Future Extreme Rainfall Projections Workshop

April 27, 2022
Welcome

Moderator: Yvette Bonilla
Housekeeping

Q&A Session

If you’re participating in person – please fill out Section 5 at the Technical Question / Public Comment Card and give to a meeting attendant

If you’re participating via Zoom – use the Q&A function to submit a written question
Housekeeping

Public Comments

If you’re participating in person – please fill out Section 6 at the Technical Question / Public Comment Card and give to a meeting attendant.

If you’re participating via Zoom – use the Raise Hand feature.

If you’re participating via Phone:
  *9 Raises Hand
  *6 Mutes/Unmutes

Moderator: Yvette Bonilla
1. Opening Remarks

Drew Bartlett
Executive Director
South Florida Water Management District
1. Opening Remarks

Wesley Brooks, Ph.D.
Chief Resilience Officer for the State of Florida
2. Resilient Florida Program and the Florida Flood Hub of Applied Research

Thomas K. Frazer, Ph.D.
Dean, College of Marine Science, University of South Florida
Director, Florida Flood Hub for Applied Research and Innovation
3. Extreme Rainfall Events as part of Flood Vulnerability Assessments

Carolina Maran, Ph.D., P.E.
District Resiliency Officer
South Florida Water Management District
Assessing Flood Vulnerability and Adaptation Solutions

- Flooding Risks
- Surface Water
- Coastal/Ocean
- Groundwater
- Rainfall
- Current Conditions
- Future Conditions
- Flood Vulnerability / Adaptation Solutions

Drivers:
- H&H Models/Components
- Drivers
- Scenarios

Presenters: Carolina Maran
SLR Projections – Reducing Uncertainty

<table>
<thead>
<tr>
<th>NOAA Curve/SLR (ft)</th>
<th>2017 (2040)</th>
<th>2022 (2040)</th>
<th>2017 (2060)</th>
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<td>2.30</td>
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<td>4.46</td>
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</table>

Global and Regional Sea Level Rise Scenarios for the United States

Virginia Key Tidal Station

Presenter: Carolina Maran
Rainfall Observations

Regional Rainfall
Changes in rainfall patterns will impact people and ecosystems by altering the amount of water in our region throughout the year.

Present: Carolina Maran
Shorter-term strategy: rainfall estimates based on available global climate model downscaled datasets.

Longer-term strategy: development of a Florida Regional Climate Model to capture particular conditions/mechanisms of rainfall occurrences in our State, including Tropical Storms and sea breeze contributions, among other important climatic processes.
Review of Past and Recent Attempts (shorter-term strategy)

- **Statistical Downscaling**
  - Bias-Corrected, Spatially Downscaled (USBR-BCSD) - SFWMD
  - Bias-Corrected, Constructed Analogs (USBR-BCCA) - SFWMD/Broward
  - Locally Constructed Analogs (LOCA) - SFWMD/Broward/USGS/FBC
  - Multivariate Adaptive Constructed Analogs (MACA) - USGS-FIU-SFWMD/FBC
  - Self Organizing Maps (SOM) (FIU, Penn State) - SFWM
  - Bias-Correction and Stochastic Analogs (UF) - USGS-FIU-SFWMD

- **Dynamical Downscaling**
  - NARCCAP (from NCAR) - Broward
  - Regional Spectral Model (RSM) (FSU) - Broward/USGS-FIU-SFWMD/FBC
  - NA-CORDEX - Broward/USGS-FIU-SFWMD

- **Hybrid (Analog) Downscaling - Jupiter Int. WRF** - Broward/USGS-FIU-SFWMD

- **Raw GCMs** - Broward
SFWMD’s Future Rainfall Needs and Applications – Resiliency Planning

INITIAL APPRAISAL REPORT FOR THE
CENTRAL AND SOUTHERN FLORIDA PROJECT
Conducted under Section 216 of the Flood Control Act of 1970, as amended

March 2020

FPLOS

Presenter: Carolina Maran
What information do we have today?

- Understanding future extreme rainfall conditions to aid planning practices and enhance flood vulnerability assessments.
- This is about event simulation scenarios (design storms) and not for long term simulation / regional planning efforts.
- This is not about average rainfall estimates or seasonality shifts into the future.
- This is not about estimating drought conditions into the future.
- This is not providing the necessary level of resolution that would be applicable to advance modernization of design criteria or to inform regulatory programs.
4. Development of Projected Depth-Duration-Frequency Curves (2050–2089)

Michelle M. Irizarry-Ortiz, P.E., CC-P
Hydrologist, USGS Caribbean-Florida Water Science Center
5. Q&A Session

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If you’re participating via Zoom – use the Q&A function to submit a written question

Moderator: Nicole Cortez
6. Adopting Future Rainfall Change Factors as part of SFWMD Resiliency Planning Efforts

TECHNICAL MEMORANDUM
ON THE ADOPTION OF FUTURE EXTREME RAINFALL CHANGE FACTORS FOR FLOOD RESILIENCY PLANNING

Carolina Maran, Ph.D., P.E.
District Resiliency Officer
South Florida Water Management District
How to best adopt these results?

Technical Memorandum: Future Extreme Rainfall Change Factors For Flood Resiliency Planning In South Florida

April 27, 2022

Incorporating Future Extreme Rainfall Change Factors in Flood Resiliency Planning

This memorandum identifies the first steps in an initiative to estimate future extreme rainfall change factors to help in the development and implementation of flood resiliency plans. The project applies a methodology developed by the Soil and Water Assessment Tool (SWAT) model under the South Florida Water Management District (SFWMD) and the U.S. Army Corps of Engineers.

