BOARD ON COASTAL ENGINEERING RESEARCH MEETING

99th

Miami Beach

Community integration with non-structural and hybrid solutions

August 15-17, 2023

99th Board on Coastal Engineering Research

Anchorage, AK

Meeting Concept: *Identify coastal research needs associated with integrated natural, nature-based, hybrid, traditional, and non-structural solutions that are co-developed to meet coastal community needs.*

MEMBERSHIP
U.S. ARMY BOARD ON COASTAL ENGINEERING RESEARCH

MG William (Butch) H. Graham

MG Graham assumed responsibility as the Deputy Commanding General for Civil and Emergency Operations, U.S. Army Corps of Engineers on July 20, 2020.

He received his commission from the Reserve Officer Training Corps in 1989 from the University of Pittsburgh. He is an Engineer Officer who has commanded Soldiers at all levels up to division. His commands include: A Company, 1st Engineer Battalion, 1st Brigade, 1st Infantry Division (Mechanized), Fort Riley, Kansas; 40th Engineer Battalion, 2d Brigade, 1st Armored Division, United States Army Europe and Seventh Army, Germany, and OPERATION IRAQI FREEDOM, Iraq; United States Army Corps of Engineers Pittsburgh District, Pittsburgh, Pennsylvania; and North Atlantic Division, United States Army Corps of Engineers, Brooklyn, New York.

Previous assignments also include: Platoon Leader, B Company and later Executive Officer, A Company, 23d Engineer Battalion, 1st Brigade, 3d Armored Division, United States Army Europe and Seventh Army, Germany, and in support of OPERATION DESERT SHIELD/DESERT STORM, Saudi Arabia; Assistant Operations Officer and later Assistant Division Engineer, Engineer Brigade, 1st Infantry Division (Mechanized), Fort Riley, Kansas; Battalion Operations Officer, 1st Engineer Battalion, 1st Brigade, 1st Infantry Division (Mechanized), Fort Riley, Kansas; Operations Officer and later Deputy Commander, United States Army Corps of Engineers Pittsburgh District, Pittsburgh, Pennsylvania; Plans and Operations Officer, Division Engineer Section, G-3, 4th Infantry Division, Fort Hood, Texas; Executive Officer, 588th Engineer Battalion, 4th Infantry Division (Mechanized), Fort Hood, Texas, and in support of OPERATION IRAQI FREEDOM, Iraq; Executive Officer, Engineer Brigade, 1st Armored Division, United States Army Europe and Seventh Army, Germany; Division Engineer, 1st Armored Division, United States Army Europe and Seventh Army, Germany, and in support of OPERATION IRAQI FREEDOM, Iraq; Director, Coalition-Joint Engineering Directorate, Combined Security Transition Command-Afghanistan, and in support of OPERATION ENDURING FREEDOM, Afghanistan; Chief of Staff, United States Army Corps of Engineers, Washington, DC; and Director, Task Force Enhanced Security Zone, OPERATION RESOLUTE SUPPORT, Afghanistan.

Graham is a graduate of the Senior Service College Fellowship at Massachusetts Institute of Technology, the Joint and Combined Warfighting School, and United States Army Command and General Staff College. He holds a Bachelor of Science in Mechanical Engineering from the University of Pittsburgh and a Master of Science in Environmental

Engineering from the University of Kansas. His awards and decorations include the Distinguished Service Medal, Legion of Merit (with one bronze oak leaf cluster), Bronze Star Medal (with four bronze oak leaf clusters), Meritorious Service Medal (with three bronze oak leaf clusters), Army Commendation Medal (with one bronze oak leaf cluster), Army Achievement Medal (with one bronze oak leaf cluster), and the Combat Action Badge.

engineering from the University of Pittsburgh and a Master of Science in environmental engineering from the University of Kansas.

His awards and decorations include the Distinguished Service Medal, Legion of Merit (with 1 Bronze Oak Leaf Cluster), Bronze Star Medal (with 4 Bronze Oak Leaf Cluster), Meritorious Service Medal (with 3 Bronze Oak Leaf Clusters), Army Commendation Medal (with 1 Bronze Oak Leaf Cluster), Army Achievement Medal (with 1 Bronze Oak Leaf Cluster), and the Combat Action Badge.

BG Daniel H. Hibner

Brigadier General Daniel H. Hibner commissioned in 1993 from Kemper Military College. During his 29 years as a commissioned officer, he served in numerous command and staff positions in the United States and the Middle East and currently serves as the commander of the U.S. Army Corps of Engineers, South Atlantic Division. Brigadier General Hibner joined the South Atlantic Division from Fort Leonard Wood, where he served as the Commandant of the U.S. Army Engineer School. Prior to his assignment as Commandant, Brigadier General Hibner commanded the U.S. Army Corps of Engineers Savanah District from 2018 to 2021. He has held various leadership positions from platoon to brigade; and has deployed once in support of Operation Joint Guardian in Kosovo, four combat tours to Iraq during Operation Iraqi Freedom, and one deployment to Afghanistan in support of Operation Enduring Freedom.

Other previous assignments include Levant Branch Chief for the Plans and Policy Directorate, U.S. Central Command; participation in the Joint Advanced Warfighting School (JAWS) Senior Service College, Norfolk, Virginia; Chief of Plans for the 4th Infantry Division; Commander of the 4th Engineer Battalion during Operation Enduring Freedom; Deputy Chief of Staff for the 4th Infantry Division; Operations Officer for the 3rd Brigade Combat Team, 4th Infantry Division; Operations Officer for 1-8 Infantry Combined Arms Battalion, 3rd Brigade Combat Team; Plans Officer for the 4th Infantry Division in Iraq; completion of Command and General Staff College and the Advanced Military Studies Program (SAMS), Emergency Operations Center Chief, District Executive Officer, Project Engineer, Construction Manager, and the Fallujah Resident Office Officer in Charge of Reconstruction for the New Orleans District; Assistant Brigade Engineer and Battalion Adjutant during Operation Joint Guardian in Kosovo; Company Commander of Alpha Company, in 11th Engineer Battalion, 3rd Infantry Division which included a deployment to Iraq for the invasion in January 2003; and Platoon Leader and Battalion Maintenance Officer in the 65th Engineer Battalion.

Brigadier General Hibner served in the U.S. Army Reserves as an infantry officer for three years before transitioning to active duty as an engineer officer. He holds a Bachelor of Science in Construction Management from Purdue University, a Master of Science in Engineering Management from the Missouri University of Science and Technology, a Master of Military Arts and Science from the School of Advanced Military Studies, a Master of Science in Campaign Planning and Strategy from the National Defense University and is a Project Management Professional. His awards and decorations include the Silver Star, Defense Superior Service Medal, Legion of Merit, Bronze Star Medal (with three oak leaf clusters), Purple Heart, Meritorious Service Medal (with three oak leaf clusters), Joint Service Commendation Medal, Army Commendation Medal (with three oak leaf clusters), Army Achievement Medal, Combat Action Badge, Ranger Tab, Expert Infantryman Badge, Basic Parachutist Badge, Air Assault Badge, and is also the recipient of the Army Engineer Association's Bronze and Silver Order of the de Fleury Medal.

BG Antoinette R. Gant

BG Antoinette R. Gant assumed duties as the Commander and Division Engineer of South Pacific Division (SPD), U.S. Army Corps of Engineers on July 9, 2021. Established in 1888 and headquartered in San Francisco, SPD is one of nine USACE regional commands. The region encompasses all or part of ten states with four operating districts headquartered in Albuquerque, Los Angeles, Sacramento, and San Francisco. As the SPD Commander and Division Engineer, she is responsible for leading a workforce of more than 2500 military and civilians, overseeing hundreds of water resource development, military, and interagency design and construction projects valued at more than $16 billion in support of our communities, our Nation, and our warfighters.

A native of Port Gibson, Mississippi, Gant graduated from Prairie View A&M University in Texas as a Distinguished Military Graduate with a Bachelor of Science in Civil Engineering and a commission in the Engineer Regiment. She holds a Master of Science in Engineer Management from Missouri University of Science and Technology, Rolla, Missouri, and a Master of Science in national resource strategy from the Dwight D. Eisenhower School, National Defense University, Washington, DC. She is a certified Project Management Professional.

Gant has served in a variety of command and staff positions for engineering units stateside and abroad. Prior to South Pacific Division, Gant was commander of the US. Army Corps of Engineers South Pacific Border District from July 2020 to June 2021. Gant previously served as the combined joint engineer for the Resolute Support and OFS headquarters, Kabul, Afghanistan, military assistant to the Assistant Secretary of the Army-Civil Works, Washington, DC, chief of operations for the engineer directorate, US Army South, Fort Sam Houston, San Antonio, Texas, and the director for the Directorates of Public Works and Installation Support, ASG-Kuwait. She also served as the Executive Officer for Special Troops Battalion and Brigade Engineer, 4BCT, 4th Infantry Division, Fort Carson, Colorado. Other USACE assignments include Commander for both the Albuquerque and Louisville Districts. She has deployed in support of Operation Iraqi Freedom, Operation Enduring Freedom, and Operation Freedom Sentinel.

A strong advocate for STEM, Gant has worked to develop partnerships with agencies and organizations to promote science, technology, engineering, and math initiatives. She has received several national and community awards, to include 2021 Black Engineer of the Year Conference Awards (BEYA) Army Stars and Stripes Award recipient, the 2020 Women of Color Career Achievement in Government Award, the YWCA Women on the Move Award, Women of

Influence in Government by Albuquerque Business First, BEYA Special Recognition Award, and Alpha Kappa Alpha Sorority, Inc., South Central Region Visionary Leader, and Global Leader Awards. Gant's military awards and decorations include the Legion of Merit (2), Defense Meritorious Service Medal, Bronze Star Medal, and Meritorious Service Medal (7). She is also a recipient of the Army Staff Identification Badge, Recruiter Badge, and the Army Engineer Association Silver de Fleury Medal.

Col. Gant is married to Leonard Gant of Kansas City, MO, who is a Middle School Math Educator. They have two children, Lauryn, 24, a third-year doctoral veterinary medicine student at Tuskegee University and Leonard II, 18 and a sophomore at Florida A&M University studying Business Administration with a concentration in Supply Chain Management.

COL John P. Lloyd

Col. John P. Lloyd joined the North Atlantic Division as its Commander and Division Engineer June 24, 2022. Previously he was assigned to Headquarters, U.S. Army Corps of Engineers, where he served as the Chief of Staff since July 20, 2020. As USACE Chief of Staff, Lloyd managed the headquarters staff of a three-star direct reporting unit comprised of more than 36,000 Soldiers and civilians with an annual portfolio of nearly $84 billion. He led the organization through many events decisive to command success, most notably, synchronizing the USACE response to COVID-19 efforts across the enterprise including resource management, personnel resources, logistical support, and subject matter expertise resulting in a coordinated USACE plan and timely response to the needs of state and local governments. He guided the staff through the development, publication, and modification of budgetary guidance to address challenges in a fiscally constrained environment and coordinated Army reporting requirements with the Office of the Chief of Engineers. Lloyd led the development of the Authorization Realignment Policy to effect strategic planning for the future workforce, served as a member of the U.S. Army's People First Task Force, and as a Cohesion Assessment Team Leader.

Prior to his assignment as USACE Chief of Staff, he served as Command Engineer, U.S. Forces Korea, and United Nations Command. As Command Engineer, he oversaw a multi-billion-dollar host nation construction program and managed the environmental program for the USFK commander. He also coordinated and synchronized mine clearing operations within the Demilitarized Zone. From July 2016 to July 2018, Lloyd served as the Commander of the USACE Pittsburgh District, and during this time, acted as Task Force Commander in the U.S. Virgin Islands and Puerto Rico. In this role, he was responsible for overseeing the USACE response to hurricanes Irma and Maria and a subsequent power grid restoration involving more than 200 enterprise employees and 5,000 utility workers. Lloyd has served in a variety of military assignments spanning his career of more than 27 years. Some of his additional assignments include Strategic Planner, 18th Airborne Corps, Fort Bragg, N.C., an assignment that included a deployment to Iraq; Combat Engineer Trainer, Fort Irwin, Calif.; Aide-de-Camp to the Deputy Commanding General, 18th Airborne Corps; Battalion Commander, 19th Engineer Battalion, Fort Knox, Ky.; and Army Fellow assigned to the Asia Pacific Center for Security Studies in Honolulu, Hawaii.

A native of Lockport, N.Y., Lloyd earned his commission May 1995 through the Reserve Officer Training Corps at Cameron University, Lawton, Okla. Along with his bachelor's degree, he has earned a master's degree in Joint Campaign and Strategic Planning from the National Defense University and graduated from the Canadian Forces College where he studied National Security Policy. Lloyd holds a certification in Construction Project Management from Columbia University in New York, a certificate in Advanced Security Cooperation from the Asia Pacific Center, and is a graduate of the Joint Advanced Warfighting School, Norfolk, Va. Lloyd's military awards and decorations include the Legion of Merit, Bronze Star Medal, Defense Meritorious Service Medal, Army Meritorious Service Medal, Army Commendation Medal, the Joint Service Achievement Medal, the Army Achievement Medal, the National Defense Service Medal, and the Bronze Order of the de Fleury Medal. Lloyd is a graduate of the U.S. Army Sapper School, Air Assault School, Pathfinder School, and is a senior rated jumpmaster.

H. Tuba Ozkan-Haller, Ph.D.

Dr. Tuba Özkan-Haller is the Interim Dean of Oregon State University ‘s College of Earth, Ocean, and Atmospheric Sciences. and Professor in the Colleges of Earth, Ocean, and Atmospheric Sciences and Engineering. CEOAS is the center of Earth sciences research and academic programs at Oregon State. Its oceanography program is ranked no. 3 in the world. Özkan-Haller previously served as Associate Vice President for Research Administration and Development in Oregon State University’s Research Office. She previously also served as Associate Dean for Research and Faculty Advancement in the College of Earth, Ocean, and Atmospheric Sciences. As a faculty member, she focuses on the use of numerical, field, laboratory, and analytical approaches to arrive at a predictive understanding of waves, circulation, and beach change in the nearshore ocean, including the continental shelf, the surf zone, inlets, and estuaries. The results of this work are being applied to navigational planning, for the development and design of wave energy conversion devices, and for forecasting of beach-goer hazards.

She has also extensively engaged in work to increase diversity and inclusivity in academia and was a co-Principal Investigator for OSU’s ADVANCE grant from the National Science Foundation aimed at increasing the participation of women and other under-represented groups within faculty in STEM disciplines. She has given various invited talks on this subject, including a plenary talk at the 2018 Goldschmidt Conference of the Geochemical Society and the European Association of Geochemistry. Özkan-Haller is passionate about communicating science to the public and has appeared in numerous documentaries produced by the History Channel, the National Geographic Channel, and Oregon Public Broadcasting, and was quoted in various news segments and newspaper articles, most recently about sneaker wave fatalities along the Pacific Northwest Coastline of the US. She has also authored various opinion pieces. Özkan-Haller is the recipient of the Office of Naval Research Young Investigator Award, the Outstanding Faculty Member Award at the University of Michigan as well as the Pattullo Award for Excellence in Teaching Award and Woman of Excellence Award at OSU. She holds a B.S. in Civil Engineering from Boğaziçi University in Istanbul, Turkey, and a M.C.E. and Ph.D. in Civil Engineering from the University of Delaware.

Lewis Ed Link, Ph.D.

Dr. Lewis E Link is currently a Senior Research Engineer, Department of Civil and Environmental Engineering, University of Maryland. His emphasis in teaching and research has been on natural hazard risk and resilience assessment and mitigation. He currently serves as an advisor to the Governor of Maryland as a member of the Maryland Coast Smart Council and to the Chief of Engineers, U S Army Corps of Engineers through the Corps Coastal Engineering Research Board. He led the post-Katrina analysis of New Orleans and Vicinity as Director of the Interagency Performance Evaluation Task Force and participated as a member of the International Advisory Commission, Netherlands, to develop a long-term strategy for adaptation to sea level rise and climate change.

Dr. Link is a contributing Editor for The Military Engineer and has assisted in the development of an enterprise-wide strategy for accelerating innovation and a new strategy for Civil Works Research and Development for the Corps of Engineers. He previously served as a Senior Executive in the Department of Army as Director of Research and Development and Chief Scientific Advisor, U. S. Army Corps of Engineers. He is a member of the National Academy of Construction and has received the Army Engineer Associations Silver and Gold DeFleury Medals as well as the Engineering News Records Award of Excellence.

Julie Dean Rosati, Ph.D., PE

Dr. Rosati is the Lead Technical Director for Civil Works R&D at the U.S. Army Corps of Engineers, Engineer Research Development Center in the Coastal & Hydraulics Laboratory. In this role, she oversees basic and applied research involving coastal, watershed, navigation, and environmental assessments over short-term storm hazards and long-term evolution. She also serves as Technical Director for the Flood & Coastal Risk Management R&D mission area.

Dr. Rosati has published more than 20 peer-reviewed journal articles, two book chapters, and mentored junior researchers in their professional growth by guiding development of their publications. Her recent research applications have focused on interagency collaborations for coastal system resilience, marine transportation resilience, and integrated engineering, environmental, and community resilience. Additional research interests include long-term coastal morphologic change and regional sediment management. Dr. Rosati is a Professional Engineer in Mississippi and serves as Technical Director for the American Shore and Beach Preservation Association, an Associate Editor of ASCE's "Waterways" journal, and represents the Corps as a founding agency of the multi-organizational US Coastal Research Program.

Charter
Board on Coastal Engineering Research

1. Committee's Official Designation: The committee shall be known as the Board on Coastal Engineering Research (BCER).

2. Authority: The Secretary of Defense, pursuant to 33 U.S.C. § 426-2 and in accordance with the Federal Advisory Committee Act (FACA) (5 U.S.C., Appendix) and 41 C.F.R. § 102-3.50(a), established this non-discretionary advisory committee.

3. Objectives and Scope of Activities: Pursuant to 33 U.S.C. § 426-2, the BCER shall provide independent advice and recommendations on the functions of the Coastal Engineering Research Center, as set out in paragraph four below.

4. Description of Duties: The BCER provides independent advice and recommendations on the work of the Coastal and Hydraulics Laboratory, which includes the Coastal Engineering Research Center, on coastal engineering research priorities and additional functions as assigned by the Commanding General, U.S. Army Corps of Engineers ("the Chief of Engineers").

5. Agency or Official to Whom the Committee Reports: The BCER reports to the Secretary of Defense or the Deputy Secretary of Defense ("the DoD Appointing Authority"), through the Secretary of the Army and the Chief of Engineers, who may act upon the BCER's advice and recommendations in accordance with Department of Defense (DoD) policy and procedures.

6. Support: The DoD, through the Office of the Secretary of the Army, provides support for the BCER's functions and ensures compliance with the requirements of the FACA, the Government in the Sunshine Act (5 U.S.C. § 552b), governing Federal statutes and regulations, and DoD policy and procedures.

7. Estimated Annual Operating Costs and Staff Years: The estimated annual operating cost, to include travel, meeting, and contract support, is approximately $327,000. The estimated annual personnel cost to the DoD is 2.0 full-time equivalents.

8. Designated Federal Officer: The BCER's Designated Federal Officer (DFO) shall be a full-time or permanent part-time DoD civilian officer or employee, or active duty member of the Armed Forces, designated in accordance with DoD policy and procedures.

   The BCER's DFO is required to attend all BCER meetings for the entire duration of each and every meeting. However, in the absence of the BCER's DFO, a properly approved Alternate DFO, duly designated to the BCER in accordance with DoD policy and procedures, shall attend the entire duration of all BCER meetings. The DFO, or the Alternate DFO, approves and calls all BCER meetings; prepares and approves all meeting agendas; and adjourns any meeting when the DFO, or the Alternate DFO, determines adjournment to be in the public interest or required by governing regulations or DoD policy and procedures.

9. Estimated Number and Frequency of Meetings: The BCER shall meet at the call of the BCER's DFO, in consultation with the BCER's Chair. The estimated number of BCER meetings is two per year.

10. Duration: The need for this advisory committee is on a continuing basis; however, the charter is subject to renewal every two years.

11. Termination: The BCER will terminate upon rescission of 33 U.S.C. § 426-2.

12. Membership and Designation: The BCER, pursuant to 33 U.S.C. §§ 426 and 426-2, shall be composed of seven members. Four members shall be officers of the U.S. Army Corps of Engineers, appointed as follows –

    a. one of whom shall be the Deputy Commanding General for Civil and Emergency Operations, U.S. Army Corps of Engineers (“the Deputy Commanding General”), who shall serve as the Chair of the BCER for no fixed term of service; and
    b. the other three shall be chosen from among the eight coastal division commanders, based on tenure as a division commander and expertise in the matters before the BCER.

    The remaining three BCER members shall be civilian engineers selected with regard to their special fitness, such as expertise and advanced education in the fields of beach erosion, shore protection, nearshore coastal processes and infrastructure, and related fields. Comprehensive expertise of the three civilian members will be able to advise on coastal processes and nearshore beach, dune and bluff response for the Atlantic, Gulf of Mexico, Pacific, and Great Lakes coastal regions of the Nation.

    The appointment of the civilian BCER members and the three coastal division commanders shall be approved by the DoD Appointing Authority, for a term of service of one-to-four years in accordance with DoD policy and procedures. Pursuant to 5 U.S.C. § 3109 and DoD policy and procedures, appointments for civilian members of the BCER are subject to annual renewals. No member, unless approved by the DoD Appointing Authority, may serve more than two consecutive terms of service on the BCER or serve on more than two DoD Federal advisory committees at one time.

    BCER members who are not full-time or permanent part-time Federal officers or employees, or active duty members of the Uniformed Services, shall be appointed as experts or consultants, pursuant to 5 U.S.C. § 3109, to serve as special government employee (SGE) members. BCER members who are full-time or permanent part-time Federal officers or employees, or active duty members of the Uniformed Services, shall be appointed pursuant to 41 C.F.R. § 102-3.130(a) to serve as ex officio RGE members.

    All BCER members are appointed to exercise their own best judgment on behalf of the DoD, without representing any particular point of view, and to discuss and deliberate in a manner that is free from conflict of interest.

    Pursuant to section 105 of the Flood Control Act of 1970 (Public Law 91-611), SGE members may be paid at a rate not to exceed the daily equivalent of the rate for a GS-15, step 10, for each day of attendance at BCER meetings, not to exceed 30 days per year, in addition to travel and other necessary expenses connected with their official duties on the BCER, in accordance with the provisions of 5 U.S.C. §§ 5703(b), (d), and 5707. RGE members shall be reimbursed for official BCER-related travel and per diem.

13. Subcommittees: The DoD has determined that subcommittees will not be authorized for this advisory committee.

14. Recordkeeping: The records of the BCER shall be managed in accordance with General Records Schedule 6.2, Federal Advisory Committee Records, or other approved agency records disposition schedule, and the appropriate DoD policy and procedures. These records shall be available for public inspection and copy, subject to the Freedom of Information Act (5 U.S.C. § 552).

15. Filing Date: April 21, 2022

99th BOARD ON COASTAL ENGINEERING RESEARCH MEETING

15-17 August 2023
Hilton Miami Dadeland Hotel
9100 N Kendall Dr, Miami, FL 33176

WebEx
https://usace1.webex.com/meet/marcus.a.spade

Meeting Number:
1991 38 8078

By Phone
US Toll Free +1-844-800-2712
US Toll +1-669-234-1177
Access code:
1991 38 8078

Agenda

THEME: Community integration with non-structural and hybrid solutions

Meeting Concept**:** *Identify coastal research needs associated with integrated natural, nature-based, hybrid, traditional, and non-structural solutions that are co-developed to meet coastal community needs.*

(All in Eastern Time)

Monday 14 August 2023 – Board Dinner

1830 Table 55- Located inside the Hilton Hotel

Tuesday 15 August 2023 – Hilton Miami Dadeland Hotel

Meeting Attire: Military- Cammies/OCP; Civilian-Business Casual

0700	0830	Registration- Grand Magnolia Ballroom
0730	0830	Breakfast
0830		**Call to Order**
0830	**0900**	**Welcome and Introductions** MG William H. "Butch" Graham, Jr., Deputy Commanding General for Civil and Emergency Operations, Headquarters (HQ), U.S. Army Corps of Engineers (USACE) COL James L. Booth, Commander, USACE Jacksonville District (SAJ)

0900	0930	Purpose and History of the BCER and Discussion of 100th BCER Meeting in 2024 Dr. Ty V. Wamsley, SES, Director Coastal & Hydraulics Laboratory (CHL)

Panel Session #1: Jacksonville District's (SAJ) Coastal Setting and Challenges

Moderator: Mr. Chris McNees, SAJ

0930	1000	USACE South Florida Resiliency Efforts: Integrating Coastal and Inland Projects Ms. Eva Velez, USACE/SAJ Mr. Timothy Gysan, USACE/SAJ
1000	**1015**	**Break**
1015	1045	Miami and Collier County Back Bay Study – Lessons Learned and Gaps Ms. Michelle Hamor, USACE/Norfolk District (NAO)
1045	1115	Partner Perspective: Miami-Dade County Back Bay Community R&D Needs Mr. Jim Murley, Miami-Dade County Chief Resiliency Officer
1115	1145	Partner / USACE Perspective: Key Biscayne – Community R&D Needs Dr. Roland Samimy, Chief Resilience Officer, Village of Key Biscayne Mr. Jason Engle, USACE/SAJ
1145	**1245**	**Working Lunch Onsite**

Panel Session #2: BCER Action Items

Moderator: Dr. Julie Rosati, CHL

1245	1315	CHART Fundamentals Mr. Kevin Hodgens, USACE/CHL
1315	1415	Better Serving the Underserved: Maximizing Comprehensive Project Benefits for Environmental Justice, Socially Vulnerable Populations And Current CSRM Challenges Ms. Susan Durden, Institute for Water Resources (IWR)
1415	1445	Industry Perspective: Tools to Assist Communities in Coastal Resilience Dr. Angela Schedel, Global Director of Coastal Programs, HDR, Inc.
1445	**1500**	**Break**

Panel Session #3: Broadening and Quantifying Benefits

Moderator: Ms. Jessie Straub, CHL

1500	1530	Quantifying Benefits of Natural and Nature-Based Solutions Dr. Soupy Dalyander, The Water Institute of the Gulf Ms. Jean Cowan, The Water Institute of the Gulf

1530	1600	Coastal Storm Damages Prevented Tool Ms. Marriah Abellera, USACE/IWR Mr. Matt Wesley, USACE/SAJ
1600	1630	Technical Site Visit Overview Mr. M. Chris McNees, USACE/SAJ Ms. Michelle Hamor, USACE/NAO
1630	1700	Wrap up Day 1 Feedback from the Board
1830	2100	Optional Evening Social TBD

<u>Wednesday 16 August 2023 – Hilton Miami Dadeland Hotel</u>

Meeting Attire: Field- For walking tour

Site Visits Led by Mr. Chris McNees, SAJ and Ms. Michelle Hamor NAO

0730	0800	Board Busses and transit to field sites
0800 - 0930		Depart Hilton Miami Dadeland Hotel 9100 N Kendall Dr, Miami, FL 33176 Transit to Miami-Dade CSRM – Segment IV Collins Park, 2100 Collins Avenue, Miami Beach, FL 33140
0930 - 1000		View recently completed Miami-Dade CSRM project
1000 - 1030		Depart Miami-Dade CSRM – Segment IV Transit to Miami Harbor Entrance - Government Cut South Pointe Park, 1 Washington Avenue, Miami Beach, FL 33139
1030 - 1100		View Miami Harbor Entrance – Government Cut Presentation on proposed Miami Back Bay features
1100	1145	Depart South Pointe Park's Parking Lot
1145	1200	Arrive Hilton Miami Dadeland
1200	1300	Box Lunch; Break

Panel Session #4: Future Coastal R&D Innovations

Moderator: Dr. Gaurav Savant, USACE/CHL

1300	1330	Board Feedback on Site Visits
1330	1400	Machine Learning and Artificial Intelligence in Coastal Applications Dr. Chris Massey, USACE/CHL
1400	1430	Coastal Adaptation Pathways for Barrier Island Communities Dr. Stephanie Patch, University of South Alabama

1430	**1445**	**Break**
1445	1515	Summary of Outcomes and Recommendations Dr. Jane Smith, USACE/CHL
1515	1545	Public Comment
1545	1615	Summary of Action Items Dr. Julie Rosati, USACE/CHL
1615	1645	Board Closing Remarks Open Discussion Board Members
1645		Adjourn

99th BOARD ON COASTAL ENGINEERING RESEARCH MEETING
Executive Session

Purpose: *Review Action Items from 99th BCER, Update Board on any older Action Items needing briefs, plan for 2024 Exec Session and 100th BCER*

17 August 2023
Hilton Miami Dadeland Hotel
9100 N Kendall Dr, Miami, FL 33176

WebEx
https://usace1.webex.com/meet/marcus.a.spade

Meeting Number:
1991 38 8078

By Phone
US Toll Free +1-844-800-2712
US Toll +1-669-234-1177
Access code:
1991 38 8078

<u>Thursday, 17 August 2023</u>

Meeting Attire: Military-ASU'B; Civilian-Business Casual

Miami Dadeland Hotel

0800 – 0815	Opening Remarks	MG Graham
0815 – 0915	Discussion of the 98th BCER	MG Graham / All
0915 – 0945	2024 Executive Session/100th BCER	Location and Focus
0945 – 1000	Break	
1000 – 1015	Action Items Update	Dr. Julie Rosati
1015 – 1045	Closing Remarks	Board
1045	Adjourn	

Presentations Day 1

MIAMI
MAMI

Ty V. Wamsley, Ph.D., SES

Dr. Wamsley was appointed to the Senior Executive Service in October 2018, he serves as Director of the Coastal and Hydraulics Laboratory (CHL) at the U.S. Army Engineer Research and Development Center (ERDC). Headquartered in Vicksburg, Mississippi, CHL performs ocean, estuarine, riverine and watershed regional scale systems analyses work in support of the U.S. Army Corps of Engineers (USACE), the Department of Defense, and other federal agencies, as well as state and municipal governments and private industry. Areas of expertise include hydrologic analysis, hydraulic structures, coastal engineering, flood risk reduction, dredging, navigation, and military logistics. As director, Dr. Wamsley leads a team of more than 270 researchers, support staff and contractors. He is responsible for planning, directing and coordinating a multi-million dollar research program, and developing new and strategic research program areas in coastal and hydraulics technical disciplines. He manages and maintains physical facilities with a total area of one million square feet. Ongoing projects execute field data collection, laboratory analysis, physical modeling, and numerical modeling to produce design guidance and cutting-edge products to support successful coastal and inland water resources management. He also serves as the senior executive lead for the ERDC Civil Works Research and Development Area. Dr. Wamsley holds a bachelor's degree in civil engineering from North Carolina University, a bachelor's degree in accounting from the University of Houston, a master's degree in ocean engineering from Texas A&M University and a PhD in water resources engineering from Lund University. Dr. Wamsley has published several publications and received numerous army awards.

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Purpose and History of the Board on Coastal Engineering Research

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

COASTAL & HYDRAULICS LABORATORY

Board on Coastal Engineering Research

TY V. WAMSLEY, PhD, SES
Director, Coastal & Hydraulics Laboratory
Engineer Research and Development Center

99th Meeting Board on Coastal Engineering Research
August 15-17, 2023

Board on Coastal Engineering Research (BCER)

- Established via Public Law 88-172 of the 88th Congress, November 1963 to *provide guidance and advice to the Chief of Engineers and the Coastal Engineering Research Center (CERC)*, which was established by the same law.
- In 1996 CERC merged with the WES Hydraulics Laboratory to become CHL and *the CERB continues to provide that same guidance to CHL, the other ERDC labs, and Corps leadership on Corps coastal research*.

CHL Strategic Goals

BCER "Fingerprints" in Today's R&D Program

- Field Research Facility was established by the CERB and operated through funds from the Coastal Field Data Collection Program

- The Dredging Research Program was initiated by the CERB and is now replaced by the Dredging Operations and Environmental Program (DOER)

- The Coastal Inlets Research Program grew from CERB efforts that started with the 53rd CERB meeting in June 1990

- Regional Sediment Management (RSM) was the theme of the 67th CERB meeting in May 1998 and has grown to a continuing national program

USACE R&D Strategy

TOP 10 USACE RESARCH AND DEVELOPMENT PRIORITIES

★ 1 Mitigate and Adapt to Climate Change

2 Win Future Wars

★ 3 Modernize our Nation's Infrastructure

★ 4 Support Resilient Communities

5 Enable Smart and Resilient Installations

★ 6 Ensure Environmental Sustainability and Resilience

7 Secure Reliable Installation Energy

★ 8 Revolutionize and Accelerate Decision Making

9 Improve Cyber and Physical Security

★ 10 Protect and Defend the Arctic

Priorities are not ranked; numbers are for identification purposes only

USACE R&D STRATEGY

Scan the QR Code at right to download a copy of the **USACE R&D Strategy** and other USACE R&D communication products

★ Board on Coastal Engineering Research Influence

USACE Civil Works Strategic R&D

STRATEGIC FOCUS AREAS

ECOSYSTEMS

Sustainable Species Management

Measuring, predicting, and managing harmful, nuisance, threatened and endangered species through ecosystem restoration

INFRASTRUCTURE

NextGen Water Resources Infrastructure

Building smarter, longer-lasting infrastructure

SEDIMENT MANAGEMENT

Innovations in Sediment Management

Maximizing beneficial use of sediments

WATER MODELING

Comprehensive Water Risk Management

Effectively and efficiently managing water before, during, and after it hits the ground

AI, ROBOTICS & DATA

I-4A: Innovative Applications of Big Data Analytics, AI & Autonomy

Leveraging robotics, AI and data as a force multiplier

CRISIS MITIGATION

Crisis Mitigation, Response & Recovery

Proactively saving lives and communities

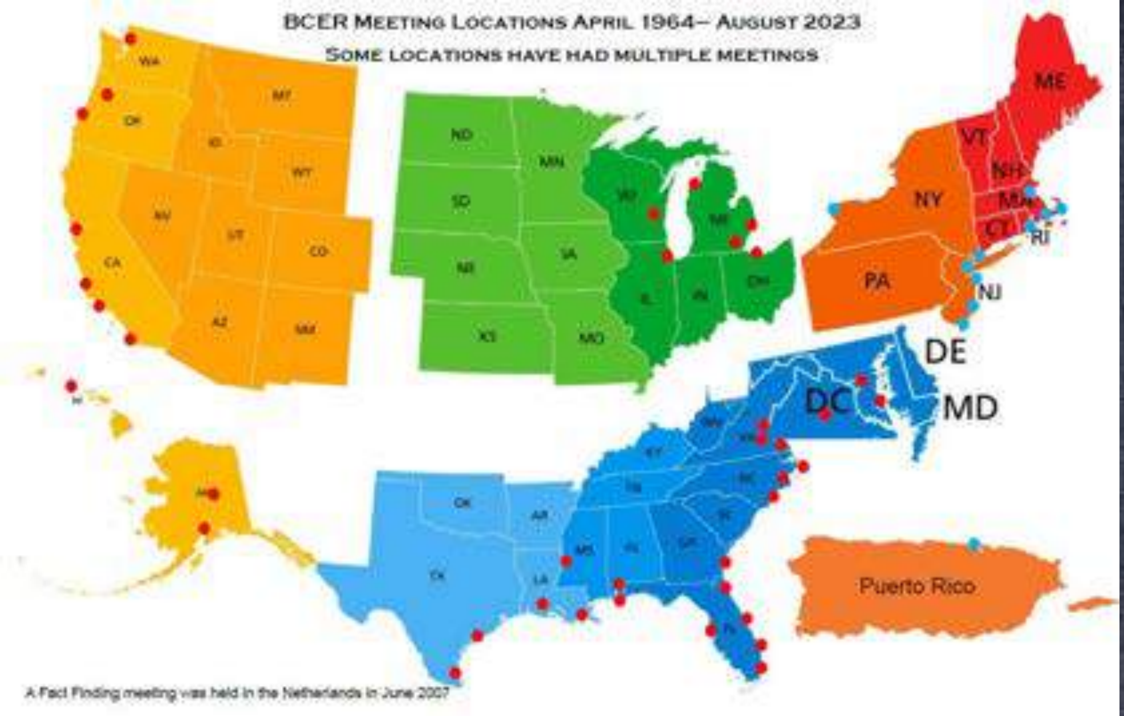
Purpose of the BCER

- Champion and guide strategic coastal R&D to solve the problems the Nation will face over the next 10-20 years.

- Recommend research priorities to the USACE Commander

- Advocate for the investment to make it happen.

100th BCER Meeting



Ideas for 100th BCER Meeting Summer 2024

- Dalecarlia Reservoir, D.C. - Revisit location of first BCER Meeting at CERC
- Wilmington, NC – Revisit location of first BCER meeting hosted by Division/District
- Savannah, GA – Revisit location of largest BCER meeting which was also the first meeting built around a theme (a practice still followed today)
- Duck, NC – Major BCER Accomplishment
- Vicksburg, MS – Home of the only federal laboratory for coastal engineering
- Visit a state with a coast the BCER has NOT had a meeting at to date: ME, NH, CT, DE, SC, IN, or MN
- Other suggestions

Decision Drivers:

- Maximize potential for attendance of past board members
- Historical tie

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

COASTAL & HYDRAULICS LABORATORY

Ty V. Wamsley, PhD, SES
Director, Coastal & Hydraulics Laboratory
Ty.V.Wamsley@usace.army.mil
(601) 634-2001

Connect to ERDC online

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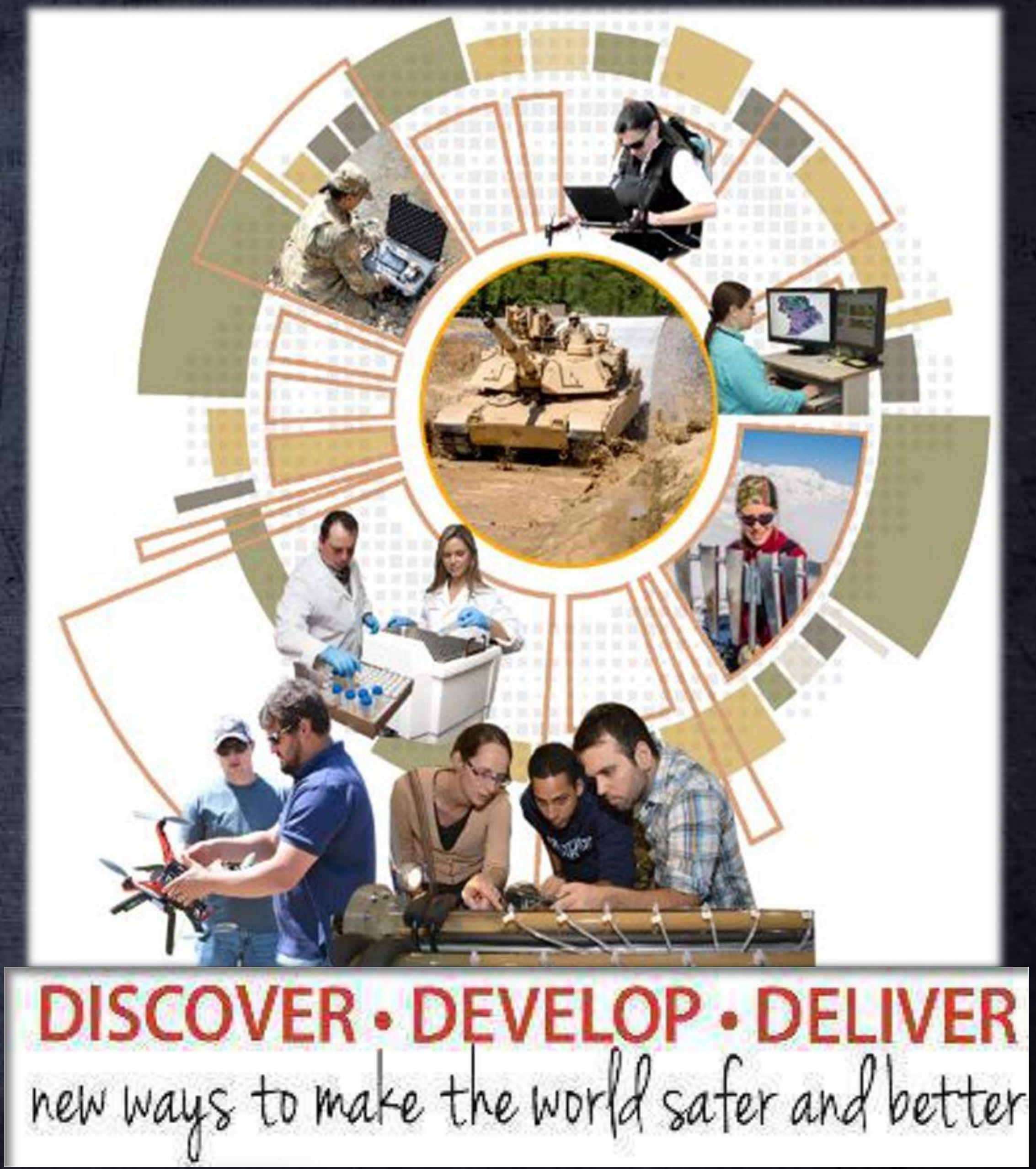


Eva B. Vélez

Ms. Vélez Eva serves the US Army Corps of Engineers (USACE) Jacksonville District as the Chief of the Ecosystems Branch in the Programs and Project Management Division, responsible for the management and execution of aquatic ecosystem restoration efforts in the South Florida Ecosystem and the resiliency efforts of the Central and Southern Florida system. The South Florida Ecosystem Restoration (SFER) program's goal is to restore and protect ~2.4 million acres known as America's Everglades. The Central and Southern Florida (C&SF) system provides flood control, water supply, recreation, navigation and preservation of fish and wildlife to a population of over ~9 million Floridians and spans 16 counties. Previously, Eva was the Strategic Program Manager of the Everglades restoration program in the Programs and Project Management Division, Ecosystems Branch, South Florida Program Office. She has supported District Command, District leadership, and the Project Delivery Teams in the execution of the South Florida Ecosystem Restoration Program (SFER). Spanning over twenty-three years, her experience includes both private and public sector work. Prior to joining USACE, Eva served the State of Florida as the Director of Everglades Policy and Coordination for the South Florida Water Management District (SFWMD). In that role, she was the SFWMD's executive leader responsible for coordination, development and implementation of comprehensive policy and projects to preserve, restore and protect the South Florida ecosystem, including America's Everglades, while recognizing the needs of external constituents, stakeholders and federally recognized tribes.

In her prior private sector work, Eva formed her own company, Velez Engineering, Inc. where she was the principal for an engineering firm with an emphasis on water resources. Much of her private sector work experience was as a Project Manager and Senior Engineer for AECOM Technical Services, Inc where she was responsible for the management, design, permitting and regulatory certification of water resources projects. Eva is a licensed professional engineer in the State of Florida since 2004. She earned a Bachelor of Science in Agricultural and Biological Engineering with an Area of Concentration in Natural Resources Conservation (Soil & Water) from the University of Florida. Some highlights of the awards she has received in her career include Young Engineer of the Year, Florida Section, American Society of Agricultural and Biological Engineers (ASABE), 2006; Engineer of the Year, Florida Section, ASABE, 2016; and 2022 Great Minds in STEM (GMiS/HENAAC) Professional Achievement Level II Award winner.

Eva is a native of Mayaguez, Puerto Rico and is bilingual in the English and Spanish language. Eva is married to her college sweetheart and is the mother of two boys – they live in Port Saint Lucie, Florida

E. Timothy Gysan

Mr. Gysan is the Resilience Senior Project Manager for the Ecosystems Projects Branch, Jacksonville District, US Army Corps of Engineers. He currently serves as the project manager for the Lake Okeechobee System Operating Manual (LOSOM), C&SF Flood Resiliency (Section 216) Study, the Kissimmee River Restoration, and the Interagency Modeling Center, which supports modeling for the South Florida Ecosystem Restoration program. Mr. Gysan previously spent sixteen years as a hydraulic engineer in the Jacksonville District Engineering Division, Water Resources Engineering Branch supporting projects including the Kissimmee River Restoration and the NRCS Agricultural Conservation Easement Program. He graduated from the University of Florida in 1997 with a degree in Environmental Engineering and received his master's degree in environmental engineering specializing in Systems Ecology in 2000. He is a Registered Professional Engineer in the state of Florida and holds a Project Management Professional (PMP) certification. Mr. Gysan is an active member of Society of American Military Engineers Jacksonville Post and was selected as Post Engineer of the Year in 2012 and Junior Engineer of the Year 2007-2008.

USACE South Florida Resiliency Efforts: Integrating Coastal and Inland Projects

Eva Velez, and E. Timothy Gysan
Jacksonville District
Jacksonville, FL.

Community resilience means systems that are adaptive to change and able to overcome catastrophic events. Healthy ecosystems and water management infrastructure are the base leading to more resilient water supply, and in conjunction with sustainable use of lands and robust transportation systems, enhance the resilience of economies, recreational opportunities, and ultimately lead improving the quality of life. Building resilience requires coordinated efforts from all levels of government; no single entity can build resilience alone. The problems related to climate change are uncertain, broad, and complex and it is essential to survey and assess relationships among all public and private sector deliverables and capabilities at local, regional, state and federal levels to determine the most appropriate and effective packaging of programs, projects, and services to accomplish resilience and sustainability objectives. Each level of government has an important part to play and partners in Miami-Dade, Palm Beach, and Broward Counties and the SFWMD are already working on their parts. USACE ongoing and future projects across business lines are part of the Federal resiliency effort.

In low lying areas like south Florida, the inland and coastal drivers of flooding must be viewed together to understand the risks to these coastal communities and how to plan projects to increase community resilience. The inland drivers and coastal forcings tend to meet in the coastal ridge area resulting in compounded water levels and increased damages. Increased rainfall runoff, due to loss of inland storage resulting from urbanization and loss of natural ecosystems, combines with higher groundwater levels, exacerbated by sea level rise, to negatively impact flood risk in these communities. In order to address flood risk across business lines, the multiple lines of defense concept is being employed to combat different climate change variables and increase community resiliency. USACE efforts from the coast to the inland areas work together to address the various sources of flooding, each playing its own role as follows:

1. Beach CSRM tackle direct impacts of coastal storm surge and sea level rise;
2. Back bay studies handle back side of barrier islands and bayfront effects from storm surge and sea level rise;

3. The C&SF Flood Resiliency study investigating effects of changed flood risk due to urbanization and increased rainfall and the compounding effects of sea level rise and storm surge;
4. CERP handles ecosystem function to provide water storage and filtration helping inland flood risk and enhanced habitat that can help coastal storm risk resiliency.

One of the major challenges we face is working within the stovepipe authority, policy, and funding system. Project integration is a way to think across business lines and coordinate efforts across USACE projects key to supporting community resilience. Integration of projects focused on building resiliency includes:

1. Communication- Internal both between teams and with leadership and external with sponsors and stakeholders;
2. Technical Coordination-During formulation including policy application, model assumptions, and project baselines and after formulation including comprehensive benefits and effects of projects on each other.

The USACE has many ongoing projects across business lines in southeast Florida helping to build community resiliency through support of multiple lines of defense concept. These include:

1. Includes multiple beach CSRM authorized projects along east coast;
2. Miami-Dade Back Bay CSRM study;
3. Navigation (Port Everglades, Miami Harbor) enhancing the transportation infrastructure;
4. CERP ecosystem restoration (BBSEER, Broward County WPAs, BBCW);
5. Flood risk management (C&SF Operations, C&SF Flood Resiliency).

Our water resource infrastructure is the great connector between all these efforts and the backbone of that system is the Central and Southern Florida Project. The C&SF Project is a large, multipurpose water resources project initially authorized by the Flood Control Acts of 1948 and 1954 for the purposes of providing flood control, water supply for municipal, industrial, and agricultural uses, prevention of saltwater intrusion, recreation, groundwater recharge, water supply for Everglades National Park, and preservation of fish and wildlife resources. The key infrastructure of the system includes approximately 2,200 miles of canals, 2,100 miles of levees/berms, 84 pump stations, and 778 water control structures and this regional system serves a population of approximately nine million residents. However, the system and drivers of flood risk have drastically changed since the 1950’s due to urbanization and climate change.

The C&SF Flood Resiliency Study, being conducted under Section 216 authority, is looking to address these impacts to reduce flood risk in southern Palm Beach, Broward, and Miami-Dade counties resulting from the combination of rainfall runoff, storm surge, high tide and/or water table. The study scope focuses on enhancing the capacity of the most vulnerable coastal water/salinity control structures and adjacent primary canals. While not formulating features to address all sources of flooding, these drivers of compound flooding will be incorporated in the planning evaluation to identify sources of residual risk. The other ongoing projects in the area are counted on to address some portion of the residual risk. The initial formulation for the C&SF Flood Resiliency Study will utilize the intermediate sea level rise curve (SLC), NOAA Atlas 14 rainfall, and utilize the ERDC Coastal Hazard System for coastal storm surge. Once a TSP is identified, sensitivities will be run using three SLCs (Low, Intermediate, high) and will look at rainfall intensification effects to address potential further impacts to flood risk. This study relies on the MIKE SHE /MIKE HYDRO model to simulate the drivers of flood risk and will also utilize data from other studies modeling tools to perform evaluations as a single modeling tool capable of simulating compound flooding is not currently available.

This study highlights the importance of project integration as the bridge across authorizations in the absence of a single authorization (like that provided in the Central and Southern Florida Comprehensive Study) covering purposes for CSRM, FRM, and AER. With multiple studies ongoing in the region, it is critical to understand how each fit into the bigger community resiliency puzzle and how each project may enhance or impact the others. Being able to communicate to stakeholders who view us as one Corps and address inevitable questions from vertical reviewers can’t be done without the efforts coordinating and collaborating. Consistency in use of technical data during evaluations better positions each effort to develop the right solutions addressing their individual project objectives and in developing the right solutions to enhance resiliency in the larger regional community. Technical collaboration will also allow consistent evaluation of benefits and impacts and documentation in the multiple reports which will move forward for authorization. Beyond project integration, some recommendations that can benefit studies in these low-lying coastal areas include implementation guidance for WRDA 2022 Sec. 8106; joint authority and combining CSRM and FRM policies; link existing inland and costal models; next generation tools capable of simulating all drivers of flood risk; rainfall intensification technical guidance.

USACE SOUTH FLORIDA RESILIENCY EFFORTS:

INTEGRATING COASTAL AND INLAND PROJECTS

Board on Coastal Engineering Research

August 15, 2023

Eva B. Vélez, P.E.
Chief, Ecosystem Branch

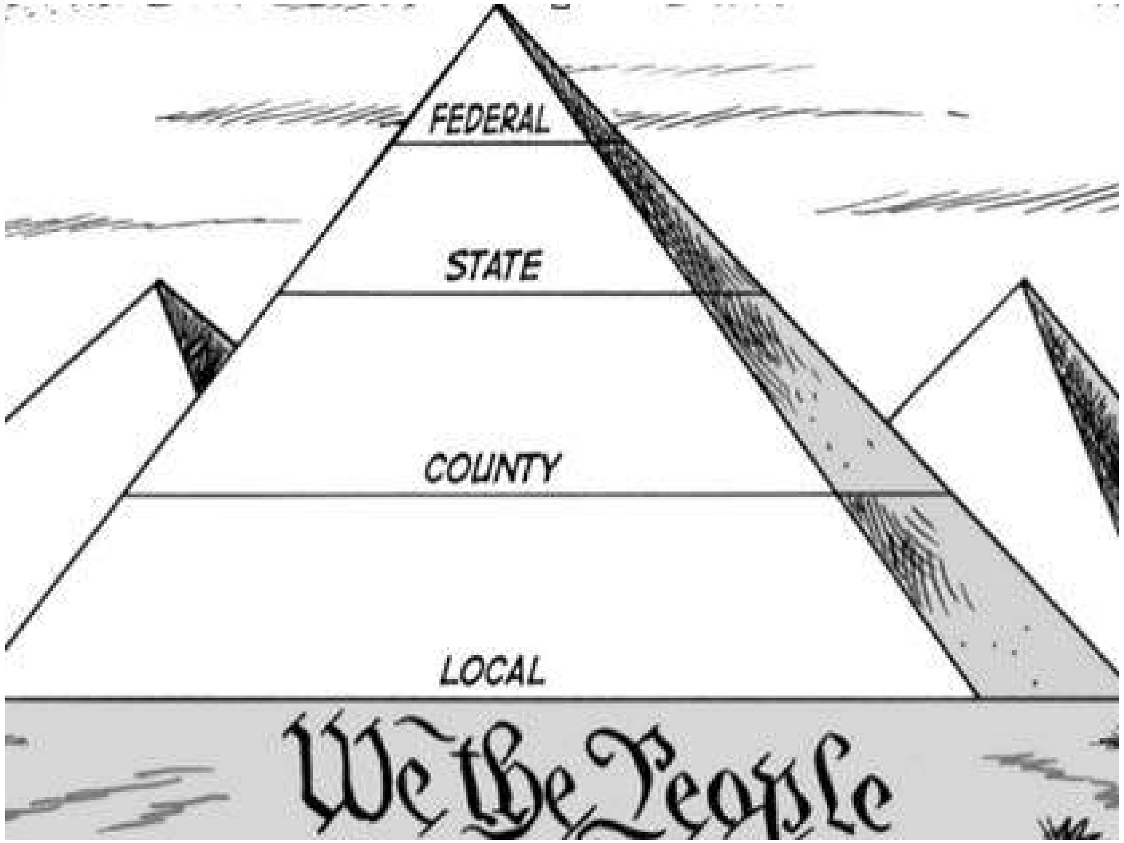
E. Timothy Gysan, P.E., PMP
Resilience Senior Project Manager
Jacksonville District
U.S. Army Corps of Engineers

U.S. ARMY

US Army Corps of Engineers

BUILDING COMMUNITY RESILIENCE

A COMPREHENSIVE AND COLLABORATIVE APPROACH



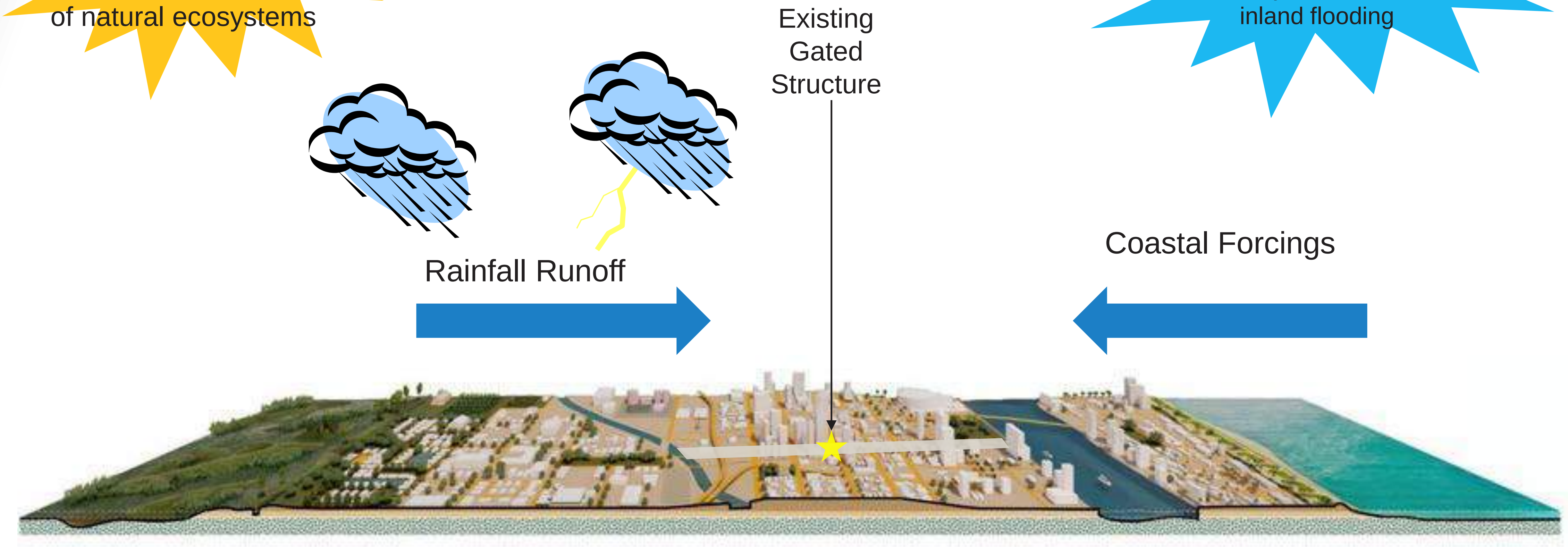
Water Resource infrastructure is the connector

SOUTH FLORIDA HYDROLOGIC CONDITIONS

TYPICAL SOUTH FLORIDA CROSS-SECTION

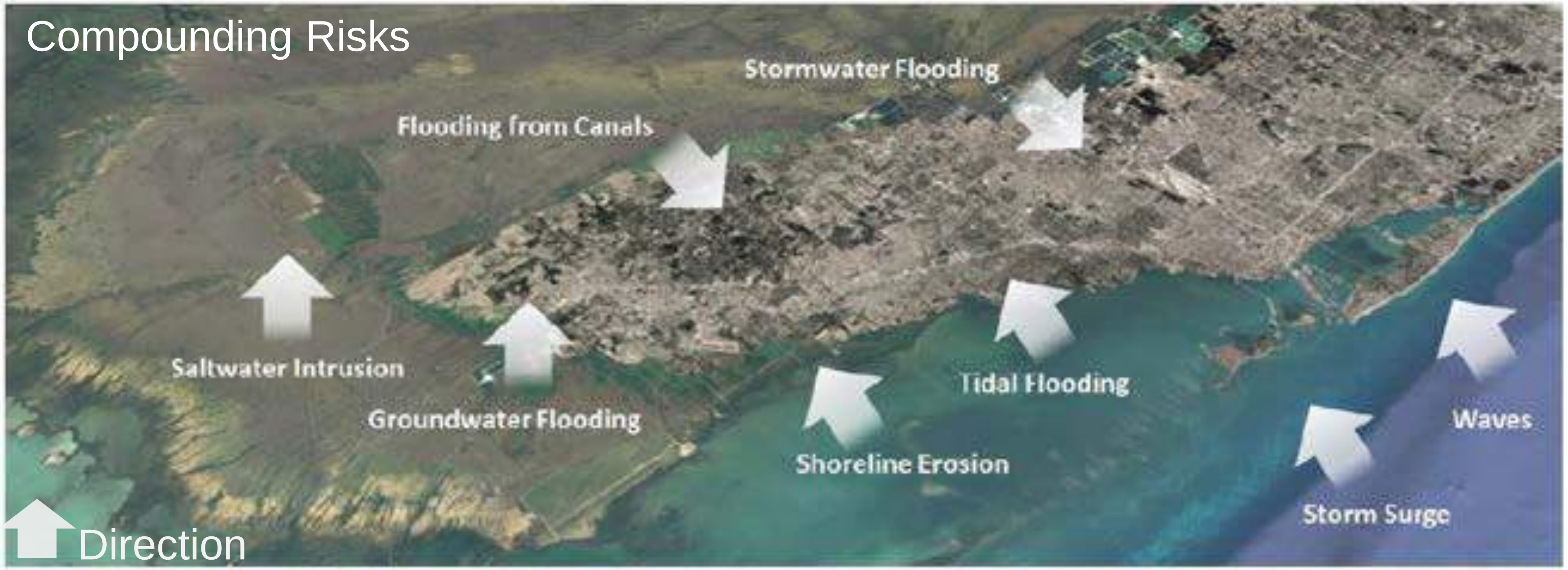
Lack of storage and conveyance caused by urbanization and removal of natural ecosystems

High groundwater levels, exacerbated by SLR, is one of the major contributors to inland flooding

