ADVISORY COASTAL FLOOD HAZARD MAPPING – PUERTO RICO

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SIMPOSIO SOBRE MANEJO DE RIESGOS COSTEROS
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HURRICANE MARÍA

- Made landfall through Yabucoa on September 20th, 2017 as a Cat 4 hurricane with sustained winds of 155 mph (NWS).

- Unprecedent atmospheric event in the Caribbean.

- Triggered a variety of hazard research and data (academic sector and government agencies).
  - USGS High Water Marks
  - FEMA Mitigation Assessment Team (MAT) Reports
  - **FEMA Advisory Base Flood Elevation (ABFE) Products**.

FEMA ABFE PRODUCTS

- After large storms, FEMA performs assessments to determine the accuracy of the effective 1% annual chance flood.
    - Age of analysis
    - Coverage of analysis
    - Models used in analysis

- ABFE Products are used to determine stronger construction parameters within the floodplain.

- They are not used to determine flood insurance rates. NFIP still determines those.

- ABFE maps have been created recently for New York and New Jersey after Sandy and US Virgin Islands and Puerto Rico after Maria and Irma.

CONSIDERATIONS

Coastal

- Work performed 2006-2008, effective 2009.
- Data acceptable but could be improved.

Riverine

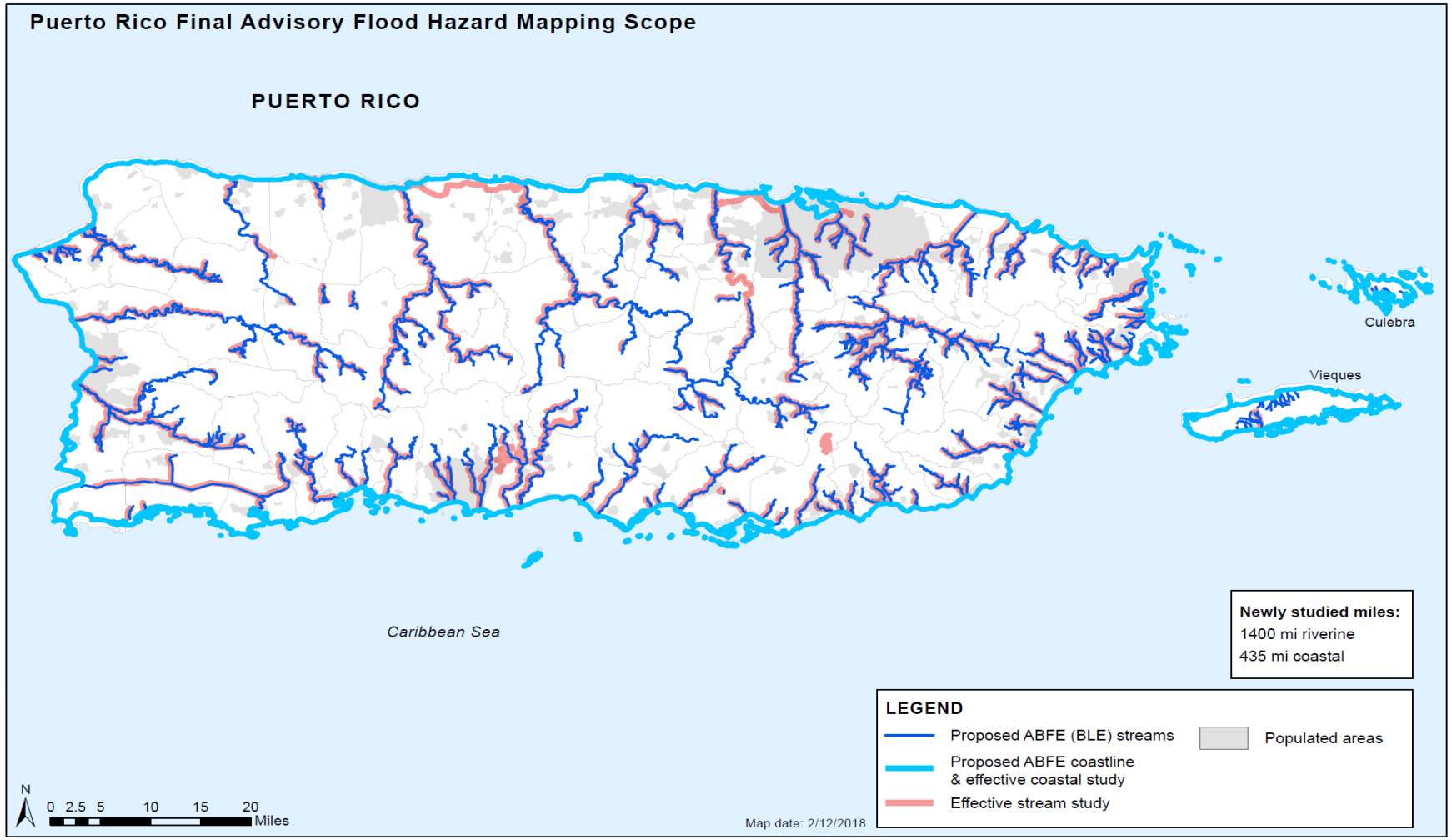
- Approximate studies date to early 1980s (~500 miles).
- Detailed studies date from early 1980s to late 2000s (~500 miles).
- Data considered to be outdated.

In many areas the flooding and erosion exceeded what is shown on FIRMs.

FIRM

ABFE

GEOGRAPHIC SCOPE



COASTAL ABFE PRODUCTS

:

- New 1-percent-annual-chance coastal floodplain boundaries, delineated to the latest topographic information.
- LiMWA lines and Coastal A Zone areas based on the 1-percent-annual-chance flood event.
- New 0.2-percent-annual-chance coastal flood zones and floodplains with elevations for critical facility guidance.
- LiMWA lines and Coastal A Zone areas based on the 0.2-percent-annual-chance flood event.
- Identification of areas vulnerable to storm erosion.
- Long-term erosion setback lines for 30-year and 60-year erosion areas.
- New stream floodplains and elevations for both the 1-percent- and 0.2-percent-annual-chance levels.