The study uses future extreme rainfall change factors to evaluate the impacts of climate change on flood resiliency planning. These factors are estimated using climate models and hydrological models to assess the potential changes in rainfall patterns and the resulting flood hazards.

MAIN CONTENT

- Summarizes research findings supporting the adoption of future rainfall scenarios as part of flood resilient planning efforts in South Florida.
- Provides an overview of the analysis performed by the SFWMD to estimate future extreme rainfall change factors and incorporates the available results of the 2020 analysis.
- Addresses recommended actions from the workshop, Development of National Vision for Flood Resilience, to ensure climate-ready flood resilience measures for long-term planning.
- Provides insight into how the estimated rainfall change factors can be applied to impact flood risk models to assess potential impacts on flood vulnerability assessments.

APPROACH

- A climate change model was used to estimate extreme rainfall change factors for 18 counties and 18 coastal areas within the District boundaries.
- The study employed a hydrological model to assess the impact of future extreme rainfall change factors on flood protection levels of service (PLOD) and flood vulnerability assessments.

ACKNOWLEDGMENTS

This technical memorandum was made possible by the support and contributions of a dedicated team of individuals at the South Florida Water Management District, United States Geological Survey, and United States Army Corps of Engineers. We would like to especially acknowledge the technical feedback provided by the United States Geological Survey, Caribbean-Florida Water Science Center and Florida International University Sea Level Solutions Center, and express our appreciation to the Fisheating Creek Resilience Project Technical Working Group members who assisted with the preparation of this memorandum.

PROJECT TEAM

South Florida Water Management District
- Carolina Maran
  - District Resilience
- Nicole Center
  - District Resilience
- Francisca Peña
  - District Resilience
- Walter Wilcox
  - Hydrology and Hydraulics Modeling
- Jennifer Barnes
  - Hydrology and Hydraulics Modeling
- Hongying Zhao
  - Hydrology and Hydraulics
- Akin Owoyale
  - Hydrology and Hydraulics
- Karen Smith
  - Water Supply Planning
- Kastapha Estrada
  - Water Supply Planning
- Sean Scally
  - Applied Sciences
- Brian Truette
  - Applied Sciences
- Todd Kimberlan
  - Meteorological Operations

United States Army Corps of Engineers
- Cynthia Pollock
  - Jacksonville District
- Dave Osmat
  - Jacksonville District
- Matt Fisher
  - Jacksonville District

Get the latest information from SFWMD

United States Geological Survey

Connect with us on Facebook, Twitter, Instagram, LinkedIn, and YouTube

2111 Sun Club Road
Palm Beach, FL 33480

Call 911 in an emergency or visit safety.fws.gov/24-district-resilience
1. INCREASE IN FUTURE EXTREME RAINFALL: global climate models (GCMs) show consistent increases in the magnitude of future extreme rainfall occurrences for the 50-year future planning horizon represented by change factors larger than 1.0

2. RCP 4.5 AND RCP 8.5 EMISSIONS SCENARIOS: resulting change factors are slightly higher in RCP 8.5 than in RCP 4.5 for all downscaled datasets, and in both climate regions, and not statistically significant

3. INDIVIDUAL DOWNSCALED DATASETS: modeled and observed records for the historical period showed different degrees of agreement among the selected datasets and models, without any stand-out condition representing one single dataset that performs significantly better than others

Presenter: Carolina Maran
Overall Observations & Findings

4. ALL MODELS OR BEST MODELS: the comparison between a subset of best models versus all models showed different degrees of agreement. Best-models subset is biased towards the MACA results.

5. RESULT RANGES: noticeable wide spread of derived change factors, potentially a result of the relatively coarse resolution, difference between statistical and dynamic downscaling approaches, biases in historically fitted DDF curves, and scenario and models spread.

6. INDIVIDUAL RAINFALL STATIONS OR REGIONAL ANALYSES: There is noticeable variation between individual rainfall stations within rainfall areas.

Presenter: Carolina Maran
Overall Recommendations

1. INCREASING FUTURE EXTREME RAINFALL: change factors larger than 1.0 are to be adopted as part of scenario formulation.

2. RCP 4.5 AND RCP 8.5 SCENARIOS: observed overlap in the results for RCP 4.5 and RCP 8.5, combined change factors are to be adopted as part of scenario formulation.

3. ENSEMBLE ESTIMATES: model spread of all available results is to be adopted as part of scenario formulation, capturing upper and lower bounds of climate scenarios.
4. ALL MODELS: ensemble estimates based on all the model results, instead of the subset of best models, are to be adopted as part of scenario formulation.

5. 50% CONFIDENCE INTERVAL FOR MODEL SPREAD: 50% confidence interval is being adopted to represent model spread, by delineating a 25th to 75th percentile range, and to limit the scenario formulation process to the 50% confident / central tendency region around the median.