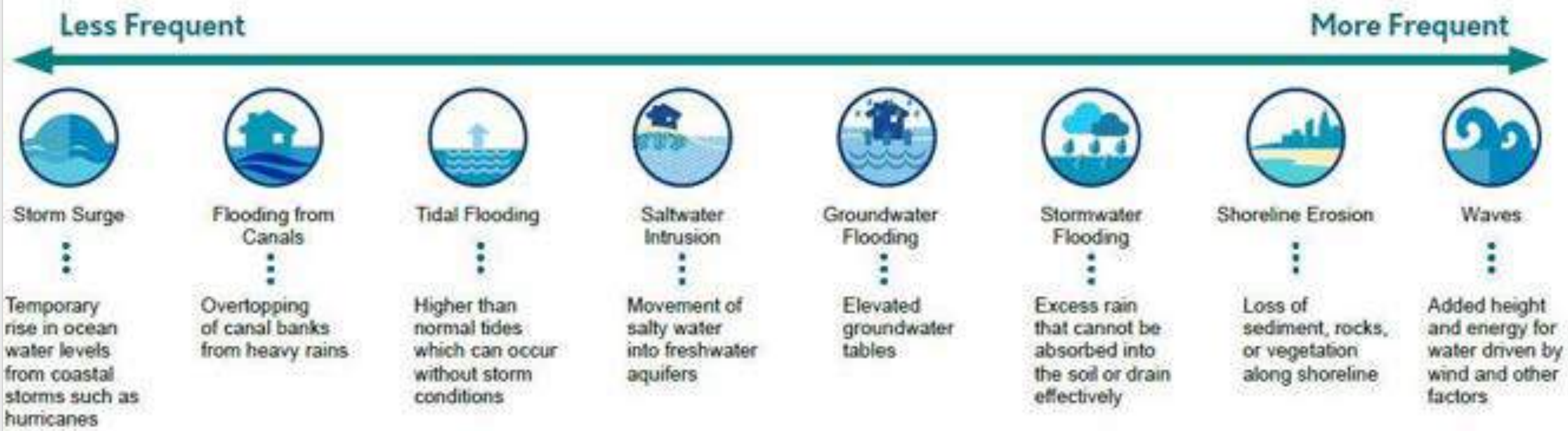


SOUTH FLORIDA HYDROLOGIC CONDITIONS

SOURCES OF FLOODING

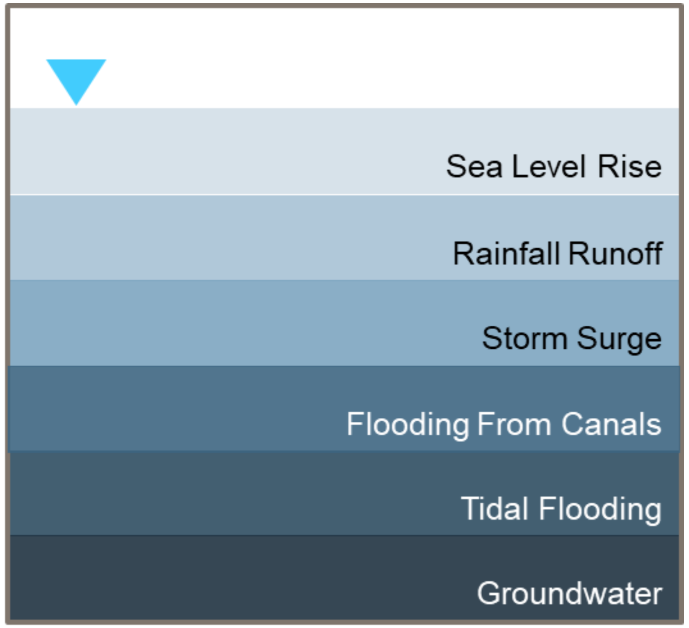


Source: Miami-Dade County Sea Level Rise Strategy (2021)



Sea level rise and future rainfall intensification will increase the frequency and impact for all sources of flooding

Total Water Level



Not to scale

USACE RESILIENCY THROUGH PROJECT INTEGRATION

Coordinating Multiple Lines of Defense

Comprehensive Everglades Restoration Plan (CERP)

Back Bay CSRM Studies

Beach CSRM Reauthorizations

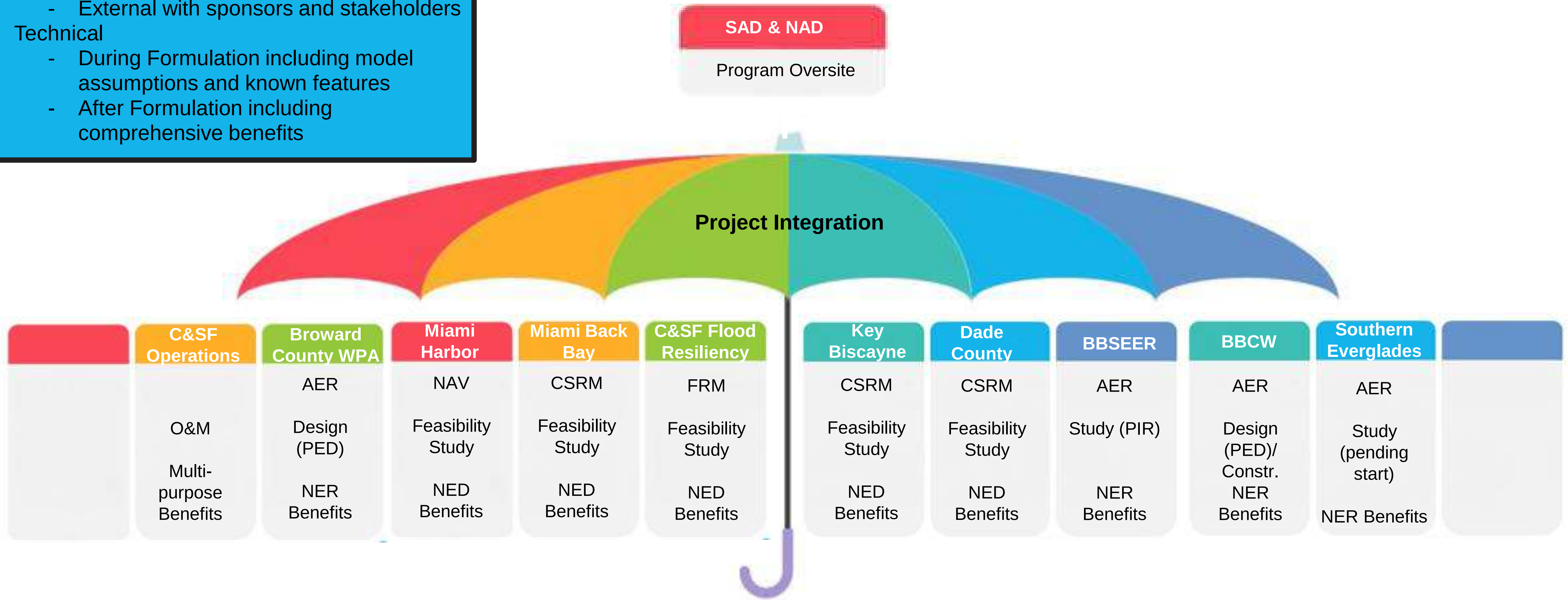
CS&F (216) Flood Resiliency Study (FRM)

USACE SOUTHEAST FLORIDA PROJECT INTEGRATION

All Projects Under One Umbrella

Integration Themes:

- Communication
  - Internal both between teams and with leadership
  - External with sponsors and stakeholders
- Technical
  - During Formulation including model assumptions and known features
  - After Formulation including comprehensive benefits



USACE PROJECT INTEGRATION

® MIAMI-DADE | BROWARD | PALM BEACH COUNTIES

(Not All Inclusive)

COASTAL STORM RISK MANAGEMENT (CSRM)

NAVIGATION

CSRM | MIAMI BACK BAY STUDY

CONTINUING AUTHORITIES PROGRAM (CAP) | SECTION 14 (Mt. Sinai)

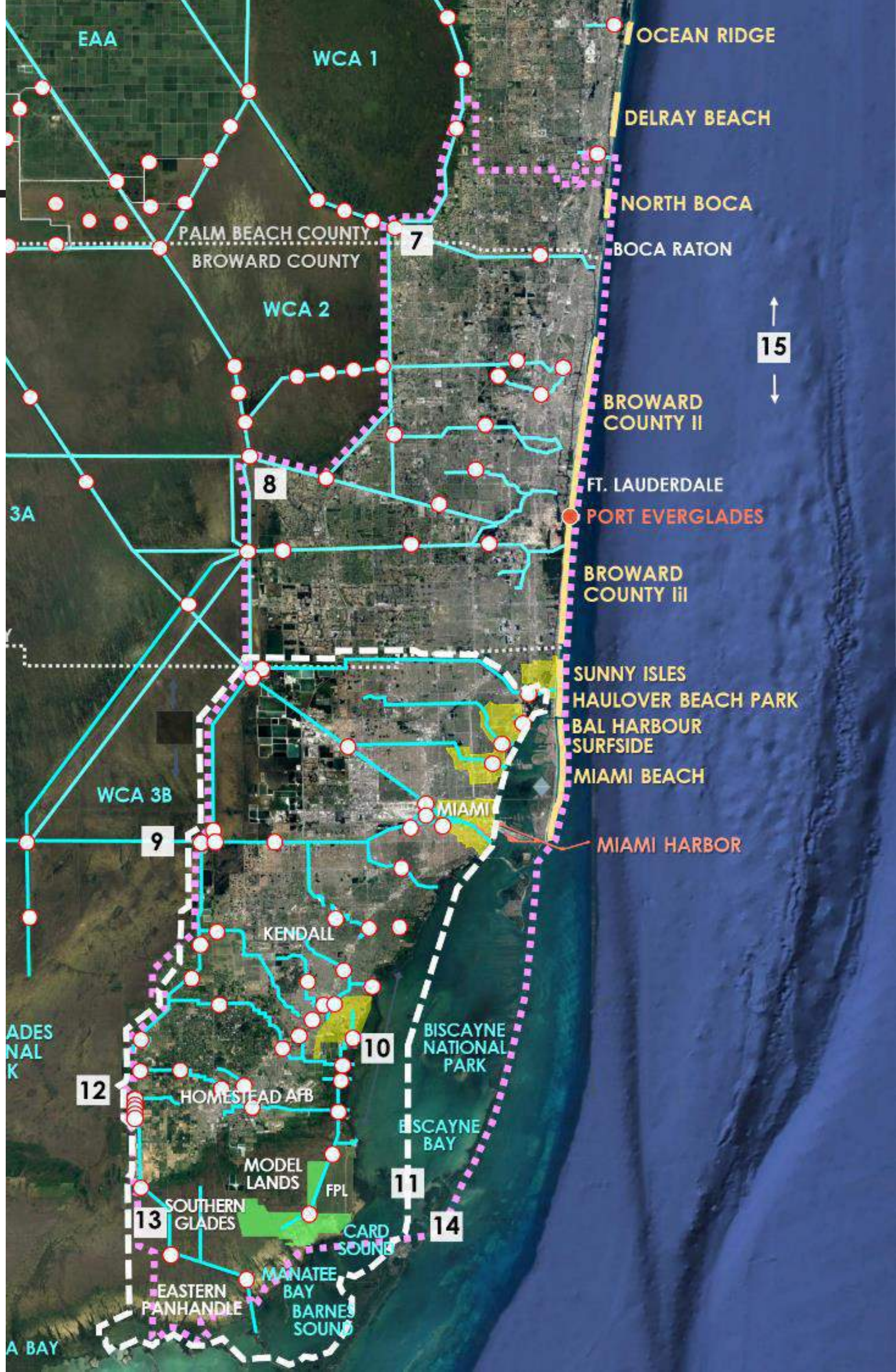
FPL MITIGATION BANK

CENTRAL AND SOUTHERN FLORIDA (C&SF) CANALS

CENTRAL AND SOUTHERN FLORIDA (C&SF) STRUCTURES

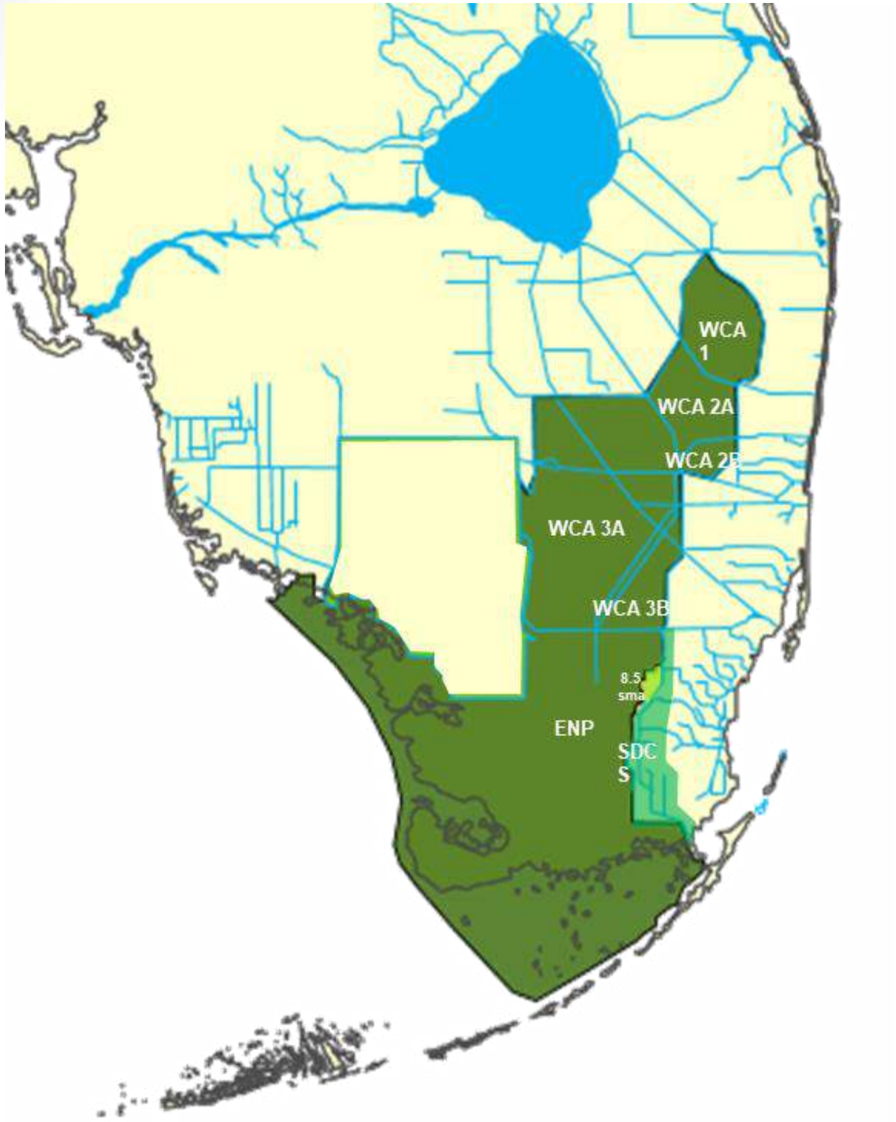
SOUTH FLORIDA ECOSYSTEM RESTORATION (SFER) PROJECTS AND STUDIES

7) Site 1 Impoundment
8) Broward County WPAs
9) Tamiami Trail Next Steps – Phase 2
10) Biscayne Bay Coastal Wetlands (BBCW)
11) Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) – STUDY BOUNDARIES
12) S-332 Pump Replacements
13) C-111 Spreader Canal Western Project
14) C&SF Flood Resiliency (Section 216) Study - STUDY BOUNDARIES
15) Melaleuca Eradication



CENTRAL & SOUTHERN FLORIDA (C&SF) PROJECT

THE BACKBONE OF THE WATER RESOURCE SYSTEM

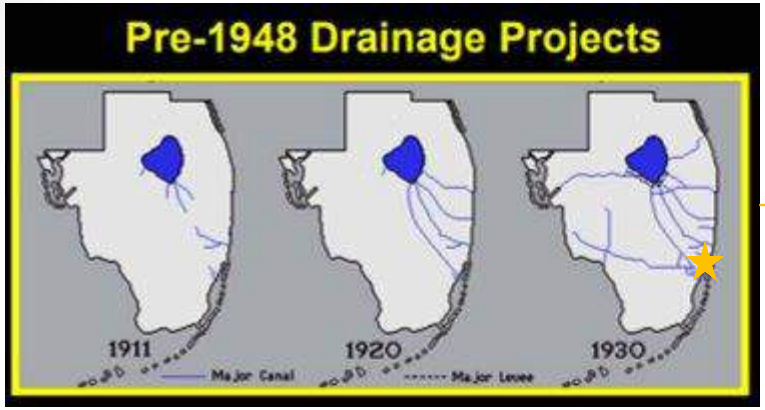


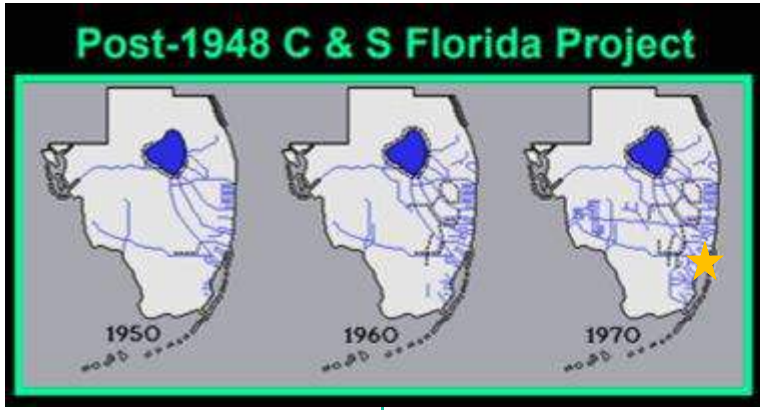
- Congressionally authorized by the Flood Control Acts of 1948 and 1954
- Large multi-purpose water resources project
- System includes canals, levees/berms, pump stations and water control structures

Balance multiple congressionally-authorized project purposes:

- Flood control
- Navigation
- Water supply
- Enhancement of fish and wildlife
- Recreation

CHANGED CONDITIONS

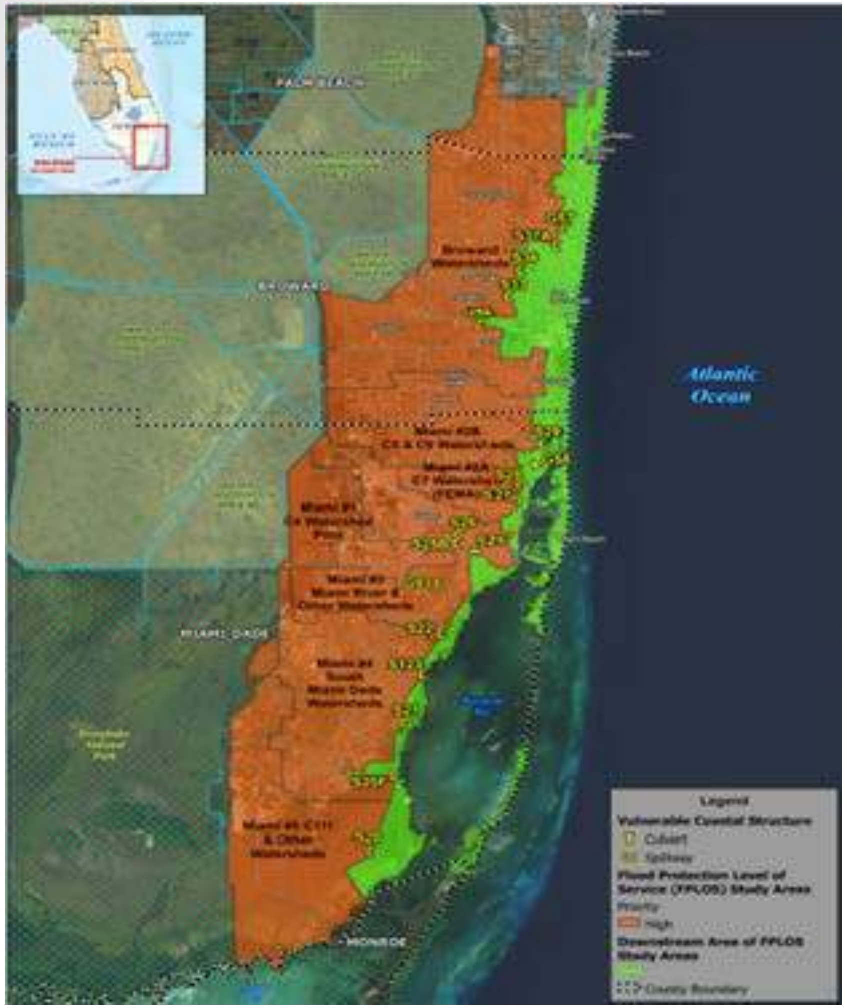




Downtown Miami

C&SF FLOOD RESILIENCY (SECTION 216) STUDY

Overview



Study objectives:

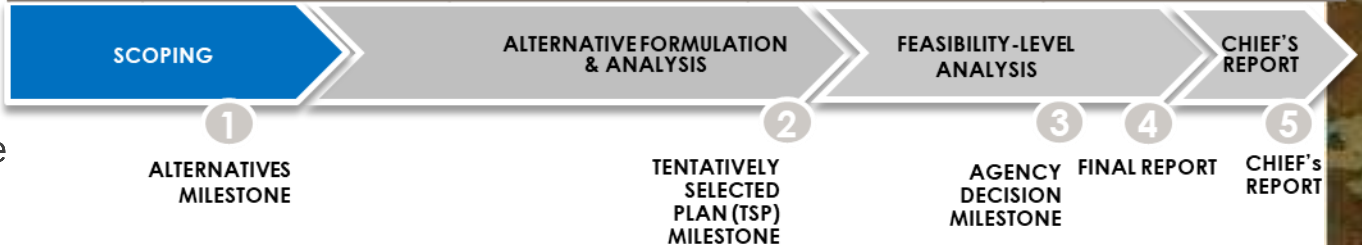
- **Reduce flood risks and damages** in southern Palm Beach, Broward, and Miami-Dade counties resulting from the combination of rainfall runoff, storm surge, high tide and/or water table

Status:

- Initial Alternatives Milestone Meeting in MAR 2023
- A final COE vertical team meeting was held July 6, 2023, in which full alignment was reached for the scope, study deliverable schedule (4 years), and for an expanded budget of $11.3M
- Study scope focuses on enhancing the capacity of the most vulnerable coastal water/salinity control structures and adjacent primary canals. The total volume of water in the system will be addressed as part of future studies through storage and further regional integration.

G-54 Structure (Sewell Lock) and flooding in Ft Lauderdale 2020.

Kick Off: SEP 2022	2023 AMM: JUNE 2023*	2024	2025 TSP: APR 2025	2026 ADM: MAR 2026 Final Report: MAY 2026 Chief's Report: SEP 2026



Sponsor and USACE Business Line –

- South Florida Water Management District
- Flood Risk Management (FRM) business line

Website:

www.saj.usace.army.mil/CSFFRS

C&SF FLOOD RESILIENCY (SECTION 216) STUDY

COMPOUND FLOODING CONSIDERATIONS

Gravity draining inland flood water to the coast

Gates closed due to increased coastal waters, which results in increased inland flood waters, combined with high groundwater levels

Gates closed due to increased coastal waters, stopping saltwater intrusion

Gates open due to extreme coastal waters, which results in greater inland flood waters and groundwater levels

Note: These are the most common scenarios experienced in the area. However, there are several other scenarios that are not represented in this slide.

COMPREHENSIVE CENTRAL & SOUTHERN FLORIDA STUDY

Overview

Authority –

- Division H Section 8214 of the National Defense Authorization Act for Fiscal Year 2023.

Scope –

- Feasibility study for **resiliency** and **comprehensive improvements** or modifications to existing water resources development projects in the central and southern Florida area
- Purposes of flood risk management, water supply, ecosystem restoration (including preventing saltwater intrusion), recreation, and related purposes.

- Recommend cost-effective structural and nonstructural projects for implementation that provide a **systemwide approach** to solutions

Key themes –

- Increase system-wide community resiliency
- Strategic long-term planning through collaboration with Federal, state, and local entities
- Focus on comprehensive benefits
- Address effects from compound flooding, climate variability, and land use changes
- Incorporate natural and nature-based features to enhance benefits

R&D NEEDS AND RECOMMENDATIONS

Two Worlds Colliding

SEC. 8106. SCOPE OF FEASIBILITY STUDIES.

(a) FLOOD RISK MANAGEMENT OR HURRICANE AND STORM DAMAGE RISK REDUCTION.—In carrying out a feasibility study for a project for flood risk management or hurricane and storm damage risk reduction, the Secretary, at the request of the non-Federal interest for the study, shall formulate alternatives to maximize the net benefits from the reduction of the comprehensive flood risk within the geographic scope of the study from the isolated and compound effects of—

(1) a riverine discharge of any magnitude or frequency;

(2) inundation, wave attack, and erosion coinciding with a hurricane or coastal storm;

(3) flooding associated with tidally influenced portions of rivers, bays, and estuaries that are hydrologically connected to the coastal water body;

(4) a rainfall event of any magnitude or frequency;

(5) a tide of any magnitude or frequency;

(6) seasonal variation in water levels;

(7) groundwater emergence;

(8) sea level rise;

(9) subsidence; or

(10) any other driver of flood risk affecting the area within the geographic scope of the study.

USACE Funding, Policy and Tools are stove-piped for FRM or CSRM

Planning and Policy

- **Studies tend to be single purpose: CSRM or FRM**
- **Guidance is generally inland or coastal focused; no guidance on compound flooding**

Technical challenges

- **Existing engineering and planning models focus on either coastal or inland processes; Untested outside of their intended application**

Recommendations

- **Policy**
  - **Short Term: implementation guidance for WRDA 2022 Sec 8106**
  - **Long Term: develop a joint authority and combine CSRM/FRM policies**
- **Technical**
  - **Short term: link inland and coastal models; develop training and support documentation for the field; inland NNBF research and project implementation guidance**
  - **Long term: next generation tools must work in a combined environment; tools that can simulate all drivers of flood risk in a single simulation are needed to assess and plan for compound flooding; rainfall intensification application technical guidance**

QUESTIONS?

Michelle L. Hamor

Ms. Hamor began as a Co-op student, while attending Old Dominion University. Ms. Hamor has worked for the Norfolk District for 30 years. She has a bachelors in civil engineering and actively supports general investigation studies such as the Raritan Bay to Sandy Hook Bay, Collier County, Miami-Dade Back Bay, and Virginia Coastal Storm Risk Management feasibility studies and Newmarket Creek, Hampton Continuing Authorities Program, Section 205 feasibility study.

Miami-Dade Back Bay Coastal Storm Risk Management

Michelle Hamor
Norfolk District
Norfolk, VA.

Objective: Conduct a study that examines the feasibility of an array of alternatives for a highly complex environmentally sensitive system, including the Atlantic Barrier alternative, and actionable measures using Tiered NEPA to recommend a plan with a Class 3 cost estimate and an 80% confidence level using available federal funding and gratuitous services and, potentially, contributed funding.

Needs: Tools/examples/processes of successfully completing a Chiefs Report with Tiered NEPA. The PDT is currently coordinating with other studies such as NYNJ HATS, Coastal Texas, NJBB and San Francisco but additional focus on how the enterprise can use the full range of tools, such as Policy Exceptions, and obtain the information necessary to successfully complete a Chiefs Report.

Three lessons learned:

1. 100% Federal Funding does not, necessarily, lend itself immediately, to a well understood partnership. It can be seen as "our study".
2. As it is well understood now, limiting a study budget to $3 million, even 3 million Federal dollars, does not always equate to a comprehensive examination of the problems.
3. Though emergency supplementals are an opportunity to complete what may have not been previously possible through the normal budget process, we need to examine if the effort can be reasonably completed under the emergency auspice or is it more feasible within the normal budgetary process, i.e., the limitations associated with the color of money.

Background: The original feasibility study began in October 2018 as a 100% federally funded feasibility study under Emergency Supplemental, Bipartisan Budget Act of 2018, with the explicit direction to quickly complete the study in 3 years and $3 million. Miami-Dade County covers a large area, and it was clear quickly that team would need to refine the study area to seven focus areas with the highest expected damage and most vulnerable populations. The Recommended Plan included structural and nonstructural measures, including critical infrastructure and natural and nature-based features. There was broad support for nonstructural measures and natural and nature-based features but there was equal opposition to the structural measures.

The team conducted extensive coordination to reduce concern but ultimately, Miami-Dade County did not feel comfortable supporting the RP and the study paused. Through extensive coordination, Miami-Dade County requested additional time and NAO submitted a time and funding exemption that was approved in August 2022.

The approval included a 12 month Go/No Meeting which is scheduled for this Friday to ensure that there is sufficient support and plan forward for the remainder of the study. Within the first year, the team has conducted two stakeholder charrettes and public meetings. The input received requests a system wide approach with multiple lines of defense, CSRM measures that address social equity, maintain community cohesion and provide environmental benefits, continued community engagement throughout the process, the need to conceptualize measures (concept drawings) so that the public can better understand and comment on the recommendations, consist of hybrid solutions – not all gray and integrate with existing federal projects and studies.

Following the second charrette in March 2023, Miami-Dade County and their consultant, Moffatt and Nichol submitted two alternatives. The first is the Atlantic Coastline Alternative and the second, not shown, is a nonstructural and natural and nature-based alternative. They serve as bookend concepts with the understanding that an array of alternatives will be necessary, and the plan may fall somewhere in-between. There a number of constructed Federal projects that will need to be considered when formulating the alternatives. The following is a list of major features considered within the Atlantic Coastline Alternative.

1. The proposed Atlantic Alternative conceptually has a number of features to complete the system. Sector Gate Surge Barrier at Haulover Inlet
2. Dune Raising/Reinforcing or Beachwalk Elevation
3. Sector Gate Surge Barrier at Government Cut
4. Dune Raising/Reinforcing and/or Seawall at Fisher Island
5. Sector Gate Surge Barrier at Norris Cut (between Fisher Island and Virginia Key)
6. Floodwall at Virginia Key
7. Two Surge Barrier/Environmental Gate Combinations at Rickenbacker Causeway with Floodwall in Between
8. Surge Barrier at Coral Gables Waterway
9. Surge Barrier at Snapper Creek Canal
10. Additional Beach and Northern Closure Preliminary analysis determined a need for a structural alignment in the north going westward to high ground to prevent flooding from Port Everglades in Broward County

In addition, the following nonstructural and natural and nature-based features are considered:

1. Reinforced Islands in Biscayne Bay
2. Mangrove Restoration along Causeways
3. Living Shoreline along Mainland
4. Reef Seawall along Edgewater
5. Hybrid Reef structure
6. Mangrove Restoration
7. Elevation and Floodproofing at Cutler Bay

Need: Additional evaluation of CSRM benefits for NNBF. Minimum design standards and costs. Benefits should consider growth time of the measure and reduced benefits following storm events. Additionally, critical infrastructure will be evaluated as actionable measures and prioritized as vulnerable facilities providing service to broad areas including environmental justice communities. Even if an Atlantic Barrier is recommended, the redundant layers will help improve the resiliency within the community and provide benefits during more frequent events when barriers would not be closed on a larger measure.

Need: More in-depth evaluation of depth damage functions for critical infrastructure. FEMA has broad information for entire facilities such as water treatment plants, but a broad stroke may over or underestimate the risk. The study area is highly complex system, including multiple waterways and inlets and the environmentally sensitive aquatic preserve, Biscayne Bay. The proposed measures will reduce risk to the study area, but residual risk will remain as starting water levels will increase with sea level rise.

Need: Modeling for complex systems so we can more accurately predict water quality impacts, design NNBFs and pump stations and gates and more accurately calculate benefits and predict residual risk.

MIAMI-DADE BACK BAY COASTAL STORM RISK MANAGEMENT MEGA STUDY

BOARD OF COASTAL ENGINEERING RESEARCH
15AUG23

Michelle Hamor
Chief, Planning and Policy Branch
U.S. Army Corps of Engineers, Norfolk District

Working Today to Build a Better Tomorrow

U.S. ARMY

US Army Corps of Engineers ®

https://www.saj.usace.army.mil/MiamiDadeBackBayCSRMFeasibilityStudy/

MIAMI-DADE BACK BAY CSRM CURRENT OBJECTIVE

- **Objective:** Conduct a study that examines the feasibility of an array of alternatives for a highly complex system, including the Atlantic Barrier, and actionable measures using a Tiered NEPA Approach to recommend a plan with a Class 3 cost estimate and an 80% confidence level using available federal funding and gratuitous services and, potentially, contributed funding.

- Our needs are defining how we get there from here.

- **Lessons Learned:**

1. 100% Federal Funding does not, necessarily, lend itself immediately to a well understood partnership.
2. Limiting a study budget to $3 million, even $3 million Federal, does not equate to a comprehensive examination of the problems.
3. We need to examine if the effort can be <u>reasonably</u> completed under the emergency auspice or is it a better fit in the normal budgetary process.

MIAMI-DADE BACK BAY CSRM MEGA STUDY BACKGROUND

- Original feasibility study scoped the study area to **seven** focus areas to investigate Coastal Storm Risk Management primarily in socially vulnerable areas of Miami-Dade County to **remain 3x3 compliant.** Miami-Dade County (MDC) did not support the entire Recommended Plan.

- ASACW directed the Corps "…**to support NFS request to develop and analyze flood risk reduction features** in addition **to investigating the incorporation of natural and nature-based features**. If upon analysis it is determined that a Locally Preferred Plan (LPP) is likely to evolve from the investigation, USACE will actively participate in development of the LPP to ensure its feasibility…."

- **Scope:** Based on feedback from the public (November 2022 and March 2023 charrettes), the USACE and MDC identified two alternatives to investigate further. Study scope **is larger** than the original time and funding request. The team is working on analysis to present at the Go/No Go meeting in August 2023

- **High Risk for Two Alternatives**
  - Large, complex system with sensitive environmental resources (Biscayne Bay)
  - Requires extensive surveying, modeling and design to achieve environmental compliance
  - Impacts multiple Federal projects and private property (Fisher Island)
  - Unlikely to complete feasibility study within current time and funding

RECOMMENDED PLAN 2021 (RP2021)

Not supported by Miami-Dade County

- **Structural Measures:** Storm surge barriers with associated floodwalls, pump stations, and tide gates at Biscayne Canal, Little River, Miami River, Coral Gables Waterway, and Snapper Creek Canal

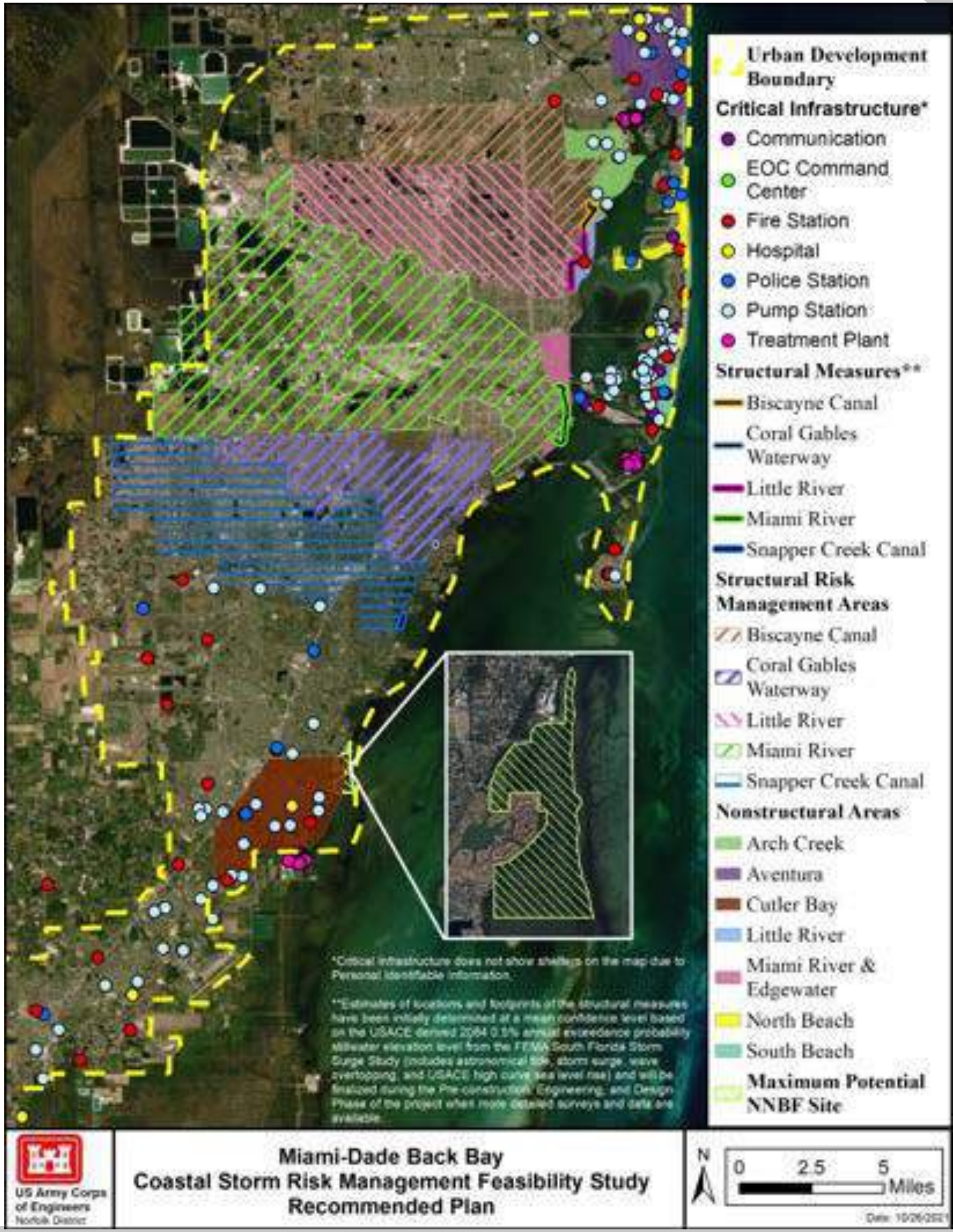
Supported by Miami-Dade County

- **Nonstructural Measures:** Elevating residential homes and floodproofing non-residential buildings

- **Dry floodproofing critical infrastructure** such as fire and police stations, medical facilities, evacuation centers, potable water facilities, and pump stations (250 locations)

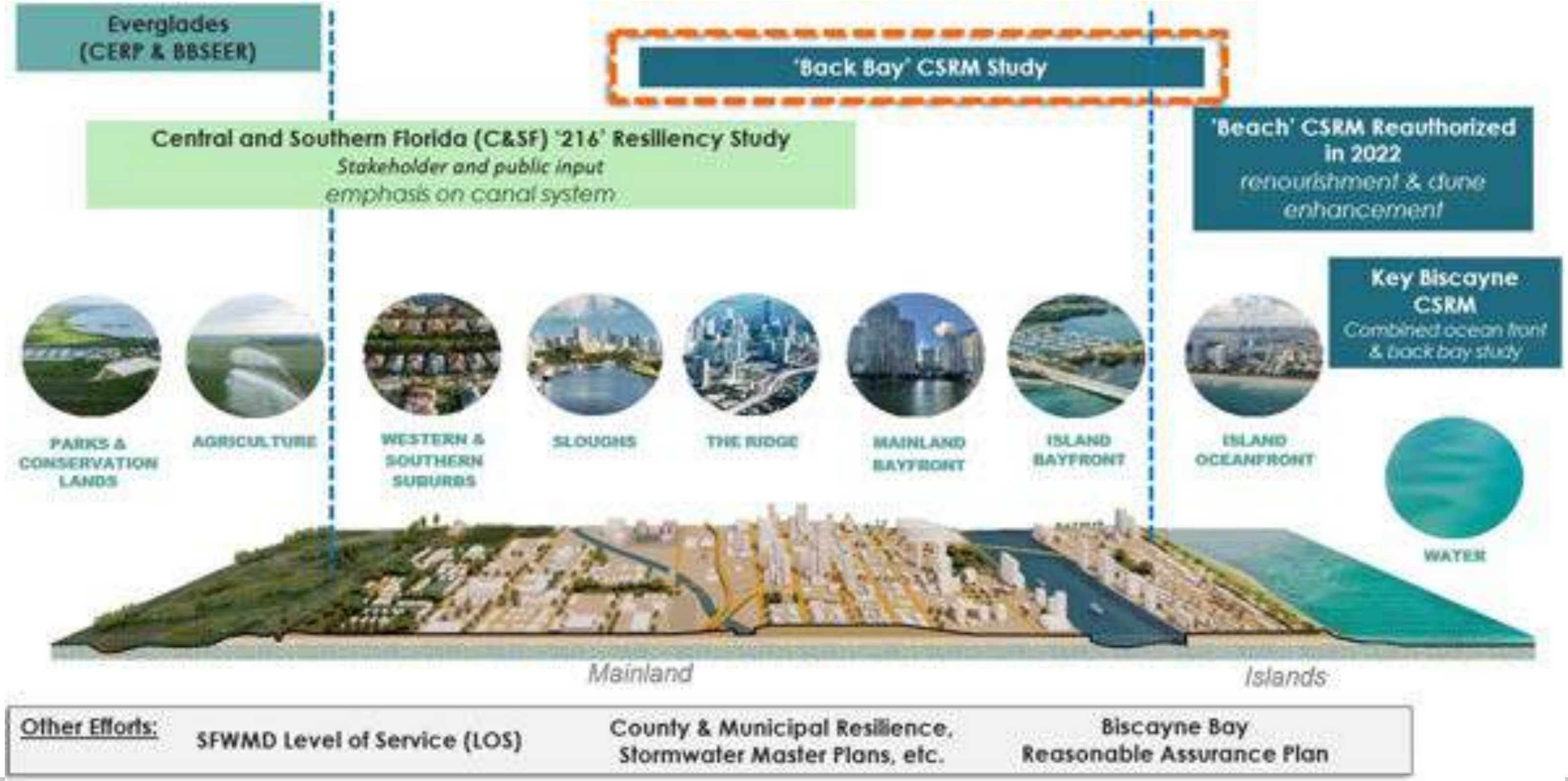
- **Natural and Nature-Based Features (NNBFs):** Coastal wetland restoration at Cutler Bay

- The study paused before submittal of the final report when Miami-Dade was unable to support the RP2021. Subsequently, Miami-Dade County requested additional time to revisit the RP and the district submitted a 3x3 exemption which was approved on August 3, 2022



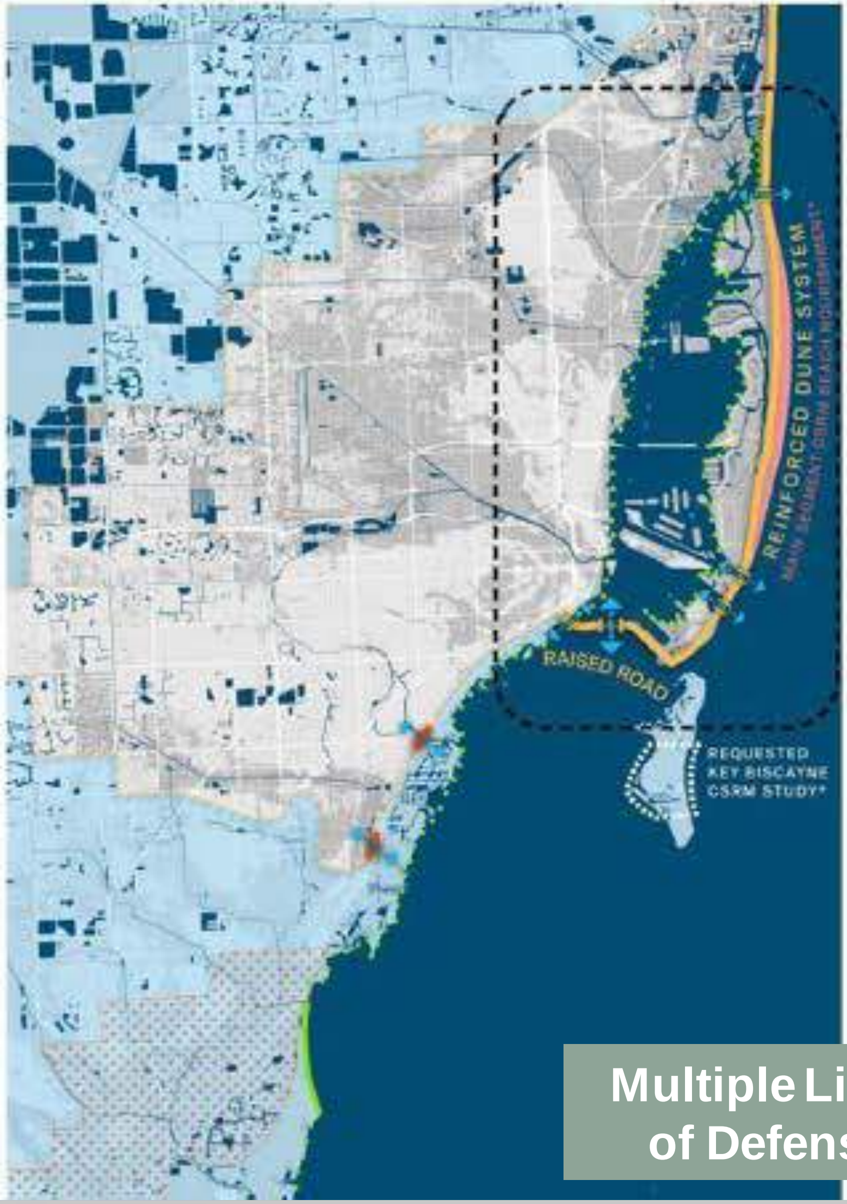
STAKEHOLDER AND PUBLIC INPUT

- System-wide approach to CSRM with **multiple lines of defense** and adaptive solutions
- Developing CSRM solutions that address **social equity, maintain community cohesion, and provide environmental benefits**
- Importance of **community engagement** throughout the process and need for **renderings** and conceptual designs for appropriate messaging
- **Hybrid solutions** comprised of elements of structural, nonstructural, and NNBFs
- **Integration** with ongoing USACE and local projects



Proposed Atlantic Coastline Alternative

Illustrative concepts inclusive of November 2022 Charrette and January 2023 Meetings



Multiple Lines of Defense

LEGEND

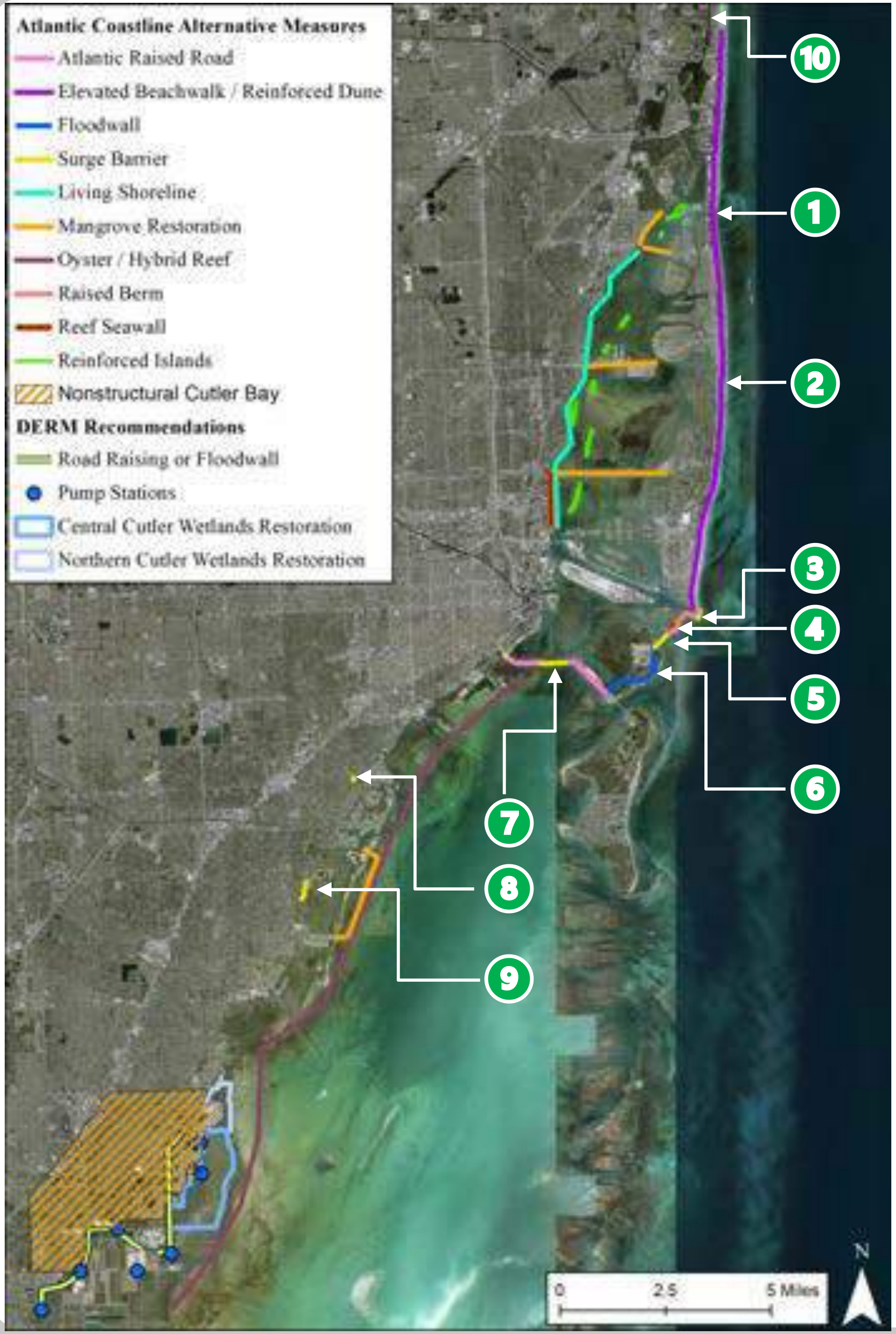
- Atlantic Alignment
- Navigation Gates / Control Structures
- Outside of Alignment
- Navigation Gates / Control Structures
- Non-Structural Measures
- Proposed Nature Based Solutions
- Possible Nature Based Solutions
- Miami-Dade County, Florida Main Segment Coastal Storm Risk Management Final Integrated Feasibility Report And Environmental Assessment

*Not included in the Miami-Dade County Back Bay CSRM Study

★ **Federal Projects:**

- Intracoastal Waterway and Haulover Inlet
- Miami Beach
- Surfside
- Haulover
- Bal Harbor
- Sunny Isles
- Government Cut

PROPOSED ATLANTIC COASTLINE ALT – STRUCTURAL COMPONENTS



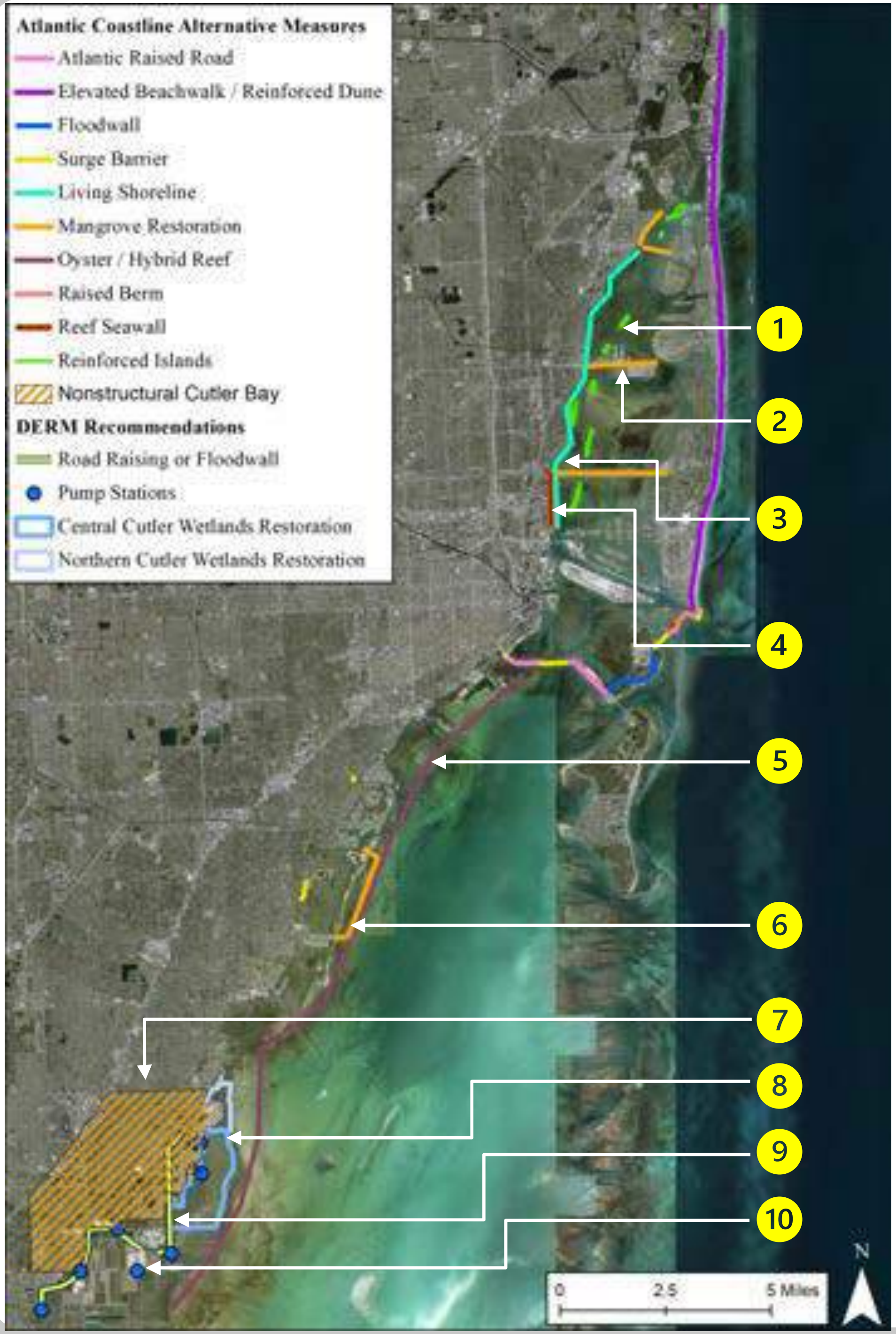
Key Structural Measures for Further Analysis as part of the **Atlantic Coastline Alternative** Include:

This list does not include all measures proposed

1. Sector Gate Surge Barrier at Haulover Inlet
2. Dune Raising/Reinforcing or Beachwalk Elevation
3. Sector Gate Surge Barrier at Government Cut
4. Dune Raising/Reinforcing and/or Seawall at Fisher Island
5. Sector Gate Surge Barrier at Norris Cut (between Fisher Island and Virginia Key)
6. Floodwall at Virginia Key
7. Two Surge Barrier/Environmental Gate Combinations at Rickenbacker Causeway with Floodwall in Between
8. Surge Barrier at Coral Gables Waterway
9. Surge Barrier at Snapper Creek Canal
10. Additional Beach and Northern Closure*

*Preliminary analysis determined a need for a structural alignment in the north going westward to high ground to prevent flooding from Port Everglades in Broward County

PROPOSED ATLANTIC ALTERNATIVE – NONSTRUCTURAL / NNBF COMPONENTS



Key Nonstructural and NNBF Measures for Further Analysis as part of the **Atlantic Coastline Alternative** Include:

This list does not include all measures proposed

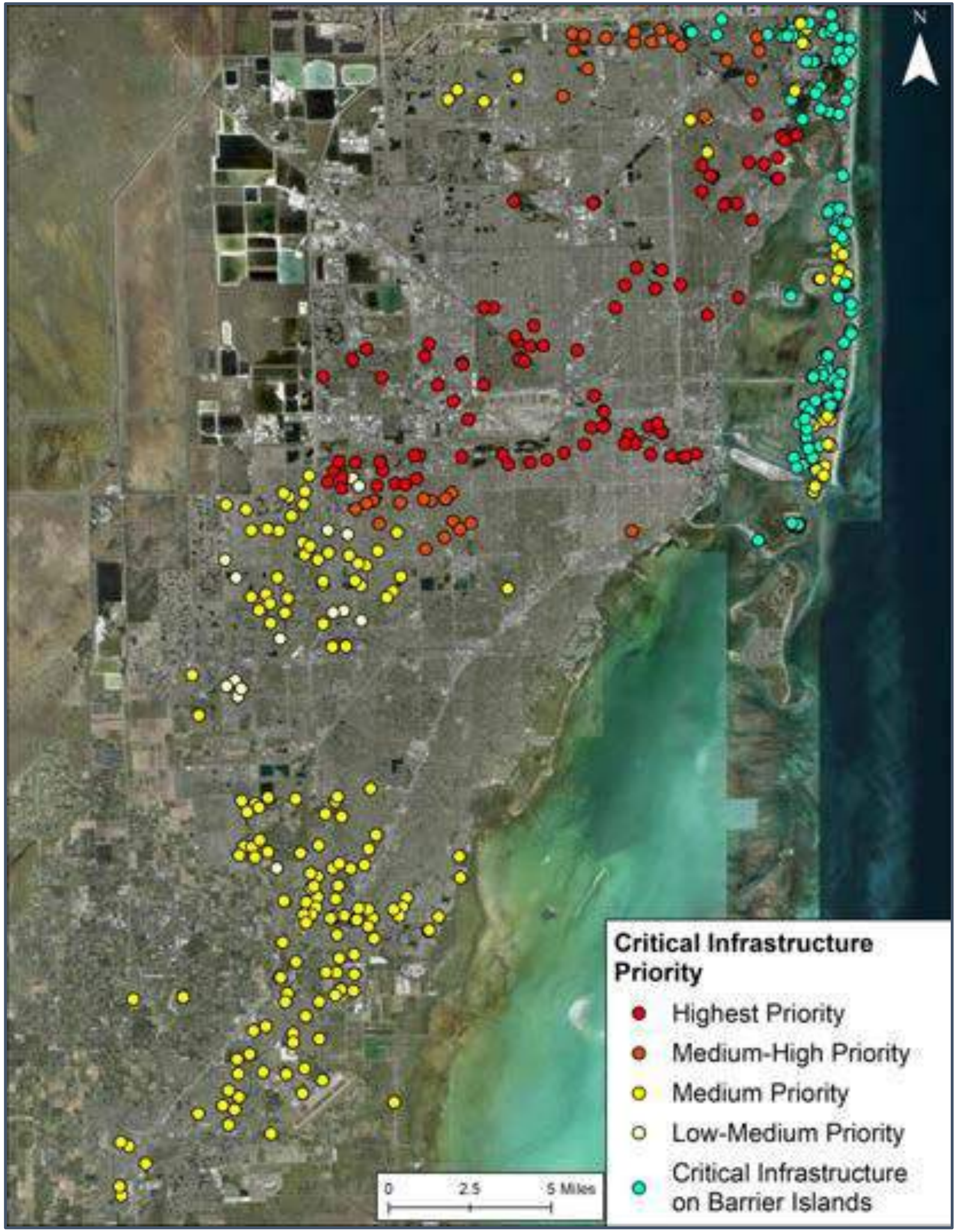
1. Reinforced Islands in Biscayne Bay
2. Mangrove Restoration along Causeways*
3. Living Shoreline along Mainland*
4. Reef Seawall along Edgewater*
5. Hybrid Reef structure*
6. Mangrove Restoration*
7. Elevation and Floodproofing at Cutler Bay

*Exact location not determined yet. Further analysis required.

