CRP
Coastal Resilience Partnership

Climate Change Vulnerability Assessment Update (2022)

The Coastal Resilience Partnership of Southeast Palm Beach County continues to show commitment to community sustainability and environmental stewardship by updating the 2021 Climate Change Vulnerability Assessment to meet the additional standards for the Resilient Florida Grant Program. This phase of the project expanded the climate scenarios and knowledge of critical infrastructure for all members of the Coastal Resilience Partnership.

Introduction

The Coastal Resilience Partnership of Southeast Palm Beach County (CRP) completed a Climate Change Vulnerability Assessment (CCVA) for the jurisdictions of Boynton Beach, Boca Raton, Delray Beach, Highland Beach, Ocean Ridge, Lantana, Lake Worth Beach, and a portion of unincorporated Palm Beach County in July of 2021. The CRP CCVA 2021 meets many of the requirements of the new Resilient Florida Grant Program (Section 380.093, Florida Statute (F.S.)), but the analysis needed to be expanded to include the National Oceanic and Atmospheric Administration (NOAA) intermediate-low and intermediate-high sea level rise projections for 2040 and 2070 to be fully compliant. The new analysis updated the storm surge and tidal flooding vulnerability assessment for all critical assets per the statute. Both storm surge and tidal flooding were included in the original 2021 CCVA but the climate scenarios differed from Resilient Florida, so the updates were necessary.

Interested parties should consult the original CRP CCVA 2021 report for more information on the original analyses and foundational information on the overall study. That report can be viewed here:

https://discover.pbcgov.org/resilience/PDF/20210903_ADA_CCVA_FinalReport.pdf

This Appendix is an official modification to the original CRP CCVA 2021 report. It is also notable that the terms rainfall-induced flooding (as outlined in the CRP CCVA 2021) and compound flooding (as defined by Resilient Florida) are interchangeable.

Sea Level Rise

The sea level rise estimates were updated using the 2017 NOAA intermediate-low and NOAA intermediate-high projections to 2040 and to 2070 to comply with Section 380.093, F.S. The total rise was calculated using guidance available in the "Unified Sea Level Rise Projection Southeast Florida, 2019 Update" from the Southeast Florida Regional Climate Change Compact. The curves for the Key West gauge were used to maintain consistency with the original CRP CCVA 2021 and to apply the most conservative estimate of rise. This resulted in the estimated future rise relative to 2020 as shown in Table 1 below. **Please note, the values below represented in feet (ft) and inches (in) have been rounded to the nearest tenths place and whole number, respectively.**

Table A9-1: Sea Level Rise relative to 2020 estimated from 2017 NOAA Intermediate-High and Intermediate-Low Curves

Estimate of Future Sea Level Rise relative to 2020				
Current (2020)	2017 NOAA Intermediate-Low Curve		2017 NOAA Intermediate-High Curve	
	2040	2070	2040	2070
0 ft	0.4 ft (4 in)	1.0 ft (11 in)	0.8 ft (10 in)	2.8 ft (33 in)

Tidal Flooding

The sea level rise estimates shown in Table A9-1 were added to 2020 King Tide flood elevation to develop inundation depths and extents. The King Tide flood elevation was established using the Adaptation Action Elevation (AAE) as defined by Brizaga in the July CRP CCVA 2021 Report. Brizaga' s AAE is defined as the 98th percentile daily higher high water. This was established as 2.2 ft North American Vertical Datum (NAVD-88 or NAVD) for the Lake Worth Pier gauge. Table A9-2 below shows the projected future King Tide flood elevations. **Please note, the values below represented in feet (ft) and inches (in) have been rounded to the nearest tenths place and whole number, respectively.**

Table A9-2: King Tide flooding with sea level rise from 2017 NOAA Intermediate-High and Intermediate-Low Curves. Elevations in feet NAVD-88.

