

BOARD ON COASTAL ENGINEERING RESEARCH

100TH MEETING

Celebrating Accomplishments of the BCER in
100 Meetings and Setting the Stage for the Future

San Francisco, CA
August 13–15, 2024

Hosted by the South Pacific Division and the San Francisco District

MEMBERSHIP
U.S. ARMY BOARD ON COASTAL ENGINEERING RESEARCH

MILITARY MEMBERS

MG (P) William H. Graham, Chair
Deputy Commanding General for
Civil and Emergency Operations
U.S. Army Corps of Engineers
441 G Street, NW
Washington, DC 20314-1000
Phone (202) 761-0099
William.H.Graham@usace.army.mil

BG John P. Lloyd
Commander
U.S. Army Engineer Division, North Atlantic
Fort Hamilton Military Community
301 General Lee Avenue
Brooklyn, NY 11252-6700
Phone (718) 765-7000
John.P.Lloyd@usace.army.mil

BG Daniel H. Hibner
Commander
U.S. Army Engineer Division, South Atlantic
60 Forsyth Street, SW, Room 10M15
Atlanta, GA 30303-8801
Phone (404) 562-5006
Daniel.H.Hibner@usace.army.mil

Col. James J. Handura
Commander
U.S. Army Engineer Division, South Pacific
450 Golden Gate Ave
San Francisco, CA 94102-1398
Phone (415) 503-6501
james.j.handura@usace.army.mil

CIVILIAN MEMBERS

Dr. H. Tuba Ozkan-Haller
College of Earth, Ocean, and Atmospheric
Sciences
Oregon State University
101 SW 12th Street
Corvallis, OR 97331
Phone (541) 737-5195
ozkan@oregonstate.edu

Dr. Lewis Ed Link
University of Maryland
Dept. of Civil Engineering
7999 Regents Dr.
College Park, MD 20742
Phone 301-471-5012
elink@umd.edu

Dr. Jack Puleo
University of Delaware
Department of Civil and Environmental
Engineering
301B DuPont Hall
Newark, DE 19716
Phone (302) 831-2442
Jpuleo@udel.edu

DESIGNATED FEDERAL OFFICER

Dr. Julie Dean Rosati
U.S. Army Engineer Research and
Development Center
Coastal and Hydraulics Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
Phone (202) 761-1850
Julie.D.Rosati@usace.army.mil

EXECUTIVE SECRETARY

Ms. Jennifer Ratliff
U.S. Army Engineer Research and
Development Center
Coastal and Hydraulics Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
Phone 601-634-3663
Jennifer.r.ratliff@usace.army.mil

Major General (P) William (Butch) H. Graham

Deputy Chief of Engineers and Deputy Commanding General / Deputy Commanding General for Civil Works and Emergency Operations

U.S. ARMY CORPS OF ENGINEERS

Major General William (Butch) H. Graham is currently serving as the Deputy Chief of Engineers and Deputy Commanding General as well as retaining his responsibilities as the Deputy Commanding General for Civil and Emergency Operations, U.S. Army Corps of Engineers until his successor completes his current assignment.

Graham 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's of Science in Mechanical Engineering from the University of Pittsburgh and a Master's 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.

Brigadier General Daniel H. Hibner

Commander, South Atlantic Division

U.S. Army Corps of Engineers

Brig. Gen. 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 Savannah 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.

Col. James J. Handura, PMP

Commander, South Pacific Division

U.S. Army Corps of Engineers

Colonel James J. Handura assumed duties as the Commander and Division Engineer of South Pacific Division (SPD), U.S. Army Corps of Engineers on Nov. 28, 2023. 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, he is responsible for leading a workforce of more than 2,500 military and civilians, overseeing hundreds of water resource development, military, and interagency design and construction projects valued at more than $6 billion in support of our communities, our Nation, and our warfighters.

A native of Clearwater, Florida, Handura graduated in 1996 from Austin Peay State University in Clarksville, Tennessee as a Distinguished Military Graduate with a Bachelor of Science in Geology, and a commission in the Engineer Regiment. He holds a Master of Science in Geology and Geophysics from the University of Missouri-Rolla, a Master's degree in Military Art and Science – Theater Operations from the U.S. Army School of Advanced Military Studies, and a Master's degree in Strategic Studies from the U.S. Army War College. He is also certified Project Management Professional.

Prior to South Pacific Division, Handura served as the Chief of Staff for the U.S. Army Corps of Engineers Headquarters in Washington, DC. Handura began his military service with the United States Navy Seabee Reserves, serving as a Utilitiesman from 1987 to 1989, at Bayboro Harbor, St. Petersburg, Florida. From 1989 to 1993, he served in the U.S. Army as an enlisted Combat Engineer, with the 82nd Engineer Battalion (Federal Republic of Germany) and the 20th Engineer Battalion (Ft. Campbell, Kentucky and later Ft. Hood, Texas).

Handura's command assignments include Commander Sacramento District, USACE; Commander 19th Engineer Battalion, 20th Engineer Brigade, XVIII Airborne Corps at Fort Knox, Kentucky; and Deputy District Commander New Orleans District, USACE.

Handura's key staff assignments include Joint Staff J7 Deployable Training Division Lead Observer Trainer, and Engineer Observer Trainer; Executive Officer and S3, 7th Engineer Battalion, 20th Engineer Brigade, XVIII Airborne Corps at Fort Drum, New York; Commander's Initiatives Group Strategic Planner, Multi-National Force-Iraq; J3 Future Operations Planner, Multi-National-Force-Iraq; Deputy Resident Engineer, and Project Engineer, Florida Area Office, Mobile District, USACE; and Assistant Task Force Engineer Task Force Falcon KFOR 3B.

Handura's operational deployments include Operation Desert Shield/Desert Storm; Operation Joint Guardian; Operation Enduring Freedom; and Operation Iraqi Freedom.

His military awards and decorations include the Legion of Merit, Bronze Star Medal, Defense Meritorious Service Medal, and the Meritorious Service Medal. He is a recipient of the Ranger Tab, Sapper Tab, Parachutist Badge, Air Assault Badge, Joint Staff Identification Badge, French Commando School Badge, and the Army Engineer Association’s Silver de Fleury Medal.

Brigadier General John P. Lloyd

Commander and Division Engineer, North Atlantic Division

U.S. Army Corps of Engineers

Brig. Gen. John P. Lloyd joined the North Atlantic Division as its commander and division engineer June 24, 2022.

The North Atlantic Division is one of nine regions providing engineering and construction services to the nation. It is the USACE headquarters for the Northeastern United States, Europe, and Africa, with offices in Concord, Mass., New York City, Philadelphia, Baltimore, Norfolk, Va., and Wiesbaden, Germany. As division commander, Lloyd oversees a regional team of more than 3,600 professionals and an annual program of more than $6 billion to plan, design and construct projects that support the military, protect America's water resources, mitigate risk from disasters, and restore and enhance the environment. He is responsible for a mission set that includes a $1.1 billion Civil Works program, the largest Military Construction and International, Interagency and Environmental programs executed within USACE in Fiscal Year 2023, and world-class support teams including Contracting, Small Business, Real Estate, and other essential enablers.

Previously he was assigned to USACE Headquarters, where he served as the chief of staff beginning July 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.

Prior to that, 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, North Carolina, an assignment that included a deployment to Iraq; combat engineer trainer, Fort Irwin, California; aide-de-camp to the deputy commanding general, 18th Airborne Corps; battalion commander, 19th Engineer Battalion, Fort Knox, Kentucky; and Army fellow assigned to the Asia Pacific Center for Security Studies in Honolulu, Hawaii.

A native of Lockport, New York, Lloyd earned his commission May 1995 through the Reserve Officer Training Corps at Cameron University, Lawton, Oklahoma. Along with his undergraduate degree, he has earned a master's 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, Virginia.

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.

Lewis Ed Link, Ph.D.

Dr. Link is a senior research engineer and research professor in the Department of Civil and Environmental Engineering at the University of Maryland. He teaches in the Honors College where his area of emphasis is disaster risk and resilience.

Prior to being on the faculty at Maryland, he spent 34 years with the U S Army Corps of Engineers, culminating in the position of Director of Research and Development and Chief Scientific Advisor for the Agency. Previously he served as the Director of the U S Army Cold Regions Research and Engineering Laboratory in Hanover, NH and Deputy Chief of the Corps of Engineers Coastal Engineering Research Center in Vicksburg, MS. He has authored over 100 technical papers and reports and was Certified as a Professional Hydrologist.

Dr. Link served as Director of the Interagency Performance Evaluation Task Force that conducted the Post Katrina forensic analysis in New Orleans, leading to the immediate repair of the flood defenses and construction of a much enhanced $15B risk reduction system that is now in place. He was also a member of the International Advisory Commission for the Netherlands, using risk and scenario based planning for examining long term adaptation strategies for climate change and sea level rise. This work resulted in a new adaptive strategy for coping with the large uncertainties of climate and sea level changes for the future. He served on the CoastSmart Advisory Council for the Governor of Maryland and currently serves on the Board of Coastal Engineering Research for the Corps of Engineers.

He has participated in multiple National Academy of Engineering, the American Society of Civil Engineers and FEMA Special Studies concerning Dam and Levee Safety, Risk and Resilience, Unified National Strategy for Floodplain Management and Critical Infrastructure. Dr. Link received both the Engineering News Record Award of Excellence and the Army Engineer Association Gold Order of the Defleury Medal and was elected to the National Academy of Construction. He received a BS degree in Geological Engineering from N C State University, a MS in Civil Engineering from Mississippi State University and a PhD in Civil Engineering from Penn State University.

H. Tuba Ozkan-Haller, Ph.D.

Dr. Tuba Özkan-Haller is the 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.

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 underrepresented 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.

Nationally, Özkan-Haller is currently serving as a member on two Federal Advisory Committees: the Hydrographic Survey Review Panel of the National Oceanic and Atmospheric Administration, and the Board on Coastal Engineering Research of the Army Corps of Engineers. She has previously served for two terms as a member of the Ocean Studies Board of the National Academies of Science, Engineering, and Medicine (NASEM) and has participated in various NASEM studies, including as the chair of a consensus study on the future of the U.S. Gulf Coast. She is currently co-chairing a NASEM committee working on a Decadal Survey of Ocean Sciences for the National Science Foundation.

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.

Jack A. Puleo Ph.D.

Dr. Jack A. Puleo is a Professor and Chair of the Department of Civil, Construction, and Environmental Engineering at the University of Delaware. He previously served as the Associate Chair for the Department of Civil, Construction, and Environmental Engineering and the Director for the Center for Applied Coastal Research. As a faculty member, he is generally interested in physical processes occurring near the shoreline. Specifically, he focuses on small-scale hydrodynamic and sediment transport processes. Other areas of research interest consist of nature-based and nature-inspired solutions for coastal disaster mitigation, developing remote sensing and in situ sensing capabilities for coastal research, and Department of Defense based applications of coastal engineering and coastal processes.

He has significant experience and interest in mentoring early career faculty and young professionals. To that end, he initiated, organized, chaired, and fundraised for the Young Coastal Scientists and Engineers Conference – Americas; just completing its 10^{th} yearly conference. Puleo is the recipient of the NSF Career Award, US Fulbright Award, Two University of Delaware Excellence in Teaching Awards, the Robert G. Dean Coastal Academic Award, and a SERDP Project of the Year Award. He holds a B.S. in Oceanography from Humboldt State University, a M.Sc. in Physical Oceanography from Oregon State University, and a PhD in Coastal Engineering from the University of Florida.

.

JULIE DEAN ROSATI , PhD, PE

Dr. Julie Rosati is the Engineer Research & Development Center's lead Technical Director (TD) for Civil Works R&D, and TD for Flood and Coastal Risk Management R&D. In this role, she oversees multi-disciplinary U.S. Army Corps of Engineers research initiatives in Flood and Coastal Risk Management, Navigation, and Environmental Restoration, as well as multiple Federal agency and international partnerships. Through this research, ERDC collaborates with academic, agency and non-governmental partners to infuse innovation into the Corps business processes, advance the state of knowledge, and improve technologies, methods, and tools.

Her background is in coastal research, with focus on regional sediment management and regional sediment budgets, coastal inlet and adjacent beach evolution, barrier island migration, and quantifying coastal resilience. Dr. Rosati serves as the Designated Federal Officer for the Board on Coastal Engineering Research, a Federal Advisory Committee that provides R&D recommendations to the Chief of Engineers and the Assistant Secretary of the Army. She is an Executive Director of the U.S. Coastal Research Program, a national community of practice via collaboration of federal agencies, academics, and stakeholders intended to address coastal research needs and transition outcomes into practice.

She has Bachelors and Masters in Civil Engineering, and a PhD in Oceanography, is a Professional Engineer in Mississippi, member of the American Society of Civil Engineers, and is an Associate Editor for the ASCE Journal of Waterway, Port, Coastal, and Ocean Engineering. She was recognized nationally with the Orville T. Magoon Sustainable Coasts Award from the American Society of Civil Engineers in 2021, and the Morrough P. O'Brien Award from the American Shore and Beach Preservation Association in 2023.

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

100th BOARD ON COASTAL ENGINEERING RESEARCH MEETING

12-15 August 2024
The Westin St. Francis
335 Powell Street
San Francisco, CA

WebEx: https://usace1.webex.com/meet/sara.j.gaul
Meeting number: 1991 66 7098
Join by phone: 1-844-800-2712
Access Code: 1991 66 7098

AGENDA

THEME: 100th Meeting of the Board on Coastal Engineering Research

Meeting Concept: *Celebrating Accomplishments of the BCER in 100 Meetings and Setting the Stage for the BCER's Future*

(All in Pacific Time Zone)

Monday August 12, 2024

1800 2000 Registration – Golden Gate Foyer: 32nd floor of the Tower Building

1845 2100 Board Informal Dinner (separate invitation - Board Members only)
John's Grill 63 Ellis St, San Francisco, CA 94102, (415) 986-0069

Tuesday August 13, 2024

Meeting Attire: Military - OCP; Civilian-Business Casual
Meeting Room: The Westin Golden Gate Room 32nd floor of the Tower Building

0730 0830 Registration

0830 0900 Breakfast

0900 Call to Order
Dr. Julie Rosati, ERDC CHL, DFO Board on Coastal Engineering Research

0900 0930 Welcome and Introductions
MG (P) William H. "Butch" Graham, Jr., Deputy Commanding General for Civil and Emergency Operations USACE-HQ

0930 0945 Welcome to South Pacific Division
COL James J. Handura, Commander, USACE SPD
0945 1030 History of BCER and Top Accomplishments in 100 Meetings
Dr. Ty V. Wamsley, Director, ERDC CHL
1030 1100 Break

Panel Session #1 Celebrating BCER Accomplishments
Moderator: Dr. Julie Rosati, ERDC CHL

1100 1130 San Francisco Bay Modeling Regional Dredge Material Management Plan
Dr. Gaurav Savant, ERDC CHL
Dr. Arye Janoff, USACE SPN
1130 1200 San Francisco Bay EWN Proving Grounds
Ms. Julie Beagle, USACE SPN
1200 1230 Dam Removal on the West Coast
Dr. Amy East, USGS
1230 1315 Lunch
1315 1345 U.S. Coastal Research Program: Celebrating a Decade of Progress & Planning for the Next Decade, Ms. Jessie Straub, ERDC CHL

Panel Session #2: Coastal System Focus: San Francisco Bay
Moderator: Ms. Julie Beagle, USACE SPN

1345 1415 History of San Francisco Bay from an Environmental Context
Mr. Jeremy Lowe, San Francisco Estuary Institute
1415 1445 Introduction to the San Francisco Waterfront
Mr. Brad Benson, Port of San Francisco
Mr. Matt Wickens, Port of San Francisco
1445 1530 Transition to Port of San Francisco
Pier 1 The Embarcadero, San Francisco, CA 94105 (Gate B)
25-minute walk, or Muni/ Bart, Uber/ Lyft is suggested; if you need help arranging transportation, please see Ms. Jennifer Ratliff or Ms. Sara Gaul.
1530 1700 San Francisco Waterfront Ferry Tour
https://www.redandwhite.com/
1700 1710 Transition to Port of San Francisco
Pier 1 The Embarcadero, San Francisco, CA 94105
Bay Side Room

Evening Celebration of Past and Future BCER Leaders
Port of San Francisco Pier 1 The Embarcadero, San Francisco, CA 94105

1710 1900 Reception with Posters and Honors: Welcome and Keynote
COL Handura
Honorable Michael Connor, Assistant Secretary of the Army (Civil Works)
1800 Recognize Previous BCER Members, Support Staff, Women of BCER
COL Handura
1900 Closing
COL Handura

Wednesday, August 14, 2024

Meeting Attire: Military-OCP; Civilian-Business Casual
Meeting Room: The Westin Golden Gate Room 32nd floor of the Tower Building

0830 0900 Breakfast
0900 0930 Welcome: Board Comments on Day 1
MG (P) Graham
BCER

Panel Session #3: Partnerships and Challenges in the Pacific
Panel Moderator: Ms. Heather Schlosser, SPD

0930 1000 NE Pacific Basin - Oceanographic Conditions and Coastal Processes
Mr. Rod Moritz, Portland District, USACE
Ms. Heidi Moritz, Portland District, USACE
1000 1030 Climate, Sea Level Change and Pacific Islands
Dr. Curt Storlazzi, USGS
1030 1100 Pacific Island Design Challenges: Kwajalein Atoll
Ms. Jessica Podoski, Honolulu District, USACE
1100 1115 Break
1115 1145 Multi - jurisdictional and Community - focused Sea level Rise Adaptation Planning: Oakland Alameda Adaptation Committee Example
Ms. Danielle Mieler, City of Alameda
Ms. Keta Price, The Hood Planning Group
1145 1215 Progress and challenges of the tidal march restoration effort in the San Francisco Bay: The South Bay Salt Pond Restoration Project
Mr. Dave Halsing, CA State Coastal Conservancy

1215 1245 Innovations in Beneficial Use for Ecosystem Resilience
Ms. Tiffany Cheng, San Francisco District, USACE

1245 1330 Lunch

Setting the Stage for Future BCER Success

1330 1400 Historical Retrospective: Impact of Basic Coastal R&D
Dr. Ed Link, University of Maryland, BCER
1400 1430 Implementation of a Basic Research Program in USACE Civil Works
Dr. Rob Holman, Oregon State University, BCER Emeritus
1430 1500 The Next Big Leap Needed in Coastal Engineering
Dr. Jack Puleo, University of Delaware, BCER
1500 1515 Break
1515 1545 Summary of Pacific Coast R&D Gaps
Dr. Jane Smith, ERDC CHL, Emeritus Senior Researcher
1545 1615 Public Comment- Written comments must be submitted to Dr. Julie Rosati (Julie.D.Rosati@usace.army.mil)
1615 1645 BCER Discussion: Closing comments and action items
BCER and Dr. Julie Rosati
1845 Evening Social - Giants vs Atlanta Braves @ Oracle Park
24 Willie Mays Plaza, San Francisco, CA 94107

Thursday, August 15, 2024

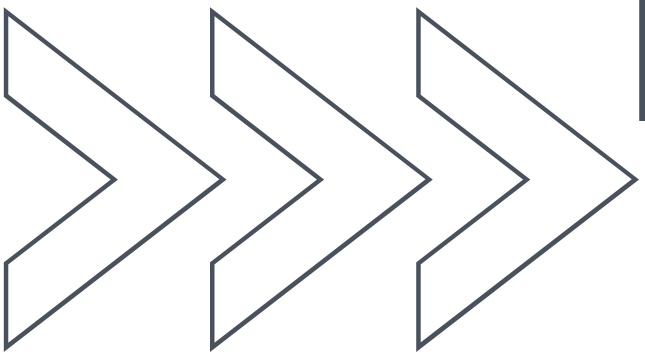
Meeting Attire: Military - OCP; Civilian - Business Casual
Meeting Room: The Westin Golden Gate Room 32nd floor of the Tower Building

BCER Business Meeting – Updates on Ongoing Action Items

0830 0900 Breakfast
0900 0915 Welcome; Opening Remarks
BCER

~~ Action Item Update Briefings 15 min with 10 min Q/A ~~
0915 0940 Sediment Transport R&D Strategy Update
Dr. Duncan Bryant, ERDC CHL
0940 1005 Update on CHL's Artificial Intelligence/ Machine Learning in Coastal Engineering Activities
Dr. Dylan Anderson, ERDC CHL
1005 1030 An Update on the Principles, Requirements and Guidelines to Implement Comprehensive Benefits
Mr. Jeff Strahan, Senior Economic Policy Advisor and Economics CoP Lead, Planning and Policy Division, USACE-HQ

1030	1045	Wrap-Up/ Comments
1045		Adjourn
		MG (P) Graham



BOARD ON COASTAL ENGINEERING RESEARCH

Presentations Day 1

Ty V. Wamsley, Ph.D., SES

Appointed to the Senior Executive Service in October 2018, Dr. Ty Wamsley 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 CHL Director, Dr. Wamsley leads a team of more than 375 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 over one million square feet in physical facilities, including the Field Research Facility in Duck, North Carolina. 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.

Dr. Wamsley also serves as the ERDC lead for the Civil Works Research and Development Area. In this role he is responsible for planning and directing a $150M+ multi-disciplinary research program with team members from across all seven ERDC laboratories.

History of BCER and Top Accomplishments in 100 Meetings

Ty V. Wamsley, PhD, SES
Director, Coastal and Hydraulics Laboratory
U.S. Engineer Research and Development Center

The 100th meeting of the Board on Coastal Engineering Research (BCER) will celebrate the Board's successes since 1963, focus on the unique coastal process environment in the Pacific region, and set the trajectory for coastal research innovations over the next decades. This presentation briefly reviews history of the BCER and summarizes challenges given to the Board by Commanding Generals (CGs) since 1963. These CG challenges, or "Charges" to the Board resulted in several major accomplishments that have impacted the Corps and Nation and provide insight into keys for successful implementation of coastal engineering innovations.

The BCER was established by 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 Hydraulics Laboratory to form the Coastal & Hydraulics Laboratory (CHL). The BCER continues to provide strategic input on coastal research to CHL and other Engineer Research and Development Center (ERDC) Laboratories. BCER champions and guides strategic coastal R&D priorities to address national decadal challenges, recommends those priorities to the USACE Commanding General and Assistant Secretary of the Army for Civil Works, and advocates for resources to implement these recommendations.

Two Boards preceded the BCER from 1929 to 1963: the Board on Sand Movement and Beach Erosion (BSMBE) and Beach Erosion Board (BEB). BSMBE and BEB initiated modern coastal engineering and established the federal role in coastal engineering research, setting the framework for the BCER, CERC and now CHL. Since reconstituted as the BCER in 1963, four CGs have challenged, or "Charged" the Board to address issues of national interest, including need to establish CERC as an internationally recognized center for coastal engineering research; develop focused research programs in specific topic areas; and establish and support field data collection programs, amongst others. These four CG Charges, along with other BCER recommendations, have significantly impacted the Corps and Nation.

Top BCER accomplishments realized through the Board's advocacy include:

- 1977: USACE Field Research Facility (FRF), Duck, NC
- 1985: Dredging Research expanded beyond disposal-focused R&D
- 1988: Coastal Zone Mapping and Imaging Lidar
- 2016: Numerical Model Modernization Program
- 2018: Nature-Based Solutions for Innovative Coastal Engineering

A focus of this 100th Meeting is to develop consensus for Board advocacy related to the next national coastal engineering challenges. In March 2024, the BCER surveyed USACE Coastal Commanders and asked for their top Decadal Challenges which resulted in a heat map of nine interrelated topics. Further synthesizing the Commander Decadal Challenges results in three priority R&D Areas which directly tie to the Civil Works R&D Strategic Focus Areas (SFAs), and four Enablers to implement and transition R&D innovations.

Commander Decadal Challenges – Priority R&D Areas

- **Watershed Assessment Technologies including Compound Flooding – Ties to WATER MODELING SFA.** Watershed scale numerical technologies are required for integrated coastal, estuarine, riverine, groundwater and weather processes that compound flooding impacts. This R&D provides a foundational capability to address combined coastal + riverine + estuarine + groundwater compound flooding.
- **Advanced Sediment Transport Predictive Technologies – Ties to SEDIMENT MANAGEMENT SFA.** Advanced sediment transport technologies are needed to estimate storm, seasonal, decadal and life-cycle performance of coastal projects. Sediment transport predictive capabilities utilize watershed-scale numerical models as a foundational need to calculate forcing conditions.
- **Nature-Based Infrastructure Solutions – Ties to ECOSYSTEMS and INFRASTRUCTURE SFAs.** Integrated technologies that incorporate lifecycle performance of nature-based infrastructure (NBI), alone and in combination with traditional built infrastructure, are required to integrate ecological and watershed processes as part of USACE NBI project planning, design, and maintenance. These technologies are founded on watershed numerical modeling technologies and sediment transport predictions and tie to the SFA for ECOSYSTEMS. To understand ecological, engineering, and social benefits of NBI requires predictions of NBI functioning over seasons to years to decades.

Commander Decadal Challenges – Priority Enablers to Implement and Transition R&D

- **Workforce** sufficient to meet Coastal Storm Risk management demand now and into the future.
- **Increased Partnering Authority** to work with non-federal sponsors.
- **Comprehensive Benefits** to assess and quantify Other Social Effects and Environmental Justice measures.
- **Adaptive Strategies** and methods for project planning.
- **Guidance and Training** transitioning new knowledge and technologies to the workforce and into practice.

The most successful BCER initiatives have had elements listed below, which may be valuable to consider for future BCER advocacy in coastal engineering innovations.

- **CG Charge** – A clear Charge from the CG to set the Command vision and identify the National Challenge to be addressed by the Board.
- **Joint Tasking** – Formulating a response team comprised of Civil and Military members to formulate a Strategic Direction from the CG's Charge.
- **Establishing a Clear Intent** – A broad Product Delivery Team (PDT) to lay out plans, goals, timeline and outcomes.
- **Sufficient Resourcing** – Providing the experts, funding, and end users to the PDT.
- **Include Transition Partners and Stakeholders** as part of the PDT to ensure that outcomes can be implemented.

HISTORY OF BCER AND TOP ACCOMPLISHMENTS IN 100 MEETINGS

Dr. Ty V. Wamsley, PhD, SES
Director, Coastal & Hydraulics Laboratory
Engineer Research and Development Center

13 August 2024

100th MEETING

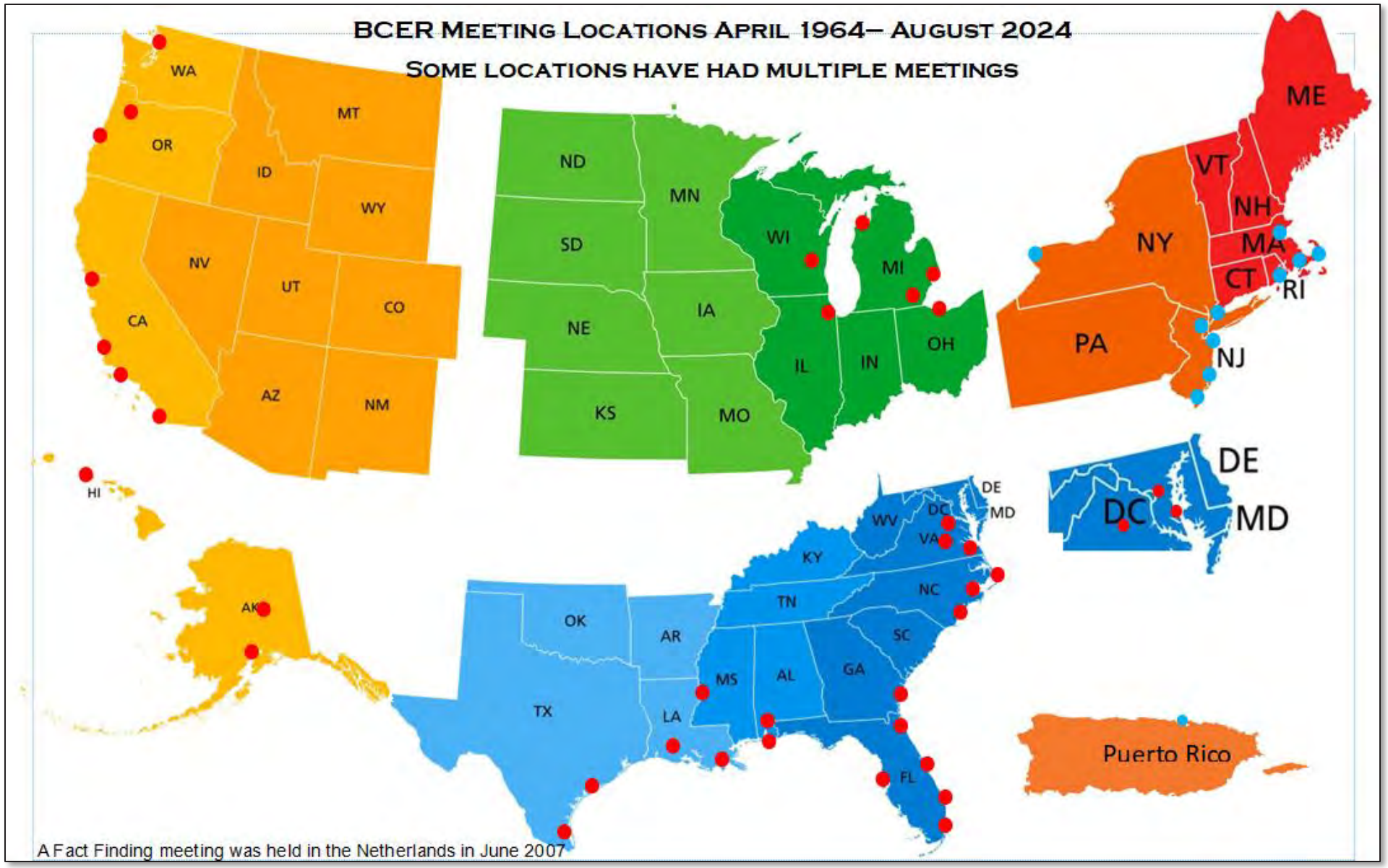


Agenda:
- Welcome
- History
- Accomplishments of BCER
- What's Next?
- Keys to Success

Controlled by: USACE ERDC
Controlled by: CHL
UNCLASSIFIED
POC: Julie Rosati

U.S. ARMY
US Army Corps of Engineers
ERDC

100 BCER Meetings Apr 1964-Aug 2024



Board on Costal 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 BCER continues to provide that same guidance to CHL, the other ERDC labs and USACE leadership on Corps coastal research*.



Purpose of BCER

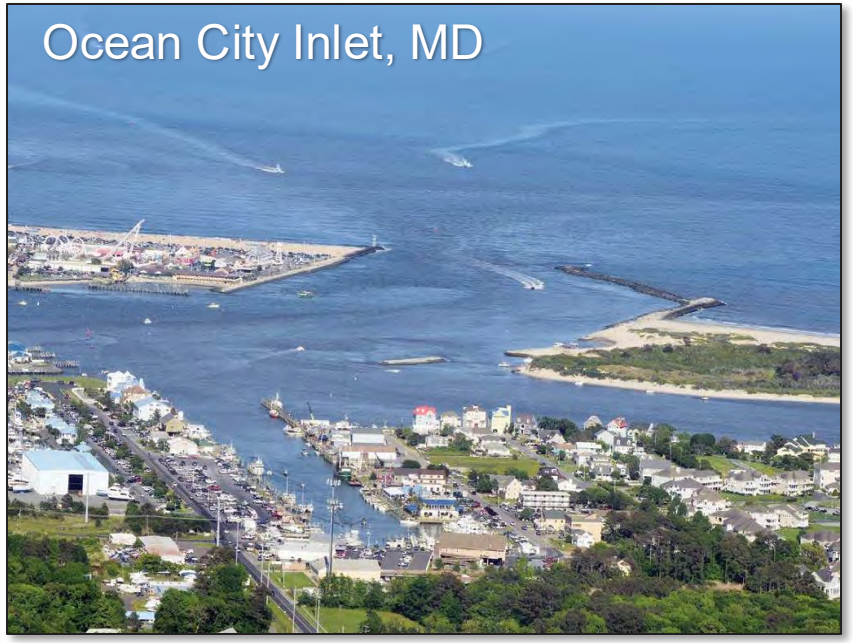
1. **Champion and guide** strategic coastal R&D to solve the problems the Nation will face over the next 10-20 years

2. **Recommend research priorities** to the USACE Commanding General and Assistant Secretary of the Army for Civil Works

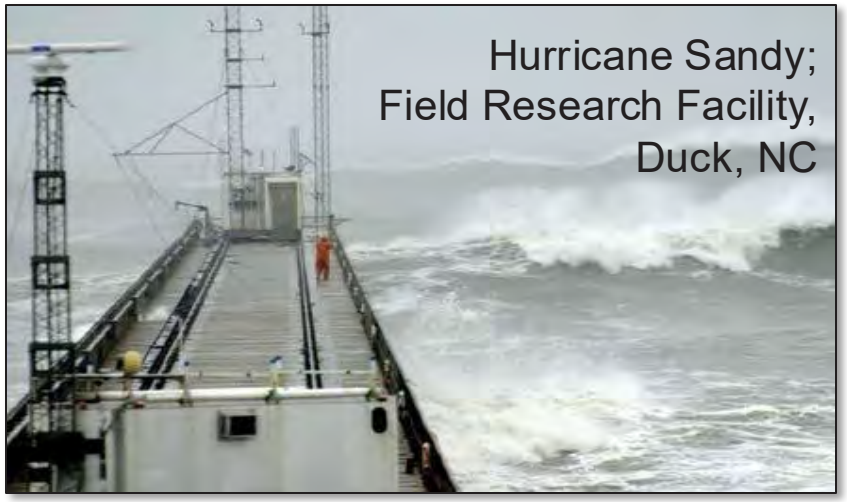
3. **Advocate** for the investment to make it happen



55th BCER, 1991, Mashpee, MA







Significance of 100th Meeting

Celebrate BCER Successes Since 1963



Consider Next Frontier of Pacific Coastal Challenges



Set Trajectory for R&D over Next Decades and Identify Keys for Success

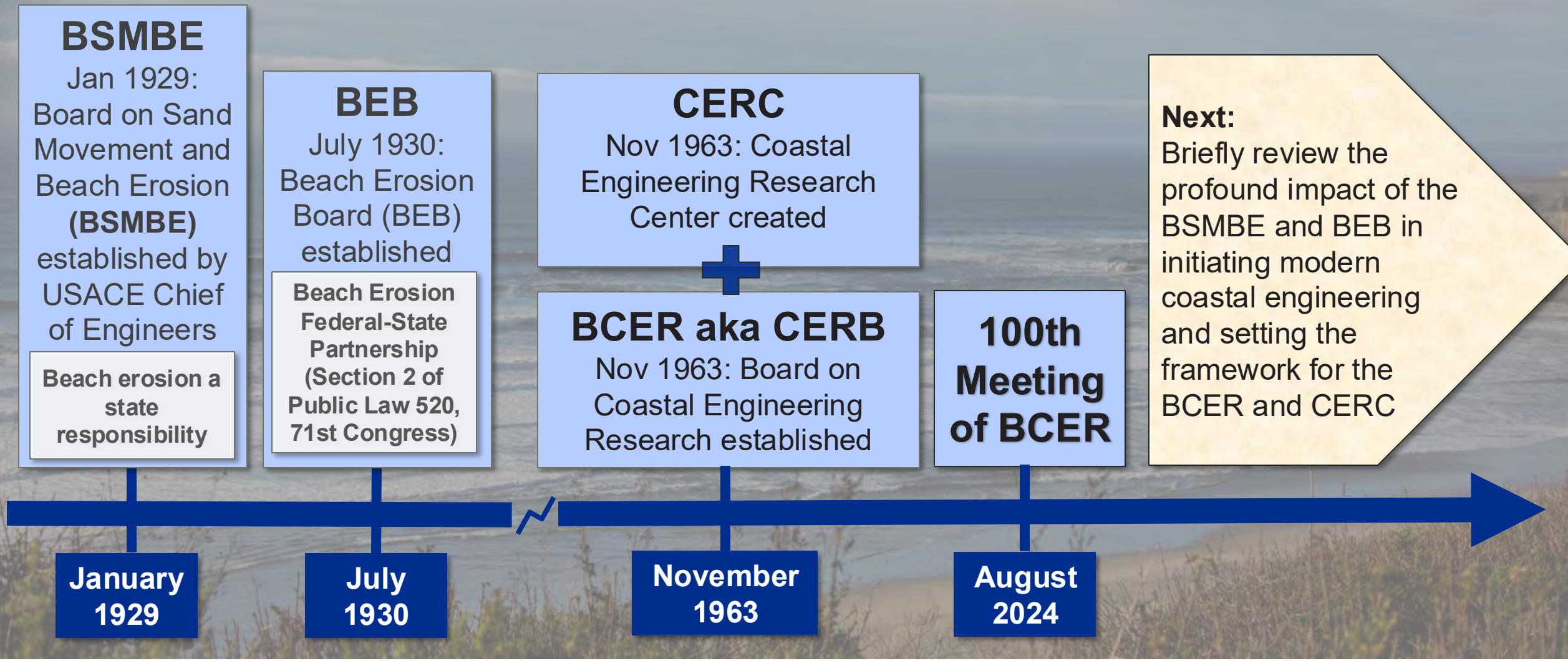
SUMMARY: Coastal Commanders' Decadal Challenges (Mar 2024)

	LRD	MVD	NAD	NWD	POD	SPD	SAD	SWD	Total
Assessment of **Value**/Impact of NNBF	3	1	5	1	1	0	5	0	16
All Things **Sediment** (influence of CC, Erosion, modeling, transport/tracking	2	0	5	1	1	2	3	0	14
More Holistic Assessment of Study Areas and Surround (**Watershed**/region)	3	0	4	1	2	1	3	0	14
Strategies for Addressing Decreasing Sustainability of Coastal **Infrastructure**	2	1	4	1	1	1	2	1	13
Compound **Flooding** Modeling and Assessment Capabilities	2	1	1	1	1	1	5	0	12
Incorporating **Adaptive** Strategies in Project Planning (methods & policy)	0	1	2	2	1	2	1	1	10
Workforce: Supporting a large & talented enough workforce to meet CSRM demand	1	0	2	0	2	2	3	0	10
Partnering with Non-Federal Sponsors (increased authority)	0	0	2	2	1	1	1	1	8
Benefits: Methods to Assess Other Social Effects and Environment	0	0	1	0	1	0	0	0	2
Districts responding per division	3	1	5	2	2	2	5	1	

KEY: # Districts in Division with Challenge
5
4
3
2
1
0

USACE Coastal Commander Decadal Challenges, March 2024

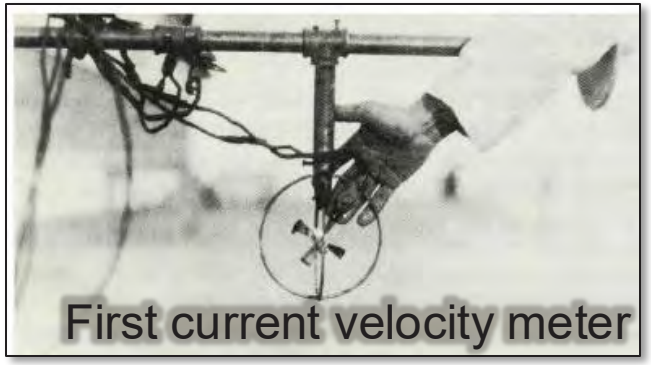
History

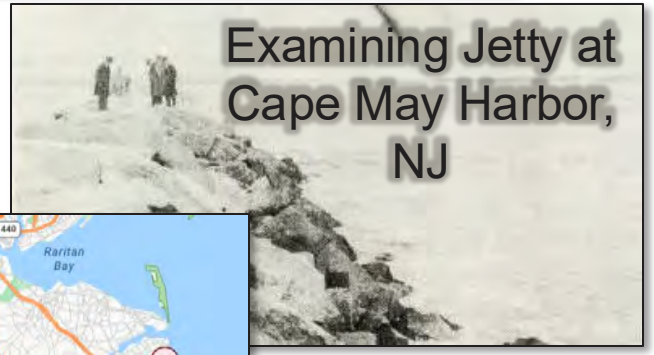

BSMBE
Jan 1929: Board on Sand Movement and Beach Erosion (BSMBE) established by USACE Chief of Engineers
Beach erosion a state responsibility
January 1929
BEB
July 1930: Beach Erosion Board (BEB) established
Beach Erosion Federal-State Partnership (Section 2 of Public Law 520, 71st Congress)
July 1930
CERC
Nov 1963: Coastal Engineering Research Center created
BCER aka CERB
Nov 1963: Board on Coastal Engineering Research established
November 1963
100th Meeting of BCER
August 2024
Next:
Briefly review the profound impact of the BSMBE and BEB in initiating modern coastal engineering and setting the framework for the BCER and CERC

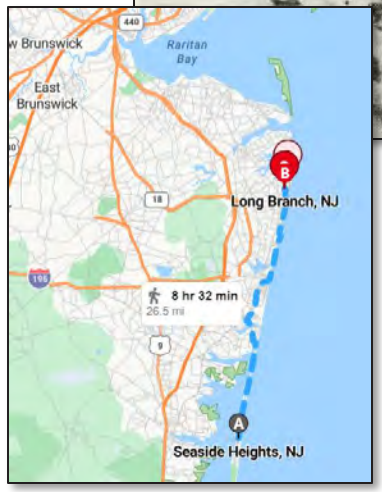
BSBME
Board on Sand Movement and Beach Erosion

Background

- **Mission:** Investigate and report on sand movements and beach erosion at Chief's designated locations
- First Federal research on the dynamics of coastal processes in the U.S.
- **BSMBE's 4 Army engineers and 3 civilian consultants initiated modern coastal engineering**


First current velocity meter


Examining Jetty at Cape May Harbor, NJ



Initial Measurements at Long Branch and Seaside Heights, NJ

Notable

- Engaged engineering students in field studies, *"…young, fearless, and motivated…." (MP O'Brien)*
- Placed U.S. at forefront of coastal engineering
- Established tradition of scientific inquiry and early coastal engineering guidance

Ref: Quinn, M. 1977. "History of the Beach Erosion Board, U.S. Army Corps of Engineers, 1930-1963," MR 77-9, 185 p.

BEB
Beach Erosion Board

- **BEB** staff & research facilities grew; located in Dalecarlia, D.C.
- **With others, performed critical work during WW2:** beach landing reports, wave research, +
- **Technical Report No. 4 (TR-4)** "Shore Protection Planning and Design" (1954)
  - **Precursor to Coastal Engineering Manual**
- **Federal role** in beach construction, coastal research activities, and staff growing over time



20x15x635-ft wave flume



"A Report on Sand Movement and Beach Erosion Along the Pacific Coast of the United States." *(March 1931)*

Manual of Procedure in Beach Erosion Studies, (1938) *[Coastal Terminology]*

Quinn, M. 1977. "History of the Beach Erosion Board, U.S. Army Corps of Engineers, 1930-1963," MR 77-9, 185 p.

CERC & BCER

1962: Chief of Engineers appointed ad hoc committee to study roles of BEB… Coastal Planning, Research, Hurricane Impacts, and District Support

07 Nov. 1963: Public Law No. 172 of the 88th Congress, abolished BEB and replaced it with:

Coastal Engineering Research Center

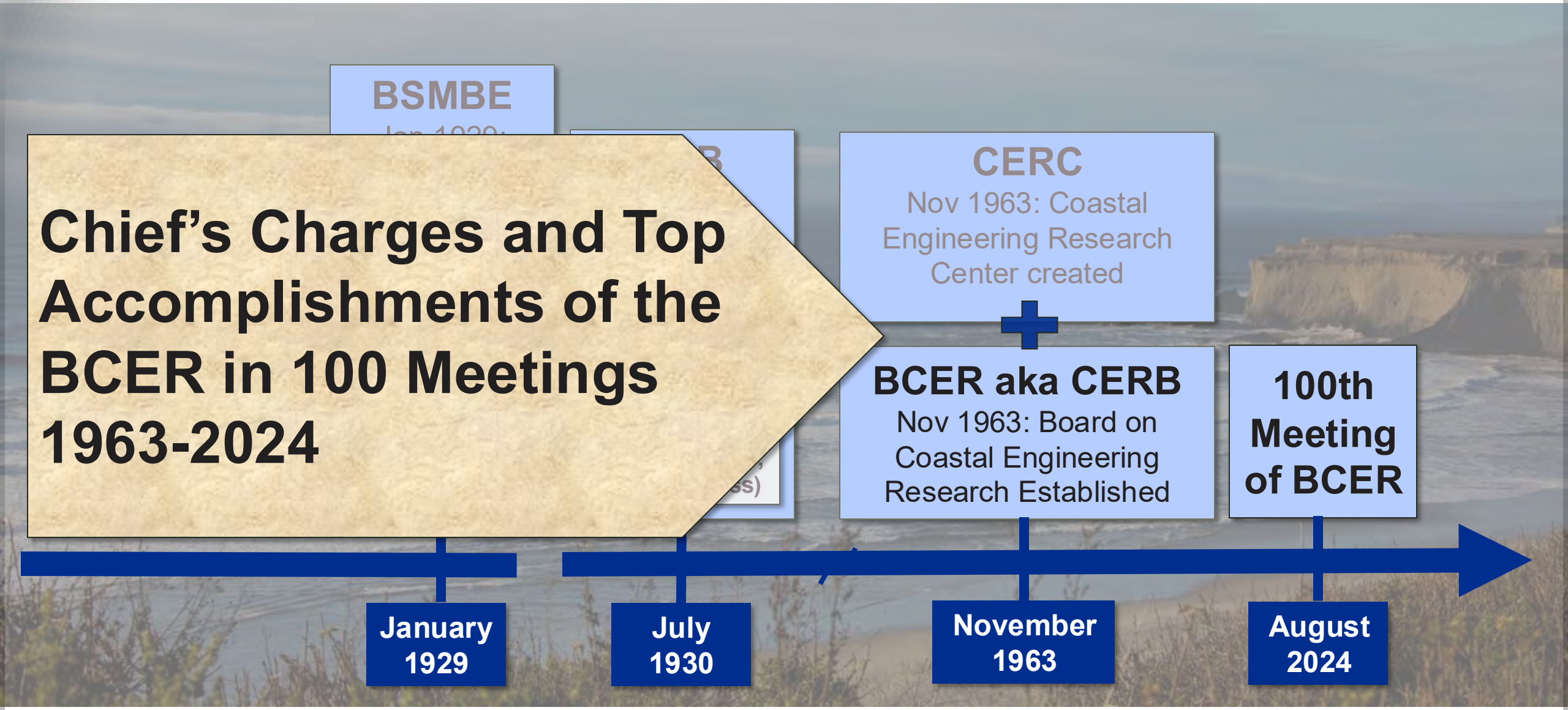
To be a Center operating under Chief of Engineers; Conduct R&D complementing WES's focus on applied studies

Board on Coastal Engineering Research

Advise Chief of Engineers and ASACW on Coastal R&D Needs

Moore J.W. and Moore, D.P.. 1991. "History of The Coastal Engineering Research Center 1963 -1983," Vol 1 WES Laboratory Series, 124 p.

History


BSMBE
CERC
Nov 1963: Coastal Engineering Research Center created
Chief's Charges and Top Accomplishments of the BCER in 100 Meetings 1963-2024
BCER aka CERB
Nov 1963: Board on Coastal Engineering Research Established
100th Meeting of BCER
January 1929
July 1930
November 1963
August 2024

Chief's Charge To BCER: 1st Charge

Four Times the Chief Of Engineers Has Charged the Board to Provide Recommendations Related to a Particular Challenge of Interest

1st Charge: Nov 1985: LTG E.R. Heiberg III charged the board to consider "Future Directions for Coastal Engineering" resulting in two task forces addressing:

Innovative Funding and Big Payoff Projects

- **Outcome:** Dredging Research – expanded Dredged Material Disposal R&D to a broader research portfolio; initiated Coastal Inlets Research Program
- **Outcome:** Field Data Collection Programs: Coastal Field Data Collection Program at FRF (1990), Coastal Zone Mapping and Imaging Lidar (1988)

Basic Research, Education, and National Laboratory

- **Outcome:** Expanded research portfolio at CERC focused on future of coastal engineering

Task Force 1:

Innovative Funding
- Work for other Federal Agencies
- Work for State or Local Governments
- Work for Private Industry
- National Science Foundation/Universities

Big Payoff Projects
- Dredging Research Program
- Dredged Material Mounds
- Surveying and Water Levels
- Field Data Collection Programs
- Operation and Maintenance
- Sedimentation Research
- Federal Coastal Commission

Task Force 2:
- National Laboratory Status
- Private Industry Use of CERC
- Dredging Research Facility
- National Coastal Laboratory
- Education and Training
- Basic/Applied/Fundamental Research

Chief's Charge to BCER: 2nd and 3rd Charges

2nd Charge: Oct 1992 -- LTG Arthur Williams charged the board in five areas:

1. **Education and Training** – expand opportunities
2. **Environment** – – Holistic approaches including sustainability – Nature-Based Solutions, Regional Sediment Management
3. **Technology Transfer** including updating Shore Protection Manual/ Coastal Engineering Manual
4. **Funding Alternatives** including cost-sharing, partnering, collaborating with others, expanding military research, e.g., Num Model Modernization
5. **Board members** encouraged to engage with field practitioners to understand problems and constraints and help consider long-range, broad coastal engineering needs

3rd Charge: Nov 2004: LTG Carl Strock charged the board to identify research & partnerships related to ocean policy

In response to the U.S. Commission on Ocean Policy Report:

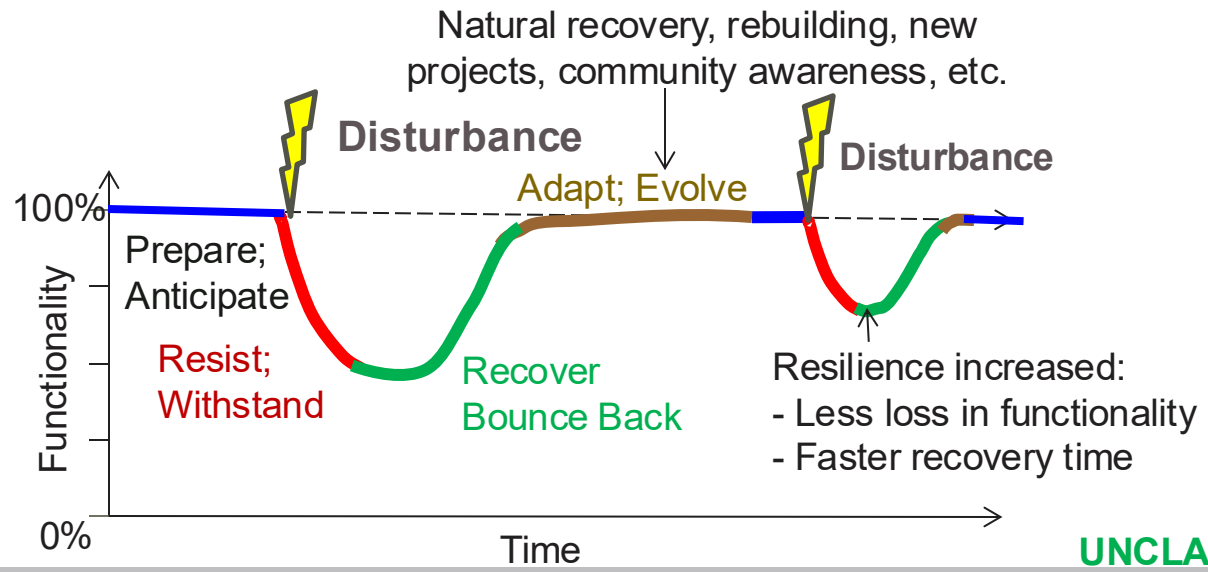
- "…we, as engineers and scientists…have a role to play in influencing policy decisions…that is what this Board is all about, provides scientific and engineering underpinning of policy."
- **Outcome:** Broader engagement with NOAA and Interagency Ocean Observation System (IOOS)

Chief's Charge to BCER: 4th Charge

4th Charge: Sep 2013: LTG Thomas Bostick charged the board to develop a strategy to enable the integration of risk reduction and resilience into Corps practices

LTG Bostick identified four tasks:

1. Engage in developing a definition of resilience in terms of the Corps mission;
2. Look at how we measure, quantify, and predict resilience;
3. Look at how resilience fits within the framework with our stakeholders and partners; and
4. Consider how to manage resilience and still sustain the function of our water resources while also mitigating the risk associated with coastal hazards.

