Leveraging Coastal Data: The Development of a Coastal MultiFrequency Geospatial Data Catalog

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Coastal MultiFrequency Data – Why, Where, How?

- Benefits of having multi-frequency flood elevation data
- FEMA is driving the development of this data in many areas, including for coastal hazards
- TMAC recommendation: structure-specific flood frequency determinations
- Multi-frequency data are in some cases already available

Coastal MultiFrequency Data – Vision

– Important first step: document which exact multi-frequency data is available from modern, detailed coastal studies.

– Coastal studies may:
  - Employ different methodologies or limiting assumptions
  - Be in different stages of production
  - Be implemented over large geographical areas

– Provide a forward-thinking vision for a coastal data catalog and enable that catalog spatially to best serve the needs of FEMA's coastal program.

– Document data characteristics to better understand data limitations, and to identify where additional multi-frequency data can be created by expanding other products.

Coastal MultiFrequency Data – Purpose

- This Catalog provides a tool that can benefit FEMA and external stakeholders by providing a point-and-click interface that could be used for a variety of applications.

- If multi-frequency data are created, a mapping tool like this one could potentially allow users to identify a structure and obtain a sense of not just the 1-percent-annual-chance flood event, but a spectrum of return periods.

- This multi-frequency data may be used to drive actions to reduce the risk of loss of property and life, and to support communities as they address risks stemming from current and future coastal flood hazards.

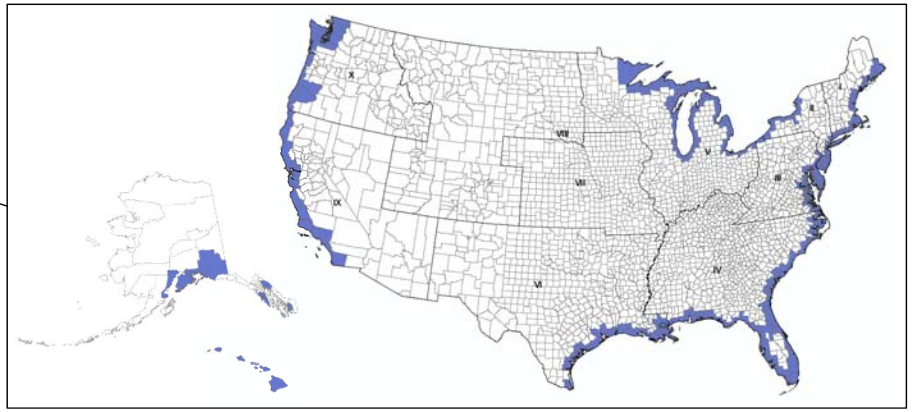
Project Team

FEMA	Tucker Mahoney	Coastal Program Specialist
	Rafael Canizares	Senior Coastal Engineer
Compass	Michael DelCharco	Project Manager
	Brian Caufield	Senior Coastal Engineer
	Elena Drei-Horgan	Senior Coastal Engineer
	Chris MacDougall	Senior GIS Specialist
STARRII	Jeff Gangai	Senior Coastal Engineer
	Gib Jones	Senior Water Resources Engineer
	Fred Knight	Coastal Resource Team Lead

Coastal MultiFrequency Data – Stats

8 Coastal FEMA Regions

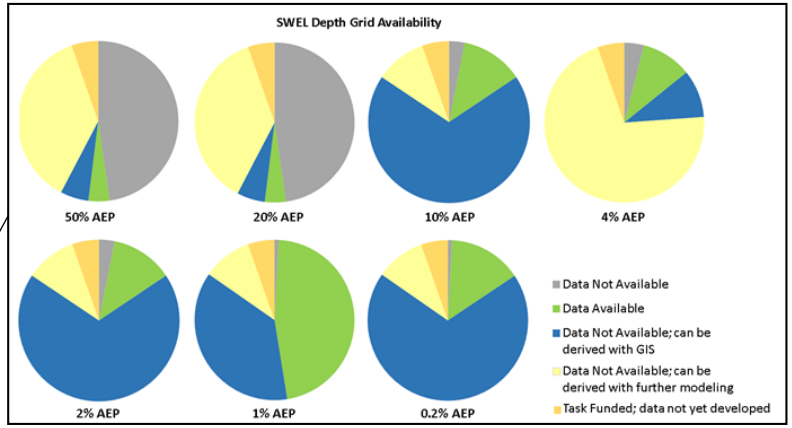
364 Coastal Counties



County	FIPS	DCS Section (May 2014)	Data	Common Data Format1	Notes/Comments	Current Status	Data Availability
Nassau	12089	2.1 - General	IDS Report 1 - 3	.doc, .pdf	including .pdf workmaps	Effective	Yes
Nassau	12089	2.1 - General	IDS Report 4-5			Effective	Yes
Nassau	12089	2.1 - General	Final/Draft FIS Report	.doc, .pdf	Graphics, Tables, Text, 0.2% wave crest Profiles	Effective	Yes
Nassau	12089	2.1 - General	Project Narrative	.doc, .pdf		Effective	Yes
Nassau	12089	2.1 - General	Certification	.doc, .pdf		Effective	Yes
Nassau	12089	2.1 - General	White Papers, Tech memos, issue papers	.doc, .pdf	If applicable	Effective	Yes
Nassau	12089	2.1 - General	Metadata files	XML	any that apply	Effective	Yes
Nassau	12089	2.2 - Correspondence	Letters, Transmittals, Memos, status report	.doc, .pdf	If Applicable	Effective	
Nassau	12089	2.3 - Stillwater_Data	Tidal Data (historic hourly data, annual max	Tables/Figures within ID	Typically, IDS reports show NOAA station locatior	Effective	Yes
Nassau	12089	2.3 - Stillwater_Data	High Water Marks	Tables/Figures within ID	Typically in IDS report sections with tables/figure	Effective	Yes
Nassau	12089	2.3 - Stillwater_Data	Wave Data (Atlantic and Gulf Coast only)	Tables/Figures within ID	Typically in IDS report sections with tables/figure	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	Desktop Hydro analysis		Details on method applied other than 2D modeling - provide works		NA
Nassau	12089	2.4 - Stillwater Analysis	2D Hydro Modeling - Geometry (final Mesh	ASCII format, or zipped f	Map files, mesh files, scatter dataset files, mode	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	2D Hydro Modeling - Tidal Calibration	ASCII format, or zipped f	Adcirc input files for tide calibration: - fort.14 ACI	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	Wind and pressure Fields		- Provide original data for each historic storm an	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	2D Hydro Modeling - Historic storm verifica	ASCII format, or zipped f	Graphic of each storm track. Plot the track and lar	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	2D Hydro Modeling - Production Runs	ASCII format, or zipped f	Graphic of each storm track. Plot the track and lar	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	2D Hydro Modeling - Statistical Analysis	txt, ASCII format, Excel D	ESP or JPM code used.Provide for all return perio	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	2D Hydro Modeling - Supplemental	multiple types	Any additional data used in WL modeling	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	2D Hydro Modeling - Spatial files	.shp, KML rasters	final 1% and 0.2% surge surfaces, as well as other	Effective	Yes
Nassau	12089	2.4 - Stillwater Analysis	2D Hydro Modeling - Field Data	photos and notes from fi	Data collected to determine surge conveyance and any friction fact		No
Nassau	12089	2.4 - Stillwater Analysis	Issue Resolution	ASCII format, or zipped f	Any additional modeling input and output files fi	Effective	Yes
Nassau	12089	2.5 - Wave Analysis	Desktop Wave Analysis		Details on method applied other than 2D modeling, such as any wa		NA
Nassau	12089	2.5 - Wave Analysis	2D Wave Model - Geometry (final mesh, DI	ASCII format, or zipped f	model boundary conditions, geometry and attrib	Effective	Yes
Nassau	12089	2.5 - Wave Analysis	2D Wave Model - Historic Storm Verificatio	txt, ASCII format, or zipp	- Inputs needed to reproduce. Outputs needed	Effective	Yes
Nassau	12089	2.5 - Wave Analysis	2D Wave Model - Wave Production Runs	ASCII format, or zipped f	For SWAN or STWAVE: - ADCIRC water-level and c	Effective	Yes
Nassau	12089	3.5 - Wave Analysis	Supplemental Data	multiple types	Any additional data used in the modeling of offshore wave conditic		NA
Nassau	12089	2.6 - Transect Based Wave	Wave Statistical Analysis - where 2D wave	ASCII format, or zipped f	Calculations to determine input wave conditions	Effective	No