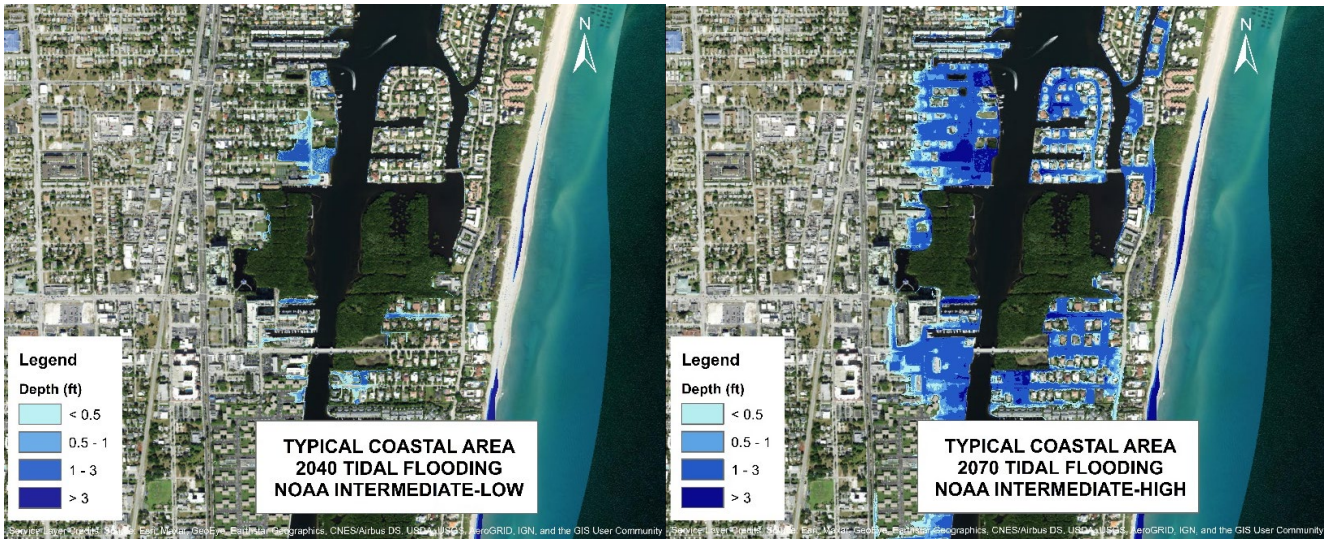
Current King Tide (2020) (ft NAVD)	2017 NOAA Intermediate-Low Curve		2017 NOAA Intermediate-High Curve	
	2040	2070	2040	2070
	Current + 4" (ft NAVD)	Current + 11" (ft NAVD)	Current + 10" (ft NAVD)	Current + 33" (ft NAVD)
2.2	2.6	3.2	3.0	5.0

Inundation depths and extents were created for areas connected directly to tidal waterbodies. Seawalls were not explicitly included unless they were reflected in the LIDAR datasets (which is uncommon in southern Palm Beach County). Engineering judgement was used to determine areas directly connected to tidal waterbodies based on:

- South Florida Water Management District (SFWMD) tidal structures and canals (SFWMD, 2022)

- Lake Worth Drainage District (LWDD) tidal structures and canals (LWDD, 2022)
- Aerial imagery (ESRI et al, 2022)
- 2016 Palm Beach County DEM (Digital Elevation Model) average vertical error (Dewberry, 2018)

Figure A9-1: Example of Tidal Flooding Analyses Completed for the CRP in April 2022



Storm Surge

The estimated sea level rise values shown in Table A9-1 were added to existing storm surge flood elevations to develop inundation depths. Existing storm surge elevations were developed from the Effective 2017 Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas (SFHA) Base Flood Elevations (BFEs) (FEMA, 2017b). It should be noted that the preliminary 2019 FEMA SFHAs BFEs (FEMA, 2019) are up to 4 feet higher within parts of the assessment area but were not used for this analysis since they were still preliminary when this analysis was completed.

To be conservative and maintain consistency with the first phase of the CRP CCVA 2021, the 2017 FEMA BFEs were adjusted for sea level rise. According to the 2017 FEMA Flood Insurance Study (FIS) Report, coastal stillwater elevations developed in 1977 were used as starting elevations for the wave runup analysis to develop the coastal SFHAs. Therefore, for this analysis, the 2017 FEMA BFEs were adjusted to account for sea level rise from 1977. The historic rate of rise at the NOAA Lake Worth Pier gauge is 3.81 millimeters (mm)/year (0.0125 ft/year); this result is a rise of approximately 0.5 feet between 1977 and 2020. Therefore, 0.5 feet was added to the 2017 FEMA BFEs to establish current 2020 flood elevations.

