



Resilience Steering Committee Countywide Risk Assessment and Resilience Plan

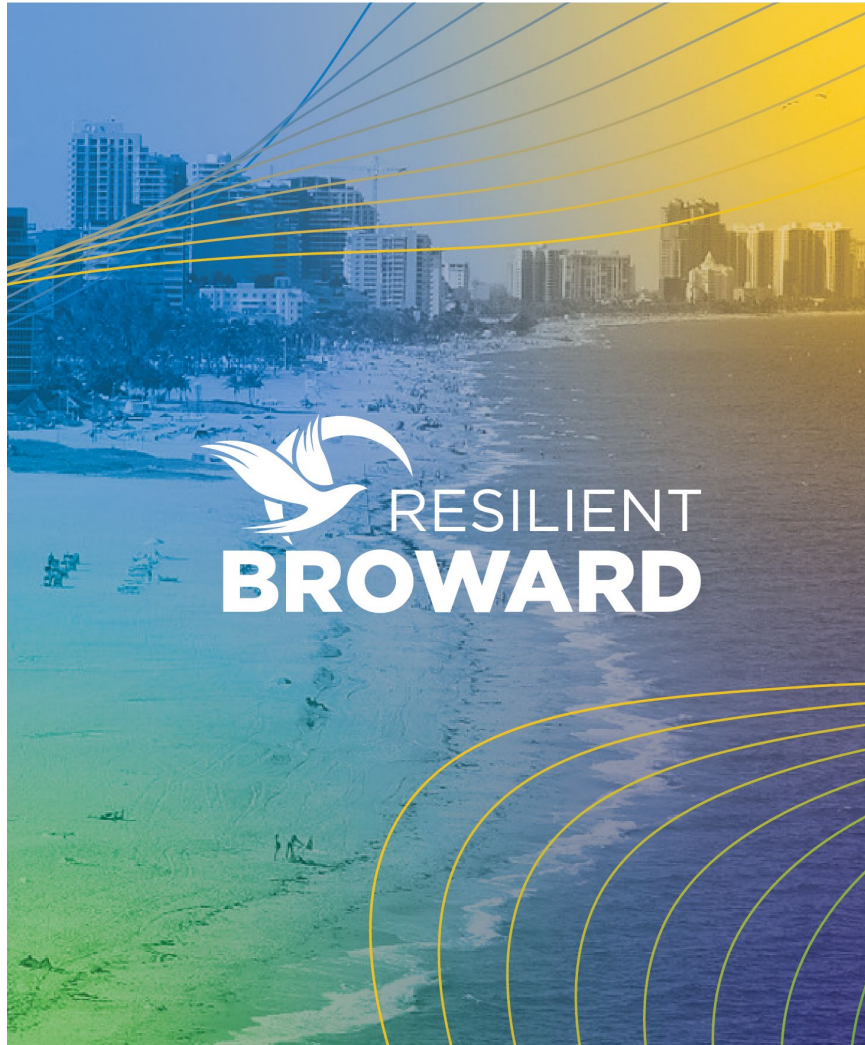
February 8, 2023



Outline



1. **Update on Economic Modeling**
2. **Update on Hydrologic Modeling**
3. **Update on County Asset Analysis**
4. **Coordination with Blue Ribbon Panel**
5. **Next Steps**



1

Update on Economic Modeling

Hazen

Broward County Risk Assessment and Resilience Plan

Introduction to Input Output Model



Recap: we are quantifying the socioeconomic risks from flooding under the County's Resilience Plan, relative to a "do nothing" approach

Scenarios

"Do nothing"

Resilience Plan

Model modules



Short-term economic losses

- Sales revenue
- Gross value add by sector
- Employment & incomes
- Profits
- Tax revenue



