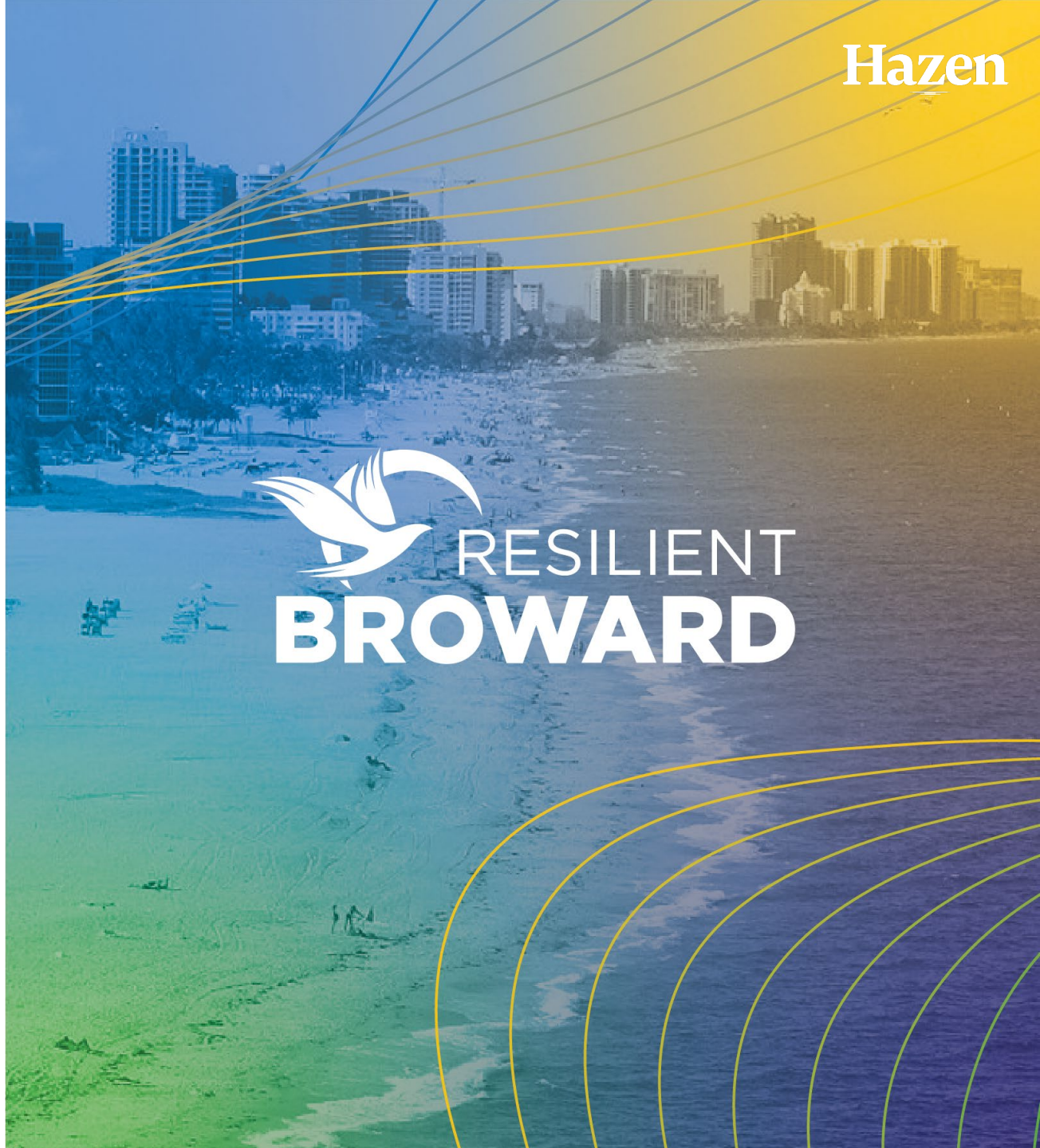
COUNTYWIDE RISK ASSESSMENT AND RESILIENCE PLAN

Resilience Steering Committee

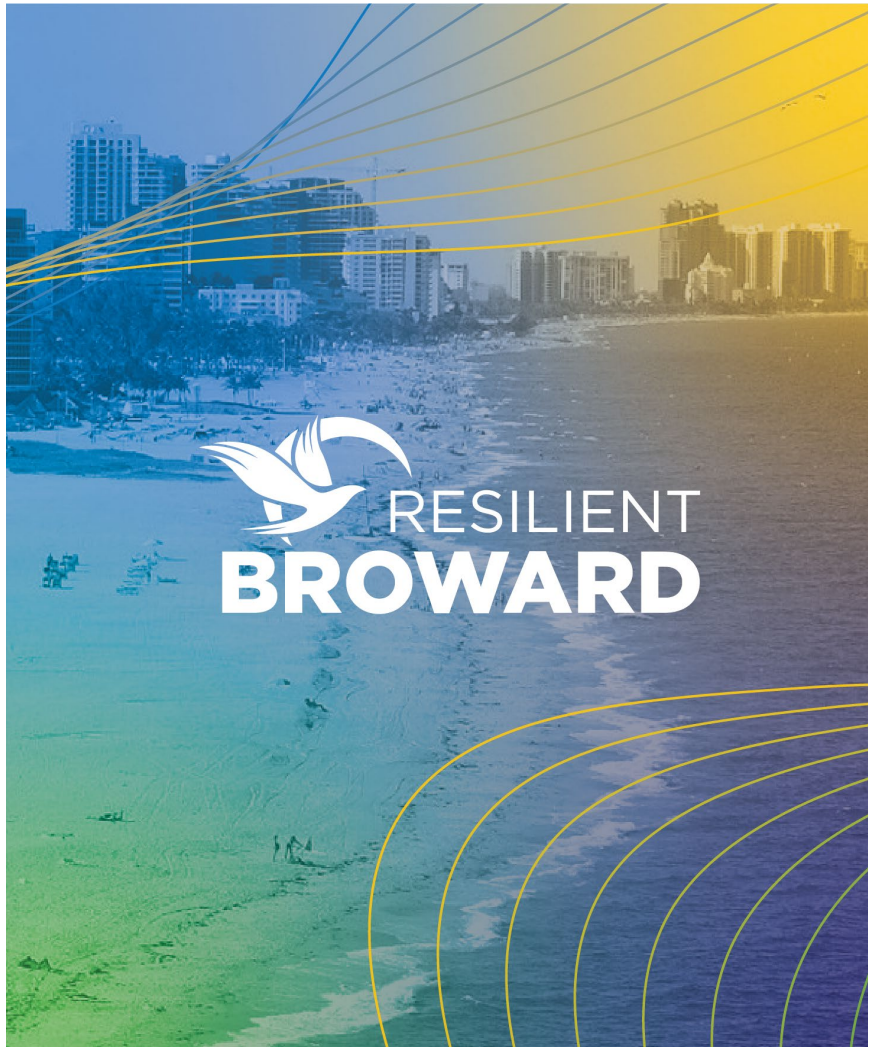
October 11, 2023



Outline

1. Welcome
2. Roll Call
3. Economic Modeling – Baseline Scenario Results
4. Outreach Plan – Intensive Effort
5. Adaptation Strategies Update
6. Asset Analysis/Platform Update

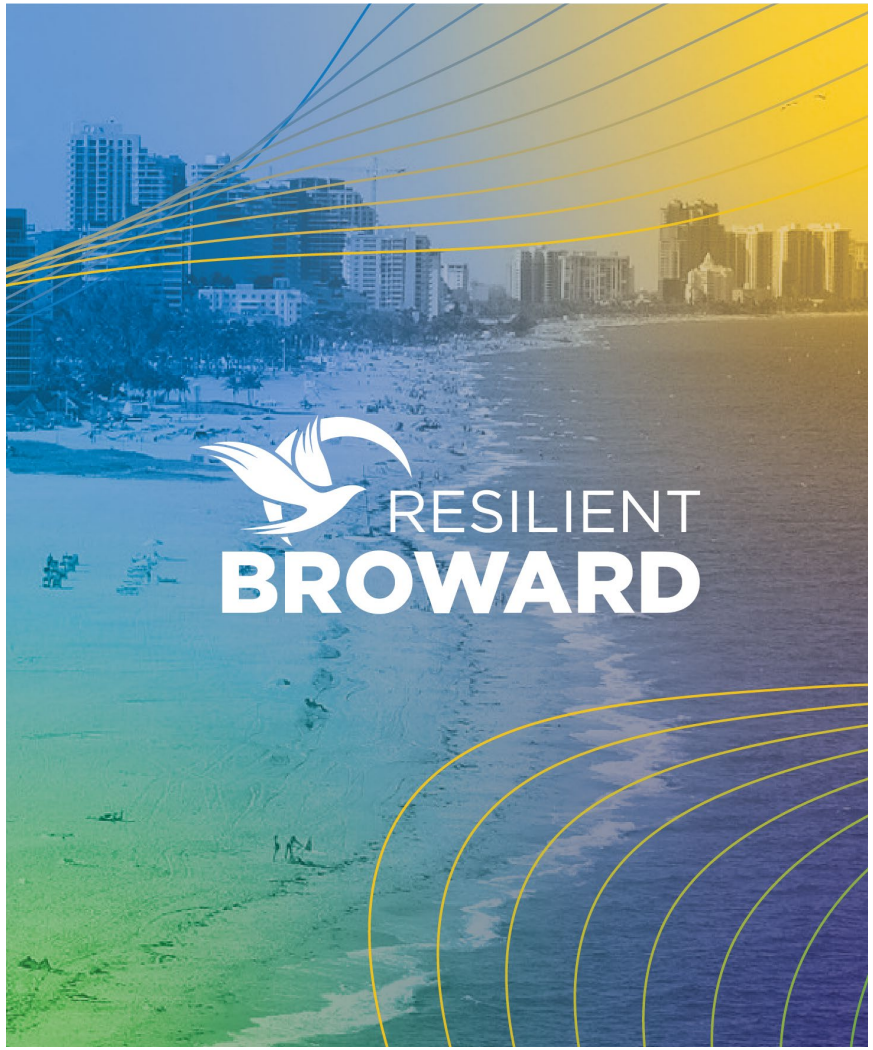
Adjournment



1

Welcome

Hazen



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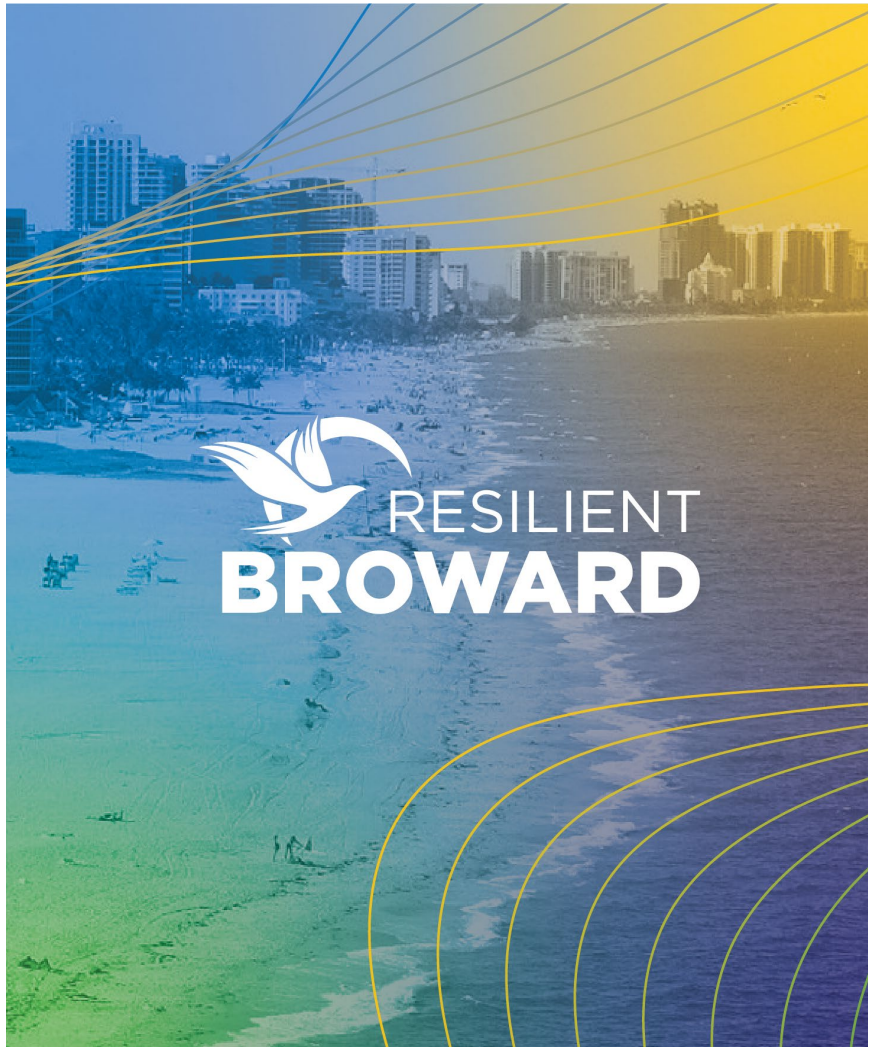
Roll Call