65 data columns

23,000 data points, plus various metrics & summaries



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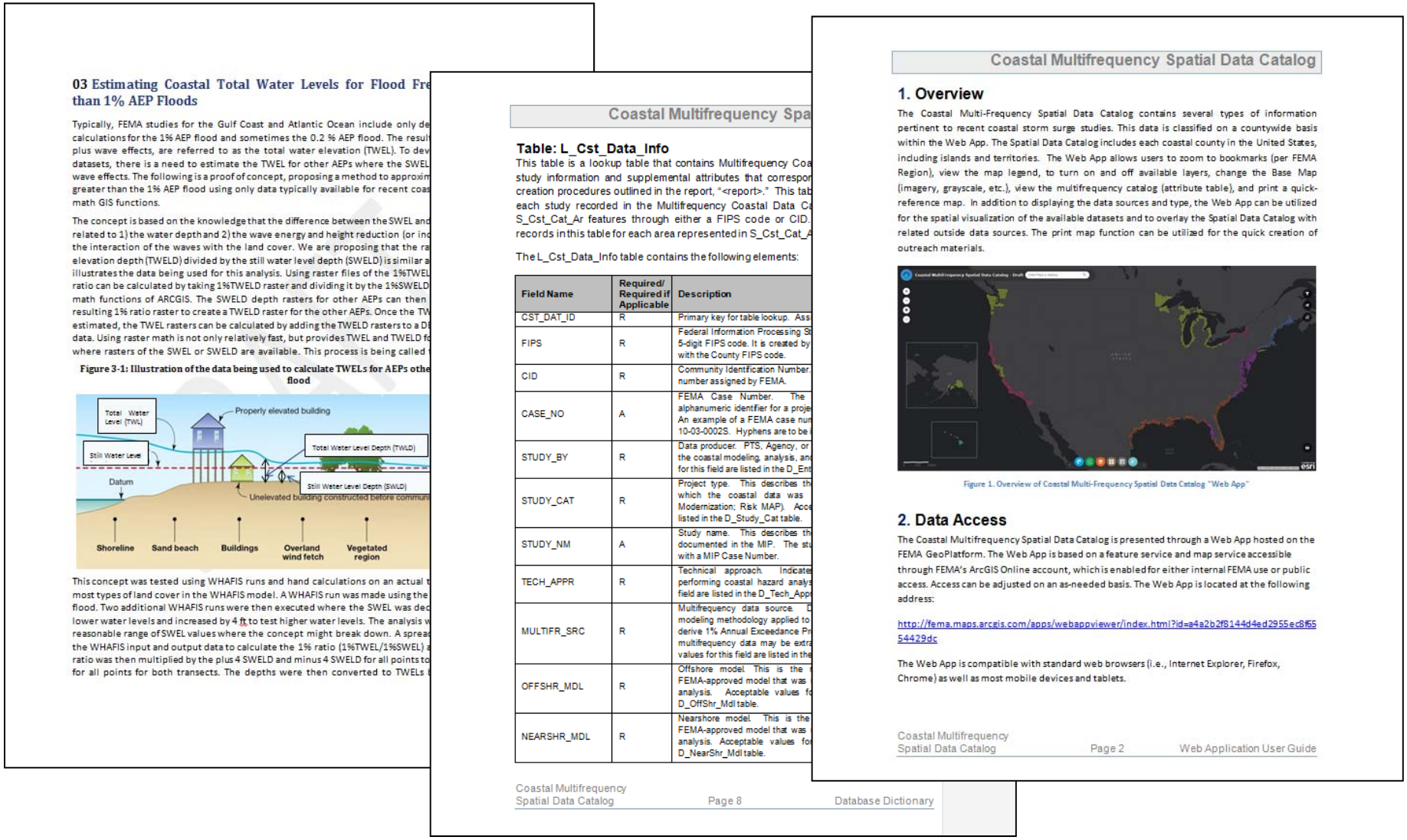
Coastal MultiFrequency Data – Spatial Implementation



03 Estimating Coastal Total Water Levels for Flood Fre
than 1% AEP Floods

Typically, FEMA studies for the Gulf Coast and Atlantic Ocean include only de
calculations for the 1% AEP flood and sometimes the 0.2 % AEP flood. The result
plus wave effects, are referred to as the total water elevation (TWEL). To dev
datasets, there is a need to estimate the TWEL for other AEPs where the SWEL
wave effects. The following is a proof of concept, proposing a method to approxim
greater than the 1% AEP flood using only data typically available for recent coas
math GIS functions.

The concept is based on the knowledge that the difference between the SWEL and
related to 1) the water depth and 2) the wave energy and height reduction (or inc
the interaction of the waves with the land cover. We are proposing that the ra
elevation depth (TWELD) divided by the still water level depth (SWELD) is similar a
illustrates the data being used for this analysis. Using raster files of the 1%TWEL
ratio can be calculated by taking 1%TWELD raster and dividing it by the 1%SWELD
math functions of ARCGIS. The SWELD depth rasters for other AEPs can then
resulting 1% ratio raster to create a TWELD raster for the other AEPs. Once the TW
estimated, the TWEL rasters can be calculated by adding the TWELD rasters to a DE
data. Using raster math is not only relatively fast, but provides TWEL and TWELD fo
where rasters of the SWEL or SWELD are available. This process is being called

**Figure 3-1: Illustration of the data being used to calculate TWELs for AEPs othe
flood**

This concept was tested using WHAFIS runs and hand calculations on an actual t
most types of land cover in the WHAFIS model. A WHAFIS run was made using the
flood. Two additional WHAFIS runs were then executed where the SWEL was dec
lower water levels and increased by 4 ft to test higher water levels. The analysis w
reasonable range of SWEL values where the concept might break down. A spread
the WHAFIS input and output data to calculate the 1% ratio (1%TWEL/1%SWEL) a
ratio was then multiplied by the plus 4 SWELD and minus 4 SWELD for all points to
for all points for both transects. The depths were then converted to TWELs

Coastal Multifrequency Spa

Table: L_Cst_Data_Info

This table is a lookup table that contains Multifrequency Coa
study information and supplemental attributes that correspor
creation procedures outlined in the report, "<report>." This tab
each study recorded in the Multifrequency Coastal Data Ca
S_Cst_Cat_Ar features through either a FIPS code or CID.
records in this table for each area represented in S_Cst_Cat_A

The L_Cst_Data_Info table contains the following elements:

Field Name	Required/ Required if Applicable	Description
CST_DAT_ID	R	Primary key for table lookup. Ass
FIPS	R	Federal Information Processing St 5-digit FIPS code. It is created by with the County FIPS code.
CID	R	Community Identification Number. number assigned by FEMA.
CASE_NO	A	FEMA Case Number. The alphanumeric identifier for a proje An example of a FEMA case nur 10-03-0002S. Hyphens are to be
STUDY_BY	R	Data producer. PTS, Agency, or the coastal modeling, analysis, an for this field are listed in the D_Ent
STUDY_CAT	R	Project type. This describes th which the coastal data was Modernization; Risk MAP). Acce listed in the D_Study_Cat table.
STUDY_NM	A	Study name. This describes th documented in the MIP. The stu with a MIP Case Number.
TECH_APPR	R	Technical approach. Indicate performing coastal hazard analys field are listed in the D_Tech_App
MULTIFR_SRC	R	Multifrequency data source. D modeling methodology applied to derive 1% Annual Exceedance Pr multifrequency data may be extra values for this field are listed in the
OFFSHR_MDL	R	Offshore model. This is the FEMA-approved model that was analysis. Acceptable values fo D_OffShr_Mdl table.
NEARSHR_MDL	R	Nearshore model. This is the FEMA-approved model that was analysis. Acceptable values fo D_NearShr_Mdl table.