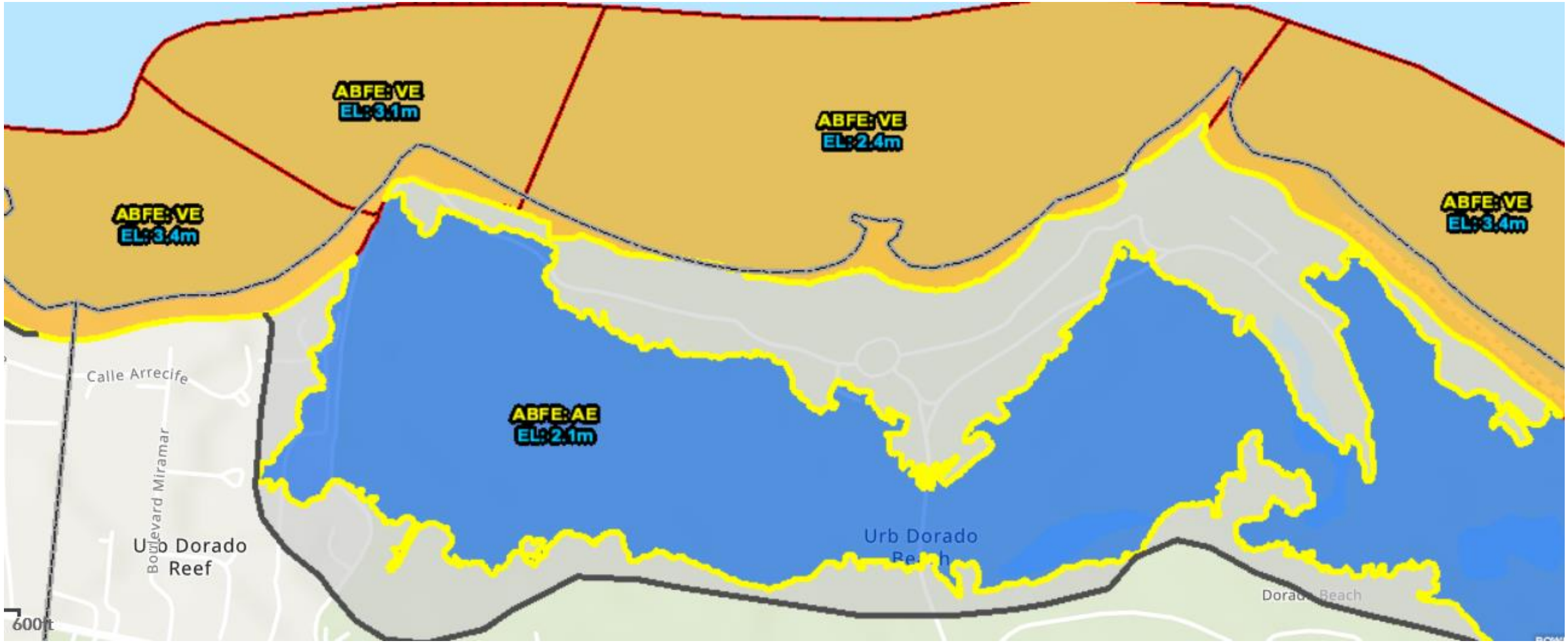
SUMMARY OF DATA

Data	Source/Notes
Topography Data	• USGS 2017 Light Detection and Ranging ("LiDAR") provided the base topographic data source for the project. This dataset was utilized for coastal modeling, riverine modeling, and erosion assessments. • 30 meter Digital Elevation Models ("DEM") from USGS National Elevation Dataset ("NED") were used only for hydrologic analyses. • 2000 USGS/NASA ATM LiDAR DEM was utilized for long-term shoreline change analyses.
Bathymetry Data	Seamless Topographic/Bathymetric DEMs developed for the 2009 effective Flood Insurance Rate Map ("FIRM") study for Puerto Rico and Municipalities. Only the bathymetric portion of the data was utilized as topographic data was provided by USGS 2017 LiDAR.
Streamlines	USGS National Hydrographic Dataset ("NHD") streamlines were utilized for developing hydrologic model stream network. The dataset also included Hydrologic Unit Code – 10 ("HUC-10") boundaries, used for data management and work distribution.
Effective FIRM Data	Effective data for the study area was obtained from published FIRM databases and the National Flood Hazard Layer.
Coordinated Needs Management Data ("CNMS")	FEMA's Coordinated Needs Management Data ("CNMS") was utilized to identify and validate the scope for riverine advisory data development.
Stillwater Elevations	Stillwater elevations developed as part of the effective coastal FEMA Flood Insurance Study ("FIS") update for Puerto Rico and Municipalities, 2009.
Pre-storm Imagery	Storm erosion analyses utilized aerial imagery from NOAA and Google Earth.
Post-storm Imagery	Storm erosion analyses utilized post-storm aerial imagery from Vexcel and NOAA.
Coastal Modeling Transects	Overland wave modeling data and transects developed as part of the effective coastal FEMA FIS update for Puerto Rico and Municipalities, 2009.

COASTAL ANALYSIS DETAILS

- 1% Annual Chance Flood Elevation
  - Analysis results from 2009 Effective Study were delineated over 2017 USGS LiDAR
  - ABFE analysis include wave setup developed in 2D model environment, to more efficiently develop floodplain boundaries
- 1% LiMWA developed and included with ABFE mapping
  - Depicts the limits of the 'Coastal A Zone'
  - Based on the results of the 2009 Effective Study
- 0.2% Annual Chance Flood Elevation
  - Statistical analysis incorporated 37 historic storms to develop new overland wave hazard for generation of BFEs
  - 0.2% LiMWA developed and included with ABFE mapping

