temperatures and very low wind chills . Freezing temperatures were noted over almost all of South Florida on the mornings of January 10th and 11th. This front resulted in the coldest 12-day period of temperatures throughout South Florida. Crop damage was extensive with total damage estimates in excess of $500 million. Thousands of customers experienced intermittent power outages during this period due to record-setting usage demands. There was one death as a result of the freezing temperatures.

January 5, 2001 –
A freeze occurred throughout the interior sections of south Florida, causing damage to certain crops. Hardest hit were certain vegetable crops with 75% losses in Hendry and east Collier counties and 30% losses in the farming areas of south Miami-Dade County. Other crops that were damaged included newly planted sugar cane, ornamentals, and tropical fruits. A heavy frost occurred in the western suburbs of Miami-Dade, Broward and Palm Beach metropolitan areas. Several daily minimum temperature records were broken. Selected minimum temperatures included 29 degrees in the Homestead agricultural area, 39 degrees at Miami International Airport and 43 degrees in Miami Beach.

February 5, 1996 – The coldest temperatures since the "Christmas freeze" of 1989 caused damage to fruit and vegetable crops in South Florida. Strong winds caused wind chill values in the teens and disrupted electrical service to over 20,000 customers throughout the region.

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TABLE 14. PRESIDENTIALLY DECLARED FREEZE EVENTS IN MIAMI-DADE

Disaster Type	Disaster Number	Title	Incident Begin Date	Declaration Date	Incident End Date	Disaster Close Out Date
DR	1359	SEVERE FREEZE	12/1/2000	2/5/2001	1/25/2001	5/14/2010
DR	851	SEVERE FREEZE	12/23/1989	1/15/1990	12/25/1989	4/23/1996
DR	732	SEVERE FREEZE	3/18/1985	3/18/1985	3/18/1985	10/27/1988
DR	526	SEVERE WINTER WEATHER	1/31/1977	1/31/1977	1/31/1977	12/18/1978
DR	304	FREEZE	3/15/1971	3/15/1971	3/15/1971	6/18/1973

Source: data.gov, FEMA Disaster Declarations Summary

<u>Vulnerability</u>

Winter Storms and Freezes			
Category		Vulnerability	Risk
Social (People, etc.)	Special Populations	Vulnerable	Medium
	Cultural Conditions	Minimally Vulnerable	Low
	Socioeconomic Conditions	Somewhat Vulnerable	Medium
Physical (Property, etc.)	Critical Infrastructure	Minimally Vulnerable	Low
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Minimally Vulnerable	Low
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Somewhat Vulnerable	Medium
	Social Conditions	Minimally Vulnerable	Low
	Environmental Conditions	Somewhat Vulnerable	Medium
	Governmental Conditions (inc. Operations)	Minimally Vulnerable	Low
	Insurance Conditions	Minimally Vulnerable	Low
	Community Organizations	Somewhat Vulnerable	Medium

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

<u>Physical Vulnerabilities</u>

Little of the built environment (Critical Infrastructure, Key Resources and Building Stock) is vulnerable to winter storms. Pipes carrying water to households could freeze and expand causing pipes to burst. Inadequately heated or insulated homes may resort to heating by kerosene heaters or stoves. These methods of heating are dangerous and contribute to carbon monoxide poisoning and household fires. Agricultural interests are more vulnerable to winter storms and frost can destroy crops. Crops most vulnerable to winter storms and freezes are the ones that are grown during the winter months and harvested in the spring months including cantaloupe, carambola, celery, cucumbers, dragon fruit, eggplant, fennel, guava, green beans, herbs, jackfruit, longyan, lychee, mushrooms, onions, papaya, passion fruit, plantains, radishes, sapodilla, spinach, squash, strawberries, sweetcorn, thyme, tomatoes and zucchini.

Social Vulnerabilities

Extreme cold weather is a particularly dangerous hazard for at risk populations such as the homeless, elderly, low income or people living in homes without heating or means to keep warm. These populations include those who have a difficult time keeping warm or finding a heat source during an extreme cold event. The homeless are particularly at risk. Age groups such as the elderly and infants have limited physiological capability to keep warm. It is estimated that there are 3,472 homeless individuals reside in Miami-Dade County as of April 2019. Larger concentrations of homeless tend to be near the down-town Miami and Miami Beach areas. Body warming mechanisms such as "goose bumps" and shivering are restricted in these groups. Outdoor animals and pets are also at risk of extreme cold temperatures. In the event that ambient temperatures in the county are forecasted to be at or below 50 degrees Fahrenheit for any period of time the Miami-Dade Homeless Trust will open and operate cold weather shelters.

Frequency/Probability

There have been 27 recorded freeze events in Miami-Dade County since 1950. The largest freezing event lasted for up to 11 days.

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Extreme Heat

Description

Extreme heat is defined as temperatures that are approximately 10 degrees or more above the average high temperature for a given region lasting a prolonged period of time, usually several weeks. Extreme heat occurs when a layer of high atmospheric pressure descends over a geographical area. High pressure causes the air normally located high in our atmosphere to descend, compress, and increase in temperature. This leads to hazy, humid, and muggy air. High pressure systems can reside in an area for weeks as they are resistant to being moved by other weather systems. In addition, high pressure inhibits wind and clouds which normally mitigates the effects of the sun.

Every year, many municipalities experience periods in which the air temperature and humidity creates conditions that could potentially harm human health. Urban areas in particular experience a “heat island” effect. Urban heat island is when an urban area experiences warmer temperatures than its surrounding rural areas. This is caused by large amounts of concrete absorbing heat from the sun during the day. The heat releases at night keeping temperatures high and allowing little time for cooling. This can lead to increased energy demands and stress at-risk populations, especially those without access to air conditioning.