Coastal Multifrequency Spatial Data Catalog

1. Overview

The Coastal Multi-Frequency Spatial Data Catalog contains several types of information pertinent to recent coastal storm surge studies. This data is classified on a countywide basis within the Web App. The Spatial Data Catalog includes each coastal county in the United States, including islands and territories. The Web App allows users to zoom to bookmarks (per FEMA Region), view the map legend, to turn on and off available layers, change the Base Map (imagery, grayscale, etc.), view the multifrequency catalog (attribute table), and print a quick-reference map. In addition to displaying the data sources and type, the Web App can be utilized for the spatial visualization of the available datasets and to overlay the Spatial Data Catalog with related outside data sources. The print map function can be utilized for the quick creation of outreach materials.

Figure 1. Overview of Coastal Multi-Frequency Spatial Data Catalog "Web App"

2. Data Access

The Coastal Multifrequency Spatial Data Catalog is presented through a Web App hosted on the FEMA GeoPlatform. The Web App is based on a feature service and map service accessible through FEMA's ArcGIS Online account, which is enabled for either internal FEMA use or public access. Access can be adjusted on an as-needed basis. The Web App is located at the following address:

http://fema.maps.arcgis.com/apps/webappviewer/index.html?id=a4a2b2f8144d4ed2955ec8f6554429dc

The Web App is compatible with standard web browsers (i.e., Internet Explorer, Firefox, Chrome) as well as most mobile devices and tablets.

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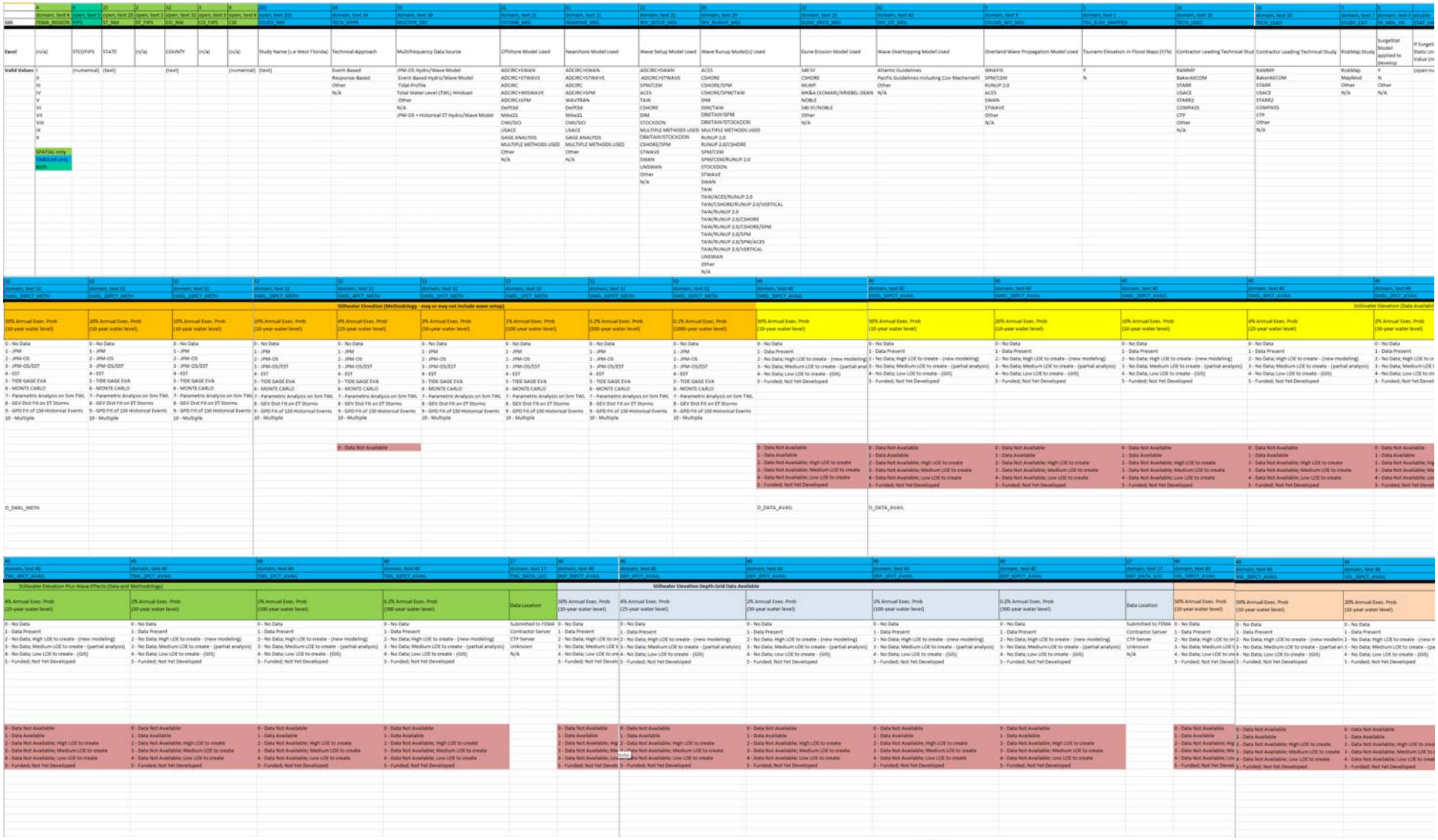
Coastal MultiFrequency Data – Attribute Compilation



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Coastal MultiFrequency Data – Tabular Catalog

STCOFIPS
STATE
COUNTY
Study Name (i.e West Florida)
Technical Approach
Multifrequency Data Source
Offshore Model Used
Nearshore Model Used
Wave Setup Model Used
Wave Runup Model(s) Used
Dune Erosion Model Used
Wave Overtopping Model Used
Overland Wave Propagation Model Used
Tsunami Elevation in Flood Maps (Y/N)
Contractor Leading Technical Study
RiskMap Study
SurgeStat Model applied to develop surfaces
If SurgeStat Applied, Static Uncertainty Term Value (m)
If SurgeStat Applied, Proportional Uncertainty Term Value
Other ways Uncertainty Included and Value
Water Level Surface Data Format