Additional Measure Considerations from Miami-Dade County Department of Environmental Resources Management (DERM) Include:

This list does not include all measures proposed

8. Wetland Restoration at Northern and Central Cutler Bay
   - Coordination is on-going with Biscayne Bay Southeastern Everglades Ecosystem (BBSEER) / Biscayne Bay Coastal Wetlands (BBCW) Project for this area
9. Road Raising or Floodwalls which includes Flood Gates at canals
10. Pump Stations



CRITICAL INFRASTRUCTURE

- Managing risk to Critical Infrastructure (CI) was fully supported by Miami-Dade County in the RP2021.
- 250 independent buildings of the 1175 total critical infrastructure were previously evaluated and included in RP2021.
- CI will be focused within the 200-yr inundation layer and then intersected with EJ communities.
  - A provisional CI prioritization concept using 3 sets of data (CEJST, CDC SVI, and CDC EJI) was developed to determine priority ranking among CI points.
  - CI that falls within high frequency events, near the coast, and on the Barrier Islands will also be a priority.
  - This resulted in 486 CI for further evaluation in Part 2:
    - Highest Priority (104), Medium-High (41), Medium (201), Low-Medium (17).
    - 123 CI fall within the Barrier Islands

*There may be additional infrastructure missing from the list which will be coordinated in Part 2

ATLANTIC COASTLINE INUNDATION BOUNDARIES

FUTURE WITHOUT PROJECT (FWOP)

FUTURE WITH PROJECT (FWP)

Notes:

- The inundation layers are based on the USACE 0.5% AEP mean value confidence level for the year 2084. The 2084 value is the total water level which includes astronomical tides, storm surge, and USACE high curve SLR for a particular storm event.
- Key Biscayne is not included in the modeling grid which is why it does not show any inundation.
- FWP inundation map is for the structural measures of the Atlantic Coastline Alternative (did not include impacts of NNBF measures)
- A 3’ SLR starting condition was used which contributed to the flooding of the barrier islands

COMPREHENSIVE BENEFITS

Atlantic Coastline Alternative

- Enhances recreational and tourism benefits
- Manages coastal storm risk to urban and community socioeconomic conditions and emergency preparedness, including evacuation routes
- This plan improves resiliency by reducing recovery time of businesses and critical infrastructure following a storm event
- Improve life safety
- Maintains community cohesion
- Manages risk to EJ communities
- Provides multiple lines of defense, and redundancies.

Nonstructural Alternative

- Long-term increases in local employment opportunities for home elevation construction and commercial building retrofits

Natural and Nature-based Features

- Water quality, habitat, and erosion reduction benefits for coastal habitats
- Provides risk management during higher frequency events to low-lying and disadvantaged communities
- Increases aesthetic value and provides educational opportunities
- Enhancement of recreational and tourism benefits

RISK OVERVIEW

Atlantic Coastline Alternative

- Government Cut – Federal Channel
- Fisher Island – Private Community (highest per capita income in US)
- Gate closures affecting Biscayne Bay; regional water quality impacts unknown (modeling to occur in Part 2)
- Environmentally sensitive area and resources including Biscayne Bay Aquatic Preserve
- Environmental compliance
- Requires a complete system of storm surge barriers for effective risk management
- Anticipating NED waiver if recommending a comprehensive benefit plan
- Gate Design for Navigation channels

Nonstructural Alternative

- Expecting much higher residual risk without structural measures
- High implementation risk due to anticipated volume of structures recommended for elevation

Natural and Nature-based Features

- Residual risk anticipated; risk management is likely to be considerably less in comparison to structural measures
- Habitat tradeoffs and existing environmental constraints associated with Biscayne Bay Aquatic Preserve

ENVIRONMENTAL JUSTICE CONSIDERATIONS

Atlantic Coastline Alternative

- Expands risk management to EJ communities
- Residual risk for disadvantaged and low-lying communities during higher frequency events when storm surge barriers are not closed

Nonstructural Alternative

- Prioritizes EJ communities for elevating and floodproofing building
- Decreased level of risk management in comparison to Atlantic Coastline Alternative

- During Part 1, several PDT members and Miami-Dade County staff began outlining the foundations of the long-term environmental justice coordination strategy and workflow for Part 2 of the feasibility study.

- An Environmental Justice Coordination Plan would be fully developed during Part 2 and would also address planned future coordination with SAJ on other projects occurring in the Miami-Dade County area and the potential for collective engagement with disadvantaged communities.

SUMMARY

- **Objective:** Conduct a study that examines the feasibility of an array of alternatives for a highly complex system, including the Atlantic Barrier, and actionable measures using a Tiered NEPA Approach to recommend a plan with a Class 3 cost estimate and an 80% confidence level using available federal funding and gratuitous services and, potentially, contributed funding.
- **Needs:**
  - Tools/examples/processes of successfully completing a Chiefs Report with complex, environmentally sensitive resources. The PDT is currently coordinating with other studies such as NYNJ HATS, Coastal Texas, NJBB and San Francisco but additional focus on how the enterprise can use the full range of tools, and obtain the information necessary to successfully complete a Chiefs Report.
  - Natural and Nature-based features – Evaluation of CSRM benefits. Benefits should consider growth time and reduced benefits following storm events
  - Depth Damage Functions for Critical Infrastructure
  - Modeling for complex systems so we can more accurately predict impacts, design NNBFs and pump stations and gates and more accurately calculate benefits and predict residual risk.

QUESTIONS AND DISCUSSION

James F. Murley

Mr. Murley is the Chief Resilience Officer for Miami-Dade County. Miami-Dade County, together with the Cities of Miami and Miami Beach, launched their Resilient 305 Strategy in May 2019. Jim previously served as Secretary of the Department of Community Affairs under Governor Lawton Chiles and was appointed Chair of the Florida Energy and Climate Commission by Governor Charlie Crist. Additionally, he served as Executive Director of 1000 Friends of Florida, spent over 10 years with Florida Atlantic University overseeing research on urban and environmental issues, and served as Executive Director of the South Florida Regional Planning Council. Jim is a founding member of the American Society for Adaptation Professionals and Resiliency Florida, a Board member of The Florida Ocean Alliance and the Southeast Coastal Ocean Observing Regional Association. He serves as Mayor Levine Cava's designee on the Miami River Commission. He is also a Fellow of the National Academy of Public Administration.

“Partner Perspective: Miami-Dade County Back Bay Community R&D Needs”

Mr. Jim Murley, Miami-Dade County Chief Resiliency Officer

Roland I. Samimy, Ph.D.

Dr. Samimy is a coastal systems and water resources scientist experienced in water supply studies, surface and groundwater hydrology, and nutrient dynamics in aquatic systems. Receiving his Ph.D. in Coastal Systems Science from the University of Massachusetts, M.S. (Water Resources Systems Engineering) and M.A. (Urban and Environmental Policy) from Tufts University, Roland currently serves as Chief Resilience and Sustainability Officer for the Village of Key Biscayne. Prior to joining the Village, Roland worked in both the private and public sector, most recently, for Atkins Global as well as the University of Massachusetts-Dartmouth, School for Marine Science and Technology, where he served as Senior Research Manager for the Coastal Systems Program and was the Technical Coordinator and Technical Lead in Hydrology for the Massachusetts Estuaries Project, one of the largest estuarine restoration programs in the United States.

Jason Engle

Mr. Engle is the Chief of the Water Resources Engineering Branch at the Jacksonville District, which is comprised of 55 engineers engaged in Coastal Storm Risk Management, Hydraulic Design, Hydrologic Modeling and Water Management across Florida, Puerto Rico and the U.S. Virgin Islands. He has 20 years of experience on the study, design, construction, and operation of coastal and inland projects.

Partner: USACE Perspective: Key Biscayne – Community R&D Needs

Jason Engle
Jacksonville District
Jacksonville, FL

Roland Samimy, Ph.D.
Village Key Biscayne, FL

The Village of Key Biscayne is pleased that a USACE Coastal Storm Risk Management study of the entire Island of Key Biscayne is being initiated later this year. The village sits prominently on a low-lying barrier island off the coast of Miami and is a thriving and vibrant community that faces the combined threats of sea-level rise and more severe and frequent storms. Although committed to protecting the community against these environmental hazards, our Village critically needs the Corps of Engineers' financial and technical help to fully safeguard our future. This study is being undertaken as a collaboration between United States Army Corps of Engineers (USACE), Miami-Dade County and the Village and will integrate into the recently completed USACE feasibility study of the ocean facing shorelines of Miami Dade barrier islands to yield a comprehensive coastal storm risk solution for the Village. This Key Biscayne-specific study that evaluates solutions for the bayside and oceanside shorelines both reinforces the broader Miami-Dade County shoreline protection efforts and advances a whole-of-system shoreline strategy for the Island of Key Biscayne, aimed at reducing damage caused by coastal storms while improving human safety and coastal resiliency.

The island-wide Key Biscayne CSRM study is a foundational element of the Village's resilience program. The Village's resilient infrastructure upgrade program is focused on multiple lines of effort: 1) coastal storm risk management in collaboration with USACE, 2) upgrading the village-wide stormwater system, 3) improving roadways and rights-of-way to further reduce street inundation, 4) harden the electrical and telecom utilities through undergrounding, 5) modifying zoning and supporting ordinances to promote resilience solutions. Without the support of USACE to address the shoreline protection line of effort in the Village's resilience program, the Village faces the risks of severe property damage and depreciated values of the community's combined $9.9 billion in real estate; the Village faces significant harm to life, health and safety as evidenced by the impacts to southwest Florida due to hurricane Ian; and a downward spiral in economic activity.

On the other hand, working collaboratively with the USACE team to develop a wholistic shoreline protection solution will move forward in parallel with the Village's multi-dimensional, 15-

year phased resilient infrastructure program to protect the island from current and future climate-related threats. The community will receive an enormous public benefit to help the village survive and thrive well into the future and the Key Biscayne solution will tie in with the broader solution being formulated for protection of Miami-Dade County. Jacksonville District USACE is entering into this island-wide study of Key Biscayne with all of the lessons learned from the Miami-Dade (beach) CSRM study (nearly completed), the Monroe County Back Bay CSRM study (complete) and lessons from ongoing studies like the Miami-Dade Back Bay CSRM, the Biscayne Bay and Southeastern Everglades Restoration (BBSEER) ecosystem restoration study and the Central and South Florida Project (C&SF) Resilience Study. Decades of success in the CSRM beach program have taught us the value of flood risk projects that work WITH nature and that have full public support based on their economic, environmental, and recreational value. There are important policy and technical challenges with bringing this success to the bay and estuarine CSRM studies—the so-called back-bay projects. We will review some of the challenges and opportunities that we have with projects like this Key Biscayne CSRM stu*dy.*

Key Biscayne Joint Partner-USACE Brief to: Board on Coastal Engineering Research

August 15, 2023

Roland Samimy, Ph.D.
Jason Engle, P.E.

ELEVATING OUR ISLAND PARADISE

WHO WE ARE

THE VILLAGE OF KEY BISCAYNE

The Village of Key Biscayne is **1.25 square miles**, sits prominently on a **barrier island** off the coast of Miami and is a **thriving and vibrant community** only minutes from downtown Miami. With more than 14,890 residents, our international community treasures our roots as a **haven** for those seeking an **island lifestyle**. Incorporated in 1991, the community purposely created a **local government** to give **voice to our residents** and guide our future while **collaborating with neighboring municipalities and agency partners**.

Median household income of $167,990

7,500 condominium units

15,000 residents - 25% growth from 2010-2023

1,000+ business and professional licenses

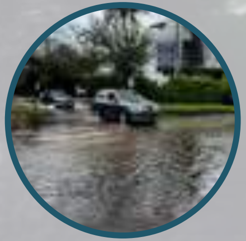
1,400 single-family homes or duplexes

7,000,000+ visitors per year

FACING

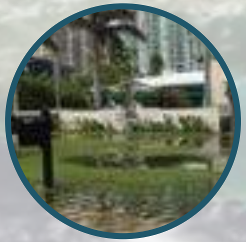
ENVIRONMENTAL THREATS

Our village is threatened by the very forces of nature that make it an island paradise



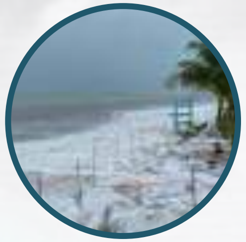
RAINFALL-INDUCED FLOODING

TIDAL FLOODING



GROUNDWATER FLOODING

STORM SURGE



COASTAL EROSION

WIND

EXTREME HEAT

THREATS STRESS

OUR VULNERABILITIES

Low-lying barrier island with a largely unprotected shoreline

An aging stormwater system in need of upgrades

Exposed electrical and telecommunications infrastructure

Built out with limited space for new infrastructure

Regulations that are incompatible with our resiliency goals

OUR THREATS CANNOT BE CHANGED.

We must adapt and mitigate… with forward thinking policies, smart investment, and decisive action to address our vulnerabilities and reduce risks to **our ISLAND PARADISE**

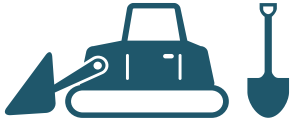
WITHOUT ACTION

WE FACE SIGNIFICANT RISKS

Increase in Damage Leads to Decrease in Property Value

Increase in Insurance Costs and Decrease in Insurability

Decline in Economic Activity



Increase in Infrastructure Cost with a Declining Tax Base

Decrease in Quality of Life

Inaction is not an option. By acting decisively, we will build a stronger, more resilient and sustainable Key Biscayne, and our residents will experience real benefits from our infrastructure investment

Integration and Implementation Plan

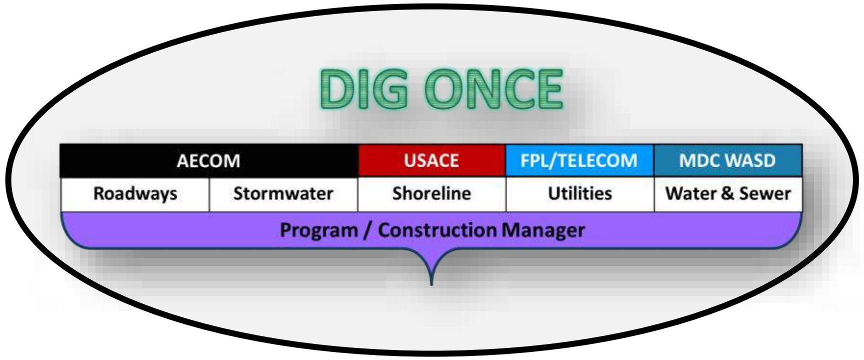
ELEVATING OUR ISLAND PARADISE

Coastal Storm Risk Management (CSRM)

Stormwater System Upgrade

Roadway Improvements

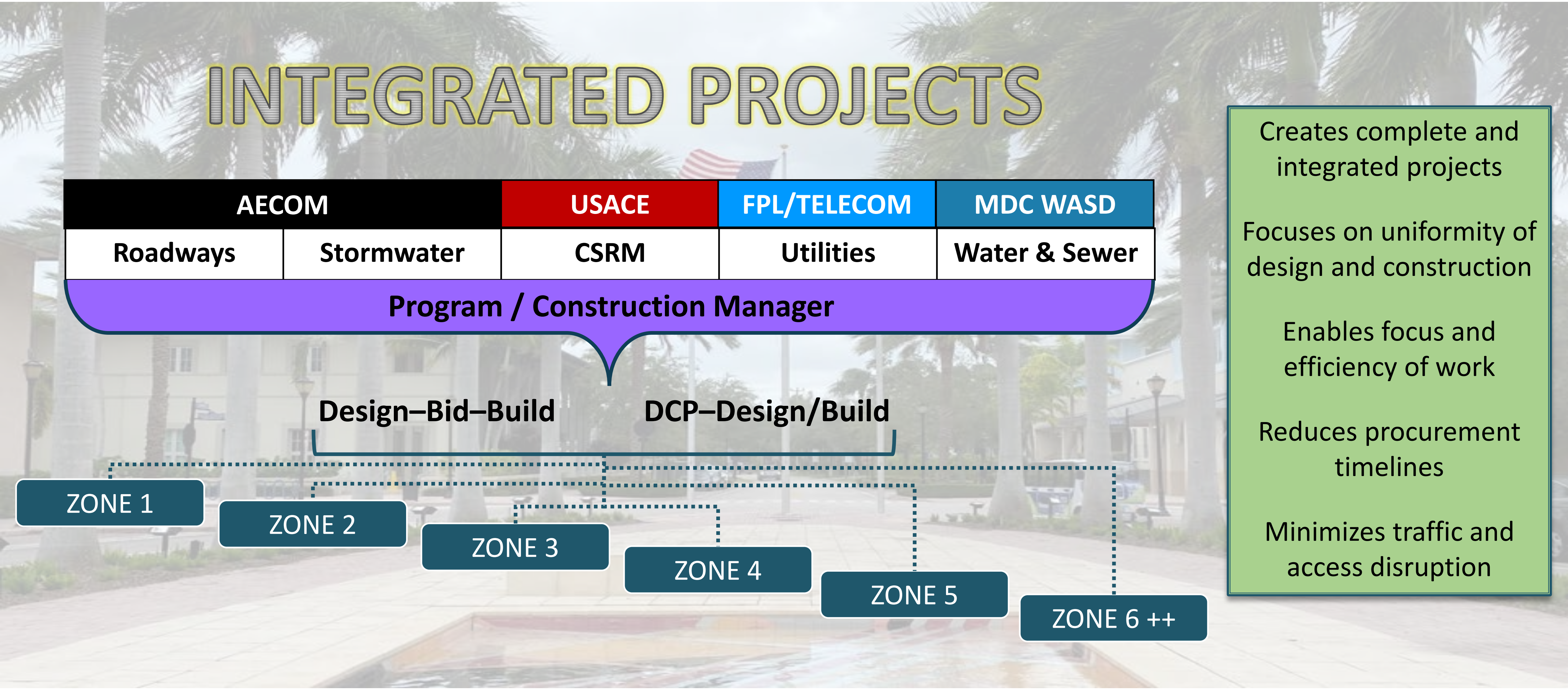
Utility Hardening and Resilience



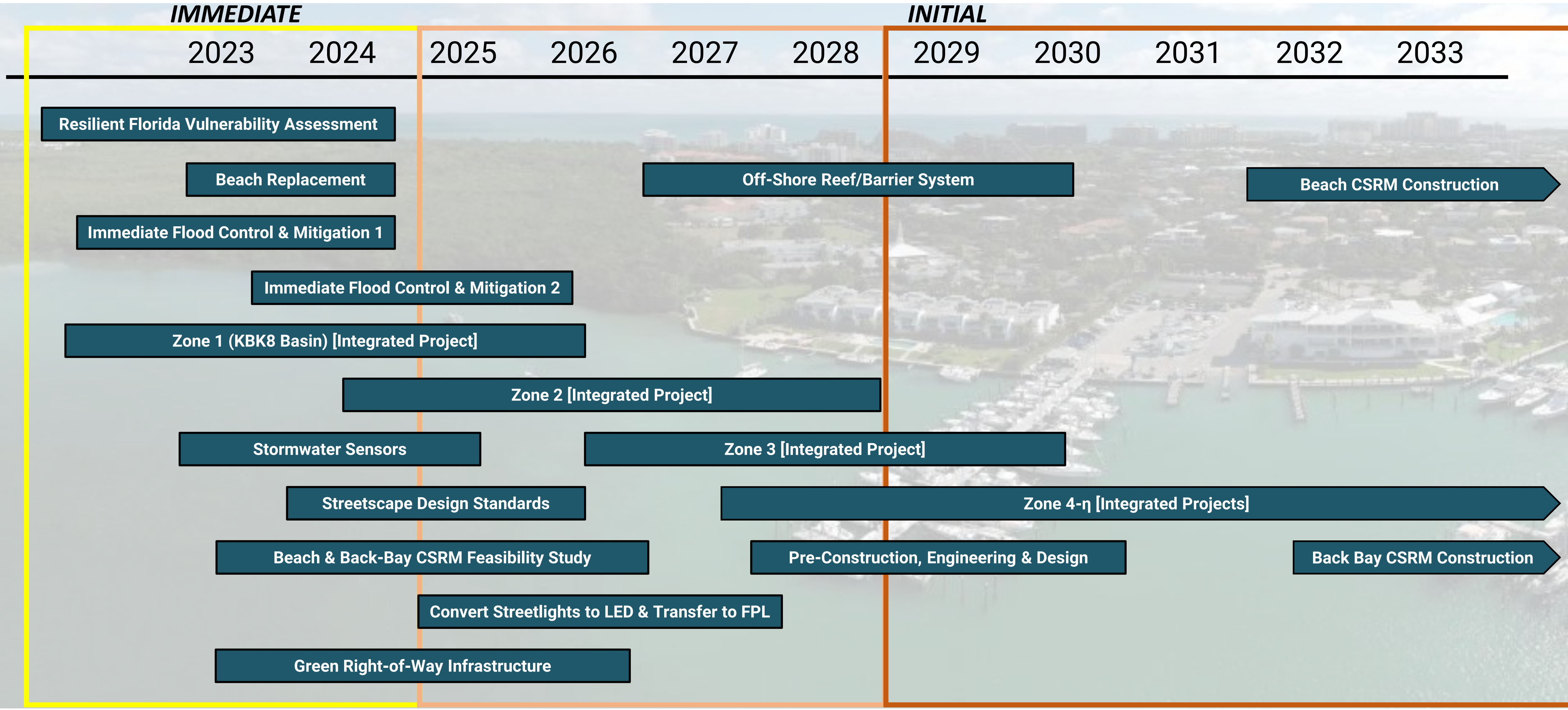
Changes to Codes, Plans, Zoning and Building Standards

Integrated Projects

ELEVATING OUR ISLAND PARADISE



Project Phasing



FEDERAL CSRM BEACH PROGRAM
KEYS TO SUCCESS

Beach Nourishment

- An original Nature-Based solution
- Environmental value
- Social value
- Regional economic value
- Cost effective (in general)

Beach restoration is valuable EVERY DAY, not just during storms

- Enhances national economic development
- Enhances recreation
- Enhances environmental quality
- Enhances local economics
- Enhances climate resilience

What is working

CHARTS: R&D on next-generation of planning tools for beach/back bay CSRM

- Strong field involvement based on lessons learned
- Well-funded
- Strong progress

Coastal Hazard System: foundational storm database for all CSRM studies

- Completed Maine through Texas
- Under development Great Lakes and West Coast/Pacific Islands
- Saving CSRM study time/effort

Coastal compound flooding: numerical modeling of inland/coastal transition zones

- Field working group within HH&C CoP
- R&D initiated/ongoing

What needs improvement

Policies on CSRM recreation and Comprehensive Benefits need to be revisited.

RECREATION LIMITATIONS ON CSRM PROJECTS

ER 1105-2-100Planning Guidance Notebook

Section 3-4 of ER 1105-2-100 (Hurricane and Storm Damage Reduction) includes several mentions that recreation benefits must be incidental… Specifically paragraph (4)(a) in this section states. "The Corps participates in single purpose projects formulated exclusively for hurricane and storm damage reduction, ... **Costs incurred for other than the damage reduction purpose, i.e. to satisfy recreation demand, are a 100 percent non-Federal responsibility**"

- Lake projects: recreation may be <50% of total project cost
- Non-lake projects: recreation may be <10% of project cost
- CSRM projects: recreation features are not cost-shared

Assistant Secretary of the Army Memo, dated 5 January 2021, COMPREHENSIVE DOCUMENTATION OF BENEFITS IN DECISION DOCUMENTS

- Supplements Planning Guidance Notebook (ER 1105-2-100) until a comprehensive update of PGN occurs
  - Total Benefits Plan*
    - NED
    - RED
    - Environmental
    - Social

Recommendation of the Total Benefits Plan requires an **exemption** from PGN requirement for selection of the NED Plan

So, while we can formulate for Total Benefits as outlined in the ASA Memo, we cannot **select** that plan without an exception from policy…

R&D AND POLICY RECOMMENDATIONS

Continue development and support of foundational engineering data sets and tools

- CHART
- Coastal Hazard System
- Continue/expand coastal compound flooding R&D

Revise PGN Policy on CSRM Recreation in Back Bay Studies

- Treat back bay projects like all other non-lake projects (<10% recreation)
- Allow cost sharing of recreational enhancements

Revise Policy on Comprehensive Benefits

- Allow for selection of Total Benefits Plan without policy exception

Kevin Hodgens

Mr. Hodgens, is a Research Hydraulic Engineer with the Coastal Hazards Group (CHG) at USACE-ERDC-CHL. His areas of expertise include design and analysis of coastal storm risk management (CSRM) projects, coastal structures, inlet hydrodynamics, coastal data collection, navigation shoaling, and hydrodynamic modeling. He previously served as a coastal engineer with the Jacksonville District (SAJ) from 2009 to 2022, and as Chief of the SAJ Coastal Design Section during the 2016 to 2022 period. Mr. Hodgens earned a B.S. degree in Civil Engineering from the University of Florida (2006) and a M.S. degree in Ocean Engineering from the Florida Institute of Technology (2009). He is presently leading research efforts to develop a new suite of tools primarily for use in CSRM feasibility studies dubbed Coastal Hazards Analysis and Risk Toolkit (CHART). He is also the PI for two additional research efforts: (1) to explore interior wave and water level propagation and application to structural damage estimates, and (2), application and productization of the Stochastic Storm Simulation System (StormSim), a suite of coastal science and engineering design tools that simplify and automate complex coastal stochastic engineering computations using Coastal Hazard System (CHS) data. Mr. Hodgens is a registered professional engineer with the State of Florida.

Fundamentals of the Coastal Hazard Analysis and Risk Toolkit

Kevin Hodgens.
Engineering Research and Development Center
Coastal and Hydraulics Laboratory
Vicksburg, MS

The Coastal Hazard Analysis and Risk Toolkit (CHART) is a $5M and five-year development effort that seeks to improve upon existing tools used in Coastal Storm Risk Management (CSRM) feasibility studies by providing users a component-based, scalable, and transparent suite of tools. Ultimately the toolkit supports federal interest determinations for the pursuit of hazard mitigation measures with non-federal project sponsors. The toolkit is comprised of a tool to aid study teams with scoping a study (CHART Scoping Tool) and a tool to perform alternatives analyses (CHART Feasibility Analysis Tool). CHART marries coastal forcing climatology and socioeconomic analysis through probabilistic lifecycle simulations that capture system responses and economic consequences from coastal hazards across existing, proposed, and forecasted conditions for a defined study area. The tool also accounts for changes in hazards (e.g., changes resulting from sea level change) and socioeconomic information (e.g., infrastructure modifications and structure rebuilding) within lifecycle simulations.

CHART is rooted in the conceptual risk equation that relates coastal storm forcing (hazards), the performance of natural or anthropogenic protection systems, the exposure of consequence receptors to coastal storms, the vulnerability of those consequence receptors, and socioeconomic damage consequences that result (Figure 1). Additionally, CHART seeks to support consequence analyses for the Regional Economic Development, Environmental Quality, and Other Social Effects categories as required by USACE policy when determining the plan that reasonably maximizes net benefits across all benefit categories.

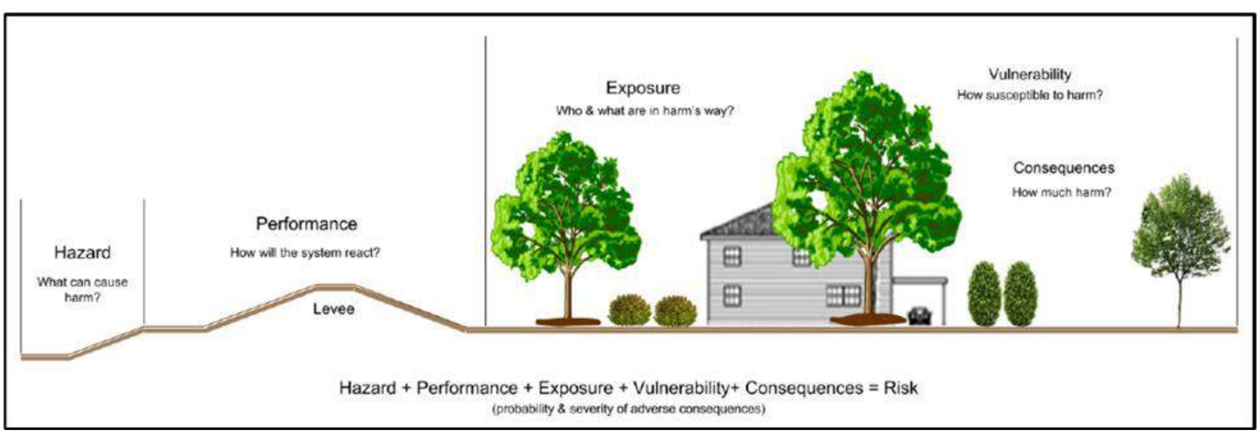


Figure 1. Conceptualization of Risk (USACE, 2017).

Socioeconomic inputs to CHART are foundational for understanding the significance of impacts that coastal storm events inflict on a study area today, and into the future, as well as shaping the focus of the feasibility study. Existing understanding of the composition and distribution of public & private property, critical infrastructure, social vulnerability, and population demographics influence the problems, opportunities, objectives, and constraints that are developed during the study. As a study progresses additional information may be collected and/or developed to support forecasts for how socioeconomic inputs will change through time under the 'No Action' plan and the various plans formulated to mitigate coastal storm risks. Probabilistic lifecycle consequences are directly compared between the No Action plan and the formulated plans to determine the benefits afforded by the plans. For a plan to be selected for recommendation to Congress it must satisfy determinations of engineering feasibility, economic justification, environmental acceptability, and provide greater net benefits across all benefit categories than the other plans, where net benefits are the difference in calculated benefits versus the cost of the plan.

CHART includes physics modules that simulate the physical effects of and response to a storm event, specifically the propagation of coastal storm hazards and performance of existing and future infrastructure across the study domain. CHART will facilitate acquisition and formatting of hazard data and the data will span the full range of hydrodynamics including coupled storm surge, currents and waves, interior flooding, polder flooding, wave and water level inundation over marsh areas, and so on. Responses will be computed within the physics modules and are expected to include levee and floodwall overtopping and overflow, forces on walls, levee erosion, rubble mound structure overtopping and overflow, low crested structure wave transmission, rubble mound structure damage, beach morphology and other common physical responses that are characteristic of USACE coastal projects. The physics engine will allow for both semi-deterministic scenario-based analysis and stochastic simulation.

Probabilistic regional hazard datasets (e.g., Coastal Hazards System) and underlying model results will be used to aid study teams with determination of study scope (i.e., via the CHART Scoping Tool) by providing event-specific flood sequences and statistics-based water surface elevations. These products help teams determine the hazard distribution, exposure and vulnerability characteristics, and complexity of physics across the domain. During the alternative analysis phase the CHART Feasibility Tool physics modules will select and distribute storm events from the CHS database based on multiparameter storm probabilities to generate unique lifecycles, typically around 50-years in duration. Once the lifecycle is specified the storms' hazards are modified according to the date of the event and corresponding USACE scenario-based sea level change value, tides, seasonal water level effects, and nonlinear residual values (i.e., the difference in water levels resulting from nonlinear interactions of storms impacting an area under a different mean sea level condition). The sequence of storm events is passed through the physics modules to generate physical responses, as well as anthropogenic responses (e.g., seawall construction), throughout the lifecycle. The responses are passed to the economic modules to determine the consequences and risk and any responses that result (e.g., rebuild occupied structure). Data and status information are stored and used as input for the subsequent event.

Software development is a large component of the CHART effort and is guided by DEVOPS principles (Gene, et al., 2016). Inherent DEVOPS objectives are to deliver useful products to customers faster, using stable and scalable infrastructure, and ensure active collaboration between developers and users. CHART is presently scoped to be hosted as a web-based software on existing USACE infrastructure. Thus, relevant existing tools require modification to deploy within a cloud environment. The CloudCompute software, developed collaboratively between HEC and CRREL, is planned to serve as the orchestration engine that syncs inputs and outputs of physics and economic computations during a lifecycle, as well as storing important model outputs. The architecture to support CHART requires development of a front-end component that displays information and allows for user interaction, and a back-end component that performs the bulk of CHART's operations, whether data acquisition support, data preparation, data transmission between workflow/production modules, computations, and archival.

The CHART Scoping Tool will be released to the field in FY24 following extensive collaboration with district users. Early functionality of the CHART Feasibility Analysis Tool (i.e., without beach morphology change processes) will be delivered in FY25, and final functionality will be delivered in FY27. Prior to the end of the development effort technology transfer will initiate including user manual and technical reference publication, training material development, and training of district staff. Beyond FY27 CHART will be maintained by the annual Scientific Engineering Technology funding source provided by the Hydraulics, Hydrology, & Coastal Community of Practice at USACE Headquarters.

FUNDAMENTALS OF THE COASTAL HAZARD AND ANALYSIS TOOLKIT (CHART)

Kevin Hodgens, P.E.

Research Hydraulic Engineer
Coastal Hydraulics Laboratory
Engineer Research Development Center

15 AUG 2023

Coastal Storm Risk Management National Planning Center of Expertise

Flood Risk Management Planning Center of Expertise

HEC

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

U.S. ARMY

US Army Corps of Engineers®

AGENDA

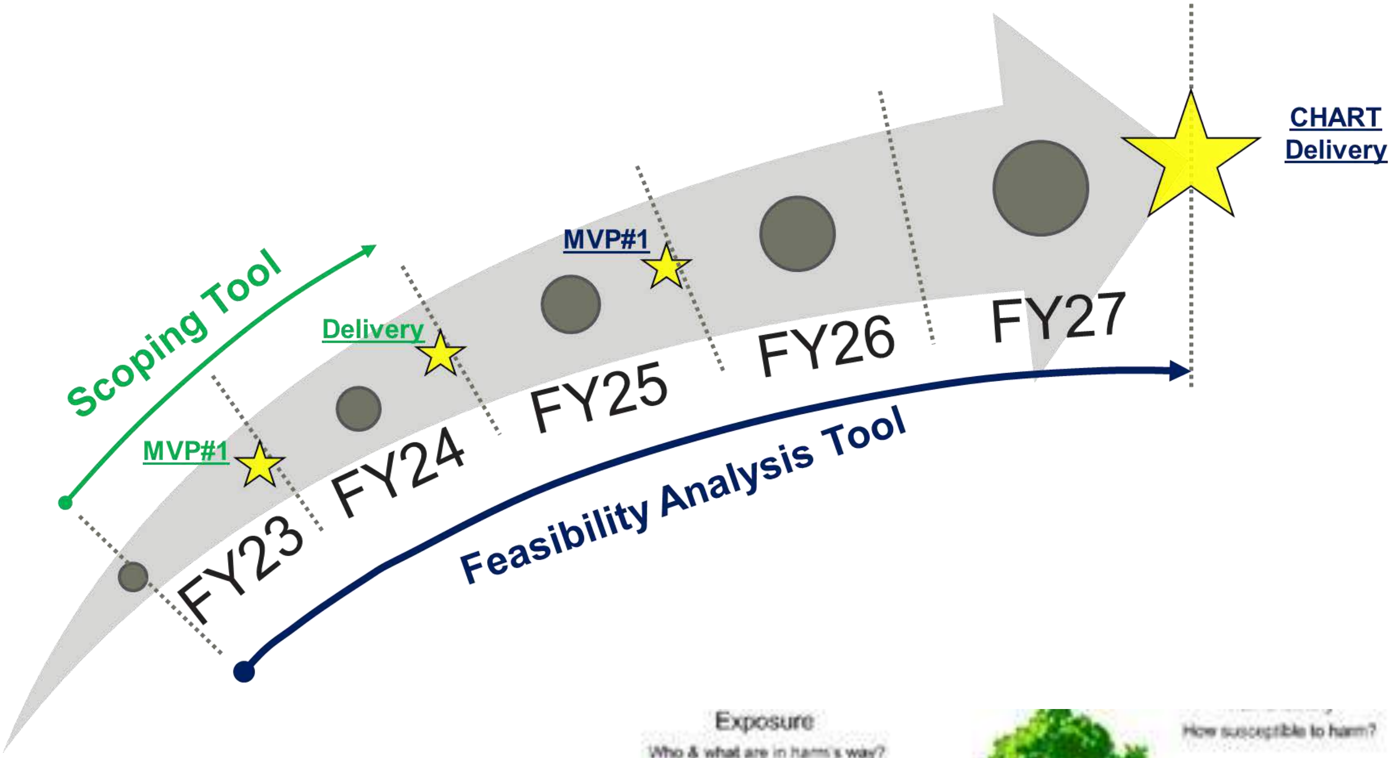
- Bottom Line Up Front
- Introduction
- CHART Scoping Tool
  - Purpose
  - Economic and Engineering Inputs
- CHART Feasibility Tool
  - Framework
  - Range of Analyses
  - Socioeconomics
- Research Recommendations

BOTTOM LINE UP FRONT (BLUF)

1. Replaces Beach-fx and Generation 2 Coastal Risk Model (G2CRM) used in Coastal Storm Risk Management (CSRM) feasibility studies
   – Constitutes base CHART functionality
2. Supports study scoping and alternative evaluation phases
3. Analyzes performance for all coastal protective measures
4. Include additional functionality and/or analyses

INTRODUCTION

- CHART is a five-year, $5M effort (FY23-FY27)
- Primary Agency Goals
  - Identify adequate resources to complete a study within first 90 days
  - Modernize existing CSRM feasibility study tools
  - Include capability to analyze complex systems (e.g., compound flooding)
  - Ensure tools are adaptable to future data, methodologies, and models
- Foundation of approach based in the conceptual risk equation



INTRODUCTION

CHART is comprised of two main tools:

1. Feasibility Study Scoping Tool
   - Acquires and displays existing national datasets and information
     - Aggregated expected annual damages (EAD; $s)
     - Total water level by annual exceedance frequency (AEF)
   - Includes user interaction support
2. Feasibility Study Alternatives Analysis Tool
   - Ability to develop and evaluate project alternatives across four benefit categories
   - Probabilistic Lifecycle Analysis (PLCA) Model
     - Forecast project performance over >50 years
     - Dynamic economic inventories (assets, population, demographics)
     - Dynamic hazards (sea level change, climatology) and protective features (morphology change, seawall construction)

Scoping Tool example output at Grand Isle, LA

CHART SCOPING TOOL

Purpose – Support early study decisions

- Study extents & boundary conditions
- Important risks, their spatial distribution, and their magnitudes
  - Which to mitigate in plan formulation?
- Measures and alternatives
- Problems, Opportunities, Objectives, and Constraints
  - NEPA Scoping
- Level of effort to deliver a risk management solution
  - Models required

Primary Agency Goal
Identify resources to complete study within first 90 days

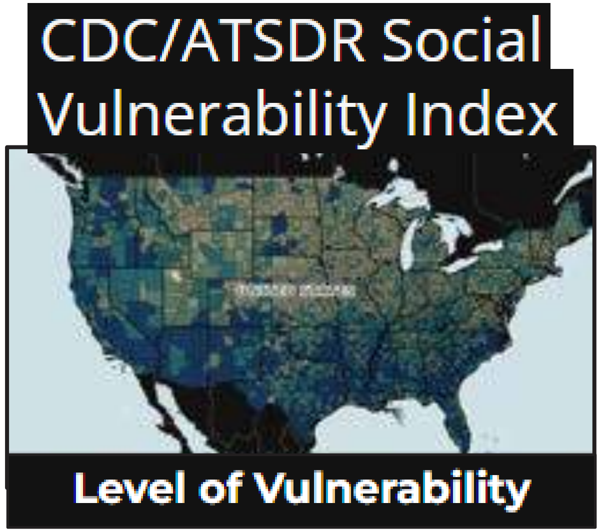
Reach Delineation (San Juan Metro Study)

Composite Risk Distribution in Miami, FL

CHART SCOPING TOOL

Economic Datasets

- Social Vulnerability and Environmental Justice
- Population Demographics
- Asset Values and Characteristics (National Structure Inventory)
- Environmental Resources
  - Coastal Barrier Resources Act areas
- Critical Infrastructure
- National Flood Insurance Program claims data



EPA EJScreen

National Structure Inventory

Coastal Barrier Resources System Mapper
U.S Fish & Wildlife Service

NATIONAL FLOOD INSURANCE PROGRAM

CHART SCOPING TOOL

Engineering Datasets

- Probabilistic Hazards
  - Tides, seasonal water levels, and sea level change
  - Storm surge
  - Waves
  - Erosion (qualitative)

- Topography and bathymetry
  - NOAA, USGS, District or Sponsor-collected

- Hydrodynamic model output
  - Historic and synthetic coastal storm events
  - Timestep plan view color maps of water level and wave hazards

- Parametric costs of measures
  - Measure dimensioning
  - Affordability analysis

CHART SCOPING TOOL

Engineering Datasets

- **Probabilistic Hazards**
  - **Tides, seasonal water levels, and sea level change**
  - **Storm surge**
  - **Waves**
  - **Erosion (qualitative)**
- Topography and bathymetry
  - NOAA, USGS, USACE (JALBTCX), District or Sponsor-collected
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Image Credit: https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/19168

FEMA

CHART SCOPING TOOL

Engineering Datasets

- Probabilistic Hazards
  - Tides, seasonal water levels, and sea level change
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Image Credit: https://www.pinterest.com/pin/topographic-map-in-2023--305048574777329363/

DIGITAL COAST

USGS science for a changing world

JALBTCX Joint Airborne Lidar Bathymetry Technical Center of Expertise

As of 01 AUG 2023; POC: Kevin Hodgens

CHART SCOPING TOOL

Engineering Datasets

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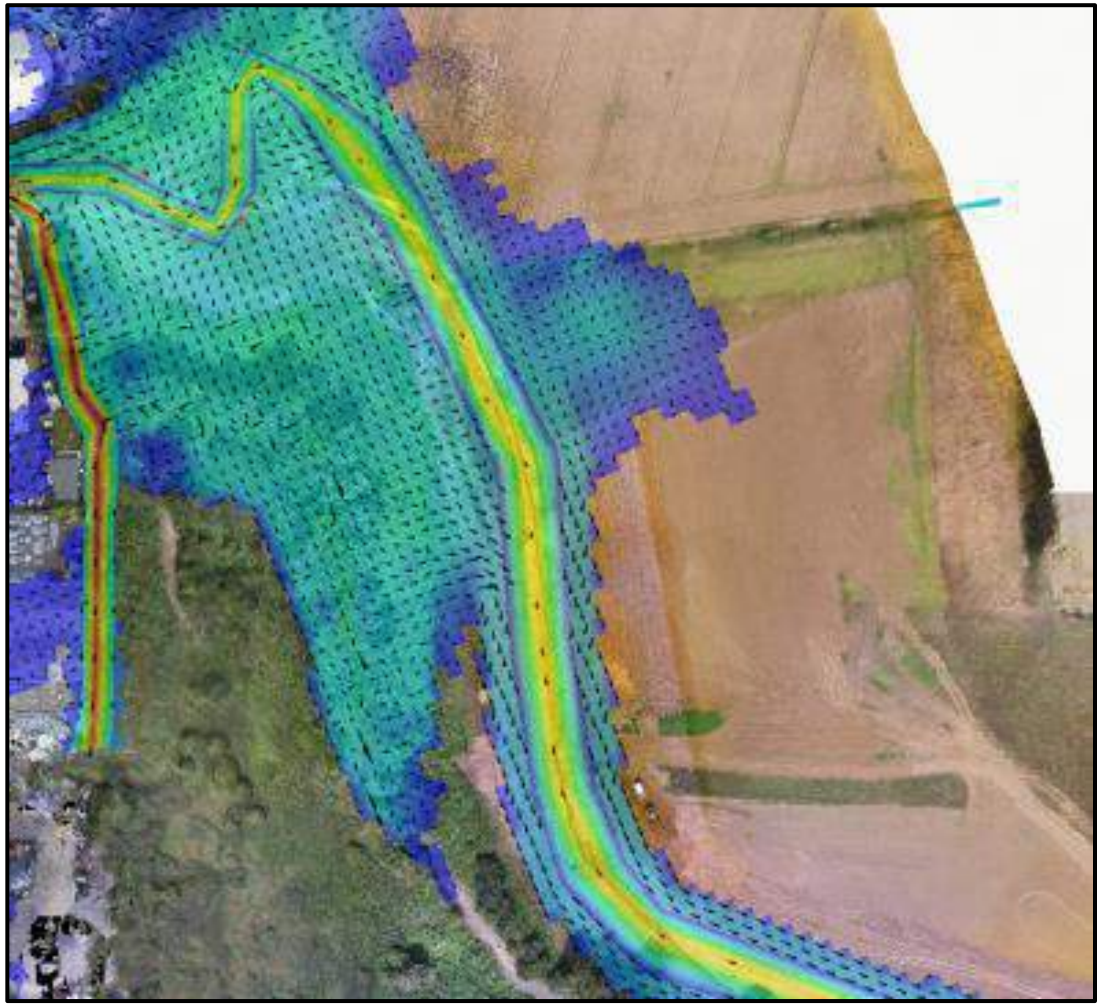

Image Credit: https://edenvaleyoung.com/services/hydraulic-modelling-flood-risk-assessments/

AdH ADAPTIVE HYDRAULICS

RAS

CHS

CSTORM-MS

CHART SCOPING TOOL

Engineering Datasets

- Probabilistic Hazards
  - Tides, seasonal water levels, and sea level change
  - Storm surge
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  - Erosion (qualitative)

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CHART SCOPING TOOL

Engineering Datasets

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Define System Characteristics

- Intervention locations, size, and order of magnitude cost
- Flood sources, magnitudes, and frequencies
- Flooding pathways
- Timing and duration of floods
- Physics model(s) required
- Protection classification

CHART FEASIBILITY ANALYSIS TOOL

Framework

- Cloud-based, modular software (1)
  - Model agnostic (2)
  - Facilitates new methodologies, data, and models (3)

Primary Agency Goals

1. Modernize and improve existing CSRM feasibility study tools
2. Include capability to analyze complex systems (e.g., compound flooding)
3. Ensure tools are adaptable to future data, methodologies, and models

- Existing USACE infrastructure (Civil Works Business Intelligence, CWBI)

- Architecture
  - Front End: user interface, canvas
  - Back End: computation engine, databases, input/output, memory controls, API, resource scheduler

- Follow DEVOPS principles
  - Deliver useful products to customers faster,
  - using stable and scalable infrastructure,
  - and ensure active collaboration between developers, operations, and users.

CHART FEASIBILITY ANALYSIS TOOL

Framework

- CloudCompute orchestration engine
  - Joint HEC – ERDC CRREL development effort
  - Syncs inputs and outputs of physics and economic modules over duration of lifecycle (LC)
  - Stores important info in memory
    - Physics, economics, and user interface inputs
    - Damage states, repair states (and duration)
    - Physical response and economic outputs

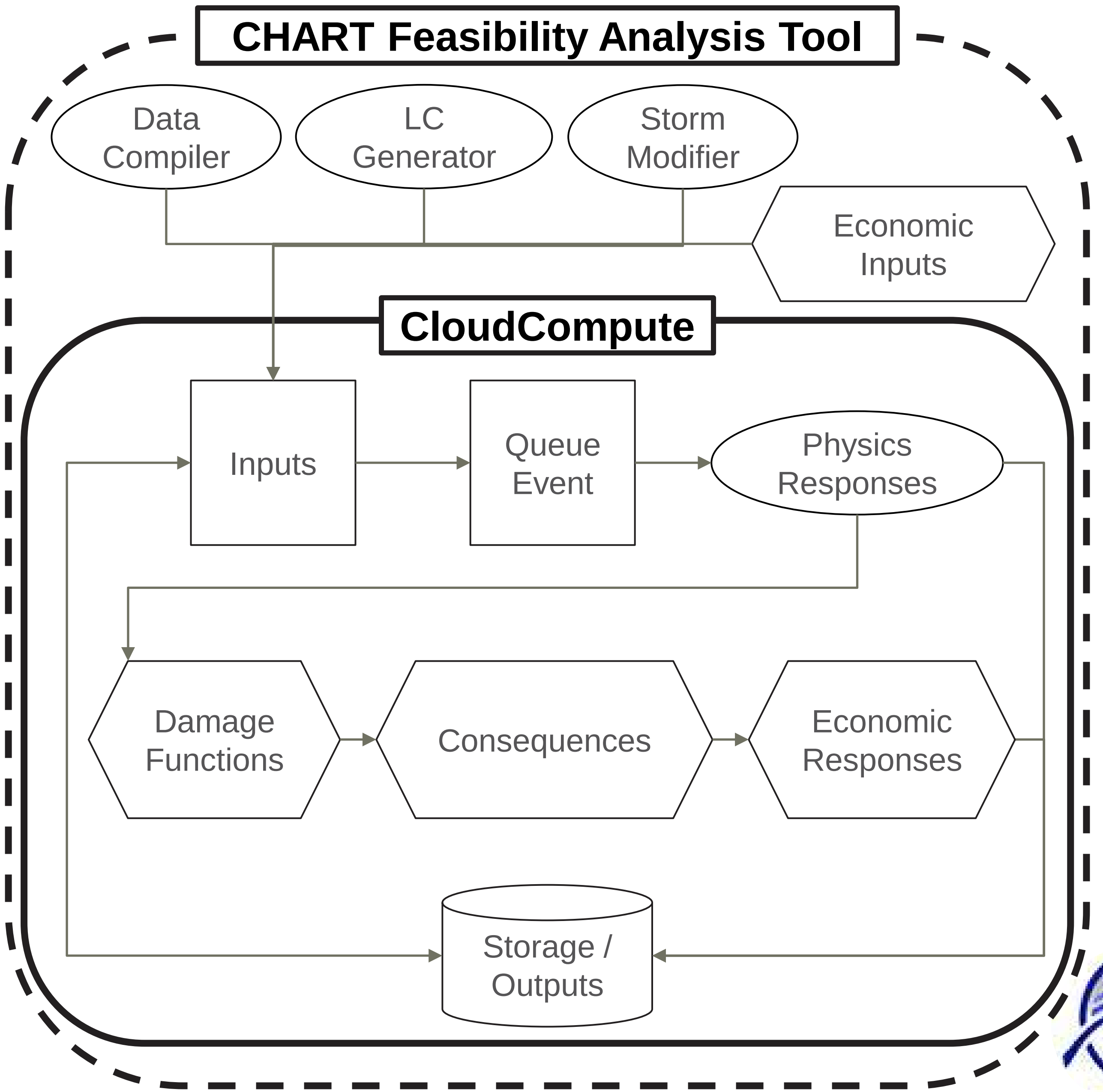


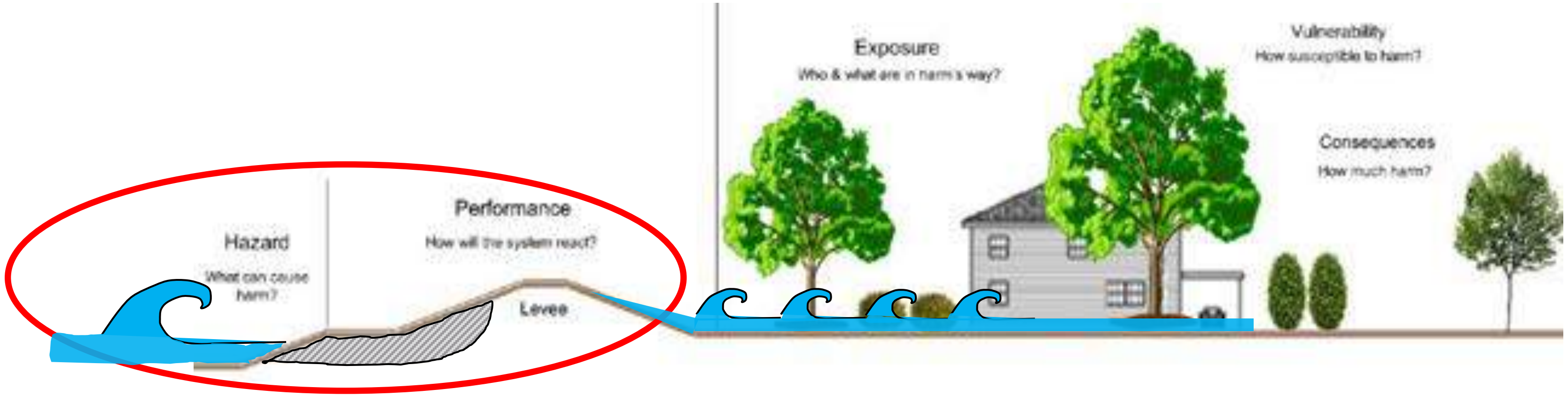
CHART FEASIBILITY ANALYSIS TOOL

Range of Environmental Forcing (Hazards)

- Coastal storm events
- AEF’s from [0.001 to >1]
  - (subannual to 1000-yr return periods)
- Primary hazards: waves, surge, erosion
- Secondary hazards: rainfall, groundwater, riverine and terrestrial inflows, high frequency flooding

Nonstationary Hazard Considerations

- Sea level change
- Storm frequency and intensity
- Rainfall frequency and intensity



Engineering Performance Analysis Models

Responses	Examples
Empirical Equations	EuroTop, StormSim
Numerical Solvers	Coupled wave and hydrodynamic models

Numerical Solvers	Examples
Phase-Averaged	Cshore, Xbeach, ADCIRC+STWAVE
Boussinesq	COULWAVE, FUNWAVE
Navier-Stokes	OPENFOAM

Analysis Dimensions	Waves and Water Levels	Morphology, Waves, Water Levels	Inland H&H
1-d Examples	Cshore, Xbeach	Cshore, Xbeach	RAS
2-d Examples	Adcirc, AdH	Xbeach, AdH, CMS	RAS, AdH

CHART FEASIBILITY ANALYSIS TOOL

Range of Performance Characterizations

Protection Types

- Sandy beaches and coastal bluffs
- Erosion control structures (groins, breakwaters)
- Revetments
- Floodwalls
- Levees
- Natural and Nature Based Features
- Storm surge barrier

Nonstationary Protection Levels

- Beach morphology change (erosion)
- Property owner interventions
- Structure failures
- Structure modifications (adaptive management)

Protective Measure Scales

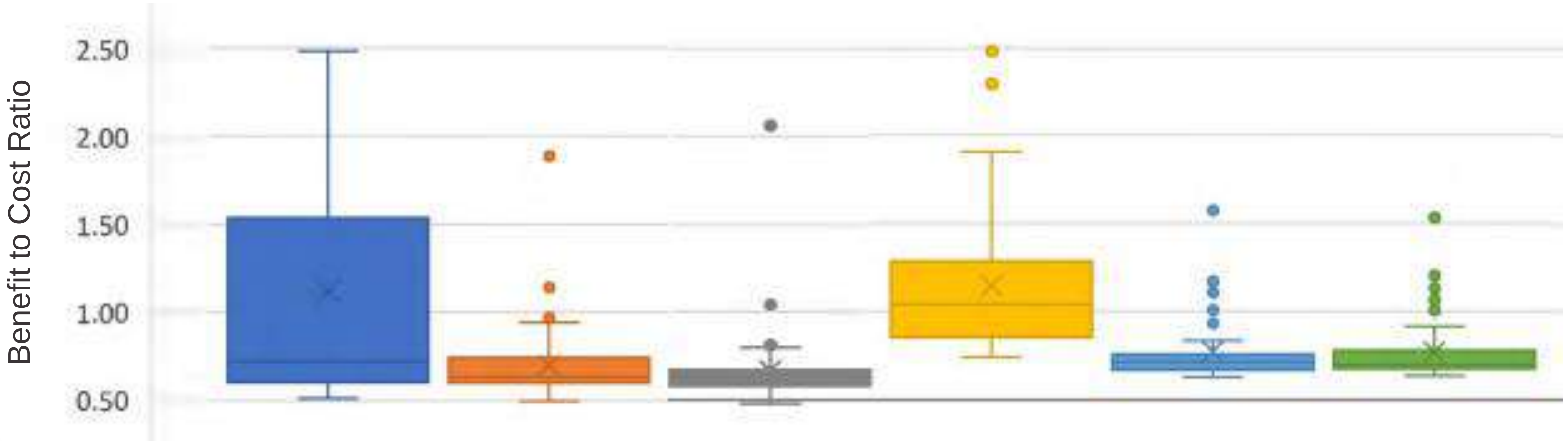
Low-reliability property owner interventions → Robust federal solutions

Image Credit: https://www.bostonherald.com/2018/03/07/duxbury-hurries-to-plug-failed-sea-wall/

CHART FEASIBILITY ANALYSIS TOOL

Socioeconomics Requirements in Alternative Evaluations

- Evaluate lifecycle performance across four economic accounts
  - Covering more than 50 years
  - Monte Carlo approach reduces aleatory uncertainty
- Explicitly consider climate change, environmental justice, NNBF, and sea level rise
- Dynamic Economic Inventories
  - Assets, population, demographics, social vulnerability



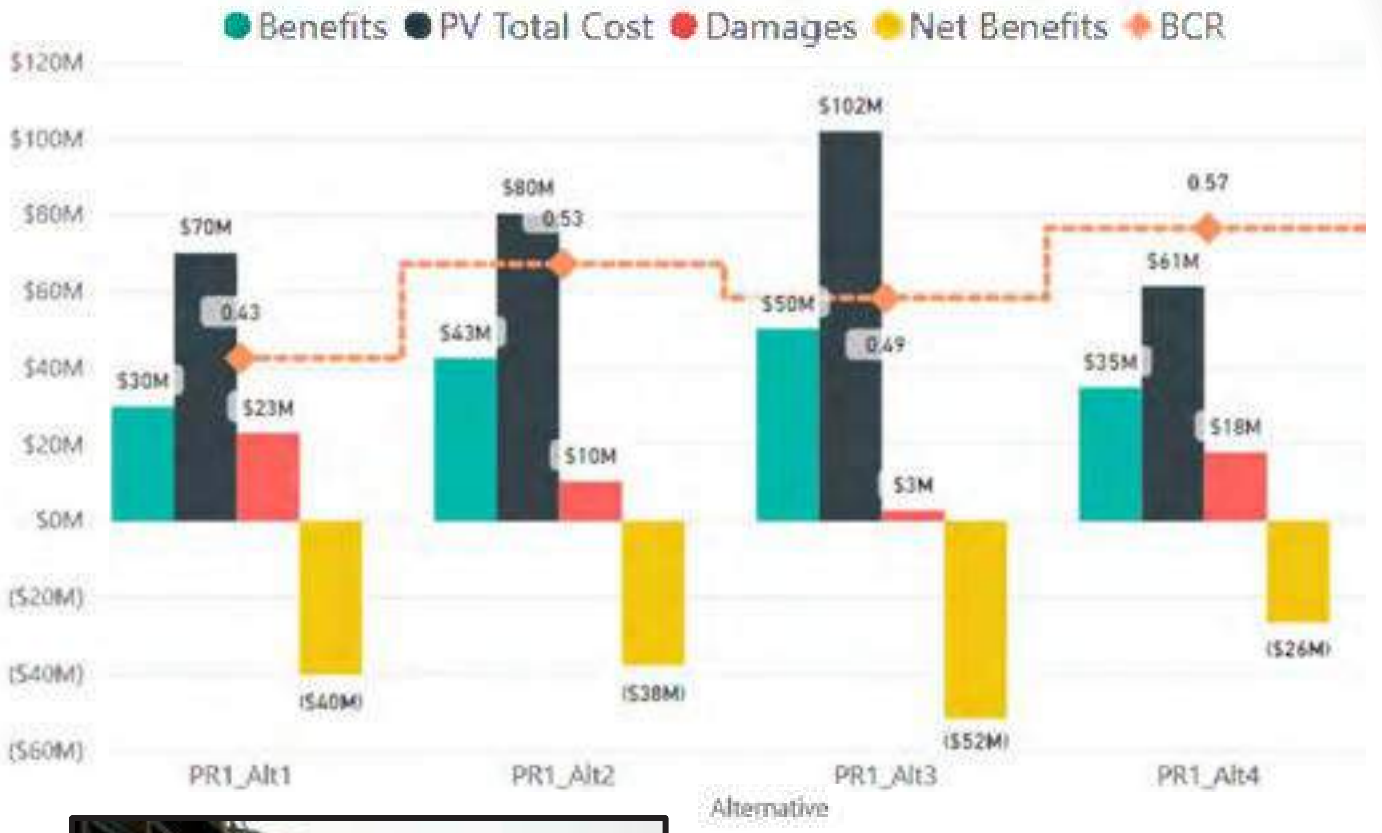
BCR Boxplots by Alternative & SLC Scenario

Economic Accounts

National Economic Development	Regional Economic Development
Environmental Quality	Other Social Effects

CHART FEASIBILITY ANALYSIS TOOL

- Plan Selection
  - Alternative with maximum net benefits
  - Benefit to cost ratio greater than 1.0
  - Demonstrate completeness, effectiveness, efficiency, and acceptability of plans
- Recommended Plans
  - **No Action**
  - **Nonstructural**
  - **National Economic Development** (or National Ecosystem Restoration)
  - **Locally Preferred**
  - **Maximize net benefits across all 4 categories**
  - Maximize net benefits for study purpose only
  - Least environmentally damaging



RESEARCH RECOMMENDATIONS

- Coastal Hazards System Expansion
  - Pacific Coast and Islands: $25M, Five years
  - Compound flooding hazards: rainfall during coastal storm events, river discharge
- Intra-lifecycle coupling of coastal and inland hydrodynamic and morphologic models
- Update engineering design guidance and ensure alignment between inland and coastal flood risk management (FRM) programs
- Seek and establish policy compliant methodologies to analyze OSE, RED, and EQ accounts with appropriate fidelity to make investment decisions

Susan Durden

Ms. Susan Durden currently works as a senior economist with the Institute for Water (IWR) Resources of the Corps of Engineers. IWR is located at the Humphreys Engineering Center in Alexandria, VA. IWR is a leader in the development of planning methods and tools to address economic, social and institutional needs in water resources planning and policy. She has degrees in economics and education with extensive post-graduate training in strategic planning, conflict resolution, environmental issue resolution and communications. She is from central Illinois where she was raised on a family farm which has been in operation for over 125 years. Her experience includes working for the Corps of Engineers at Savannah District (South Atlantic Division), Baltimore District (North Atlantic Division) and Nashville District (Lower Rivers Division). She has served as an economist, study manager, project manager and supervisor. She was Chief of Economics in the Baltimore District and worked extensively with the Office of the Assistant Secretary of the Army for Civil Works on Congressionally mandated flood control projects in Wyoming Valley, PN. In addition to her tenure with the Corps of Engineers, Ms. Durden was the Eastern U. S. and Great Lakes Regional Manager at NOAA Headquarters. She worked as an economic development and grant specialist at the Northwest Alabama Council of Local Governments and has taught as an adjunct faculty member at several colleges and universities. Major technical interests include: communicating science to the public, monetary values for social and environmental benefits, models as tools in decision making, and partnerships with non-traditional customers. Ms. Durden serves as a mentor and works with several organizations to promote interest in science and math among girls.