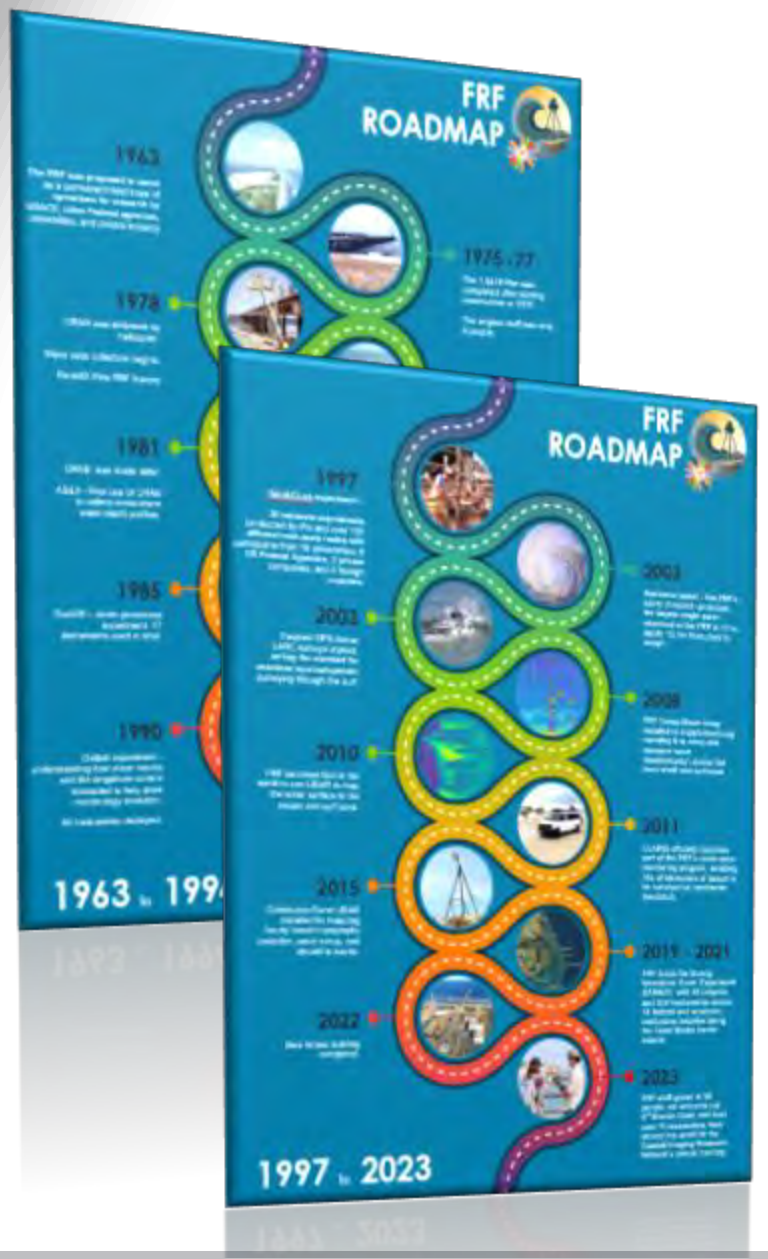




USACE's Principles of Resilience

Top 5 Impacts of BCER

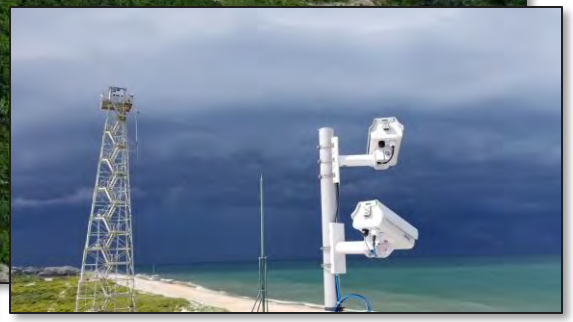
Field Research Facility (1977)







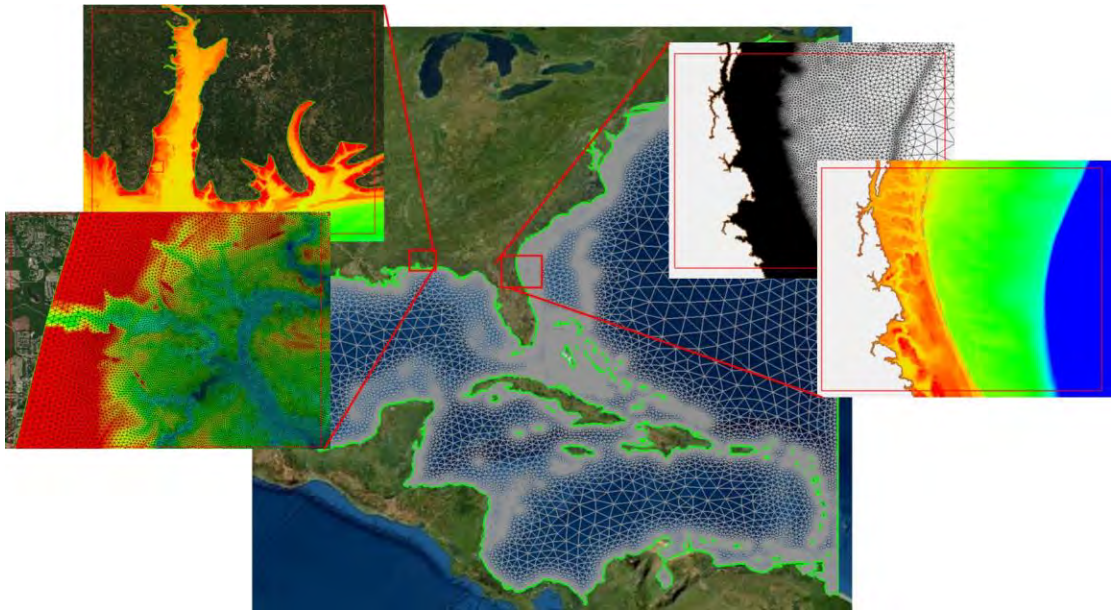




Top 5 Impacts of BCER

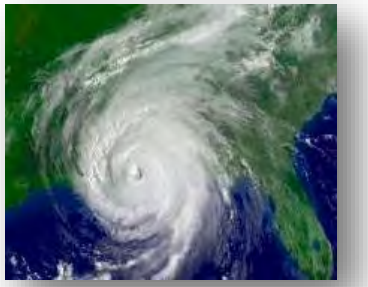
Dredging Research (1985)

- Dredging Research Program
  - ✓ Fundamental development of Advanced CIRCulation Model (ADCIRC)
  - ✓ Open-source community model development
  - ✓ Utilized post-Katrina, Sandy; CSTORM; Coastal Hazards System
- Dredging Operations & Environmental Research Program



DRP: Fundamental ADCIRC Development

http://erdc.usace.army.mil



Applications:
Coast LA
NACCS
SACS
Coast TX
+ others



DOER: *Beneficial Use Comprehensive Benefits Tool* (Suedel et al. 2023)

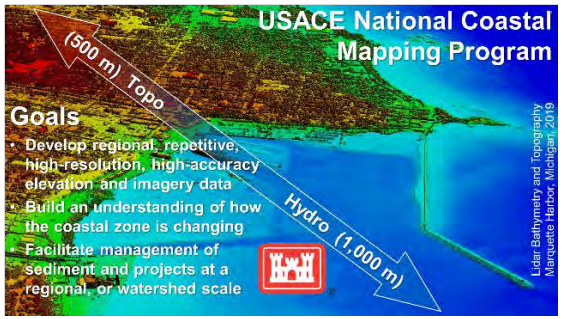
https://doer.el.erdc.dren.mil/

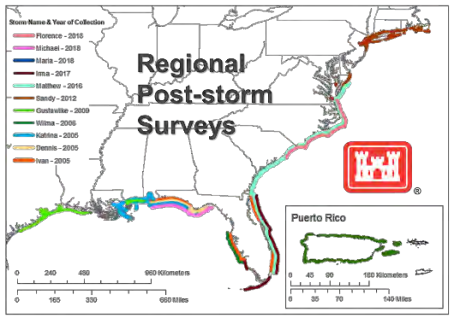
Top 5 Impacts of BCER

CZMIL Coastal Zone Mapping and Imaging Lidar (1988)



- CERB endorsed development of airborne lidar bathymetry technologies in the 1980s
- CZMIL is the third generation airborne lidar bathymetry system developed by ERDC in collaboration with industry
- CZMIL is operated out of the Joint Airborne Lidar Bathymetry Technical Center of Expertise
- JALBTCX uses CZMIL year-round and worldwide:
  - USACE National Coastal Mapping Program
  - Naval Oceanographic Office Airborne Coastal Surveys
  - Reimbursable surveys for districts and other agencies
  - USACE and FEMA use the technology for post-storm surveys





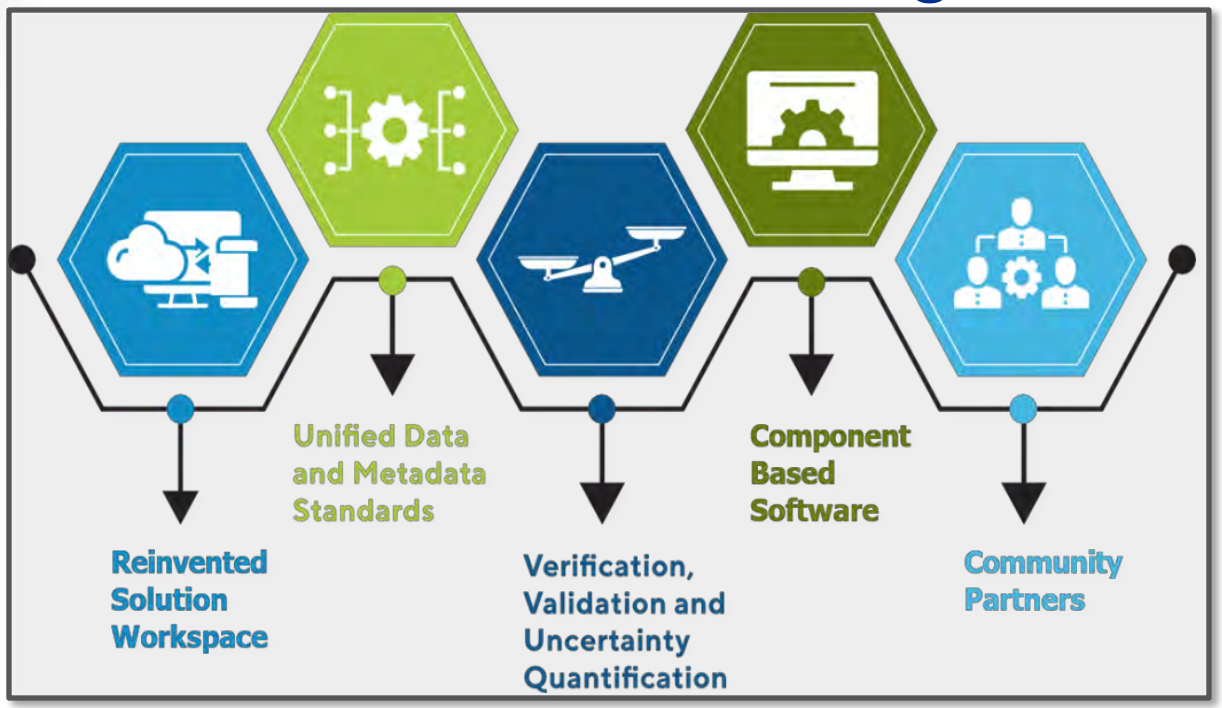
NCMP

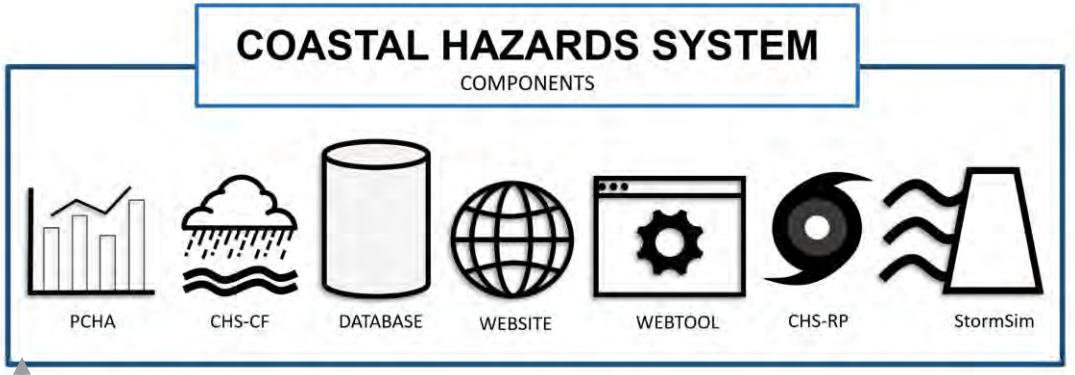
Jennifer.M.Wozencraft@usace.army.mil 228-806-6044

Top 5 Impacts of BCER

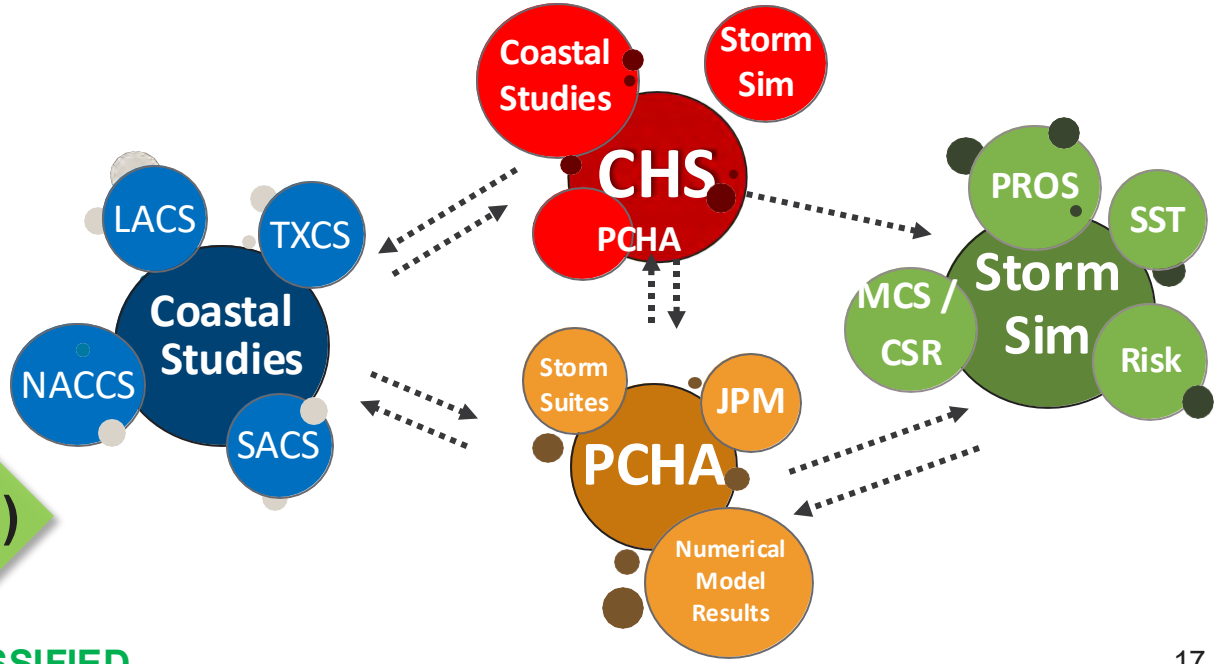
Numerical Model Modernization (2016)

Numerical Model Modernization Program





Interconnection between CHS Components



Recommendation to Advance Pacific CHS (2022)

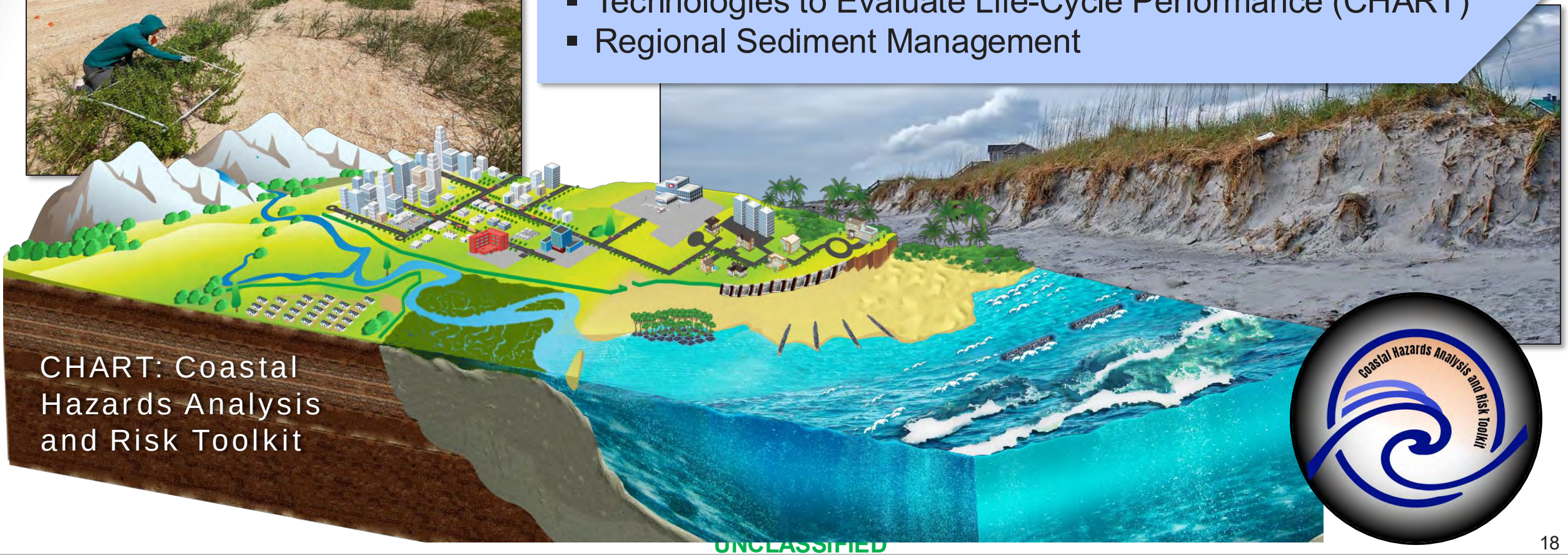
Top 5 Impacts of BCER

Nature-Based Solutions for Innovative Coastal Engineering (2018)



Nature-Based Solutions

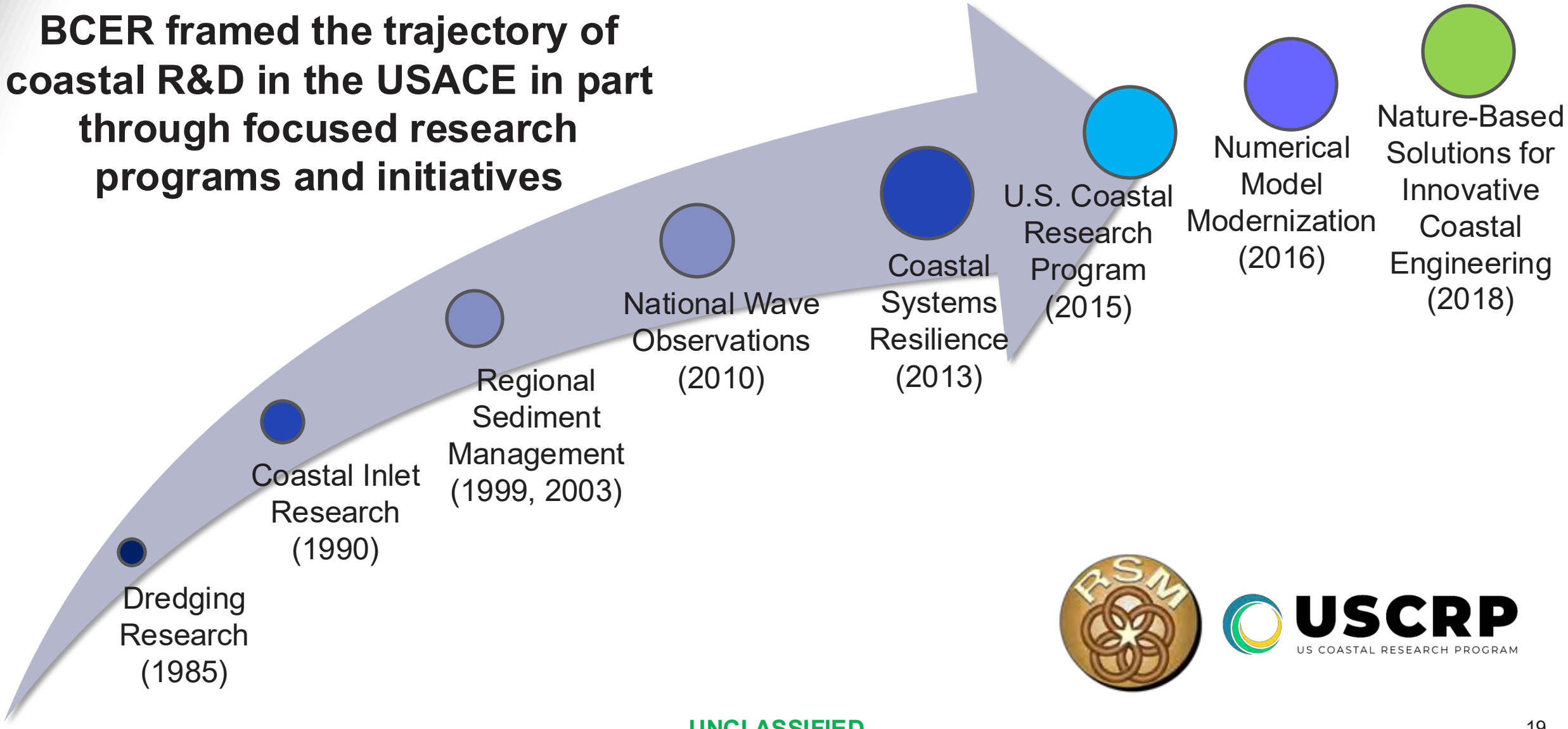
- Single + Multiple Lines of Risk-Reduction Features
- NBS + Hybrid Solutions
- Technologies to Evaluate Life-Cycle Performance (CHART)
- Regional Sediment Management



Summary

Focused R&D Topics and Programs

BCER framed the trajectory of coastal R&D in the USACE in part through focused research programs and initiatives



What's Next?

PRIORITY

ERDC

MG Graham's Charge (2020): What is the Next Big Breakthrough?

Coastal Commanders' Decadal Challenges (Mar 2024)

	LRD	MVD	NAD	NWD	POD	SPD	SAD	SWD	Total	KEY:% Divisions with Challenge
Assessment of **Value**/Impact of NNBF	100%	100%	100%	50%	50%	0%	100%	0%	76%	
All Things **Sediment** (influence of CC, Erosion, modeling, transport/tracking	67%	0%	100%	50%	50%	100%	60%	0%	67%	100%
More Holistic Assessment of Study Areas and Surround (**Watershed**/region)	100%	0%	80%	50%	100%	50%	60%	0%	67%	80%
Strategies for Addressing Decreasing Sustainability of Coastal **Infrastructure**	67%	100%	80%	50%	50%	50%	40%	100%	62%	60%
Compound **Flooding** Modeling and Assessment Capabilities	67%	100%	20%	50%	50%	50%	100%	0%	57%	40%
Incorporating **Adaptive** Strategies in Project Planning (methods & policy)	0%	100%	40%	100%	50%	100%	20%	100%	48%	20%
Workforce: Supporting a large & talented enough workforce to meet CSRM demand	33%	0%	40%	0%	100%	100%	60%	0%	48%	0%
Partnering with Non-Federal Sponsors (increased authority)	0%	0%	40%	100%	50%	50%	20%	100%	38%	
Benefits: Methods to Assess Other Social Effects and Environment	0%	0%	20%	0%	50%	0%	0%	0%	10%	

Key R&D

- Nature-Based Infrastructure
- Sediment Transport
- Watershed Assessments for Compound Flooding

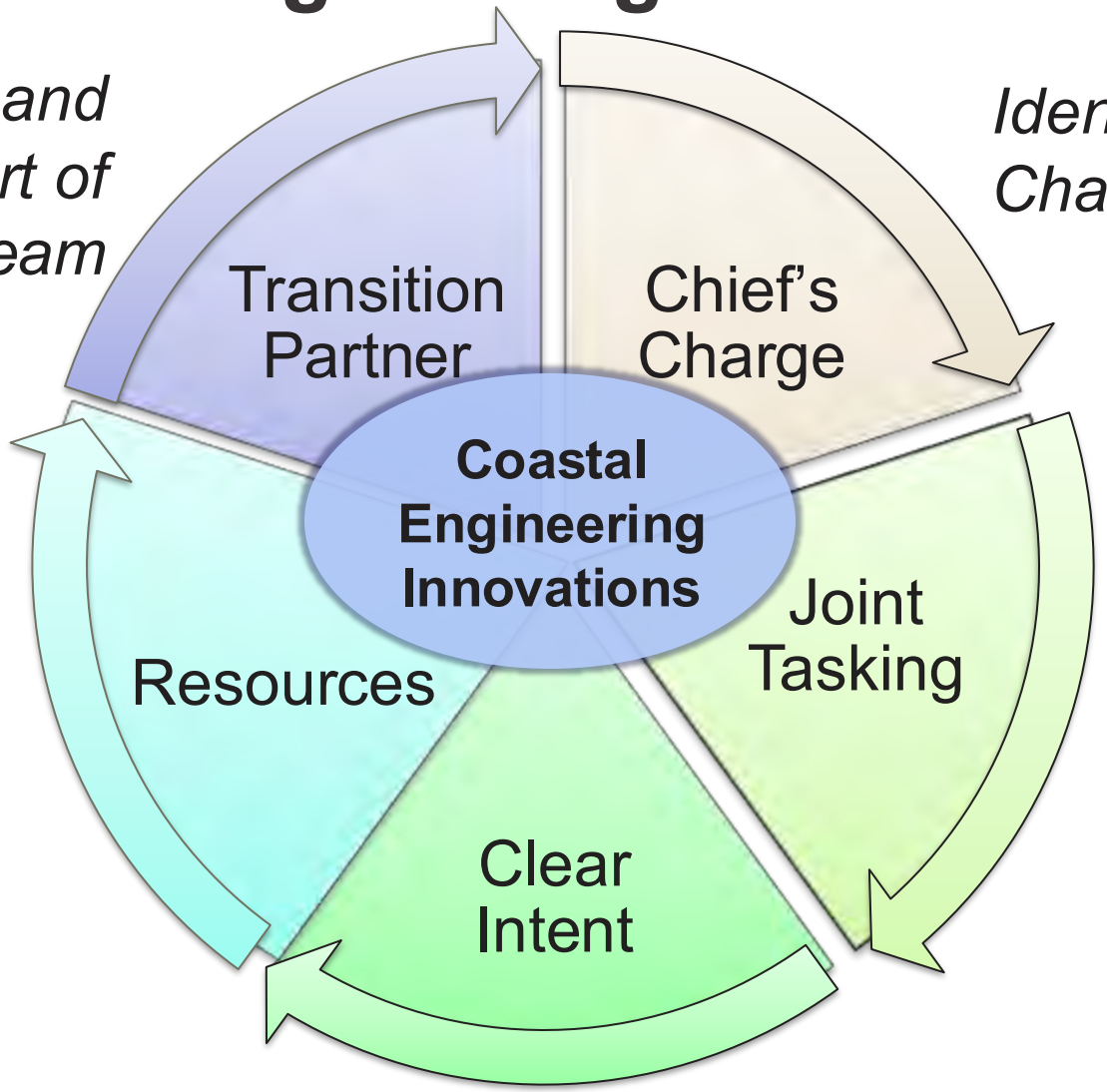
Enablers

- Workforce for CSRM
- Increased Partnering Authority
- Compre-hensive Benefits
- Adaptive Strategies
- Guidance & Training

STRATEGIC FOCUS AREAS

- ECOSYSTEMS
- INFRASTRUCTURE
- SEDIMENT MGT
- WATER MODELING

Conclusion: Keys to BCER Coastal Engineering Innovations



Transition Partners and Stakeholders part of Tasking Team

Identify National Challenges

Civilian + Military Team Set Strategic Direction

Concur on Plans & Outcomes

Experts Funding Product Owners

CONNECT WITH US

Dr. Ty V. Wamsley, PhD, SES

Director, Coastal & Hydraulics Laboratory
U.S. Army Engineer Research and Development Center
U.S. Army Corps of Engineers
Ty.V.Wamsley@usace.army.mil
601-634-2001

LinkedIn

YouTube





Scan this QR code with your phone for instant access



U.S. ARMY

US Army Corps of Engineers

ERDC

Arye M. Janoff, Ph.D.

Dr. Arye Janoff is from the northern New Jersey suburbs of New York City and is an earth and environmental scientist with a specialization in coastal geomorphology, economics, and maritime transportation. He began his career with the United States Army Corps of Engineers (USACE) San Francisco District on 28 February 2022. He currently works in plan formulation on regional dredged material management, navigation, beneficial use of dredged material, and Engineering with Nature projects, and is a San Francisco Bay Long Term Management Strategy (LTMS) Program Manager. For his role as lead planner on the district priority project, the Regional Dredged Material Management Plan, and for his agency representation as an LTMS Program Manager, Janoff received the 2023 San Francisco District's Commander's Leadership Award.

Dr. Janoff also serves as an Action Officer on the USACE San Francisco District's Infrastructure Assessment Planning and Response Team, which supports USACE's Emergency Management mission and FEMA disaster response and recovery efforts. In this role, he deployed to southwest Florida in 2022 for Hurricane Ian, where he oversaw the execution of approximately 10,000 infrastructure assessments and was awarded the US Army Civilian Service Commendation Medal.

Dr. Janoff previously served as a National Oceanic and Atmospheric Administration 2021 Knauss Marine Policy Fellow with the U.S. House of Representatives Committee on Transportation & Infrastructure Subcommittee on Coast Guard and Maritime Transportation. There, he helped increase climate change resiliency funding for Coast Guard and port infrastructure through policy and legislation including the Infrastructure Investment and Jobs Act (i.e., the Bipartisan Infrastructure Law), the National Defense Authorization Act, and the Coast Guard Authorization Act. In addition, he led congressional hearings, briefings, and oversight of the US Coast Guard, the Maritime Administration, and the Federal Maritime Commission. Prior to his time in Congress, Janoff earned his PhD modeling developed coastal system evolution to predict and inform community-scale responses to sea-level rise and changes in sand supply. During his time in graduate school, he also served as a Teaching Assistant and guest lecturer for undergraduate and graduate courses in the earth and environmental sciences.

Dr. Janoff earned a Bachelor of Science in Environmental Science (Earth Science concentration) from Tulane University, and a Doctor of Philosophy in Environmental Science and Management (Coastal Geomorphology and Economics concentration) from Montclair State University. He is an avid surfer and resides in the Presidio in San Francisco, a former Army base which is currently owned by the National Park Service as part of Golden Gate National Recreation Area. His love of the ocean and his dedication to public service fuel his passion to solve water resource problems for the San Francisco District and the nation.

Gaurav Savant, Ph.D., P.E., BC.WRE

Dr. Gaurav Savant is a Senior Scientific Technical Manager with the U.S. Army Engineer Research and Development Center (ERDC) in Vicksburg, Mississippi, where his work is focused on leading and guiding a large team of engineers and scientists to find solutions for the nation's most pressing water resources challenges. With nearly two decades of professional experience in water resources engineering and research, Dr. Savant's expertise includes numerical model development and application in support of civil works and military engineering. In his career he has provided engineering, permitting, and research support for a variety of water resources problems in the realms of inland and coastal compound flood risk management, design of hydraulic structure, sediment transport for navigation, natural and nature-based features for flood control, and habitat construction, and salinity intrusion into bay and estuaries. In the field of Military Engineering, Dr. Savant has used his expertise in Computational Fluid Dynamics (CFD) to ensure resilient logistics for the warfighter in a contested battlefield and the survivability of critical military and civilian assets in the strategically important coastal zone. Currently, Dr. Savant is leading efforts to revolutionize the use of synthetic operational environments for watercraft and vessel handling in the littoral zone through the use of high-fidelity physics in an augmented/virtual reality environment, and efforts to understand and mitigate the damaging effects of underwater nuclear explosions on DoD assets. Additionally, he is leading programs to mitigate and adapt to climate change and to ensure community and installation resilience.

He holds adjunct associations with several universities, is the author of more than 60 journal articles and technical reports and is actively collaborating with greater than 10 universities and institutions throughout the world.

Gaurav earned his doctorate in Estuarine Engineering and MSCE in Water Quality at the Mississippi State University, and his bachelor's in civil engineering from the Punjab Engineering College, India. He is a registered P.E. in Mississippi.

San Francisco Bay Modeling and Regional Dredged Material Management Plan Abstract

Arye Janoff, Ph.D.[1], Gaurav Savant, Ph.D. P.E., BC.WRE[2]

[1]US Army Corps of Engineers San Francisco District

[2]US Army Corps of Engineers Engineer Research and Development Center

USACE maintains safe and efficient navigation in San Francisco Bay in support of regional and national commerce by dredging federal navigation channels. Dredging comprises removal of sediment from the benthic environment in a waterway to reach a certain water depth to support vessel draft requirements. That sediment is then transported to and placed at permitted placement sites. Recent efforts and policy initiatives have focused on beneficially using this dredged material (BU), which is both a national and a regional priority. In January 2023, the Chief of Engineers', LTG Spellmon, issued a Command Philosophy Notice to achieve 70% BU agency-wide by 2030. Similarly, the USACE San Francisco District (SPN) identified multi-benefit navigation as a priority of its 20-year strategic plan completed in 2022.

As upland BUDM placement sites become more limited in San Francisco Bay over the next several years, there is a need to develop a Bay-wide long-term plan for placing dredged material. Under Corps policy, this plan is called a Dredged Material Management Plan (DMMP). The Regional DMMP (RDMMP) effort includes the 10 federally authorized channels in and adjacent to San Francisco Bay.

The Corps requires that all its federally maintained navigation projects identify sufficient dredged-material placement capacity for a minimum of 20 years and identify the Federal Standard Base Plan (i.e., the least cost, environmentally acceptable, and technically feasible dredging and placement option). The DMMP is a detailed assessment of dredged-material placement alternatives and serves as a validation that there is federal interest in continued maintenance dredging for authorized projects. The RDMMP estimates future maintenance dredging volumes, evaluates management alternatives for 20 years and recommends the Federal Standard Base Plan.

The initial stages of the RDMMP in 2019-2020 included a variety of meetings, charrettes, and presentations to relevant stakeholders, community organizations, and members of the public. These meetings provided a forum for public comment and recommendations about the scope of the RDMMP (i.e., on the Project Management Plan, or PMP); to evaluate SPN's Navigation Program to best position the program for success over the next several decades; and to identify the San Francisco Bay region's gaps in knowledge around dredging, placement of dredged material, and beneficial use of dredged material.

These charrettes helped scope supporting products and studies to frame sustainable dredging and placement solutions; to quantify metrics to support and prioritize BU efforts; to model sediment transport processes at the Bay-wide scale; to develop a framework to monitor sediment transport processes and pathways; to model ecological impacts from dredging and placement activities; and to provide decision support and benefit-pathways analysis. These studies (referred to collectively as the Gaps Analyses) were developed based on the input received from these charrettes, and an Interagency Working Group was developed to provide ongoing input to these study efforts and products. These studies supported the development of the RDMMP and will continue to support future efforts to bring

new BU sites online; to pilot novel Engineering with Nature approaches to dredged material management; and to identify opportunities to cost-share BU placements.

The RDMMP recently wrapped up its plan formulation process, in which data were inventoried and future conditions forecast; alternative actions were developed, analyzed, and compared; and a plan was selected, which is currently under agency review. The Project Delivery Team (PDT) is targeting four action alternatives for comparison against the future without project condition or no action alternative (i.e., continuing the current O&M dredging program as is): 1) divert sediment from deep ocean disposal to increase BU from a single channel; 2) regionally optimize dredge methods and placement sites to identify a regional Federal Standard Base Plan, increase BU substantially across the navigation program, and keep sediment in the estuarine system (i.e., San Francisco Bay) by reducing deep ocean disposal of sediment; 3) increase BU above the regional Federal Standard in line with a recent WRDA 2020 Section 125(a) cost-sharing threshold; and 4) maximize BU by taking all suitable dredged material to BU placement sites.

Concurrently with this plan formulation process, the PDT is working with various entities to develop the Gaps Analyses, including the USACE Engineer Research and Development Center (ERDC) on sediment transport modeling. This modeling is targeted to support the RDMMP, including the identification of optimal placement locations in the bay for strategic placement to maximize long-term viability and stability of the wetlands. The modeling effort is providing information to quantify the amount of dredged material that is placed in the nearshore environment and transported to the wetlands due to tidal and wave forcing, as well as the long-term behavior of these placements under sea-level rise scenarios. An added benefit of the modeling effort is the creation of an agency and community capability that can be (and is currently being) used to assist in other SPN efforts such as the determination of potential navigation hazards from in-bay placement.

The RDMMP PDT is targeting a recommended plan by 2nd quarter FY 2025 alongside a contracted NEPA document in time for the 2025 O&M dredging season beginning in June 2025. Subsequent RDMMP updates may be implemented (per WRDA 2020 Section 125(c) guidance) as new placement sites and methods come online, as informed and supported by the Gaps Analyses.

SAN FRANCISCO BAY MODELING AND REGIONAL DREDGED MATERIAL MANAGEMENT PLAN

Board on Coastal Engineering Research Meeting
13 August 2024

Arye Janoff, Ph.D.
USACE San Francisco District

Guarav Savant, Ph.D., P.E., BC.WRE
USACE Engineer Research & Development Center

U.S. ARMY

US Army Corps of Engineers





BOTTOM LINE UP FRONT (BLUF)

This study implements 100th BCER Initiatives for

- Regional Sediment Management
- Beneficial Use of Dredged Material
- Comprehensive Numerical Modeling that represents a “Digital Twin” of Bay
- Use of Nature-Based Solutions and natural processes to achieve engineering benefits

Addresses Coastal Commander Decadal Challenges

Recommends R&D and Policy changes to Discover and Transition R&D innovations

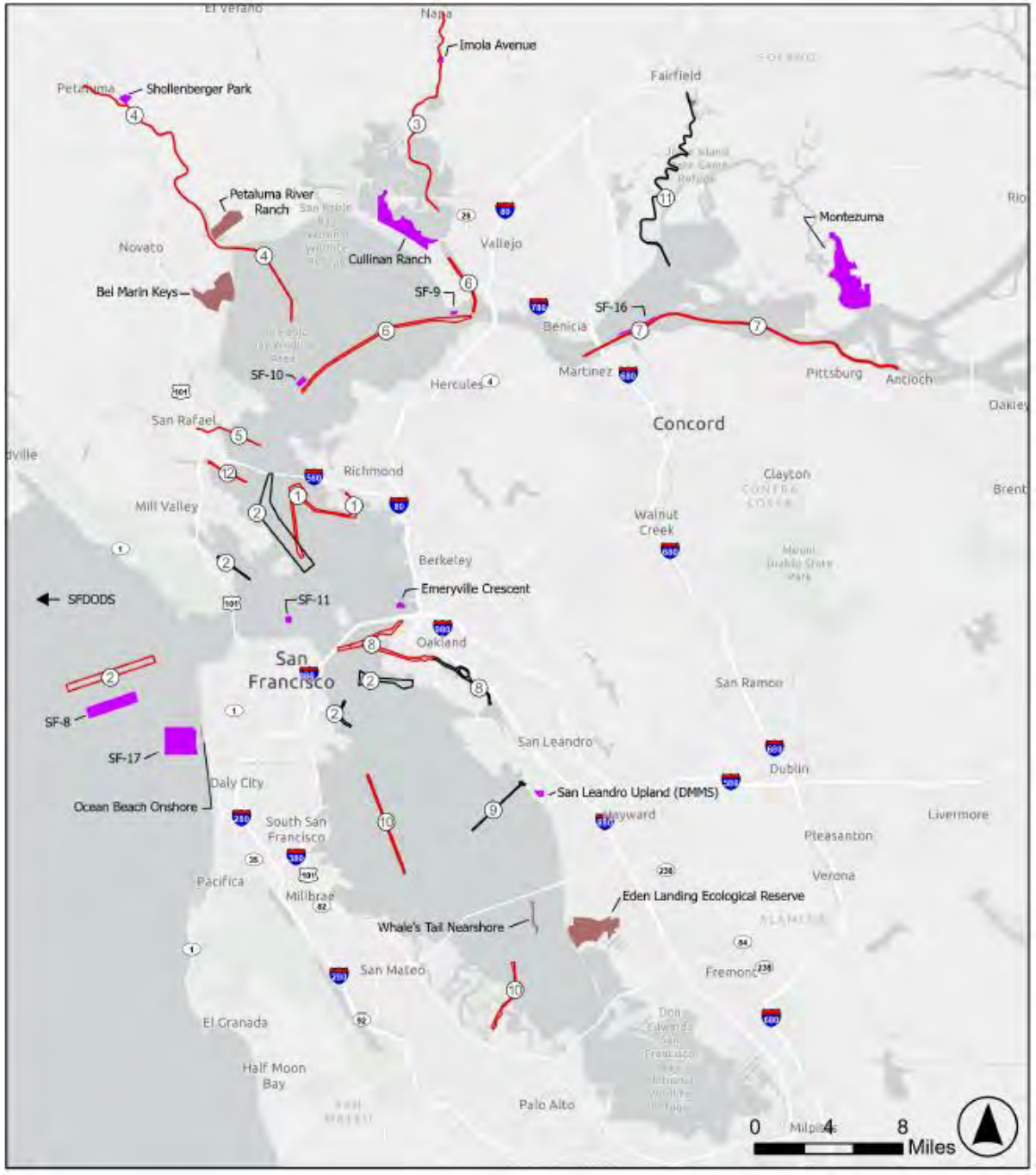
- Foundational Civil Works R&D needed to Discover Sediment, Ecological, and Hydrologic knowledge
- Policy needed to codify Technology Transition and Product Ownership

SF BAY NAVIGATION

Federal Channels (Red)
- 5,700 acres
- 2.2% of the Bay surface area

1.5 – 2 Million cubic yards of dredged material per year

Placement Sites (Purple & Brown)
- In-Bay
- Ocean
- Wetland Restoration



* Not shown: San Francisco Deep Ocean Disposal Site (SF-DODS)

THE FEDERAL STANDARD & INCREMENTAL COST

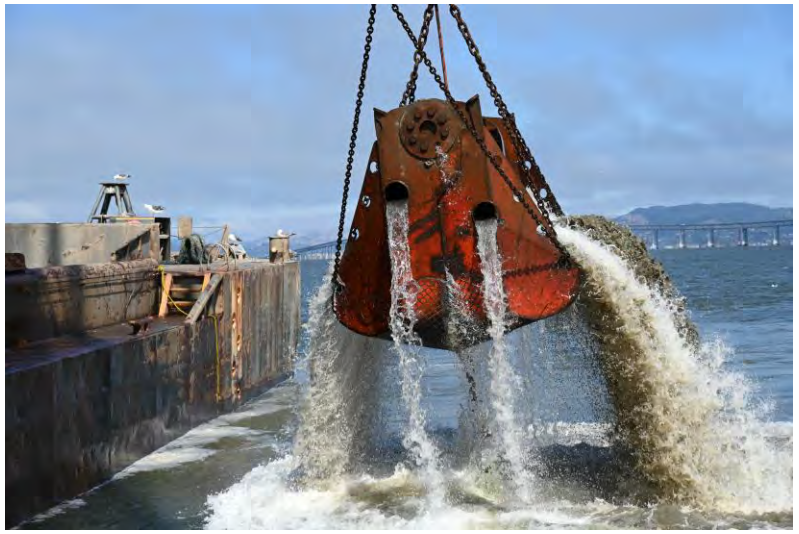
Federal Standard Base Plan (33 C.F.R. 335.7)

- Least costly dredging and placement alternative
- Consistent with sound engineering practices
- That meets all federal environmental requirements

Relative cost of San Francisco Bay placement sites

In-Bay ***Ocean*** ***Wetland***

Lower Cost *Higher Cost*



Incremental (additional) Cost

- Cost above the Base Plan to divert material
  - Often needed to take material to beneficial uses (BU)
- Funded by non-federal partner (historically at 100%)

Incremental cost **= [$ to take material to BU] – [$ for Base Plan]**

Partner Funding ***Federal O&M Funding***

O&M = Operations & Maintenance

USACE BENEFICIAL USE POLICY SHIFT

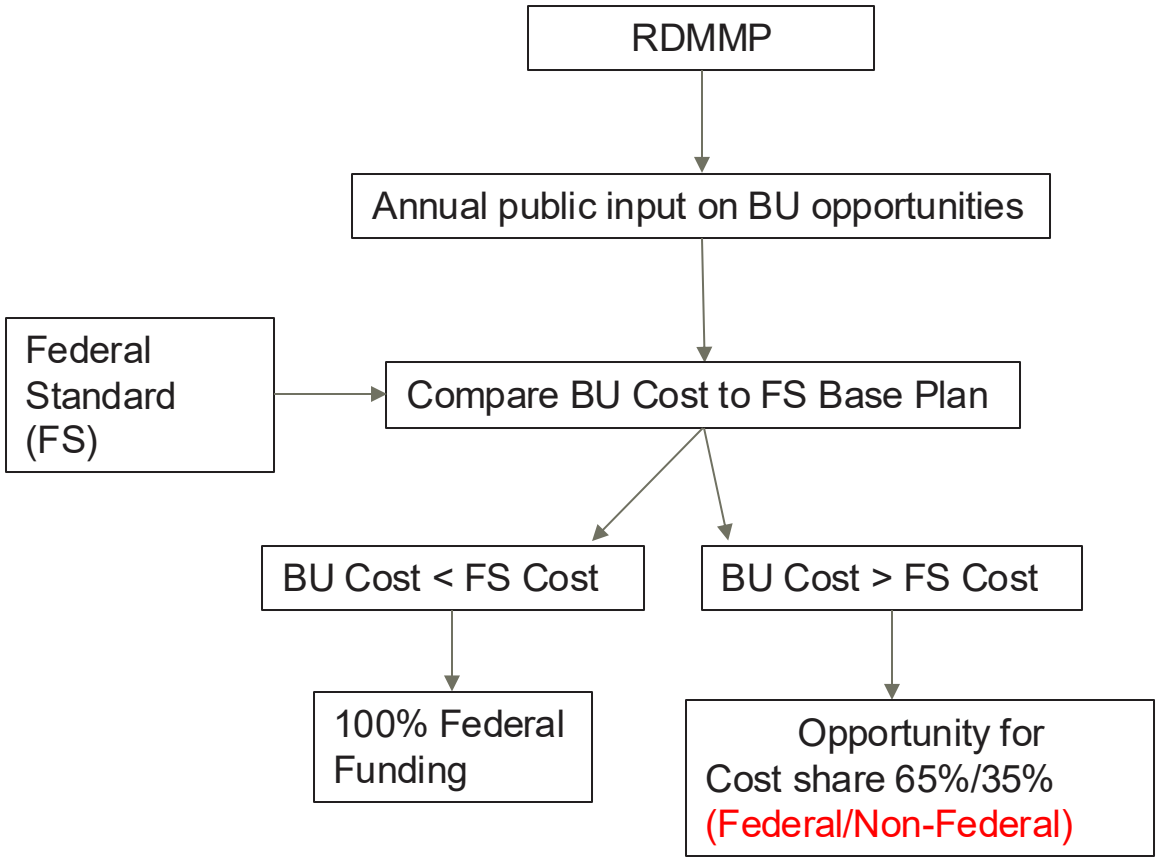




Sec. 125 of Water Resources Development Act of 2020

- Annually update RDMMP with public/stakeholder input on BU opportunities

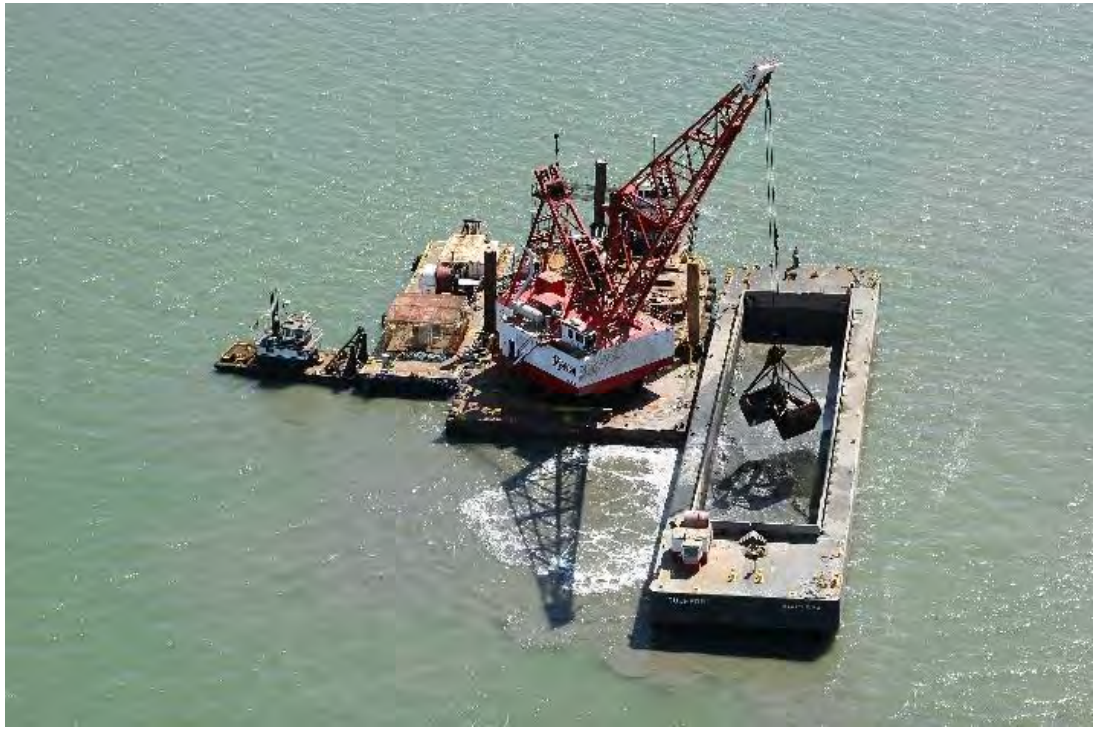
- Cost-share incremental cost of BU
  - 65% federal
  - 35% non-federal