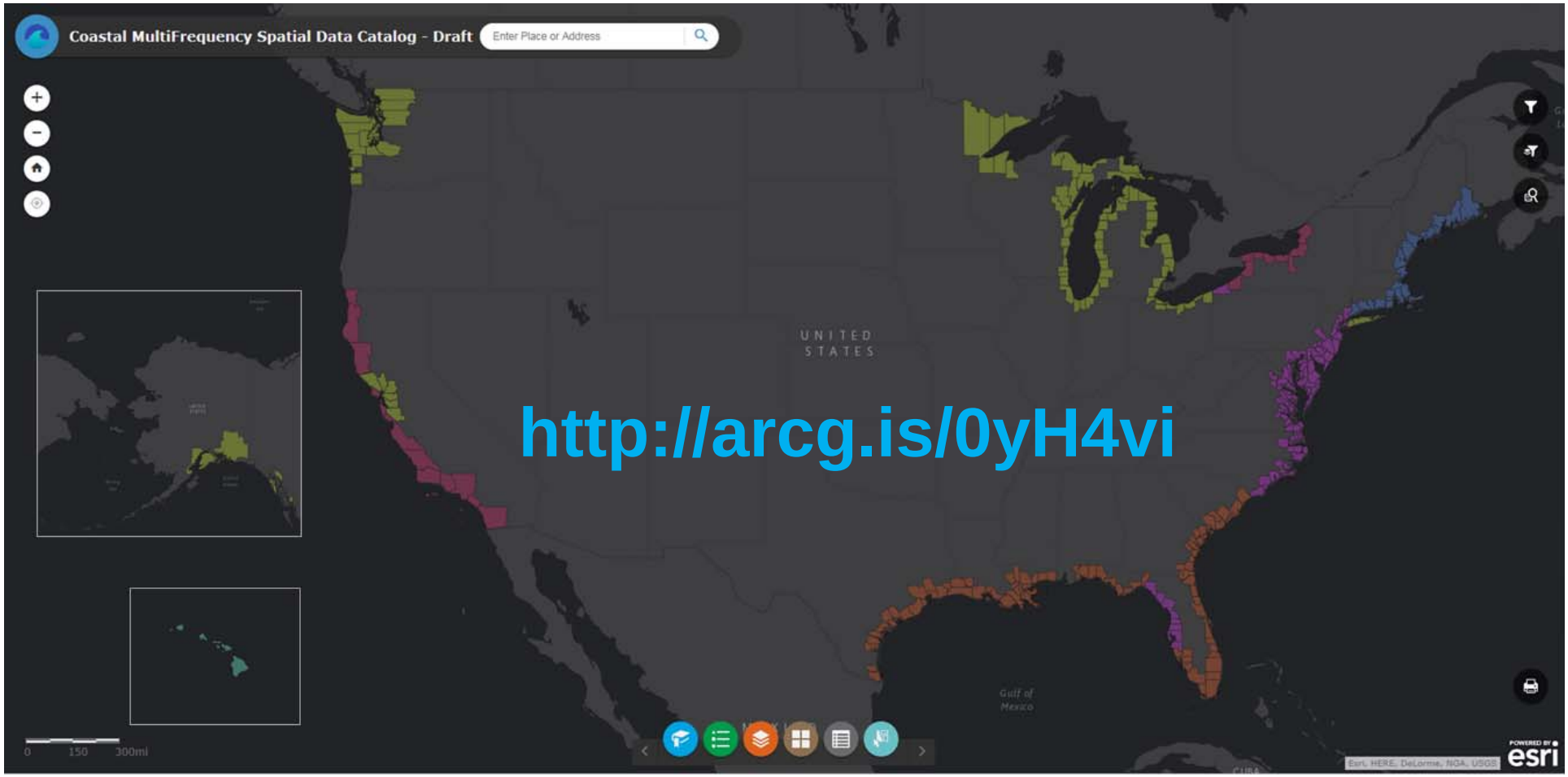
Stillwater Methodology - may or may not include wave setup	50% Annual Exec. Prob (2-year water level)
Stillwater Elevation Data Available	20% Annual Exec. Prob (5-year water level)
	10% Annual Exec. Prob (10-year water level)
Stillwater Elevation Plus Wave Effects Data Available	4% Annual Exec. Prob (25-year water level)
	2% Annual Exec. Prob (50-year water level)
Stillwater Elevation Depth Grid Data Available	1% Annual Exec. Prob (100-year water level)
	0.2% Annual Exec. Prob (500-year water level)
Stillwater Elevation Plus Wave Effects Depth and Velocity Grid Data Available	Data Location

Stillwater Elevation Methodology	
0	No Data
1	JPM
2	JPM-OS
3	JPM-OS/EST
4	EST
5	Tide Gage EVA
6	Monte Carlo
7	Parametric Analysis on Sim TWL
8	JPM-OS/EV Fit on ET Storms
9	GPD Fit of 150 Historical Events
10	Multiple

Data Availability	
0	Data Not Available
1	Data Available
2	No Data; Derive with GIS
3	No Data; Develop with Further Modeling
4	Funded; Data Not Yet Developed

Stillwater Elevation Methodology (may or may not include wave setup)								Stillwater Elevation Data (may or may not include wave setup)									Stillwater Elevation Plus Wave Effects (Data and Methodology)								
50% Annual Exec. Prob (2-year water level)	20% Annual Exec. Prob (5-year water level)	10% Annual Exec. Prob (10-year water level)	4% Annual Exec. Prob (25-year water level)	2% Annual Exec. Prob (50-year water level)	1% Annual Exec. Prob (100-year water level)	0.2% Annual Exec. Prob (500-year water level)	0.1% Annual Exec. Prob (500-year water level)	50% Annual Exec. Prob (2-year water level)	20% Annual Exec. Prob (5-year water level)	10% Annual Exec. Prob (10-year water level)	4% Annual Exec. Prob (25-year water level)	2% Annual Exec. Prob (50-year water level)	1% Annual Exec. Prob (100-year water level)	0.2% Annual Exec. Prob (500-year water level)	0.1% Annual Exec. Prob (500-year water level)	Data Location	50% Annual Exec. Prob (2-year water level)	20% Annual Exec. Prob (5-year water level)	10% Annual Exec. Prob (10-year water level)	4% Annual Exec. Prob (25-year water level)	2% Annual Exec. Prob (50-year water level)	1% Annual Exec. Prob (100-year water level)	0.2% Annual Exec. Prob (500-year water level)	0.1% Annual Exec. Prob (500-year water level)	Data Location
No Data	No Data	JPM-OS	No Data	JPM-OS	JPM-OS	JPM-OS	No Data	Data Not A	Data Not A	Data Avail	Data Not A	Data Avail	Data Avail	Data Avail	Data Not A	Submitted	Data Not A	Data Not A	Data Not A	Data Not A	Data Not A	Data Avail	Data Available		Submitted
No Data	No Data	JPM-OS	No Data	JPM-OS	JPM-OS	JPM-OS	No Data	Data Not A	Data Not A	Data Avail	Data Not A	Data Avail	Data Avail	Data Avail	Data Not A	Submitted	Data Not A	Data Not A	Data Not A	Data Not A	Data Not A	Data Avail	Data Available		Submitted
No Data	No Data	JPM-OS	No Data	JPM-OS	JPM-OS	JPM-OS	No Data	Data Not A	Data Not A	Data Avail	Data Not A	Data Avail	Data Avail	Data Avail	Data Not A	Submitted	Data Not A	Data Not A	Data Not A	Data Not A	Data Not A	Data Avail	Data Available		Submitted
Tide Gage	Tide Gage	Tide Gage	Tide Gage	JPM-OS	JPM-OS	JPM-OS	No Data	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Not A	Submitted	Data Not A	Data Not A	Data Not A	Data Not A	Data Not A	Data Avail	Data Available		Submitted
Tide Gage	Tide Gage	Tide Gage	Tide Gage	JPM-OS	JPM-OS	JPM-OS	No Data	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Not A	N/A	Data Not A	Data Not A	Data Not A	Data Not A	Data Not A	Funded; D	Funded; Data Not Ye		N/A
Tide Gage	Tide Gage	JPM-OS	JPM-OS	JPM-OS	JPM-OS	JPM-OS	No Data	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Avail	Data Not A	N/A	Data Not A	Data Not A	Data Not A	Data Not A	Data Not A	Funded; D	Funded; Data Not Ye		N/A