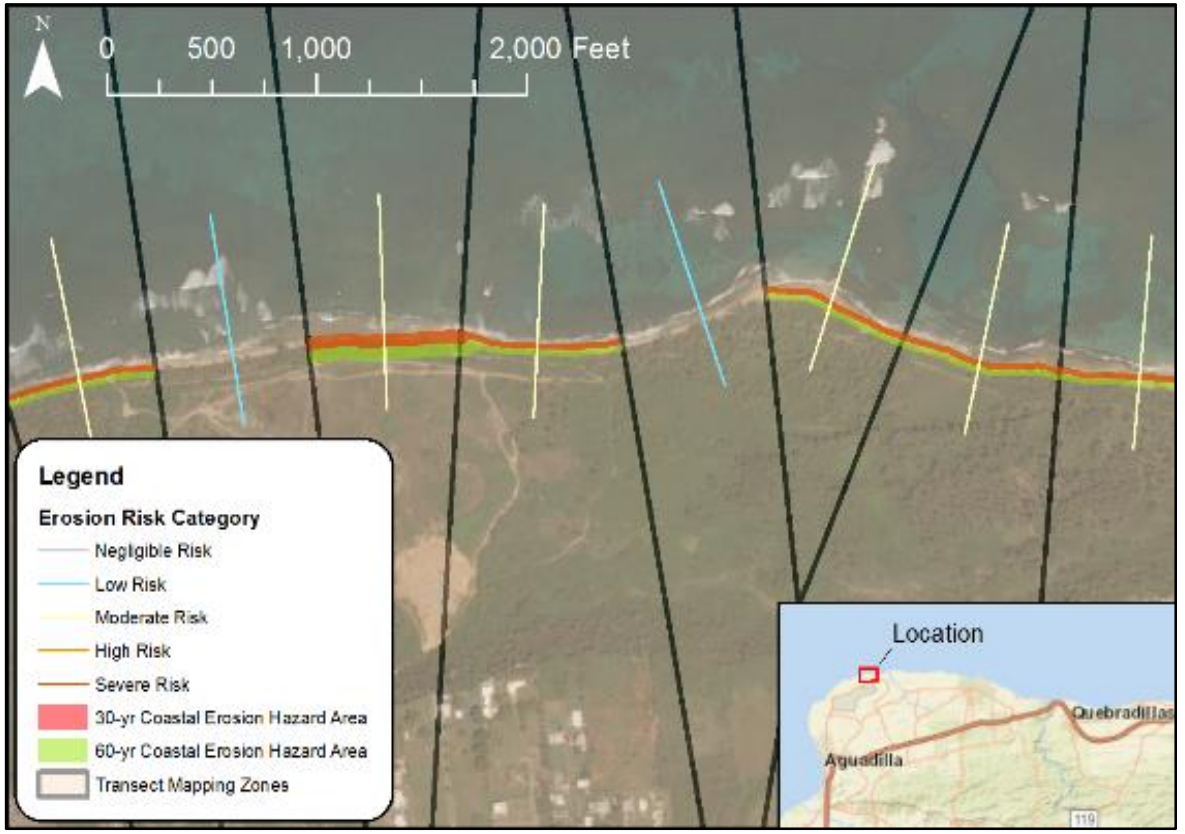
COASTAL FLOOD ZONES



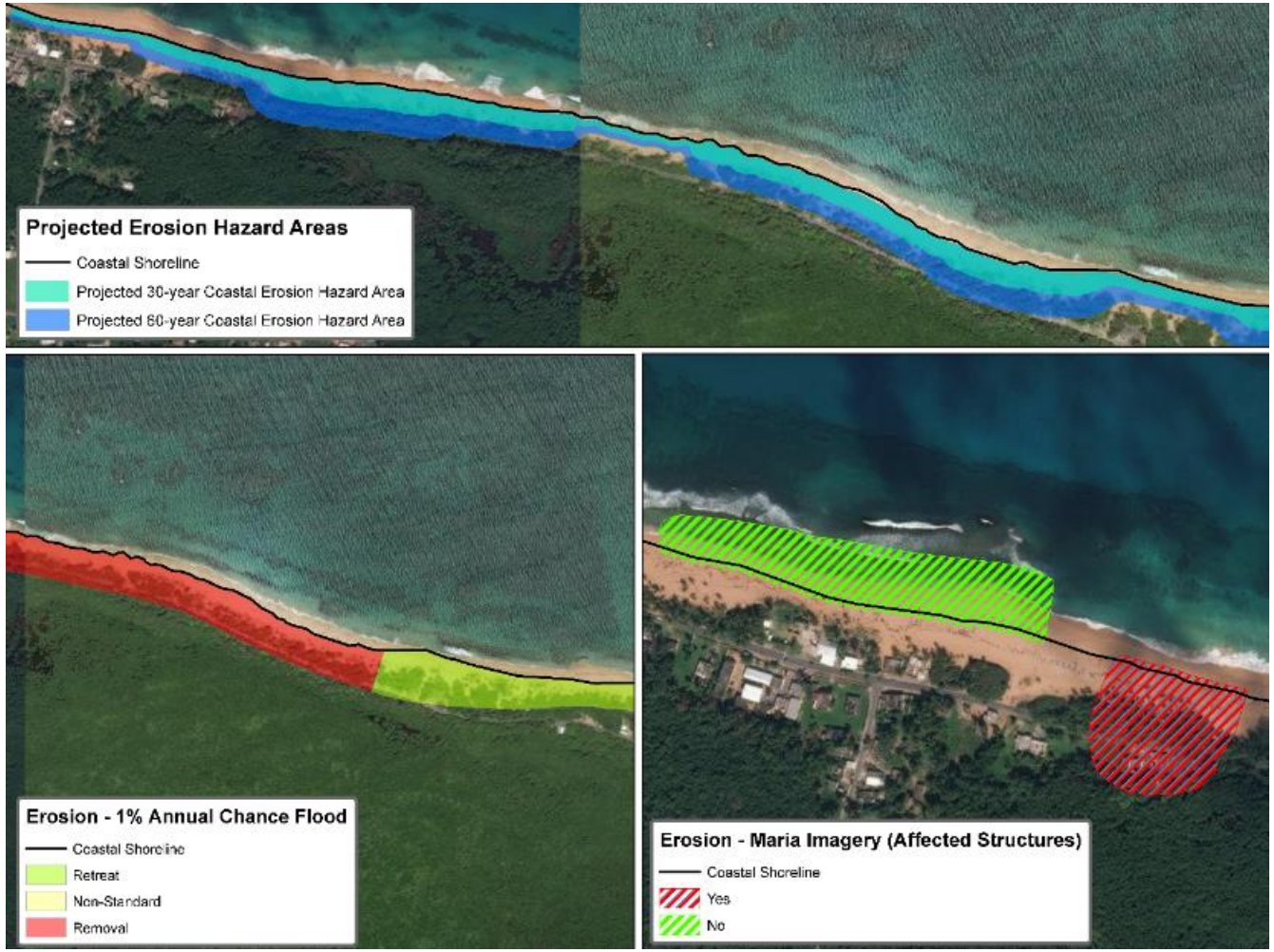
1% LIMWA

COASTAL EROSION PRODUCTS

- Long-term Erosion
  - 30 and 60-year zones
  - LiDAR Based, using 2000 vs 2016 comparison
  - Developed risk classifications along shoreline:
    - Negligible, Low, Moderate, High, Severe
- Storm-induced Erosion
  - Based on visual inspection of pre vs. post-storm imagery
- Areas of storm-induced erosion potential
  - Identified from effective FIS and available as layer in ABFE mapping