Hazen



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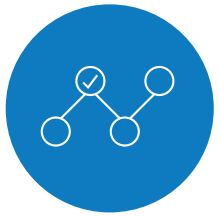
Economics Modelling – Baseline Scenario Results

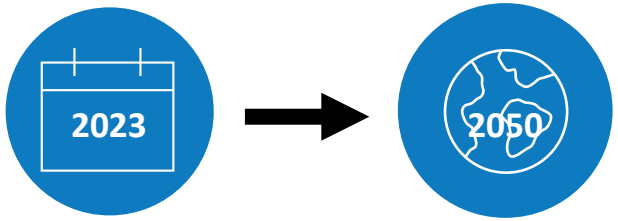
Hazen

The baseline results represent the “no adaptation” scenario, to compare with the scenario with adaptations included

How to interpret these results



Intermediate work product – no adaptation included in these results; outputs are dependent on scenario inputs (e.g., 2017 NOAA sea level rise estimates); economic analysis overlaid on assessment of flood extent, duration, depth, and likelihood



Current Broward County economy placed into future scenarios (i.e., no economic or demographic change assumed)

Composite view across all frequencies and severities of flood events (including rainfall, storm surge, and sea level rise in isolation and combination); no changes in decarbonization trajectories included

These results represent what the Broward County of today could experience in the future if no climate adaptation actions are taken

The baseline results provide socioeconomic analysis based on the economic methodology memo and the hydrologic modelling

Focus of today's Steering Committee meeting

Methodology development	Hydrologic modelling	Socioeconomic analysis	Adaptation scenarios
• Identified nine socioeconomic impacts of flooding • Prioritized four impact areas for quantitative analysis • Described methodology and data sources for quantitative analysis	• Hazen shared data on: – Building-level property value and damages – Flood extent – Probability of flood events occurring – Flood duration	• Developed qualitative risk narratives • Completed quantitative analysis for four prioritized impact areas: – Flood insurance premia – Lowered real estate analysis – Fiscal impacts to the County – Short-term economic losses – Exposure of vulnerable populations	• Model flooding across six adaptation scenarios • Assess the socioeconomic impacts of flooding in each adaptation scenario • Quantify the return-on-investment for each adaptation scenario

Interim Results (Baseline/No adaptation actions considered)

We have prepared quantitative analytical results across four key impact areas

	Narrative	Analytical approach	Assumptions and notes
A. Short-term economic losses	Floods damage buildings, assets and infrastructure – causing repair/ replacement costs and associated downtime losses. These impacts propagate through supply chains to indirectly impact the economy.	**Sales revenue loss**: multiply daily sales revenue (*ESRI business analyst*) by maximum days of downtime (*FEMA disruption curves*)	Only maximum loss in sales revenue; no changes in baseline sales revenue assumed
		Transportation disruption: overlay flood extent maps with the location of businesses and business centres	6 inches of flooding makes a road impassable
		Indirect economic impacts: use the V-ARIO model (*IMPLAN*) to analyse the economy-wide impact of flood damages and transport disruption	No changes in baseline economic conditions within the County included in future projections
B. Reduced insurance affordability	Increasing flood risk is expected to lead to higher insurance premia. Higher premia could increase rates of underinsurance, reducing households and businesses' abilities to recover from flood events.	**Increase in NFIP premia**: increase risk-based premia (*FEMA*) with residential average annual damages	Current Risk Rating 2.0 program remains in place to price in risk progressively; no additional subsidies introduced
		Reduction in NFIP coverage: apply elasticities to estimate drop-out due to increased premia; estimate increase in policies due to re-zoning; estimate expected coverage	Consumer responsiveness to price changes remains the same as today
		Uninsured damages: compare expected coverage with damages	Consumers do not purchase private sector flood insurance if they drop out their NFIP policies
C. Lowered real estate values	Increasing flood risk reduces property value, as buyers will expect to face higher costs, disruption to property use, and disruption to local amenities and services.	**Reduction in real estate value:** estimate effective loss in net operating income by summing increase in NFIP premia, average uninsured damages and average losses attributable to property downtime; use capitalisation rates (*CBRE*) to analyse the impact of reduced NOI on property value	Impacts to community attractiveness and inflation are not included; uses rental income relationships to translate home ownership costs into valuation
D. Heightened fiscal risks to the County	Floods result in relief and recovery costs, and losses in sales and tourism development tax revenue. This could lead to a lower credit rating, increasing the County's borrowing costs.	**Short-term tax disruption**: use the V-ARIO model (*IMPLAN*) to analyse the impact of flood damages and transport disruption on tax revenue	No changes in baseline economic conditions within the County included in future projections
		Reduction in property tax revenue: multiply the reduction in property value by the millage rate	Changes in sales revenue, valuation impacts due to attractiveness, and County expenditures are not included

Interim Results (Baseline/No adaptation actions considered)

Overall, without adaptation, increased flood risk will likely affect residents, business owners, and the economy of Broward County

POTENTIAL IMPACTS IN 2050 WITHOUT ADAPTATION; BASED ON PRESENT DAY ECONOMY

	Today	2.0ft SLR (2050)	3.3ft SLR (2070)
Annual average damages	$797M	$2,474M (+210%)	$4,908M (+515%)
NFIP policy count	175,002	49,479 (-72%)	41,069 (-77%)
Property value change	-	-13%	-21%
Property tax change	-	-18%	-27%
Annual jobs at risk	3,300	~5,700 (+70%)	~12,100 (+265%)

Broward County's **adaptation efforts will be of critical importance**, given the baseline results

Adaptation options will allow for comparison against this baseline to **quantify return on investment** across the economy

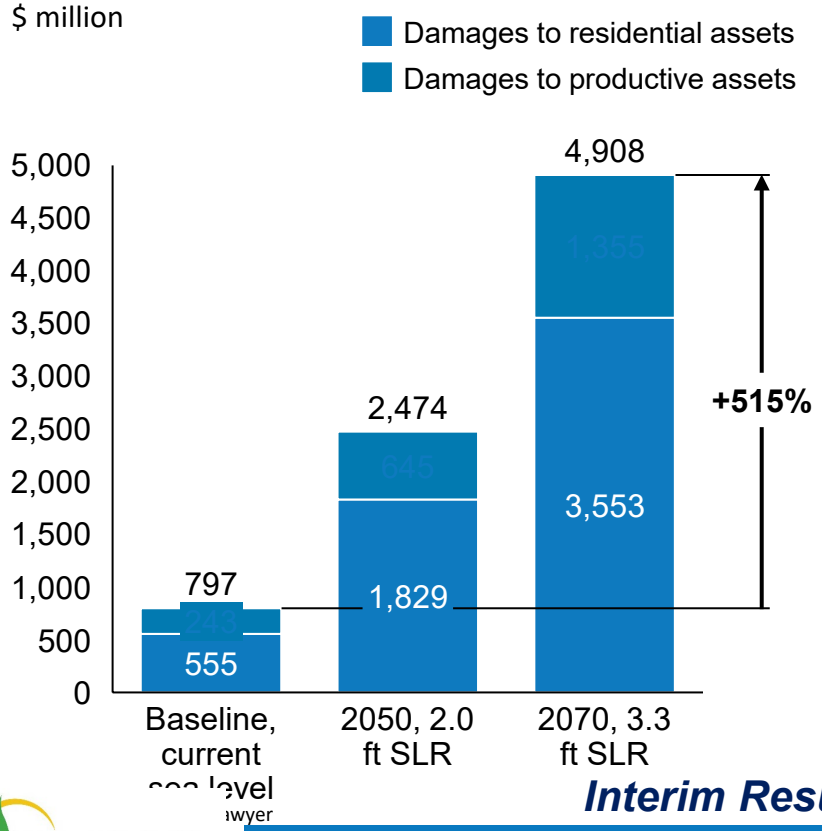
Interim Results (Baseline/No adaptation actions considered)

Without adaptation, flood-related damages are likely to increase in Broward County due to climate change

NO ADAPTATION INCLUDED

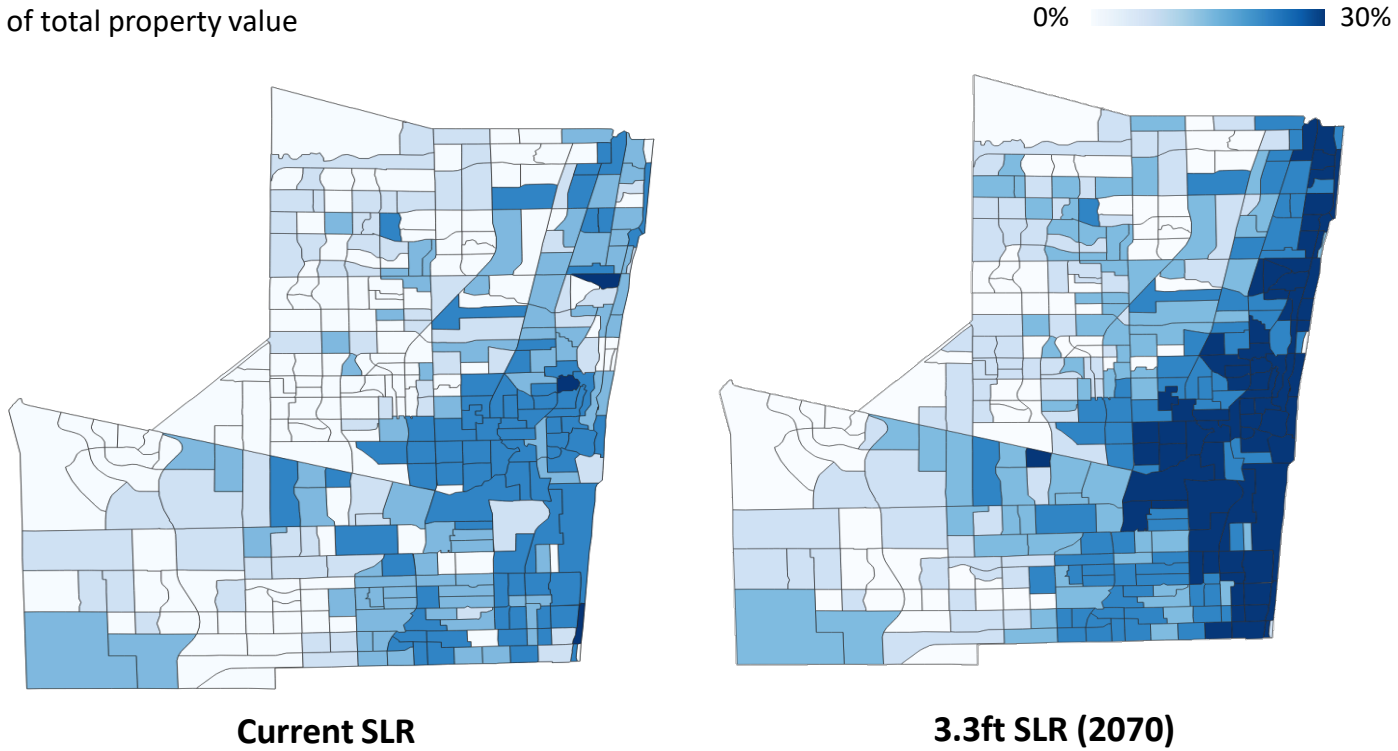
By 2070, residential/productive asset damage could increase 6.4x/5.6x times compared to baseline

Average annual damage, total
$ million



Most flood damage is concentrated along the coast

Average annual damage per census tract
% of total property value



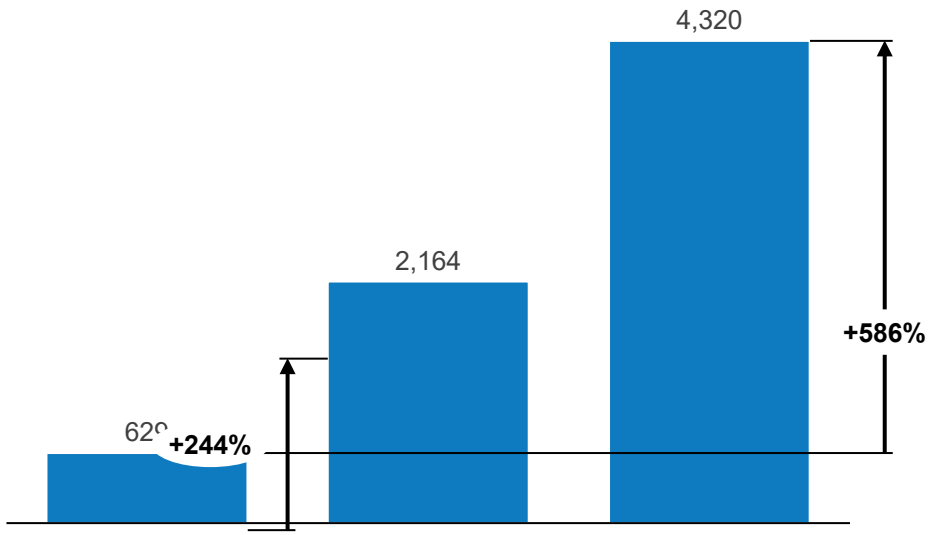
Interim Results (Baseline/No adaptation actions considered)

Increased flood risk could reduce the availability of affordable insurance, widening the protection gap