6. RESULTS BY REGION: median change factors across selected regions with respective spread are to be adopted as part of scenario formulation.
 Counties Future Rainfall Change Factors
(median and 50% confidence interval, 100-year/3-day and 25-year/1-day)

Future Rainfall Change Factors
25-yr 1-day Duration - Median and 50% Confidence Interval

St. Lucie County
Polk County
Palm Beach County
Osceola County
Orange County
Glades County
Hendry County
Highlands County
Hendry County
Collier County
Charlotte County
Broward County

Future Rainfall Change Factors
100-yr 3-day Duration - Median and 50% Confidence Interval

St. Lucie County
Polk County
Palm Beach County
Osceola County
Orange County
Glades County
Highlands County
Hendry County
Collier County
Charlotte County
Broward County

Presenter: Carolina Maran
Monroe County
Future (50-year) Extreme Rainfall Change Factors

Monroe County
Future (50-year) Extreme Rainfall Change Factors
6a. Adopting Future Rainfall Change Factors as part of SFWMD Resiliency Planning Efforts

FLOOD PROTECTION LEVEL OF SERVICE PROGRAM
“adding rainfall to the mix”

Akintunde Owosina, P.E.
Chief, Hydrology and Hydraulics Bureau
South Florida Water Management District
We have aging infrastructure approaching or past design end of life, in addition to changing conditions (land use, sea level rise, rainfall, groundwater levels)

- Do I replace them?
- When do I replace them?
- What do I replace them with
- Where and how?
- What liability or risk am I exposed to – due to action or inaction
- Who pays for the fix
- What assurances do I have, considering associated uncertainties?
Flood Protection Response

- Flood Protection Level of Service program:
  - Assess flood protection performance of flood control infrastructure
  - Support decision making on prioritizing improvements and adaptation

New Pump Station
C-7 Basin (Miami Dade)
Big Cypress Basin
Lower East Coast LOS Basins

Presenter: Akintunde Owosina
Three Phases of the FPLOS Program

**Phase 1: Assessment**
- Focus on Flood Control Assets in Primary system
- Identify flood vulnerable assets and regions

**Phase 2: Mitigation and Adaptation Planning**
- Focus on Primary, Secondary and Tertiary systems
- Collaboratively identify projects, operations or regulations to meet flood control needs

**Phase 3: Implementation**
- Design, permit and build identified projects to achieve resilient flood protection goals, integrated into the Sea Level and Flood Resiliency Plan

Presenter: Akintunde Owosina
Exposure Screening and Vulnerability Assessment

Presenter: Akintunde Owosina
Flooding depends on the location of water table

Presenter: Akintunde Owosina
With Higher Water Table Due to Sea Level Rise

*A rise in water table will reduce soil storage and rapid runoff during storms*
.. Then With Increase in Extreme Rainfall

*A rise in water table will reduce soil storage and rapid runoff during storms

Presenter: Akintunde Owosina
Two New Starts for FY2022

Upper Kissimmee Basin
- Land locked
- Significant development pressure
- Lake systems

Palm Beach County
- Coastal with large headwater tailwater difference
- Heavily managed
- Land use changes

Presenter: Akintunde Owosina
Flood Protection Level Of Service for Eastern Palm Beach County Watersheds

Started in April 2022

Objectives: to conduct a Flood Protection Level of Service analysis for seven watersheds in Palm Beach County: L-8, C-51 East, C-51 West, C-17, C-16, C-15 and W.P.B.

Major Products:
- Calibrated and validated hydrologic and hydraulic (H&H) model
- Assessment of current level of flood protection for existing infrastructure and for current sea level conditions.
- Assessment of future level of flood protection assuming current drainage infrastructure,
  - Future rainfall for different return Periods (Using change factor)
  - Three sea level rise scenario
  - Future land use and future groundwater
- Identify FPLOS deficiencies for different watersheds
Flood Protection Level Of Service for Upper Kissimmee Basin

Started in April 2022

**Objectives:** to conduct a Flood Protection Level of Service analysis for 26 watersheds in Upper Kissimmee Basin

**Major Products:**
- Calibrated and validated hydrologic and hydraulic (H&H) model
- Assessment of current level of flood protection for existing infrastructure
- Assessment of future level of flood protection assuming current drainage infrastructure,
  - Future rainfall for different return Periods (Using change factor)
  - Future land use and future groundwater level
- Identify FPLOS deficiencies for different watersheds
6b. Adopting Future Rainfall Change Factors as part of SFWMD Resiliency Planning Efforts

DATA APPLICATION: Sensitivity Tests at the C-8 And C-9 Basins, Using the Flood Protection Level of Service Integrated Hydrology and Hydraulics Modeling

Francisco Peña, Ph.D.
Resiliency Project Manager, SFWMD
Courtesy Post-Doc, Florida International University
Sensitivity Analysis

Overview:

- Rainfall Change Factor Thresholds: 20%, 30%, 40%, 50%, and 75%
- Assess the potential future rainfall impacts in northern Miami-Dade County (C-9 Basin) and southern Broward County (C-8 Basin), for a 3-day design events of 100-year recurrence frequency to evaluate current conditions (CC) and SLR with 1, 2, and 3-ft impacts

<table>
<thead>
<tr>
<th>Rainfall Change Factor Threshold</th>
<th>Increases in Water Elevation (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C-8 Profile (PM1)</td>
</tr>
<tr>
<td>20%</td>
<td>≈ 0.1 – 0.25</td>
</tr>
<tr>
<td>30%</td>
<td>≈ 0.25 – 0.4</td>
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<tr>
<td>40%</td>
<td>≈ 0.4 – 0.55</td>
</tr>
<tr>
<td>50%</td>
<td>≈ 0.55 – 0.7</td>
</tr>
<tr>
<td>75%</td>
<td>≈ 0.7 – 1.0</td>
</tr>
</tbody>
</table>

Table 1: Relationship between rainfall change factors and increased flood depths for the C-8 profile, C-9 profile, and across both basins combined.
C-8 and C-9 Basin
Results:

- Consistent increase pattern in peak stage profiles as result of rainfall increase
- Downstream reach is limited to enforced simulated tidal boundary conditions at S-28 Structure (red arrow)
- Coastal Structure operational limitations play a key role in allowing the tidal conditions to influence the canal levels upstream
Results:

- Consistent increase pattern with C8 Canal:
  - 20% - 0.2 ft
  - 30% - 0.3 ft
  - 40% - 0.4 ft
  - 50% - 0.5 ft
  - 75% - 0.75 ft

- Downstream reach is limited to enforced simulated tidal boundary conditions at S-29 Structure (red arrow)
Results:

- Root Mean Square Difference (RMSD) was selected to measure differences across the profile.