Increased flood insurance (NFIP) premia

- NFIP premia
- NFIP affordability
- NFIP coverage
- Uninsured property damages



Lower real estate values

- Property value



County fiscal risks

- Property tax revenue



Economic feasibility analysis

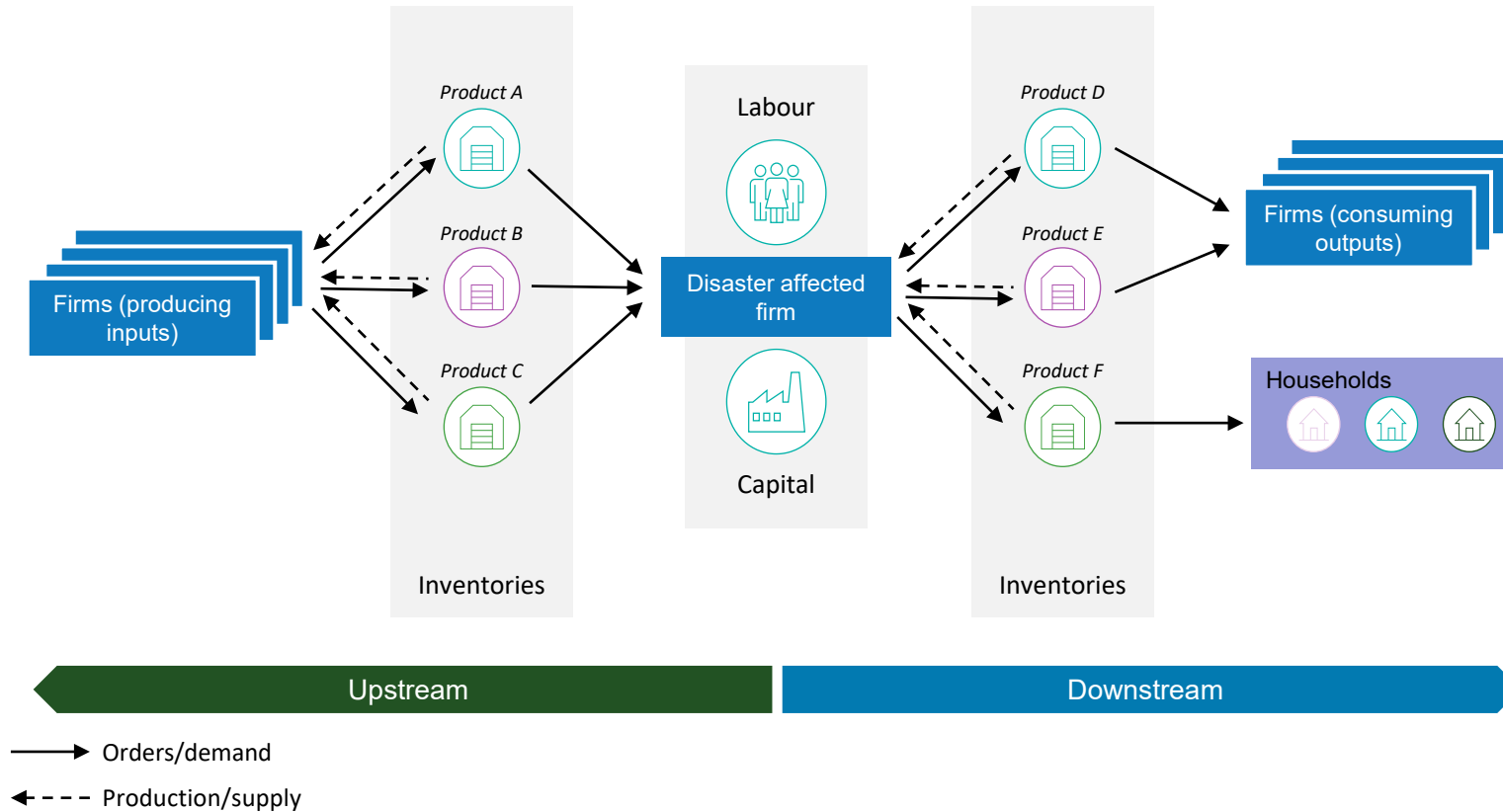
We will use the Vivid Adaptive Regional Input Output model to simulate the post-disaster economy to assess the short-term economic losses

V-ARIO models the second-order impacts of disasters to assess economy-wide risks



The model relies on input-output tables which reveal transaction linkages within an economy

Economic linkages between firms and households



- V-ARIO models indirect impacts via **economic linkages** derived from input output tables
- Linkages show how disasters can cause **downstream disruptions** and **upstream demand contractions**
- **Product inventories** allow for buffers in the presence of supply disruptions
- Indirect losses also occur due to capacity **constraints and rationing**

Source: Vivid Economics, adapted from Guan et. al. 2020. *Global supply-chain effects of COVID-19 control measures*

V-ARIO simulates the path of economic activity from a “shock” until the return to equilibrium

Indirect impacts can be reported for changes in:



Firm profits



Tax receipts



Labour incomes



Employment



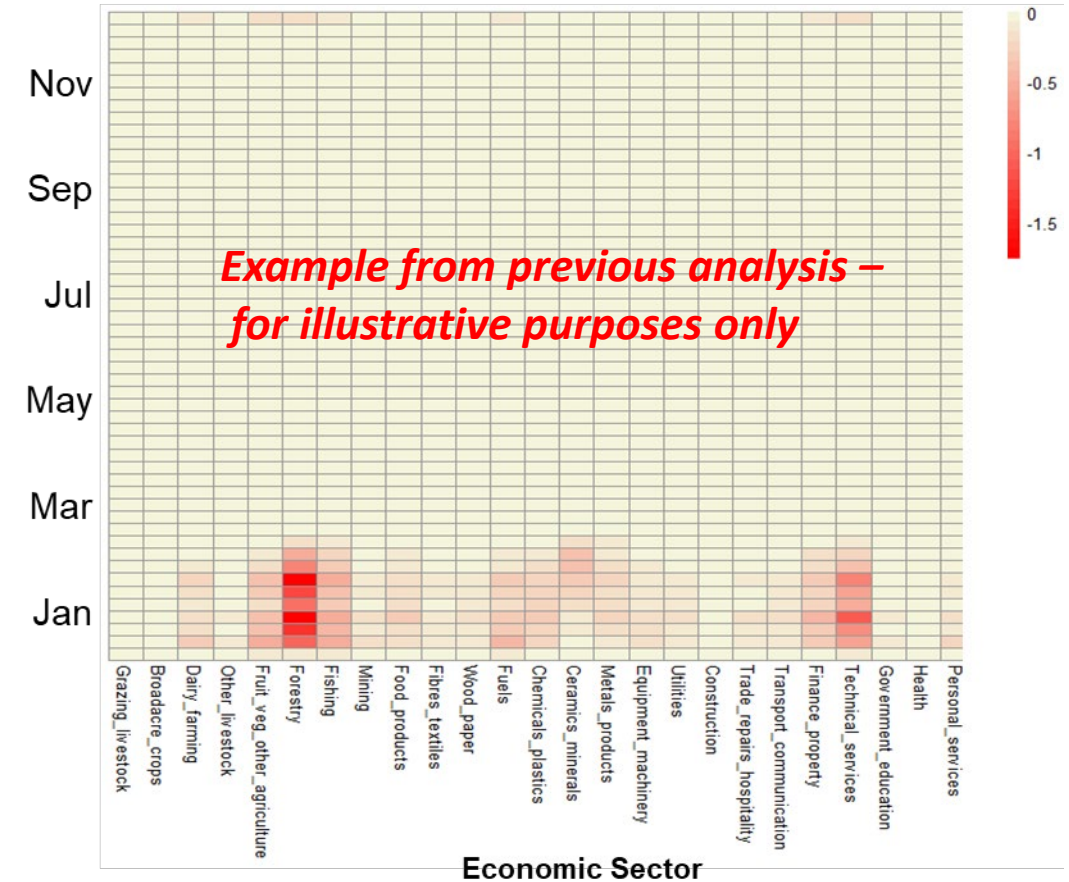
Gross Value Add,
Gross Domestic
Product

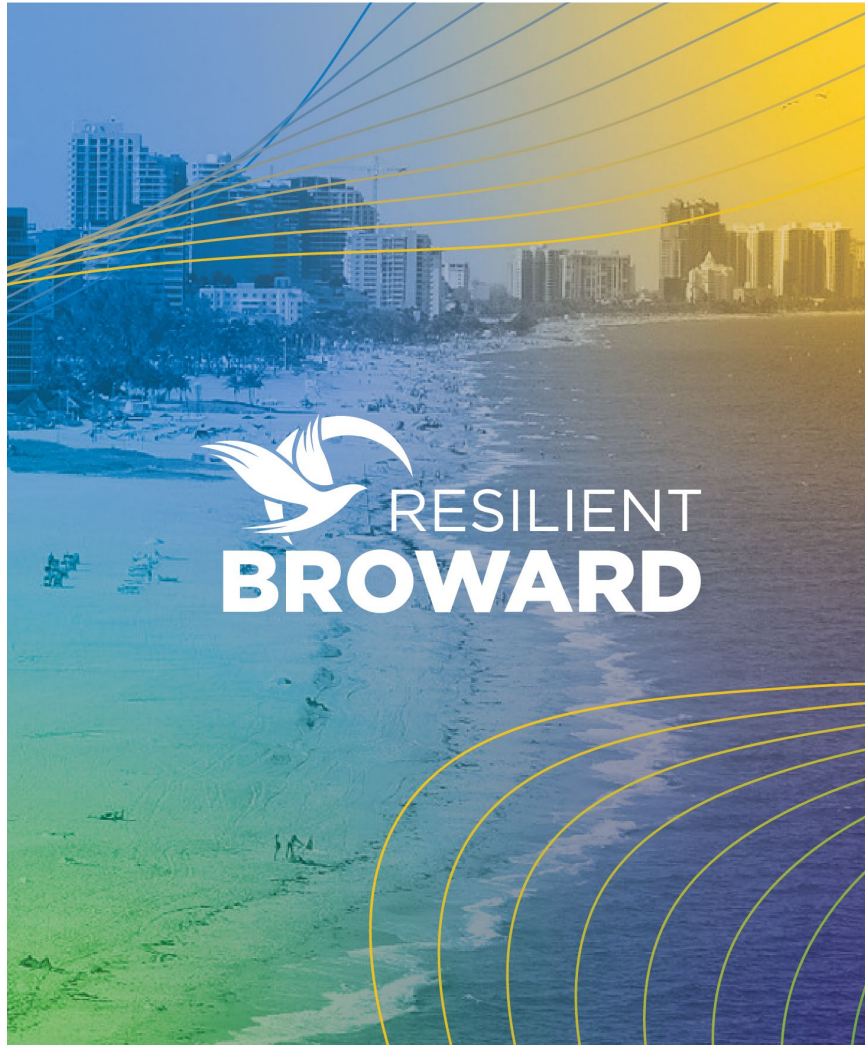
With outputs reported for different time periods, to track path to recovery



Economic losses due to impacts of extreme heat on labour over an average year by 2050