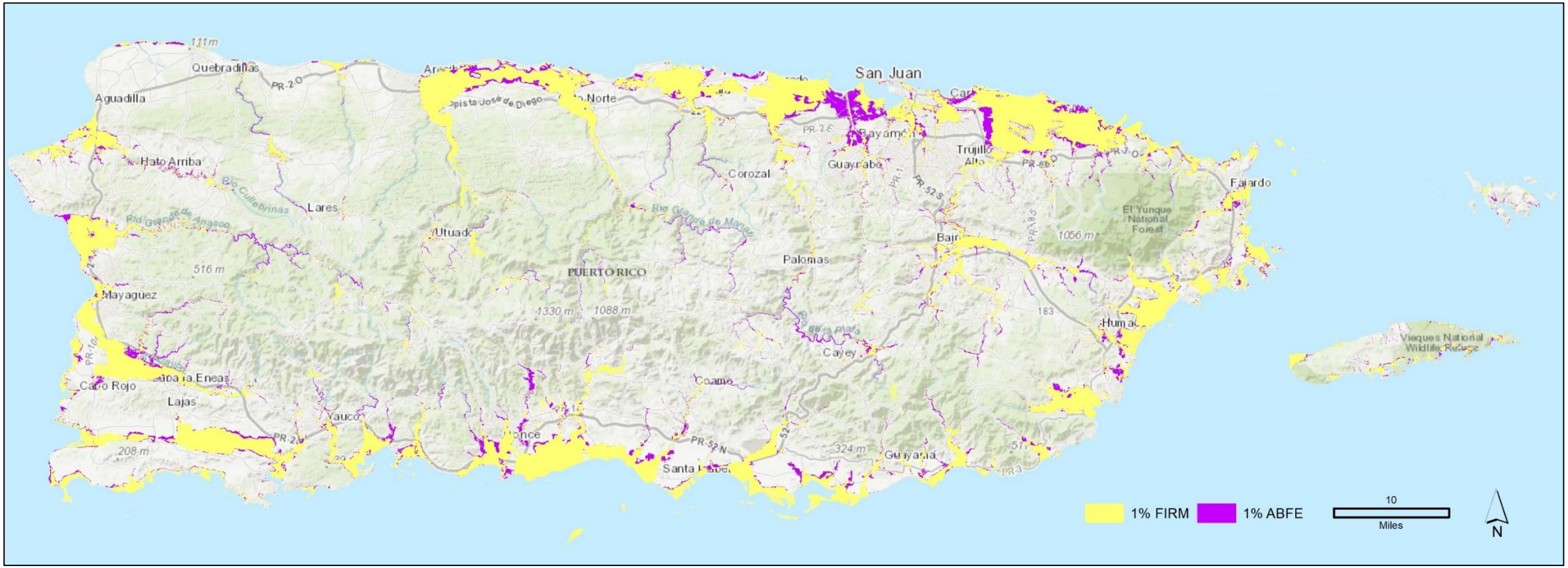


COASTAL EROSION PRODUCTS



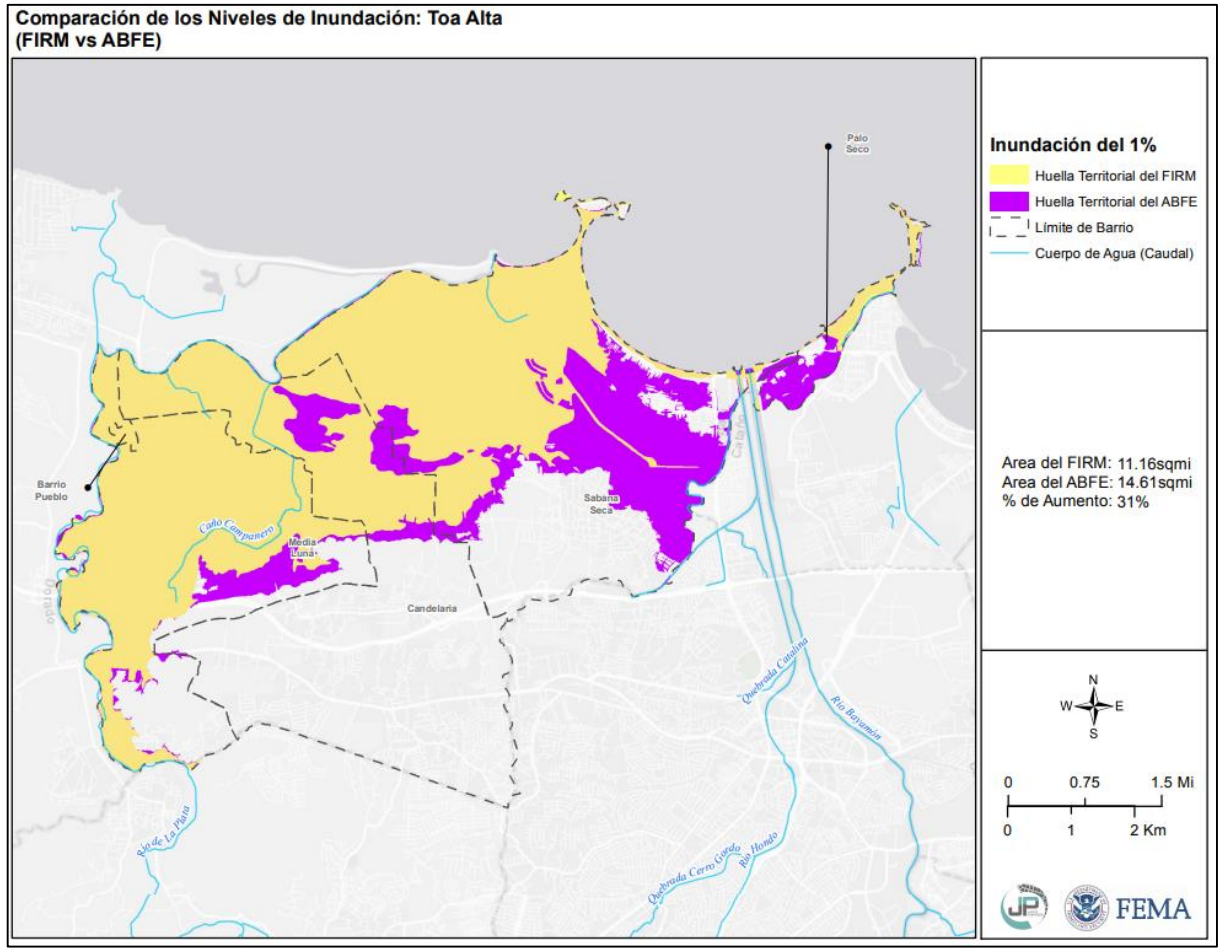
SUPPORTING RECOVERY USING ABFE PRODUCTS

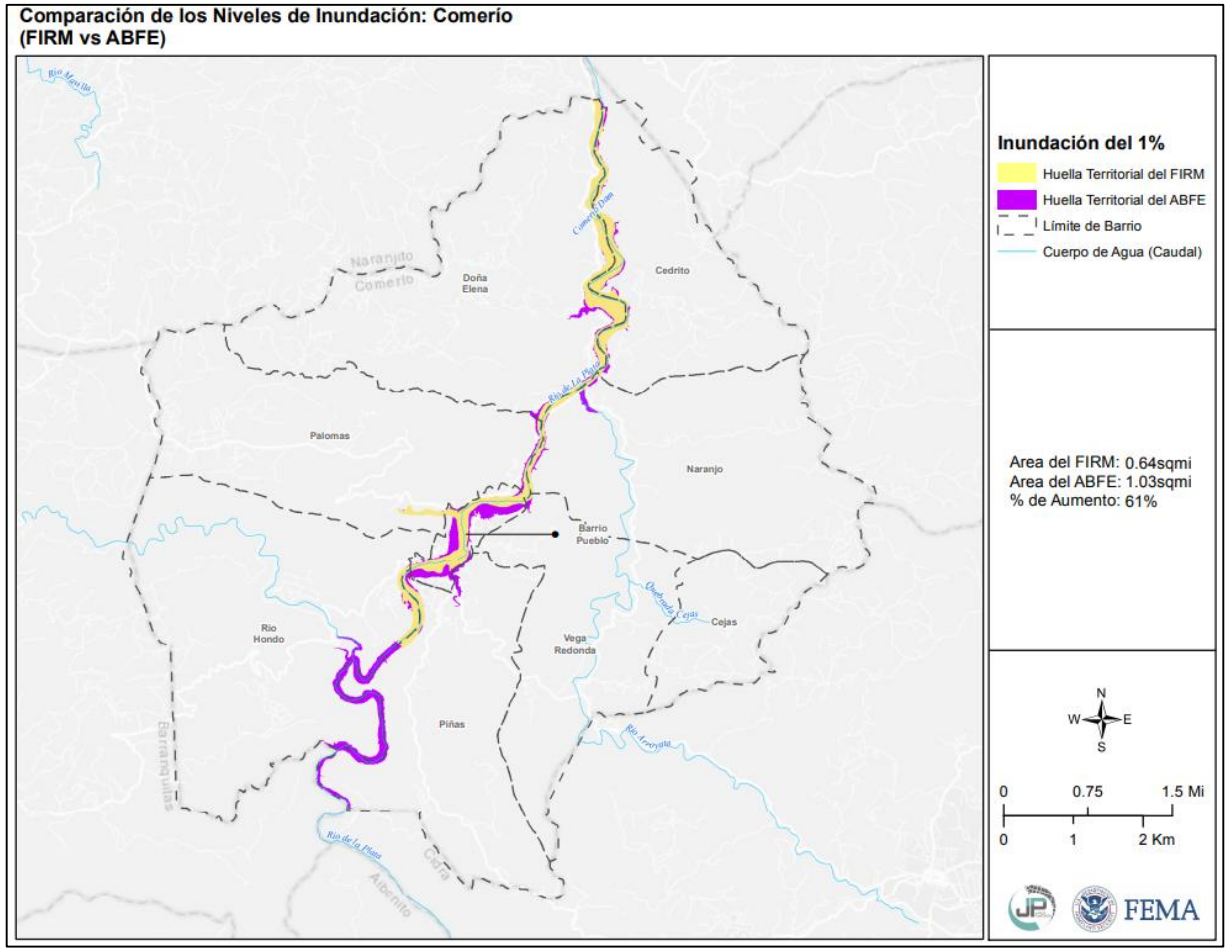
- ✓ Determining increase in 1% annual flood territorial footprint.
  - 20% increase in the floodplain (74.25 mi²)



SUPPORTING RECOVERY USING ABFE PRODUCTS

- ✓ Determining increase in 1% annual flood territorial footprint.
  - Increase by municipality





SUPPORTING RECOVERY USING ABFE PRODUCTS

- ✓ Identifying critical facilities within the floodplain.

Figure 1

Table

Critical_Facilities

FID	Shape	Name	Type	ABFE
1159	Point	ANTONIO VALERO BERNABE	Schools	NO
965	Point	ANTONIO VELEZ ALVARADO	Schools	NO
732	Point	Apeadero	Potable Water Treatment Plant	NO
3779	Point	Apeadero	Water Pump Stations	NO
1839	Point	APEADERO	Schools	NO
3148	Point	Apolo	Waste Water Pump Stations	NO
1014	Point	APOLO SAN ANTONIO	Schools	NO
1272	Point	APOLONIA VALENTIN	Schools	NO
2739	Point	April Gardens	Waste Water Pump Stations	NO
4532	Point	April Gardens (Montones 1)	Water Pump Stations	NO
2952	Point	Aquatika	Waste Water Pump Stations	YES
1263	Point	AQUILINO CABAN	Schools	YES
1929	Point	AQUILINO RIVERA OLAN	Schools	NO
4125	Point	Arca de Noé	Water Pump Stations	NO
5068	Point	Arcadia	Water Pump Stations	NO
402	Point	Arecibo	Fire Stations	NO
3652	Point	Arecibo RWWTP	Waste Water Treatment Plant	NO
2762	Point	Arenales	Waste Water Pump Stations	NO
4765	Point	Arenales (Mantilla)	Water Pump Stations	NO
2654	Point	Arenas	Waste Water Pump Stations	NO
3946	Point	Arenas	Water Pump Stations	NO
1824	Point	ARISTIDES CALES QUIROS	Schools	YES
411	Point	ARMY	Military Facilities	NO
415	Point	ARMY	Military Facilities	NO
416	Point	ARMY	Military Facilities	NO
419	Point	ARMY	Military Facilities	YES
4319	Point	Arrayanes 1	Water Pump Stations	NO
4882	Point	Arrayanes 2	Water Pump Stations	NO
5000	Point	Arrendado	Water Pump Stations	NO
396	Point	Arroyo	Fire Stations	YES
525	Point	Arroyo	Police Stations	YES
679	Point	Arroyo	Police Stations	YES
3107	Point	Arroyo (Troncal Arroyo)	Waste Water Pump Stations	NO
2073	Point	ARSENIO MARTINEZ	Schools	YES
1776	Point	ARTURO GRANT PARDO	Schools	NO
1617	Point	ARTURO LLUBERAS	Schools	NO
4171	Point	Arturo López (La Agricola) Cortina	Water Pump Stations	NO

0 (0 out of 5184 Selected)