The minimum and maximum storm surge elevations used for the study area are shown in Table A9-3 below. The minimum elevations were used along the most inland portions of the storm surge flooding while the maximum elevation was used along the coast. Elevations vary between the minimum and maximum elevation based on the 2017 FEMA BFEs. **Please note, the values below represented in feet (ft) and inches (in) have been rounded to the nearest tenths place and whole number, respectively.**

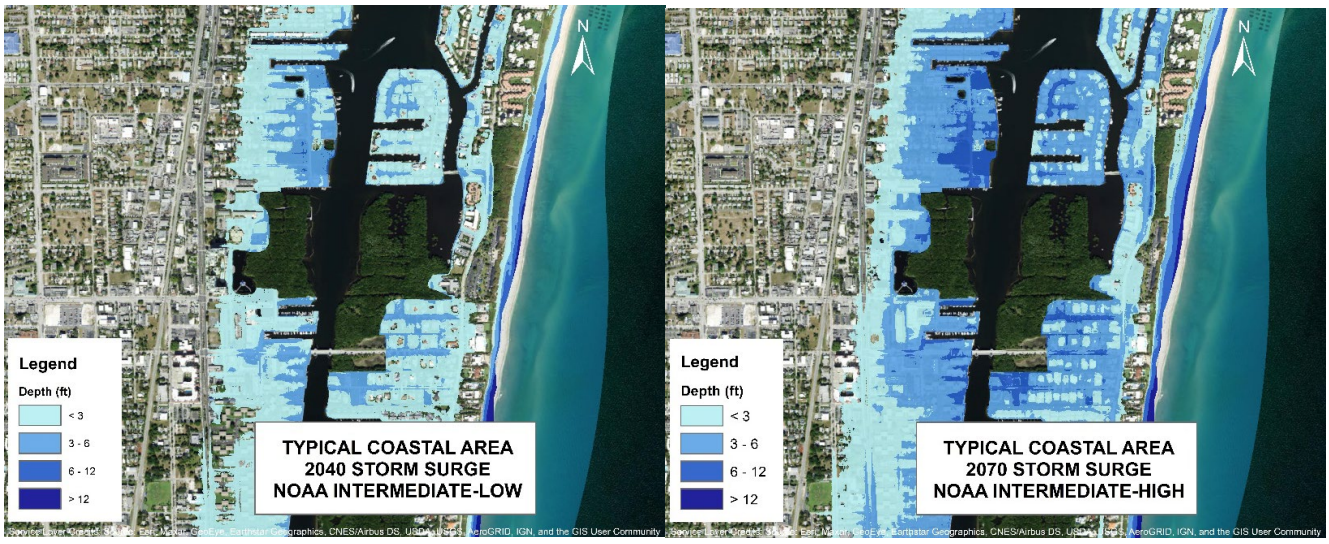
Table A9-3: Storm surge minimum and maximum elevations used within the study area with sea level rise from 2017 NOAA Intermediate-High and Intermediate-Low curves. Elevations in feet NAVD-88.

	Current 2020 BFEs (2017 BFE + 0.5') (ft NAVD)	NOAA INT-LOW		NOAA INT-HIGH	
		2040	2070	2040	2070
		Current + 4" (ft NAVD)	Current + 11" (ft NAVD)	Current + 10" (ft NAVD)	Current + 33" (ft NAVD)
Minimum	**6.5**	**6.9**	**7.5**	**7.3**	**9.3**
Maximum	**13.5**	**13.9**	**14.5**	**14.3**	**16.3**

Inundation depths and extents were created for areas connected directly to tidal waterbodies. Seawalls were not explicitly included unless they were reflected in the LIDAR datasets (which is uncommon in southern Palm Beach County). Engineering judgement was used to determine areas directly connected to tidal waterbodies based on available information including:

- South Florida Water Management District (SFWMD) tidal structures and canals (SFWMD, 2022)
- Lake Worth Drainage District (LWDD) tidal structures and canals (LWDD, 2022)
- Aerial imagery (ESRI et al, 2022)
- 2016 Palm Beach County DEM (Digital Elevation Model) average vertical error (Dewberry, 2018)

Figure A9-2: Example of Storm Surge Analyses Completed for the CRP in April 2022



Updated Asset Vulnerability Analysis

Once the tidal flooding and storm surge elevation information was updated to comply with Section 380.093, F.S., the asset data for the CRP jurisdictions was analyzed against the updated elevations.

The update included 80 permutations (2 time horizons x 2 sea level rise scenarios x 2 flood threats x 10 asset categories). The 10 asset categories were based on the previous asset categories used in the 2021 CCVA. The Resilient Florida Grant Program (Section 380.093, Florida Statute (F.S.)) specified

analysis of asset categories for transportation assets and evacuation routes; critical infrastructure; critical community and emergency facilities; and natural, cultural, and historic resources.

The 4 asset categories specified were spread across 9 of the 10 categories* used in the CRP CCVA 2021. The categories included:

- Energy and Communications
- Health and Medical
- Public Safety and Government Owned
- Natural
- Commercial and Industrial
- Parks and Cultural Property
- Residential
- Transportation Facilities
- Roads

*Food Infrastructure was also assessed but did not include assets listed from 380.093 F.S.