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Better Serving the Underserved: Maximizing Comprehensive Project Benefits for Environmental Justice, Socially Vulnerable Populations Current CSRM Challenges

Susan Durden
Institute for Water Resources
Alexandria, VA.

This presentation will address best practices for addressing comprehensive benefits and will illustrate how teams are actively employing these best practices in coastal studies. The studies which are highlighted are joint efforts of the District and the Coastal CX. They emphasize key best practices such as: incorporating comprehensive benefits consideration at the beginning of a study; using comprehensive benefits as the framework for a fully integrated analysis; recognizing and accommodating the varying needs of a variety of populations—technically and for engagement. These efforts are a tangible demonstration of the path forward in molding our problem identification, opportunities, analyses and recommendations to serve many of those who are in the greatest need.

Studies included:

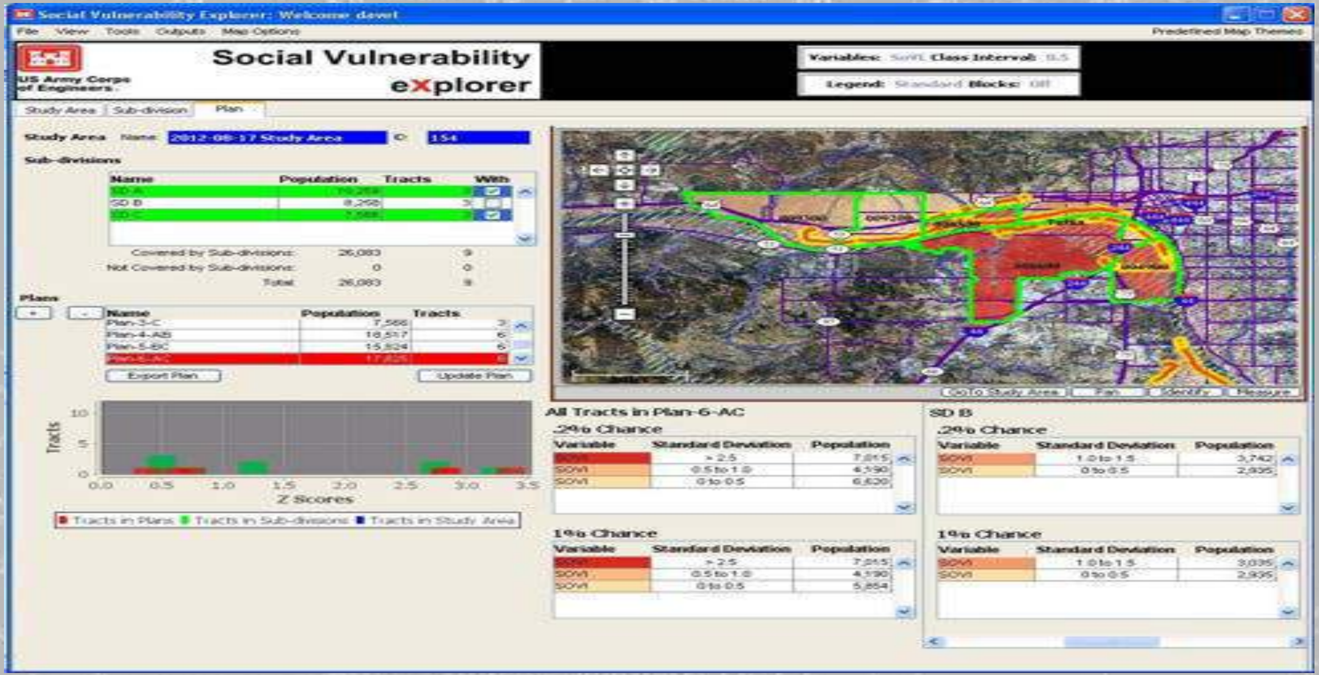
- Environmental Justice – Structural and Nonstructural
  - Miami Dade Back Bays
  - NY NJ Harbor and Tributaries
  - Nassau County, NY Back Bays
  - New Jersey Back Bays
- Nonstructural /Socially vulnerable community
  - Norfolk Coastal storm Risk Management
- NED Policy Exceptions to Better Serve the Underserved – Comprehensive Benefits
  - Puerto Rico Coastal
- NED Policy Exceptions to Better Serve the Underserved—Life Safety, OSE
  - Collier County, FL
  - Rhode Island Coastline

The last module of the presentation will highlight a selection of Quick Look tools to assist teams at the initial investigation stage to determine if other social effects, EJ, social vulnerability are likely to be important to the study. A second set of techniques provides a variety of approaches, including monetization, that can be employed during analysis to add new dimensions to evaluation of alternatives and plans. These tools and techniques have been reviewed by HQ and are transparent and scientifically defensible. Looking Forward (final slide) will propose to the Board research needed to bolster, advance and expand our abilities to address comprehensive benefits.

BETTER SERVING THE UNDERSERVED: MAXIMIZING COMPREHENSIVE PROJECT BENEFITS FOR ENVIRONMENTAL JUSTICE SOCIALLY VULNERABLE POPULATIONS CURRENT CSRM CHALLENGES

Susan Durden
Institute for Water Resources

15 August 2023



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LOOK AHEAD

Discover the Story, Tell the Story

The Story We Tell Ourselves

The Assumptions

Best Practices

Applying Best Practices

CSRM Examples

Tools and Techniques

R&D

Gaps, Needs, Opportunities

THE BASICS

What are Comprehensive Benefits?

"Significance– they are integrally related to the basic values and goals of society"

Last administration, Jan. 2021

- Comprehensive Benefits memo from ASA
  - Mandatory incorporation of all accounts
  - HQ guidance prohibited

Current administration, spring 2021

- EJ emphasis, Justice 40
- PR&G balanced use of accounts
  - Specific consideration of social
- WRDA 2020
  - Provisions for demonstrations, full Federal cost

THE BASICS

- **What is Environmental Justice?**

________EJ is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Executive Order 12898, 1994

- **What are Socially Vulnerable Populations?**

Individuals and communities which may require additional support or assistance based on demographic characteristics such as age, income, substandard housing, lack of transportation.

- **How do EJ, Socially Vulnerable Populations Intersect?**

Other Social Effects is one of four accounts for analysis
EJ considerations fit under OSE umbrella
OSE is an account. EJ is not.

THE BASICS

OSE and SV Analysis: Existing Resources (Tech Note)

erdc-library.erdc.dren.mil/jspui/handle/11681/44662

Income, Employment

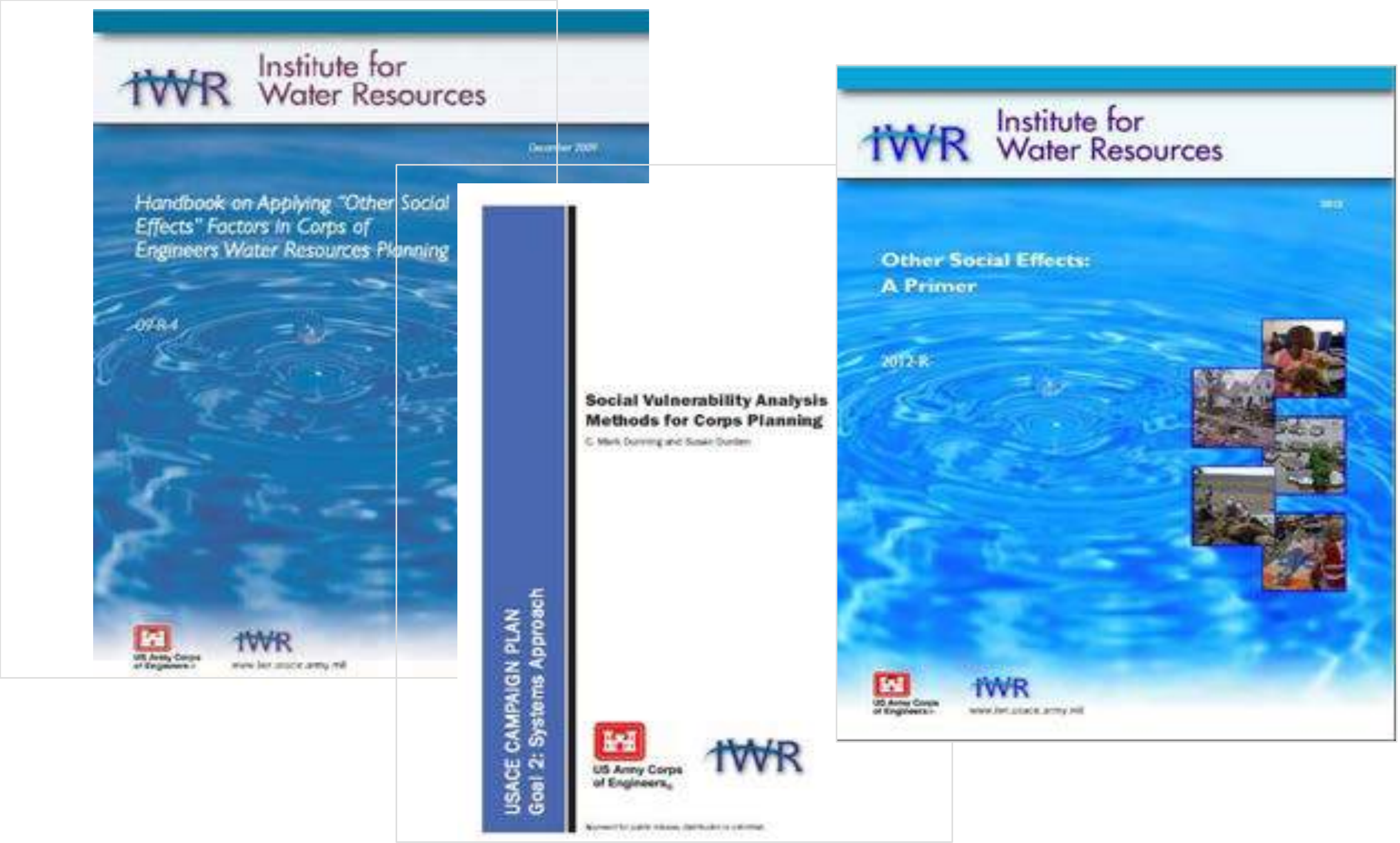
Life, Health, Public Safety

Education, Cultural, Recreation

Community Cohesion

Aesthetics

Resilience



THE STORY WE TELL OURSELVES

- Comprehensive Benefits
  - the whole picture
  - from the start
    - wrong problem=wrong solution
  - not separate, not a checklist, not new
  - New: place in decision making process

- Comprehensive Benefits is also NED
  - not a second choice-”we didn’t make NED”
  - accounts overlap   NED & RED; OSE & RED; OSE & EQ

- Tradeoffs aren’t absolute
  - The whole can be greater than the sum of the parts

THE STORY WE TELL OURSELVES

An Honest Relationship

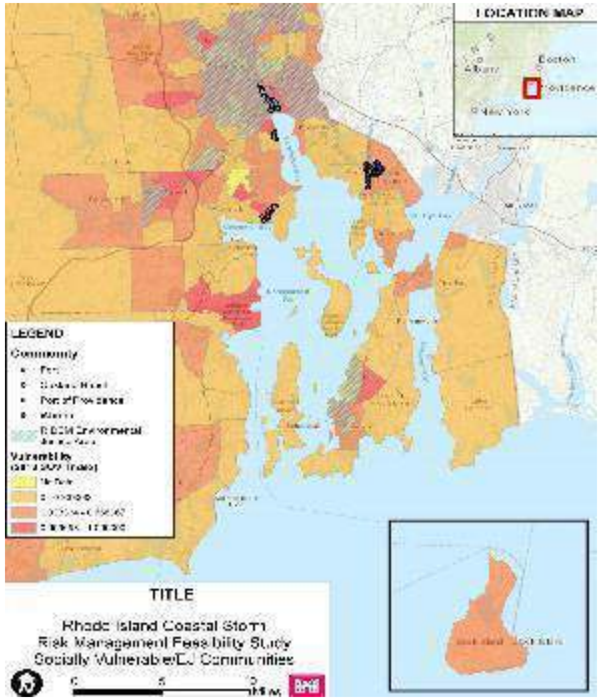
Just do it
Fulfill the intent
Live our values

Incremental Steps

NED POLICY EXCEPTIONS TO BETTER SERVE THE UNDERSERVED SUPPORTED BY LIFE SAFETY/OSE BENEFITS

RI Coastline - nonstructural

- Communities were assessed using the CDC Social Vulnerability Index (SVI) and RI Dept. Env. Management EJ Mapping.
- Recommended Plan includes 3 Socially Vulnerable communities/ 1 Environmental Justice community → 99 additional structures to be elevated and 1 to be floodproofed.



Collier County, FL – separable structural solution

- Inclusion of Planning Area 5 (PA5) and Tamiami Trail Floodwall resulted in considerable impacts on the residual risk and life loss of the overall recommended plan, critical not only in achieving desired coastal storm risk management benefits for project, but also vital in ensuring safety, health, and economic livelihood of the community, including coastal storm risk management benefits to the Naples Municipal Airport and to approximately 17,000 structures, totaling 32% of all structures throughout Collier County, defined as EJ by CEJST.
- PA5 (BCR = .8) alone – 63% reduction in life loss, 88% reduction in structures determined to be at risk and 55% reduction of expected annual damages. Compared to the overall recommended plan, PA5 accounts for 19% of the total reduction of life loss, 48% of the total reduction to structures at risk, and 32% of total reduction to expected annual damages.
- Alternative no longer being considered, EJ being reanalyzed in rescoped study.

NED POLICY EXCEPTIONS TO BETTER SERVE THE UNDERSERVED – COMPREHENSIVE BENEFITS

Puerto Rico Coastal

- Plan includes managed retreat through 115 property acquisitions
- Stella is an environmental justice community in Rincón with 75% of the population having low income (1/3 less than the national median income)
- Would prevent 84% of forced relocations compared to FWOP – 46 out of 55 structures prevented from condemnation
- BCR = .29
- NED - Increases beach related recreation by $496,000 (AAEQ)
- RED - Maintains $3,372,000 AAEQ worth of local tourism spending
- EQ - Creates ~17 acres of beach habitat (estimated 4.14 AAHU)
- TSP supports Other Social Effects (OSE) benefits in the category of community cohesion by allowing the town of Stella located in the southern part of Rincón to remain connected culturally and economically to the northern part of Rincón.
- Reduces the effects of community "blight" condition spreading in the city of Stella and beyond over the next 50 yrs.

ONGOING CSRM STUDIES
ENVIRONMENTAL JUSTICE – STRUCTURAL AND NONSTRUCTURAL

Nassau County, NY Back Bays

- Recommended plan includes EJ communities (approximately 854 structures of the 6,075 structures in EJ communities in the study area) via nonstructural solutions.
- EJ communities included based upon NED; however, it is important to note that inclusion/optimization was based on a comparison of FFE to an optimized eligibility AEP and associated WSE, which was dependent on the unit cost for nonstructural solution. Unit cost was averaged across the inventory based on structure type and appropriate elevation method for that structure type).
- Some EJ communities are left out of the recommended plan, no policy exception request to include based upon other benefit accounts.

New Jersey Back Bays (NJBB)

- EJ communities located within the study area and recommendations include Wildwood, West Wildwood, Stafford Township and Atlantic City and surrounding areas. Combination of nonstructural and structural since risk to Stafford Township would be managed by the Barnegat Inlet and Manasquan Inlet storm surge barriers.
- All recommendations for NJBB were justified using NED. OSE and EQ benefits were also calculated using IMPLAN/RED but not used for study justification in the current analysis.
- Not likely to seek a policy exception to include those EJ and/or socially vulnerable communities that may have been left out of the recommended plan as part of a comprehensive benefits plan, unless directed.

ONGOING CSRM STUDIES
ENVIRONMENTAL JUSTICE – STRUCTURAL AND NONSTRUCTURAL

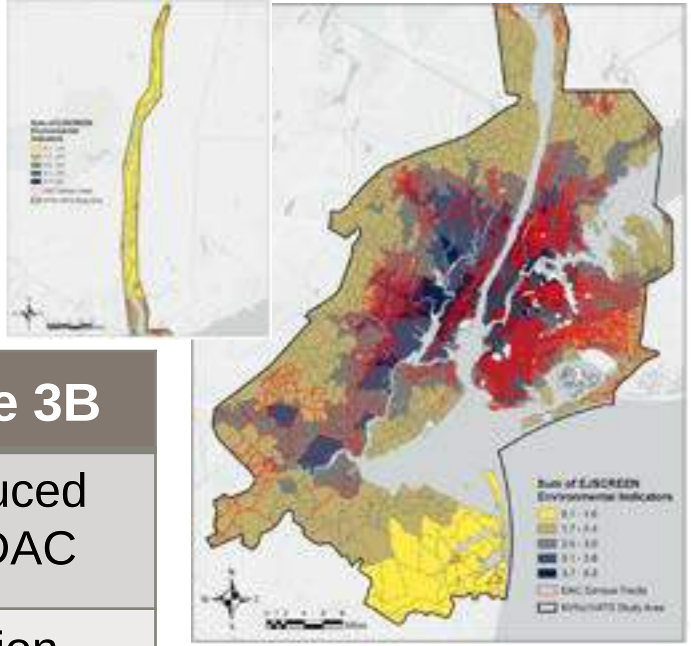
Miami-Dade Back Bays

- Currently considering comprehensive structural alignment or a combination of wide-ranging nonstructural plans with NNBF that include EJ communities (yellow shaded areas – Little River and Little Haiti).
- Team will develop EJ Coordination Plan if Phase 2 is approved by ASA(CW).

NYNJ Harbor and Tributaries

Disadvantaged Communities (DAC) in study area:

- 23.59% or more of the population below the federal poverty level
- 51.1% or more of the population identify as minority

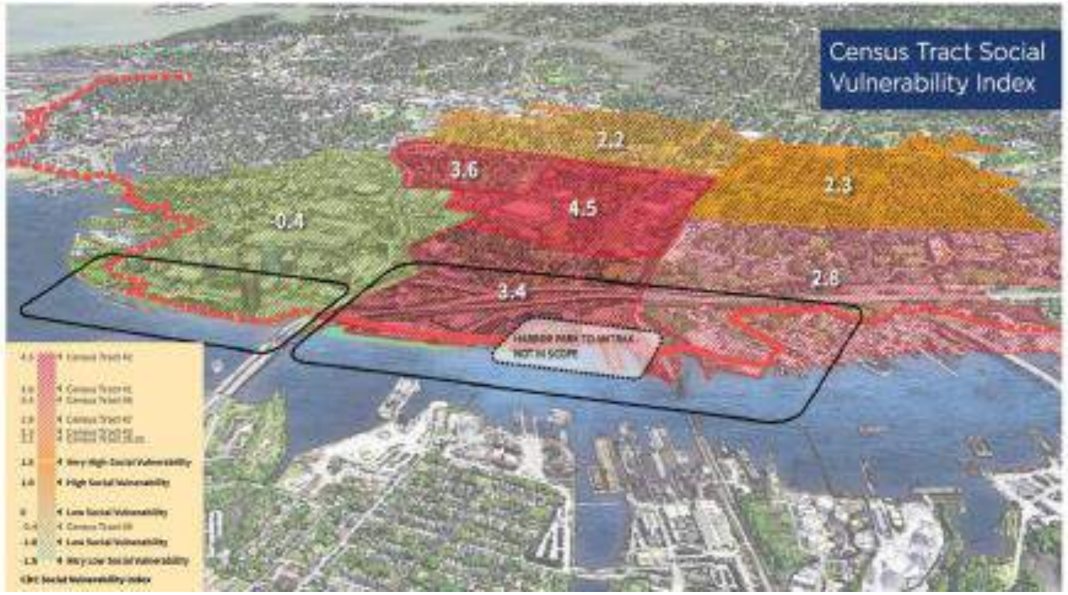


EJ and the TSP/Alternative 3B
63% of census tracts in the Reduced Risk Areas meet the criteria for DAC
63 census tracts in the construction footprint meet the criteria for DAC
Virtually every feature of the Tentatively Selected Plan touches a DAC

NORFOLK COASTAL STORM RISK MANAGEMENT NONSTRUCTURAL/SOCIALLY VULNERABLE COMMUNITY

PROJECT INFORMATION

Description/Scope: The Norfolk CSRM Nonstructural program includes elevations and basement fills for residential structures, and floodproofing measures for 55 structures, including critical infrastructure (non-residential), including **the Southside.** During the feasibility study conducted in 2018, the evaluation criteria for structural measures was based purely on a benefit-to-cost ratio (BCR). Not all areas of the City met the criteria for structural flood measures. The study's BCR analysis only focused on the value of properties compared to the cost of building a structure, once again leaving out some of Norfolk's historically black neighborhoods, which have been undervalued. A PACR for this area is proposed to evaluate the opportunity for a structural measure versus the proposed non-structural measure.



DRAFT MILESTONES

- Aug 23 - Submit request to the vertical team to initiate the study with available funding
- Fall 23 - Start Study (if approved to use available funding)
- Summer 25 – Complete Study
- Fall 25 – Submit for WRDA 26, for any recommended changes to the authorized project.

STATUS/CHALLENGES/WAY AHEAD

STATUS: **The NFS and NAO have participated in multiple community meetings where the southside community has expressed concern.** The residents cited the Environmental Justice 40 Initiative, expressing concern that the non-structural plan (primarily home elevations) proposed for their neighborhood was inadequate. The City sent three letters of request to initiate PACRs and willingness to participate cost sharing. It was determined the best strategy to accomplish the studies, would be to combine the Non-structural PARCs. NAO is requesting to use the BIL funds to accomplish the Non-Structural PACR.

CHALLENGES:

- Combined PACR for the Southside, Willoughby and Conversion from Acquisition to Elevation.
- Low BCR for a structural measure for the southside of Norfolk during feasibility.

WAY AHEAD:.

- Submit the request to start the PACR and further define scope, schedule and budget.

INITIATIVES

IS NONSTRUCTURAL A GOOD CHOICE?

1. The Event
   - Source of flooding
   - Frequency of flooding
   - *Timing of flooding (arrival, duration)*
   - *Physics of flooding (depths, velocities, d*v)*
   - Spatially separated areas of flooding

2. Structure Characteristics
   - First floor elevation
   - Common land use, structure type, construction method/category, age
   - *Suitability to elevate, floodproof*
   - Density of development
   - Historic areas or neighborhoods
   - Shared infrastructure (physical)
   - Shared critical infrastructure (buildings)

3. Community Characteristics
   - Shared demographics
   - *Shared socioeconomics (i.e., EJ)*
   - *Shared cultural values*
   - Political jurisdictions

4. Life Risk Characteristics
   - *Population age (over 65/under 5)*
   - Available evacuation routes
   - Accessibility to public transportation
   - *Need for assistance—ability to evacuate*
   - *Services at shelter*

5. Other Characteristics
   - Potential for reuse of evacuated floodplain for ecosystem restoration or recreation

TOOLS

- **Quick Look Tools**
  Dashboard
  Ranger
  Comprehensive Benefits

- ***SOVI-X (Social Vulnerability Index Explorer)***
  Does alternative analysis
  Well vetted tool customized for Corps

Techniques

Monetized OSE
Multiplier
Benefit-Cost Equity, aka, Apples to Apples
OSE, EJ, Risk Informed Planning

Fact Sheets, Slide decks, Users Guides, Technical Reports, White Papers

TOOLS DASHBOARD

Create dashboard by selecting the state and counties that will be used as comparison areas.

Then select the census tracts within the floodplain (FP) community

Select the state and counties to compare with the floodplain community.

1. Select the state by clicking on the orange cell and beginning to type the state's name. Then select from the dropdown menu by clicking the button that appears to the right of
2. Select the counties in the same manner you selected the state.

You can select up to two counties from all of the counties within the state that you selected. You cannot select counties from a different state.

Comparison Areas		
State	**County 1**	**County 2**
Florida	DeSoto County, Florida	Miami-Dade County, Florida

Select the census tracts that are part of the floodplain community.

1. Click on the button in the bottom right of cell A16.
2. Unselect the "Select All" option by clicking on the box to the left of "Select All" so that the box is no longer checked.
3. Select the census tracts that are part of the floodplain community by scrolling through the list of census tracts and selecting all that are part of the floodplain community. You can also search for census tracts by number or county name, but be sure to unselect the "select all search results" option, select only those you want to add, and select "add current selection to filter".

You can select any census tracts within the state that you selected above. You cannot select census tracts from a different state.

Floodplain Community
Census Tracts (select all in floodplain community)
Census Tract 44.03, Miami-Dade County, Florida
Census Tract 44.04, Miami-Dade County, Florida
Census Tract 44.05, Miami-Dade County, Florida
Census Tract 44.06, Miami-Dade County, Florida

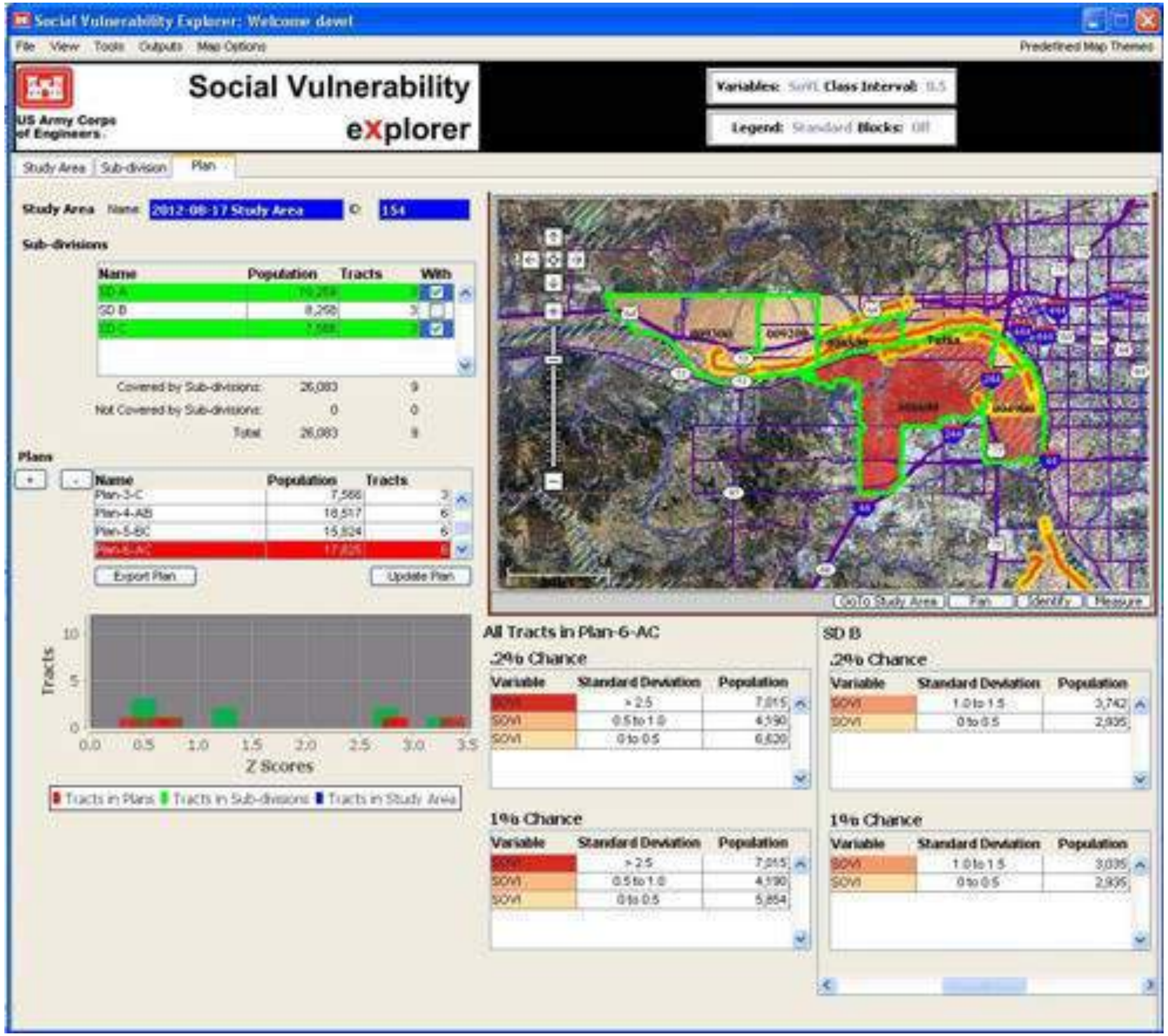
TOOLS


Community Profile Dashboard
OSE Analysis Support Tool
% Minority
25%
16%
25%
40%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY
% Hispanic or Latino
26%
32%
68%
63%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY
% Limited English Households
6.9%
11.3%
25.1%
31.2%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY
% Population 60 years and over
26.6%
27.9%
21.5%
18.7%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY
% Population 5 and under
5.4%
5.0%
5.9%
6.0%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY
% Below poverty level
14.0%
26.8%
17.1%
21.9%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY
% Mobile home
8.9%
31.0%
1.2%
0.4%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY
% No vehicles available
6.3%
6.9%
10.3%
40.6%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY
% Built 1939 or eariler
2.1%
2.3%
3.6%
18.9%
FLORIDA
DESOTO COUNTY, FLORIDA
MIAMI-DADE COUNTY, FLORIDA
FLOODPLAIN COMMUNITY

TOOLS SOCIAL VULNERABILITY INDEX EXPLORER

SOVI-X

1. Assemble base map, “parent area”
2. Delineate “study area” boundaries
3. Create SoVI for study area
4. Identify relevant “sub-areas” (reaches, neighborhoods , etc.)
5. Create table of “population at risk” under “without project” and “with project”
6. Export to planning



TOOLS

Status

- Doing Refresh
- Beta version received late July
- Technical Team Testing

Rollout

- 1st quarter FY 24
- Available by request Sept 2023

			1% Chance Flood		.2% Chance Flood	
Population			Without	With	Without	With
Total:	26,083		5,970	17,059	6,677	17,825
1% Chance Flood:	23,029					
.2% Chance Flood:	24,502					
Vulnerability Index	Class Breaks					
	Low	High				
SoVI	3.0			1,620		1,620
SoVI	2.0	3.0		5,395		5,395
SoVI	1.0	2.0	3,035		3,742	
SoVI	0	1.0	2,935	10,044	2,935	10,810
SoVI	-1.0	0				
SoVI	-2.0	-1.0				
SoVI	-3.0	-2.0				
SoVI		-3.0				
Race and Poverty +	3.0					
Race and Poverty +	2.0	3.0		2,316		3,082
Race and Poverty +	1.0	2.0		2,531		2,531
Race and Poverty +	0	1.0	5,970	8,674	6,677	8,674
Race and Poverty +	-1.0	0		3,538		3,538
Race and Poverty +	-2.0	-1.0				
Race and Poverty +	-3.0	-2.0				
Race and Poverty +		-3.0				
Urban/Rural II	3.0					
Urban/Rural II	2.0	3.0				
Urban/Rural II	1.0	2.0		5,180		5,946
Urban/Rural II	0	1.0	5,970	11,879	6,677	11,879
Urban/Rural II	-1.0	0				
Urban/Rural II	-2.0	-1.0				
Urban/Rural II	-3.0	-2.0				
Urban/Rural II		-3.0				
Wealth -	3.0					
Wealth -	2.0	3.0				
Wealth -	1.0	2.0				
Wealth -	0	1.0	5,970	17,059	6,677	17,825
Wealth -	-1.0	0				
Wealth -	-2.0	-1.0				
Wealth -	-3.0	-2.0				
Wealth -		-3.0				
Age +	3.0					
Age +	2.0	3.0				
Age +	1.0	2.0		3,538		3,538
Age +	0	1.0	4,260	8,674	4,967	8,674
Age +	-1.0	0	1,710	2,531	1,710	2,531
Age +	-2.0	-1.0		2,316		3,082
Age +	-3.0	-2.0				
Age +		-3.0				
Hispanic +	3.0					
Hispanic +	2.0	3.0				
Hispanic +	1.0	2.0	1,710		1,710	
Hispanic +	0	1.0	1,325	8,674	2,032	8,674
Hispanic +	-1.0	0		8,385		9,151
Hispanic +	-2.0	-1.0	2,935		2,935	
Hispanic +	-3.0	-2.0				
Hispanic +		-3.0				
High Pop. Households +	3.0					
High Pop. Households +	2.0	3.0				
High Pop. Households +	1.0	2.0				
High Pop. Households +	0	1.0		7,015		7,015
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High Pop. Households +	-3.0	-2.0		2,316		3,082
High Pop. Households +		-3.0				

TOOLS COMPREHENSIVE BENEFITS SCREENING

simple and **easy** way to compare alternative plans across multiple user-defined criteria (e.g., NED impacts, impacts to EJ communities).

Evaluate measures for contribution to NED, RED, OSE, & EQ **early in the planning process**.

Existing data

Any metric

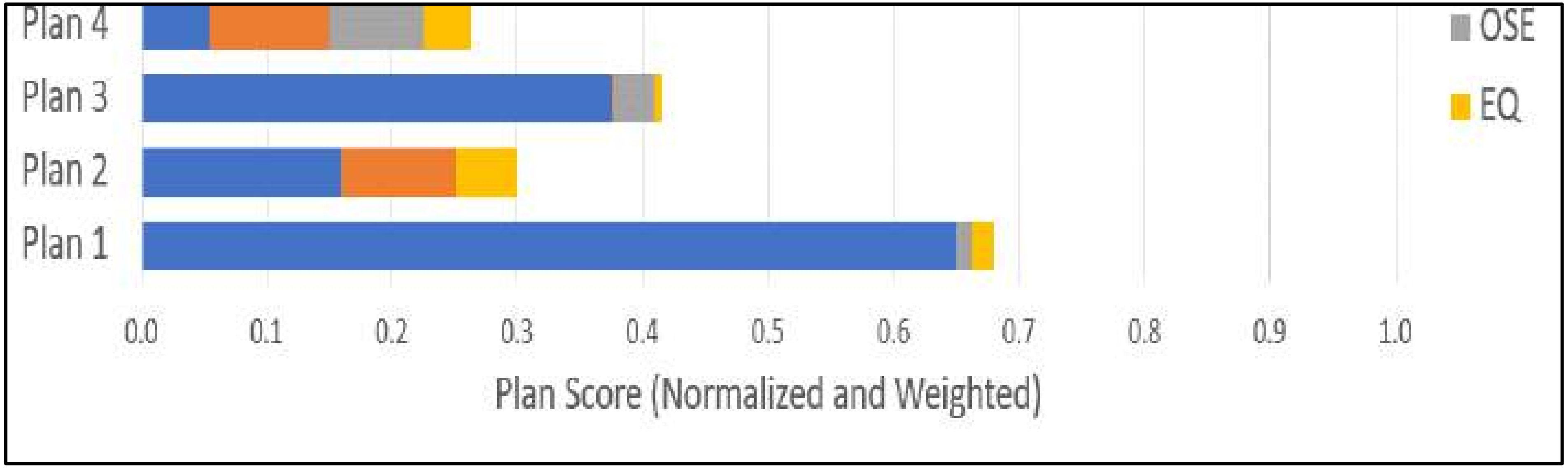
TABLE 1		Criterion 1 NED	Criterion 2 RED	Criterion 3 OSE	Criterion 4 EQ
Plan 1	3ft Raise current	71,735,251	11,632,500	4	16,500
Plan 2	7ft Raise current	121,949,927	57,105,000	5	19,000
Plan 3	3ft Raise expanded	93,255,826	12,160,500	3	15,675
Plan 4	7ft Raise expanded	143,470,502	59,697,000	2	18,050
Plan 5	7ft Raise other	157,817,552	61,600,500	1	15,200
	Desired Outcome	Minimize positive value 3	Maximize positive value 1	Minimize positive value 3	positive value 1

Enter the quantitative information.
Data can be on different scales.
Data must be numerical or ordinal rankings.
The tool normalizes the data so it can be compared in a meaningful way.

Don't have a measurable quantitative input for a criterion? That's OK! You can rank order the plans as shown in the OSE column.

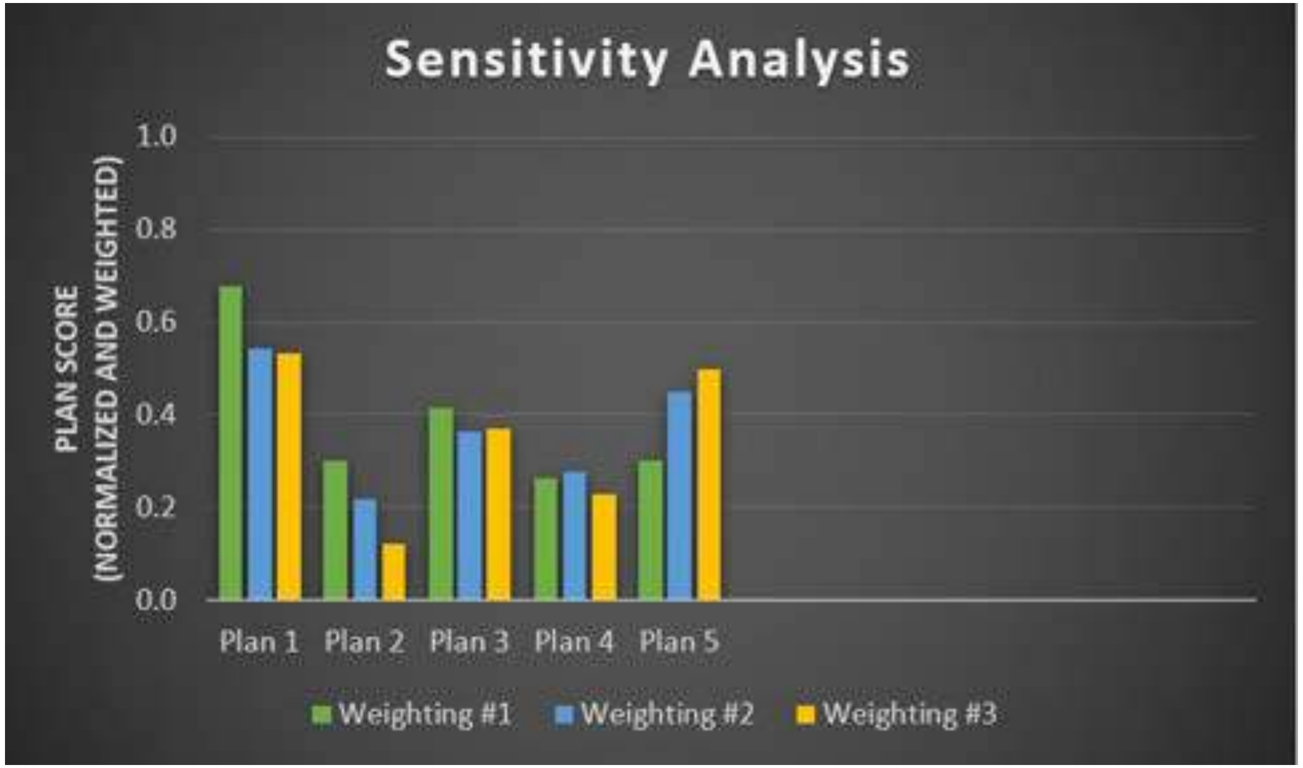
COMPREHENSIVE BENEFITS SCREENING TOOL

Weighting Table	Total (must be 100%)	Criterion 1 NED	Criterion 2 RED	Criterion 3 OSE	Criterion 4 EQ
Weights	100%	65%	10%	20%	5%



Interpreting the data Which plan has the highest overall score and makes the greatest contribution to comprehensive benefits? The weights can have a significant impact on which plan has the highest overall score. It is important to perform a sensitivity analysis to assess how different weights may affect the results

COMPREHENSIVE BENEFITS SCREENING TOOL



Conduct a sensitivity test by entering in alternative weights and comparing how it changes the results. For example, Plan 2 shows the greatest sensitivity to the choice of weights. Is it what you expected? Does it make sense? Should changes be made before the alternatives are finalized?

TECHNIQUES

Techniques

- ❑ Monetized OSE
- ❑ Multiplier
- ❑ Benefit-Cost Equity, aka, Apples to Apples
- ❑ OSE, EJ, Risk Informed Planning

Potential to change the foundations of our analyses

- ✓ Reviewed by HQ
- ✓ Can be applied by field for a screening, sensitivity analysis, additional perspective, add a chapter to the story
- ✓ Within direction for field to identify, apply innovative techniqes
- ✓ Developed by SMEs
- ✓ Well documented
- ✓ Drawn from well established approaches in other Federal agencies

GAPS AND NEEDS FOR R&D RESEARCH

Make Resilience as a Goal a Reality

Community Viability, Continuity

Leverage Work from Other Agencies, Countries

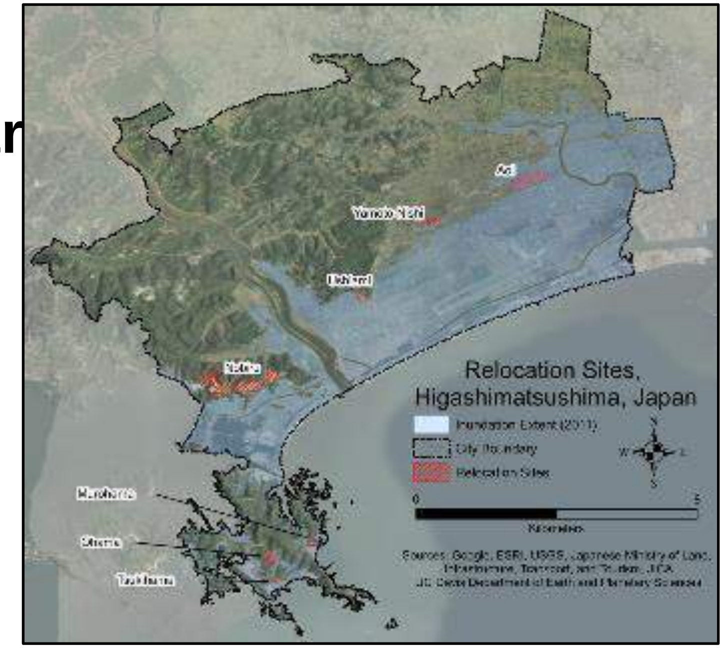
Operating Procedures-Relocation of Utilities, Community Services

Critical Infrastructure

Differentiate Acquisition/Buyouts—Relocation—Managed Retr

Community-Beyond Buyouts-Implementing in USACE

Climate Change Characteristics as a Determinant



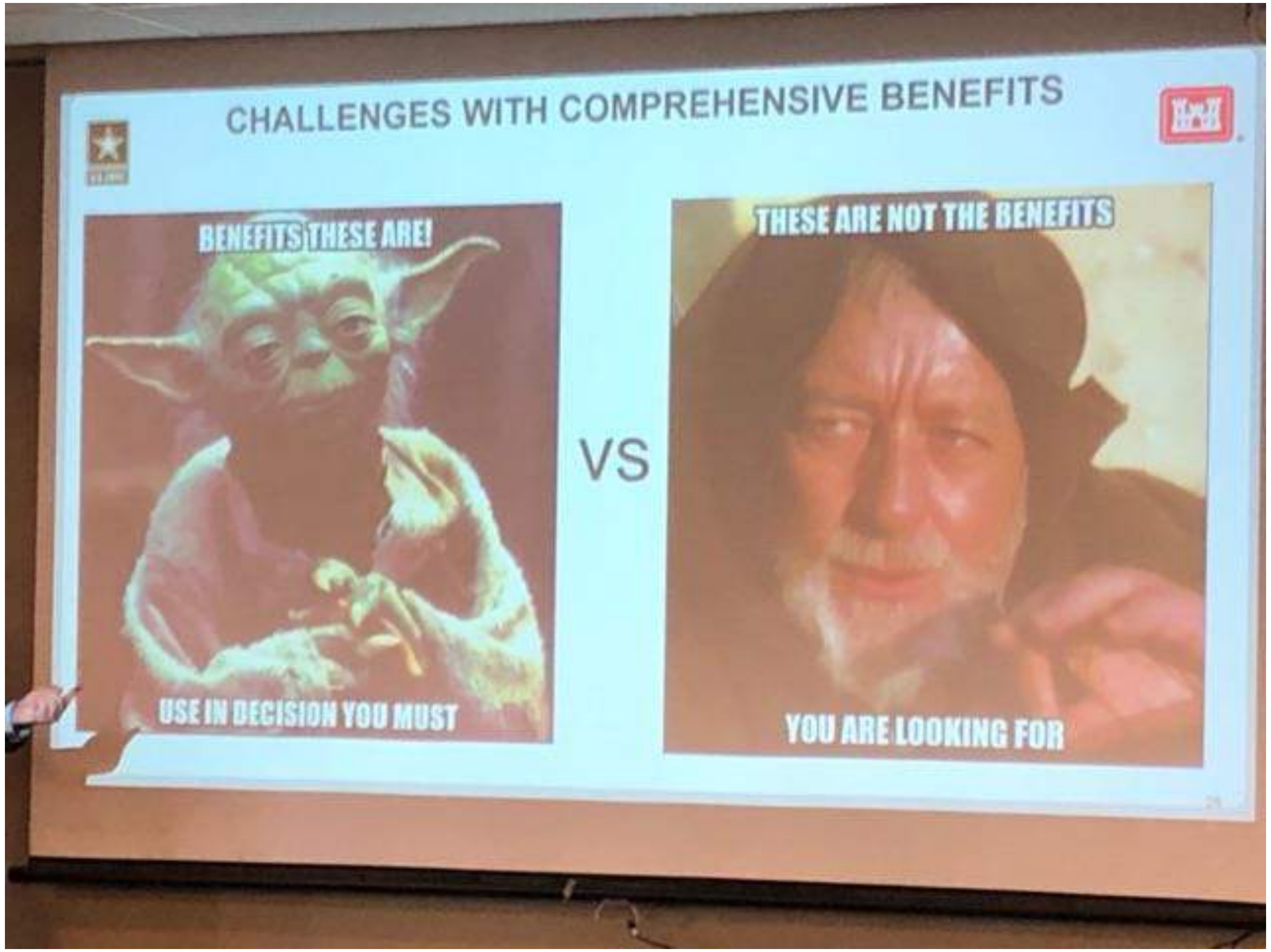
Assess Shelter in Place, Vertical Evacuation as an Option

Reinstitute a Social Science Training Program

EJ within the Inclusive Social Science Framework

Modules: climate change, nonstructural, ecosystem restoration

DISCUSSION


CHALLENGES WITH COMPREHENSIVE BENEFITS
BENEFITS THESE ARE!
USE IN DECISION YOU MUST
VS
THESE ARE NOT THE BENEFITS
YOU ARE LOOKING FOR

INITIATIVES

WHAT ARE THE NEEDS?

INITIATIVES

HOW DO WE DESCRIBE AND COMPARE?

Social Factor and Metrics	Flood Barriers	Diversion Channels	Non-structural Measures	Flood Storage	Tunneling	Bridge Replacement or Modification	Interstate 29 Viaduct	Dredging and Widening	Wetland and Grassland Restoration	Cut-off Channels
	Alternatives									
	D / E	D / E	D / E	D / E	D / E	D / E	D / E	D / E	D / E	D / E
Health and Safety										
Mental Health	2 / 2	3 / 3	0 / 0	2 / 2	3 / 3	0 / 1	3 / 3	1 / 1	0 / 1	1 / 1
Physical Health	2 / 2	3 / 2	0 / 0	2 / 2	3 / 2	0 / 1	3 / 2	1 / 1	0 / 1	1 / 1
Physical Safety	0 / 2	0 / 2	0 / 0	0 / 2	0 / 2	0 / 1	0 / 2	0 / 1	0 / 1	0 / 1
Regional Healthcare	0 / 2	0 / 3	0 / 0	0 / 2	0 / 3	0 / 1	0 / 3	0 / 1	0 / 1	0 / 1
Economic Vitality										
Business Climate	2 / 2	2 / 3	0 / 0	2 / 2	3 / 3	0 / 1	3 / 3	1 / 1	0 / 1	1 / 1
Employment Opportunities	2 / 2	2 / 3	0 / 0	2 / 2	3 / 3	0 / 1	3 / 3	1 / 1	0 / 1	1 / 1
Financial Impacts	-1 / 1	-2 / 1	0 / 0	-1 / 1	-2 / 1	0 / 0	-2 / 1	-1 / 1	0 / -1	-1 / 1
Municipal Services	-1 / 2	-2 / 2	0 / 0	-1 / 1	0 / 2	0 / 0	-1 / 2	0 / 1	-1 / 0	0 / 1
Social Connectedness										
Community Cohesion	-1 / 2	0 / 2	0 / 0	0 / 2	0 / 2	0 / 1	0 / 2	0 / 1	0 / 1	0 / 1
Community Facilities	0 / 2	0 / 2	0 / 0	0 / 2	0 / 2	0 / 0	0 / 2	0 / 1	0 / 1	0 / 1
Identity										
Cultural Identity	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Community Identify	1 / 1	1 / 1	0 / 0	1 / 1	1 / 1	0 / 1	1 / 1	1 / 1	0 / 0	1 / 1
Social Vulnerability and Resiliency										
Residents of Study Area	-1 / 2	0 / 2	0 / 0	0 / 1	0 / 2	0 / 1	0 / 2	0 / 1	0 / 1	0 / 1
Socially Vulnerable Groups	-1 / 2	0 / 2	0 / 0	0 / 0	0 / 2	0 / 1	0 / 2	0 / 1	0 / 1	0 / 1
Participation										
Public Participation	1 / 2	1 / 2	0 / 0	0 / 1	0 / 2	0 / 1	1 / 2	0 / 1	0 / 1	1 / 1
Leisure and Recreation										
Recreational Activities	-1 / 1	0 / 1	1 / 0	0 / 1	0 / 1	0 / 0	0 / 1	1 / 1	1 / 1	0 / 1

Notes:
- Impacts are measured in comparison to the Without-Project Alternative
- D = impacts to daily lifes (no flooding); E = impacts during a flood event
- Scores can range from -3 (significant negative impact) to +3 (significant beneficial impact)
- No more than 25 percent of the metric scores for an alternative should be either a -3 or +3

BEYOND OUR BORDERS

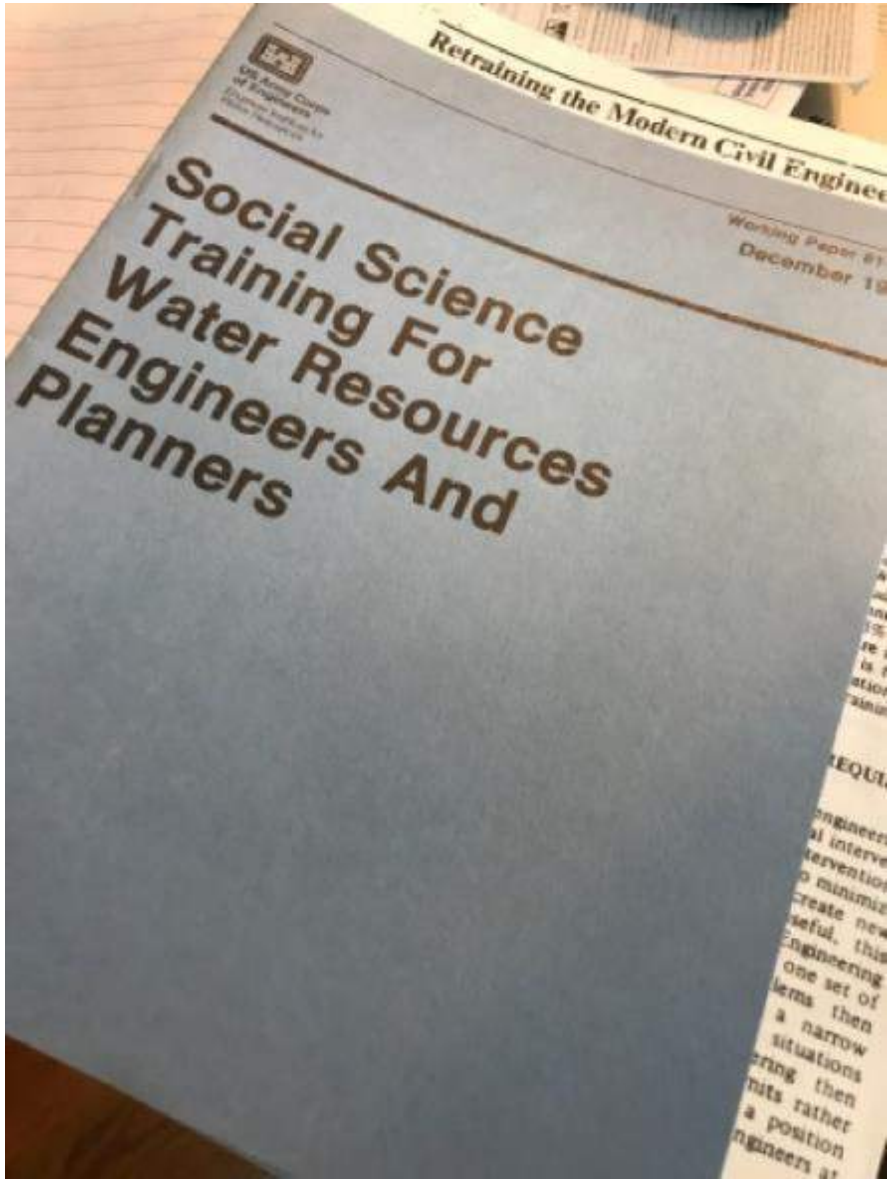
- **UK**
  - Social Effects Integral in Flood Risk Management Analysis
  - Long Term Studies of Impacts on Daily Life Due to Flood Event
  - Managed Retreat in Select Coastal Locations
  - Shelter in Place a Strategic Choice
  - National Strategy; Local Councils Implement, Prioritize

- **Japan**
  - Provisions for the Elderly
  - Government Determined; Locally Lead
  - Post Tsunami Relocations within 3 Years

- **Australia**
  - Locally Sponsored
  - Privately Implemented

GAPS AND NEEDS

- Reinstitute a Social Science Training Program
    - EJ within the Inclusive Social Science Framework
    - Modules: climate change, nonstructural



DISCUSSION


SUBCOMMITTEE ON OCEAN SCIENCE AND TECHNOLOGY
ENVIRONMENTAL JUSTICE WEBINAR
NOVEMBER 2, 2021 1 - 3 PM (ET)
REFERENCE KIT

INITIATIVES
MANAGED RETREAT

Hello attendees of the 2022 International Forum on Managed Retreat! The meeting video and presentations are available online here:
https://www.nationalacademies.org/event/04-08-2022/international-forum-on-managed-retreat-global-lessons-for-success
Thank you for your interest in our project.

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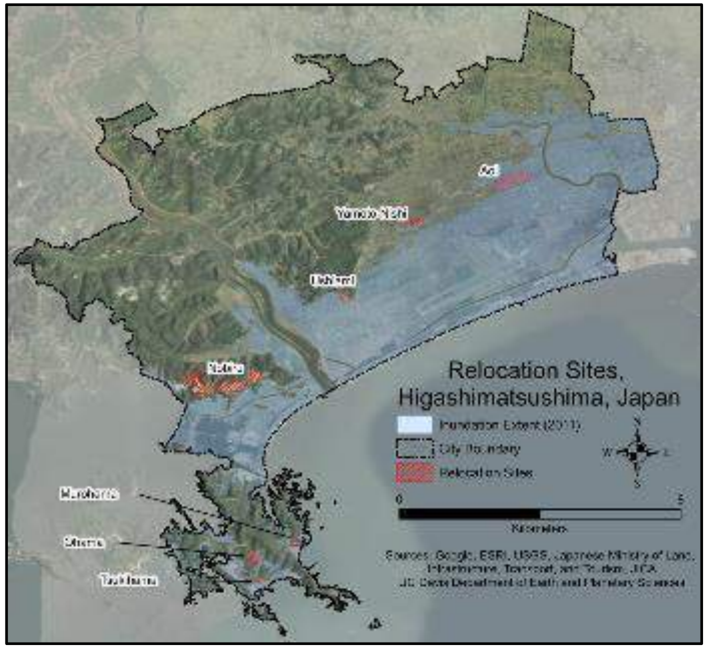


U.S. OTHER AGENCIES

- Pre-event, Regional, Adaptable
- “locally executed, state managed, federally supported”
- Most local cost share
  - FEMA, HUD
    - New York Rising; NJ Reconstruction Rehabilitation Elevation and Mitigation
      - Elevation, floodproofing, buyouts/acquisitions
- Grants
  - FEMA, EPA
    - BRIC (Building Resilient Infrastructure and Communities)
    - Building Codes Strategy
- Interagency
  - FPMS
    - nonstructural special studies

MORE QUESTIONS THAN ANSWERS

- ✓ Definitions? Language?
  - Disadvantaged, socially vulnerable, underserved
- ✓ Metrics?
  - Poverty, environmental conditions, housing stock, risk exposure
- ✓ What?
  - Feasibility studies (new projects); Regulatory; Recreation, Operations

STILL MORE QUESTIONS THAN ANSWERS

National Listening Sessions, summer 2022

Define disadvantaged communities

Office of Management and Budget

National Outreach Strategy

- Engaging with communities
- Not overwhelm
- Federal family effort
- Funding community's time

HOW DO WE DO IT?