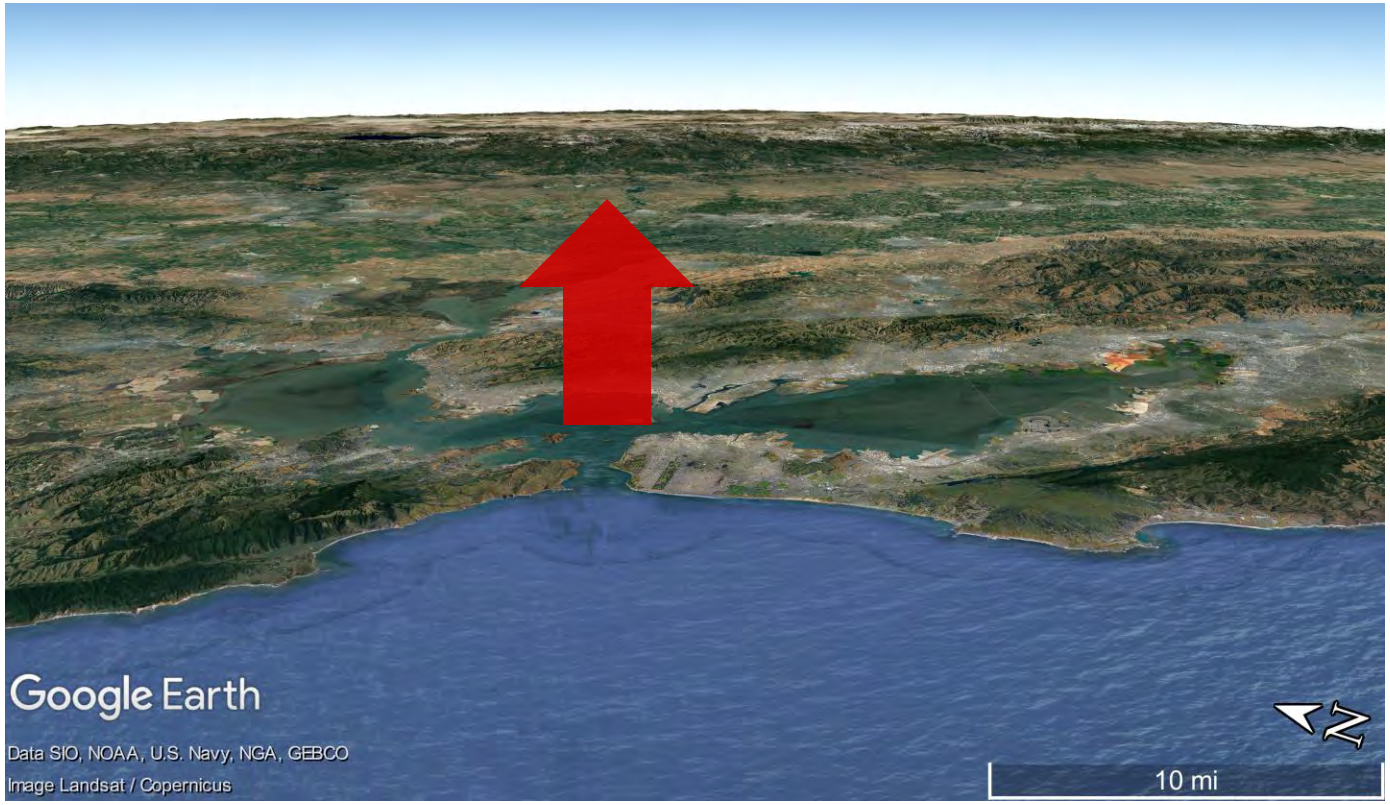


RDMMP = Regional Dredged Material Management Plan

CURRENT STATE IN SF BAY

- Sea-level rise and decreasing dredging volumes
  - Current paradigm results in sediment lost to ocean disposal
    - Change paradigm by **regionalizing** approach prioritizing **beneficial use** and **avoiding ocean disposal**

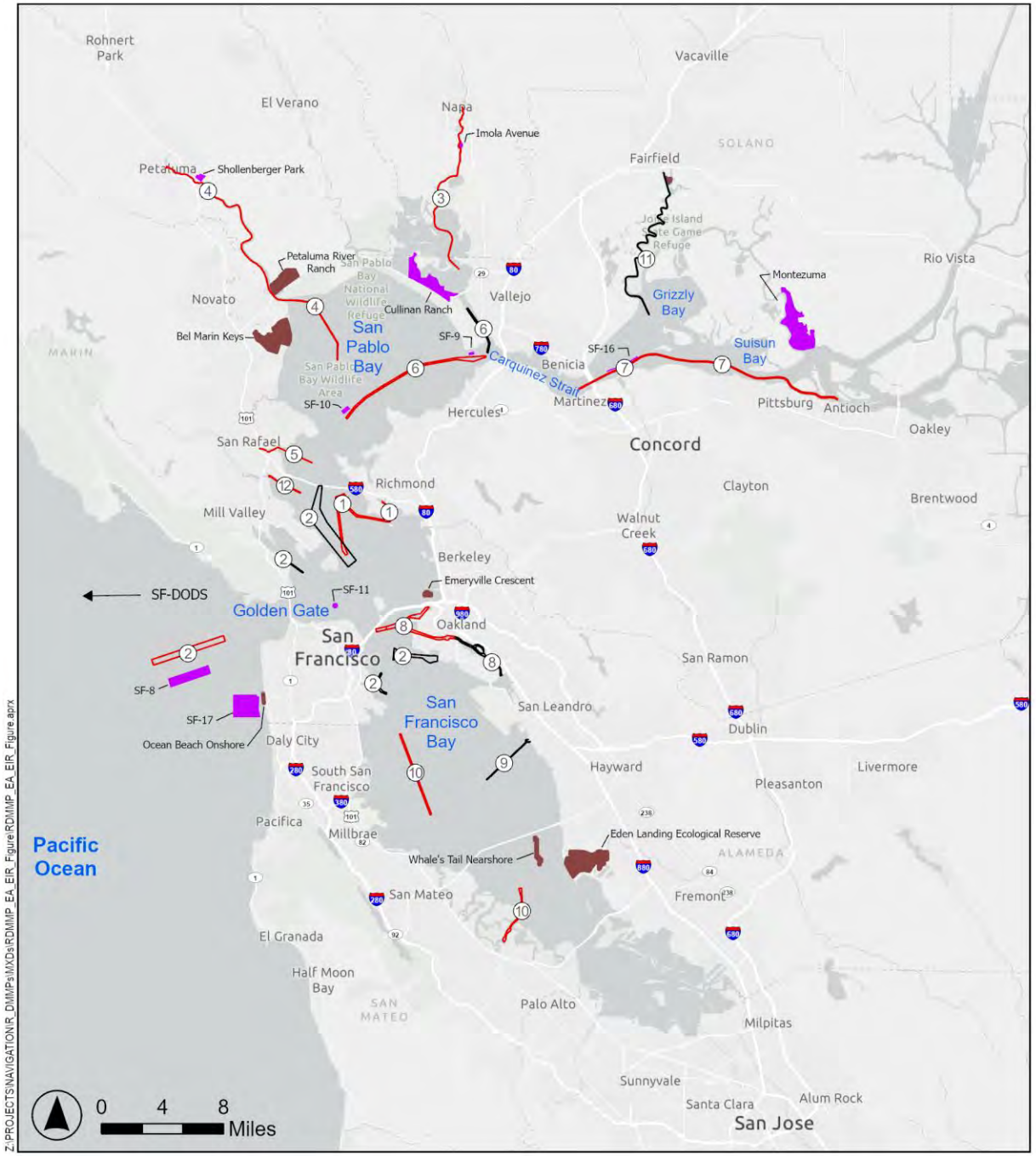




RDMMP OVERVIEW

- **20-year plan** for dredging and sediment placement from 10 federal channels
- Identify **least cost, environmentally acceptable, technically feasible** = federal standard (base plan)
- Goal: **beneficial use within federal standard and avoid ocean disposal**
- **Broad stakeholder engagement**





GAPS ANALYSES

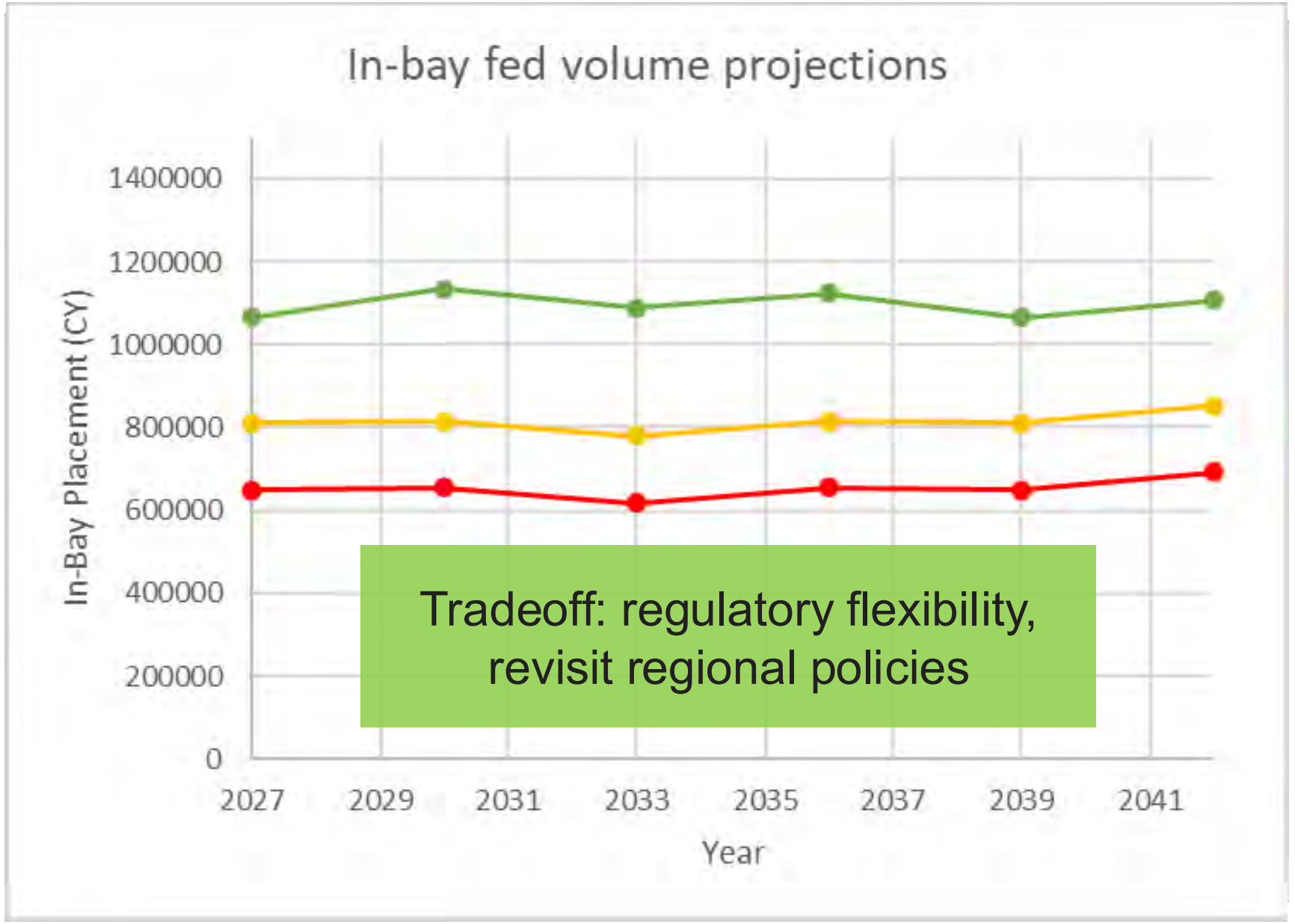
- Series of charrettes with stakeholders (2019) to **identify knowledge gaps**

- Four gaps identified and one additional gap added
  - Regional analysis
  - **Sediment transport modeling**
  - Sediment monitoring framework
  - Ecological modeling
  - Decision-support and benefit-pathways analysis

- Information from these studies will inform RDMMP and future updates via the WRDA 2020 Section 125 process
  - Justifying benefits of incremental cost-share
  - Beneficial Use Decision Document Integration
  - Annual 5-year spreadsheet when new sites come online

KEY POINTS

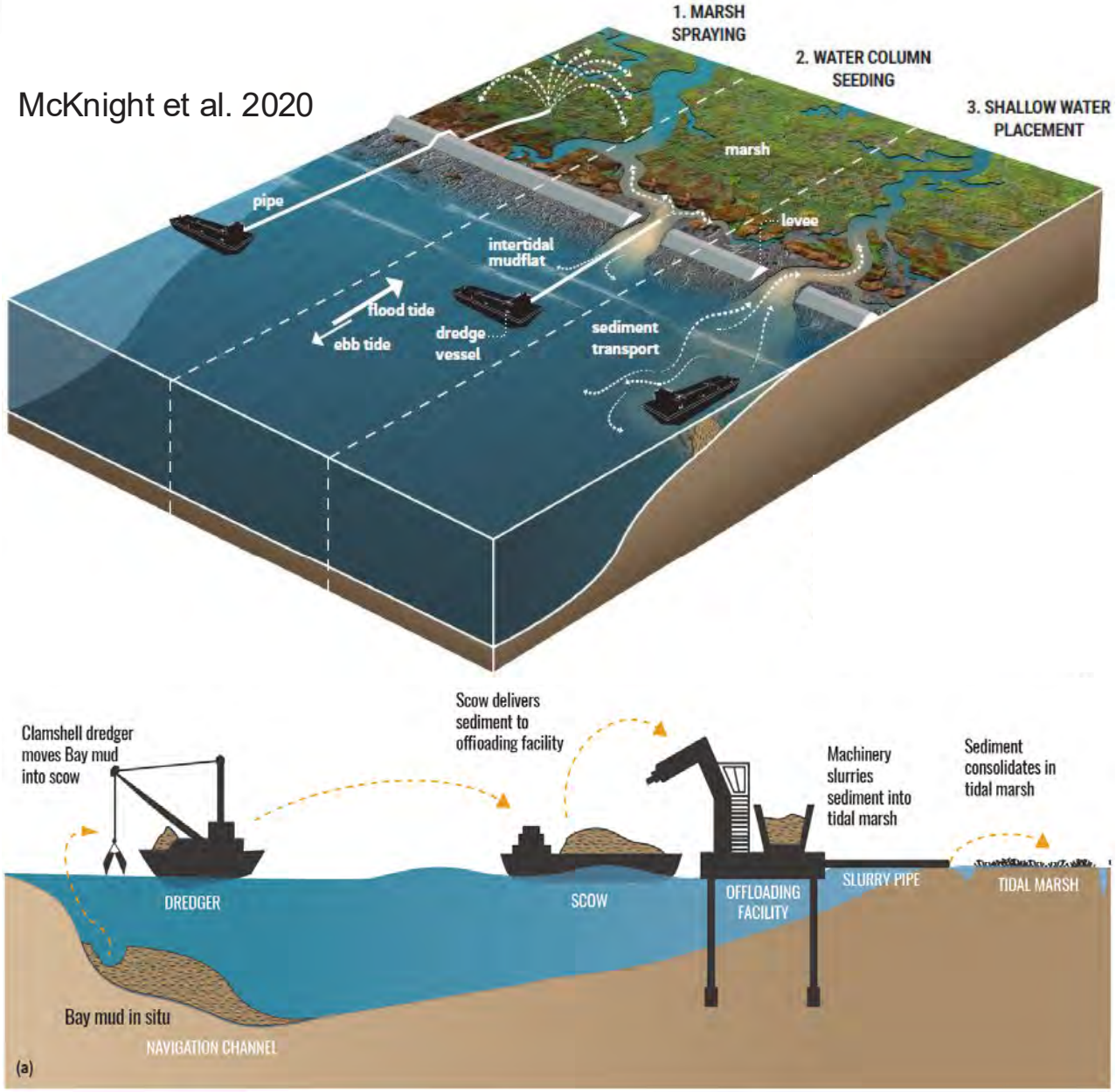
Preliminary Alternatives	
Current Paradigm	Equal Cost
Beneficial Use - Divert Ocean to BU/In-bay	Equal Cost
Regional Optimization, Most BU in Base Plan	Equal Cost
Beneficial Use - Cost-Sharing	Higher Cost
Beneficial Use - Maximized	Higher Cost

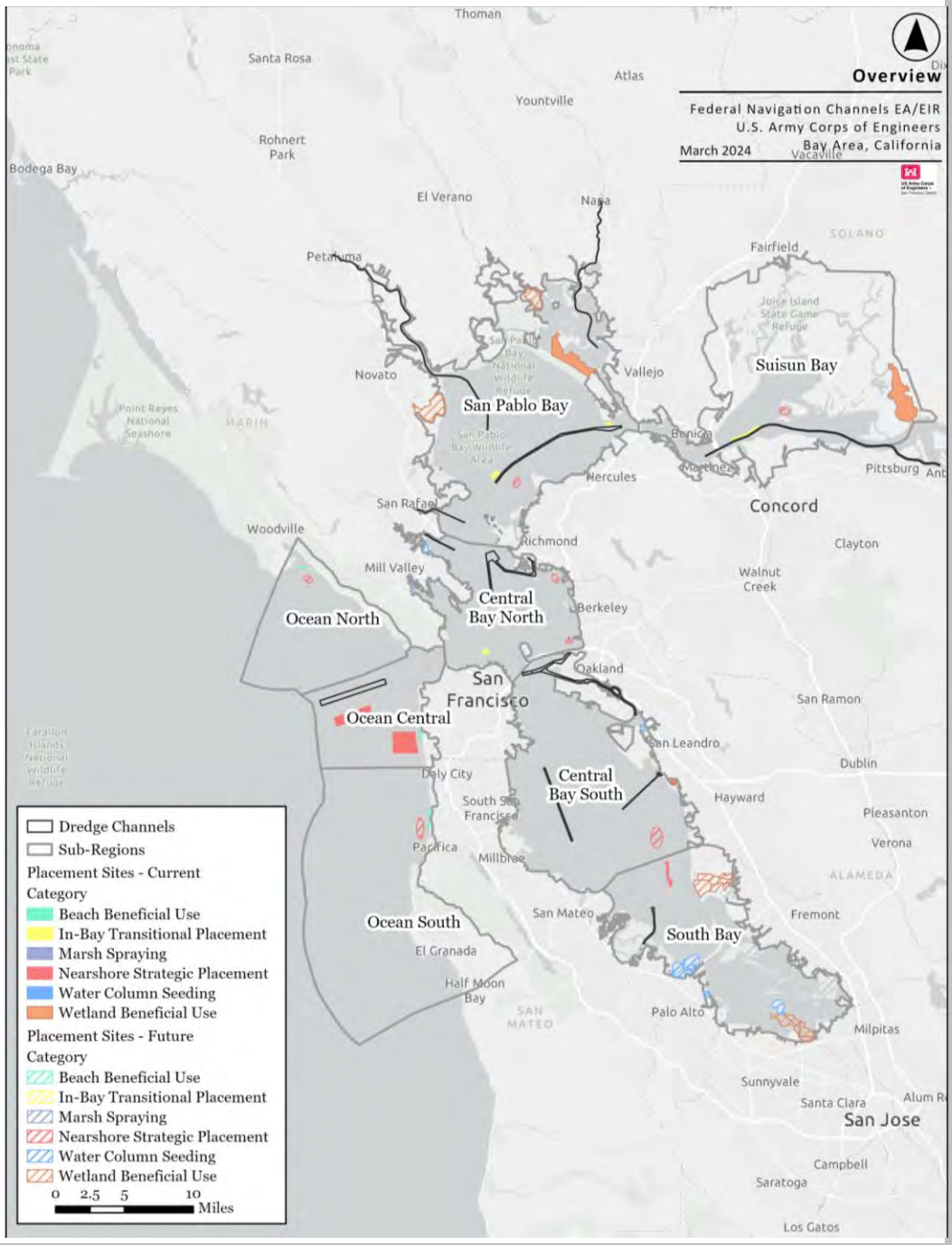


U.S. ARMY

FUTURE INNOVATION

McKnight et al. 2020



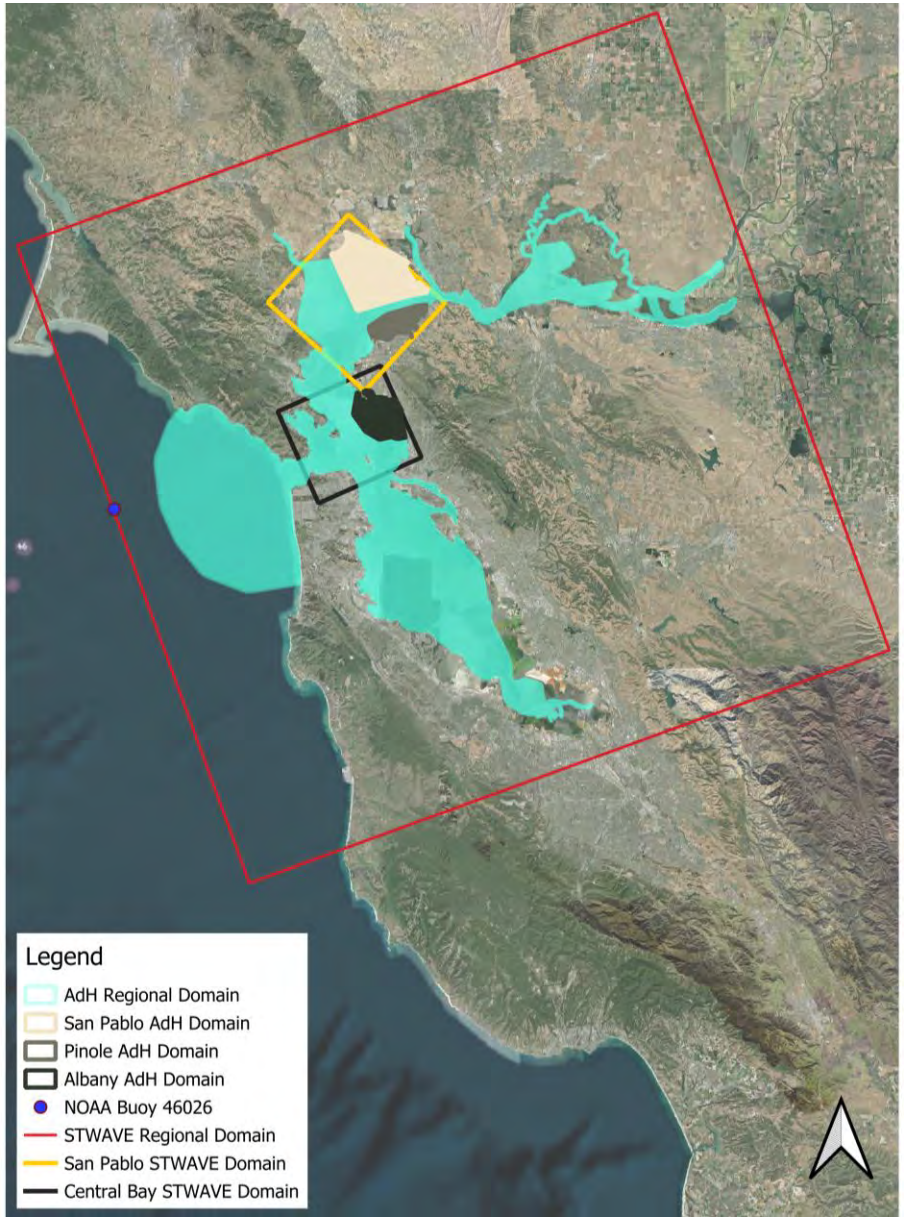


RDMMP SEDIMENT TRANSPORT MODELING

- Goal – Fill identified knowledge gaps
  - Identify optimal placement locations in the SFB for strategic shallow water placement of dredged material to maximize long-term stability of wetlands.
  - Specifically:
    - What are the current hydrodynamic forcings and how those will change with sea level change?
    - What is the total transport of placed material to the marshes and mudflats?
    - Do certain sites provide increased resilience and more favorable transport with changing conditions?
- Goal – Create capabilities that can support a broad range of SPN requirements.
- Goal – Transition capability to SPN.

NUMERICAL MODELING FRAMEWORK

- Adaptive Hydraulics (AdH) model
  - Regional Model
    - 2D/3D
  - Local Models
    - Berkeley/Albany
    - Pinole
    - East San Pablo
- STWAVE (STeady-state spectral WAVE) Model
  - Regional Model
  - Local Models
    - Central Bay
    - San Pablo Bay
- The Particle Tracking Model (PTM)
  - Simulations forced with hydrodynamic outputs
  - Simulations completed within local AdH domains



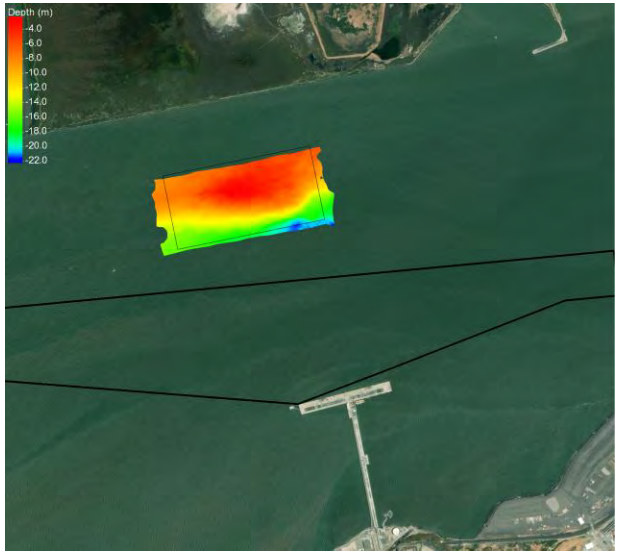
IN-BAY PLACEMENT

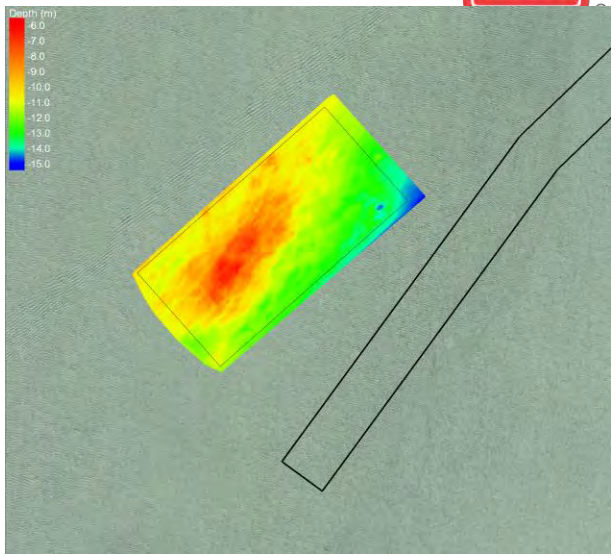
U.S. ARMY

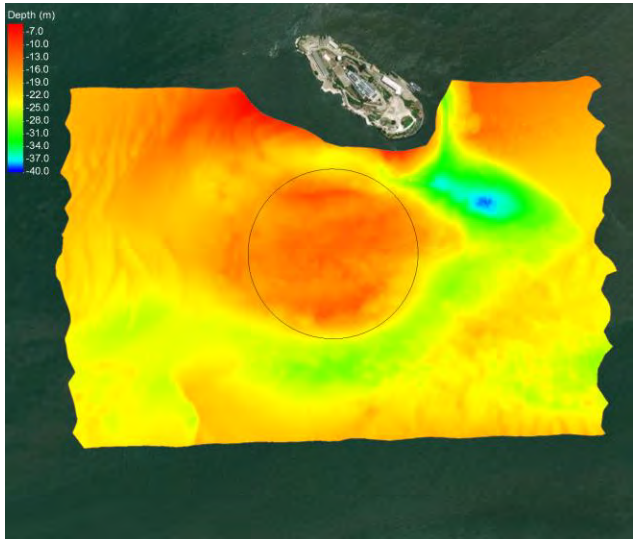
- In the 1980's, placement at SF-11 caused unexpected mounding of material and raised the issue of placement site management and navigation safety

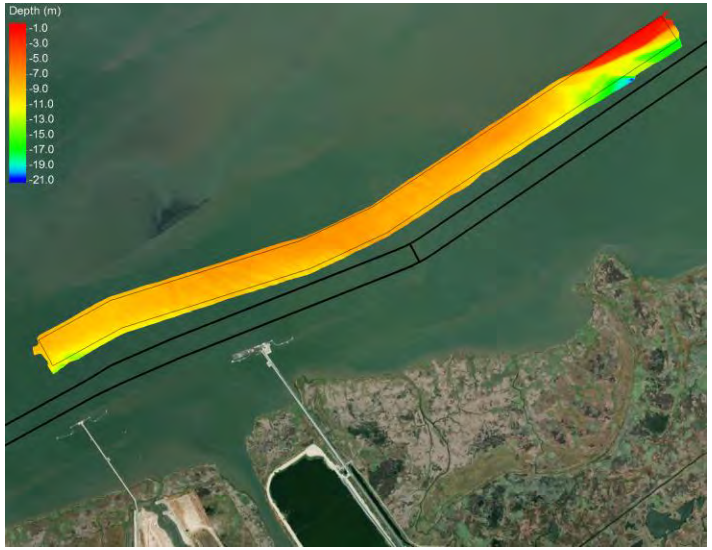
- The SFB AdH model will be used to evaluate potential future increases to volume placed at SF-9, SF-10, SF-11, SF-16

- Model results will estimate the evolution of the placement sites & give insight to the final fate of placed material







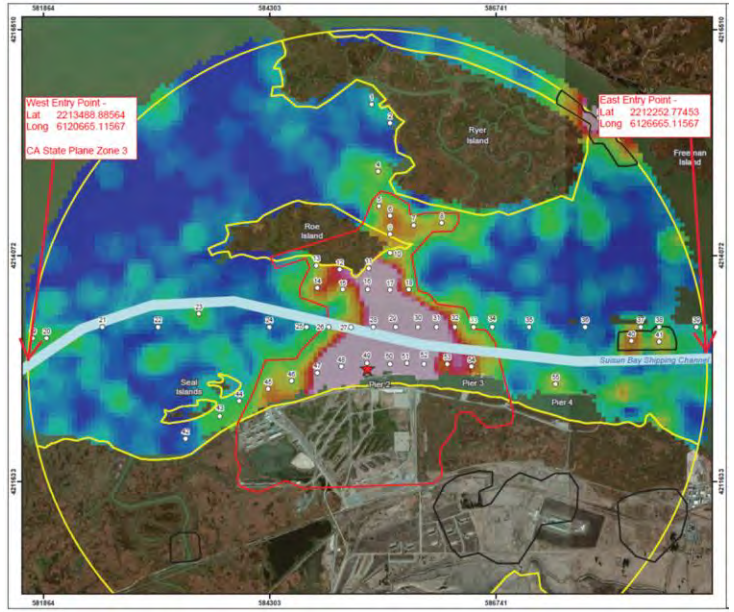


MILITARY OCEAN TERMINAL CONCORD (MOTCO) BENEFICIAL USE PROJECT

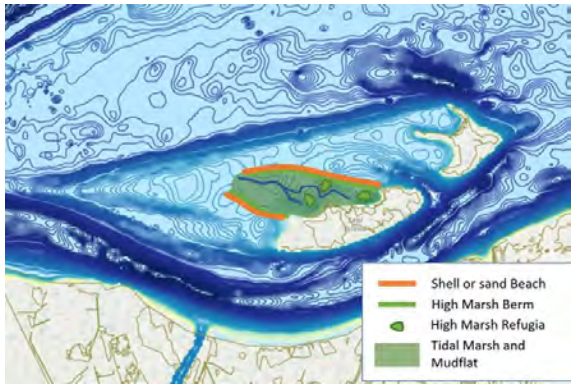
- Placement locations for material dredged from MOTCO are limited due to the possibility of unexploded ordnances

- Unique opportunity to utilize material to nourish wetland and construct island within Munition Response Sites (MRS) .

- The SFB AdH model is being used to inform potential strategic shallow water placement at Ryer Island and the design of marsh restorations at the Seal Islands.





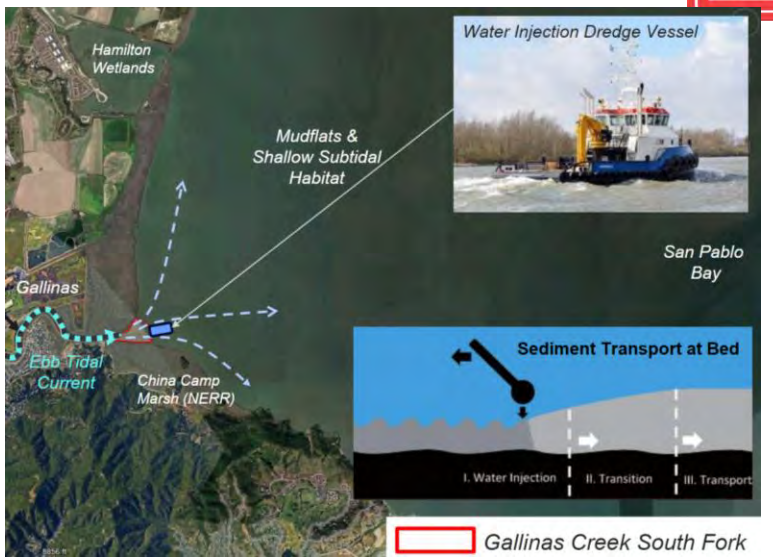


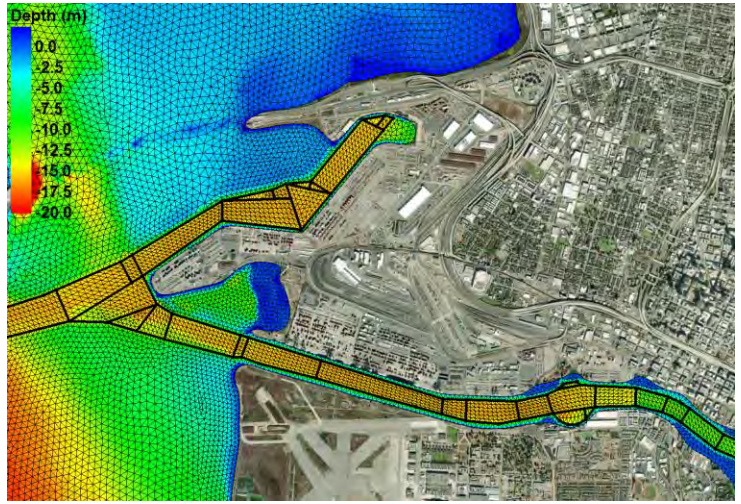
LEVERAGING THE RDMMP MODEL TO SUPPORT PROJECTS ACROSS SPN

- The development of a multi-dimensional hydrodynamic, sediment transport, and wave model for the San Francisco Bay provides SPN a tool for beneficial use and navigation projects

- The model is currently being used for the following BU projects:
  - FPMS sediment pulse delivery pilot
  - MOTCO BU with Unexploded Ordinance (UXO) concerns

- The model can provide hydrodynamic inputs for ship simulation studies of navigation improvements:
  - Oakland Harbor Turning Basins Widening



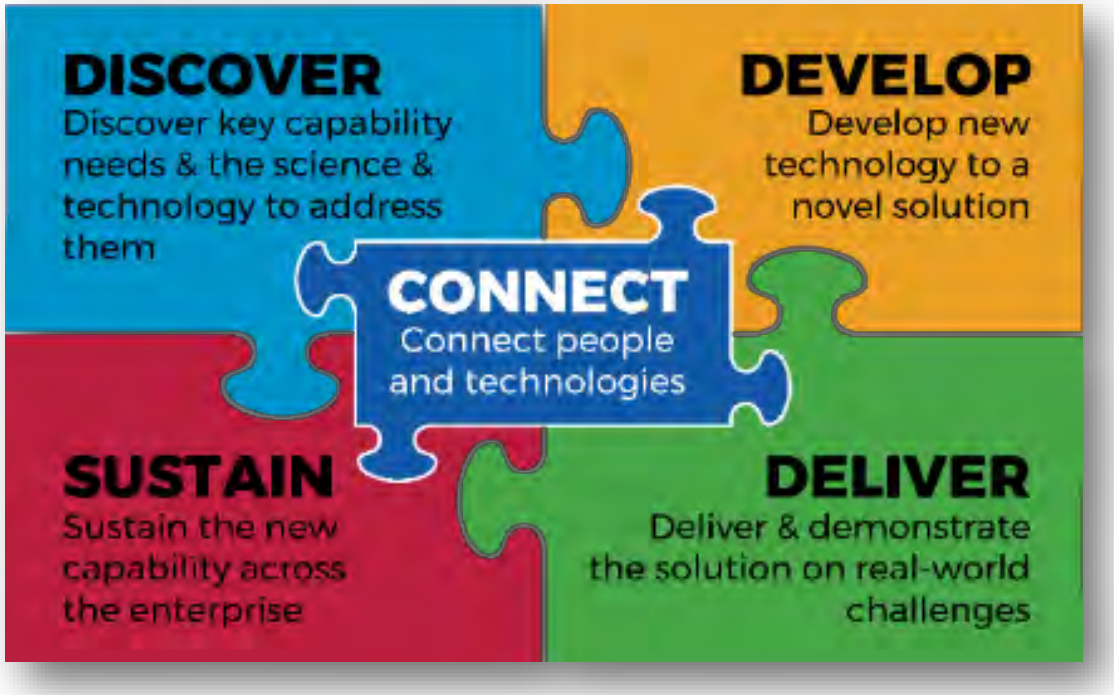


WHAT R&D/POLICY IS NEEDED FOR INNOVATION

- Foundational Research for Civil Works
  - Sediment Processes
    - Response of fine and cohesive sediment to natural and anthropogenic processes (injection dredging, etc.)
      - Short and Long-Term Fate
    - Behavior of sediment impacted by wildfires
      - Characteristics, behavior, timescales of transport into rivers to the coast
      - Suitability for BU
  - Ecological Processes
    - Wetland response to changing conditions and engineering properties as Nature Based Solutions
    - Non-linear and cascading effects of non-stationarity on ocean and upland drivers
  - Hydrodynamic and Hydrologic Processes
    - Fine scale hydrologic processes – how does water infiltrate after prolonged droughts and how much makes it to the coasts; implications for groundwater, water supply, salinity intrusion.
    - Others

WHAT R&D/POLICY IS NEEDED FOR INNOVATION

- Ownership of Innovation Products
  - Ownership = Transition = Sustainment
  - There is a need for a PEO & PdM concept for Civil Works





QUESTIONS



Julie Beagle

Julie Beagle is the Environmental Services Branch Chief for the US Army Corps of Engineers San Francisco District (SPN). She brings a focus on integrating nature-based approaches into USACE studies, projects, and operations. She is the environmental technical lead on several Engineering with Nature pilot projects, including piloting strategic shallow water placement of dredged materials in SF Bay to support marsh and mudflat resilience to sea-level rise. Julie is also a National Practice Lead for the Engineering With Nature Program. Previously Julie was the Deputy Director of the Resilient Landscapes Program at the San Francisco Estuary Institute (SFEI) where she led many of the shoreline resilience and adaptation efforts. Prior to her ten years at SFEI, Julie worked with land managers on the North Coast of California to reduce fine sediment runoff into salmonid streams, and contributed to watershed-scale river restoration projects. She has worked as a fluvial and estuarine geomorphologist throughout the rivers and wetlands of California for the last 15+ years and has a master's degree in environmental planning from the University of California, Berkeley.

Engineering With Nature®

Overview of the San Francisco District EWN Proving Ground

Julie Beagle, USACE San Francisco District
Environmental Services Branch Chief
EWN Program Practice Lead

U.S. ARMY

US Army Corps of Engineers

August 13, 2024





GUIDING PRINCIPLES FOR EWN PROVING GROUNDS

- **Adapting to climate change** will require us to manage landscapes differently than we have in the past

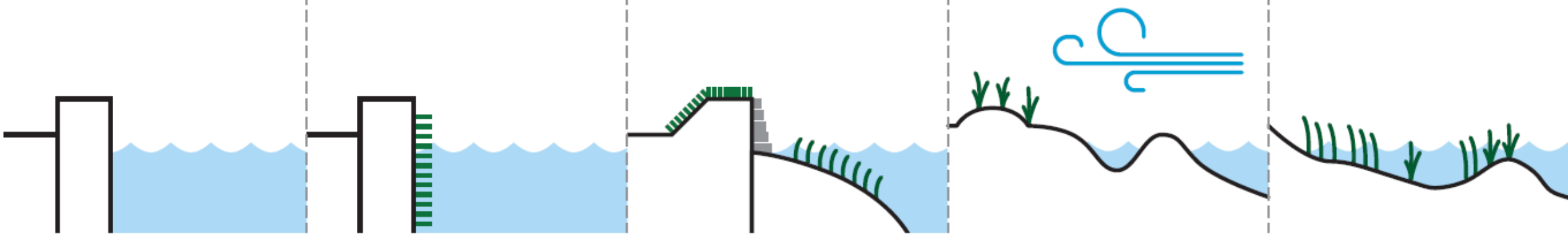
- If we **work with nature rather than fight against it**, we will likely be more successful in enhancing resilience for **species, habitats, and humans**.

- There are **real challenges** between our status quo and where we need to be as the climate changes.

- **Collaboration** across agencies, communities, and sectors will be increasingly important for **equitable adaptation.**

Gray → **Nature-Based and Green-Gray Solutions** → **Green**

Conventional Engineering	Green Gray	Hybrid	Prompted Recovery	Natural
Project or scheme constructed with little or no ecological consideration	Gray infrastructure that intrinsically incorporates green habitat elements by design or retrofitting	Traditional engineering fronted by a created "natural" feature; e.g., salt marsh in front of sheet piling	Scheme initiated by human input that is then dependent on natural process; e.g., dune restoration, sand motor	Naturally occurring habitat; e.g., mangrove, salt marsh, dunes, shingle, rocky shore



INSTITUTIONALIZING EWN



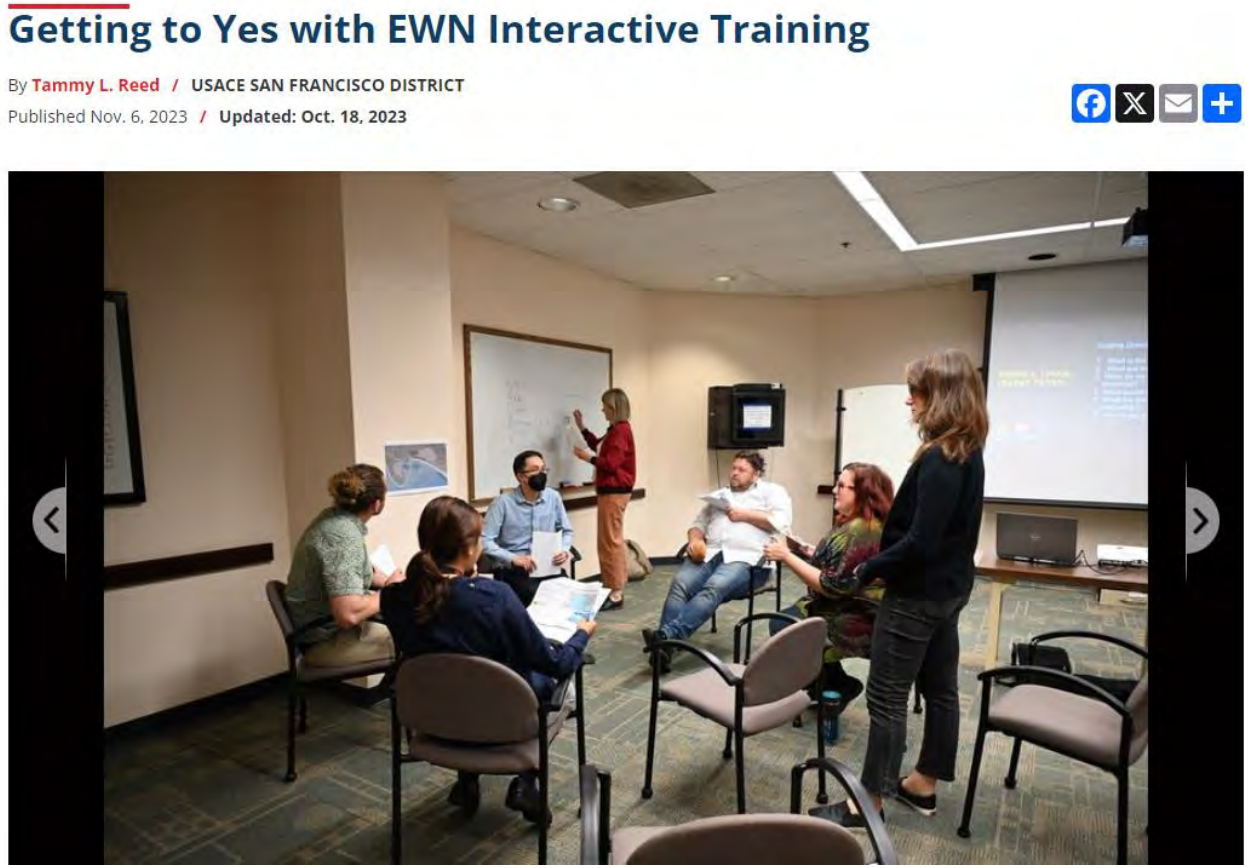
Invest in **PEOPLE**
Build **PORTFOLIO**
Develop **PROCESS**
Develop and test **POLICY**
Grow **PARTNERSHIPS**

INVEST IN PEOPLE

2021-2024 Successes

- ✓ Broad team across disciplines
- ✓ New hires drawn to focus on NBS and EJ related work
- ✓ EWN Active Learning Module
- ✓ EWN Monthly Webinar series
- ✓ EWN Scoping Cadre at SPD to support New Starts
- ✓ EWN technical support to Division and Enterprise





PROJECTS: BUILD EWN AND EJ PORTFOLIO

- Focus on **single-purpose projects** across the **watershed** (FRM, CSRM, NAV)
- **Pilot projects**, technical assistance and small projects to build pipeline
- Use **policy tools** to improve project outcomes
- Improve **public outreach**, participation and EJ relationships

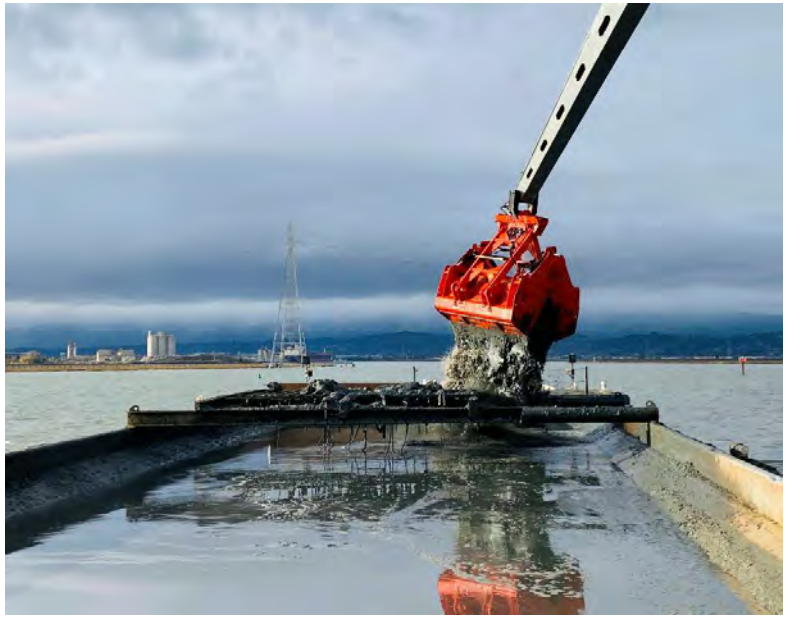




EWN AND BU INTO NAVIGATION O&M

Successfully implemented 1122 Shallow Water Strategic Placement Pilot Project

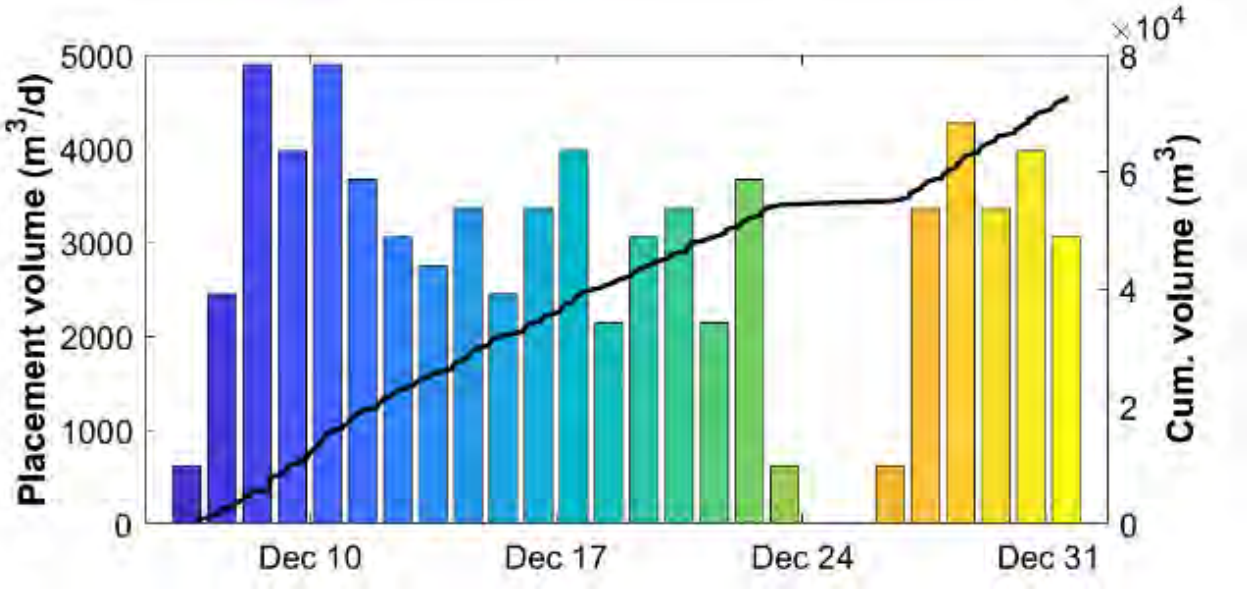
- 90K CY Dredged Material placed offshore of eroding marsh in **December 2023**
- Monitoring impacts, **fate** and **transport** of **sediment** through 2024





Pulse Dredging Pilot Study

- Using Technical Assistance Programs (FPMS)
- Modeling Water Injection Dredging **timed with storms** to dredge small tidal channels and **distribute sediment** to Baylands