Studies indicate that climate change is expected to make extreme heat worse. According to the National Weather Service, in the summer of 2021, Miami observed 60 days of temperatures at or above 90°F. As shown in the graph below, Miami-Dade County's minimum temperature has been warming at a rate of +0.6°F per decade since 1985. Depending on how greenhouse gas emissions are managed, there are different future warming scenarios predicted for South Florida. Days with a high heat index in South Florida are also projected to increase with climate change. Additionally, if greenhouse gas emissions continue without mitigation, Miami-Dade is projected to have 14 "off the chart" heat index days by late century (2070-2099), "off the chart" being a value of over 135°F.

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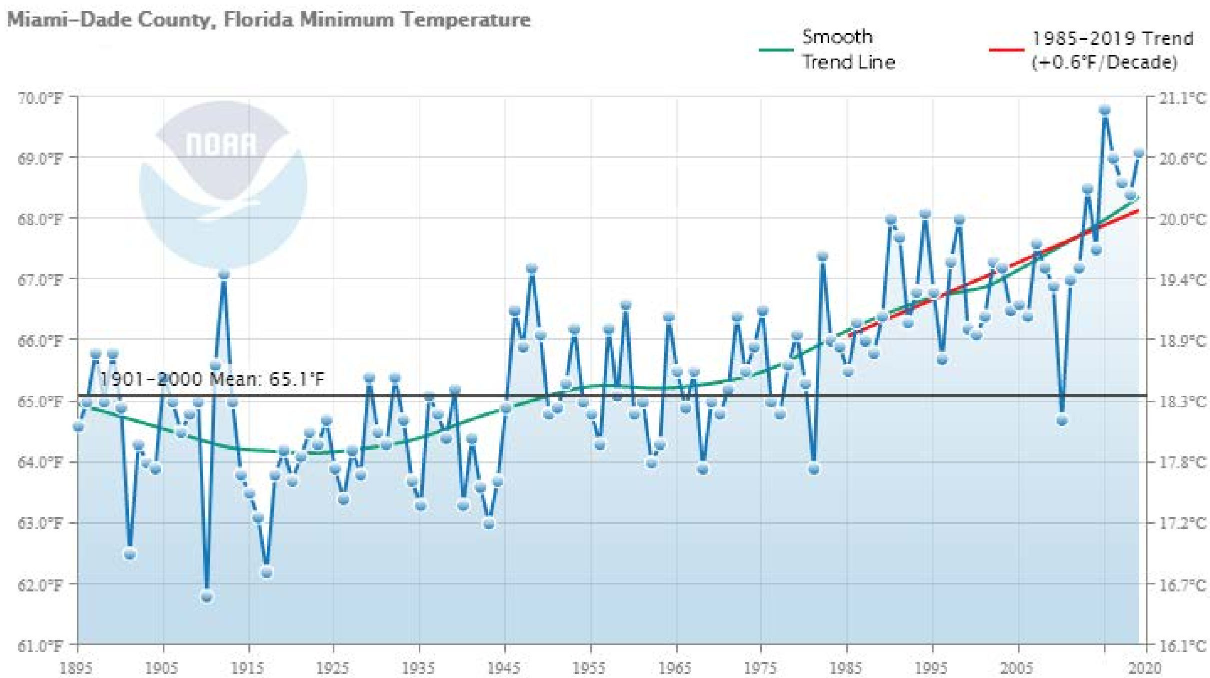

This graph shows the minimum temperature in Miami-Dade county from 1895 - 2020.

MIAMI-DADE COUNTY				
Heat Index above	Historical (1971-2000)	By midcentury (2036-2065)	By late century (2070-2099)	By late century, if we limit warming to 2℃ (2070-2099)
90℉ ------	154 days	187 days	200 days	183 days
100℉ ------	41 days	134 days	166 days	115 days
105℉ ------	7 days	88 days	138 days	60 days
Off the Charts	0 days	1 days	14 days	0 days

This image shows the Southeast Florida Regional Climate Change Compact heat index projection for Miami-Dade.

Heat Index

Heat index is a measurement created by the National Weather Service to illustrate the apparent temperature (i.e. the temperature the human body generally feels) when the air temperature is combined with the relative humidity. The heat index is generally used to determine the effects the temperature and humidity can have on the population. Heat index values are reduced by shady, light wind conditions. Full sunshine conditions can increase heat index values by up to 15 degrees.

TABLE 6A-15 HEAT INDEX

Relative Humidity \ Temperature	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	109	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	114	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	118	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	124	137			
60	82	84	88	91	95	100	105	110	116	123	129	129				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution	Extreme Caution	Danger	Extreme Danger

Source: National Oceanic and Atmospheric Administration

<u>Location</u>

The entire county is at risk for extreme heat.

<u>Extent</u>

The average annual high temperature in Miami-Dade County is 84.2ºF, and the average annual relative humidity is 83% in the morning and 61% in the afternoon. The heat index has reached up to at least 110ºF.

Extreme heat is typically seasonal in nature with heat waves occurring in the summer months. However, heat waves are associated with high pressure systems and can occur in late spring and early fall as well. For regions in southern latitudes, extreme heat events can occur any time of the year. High pressure systems associated with heat waves can move into an area within a matter of days. These systems are resistant to being moved by other systems and can affect a region for days, weeks, or months. The frequency of extreme heat is dependent on weather patterns within a particular region. Weather patterns are affected by many variables including ocean currents, jet streams, and man's footprint on the environment.