Critical_Facilities

Figure 2

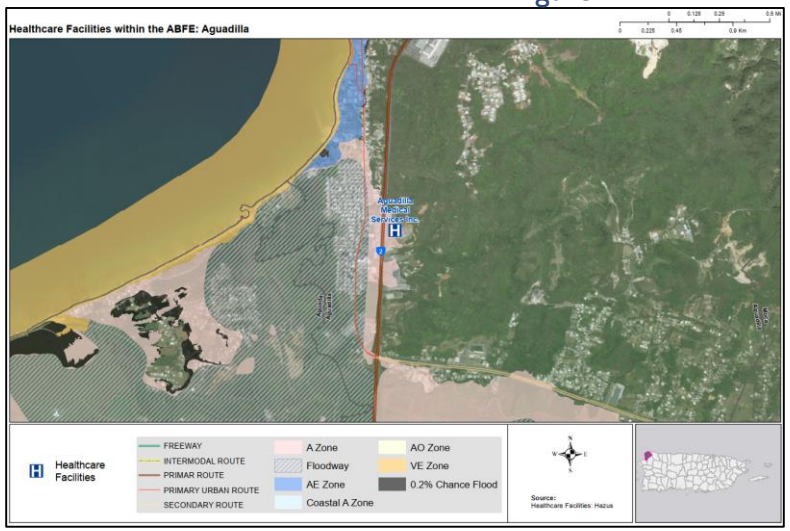


Figure 3

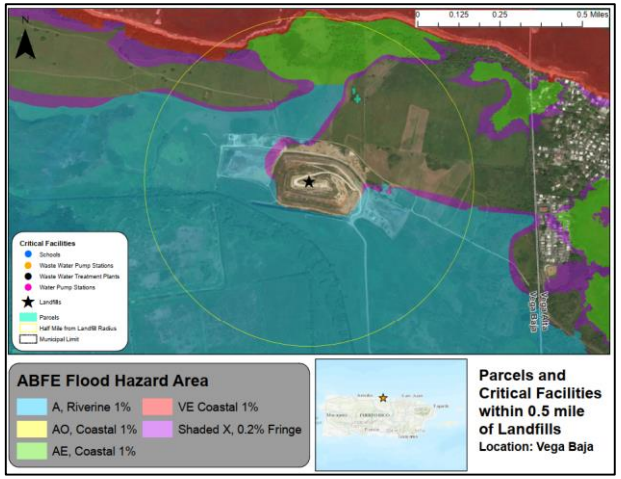
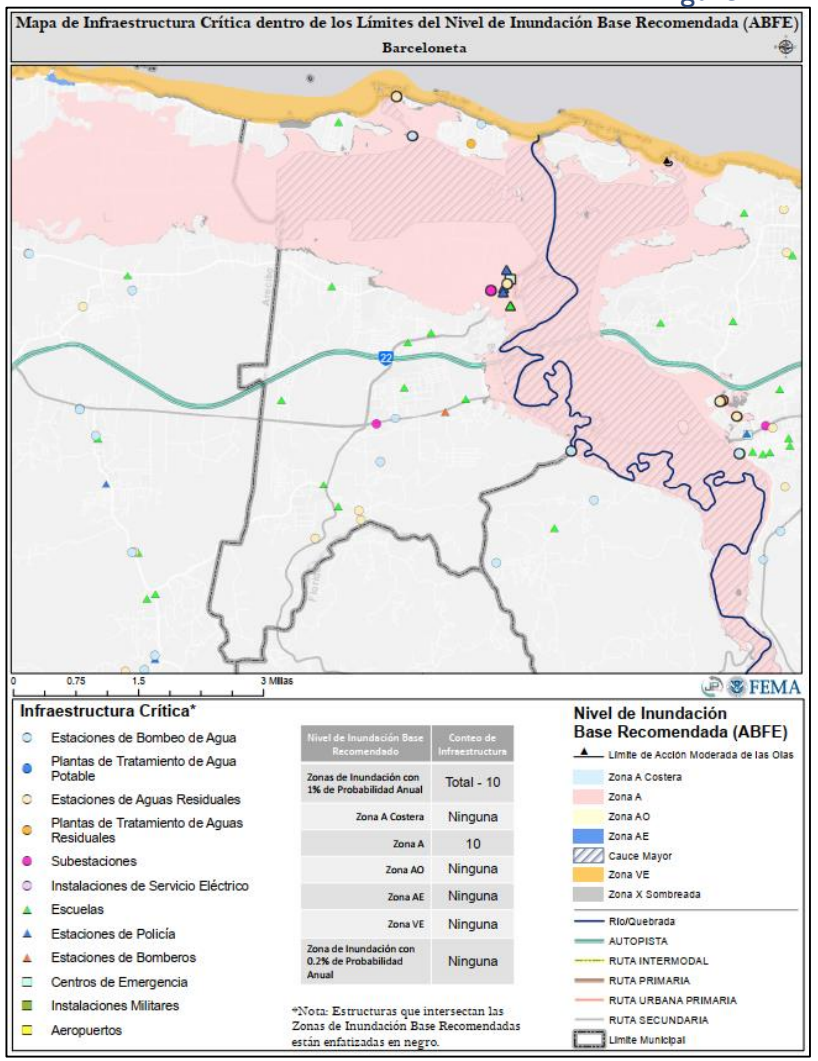


Figure 4



SUPPORTING RECOVERY USING ABFE PRODUCTS

Figure 1: Power Plants

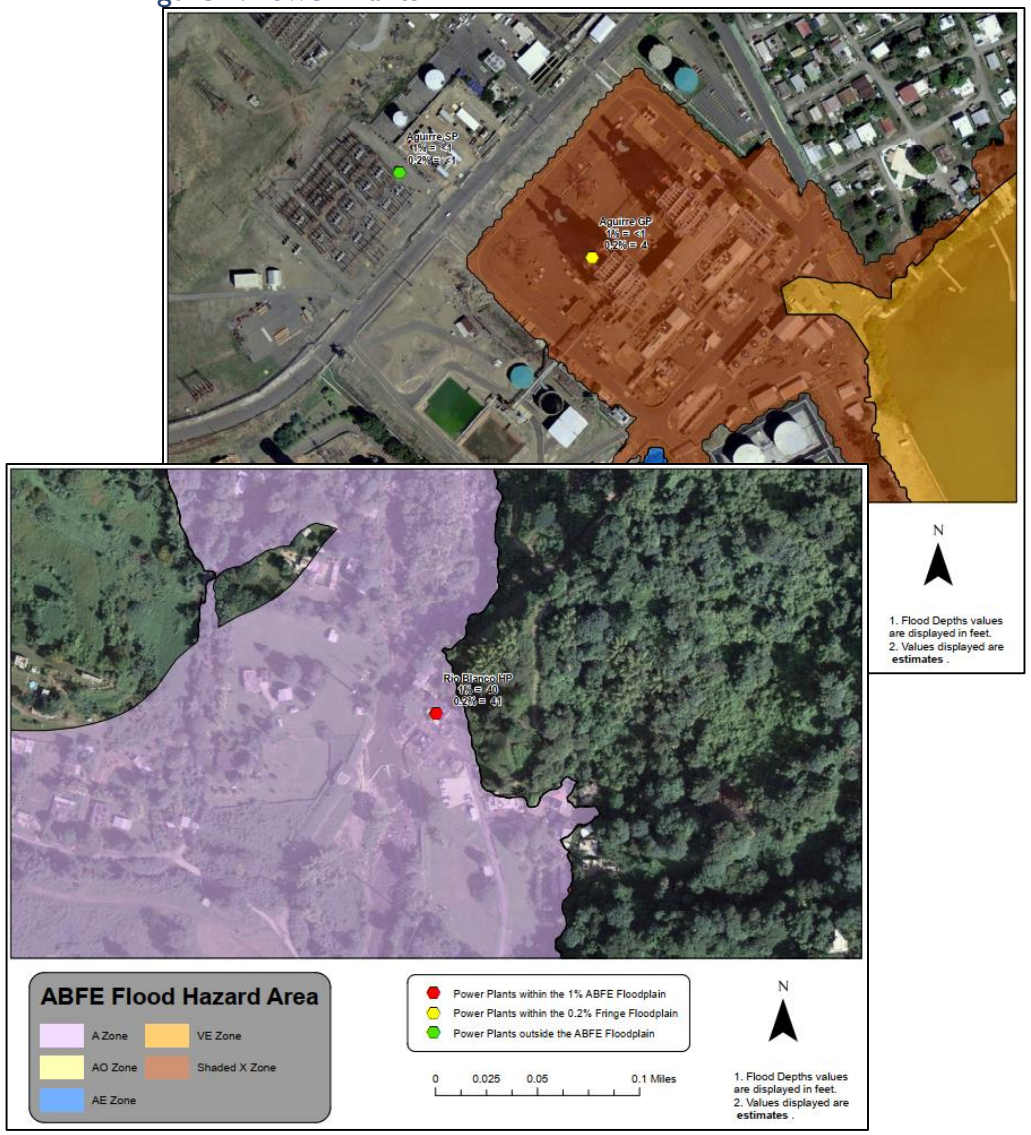
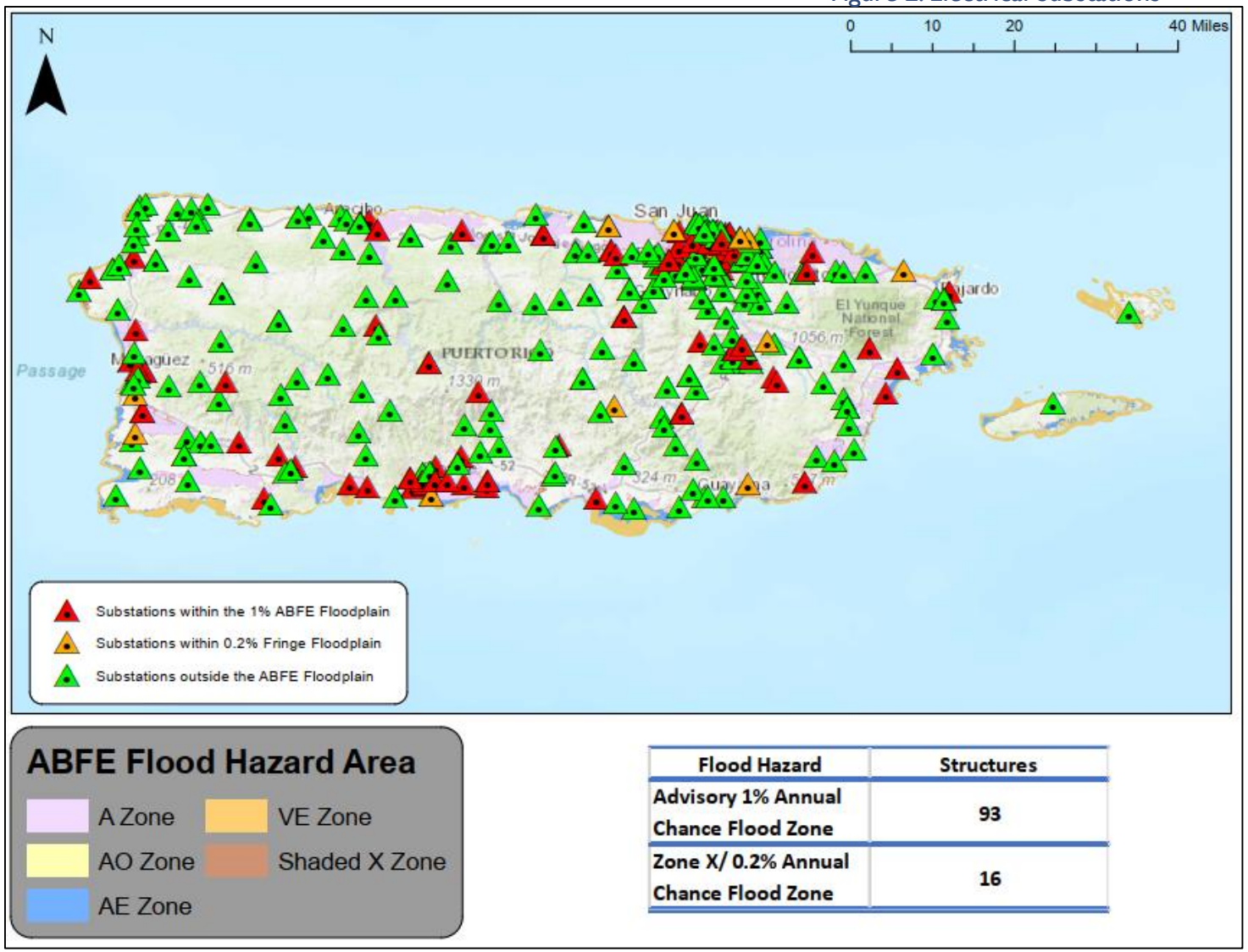