NO ADAPTATION INCLUDED

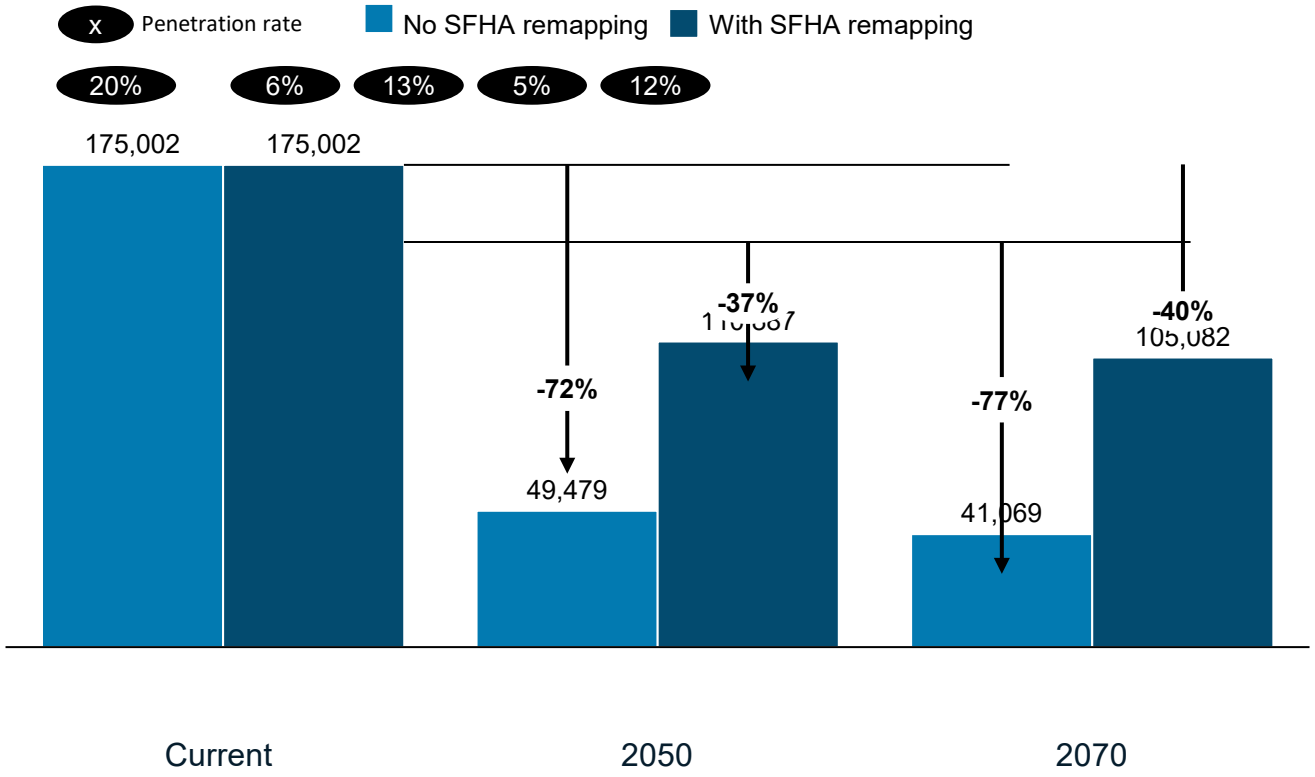
Damages to residential properties could more than triple by 2050 on average…

Average annual damages per housing unit, $



…which could lead to a significant increase in NFIP premia[1] and decrease in penetration[2]

Total policy count and penetration rate[2]



1. NFIP premia is computed assuming that, given Risk Rating 2.0, risk-based premia increase in line with annual average damages
2. Analysis based on responsiveness of consumers to flood insurance costs; analysis does not take into account risk responsiveness of consumers. Sensitivity analysis performed on the scenario where Special Hazard Flood Area (SFHA), where flood insurance is mandatory for properties that are federally funded or funded by a federally-insured mortgage, are expanded to reflect the increase in flood risk in 2050 / 70, where consumers are willing to pay more for insurance if coverage is mandatory.

g and damages from Hazen and Sawyer

Interim Results (Baseline/No adaptation actions considered)

RESILIENT BROWARD

Hazen

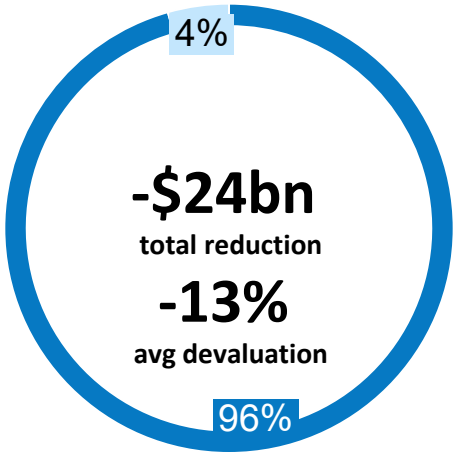
Increased damages could reduce property values by ~13% Countywide in 2.0ft SLR scenario

NO ADAPTATION OR INFLATION INCLUDED

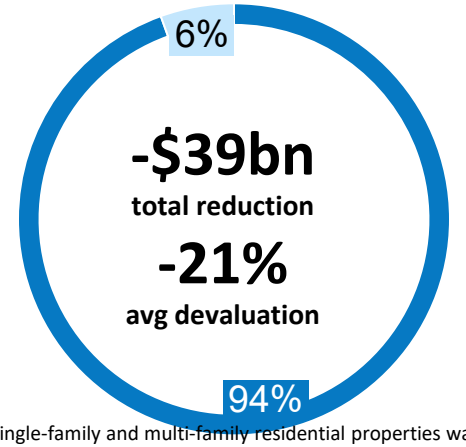
Total reduction in residential property value[1,2]

Drivers: Asset damages | Loss of use

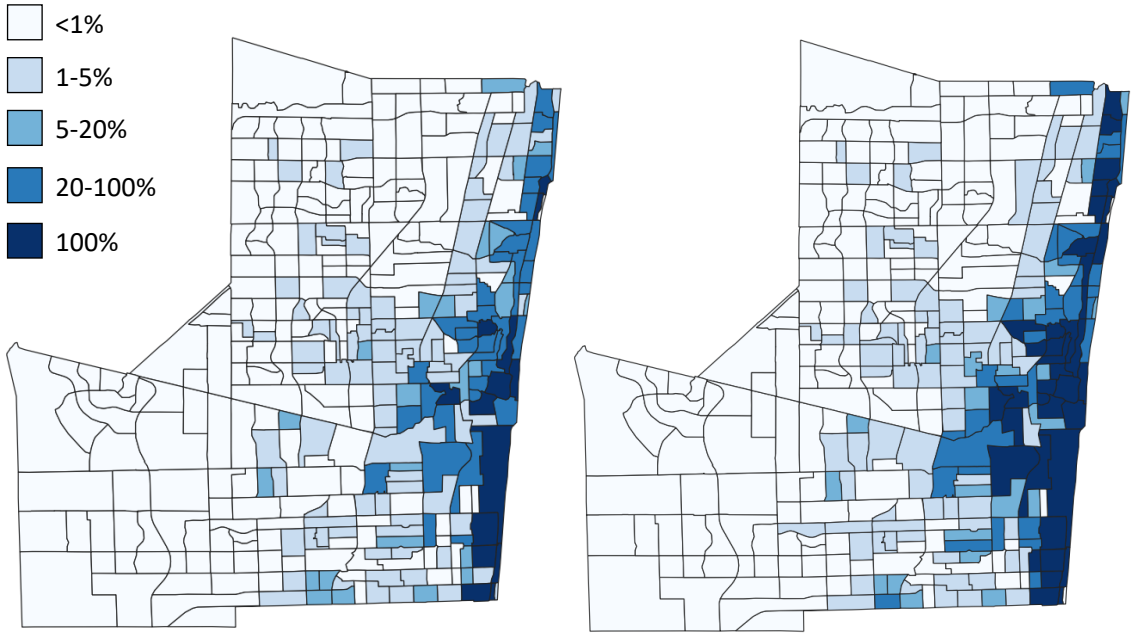
2.0ft SLR (2050) vs current



3.3ft SLR (2070) vs current



Distribution of census tracts by average residential building devaluation (%)



2.0ft SLR (2050) **3.3ft SLR (2070)**

Interim Results (Baseline/No adaptation actions considered)

1. Capitalization rate used for both single-family and multi-family residential properties was the average capitalization rate for multi-family residential properties in 4 Florida cities as per CBRE 2023 1H
2. The analysis does not consider impact from loss of local amenities and services as well as second-order impact from reduced economic activities
3. Downtime-related losses assume owners do not derive value for the property while it is uninhabitable
4. A census tract is considered to experience complete loss in property value if the average annual flood-related loss increase (vs current) is greater than current net operating income (i.e., around $23k, which is 4.94% of average property value).

Source: Flood modeling and damages from Hazen and Sawyer

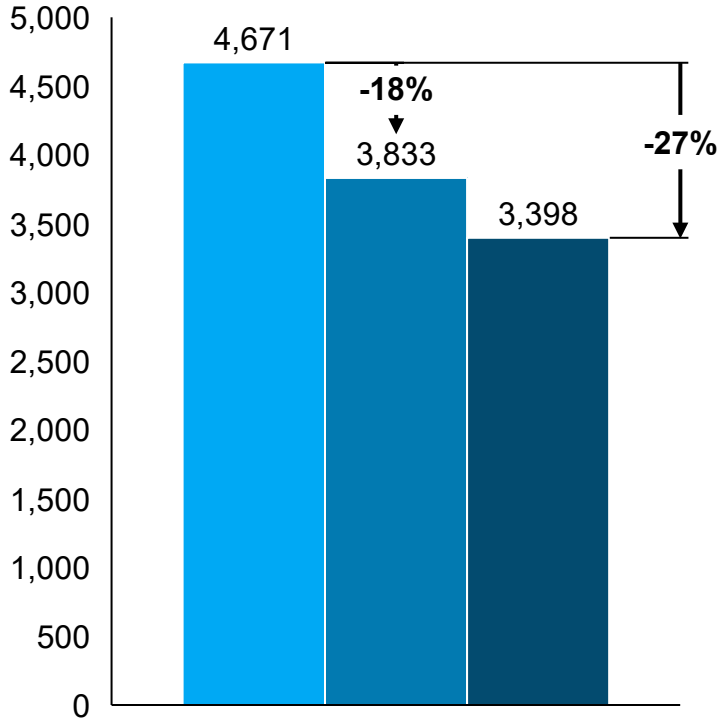
Real estate devaluation could drive 18% loss in property taxes by 2050, diminishing a major and stable revenue source

NO ADAPTATION INCLUDED

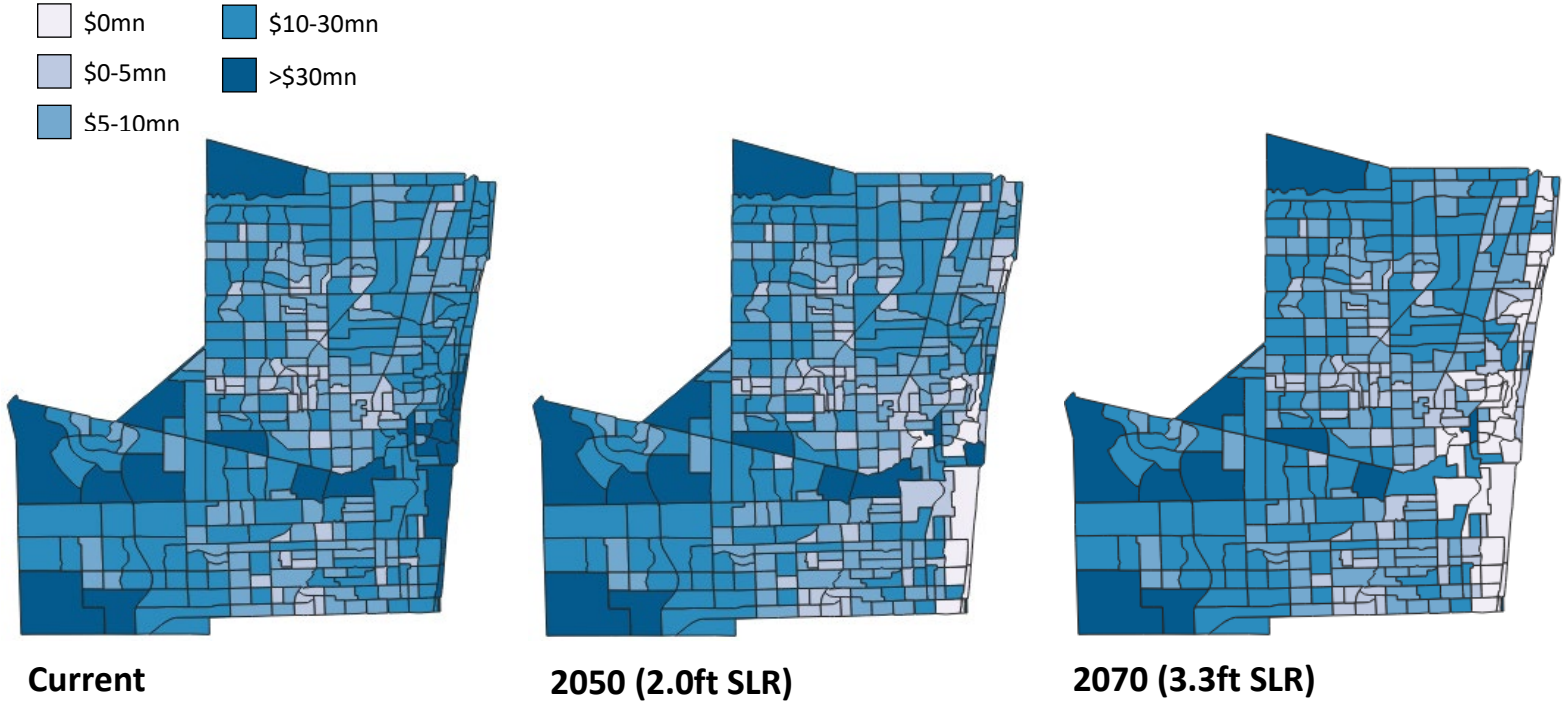
Total ad valorem property tax[2] ($ million)