*Pilot projects are great **and** we need to do them more than once!*

EWN INTO COASTAL STORM RISK MANAGEMENT

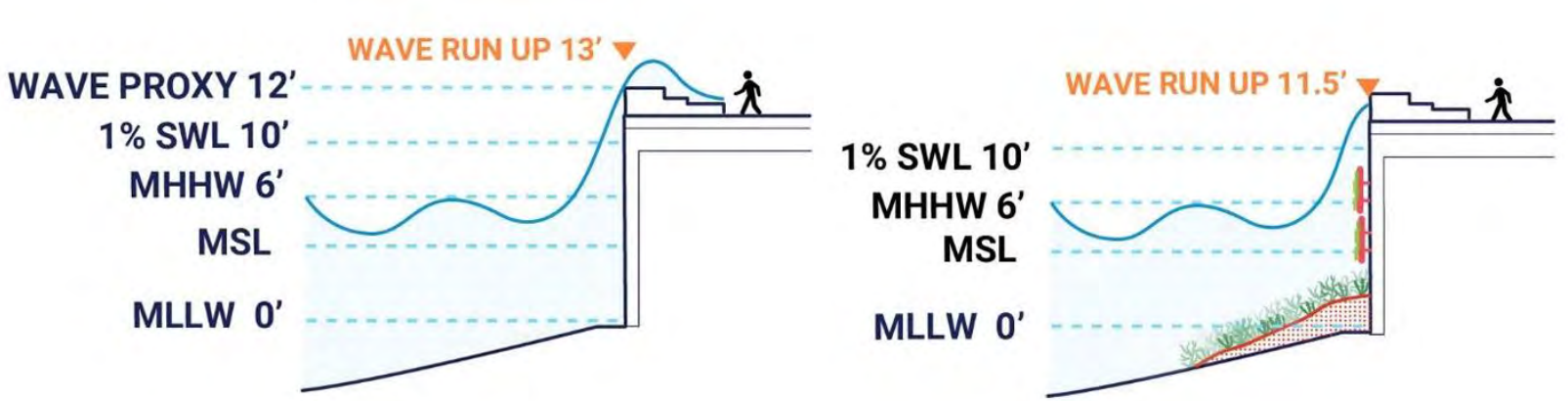
San Francisco Waterfront Flood Study

- SF Port-led **EWN working group** to integrate nature-based features equitably across the project area
- **Drawing on experience** in Australia, Seattle, New York, and other steep urban shorelines
- Successfully included **3 miles of NBS** into Recommended Plan





Late stage development barrier beaches at Pier 94



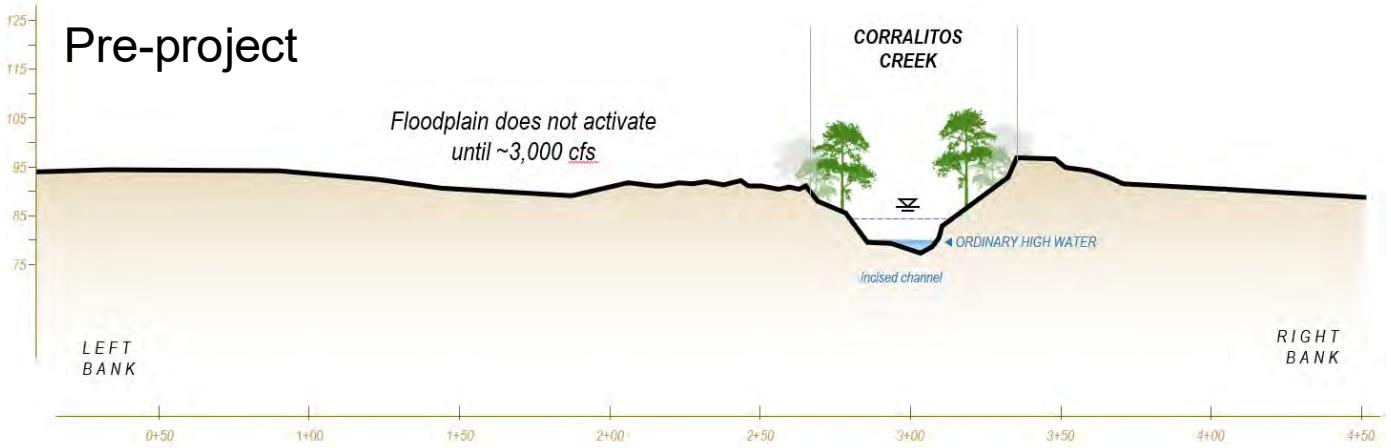
EWN INTO FLOOD RISK MANAGEMENT STUDIES

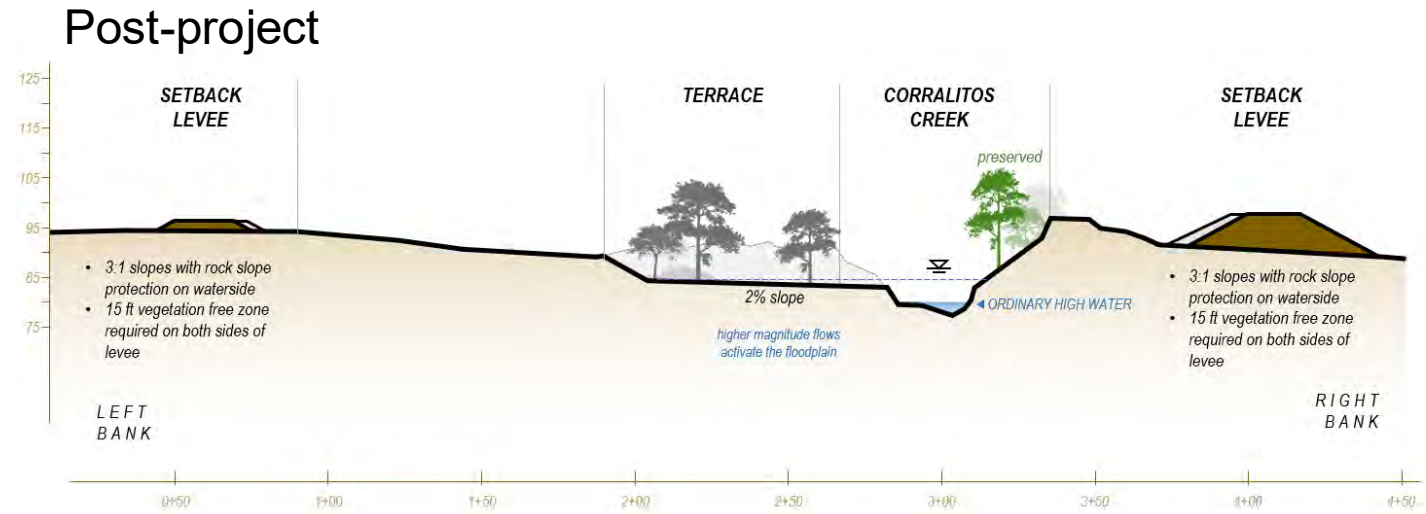
Upper Guadalupe River FRM Project

- Replace bypass flood control channel with a **floodplain bench**
- Integrate multiple benefits for endangered **salmonids**
- **Lower flood stage** and velocities

Pajaro River FRM Project

- Setback levees + floodplain bench
- Using borrow material to **decrease cost of levee**, increase riparian corridor, **groundwater recharge**
- Partnering with CBOs/**youth training program** to revegetate





CASE STUDY: PAJARO RIVER









- Existing levees provide 8-year level of flood risk reduction
- Community of Pajaro average median income is $22,000/year
- Project sets back levees to give river room to activate floodplain, and alleviate flooding

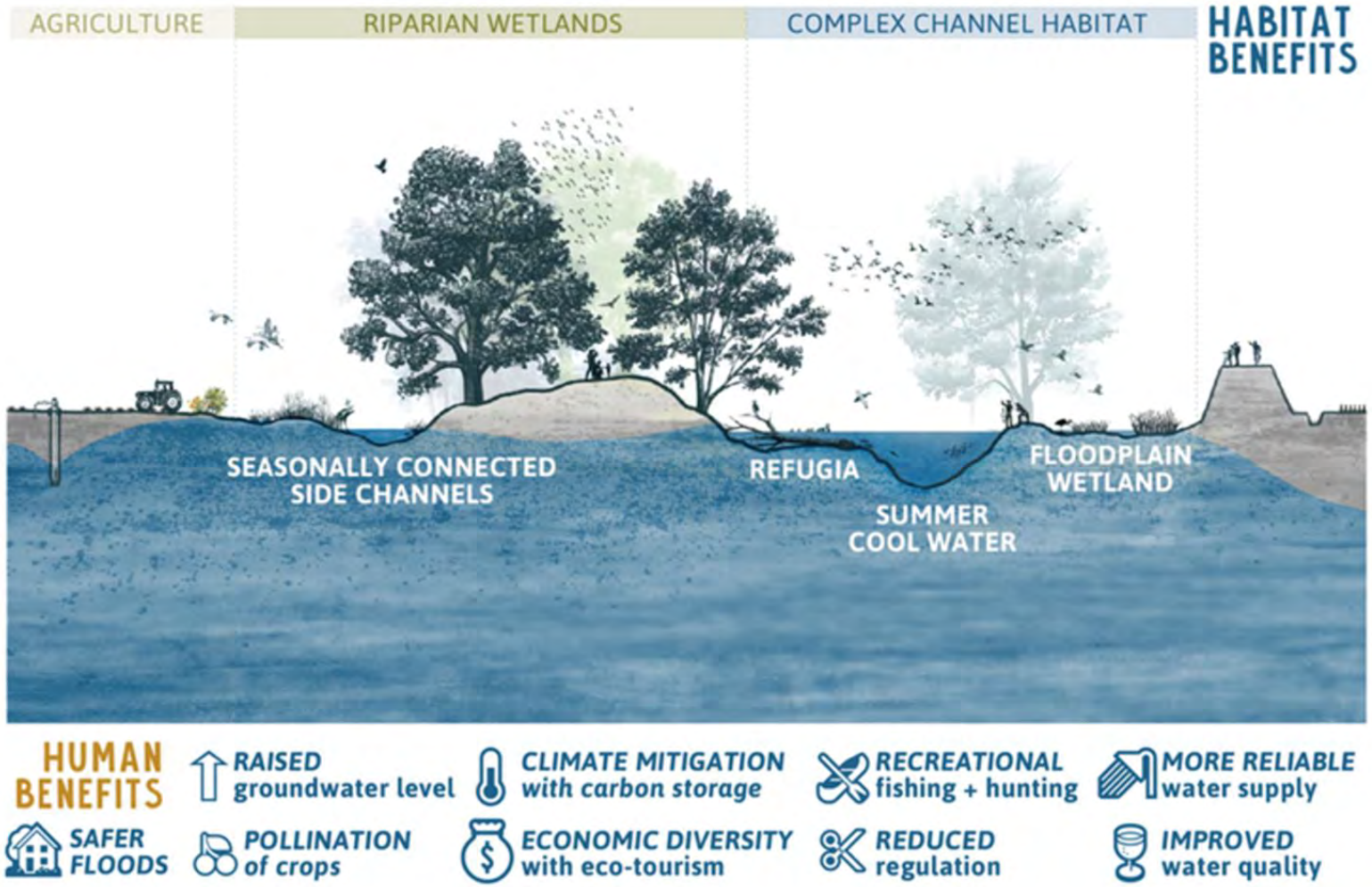


Residents in Pajaro, Calif., were forced to evacuate in the middle of the night after an atmospheric river surge broke a Pajaro River levee and sent floodwaters flowing into the community on Saturday.

Josh Edelson/AFP via Getty Images

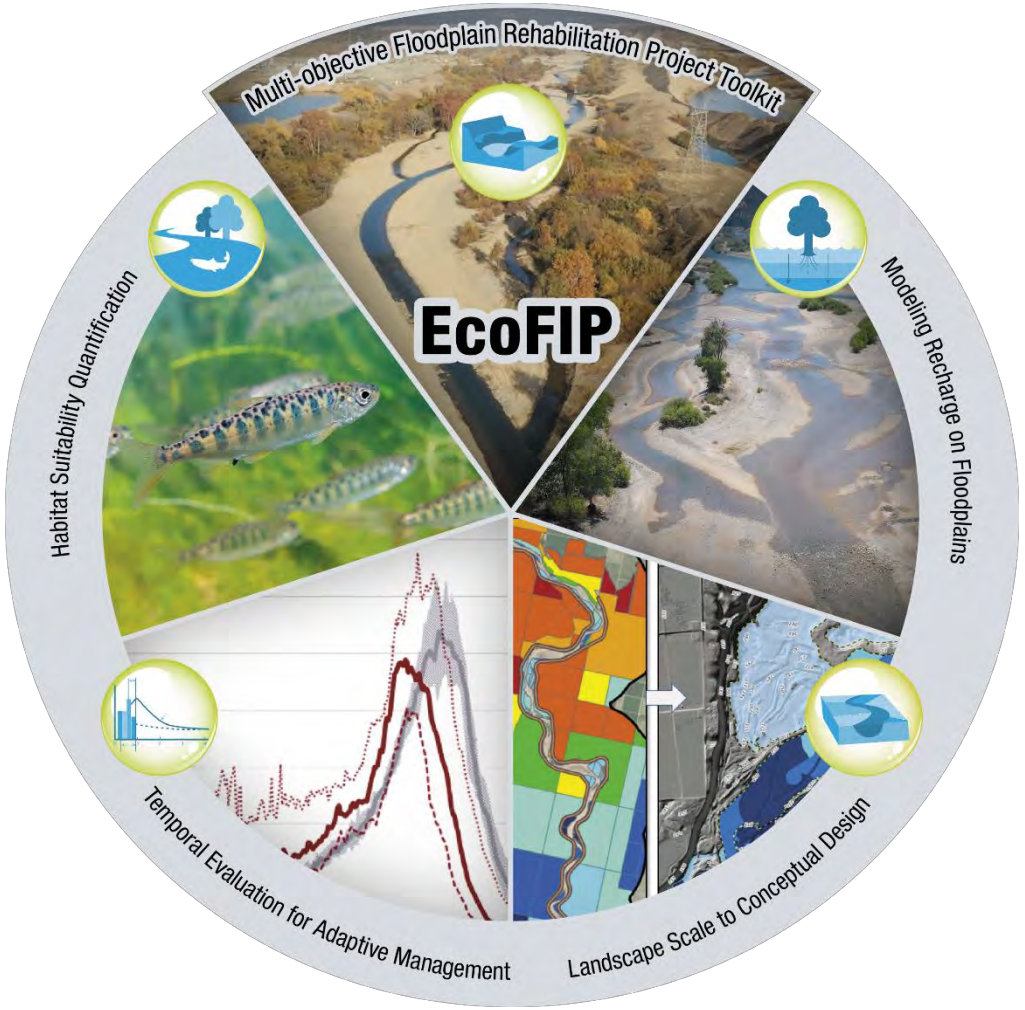
MARCH 2023, SF GATE

Benefits of Floodplain Features



American Rivers
RIVERS CONNECT US®

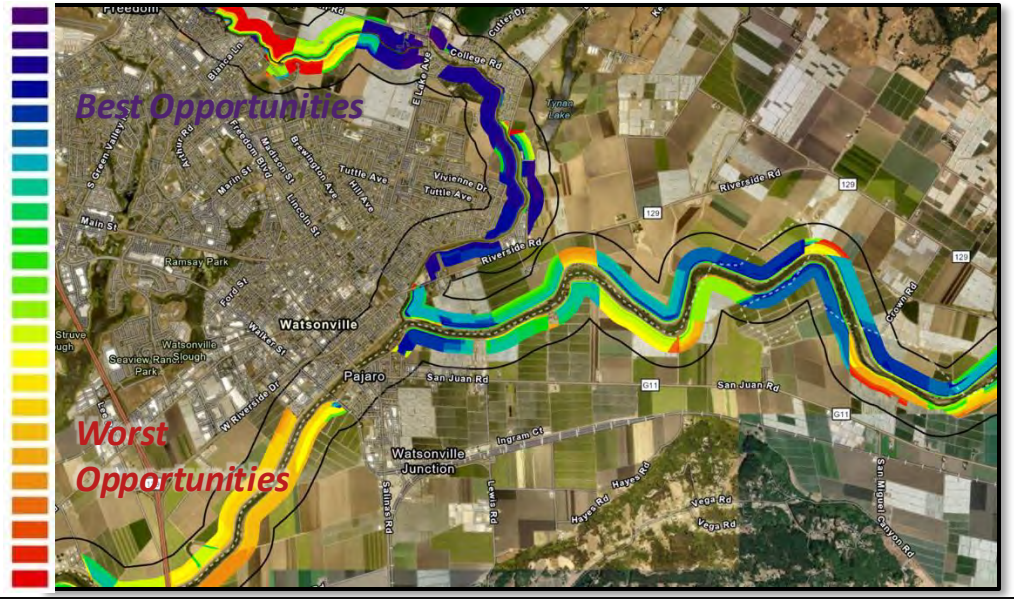
MULTIPLE BENEFITS FOR FLOODPLAINS



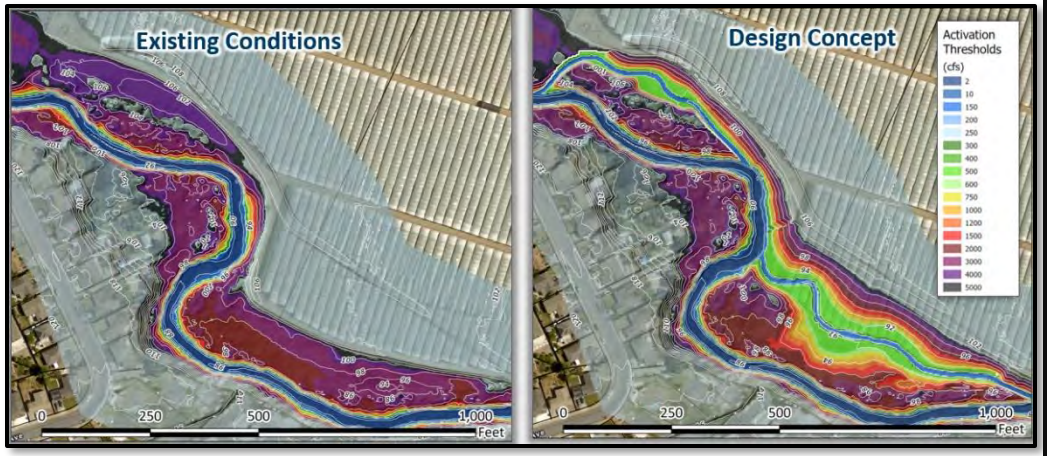
https://storymaps.arcgis.com/stories/f899bf3c36a2403d9e0bd3c70dc2dfc5

cbec Jacobs CALIFORNIA DEPARTMENT OF WATER RESOURCES

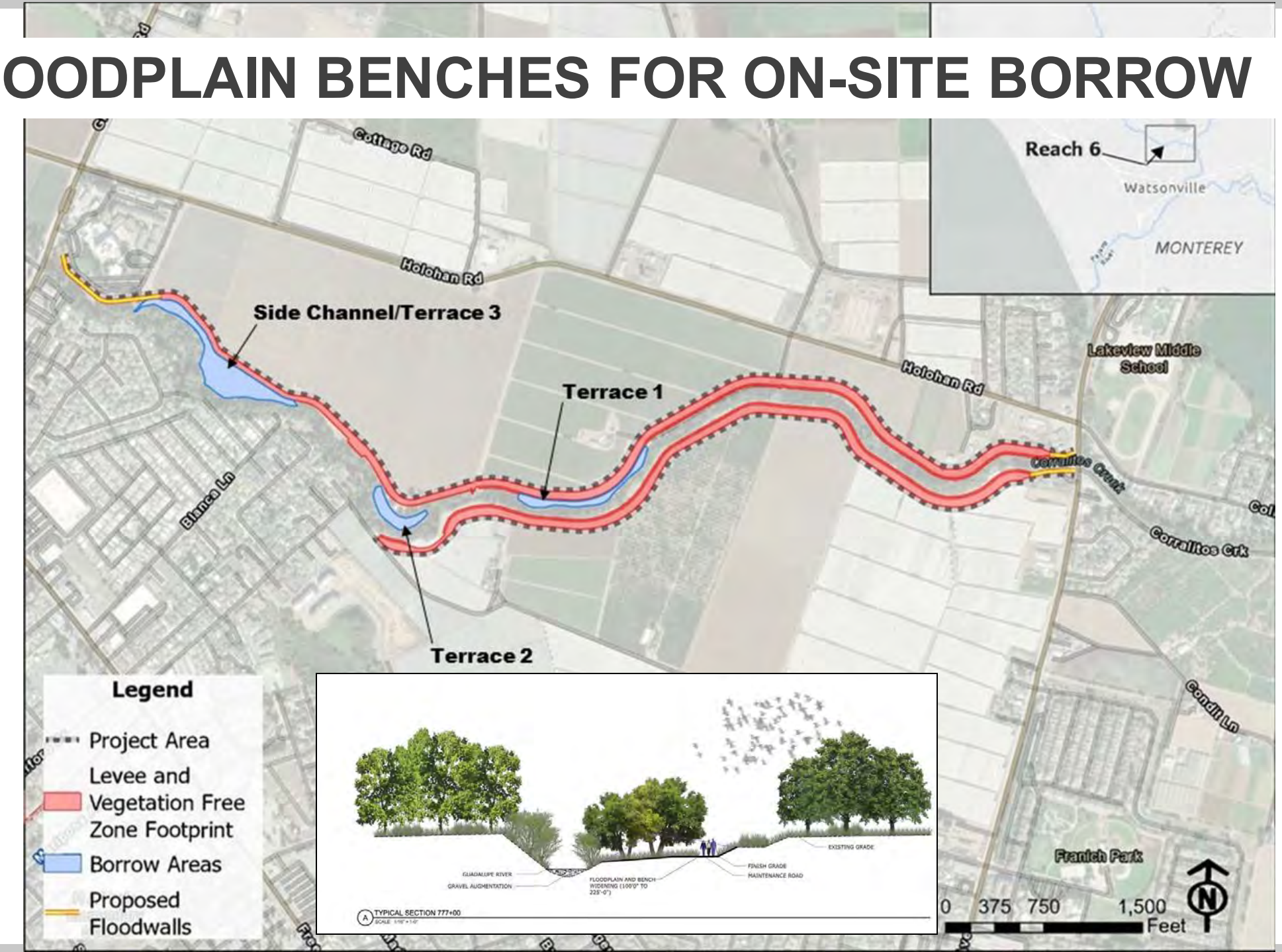
Identification, Analysis, and Prioritization



Ideas -> Implementation



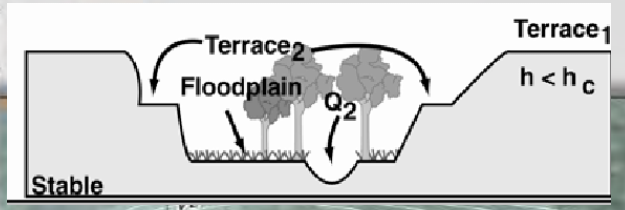
FLOODPLAIN BENCHES FOR ON-SITE BORROW

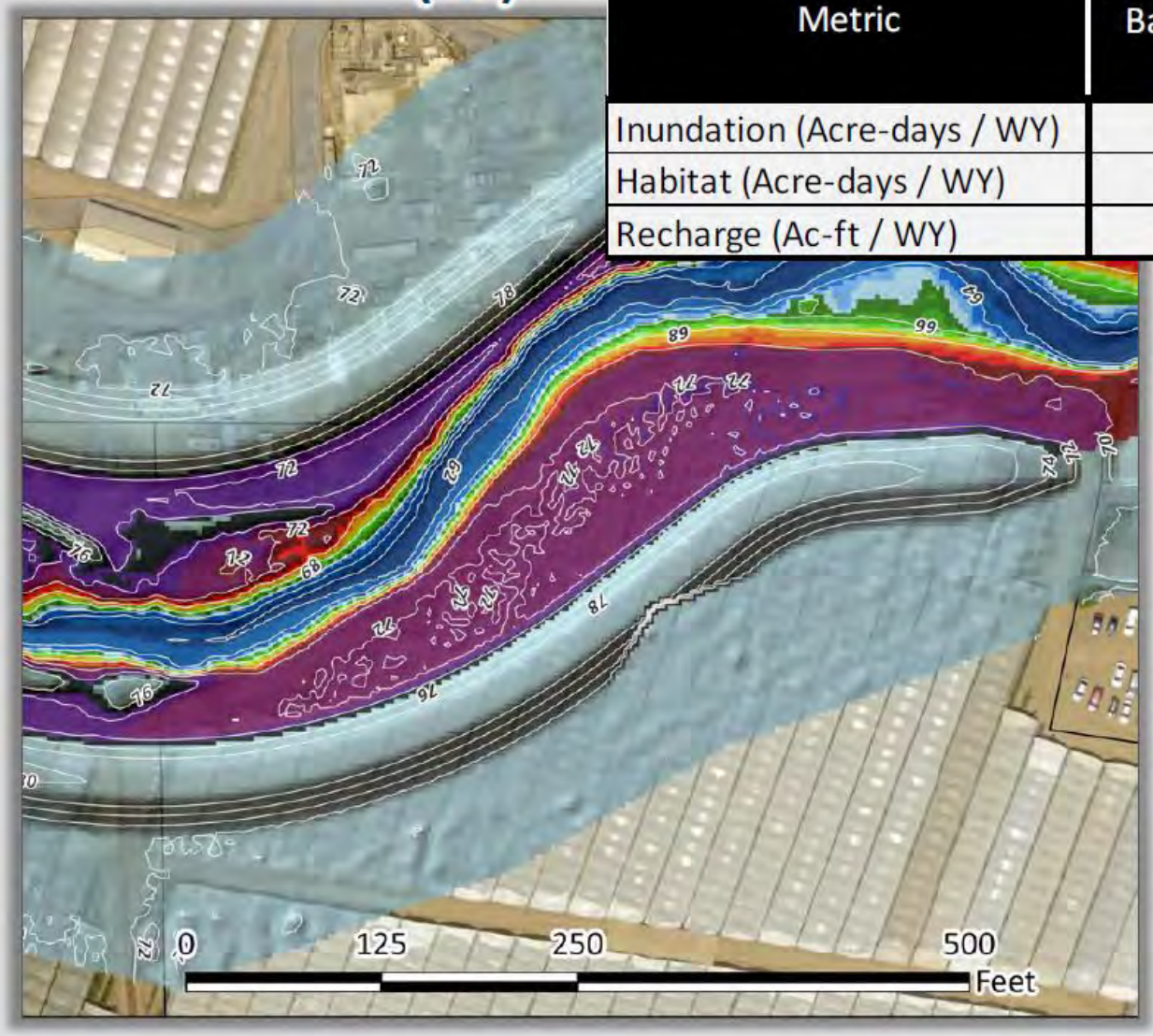


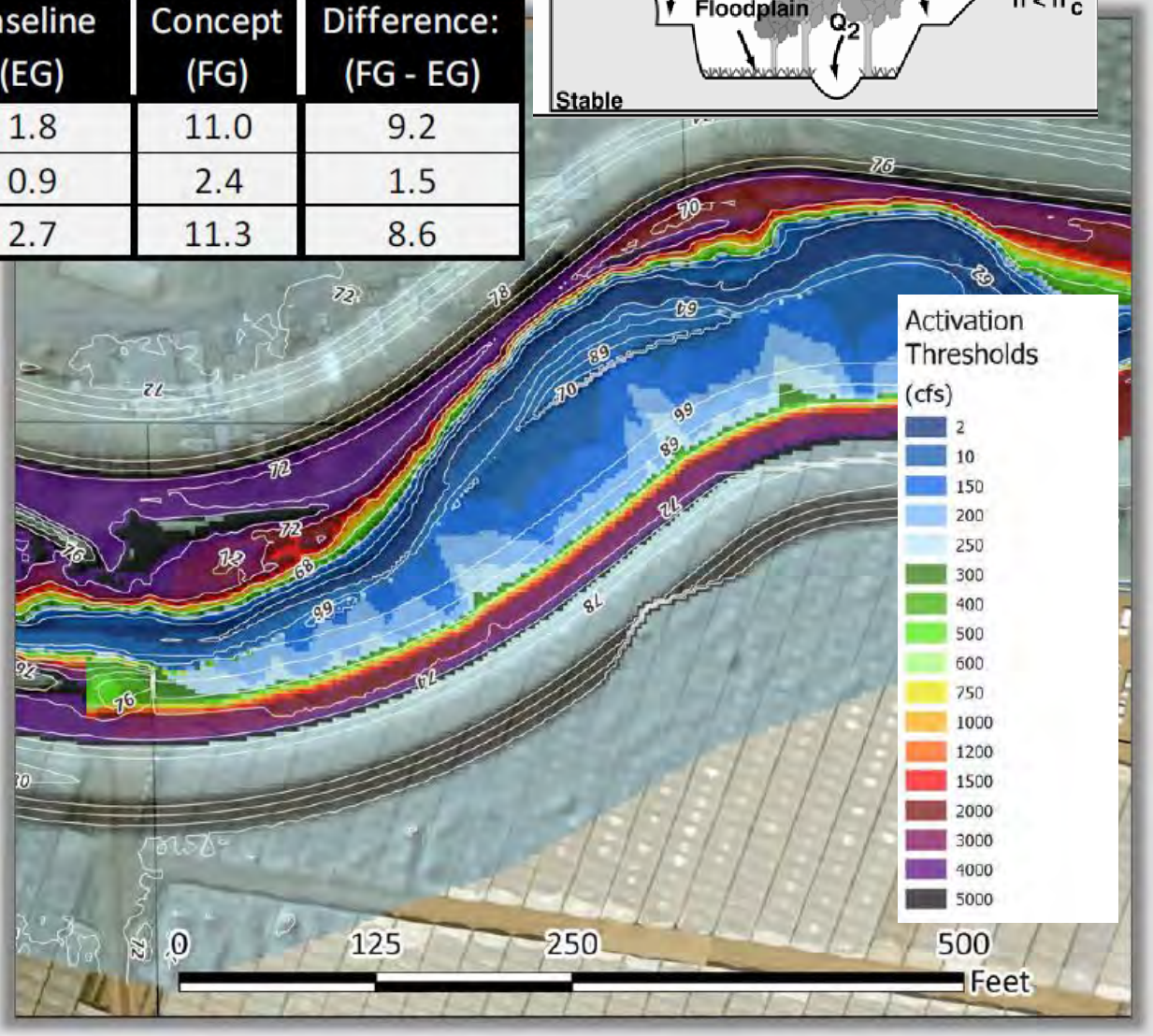
Terrace 1

(EG)

Metric	Scenario		
	Baseline (EG)	Concept (FG)	Difference: (FG - EG)
Inundation (Acre-days / WY)	1.8	11.0	9.2
Habitat (Acre-days / WY)	0.9	2.4	1.5
Recharge (Ac-ft / WY)	2.7	11.3	8.6







WIN-WIN-WINS OF INTEGRATING NBS

- Reach 6 EWN borrow designs **saved 20% of borrow costs**
- **UCOP research partnership**: empirical data quantifying groundwater recharge, nutrients and sediment transport.
- All other project reaches will use this approach
- **Floodplain benching TR and E&C Guidance forthcoming**



Cottonwood stand on Reach 6. Moved terrace location to avoid impacts.

LESSONS LEARNED

- **Across USACE:** Supporting project teams across SPD and elsewhere.

→ *It is better when there is **more than once voice** on the team thinking about EWN*

- **Partnerships** with other agencies (CA DWR, TNC, Industry) brings opportunities/innovation.

→ *It is so helpful for USACE teams to collaborate with partners and applicable research to aid **design, decision-making** and **story-telling***

- **Integrating Research:** ERDC, N-EWN, University partners.

- **Centering community**: focusing on places with less investment, where can humans benefit from NBS.

→ *EJ and EWN are **intertwined**. Towards **empowering** and centering those we serve.*

R&D RECOMMENDATIONS

- **Continue to develop methods for USACE teams to evaluate NBS in Planning and Design**
- **Develop Engineering and Construction Guidance for NBS**
- **Support active project teams with EWN research and support during the planning and design phases of projects**

THANK YOU

Contact: Julie.R.Beagle@usace.army.mil



Amy East, Ph.D.

Dr. Amy East is a senior research geologist with the U.S. Geological Survey's Pacific Coastal and Marine Science Center in Santa Cruz, California. She joined the USGS in 2003 after completing a Ph.D. in geology and geophysics at MIT. Her research focuses on sedimentary and geomorphic responses to river-management actions and extreme events (wildfires, extreme rain), with recent emphasis on climate-change hazards. She is the Editor-in-Chief of the Journal of Geophysical Research: Earth Surface and a Fellow of the Geological Society of America.

Among her ~100 authored and coauthored publications, Amy's studies of large dams and dam removals include long-term analyses of downstream effects of Glen Canyon Dam operations on the Colorado River[1,2] and before-after/control-impact studies of large dam removals on the Elwha River, Washington[3], the Carmel River, California[4], and the Klamath River, California and Oregon[5]. She was part of the Elwha River science team that received the Department of Interior Unit Award for Excellence of Service (2018). Amy was a Co-Principal Investigator of a USGS synthesis working group on dam removal (2013–2015)[6]. Her recent work also involves collaborating with the U.S. Army Corps of Engineers to evaluate large-scale erosion and sediment-pulse evolution after a highly unusual lava-dam collapse on the Rio Coca, Ecuador[7], and co-writing the UN Environment Programme's Rapid Environmental Assessment after wartime destruction of the Nova Kakhovka Dam, Ukraine, in 2023. Amy has also written extensively about climate-change impacts in the western U.S.[8–9] and served as a chapter author on the 5th National Climate Assessment.

1 Effects of river regulation on aeolian landscapes, Colorado River, southwestern USA, https://doi.org/10.1029/2011JF002329

2 Conditions and processes affecting sand resources at archeological sites in the Colorado River corridor below Glen Canyon Dam, http://dx.doi.org/10.3133/pp1825

3 Geomorphic evolution of a gravel-bed river under sediment-starved vs. sediment-rich conditions: river response to the world's largest dam removal, https://doi.org/10.1029/2018JF004703

4 Six years of fluvial response to large dam removal on the Carmel River, California, https://doi.org/10.1002/esp.5561

5 A watershed moment for western U.S. dams, https://doi.org/10.1029/2023WR035646

6 Dam removal: Listening in, https://doi.org/10.1002/2017WR020457

7 Major fluvial erosion and a 500-Mt sediment pulse triggered by lava-dam failure, Rio Coca, Ecuador, https://doi.org/10.1002/esp.5751

8 Geomorphic and sedimentary effects of modern climate change: current and anticipated future conditions in the western United States, https://doi.org/10.1029/2019RG000692

Dam Removal on the West Coast

Amy E. East
[1]U.S. Geological Survey, Santa Cruz, CA; aeast@usgs.gov

Summary

Removing dams is an increasingly common tactic for restoring rivers and shorelines while removing the liabilities and hazards of aging dams. With growing knowledge of fluvial and coastal responses to large dam removal, managers have new opportunities for regional sediment management to support restoration objectives. This presentation will summarize long-term responses of two western-U.S. rivers with different sediment-management strategies after large dam removal: the Elwha River, Washington, where two dams (32 m and 64 m high) were removed over 2011–2014, and the Carmel River, California, where one 32-m-high dam was removed in 2015. Each of these dam removals included long-term before-after/control-impact studies by Federal, State, Tribal, and academic scientists.

During the Elwha River dam removals, sediment was exported from the reservoirs by natural river erosion, causing substantial aggradation downstream (widespread deposition 1–3 m thick in the lower river), temporary conversion of the channel morphology from pool-riffle to braided and plane-bedded morphology, and major growth of the river-mouth delta. As of 2022, almost a decade after the peak of the sediment pulse, the lowermost Elwha River still had bed elevations >1 m higher than before dam removal. The coastal zone still showed net aggradation of 3 million m^3 as of 2023 despite wave and current action transporting some of the new sediment alongshore. These changes occurred in response to a 20-million-ton sediment pulse, equivalent to 5–7 decades of background sediment output from the Elwha River watershed and intended as part of a whole-watershed restoration approach.

In contrast, dam removal on the Carmel River was managed deliberately to limit reservoir-sediment export, to prevent aggradation downstream that would have increased flood risk. This was achieved with an engineering design that sequestered two-thirds of the reservoir sediment and re-routed the river over a newly constructed bedrock-based channel that limited the base-level drop relative to the original channel configuration. This strategy successfully prevented major sediment export, and geomorphic changes downstream of the dam site were relatively minor: pools filled, but aggradation was generally limited to 0.5–1 m or less and no major planform changes occurred downstream in the river or in the nearshore zone; the dam-removal sediment pulse was equivalent to less than one year of annualized long-term sediment export. Most geomorphic change on the Carmel River was attributable to effects of high flows after dam removal, not to increased sediment supply. In contrast, on the Elwha River most geomorphic change was driven by new sediment supply (most sediment export occurred in the first two years after dam removal despite a lack of floods).

On both rivers, dam removal successfully achieved the desired management outcomes. The Elwha River dam removals were intended to facilitate full-watershed restoration as they allowed anadromous fish passage past the dam sites; the new sediment on the riverbed was finer-grained (improving fish-spawning habitat) and reversed decades of coastal erosion. The Carmel River dam removal was not intended as a full-watershed restoration (another dam remains upstream) but achieved the desired outcome of removing an unsafe dam while improving fish passage and avoiding major aggradation downstream. The Elwha River example demonstrates that when large dam removals are managed using

natural river erosion in a steep watershed with high sediment supply, a large sediment pulse will result, with some sediment effects lasting more than a decade: rivers in steep terrain can efficiently export a large sediment pulse, although the signal in low-gradient river and coastal areas can persist >10 years. The Carmel River example shows that it is possible for a large dam removal to have relatively little impact downstream if the sediment release is limited intentionally, e.g., in watersheds where sediment deposition (bed aggradation) would be undesirable or hazardous.

Ongoing removal of four aging hydropower dams on the Klamath River, southern Oregon and northern California, represents a new, complex chapter in dam-removal science and practice. Because most dam removals thus far have been small (and relatively low-impact in terms of sediment disturbance), each new large dam removal offers important opportunities to learn from a more diverse geographic, hydroclimatic, and management setting. The anticipated results from the major Klamath River dam removals will therefore inform river and coastal management for decades to come.

Acknowledgement: These studies were supported by the U.S. Geological Survey, National Oceanic and Atmospheric Administration, and Bureau of Reclamation.

For more information:

East & Grant (2023). A watershed moment for western U.S. dams. Water Resources Research, https://doi.org/10.1029/2023WR035646

East et al. (2018). Geomorphic evolution of a gravel-bed river under sediment-starved versus sediment-rich conditions: river response to the world's largest dam removal. JGR Earth Surface, https://doi.org/10.1029/2018JF004703

East et al. (2023). Six years of fluvial response to a large dam removal on the Carmel River, California, USA. Earth Surf. Proc. Landforms, https://doi.org/10.1002/esp.5561

Foley et al. (2017). Dam removal: listening in. Water Resources Research, https://doi.org/10.1002/2017WR020457

Harrison et al. (2018). River response to large-dam removal in a Mediterranean hydroclimatic setting: Carmel River, California, USA. Earth Surf. Proc. Land., https://doi.org/10.1002/esp.4464

Ritchie et al. (2018). Morphodynamic evolution following sediment release from the world's largest dam removal. Scientific Reports, https://doi.org/10.1038/s41598-018-30817-8

USGS Dam Removal Information Portal (DRIP): https://data.usgs.gov/drip-dashboard/

Warrick et al. (2019). World's largest dam removal reverses coastal erosion. Scientific Reports, https://doi.org/10.1038/s41598-019-50387-7

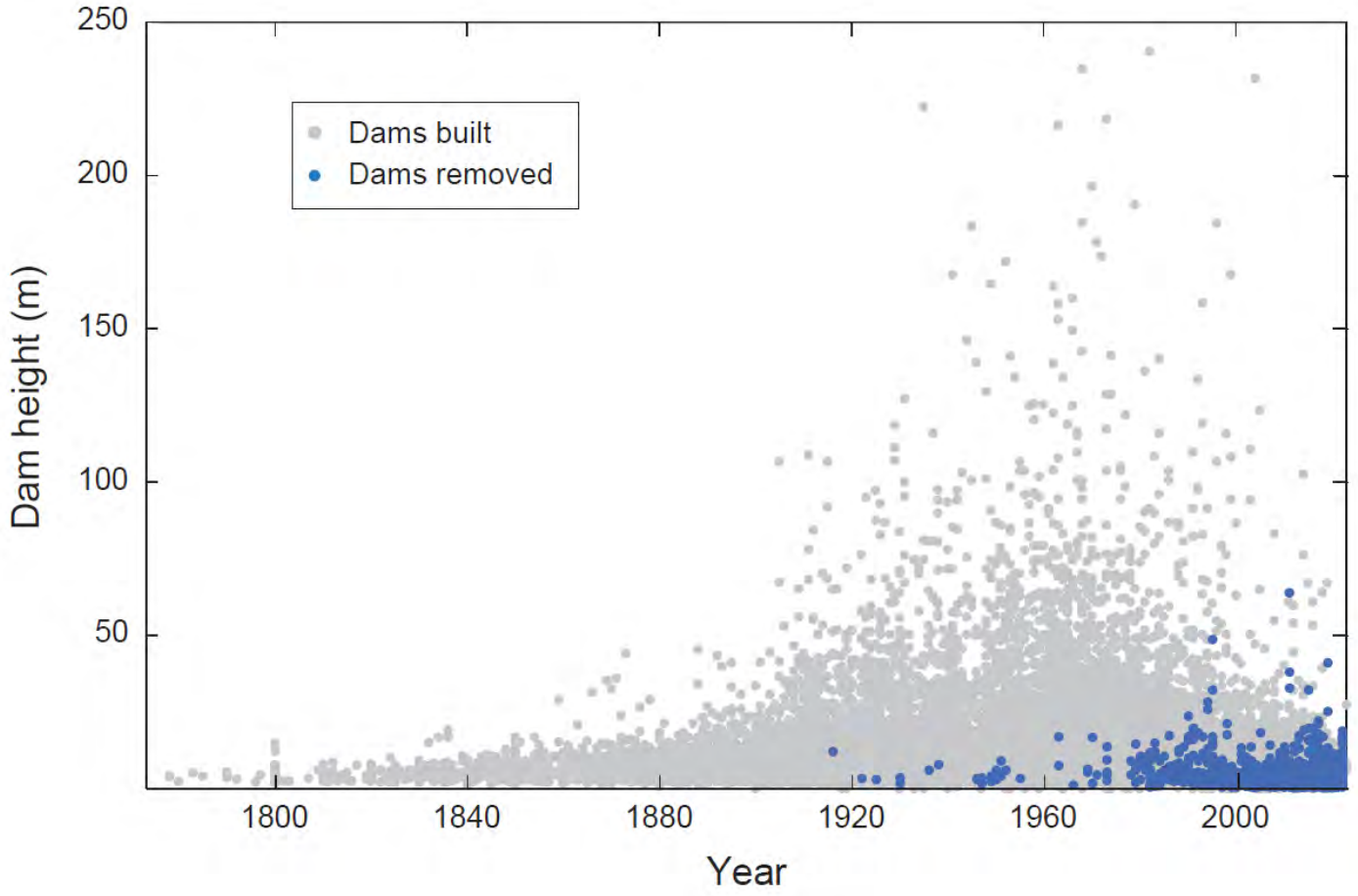
Dam Removal on the West Coast

Amy E. East

US Geological Survey, Santa Cruz, California, USA

Dam removal is now a common practice

- For obsolete or unsafe dams that are no longer economically viable, dam removal is now a common option
- River restoration / environmental benefits
- Managing opportunity and risk (including from sediment)



East & Grant, 2023; data from National Inventory of Dams and American Rivers

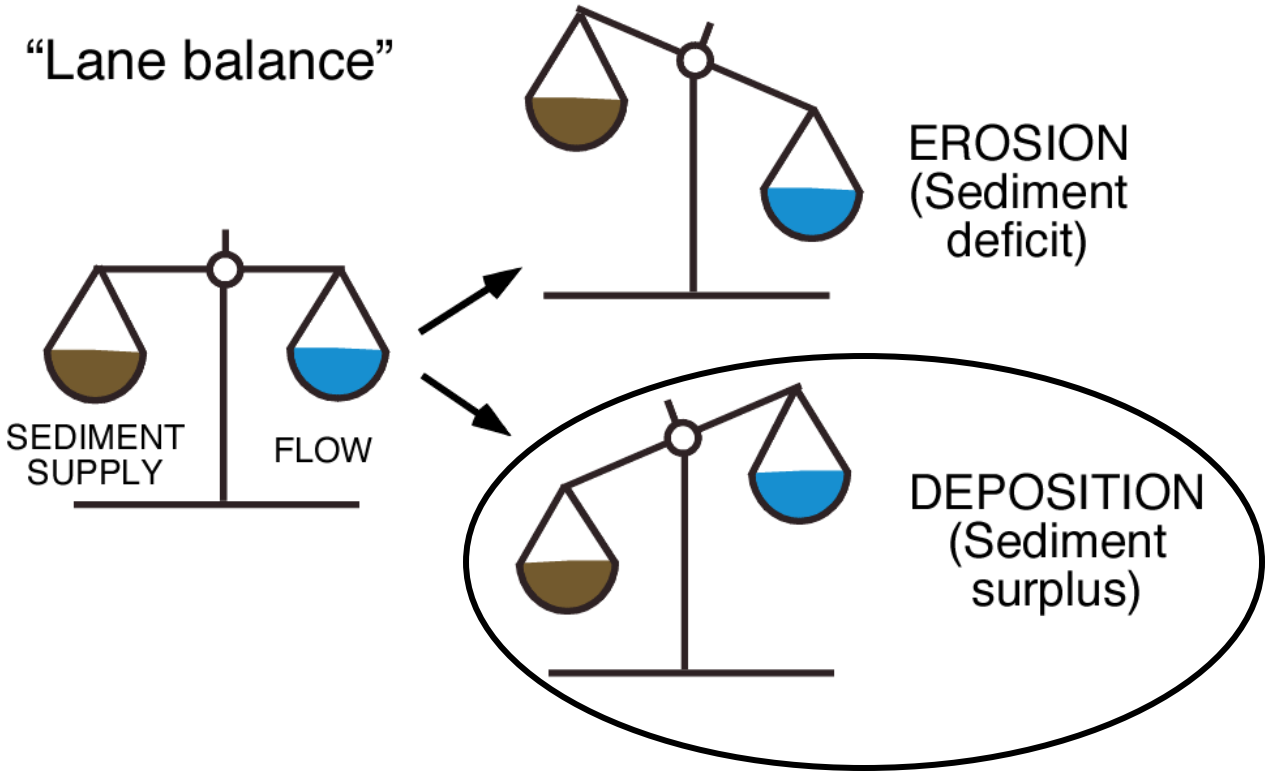
Expected changes after dam removal

Physical effects:

- Erosion of reservoir sediment
- Deposition of sediment downstream (river corridor, coastal aggradation)
- Bed sediment grain size fines
- Large wood often also released downstream

Ecosystem effects:

- Restore upstream-downstream connectivity
- Lake environment becomes river again
- Temporary negative impacts on benthic macroinvertebrates and fish



Why manage sediment during dam removal?

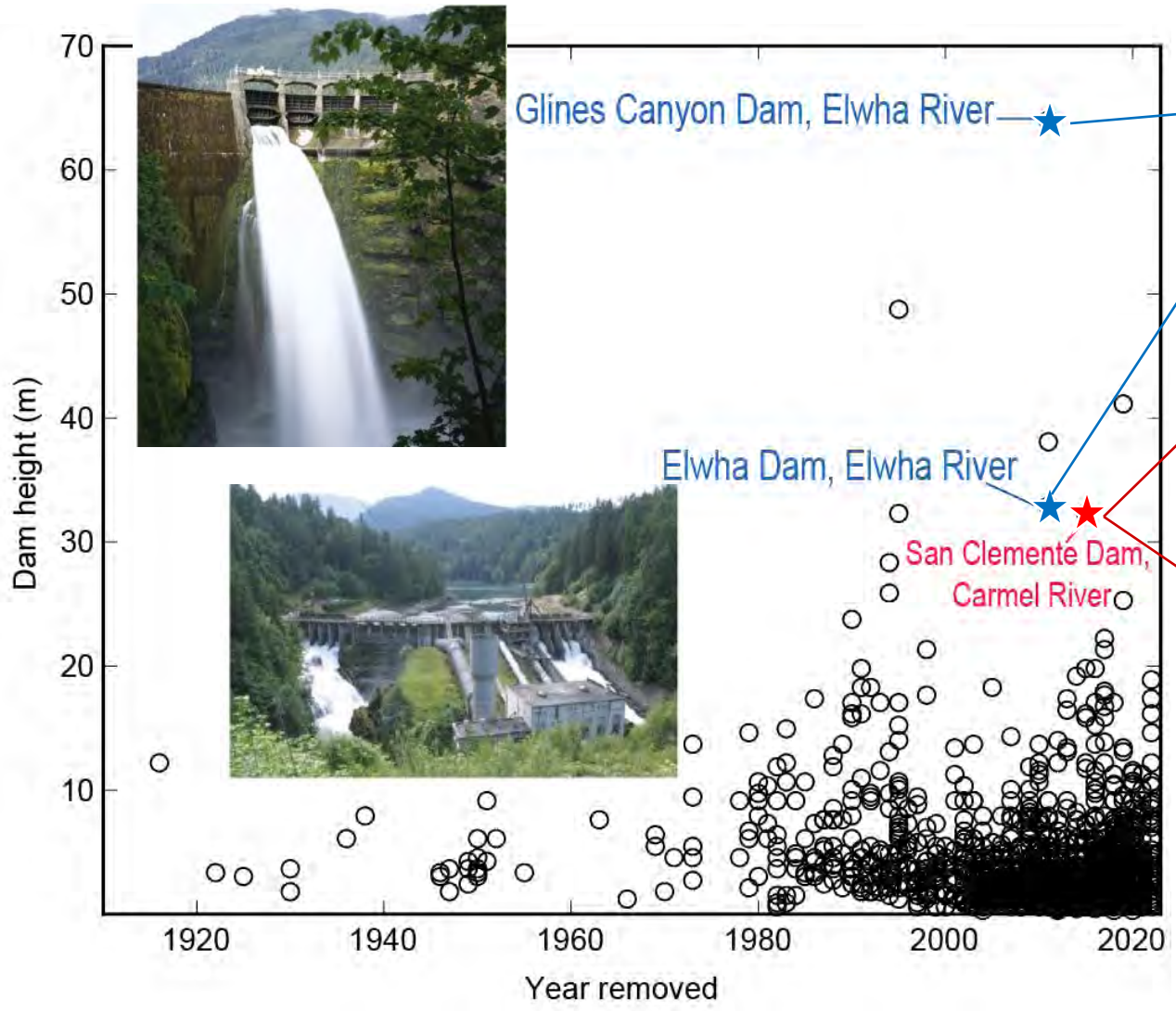
- Reduce downstream turbidity/water-quality problems
- Prevent downstream transport of contaminants (if any) in reservoir
- Reduce the risk of downstream bed aggradation that raises flood risk

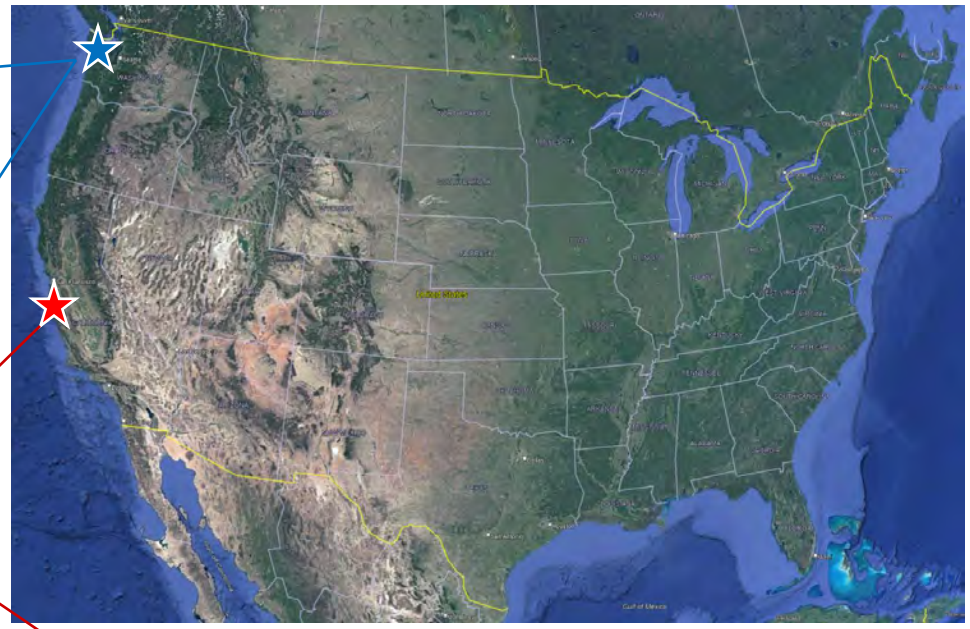
Some dams can pass sediment through and do so regularly while the dam was operated. Many dams cannot pass sediment, so those reservoirs end their life full or nearly full.