In the event of extreme heat, the National Weather Service will issue heat advisories based on heat indices through media messages. The National Weather Service provides assistance to state and local health officials in preparing emergency messages in severe heat waves in addition to issuing special weather statements such as who are at most risk, safety rules, and the severity of the hazard. The National Weather Service will also aid state and local authorities on issuing warnings and survival tips. State and local health officials will be responsible to check on vulnerable populations such as the disabled and the elderly. Residents will be notified to remain indoors and refrain from strenuous activities. They will also be reminded to consume fluids often throughout the day and to stay near air conditioning, fans, and so forth. Exposure to extreme heat can result in various health issues such as sunburn, dehydration, heat cramps, heat exhaustion, and heat stroke. The following table lists some common health hazards that correspond to a certain range of heat index and how dangerous the conditions may be:

TABLE 6A-17HEAT HEALTH HAZARDS

Category	Heat Index	Health Hazards
Extreme Danger	130° F- Higher	Heat stroke/ Sunstroke is likely with continued exposure
Danger	105° F- 129° F	Sunstroke, muscle cramps, and/or heat exhaustion with prolonged exposure and/or physical activity.
Extreme Caution	90° F- 105° F	Sunstroke, muscle cramps, and/or heat exhaustion with prolonged exposure and/or physical activity.
Caution	80° F- 90° F	Fatigue possible with prolonged exposure and/or physical activity.

Source: National Weather Service

<u>Impact</u>

Impact to Miami-Dade County Residents

Population groups that may be more vulnerable to the impacts of extreme heat include children, the elderly, pregnant women, individuals with respiratory illnesses, outdoor workers, and transients. Children tend to be especially vulnerable to extreme heat. Their small bodies can overheat more quickly than adult bodies because they do not have fully developed temperature regulation mechanisms, they are not always able to recognize the physical symptoms associated with heat illness, and they tend to spend more time outdoors than adults. Elderly adults and the disabled may be vulnerable because they are frailer and the possible interaction of high temperatures with certain medications and side effects (including dehydration). This population may also be socially alienated, reducing their social support system. Low-income households may not be able to afford air conditioning. Individuals with respiratory illnesses are also vulnerable because extreme heat increases the production of ground-level ozone, a known respiratory irritant. Finally, transients may be vulnerable for a few reasons; tourists may not follow heat warnings and continue to pursue outdoor activities, and the homeless may not have a place to find respite from the heat or enough clean water to stay hydrated. The consequence of such an incident will be dependent upon the location, scale, magnitude and extent of the incident in addition to the aforementioned vulnerabilities and community conditions described above.

Consequences related to the public following an extreme heat event may include:

- Increased need for medical care, causing a potential surge at local hospitals

Impact to Essential Facilities and Other Property

All essential facilities and buildings could be vulnerable to extreme heat. An essential facility could encounter many of the same impacts as any other building within the jurisdiction. These impacts will vary based on the temperature caused by extreme heat, but can include temporary loss of facility functionality (e.g., a police station with a power outage causing no air conditioning may be temporarily unable to serve the community).

Consequences related to essential facilities and property following an extreme heat event may include:

- Loss of building function (e.g., power outage at a residence may temporarily be uninhabitable, causing residents to seek shelter).
- Business/service interruption, causing an impact to the local economy as well as individual households

Impact to Critical Infrastructure

Spikes in usages of electricity to meet air conditioning demands could cause a strain on the electric infrastructure and possibly cause rolling blackouts or outages. Extreme heat could impact agricultural and aquaculture interests and exacerbate animal or plant diseases. In 2014, South Florida Water District had to provide additional water for the Turkey Point Nuclear Power Plant cooling canals in order to maintain the desired operational temperature range.

Consequences related to critical infrastructure following an extreme heat may include:

- Disruption in the transportation of goods
- Shortage of production of agriculture and livestock
- Disruption to the power grid

Impact to Environment

Extreme heat events can exacerbate drought, and hot, dry conditions can cause wildfire events. Infrastructure such as buildings and roads absorb heat and can increase temperatures. Extreme heat may kill animals and damage farmland.

Consequences related to the environment following an extreme heat event may include:

- Trees and plants could be ignited by extreme heat causing wildfires
- Disruption of the ecosystem causing various species to be extinct
- Increase in temperatures contribute to global warming, increasing the possibility of other hazards.

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Previous Occurrences

July 25, 2017— High pressure in place with abundant moisture led to high temperatures and dewpoints. This led to the heat index reaching 108-110 degrees. With these high heat indices many people were treated for heat related illness at Miami Beach.

September 8, 2011— Very warm and humid weather conditions led to heat indexes near 110 degrees across northeast Miami-Dade County. Eight students were treated for heat-related illnesses at Ruth Broad Bay Harbor K-8 Center in Bay Harbor Islands after physical education class. One student was transported to a hospital and the other seven students were treated at the scene. Temperatures were around 90 degrees with relative humidity values around 70 percent near the time of the event, yielding heat index values in the 106 to 111 degree range.