Coastal MultiFrequency Data – Spatial Version 1.0



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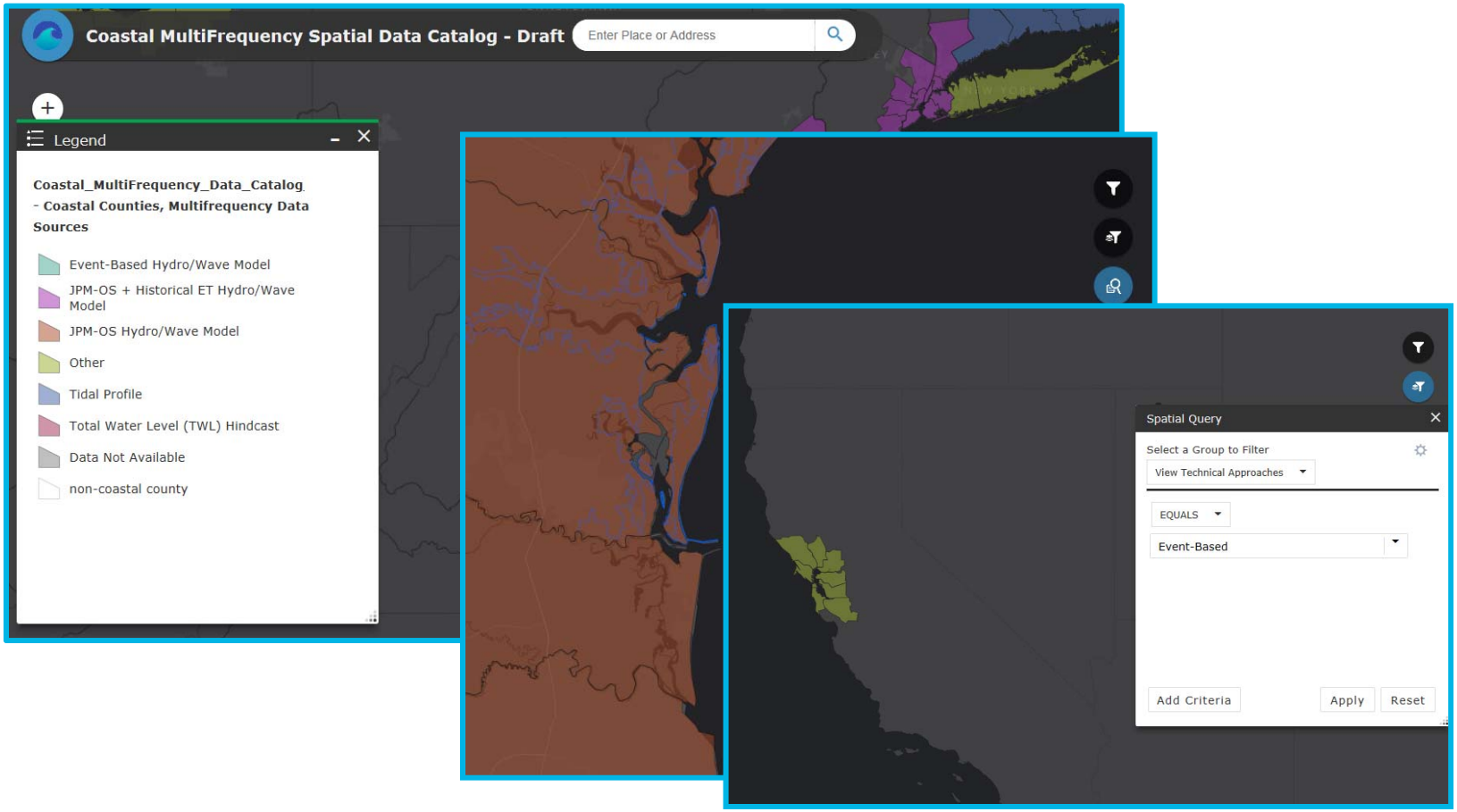
Coastal MultiFrequency Data – Spatial Version 1.0



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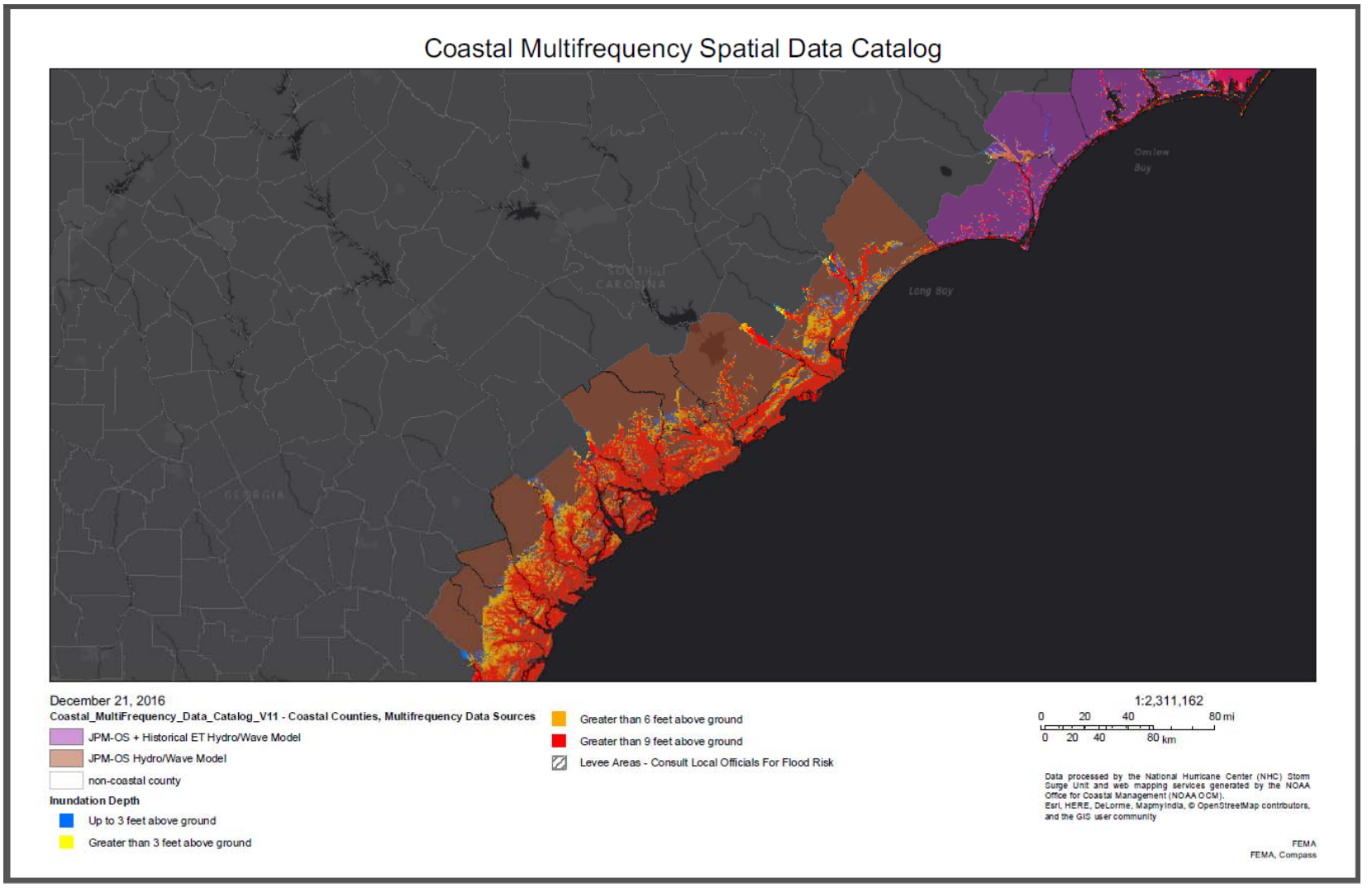
Coastal MultiFrequency Data – Spatial Version 1.0