% change in Gross Value Added from baseline





2

Update on Hydrologic Modeling

Update – Model Refinement

Model eastern boundary extension



Addition of canals



Impervious areas



- Image training process

Drainage routing revision



- Guided by collected stormwater data

Groundwater layering reduction for efficiency



Model numerical stability tests



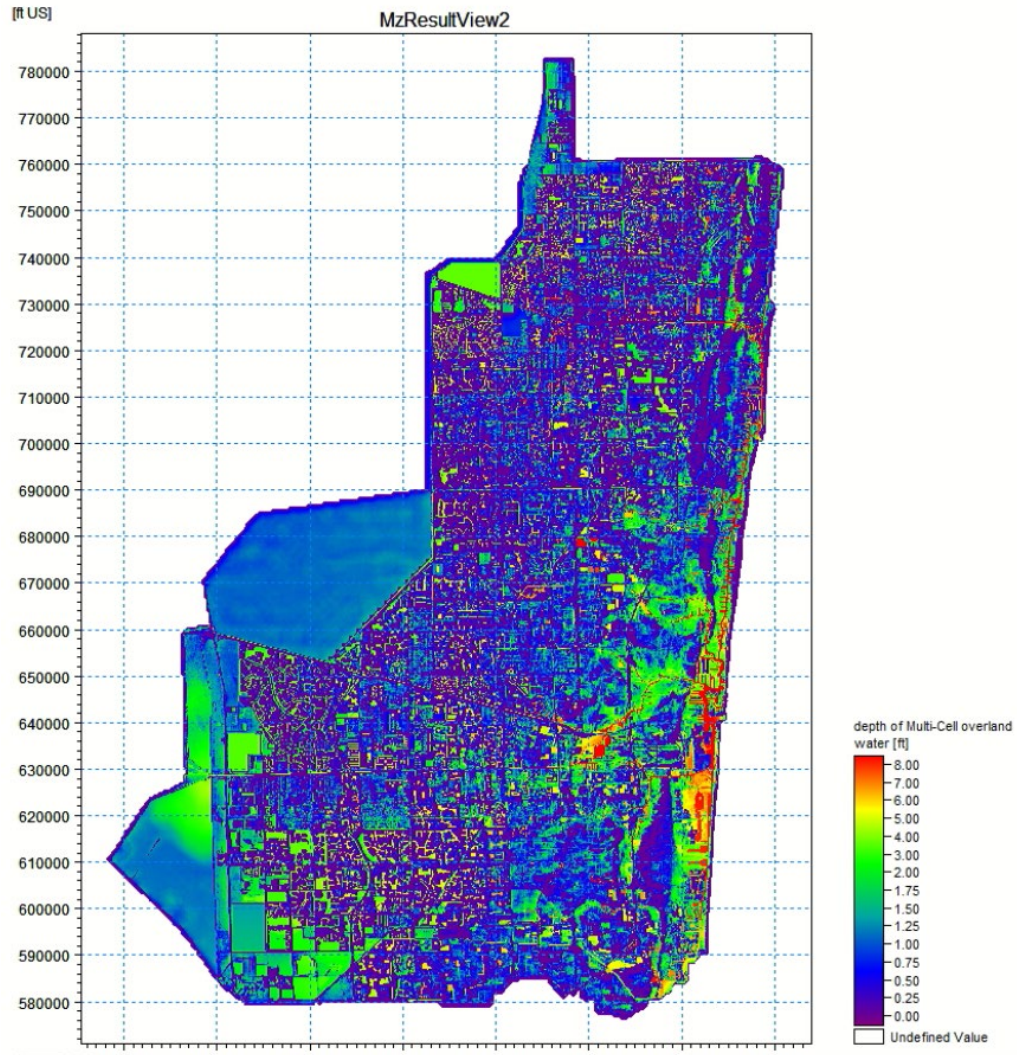
- Use a maximum stress scenario



Model Refinement – Continued

Review of Tidal Structures Configuration	<input checked="" type="checkbox"/>
Develop Model Configuration to Represent GW Saturated Conditions	
• Setup, run and post-process model runs	<input checked="" type="checkbox"/>
• Discuss with BC-RED the results for different configurations and select preferred configuration	In progress
Run No-Action Scenarios	
• 24+ Resilience Plan Scenarios (including sunny day flooding and higher frequency events scenarios).	In progress
• 30 Vulnerability Assessment Scenarios	
Coordination with SFWMD (FPLOS) and USACE (C&SF Project)	In progress throughout the project

Sample Preliminary Results



Next slide will present a video of the model results showing Water Depth for Scenario RP-18

- Rainfall : 100-yr storm event
- Sea Level Rise : 3.3-ft
- Surge : 100-yr
- Groundwater Condition: Fully Saturated

The video shows the map of Broward County and adjacent areas. On the map, the **change of water depth through time** during the event is shown using a color ramp. Purple is zero depth; **red being the highest depth.**

The video shows the effect of the tidal fluctuation before the storm. Towards the middle of the video, it shows the effect of the surge as it happens simultaneously with the rainfall event. After the peak of the storm, water levels start to recede, although very slowly.

Event simulations, boundary conditions, outputs

RESILIENCE PLAN SCENARIOS

RP-1	25-yr	2.0 ft	Variable GW	
RP-2	50-yr			
RP-3	100-yr		Saturated System	
RP-4	25-yr	2.0 ft	Variable GW	
RP-5	50-yr			
RP-6	100-yr		Saturated System	
RP-7	25-yr	2.0 ft	Variable GW	
RP-8	50-yr			
RP-9	100-yr		Saturated System	
RP-10	25-yr	3.3 ft	Variable GW	
RP-11	50-yr			
RP-12	100-yr		Saturated System	
RP-13	25-yr	3.3 ft	Variable GW	
RP-14	50-yr			
RP-15	100-yr		Saturated System	
RP-16	25-yr	3.3 ft	Variable GW	
RP-17	50-yr			
RP-18	100-yr		Saturated System	
RP-19	3-day 10-yr + 20%	2.0 ft	Variable GW	
RP-20				
RP-21				
RP-22				
RP-23				