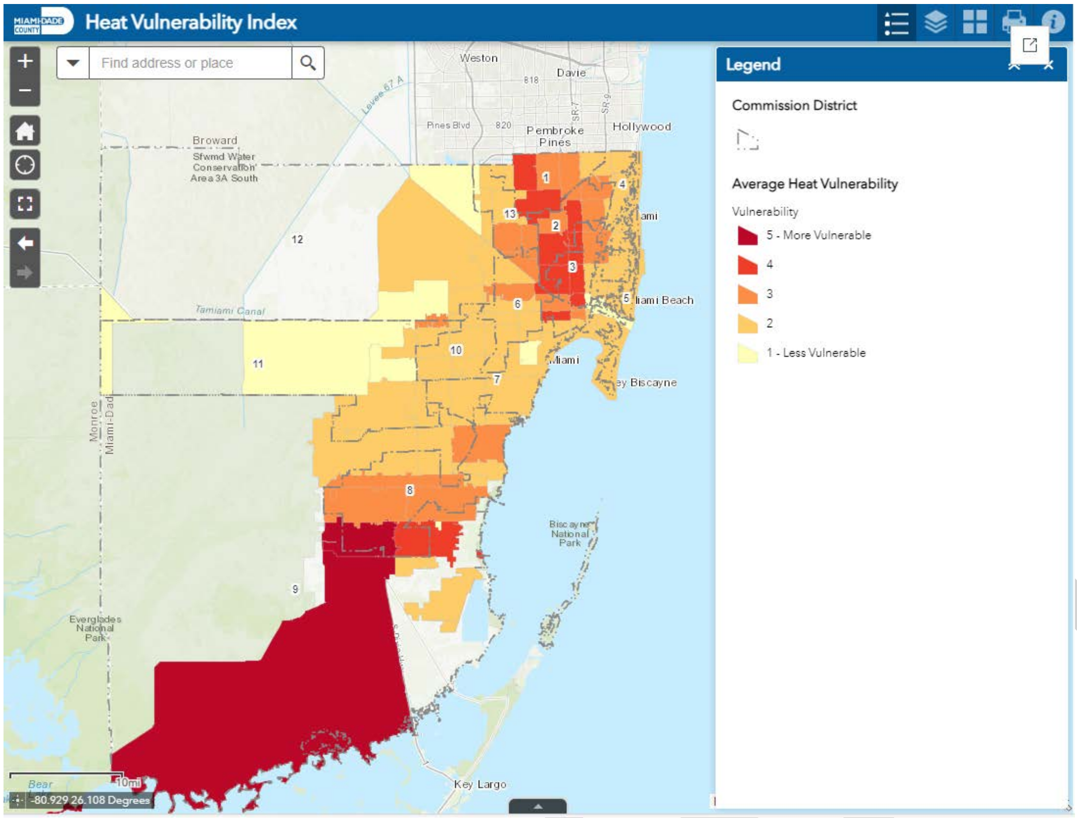
November 15, 2011— Unseasonably warm and humid weather occurred across south Florida through the middle of November in association with southeast wind flow around a high-pressure area over the Atlantic.

June 2009 – Strong surface west winds ahead of a rare late June cold front over north Florida along with strong high pressure aloft led to record heat over southeast Florida. Many locations over the southeast Florida metro area reached the upper 90s, falling just short of the 100 degree mark. Miami International Airport tied an all-time record for June with a reading of 98 degrees, and West Palm Beach broke a daily record with a high of 96. Moore Haven in Glades County reached 100 degrees.

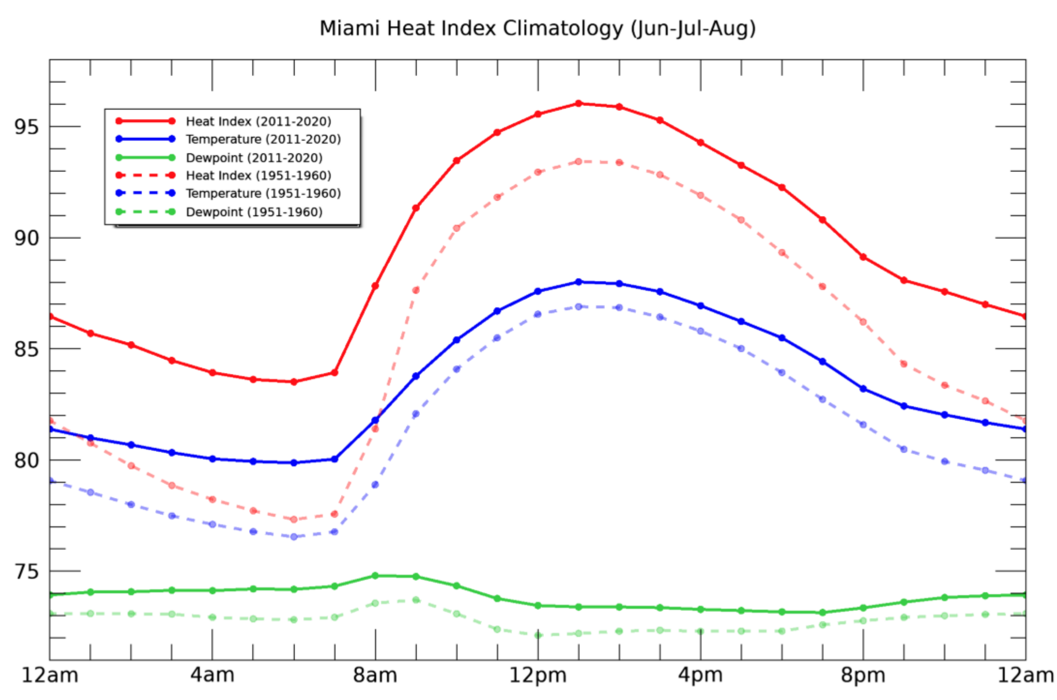
Vulnerability

Extreme Heat			
Category		Vulnerability*	Risk*
Social (People, etc.)	Special Populations	Vulnerable	High
	Cultural Conditions	Somewhat Vulnerable	Medium
	Socioeconomic Conditions	Vulnerable	High
Physical (Property, etc.)	Critical Infrastructure	Somewhat Vulnerable	Medium
	Key Resources	Somewhat Vulnerable	Medium
	Building Stock	Somewhat Vulnerable	Medium
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Somewhat Vulnerable	Medium
	Social Conditions	Somewhat Vulnerable	Medium
	Environmental Conditions	Vulnerable	High
	Governmental Conditions (inc. Operations)	Somewhat Vulnerable	Medium
	Insurance Conditions	Somewhat Vulnerable	Medium
	Community Organizations	Somewhat Vulnerable	Medium

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*



Source: Miami-Dade Extreme Heat Vulnerability Mapping Report (Uejio and Ahn, 2022).