Nuts and Bolts—Integrating in our process

Planning Process

Problem Identification

Screening, Analysis, Evaluation

Nuts and Bolts--Tools and Techniques

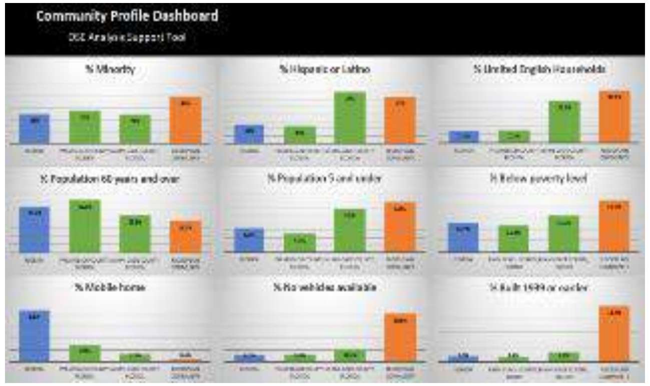
Metrics—what?

Analysis—how?

Monetize, Multiplier

Tools

Dashboard, EJ Screen, CEQ tool, SOVI-X



HOW DO WE DO IT?

Nuts and Bolts—Implementation

- Cost Sharing
  - Broaden existing special authorities
  - Expand, revise ability to pay provisions
  - Generous Use of in-kind services
- Real Estate
- Operation, maintenance

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High Pop. Households +	-3.0	-2.0		2,316		3,082
High Pop. Households +		-3.0				

COFFEE AND DESSERT

What next?

Increasing Robustness of Monetize, Multiplier techniques

Starter kits for non Flood and Coastal

Complete and implement national outreach strategy

How to not overwhelm communities

Continue gathering, sharing creative field approaches

Directly support field teams

THANK YOU!

Angela Schedel, Ph.D.

Dr. Angela Schedel is the Director of Coastal Programs and a Vice President at HDR, Inc., based in Jacksonville, Florida. A licensed Professional Engineer, she manages client development, proposal reviews, and project performance evaluations for coastal work. In this position, her main role is to strengthen and accelerate the firm's efforts in helping communities face coastal zone impacts. Prior to joining HDR, Dr. Schedel was a Vice President at Taylor Engineering where she built their coastal resilience practice from 2018 to 2023. In that role, she oversaw a team of engineers and scientists whose projects covered a variety of activities including sand source and geotechnical investigations, dredging and dredge material management solutions, erosion control measures, shore protection, beach monitoring, and resilience planning. As Taylor's resilience lead, she led projects conducting vulnerability assessments, climate adaptation recommendations, and coastal resilience plans. Within her resilience portfolio, she led teams creating web applications for flood risk assessments and cost benefits analysis for USACE, International Code Council, Florida Department of Environmental Protection, South Florida Water Management District, Northeast Florida Regional Council, and the Tampa Bay Regional Resiliency Coalition.

A civil engineer with a 24-year career in the U.S. Navy, she taught ocean engineering at the U.S. Naval Academy for nine years. While there, she served as the first woman deputy director of the engineering division – a title equivalent to an assistant dean at a university. At the academy, she led hundreds of diverse faculty and staff teaching engineering courses to 3,000 students each semester. She contributed her engineering expertise to the academy's first Sea Level Rise Advisory Council and the STEM outreach program for K-12 students. A former Navy helicopter pilot, Schedel was one of the first 10 instructor pilots to teach students in the new Sierra-model Seahawk. She served aboard ships in the Pacific Ocean and the Persian Gulf during two deployments, flying missions in logistics, search and rescue, and vertical replenishment in the CH-46D Sea Knight. In addition to her doctorate, she holds a master's in civil engineering from the University of Maryland and a bachelor's in ocean engineering from the U.S. Naval Academy. Schedel is a member of several key industry organizations, including the American Shore & Beach Preservation Association; American Society of Civil Engineers; Coasts, Oceans, Ports and Rivers Institute; and the Society of American Military Engineers. She also serves on the Florida Shore & Beach Preservation Association board, as an ex-officio member..

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Industry Perspective: Tools to Assist Communities in Coastal Resilience

Angela Schedel, Ph.D.
Director of Coastal Programs
Jacksonville, FL.

Economists and policy makers have long debated the fairness of the federal standard for calculating benefit-cost analyses (BCA) in USACE civil works projects. With a focus on coastal resilience, engineering consultants are guiding local governments with the addition of a social equity element to supplement decision making for local flood mitigation and adaptation projects. Social equity, or environmental justice, is defined by the federal government as the “fair treatment and involvement of all people and communities regardless of race, gender, national origin, or income level in the development, implementation, and enforcement of environmental laws, regulations, and policies.” Policy guidance from the current administration directs that social equity be evaluated in federal agency assessments. For example, the Justice40 Initiative sets a goal that 40% of the benefits of federal investments should support disadvantaged communities. In 2022, FEMA published guidance permitting an alternative cost-effectiveness method for calculating BCA for Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA) grants. This alternative method prescribed three conditions to be met for determining a project’s cost effectiveness:

1. BCR => 0.75, using 7% discount rate
2. BCR=> 1.0, using 3% discount rate
3. Meets at least ONE of following criteria:
    a. Provides benefits to underserved communities either:
        i. Rated =>0.6 SVI score on CDC’s SVI tool,
        ii. Within tribal jurisdiction; or
        iii. Only for BRIC, benefits Economically Disadvantaged Rural Community
    b. Addresses climate change impacts
    c. Has higher costs due to low-carbon materials or in compliance with Federal Flood Risk Management Standard
    d. Provides significant benefits that are difficult to quantify or cannot be monetized

Coastal engineers leading vulnerability assessments in the state of Florida are experimenting with various methods to incorporate social equity in the prioritization of local mitigation strategies. The federal government packages geospatial data produced by the CDC’s Social Vulnerability Index

(SVI) and the EPA's Environmental Justice mapping and screening tool, EJScreen, for use by the public. These datasets are a compilation of U.S. Census data which determines level of risk due to a variety of factors. For example, the CDC's SVI considers these four factors to create an SVI "score" for each census tract within a county:

- Socioeconomic status (below 150% poverty, unemployed, housing cost burden, no high school diploma, no health insurance)
- Household characteristics (aged 65 or older, aged 17 or younger, civilian with a disability, single-parent households, English language proficiency)
- Racial and ethnic minority status
- Housing type & transportation (multi-unit structures, mobile homes, crowding, no vehicle, group quarters)

The geospatial data provided by both SVI and EJScreen is publicly accessible and easily downloadable to overlay on a detailed map with flood vulnerabilities. By using a dataset produced by the federal government, decision makers at local governments can reduce bias to help objectively determine where to apply funding to mitigate coastal flooding. The SVI website provides a compiled index for each census tract whereas the EJScreen tool allows the user to overlay a variety of coastal flooding layers with a selection of demographic and environmental risks. Other tools such as the FEMA National Risk Index (NRI) and University of Central Florida's SoVI® also provide data to help prioritize adaptation projects. An alternative method for assessing social equity is an economic approach called "weighted BCA" (WBCA). A WBCA emerges from economic theory on project and policy evaluation from the 1940s. HDR funded a research program to determine how to apply this concept to infrastructure projects. HDR formed an expert panel to provide insights on HDR's research and conclusions. The WBCA method determines a project value by accounting for incomes of beneficiaries, since economic research has shown that as a person's income increases, the value of an additional dollar to that person declines. The implication for civil works projects is that residents with lower incomes gain more value from outcomes such as flood risk mitigation.

The Office of Management and Budget has drafted revisions to Circular A-94, a publication which sets guidelines on approved Benefit to Cost Analysis procedures. The draft revisions include weighted BCA as an alternative method for evaluating federally funded infrastructure projects. Sufficient evidence exists to apply WBCA, however more research is needed for coastal engineering civil works projects.

Alternative Methods to “Level the Playing Field”

Taking Social Equity into Account for Coastal Engineering Civil Works Projects

Angela Schedel, PhD, PE

HDR

08/15/2023

01 Calls for Equity Inclusion

02 Incorporating Equity in Coastal Engineering Projects

03 Innovative Approach

04 R&D Recommendations

Calls for Equity Inclusion

1994

Executive Order 12898
- *Established Interagency Working Group on Environmental Justice*

2003

Circular A-4
- *Allows Distributional Effects Analysis*

2013

Executive Order 13653
- *Evaluates Social Equity in Infrastructure*

Calls for Equity Inclusion

(Current Administration)

2021

Executive Order 13985

- *Required Equity Assessments for Federal Agencies*

2021

Executive Order 14008

- *Introduced Justice40 Initiative*

2023

Executive Order 13653

- *Created Flexibility in Federal Funding for Underserved Communities*

You and I come by road or rail, but economists travel on infrastructure.

MARGARET THATCHER

Incorporating Equity in Coastal Engineering Projects

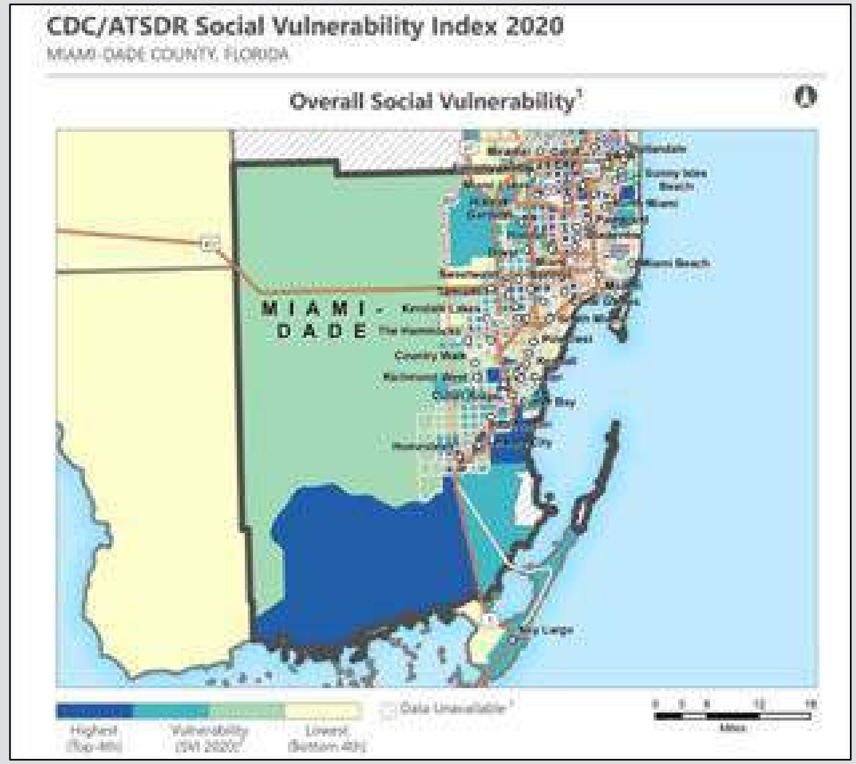
FEMA Alternative Cost-Effectiveness Methodology

- October 2022 Memo
- Applicable for FY22 only
- Building Resilient Infrastructure and Communities (BRIC) grants
- Flood Mitigation Assistance (FMA) grants
- Reduced discount rate for Benefit Cost Analysis (BCA) for disadvantaged communities

Incorporating Equity in Coastal Engineering Projects

Data Sources Available

- CDC/ATSDR Social Vulnerability Index (SVI)
- FEMA National Risk Index (NRI)
- EPA Environmental Justice (EJScreen) Tool
- UCF & UofSC SoVI®



Incorporating Equity in Coastal Engineering Projects

How to Use the Data

- Municipalities find it easy to use
- Helps decision makers prioritize adaptation projects (e.g. Resilient Florida program)
- Indices can be used as weightings for selected evaluation criteria

BCA provides decision makers with a clear indication of the most efficient alternative, that is, the alternative that generates the largest net benefits to society (ignoring distributional effects)

FROM 2003 A-4

Innovative Approach

Original Economic Valuation of Projects

- HDR funded a 2022 Fellowship — internal research
- Expert advisory panel guided this applied economics effort
- Investigated valuating distributional effects of projects

Weighted BCA (WBCA):

Analysis of Distributional Effects

- WBCA is derived from economic theory
- Weights w_i^{α} equal marginal utility of income "MU" ($\delta U / \delta y_i$) for an income (or group of incomes)
- Weights convert to a project value (based on \$ WTP) into "weighted dollars"
- Social equity value (**SEV**) combines weights with estimated benefits $\boldsymbol{B_{ij}}$ and costs $\boldsymbol{C_{ik}}$:

$$SEV = \sum_{i}^{I} \left[\sum_{j}^{J} w_i^{\alpha} \cdot B_{ij} - \sum_{k}^{K} w_i^{\alpha} \cdot C_{ik} \right]$$

ε = elasticity of marginal utility of income

y_α = benchmark income of region

$$w_i^{\alpha} = \left(\frac{y_\alpha}{y_i} \right)^{\varepsilon}$$

y_i = income group i in region

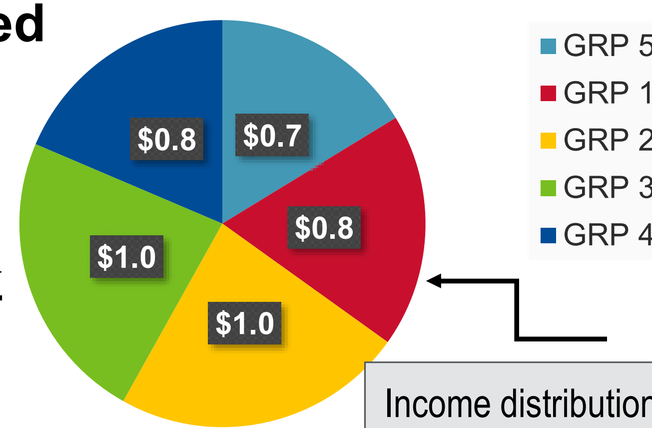
- Equity is represented by distribution of benefits & costs and associated utility value of outcomes
- Precedence in method: UK Green Book *(equivalent to US OMB)*

Analytical Approach *Illustration*

Standard BCA

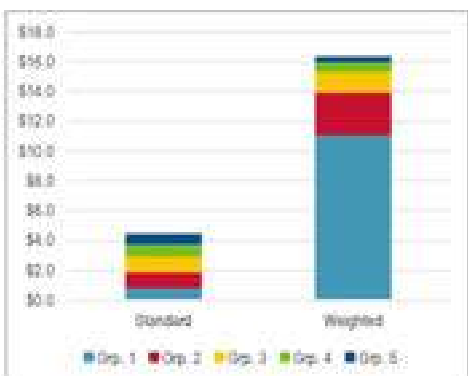
Benefit Category	Present Value ($M)
Residential Structures	$430
Residential Contents & Displacements	$$$
Commercial Structures	$$$
Commercial Contents & Displacements	$$$

Distributed Benefits

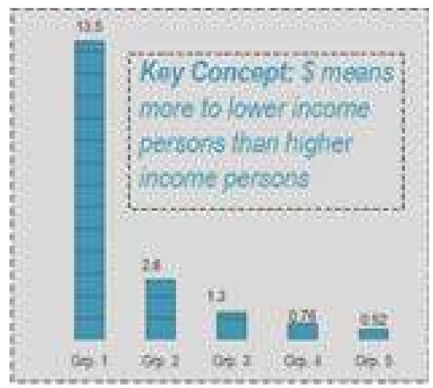


Income distribution of beneficiaries

Weighted BCA



Income-Based Weights



Income distribution of region

Innovative Approach

Next Steps

- OMB has drafted revisions to Circular A-94, related to BCA of projects
- Draft revisions include weighted BCA
- Apply WBCA to infrastructure projects
- Current areas of WBCA evaluations:
  - Flood risk and other hazard mitigation
  - Transportation systems
  - Broadband expansion
  - Renewable energy programs
  - Water and wastewater utility services

***No research without action,
no action without research.***

KURT LEWIN

R&D Recommendations

- Establish collaborative team with HDR, USACE
- Identify several potential locations for demonstrations
- Compute WBCAs to compare with BCAs, covering:
  - Flood risk
  - Property valuation
  - Recreational activity
  - Ecosystem services
- Policy questions:
  - How is WBCA incorporated into decisions, relative to BCA?
  - Is there a minimum BCA? And then ranking by WBCA?
  - On what basis can a project be funded with WBCA?

A rising tide raises all boats,
but you need a boat to rise with the tide.
What does he who does not have a boat do?

RAHUL GANDHI

Soupy Dalyander, Ph.D.

Dr. Patricia “Soupy” Dalyander, oceanographer and mechanical engineer, has over 20 years of experience in research and decision-support. Dalyander’s professional experience includes working with the Coastal and Marine Hazards and Resources Program of the U.S. Geological Survey. In addition, she worked on decision-support projects, sediment management, and water quality as a research scientist for the Engineering Research and Development Center of the U.S. Army Corps of Engineers (USACE). Dalyander studies sediment transport and morphodynamic change, beach and barrier island evolution, and developing ways to predict coastal restoration project success. She also specializes in structured decision-making and ecosystem service quantification and has been certified through the U.S. Fish and Wildlife Service National Conservation Training Center. At The Water Institute, she is the PI for the Louisiana Barrier Island System Management (BISM) program and Accelerating Integration of Natural and Nature Based Features into USACE Civil Works project. She led a team assisting the USACE Southwestern Division in the development of a Civil Works Strategic Plan, co-led team to develop a Research & Development Strategy for USACE, and created a new barrier island evolution numerical model for the Louisiana Coastal Protection and Restoration Authority (CPRA). Her activities at the U.S. Geological Survey included developing a new empirical dune growth model and contributing to frameworks to predict the decadal scale evolution of Dauphin Island, Alabama, and Breton Island, Louisiana, as well as collaborating to develop new ways to incorporate data and models into decision-support for the restoration of Ship Island, Mississippi under the USACE Mississippi Coastal Improvements Program (MSCIP).

Jean Cowan

Ms. Cowan, Senior Project Manager, brings more than 35 years of experience in coastal science and project management to The Water Institute team. After 15 years working on applied research at marine science laboratories, Cowan worked at Louisiana Department of Natural Resource as a coastal resource scientist during a pivotal time in Louisiana's coastal work 2002-2007. In 2007, Cowan moved to the National Oceanic and Atmospheric Administration where she spent nine years as a marine habitat resource specialist working on Natural Resources Damage Assessment and Restoration. In 2016, Cowan moved to the Gulf Coast Ecosystem Restoration Council, where she became the director of the Ecosystem Restoration Programs for the Gulf Coast Ecosystem Restoration Council. In this role, she led the development of programmatic documents that guide the Council's restoration decisions, worked to develop consensus among council members and coordinated the development of the Council's science-based monitoring and adaptive management guidelines. She is also trained in the process of Structured Decision-Making. This added expertise builds on a career that includes facilitating groups to reach decisions on complex issues

Quantifying Benefits of Natural and Nature-Based Solutions

Soupy Dalyander, Ph.D.
The Water Institute
Baton Rouge, LA

Jean Cowan
The Water Institute
Baton Rouge, LA

To accelerate progress and delivery of new and enhanced infrastructure projects for navigation, flood risk management, water operations, and ecosystem restoration consistent with its Engineering With Nature® (EWN) Program, the U.S. Army Corps of Engineers (USACE) has engaged in a collaborative effort with The Water Institute (the Institute) to research benefits evaluation of Natural Infrastructure, Natural and Nature Based Features, and other Nature-Based Solutions (NBS). The Institute analyzed and reported on how to best quantify, and potentially monetize, a more comprehensive range of economic, environmental, and social costs and benefits of NBS. The first phase described the evolution of USACE project evaluation methods from prior eras to the present day1. The second investigated NBS consideration in 150 USACE feasibility studies from 2005–20202. The third reviewed planning and valuation methods that could be applied by USACE to improve NBS evaluation3. The Institute then worked with USACE to conduct case studies on six of the 150 feasibility studies, comprised of investigating opportunities for USACE to apply new or augmented evaluation methods to capture a wider range of social, environmental, and economic benefits and costs from NBS. The analysis included 1) approaches that simultaneously assess multiple objectives measured with different performance metrics, and 2) ecosystem service valuation methods to integrate additional categories into the formal benefit cost analysis (BCA) currently applied to evaluate and prioritize alternatives within a USACE planning study4.

Under ongoing work, the Institute is working with the USACE EWN Technical Practitioner Leads, other District personnel, and individuals with relevant expertise to identify NBS challenges in practice and accompanying opportunities and enablers for accelerating implementation. The Institute is also working to identify methodologies for capturing the benefits NBS can provide for social equity specifically and for implementation of NBS on Department of Defense lands.

Summary of Findings

Through the analysis of the six case studies, the study team identified several key findings and opportunities for USACE to enhance its planning and evaluation process to include a wider range of social, environmental, and economic benefits and costs, as summarized in Table 1. These opportunities can support USACE in developing and applying forward-looking and practical approaches for formulating, evaluating, and developing water resources projects in a way that integrates and considers multiple benefits as required by the latest Principles, Requirements, and Guidelines (PR&G).

Planning Stage	Key Finding	Opportunity
Study Scope	Scoping within separate mission areas limits NBS opportunities.	Use an integrated, multi-objective approach to scope planning studies.
Alternative Formulation	NBS options are often excluded during alternative formulation.	Formulate integrated alternatives to provide benefits across all PR&G guiding principles.
Evaluation of Non-Monetized Outcomes	Existing tools can support non-monetary benefit estimation.	Evaluate alternatives using metrics for all PR&G guiding principles and communities of interest.
Ecosystem Service Valuation	A range of existing methods may be applied for more comprehensive valuation.	Develop USACE guidance, resources, and tools for monetizing a broader range of benefits.
Prioritization and Alternative Selection	Monetizing ecosystem services improved BCA analysis could not fully account for all benefits with multi-objective analysis.	Apply transparent multi-criteria decision analysis as primary approach for alternative ranking and selection.

QUANTIFYING BENEFITS OF NATURAL AND NATURE-BASED SOLUTIONS

P. Soupy Dalyander, Jordan Fischbach, Tim Carruthers, Colleen McHugh, Allison DeJong, Brett McMann, Abby Littman, Allison Haertling, Patrick Kane, Craig A. Bond, Jean Cowan

August 15, 2023

PROJECT APPROACH

SUMMARIZE	Historical and current alternative evaluation policies and practices
IDENTIFY	Six historical planning studies that considered NBS alternatives
REVIEW	Planning frameworks and valuation methods that incorporate environmental and social benefits
ANALYZE	Conducted case studies using updated methods and exploratory analysis to look beyond current policy constraints

FINDINGS FROM CROSS-CUTTING ANALYSIS INFORM RECOMMENDATIONS

STUDY SCOPING

ALTERNATIVES FORMULATION

EVALUATION OF NON-MONETIZED OUTCOMES

ECOSYSTEM SERVICE VALUATION

HOLISTIC ANALYSIS ACROSS MULTIPLE GOALS

CASE STUDIES SELECTED BASED ON MISSION AREA, LOCAL INTEREST, AND AVAILABLE DATA

CASE STUDY
SOUTH SAN FRANCISCO BAY, CA

Photo by Chris Benton

CASE STUDY

JACKSONVILLE HARBOR, MILE POINT, FL

Mile Point Construction (Photo by Mark Bias)

MONETARY AND NON-MONETARY METHODS ARE AVAILABLE TO EXTEND EVALUATION OF ECOSYSTEM SERVICES

Non-Market Valuation Methods
for Ecosystem Goods and Services

Worth (how much people would be willing to pay) is not revealed in market prices

***Multi-Objective Decision Support** Approaches*

Evaluate with multiple criteria using valuation, other quantitative, and non-quantitative metrics

BENEFIT RECREATIONAL USE

- **Multiple potential benefits:** fishing, camping, eco-tours, etc.
- **Recreational day use value:** aggregate value across uses such as hiking, birdwatching, etc.

BENEFIT

WATER QUALITY AND ACCESS

- **Water quality** supports species, recreation…but people also pay more for **water quality and water access**
- **Hedonics pricing:** estimate of enhanced value of home

BENEFIT

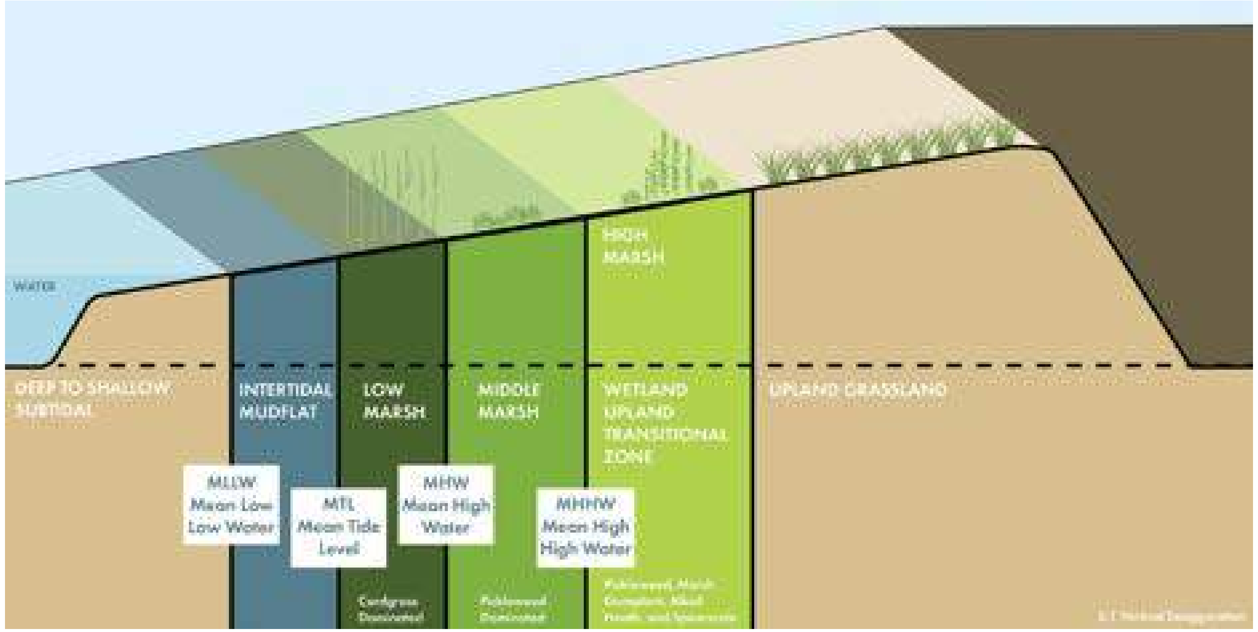
CARBON SEQUESTRATION

- Wetland ecosystems provide **carbon sequestration**
- **Method:** Estimate the acreage created and the associated carbon sequestration, then valuate as $$/Tonnes/CO_2/Acre

BENEFIT

FLOOD RISK REDUCTION…AND PROJECT LONGEVITY

- Marsh, dune, and beach **attenuate storm surge and wave energy**
- **Integrated solutions:** NBS can prolong life, reduce failure risk of gray infrastructure



BENEFIT

SEDIMENT MANAGEMENT COST REDUCTION

- **Beneficial use** preserves upland dredge disposal areas and extends the usable lifetime
- Benefit quantified through **value of preserved space** using cost of alternative offshore disposal


Image from Great Lakes Dredge & Dock Company, LLC Website


Image from USACE Mobile District

ONGOING ACTIVITIES

Case study extension to focus on **social outcomes and equity**

Practical implementation guidance and support for USACE practitioners

R & D RECOMMENDATIONS

- **Foundational research**
  - Risk / failure analysis of NNBF
  - Quantification of storm, flood risk reduction
  - Social equity outcome quantification
- **Development of District-ready tools**
  - Expansion of USACE-certified modeling toolkit, planning tools
  - Benefits transfer and case databases
  - Multi-criteria decision analysis frameworks
- **Development of guidance materials**
  - Integrated, multi-objective project scoping & alternative formulation
  - NNBF and integrated green/gray alternative design
  - Implementation, O&M, and adaptive management
  - Intra- and interagency collaboration: regional sediment management, partnering, etc.

EWN Engineering With Nature | US Army Corps of Engineers | THE WATER INSTITUTE

P. Soupy Dalyander

Link to Capstone Report

Marriah Abellera

Ms. Abellera is the Coastal Program Manager for the U.S. Army Corps of Engineers, Institute for Water Resources leading multiple initiatives focused on innovative solutions for coastal resilience. Marriah is currently managing several national coastal climate adaptation and coastal resilience programs to include the National Shoreline Management Study (NSMS), Systems Approach to Geomorphic Engineering (SAGE), and Coordination with Other Water Resource Agencies programs. Her work is focused on advancing integrated water resource solutions across interagency collaborative partnerships. Her recent work is centered on the development of a national coastal assessments and Nature-Based (NBS) solutions for civil works projects. She is also managing the development of multiple tools for USACE, to include Coastal Storm Damages Prevented (CSDP)Tool and Ecosystem

Matthew Wesley

Mr. Wesley is a Coastal Engineer with the Los Angeles District with over 8 years of experience. Duties include both engineering design work and technical analysis of complex coastal systems in multidisciplinary teams. He has led the technical analysis of coastal storm risk management and aquatic ecosystem restoration studies as well as operation and maintenance of navigable waterways, breakwaters and jetties. Mr. Wesley holds a Bachelor of Science in Civil Engineering and a Master of Science in Ocean Engineering from the University of Hawai'i at Mānoa. He is a registered Professional Civil Engineer in the state of California and his work has been published in Coastal Engineering. He is an active member of the Coastal Working Group and the HH&C community of practice. As an avid sailor, in his free time, Matt explores the majestic coastal waterways of California when conditions are right.

US ARMY CORPS OF ENGINEERS

Coastal Storm Damages Prevented (CSDP)

Overview

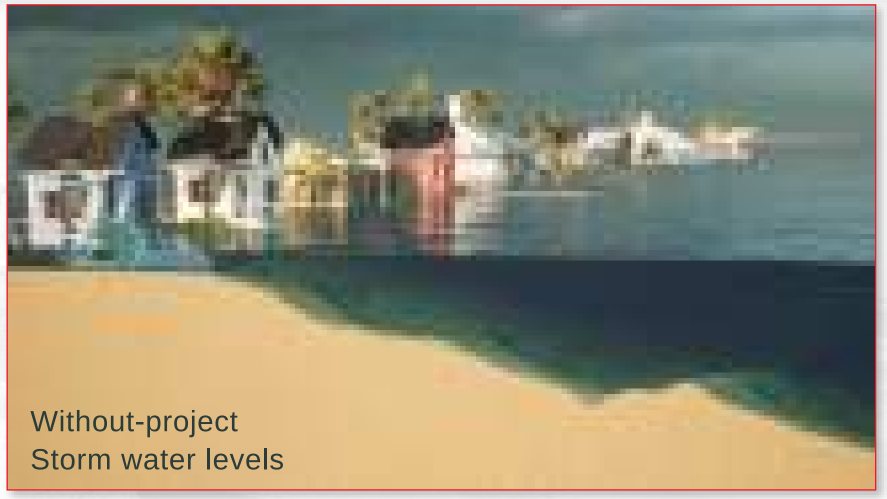
The U.S. Army Corps of Engineers (USACE) has developed the **Coastal Storm Damages Prevented (CSDP)** tool to provide USACE project managers, planners, coastal engineers, and economists the capability to develop regional and national assessments of damages reduced by USACE Coastal Storm Risk Management (CSRM) projects. CSDP allows USACE to report the benefits of USACE CSRM projects to technical experts and decision makers, USACE leadership, Congress, and the public.

The CSDP tool provides USACE with a consistent approach for assessing damages prevented by CSRM projects. CSDP has two parts: **Annual CSDP Reporting** and **What-if Scenario Analysis**.

Annual CSDP reporting estimates damages prevented by a CSRM project for storms for a reporting year. Input consists of data describing the project, storm characteristics, damage functions, and structure information. The analysis applies the same storm and structure inventory to the with- and without-project conditions. Damages are calculated at the structure level. Damages prevented are the difference between total damages with and without the project being in place.

Outputs are used to inform Congress of CSRM project benefits in the **Annual Flood Damage Report** to Congress. Outputs are available at different spatial levels (census block group, census tract, and then USACE Districts, Divisions, and/or the national boundaries).

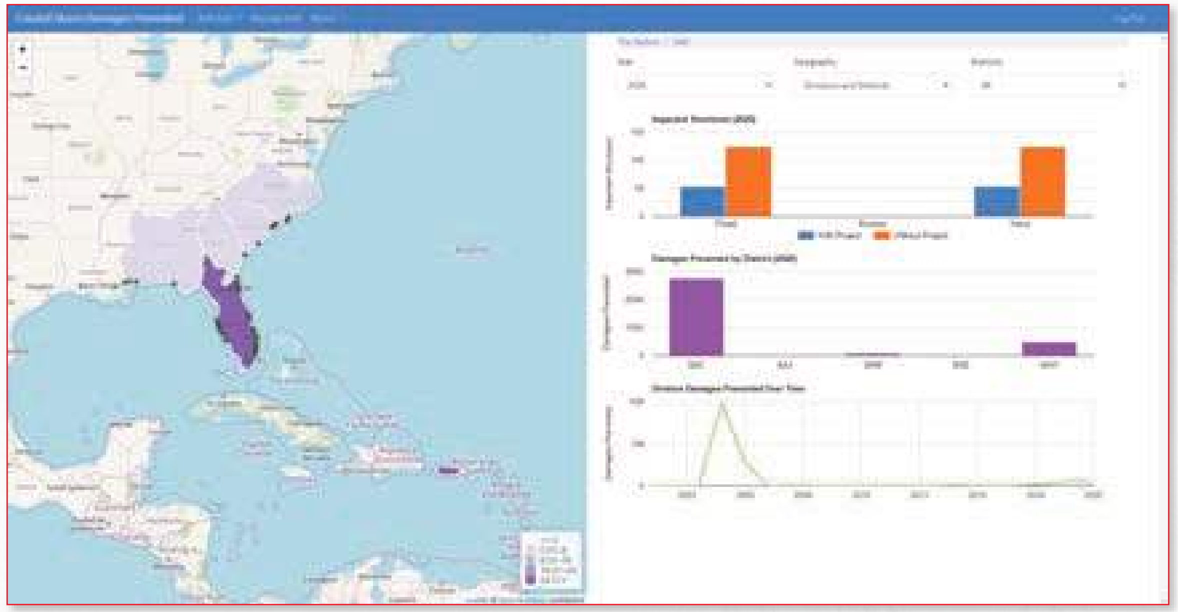
What-if Scenario Analysis adds features and flexibility that allow for rapid screening-level examination of planned or existing CSRM project performance under different conditions such as alternative designs, increased storm intensity, and risk due to sea level rise at a study location.



Without-project
Storm water levels

With-project
Storm water levels

CSDP Dashboard Tool: Damages prevented ($) and # of impacted structures, displayed by Division, District, and over time.



CSDP uses a cloud-based design that:

- is easy to deploy to the field through a browser interface;
- uses technical methods based on standard
- USACE models and approaches; provides a variety of reports, charts, and maps at different levels of aggregation through an easy to use dashboard; and
- can incorporate new advances in coastal engineering analysis.

Benefits

- **Highlights Value of CSRM Projects - Return on Investment**
- **Reports Damages Reduced**
- **Communicate Benefits of CSRM**
- **Assess Current and Future Risks**
- **Supports Project Scenario Analyses**

IWR

US Army Corps of Engineers.

Coastal Storm Damages Prevented

How CSDP Works

CSDP is a cloud-based system and back-end database that provides a uniform methodology for the analysis of storm-induced morphology changes and structure damages. Users submit a package of information involving transect-based morphology, storm information, structure inventory, and damage functions, using standard spreadsheet and geographical information system (GIS) formats. A **morphology model**, which determines the response of the beach profile to the input storm, provides storm-induced flood, erosion, and wave hazard estimates. A **consequence model** determines damages at the structure level from the hazard values. The **user interface** provides the capability to submit and edit packages and view and download results of the morphology and consequence modeling. A **top-level dashboard** displays data on damages prevented through charts, tables, and maps. The dashboard provides users the flexibility to visualize results at the project level or through roll-ups, across a District, Division, or nationally, and through examination of results across years. In addition to the annual reporting capabilities, the **What-If Scenario Analysis** tool can be used assess impacts of alternative futures scenarios.

Consequence Visualization Tool:
Damages Prevented by Census Tract

Dashboard Example:
Summary Project Analysis for a given year

User Application

Districts prepare annual data on the significant storms in the reporting year. Those data are combined with morphologyinformation (with- and without-project conditions) and an inventory of structures subject to damage. The total set of information submitted is referred to as a package. An automated cloud-based analytical process using standard USACE technical approaches and models calculates damage in with- and without-project conditions. Damages prevented are obtained by subtracting calculated with-project damages from calculated without-project damages. The steps are as follows:

1
A one-time initial setup defines the project situation in terms of with- and without-project beach profiles and structure inventory and damage function data. The anticipated level of user effort is less than a week for the initial project setup; the annual update should take about one day.

2
Data are prepared locally at the District level on an annual basis in standard formats (spreadsheets, GIS) and uploaded to the CSDP system.

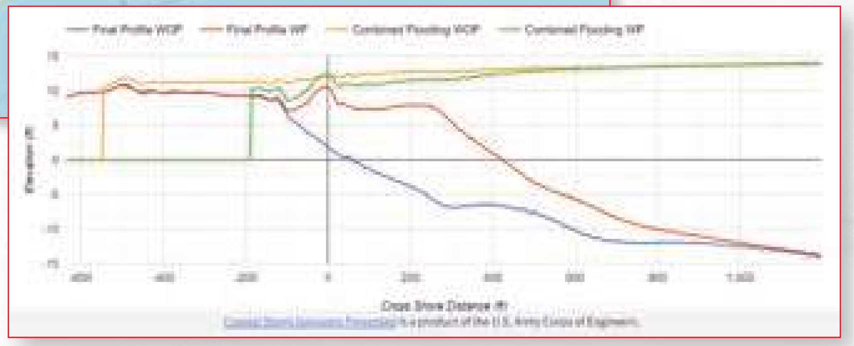
3
Numerical modeling using CSHORE automatically creates hazard profiles describing wave, water level, and erosion hazards. Provisions can be made for other morphology model results if desired.

4
Damages are estimated at each structure using hazard profiles and damage functions that describe structure and content loss given calculated wave, water level, and erosion hazards at the structure. These data are determined for with- and without-project conditions.

5
Results at the structure level are rolled up to census block group and census tract levels for display in a consequence visualization tool.

Scenario Analysis Results Visualization:
Damages Prevented at Structure Level

Results Visualization:
Morphology Model



CSDP Investment Needs For Future Development

- Expansion of the tool will provide analyses across the portfolio of CSRM projects to include hardened structures, nonstructural alternatives, and natural and nature-based features (NNBF).
- Implementation of a direct linkage to the National Structure Inventory (NSI) will allow for simple and uniform specification of the structure inventories used in the analysis.

US Army Corps of Engineers

IWR

Learn More
Website: www.iwr.usace.army.mil/Missions/Coasts/National-Shoreline-Management
Email: NSMS@usace.army.mil

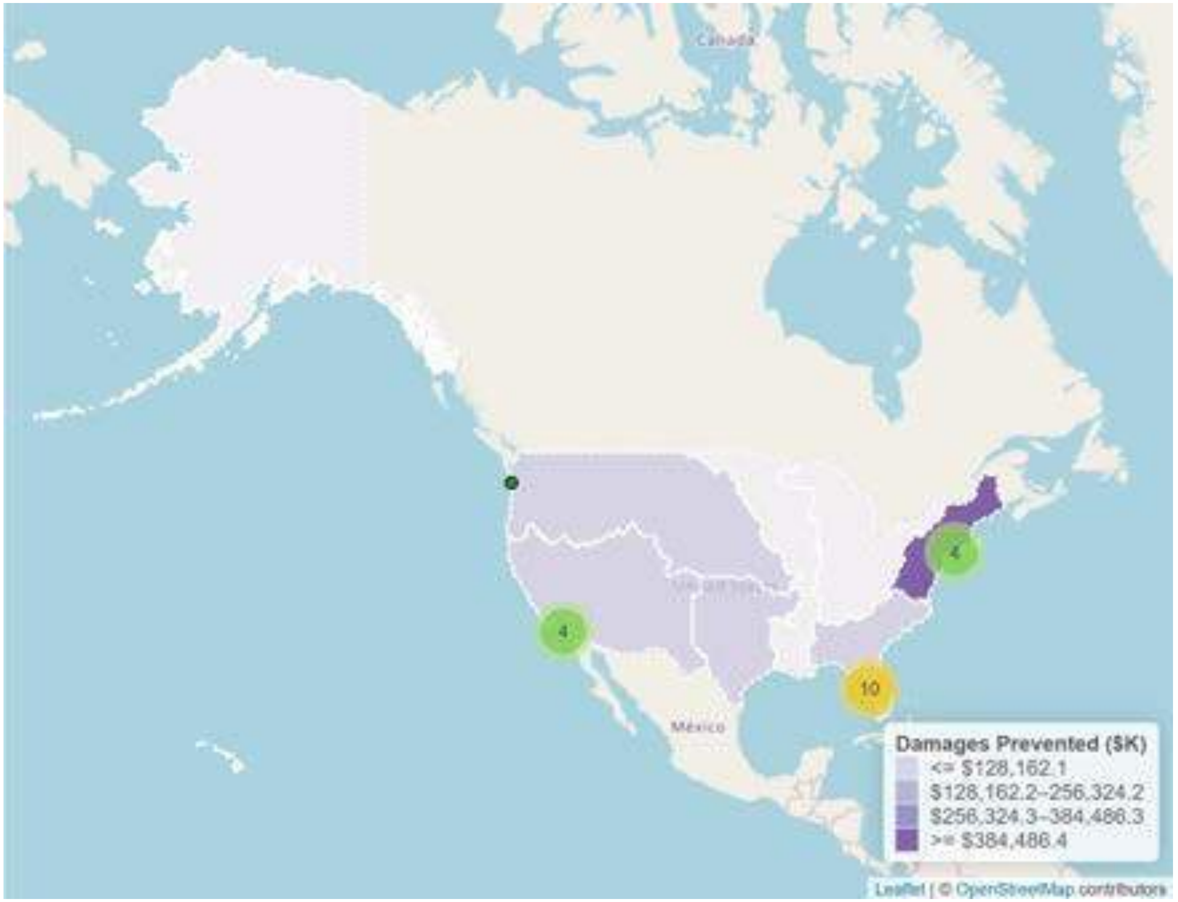
Coastal Storm Damages Prevented Tool

BCER
August 2023

Marriah Abellera
Matt Wesley

U.S.ARMY
US Army Corps of Engineers
IWR

CSDP PROJECT INTENT



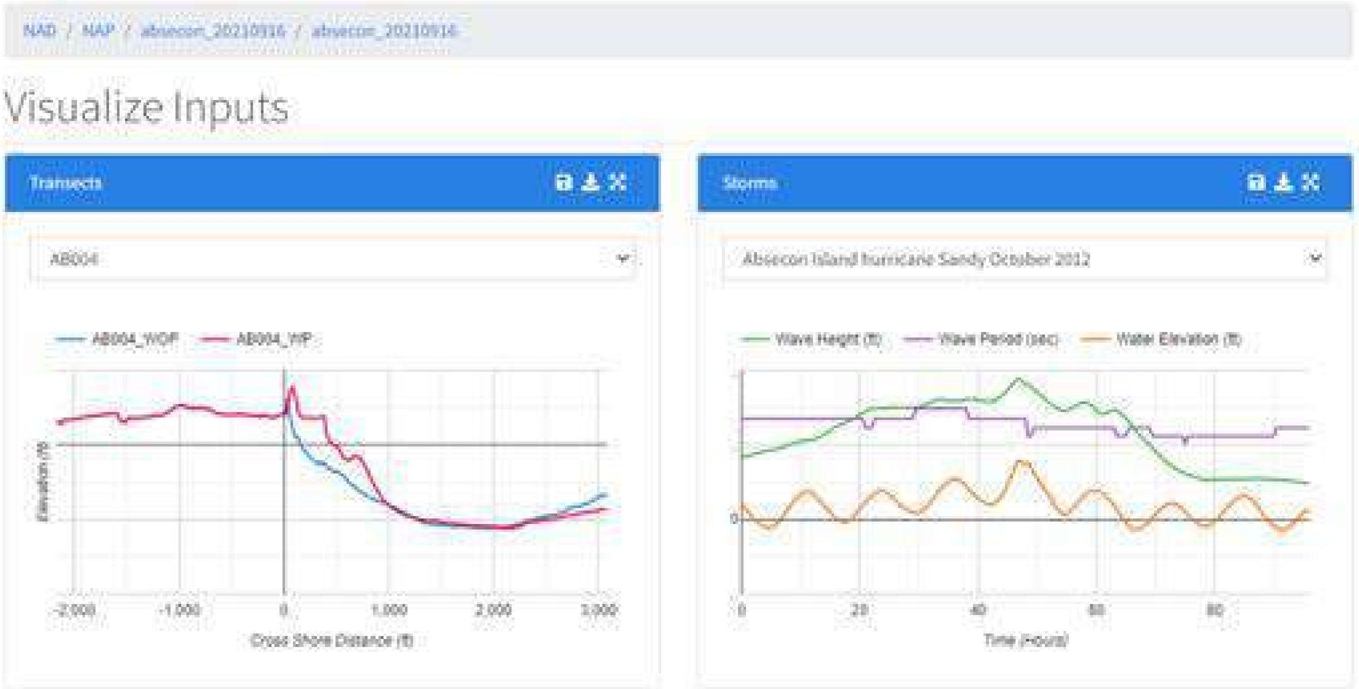
Support the development of a **national framework for retrospective assessments of damages reduced by coastal projects and forward looking regional and national assessments of comparative existing and future risks** that are accessible to technical experts, USACE leadership, Congress, and the public.

WHY THIS IS IMPORTANT

- ➢ USACE coastal projects lack visibility on damages prevented to decision-makers (US Congress)
  - District/Division/USACE roll-ups
- ➢ We are not highlighting the value and successes of our projects
- ➢ Poor public perception of coastal projects
  - Projects primarily serve only those living on the beach
- ➢ Physical performance of coastal FRM projects poorly understood
  - Costly projects “washed away” in first storm season
- ➢ Coastal project role in community resiliency not fully appreciated
- ➢ Consequences are realized but we don’t cast those consequences in the context of what could have been in the absence of a project

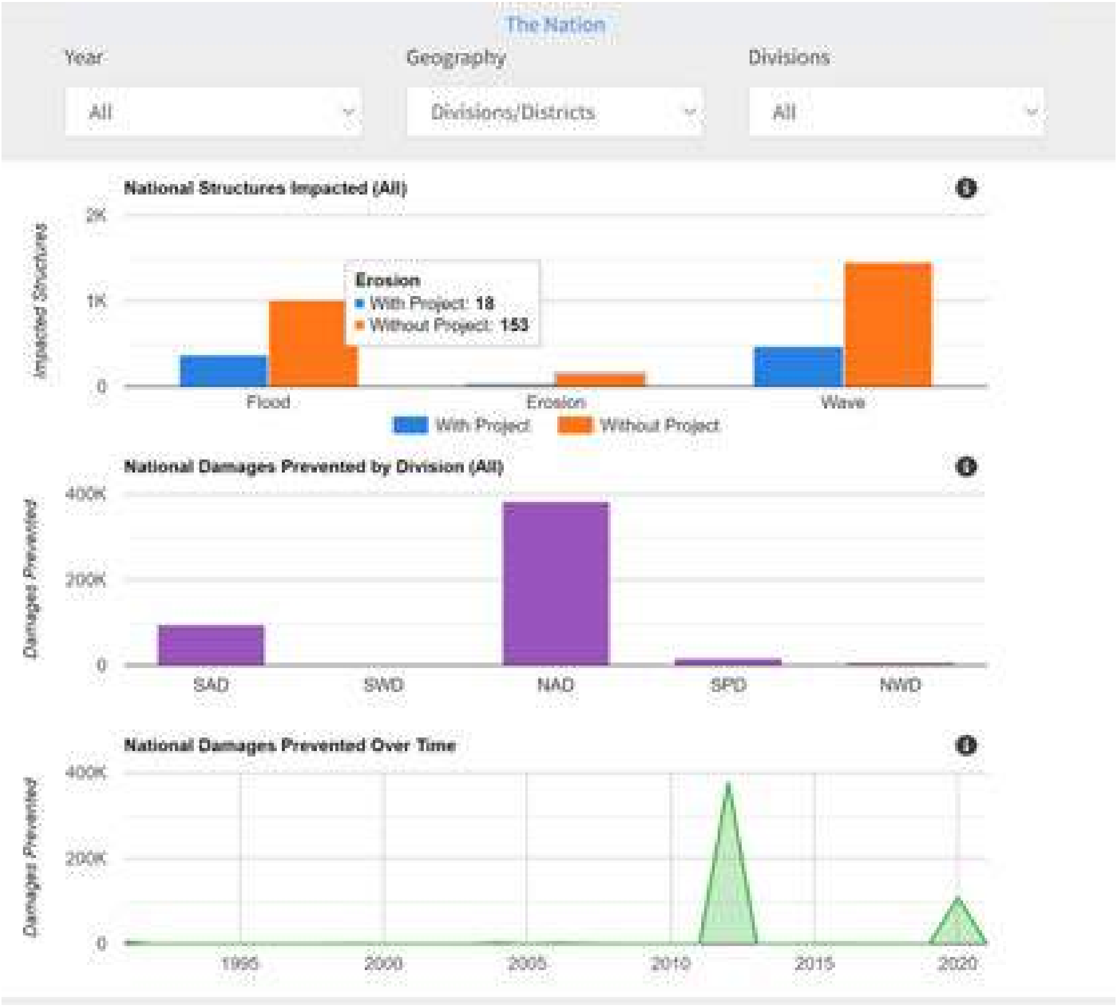
TESTING & TRAINING PILOT PROJECTS

- Martin County, FL (SAJ)
- Duval County, FL (SAJ)
- Pinellas, FL Treasure Island (SAJ)
- Pinellas, FL Long Key (SAJ)
- Absecon Island, NJ (NAP)
- Revere Beach, MA (NAE)
- Galveston, TX (SWG)
- Saipan Beach Road, Saipan Island (POH)
- Shoalwater Bay, WA (NWS)
- Surfside Sunset CSRM, CA (SPL) [4 projects]



ROLLOUT

- Introductory Webinar (Jan 2023)
- Demonstration Webinar (Feb 2023)
- Initiate CSDP roll out (Mar 2023)
  - ➢Helpdesk support available
- Requesting Data for Annual Damages Reduced Report to Congress (2nd QTR 2024)



WHAT-IF SCENARIO ANALYSIS

The What-if Analysis tool provides a methodology to illustrate future flood risk. It provides the opportunity to look to the future for decision support purposes. Technology can be leveraged for what-if scenario analysis and exploration of risk due to sea-level rise and increased storm frequency and/or intensity. This type of scenario analysis helps demonstrate the benefits of USACE coastal projects by showing a comparison of current and future scenarios.

Types of What-if Analysis

- How would a project perform if sea level were to rise by 10 feet?
- What would a beach look like after a storm?
- How would conditions differ with two different scenarios?