Table A9-4 shows how the specific critical asset categories called out in Resilient Florida intersect with each of the CRP CCVA 2021 categories.

Table A9-4: Detailed comparison of CRP CCVA 2021 asset categories compared to 2022 Resilient Florida critical asset categories.

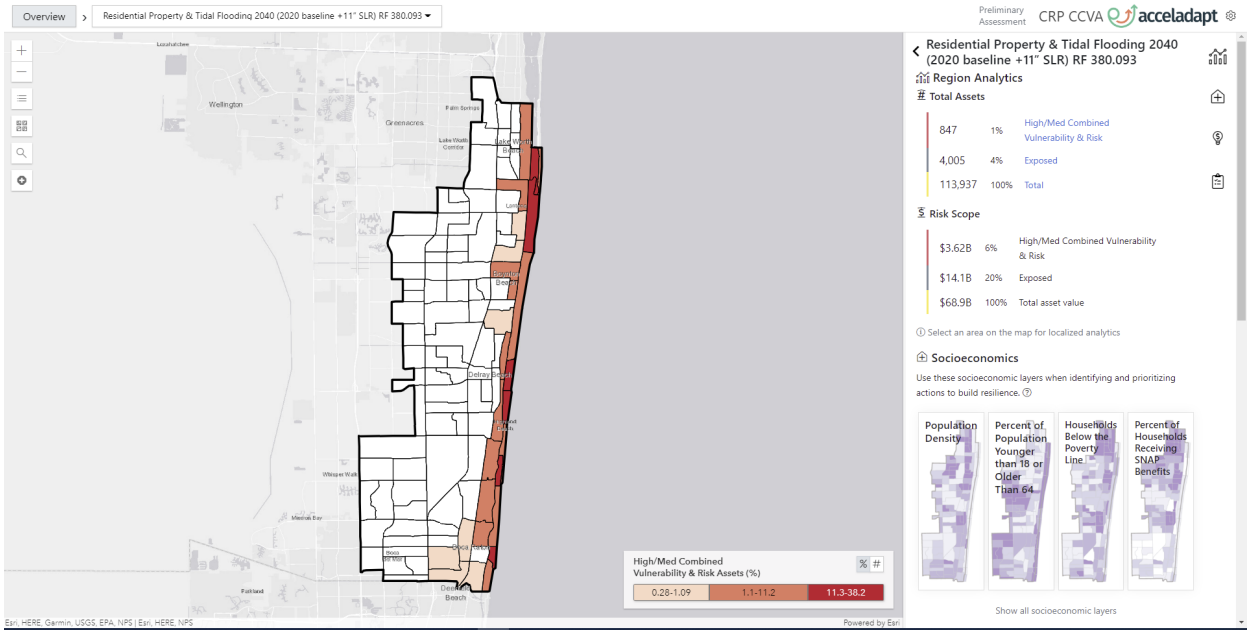
CRP 2021 CCVA Asset Categories	2022 Resilient Florida Critical Assets			
	Transportation Assets and Evacuation Routes	**Critical infrastructure**	**Critical Community and Emergency Facilities**	**Natural, Cultural, and Historical Resources**
Energy and Communications		Electric production and supply facilities, communications facilities		
Food Infrastructure	No Resilient Florida Reference but included in 2021 CCVA			
Health and Medical			Emergency medical service facilities, health care facilities, hospitals	
Natural				Conservation lands, wetlands (if part of managed areas), shorelines, surface waters
Commercial and Industrial		Solid and hazardous waste facilities, disaster debris management sites		
Parks and Cultural Property			Community centers	Parks, historical and cultural assets

CRP 2021 CCVA Asset Categories	2022 Resilient Florida Critical Assets (Continued)			
	Transportation Assets and Evacuation Routes	Critical infrastructure	Critical Community and Emergency Facilities	Natural, Cultural, and Historical Resources
Public Safety and Government Owned		Military installations (federal-owned properties were included in the CRP's analyses, it is possible some military installations were included but local governments do not have military specific data). Wastewater treatment facilities and lift stations, stormwater treatment facilities and pump stations, drinking water facilities, water utility conveyance systems (this analysis is contained in a separate confidential dataset that was provided to each jurisdiction).	Schools, colleges, universities, correctional facilities, disaster recovery centers, emergency operation centers (if part of municipal-owned), fire stations, law enforcement facilities, local government facilities, logistical staging areas (if part of municipal-owned property), risk shelter inventory (if part of municipal-owned), state government facilities (only state-owned properties were included)	
Residential			Affordable public housing	
Transportation Facilities	Airports, bus terminals, ports, marinas, rail facilities, railroad bridges (railroad bridges are not contained in study area)			
Roads	Bridges, major roadways, evacuation routes			