Event simulations, boundary conditions, outputs

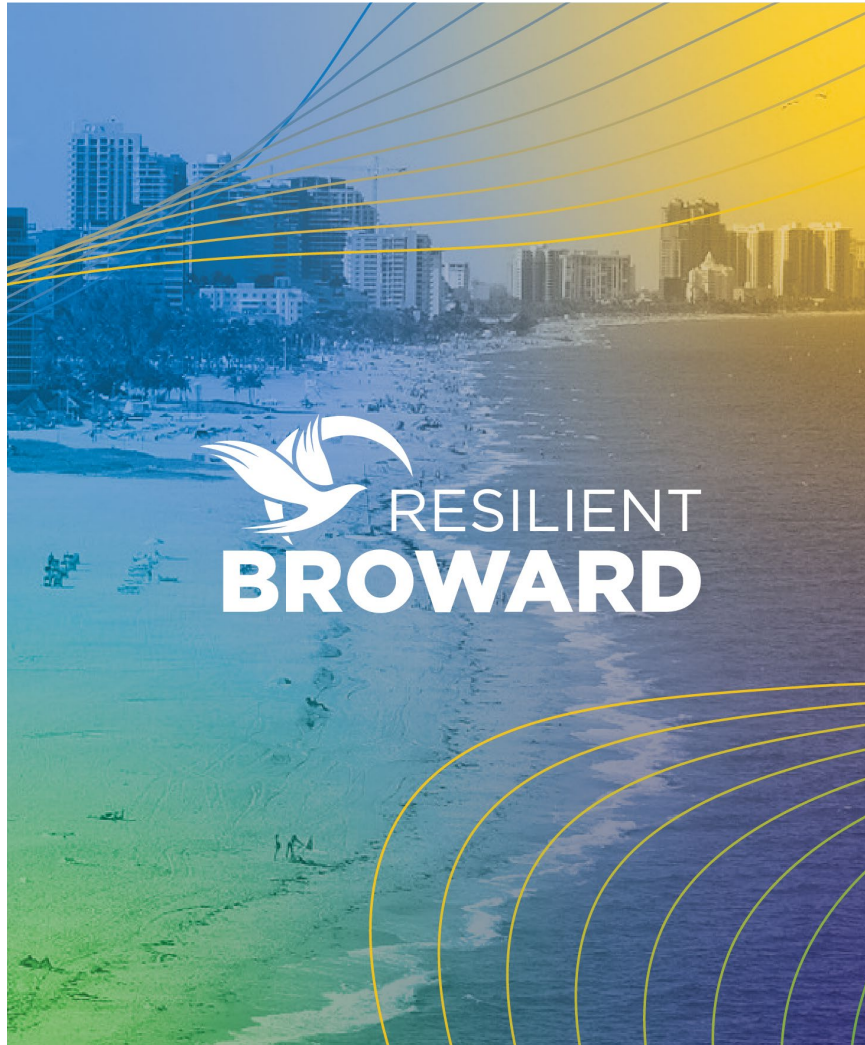
VULNERABILITY ASSESSMENT SCENARIOS

Scenario No.	Rainfall	Sea Level Rise Projection	Planning Horizon	Tidal Condition	
VA-1	10-yr	N/A	2021 - Current	Normal High Tide	
VA-2	25-yr				
VA-3	100-yr				
VA-4	10-yr	2017 NOAA Intermediate Low	2040		
VA-5	25-yr				
VA-6	100-yr				
VA-7	10-yr	2017 NOAA Intermediate High	2070		
VA-8	25-yr				
VA-9	100-yr				
VA-10	10-yr	2017 NOAA Intermediate Low	2021 - Current		Storm Surge (Cat 5)
VA-11	25-yr				
VA-12	100-yr				
VA-13	10-yr	2017 NOAA Intermediate High	2040		
VA-14	25-yr				
VA-15	100-yr				
VA-16	10-yr	N/A	2070		
VA-17	25-yr				
VA-18	100-yr				
VA-19	10-yr	2017 NOAA Intermediate Low	2021 - Current		
VA-20	25-yr				
VA-21	100-yr				
VA-22	10-yr	2017 NOAA Intermediate High	2040		
VA-23	25-yr				
VA-24	100-yr				
VA-25	10-yr	2017 NOAA Intermediate Low	2070		
VA-26	25-yr				
VA-27	100-yr				
VA-28	10-yr	2017 NOAA Intermediate High	2021 - Current		
VA-29	25-yr				
VA-30	100-yr				

Stakeholder engagement and coordination continues throughout the project

Our hydrologic modelers participated in workshops/charettes.

- U.S. Army Corps of Engineers (USACE) / Broward County RED/SFWMD. A coordination meeting was held to make sure model refinements are updated across projects. A follow-up workshop will be scheduled for the second week of February.
- U.S. Army Corps of Engineers USACE / South Florida Water Management District (SFWMD) Planning Charette for the Central and Southern Florida (C&SF) Flood Resiliency Project on January 11 and 12. Follow up meetings scheduled for February 15.

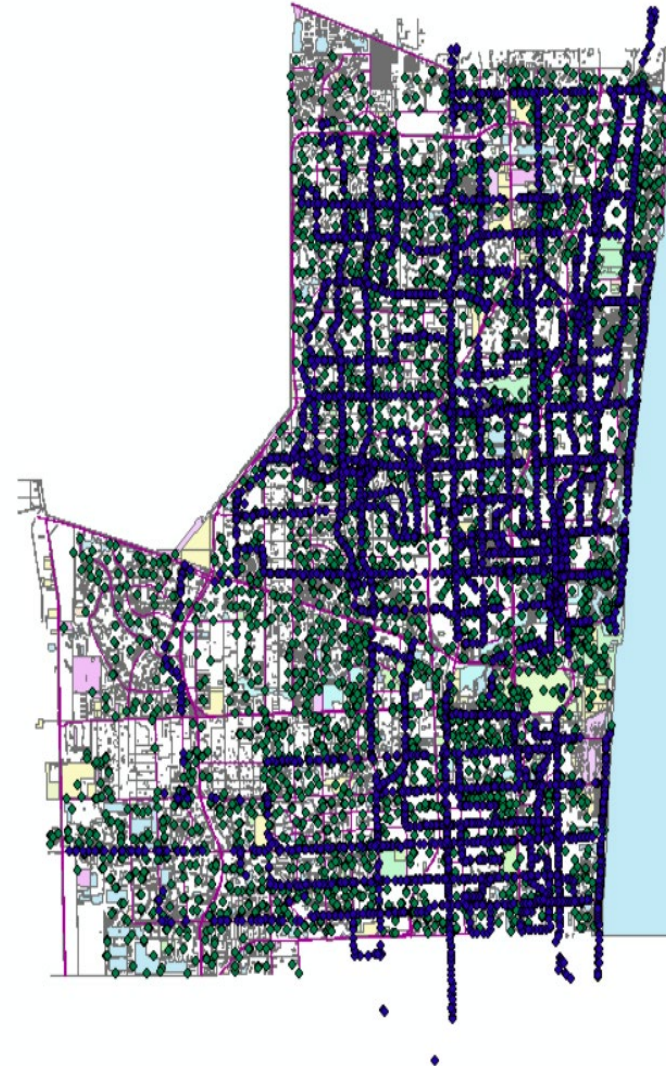


3

Update on County Asset Analysis

The GIS data received from the County's previous Vulnerability Assessment Study is extensive.

- 155 layers
- 33 types of layers
- Over 20,000 features



Hazen reviewed the data and prepared a TM entitled “Identification of Critical Infrastructure Methodology” for analyzing the critical assets.



CUMMINS | CEDERBERG
Coastal & Marine Engineering

Lou Aurigemma

Hazen discussed with the subconsultants on January 5th and with County on Jan 17th

Hazen will continue Task 3 – County Asset Analysis in parallel with the other tasks.