As a % of County revenue in FY22[3]

37%



Distribution of census tracts by annual property tax collected



1. We assumed the percentage reduction in taxable property value for residential and non-residential properties in a census tract is equal to the percentage reduction in residential property just value in the same census tract, given similar risk level and the difficulty in evaluating the taxable value, which depends on occupier-specific characteristics.
2. Includes County Commission, which is $1.3b, and taxes for other government functions (e.g., school board) and municipalities.
3. Based on the FY22 Financial Report of Broward County, total property tax revenue was $1,208mn, which is 37% of total government revenue of $3,288mn. This does not account for $3,605mn of property tax collected for other functions (e.g., School Board) or

and damages from Hazen and Sawyer

Interim Results (Baseline/No adaptation actions considered)

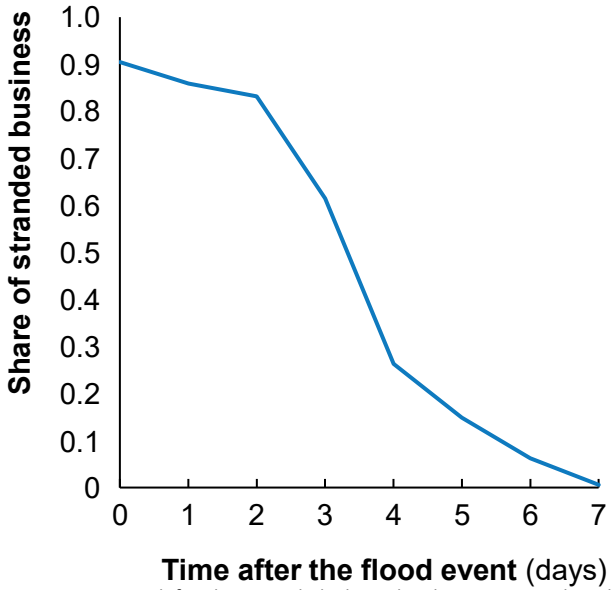
Transport disruption and sector bottlenecks amplify economic losses beyond pure damages in extreme flood events

Examples presented on this page are for individual flood events under 3.3 ft SLR scenario; they do not represent the annual average view

The immediate disruption to the road network can result in widespread economic constraints in the short-term

Share of business stranded over time[1]

Example: 100-year rainfall event (no storm surge, 3.3-ft SLR, 2070)



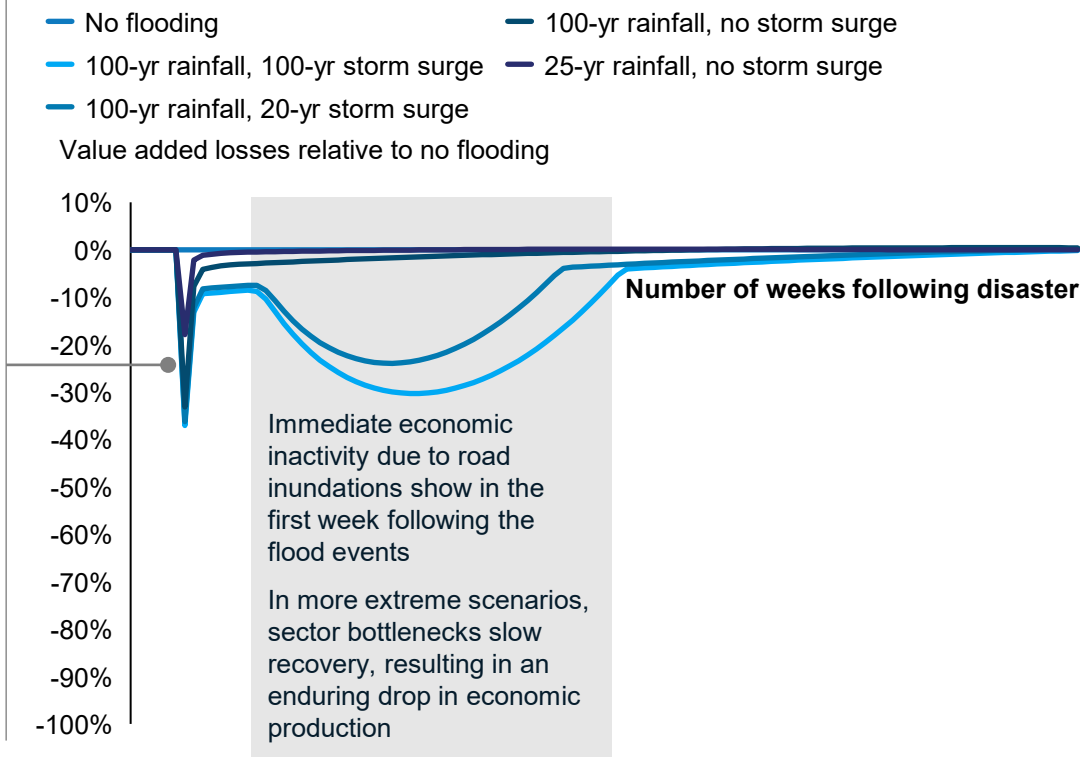
Road network flooding duration (h)

1. Businesses are defined as stranded where they have access to less than 10% of Broward's 200 major production and consumption sections
2. due to roads being impassable (0.5ft flood depth).

Source: Hazen and Sawyer for flood modeling and damages; Vivid-Adaptive Regional Input Output model

Extreme events cause disproportionately high GVA losses and 2 year+ recovery time

Time path to recovery for 3.3 ft SLR (2070) flood events

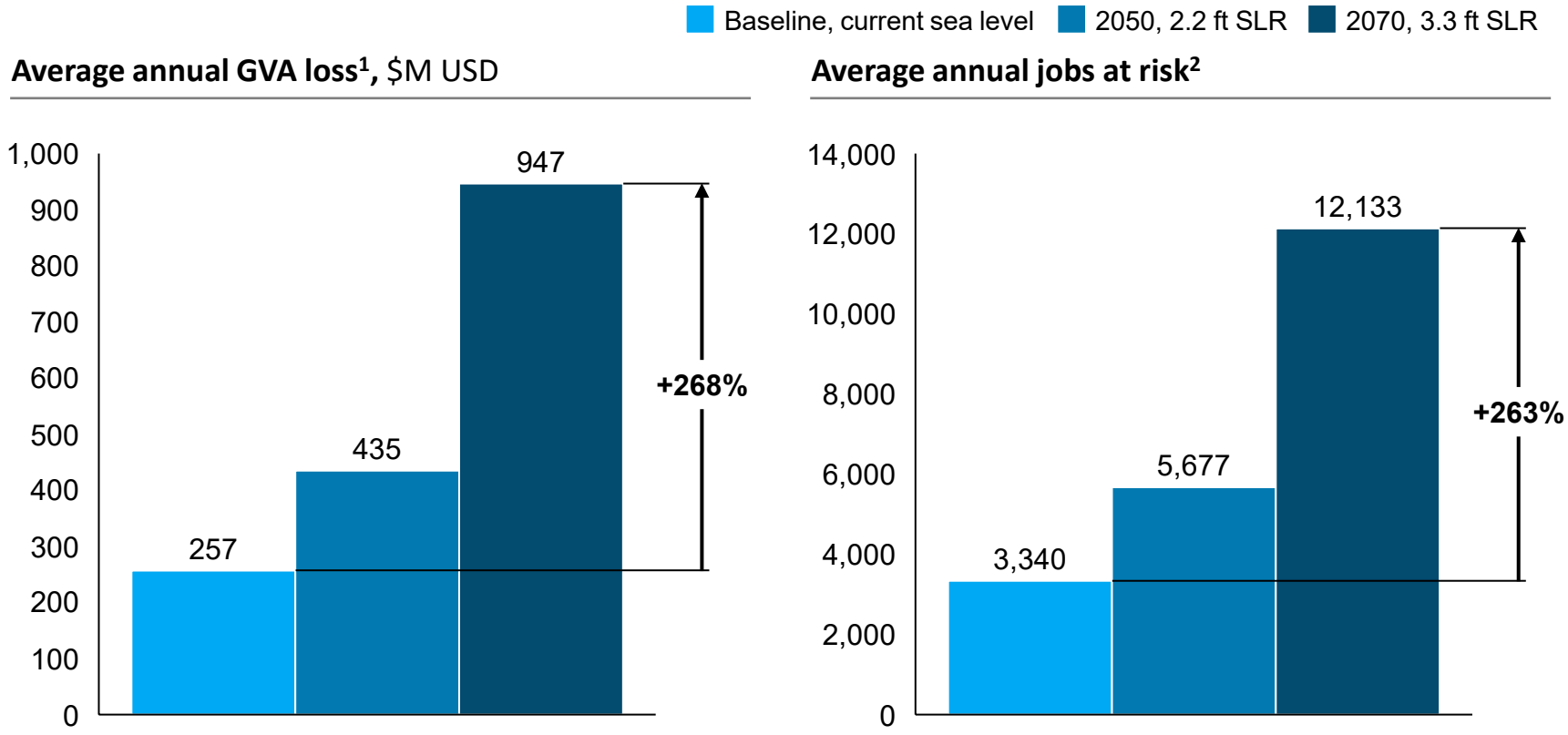


Interim Results (Baseline/No adaptation actions considered)

As a result, Broward County's economy may experience material productivity losses, as flooding interrupts commerce and transportation

NO ADAPTATION INCLUDED

The increase in average annual damages to residential and productive assets results in a four fold increase in average economy-wide impacts by 2070



1. Base GVA is held constant at 2023 levels in future scenarios
2. Jobs at risk are defined as positions that are vulnerable to layoffs following flood events, as a result of lost economic activity

Source: Hazen and Sawyer for flood modeling and damages; Vivid-Adaptive Regional Input Output model

Gross Value Added

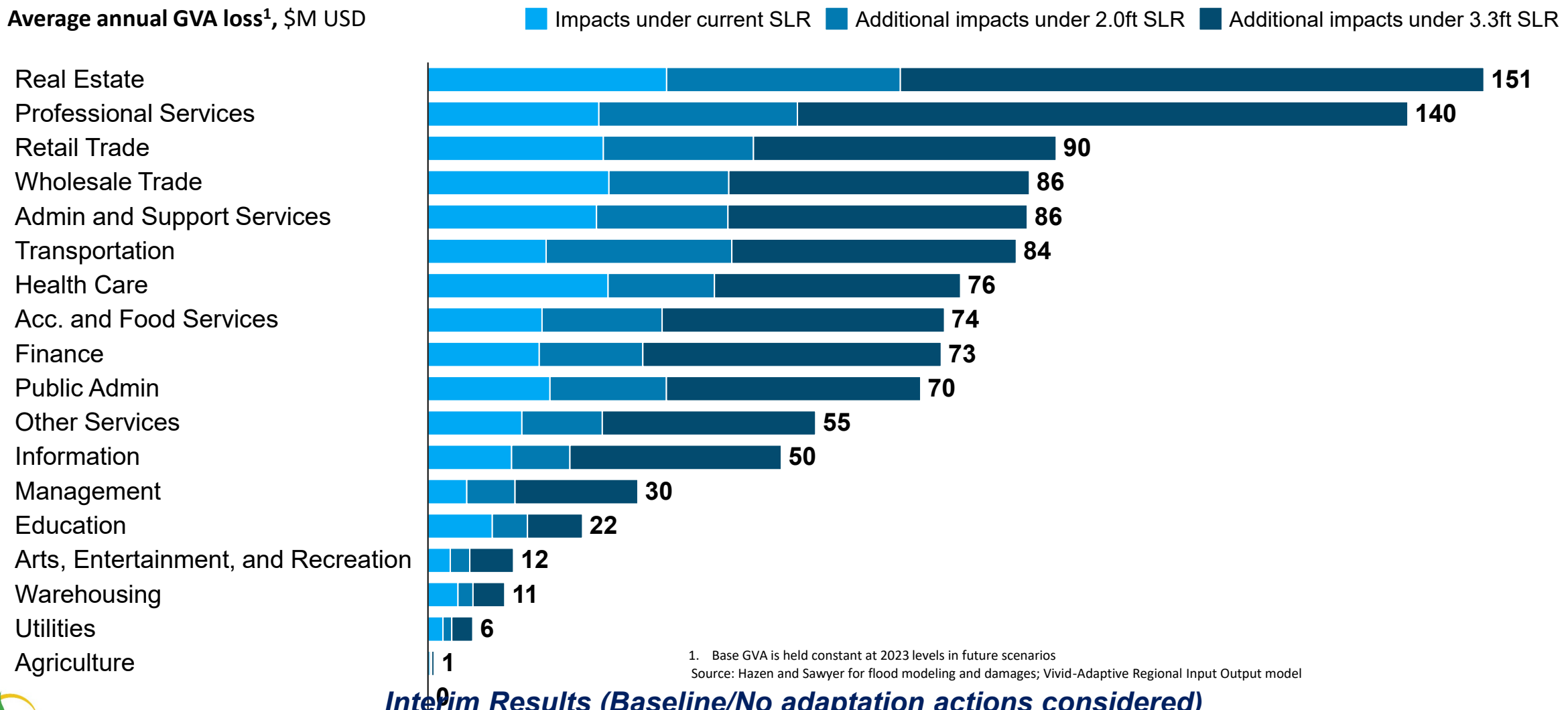
Gross Value Added (GVA) is a standard international and national **metric of economic activity.**

Specifically, it measures the difference between the value of goods and services an economy, industry, region, or business produces and the value of the raw materials required to produce them.