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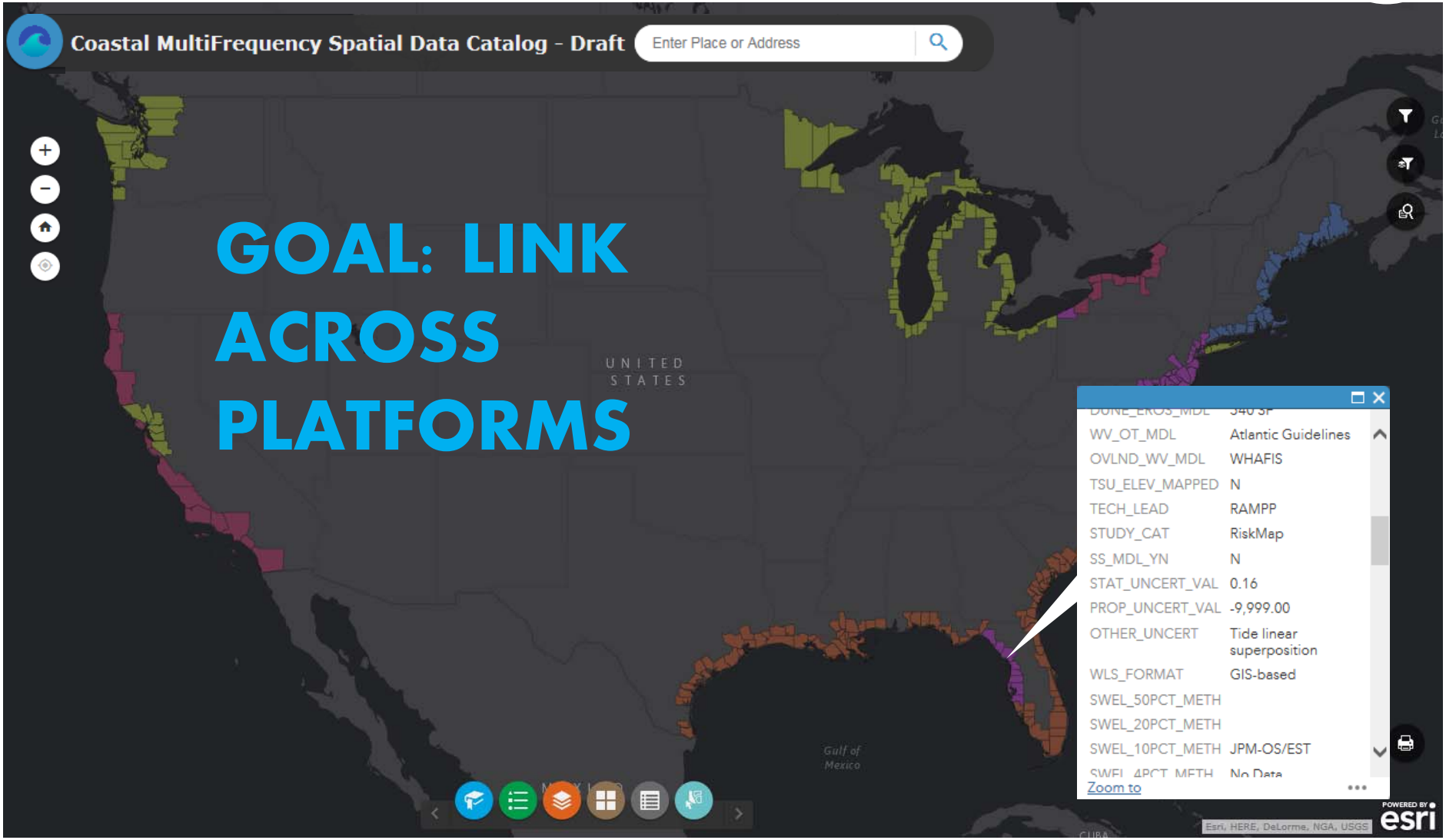
Version 1.0 Means Expanded Data in the Future



Coastal MultiFrequency Data – Future Vision

– The Catalog is being expanded to include many additional inventory attributes.

– Being implemented in the spatial data in phases during the current hurricane season, starting with Regions 4 & 6.

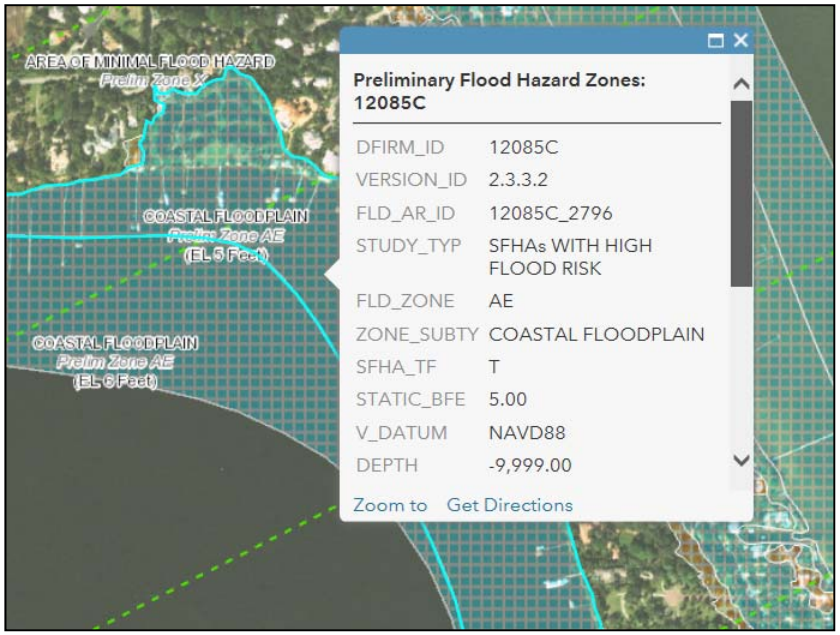
– Includes, not limited to:

- Surge/Stillwater study Summary Polygons
- Coastal Flood Zone (SFHA) footprints, including CP areas
- County FIPS code link, MIP Case Number links where possible
- Data represented at “smallest” common denominator of SFHA footprints so that queries, summaries, filters, etc. can always be applied “up” at a more general basis when needed

Coastal MultiFrequency Data - Ongoing

– The end goal of this is **not** to duplicate the NFHL or other datasets (CNMS, Coastal Tracker, etc.)

– Key is to leverage as much of the existing data as possible to “connect the dots” within coastal datasets and across other platforms



Coastal MultiFrequency Data – Expanded Inventory

State	County	Study	FEMA Case Number	udy Contrac	Study Point of Contact
Florida	Flagler	IDS 1 -3	11-04-1621S	BakerAECOM	Michael DelCharco
Florida	Flagler	IDS 4-5	11-04-1996S	BakerAECOM	Chris Mack
Florida	Flagler	Products/		BakerAECOM	Chris Mack

DCS Section (May 2014)	Data
2.1 - General	
Documentation	IDS Report 1 - 3
	IDS Report 4-5
	Final/Draft FIS Report
	Project Narrative
	Certification
	White Papers, Tech memos, issue papers
	Metadata files
2.2 - Corresponence	
	Letters, Transmittals, Memos, status reports, special problem reports, scientific resolution panel documentation
2.3 - Stillwater_Data	
	Tidal Data (historic hourly data, annual max)
	High Water Marks
	Wave Data (Atlantic and Gulf Coast only)
2.4 - Stillwater Analysis	
	Desktop Hydro analysis
	2D Hydro Modeling - Geometry (final Mesh, DEM, other El
	2D Hydro Modeling - Tidal Calibration
	Wind and pressure Fields
	2D Hydro Modeling - Historic storm verification
	2D Hydro Modeling - Production Runs
	2D Hydro Modeling - Statistical Analysis
	2D Hydro Modeling - Supplemental
	2D Hydro Modeling - Spatial files
	2D Hydro Modeling - Field Data
	Issue Resolution