This image shows the average hourly heat index from 2011-2020 compared to 1951-1960.

Source: Miami Heat Index and Dewpoint Climatology for Miami, FL (McNoldy, B. D., 2022)

Physical Vulnerabilities

Due to various exposure and sensitivity factors some neighborhoods experience increased risk to extreme heat effects. Neighborhoods with less trees and green space as well as densely populated urban areas are more vulnerable to the effects of extreme heat due to the Urban Heat Island Effect. Trees help cool surface temperatures through evapotranspiration. High amounts of impervious surfaces allow little or no storm water infiltration into the concrete ground which would help cool the area. All essential facilities and buildings could be vulnerable to extreme heat. An essential facility could encounter many of the same impacts as any other building within the jurisdiction. These impacts will vary based on the temperature caused by extreme heat, but can include temporary loss of facility functionality.

Social Vulnerabilities

All people in Miami-Dade are at risk, but some groups are more sensitive than others. High-risk groups for heat related illnesses include adults over 65 years, young children, homeless population, pregnant women, lower-income populations, outdoor workers, people recreating outside, athletes, and people with pre-existing (heart, lung, kidney) conditions who take certain medications that reduce their body's ability to keep cool.

Frequency/Probability

Since 2019, Miami-Dade has experienced a significant increase in the number of days of documented extreme heat based on heat advisories given by the National Weather Service Weather Forecast Office. A heat advisory is issued when the heat index value is expected to reach 105 to 110 degrees for at least 2 consecutive days, this being a lower threshold established by the NWS Office in Miami since 2023. The number of advisories has averaged nineteen annually in the past five years. With this pattern, it is likely that extreme heat events will continue to happen at a higher frequency than ever.

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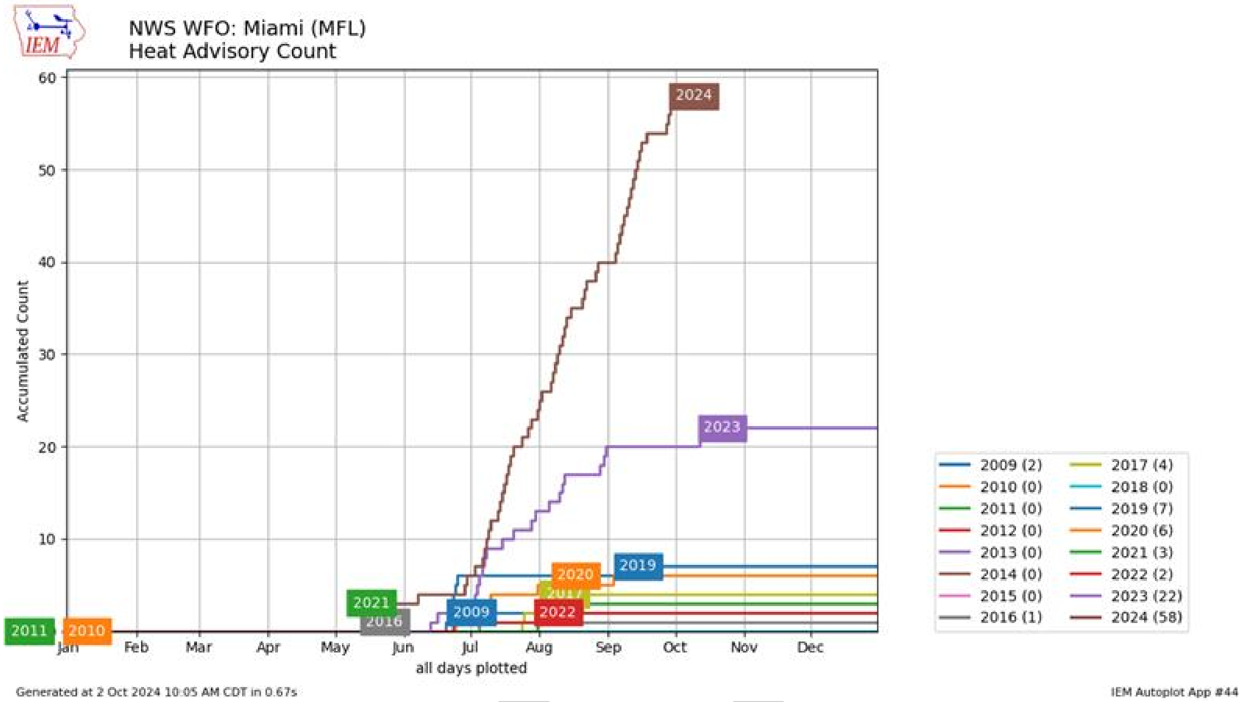
NWS WFO: Miami (MFL)
Heat Advisory Count
Accumulated Count
all days plotted
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
2009 (2)
2010 (0)
2011 (0)
2012 (0)
2013 (0)
2014 (0)
2015 (0)
2016 (1)
2017 (4)
2018 (0)
2019 (7)
2020 (6)
2021 (3)
2022 (2)
2023 (22)
2024 (58)
Generated at 2 Oct 2024 10:05 AM CDT in 0.67s
IEM Autoplot App #44

Epidemic/Pandemic

Description

An epidemic is a widespread occurrence of an infectious disease in a community at a particular time. According to the Dictionary of Epidemiology, a pandemic is an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting many people. For the World Health Organization (WHO) to label an ailment as a pandemic (recently, often influenza based), it must meet three requirements:

- Able to infect humans
- Able to cause disease in humans
- Able to spread from human to human easily

Pandemics can be spurred from a number of illnesses, including influenza, cholera, smallpox, typhus, measles, tuberculosis, leprosy, malaria and yellow fever. This hazard section will tend to focus on pandemic influenza, as it is the highest pandemic threat in the United States.