It includes the income that residents receive, company profits, depreciation and subsidies.

Interim Results (Baseline/No adaptation actions considered)

The Real Estate and Professional Services economic sectors are most likely to be affected by flood risk



1. Base GVA is held constant at 2023 levels in future scenarios

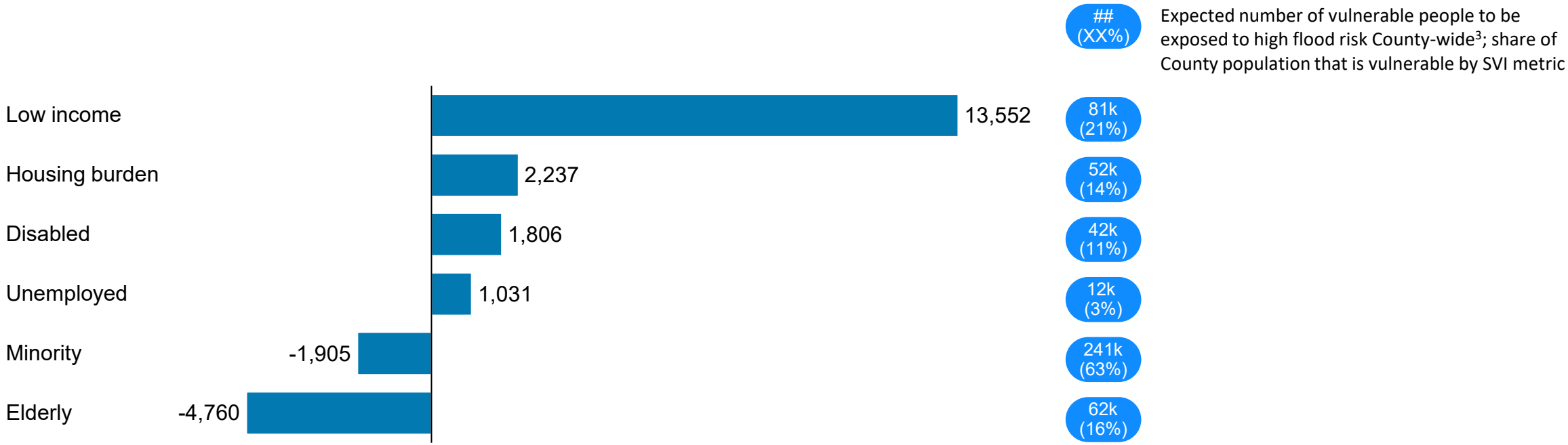
Source: Hazen and Sawyer for flood modeling and damages; Vivid-Adaptive Regional Input Output model

Interim Results (Baseline/No adaptation actions considered)

Flood risk is slightly regressive for economically vulnerable groups, with 41% more people exposed by 2050

NO ADAPTATION INCLUDED

Number of vulnerable people[1] in high flood damage[2] areas, more/less than expected in general population



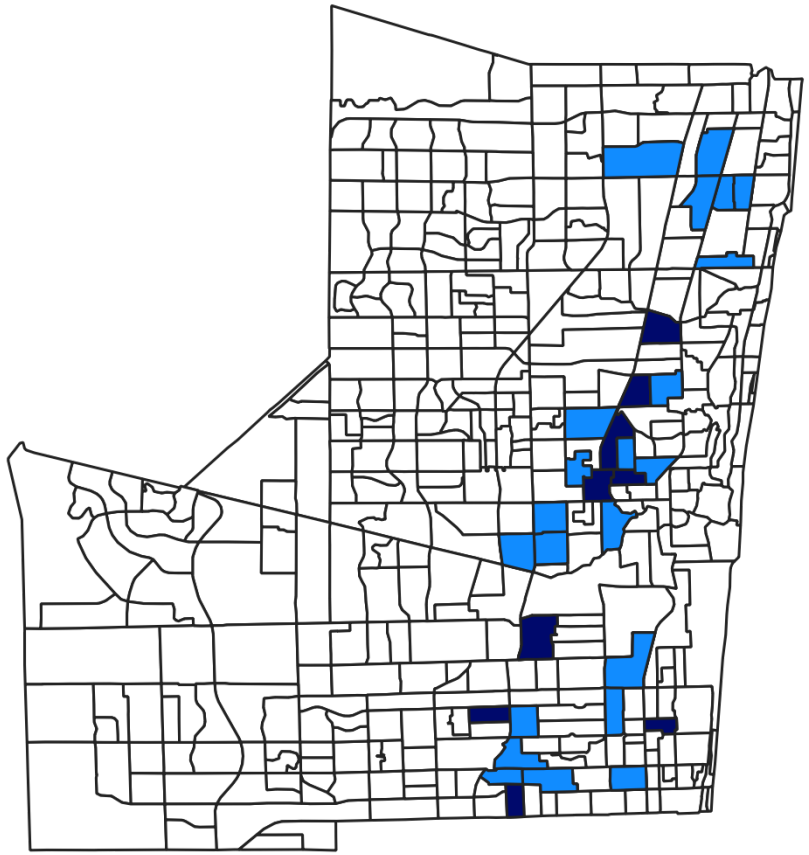
1. Vulnerable people are defined across 16 metrics in the SVI database for state of Florida. Total SVI metric is composed of all 16 metrics of vulnerability.
2. High flood damage census tracts are defined as being in the top quartile of current flood property damage, across all census tracts In Broward.
3. Expected number of vulnerable population in high flood damage areas is derived from the total share of vulnerable population in Broward. For example, if the elderly make up 21% of total population in Broward County, the expected share of elderly in high flood risk areas would also be 21% if flooding is not regressive.

Source: Hazen and Sawyer for flood modeling and damages; Center for Disease Control and Prevention's Social Vulnerability Ind ex

Interim Results (Baseline/No adaptation actions considered)

Substantial flood damage could affect 41% more vulnerable people by 2050

Census tracts with substantial flood damage and vulnerable population, total SVI metric[1,2]



High-risk areas under **current** SLR

Additional high-risk areas under **2.0ft** SLR

By 2050, high flood damage could be experienced by

Number of affected people (% of total vulnerable population in municipality)

45,000 (86%)

below 150% poverty population in Fort Lauderdale

33,000 (88%)

elderly population in Fort Lauderdale

51,000 (53%)

minority population in Dania Beach

1. Vulnerable people are defined across 16 metrics in the SVI database for state of Florida. Total SVI metric is composed of all 16 metrics of vulnerability.
2. High flood damage census tracts are defined as being in the top quartile of current flood property damage, across all census tracts in Broward County.

Source: Hazen and Sawyer for flood modeling and damages; Center for Disease Control and Prevention's Social Vulnerability Index

Interim Results (Baseline/No adaptation actions considered)

Residential property damage and value loss by municipality (1/2)

Municipality	Average annual residential damage ($ Millions)			Average property value loss (%, relative to present value)	
	Today	2.0ft SLR (2050)	3.3ft SLR (2070)	2.0ft SLR (2050)	3.3ft SLR (2070)
Cooper City	24	28	29	1	1
Coral Springs	16	26	26	1	1
Dania Beach	41	163	336	31	46
Davie	2	4	4	1	1
Deerfield Beach	5	8	9	2	3
Fort Lauderdale	184	901	1,943	32	58
Hallandale Beach	19	143	307	39	51
Hillsboro Beach	20	98	225	55	81
Hollywood	30	53	82	7	15
Lauderdale Lakes	2	3	4	2	2
Lauderhill	1	3	3	1	1
Lighthouse Point	13	82	218	28	49
Margate	3	4	5	0	0
Miramar	7	16	21	4	7

Source: Flood modeling and damages from Hazen and Sawyer

Interim Results (Baseline/No adaptation actions considered)

Residential property damage and value loss by municipality (2/2)

Municipality	Average annual residential damage ($ Millions)			Average property value loss (%, relative to present value)	
	Today	2.0ft SLR (2050)	3.3ft SLR (2070)	2.0ft SLR (2050)	3.3ft SLR (2070)
North Lauderdale	8	11	12	1	1
Oakland Park	6	10	10	3	4
Parkland	0	1	1	0	0
Pembroke Park	4	6	6	2	3
Pembroke Pines	23	40	45	2	2
Plantation	13	20	22	1	1
Pompano Beach	36	97	174	19	24
Southwest Ranches	4	5	5	0	0
Sunrise	8	15	16	1	1
Tamarac	0	1	4	3	9
Hollywood Reservation	3	5	5	2	2
Weston	2	3	3	0	0

Source: Flood modeling and damages from Hazen and Sawyer

Interim Results (Baseline/No adaptation actions considered)

Economic losses by sector and scenario

Sector	Gross Value Added (GVA) loss ($ Millions)		
	Today	2.0ft SLR (2050)	3.3ft SLR (2070)
Agriculture	298,236	532,178	892,350
Mining	29,265	52,611	87,543
Utilities	2,138,550	3,397,859	6,406,146
Wholesale Trade	25,828,342	42,954,901	85,861,046
Retail Trade	25,026,493	46,470,632	89,683,084
Transportation	16,856,533	43,365,968	83,986,163
Warehousing	4,282,853	6,441,004	10,958,956
Information	11,950,032	20,274,556	50,445,941
Finance	15,881,158	30,653,000	73,268,396
Real Estate	34,059,875	67,424,656	150,730,261
Professional Services	24,395,298	52,735,025	139,866,663
Management	5,526,194	12,425,226	29,972,344
Admin and Support Services	24,049,927	42,830,466	85,551,227
Education	9,182,169	14,194,421	22,062,183
Health Care	25,714,010	40,876,793	76,036,445
Arts, Entertainment, and Recreation	3,182,486	5,960,411	12,226,618
Acc. and Food Services	16,269,539	33,417,105	73,721,291
Other Services	13,411,137	24,876,708	55,350,307
Public Admin	17,404,882	34,027,593	70,341,061

Source: Flood modeling and damages from Hazen and Sawyer

Interim Results (Baseline/No adaptation actions considered)

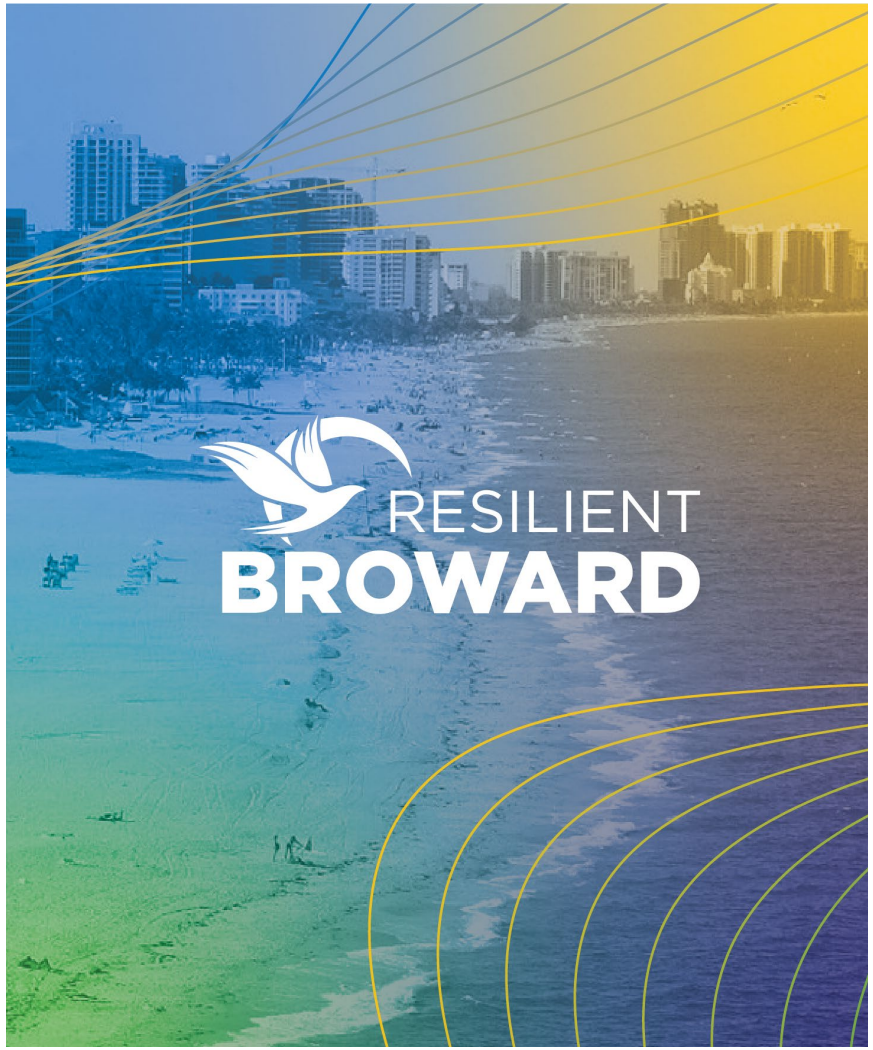
Looking ahead to adaptation scenarios…

For discussion

What are your key takeaways from the baseline results presented today?