Former reservoir behind Glines Canyon Dam, Elwha River, WA

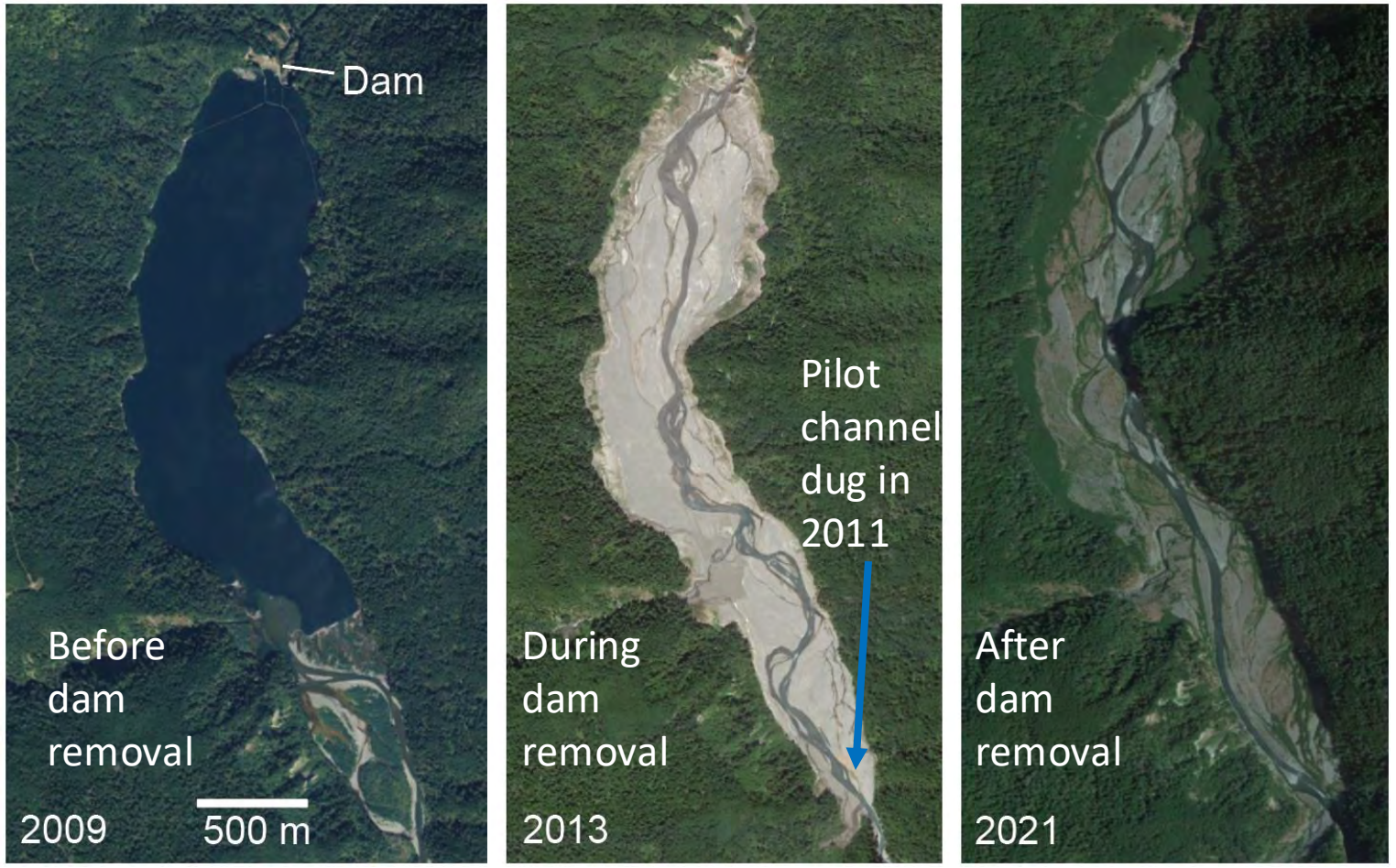
Large dam removals on the west coast, with and without direct sediment management







Elwha River: two dams removed (2011-2014), essentially no direct sediment management



- 833 km^2 coastal watershed
- Two reservoirs stored 30 million tons (21 million m^3) of sediment
- In national park, no contaminants
- Mechanical removal too expensive, infeasible
- Phased dam removals over 3 years, allowing natural river erosion of reservoir deposits

Reservoir behind Glines Canyon Dam (64 m high)

Elwha River: two dams removed (2011-2014), without direct sediment management

- Downstream, levees were raised to accommodate higher water-surface elevations due to bed aggradation
- New water-treatment plant to manage high suspended-sediment concentrations

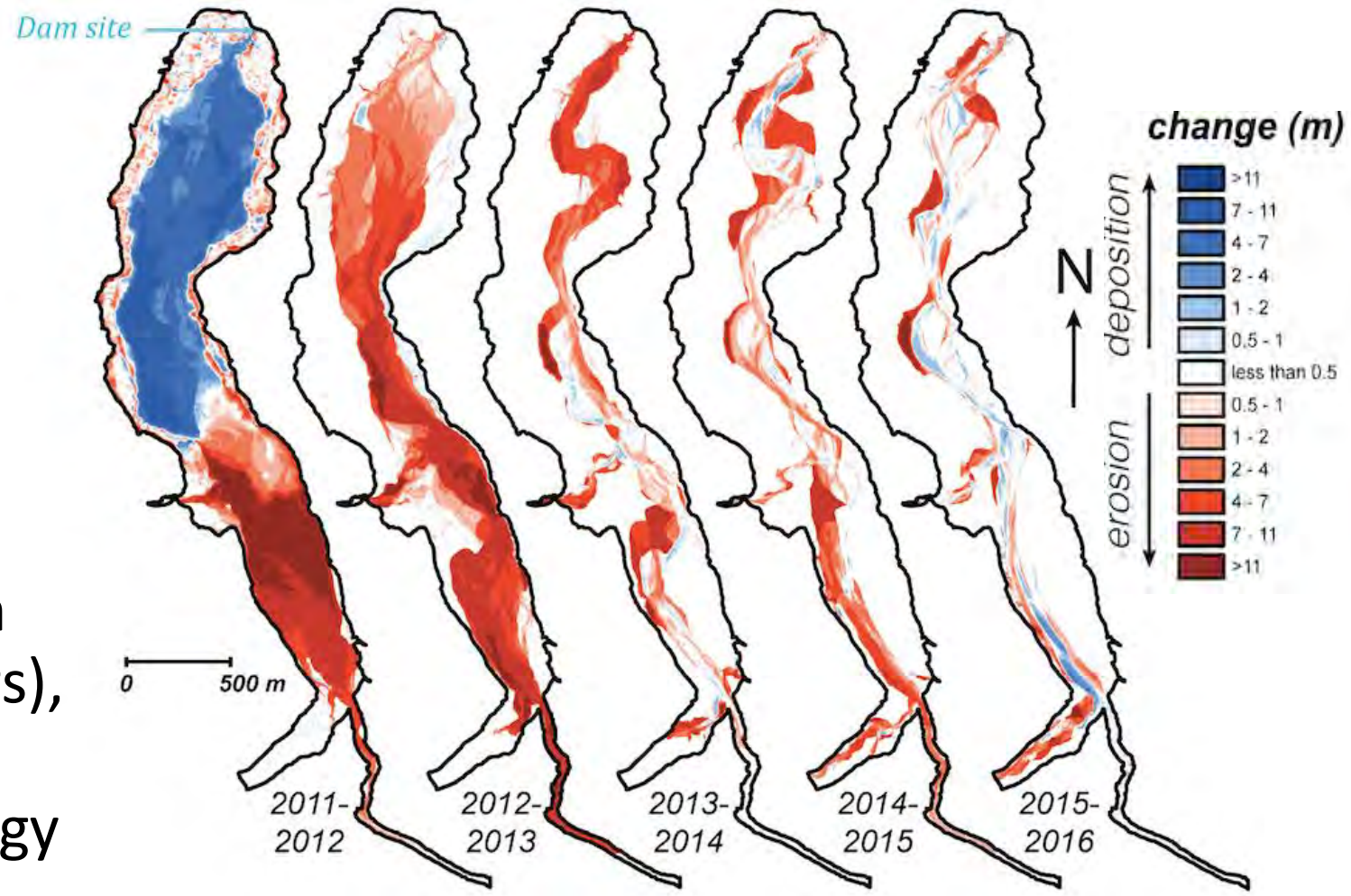






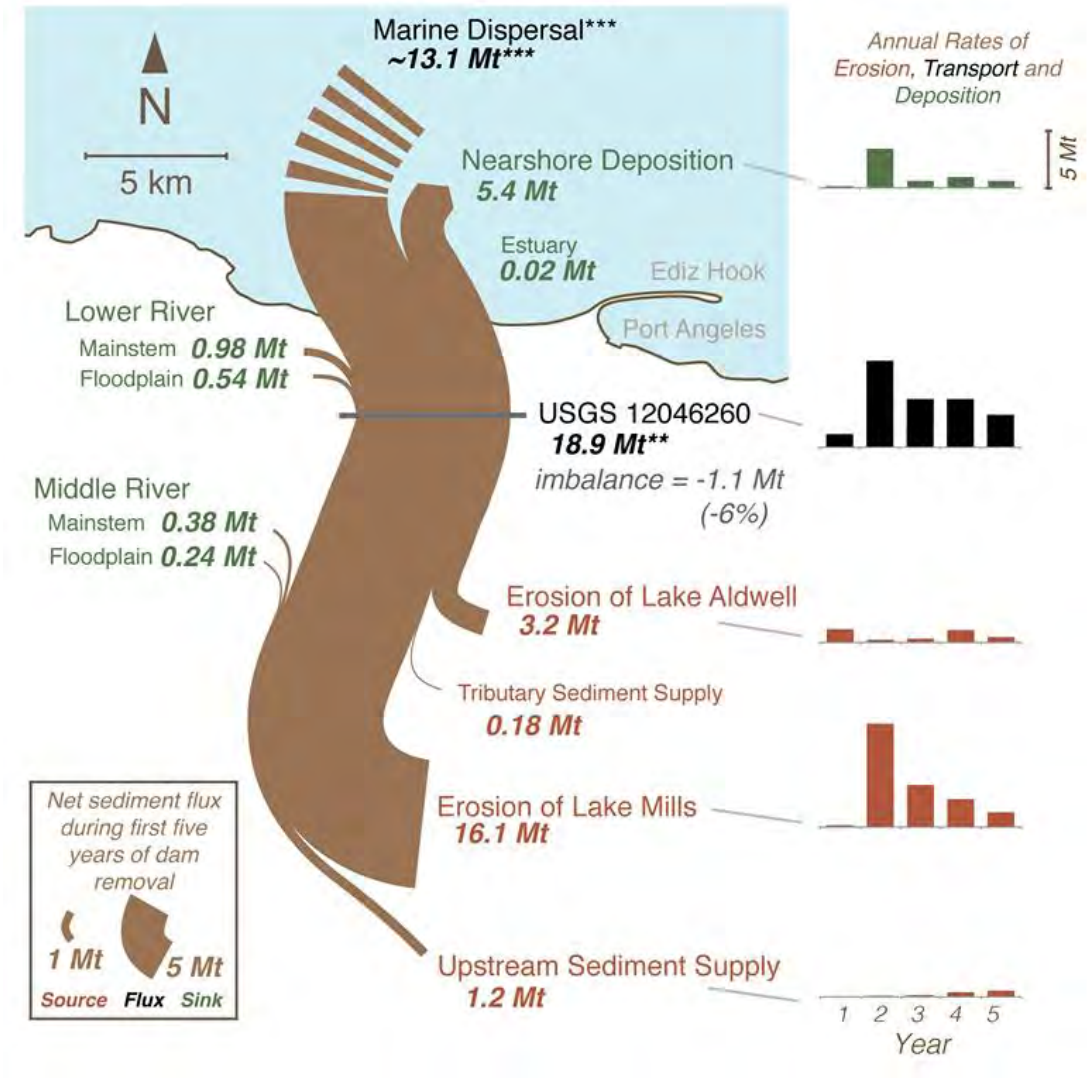
Elwha River: results

- Most reservoir sediment erosion occurred in first 1-2 years
- Suspended-sediment concentration increased from 10 to 1000s mg/L
- Downstream bed aggradation 1-3 m (has persisted >10 years), change from pool-riffle to plane-bed, braided morphology
- Bed sediment grain size finer

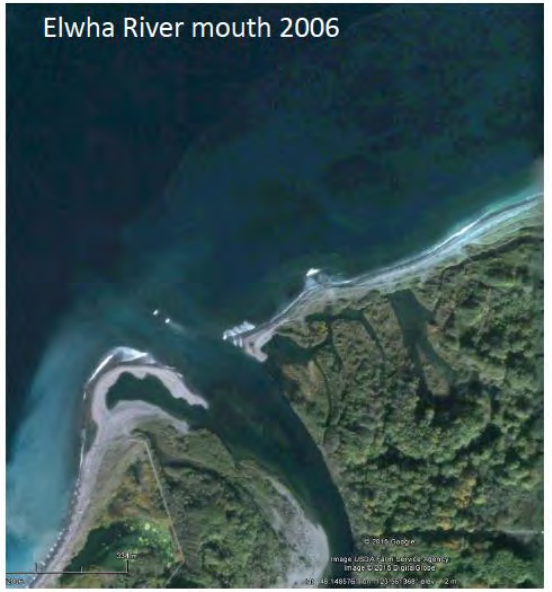


Ritchie et al., 2018, *Scientific Reports*

Elwha River: results



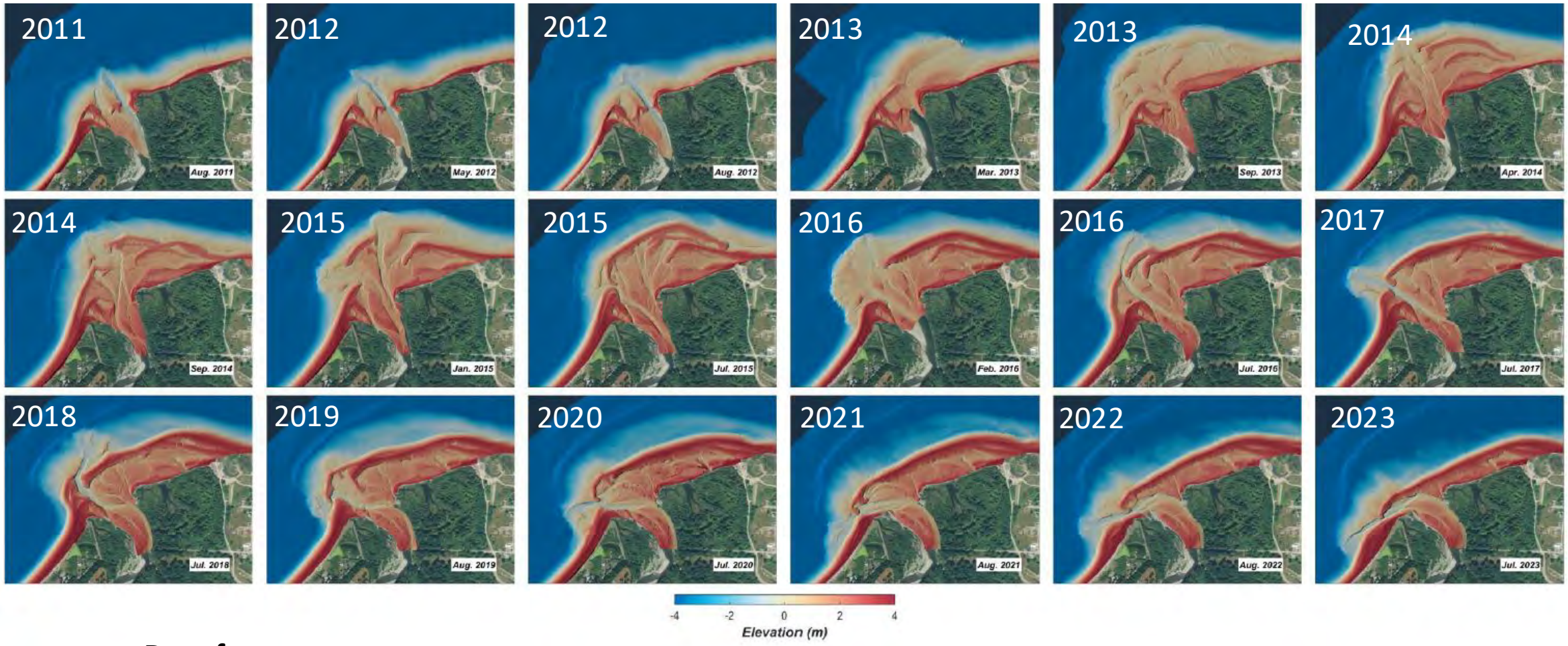
Ritchie et al., 2018, *Scientific Reports*





- After 5 years, ~20 million tons of sediment eroded from the two reservoirs, 2/3 of the stored amount = 50–70 years' worth of accumulation
- 90% made it to the river mouth
- Efficiently exported sediment even without floods (first two years)
- Major delta growth

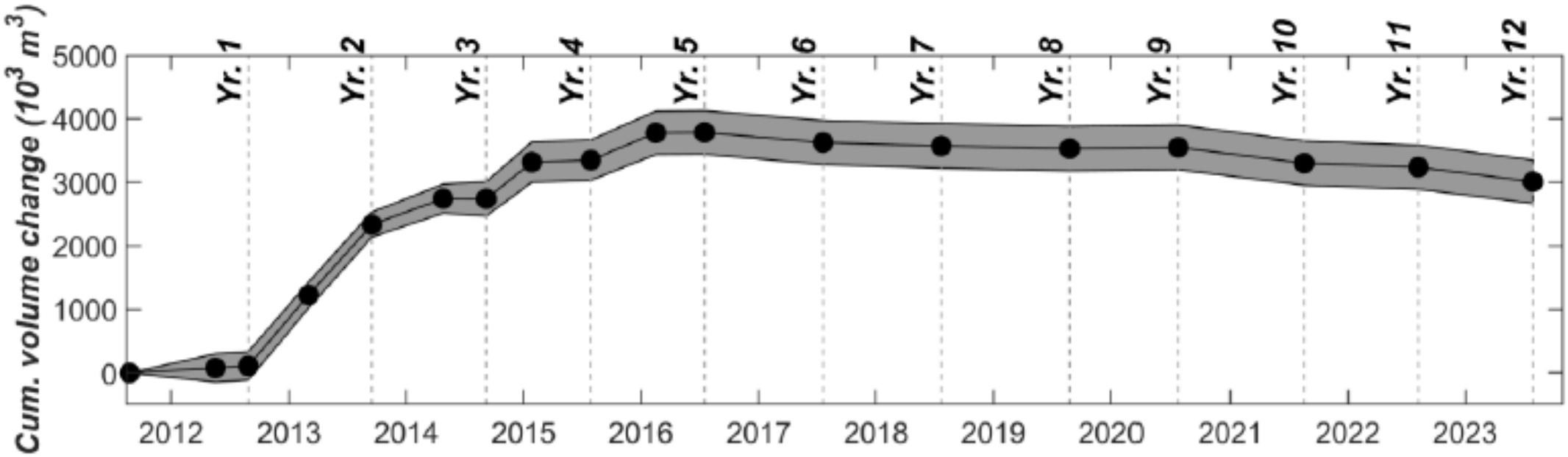
Coastal response to Elwha River dam removals



Data from
A.W. Stevens, USGS

Sediment pulse from dam removal reversed decades of coastal erosion/retreat (see Warrick et al., 2019)

Coastal response to Elwha River dam removals

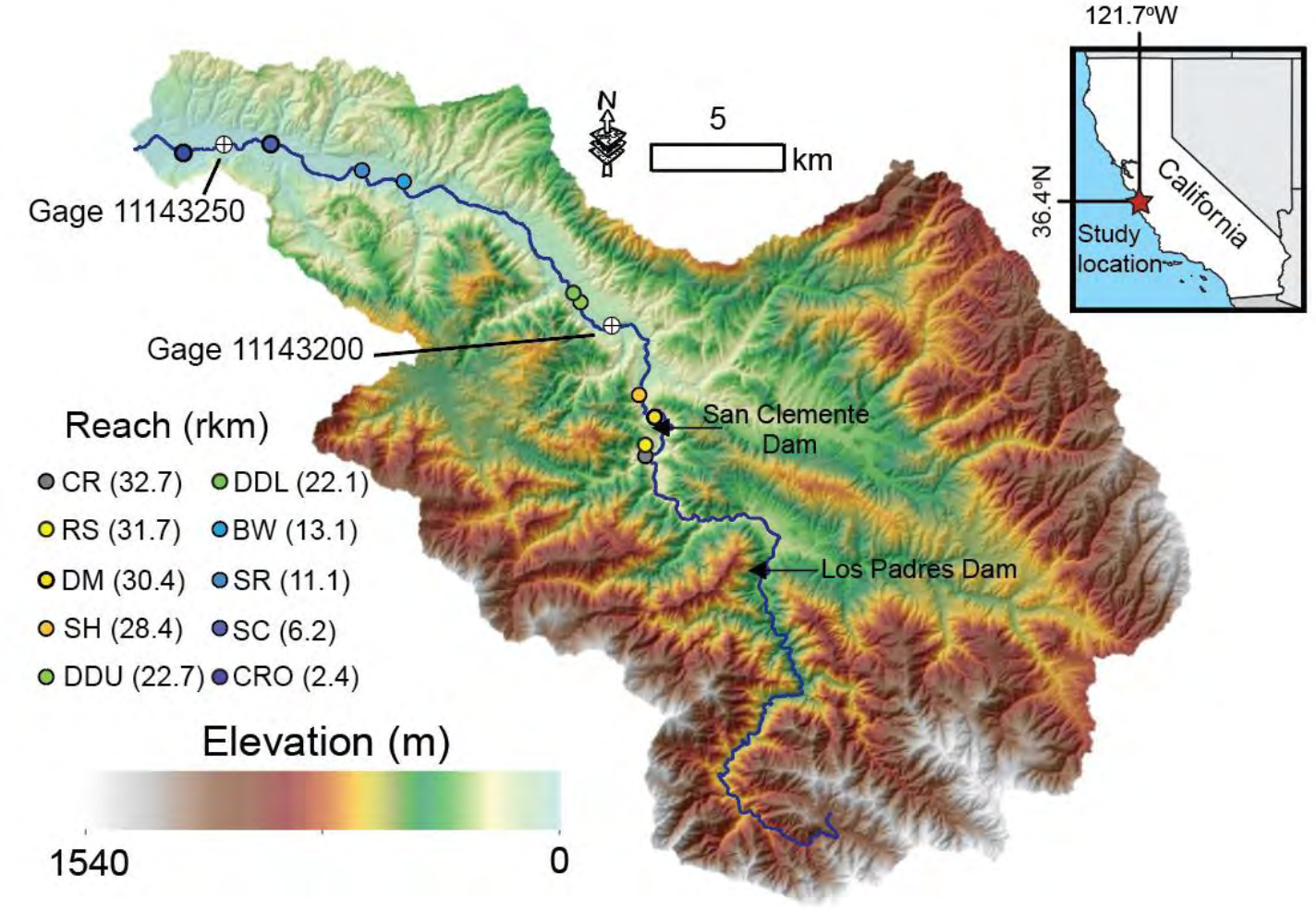


Data from
A.W. Stevens, USGS

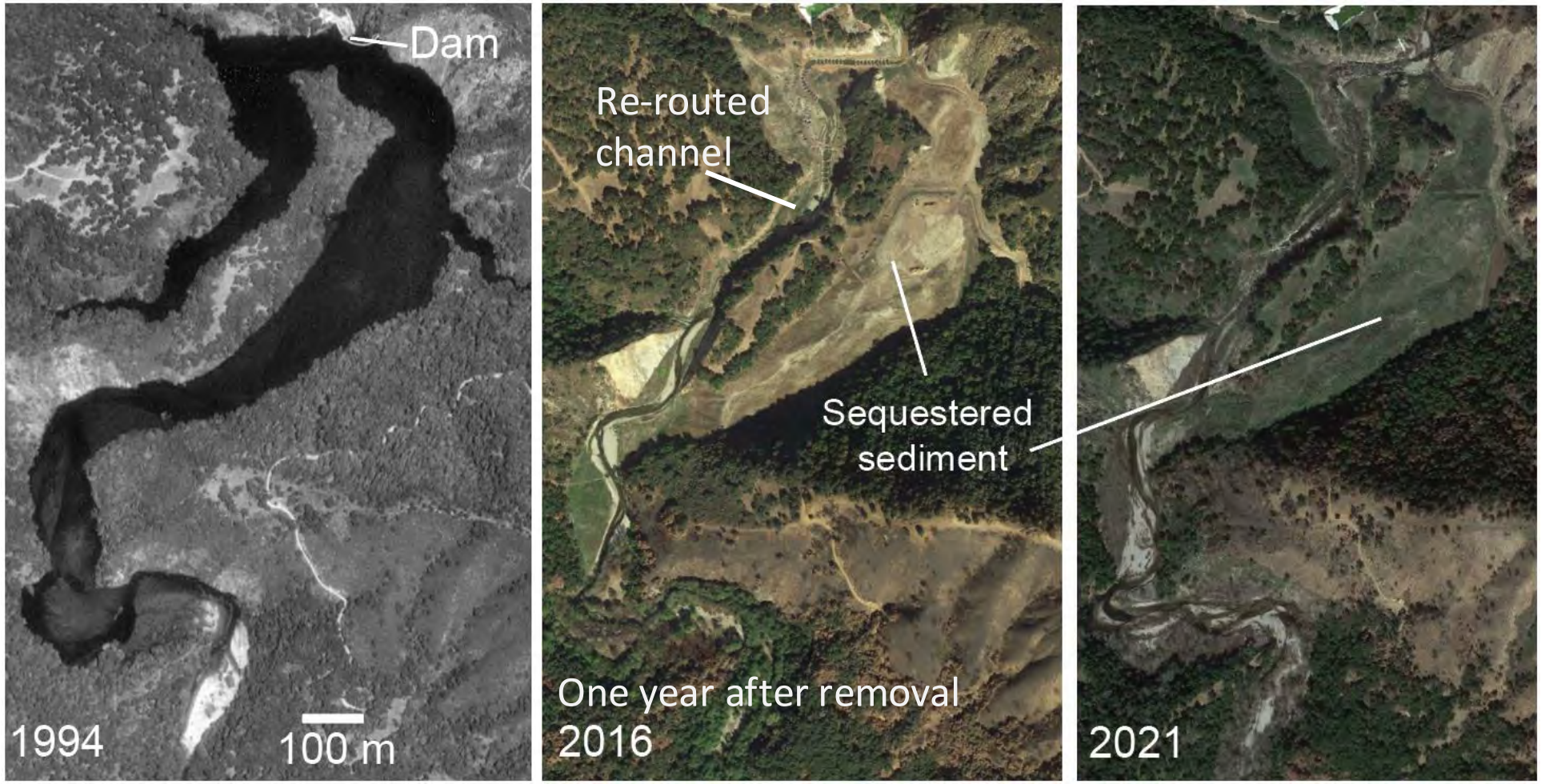
Sediment pulse from dam removal reversed decades of coastal erosion/retreat (see Warrick et al., 2019)

Carmel River, California: large dam removal with sediment management

- 650 km^2 coastal watershed
- Many buildings on 100-year floodplain. To prevent major aggradation (flood risk), most sediment had to be retained in reservoir

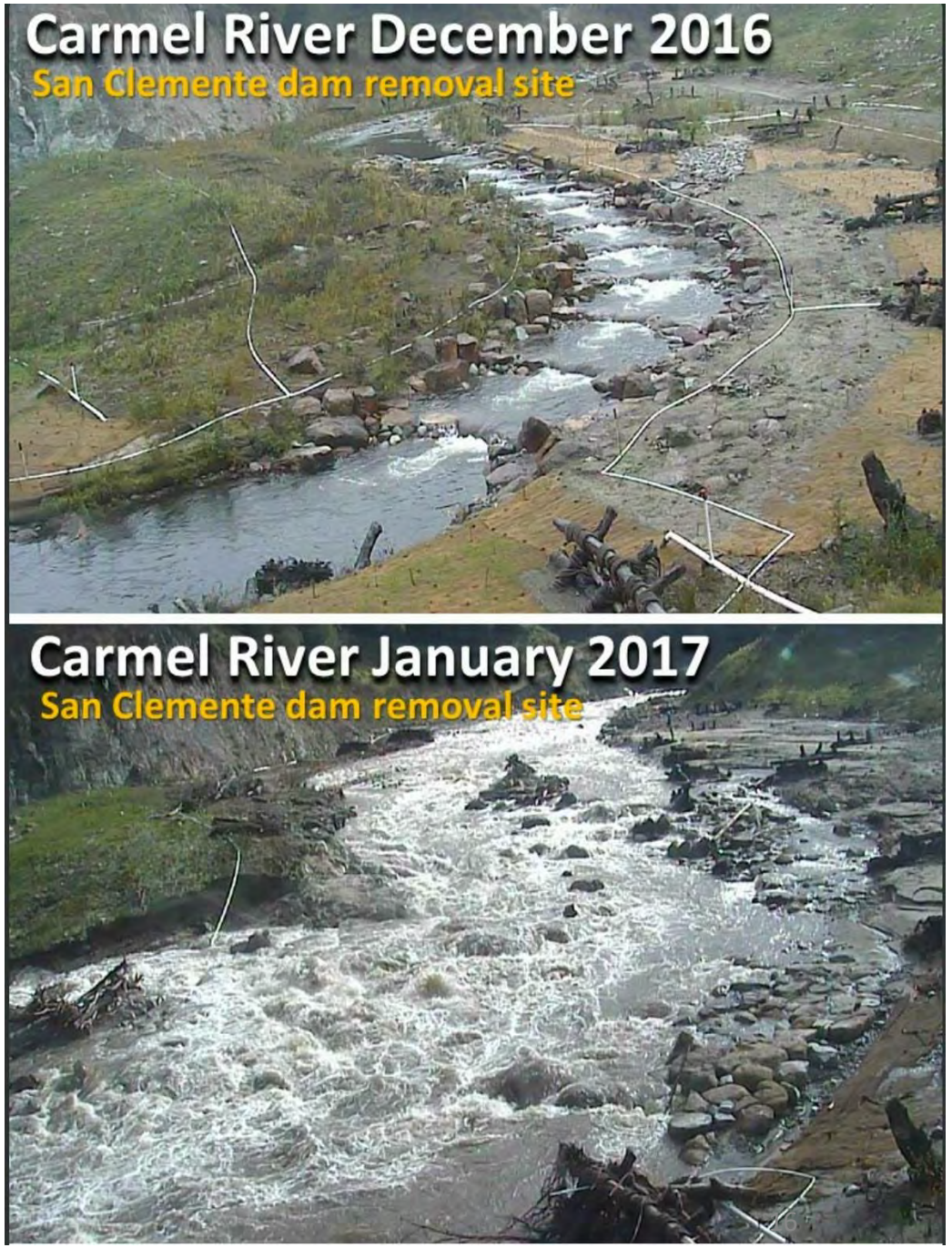


Carmel River: sediment retained in reservoir by re-routing the river channel around deposits



Carmel River: results

- Large floods (40-year peak, two 10-year peaks) a year after dam removal caused some bank erosion, incision, and reworked the newly constructed channel reach
- Some bed-sediment fining
- But over 6 years, no major bed aggradation downstream, no large new deposits observed. No change in coastal morphology
- Goal of preventing major bed aggradation was achieved – sediment pulse was very small (less than 1 year's sediment output from this watershed)



Coastal response, Carmel River:



Carmel River mouth showed essentially no change from river processes during/after dam removal (*Google Earth*)

Klamath River - California & Oregon

- 4 hydropower dams being removed, 2023-2024
- Opening 372 km of free-flowing river, aiding salmon migration through Yurok, Hoopa Valley, Karuk, Klamath Tribal lands
- Water-quality concerns >> sediment concerns

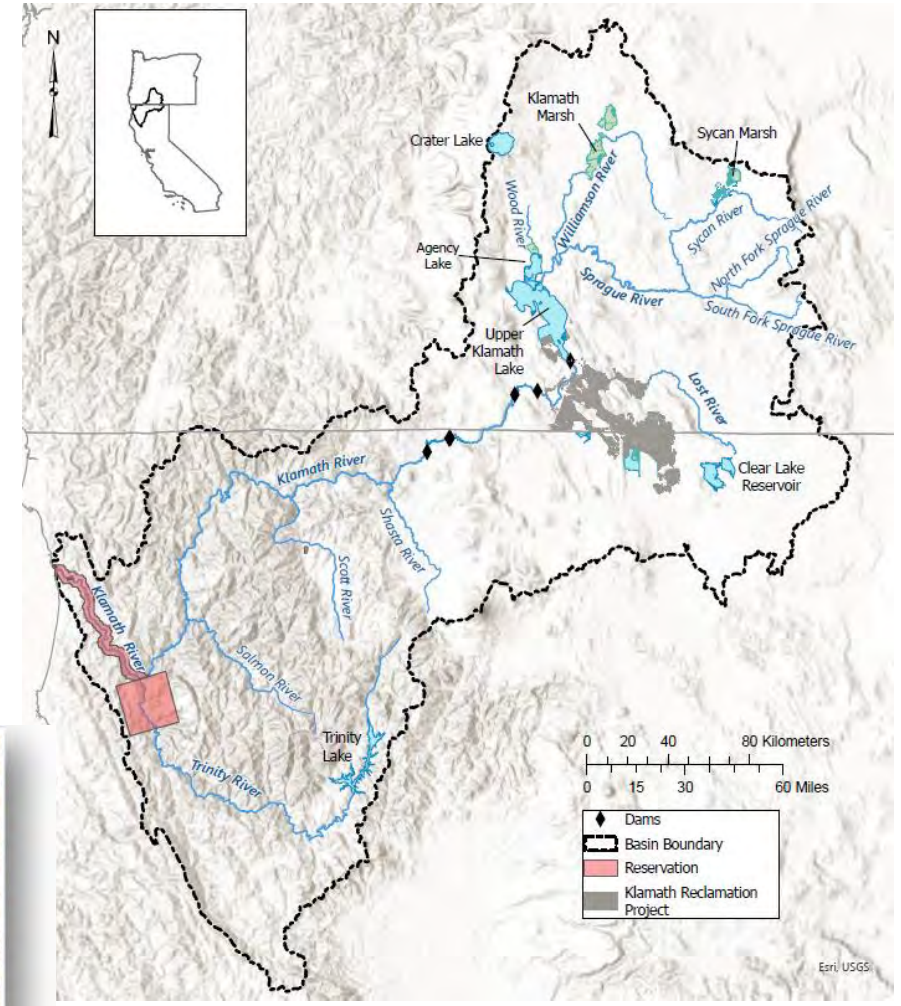




Photo Credit: Klamath RiverKeeper

Klamath River overview

- Reservoir sediment: total 12 million m^3, 85% silt and clay
- Erosion likely to be 1.4 – 2.2 Mt (10% of Elwha dam removals' eroded mass)
- Downstream river corridor narrow, incised, confined (canyon)
- Anticipating deposition in first ~13 km, and systemwide bed fining, >300 km (to river mouth)



Photo Credit : EcoFlight
Iron Gate Reservoir
https://klamathrenewal.org/photos/

Summary of R&D Gaps and Recommendations

- Removing large dams with and without sediment management can be “successful” (meeting management objectives)
- Few examples thus far of large dam removals. Most dam removals are small, low-sediment-impact; few are studied in detail. More data from large-scale examples, in more geographic/hydroclimatic settings
- Mis-match between model predictions and field results: on Elwha River, more sediment moved, and faster, compared to simulations. Value in improving predictive capability
- Klamath River – a new chapter in large dam removals

Acknowledgements

- Funding from USGS, NOAA Fisheries, California State University Monterey Bay
- Collaborations/idea sharing with Jon Warrick, Andrew Stevens, Josh Logan, Andy Ritchie, Liam Schenk, Jennifer Curtis, Patrick Haluska, Matt Marineau, Josh Cahill, DJ Bandrowski, George Pess, Jeff Duda, Melissa Foley, Ryan Bellmore, USGS Powell Center Working Group on Dam Removal

- For more information:
  - East et al., 2018: https://doi.org/10.1029/2018JF004703
  - Harrison et al., 2018: https://doi.org/10.1002/esp.4464
  - East et al., 2023: https://doi.org/10.1002/esp.5561
  - Ritchie et al., 2018: https://doi.org/10.1038/s41598-018-30817-8
  - Warrick et al., 2015: https://doi.org/10.1016/j.geomorph.2015.01.010

Jessamin (Jessie) Straub

Jessamin (Jessie) Straub is a Research Oceanographer at the U.S. Army Engineer Research and Development Center (ERDC) Coastal & Hydraulics Laboratory (CHL). She is the Program Manager for the U.S. Coastal Research Program (USCRP) and has expertise in coastal resilience research and coordination with federal agency and academic coastal research needs and program management.

As the USCRP Program Manager, Jessie coordinates with USCRP lead agencies to synthesize federal agency coastal research needs, partner with academics and non-governmental organizations, and summarize academic research outcomes. She serves as the lead to facilitate academic and industry partnering, serves as the lead expert for academic and industry proposal review and contracting, as well as connecting R&D collaboration opportunities and communicating outcomes to CHL, ERDC and USACE leadership.

As a Research Oceanographer at the CHL Field Research Facility, Jessie is the Remote Sensing Team Project Manager working across civil works and military projects. Jessie works with the Remote Sensing Team and military customers to deliver technology to the warfighter. She is a graduate of the ERDC Leadership Development Program and is starting the Emerging Leaders Program in FY25.

Prior to her current role as a Research Oceanographer and Program Manager for the USCRP, Jessie was competitively selected as a NOAA Sea Grant Knauss Fellow for ERDC where she was the Advisor to the Technical Director for Civil Works R&D. While a Knauss Fellow for ERDC, she supported the U.S. Coastal Research Program and assisted with communication efforts, workshops, and the application review process. Previously she worked at the National Science Foundation's Earth Sciences Division as a Physical Scientist working to communicate broader impacts of technical projects.

Jessie attended Coastal Carolina University, graduating with her B.S. in Marine Sciences, and received her M.S. degree in Marine Sciences from the University of North Carolina, Chapel Hill.

U.S. Coastal Research Program: Celebrating a Decade of Progress & Planning for the Next Decade

The U.S. Coastal Research Program (USCRP) is a collaboration of Federal agencies, academics, and stakeholders leading a national effort to coordinate federal activities, strengthen academic programs, and address the growing needs of coastal communities. The program represents a community of researchers and practitioners with shared passions for coastal science and engineering and applications, working together to identify priorities and leverage resources that support our research-to-user objectives. The USCRP aligns resources to support academic studies in fostering the nation's future coastal workforce. By facilitating existing partnerships and multi-agency collaborations, and leveraging limited resources, the USCRP increases the value and impact of coastal research and applications.

Program Objectives

The USCRP is leading a community of practice representing Federal agencies, academics, and stakeholders working together to:

- ***Identify societally relevant research priorities and fundamental knowledge gaps***
  - The USCRP brings together Federal researchers, academics, and coastal stakeholders to discuss societal needs within specific topical areas and identify related science gaps. Thematic workshops produce authoritative products that define user needs, prioritize research directions, and inform annual academic funding opportunities.
- ***Enhance funding opportunities for academics and students***
  - The USCRP enhances research opportunities for academics and students by securing and directing funding to university programs. Funding from federal sources is targeted at research that addresses user challenges and priority science questions pertaining to the three priority research themes identified in the 2014 Nearshore Report. By leveraging and expanding federal funding, opportunities are created for coastal science and engineering university programs to advance their research directions, provide graduate student opportunities, and connect their work to national coastal priorities.
- ***Foster collaborative research opportunities***
  - The USCRP has built a community of practice of over 1,000 coastal experts from Federal agencies, universities, industry, and NGOs through continuous engagement via monthly meetings, workshops, webinars, surveys, social media, blog posts, and newsletters, etc. Each of the USCRP convening activities and community experiments has facilitated communication and development of new networks to encourage shared learning and collaboration.
- ***Translate fundamental science to outcomes that benefit users***
  - Stakeholders are engaged through workshops and surveys to identify user needs and management challenges which are then used to inform research priorities. Funded research teams are asked to collaborate with stakeholders during the research and development process. This model helps ensure that societally relevant coastal research

is effectively shared with, communicated to, and used by coastal practitioners and communities.

Background & Impacts

The USCRP was formed from the 2014 Future of Nearshore Processes Workshop Nearshore Report because the community of researchers from Federal agencies, academia, industry, and NGOs recognized the growing need for a coordinated, National science plan to address societal needs along the coast. The group developed research priorities and recommendations for achieving the shared vision which are outlined in the National Plan. The three main research priority focus areas are long-term processes and coastal responses, extreme events, and human and ecosystem health.

- **2015:** The National Dune Management Workshop brought together managers and researchers to communicate the challenges of dune management, which resulted in five academic research projects on dune processes and management in 2016.
- **2016:** USCRP hosted the first National Nearshore Collaboration Visioning Session, which resulted in multi-agency collaborative projects that were conceived based on topics and concepts identified in the Nearshore Report and the National Plan with the goal of improving the impact and demonstrating the value of leveraging agency investments, including funding of academic collaborators.
- **2018:** USCRP hosted the Storm Processes and Impacts Workshop to convene coastal stakeholders to foster academic-practitioner partnerships to address research needs and synthesize our present capabilities for modeling storm processes, forecasting impacts, and determining and prioritizing needed advancements. The 2018 workshop included an academic challenge component, which resulted seven academic research projects.
- **2019:** A Congressional Add of $5M specifically to support academic coastal research allowed the USCRP to challenge academics to submit proposals in 12 topic areas, including reducing model uncertainty, identifying and communicating coastal impacts, crossroads of human and ecosystem health, and nearshore sediment transport and sediment budgets over decadal scales. Approximately 250 submissions were received, reviewed, and ranked resulting in 24 academic research projects.
- **2019-2021:** The During Nearshore Event Experiment (DUNEX), was an academic, federal agency, and non-government collaborative community experiment to study nearshore coastal processes during storms. By leveraging research efforts from 30 distinct Federal and academic research groups, DUNEX research results will improve our basic understanding, predictive capabilities, and observational technologies for extreme coastal storm processes and impacts, train students and inform community members, and provide a long-term dataset.
- **2020:** USCRP hosted two virtual workshops for federal agencies to communicate their high priority coastal research and development activities and to identify knowledge gaps, which resulted in 15 academic projects spanning topics of long-term processes and coastal response and estuarine ecosystems.
- **2021:** USCRP hosted a Human and Ecosystem Health in Coastal Systems Workshop series and produced a report to identify key management challenges and high priority federal agency needs that can be addressed by coastal science research at the intersection of coastal physical processes and human and ecosystem health, which resulted in 11 academic projects.

- **2022:** USCRP partnered with the NOAA National Sea Grant Office to translate research into application through 10 collaborative projects aimed at improving resilience with coastal communities.
- **2023:** USCRP surveyed federal agency partners on needs in sediment transport and compiled a Sediment Transport Tiger team to identify key challenges and fundamental needs. The SEDiment transport COllaborative LABoratory Experiment (SEDCOLAB) was formed as a collaborative academic research campaign to address the objectives of understanding fundamental processes of sediment transport, improving numerical modeling of sediment transport, and Improving instrumentation and advances in experimental techniques.
- **2024:** USCRP hosts the 2024 USCRP Decadal Visioning Workshop with the objective of bringing together Federal Agencies, Stakeholders, and Academia to identify and prioritize key management challenges and high priority science gaps to guide the next decade of coastal research.

Year	Research Theme	Needs Identified Via	Number of Funded Projects	Total Funding
2016	Dunes on Developed Coasts	**Thematic Workshop**	5	**$220K**
2018	Storm Processes and Impacts	**Thematic Workshop**	7	**$775K**
2019	Research in Support of Federal Stakeholder Priorities (Including DUNEX)	**Interagency Collaboration**	24	**$5.4M**
2020	Federal Science Priorities in Long-term Processes and Estuarine Ecosystems	**Interagency Collaboration**	15	**$5.0M**
2021	Human and Ecosystem Health in the Coastal Zone	**Thematic Workshop**	11	**$3.3M**
2022	Translating Coastal Research into Application	**Interagency Collaboration**	11	**$4.4M**
2023	SEDiment transport COllaborative LABoratory Experiment (SEDCOLAB)	**Interagency Collaboration, Expert Steering Committee**	5	**$5.0M**


Photo credit: USGS

USCRP
US COASTAL RESEARCH PROGRAM

U.S. Coastal Research Program: Celebrating a Decade of Progress & Planning for the Next Decade

Jessie Straub
USCRP Managing Director

U.S. Army Engineer Research & Development Center
Coastal & Hydraulics Laboratory

Board on Coastal Engineering Research
13 August 2024

UNCLASSIFIED

State of Nearshore Research: A Decade of Progress

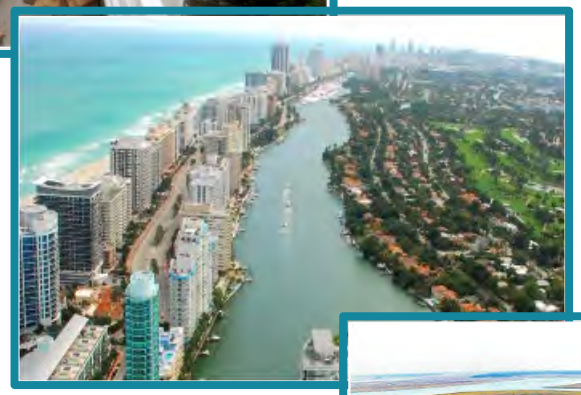
USCRP
US COASTAL RESEARCH PROGRAM

BCER initiative to develop and coordinate a National Science Plan addressing coastal research priorities of greatest relevance to coastal communities and rebuild a skilled U.S. coastal work force.



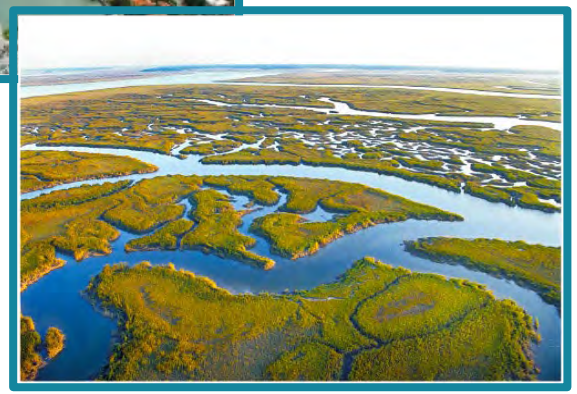
Extreme Events

Storm-induced flooding, coastal erosion, community impacts, natural recovery



Long-term Processes and Coastal Response

Sea level change, future storms, sediment supply, land use changes, human interventions



Biological, Chemical, and Physical Processes

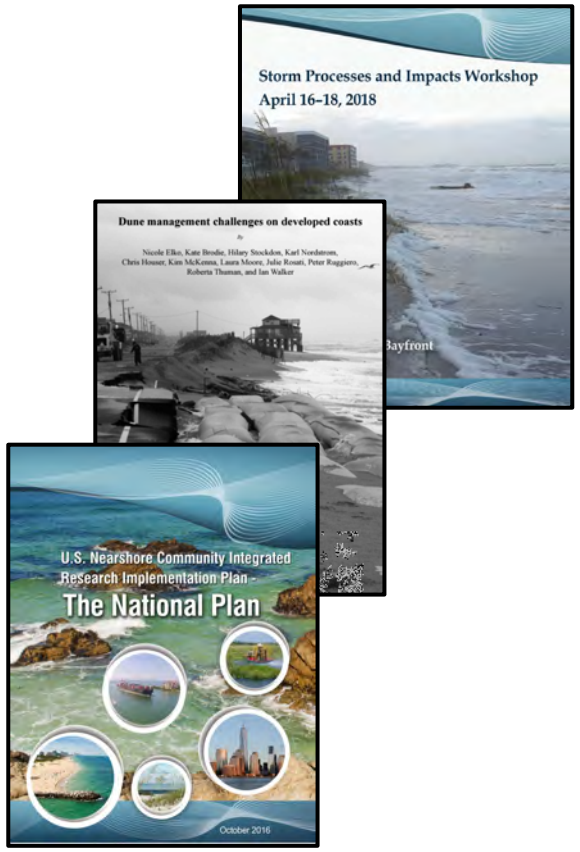
Impacting human and ecosystem health

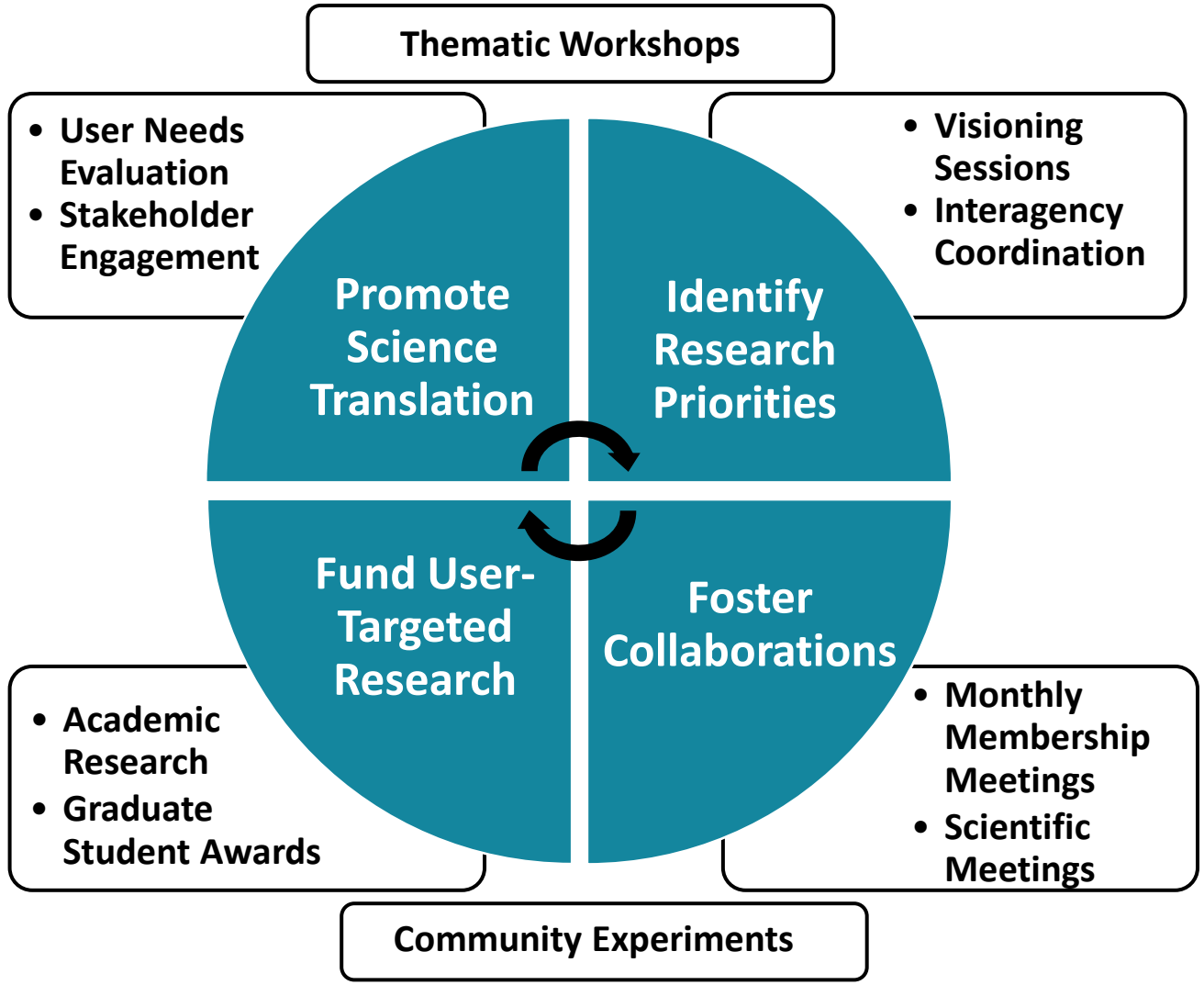
2014 Future of Nearshore Processes Research



Objectives of the USCRP Community of Practice

A National coastal effort to coordinate Federal activities, strengthen academic programs, & address coastal community needs.