Figure 2: Electrical Substations



Flood Hazard	Structures
Advisory 1% Annual Chance Flood Zone	93
Zone X/ 0.2% Annual Chance Flood Zone	16

SUPPORTING RECOVERY USING ABFE PRODUCTS

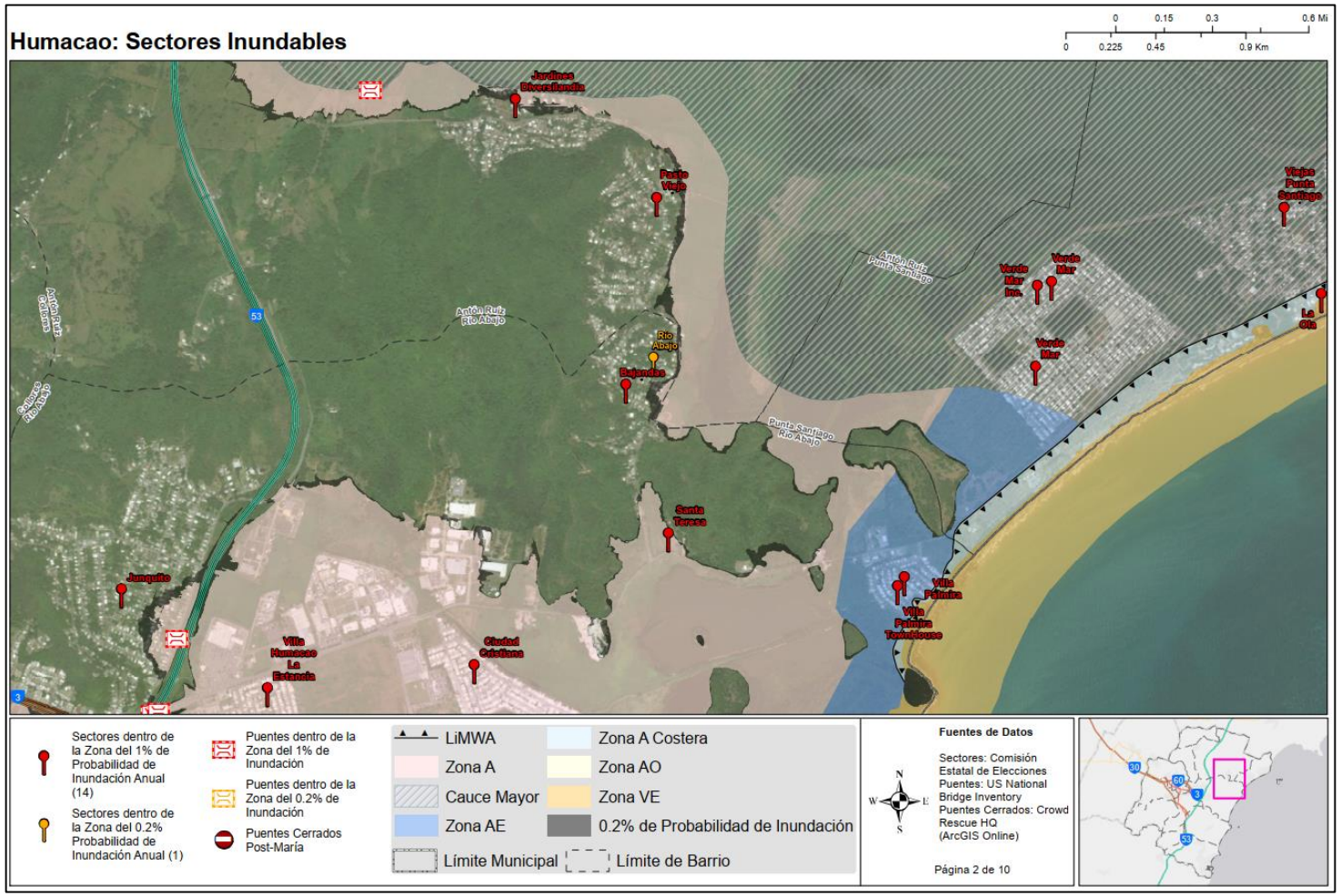
- ✓ Identifying critical infrastructure threatened by coastal erosion.