Influenza is a virus that occurs on seasonal basis and presents itself in one of many different genetic combinations. Influenza has been classified into three types of viruses: A, B and C. The A and B viruses are responsible for seasonal epidemic spikes and cause illness in 5% to 20% of the population. The C virus is less virulent and causes only mild respiratory illness. Once the influenza is introduced to a host, it has the ability to replicate itself billions of times resulting in illness. Due to its persistence in the population and its seasonal nature, humans have developed a natural resistance to many of the genetic variations of the influenza virus. However, when a novel genetic variation presents itself in a population, humans will be absent their natural resistance to the virus. This will allow the virus to spread rapidly from host to host causing larger than normal morbidity and mortality rates. This occurrence is classified as pandemic influenza.

Pandemics typically occur in waves lasting anywhere from six to eight weeks. As immunity is developed within a population, the virus will recede for a period of 8-12 weeks. The virus will then reemerge slightly mutated for another wave lasting six to eight weeks. This process repeats during a pandemic two to three times.

Symptoms of pandemic influenza vary depending on the virulence of the strain but mirror typical seasonal symptoms including, fever, coughing, sore throat, congestion headaches, soreness in the muscles and joints, chills and fatigue. During a pandemic, these symptoms can be severe resulting in hospitalizations and death.

The most effective strategy to combating pandemic influenza is vaccination. However, since a pandemic is caused by a novel strain, it is likely vaccine will not be available for the first wave and sometimes not until the middle of the second wave. Alternate

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strategies for mitigation include the use of antiviral medication, antibiotics for bacterial pneumonia often associated with influenza, social distancing, and public health hygienic practices.

SARS-CoV-2

The World Health Organization (WHO) reports that the current COVID-19 pandemic is caused by a coronavirus named SARS-CoV-2. Coronaviruses (CoVs) are a large family of viruses, several of which cause respiratory diseases in humans, from the common cold to more rare and serious diseases such as the Severe Acute Respiratory Syndrome (SARS) and the Middle East respiratory syndrome (MERS), both of which have high mortality rates and were detected for the first time in 2003 and 2012, respectively.

The first cases of COVID-19 were reported in late December 2019 directly linked to the Huanan Wholesale Seafood Market in Wuhan, China where seafood, wild, and farmed animal species were sold. After investigation by the WHO, it was found that many of the initial patients were either stall owners, market employees, or regular visitors to this market. Environmental samples taken from this market in December 2019 tested positive for SARS-CoV-2, further suggesting that the market in Wuhan City was the source of this outbreak or played a role in the initial amplification of the outbreak.

On January 20, 2020, the U.S. Centers for Disease Control and Prevention (CDC) activated its EOC to support public health partners response to the outbreak identified in China. On January 30, 2020, the International Health Regulations Emergency Committee of the World Health Organization (WHO) declared the outbreak a public health emergency of international concern. The next day, U.S. Health and Human Services (HHS) Secretary, Alex M. Azar II, declared a public health emergency for the United States to aid the nation's health care community response to COVID-19.

On March 11, 2020, the Florida Department of Health (FDOH) confirmed the first COVID-19 case in Miami-Dade County. On the same day, the WHO declared COVID-19 a pandemic—as the virus began to rapidly spread to a growing number of countries. After Miami-Dade County Mayor, Carlos Gimenez, declared a Local State of Emergency in Miami-Dade County, the Miami-Dade EOC activated to a Level 2 (Partial) to support healthcare, public safety, and municipal partners in emergency preparedness efforts and response operations.

FIGURE 6A-7 – FLORIDA'S COVID-19 DATA AND SURVEILLANCE DASHBOARD JAN. 2021

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Source: FDOH, Division of Disease Control and Health Protection

<u>Location</u>

The entire county is vulnerable to epidemics and pandemics. Locations of high density may be more at risk than others (schools, universities, large work buildings, etc.).

<u>Extent</u>

In contrast to seasonal influenza when it occurs during the late fall and early winter months, pandemic influenza can occur during any month or season. Pandemic Influenza generally occurs in multiple waves (2 to 3) that last a period of six to eight weeks each. Generally, each wave will occur approximately 12 weeks apart. Once a novel strain of influenza can achieve human to human transmission, the pandemic is expected to spread rapidly and across geographic barriers. Although the likelihood of pandemic is a certainty, their frequency is difficult to predict. In the 20th century, there were three influenza pandemics. In the 21st century, there has been one to date. There has been an average 3 pandemics per century, occurring at intervals of 10-50 years. Pandemic influenza is characterized based on its ability to spread, not its virulence. Pandemics in the past have ranged from severe to mild. The severity of pandemic influenza has varied in the past, but estimates range from an infection rate of 30% to 40%. Mortality rates will depend on the virulence of the strain. The 1918 strain had an estimated mortality rate of 3% of infected persons.

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The Pandemic Severity Index (PSI), released by the U.S. Department of Health and Human Services, categorizes flu pandemics on a scale of 1 to 5, with 5 being the deadliest, similar to the Saffir-Simpson Scale. The benefit of categorizing pandemic intensity is the correlated preventative recommendations.