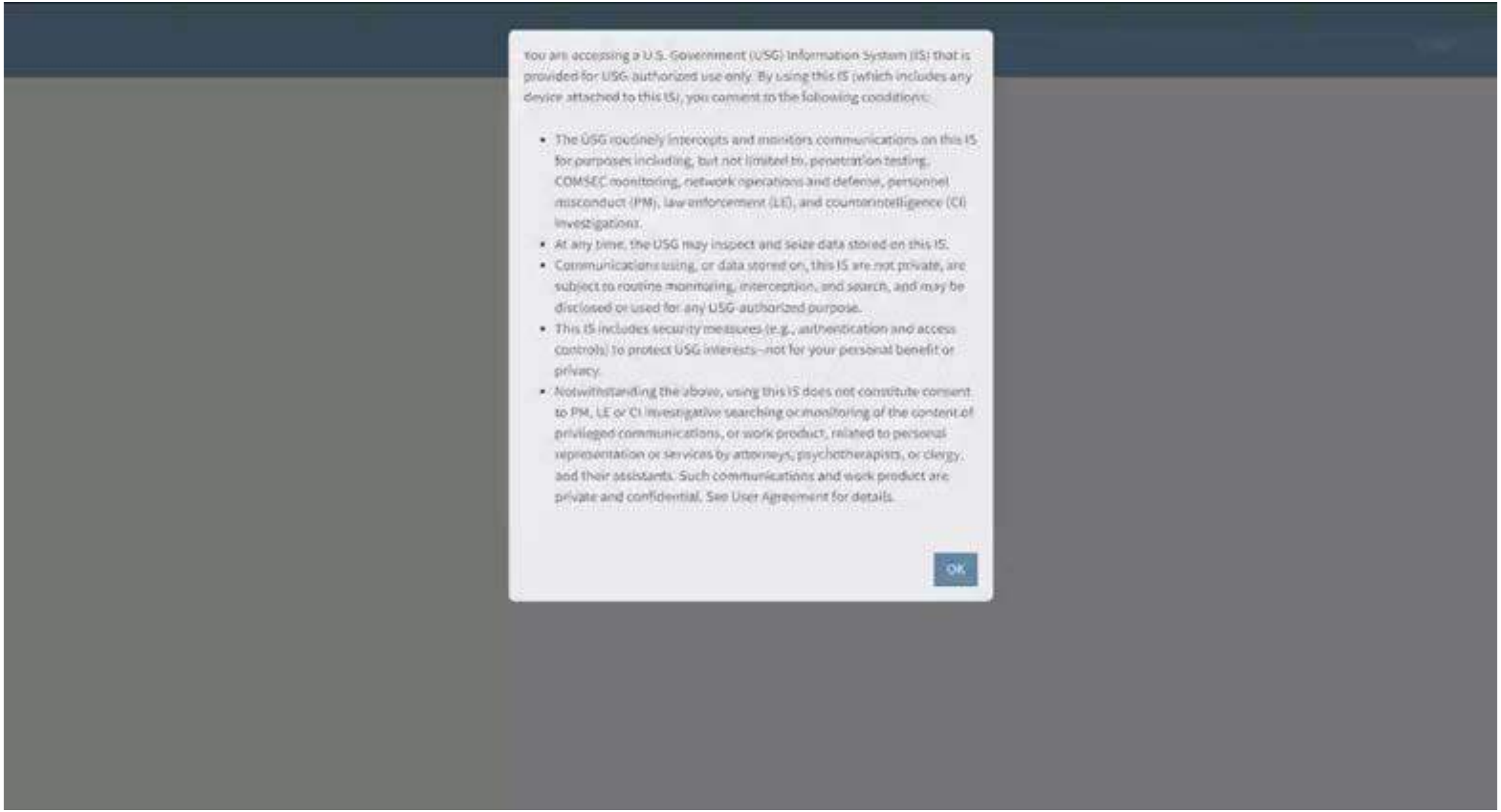
CSDP PDT AT DISTRICT/DIVISION LEVEL

- Coastal/Hydraulic Engineer
  - Profiles (survey information), waves & water levels

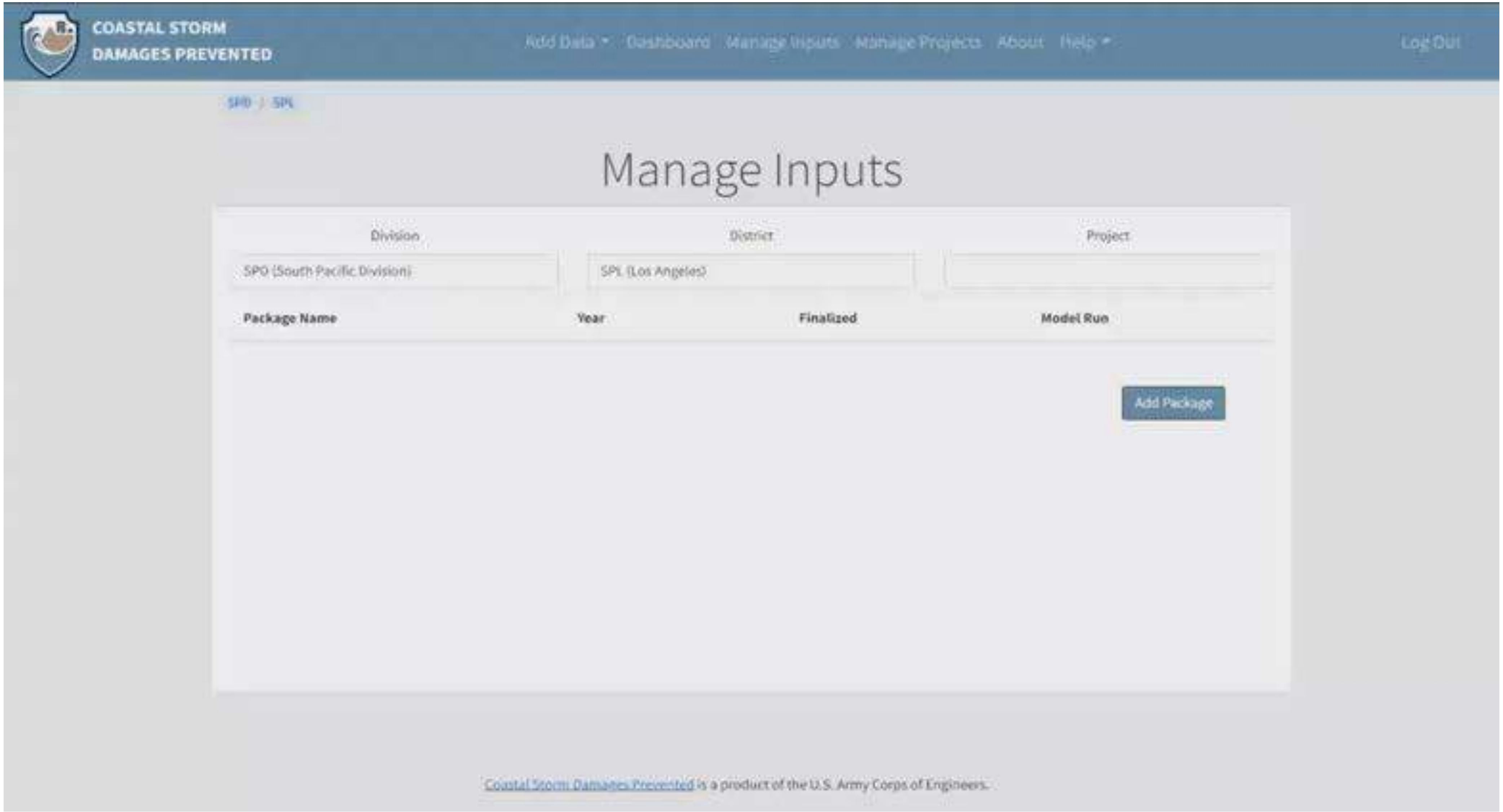
- Economist
  - Asset inventory & damage functions

- GIS Analyst

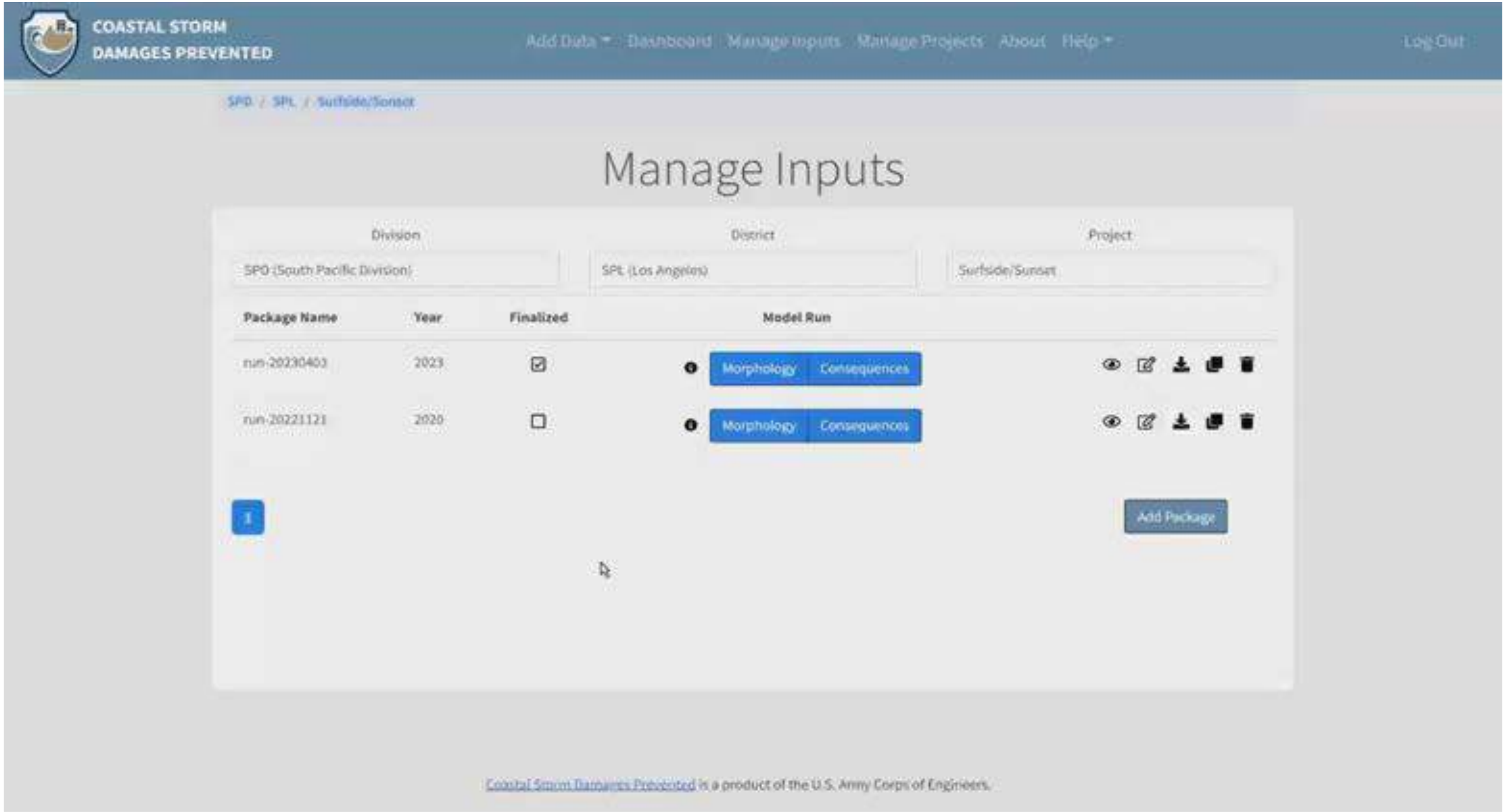
LANDING PAGE & LOGIN



PROJECT CREATION



PACKAGE CREATION



PROJECT WORKBOOK

- Contains:
  - Project information
  - Datums
  - CSHORE parameters
  - Transect information
  - Distance, Elevation pairs for with & without project profiles

- With project condition based on more recent survey information (pre-storm)

- Without project based on pre-project conditions or engineering best judgement

Identifier	Value
Name	Surfside/Sunset CSRM Profiles SS001 - SS008a
ProjectYear	2022
CRS	6426
Vertical Datum	North American 1988 (NAVD 88)
Prepared By	Matt Wesley (SPL)
Description	FY 2022 storm of record. Transects from CONED + 2016 USGS Lidar
CellSize (m)	0.5
Gamma	0.6
GrainSize(mm)	0.3
SuspensionEfficiency	0.005

Project information

CSHORE information

Profile	Transect	ID	Type
SS001_WOP	SS001	1	Pre
SS002_WOP	SS002	2	Pre
SS003_WOP	SS003	3	Pre
SS004_WOP	SS004	4	Pre
SS005_WOP	SS005	5	Pre
SS006_WOP	SS006	6	Pre
SS007_WOP	SS007	7	Pre
SS008_WOP	SS008	8	Pre
SS008a_WOP	SS008a	37	Pre
SS001_WP	SS001	1	Post
SS002_WP	SS002	2	Post
SS003_WP	SS003	3	Post
SS004_WP	SS004	4	Post
SS005_WP	SS005	5	Post
SS006_WP	SS006	6	Post
SS007_WP	SS007	7	Post
SS008_WP	SS008	8	Post
SS008a_WP	SS008a	37	Post

Matching without- (WOP) & with-project (WP) pairs

ID_Number	Transect	Northing	Easting	Azimuth
1	SS001	2214049.5	6004106.6	220.3
2	SS002	2212876.5	6005025.8	224.6
3	SS003	2211509.8	6006606.8	224.5
4	SS004	2209682.1	6008221.6	224.7
5	SS005	2205868.6	6011473.4	225.0
6	SS006	2202373.6	6014407.7	237.1
7	SS007	2199602.2	6016506.3	228.8
8	SS008	2197546.5	6018078.3	231.1
37	SS008a	2196884.3	6018612.3	231.1

Transect baseline

STORM WORKBOOK

- Contains:
  - Storm information
  - Datum
  - Wave and Water Level (Surge) Hydrograph

- Waves from nearby buoy, transformed to the project site if needed

- Water levels from nearby gauge (adjusted as necessary)

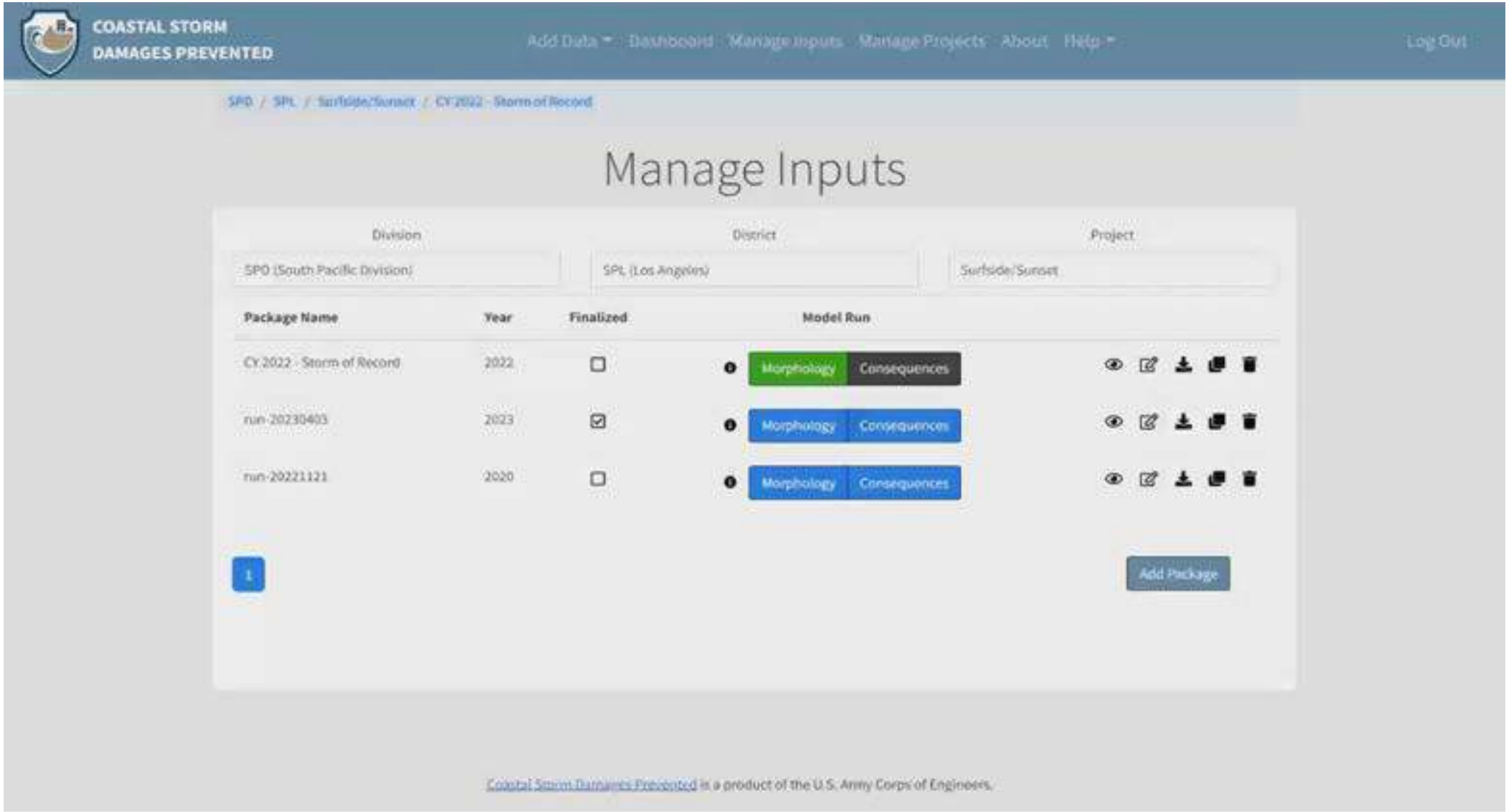
Storm information

StormID	Description	Vertical_Datum
OC608_SUM_2022	Summer king tides in July 2022, waves from local MOP OC608	North American 1988 (NAVD 88)

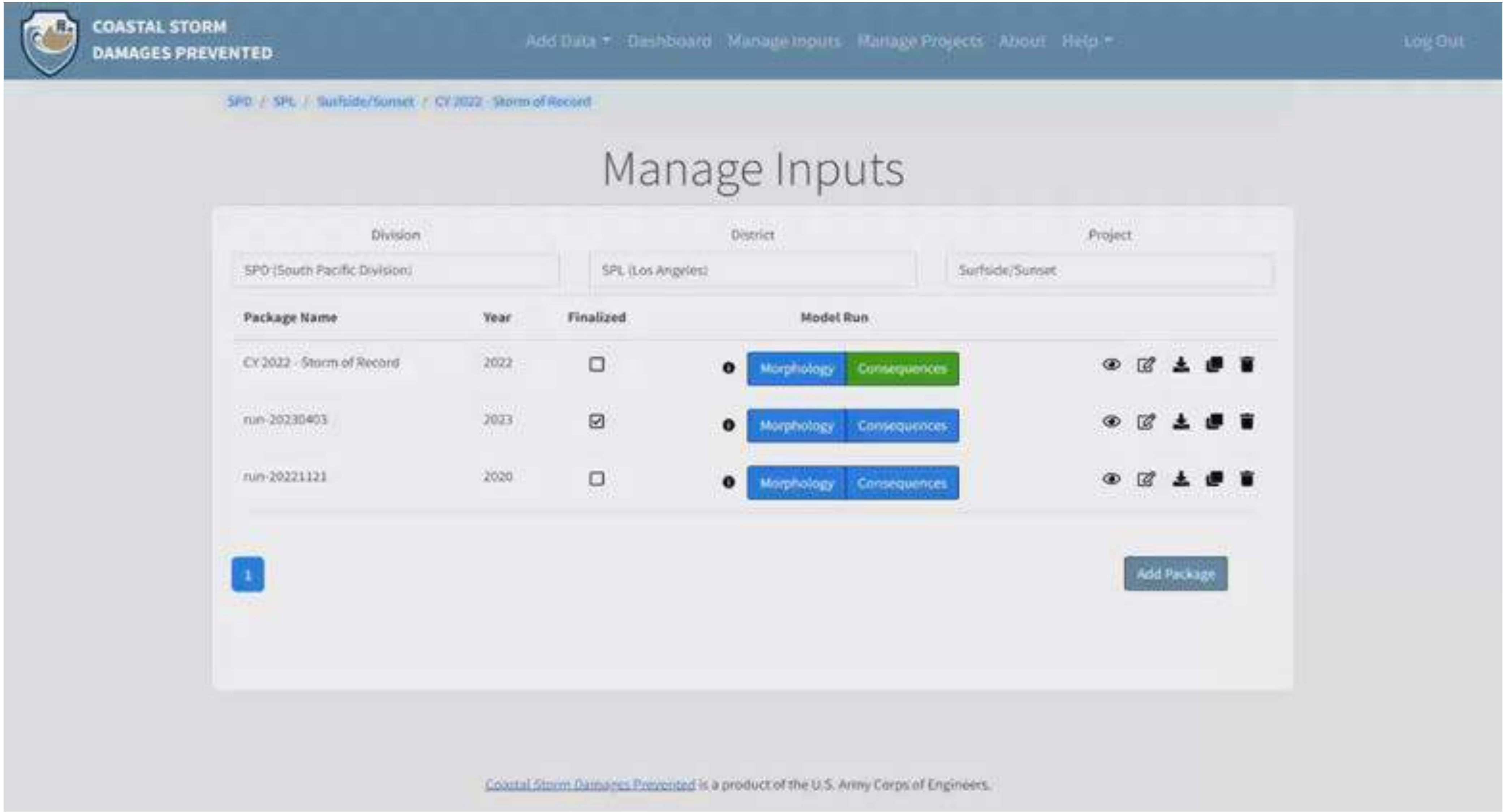
Storm hydrograph

Time	WaveHeight	WavePeriod	WaterElevation	WaveAngle
0	1.99	16.7	-0.31	0
0.5	1.98	16.7	-0.53	0
1	1.98	16.7	-0.58	0
1.5	1.94	16.7	-0.55	0
2	1.90	16.7	-0.36	0
2.5	1.90	16.7	-0.01	0
3	1.89	16.7	0.48	0
3.5	1.84	16.7	1.01	0
4	1.79	16.7	1.52	0
4.5	1.76	16.0	2.04	0
5	1.73	15.4	2.56	0
5.5	1.67	15.4	2.96	0
6	1.62	15.4	3.31	0
6.5	1.66	15.4	3.58	0
7	1.70	15.4	3.67	0
7.5	1.70	15.4	3.63	0
8	1.70	15.4	3.54	0
8.5	1.81	15.4	3.33	0
9	1.92	15.4	3.07	0
9.5	1.89	15.4	2.77	0
10	1.87	15.4	2.47	0

MANAGE INPUTS

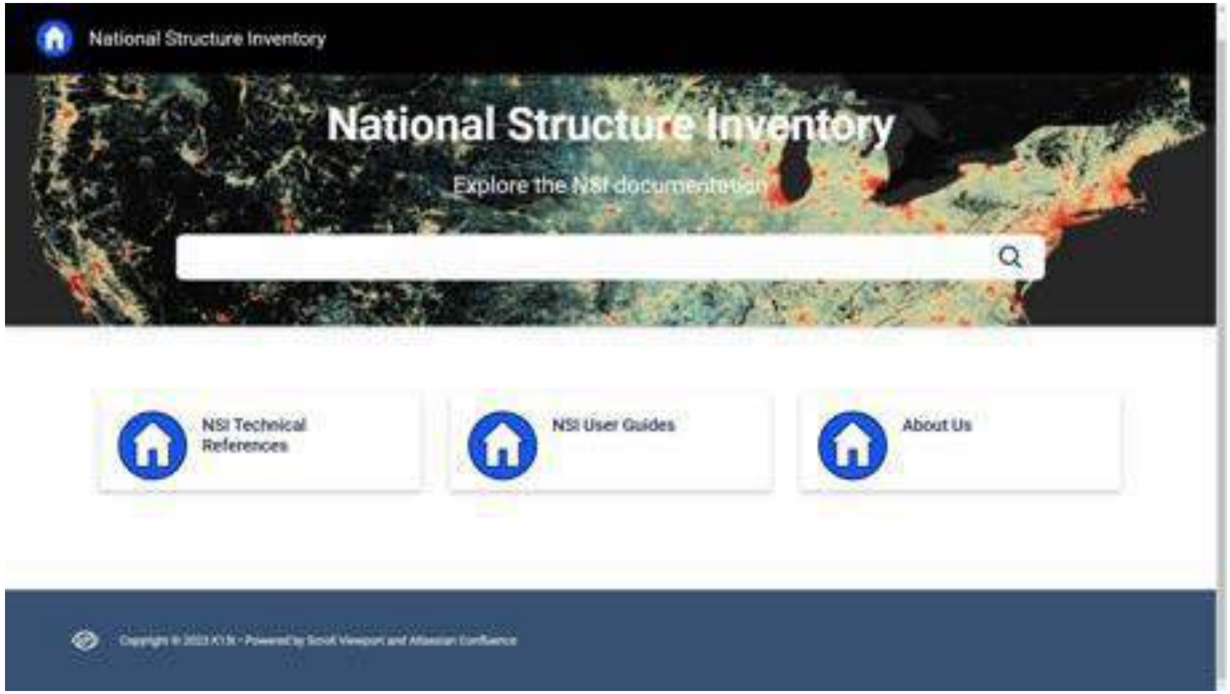


VIEW MORPHOLOGY

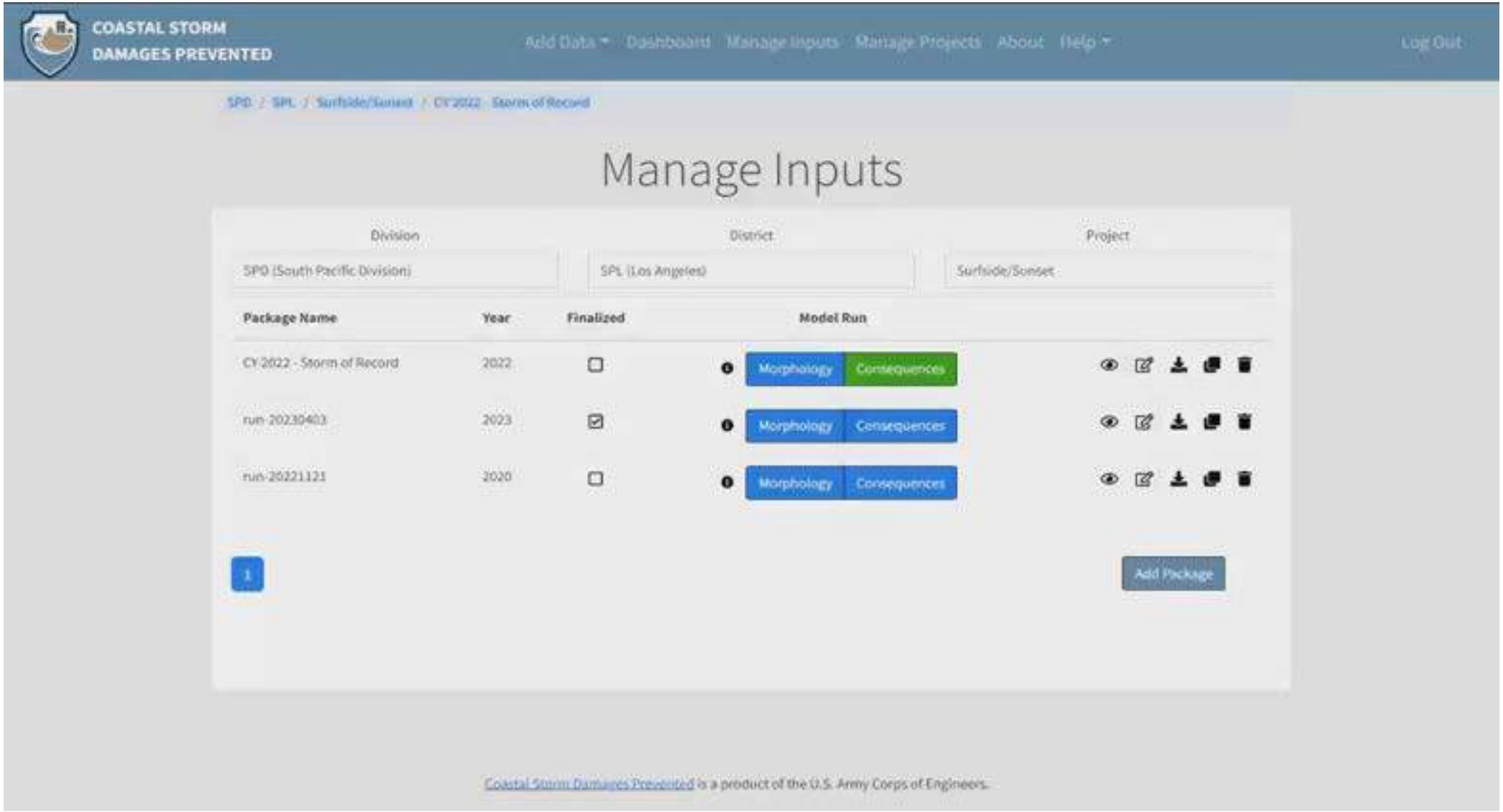


ASSETS & DAMAGE FUNCTIONS

- Asset Inventory
  - Crop to area and convert to geojson using GIS
  - National Structure Inventory (NSI)
    - Well documented
  - Local inventory in NSI format
- Damage Functions for wave, inundation and erosion
  - User specified in spreadsheet
  - NACCS
  - Local

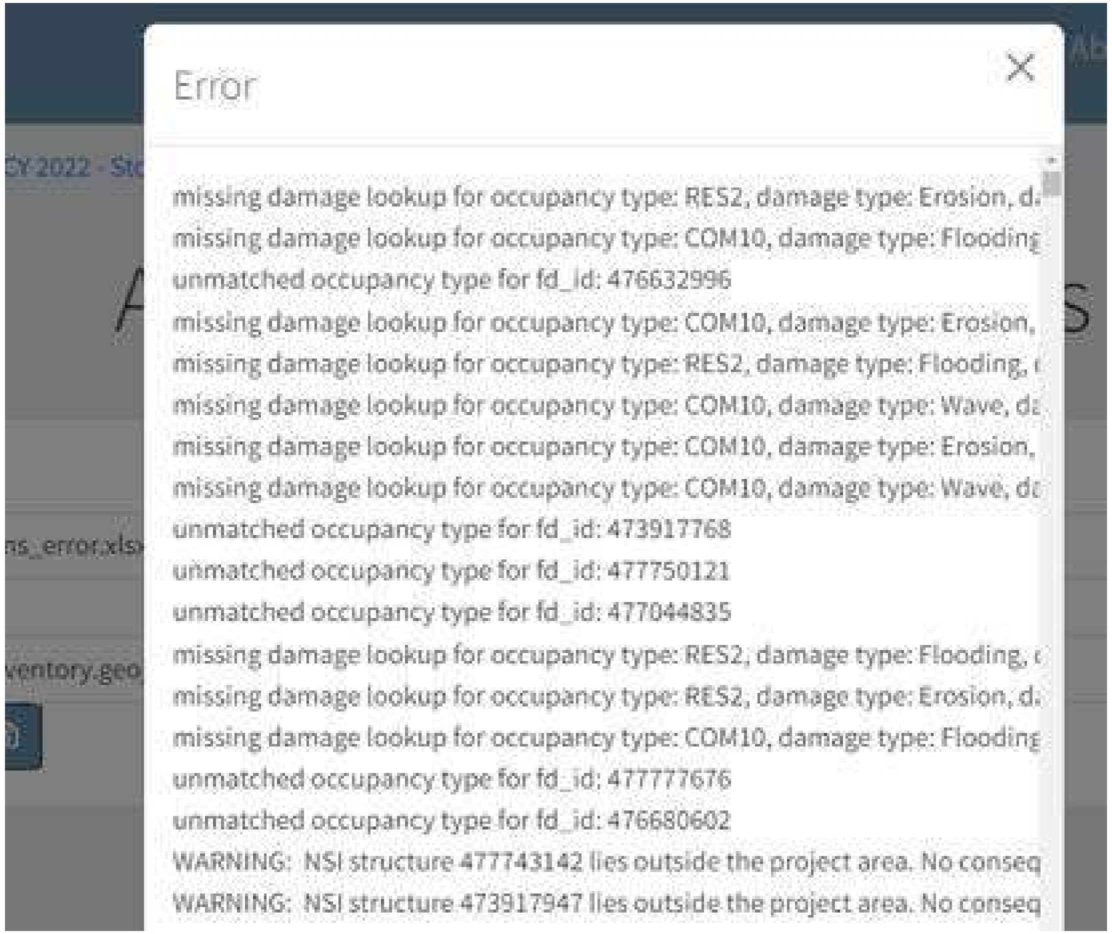


RUNNING CONSEQUENCES

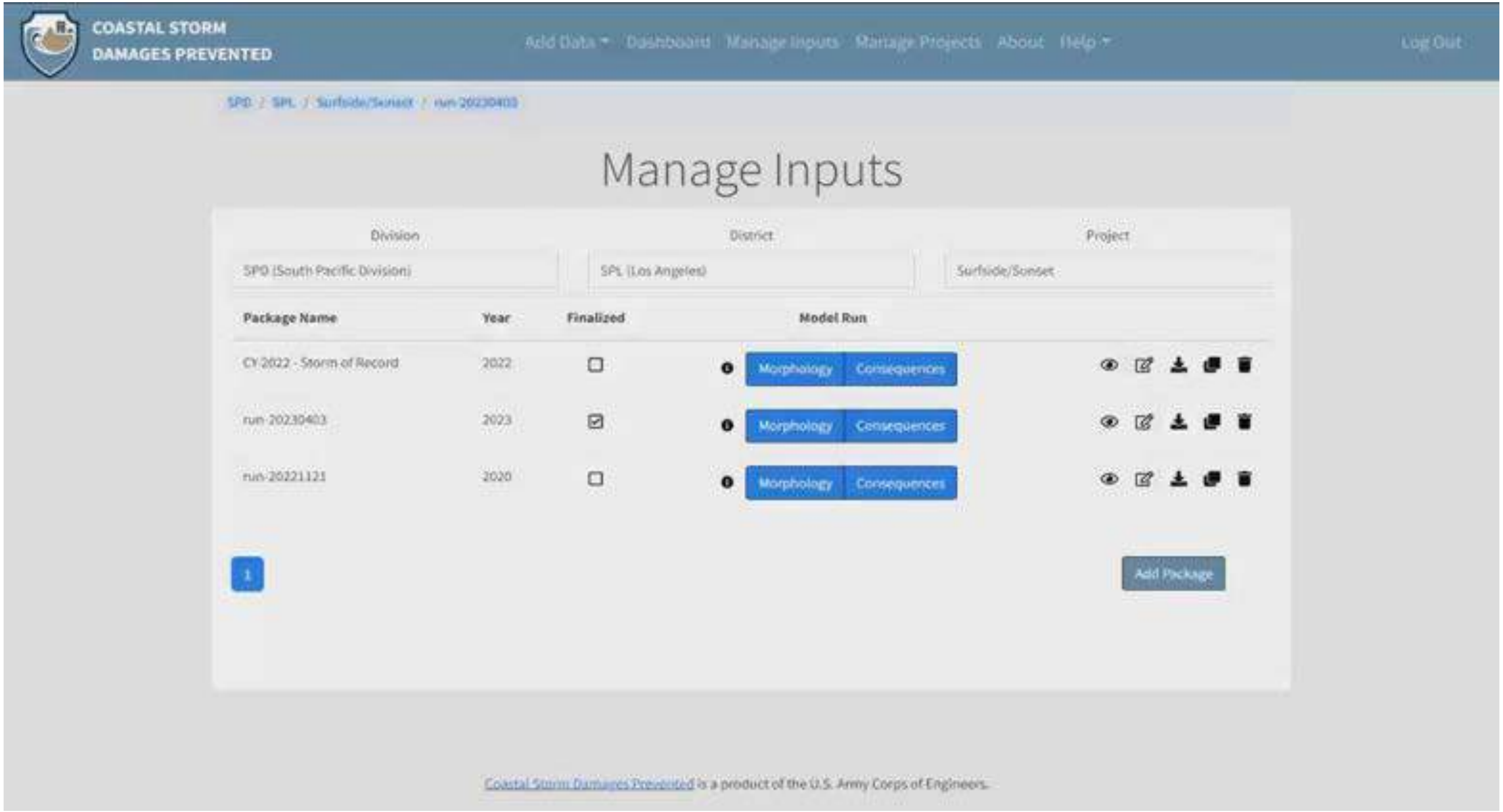


VALIDATION CHECKS

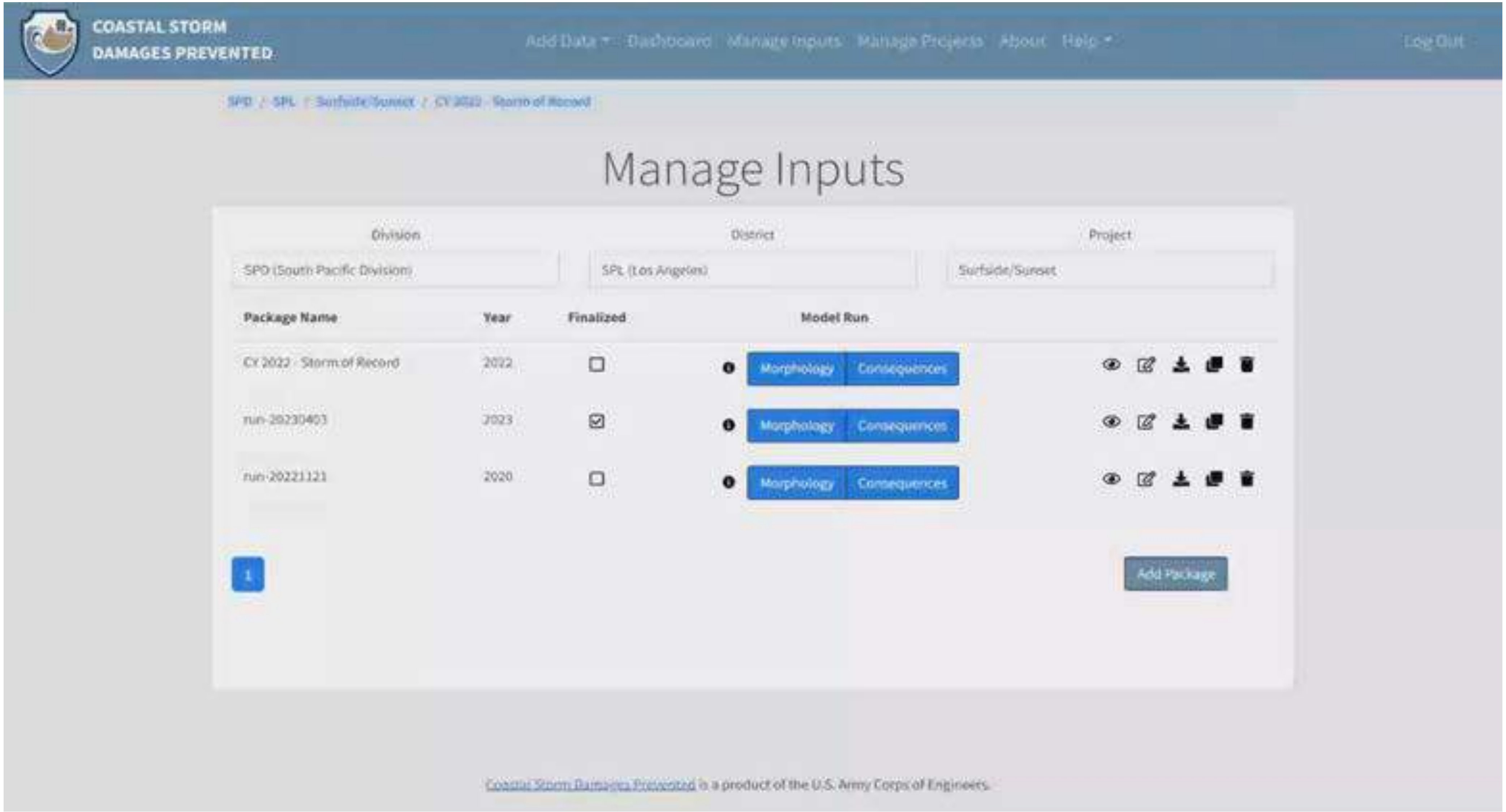
- Provides validation checks when relating asset inventory to damage functions
- Will not run unless checks are satisfied
- User can modify asset inventory or damage functions



VIEWING CONSEQUENCES



ROLLUP DASHBOARD



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Lauren Molina
Donald Cresitello
John Winkleman
Sean Smith

Questions & Discussion

US Army Corps of Engineers

IWR

Site Visit

M. Chris McNees

Mr. McNees is a Project Manager with the Jacksonville District US Army Corps of Engineers where he is responsible for leading interdisciplinary Project Delivery Teams consisting of engineering, planning, construction, and/or operational personnel in the execution of large-scale civil works projects. Currently, he serves as the Project Manager on various Federally-authorized navigation projects in Florida, including Miami Harbor, Palm Beach Harbor, and Matanzas Pass in Ft. Myers Beach, and in the US Virgin Islands, including Christiansted Harbor in St. Croix. In addition, he manages various flood risk management projects in the USVI and coastal storm risk management (CSRM) projects in Miami-Dade County, Palm Beach County, and Lee County. He is responsible for the execution and completion of navigation improvement and CSRM feasibility studies, including the ongoing Miami Harbor Navigation Improvement Study and the soon-to-start Key Biscayne, FL CSRM Study. Most recently, the Miami-Dade County CSRM Study for the Main Segment was completed in September 2022 and authorized in the Water Resources Development Act of 2022.

Throughout his 25-year professional career, Mr. McNees has also worked as a project manager in regulatory compliance, environmental risk management, and contamination assessments and remediation; a program manager in corporate quality assurance/quality control; a community outreach facilitator as part of the Air Force Community Partnership Program; a contracts manager responsible for review, negotiations, and approval of proposals and contracts; and a personnel manager having led staff ranging from 10 to 30 employees at different times. Mr. McNees holds a Bachelor of Science Degree in Biology from the University of North Florida. Mr. McNees currently serves as a board member on the Clay County Utility Authority's Board of Supervisors and as Past-President of the Rotary Club of Orange Park Sunrise. Mr. McNees' community involvement has also included serving as a past-Chairman of the Clay County Chamber of Commerce, a previous past-President of his Rotary club, a basketball coach for Upward Youth Sports, a bell ringer for the Salvation Army's Red Kettle Campaign, and a board member on his church's Personnel Committee.

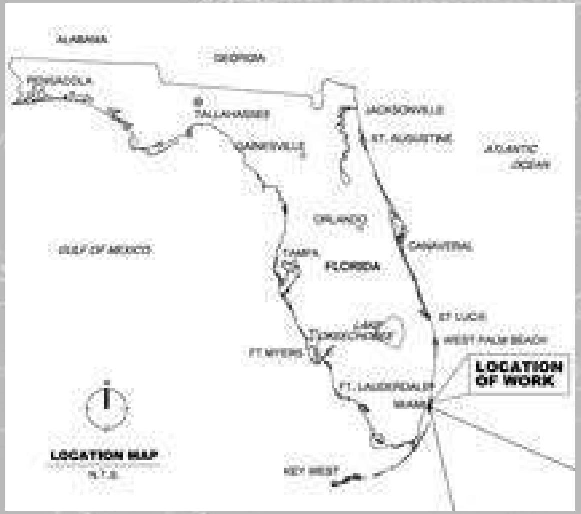
MIAMI-DADE COUNTY (MDC) BEACH RENOURISHMENT – CONTRACT E

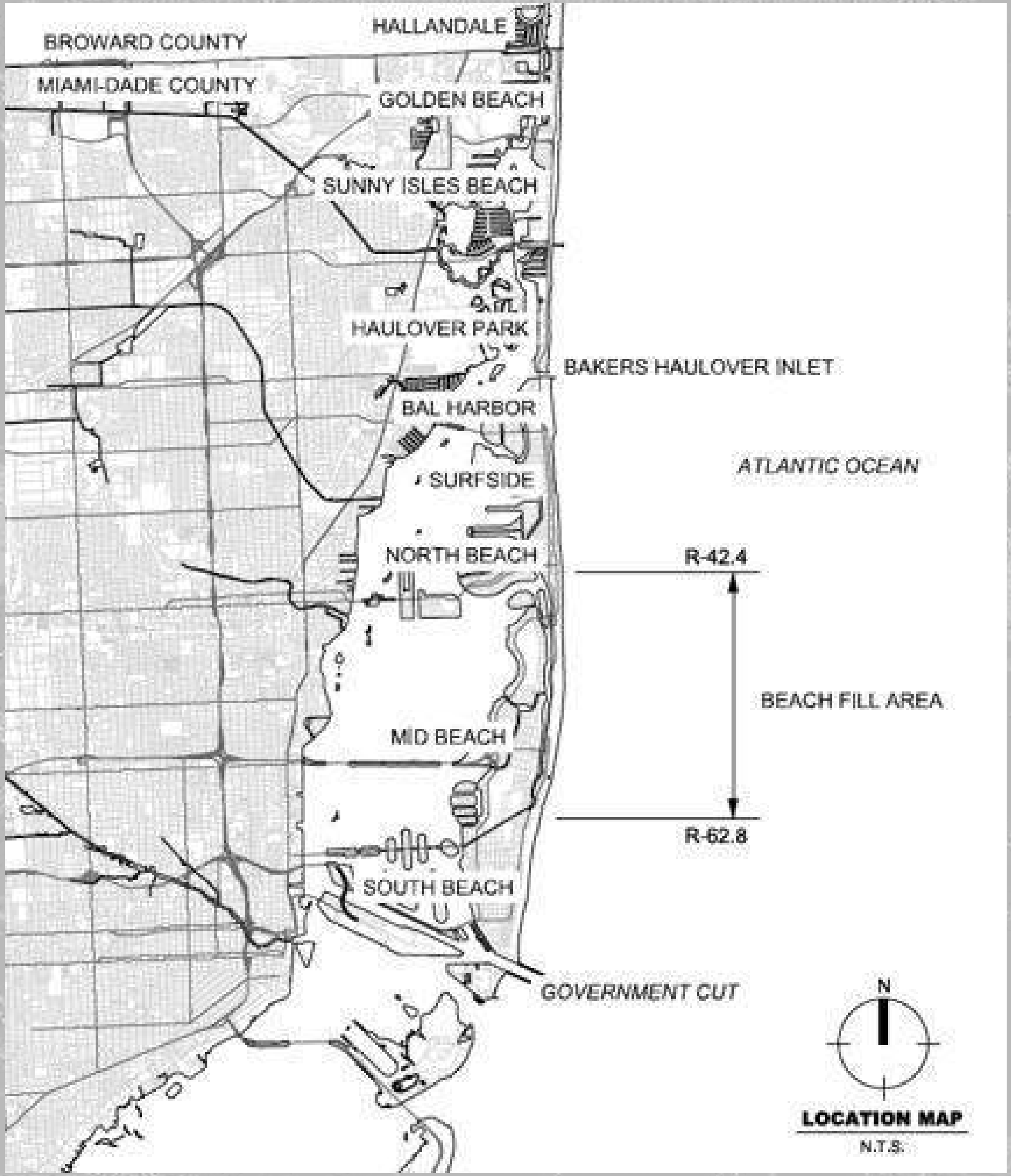
15 August 2023

Chris McNees

Project Manager

SAJ – Programs & Project Management Division





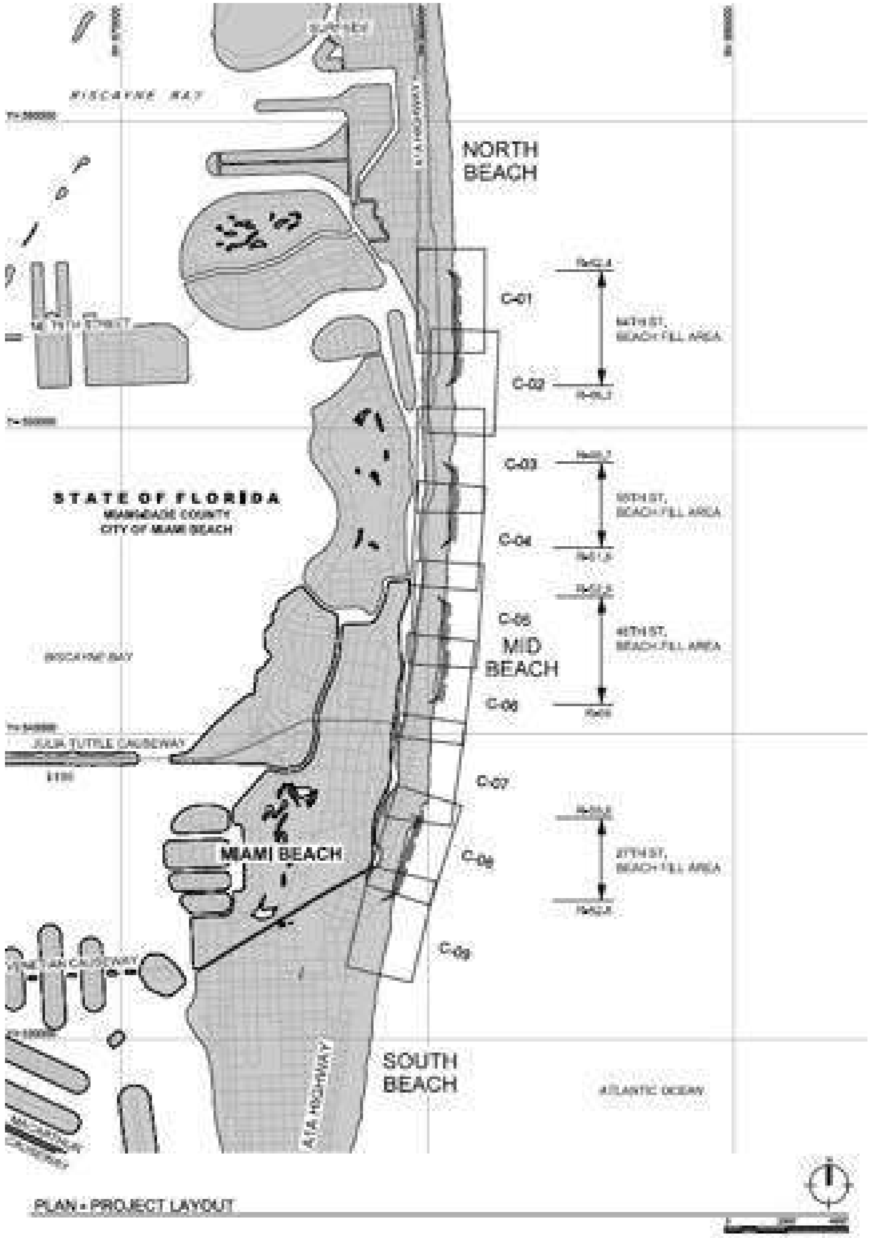
U.S. ARMY

US Army Corps of Engineers

MDC BEACH RENOURISHMENT – CONTRACT E

Contract Overview

- **Title:** Beach Erosional Control and Hurricane Protection Project, Miami Beach Renourishment 2021, Miami-Dade County, Florida
- **Contract No.:** W912EP21C0013
- **Contractor:** Continental Heavy Civil Corporation
- **Contract Amount:** $40,486,000
- **Award Date:** 30 July 2021
- Four Segments of Nourishment
  - ❖ 64th Street Fill Area – R-42.4 to R-46.3
  - ❖ 55th Street Fill Area – R-48.7 to R-51.6
  - ❖ 46th Street Fill Area – R-52.9 to R-56
  - ❖ 27th Street Fill Area – R-59.6 to R-62.8
- Approximately 13,000 linear feet of nourishment
- Estimated Quantity – 835,000 cubic yards (cy)

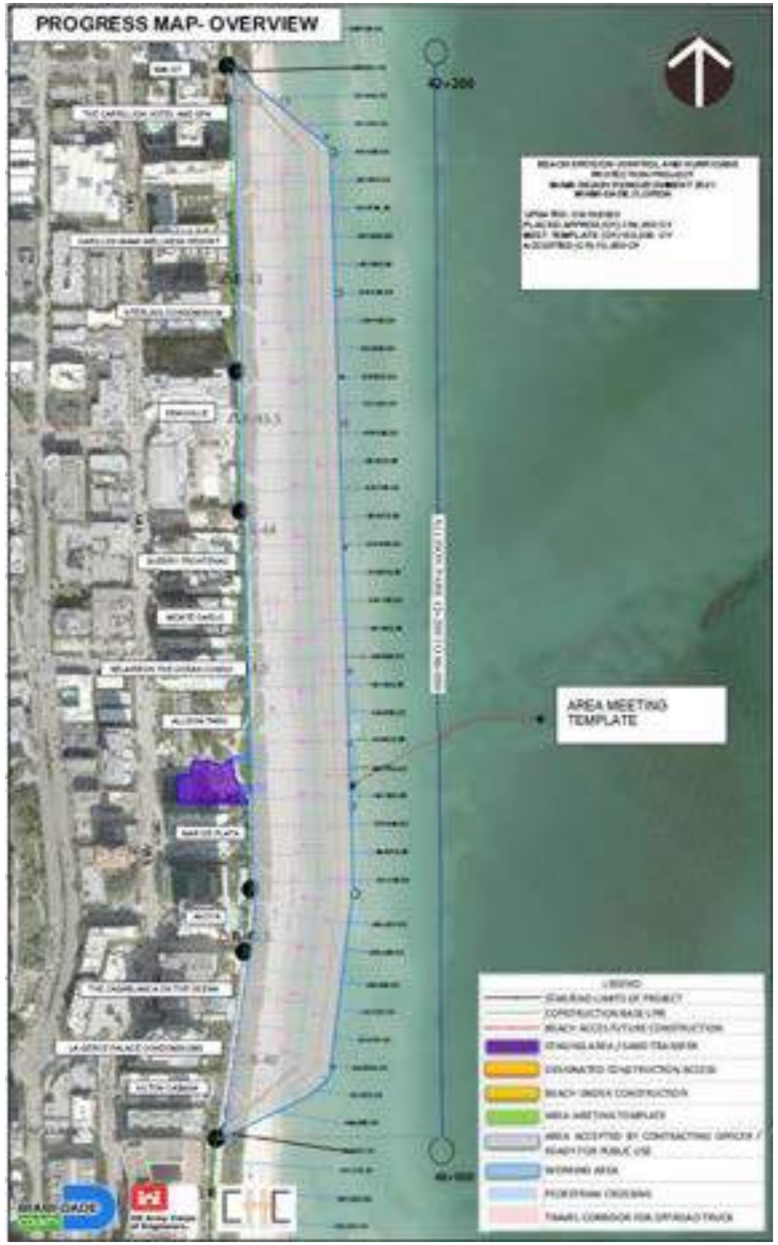


MDC BEACH RENOURISHMENT – CONTRACT E

U.S. ARMY

64th Street Fill Area – R-42.4 to R-46.3

- **Segment 1** - Allison Park – 65th Street
- **Length:** Approximately 3,800 Linear Feet
- **Estimated Quantity:** 210,000 cy
- **Final Quantity:** 206,222 cy
- **Nourishment Activities Completed:** 13 Oct 2022



MDC BEACH RENOURISHMENT – CONTRACT E

55th Street Fill Area – R-48.7 to R-51.6

- **Segment 2** - Beach View Park – 53rd Street
- **Length:** Approximately 2,800 Linear Feet
- **Estimated Quantity:** 175,000 cy
- **Final Quantity:** 198,061 cy
- **Nourishment Activities Completed:** 21 Feb 2023

MDC BEACH RENOURISHMENT – CONTRACT E

U.S. ARMY

46th Street Fill Area – R-52.9 to R-56

- **Segment 3** - Indian Beach Park – 46th Street
- **Length:** Approximately 3,500 Linear Feet
- **Estimated Quantity:** 245,000 cy
- **Final Quantity:** 231,222 cy
- **Nourishment Activities Completed:** 06 Apr 2023

MDC BEACH RENOURISHMENT – CONTRACT E

27th Street Fill Area – R-59.6 to R-62.8

- **Segment 4**
- **Length:** Approximately 3,000 Linear Feet
- **Estimated Quantity:** 205,000 cy
- **Final Estimated Quantity:** 215,000 cy
- **Nourishment Activities Completed:** 03 Aug 2023

MDC BEACH RENOURISHMENT – CONTRACT E

HOW DID WE DO IT?...SAND IS DREDGED AT THE MINE

MDC BEACH RENOURISHMENT – CONTRACT E

HOW DID WE DO IT?...DREDGED SEDIMENTS/SLURRY PUMPED TO THE PLANT

Dredge Pipeline to Plant

MDC BEACH RENOURISHMENT – CONTRACT E

HOW DID WE DO IT?...PLANT SEGREGATES THE BEACH-QUALITY SAND.

MDC BEACH RENOURISHMENT – CONTRACT E

HOW DID WE DO IT?...TRUCKS ARE LOADED…SOUTHBOUND TO MIAMI !

MDC BEACH RENOURISHMENT – CONTRACT E

HOW DID WE DO IT?...SAND IS OFFLOADED AND TRANSFERRED TO OFF-ROAD DUMP TRUCKS.

MDC BEACH RENOURISHMENT – CONTRACT E

HOW DID WE DO IT?...SAND IS PLACED AND BULLDOZERS SHAPE THE BERM'S HEIGHT AND WIDTH.

MDC BEACH RENOURISHMENT – CONTRACT E

HOW DID WE DO IT?...VOILA – A RENOURISHED BEACH!

MDC BEACH CSRM – AUTHORIZED WRDA 2022

Project Location & Study Area

- **Sunny Isles**
  - ❖ 4.0 Miles Long
- **Main Segment**
  - ❖ 10.8 miles long
  - ❖ Reaches
    - Haulover Beach Park
    - Bal Harbour
    - Surfside
    - Miami Beach
  - ❖ Focused Study Area
    - 9.4 Miles Long
- **Key Biscayne**
  - ❖ 1.2 Miles Long

MDC BEACH CSRM – AUTHORIZED WRDA 2022

U.S. ARMY

Authorized Plan

- **Periodic Beach Renourishment (6.1 Miles, includes dunes)**
  - R-27 to R-39.5: 25-ft wide equilibrated berm at elevation 7 feet NAVD88 (6.1 feet MSL)
  - R-39.5 to R-56.5: 50-ft wide equilibrated berm at elevation 7 feet NAVD88 (6.1 feet MSL)
  - Transition from a 25-ft to 50-ft side berm template between R-39 and R-39.5 and taper from R-56.5 to R-57.5
  - 20-ft wide dune crest at elevation 9.5 feet NAVD88 (8.6 feet MSL)
- **Five Groins**
  - R-28 to 31.5: Bal Harbour Reach
- **Sand Sources**
  - Bakers Haulover Inlet (BHI) Complex Borrow Areas
  - Back-passing from the existing and expanded beach and nearshore areas of South Beach
  - New offshore sites
  - Anticipated reduction, if not elimination, of truck-haul events

Navigation Improvement Study

- **Purpose:** Achieve transportation cost savings through increased economic efficiencies within Miami Harbor
- **Study Authorization:** Section 216 of the Flood Control Act of 1970

- **Key Features**
  - Deepening:
    - Outer Entrance Channel (Flare, Cut 1, Cut 2): Up to 60 feet
    - Inner Channel (Cut 3, Fisher Island Turning Basin, Fishermans Channel and Lummus Turning Basin): Up to 55 feet
  - Widening
    - Start of Entrance Channel through to start of Dodge Island Cut

Existing Project Footprint

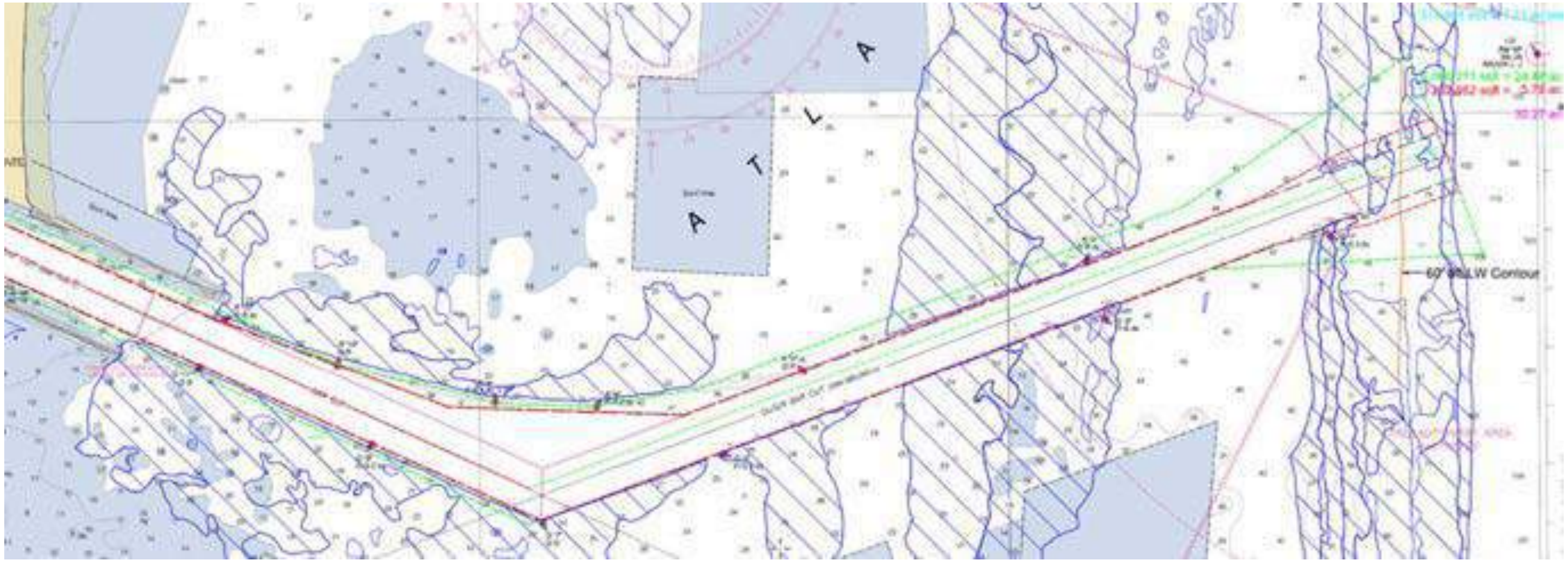
MIAMI HARBOR NAVIGATION IMPROVEMENT STUDY

Navigation Improvement Study

- **Schedule:**
  - ❖ Tentatively Selected Plan: 25 Oct 2024
  - ❖ Agency Decision Milestone: 23 Jun 2025
  - ❖ Signed Chief's Report: 16 Jun 2026

- **Challenges / Risks**
  - ❖ Environmental Compliance
    - Reduce Direct and Indirect Impacts to Resources
    - Developed Multiple Alternatives to Test at Ship Simulation (Direct)
    - Use SE FL Morphodynamics Study to Investigate Potential for Reduction in Mitigation Costs (Indirect)
  - ❖ Economically Justified Project (due to very high environmental costs)

Hardbottom/Coral Resources



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Presentations
Day 2

MIAMI
MAMI

Thomas C. (Chris) Massey, Ph.D.

Dr. Massey serves as a Research Mathematician at the US Army Corps of Engineers at the Engineering Research and Development Center (Waterways Experiment Station), Coastal and Hydraulic Laboratory since 2008. He is a recognized expert in the development and application of coastal and riverine numerical models, in storm surge modeling, and model coupling and system integration. Dr. Massey is currently (1) leading the continued development of the Coastal Storm Modeling System, (2) leading the CHL numerical technology modernization effort, (3) leading multiple coastal numerical modeling studies for storm damage reduction, and (4) working with an interdisciplinary team to develop a USACE capability for coastal compound flood coupling. Dr. Massey is on the steering committee for the Coastal Coupling Community of Practice. Dr. Massey also serves as one of the Army's representatives on the DoD High Performance Computing Modernization Programs (HPCMP) User's Advocacy Group. Dr. Massey has authored and co-authored over 25 publications and is a member of AGU, ASBPA, and SIAM.

Machine Learning and Artificial Intelligence in Coastal Applications

Chris Massey, Ph.D.
Engineering Research and Development Center
Coastal and Hydraulics Laboratory
Vicksburg, MS

The purpose of this presentation is to present a broad perspective on Artificial Intelligence (AI) and Machine Learning (ML) in contrast to traditional computer programming along with examples of how ML/AI are presently being applied in the coastal zone along with some possible future applications. Artificial Intelligence can be defined as the effort to automate intellectual tasks that are normally performed by humans (Chollet, 2017). Early chess engines (1950s to 1980s) are examples of AI, wherein a programmer explicitly codes in tens of thousands of possible Chess moves. Machine Learning is a subset of AI and often colloquially used interchangeably with AI. ML can be defined as a field of study in which computers learn without being explicitly programmed (Samuel, 1959). ML algorithms are mathematical model mapping methods, also referred to as layers or representations, used to learn or uncover underlying patterns embedded in data presented to it, (Palanichamy, 2019). A ML system is trained rather than explicitly programmed. This is accomplished by presenting the system with many relevant examples to find statistical structure in those examples, which then eventually leads to rules for automating (Chollet, 2017). Deep Learning (DL) is a further subset of ML, in which successive layers of data representations (mappings) are used instead of a single layer. AI, ML and DL are used colloquially as the same things, with AI and ML most often mentioned.

There are many ML algorithms, and they can be broken down into various classifications or types, such as Supervised Learning, Unsupervised Learning, and Reinforcement Learning. Another grouping of ML algorithms would be Regression, Clustering, Classification, and Dimension Reduction (Liu et al. 2021). Some specific popular examples include artificial neural networks (ANN), Support Vector Machine (SVM), Random Forest, and Gaussian Progress Regression to name just a few. Regardless of the specific algorithm or approach, the workflow for ML has five major steps according to Edwards (2019): (1) data collection, (2) data preparation, (3) training, (4) evaluation, and (5) tuning. It is tempting to look at the often-impressive end results of ML tools without considering the amount of data, computing power, and evaluations it took to achieve those results. As the saying goes, there is no free lunch. A large quantity of quality data is required to achieve good ML results. Not only does one need good data and lots of it, but one also needs to often manually prepare that data to be used, which is a laborious process and is subject to human error.

Undoubtedly by this time, the reader has at least heard of ChatGPT, which is a natural language processing (NLP) AI chatbot developed by OpenAI. It generates new content such as chats and conversations based on user supplied prompts and not just canned responses. ChatGPT was specifically trained through human interaction to understand the intent of the question and provide the most natural-sounding and helpful answers. This was accomplished in part by using reinforcement learning from human feedback (RLHF) which combines reinforcement learning techniques, such as rewards and comparisons, with human guidance. OpenAI uses a large language model (LLM) which can answer an ever-increasing array of questions, aka prompts. It is worthwhile to note that the OpenGPT agent is pre-trained on existing data, currently up to 2021, and is not connected to the internet for further training or verification (Cretu, 2023; and Patrizio, 2023). Some examples of things you can use ChatGPT to do include write or debug computer code; draft essays, business plans or even curriculum vitae; translate text; or write a story or poem. To do so, a user might prompt ChatGPT by saying, “Act as a Python code developer and write a code to read and then print duplicate records from the provided CSV (comma separated values) file.

While there are many examples of AI/ML being applied to coastal applications, see for examples Goldstein et al. 2019 and Kim and Lee 2022, we will only highlight a few of them. The first example comes from Granata and Nunno (2021) with their work exploring three different ML algorithms applied to predicting time series water levels within the Venice Lagoon. It is noted that the water levels in Venice Lagoon are dominated by astronomical tides which are semidiurnal dominant, but that local meteorological conditions can alter the water levels, but mostly during storm events. In their example, they trained on water level timeseries data from a few nearby gauges and found good agreement in phase and amplitude. They further compared their results with a couple of statistical methods involving multivariate time series analysis using a moving average to predict future water levels. The ML/AI results showed marked improvement over those.

Within the US Army Corps of Engineers two example programs where ML/AI is used with imagery processing is the SandSnap program and the Coastsat program. SandSnap (McFall et al., 2023) is being used to build a nationwide beach grainsize database using crowd sourced sediment data. The process saves money on data collection and captures spatial and temporal variations in beach grainsize which improves beach life cycle and uncertainty analysis. Coastsat (Vos et al. 2019) is an open-source code that uses Sentinel and Landsat satellite images to map out shorelines. It is used for long term shoreline tracking, erosion tracking, beach slope calculations and wave breaking locations to name a few.