The analysis tool AccelAdapt (Fernleaf, 2022) was updated with the new horizons, updated scenarios, and updated threats (https://sepbc.acceladapt.com/). A screen shot of AccelAdapt is shown below in Figure A9-3. In addition to the AccelAdapt tool, deliverables submitted included:

1) "1_20220819_Task2Memo_Final" in .pdf and .docx formats – Technical memorandum (including a summary of the workshop with attendee feedback and outcomes)
2a) "2a_CCVA Update and AccelAdapt.pptx" - Slide deck of material covered in the workshop in a PowerPoint format
2b) "2b_update_pngs.zip" – All maps from AccelAdapt in PNG format
3a) "3a_CCVA 2022 Update Data Sources.docx" – Sources of GIS data that were developed into ESRI compatible formats
3b) "3b_Data Documentation Update 2022_5.26.2022.docx" – a summary of the data and metadata
4) "4_GISfiles" – GIS shapefiles and other electronic mapping data
5) "5_20220707_SigImpAssets.xlsx" – The list of critical assets and regionally significant assets

Figure A9-3: Image from AccelAdapt - Residential Property & Tidal Flooding 2040 (2020 Baseline + 11" SLR) RF 380.093



Outcomes

The Tidal Flooding and Storm Surge rasters corresponding with the 2017 NOAA Intermediate-High and Intermediate-Low curves did not visually appear significantly different than the CCVA project as finalized in July 2021 - primarily because each scenario was within a few inches. These differences (a few inches) are virtually undetectable upon visual inspection and are very close to the uncertainty created through both the use of the LIDAR data and subsequent inundation modeling. **So, while the data is now fully compliant with Resilient Florida (as of 2022), the update did not appreciably change the results for tidal flooding and storm surge.**

The CRP was consulted on updating analysis datasets in AccelAdapt to use the flood elevations aligning with the 2017 NOAA Intermediate-High and Intermediate-Low curves that satisfy the Resilient

Florida Grant Program (Section 380.093, Florida Statute (F.S.)). The CRP agreed to having datasets updated with corresponding values.

Additionally, as seen previously in Table A9-1, the resulting values for future sea level rise are 4-, 11-, 10- and 33-inches corresponding with NOAA intermediate-low values for 2040 and 2070 and with NOAA intermediate-high values for 2040 and 2070, respectively. For the asset analyses, the 11" SLR scenario appears to provide a reasonable estimate for the NOAA Intermediate-High 2040 scenario as well as the NOAA Intermediate-Low 2070 scenario; therefore, the 11" SLR was used to reflect both. Vulnerability at the census tract level of analysis did not change when using this parameter.

Table A9-5: Example Outcome:
Roads and Parcels Storm Surge Analytics from 2022 Update (as portrayed in AccelAdapt Assessment (Fernleaf, 2022))

Roads and Parcels Inaccessible Due to Storm Surge (100-yr, 24-hr storm)			
Assessment Year	**Scenario**	**Number of Assets Exposed (out of 120,220 Assets)**	**Percent of Assets Exposed**
2020	Baseline 2020	10,145	8%
2040	2020 + 4" SLR	11,097	9%
2040/2070	2020 + 11" SLR	11,813	10%
2070	2020 + 33" SLR	15,489	13%

Table A9-6: Example Outcome
Roads and Parcels Tidal Flooding Analytics from 2022 Update (as portrayed in AccelAdapt Assessment (Fernleaf, 2022))

Roads and Parcels Inaccessible Due to Tidal Flooding			
Assessment Year	**Scenario**	**Number of Assets Exposed (out of 120,220 Assets)**	**Percent of Assets Exposed**
2020	Baseline 2020	1,011	1%
2040	2020 + 4" SLR	1,488	1%
2040/2070	2020 + 11" SLR	2,385	2%
2070	2020 + 33" SLR	5,923	5%

All analytics for the updated datasets, such as those portrayed in Tables A9-5 and A9-6, can be found within the AccelAdapt program.

References

Coastal Resilience Partnership: Palm Beach County. Multi-Jurisdictional Climate Change Vulnerability Assessment. (2021). Final Project Report. Version 1.1 (July 2021). Available at: https://discover.pbcgov.org/resilience/PDF/20210903_ADA_CCVA_FinalReport.pdf.

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