- Different combinations of rainfall change factors and SLR can produce "similar" water surface elevation on "inland" portion of canal (red arrow).
PM5- Overland Flooding

Figure 2: Overland inundation map for 100-year 72-hour design storm event for current conditions with a range of rainfall change factor thresholds.

Total Flood Area Under Current Conditions for C-8 & C-9

<table>
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<tr>
<th>Value Range (feet)</th>
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<th>cc_40</th>
<th>cc_50</th>
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<td>20.56%</td>
<td>18.17%</td>
<td>15.29%</td>
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<td>22.31%</td>
<td>21.79%</td>
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<td>13.72%</td>
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<td>5.14%</td>
<td>5.48%</td>
<td>5.94%</td>
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<td>4.32%</td>
<td>4.72%</td>
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<td>2.70%</td>
<td>2.92%</td>
<td>3.05%</td>
<td>3.16%</td>
<td>3.45%</td>
<td>4.07%</td>
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<td>1.75 - 2.00</td>
<td>2.88%</td>
<td>2.56%</td>
<td>2.57%</td>
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<td>15.80%</td>
<td>17.04%</td>
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Presenter: Francisco Peña
PM5- Overland Flooding

Figure 2: Overland inundation map for 100-year 72-hour design storm event for current conditions with a 20% and 75% rainfall change factor thresholds

Presenter: Francisco Peña
Figure 1: Overland inundation map for 100-year 72-hour current conditions for a 20% and 75% rainfall increase change factor

Presenter: Francisco Peña
Figure 1: Overland inundation map for 100-year 72-hour current conditions for a 20% and 75% rainfall increase change factor.
Results:

- Rainfall change factors increase overland flooding depths across both basins (0.25 ft to 1.0 ft)
- Most vulnerable areas:
  - Locations subject to riverine flooding due to overbank flow
  - Low elevation, coastal and transition zones
- Flood Depths:
  - Urban areas within 8 miles (1.0 ft to 1.50 ft)
  - Coastal zones (up to 2.25 ft)
Lessons Learned

A- The basins mostly experience low to moderate flooding conditions, producing spread out inundation across both Basins

B- Transitions Zones across low elevation inland and coastal zones are highly vulnerable to compound flood hazards (rainfall + tides + water table)

C- It is possible to produce equivalent/similar outcomes of rainfall increase with SLR scenarios to assess inland flooding conditions*

D- Next Steps: Incorporate additional Performance Metrics and replicate effort in other basins

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*Presenter: Francisco Peña
6c. Adopting Future Rainfall Change Factors as part of SFWMD Resiliency Planning Efforts

DATA ACCESSIBILITY:
Resilience Metrics Hub

Nicole A. Cortez
Resiliency Coordinator
South Florida Water Management District
District Resiliency

Ensuring the Region’s Water Resources and Ecosystems Resilience Now and in the Future

The South Florida Water Management District is strongly committed to addressing the impacts of climate change, including rising sea levels, changing rainfall and flood patterns, and as such, has named its first District Resiliency Officer, Carolina Macan, Ph.D., P.E. The current resiliency efforts focus on assessing how sea level rise and extreme events, including flood and drought events, happen under current and future climate conditions, and how they affect water resources management. The District is also making significant infrastructure adaptation investments that are needed to successfully implement its mission of safeguarding and restoring South Florida’s water resources and ecosystems, protecting communities from flooding, and ensuring an adequate water supply for all of South Florida’s needs. Working to ensure the region’s water resources and ecosystems resiliency, now and in the future, is part of everything the District does.

Actions
- Resilience and Flood Protection
- Resilience and Water Supply
- Resilience and Ecosystem Restoration

Metrics
The South Florida Water Management District is implementing Water and Climate Resilience Metrics to track and document trends in its relevant water and climate observed data. These efforts support the identification of current and future climate condition scenarios, operational decisions, and District resiliency priorities.

Upcoming Workshop
The SFWMD Future Extreme Rainfall Projections Public Workshop will present the proposed adoption of future extreme rainfall projections by the SFWMD, developed in collaboration with the USGS Caribbean-Florida Water Science Center (CFWSC) and Florida International University. This effort builds on long-term observed rainfall data and available Global Climate Models downscaling datasets and constitutes a first step in developing future rainfall projections for South Florida. The adoption of future extreme rainfall scenarios supports the District’s mission and resiliency priority efforts and will provide unified resources for partner agencies and local government in South Florida. This meeting is for technical experts and researchers, planners, water managers, and is open to the public.

Meeting Agenda
Zoom Registration Link
Water and Climate Resilience Metrics

As part of our ongoing resilience initiatives, the District developed a set of Water and Climate Resilience Metrics to track and document shifts and trends in District-managed water and climate observed data. These efforts support the assessment of current and future climate condition scenarios, operational decisions, and District resiliency priorities. The District published the Water and Climate Resilience Metrics Final Report in December 2021.

The District's commitment to resiliency includes informing stakeholders, the public, and partner agencies to support local resiliency strategies. Visit the [Resilience Metrics website](#) to learn more about the data driving the District's resiliency efforts.

The first Water and Climate Resilience Metrics Public Workshop was hosted on January 22, 2021.