Figure 1

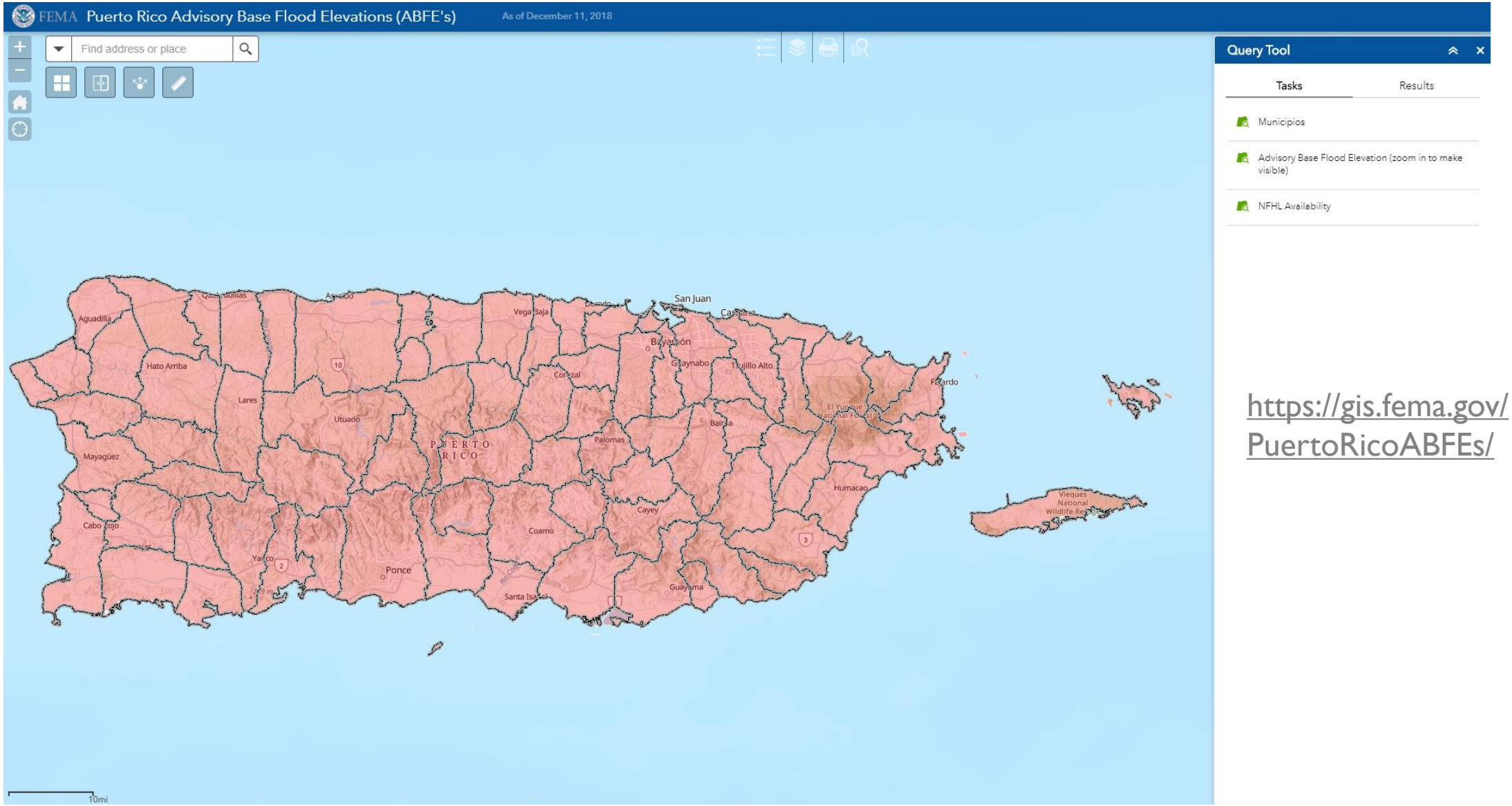
Figure 2

SUPPORTING RECOVERY USING ABFE PRODUCTS

- ✓ Identifying neighborhoods within the floodplain.
- ✓ Identifying bridges within the floodplain.



VIRTUAL TOOL: FEMA



https://gis.fema.gov/PuertoRicoABFEs/

ABFE LANDING PAGE

http://cedd.pr.gov/fema/

HECRAS Models for the PR Advisory Maps

- HECRAS

Mapas(.zip file)

- SHP
- Metadata
- Puerto Rico Advisory Data (.zip file)

Below is link to download the revised deliverable for PR. It includes GIS data (File Geodatabase and shapefile formats including metadata) and MXDs for web publishing. This corrects the XSs that were not showing the most conservative value. It also corrected the VE zone in Aibonito.

- Históricos

Información Adicional por Municipio

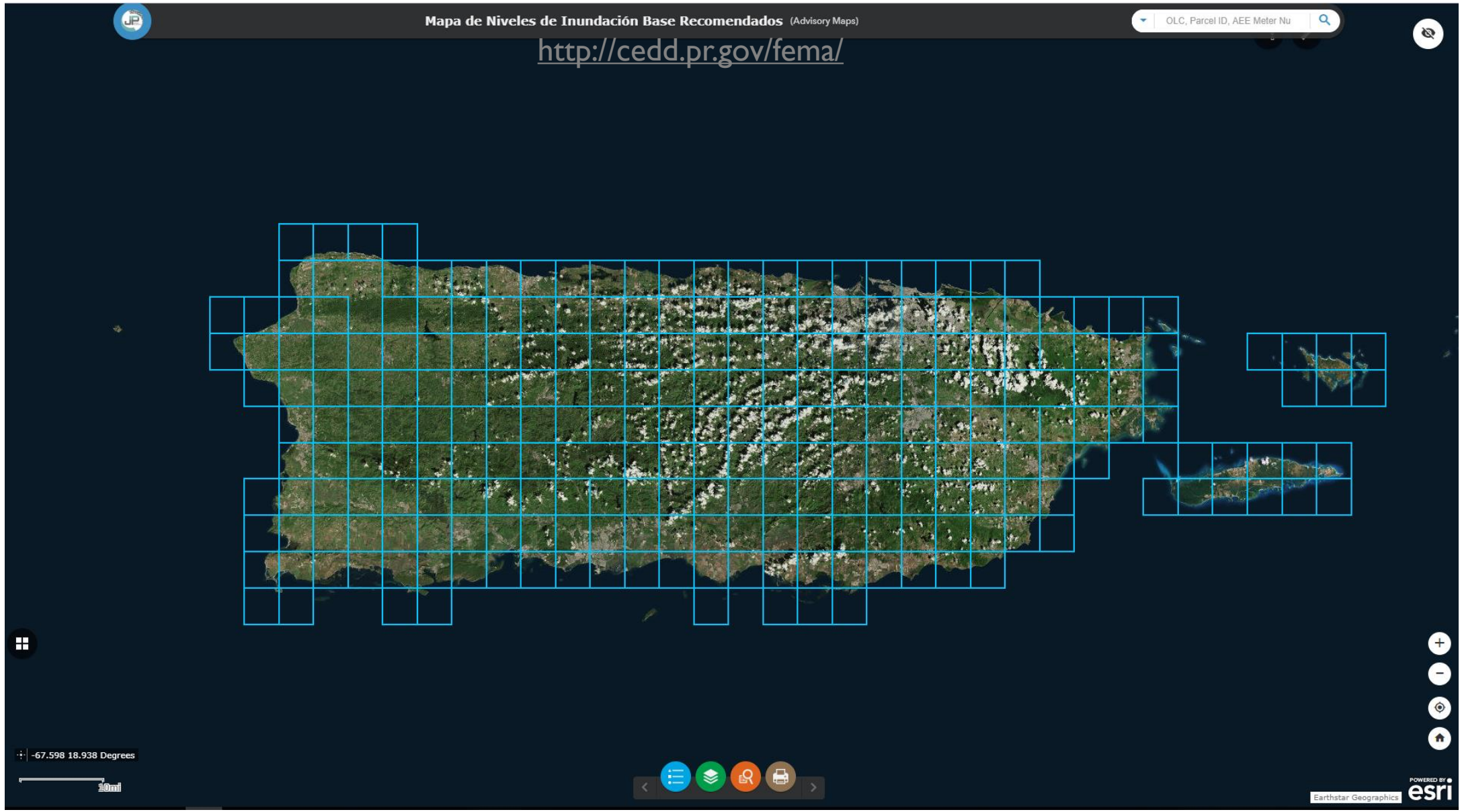
- Aumento de Zonas Inundables
- Infraestructura Crítica en Zona Inundable
- Sectores en Zona Inundables

Water Surface Elevations

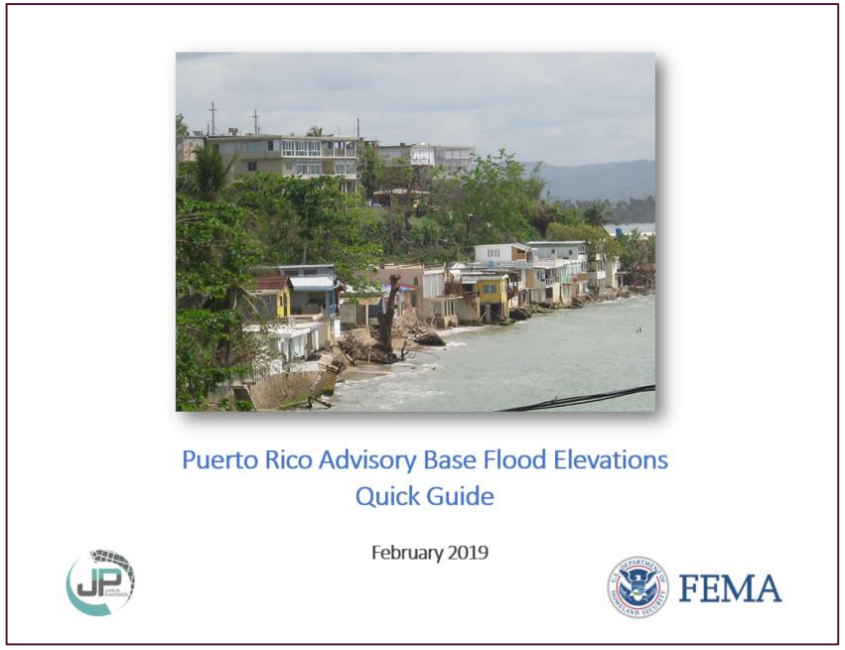
Estos geodatos representan los niveles de inundación base recomendados en metros referenciados al PRVD02 para todas las zonas inundables de los Mapas ABFE a excepción de las zonas AO, las cuales se muestran directamente en el mapa.