- Develop the final critical asset layers in GIS (following County’s final review and input on the methodology)
- Collect finished floor elevations
- Analyze the assets

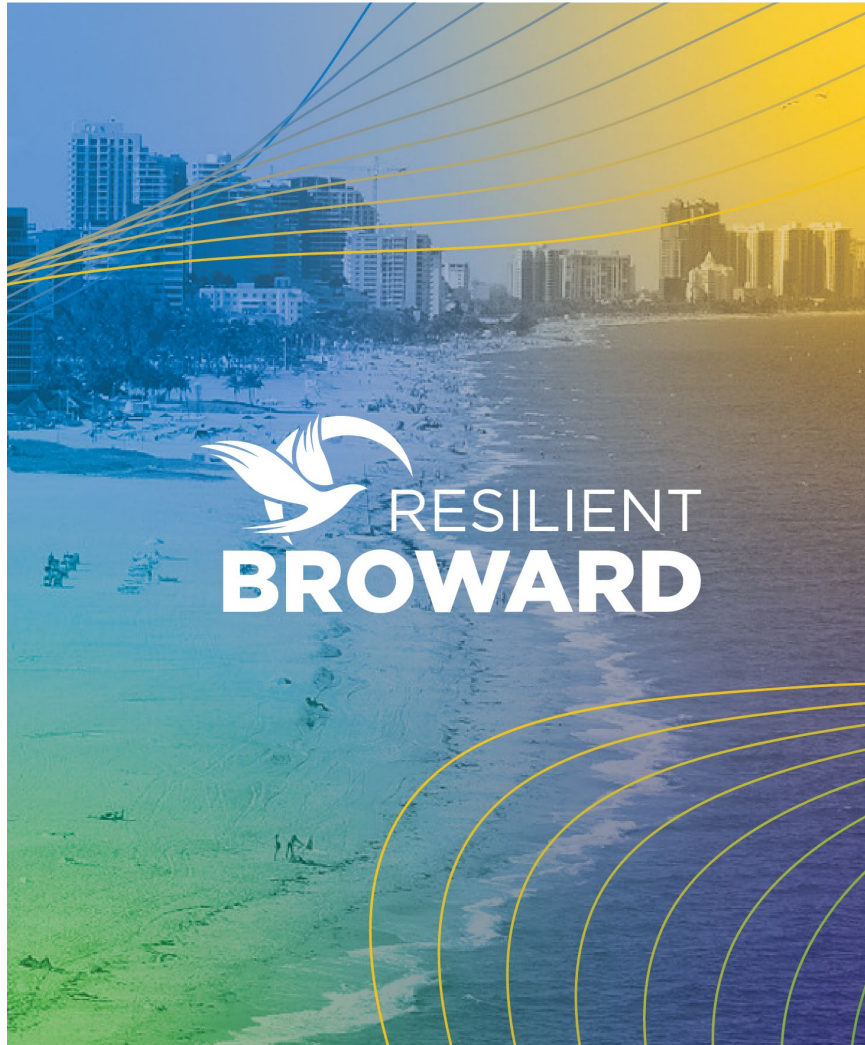


- Continue to meet internally to develop potential adaptation strategies
 - Compile resources and organize these strategies
 - Develop conceptual asset site-specific adaptation plans



- Develop capital planning checklists





4

Coordination with
Blue Ribbon Panel

Hazen

Engagement of our Blue Ribbon Panel is under way



Daniel Stander



Michael Sukop, PhD



Hugh Roberts, PE



Cheryl Holder, MD



Jeff Hébert



Rowan Douglas, CBE

- Risk Modeling
- Social Equity
- Equitable Redevelopment
- Hydrology/Hydraulics
- Climate Change
- Economics

Hydrologic and Climate Change SME's met with Hydrologic modeling leaders

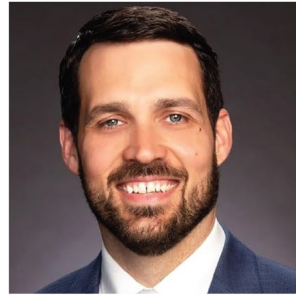
BRP Hydrologic and Climate Change SME's



Daniel Stander



Michael Sukop, PhD



Hugh Roberts, PE

Feedback from SME's

- Interest in the type of events modeled and the value in vulnerability assessment and resilience planning
- Interest in the manner in which groundwater impact was modeled
- Interest in further information on "machine learning" used in model refinement
- Interest in assignment of probability (including compound probability) to scenarios (Hugh Roberts provided some journal material)