- [Presentation](#)
- [Video](#)

The second Water and Climate Resilience Metrics Public Workshop was hosted on December 17, 2021.

- [Presentation](#)
- [Video](#)
- [Report](#)
Water and Climate Resilience Metrics

The South Florida Water Management District is strongly committed to addressing the impacts of sea level rise and a changing climate. The District's resilience efforts support its mission of safeguarding and restoring South Florida's water resources and ecosystems, protecting communities from flooding, and ensuring we are able to meet South Florida's water needs while connecting with the public and stakeholders.

Objectives

As part of the suite of Water Resilience Indicators addressing changing conditions, the District is developing a suite of water and climate resilience metrics to track progress. These science-based metrics are being developed with the goal of tracking and documenting shifts and trends in District-managed water and climate-related data, measuring the performance of current and future climate change scenarios, and assist in operational decisions, and informing stakeholders, investors, and policymakers. As part of the District's communications and public engagement strategies, this effort informs stakeholders, the general public, and partner agencies about the District's needs and efforts, while also promoting new policy strategies. This page was designed as a living page and will be updated as necessary. Check back frequently for updated data and resilience information.

Emerging Trends in Regional Resiliency

- **Regional Rainfall**
  Changes in rainfall patterns will impact people and ecosystems by altering the amount of water our region has throughout the year.

- **Elevations at Coastal Structures and Sea Level Rise**
  Tidal and freshwater inflows to coastal structures represent how sea level rise affects freshwater recharge capacity in South Florida.

- **Saltwater Intrusion in Coastal Aquifers**
  The inland migration of saltwater poses a threat to water supply and critical freshwater habitats.

- **Salinity in the Everglades**
  The salt injection of semiarid freshwater systems poses threats to several factors.

- **Tellusine and Mangrove Inland Migration**
  Tidal erosion on Seminole Island raises the question to the impacts of sea level rise in coastal areas and the Everglades.

- **Sea Subsidence in South Florida**
  Maintenance of wetlands within coastal and wetland habitats, as sea level changes, is an indicator of long-term stability of coastal wetlands.
Future Outlook in Regional Resiliency

Presenter: Nicole Cortez
Extreme Rainfall Change Factors for Resiliency Planning in South Florida

Presenter: Nicole Cortez
**Tool Description**

This tool provides access to future extreme rainfall change factors for resiliency planning for the 16 counties and 14 rainfall areas within SFWMD boundaries, as well as the Everglades National Park rainfall area, and an additional combined rainfall area for the Florida Keys and Biscayne Bay.

**How to Use the Data**

The estimated change factors available in this tool apply only to NOAA Atlas 14 precipitation frequency estimates to represent future extreme rainfall conditions in the period centered around 2070, based on historical period around 1966-2005. The 50th percentile confidence interval represents the spread of change factors and median for each area, the range of uncertainty is outlined by the 25th and 75th percentile limits.

The data should not be applied to Atlas 14 values that have a different period than the available results (1966-2005) and no OF data was available from Atlas 14. These change factors do not represent changes in future rainfall average conditions, either seasonally or annually, nor for estimating drought conditions into the future. Different change factors were estimated for each return period and duration to be applied as part of event simulations and are not representative of regional long-term simulations.

**Original Data Source**

Zip file will download
If you’re participating in person – please fill out Section 5 at the Technical Question / Public Comment Card and give to a meeting attendant.

If you’re participating via Zoom – use the Q&A function to submit a written question.

Moderator: Nicole Cortez
8. Break

Great Blue Herons
by Michelle Irizarry-Ortiz

Krista Romita Grocholski, Ph.D.
Physical Scientist,
RAND Corporation

Alan Cohn
Managing Director,
Integrated Water Management,
NYC Department of Environmental Protection

Jordan Fischbach, Ph.D.
Director of Planning and Policy Research,
The Water Institute of the Gulf

Moderator: Carolina Maran

FUTURE PROJECTED INTENSITY-DURATION-FREQUENCY (IDF) CURVES FOR THE CHESAPEAKE BAY WATERSHED AND VIRGINIA

Krista Romita Grocholski, Ph.D.
Physical Scientist,
RAND Corporation
DESIGNING AND IMPLEMENTING GREEN INFRASTRUCTURE PROJECT WITH CONSIDERATION OF FUTURE RAINFALL PROJECTIONS ADOPTED IN NEW YORK CITY

Alan Cohn
Managing Director, Integrated Water Management, NYC Department of Environmental Protection
EVALUATING THE BENEFITS AND COSTS OF GREEN STORMWATER INFRASTRUCTURE IN PENNSYLVANIA’S NEGLEY RUN WATERSHED

Jordan Fischbach, Ph.D.
Director of Planning and Policy Research, The Water Institute of the Gulf
Recording Breaking Rains in 2021

Tropical Storm Elsa: July 8-9
- Max 1-hr rainfall rate: 2.75 to 3 in/hr

Tropical Storm Henri: August 21-23
- Central Park reported 4.45 inches of rain on Aug. 21 alone, with 1.94 inches falling between 10 to 11pm.