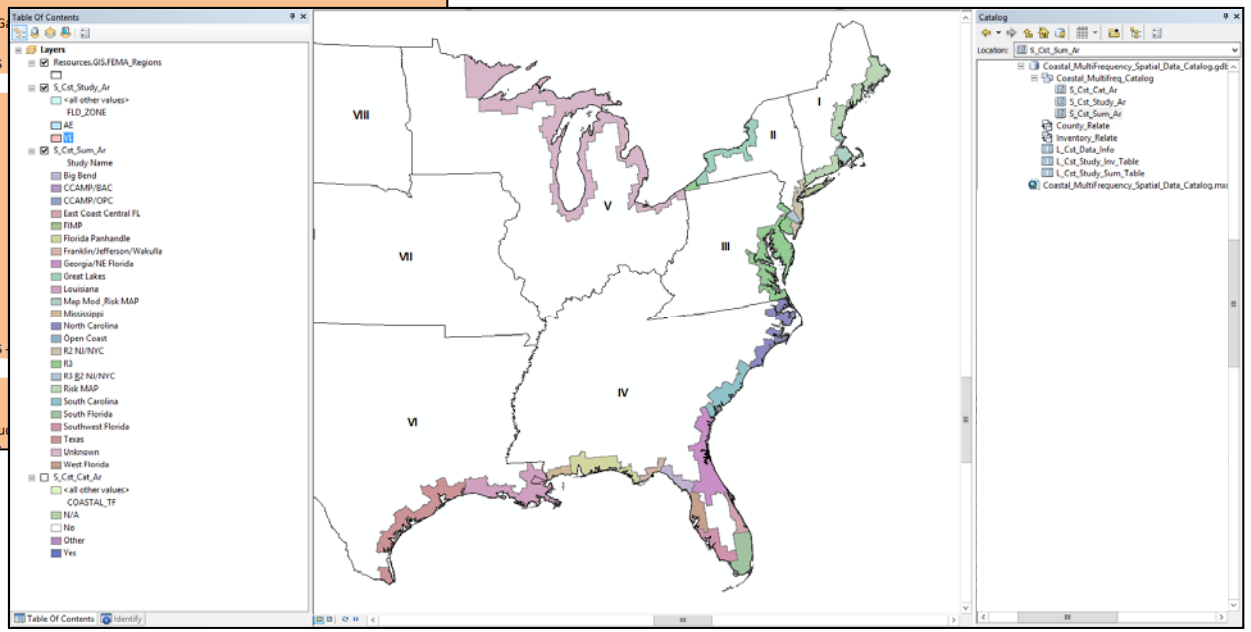
2.5 - Wave Analysis	
	Desktop Wave Analysis
	2D Wave Model - Geometry (final mesh, DEM, other eleva
	2D Wave Model - Historic Storm Verification
	2D Wave Model - Wave Production Runs
	Supplemental Data
2.6 - Transect Based Wave	
	Wave Statistical Analysis - where 2D wave modeling is us
	Wave Hazard Model - Erosion (geometric or numeric mod
	Wave Hazard Analysis - Dune Erosion Modeling for Pacific Coast (various models)
	Wave Hazard Model- waves
	Wave Hazard Model - runup
	TWL Hindcast (wave Setup and Runup) - Response Based
	Structures Analysis/Treatment
	Wave Hazard Model - overtopping
	1-percent-annual-chance wave envelop profiles
	0.2-percent-annual-chance wave analysis
	Spatial Files - field data, landuse, transect layouts
	Spatial Files - terrain or DEM, or survey data used for 1-D
	Spatial Files - Starting wave extraction locations
	Combined Probability Analysis
	Issue Resolution
	LOMRs
	Supplemental Data
	Appeal Modeling

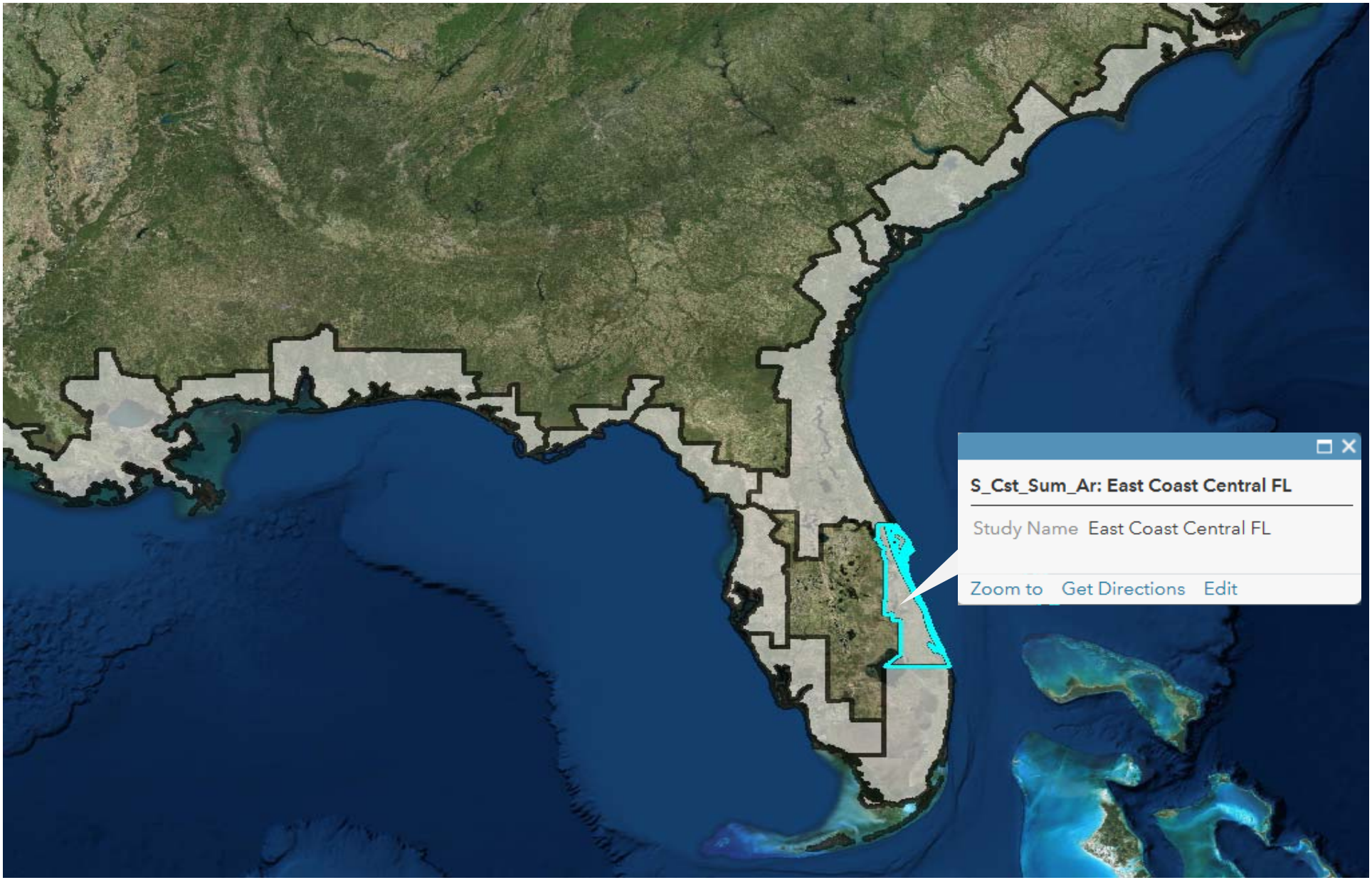
2.7 - Spatial Data	
	FIRM Database
	PFD
	Workmaps
2.8 - Coastal Flood Risk Spatial Files	
	Flood Risk Products
	Additional Non-regulatory products

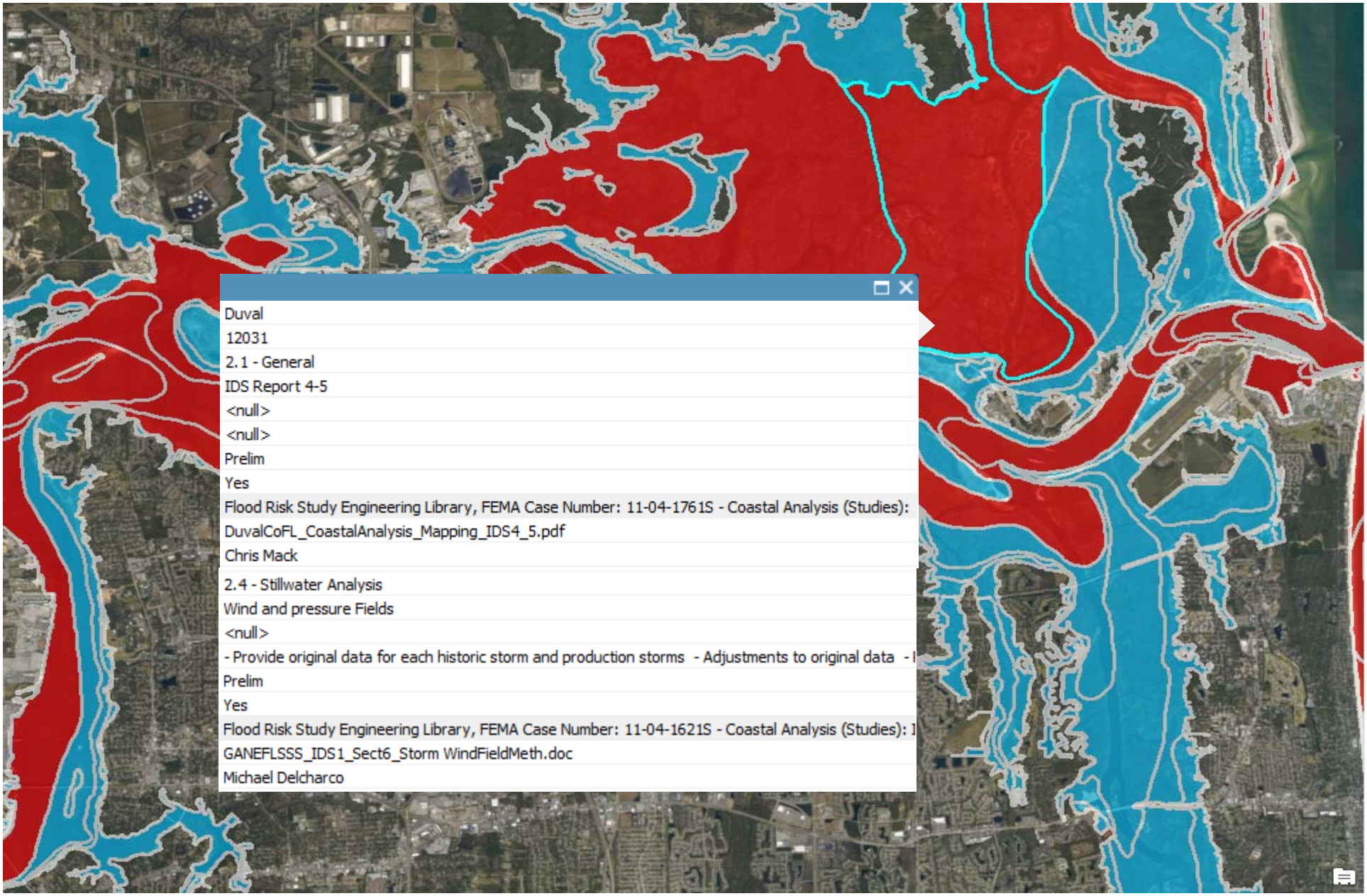
Coastal MultiFrequency Data – Expanded Inventory