Economic and Social Equity SME's meeting planned for February

BRP Economic and Social Equity SME's



Daniel Stander



Cheryl Holder, MD

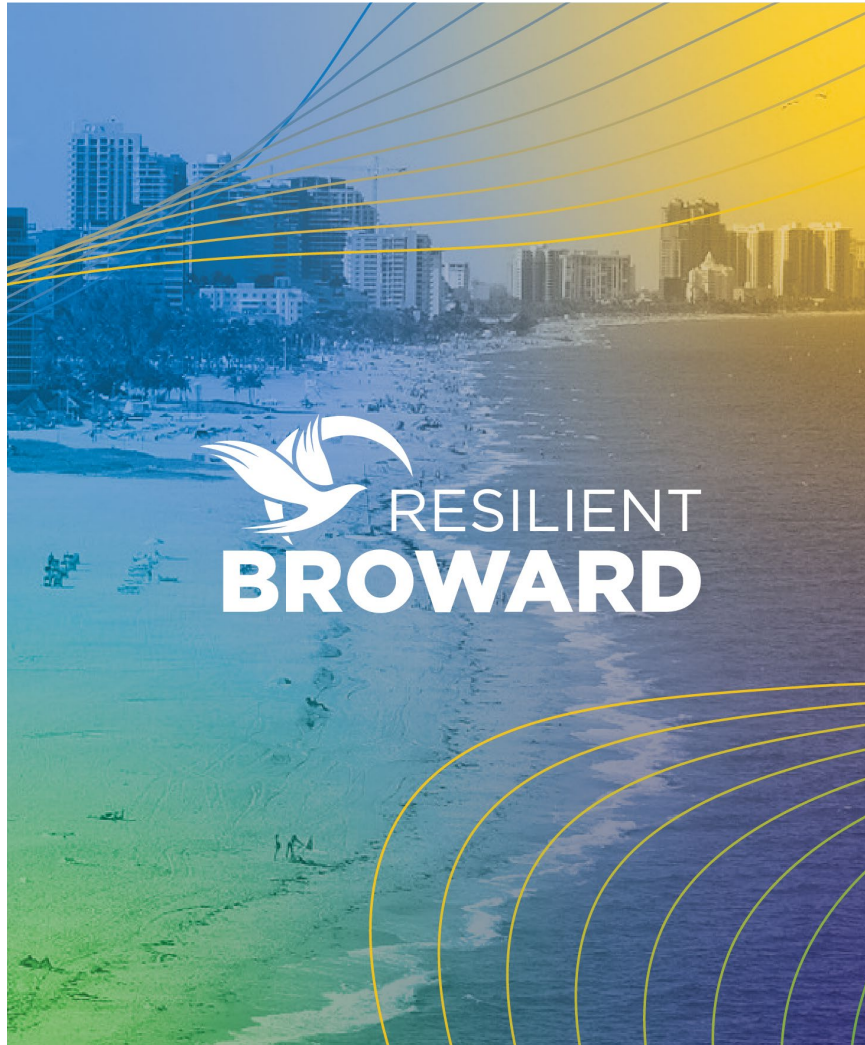


Jeff Hébert



Rowan Douglas, CBE

Feedback similar to that from the Hydrologic SME's will be sought.

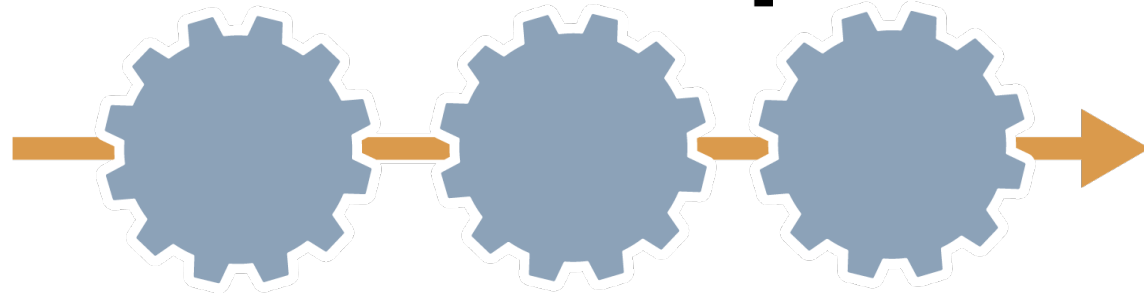


5
Next Steps

Over the course of the two months before we meet again in April, we expect the following progress...

- Completion of Task 2 (Hydrologic Modeling – no action)
- Completion of Task 3 (County Asset Analysis) with exception of Task Summary Memorandum
- Progress on Task 4 (Economic Modeling) - methodology complete and about 50% through Development of Modeling Package

Next Steps



Next Steps Specific to Task 2 Hydrologic Modeling

- Within the next few days, the Hazen Team will run modeling scenarios after selecting the methodology used to represent fully saturated conditions (all scenarios are setup and ready to run).
- Hazen will present the Model Calibration and Results at the February 17th, Broward County Technical Advisory Committee meeting. Hazen will also participate in coordination meetings with the USACE and SFWMD related to the modeling tools used in this project and to the planning activities within the Central and Southern Florida (C&SF) Flood Resiliency Project
- Hazen will compare flooding levels with finish floor elevation of structures, determine level of damages for each parcel for each scenario, and aggregate cost of damages to calculate annual average damages based on the compound probability of each simulated scenario.

Next Steps Specific to Task 3 Asset Analysis

- County will approve methodology by mid-February; Hazen will then analyze assets
- Hazen will work with County to Setup Design Phase Project and Checklist Development meetings with select departments for February and March dates
 - a. Construction management
 - b. Facilities
 - c. Parks and Recreation
 - d. Highway Construction and Engineering
 - e. Other?
- Hazen will develop six site specific adaptation plans in March/April



The checklists for capital project planning supporting similar municipal projects: will be a shared tool

Additionally, our team will be meeting internally in February to further develop strategic planning and stakeholder engagement...