Tropical Storm Ida: September 2
- The Central Park rain gauge set a new record for 1-hour rainfall with 3.15 inches (previously 1.94 in. from Tropical Storm Henri)
Critical equipment is being designed for climate change.
Extreme rainfall risk is the latest to be made public

Sea level rise + coastal storms
- Projections: Downscaled sea level rise projections available
- Mapping: Future flood mapping under development; FEMA flood mapping well understood

Extreme Heat
- Projections: Downscaled heat wave projections available
- Mapping: Heat vulnerability index encourages prioritized mitigation

Extreme Rain
- Projections: Average increases available, rainfall intensity projections to be studied further
- Mapping: Maps of areas most vulnerable to flooding from extreme rain

Presenter: Alan Cohn
NYC Stormwater Flood maps

- ~2 inch/hr rain + 2.5 ft sea level rise (2050s high estimate)
- ~3.5 inch/hr rain + 4.8 ft sea level rise (2080s high estimate)
Applying the “cloudburst management” approach

- **RISK**: Where does water come from? Where are the risks?
- **POTENTIAL**: Where can water be stored?
- **TERRAIN**: Where does the water flow? Where should it flow?
- **FRAMES**: What can we (not) accept?
- **SYNERGY**: Where can we improve urban connectivity?

**Cloudburst road**
- Used to convey water where the terrain is favourable.

**Cloudburst pipe**
- Used to convey water where the terrain does not permit BGI projects.

**Central retention**
- Used to retain water in a larger area connected to other BGI projects.

**Retention street**
- Used to retain water where the terrain is favourable.

**Local retention**
- Used to retain water in larger areas from roofs and local surroundings.
Using rainfall projections for cloudburst design

### 1-hour duration rainfall depths

<table>
<thead>
<tr>
<th>End of useful life</th>
<th>5-year design storm (in)</th>
<th>50-year design storm (in)</th>
<th>100-year design storm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>1.61</td>
<td>2.57</td>
<td>2.87</td>
</tr>
<tr>
<td>Through to 2039</td>
<td>1.83</td>
<td>3.02</td>
<td>3.41</td>
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<tr>
<td>2040-2069</td>
<td>1.97</td>
<td>3.33</td>
<td>3.93</td>
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<tr>
<td>2070-2099</td>
<td>2.12</td>
<td>3.74</td>
<td>4.34</td>
</tr>
</tbody>
</table>

#### 10-year 2.30

### 24-hour duration rainfall depths

<table>
<thead>
<tr>
<th>End of useful life</th>
<th>5-year design storm (in)</th>
<th>50-year design storm (in)</th>
<th>100-year design storm (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>4.70</td>
<td>7.83</td>
<td>8.79</td>
</tr>
<tr>
<td>Through to 2039</td>
<td>5.41</td>
<td>9.21</td>
<td>10.55</td>
</tr>
<tr>
<td>2040-2069</td>
<td>5.88</td>
<td>10.13</td>
<td>12.31</td>
</tr>
<tr>
<td>2070-2099</td>
<td>6.35</td>
<td>11.28</td>
<td>13.40</td>
</tr>
</tbody>
</table>
Pilot Project: South Jamaica Houses

Features:
- Grassy areas and basketball court that infiltrate stormwater and fill up in heavier rain events
- Enhancement of walking paths, lighting, and benches near basketball courts

Design Criteria:
- 2.30" in an hour (10-Year Design Storm over a duration of 1 hour)
- Based on 2040-2069 projected 10-Year event

Capacity:
- Approximately 300,000 gallons (40,000 cf)

Status:
- 100% Design completed
- Construction anticipated in late 2023
Drainage pipes will be diverted from the sewer
South Jamaica Houses “Cloudburst” Pilot Project
Cloudburst Pilot Projects

Clinton Houses

Beach 67th Street

Legend
- In Design
- Conceptual

South Jamaica Houses

Sayres Ave. & St. Albans Park

St. Albans/Addisleigh Park

Presenter: Alan Cohn

Krista Romita Grocholski, Ph.D.
Physical Scientist, RAND Corporation

Alan Cohn
Managing Director, Integrated Water Management, NYC Department of Environmental Protection

Jordan Fischbach, Ph.D.
Director of Planning and Policy Research, The Water Institute of the Gulf

Moderator: Carolina Maran
Panel Discussion Takeaways

- Relevance of Determining Future Rainfall Estimates
- Comparable approaches adopted throughout the U.S.
- Incorporation of rainfall projections into design and regulation
- Uncertainty ranges and risk levels – decision making and communicating effectively
- Different ways of looking at the data and assuming uncertainty
- Other efforts going on in Florida, e.g. Planning Councils and Florida Building Commission
10. Development of Future Climate Scenarios for Regional Hydrologic Simulations in South Florida and Statewide Florida Building Commission Extreme Rainfall Results

Jayantha T. Obeysekera Ph.D., P.E.
Director & Research Professor
Sea Level Solutions Center, Institute of Environment
Florida International University
Development of Future Climate Scenarios for Regional Hydrologic Simulations in South Florida

Sponsor:
South Florida Water Management District
Project Managers: Jenifer Barnes, Walter Wilcox
Scenario Development Approach

- Climate Model Data (native resolution)
  - Re-mapping to SFWMM (2x2) resolution
    - Model Culling using Climate Indices
      - Best Models for Each Climate Region
    - Statistical Analysis of current and future periods
      - Selection of Scenarios and Corresponding Models

DRAFT RESULTS - The data presented here are under development and have not yet been reviewed and published.
# Model Culling: Metrics