What other visualizations or analyses would you like to see to better understand and communicate these results with your stakeholders?

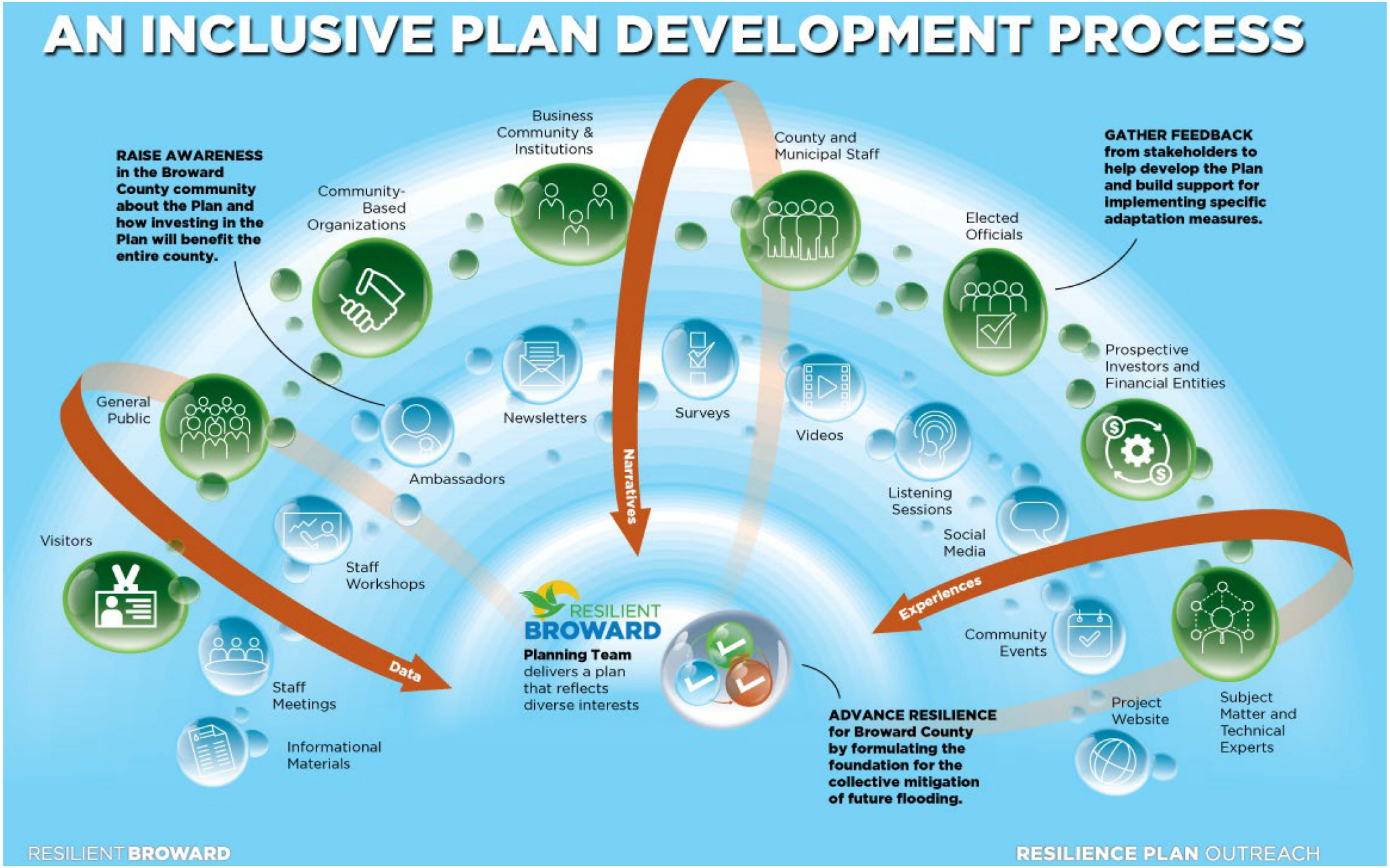
Are there additional areas of focus we should include when considering the adaptation solutions?



4

Outreach Plan – Intensive Effort

Hazen


AN INCLUSIVE PLAN DEVELOPMENT PROCESS
RAISE AWARENESS in the Broward County community about the Plan and how investing in the Plan will benefit the entire county.
Community-Based Organizations
Business Community & Institutions
County and Municipal Staff
Elected Officials
GATHER FEEDBACK from stakeholders to help develop the Plan and build support for implementing specific adaptation measures.
Prospective Investors and Financial Entities
General Public
Ambassadors
Newsletters
Surveys
Videos
Listening Sessions
Social Media
Visitors
Staff Workshops
Staff Meetings
Informational Materials
Narratives
Data
Experiences
RESILIENT BROWARD
Planning Team delivers a plan that reflects diverse interests
ADVANCE RESILIENCE for Broward County by formulating the foundation for the collective mitigation of future flooding.
Community Events
Project Website
Subject Matter and Technical Experts
RESILIENT BROWARD
RESILIENCE PLAN OUTREACH

Listening Sessions are Presently Being Scheduled

Urban League of Broward County

Neighborhood Meeting - November 14, 2023

COMMUNITY FOUNDATION OF BROWARD

Staff Focus Group – October 19, 2023

MUSEUM OF DISCOVERY AND SCIENCE
AutoNation IMAX 3D Theater

Student Focus Group – TBD

HISPANIC UNITY of FLORIDA

SEMINOLE TRIBE OF FLORIDA · Tribal Council · IN GOD WE TRUST

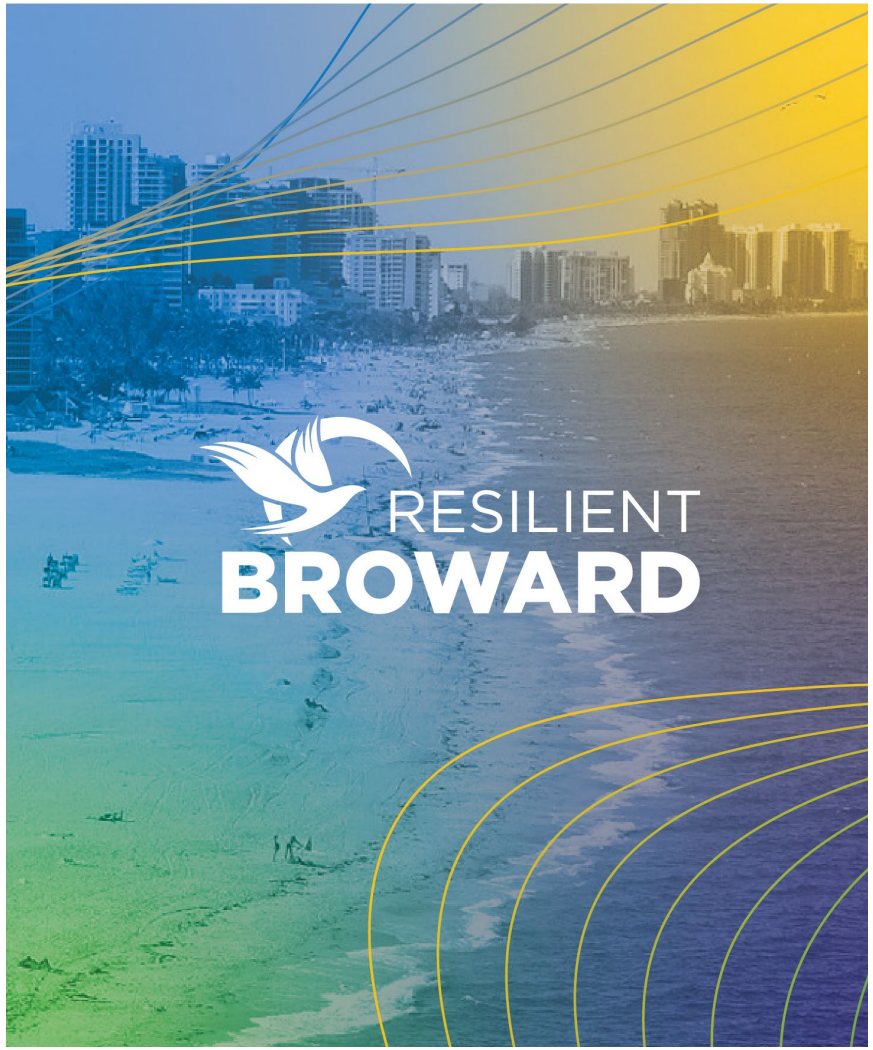
Staff (and member) Focus Groups - TBD

Listening Sessions will be Centered on Three Questions:

How have flooding and heat impacted your members, their property, and their workforce?

What would you like to see the County do to help with flooding and heat reduction?

With whom else should we speak?



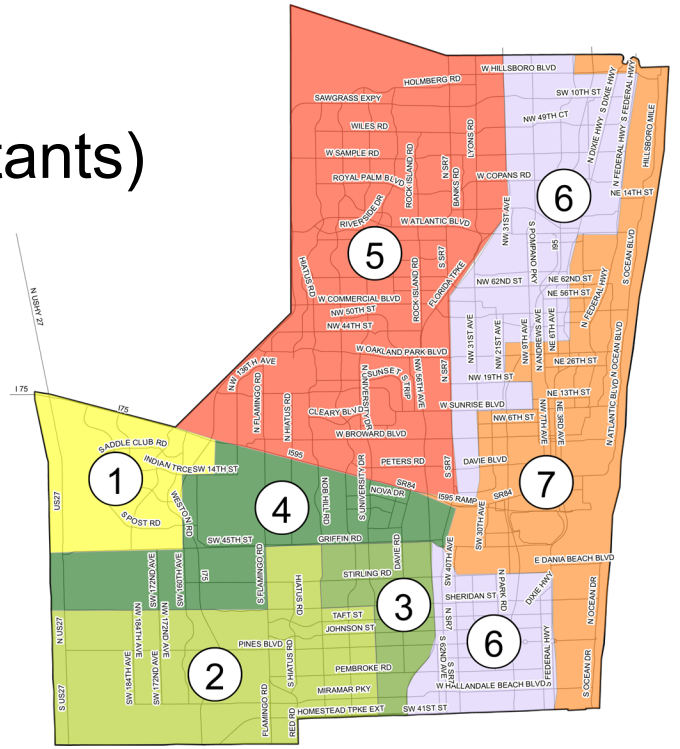
5

Adaptation Strategies

Hazen

Adaptation strategies evaluation well underway

- Initial brainstorming meeting held December 16, 2022
- Adaptation Strategy Kickoff held April 3, 2023 (response to ‘No Action” results)
- Full workshop August 28, 2023 (Hazen and subconsultants)
  - Confirmed general strategies
  - Targeted adaptations to specific locations/regions
  - Developed analytical tasks for testing efficacy



Most flood damage and economic impacts would be along coast within Adaptation Zone 7

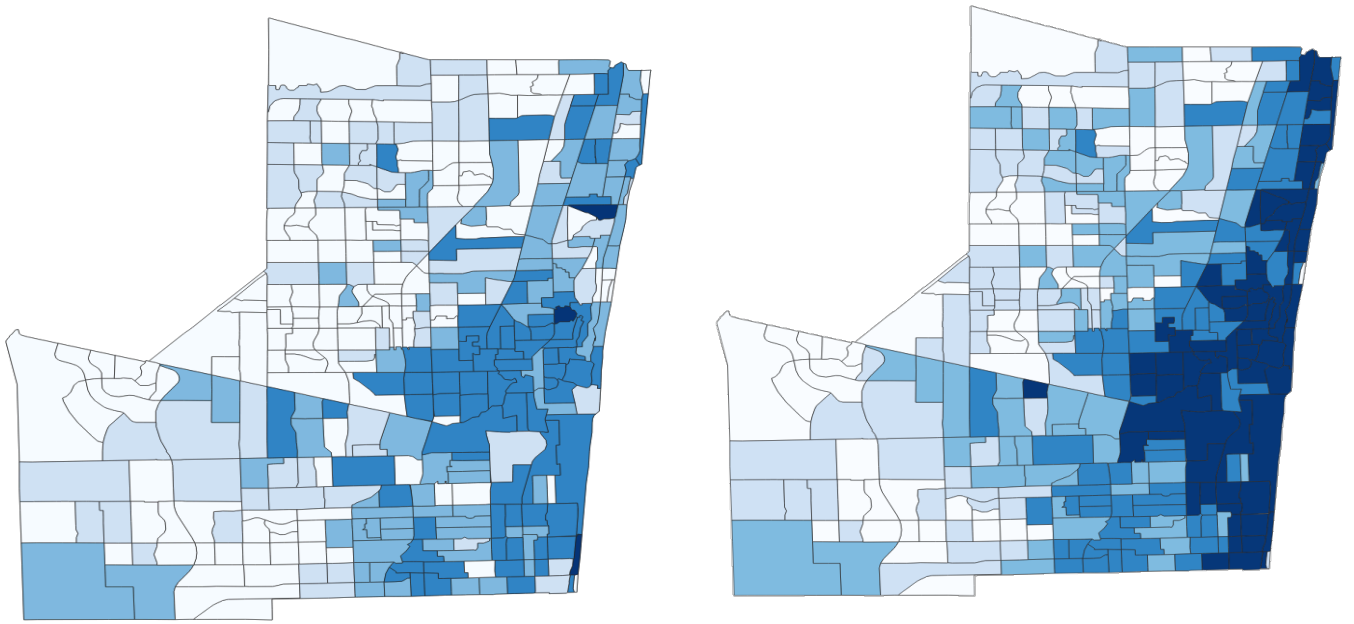
The most impacted areas are these cities:

- Dania Beach
- Fort Lauderdale
- Hallandale Beach
- Hillsboro Beach
- Hollywood
- Lighthouse Point
- Pompano Beach

The socially vulnerable communities within these cities would be most impacted of all vulnerable communities.