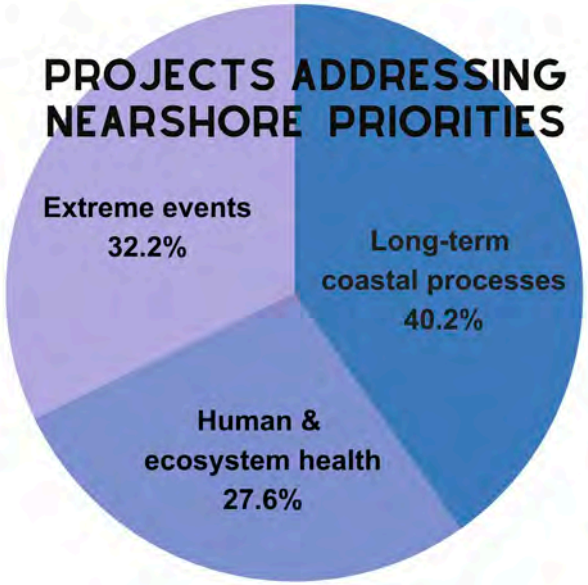


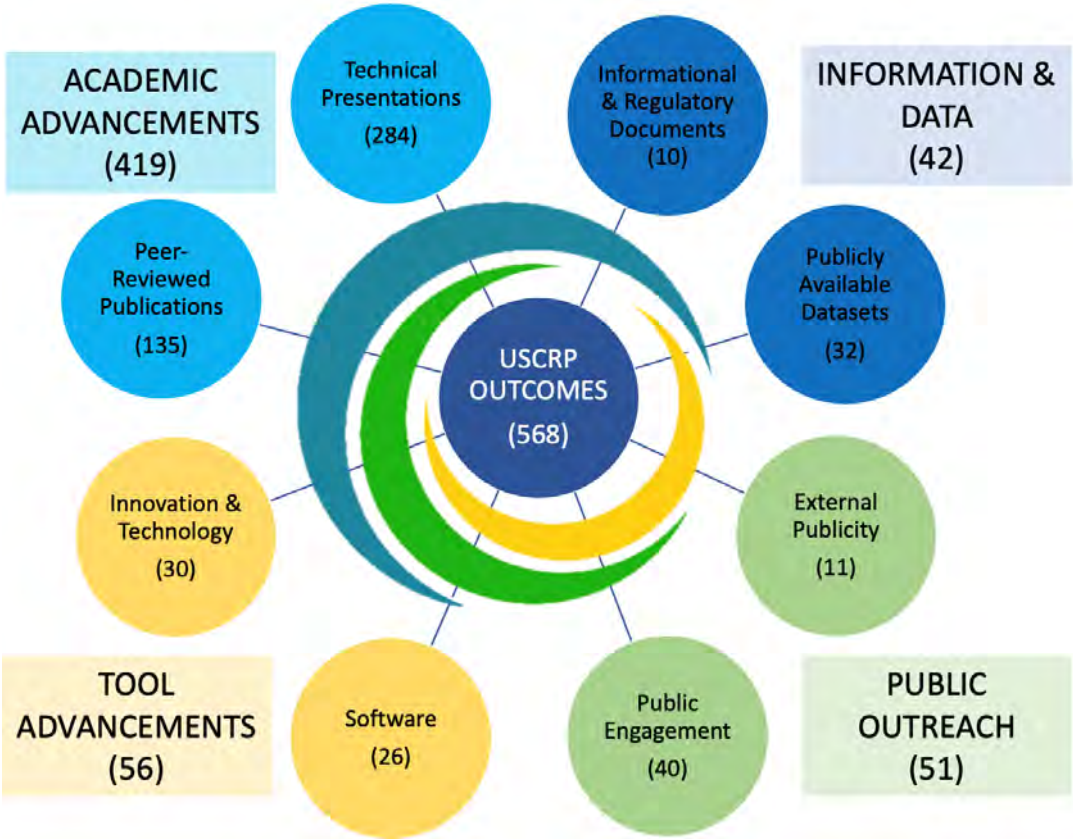


USCRP Overview (2016-2023)

"Coastal research needs in terms of data, knowledge and tools span multiple agencies, and exceed the capacity of individual agencies."

- 77 proposals funded across 28 states
- $23.5M awarded ($3-5M/year)





OUR PARTNERS

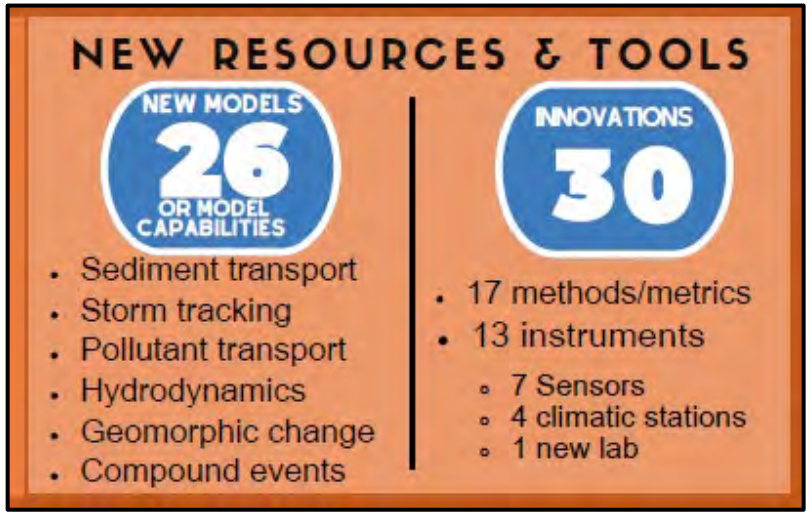
ONR · CSO · FEMA · U.S. Naval Research Laboratory · asbpa · US Army Corps of Engineers · USGS science for a changing world · BOEM · U.S.NRC · NASA · NOAA

USCRP USACE Impacts

Advancing Coastal Modeling

CSTORM-MS Improvements

- 70-90% runtime reduction
- Improved simulation cost and accuracy



Fostering Collaborations

DUNEX
During Nearshore Event Experiment

DURING NEARSHORE EVENT EXPERIMENT (DUNEX)
Organized, executed, & partially funded large-scale field collaboration for predicting extreme coastal event impacts & processes

OVER 300 INSTRUMENTS DEPLOYED

$2.5 MILLION invested in ERDC infrastructure

SEDiment transport COllaborative LABoratory Experiment (SEDCOLAB)

- **Understand fundamental processes**
- **Improve numerical modeling**
- **Improve instrumentation**

Multi-team sediment transport study at ERDC-CHL

Targeted Research in R&D Priorities

Compound Flooding

- Identifying dominant flood pathways/drivers
- Coastal and riverine interactions
- Impacts of groundwater discharge

Beneficial Use of Dredge Material

- Decision framework for evaluating thin-layer placement sites
- Evaluating ecosystem services

SEDiment transport COllaborative LABoratory Experiment (SEDCOLAB)

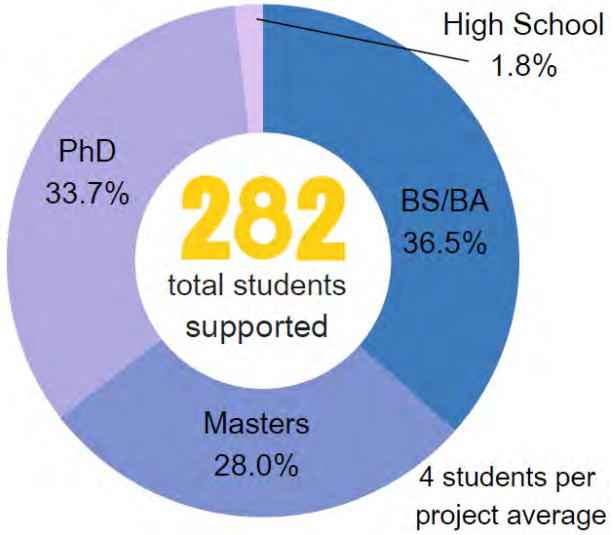
- Multi academic team sediment transport study hosted at EDRC-CHL
- Research Campaign Objectives
  - ***Understanding fundamental processes of sediment transport***
  - ***Improving numerical modeling of sediment transport***
  - ***Improving instrumentation and advances in experimental techniques***



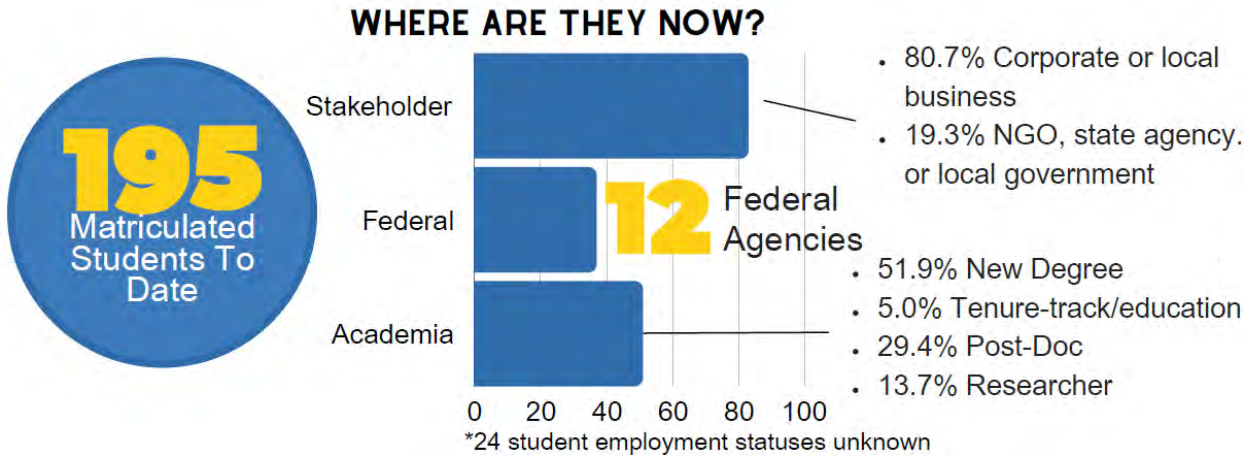




USCRP Workforce Development & Training Impacts







Developing the USACE Coastal Workforce

- 1 in 3 students work with a USACE employee as part of their USCRP R&D.
- 20% of graduated students have gone on to take Federal roles.
- 7 of 38 students entering government roles after graduating have joined USACE.

USCRP 2024 Decadal Visioning Workshop

Workshop Objective: *Bring together federal agencies, stakeholders, and academia with the goal of* ***identifying and prioritizing*** *key management* ***challenges*** *and* ***high priority science gaps*** *that will* ***guide*** *the next decade of* ***coastal research***.



Pre-Workshop Information Gathering

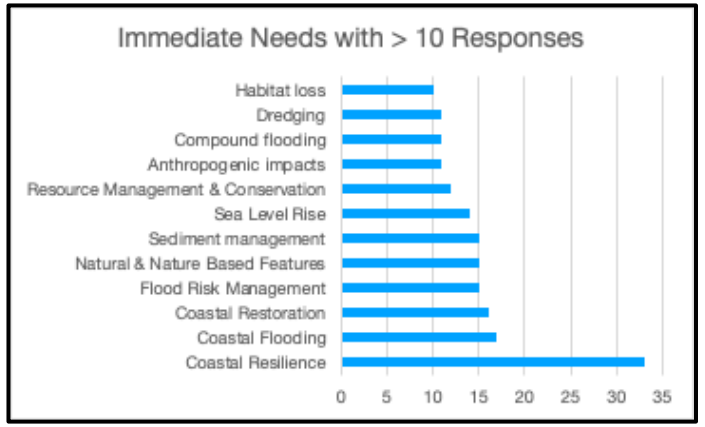
Federal Agency Partner Survey & Scoping Session

- Top immediate coastal research needs and technical challenges relate to **sediment transport** and **compound flooding.**
- Top long-term priority coastal topics relate to **flood risk reduction.**

Immediate Needs & Technical Challenges	NOAA	USGS	USACE	DOT	NRL	NASA	BOEM	FEMA	NPS
Compound flooding tools			x	x	x			x	X
Sediment transport processes			x		x		x		X
Longterm trend data	x			x				x	x
Climate change impact		x	x				x		x

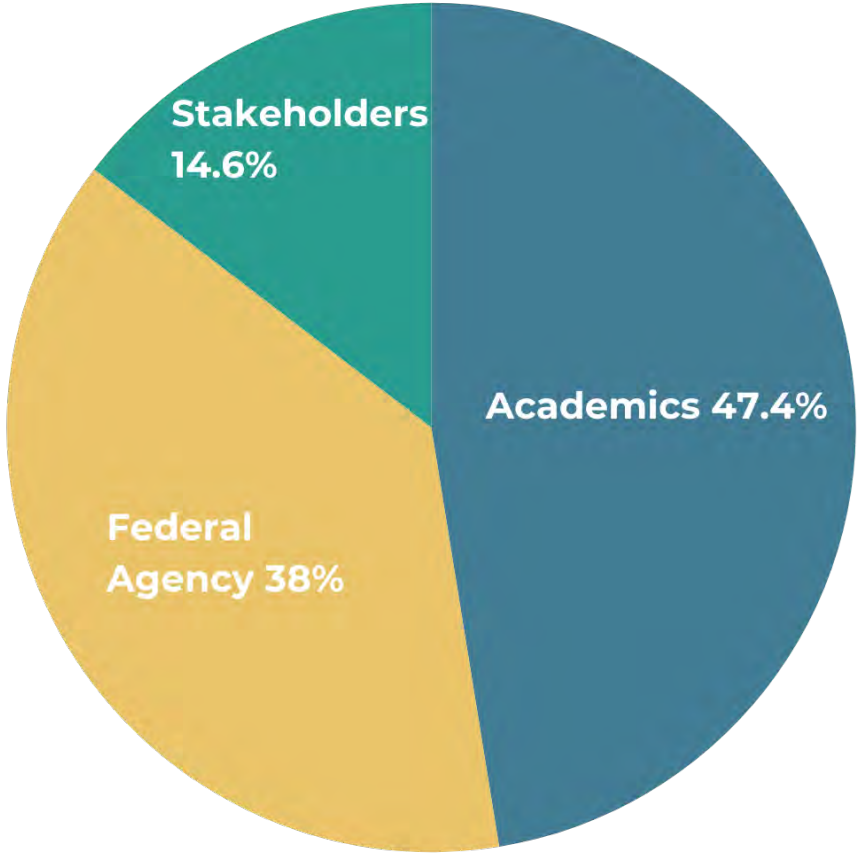
Stakeholder Survey & Scoping Session

- **Coastal resilience** was the most significant immediate challenge faced by stakeholders.
- Coastal stakeholders most common shortcomings include **research, outreach, and data.**



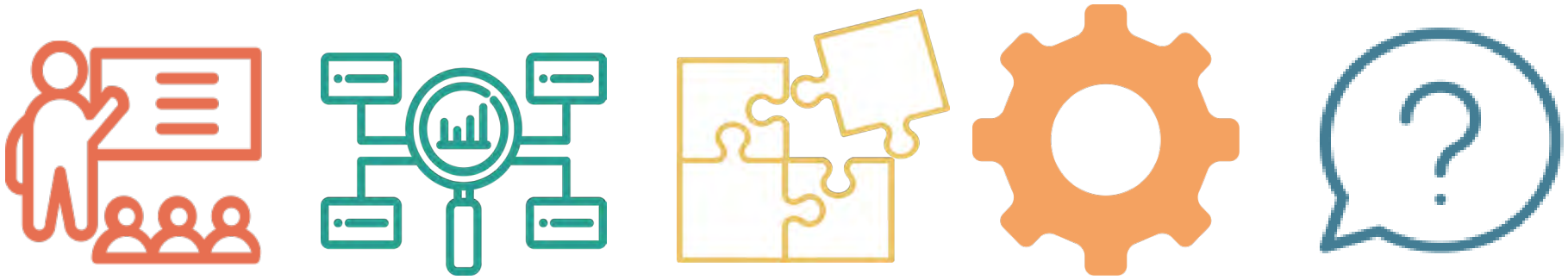
2024 Decadal Visioning Workshop Participants





USCRP 2024 Decadal Visioning Workshop

Working through challenges and solutions to actionable research.



Presentations

Speakers discuss progress and perspectives on coastal challenges and priorities for the next 10 years of coastal research.

Community Needs

What challenges will we face in the next 10 years?

Co-Developed Solutions

How do we move forward to addresses these challenges?

Tools & Approaches

What tools and implementation strategies do we need to achieve solutions?

Research Questions

What research questions need to be addressed for successful tools and approaches?

Workshop Priority Coastal Challenges Identified

Coastal Flooding & Extreme Events



Adaptation



Sediment Transport & Morphologic Change



Ecosystem Restoration & Water Quality



Decadal Visioning Workshop Takeaways

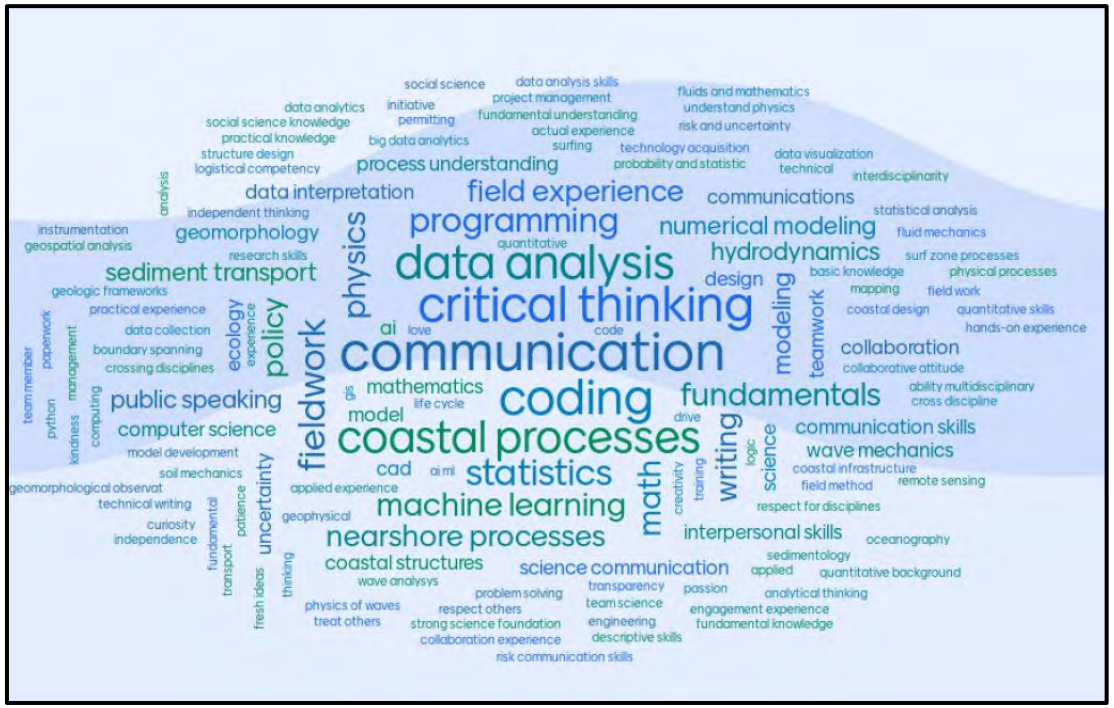
- Research is needed at **all scales** to transition from **foundational science** to **operational models** to **public information**.
- Need to collaborate **across disciplines** to **co-develop** effective **solutions** to coastal challenges.
- Interdisciplinary work must be at the right scale, **intentional**, **well-planned**, and **inclusive**.
- Need to incorporate influences of **humans and ecosystems** to understand current and future **shoreline change**.
- **Nature Based Solutions** should be considered as a **continuum**.
- Need methods to measure **effectiveness** in **adaptation strategies.**



Workforce Development Session Takeaways

- **2012** → U.S. programs in decline due to lack of funding, educational opportunities decreasing, USACE R&D funding declining
- **2018** → Funding decreasing/difficult to obtain, generally small number of faculty, post-docs, substantial staffing needs in fed agencies
- **2024 Survey Preliminary Results:**
  - Funding for research/graduate student training has increased.
  - Graduate programs have stable or increasing course offerings, where fundamentals are taught regularly.
  - Fewer students are remaining in academia.

Key Skills and Competencies Needed



Summary of R&D Gaps and Recommendations

What's Next

- Seeking detailed feedback from the community on themes, content, and priorities identified through the workshop.
- 2024 coastal research consensus report that lays the foundation for the next decade.

BCER Guidance on USCRP R&D Gaps and Needs

- 2025 Federal Agency Leadership Meeting
  - Federal agencies define a common purpose and goals to advance a common mission, each bringing unique expertise.
  - Need BCER champion to engage top federal agency leadership.
  - Develop strategic implementation plan in collaboration with federal agency partners.
- As a BCER initiative, is the USCRP on track and aligned with BCER needs and expectations? What should be the USCRP focus moving forward?

Thank you!
Questions?

USCRP
US COASTAL RESEARCH PROGRAM

USCRP Decadal Visioning Workshop Materials:
https://uscoastalresearch.org/2024-decadal-workshop





Jeremy Lowe

Jeremy Lowe is a Coastal Geomorphologist at the San Francisco Estuary Institute. He has more than 35 years of experience in tidal wetland restoration and sea-level rise adaptation planning on the Pacific West Coast and Europe. His work has included the design of sea defenses to reduce flood hazards in Venice, Italy; leading wetland restoration planning and design at Ballona Wetlands in Venice, California; and is the author of tidal wetland design guidelines for San Francisco Bay, for Puget Sound, and for the Lower Columbia Estuary. More recently, Jeremy has been working on nature-based climate change adaptation in San Francisco Bay and Southern California.
He worked with San Mateo County's Office of Sustainability SeaChange project and the County of Marin's BayWave project to develop science-based approaches to assess the feasibility of natural and nature-based climate adaptation strategies in the two counties. Jeremy is presently working with the SF Regional Water Quality Control Board and USACE to develop a science-based approach to assess the benefits and effectiveness of natural and nature-based climate adaptation strategies in the Bay. For the Metropolitan Transportation Commission, he has led working groups providing scientific input to engineering design alternatives for the adaptation of Highway 37 to sea-level rise. For the Coastal Conservancy, he is helping lead the Regionally Advancing Living Shorelines Project. Jeremy is part of the project teams that have developed long-term landscape restoration and adaptation visions of Novato Creek, Walnut Creek, Sonoma Creek, Petaluma River, and Sunnyvale, incorporating wetlands, fluvial floodplains, infrastructure, and nature-based solutions.

San Francisco Estuary Institute

The San Francisco Estuary Institute (SFEI) is a non-profit organization dedicated to advancing the science needed to restore and sustain San Francisco Bay's ecological health and resiliency. SFEI plays a pivotal role in the Bay, working with academic institutions, tribes, non-profits, the private sector, and government agencies to maintain and improve our natural and built shorelines while making them more resilient to climate change. We bring expertise in geomorphology, wetlands ecology, sediment science, planning, and landscape design to arrive at science-based, nature-based, and landscape-scale solutions for shoreline restoration, adaptation, and resilience. We share our knowledge and expertise through technical assistance to many communities and agencies around the Bay.

History of San Francisco Bay from an environmental context

Jeremy Lowe, San Francisco Estuary Institute

San Francisco is an urbanized estuary. For the last two centuries, there has been considerable diking, draining, and development of the Baylands. This has provided economic benefits but at a cost to the natural system. The form of this development, its impacts on natural habitats, its vulnerability to climate change, and opportunities for restoration and adaptation reflect the natural landscape of the Bay.

The estuary is divided into four subembayments. The North Bay, South Bay, and Suisun Bay are wide alluvial valleys that historically had large salt and freshwater marsh complexes. The Central Bay is more constrained by the headlands and small valleys of Marin and the alluvial fans of the East shore, which have narrower marsh plains.

In the last two centuries, much of the marshes, wet meadows, and grasslands surrounding the Bay have been developed. Many of the natural channels were straightened and connected directly to the Bay, and much of the area was drained with channels and pumps. In addition, land subsidence of diked areas and inadequate drainage to the Bay exacerbated flooding in low-lying areas. The lowest areas, the tidal marshes overlying thick Bay Mud, are challenging to build in. In the North, South, and Suisun Bays, urban development, transportation, and industry kept out of them as much as possible, and instead, they were diked off to become ponds for the production of salt, for agriculture, or managed for hunting. These low-lying areas are known as the diked baylands and form a band between the urban areas and the Bay. In the Central Bay, in the areas close to San Francisco and Oakland, many of these diked baylands have been modified to allow them to be developed.

Many of the modifications have increased their vulnerability. Channels have been dammed higher up in their watershed, trapping sediment before it reaches the Bay. Where they cross through the historical marshes, channels have been leveed, preventing water and sediment from spreading over their floodplains and increasing backwater effects as Bay levels rise. Levees protect low-lying areas to allow development but require storage and pumping of stormwater. Areas that have been filled higher to reduce the need for levees have subsided. From the 1940s, the flat and often undeveloped baylands attracted significant infrastructure, such as wastewater facilities, airports, refineries, power plants, and landfills, with their accompanying network of pipelines and transmission towers.

The present landscape is, therefore, vulnerable to a number of flooding sources. Coastal flooding from extreme water levels in the Bay will increase with the rise of sea levels. Creek flooding in urbanized areas is increased because of a lack of detention capacity and backwatering with high Bay levels. Shallow groundwater rise may impact underground utilities and structures if they corrode and become buoyant. In very low-lying areas, it could lead to surface flooding.

These vulnerabilities vary around the Bay, as do the opportunities for restoration and adaptation. In the North, South, and Suisun Bays, large areas of former salt ponds and agricultural land are in public ownership and are gradually being restored, with significant opportunities for nature-based adaptation. In the Central Bay, the majority of the former wetlands have been developed, leaving more constrained opportunities for nature-based adaptation.

There is a long history of marsh restoration in the Bay, starting in the mid-1970s. There is considerable experience in restoration techniques, particularly for tidal marsh, building up to large-scale projects such

as the South Bay Salt Ponds, Napa-Sonoma Marshes, and Hamilton Airfield Wetlands. The experience with nature-based solution (NBS) projects is more recent. Since the early 2010s, an increasing number of projects have been developed with attention to rising sea levels in mind. These have covered all parts of the green-to-gray spectrum, including many hybrid approaches. Three examples of the larger projects are given below.

State Route 37 is a 21-mile highway in the North Bay that provides access for disadvantaged communities in Solano to jobs in Marin; it is also unique in the Bay as it runs almost entirely through present marshes or diked baylands. **Resilient SR37** is a collaborative roadway and bayland partnership between transportation and natural resource agencies to address near-term solutions to chronic traffic congestion and periodic flooding and long-term solutions to sea-level rise for the road. Through FHWA's Preliminary Environmental Linkages (PEL) process, an earlier and broader consideration of the environmental issues has been undertaken. This has allowed collaborative planning of the road redesign and the restoration of several thousand acres of diked agricultural land resulting in increased protection to the road and significant ecological lift.

The goal of the Coastal Conservancy's **Regionally Advancing Living Shoreline (RALS)** project is to scale up and increase the pace and effectiveness of new living shoreline projects such as nearshore reefs, SAV and shoreline planting, beaches, enhanced rock slopes, and living seawalls. The project will help share ideas and experience to improve the body of practice, generate design guidance based on existing pilot projects, develop programmatic permitting pathways, and promote engagement and training of local workforces. Central to the RALS project is to work with landowners to develop preliminary site designs to 30-60% for ten living shoreline projects in the more highly developed Central Bay.

The **Sunnyvale Shoreline Vision** in 2020 was a precursor to the present Phase III of the South San Francisco Bay Shoreline Study. The goal was to bring together landowners and land managers along the Sunnyvale shoreline to identify and collaborate on shared goals, especially related to climate resilience. Participants included the City of Sunnyvale, Google, Lockheed Martin, NASA Ames Research Center, Midpeninsula Regional Open Space District, the South Bay Salt Ponds Restoration Projects, US Fish and Wildlife Service, and Valley Water. Through a series of workshops, information on the vulnerabilities and future plans of the participants was developed, along with the development of a preferred levee alignment. This information was then shared with the Shoreline Study when it commenced.

These projects all share the common goal of significant implementation of NBS at the landscape scale in the Bay. To this end, there are three gaps that have become apparent:

1. Regional engineering guidance for NBS approaches. There is a critical need for engineering and ecological guidance at the local level. Ecological ideas and concepts need to be better translated into engineering designs and construction documents.
2. Methods to assess the benefits of alternative shoreline approaches. Consistent and validated methodologies are needed to evaluate the multiple benefits of NBS, including hybrid solutions, at the site and regional level.
3. Methods to assess the effectiveness of implemented projects. Consistent and validated methodologies are required to monitor and evaluate the effectiveness of NBS. This is necessary to guide the adaptive management of the projects and the region.



History of San Francisco Bay from an environmental context

Board on Coastal Engineering Research (BCER) Meeting
August 13, 2024

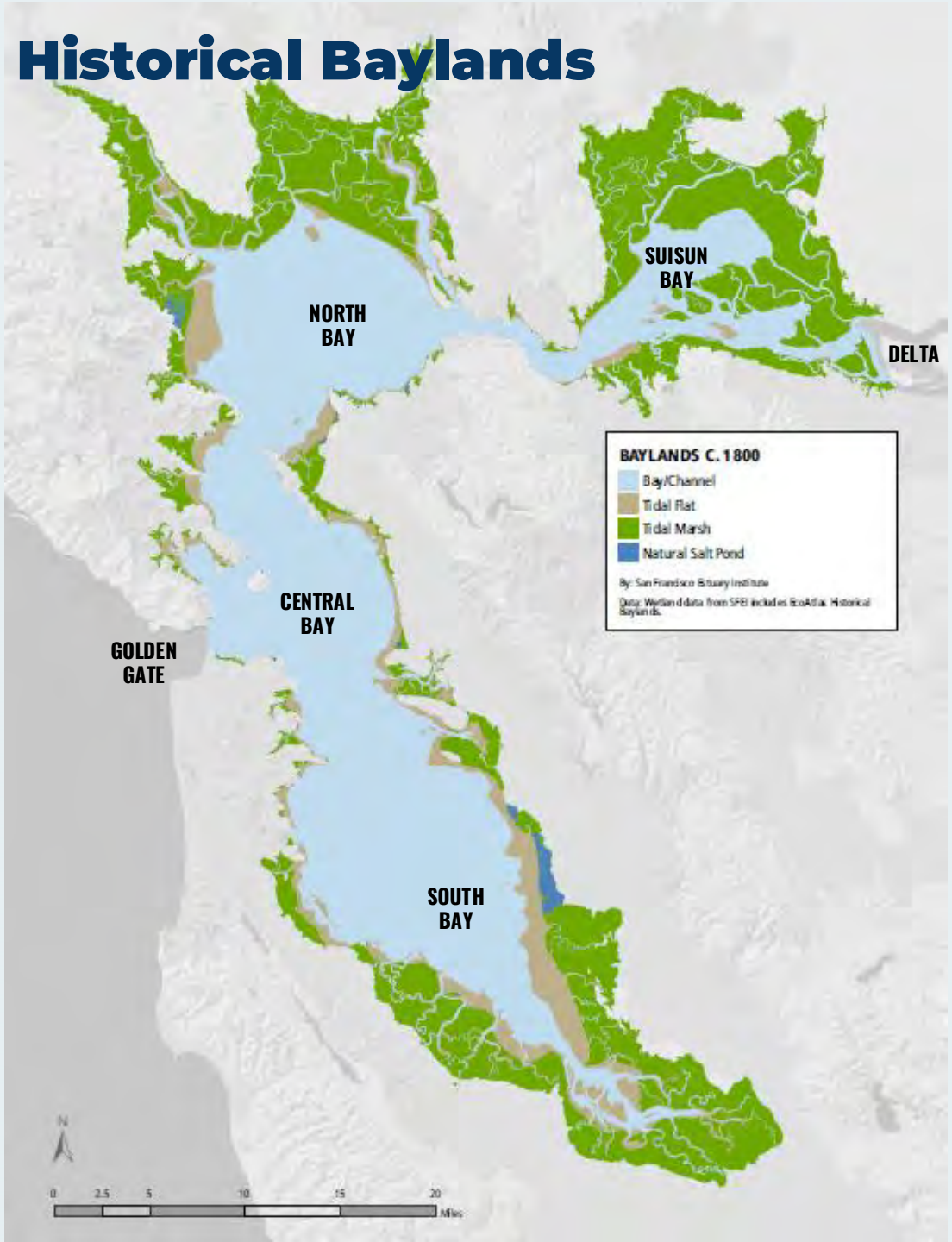
Jeremy Lowe, San Francisco Estuary Institute