<table>
<thead>
<tr>
<th>ID</th>
<th>Indicator Name</th>
<th>Definition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRcptot</td>
<td>Annual total precipitation</td>
<td>Annual total, days &gt; 1mm</td>
<td>inches</td>
</tr>
<tr>
<td>Pmmean</td>
<td>Seasonal Pattern</td>
<td>Mean monthly rainfall</td>
<td>inches</td>
</tr>
<tr>
<td>Wstart</td>
<td>Wet Season Start Date</td>
<td>Start of the Wet Season</td>
<td>days</td>
</tr>
<tr>
<td>R10mm</td>
<td>Heavy precipitation days</td>
<td># of days with &gt; 10mm</td>
<td>days</td>
</tr>
<tr>
<td>R20mm</td>
<td>Heavy precipitation days</td>
<td># of days with &gt; 20mm</td>
<td>days</td>
</tr>
<tr>
<td>Sdii</td>
<td>Daily intensity index</td>
<td>Ratio Annual precipitation / # wet days</td>
<td>inches/day</td>
</tr>
<tr>
<td>Cdd</td>
<td>Consecutive dry days</td>
<td># max. consecutive days &lt; 1 mm</td>
<td>days</td>
</tr>
<tr>
<td>Cwd</td>
<td>Consecutive wet days</td>
<td># max. consecutive days &gt; 1 mm</td>
<td>days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>Indicator Name</th>
<th>Definition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX1day</td>
<td>Max 1-day precipitation amount</td>
<td>Annual maxima of 1-day precipitation</td>
<td>inches</td>
</tr>
<tr>
<td>R95p</td>
<td>Very wet days</td>
<td>Annual precip from days &gt; 95%</td>
<td>inches</td>
</tr>
<tr>
<td>R99p</td>
<td>Extreme wet days</td>
<td>Annual precip from days &gt; 99%</td>
<td>inches</td>
</tr>
<tr>
<td>RX3day</td>
<td>Max 3-day precipitation amount</td>
<td>Annual maxima of 3-day precipitation</td>
<td>inches</td>
</tr>
<tr>
<td>RX5day</td>
<td>Max 5-day precipitation amount</td>
<td>Annual maxima of 5-day precipitation</td>
<td>inches</td>
</tr>
<tr>
<td>RX7day</td>
<td>Max 7-day precipitation amount</td>
<td>Annual maxima of 7-day precipitation</td>
<td>inches</td>
</tr>
<tr>
<td>RX10day</td>
<td>Max 10-day precipitation amount</td>
<td>Annual maxima of 10-day precipitation</td>
<td>inches</td>
</tr>
</tbody>
</table>

*Draft results – These data are under development and have not yet been reviewed and published.*
Total Precipitation (Entire SFWMD Region)

DRAFT RESULTS – These data are under development and have not yet been reviewed and published.

Presenter: Jayantha Obeysekera
CORDEX and Seasonality

DRAFT RESULTS – These data are under development and have not yet been reviewed and published.

Presenter: Jayantha Obeysekera
### Scenarios by Dataset

#### LOCA

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Model #</th>
<th>Percentile</th>
<th>Average Rainfall (inches)</th>
<th>Model Name</th>
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<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>5%</td>
<td>41.36</td>
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<tr>
<td>2</td>
<td>5</td>
<td>25%</td>
<td>46.44</td>
<td>pr_CCSM4_r6i1p1_rcp85_2006-2100</td>
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<tr>
<td>3</td>
<td>4</td>
<td>50%</td>
<td>50.18</td>
<td>pr_CanESM2_r1i1p1_rcp85_2006-2100</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>75%</td>
<td>52.14</td>
<td>pr_HadGEM2-CC_r1i1p1_rcp85_2006-2100</td>
</tr>
<tr>
<td>5</td>
<td>29</td>
<td>95%</td>
<td>56.97</td>
<td>pr_MRI-CGCM3_r1i1p1_rcp85_2006-2100</td>
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</table>

#### MACA

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Model #</th>
<th>Percentile</th>
<th>Average Rainfall (inches)</th>
<th>Model Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21</td>
<td>5%</td>
<td>42.97</td>
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<td>2</td>
<td>25</td>
<td>25%</td>
<td>48.45</td>
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<td>3</td>
<td>24</td>
<td>50%</td>
<td>52.58</td>
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<tr>
<td>4</td>
<td>18</td>
<td>75%</td>
<td>54.17</td>
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</tr>
<tr>
<td>5</td>
<td>39</td>
<td>95%</td>
<td>60.28</td>
<td>macav2metdata_pr_MRI-CGCM3_r1i1p1_rcp85</td>
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</tbody>
</table>

#### CORDEX

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Model #</th>
<th>Percentile</th>
<th>Average Rainfall (inches)</th>
<th>Model Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>5%</td>
<td>49.10</td>
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<td>2</td>
<td>18</td>
<td>25%</td>
<td>51.91</td>
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<tr>
<td>3</td>
<td>14</td>
<td>50%</td>
<td>55.82</td>
<td>EC-EARTH.RCA4.day.NAM-44i.mbcn-gridMET</td>
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<tr>
<td>4</td>
<td>21</td>
<td>75%</td>
<td>57.86</td>
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<tr>
<td>5</td>
<td>51</td>
<td>95%</td>
<td>62.80</td>
<td>MPI-ESM-MR.CRCM5-UQAM.day.NAM-22i.mbcn-Daymet</td>
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</table>

DRAFT RESULTS – These data are under development and have not yet been reviewed and published.
Evapotranspiration

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Model #</th>
<th>Percentile</th>
<th>Average Temperature (deg C)</th>
<th>Model Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>5%</td>
<td>31.4</td>
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<tr>
<td>2</td>
<td>6</td>
<td>25%</td>
<td>31.8</td>
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<td>3</td>
<td>15</td>
<td>50%</td>
<td>32.0</td>
<td>tasmax_GFDL-ESM2G_r1i1p1_rcp85</td>
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<tr>
<td>4</td>
<td>20</td>
<td>75%</td>
<td>32.5</td>
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<td>14</td>
<td>95%</td>
<td>33.0</td>
<td>tasmax_GFDL-CM3_r1i1p1_rcp85</td>
</tr>
</tbody>
</table>

DRAFT RESULTS – These data are under development and have not yet been reviewed and published.