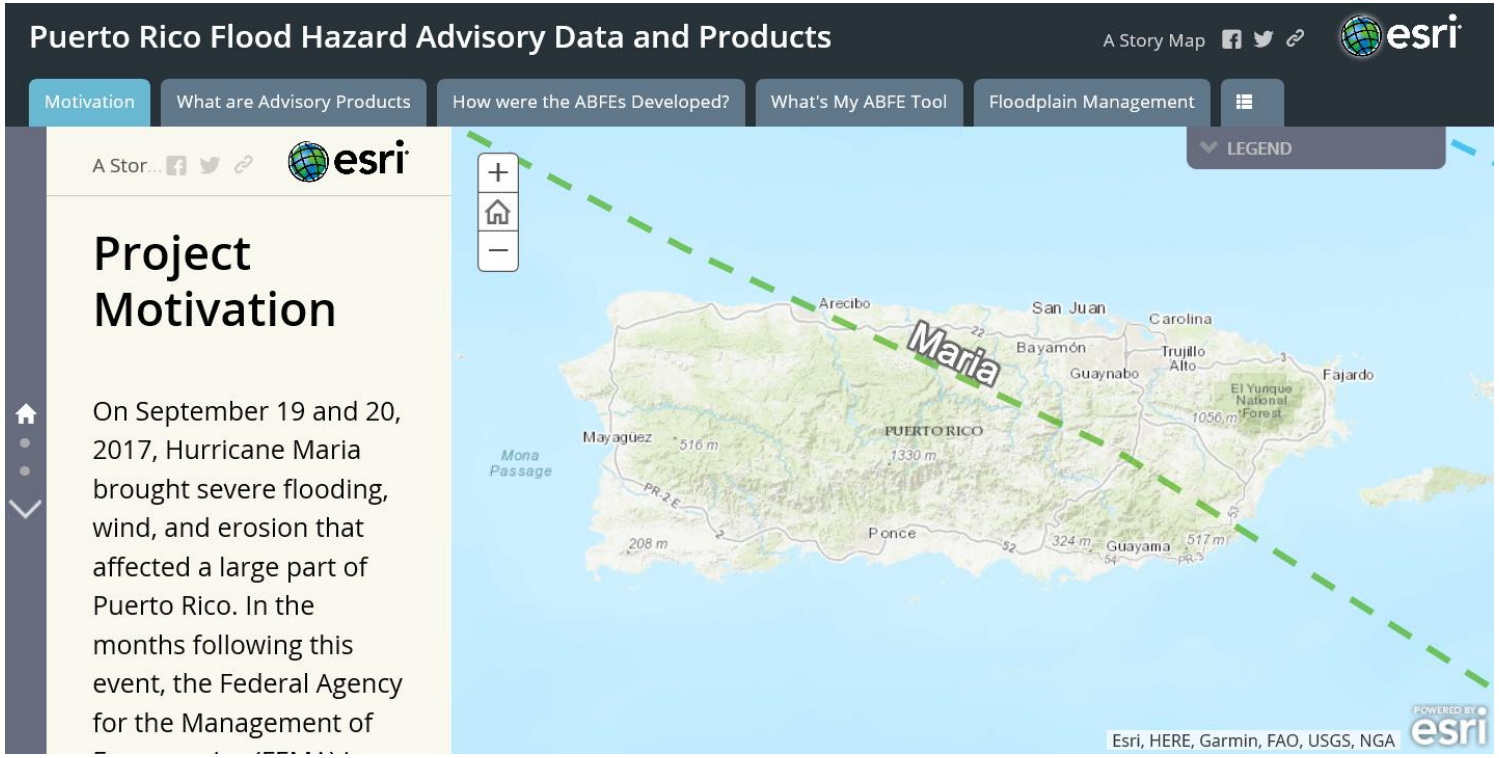
- Geodatos

VIRTUAL TOOL: PUERTO RICO PLANNING BOARD

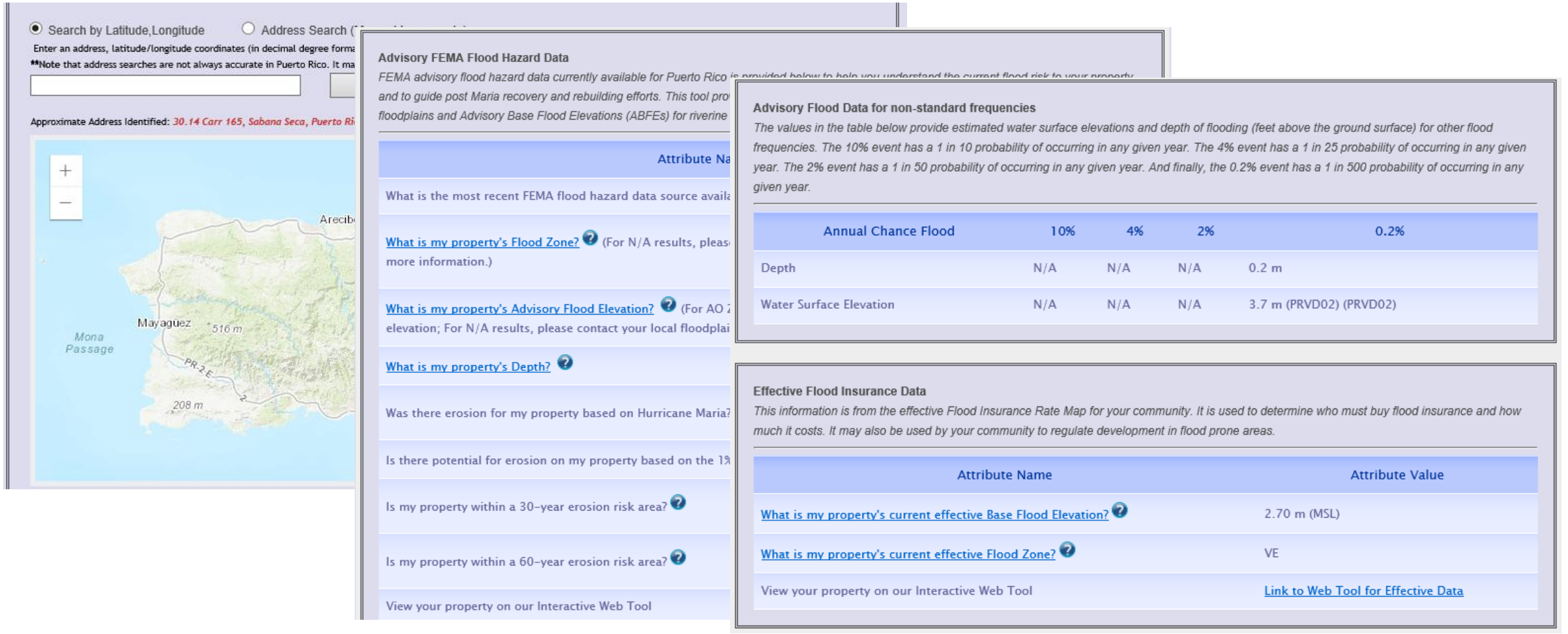


ADVISORY DATA AND PRODUCTS QUICK GUIDE & STORY MAP





WHAT'S MY BFE TOOL



GOING FORWARD

- Data Availability
  - Effective and advisory modeling data/products available for download and use
  - Additional flood frequencies included in model data (10%, 4%, 2%)
  - Historical model runs can be extracted and used
- Incorporation of advisory products into coastal construction guidance/standards
  - Erosion products can be used to inform setback limits
  - FEMA Recovery Advisories available
    - RA2 – Siting, Design, and Construction in Coastal Flood Zones
    - RA4 – Best Practices for Minimizing Flood Damage to Existing Structures
- Enhancement of Existing Data
  - Advisory products provide initial assessments of key data, but can always stand to be improved upon