Average annual damage per census tract
% of total property value

NO ADAPTATION INCLUDED
0% 30%



Current SLR **3.3ft SLR (2070)**

Interim Results (Baseline/No adaptation actions considered)

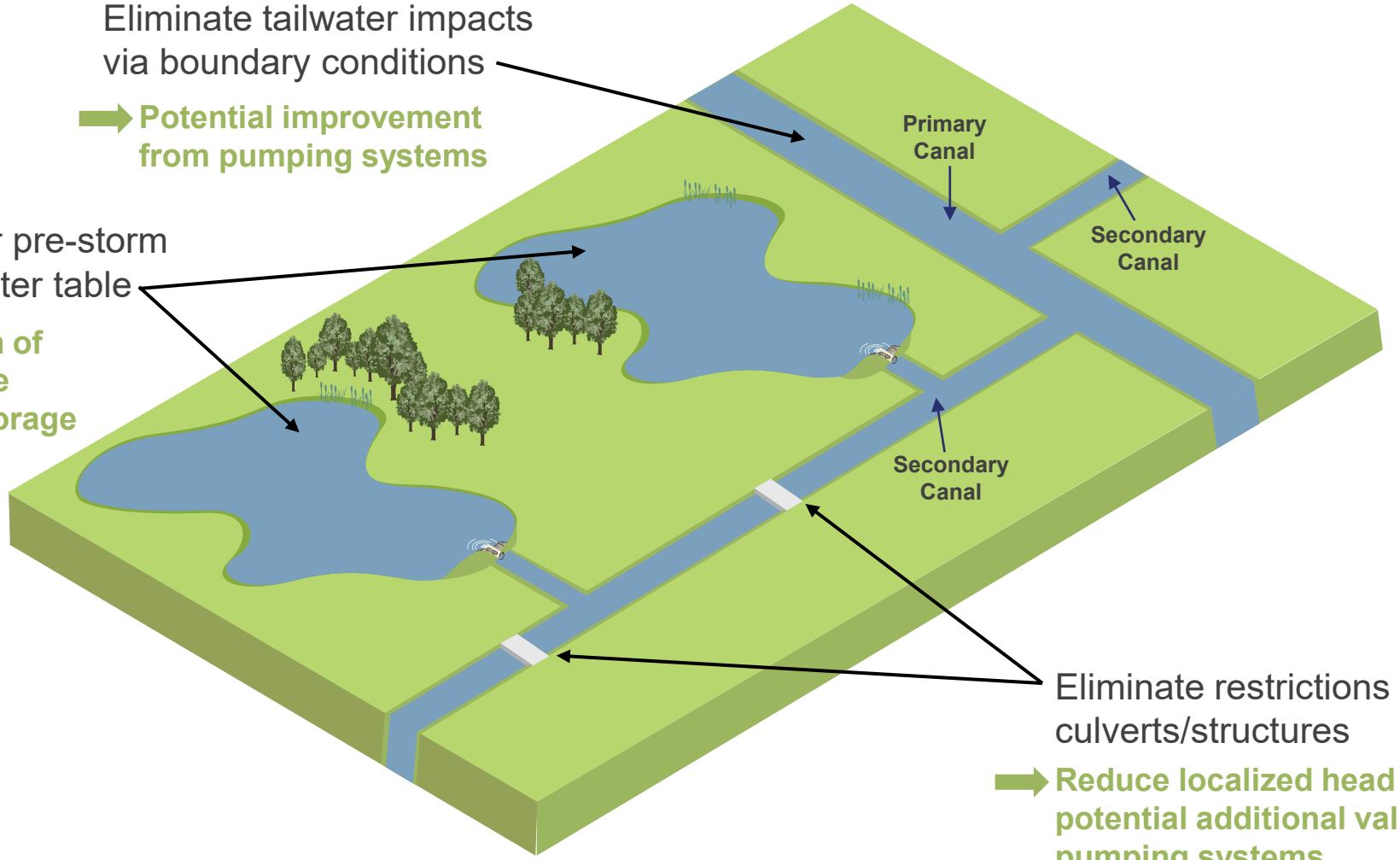
Evaluating conveyance and storage improvements' potential

Eliminate tailwater impacts via boundary conditions

→ **Potential improvement from pumping systems**

Seasonal and/or pre-storm drawdown of water table

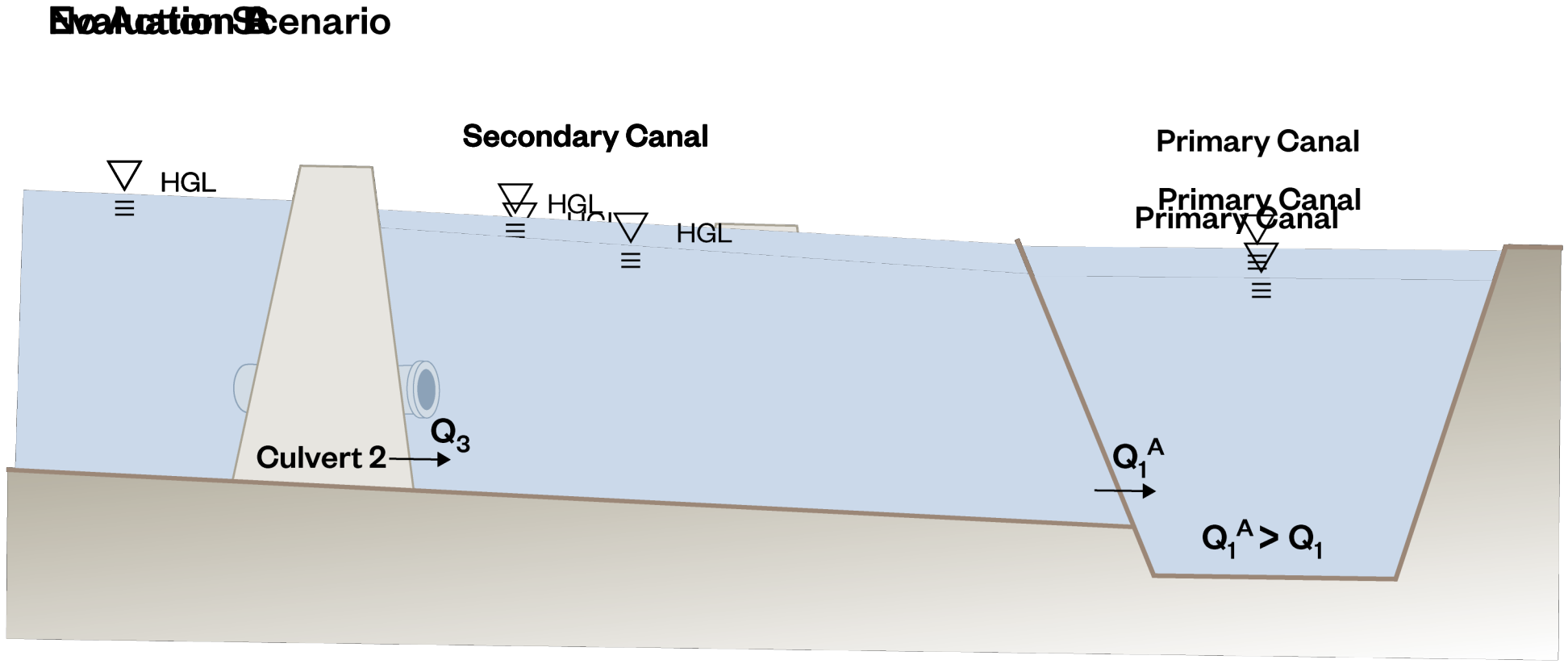
→ **Potential creation of additional surface and/or ground storage**



Eliminate restrictions from culverts/structures

→ **Reduce localized head losses, potential additional value from pumping systems**

A systematic H&H analyses streamlines identification/quantification of adaptation strategies

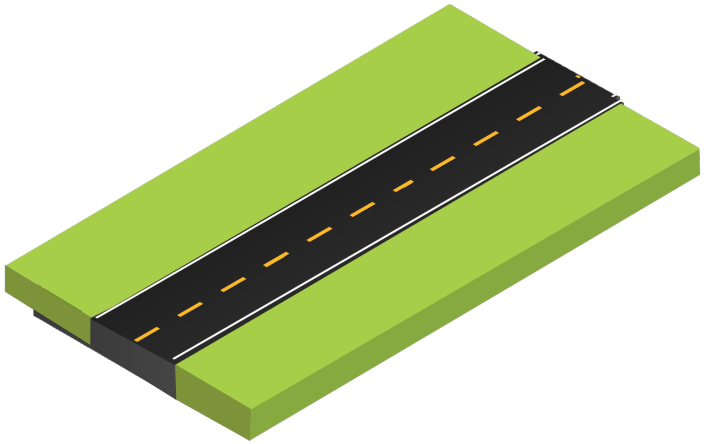


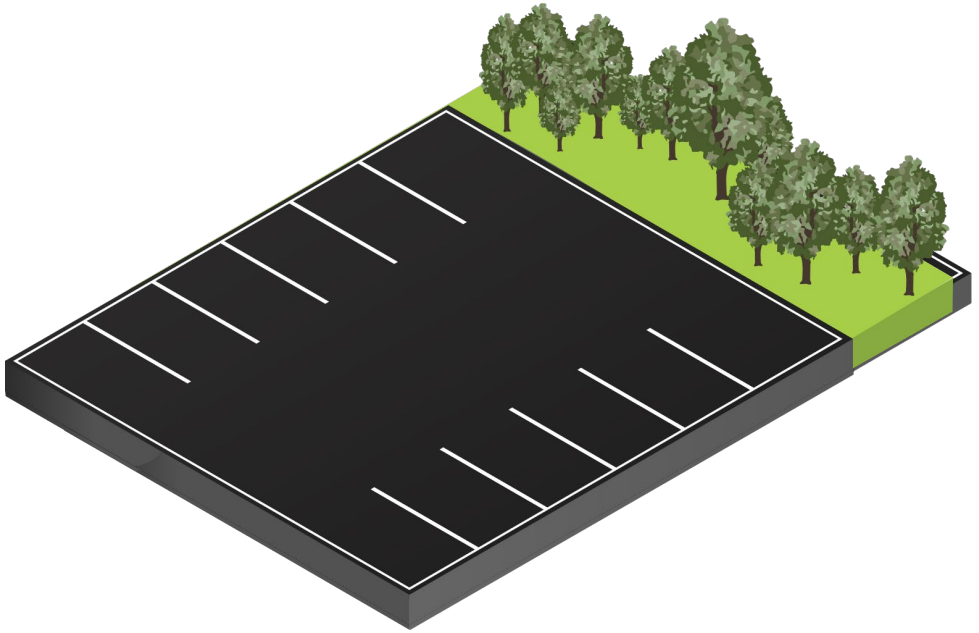
GIS vetting for potential adaptation strategies

POTENTIAL ADAPTATION STRATEGY	GIS LAYERS	VETTING
Remove roadway lanes and convert to pervious surface	Roadway Extent Polygons, Roadway Classification, AADT Data, Impervious Surface Raster	Identify roadways that would still function if lanes were removed
Increase storage	Landuse, Depth to Groundwater, Floodplain	Identify possible areas for additional storage
Convert parking to pervious surfaces	Depth to Groundwater, Impervious Raster, *Parking Area Polygons, Landuse	Identify areas where parking could be decreased
Green Infrastructure adaptations	DEM, Landuse, *Removed pavement	Identify areas where green infrastructure strategies can be implemented
Development Code Updates – limit driveway areas	Impervious Surface Raster	Assume percent decrease in impervious area based on suggested changes to driveway code

*** Hazen to create GIS layer**

Once ability to incorporate strategy has been determined, value-added and anticipated public acceptance must be weighed