Presenter: Jayantha Obeysekera
Statewide Florida Building Commission Extreme Rainfall Results

Sponsor:
Florida Building Commission
Hurricane Research Advisory Committee

Presenter: Jayantha Obeysekera
Methodology

- Same Climate Model Datasets, Statistical Methods used in the USGS/SFWMD/FIU research on South Florida
- Alternative presentation of results for aggregated climate divisions for the entire state

Presenter: Jayantha Obeysekera
# Metrics of Evaluation

<table>
<thead>
<tr>
<th>Name</th>
<th>Name</th>
<th>Definition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRCPTOT</td>
<td>Annual total wet days</td>
<td>Annual total, days &gt; 1mm</td>
<td>inches</td>
</tr>
<tr>
<td>R10mm</td>
<td>Heavy precipitation days</td>
<td># of days with &gt; 10mm</td>
<td>days</td>
</tr>
<tr>
<td>R20mm</td>
<td>Heavy precipitation days</td>
<td># of days with &gt; 20mm</td>
<td>days</td>
</tr>
<tr>
<td>SDII</td>
<td>Daily intensity index</td>
<td>Ratio Annual / # wet days</td>
<td>inches</td>
</tr>
<tr>
<td>CDD</td>
<td>Consecutive dry days</td>
<td>#max. consecutive days &lt; 1 mm</td>
<td>days</td>
</tr>
<tr>
<td>CWD</td>
<td>Consecutive wet days</td>
<td>#max. consecutive days &gt; 1 mm</td>
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</tr>
<tr>
<td>RX1day</td>
<td>Max 1-day precip amount</td>
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<td>Annual precip from days &gt; 95% %</td>
<td>Inches</td>
</tr>
<tr>
<td>R99p</td>
<td>Extreme wet days</td>
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<td>Max 1-day precip amount</td>
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<tr>
<td>RX10day</td>
<td>Max 1-day precip amount</td>
<td>Annual maxima of 10-day precip</td>
<td>inches</td>
</tr>
</tbody>
</table>

Presenter: Jayantha Obeysekera
Median Change Factor (NEAR Term)
FBC’s Statewide Study
High Level Results Comparison to SFWMD TM Results

Change Factors (100-year/3-day Duration)

Climate Region 4
- 1.53 (75th Percentile/SFWMD)
- 1.26 (Median/SFMWD)
- 1.04 (25th Percentile/SFWMD)

Climate Region 5
- 1.48 (75th Percentile/SFWMD)
- 1.24 (MACA Median/FBC)
- 1.17 (CORDEX Median - FBC)

Notes: FBC’s estimates are based on best models within each downscaled dataset, for the far period (2060-2099). SFWMD TM estimates are based on the ensemble for all models for all downscaled datasets, for the period centered within 2050-2089. The FBC's CORDEX estimates do not reflect the latest revised CORDEX results.

Presenter: Jayantha Obeysekera
11. Next Steps – Statewide Regional Climate Projections

Adam Blalock
Deputy Secretary for Ecosystems Restoration
Florida Department of Environmental Protection
11. Next Steps – Statewide Regional Climate Projections

Regional climate model data for historical and projected climate using 10-km regional coupled ocean-atmosphere model and 2-km Weather Research and Forecasting Model, derived from state-of-the-art climate models centered over Florida and its watersheds/aquifers, that can reproduce rainfall drivers in Florida and more accurately represent future rainfall totals, seasonal, average, extreme dry and extreme wet.

- Support for Section 380.093 F.S. Resilient Florida’s Statewide Flood Vulnerability Assessment
- Accessible statewide regional climate projections web portal and local governments engagement
- Scientist-Stakeholder Workgroup Recommendations Report
- Future rainfall depth duration frequency curves and other estimated data summaries
Project Highlights:

• develop a high-resolution coupled ocean-atmosphere model

• produce comprehensive analysis of extremes and estimates of climate projection with reduced uncertainty

• involve stakeholders, so outcomes are actionable and fully utilized

• support effective, adaptive, and resilient operational, infrastructural decisions

• allow for informed planning for adaptation/mitigation measures at local and regional levels, integrated to coastal risk strategies (sea level rise driven)

Presenter: Adam Blalock
11. Next Steps – Statewide Regional Climate Projections

Tirusew Asefa, Ph.D., Ph.D., P.E., D.WRE, F.ASCE
Chair, Florida Water and Climate Alliance
System Decision Support Manager, Tampa Bay Water
12. Q&A Session

If you’re participating in person – please fill out Section 5 at the Technical Question / Public Comment Card and give to a meeting attendant.

If you’re participating via Zoom – use the Q&A function to submit a written question.
13. Public Comments

If you’re participating in person – please fill out Section 6 at the Technical Question / Public Comment Card

If you’re participating via Zoom – use the Raise Hand feature

If you’re participating via Phone –
*9 Raises Hand
*6 Mutes/Unmutes
14. Closing Remarks

Carolina Maran, Ph.D., P.E.
District Resiliency Officer
South Florida Water Management District
Subscribe for District Resiliency Updates

- Sign-up for our updates by visiting https://www.sfwmd.gov/news-events and following these steps:
  1. Click on the “Subscribe for Email” icon
  2. Enter your email address
  3. Select “District Resiliency” under Subscription Topics
Thanks for participating!