HR&A

Munich RE 

McKinsey
& Company

WillisTowersWatson 



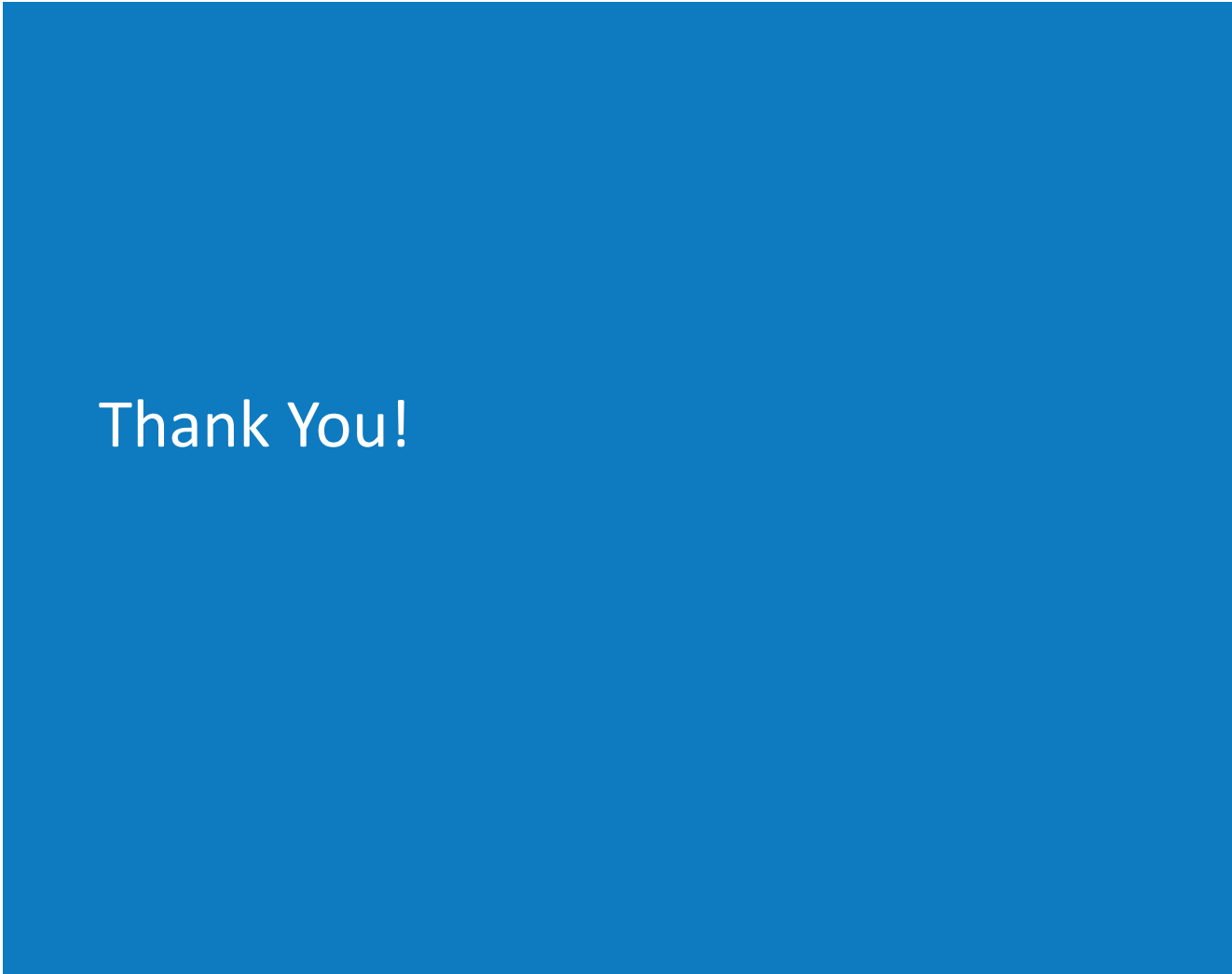
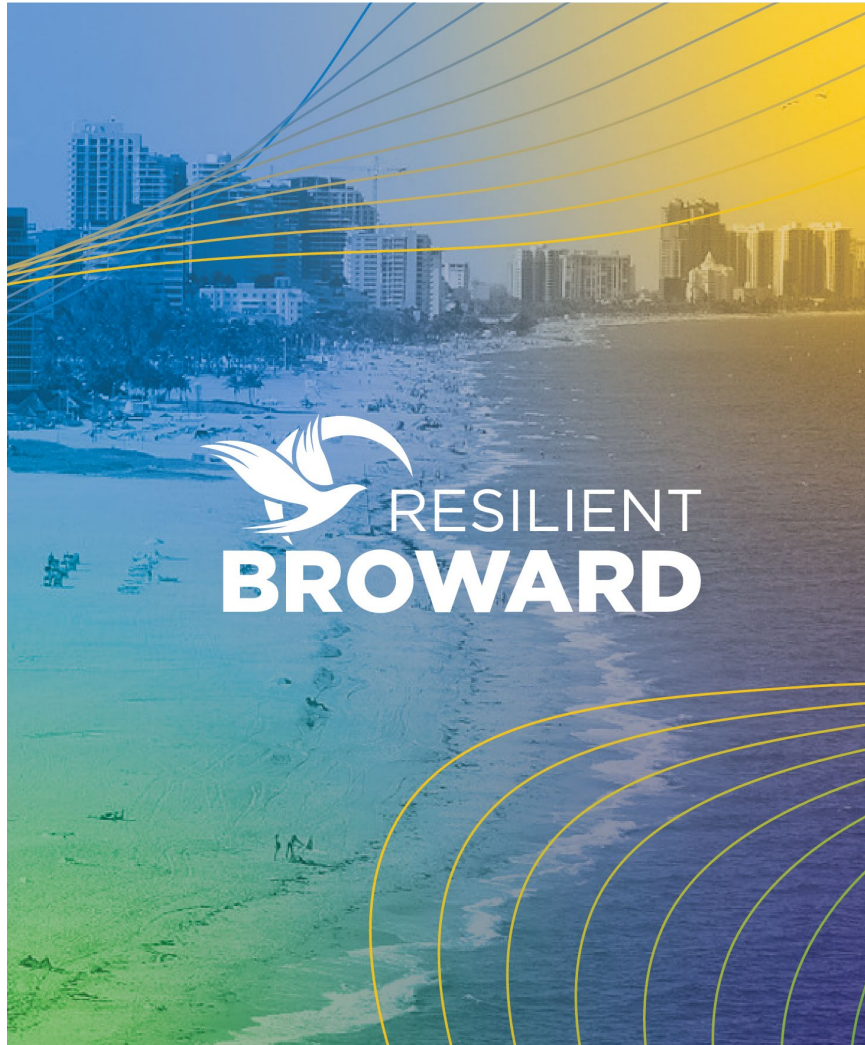
Daniel Stander



 Climate
Resilience
Consulting

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...as well as interact with the economic, socio-economic, and reinsurance experts.



Hazen