Another example from the Corps current use of ML/AI is in the context of probabilistic coastal hazards. The Coastal Hazards System (CHS) (Nadal et al. 2020) is supported by a probabilistic coastal hazards analysis (PCHA) statistical and machine learning framework. The water level and wave height hazard curves within CHS, describe the full probability space of storm responses and are used to support risk assessments, engineering, reliability analysis and further modeling to name a few. ML is used in multiple steps within the overall CHS-PCHA and includes augmented tropical cyclone suite productions (Kyprioti et al., 2022) which improves the hazards estimation by expanding from hundreds to hundreds of thousands of tropical cyclone parameters. Combining the PCHA results and the Coastal Storm Modeling System (CSTORM) (Massey et al. 2011; Massey et al. 2021) model data, the CHS also uses ML algorithms for rapid prediction of tropical cyclones, e.g., a rapid forecasting of water levels. The webtool is called CHS-RP and allows for on-the-fly prediction of incoming hurricane impacts, using National Hurricane Center (NHC) forecast advisories, for water levels and wave heights. The CHS-RP returns results in seconds instead of hours required on the full physics CSTORM models. Furthermore, it allows for ensembles of storm track and intensity forecasts to be evaluated to provide decision makers with more scenarios and statistical likelihoods of results.

Lastly, proposals are underway to incorporate ML into the high-fidelity numerical modeling required to assess and design coastal storm risk management (CSRM) features, such as floodwalls, dunes, mangroves, and wetlands. Currently, the CHS-RP surrogate models are trained on existing conditions geometry and do not have data training sets for how the water responds to altering it by including the CSRM features. Subdomain modeling (SDM) (Altuntas and Baugh, 2017) offers a possible way around having to model the entire domain when changing local features. The benefit is that by using SDM, the computation domain is significantly reduced, thus requiring far fewer computing resources. However, to achieve accurate results, requires collecting high temporal output at special boundary condition locations and that data is not available without rerunning the full models. However, ML surrogate models can instead supply that special boundary data and do so with high accuracy since the boundary conditions will be far enough away from the CSRM features to not alter the hydrodynamics.

These are just a few examples of how ML/AI are currently being used and could be used in the future by not just the USACE, but the community of practice. The application of AI/ML is a three-legged stool that requires expertise and interactive partnerships between algorithm development experts, computing resources specialists and coastal subject matter experts.

Research and Development for AI/ML coastal applications is needed and should include exploring under which conditions it can be applied to get large returns on investments, like CHS-RP and CSRM with subdomain. But also, testing and selecting corresponding AI/ML algorithms for use in those coastal applications and how coastal engineering workflows can be adapted or recreated to make use AI/ML. AI/ML is a promising transformative technology that is rapidly being developed and used. Community based involvement by sister federal agencies and academic partners is necessary to develop state-of-the-art open-source/open-access tools for AI/ML within coastal applications and layout best practices for its use, particularly for engineering purposes.

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE IN COASTAL APPLICATIONS

Dr. Chris Massey,
Research Mathematician
USACE-ERDC-CHL

99th BCER
Miami, FL
Aug. 16, 2023

U.S. ARMY

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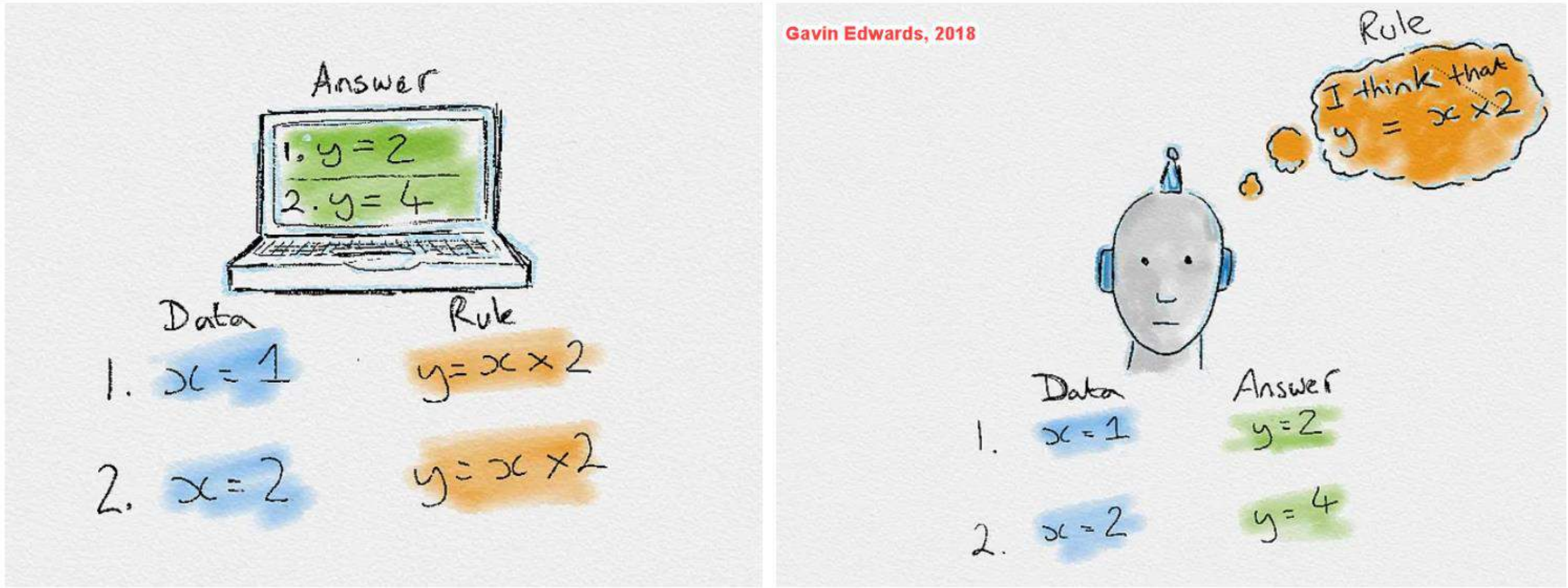
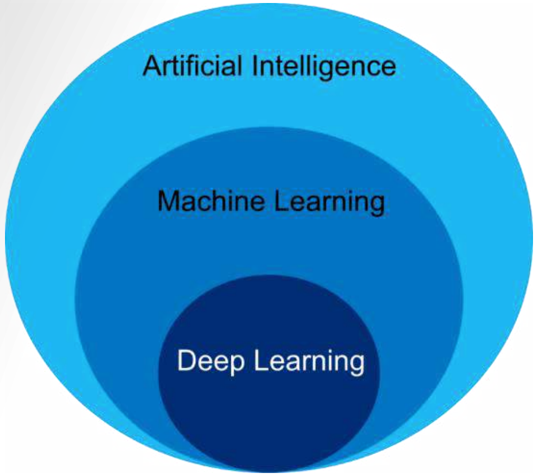
INTRODUCTION TO AI/ML

Traditional software engineering combines human created *rules* with *data* to **create answers to a problem**. Machine learning uses *data* and *answers* to **discover rules behind a problem** (Chollet, 2017).



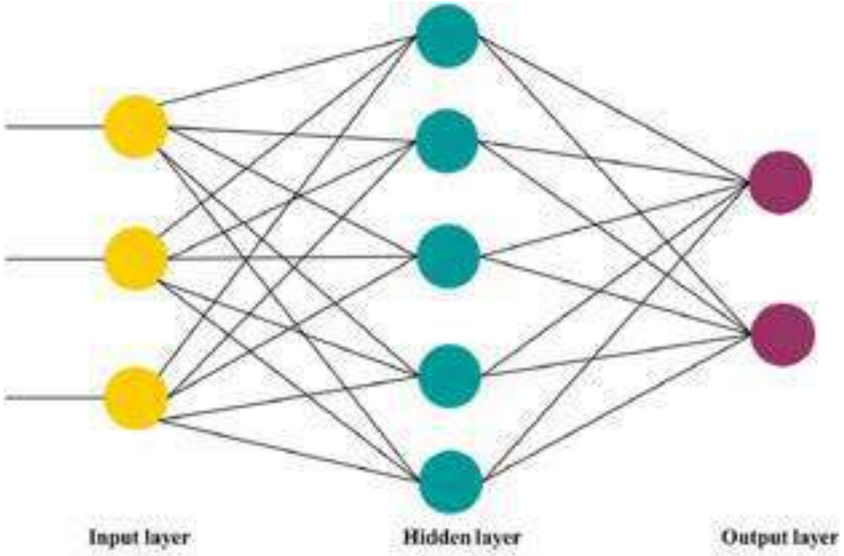
Machine learning algorithms are mathematical model mapping methods (aka layers or representations) used to “learn” or “uncover” underlying patterns embedded in the data (Palanichamy, 2019).

INTRODUCTION TO AI/ML



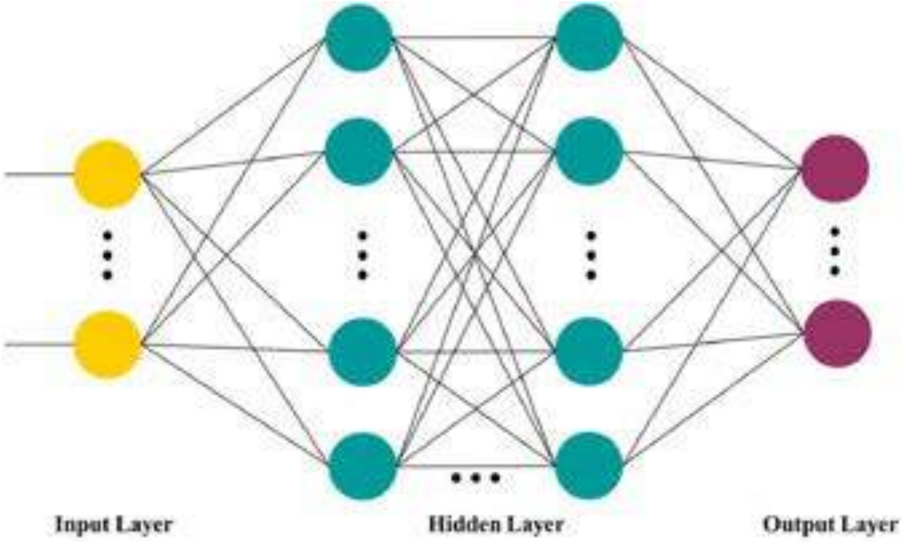
- Artificial Intelligence (AI) can be defined as the effort to automate intellectual tasks normally performed by humans (François Chollet, 2017).
- Machine Learning (ML) can be defined as a field of study in which computers “learn” without being explicitly programmed (Arthur Samuel, 1959).
- Deep Learning can be defined as ML with successive layers of representations (Chollet, 2017).

Artificial Neural Network



Adapted from Liu et al. 2021

Deep Learning Neural Network



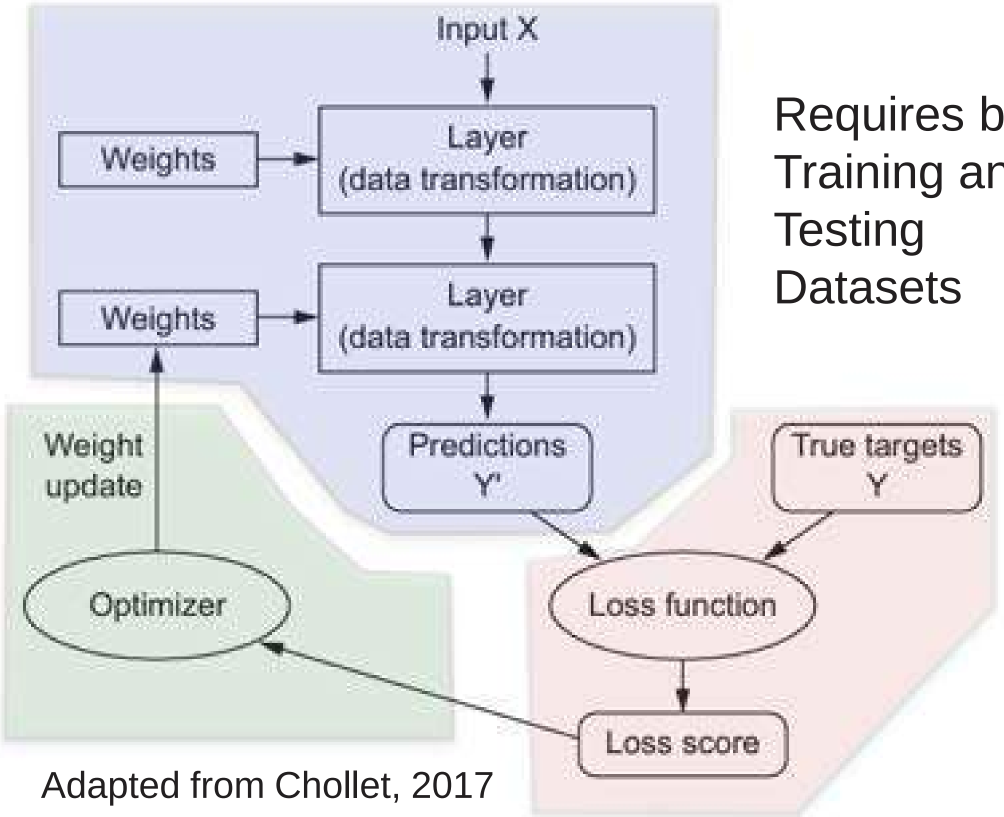
Adapted from Liu et al. 2021

INTRODUCTION TO AI/ML

A ML system is **trained** rather than explicitly programmed, by being presented with many relevant examples and then finding **statistical structure** in these examples that eventually leads to rules for automating (Chollet, 2017).

Training ML can be compared to musicians in an orchestra learning to play a new piece.

Basic Deep Learning Components



Adapted from Chollet, 2017

Requires both Training and Testing Datasets

General ML Workflow (Gavin Edwards (2019))

1. Data Collection: Collect the data that the algorithm will learn from.

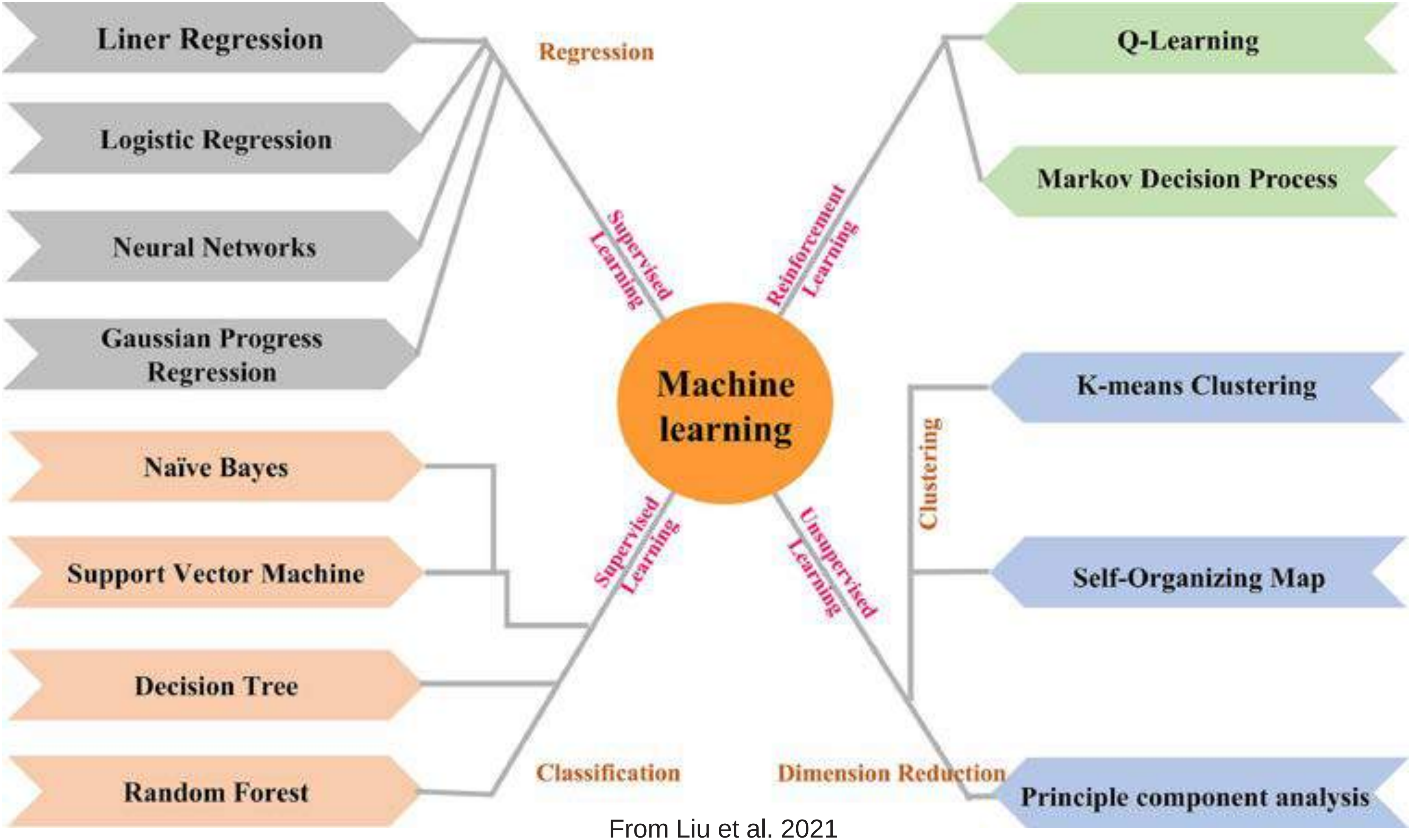
2. Data Preparation: Format and engineer the data into the optimal format, extracting important features and performing dimensionality reduction.

3. Training: Also known as the fitting stage, this is where the Machine Learning algorithm actually learns by showing it the data that has been collected and prepared.

4. Evaluation: Test the model to see how well it performs.

5. Tuning: Fine tune the model to maximize its performance.

SOME TYPICAL ML ALGORITHMS



From Liu et al. 2021

ML WORKFLOWS & CONSIDERATIONS

General ML Workflow (Gavin Edwards (2019))

1. **Data Collection:** Collect the data that the algorithm will learn from.

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4. **Evaluation:** Test the model to see how well it performs.

5. **Tuning:** Fine tune the model to maximize its performance.

Practical Considerations (No Free Lunch)

- Quality and Quantity of the data is important for both Training and Evaluating
- Data preparation can be a laborious process and is subject to human error…"Junk In = Junk Out"
- Algorithms/Training is where R&D is most needed in the coastal applications to determine the best methods to use for a particular problem
- How long it takes to train a model
- ML needs different computer specifications (hardware) than traditional physics-based programs (High memory, fast file access, many GPUs)

INTRODUCTION TO AI/ML (CHAT GPT)

OpenAI ChatGPT

- **ChatGPT is a natural language processing (NLP) AI Chatbot** driven by AI technology developed from Open AI.
- ChatGPT is a generative AI tool that creates new content, such as chats and conversations, based on prompts and not just canned-responses.
- The chatbot has a language-based model that the developer fine-tunes (with help from user feedback) for human interaction.
- The **large language model (LLM)** OpenAI uses can answer an ever-increasing array of questions and reply to 'prompts' on request. It is pre-trained on existing data (up to 2021) and is not connected to the internet.

- **RLHF – reinforcement learning from human feedback** combines reinforcement learning techniques, such as rewards and comparisons, with human guidance to train an artificial intelligence (AI) agent.
- ChatGPT was specifically trained through human interaction to understand the intent of the question and provide the most natural-sounding and helpful answers.

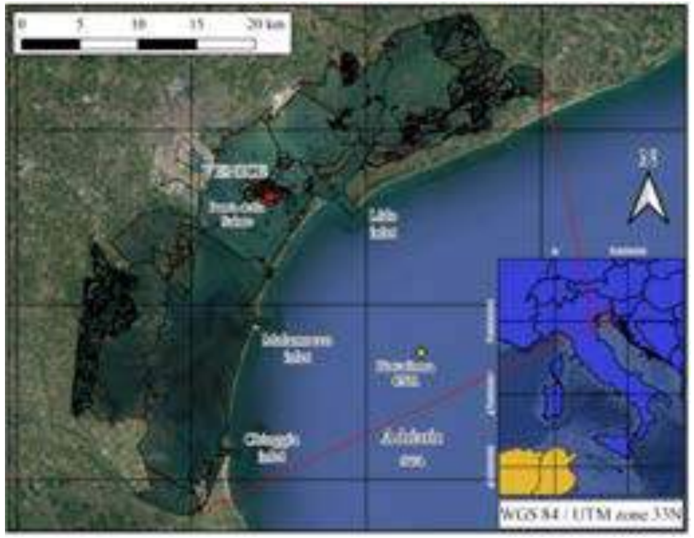
You use ChatGPT by "chatting" with it, by giving it prompts. Things you can use it to do:

- Write code or debug
- Draft essays
- Translate text
- Draft a CV or a Business Plan
- Write a story/poem

Example: Act as a Python developer. Write code to read and print duplicate records from the provided CSV file.

COASTAL APPLICATIONS – TIDE PREDICTIONS

Venice Lagoon + Stations

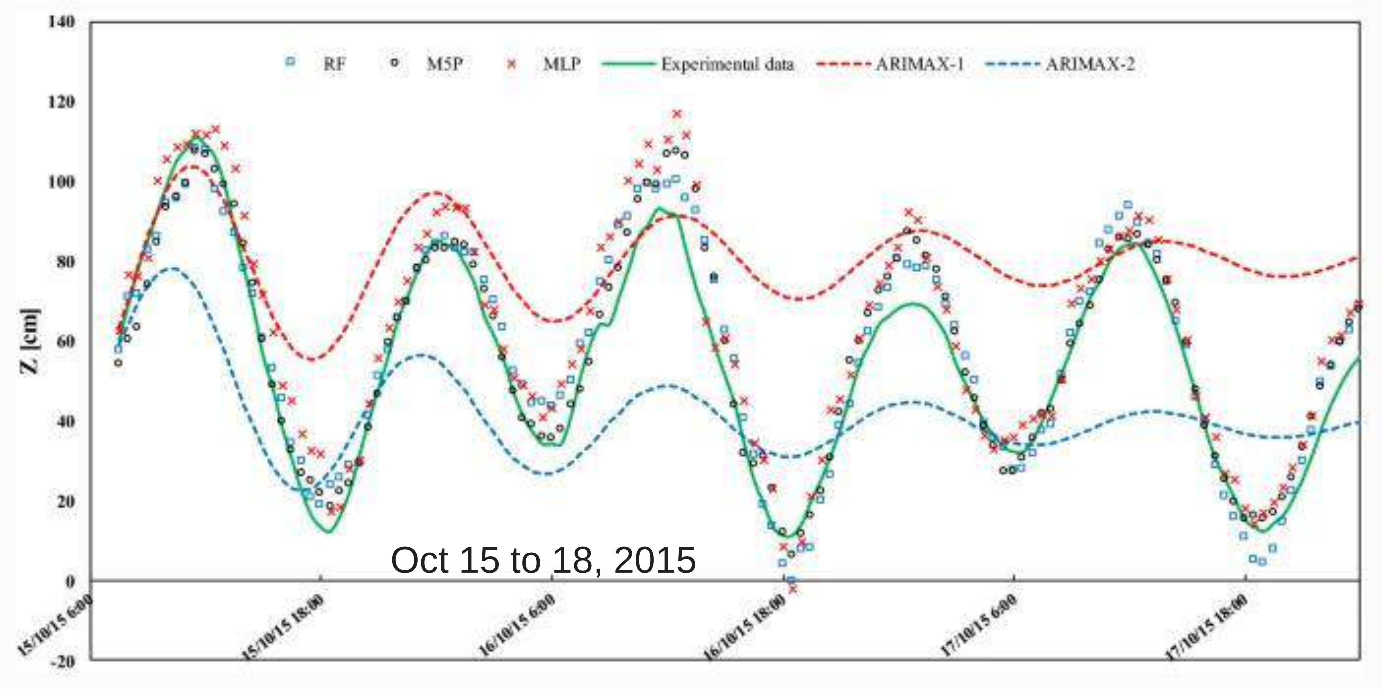


Granata and Nunno, 2021

https://doi.org/10.1007/s00477-021-02018-9

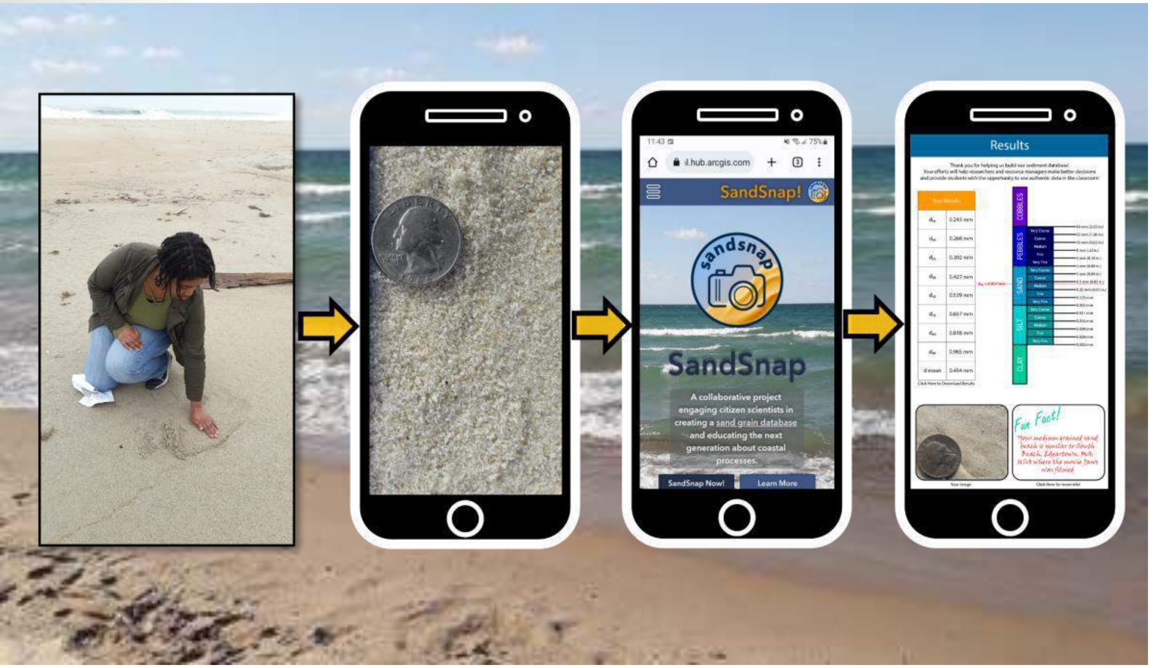
In ordinary conditions within Venice Lagoon, the meteorological effects are small, and the observed water level is little different from that induced solely by the astronomical tide, which is semidiurnal dominant.

Comparison of Three ML and Two Moving Averages



- The **M5P** algorithm (Quinlan 1992) develops a regression tree to get predictions.
- A **Random Forest** is an ensemble of simple regression trees (Breiman 2001), whose predictions are combined to evaluate the final output.
- A **Multilayer Perceptron (MLP)** is a class of feedforward Artificial Neural Network (Ruck et al. 1990), which can perform regression operations. A MLP contains at least three layers of nodes: an input layer, a hidden layer and an output layer.
- **AutoRegressive Integrated Moving Average with Exogenous** inputs (**ARIMAX**) models is a multivariate time series statistical analysis to predict future trends and has been widely used in hydrology for time series predictions.

COASTAL APPLICATIONS -- SANDSNAP



- SandSnap is used to build a nationwide beach grainsize database using crowd sourced, citizen scientist supplied, sediment data.
- This processes saves money on data collection, captures critical spatial and temporal variations in beach grain size and improves beach life cycle and uncertainty analysis to name just a few benefits.

Scan Me

- Interactive web app.
- Citizen scientists collect beach sand images.
- App uploads to GovCloud.
- Processed with two AI/ML neural network algorithms.
- Measures grainsize distribution.

- One determines location of the coin in picture and how big it is (this is used to convert mm to pixels).

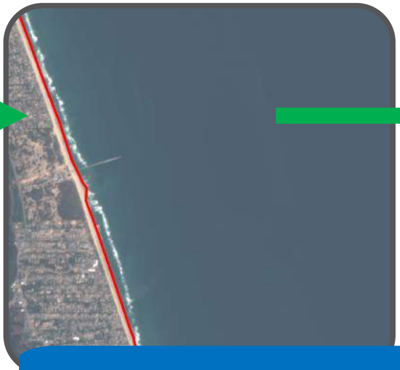
- The other is a SediNet model trained by Dan Buscombe of MARDA Science that estimates the grain size distribution in pixels, which is converted to mm with the results from step one.

POC: Brian.C.McFall@usace.army.mil

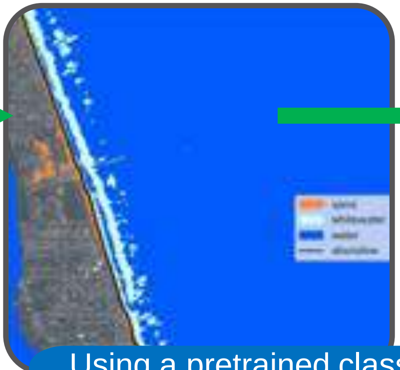
COASTAL APPLICATION – COASTSAT

- Coastsat (Vos et al, 2019) is an open-source python code that uses Sentinel and Landsat images to map out shorelines with minimal user intervention
- Used for long term shoreline tracking, erosion tracking, identifying breaking locations, beach slope calculations, general coastline monitoring, etc.
- Current work includes creating a Coastsat Arc GUI, mapping Lake Ontario, and expanding to Planet Imagery (CODS and CIRP projects)

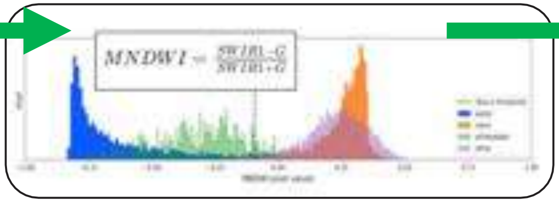
Tool downloads imagery in user defined AOI and date range using Google Earth Engine



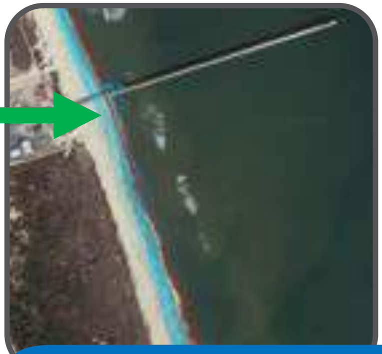
A user draws a shoreline



Using a pretrained classifier (Neural Network classifier), the tool classifies each pixel in the image as 'sand', 'water', 'white-water', and 'other land features'



Using the Modified Normalized Water Index (MNDWI) the tool identifies the boundary between sand and water using Otsu's thresholding algorithm (Otsu, 1979) → maximizes variance between sand and water



Tool draws a shoreline for each image based on this indexing/boundary

Slide by Katie DeVore, USACE/ERDC/CHL (Member of the Littoral Operations & Coastal Remote Sensing Group (LORS))

EXAMPLES FROM QUANTIFYING COASTAL HAZARDS

Approach

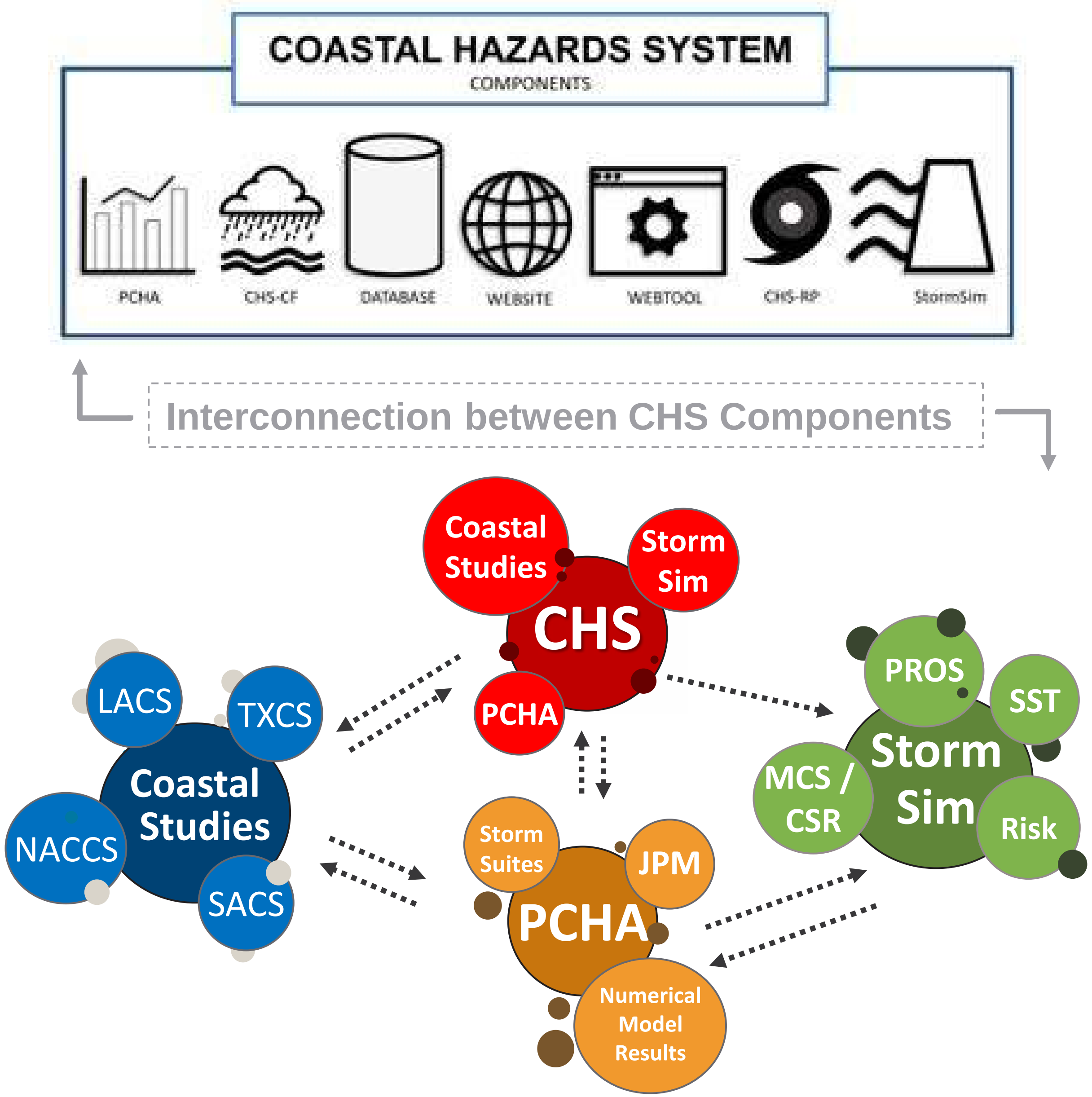
- Conduct comprehensive studies to quantify coastal hazards on a regional scale
- Coastal Hazards System (CHS)
- Coastal Storm Modeling System (CSTORM)

Methodology

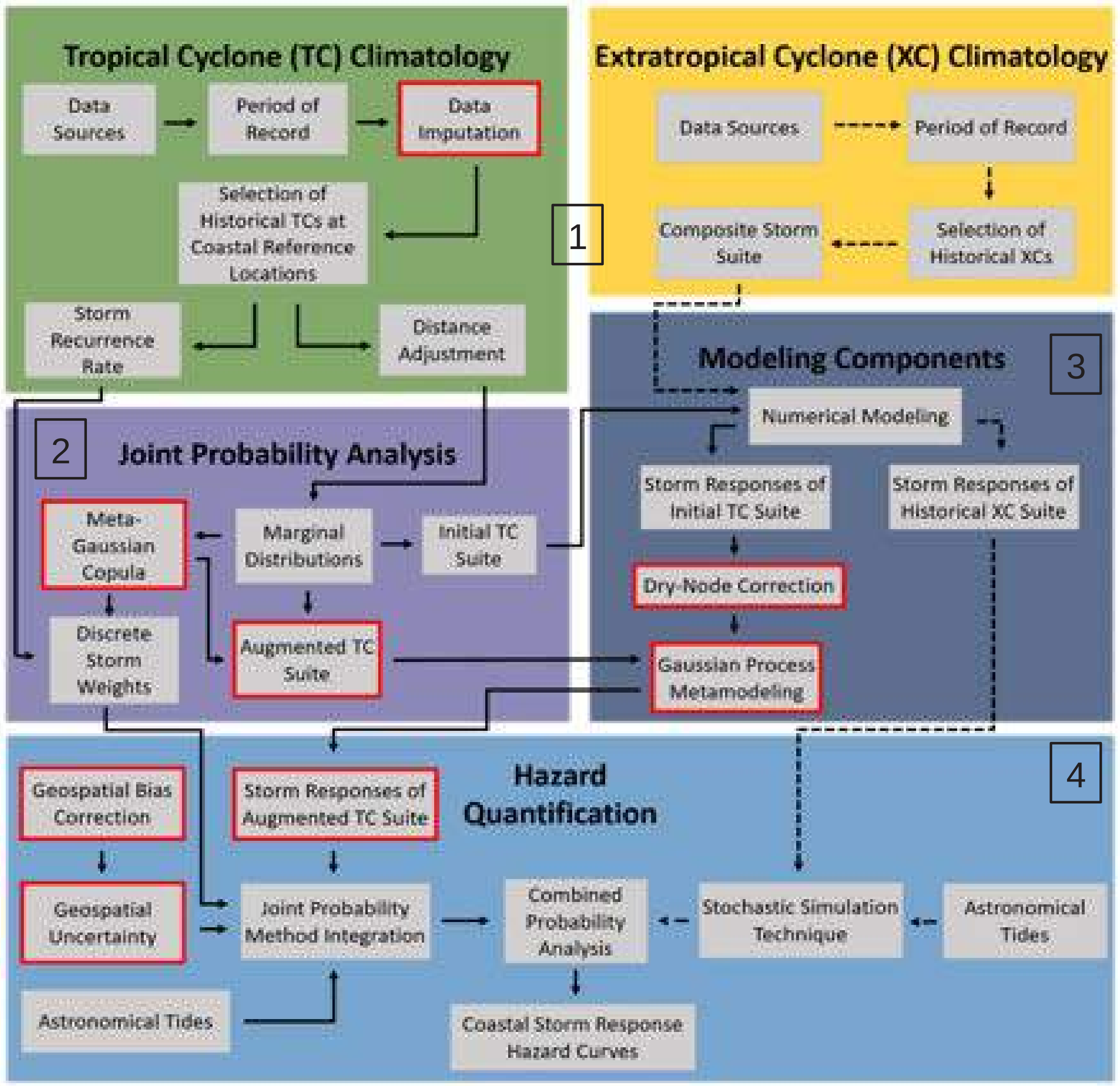
- Probabilistic Coastal Hazard Analysis (PCHA) is a statistical and machine learning framework supporting CHS
- Goal: fully cover parameter and probability spaces of coastal storm responses (frequent to rare)
- Machine learning is integral to the CHS-PCHA

Benefit

- Hazard curves describing the full probability space of storm responses, with uncertainty estimates
- Direct input of results to support risk assessments, engineering, reliability, downstream modeling, etc.



CHS-PCHA: MACHINE LEARNING APPLICATIONS



Red boxes indicate CHS-PCHA advancements relative to the Joint Probability Method

Probabilistic Coastal Hazard Analysis (PCHA)

1. **Storm Climatology Analysis**
   - ➢ Processing of historical TC data at points along the coastline (Ex: TC parameters, historical TC tracks)
   - • Select suite of historical XCs
2. **Joint Probability Analysis**
   - • Develop initial synthetic TC suite (ITCS) for numerical model simulations and assign probability masses
   - ➢ Develop augmented TC suite (ATCS) to expand coverage of parameter and probability space
3. **Modeling Components**
   - • Simulate storms with high-resolution/fidelity numerical models
   - ➢ Perform post-processing of data (Dry Node Correction)
   - ➢ Train Gaussian process metamodel (GPM) on ITCS simulations to predict responses for ATCS
4. **Hazard Quantification**
   - • Quantify modeling and measurement uncertainties
   - ➢ Quantify storm-induced hazards for TCs and XCs
   - • Develop hazard curves describing the magnitude of the hazard as a function of annual exceedance frequencies (AEFs)

CHS-PCHA: MACHINE LEARNING APPLICATIONS

Augmented Tropical Cyclone Suites (ATCS)

Goal:

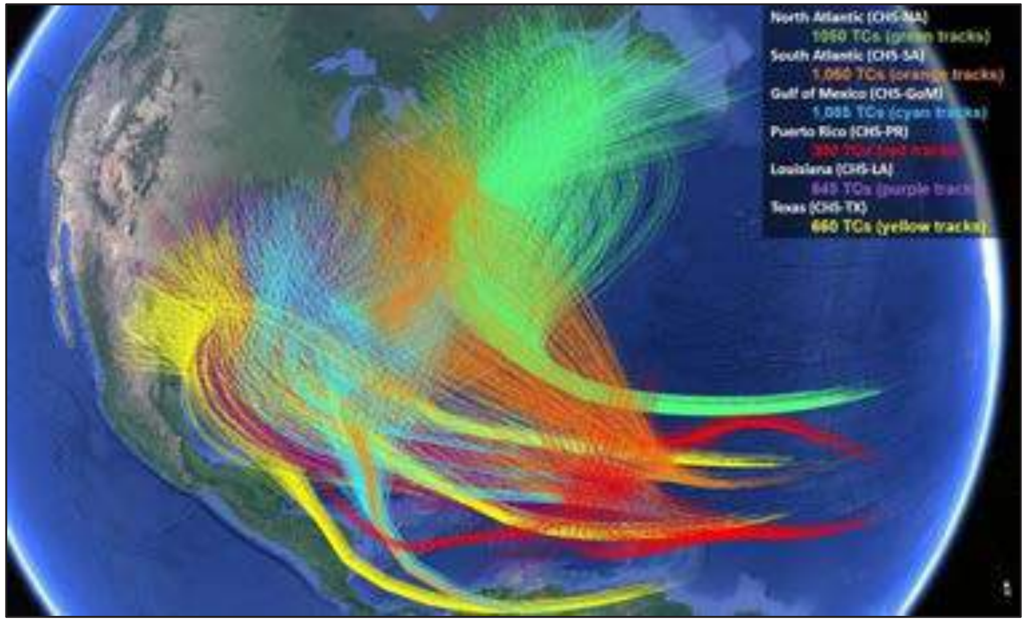
- Expand the number of synthetic TCs
- Increase resolution of the parameter and probability space of the TCs

Benefit:

- Incorporating more responses to improve accuracy of hazard estimation
- Expanding from thousands to hundreds of thousands/millions of TCs

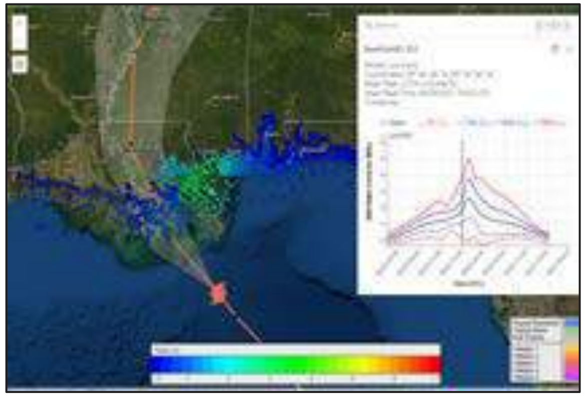
Method:

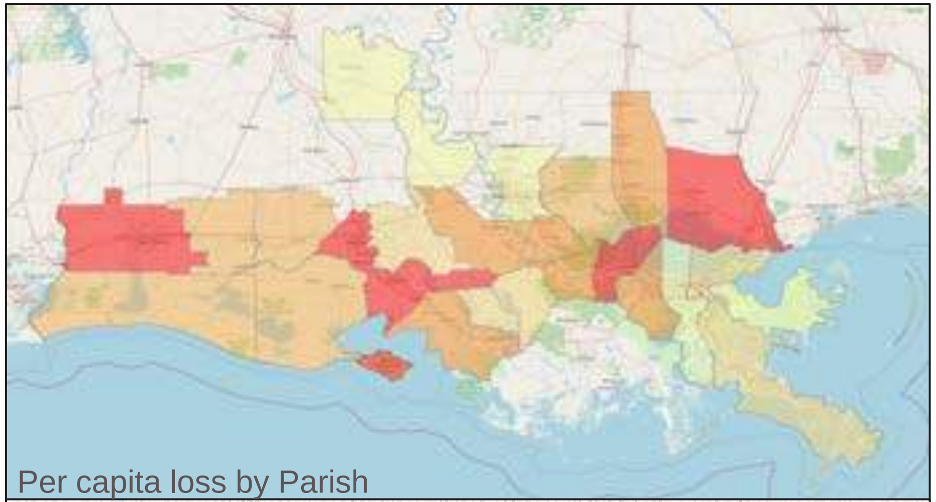
- Parameters of the initial TC suite (ITCS) are further discretized to create an augmented TC suite (ATCS)
- Example: 300 to 348,000 TCs for Puerto Rico



TC Parameter	ITCS		ATCS	
	Range	Discretization	Range	Discretization
θ	-140° : 60° (clockwise from North)	40°	-140° : 60° (clockwise from North)	40°
Δp	8 : 148 hPa	10 hPa	8 : 148 hPa	5 hPa
R_{max}	8 to 143.6 km (from BQ sampling)	-	10 : 155 km	5 km
V_t	8 to 40 km/h (from BQ sampling)	-	10 : 50 km/h	5 km/h
Total	300		348,000	

COASTAL HAZARDS SYSTEM–RAPID PREDICTION (CHS-RP) WEBTOOL





State	County	Residential Structures	Non-Residential	Residential Damages ($)	Non-Residential Damages ($)	Total Building Value	Total Building Loss	Business
22	53	541	57	1.44E+07	8.23E+06	4.13E+09	2.26E+07	-23.74
22	71	55032	6281	5.60E+08	3.57E+08	8.01E+10	9.17E+08	-6126.96
22	47	44	0	6.38E+06	0	6.86E+09	6.38E+06	-0.48
22	99	844	53	2.04E+07	5.02E+06	7.59E+09	2.55E+07	-18.38
22	31	0	2	0	0	9.82E+10	0	0
22	75	6314	1185	5.66E+07	4.83E+07	5.31E+09	1.05E+08	0
22	59	15075	1147	9.62E+08	7.21E+08	4.36E+10	1.68E+09	-2475.8
22	87	7897	881	9.92E+07	2.64E+07	6.54E+09	1.26E+08	-420.29
22	51	80	1	1.12E+07	225088.7879	4.45E+10	1.14E+07	-25.44

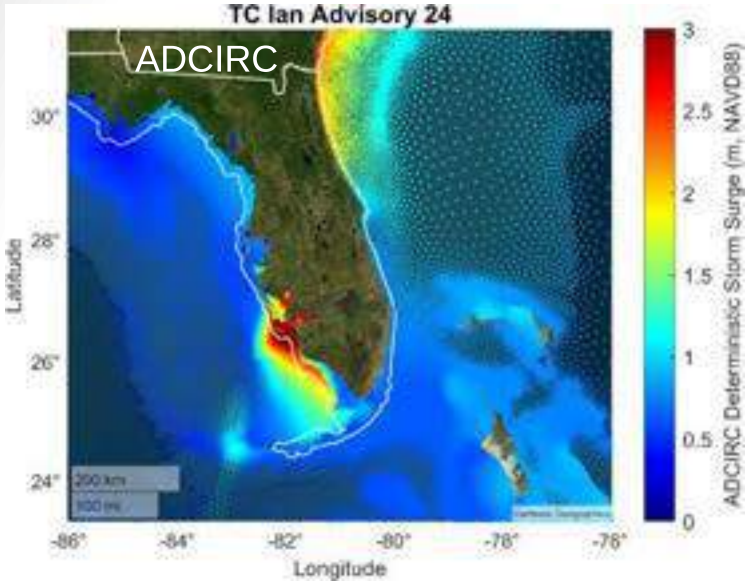
Demo showing use of CHS-RP nodal output in Go-Consequences damage estimates for Hurricane Gustav (2008)

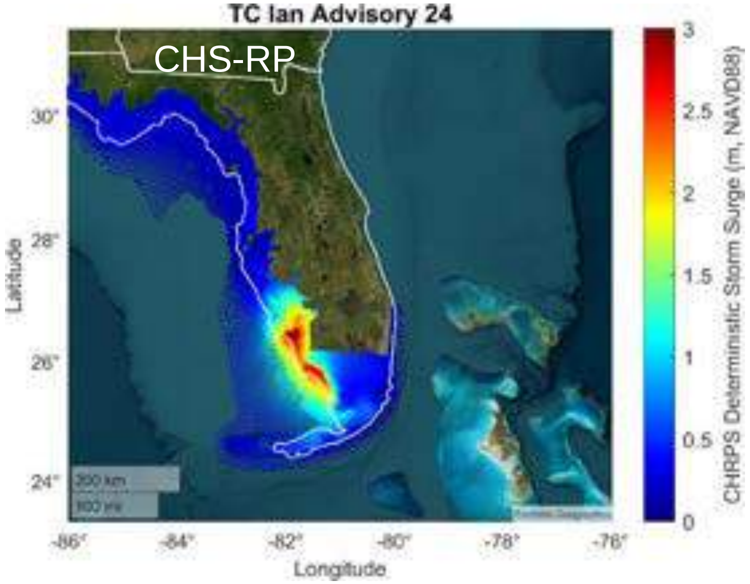
- Developed for on-the-fly prediction of incoming hurricane impacts, including storm surge and other coastal hazards.
- How can CHS-RP support USACE emergency operations?
  - Peaks and timeseries of coastal storm hazards
  - During days and hours preceding a storm
  - With the evaluation of what-if hurricane scenarios
  - On short- and long-term risk applications
  - Not the official forecast
- CHS-RP relies on metamodels trained on the database of storm simulations within CHS
- Updated machine learning capabilities allows for hazard predictions at the nodes
- Nodal results applicable for other applications (i.e. coupling with consequence models)

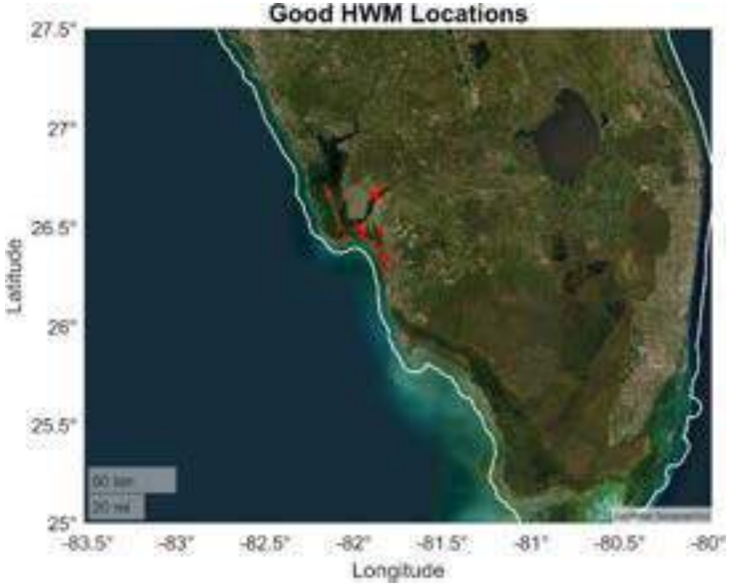
https://chrps.erdc.dren.mil/

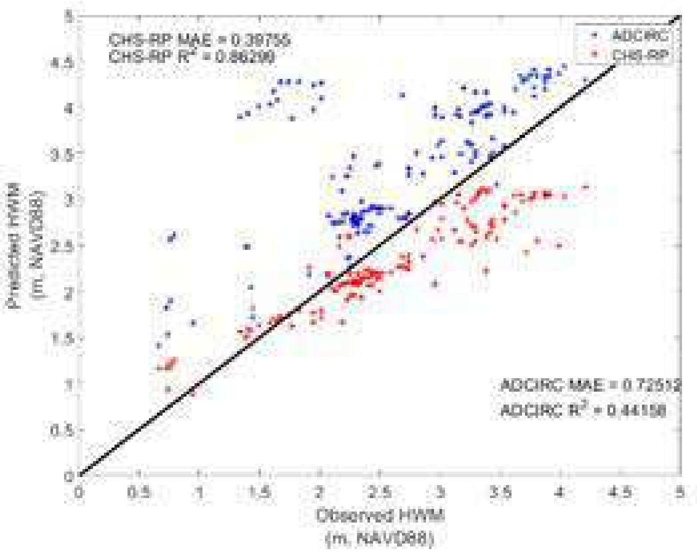
CHS – RP FOR HURRICANE IAN

ADCIRC and CHS-RP *forecast* peak water levels (m, NAVD88)









- The CHS-RP's Gaussian process metamodeling (GPM) was trained on the high resolution CSTORM storm surge and wave data computed as part of the **South Atlantic Coastal Study (SACS).**
- The input vector to the GPM is the tropical cyclone (TC) forcing parameters, and the output is storm response.

FUTURE CSRM CSTORM MODELING WITH ML

- Existing high-fidelity numerical model data and CHS statistical data, provide jumpstarts to the evaluation and design of CSRM projects.

- However, the computationally expensive full-physics high fidelity models still need to be executed with the CSRM projects in place in order to accurately capture the water's response to those projects.

- In the near-future, **ML applications** combined with **sub-domain modeling** could be leveraged to reduce by orders of magnitude the computational cost of executing those models.

Standalone Issues

- ML models trained on no-project conditions cannot represent with-project conditions. Training set does not include that data.
- Sub-domain modeling requires more data than is available from the existing without-project modeling.

Future ML Enabled CSRM Workflow

Access Existing Modeling / Statistics → Storm Selection & Model Domain Updating → Sub-Domain Selection & ML Training → Execute w/Project Condition using ML Driven Sub-Domain

SUMMARY

- AI/ML is a promising and transformative technology being applied across many geospatial applications
- Development and testing of AI/ML algorithms, particular for coastal applications, is happening across federal agencies and academia
- Application of AI/ML algorithms is a three-legged stool and must be done as a partnership between the AI/ML algorithm experts (often mathematicians, statisticians and data analytics experts), computing resource specialist (in high performance computing/cloud computing), and subject matter experts.
- R&D investments for AI/ML applications into the coastal arena are needed:
  - Select appropriate use cases with large return on investments
  - Test/Select corresponding AI/ML algorithms for use cases
  - Adapt/Recreate coastal workflows to use AI/ML
- Open involvement with sister agencies and academia to develop community version solutions
  - Academic partners are instrumental in developing new machine learning capabilities
  - Communication between other agencies (NOAA, USGS, Navy, DOE) to understand uses/applications

Stephanie Patch, Ph.D.

Dr. Patch is an Associate Professor of coastal engineering at the University of South Alabama with expertise in physical changes of sandy beaches, with focus on developed and natural barrier island systems, due to short-term and long-term processes. She is also the co-owner of Coastal Zone Engineers, LLC, a woman and veteran owned small business, and is a licensed Professional Engineer in Alabama. Stephanie received her BSCE (2010) and MSCE (2012) from Georgia Tech and her PhD (2016) from Virginia Tech, and she has more than 10 years of experience as a coastal engineer. She uses hydrodynamic and morphodynamic modeling to analyze the interactions between civil infrastructure and morphological changes on barrier islands during tropical cyclones. Stephanie has developed “adaptation pathways” for barrier island communities in New Jersey and Alabama as responsive planning tools for adapting to sea level rise and future storms. She has served on reconnaissance missions with National Science Foundation Geotechnical Extreme Event Reconnaissance (GEER) and Structural Extreme Event Reconnaissance (StEER) teams to survey damage in communities by hurricanes and tornadoes.

Stephanie is passionate about involving the general public in coastal resilience education and continually seeks collaboration with colleagues in multidisciplinary fields to remain involved in community outreach and education. Stephanie served as the lead facilitator and co-organizer of a day-long forum designed to involve the general public in coastal resilience planning. She was also part of a team to develop Sea Level Rise in the Classroom curricula for Alabama and Mississippi high school teachers, which is now being expanded to Florida, Louisiana, and Texas. Stephanie has earned several awards, including the Andy and Carol Denny National Alumni Association Excellence in Teaching Award (2021) and the Gulf Research Early-Career Faculty Fellowship (2020). She is a member of several organizations, including the American Shore and Beach Preservation Association (ASBPA) and American Society of Civil Engineers (ASCE), and she serves as the faculty advisor for the Society of American Military Engineers (SAME) student chapter at the University of South Alabama.

Coastal Adaptation Pathways for Barrier Island Communities

Stephanie Patch, Ph.D.
University of South Alabama
Mobile, AL

This presentation describes adaptation pathways, how they are developed and able to be used as planning tools, and provides a case study for the creation of a pathway for a barrier island community. Morphodynamic modeling and science extension methodologies were employed to develop an adaptation pathway for Dauphin Island, AL. Community leaders and members were engaged at the onset of the project to help guide the pathway's development, and were reengaged periodically throughout the project to ensure a beneficial outcome. Pathways increase resilience by mitigating damage to built infrastructure and are comprised of several strategies for barrier island adaptation to hurricanes and sea level rise (SLR). The strategies are arranged based on their effectiveness in protecting the island from damage. "Tipping points" are identified as the moment a strategy no longer meets its original objective of mitigating storm damage, necessitating the implementation of another strategy.

The Dauphin Island Adaptation Pathway project, funded by the U.S. Coastal Research Program, aimed to identify impacts of storm surge, waves, and SLR on Dauphin Island to protect its people and infrastructure. This project kicked off with a meeting between the research team and key stakeholders to discuss the desired outcomes of the adaptation pathway. Stakeholders identified locations of vulnerable infrastructure, geographical "weak points" on the barrier island, possible adaptation strategies for those locations, and risk thresholds for SLR adaptation. The research team used this stakeholder input to guide the direction of the rest of the two-year project. We focused on two locations on Dauphin Island for creating the adaptation pathway and generated high-resolution (1 m X 1 m) grids of existing conditions. Adaptation strategies were implemented into the grids and included proposed solutions by the project team and stakeholders. We also collaborated with managers of ongoing projects and implemented those designs into the model grid. Using the numerical model XBeach and a calibrated model setup ("excellent" model skill of 0.85 – 0.93 out of 1.00), we simulated morphodynamic impacts of Hurricane Nate (2017) on Dauphin Island. We implemented SLR using a bathtub approach, re-simulated storm impacts, and evaluated the effectiveness of adaptation strategies using qualitative and quantitative metrics. The project concluded with a final meeting with Dauphin Island stakeholders to discuss the pathways, how the model results align with and refocus stakeholder priorities, and next steps in climate adaptation for the island.

Four adaptation pathways were created for Dauphin Island: the east end pathway used overwash of saltwater into a freshwater source as a tipping point; and the three middle west end pathways used barrier island breaching, overwash onto the main access road along the island, and overall island elevation as tipping points. Two of the four adaptation pathways are described in this presentation. The pathways show that beach nourishment is an effective strategy to mitigate damage to the Gulf-side of the island, but the backbarrier inundates as seas rise without raising backbarrier elevations. The adaptation pathways developed from this work identify best practices for increasing barrier island resilience to hurricanes under varying levels of SLR while also improving the understanding of developed barrier island responses to future storms. The pathways also inform coastal management officials of the critical moment to implement a certain adaptation strategy based on observed SLR rather than uncertain long-term predictions, thereby reducing unnecessary costs.

The Dauphin Island Adaptation Pathway project was integrated into other on-going climate adaptation efforts, including economic diversification and strategic relocation. Because we implemented the proposed designs for ongoing projects in our simulations, we were able to show their effectiveness in mitigating damage due to a Hurricane Nate-like storm under SLR; this indicates the island is successfully planning for future sea levels. However, our model results also identified challenges with inundation on the north (Sound) side of the island for sea levels rising above 0.5 m MSL, an amount of SLR likely met or exceeded in the area within the next 30 years.