TABLE 6A-13 PANDEMIC SEVERITY INDEX

Category	Case Fatality Ratio (CFR)	Projected Number of Deaths (US Population, 2006)*
1	<0.1%	<90,000
2	0.1% - <0.5%	90,000 - <450,000
3	0.5% - <1.0%	450,000 - <900,000
4	1.0% - <2.0%	900,000 - <1,800,000
5	>=2.0%	>=1,800,000

*Source: Centers for Disease Control and Prevention, *Assumes 30% illness rate*

TABLE 6A-14 COMMUNITY STRATEGIES BY PANDEMIC FLU SEVERITY

Interventions by Setting	Pandemic Severity Index		
	1	2 and 3	4 and 5
Home			
Voluntary isolation of ill at home (adults and children); combine with use of antiviral treatment as available and indicated	Recommended	Recommended	Recommended
Voluntary quarantine of household member in homes with ill persons (adults and children); consider combining with antiviral prophylaxis if effective, feasible, and quantities sufficient	Generally not Recommended	Consider	Recommended
School			
Dismissal of students from schools and school-based activities, and closure of child care programs	Generally not Recommended	Consider: <= 4 weeks	Recommended <= 12 weeks
Reduce out-of-school contacts and community mixing	Generally not Recommended	Consider: <= 4 weeks	Recommended <= 12 weeks
Workplace/Community			
Decrease number of social contacts (e.g. encourage teleconferences, alternative to face-to-face meetings)	Generally not Recommended	Consider	Recommended
Increase distance between persons (e.g. reduce density in public transit, workplace)	Generally not Recommended	Consider	Recommended
Modify, postpone, or cancel selected public gatherings to promote social distance (e.g. stadium events, theater performances)	Generally not Recommended	Consider	Recommended

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Interventions by Setting	Pandemic Severity Index		
	1	2 and 3	4 and 5
Modify workplace schedules and practices (e.g. telework, staggered shifts)	Generally not Recom-mended	Consider	Recom-mended

Source: Centers for Disease Control and Prevention

<u>Impact</u>

Impact to Miami-Dade County Residents

As mentioned above, due to Miami-Dade County's large population and high levels of international travel and trade, the county may experience greater incidence and prevalence of epidemics and pandemics, especially those coming from Central and South America. The specific populations who are most at-risk are children, the elderly, and those who are disabled. Young children have an immune system that is not fully developed and may be a detriment to fighting off an illness. The elderly and the disabled have weakened immune systems that may not be strong enough against an epidemic/pandemic. Schools and universities may need to adjust their schedule and/or services offered depending on the severity of the outbreak and choose to limit students per classroom. Additionally, the economy may be damaged if workers are unable to perform; they may be sick, caring for someone who is sick, or the office may be closed. Certain population groups may be impacted and/or more vulnerable based on location/proximity to the incident or other social vulnerability condition(s).

Although not exhaustive, the following is a list of potential social populations that may be more heavily affected by this hazard than other groups.

- Children
- Disabled
- Elderly

Consequences related to the public following an epidemic/pandemic may include:

- Increased need for medical care, causing a potential medical surge at local hospitals
- Temporary/permanent loss of employment/business income, causing an increased need for loans due to employees falling sick
- Temporary loss of services/utilities, medical personnel falling ill and staff shortages

Impact to Essential Facilities and Other Property

Epidemics and pandemics typically do not affect physical structures, essential services, or other key community assets, however emergency services and healthcare providers may be overwhelmed by the amount of people seeking treatment or a medical surge.

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Building Inventory: Epidemics and pandemics typically do not affect building inventory. For more information on vulnerabilities to key resources and building stock, please refer to the respective section in the Vulnerability Index & Assessment (THIRA Volume II, pages 79 - 168).

Consequences related to essential facilities and property following an epidemic/pandemic may include:

- Business/service interruption, causing an impact to the local economy as well as individual households due to employees falling sick (e.g. staff shortages)

Impact to Critical Infrastructure
Epidemics and pandemics typically do not affect physical structures, essential services, or other key community assets.

Consequences related to critical infrastructure following an epidemic/pandemic may include:

- Shortage of medical supplies dependent on the scale and magnitude of the epidemic/pandemic

Impact to Environment
Epidemics and pandemics typically do not affect the environment negatively, however, air quality may significantly improve, and ecological systems may be restored.

No consequences related to the environment following an epidemic/pandemic.

Impact to Operations
Vulnerabilities associated with an epidemic/pandemic are impacts to emergency services and possible medical surges at hospitals.

Consequences related to operations following an epidemic/pandemic may include:

- Continued delivery of services, life safety operations, etc. may require the use of mutual aid and emergency contracts
- Shortage of medical personnel and supply chain issues for medical supply
- Continuity of Operations Plans may need to be activated to address impacts to systems and essential functions

Consequences related to responders following an epidemic/pandemic may include:
- Increased potential for human to human transmission while performing response (e.g. EMS teams, medical personnel, fire rescue)
- Staff shortages requiring activation of mutual aid agreements

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Slow recovery from an epidemic/pandemic could also impact the local economy. Businesses seriously impacted by an epidemic/pandemic may close permanently due to short staff or simply no business.

Previous Occurrences

Only notable occurrences, if applicable, have been included in this section; and this section does not represent an all-inclusive list of past hazard incidents/events.

Miami-Dade County

There have been no instances of an epidemic only affecting Miami-Dade County.

2009 (Swine Flu-H1N1): H1N1 was first detected in the United States in April 2009. The virus genes were a combination of genes most closely related to North American swine-lineage H1N1 and Eurasian lineage swine-origin H1N1 influenza viruses. Because of this, initial reports referred to the virus as a swine origin influenza virus. The CDC estimates about 55 million people were infected, 246,000 H1N1-related hospitalizations, and 11,160 H1N1-related deaths in 2009. There were 3,676 confirmed cases in Florida and 230 confirmed deaths, with the first cases appearing in Lee and Broward Counties. According to weekly Swine Flu Surveillance Reports published by the Florida Department of Health, at least 38 people came down with Swine Flu in Miami-Dade County.