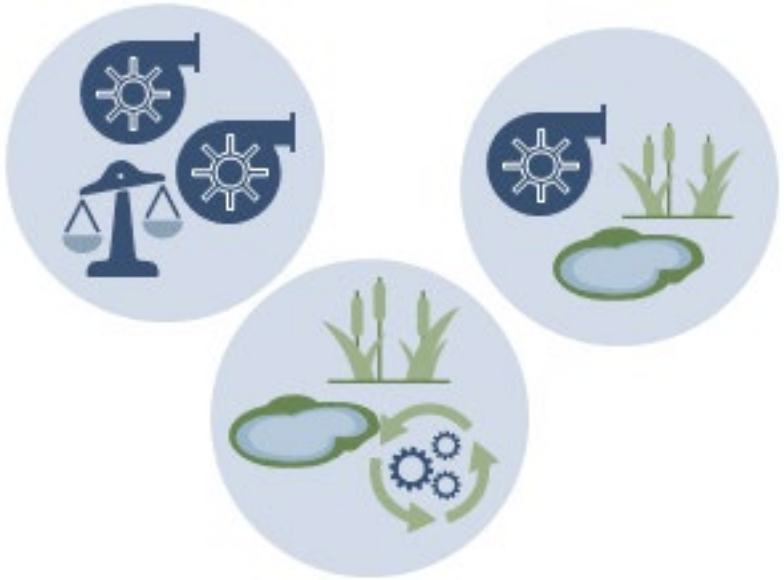


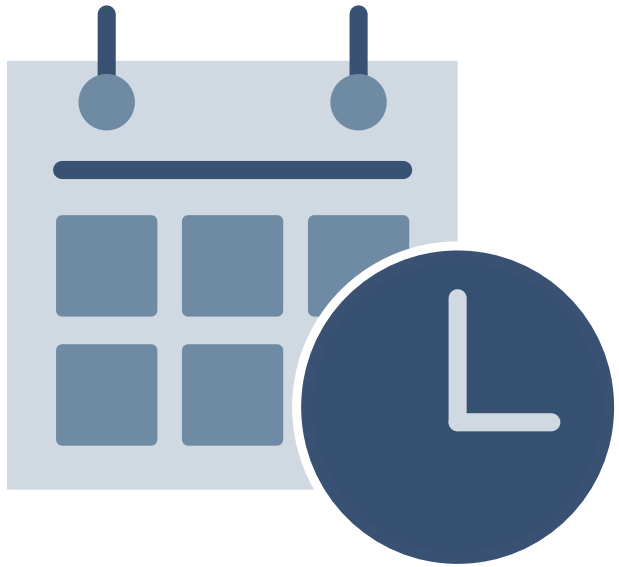


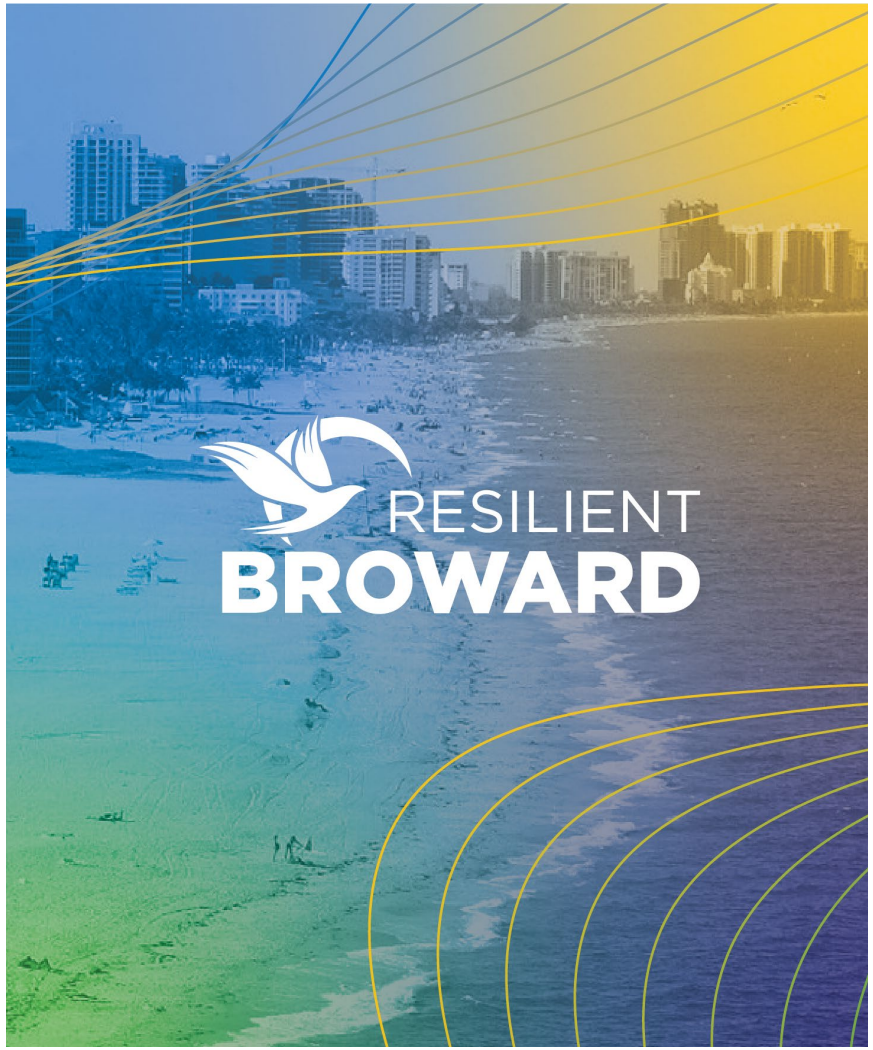
- Change in flood levels
- Reduction in (negative) economic impact

Testing of specific suites of strategies is upcoming

- Evaluation using the Hydrologic Model will proceed in Q4 2023
- Communication with Stakeholders regarding findings is expected in late January 2024
- Report to RSC tentatively planned for February 14, 2024







6

Asset Analysis/Platform Update

Hazen

County-owned critical assets were scored for criticality by the County

- Parks – September 25, 2023

- Facilities/Construction Management Division – September 18, 2023

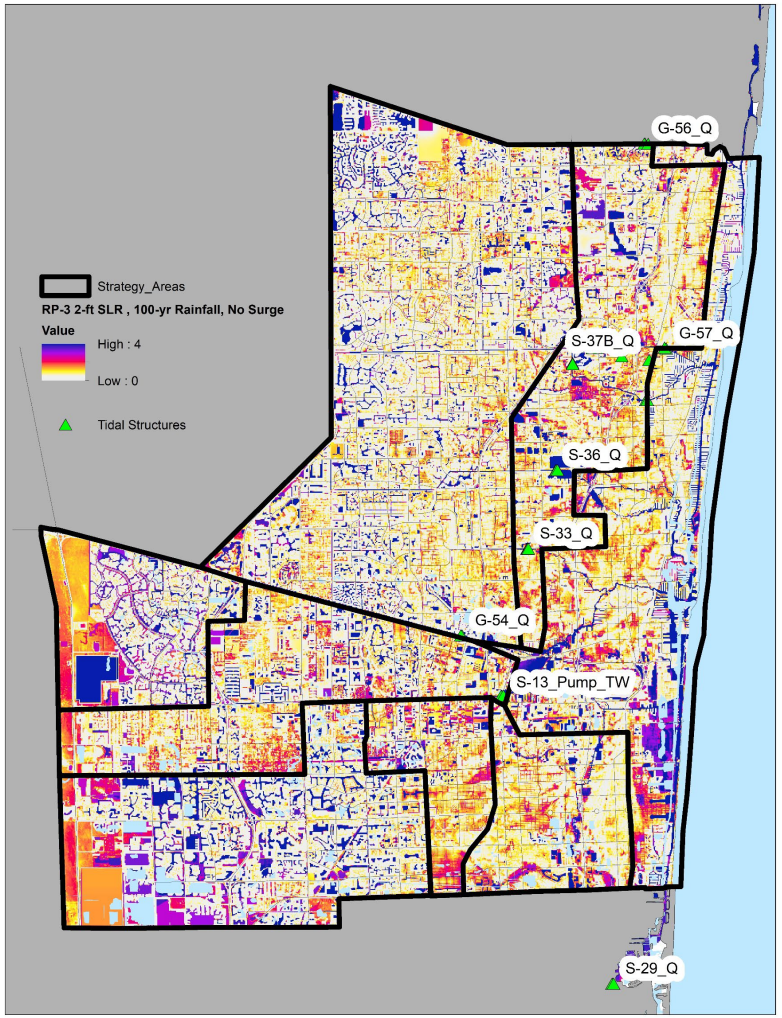
- All other Critical Assets - September 8, 2023

Hazen computed and entered the vulnerability scores and calculated the resulting Risk Factor – See example below for fire stations

Vulnerability Score * Criticality Score = Risk Factor

Asset Name	Unique ID	Vulnerability Score	Criticality Score	Risk Factor	Rank
BE FIRE RESCUE STATION BROWARD ESTATES	131	1.43	5	**7.13**	1
BSO FIRE RESCUE STATION 111	140	1	5	**5**	2
LL FIRE RESCUE STATION 37	152	0.2	5	**1**	3
BSO FIRE RESCUE STATION 4	144	0.13	5	**0.66**	4
BSO Fire Rescue Station 17	142	0.13	5	**0.66**	5

For the roadways, Hazen/Behar entered the updated AADT data and roadway classifications and is finalizing the scorings and graphics



Summary Tables

GIS data

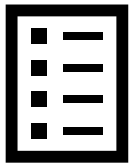
Platform: The Team is taking 360 Degree photos throughout the County for visualization of baseline conditions and future adaptations

- Flood prone areas
- Historical/cultural locations
- Recognizable locations
- Geographical diverse areas

Input welcome for up to six additional locations!

Platform: Example of 360 Degree Photo

Platform: Anticipated PowerBI Queries for Display/Routine Updating



PROJECTS INCLUDED under the ResPlan (includes both developed under the ResPlan as well as previously conceived)

COMPLETION STATUS of Projects (display as $s complete and % complete by time per project)

FUNDING TRACKER (funded amount to investment amount; funding by funding agency; funding by each municipality)

Platform: Anticipated Project Summary Data for Display

- **TOTAL COSTS** (of all projects identified within adaptation strategies for Countywide Resilience)

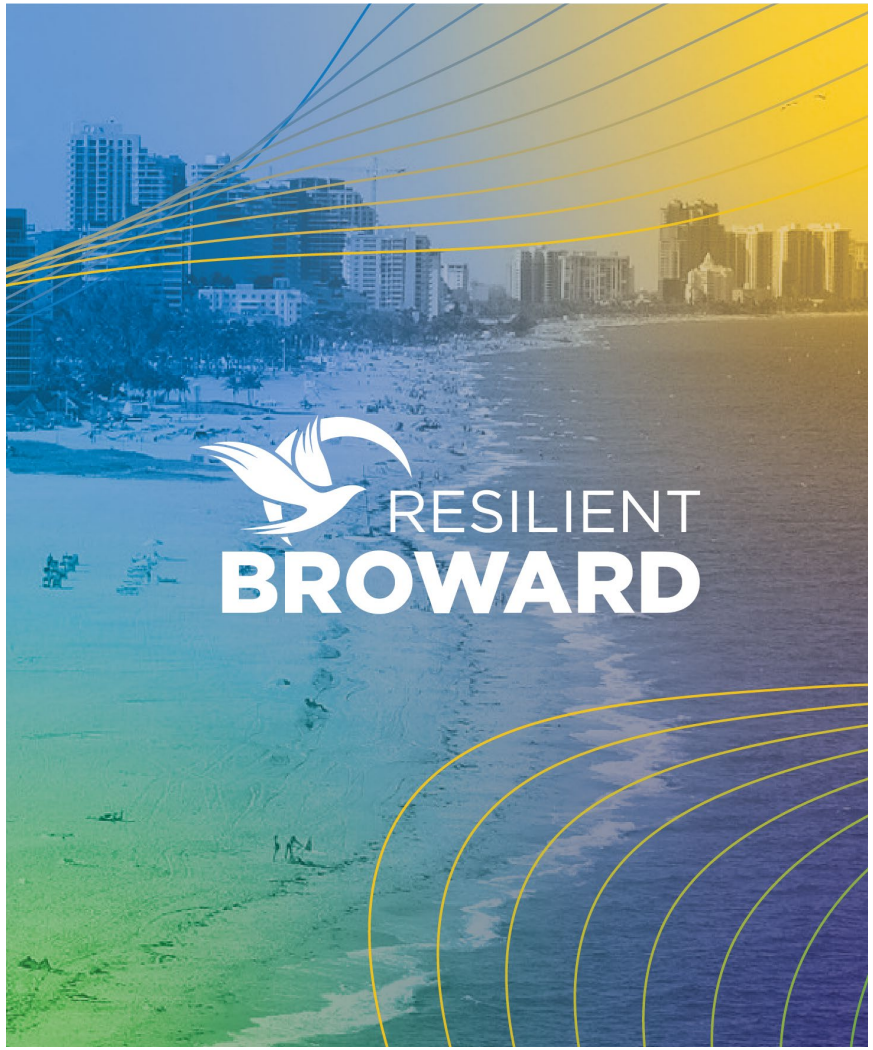
- **TOTAL BENEFIT** (of all adaptation strategies for resilience)

Short-Term Economic Benefits

Increase in Real Estate Value

Reduction in Insurance Premia

Fiscal Benefits to County



Adjournment – Thank You!

Hazen