Source: USACE

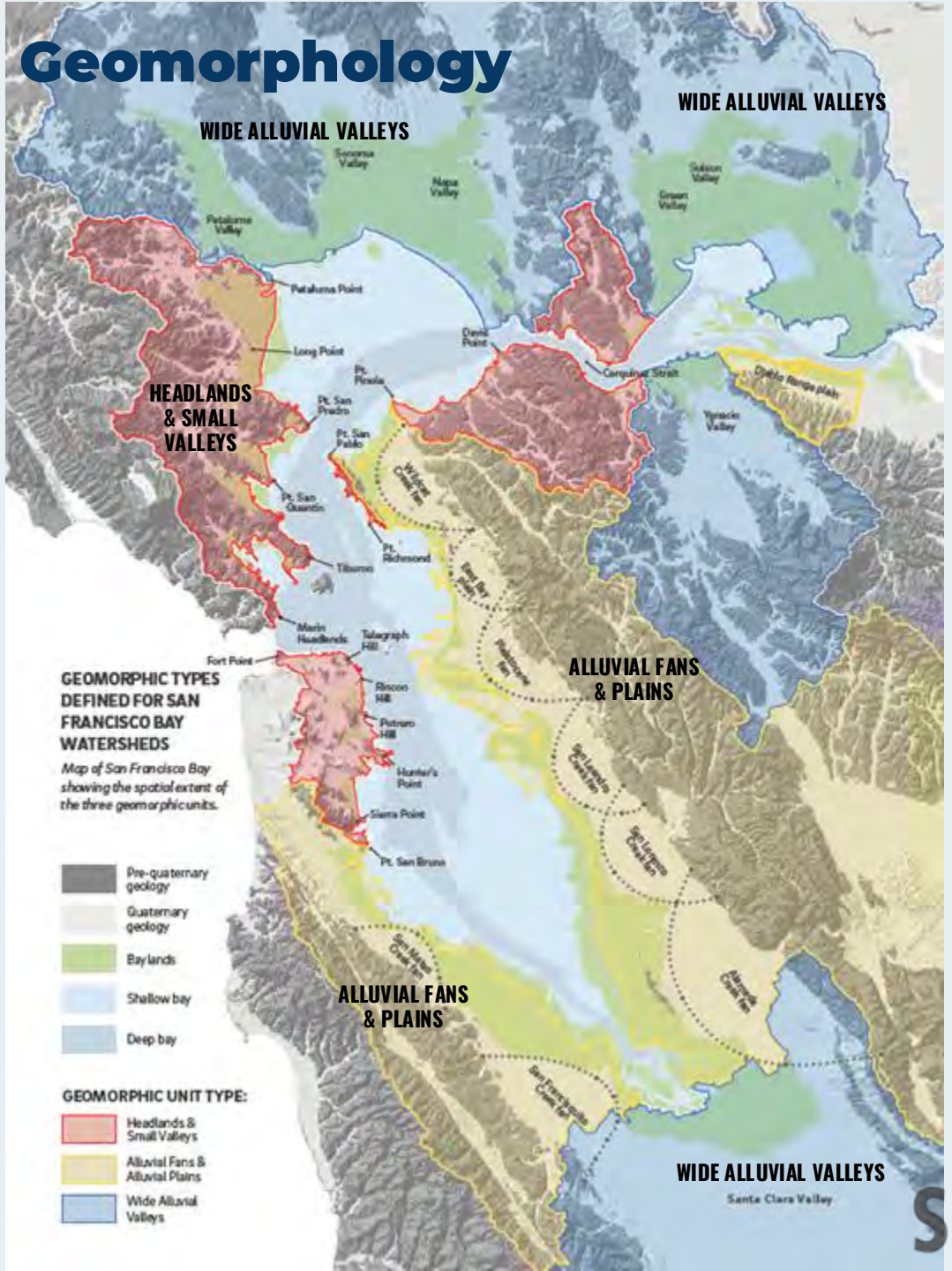


Source: USACE

Historical Baylands

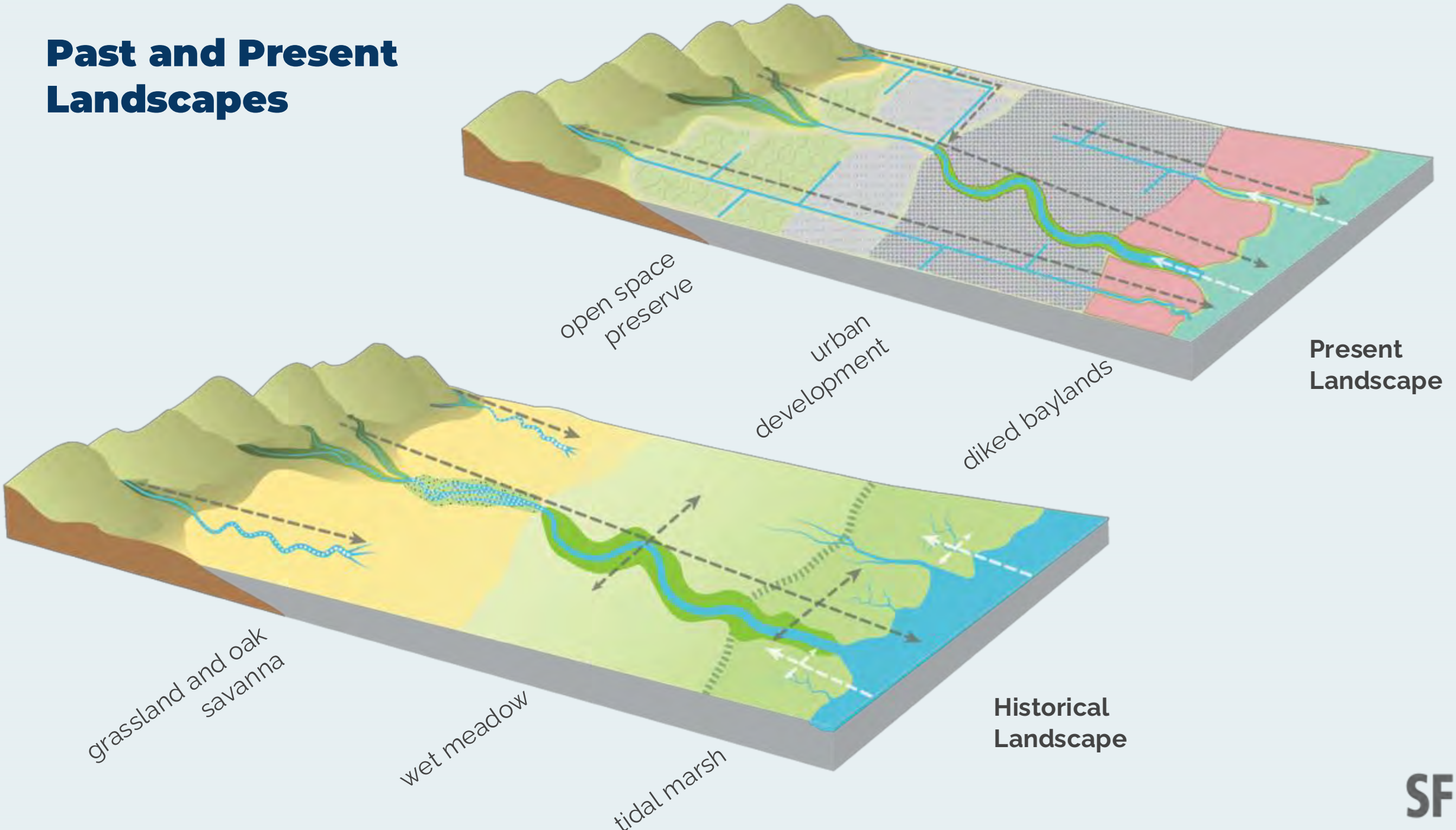


Geomorphology



SFEI

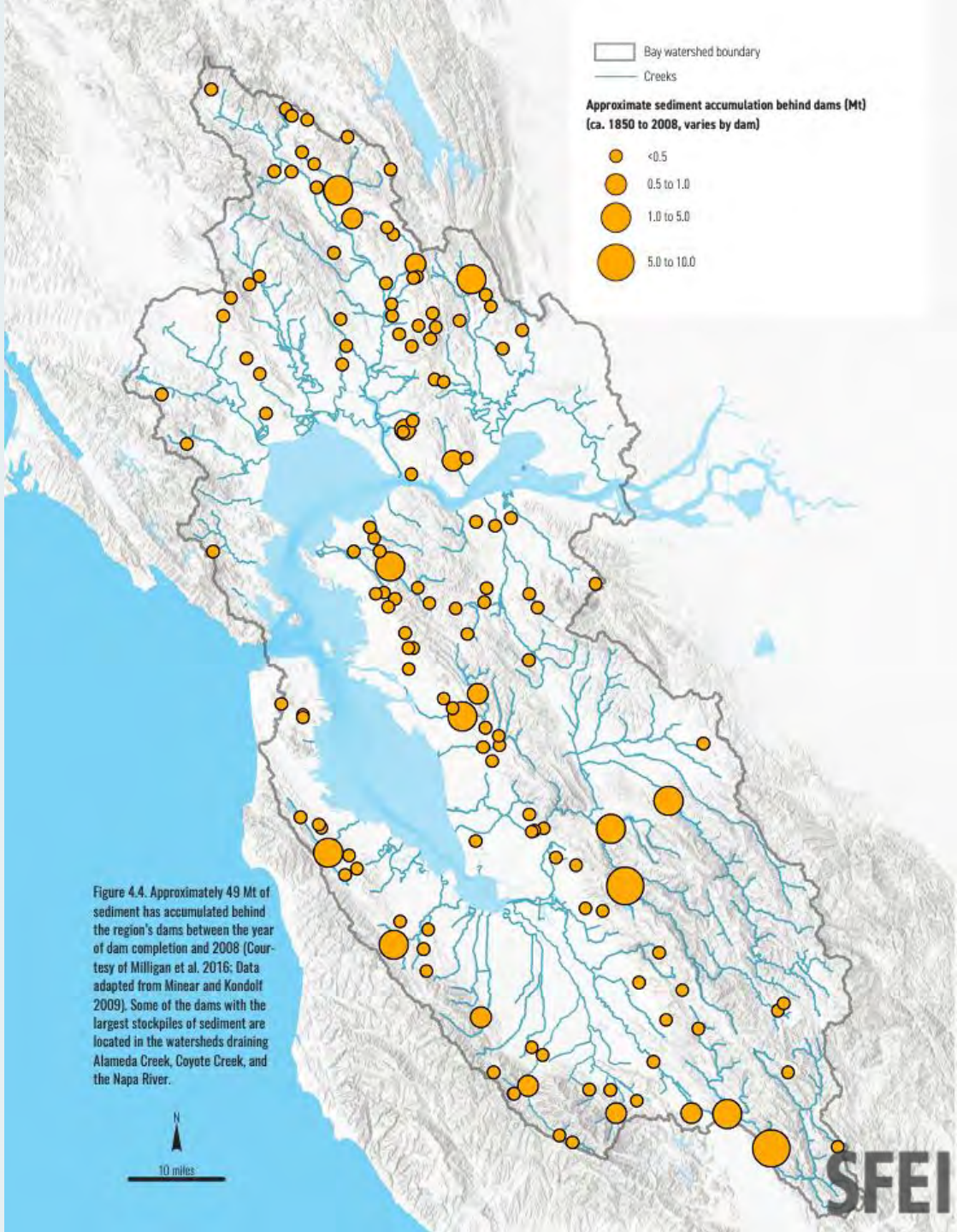
Past and Present Landscapes



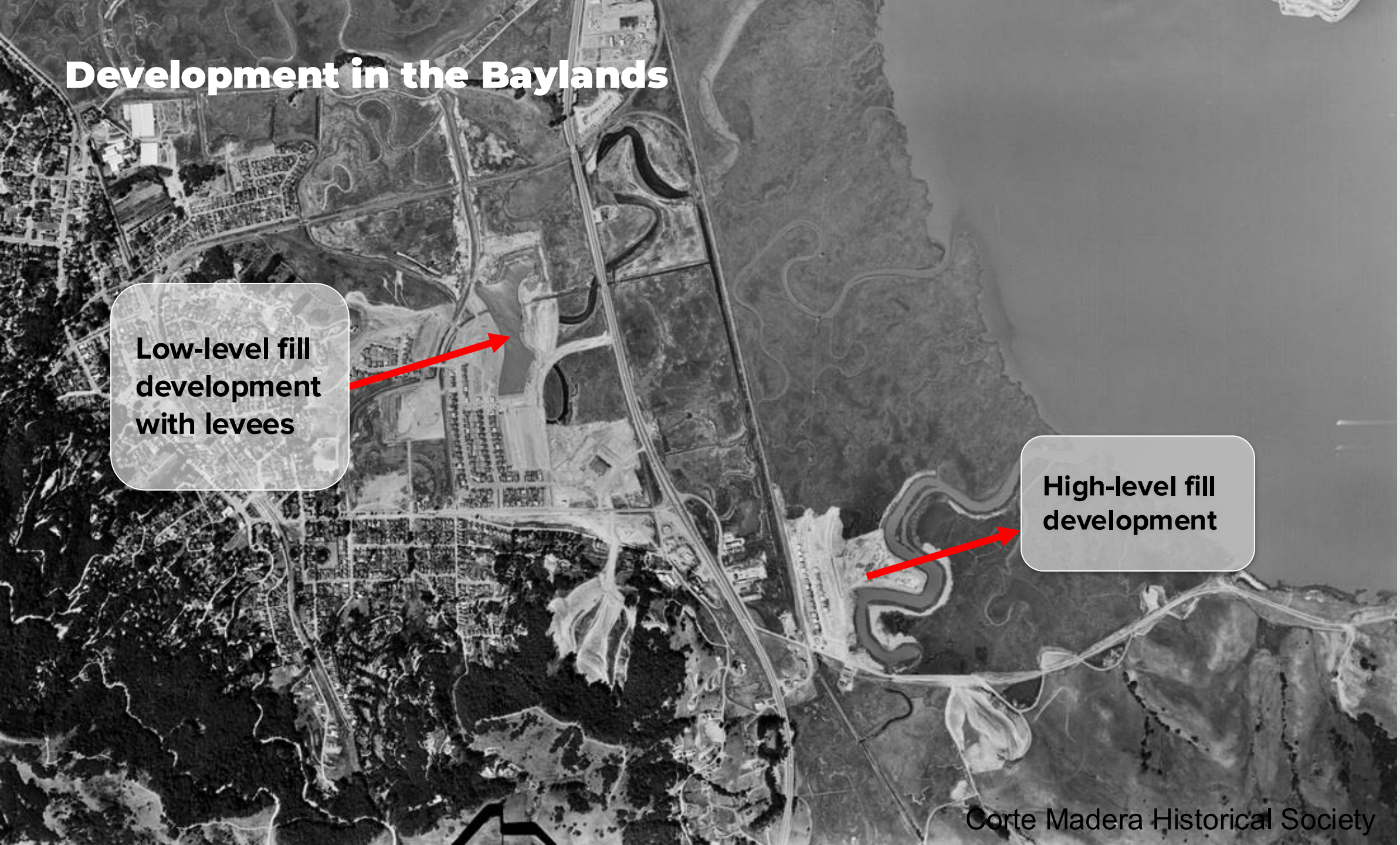
SFEI

Channel Modifications





Development in the Baylands

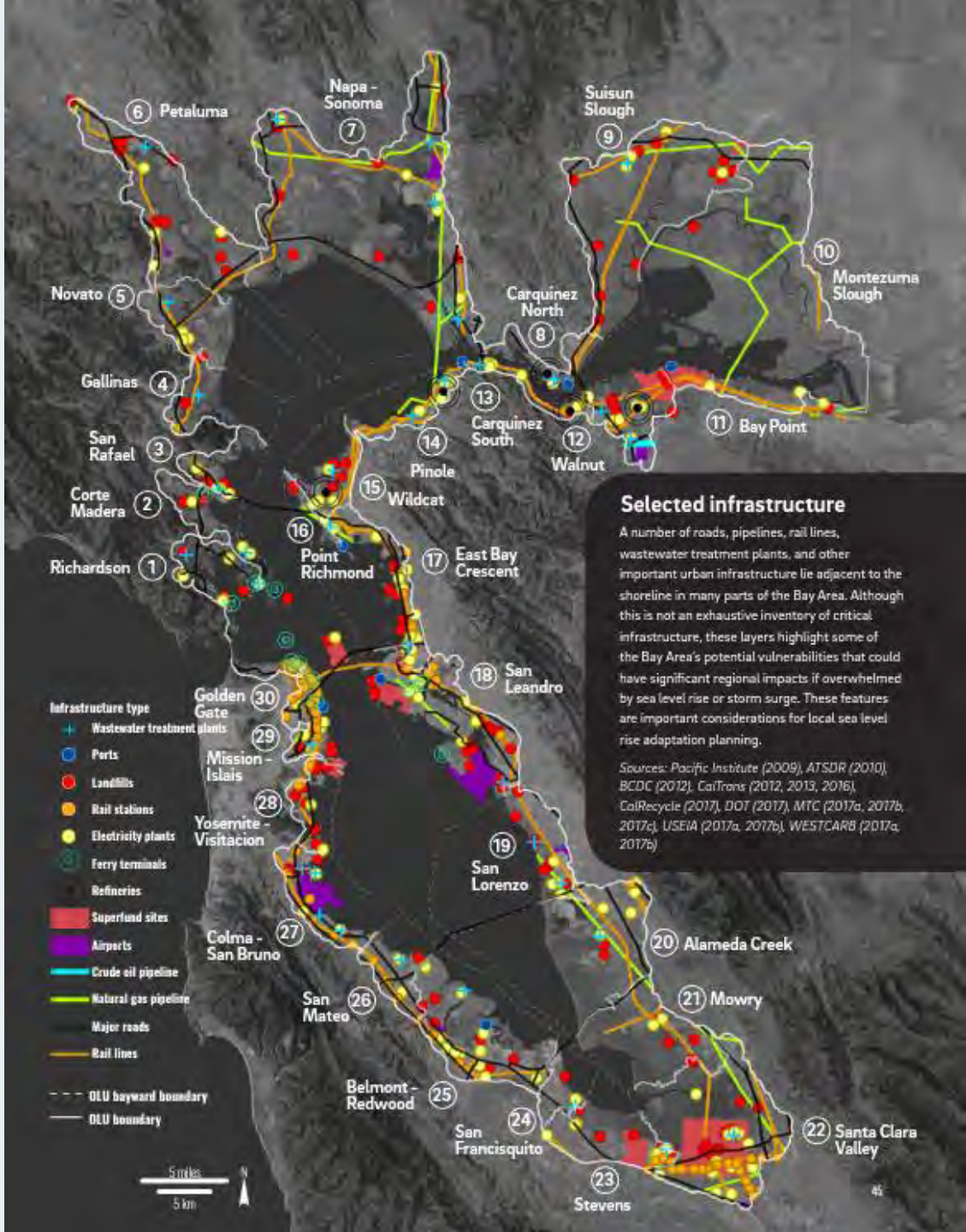


Corte Madera Historical Society

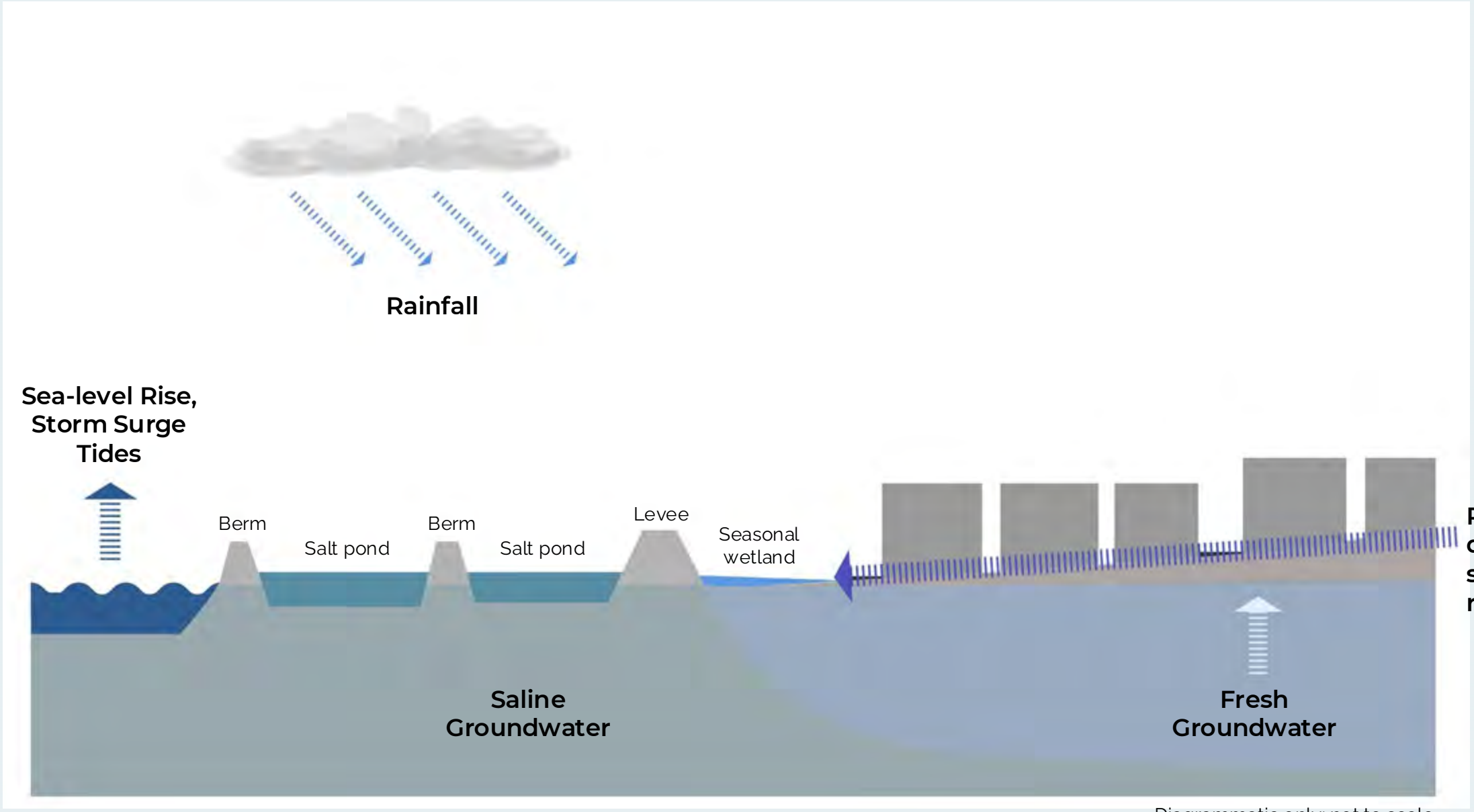
SFEI

Infrastructure in the Baylands





Sources of Flooding

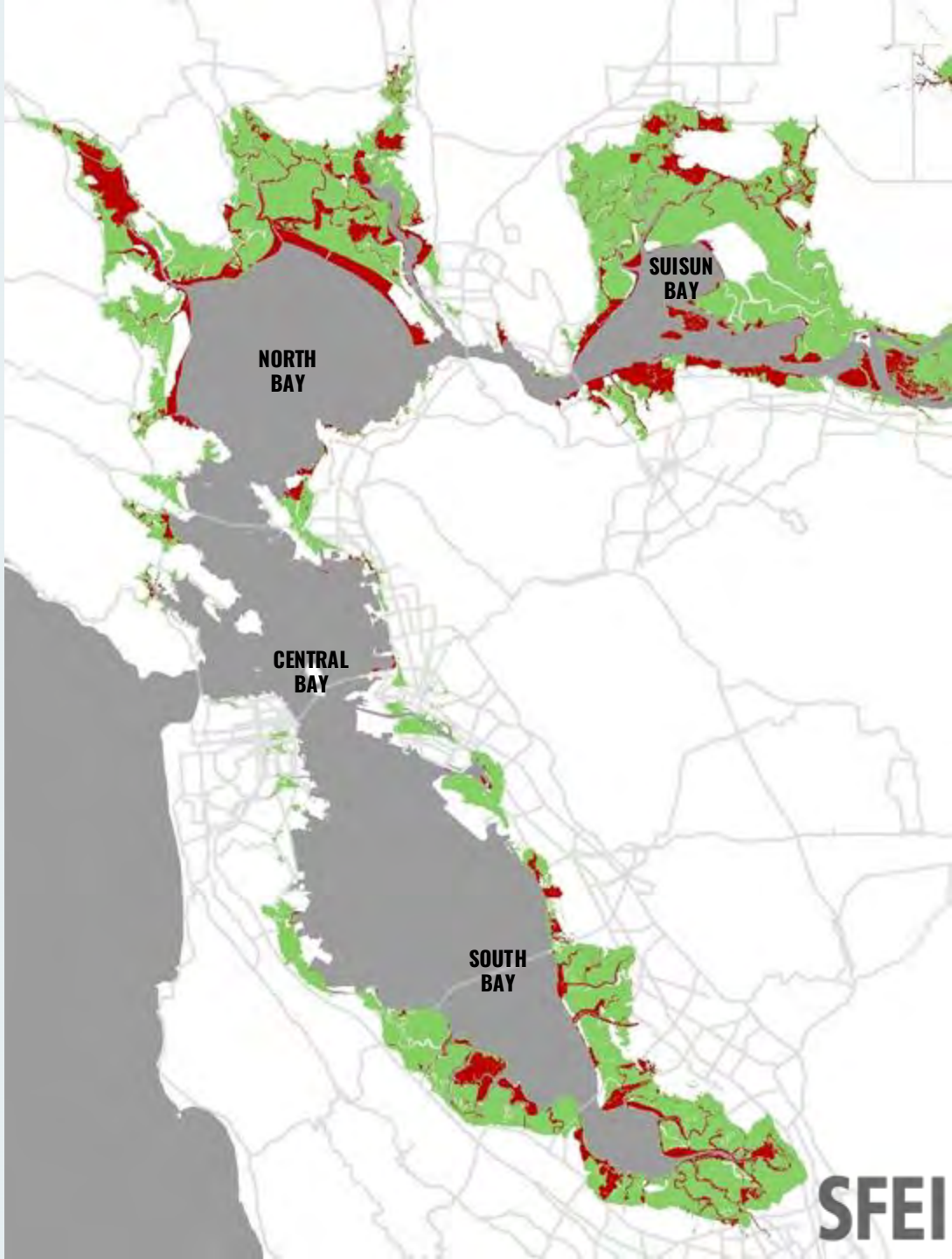


Diagrammatic only: not to scale

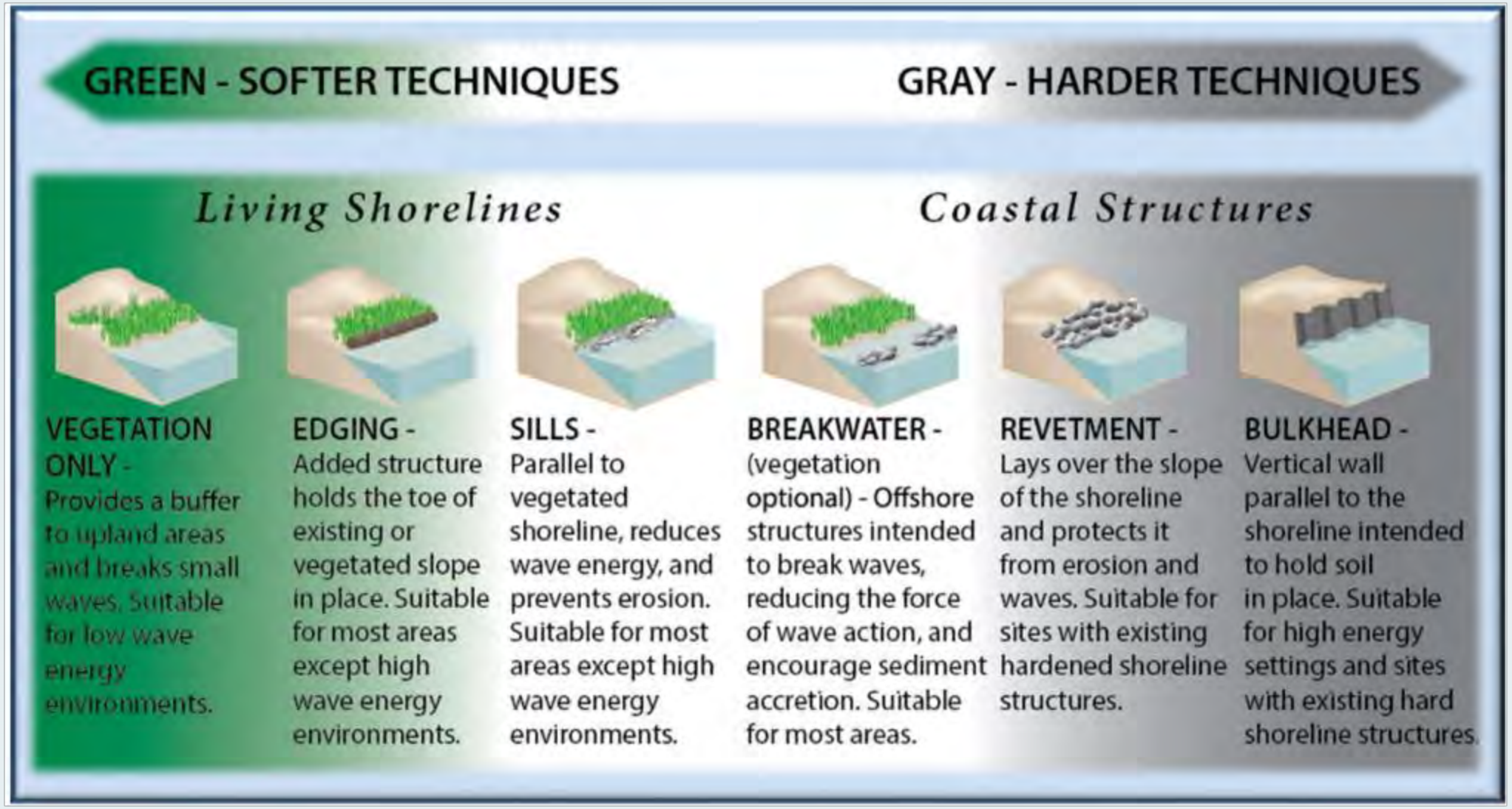
SFEI

Changing Land Use and Vulnerability

	Area, ac 1800	Area, ac 2010
Tidal wetlands	190,000	38,000
Tidal mudflats	51,000	31,000
Salt ponds	2,000	38,000
Diked wetlands		52,000
Developed/ag land		90,000
	243,000	**249,000**



Spectrum of adaptation approaches



Based on approach outlined in SAGE 2015

SFEI

Resilient SR37

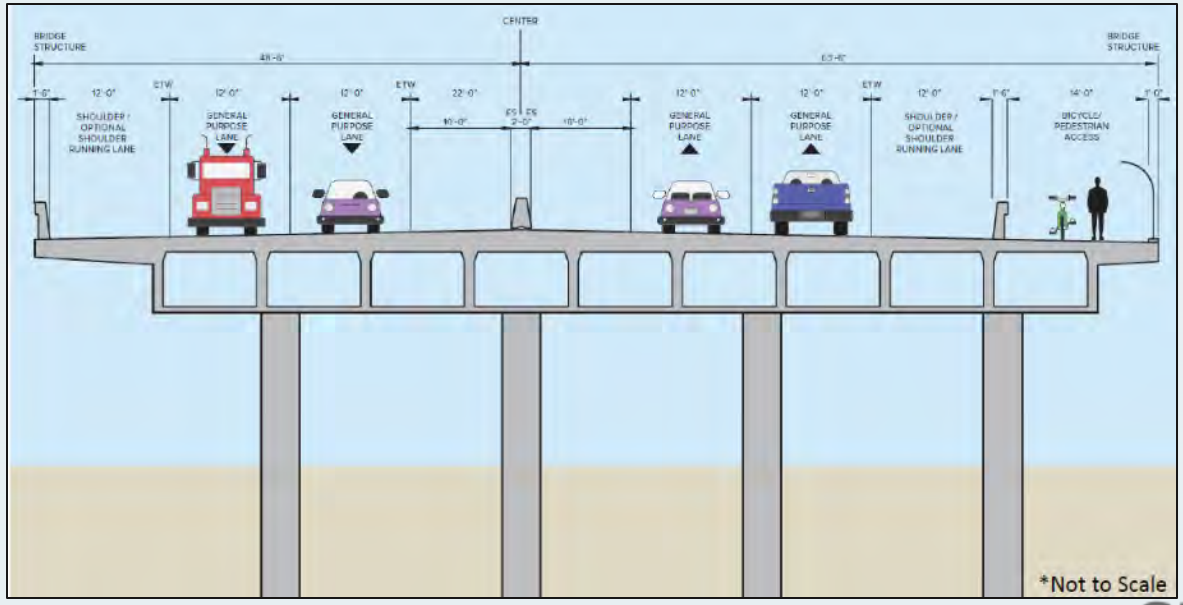
Integrated Landscape Planning

- Examines a broader area
- Long-term transportation and landscape vision
- Early consideration of environmental issues

Lessons Being Learned

- **Collaborative planning** to integrate equity, restoration, and transportation efforts in a phased manner.
- **Innovative regulatory approaches** to "integrate before mitigate."
- **Coordinated strategies** to plan, design, fund, and implement projects.





METROPOLITAN TRANSPORTATION COMMISSION · Caltrans · SAN FRANCISCO ESTUARY · scta · SFEI

Regionally Advancing Living Shorelines

Goals:

- Advance nature-based adaption body of practice
- Build on pilot project data 2012-23
- Build regional capacity through knowledge transfer
- Pilot multi-objective designs in different settings
- Encourage local labor and involvement

Approaches:

- Nearshore reefs
- SAV and shoreline vegetation plantings
- Beaches
- Woody debris
- High tide islands
- Enhanced rock slopes
- Living seawalls
- Derelict piling and debris removal

Coastal Conservancy



Sunnyvale Shoreline Vision

Goals:

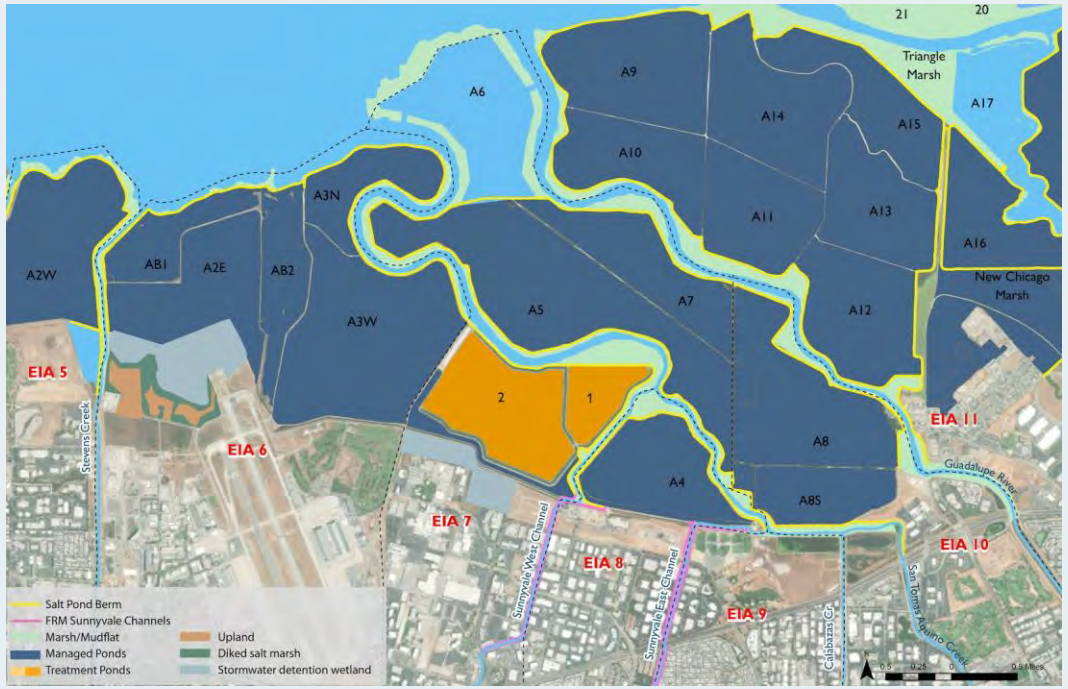
- Bring together landowners and land managers along the Sunnyvale Shoreline to identify shared goals, especially climate resilience.
- Preparing for Phase III of the South San Francisco Bay Shoreline Study.

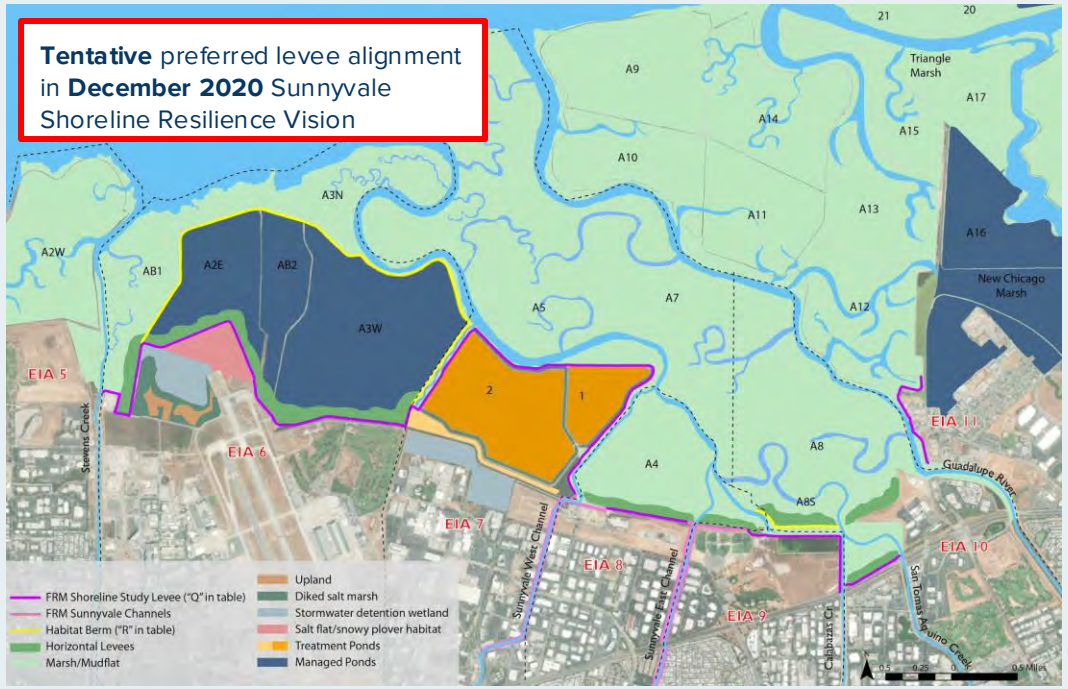
Participants:

- City of Sunnyvale
- Google
- Lockheed Martin
- Midpeninsula Regional Open Space District
- NASA
- South Bay Salt Pond Restoration Project
- US Fish and Wildlife Service
- Valley Water

Sunnyvale

Valley Water





SFEI

R&D Gaps and Recommendations

- Regional engineering guidance for NBS approaches
- Methods to assess the benefits of alternative shoreline approaches
- Methods to assess the effectiveness of implemented projects

SFEI

Brad Benson

Brad Benson is the Port of San Francisco's Waterfront Resilience Program Director. He oversees the expenditure of 2018 Proposition A Seawall Earthquake Safety Bond funds to stabilize waterfront structures and development of the $13.5 billion United States Army Corps of Engineers/Port of San Francisco Draft Plan to adapt the San Francisco's bay shoreline to sea level rise and coastal storm risk along 7.5 miles of the Port's waterfront through the San Francisco Waterfront Coastal Flood Study.

Before he was named Waterfront Resilience Program Director in early 2019, Brad was the Director of Special Projects and oversaw the Port's local, state, and federal legislative program. During this time, Benson developed the state legislation that guides two of the Port's largest development projects at Pier 70 and Mission Rock. He also developed the state and local legislation that allows the Port to form infrastructure financing districts on Port property, to leverage private dollars for the benefit of the public. He collaborated in the preparation of the Port's 10 Year Capital Plan to ensure an economically stable Port. Brad also served as the Port's Pier 70 Waterfront Site Project Director to oversee planning, financing and entitlement of a new proposed transit-oriented, Type 1 Eco-District neighborhood in the southern waterfront.

From 2010-13, Brad served as the Port's project manager for the 34th America's Cup, that attracted millions of visitors and generated $1.4 billion in economic impacts to San Francisco.

Prior to joining the Port, Brad served as the Honorable Tom Ammiano's legislative aide from 1997-2005. He worked with constituents and City staff to write legislation, staff San Francisco Board of Supervisors meetings and committees, and manage day-to-day Board affairs during Supervisor Ammiano's terms as Board President.

Matt Wickens, PE

Matt Wickens is a Project Manager and Engineering with the Port of San Francisco, who currently serves as the Technical Lead on the San Francisco Waterfront Coastal Flood Study. Since joining the Port in 2018 his responsibilities have included technical review and management of geotechnical exploration, seismic and coastal analyses, economic impact evaluation, multi-hazard risk assessment and coordination with critical systems and/or emergency response asset owners.

Over the course of his career, Matt has contributed to a wide range of new, retrofit and repair projects involving the design and construction of bridges, tunnels, seawalls, piers, ports, and ferry terminals. His experience includes project management, structural analysis, design, constructability evaluation and design services during construction for a variety of transportation and waterfront structure projects. When away from the office, Matt enjoys spending time with his three young kids, barbequing, gardening and woodworking.



SAN FRANCISCO WATERFRONT

Board on Coastal Engineering Research

August 13, 2024

SAN FRANCISCO BAYSIDE SHORELINE EVOLUTION

Past + Present



Past

Before the arrival of European migrants, the peninsula's eastern waterfront featured large expanses of coves, mudflats and tidal wetlands fed by the historic tributaries of Mission Creek and Islais Creek.



Present

Much of the waterfront was filled to support urban development. Today, only the Pier 94 and Heron's Head wetlands remain of the shoreline's once vast marshlands. City Parks dot the shoreline.

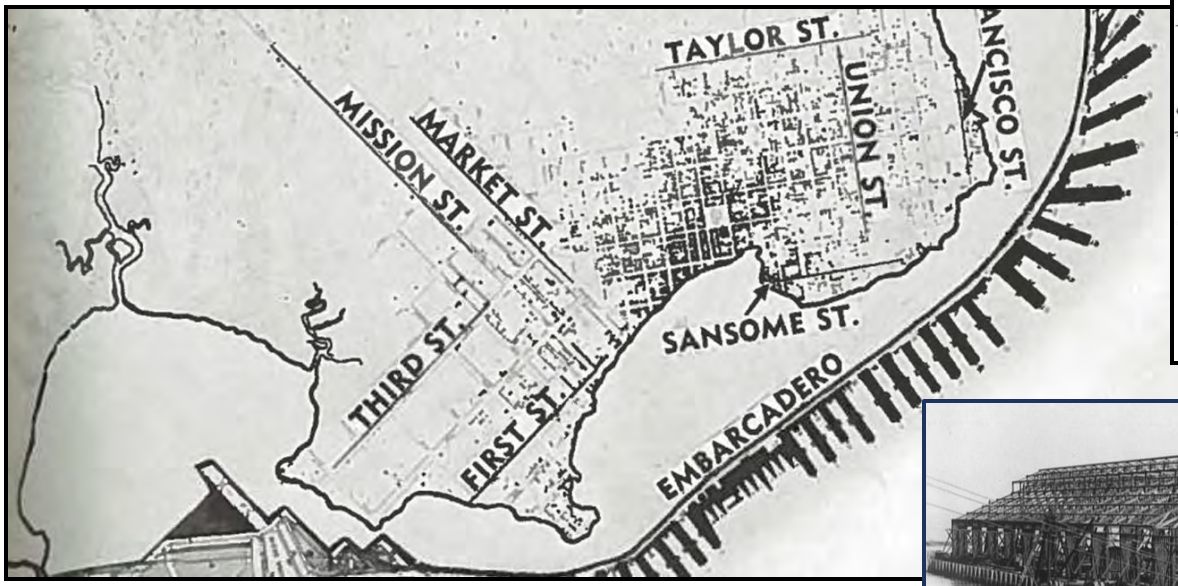
SAN FRANCISCO MUDFLATS

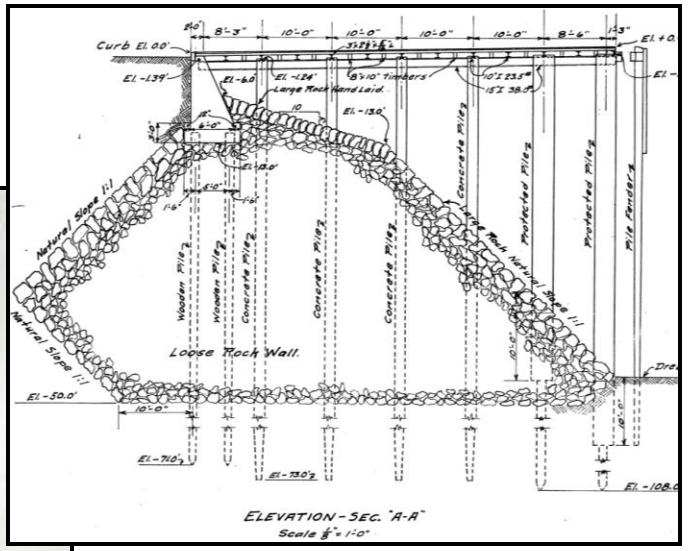
Circa 1850’s



BUILDING THE SEAWALL & PIERS

Roughly 1880 to 1930's







INDUSTRIAL WATERFRONT

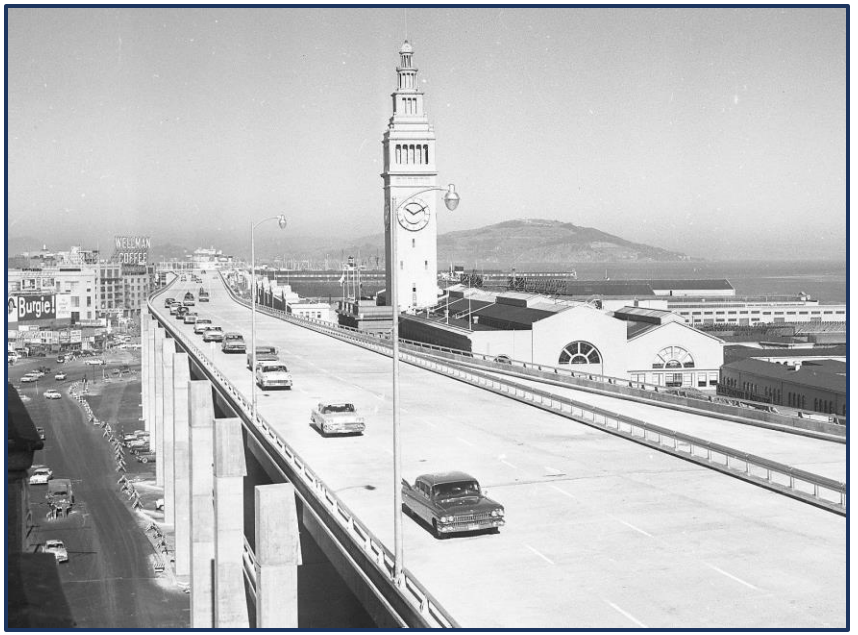
Early to Mid 1900's



EMBARCADERO EVOLUTION

1950's to 1990's





1950's – Construction starts but never completed

1980's – Removal contemplated

1989 – Loma Prieta earthquake damage

1991 – Approval to remove

TODAY'S WATERFRONT



PORT OF SAN FRANCISCO

SAN FRANCISCO IS AN ICONIC, BELOVED WATERFRONT CITY










PORT OF SAN FRANCISCO

US Army Corps of Engineers®

WHAT IS THE FLOOD STUDY?

- The **USACE SF Waterfront Coastal Flood Study** analyzes **coastal flood risk** and the effects of **sea level rise** to the San Francisco waterfront along the Port's 7.5-mile jurisdiction over the next 100 years.
- The **Draft Plan** will inform subsequent stages of funding and design to develop targeted construction projects.
- The proposed solutions are estimated to cost **$13.5 billion** (high-level, preliminary cost estimate) and, if approved by Congress, the Federal government may pay **65% of the cost**.
- The Flood Study is led by the **U.S. Army Corps of Engineers** (USACE) in collaboration with the **City of San Francisco**.



DRAFT PLAN ENGAGEMENT & FEEDBACK

January – March 2024



Focused on sharing the Draft Plan and collecting Public Comments

Engagement included:

- **14 events open to the public:** community workshops, waterfront walking tours, and webinars
- **50+ Briefings** to Community Organizations, Community Advisory Councils, agencies, and Port tenants
- **970+ people participated** in all events combined

WHAT'S AT RISK?

Potential Sea Level Rise by 2100



San Francisco's waterfront location makes it ***increasingly vulnerable to coastal flooding*** due to ***sea level rise***

Without a Federal project, modeling shows:

- By 2050, ***100 to 500 structures*** and ***assets*** will be vulnerable to flooding
- By 2140, damages could amount up to ***$23 billion***

US Army Corps of Engineers

PORT

COASTAL ENGINEERING

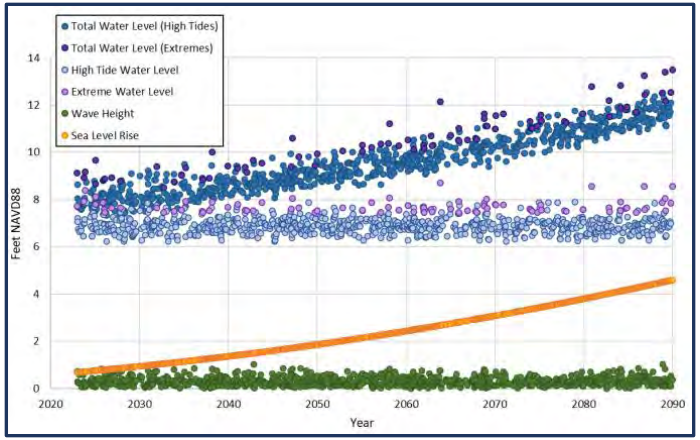
Coastal Storm Database for Generation II Coastal Risk Model (G2CRM)

Wave & Overtopping Evaluation

Baywide Induced Flooding Assessment

Groundwater Response to Sea Level Change

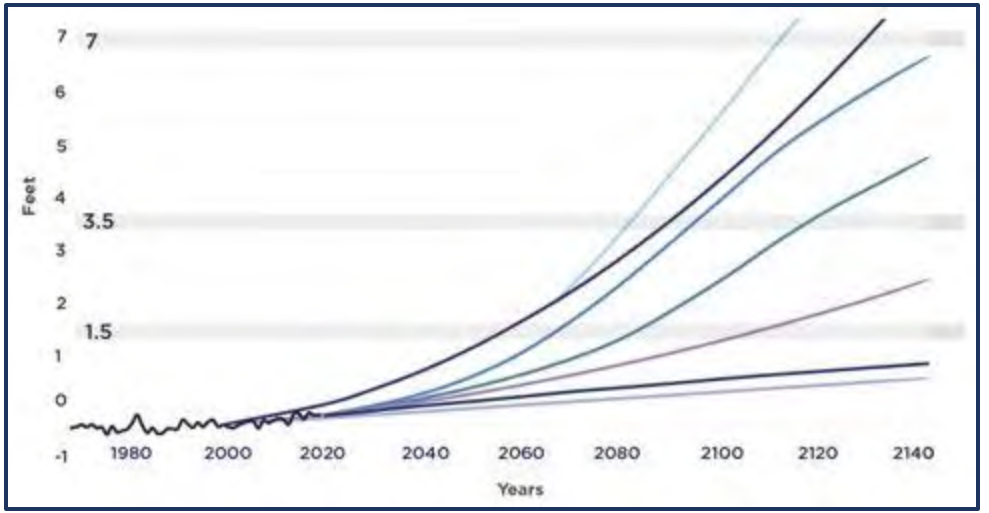




CHALLENGES ADDRESSED WITHIN THE STUDY



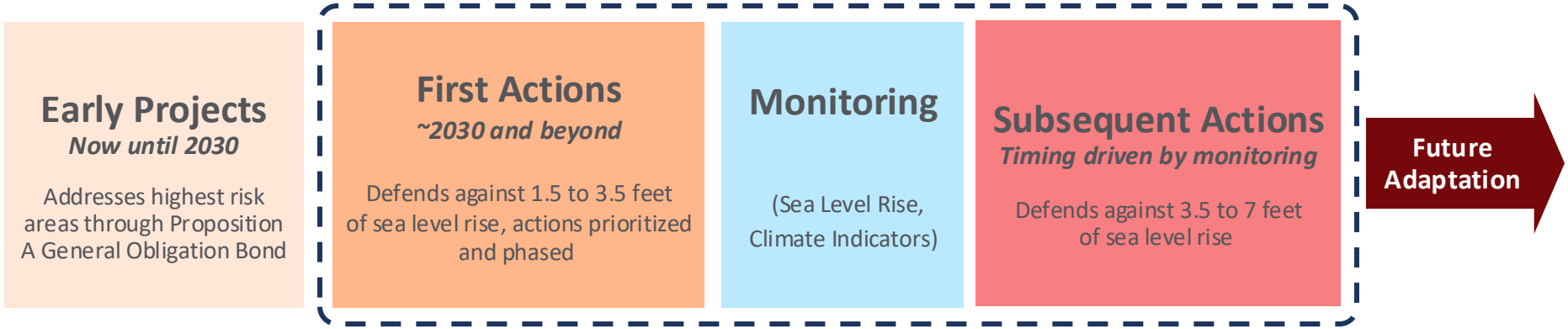
Seismically Active Location



Range of Relative Sea Level Change Projections

ADAPTATION ACTIONS OVER TIME

Federal Actions



COST BENEFIT ANALYSIS THAT ELEVATES EQUITY

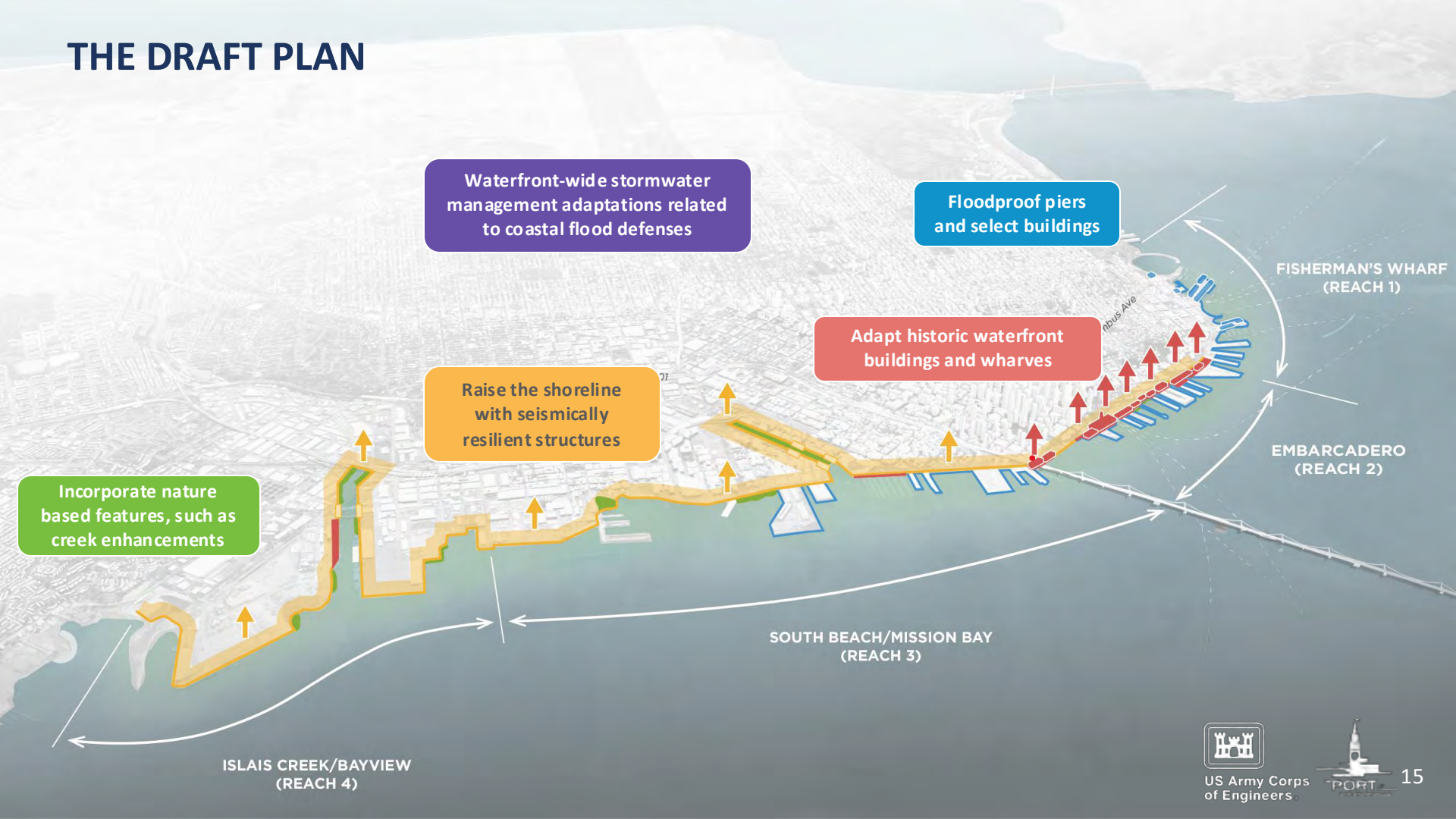
Four categories of analysis:

+ National Economic Development (including damages prevented)
+ Regional economic impacts (including jobs)
+ Environmental quality, consequences, and compliance
+ **Other social effects (including impacts to vulnerable populations)**

US Army Corps of Engineers

Note: Dates are approximate and subject to change. Projects will occur in phases which will extend over decades.

THE DRAFT PLAN



US Army Corps of Engineers

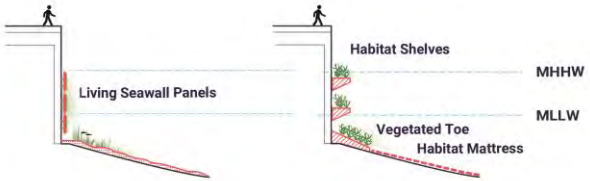
NATURE BASED SOLUTIONS (NBS)

Included in EIS Report

Coarse Beach



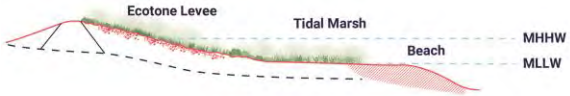
Living Seawall



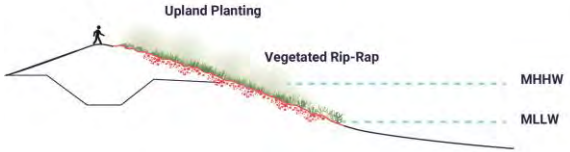
Wetland Creation



Ecotone Levee



Embankment Shoreline



Enhancement of Existing Wetlands



Ecological Armoring



Naturalized Shoreline



Creek Enhancements



PORT OF SAN FRANCISCO

LIVING SEAWALL PILOT PROJECT







- 3 Locations, 3 tidal elevations, 90 small tiles and 6 large tiles per site
- Small Test Tiles:
  - smooth surface, standard marine grade concrete,
  - smooth surface, admixture to promote marine growth,
  - textured surface, admixture to promote marine growth
- Large precast textured concrete tiles with admixture



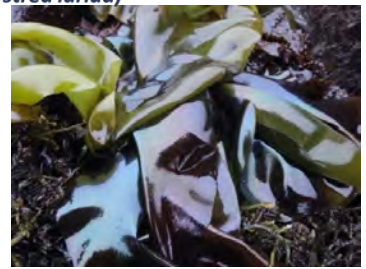
Native Olympia Oysters *(Ostrea lurida)*



Pacific herring *(Clupea pallasii)*



Littorines



Rainbow Seaweed



Rockweed *(Fucus distchus)*

SUMMARY OF R&D GAPS AND RECOMMENDATIONS

Guidance on allowable overtopping rates for urban waterfronts.

Evaluate NBS and wave interaction along steep and vertical shorelines.

Guidance for incorporating Climate Change impacts to risk mitigation and interior drainage systems such as changing:

- groundwater table
- frequency of extreme coastal water levels
- intensity and frequency of extreme precipitation

Recognize uncertainty within the feasibility study process and long-term planning horizon to enable risk informed decisions with enough flexibility to respond to future challenges.

Align Relative Sea Level Change scenarios among Federal agencies

Complete Pacific Study for Coastal Hazards System

Note: These gaps and recommendations reflect only the view of the Port of San Francisco as a non-federal partner.

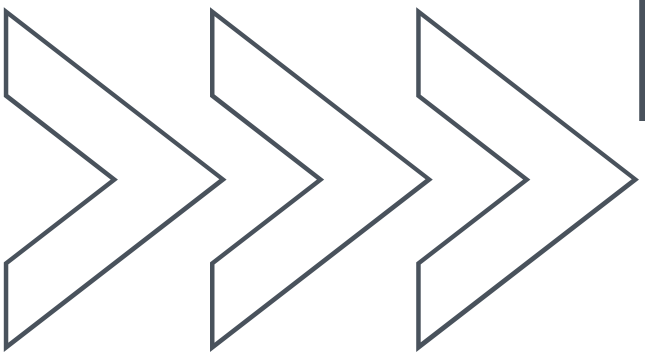


Thank you

Port of SF Waterfront Resilience Program | wrp@sfport.com

PORT OF SAN FRANCISCO

Waterfront Resilience Program



BOARD ON COASTAL ENGINEERING RESEARCH

Presentations Day 2

Hans R. (Rod) Moritz

Mr. Moritz's working experience centers on his activities within the US Army Corps of Engineers (USACE) for the past 30 years, where he has worked as a hydraulic engineer at the Portland & Chicago Districts. During the intervening period between USACE employment, he was engaged in consulting activities. Mr. Moritz routinely collaborates with other USACE districts, the Engineering Research Development Center (ERDC), state and federal agencies, academic institutions, and the private sector.

His generalized experience includes design and operation of coastal/maritime/riverine infrastructure, eco-system restoration, beneficial management of water-borne sediment, application of risk/reliability techniques to optimize navigation and flood-risk reduction projects, and evaluation of climate change vulnerability & resilience for water resource projects. Mr. Moritz's core experience has been informed by activities dealing with data collection and analytic techniques assessing oceanographic-estuarine-riverine processes, and hydraulic modelling.

Mr. Moritz is a cadre member for USACE-HQ civil works policy and legal compliance review team. He is a member of the USACE Committee for Tidal Hydraulics and is subject matter expert for Regional Sediment Management, Coastal Hydraulic Design, and Climate Preparedness and Resilience. Mr. Moritz graduated from Montgomery High School, Montgomery Texas, in 1982. He attained a Bachelor of Science degree in Ocean Engineering from Texas A&M University in 1986 and a Master of Engineering degree in 1991. His citations include the Department of the Army's Meritorious Civilian Service Medal and the Achievement Medal for Civilian Service (3 instances). Mr. Moritz is a registered civil engineer in the state of Oregon.

Heidi P. Moritz, P.E.

Coastal Engineer/Climate Preparedness and Resilience SME, Heidi P. Moritz, P.E., CENWP-ENC-HD, 503-808-4893, Heidi.p.moritz@usace.army.mil.

Ms. Moritz received a Bachelor of Science degree in Civil Engineering from Valparaiso University in 1981 and a Master of Engineering degree in Ocean Engineering from Texas A&M in 1991, through the CERC long-term education program. Prior to starting with the Corps of Engineers, Ms. Moritz spent 2.5 years in Thailand with the Peace Corps working on water resources projects. Ms. Moritz worked at the Chicago District, USACE, for 8 years as a hydraulic/coastal

engineer and at the Portland District, USACE, for 31 years. She is a member of the Coastal Working Group Advisory Board and has served as a member of the ICE Maritime Engineering Journal Advisory Panel. Ms. Moritz' primary areas of work with the Corps of Engineers include navigation structure design, risk and reliability analysis of coastal structures, shoreline protection and coastal structure design, total water level and extreme event analysis, storm power and storm clusters, and planning and adapting to climate change. Since 2008, Ms. Moritz has been working in the Responses to Climate Change program, specifically to develop USACE adaptation guidance for Corps projects to sea level change. Ms. Moritz led the guidance development team for EP 1100-2-1, Procedures to Evaluate Sea Level Change Impacts, Responses, and Adaptation.

Northeast Pacific Basin – Oceanographic Conditions and Coastal Processes

Hans Moritz and Heidi Moritz, Portland District

The Pacific Basin is much larger and more complex than the Atlantic or Gulf regions. It is very important to approach the Pacific Basin by understanding the larger processes (including potential changes into the future) as well as the distinctive differences between sub-regions. The coastal margin along many areas bordering the west coast/NE-PAC has a continental shelf 1-25 miles wide, is affected by mixed semidiurnal tide having MLLW to MHHW range of 1.6 to 7.9 ft, and is subjected to a storm season of 3- to 6-months. During October-April, landfall of convergent frontal systems and maritime extra-tropical low-pressure systems are the dominant factors affecting the wave environment along the US Pacific west coast. NE-PAC maritime storms have wind fetch distances extending 100s of miles with 40-knot sustained windspeeds (gusts to >70 knots), producing large waves. Individual storm events can be energetic and complex and persist for 6-48 hours as they make landfall. Due to the annual frequency and long duration of typical storm events, the likelihood of experiencing a high water level during a storm event are significantly increased from storms along other coasts. For the west coast, storm systems (and storm-generated waves) approach the coast from the southwest-northwest and are composed of sea and swell generated within the local storm system. Some wave events include swell generated from distant storm events in the Southern Ocean. Maritime storms having offshore wave height (Hs) > 20 ft can occur multiple times per year. The 1-year and 10-year offshore significant wave height for many NE-PAC regions may vary by less than 20%. Wave period (Tp) for winter storm events typically ranges between 12 to 22 seconds. When these waves reach the nearshore, they can move armor stone and vast amounts of sediment within the littoral zone and at coastal inlets. The annual depth of closure (which is defined by wave height) for the nearshore seabed can vary from 25 to 65 ft, depending on location. This is very important when discussing effective sediment management.

Some summary west coast/NE Pacific Basin characteristics:

Tides: West coast has a larger tide range (3-8 ft) than east coast locations south of Georgia and Gulf Coast (0.5 – 2 ft).

Storm Type & Intensity: The west coast is predominantly affected by extra-tropical cyclones (ETCs) and atmospheric rivers (ARs, convergent frontal systems with long tails that drape high wind and heavy rain onto coastal areas for prolonged periods). West coast ETCs can have an intensity similar to hurricanes (wind gusts > 90 mph, offshore waves 20-60 ft). There is a perception that west coast storms are not as severe as east/gulf coast storms; this is not true for most conditions. During summer, tropical cyclones (TCs) occur infrequently within the southern quarter of the NE-PAC (hurricanes and tropical storms).

Storm Duration: West coast storm events can have duration (10-72 hours) considerably longer than east/gulf coast hurricanes (4-24 hours); which means that occurrence of high tide during west coast storms is likely and directly translates into coastal zone risk. The occurrence of high tide and storm surge should not be assumed to be random independent events. For much of the west coast, the wintertime adage is: if it's high tide, there's likely to be a storm arriving.

Storm Frequency: Annual west coast storm season can impose many high intensity storms along the coast (1-11 events/yr having offshore waves > 21 ft); more than what may occur along the east/gulf coast. Because of the frequency of storm events on the west coast, the likelihood of large waves combining with high water levels and/or an atmospheric river is more likely than on the East or Gulf coasts.

Storm Season: West coast storm season is OCT-MAR, with some odd-ball storms as early as AUG and as late as MAY. The R&D focus for East coast & Gulf storm season is dominated by "hurricane season" which is JUN-NOV. Some areas of the east coast are affected by ETCs (Nor'easters) during OCT-MAR. Focus of CHS for east and gulf coasts has been "hurricane season".

Storm Surge magnitude: Peak surge magnitude for West Coast storm surge (3-5 ft) is less than east coast (3-15+ ft), due to the narrow continental shelf on west coast.

Variation Total Water Level (TWL) between frequent & infrequent storms: For many west coast locations, there is a small difference in TWL between the 2-year storm-induced water level and the projected 100-yr storm-induced water level (2 ft variation). This is due to the small variation in storm surge; recall west coast storm surge is limited by the narrow continental shelf. Along the east and gulf coasts there is considerable difference in storm surge between the 2-year and 100-yr events (10 ft variation). Bottom line is that there can be a high CSRM consequence/sensitivity to a small variation in TWL, for some west coast locations unlike the east coast.

Storm Waves: West coast storm waves can be swell-dominated, having much longer wave length and wave height closer to shore. Longer and higher waves affect sediment transport at deeper water depths, impose greater wave forcing on shore assets, reduce navigability at USACE coastal-navigation projects more often, and can affect more vigorous shore erosion hot-spots. West coast storm (long period) waves can affect a transient set-up in coastal water level (lasting several minutes) with a magnitude that is equal to storm surge.