S_Cst_Cat_Ar				L_Cst_STUDY_Info		
Field		**PK**	**FK**	**Field**		Source
Region	1		FK	FIPS	09005	"Summary" Spreadsheet
State	CT			IDS1_Avail	Y	
Name	Fairfield County			IDS2_Avail	Y	
FIPS	09005	PK		IDS3_Avail	Y	
				IDS4_Avail	Y	
				IDS5_Avail	Y	
				~~RMP_MIP~~	~~Are Flood Risk Products on the MIP, Y/N~~	
				Comment	have coastal summary assumed to cover IDS 1-3 some technical components may be missing/ 4-5 Partial nearshore hydraulic data but not complete	

S_Cst_Zone_Ar				L_Cst_SWSurge_Info		"Summary" Spreadsheet
FIPS	09005		FK	FIPS	09005	
FLD_ZONE	VE			SW_Std_Nm	Cape Tidal G	
ZONE_SUBTY				SW_Std_Avail	Y	
V_DATUM	NAVD88		FK	MIP_Case_No	01-09-0026S	
SOURCE_CIT	STUDY1					
	01-09-0026S -					
REG_Case_No	REG	PK		L_Cst_Data_Info		
	01-09-0027S -					
FRP_Case_No	FRP			FIPS	09005	
				ETC		
				BFE_VEL_2PCT_AVAIL		
				BFE_VEL_4PCT_AVAIL		
				BFE_VEL_10PCT_AVAIL		
				BFE_VEL_50PCT_AVAIL		
				BFE_VEL_1PCT_AVAIL		
				BFE_VEL_02PCT_AVAIL		
				BFE_VEL_01PCT_AVAIL		
			FK	FRP_Case_No	01-09-0027S	
				L_Cst_Inv_Info		
				FIPS	09005	
				Study Status	Status of stu	




S_Cst_Sum_Ar: East Coast Central FL
Study Name East Coast Central FL
Zoom to
Get Directions
Edit


Duval
12031
2.1 - General
IDS Report 4-5
<null>
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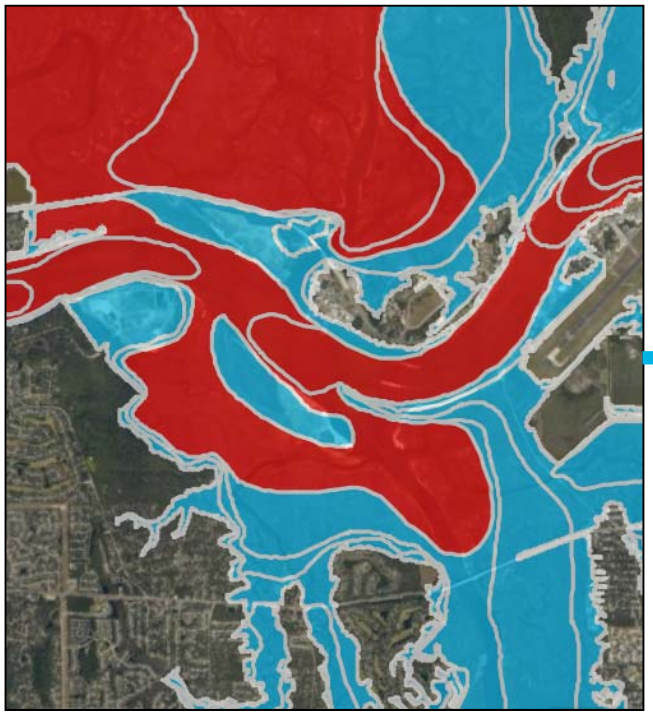
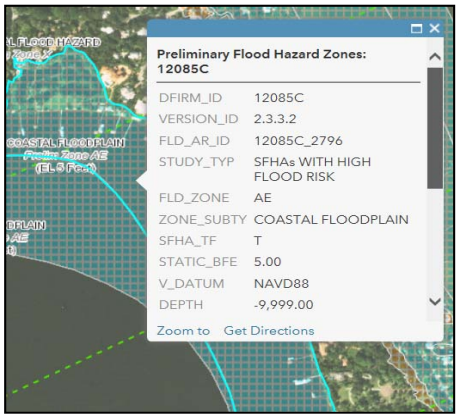
Prelim
Yes
Flood Risk Study Engineering Library, FEMA Case Number: 11-04-1761S - Coastal Analysis (Studies):
DuvalCoFL_CoastalAnalysis_Mapping_IDS4_5.pdf
Chris Mack
2.4 - Stillwater Analysis
Wind and pressure Fields
<null>
- Provide original data for each historic storm and production storms - Adjustments to original data -
Prelim
Yes
Flood Risk Study Engineering Library, FEMA Case Number: 11-04-1621S - Coastal Analysis (Studies):
GANEFLSSS_IDS1_Sect6_Storm WindFieldMeth.doc
Michael Delcharco

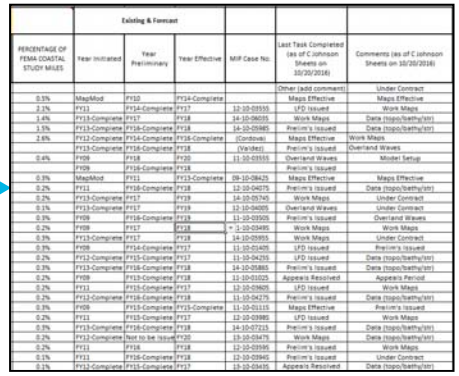
Future Vision?

CATALOG

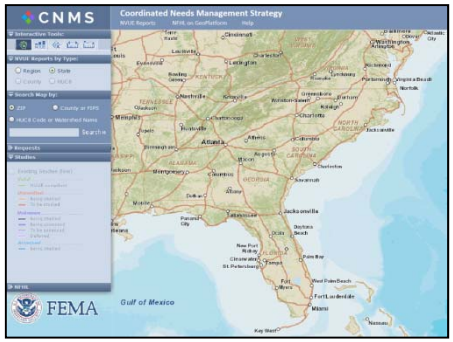




NFHL



TRACKER



CNMS

FEMA

compass
Identify, Interpret, Integrate

Thank You

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