1918 (Spanish Flu): The influenza pandemic of 1918-1919 was one of the deadliest epidemics in history, causing influenza-related symptoms in more than 20% of the world's population and claiming more than 21 million lives worldwide. It spread along trade routes and shipping lines. Outbreaks swept through North America, Europe, Asia, Africa, Brazil and the South Pacific. World War I probably aided in its rapid diffusion and attack through the mass movements of men in armies and aboard ships. A study attempted to reason why the disease had been so devastating in certain localized regions, looking at the climate, the weather and the racial composition of cities. They found humidity to be linked with more severe epidemics. Therefore, Miami-Dade County may be more susceptible to influenza pandemics than other, drier locations.

Florida

2014/2015 Flu Season (H3N2): Florida was among 22 states where the CDC claimed influenza reached epidemic levels. By the end of 2014, 15 children had died due to flu complications, one of which was in Tampa Bay. The epidemic comes during a season where the flu vaccine was not well-matched to the predominant circulating flu strains. The Florida Health Department estimated that between 15% & 40% of the population is likely to develop the flu.

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Vulnerability

Epidemic/Pandemic			
Category		**Vulnerability***	**Risk***
Social (People, etc.)	Special Populations	Very Vulnerable	High
	Cultural Conditions	Vulnerable	High
	Socioeconomic Conditions	Vulnerable	High
Physical (Property, etc.)	Critical Infrastructure	Minimally Vulnerable	Low
	Key Resources	Vulnerable	High
	Building Stock	Minimally Vulnerable	Low
Community Conditions (Environment, Operations, etc.)	Economic Conditions	Vulnerable	High
	Social Conditions	Vulnerable	High
	Environmental Conditions	Minimally Vulnerable	Low
	Governmental Conditions (inc. Operations)	Somewhat Vulnerable	Medium
	Insurance Conditions	Somewhat Vulnerable	Medium
	Community Organizations	Somewhat Vulnerable	Medium

**Vulnerability ratings take in consideration baseline vulnerabilities described in THIRA Volume 2 with adjustment based on this specific hazard. Risk ratings consider probability & frequency, potential magnitude & scale, vulnerabilities, potential impacts, capabilities, and mitigation efforts related to this specific hazard.*

Physical Vulnerabilities

Physical structures, essential services, and other key community assets are not typically vulnerable to epidemics or pandemics.

Social Vulnerabilities

The most vulnerable population would depend on the unique features of the illness causing the epidemic or pandemic. With COVID-19, those with previous health conditions and the elderly were most at-risk as well as those special populations within lower socio-economic communities or densely populated communities that could not establish many protective social distancing measures. However, the entire population in Miami-Dade County is vulnerable to epidemics and pandemics, especially when considering the high levels of international travel and trade that occur within the county.

Frequency/Probability

The frequency and probability of an epidemic/pandemic is difficult to predict. As mentioned previously, in contrast to seasonal influenza when it occurs during the late fall and early winter months, pandemic influenza can occur during any month or season. Pandemic Influenza generally occurs in multiple waves (2 to 3) that last a period of six to eight weeks each.

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Data Sources

We have identified the following data sources as being important and comprehensive to the development of this plan and the accomplishment of our mitigation goals moving forward.

Federal Emergency Management Agency (FEMA)

- National Flood Insurance Program repetitive loss inventory.
- Flood Insurance Rate Maps, hurricane storm surge maps, and previous natural hazard computer modeling results.
- The FEMA website www.fema.gov has a wealth of accumulated data that can be extremely valuable in developing mitigation measures.

Other U. S. Government Databases and Information Sources

- National Hurricane Center and the National Oceanographic Atmospheric Administration (NOAA) historical storm related data (including, National Climatic Data Center).
- The National Weather Service Miami Forecast Office data files.
- National Hurricane Center “SLOSH” models.
- National Priorities List (NPL)
- Comprehensive Environmental Response, Compensation and Liability Information System List (CERCLIS – the “Superfund”)
- No Further Remedial Action Planned List (NFRAP)
- Emergency Response Notification System List (ERNS)
- RCRA Corrective Action Tracking System List (CORRACTS)
- Resource Conservation and Recovery Information System List (RCRIS)
- Hazardous Waste Data Management System List (HWDMS)
- Facility Index Data System List (FINDS)
- Toxic Release Inventory System List (TRIS)
- U. S. Immigration and Naturalization Service databases.

State of Florida

- Florida State University Department of Meteorology hurricane historical database.
- State-Funded Action Sites List (SFAS).
- State Sites List (SITES).
- Solid Waste Facilities List (SLDWST).
- Petroleum Contamination Tracking System Report (PCTS).
- Stationary Tank Inventory System List (TANKS).
- Hazardous Waste Compliance & Enforcement Tracking System List (COMHAZ).
- South Florida Water Management District (SFWMD).

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Miami-Dade County

- Municipal and County Emergency Management Plans and Comprehensive Plans.
- Municipal and County Floodplain Management Plans.
- Miami-Dade Stormwater Management Master Plan and Capital Improvements Projects.
- Miami-Dade County, Division of Environmental Resources Management (DERM) GIS database.
- Miami-Dade County, Information Technology Department, Critical Facilities Inventory and other GIS databases.
- Enforcement Case Tracking System Report (ECTS).
- Fuel Spill Report (FSPILL).
- Hazardous Waste Report (HW).
- Industrial Waste Reports.
- Underground Storage Tanks Report (UST).
- Agriculture extension services and databases.

Municipal Agencies

- Staff resources, records and data files.

Additional Resources

- The American Red Cross will provide information regarding shelters, as well as staff resources and records
- Internet web sites provided by the Florida Division of Emergency Management as part of the Local Mitigation Strategy Guidebook

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