While the pathway was originally created as an adaptive planning tool, we discovered potential uses and applications beyond planning, which include effectively communicating scientific research and identifying key messages for community engagement and buy-in. Engaging stakeholders at the onset of the project was critical for us to appropriately identify locations on Dauphin Island to focus our study, adaptation strategies to consider – and not to consider – based on community perceptions, and scientific results of most interest for adaptation planning. While the project team correctly identified several of these aspects, we did not anticipate the inundation of a freshwater aquifer by dune overwashing to be a desired focus by the community. Likewise, the community identified sediment overwash deposits on the main roadway along the island as a major vulnerability because of the resources burden it places on municipalities to remove the sand after a storm. This study is limited to a model setup calibrated with only Hurricane Nate. R&D Recommendations include a validation of the model using data from another storm that impacts Dauphin Island. We also used only Hurricane Nate hydrographs and spectral wave conditions to evaluate adaptation strategies. Ongoing work is expanding this study to include additional storms available through the South Atlantic Comprehensive Study

(SACS). A bathtub approach to modeling SLR was used and barrier island evolution due to SLR was not considered. Both are limitations of this study and should be addressed in subsequent projects. The results of this study and the final adaptation pathways also assume monitoring and maintenance efforts of beach profiles will continue into the future and that the pathway may change if a major hurricane were to reshape the island. Additionally, collaboration with stakeholders should commence to package the adaptation pathway into various messaging campaigns, implementation proposals, and town policy and ordinance proceedings so that it may better serve the community’s needs. Implementation of adaptation pathways also require knowledge of trigger points, which occur prior to tipping points and prompt the community to action, and funding sources, both of which are not represented by the current pathway and present another area for research on this topic.

COASTAL ADAPTATION PATHWAYS
FOR
BARRIER ISLAND COMMUNITIES

Stephanie Patch[1], Renee Collini[2]

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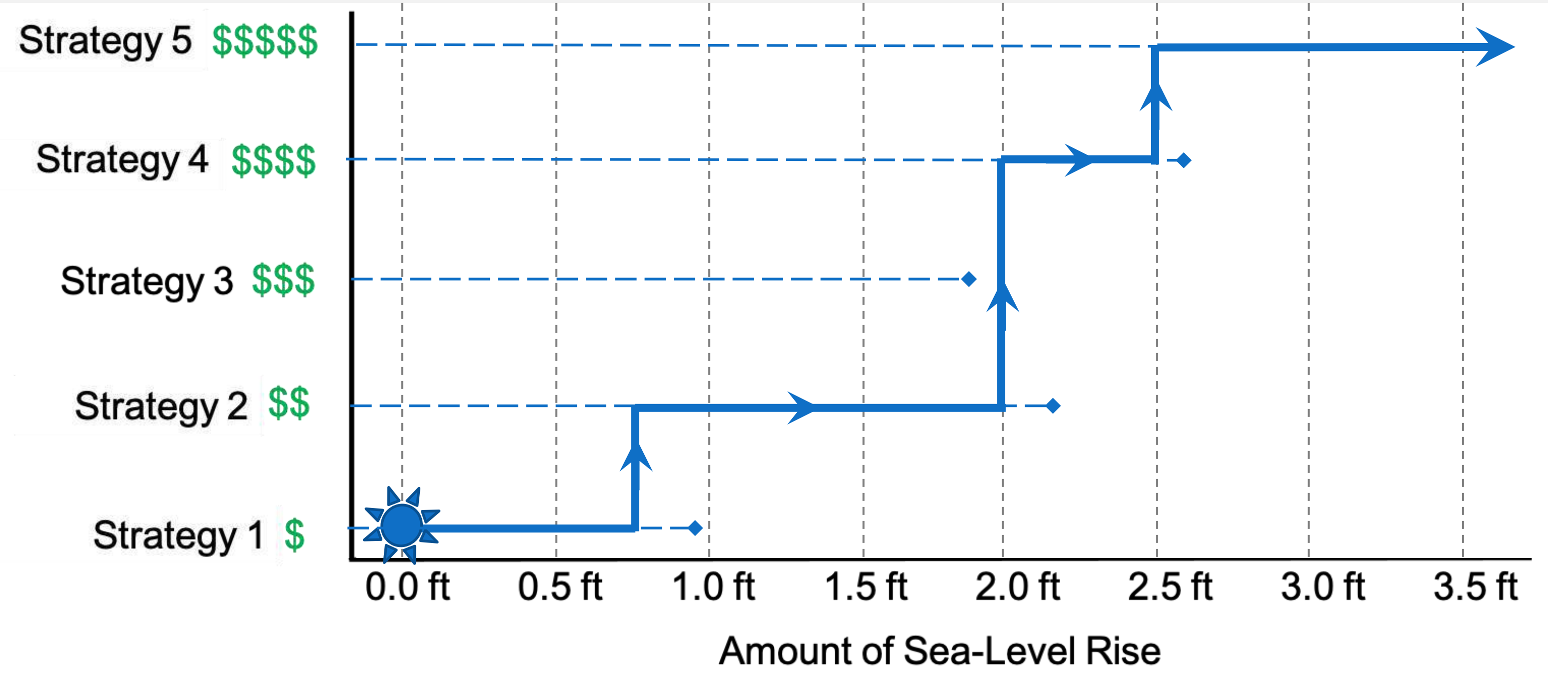
[2] Director, Center for Equitable Climate Resilience, The Water Institute

99th Board on Coastal Engineering Research Meeting

August 15 – 17, 2023

ADAPTATION PATHWAYS OVERVIEW

- Series of adaptation strategies
- Allows for action based on observed changes
- Pathway developed from tipping points
- Actions build on each other
- Well suited for:
  - Dynamic systems (e.g., dunes/beaches)
  - Low-budget situations

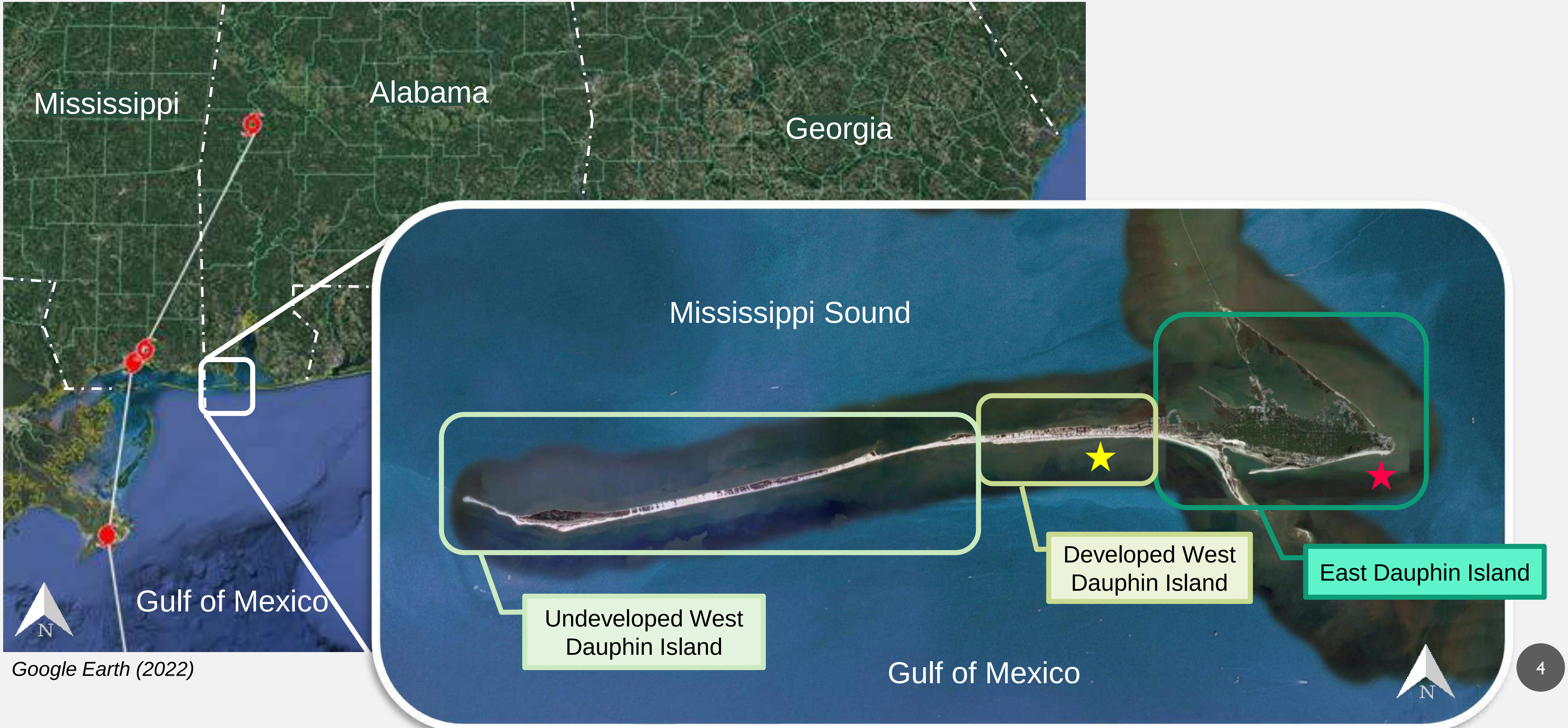


EXAMPLE: DAUPHIN ISLAND, ALABAMA

USCRP Funded Project (2019)

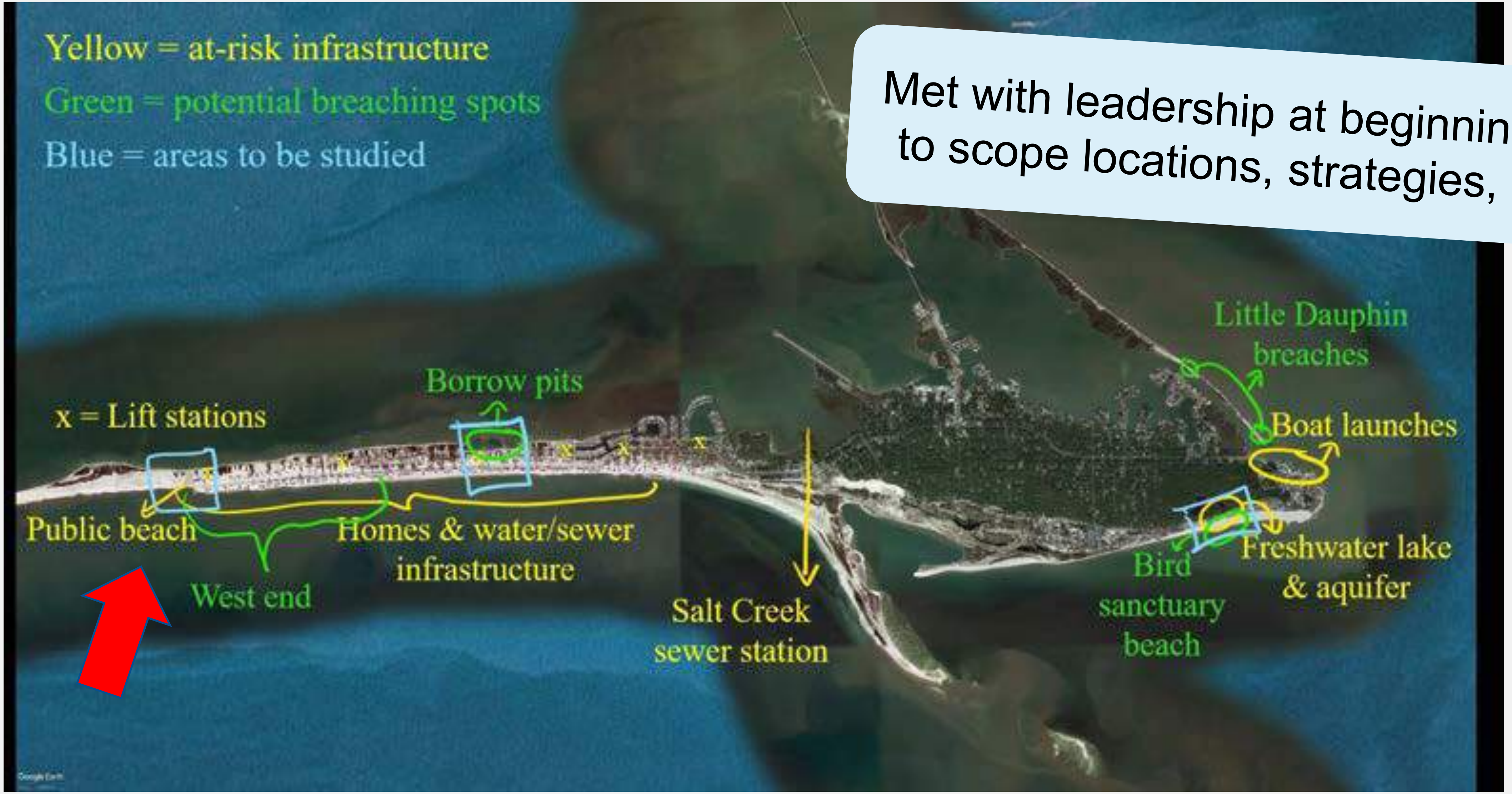
- Concerned about resilience in the face of low-intensity tropical events
- Evaluated adaptation strategies against three standards of success
  - Breaching
  - Sand on Bienville (main road)
  - Sand volume and elevation across the island (overall resilience)

STUDY SITE



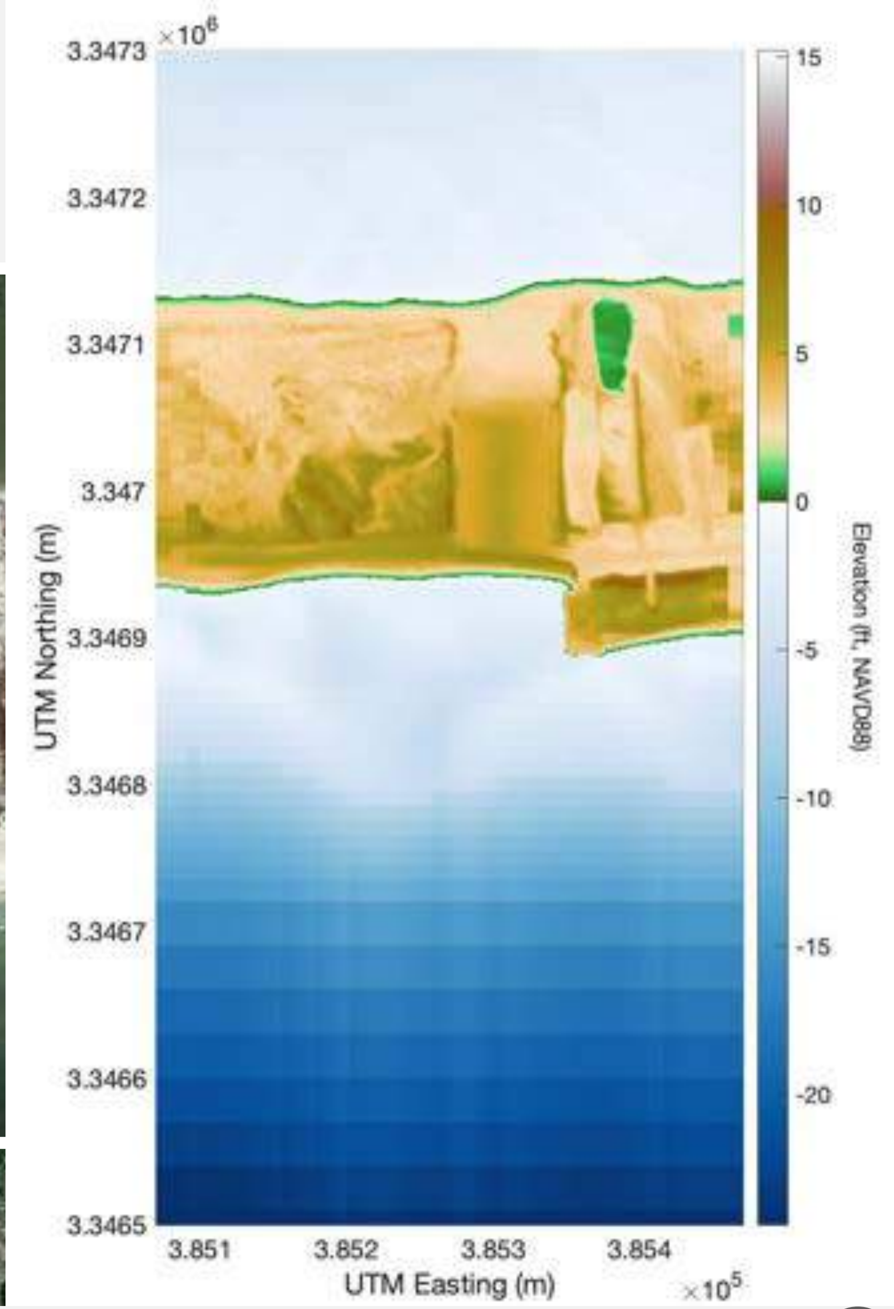
Google Earth (2022)

COMMUNITY LEADERSHIP ENGAGEMENT



Met with leadership at beginning of project to scope locations, strategies, conditions

MORPHODYNAMIC MODELING



MODEL CALIBRATION

XBeach Modeling Results

- Brier Skill Score (BSS)

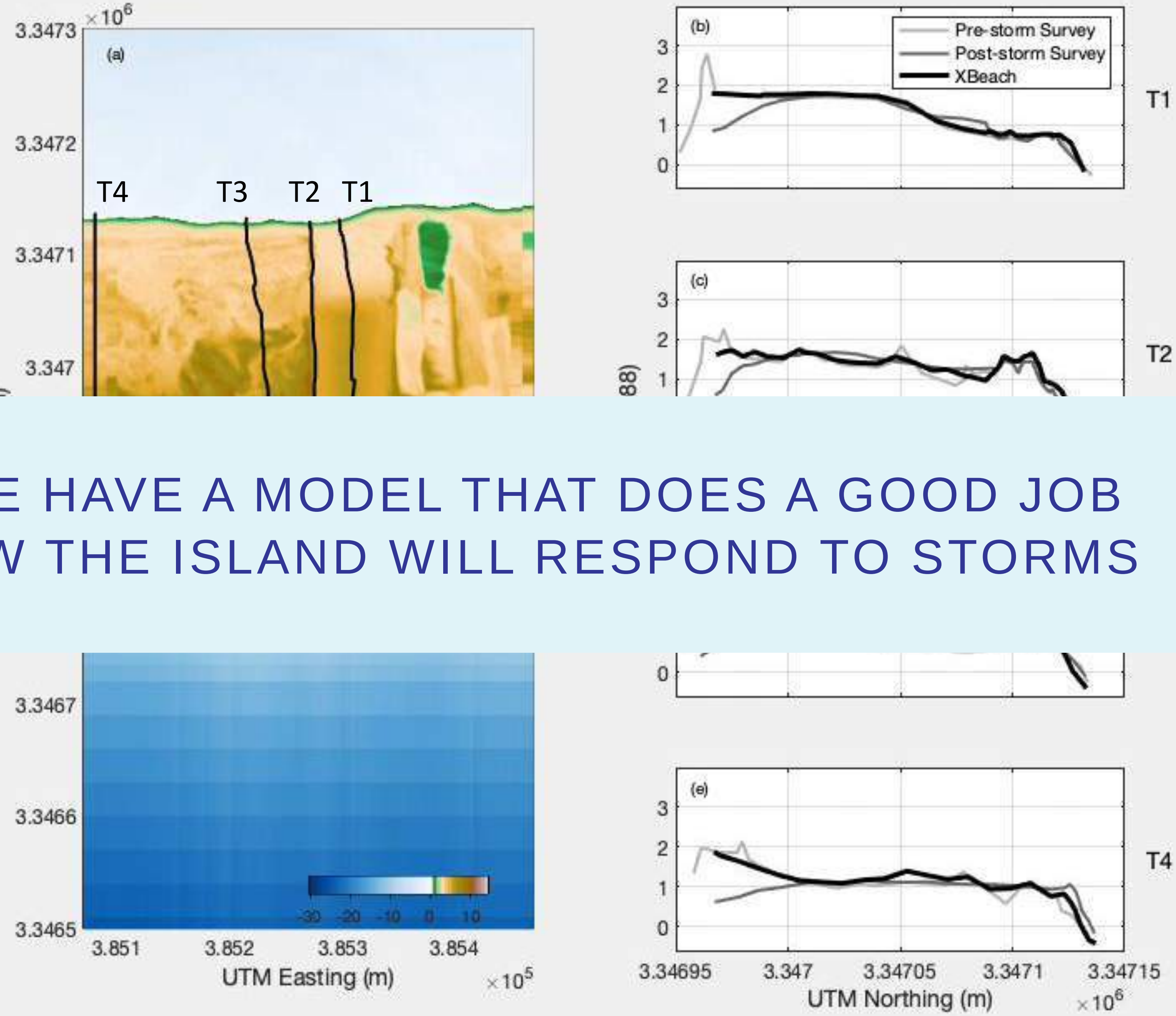
survey and model

T1: BSS = 0.88

T2: BSS = 0.86

T3: BSS = 0.94

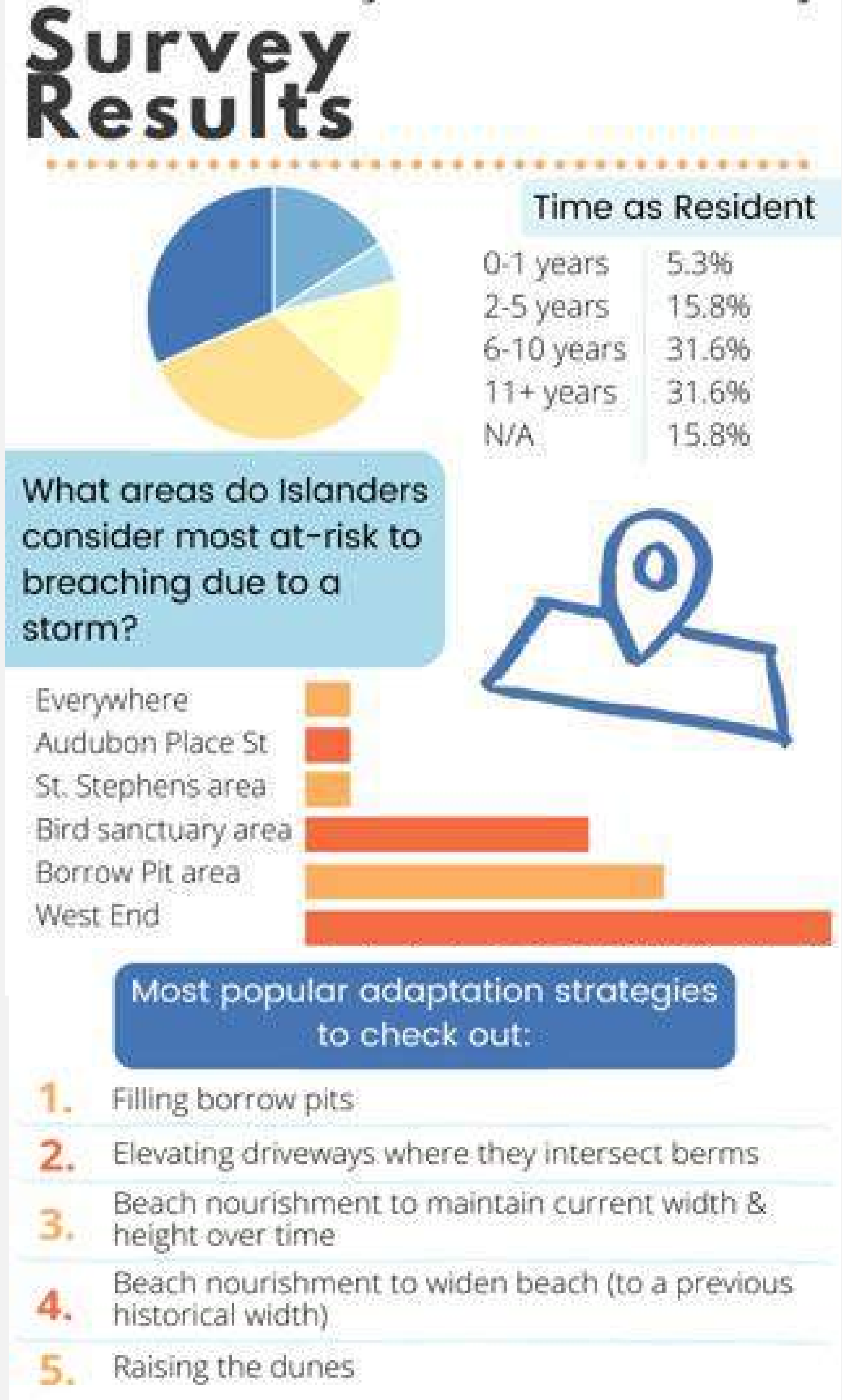
T4: BSS = 0.84



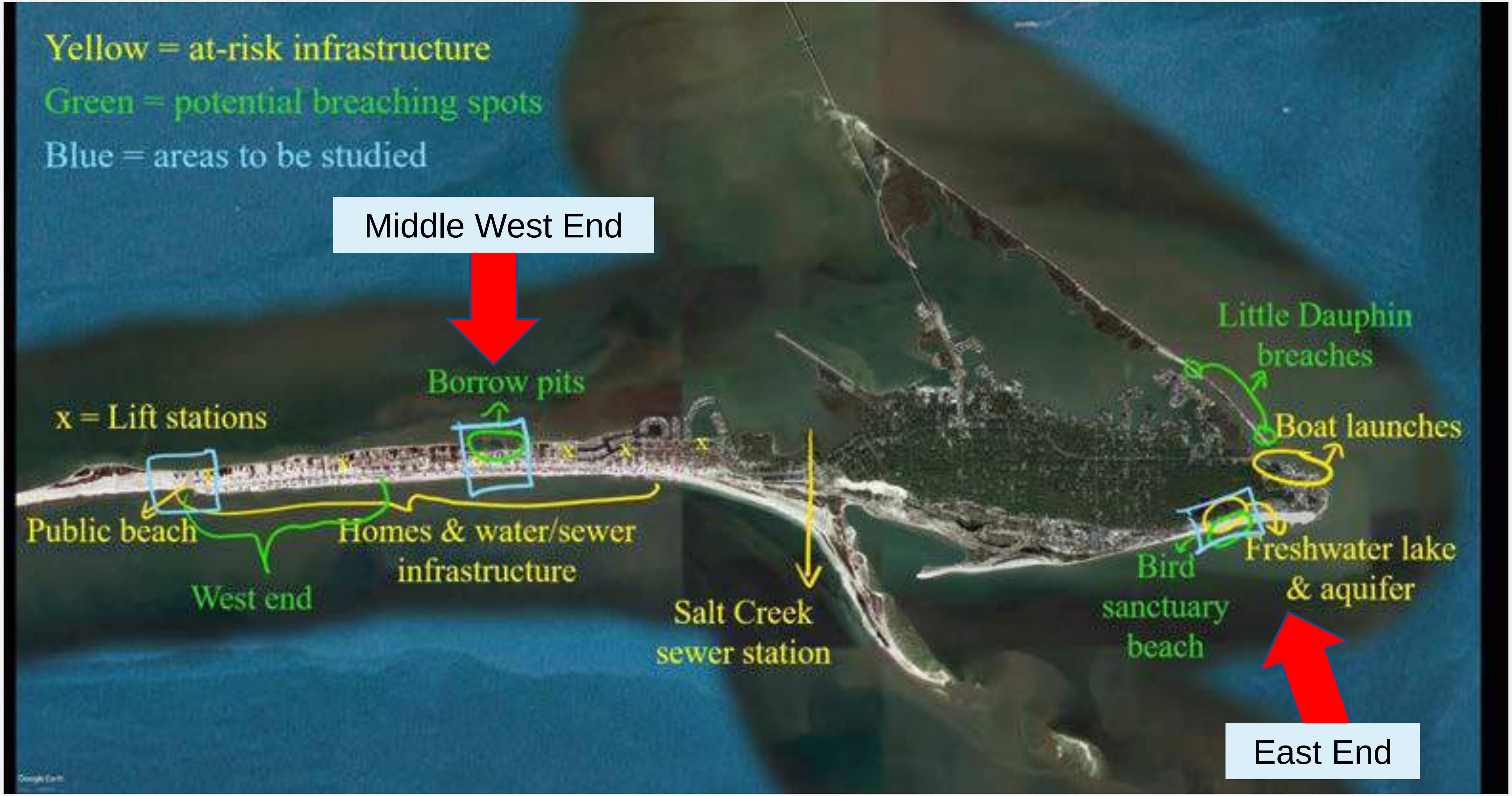
TAKE AWAY – WE HAVE A MODEL THAT DOES A GOOD JOB PREDICTING HOW THE ISLAND WILL RESPOND TO STORMS

COMMUNITY MEMBERS ENGAGEMENT

Talked to residents to get their input on solutions & locations too



COMMUNITY LEADERSHIP ENGAGEMENT



FINAL RESEARCH SCOPE

WEST END BEACH

Beach nourishment

Dune elevation

MID WEST END

Filling borrow pits

Elevating driveways

Beach nourishment

EAST END BEACH

Beach nourishment

Beach elevation

Dune elevation

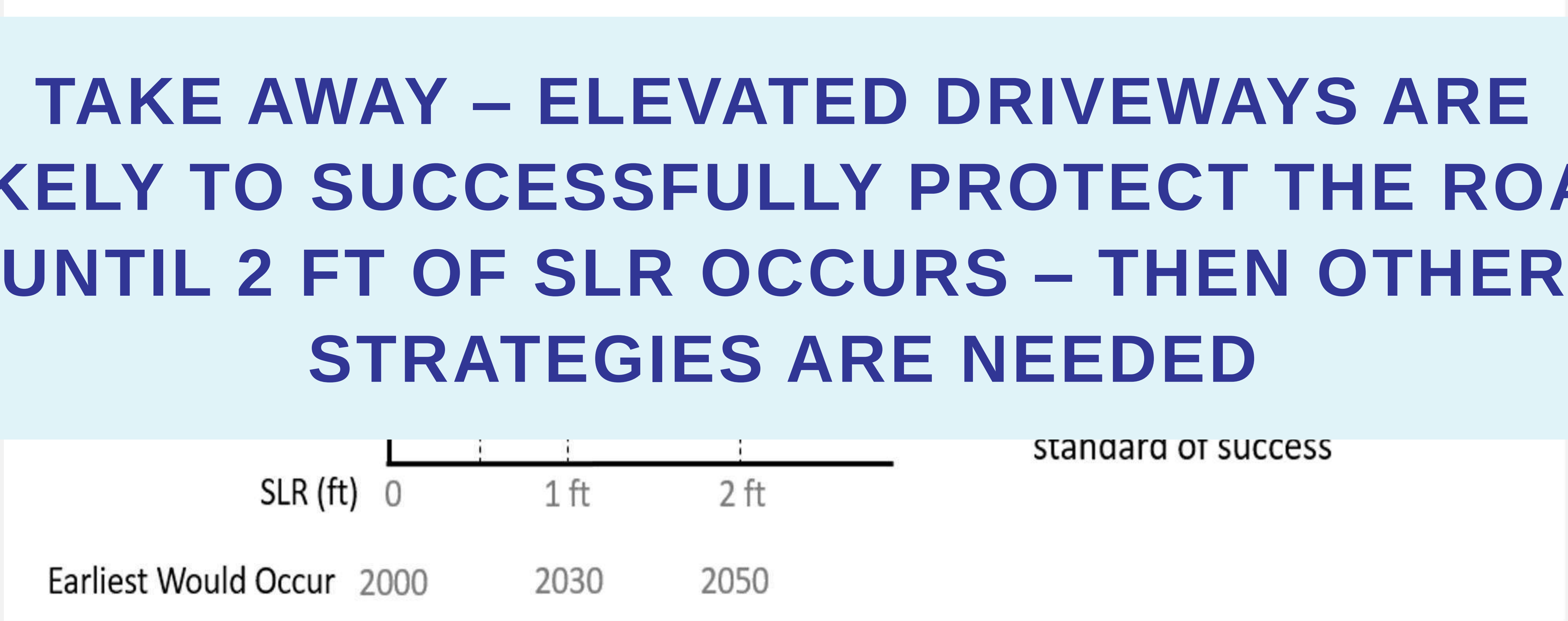
Evaluated strategies for Hurricane Nate

Considers sea-level rise up to 2 ft

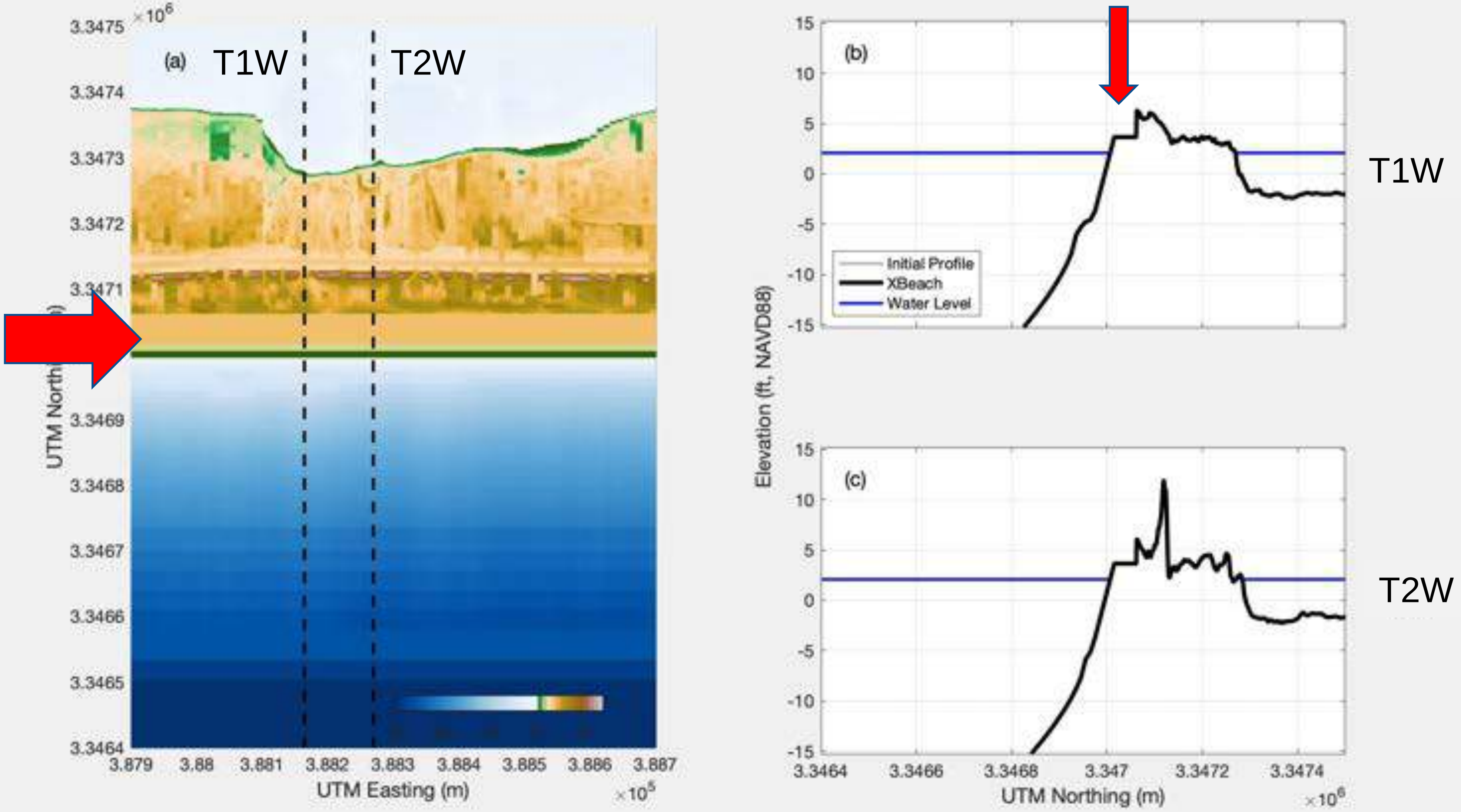
ADAPTATION STRATEGY EVALUATION

PATHWAY – SAND ON BIENVILLE

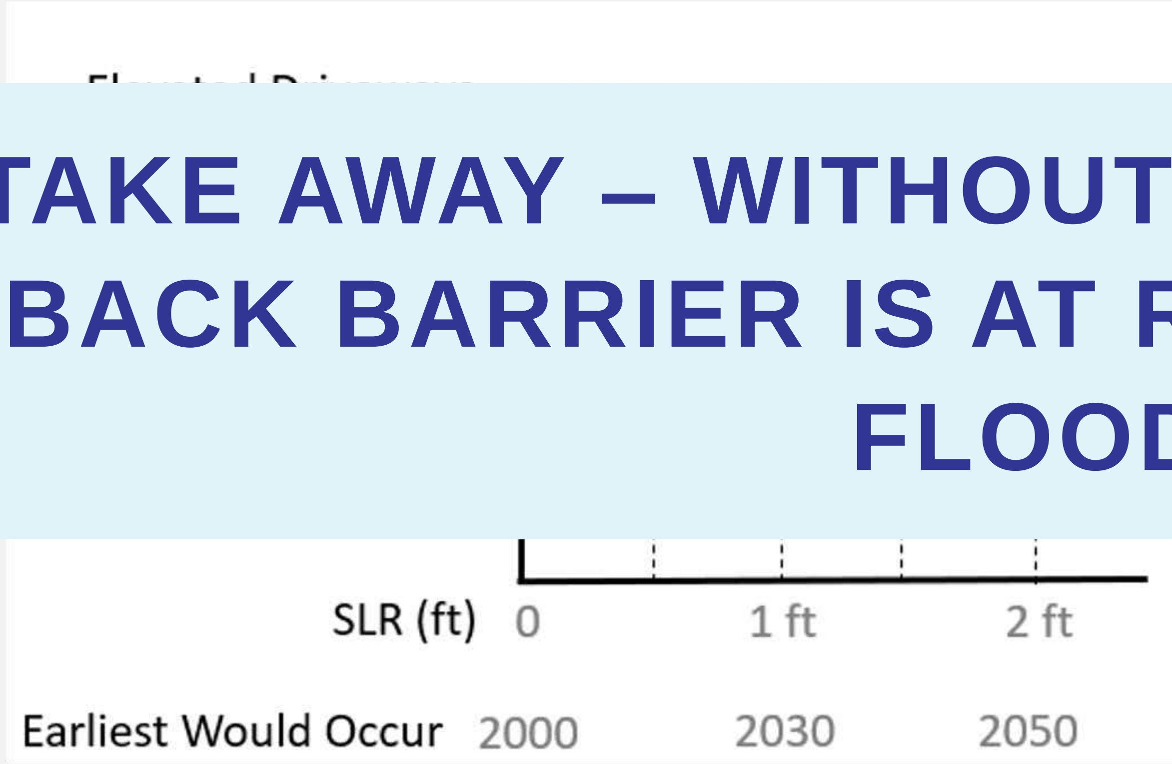
TAKE AWAY – ELEVATED DRIVEWAYS ARE LIKELY TO SUCCESSFULLY PROTECT THE ROAD UNTIL 2 FT OF SLR OCCURS – THEN OTHER STRATEGIES ARE NEEDED



ADAPTATION STRATEGY EVALUATION



PATHWAY – OVERALL RESILIENCE



TAKE AWAY – WITHOUT ADDITIONAL ACTION BACK BARRIER IS AT RISK TO PERMANENT FLOODING

Essentially, with each small storm as seas rise, the back barrier gets lower without access to additional sand

CONCLUSIONS

- Successes
  - Driveways are being (or have been) elevated
  - East end is being nourished
  - West end nourishment project in the works
- Benefits
  - Action can be trigged by observations
  - Reduce unnecessary spending in dynamic systems
- Considerations
  - Maintenance & monitoring are key
  - Consider tipping points vs trigger points

R&D RECOMMENDATIONS

- Create pathway with additional storms
- Consider island evolution with SLR
- Determine uncertainty of trigger points
- Develop robust models/modules
  - Long-term barrier island evolution
  - Groundwater impact on sediment transport
- Implement adaptation pathways and evaluate performance in communities
  - Probabilistic SLR projections
  - Advancing policy and practice in the U.S.
- Evaluate pathways based on definitions of resilience
- Identify trigger points and funding mechanisms

THANK YOU

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UNIVERSITY OF
SOUTH ALABAMA

Summary of Outcomes and Recommendations: Community Integration with Non-Structural and Hybrid Solutions

Jane McKee Smith

Emeritus Senior Scientist

Engineer Research & Development Center
U.S. Army Corps of Engineers

15-17 August 2023, Miami, FL

Coastal R&D needs associated with integrated natural, nature-based, traditional, and non-structural solutions co-developed to meet community needs

Why is BCER in Miami?

Community Integration:

- Stakeholders outspoken
  - Social and environmental benefits
  - Nature-based/hybrid solutions
  - Nonstructural solutions
- Policy, but lacking Guidance and Tools
  - Comprehensive benefits (all 4 accounts)
  - High-density system impacting community resilience (e.g., evacuation, ability for natural adaptation, limited overland flow/ storm water conveyance options, etc.)

Complex Physical System

- Compound flooding: inland, coastal, surface and groundwater interactions
- Salt-water/freshwater interplay exacerbated by changing climate
- Climate change impacts and non-stationarity ~ uncertainty
- Environmentally sensitive areas
  - Barrier Islands and beaches
  - Bays and wetlands
  - High population density

South Florida: Integrating Coastal and Inland Projects

Planning and Policy Needs:

- Challenge: Single purpose studies: inland flood OR coastal storm; lack Guidance for compound flooding
- Needs:
  - Short-term: Implementation guidance for WRDA 2022 Sec 8106
  - Long-term: Joint authority for inland and coastal risk (FRM/CSRM)

Research Needs:

- Challenge: Engineering/planning models focus on inland OR coastal processes; untested for compound flooding
- Needs:
  - Short term: Link inland & coastal models + training and documentation
  - Inland natural and nature-based feature R&D and guidance
  - Long-term: Next generation tools for combined environment

Miami Back Bay Mega Study

MEGA Coastal Storm Risk Management Study:

- Highly complex, environmentally sensitive, highly visible project
- Stakeholder input:
  - System-wide, multiple lines of defense, adaptive approach
  - Social equity, community cohesion, and environment benefits
  - Miami-Dade County did not support structural measures

Research Needs:

- Tools, examples, and processes to complete Chiefs Report
- Methods to evaluate non-stationary benefits for natural & nature-based features
- Depth-damage functions for critical infrastructure
- Modeling tools for
  - Complex system impacts
  - Natural and nature-based feature design
  - Pump station and gate design

Coastal Hazard Analysis and Risk Toolkit (CHART)

Coastal Storm Risk Management Analysis Framework:

- Evaluate project alternative performance and benefits through life cycle analysis
- Consistent, modular framework: 1. Scoping and 2. Feasibility analysis
- Links to engineering databases and models
- Consistent with Policy

Research Needs:

- Coastal Hazards System (CHS) expansion
  - Pacific coast and islands
  - Compound flooding
- Intra-lifecycle coupling of coastal/inland hydrodynamic and morphology models
- Engineering design guidance to align inland and coastal flood risk management
- Policy-compliant analysis methods for Environmental Quality, (EQ), Regional Economic Development (RED), and Other Social Effects (OSE)

Key Biscayne: Resilient Infrastructure & Adaption

Barrier Island Vulnerability:

- Low elevation, aging/exposed critical infrastructure, limited space, regulations incompatible with resiliency goals
- Risks to property, economy, quality of life → action required
- Beach restoration → economic, environmental, and social value

Policy Needs:

- Revisit treatment of recreational benefits & allow cost sharing of enhancements
- Allow selection of Total Benefits Plan, without policy exception

Research Needs: Continued development:

- Coastal Hazard Analysis & Risk Toolkit (CHART)
- Coastal Hazard System (CHS)
- Coastal compound flooding R&D

Better Serving the Underserved

Comprehensive Benefits:

- Incorporation of all accounts:
  - National Economic Development (NED)
  - Environmental Quality (EQ) ~ natural and cultural resources
  - Regional Economic Development (RED)
  - Other Social Effects (OSE) ~ environmental justice, social vulnerability
- NED exceptions; tools and techniques for OSE

Research Needs:

- Focus on resilience: community viability, critical infrastructure
- Differentiate buyouts v. relocation v. managed retreat, role of climate change
- Develop options for shelter in place and vertical evacuation
- Reinstate social science training program (modules: climate change, nonstructural, and ecosystem restoration)

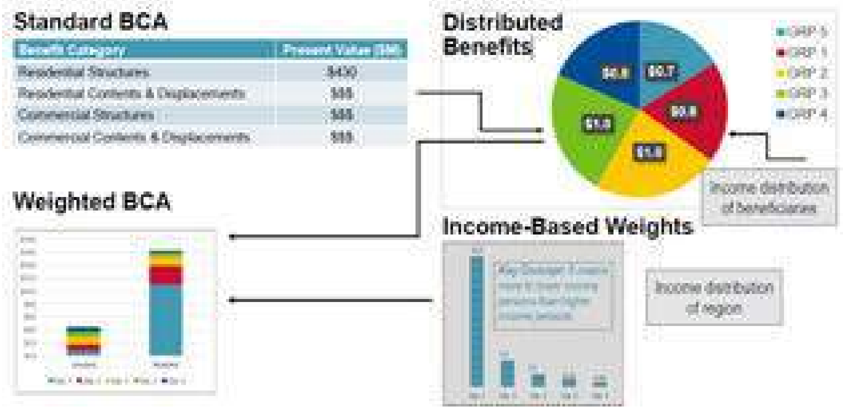
Alternative Methods to Level the Playing Field

Weighted Benefit Cost Analysis (WBCA):

- Weight cost and benefits by income group → Social Equity Value
  - Distributed benefits
  - Weighted BCA
- Areas of application: Flood risk + other infrastructure systems

Research Needs:

- Establish collaborative team
- Identify demo locations
- Compare WBCA and BCA
- Policy-wise ~ application of WBCA?



Quantifying Natural and Nature-Based Benefits

Case Studies to Look Beyond Policy Constraints

- Ecosystem goods and services and multi-objective decisions support
- Benefits: recreation, water quality and access, carbon sequestration, flood risk reduction & longevity, and sediment management cost reduction

Research Needs:

- Foundational research – risk/failure, risk reduction, social equity quantification
- District-ready tools – modeling toolkit, benefit databases, multi-criteria frameworks
- Guidance materials
  - Integrated, multi-objective scoping and alternative formulation
  - NNBF and hybrid design
  - Implementation, O&M, and adaptive management
  - Intra- and interagency collaboration

Coastal Storm Damages Prevented Tool

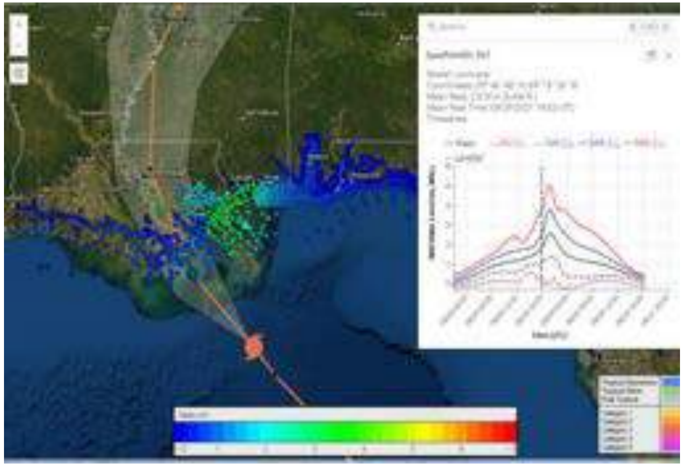
Purpose

- Retrospective assessment of damages prevented
- Assessment of comparative existing and future risk
- Case studies and highlight value of projects

Research Needs:

- Expand nationally
- Validate
- Improve national structure inventory and damage functions
- Apply to future changes in risk (sea level rise, storm climatology changes)
- Story telling ~ how to effectively use the results

Machine Learning (ML) and Artificial Intelligence (AI) in Coastal Applications



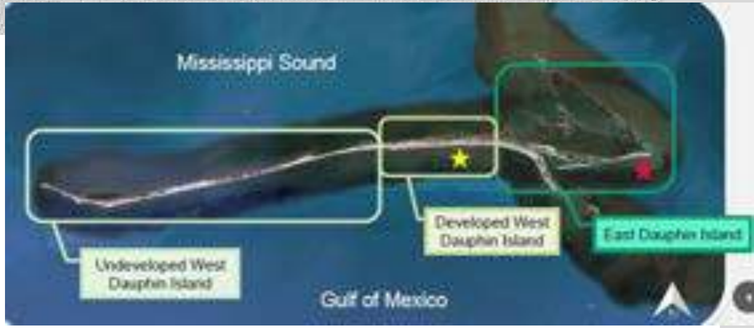
Data-driven Modeling

- Tide predictions
- SANDSNAP
- COASTSAT
- Coastal Hazards System – Probabilistic Coastal Hazard Analysis and Rapid Prediction web tool
- Future Coastal Storm Risk Management → CSTORM modeling with ML

Research Needs:

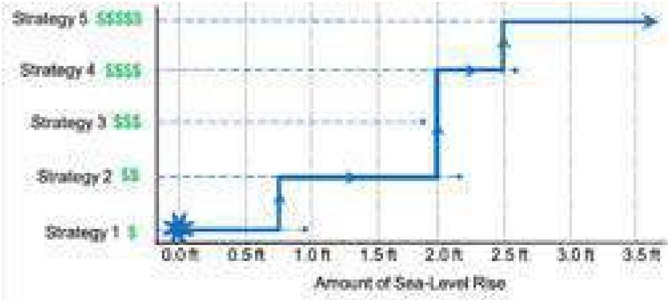
- Further test ML/AI algorithms for coastal applications
- Adapt/develop coastal workflows using ML/AI
- Partner with other agencies and academia for community solutions

Coastal Adaptation Pathways for Barrier Island Communities



Adaption Pathways

- Series of adaptation strategies, well-suited for dynamic systems
- Actions based on observed changes ~ triggers (context of tipping points)
- Dauphin Island example
  - Stakeholder engagement
  - Reduce unnecessary spending
  - Maintenance & monitoring are key



R&D Needs:

- Trigger points – how to identify, uncertainty, funding mechanism
- Robust model of barrier island evolution + groundwater impact
- Evaluate pathways → probabilistic SLR projections + storms + policy/practice
- Evaluate success based on definition of resilience

Challenges and BCER Feedback

Feedback on Priorities
What is missing?
Where to invest?

- **Efficiently, effectively get R&D into guidance:**
  - Comprehensive benefits – integrate 4-account tradeoffs
  - Use of natural and hybrid infrastructure
  - Compound flooding (FRM + CSRM)
- **Under-served communities**
  - Focus on resilience: community viability, culture, critical infrastructure
  - Enhance & integrate assessment tools
- **Complex physical processes and integrated system analysis**
  - Compound flooding: inland + coastal + groundwater
  - Climate change impacts and non-stationarity ~ uncertainty
  - Coastal and inland NNBF R&D (evolution, risk/failure, design, benefits)
  - Robust depth-damage functions
  - CHS expansion to the Pacific
  - CHART development
  - Adaptive pathway approach

Action Items and Recommendations: 2023 Executive BCER				
NUMBER	**ACTION ITEM / RECOMMENDATION**	**Due**	**POC(s)**	**Status**
ACTION ITEMS Executive BCER Meeting, Chicago, IL				
2023-Exec-1	Briefing on CHART Fundamentals. Brief BCER on Fundamentals of the Coastal Hazard Analysis and Risk Toolkit (CHART); Describe CHART Capability to Evaluate Range of Engineering and Environmental Scenarios	2023 Full BCER	Kevin Hodgens	
2023-Exec-2	Briefing on NAD Environmental Justice and Non-Structural Challenges. Brief BCER on North Atlantic Division's non-structural challenges and potential solutions	2023 Full BCER	Susan Durden	
2023-Exec-3	Incorporating Environmental Justice into Coastal Analyses Summarize Approaches to Incorporate Environmental Justice data into coastal planning, engineering and design	2023 Full BCER	Susan Durden	
2023-Exec-4	BCER Feedback. At their request, provide BCER feedback on their effectiveness in providing impactful and actionable advice and recommendations to the Coastal and Hydraulics Laboratory, the Chief of Engineers, and the Secretary of the Army	2024 Executive BCER	Wamsley, Rosati	
2023-Exec-5	Proposal for 100th BCER Meeting. BCER requested a briefing with ideas to celebrate the 100th meeting of the board which will occur Summer 2024. Briefing will include proposed theme, location and venue, and suggested VIP attendees	2023 Full BCER	Wamsley	
2023-Exec-6	"Moonshot" R&D to Address Coastal Engineering Challenges. Brief the BCER on "moonshot" ideas in coastal engineering to address the next-generation challenges	2024 Executive BCER	Rosati, BCER	
RECOMMENDATIONS Executive BCER Meeting, Chicago, IL				

2023-Exec-REC-1	Pursue Development of a National Coastal Risk Map. Integrate with physical processes (Coastal Hazards System), Coastal Storm Risk Management projects, Structural Inventory, and Social Vulnerability/ Environmental Justice; incorporate tools for adaptation pathways.			
2023-Exec-REC-2	Conduct a Forensic Review of Coastal Storm Risk Management Projects exceeding Original Cost Estimates Original projects designs may not be sufficient; review why costs were exceeded, and document lessons learned for use in future project planning and design process. Review how benefits were quantified in each of the four benefit categories, and the criteria used to approve project construction.			
2023-Exec-REC-3	Collaborate with NOAA's Interagency Group Collecting Data on Underserved Communities as part of NOAA's Coastal Resilience Mission			

COASTAL ENGINEERING RESEARCH BOARD MEETINGS

NO.	LOCATION	HOST	DATE
1st	Coastal Engineering Research Center (CERC)	CERC	April 1964
2nd	CERC	CERC	August 1964
3rd	Vicksburg, MS	WES	December 1964
4th	CERC	CERC	June 1965
5th	Port Huron, MI		October 1965
6th	CERC	CERC	May 1966
7th	Vicksburg, MS	WES	December 1966
	Vicksburg, MS (Civilian Members Only)	WES	April 1967
8th	CERC	CERC	May 1967
9th	Lake Survey District		October 1967
10th	Palm Beach - Miami Beach, FL		May 1968
11th		SPD	October 1968
	Vicksburg, MS (Civilian Members Only)	WES	January 1969
12th	CERC	CERC	July 1969
13th	Galveston, TX		October 1969
14th	Vicksburg, MS	WES	Mar-Apr 1970
15th	Cambridge, MA	MIT	October 1970
16th	Vicksburg, MS	WES	April 1971
17th	CERC	CERC	October 1971
18th	Portland and Newport, OR		April 1972
19th	Jacksonville, FL	SAD	October 1972
20th	Washington, D.C.		May 1973
21st	North Central Division	NCD	October 1973
22nd	San Francisco, CA	SPD	March 1974
23rd	Wilmington, NC	SAD	September 1974
24th	North Falmouth, MA	NED	July 1975
25th	San Diego, CA	SPD	December 1975
26th	Fort Belvoir, VA	CERC	May 1976
27th	Mobile, AL	SAD	November 1976
28th	New York, NY	NAD	June 1977
29th	Wilmington, NC	SAD	October 1977

30th	Corpus Christi, TX	SWD	April 1978
31st	San Francisco, CA	SPD	October 1978
32nd	Miami Beach, FL	SAD	April 1979
33rd	Seattle, WA	NPD	September 1979
34th	Cleveland, OH, and Erie, PA	NCD	April 1980
35th	Baltimore, MD	NAD	November 1980
36th	Galveston, TX	SWD	March 1981
37th	Vicksburg, MS	LMVD	November 1981
38th	San Diego, CA	SPD	April 1982
39th	Wilmington, NC	SAD	May 1983
40th	North Falmouth, MA	NED	October 1983
41st	Seattle, WA	NPD	June 1984
42nd	Chicago, IL	NCD	December 1984
43rd	Vicksburg, MS	WES	May 1985
44th	San Francisco, CA	SPD	November 1985
45th	Fairbanks and Homer, AK	NPD/NPA	May 1986
46th	Vicksburg, MS	WES	October 1986
47th	Corpus Christi, TX	SWD/SWG	May 1987
48th	Savannah, GA	SAD/SAS	November 1987
49th	Oconomowoc, WI	NCD/NCE	May 1988
50th	Virginia Beach, VA	NAD/NAO	November 1988
51st	Wilmington, NC	SAD/SAW	May 1989
52nd	Redondo Beach, CA	SPD/SPL	October 1989
53rd	Fort Lauderdale, FL	SAD/SAJ	June 1990
54th	New Orleans, LA	LMVD/LMN	June 1991
55th	Mashpee, MA	NED	Oct/Nov 1991
56th	Newport, OR	NPD/NPP	June 1992
57th	Honolulu, HI	POD	October 1992
58th	Atlantic City, NJ	NAD/NAP	June 1993
59th	Point Clear, AL	SAD/SAM	November 1993
60th	Vicksburg, MS	WES	November 1994
61st	Galveston, TX	SWD/SWG	May 1995
62nd	Fort Lauderdale, FL	SAD/SAJ	October 1995
63rd	San Diego, CA	SPD/SPL	June 1996

64th	Morro Bay and San Francisco, CA (Civilian Members)	SPD	January 1997
65th	Chicago, IL	NCD/NCC	June 1997
66th	New York, NY	NAD	October 1997
67th	Fort Lauderdale, FL	SAD/SAJ	June 1998
68th	Wilmington, NC, and Norfolk, VA	SAD/NAD	November 1998
69th	Honolulu, HI	POD	April 1999
70th	Dauphin Island, AL	SAD/SAM	October 1999
71st	Dana Point, CA	SPD/SPL	June 2000
72nd	Galveston, TX	SWD/SWG	Jul/Aug 2001
73rd	Avalon, NJ	NAD/NAP	March 2002
74th	Duck, NC	ERDC	September 2002
75th	Lafayette, LA	MVD/MVN	June 2003
76th	Portland, OR	NWD/NWP	October 2003
77th	Traverse City, MI	LRD/LRE	June 2004
78th	Silver Spring, MD	ERDC/CHL	November 2004
79th	Anchorage, AK	POD/POA	June 2005
80th	St. Petersburg, FL	SAD/SAJ	November 2005
81st	Vicksburg, MS	ERDC	July 2006
82nd	Long Branch, NJ	NAD/NAN	October 2006
	The Netherlands (Fact-Finding Meeting)	NAD/ERDC	June 2007
83rd	Alexandria, VA	ERDC	September 2007
84th	New Orleans, LA, and Mobile, AL	SAD/LMV	April 2008
85th	Portland, OR	NWD/NWP	September 2008
86th	San Diego, CA	SPD/SPL	June 2009
87th	Jersey City, NJ	NAD/NAN	June 2010
88th	Niagara Falls, NY	LRD/LRB	July 2011
89th	Jacksonville, FL	SAD/SAJ	September 2012
90th	Long Branch, NJ	NAD/NAN/NAP	September 2013
91st	San Francisco, CA	SPD	September 2014
92nd	Galveston, TX	SWD/SWG	September 2015
93rd	San Juan, PR	SAD/SAJ	August 2016
94th	Honolulu, HI	POD	June 2017
95th	Providence. RI	NAD	August 2018

96th	Detroit, MI	LRD/LRE	August 2019
97th	Vicksburg, MS	ERDC/CHL	August 2020
No meeting held in 2021 due to FACA Zero Based Review Audit			
98th	Anchorage, AK	CHL/POA	September 2022
99th	Miami, FL	SAD/SAJ	August 2023

Thank You for Attending the 99th BCER

MIAMI
MAMI