El Nino/La Nina: The west coast can experience a pairing of El Nino/La Nina events every 5-8 years. These events can seasonally elevate mean sea level for several months duration (fall-spring) and increase the frequency and intensity of coastal storms, effectively modulating TWL for much of the coast (1-2 ft surcharge for months).

Sea Level Change: The west coast is tectonically active. There are regions where observed relative sea level change (over past 30-50 years) is rising, stationary, or falling with respect to land movement. The assumption that relative sea level change is in the "same direction" along the west coast is not correct.

Earthquake & Tsunami: These infrequent events can occur along the Pacific Basin, severely affecting our AOR. There is a 30% probability that a mag-8+ Cascadia subduction zone earthquake will occur along the PAC-NW coast within the next 30-50 years. Such an event can generate a tsunami with nearshore height > 30 ft. Damage to the coastal margin of Nor-Cal, Oregon, Washington could be significant. USACE needs to have a robust response plan for this type of event, to quickly re-establish a coastal navigation logistics support route.

The dominant USACE mission areas for the Pacific Basin are different than East Coast. Coastal navigation is the main mission area. A necessary aspect of the navigation mission as well as shoreline management is informed sediment management. District awareness is increasing for actionable and sustainable sediment management solutions. Engineered inlets continue to evolve under the strong annual climate. There are some coastal storm risk management projects, however, they are much fewer than on the East/Gulf coasts. Pacific Basin districts provide planning assistance to states (PAS), FEMA, and provide interagency and international services support (IISS). Community resilience and long-term impacts for disadvantaged communities, tribes, and territories are of significant concern. There also continues to be an ecosystem emphasis for many existing and new projects. Data analyses and tools that may have worked for other USACE regions may not be applicable in the Pacific Basin. It is very important to approach the Pacific Basin by understanding the larger important processes as well as the distinctive differences between sub-regions. In addition, for each sub-region, coastal zones have distinct characteristics defined by variability in the nearshore, shoreline geology and topography. Due to the wide variability in storm climate, hydrodynamic loading, offshore to nearshore transformation, and coastal exposure within the NE Pacific Basin, it will be important for research efforts to start with sub-regions and work outward. Involving experienced district coastal representatives is essential to achieving mission area usefulness. Establishing a framework, defining uses, and identifying relevant products for the sub-regions will help target the data/analysis research needs so that funds are used wisely and produce a usable product that achieves mission execution.

NORTHEAST PACIFIC BASIN – OCEANOGRAPHIC CONDITIONS AND COASTAL PROCESSES

Hans Moritz
Hydraulic Engineer
Portland District
U.S. Army Corps of Engineers

Heidi Moritz
Coastal Engineer
Portland District
U.S. Army Corps of Engineers

100th BCER
San Francisco, CA
14 August 2024

U.S.ARMY

US Army Corps of Engineers®





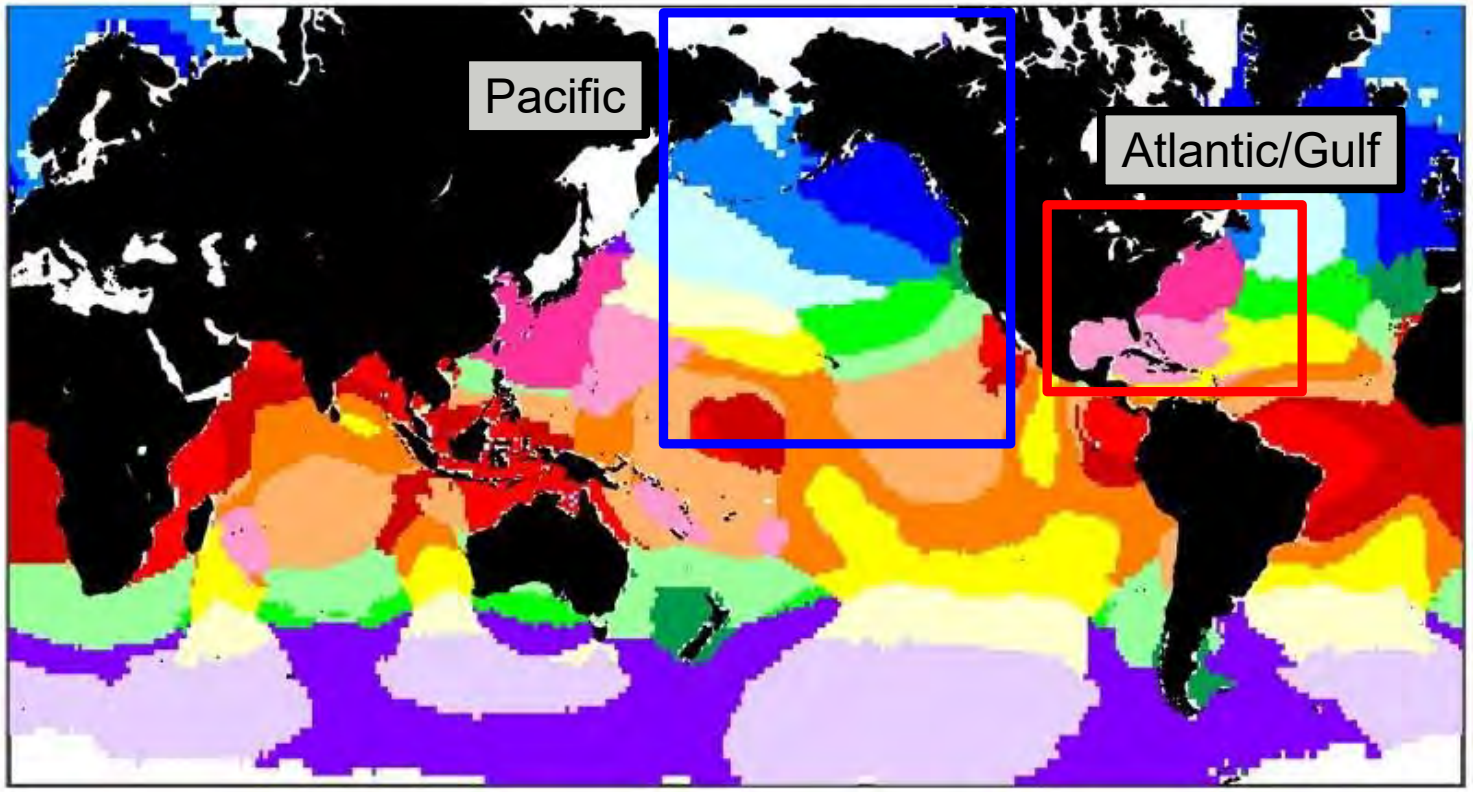




NE Pacific Basin Approach– Bottom Line

- Important to understand the **significant differences within the Pacific Basin regions** – storm climate, water level trends, project area exposure
- **Extratropical storm systems dominate** placing more emphasis on duration, frequency, and combined forcing for all seasons – *(time series data in addition to extremal statistics)*
  Large storm surge is not a driving variable.
- Each USACE mission area may be controlled by a **different range/frequency/sequence/ combination** of oceanographic and coastal variables *(Navigation is main mission area. Fewer Coastal Storm Risk Management projects in the Pacific Basin)*
- Ignoring the **infragravity water level component** will significantly underestimate total water level, wave loading, and sediment movement (erosion & deposition).
- **Transformation of hydrodynamic forcing across the nearshore and coastal zone** drives risk and will change over time *(depth-limited wave height and water level combinations, interaction with land-based processes)*
- **Project study needs differ** between USACE mission areas and investigation, operational, planning and engineering applications – (*avoid the one-size-fits-all approach)*

Wide Variability of NE Pacific Basin Forcing
(and contrast to Atlantic / Gulf coasts)



One study conducted by Rueda, et al produced a graphical guide to the main drivers of coastal flood hazards, including tide, tropicals, extratropicals, wave, surge, etc. This study acknowledged the wide range of coastal driving forces and lays out approximate boundaries.

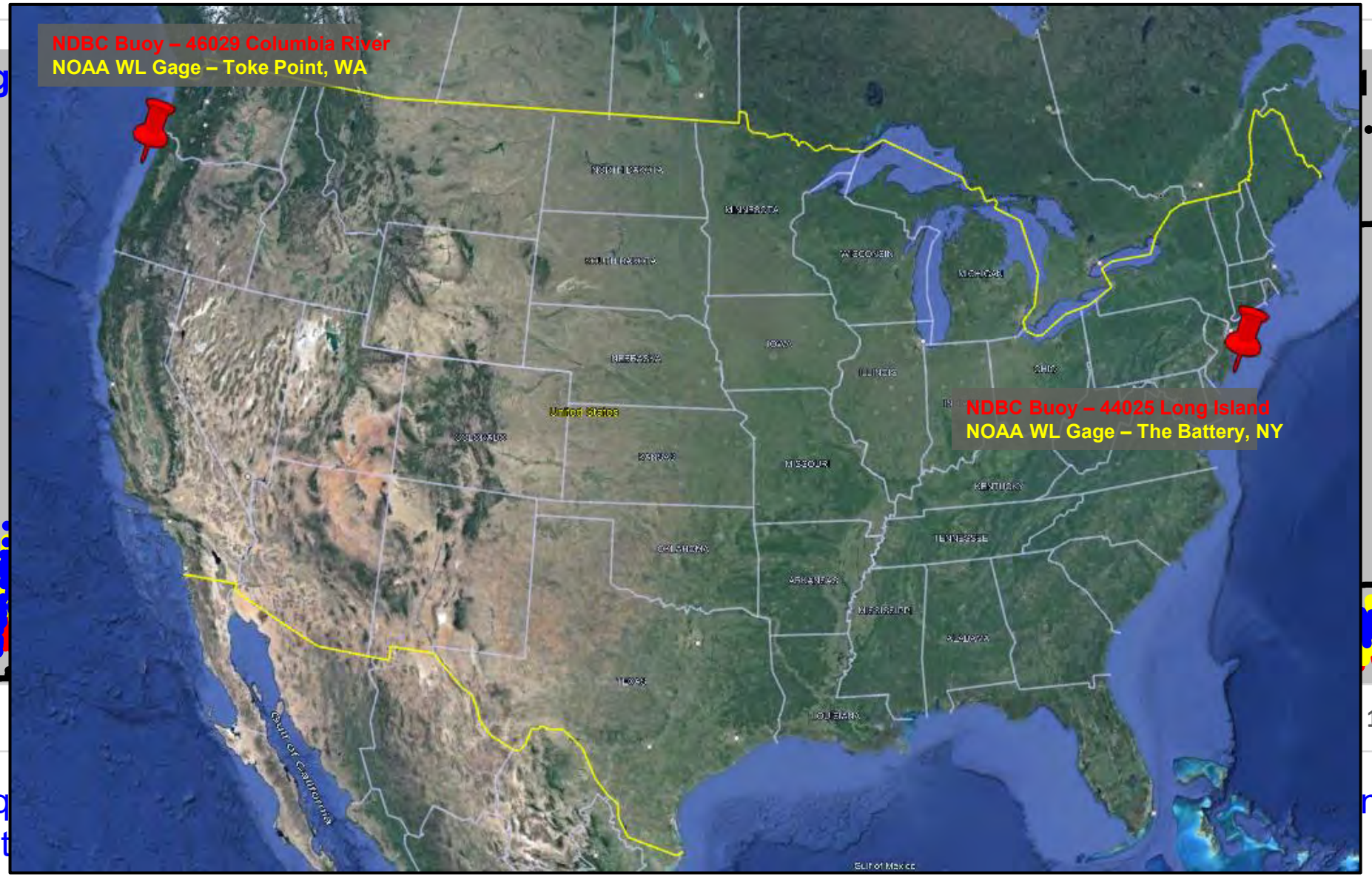
Contrast size and variability of ocean basins – East\West\Gulf coasts

Important to be aware of the tendency to lean on a one-size-fits-all or enterprise system approach. If applied inappropriately, major hydrodynamic loading and risk factors (as well as changes into the future) may be missed.

POSSIBLE IMPACTS: getting the answer wrong, inefficiency of study dollars, not achieving effective mission execution.

Storms and Loading Climate – Comparing East to West Coasts

Long Island, NY to Columbia River, OR Waves and Storm Power



Oreg

100

Wave Height (m)

16
14
12
10
8
6
4
2
0

27-Aug

12-Aug

40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0

Cumulative Storm Power (Joules (10^{10}) per 100-meter wave crest)

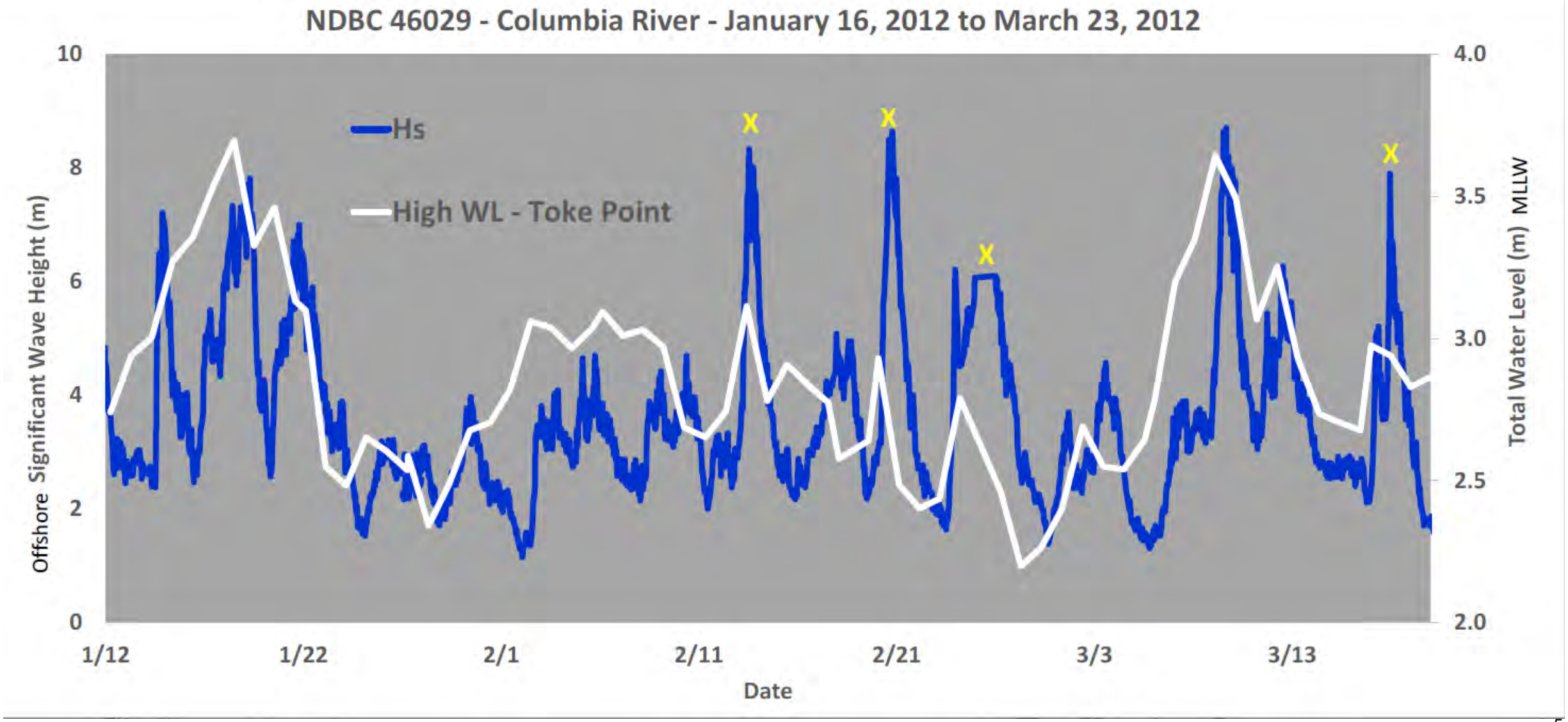
The freq

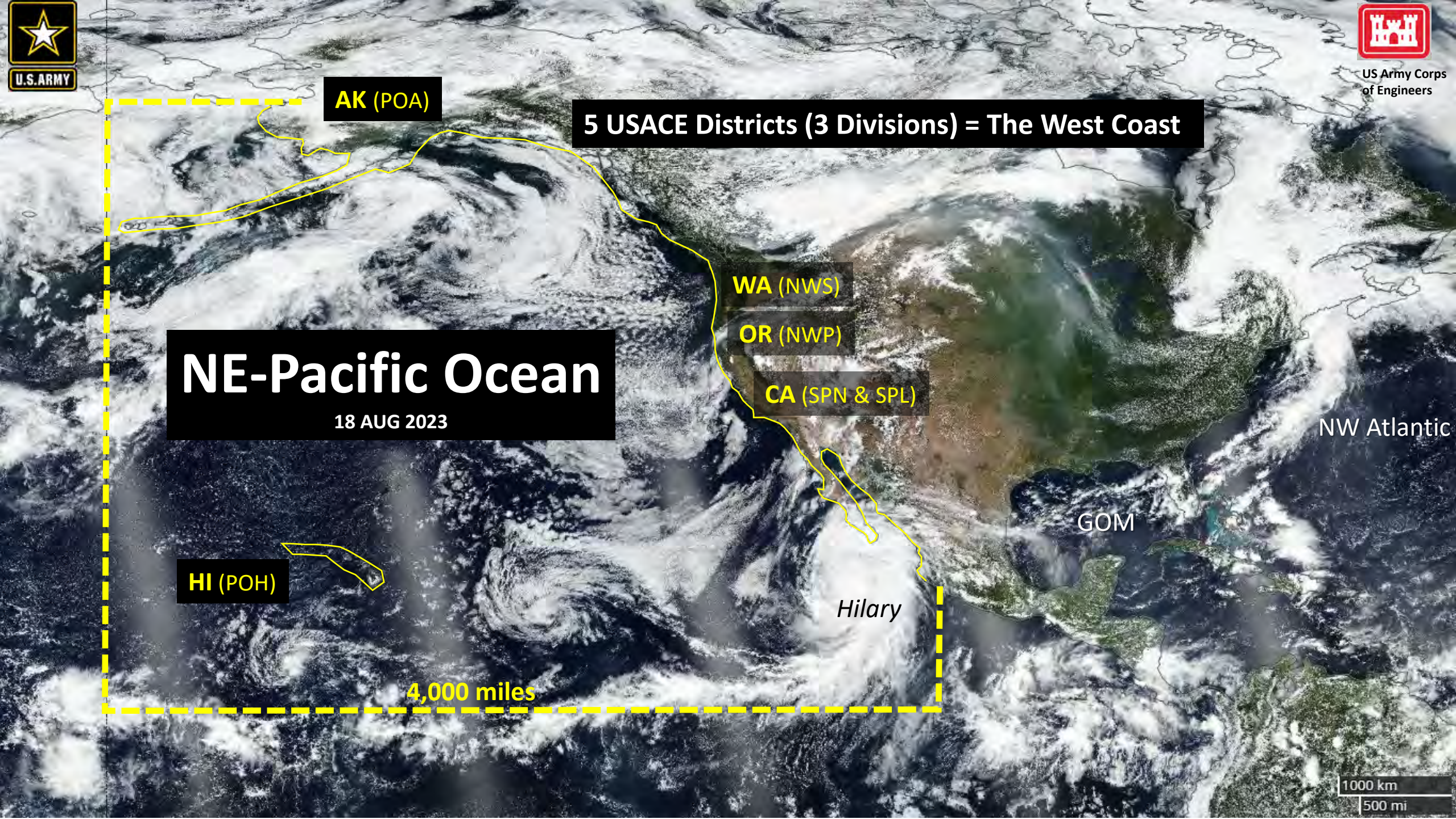
nd El Nino

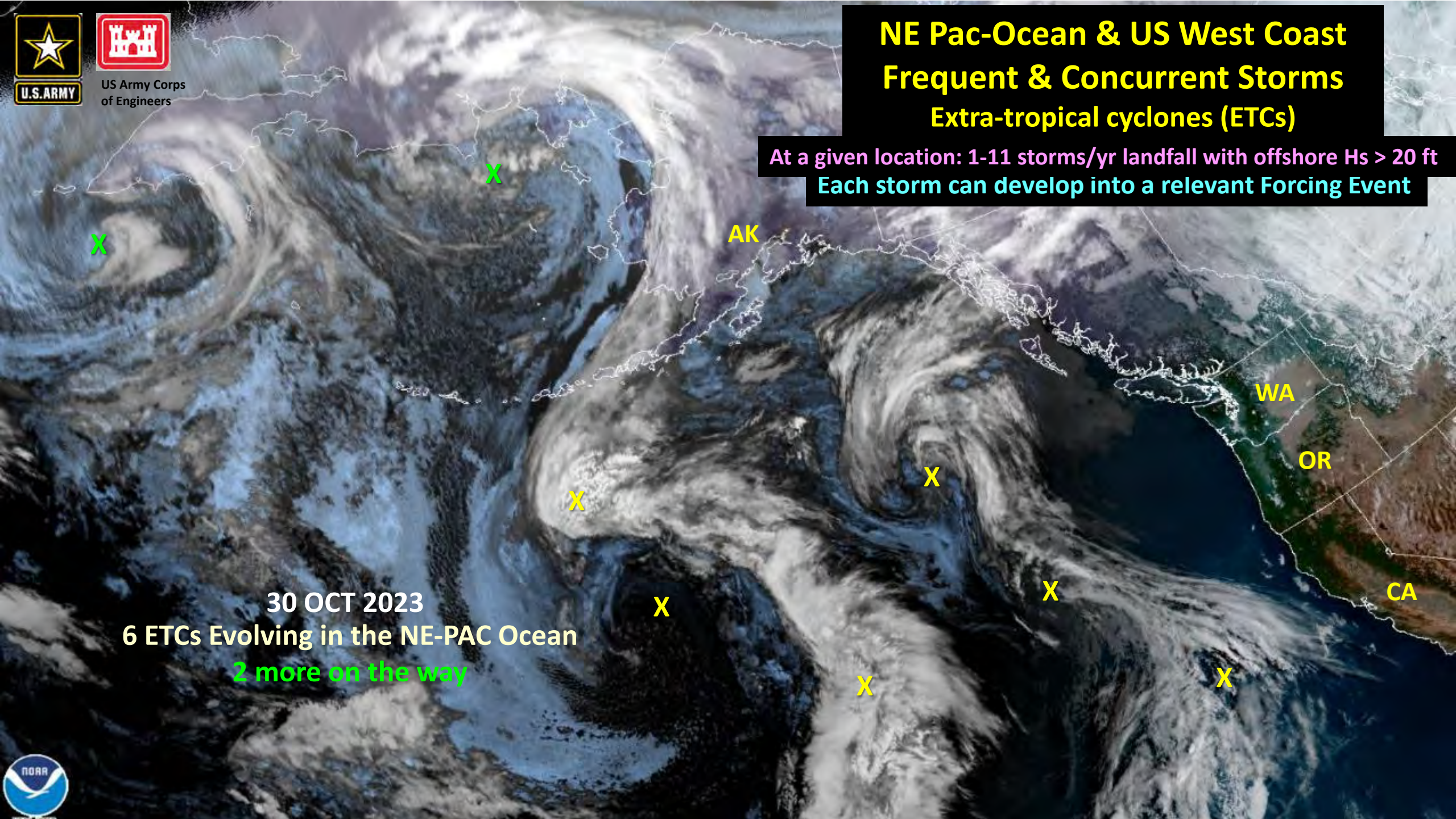
applies t

Defining a Storm Event by Water Level will NOT include Important Wave Events (X)

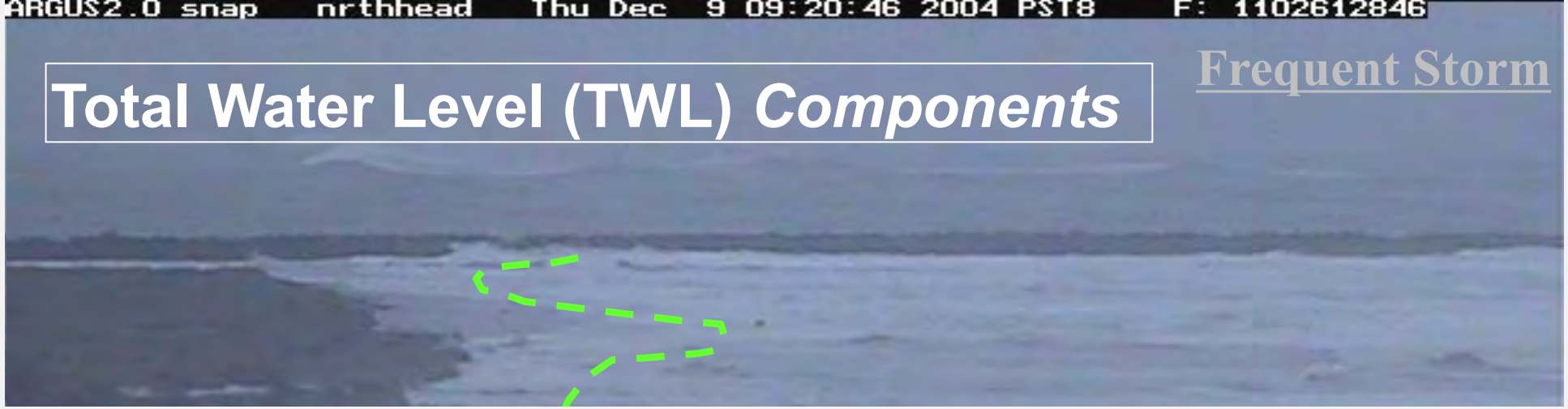
For West Coast----Define Coastal Forcing Events using Wave metrics (height and period)---consider Storm Power
Include total water level as contributing metric




U.S.ARMY
US Army Corps of Engineers
AK (POA)
5 USACE Districts (3 Divisions) = The West Coast
WA (NWS)
OR (NWP)
CA (SPN & SPL)
NE-Pacific Ocean
18 AUG 2023
NW Atlantic
GOM
HI (POH)
Hilary
4,000 miles
1000 km
500 mi


U.S.ARMY
US Army Corps of Engineers
NE Pac-Ocean & US West Coast
Frequent & Concurrent Storms
Extra-tropical cyclones (ETCs)
At a given location: 1-11 storms/yr landfall with offshore Hs > 20 ft
Each storm can develop into a relevant Forcing Event
AK
WA
OR
CA
X
X
X
X
X
X
X
30 OCT 2023
6 ETCs Evolving in the NE-PAC Ocean
2 more on the way
NOAA


U.S.ARMY
US Army Corps of Engineers
AK
WA
OR
CA
West Coast Storm Environment: Bottom Line
Extra-Tropical Storms can be Severe, Occur Frequently, and impose Big & Complex effects on the Coastal Zone
USACE west coast districts need ERDC West Coast R&D efforts to focus on understanding how ETCs and long-period waves affect nearshore waves, water levels, and circulation within various regions of the NE-PAC basin.
NOAA
NOAA/STAR
06 Apr 2024 20:40Z - NOAA/NESDIS/STAR - GOES-West - GEOCOLOR Composite - NP



US Army Corps of Engineers

TWL = *Water Level due to TIDES* *(high tide for 1-hour, every 12 hours)*

+ *Static STORM surge* *(6-72 hours)*

+ *Infragravity (IG) transient* ** *(2-3 minutes, every 10-60 minutes)*

** = R&D Need

+ *Seal Level Rise* *(years)*

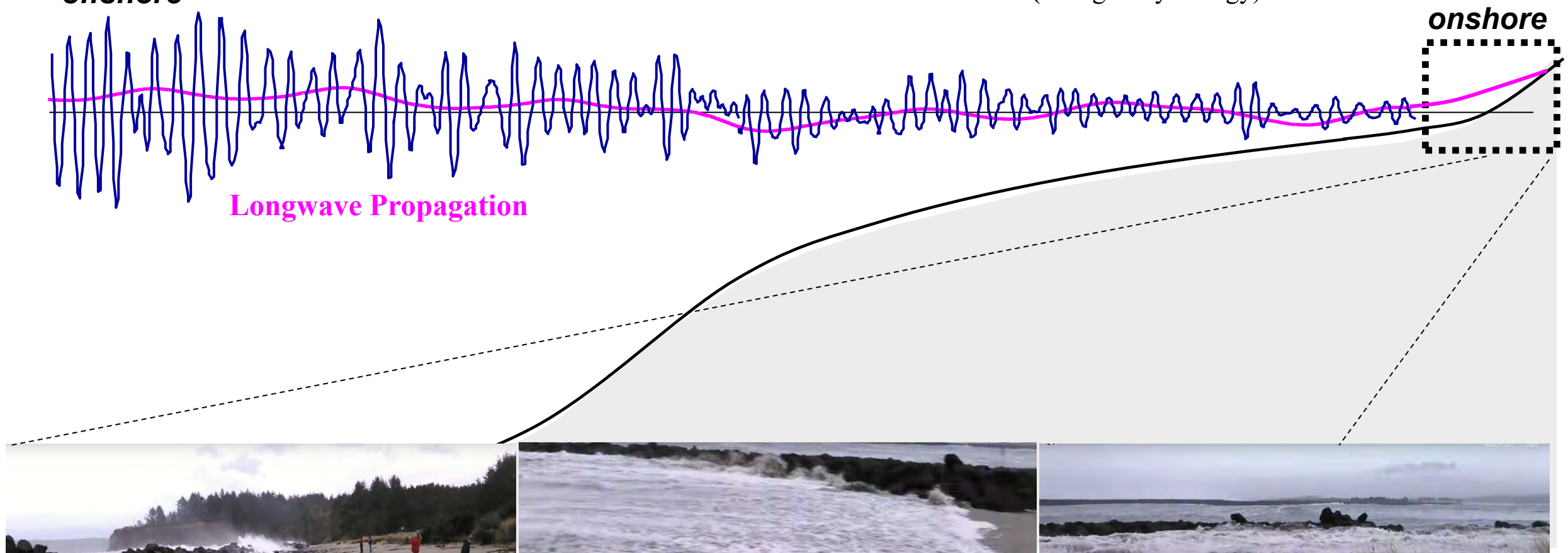
>> Accounting for ALL relevant water Level Components is essential for evaluating *Depth-Limited* *Wave Height* in coastal zone**

Not doing so will result in deficit project design, poor project performance, and increased risk.

Water Level Component: *Infragravity Transients within Nearshore*

US Army Corps of Engineers

Effect on water level & Erosion is like a mini tsunami (Infragravity Energy)









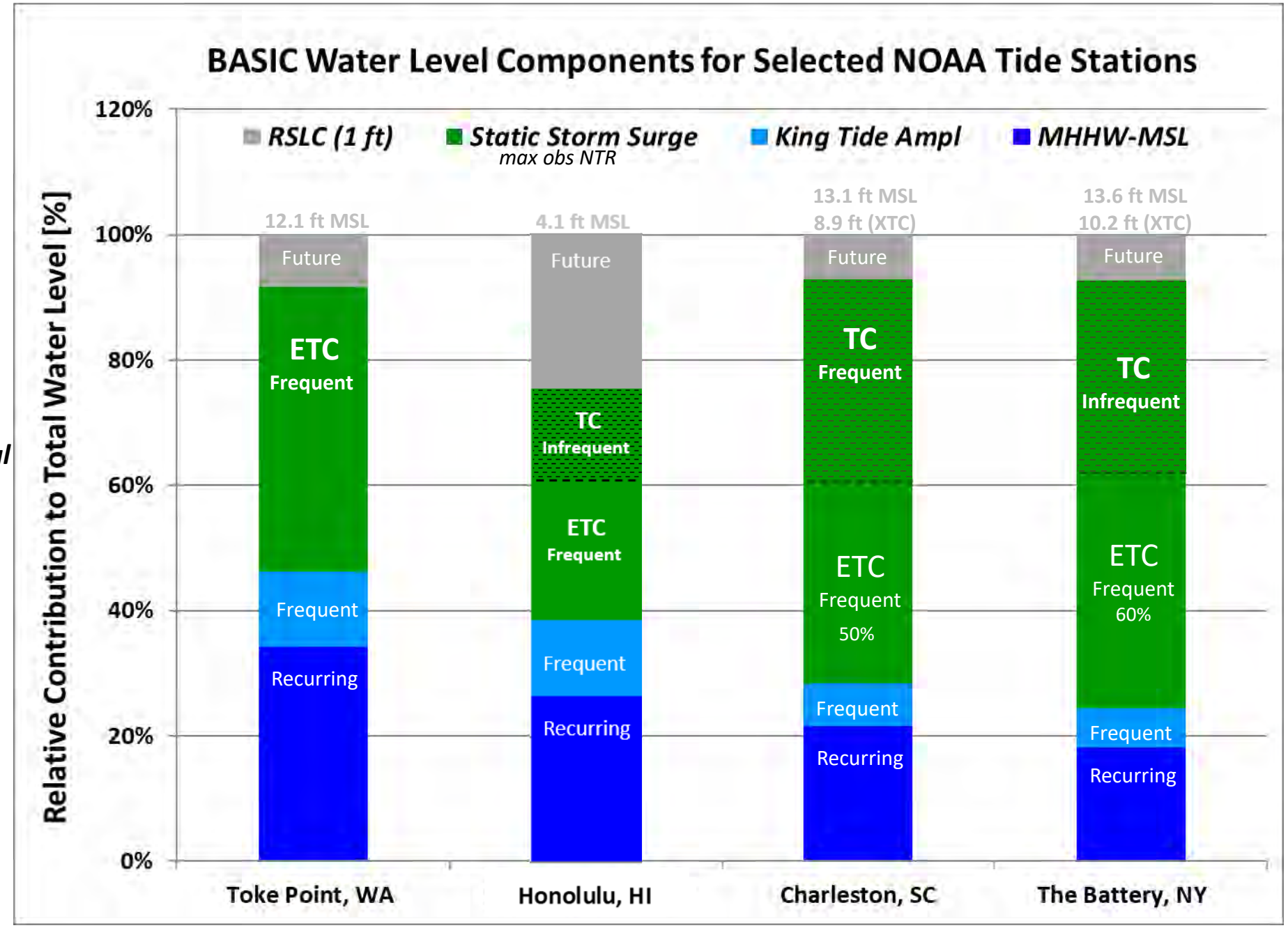
——— = long (bound) waves produce 1 to 3+ ft water level transients lasting 1-3 minutes, η

US Army Corps of Engineers

TIDE
Very important for West Coast water level

ETCs
Big driver for total water level for most of West Coast

RSLC
Relevant for all West Coast. Some locations highly sensitive.



ETCs
relevant to East and West Coast

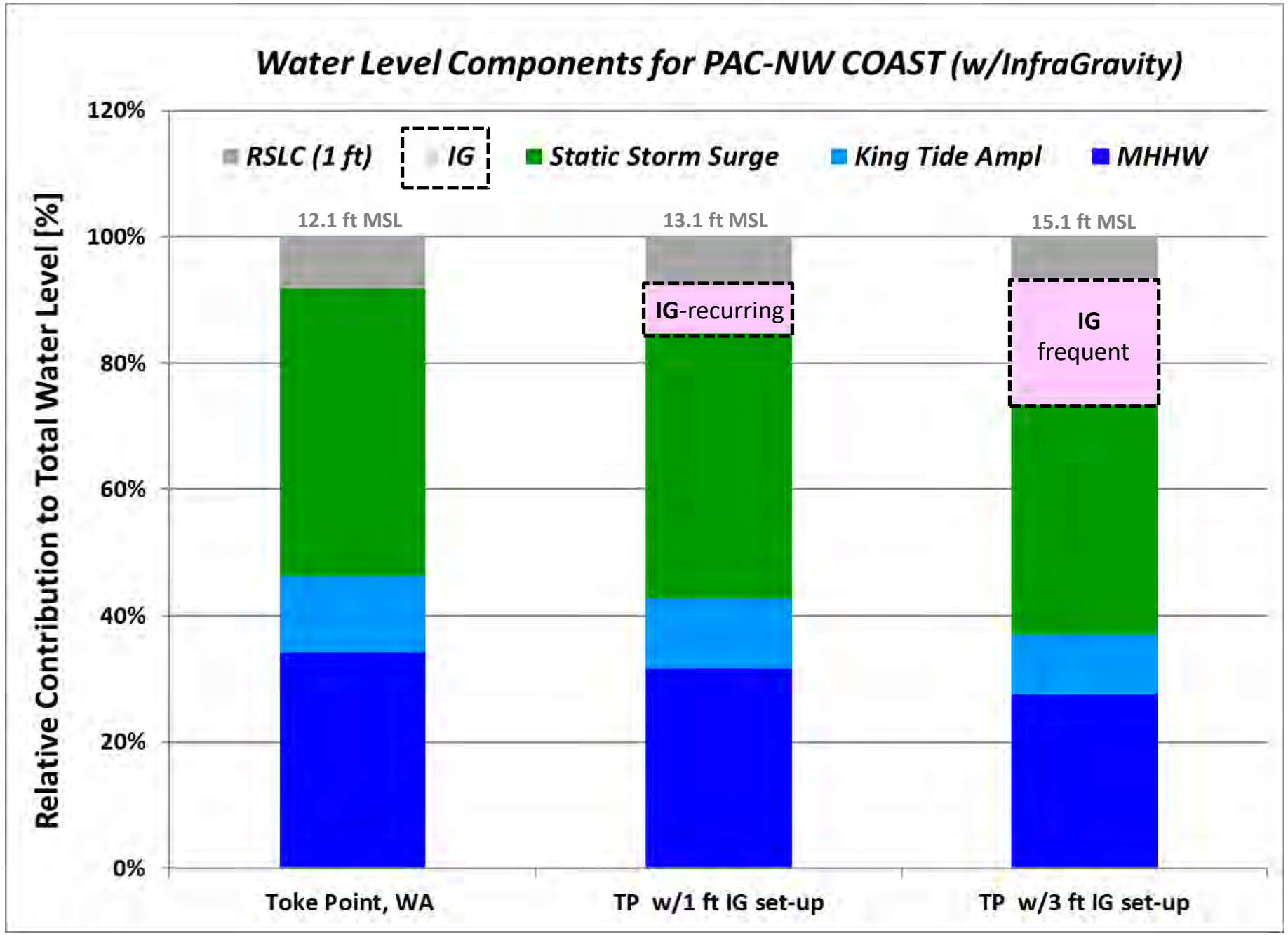
RSLC wrt 1992 MSL

US Army Corps of Engineers

IG Waves

Very important for West Coast total water level.

May have relevance for other coasts affected by long period waves



IG Waves

Ignoring IG will significantly underestimate TWL, wave loading, and sediment movement (erosion & deposition).

RSLC wrt 1992 MSL

Mission Areas within the Changing Coastal Zone

(What is a Pacific Ocean basin hazard and how might that differ from other coasts?)

Coastal Zone Extends from Offshore to Backshore/Estuaries - Districts need a larger understanding of the nonstationarity and weak points of the Coastal Zone with climate change and over time for the range of mission areas

Wide and Diverse Range of Nearshore and Shoreline Types – sandy beaches, cobble beaches, permafrost shorelines, ice-protected areas, high coastal bluffs, islands, fringing reefs, evolving estuaries, river- vs ocean-dominated inlets

Land-based vs nearshore vs ocean-based processes – combining with rivers, precipitation, atmospheric rivers

Range of USACE Mission Areas and Risk Management – how should we be analyzing risk, resilience, and adaptation in the larger coastal zone

Better Coastal Zone Understanding Moves USACE away from Disaster Reactions – National Shoreline Management Reports have been developed for all USACE regions and can present results

Understanding the full coastal zone exposure and response will inform data needed and coastal processes requiring more research.

Changing Coastal Zone Impacts to Community Resilience

Union of Concerned Scientists Climate Energy Transportation Food Nuclear Weapons Scien

REPORTS & MULTIMEDIA / REPORT

Looming Deadlines for Coastal Resilience

Rising Seas, Disruptive Tides, and Risks to Coastal Infrastructure

Published Jun 25, 2024

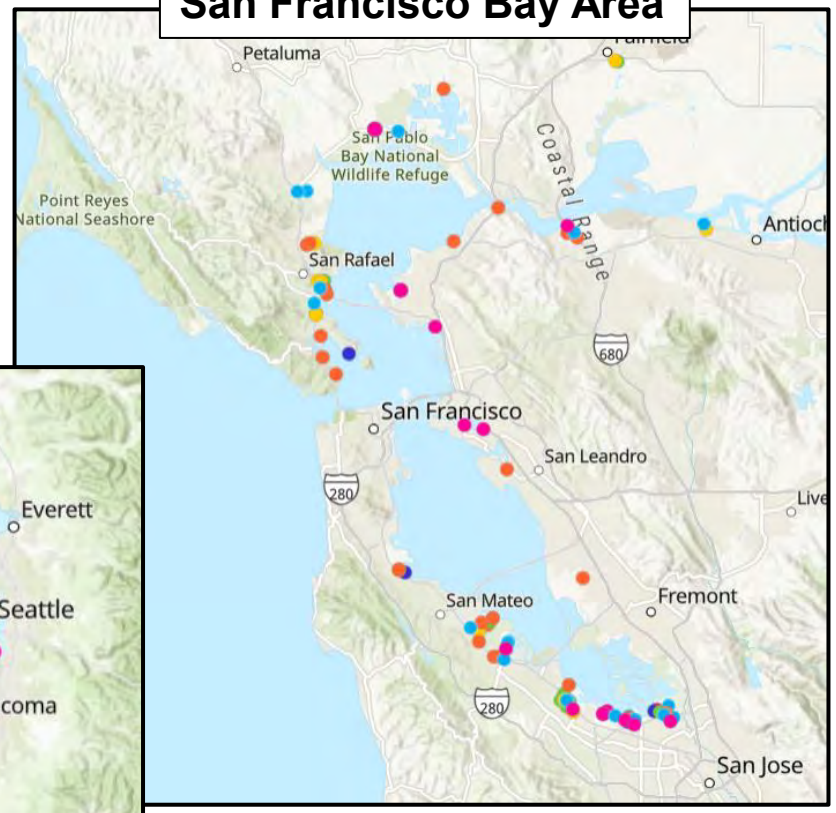
Critical infrastructure up and down the coastlines of the United States is increasingly under assault from flooding during high tides and frequent storms as climate change-driven sea level rise brings water further into coastal communities.

The impacts on critical infrastructure are borne disproportionately by disadvantaged communities.

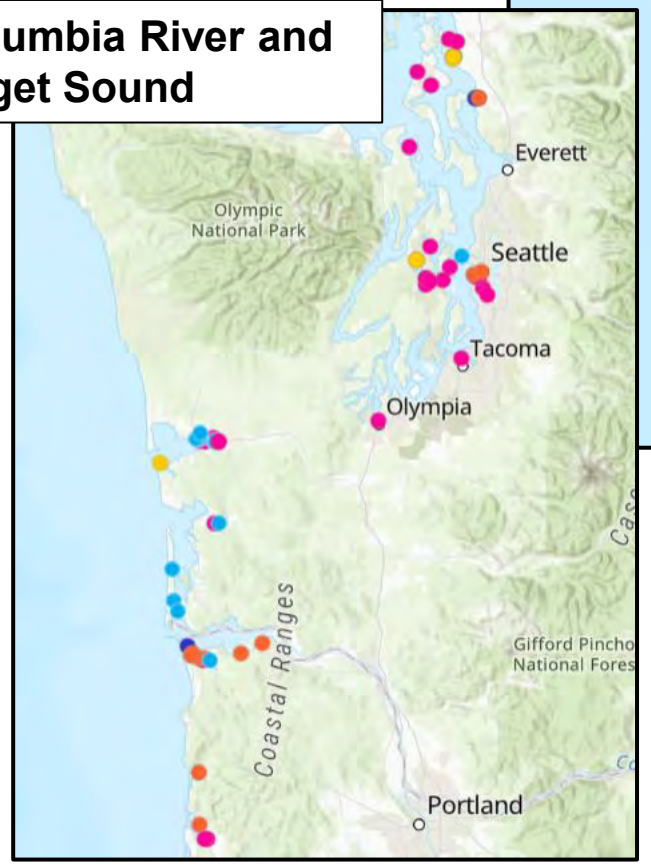
The analysis points to actionable, science-informed steps that can and must be taken to protect vital infrastructure and services.

In Oregon, critical infrastructure appears most vulnerable around Astoria, Tillamook, and Coos Bay.

San Francisco Bay Area



Columbia River and Puget Sound



Category of affected infrastructure

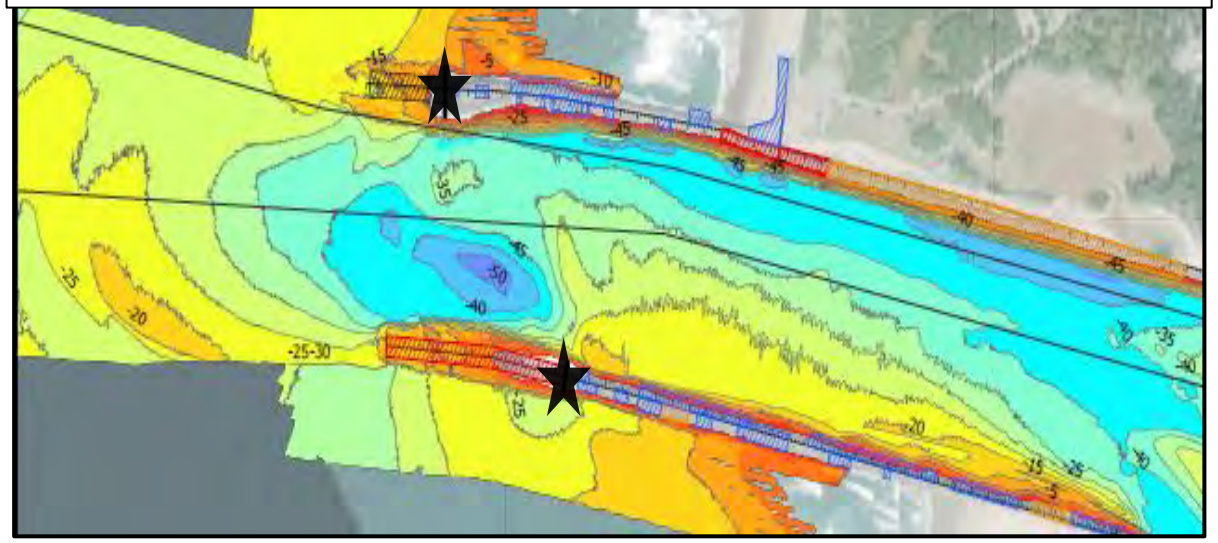
- Public & affordable housing
- Energy infrastructure
- Industrial contamination sites
- Public safety or health facilities
- Government facilities
- Educational institutions

Hazardous Coastal Navigation Entrances and Small Vessel Navigation Criteria

- Navigation entrances are routinely used during high storm power months – November to March – per fishery season and as harbors of refuge.
- Coastal structure maintenance backlog can leave structures damaged and can result in entrance shoaling changes and complex wave/current interactions.
- At what jetty length loss are we substantially impacting the navigation entrance and the project function?
- What would be a justified maintenance investment to reduce navigation reliability risk and address life safety concerns?
- Many of these projects serve EJ or disadvantaged communities.
- **Research Needed:** Structure deterioration impacts on navigation reliability – connected to Comprehensive Benefits for disadvantaged coastal communities.



Entrance bathymetry mirrors the receded location of the damaged jetty heads – noted by the black stars.



Sediment Management at *West Coast* Inlets & Estuaries

Coastal Navigation is a Legacy of Inlet Stabilization

Many engineered inlets are evolving (energetic coastal forcing) --- NAV infrastructure requires SMART maintenance

Evolving Morphology Conditions Dictate Maintenance

Resilience Strategy #1--- Understand the forcing environment *(ETCs & cyclic climate drive inlet response = dredging)*
Resilience Strategy #2--- Use dredged material to sustain sediment budget & morphology *(need 'tools' for ETC effects)*
Resilience Strategy #3--- Do no harm to ecology & stakeholder use of the area = Do good Science & COLLABORATE !

Navigation Assets & Ecology are linked to Sustaining Morphology = Sediment Management

USACE objective: Achieve 70% *Beneficial-Use* for dredged sediment = where-when to efficiently place w/o adverse effects

Engineered Inlets & Estuaries Continue to Evolve **big processes (changes) can affect big responses (changes)**

Sustaining Coastal Mission Assets Never Ends = We NEED capability to anticipate project maintenance & adaptation

BOTTOM LINE: USACE west coast districts NEED improved insight for how 'west-coast' coastal processes affect sediment, morphology change, structure-morphology interaction.

If not, then we will not be able to successfully manage sediment for our coastal NAV, ER, and CSRM projects

U.S.ARMY

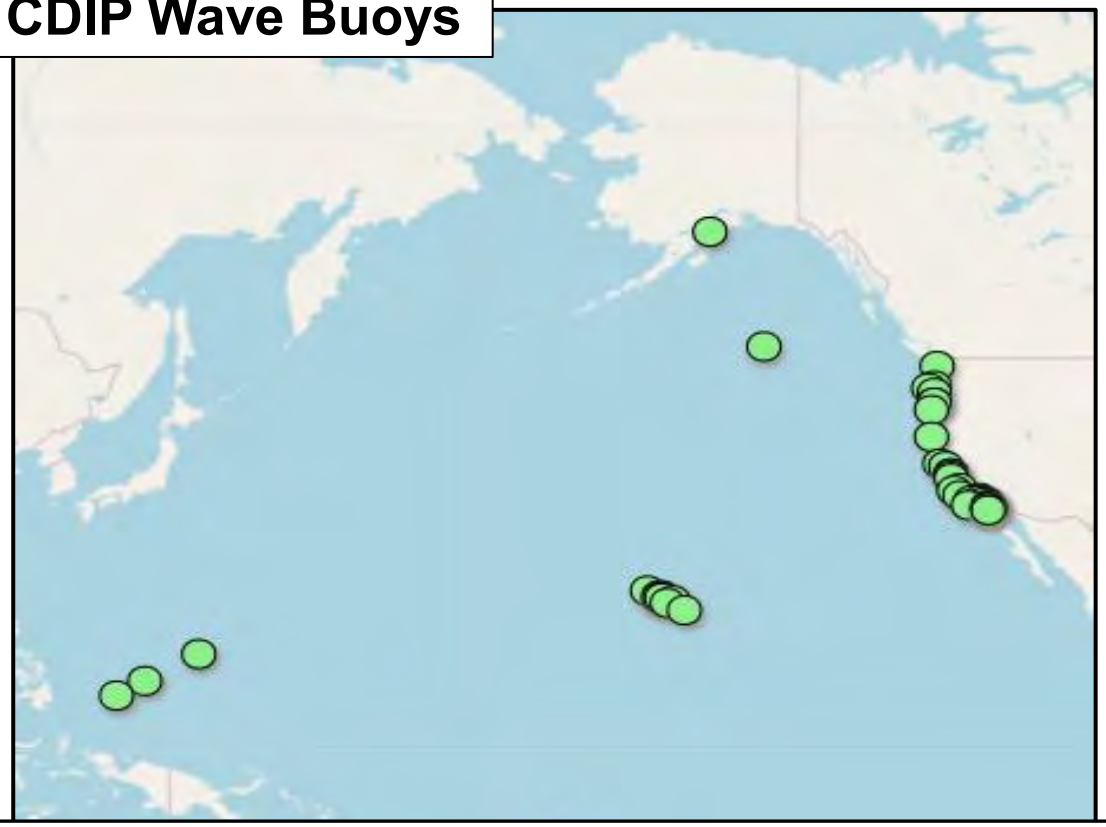
US Army Corps of Engineers

Data Currently Available and Used

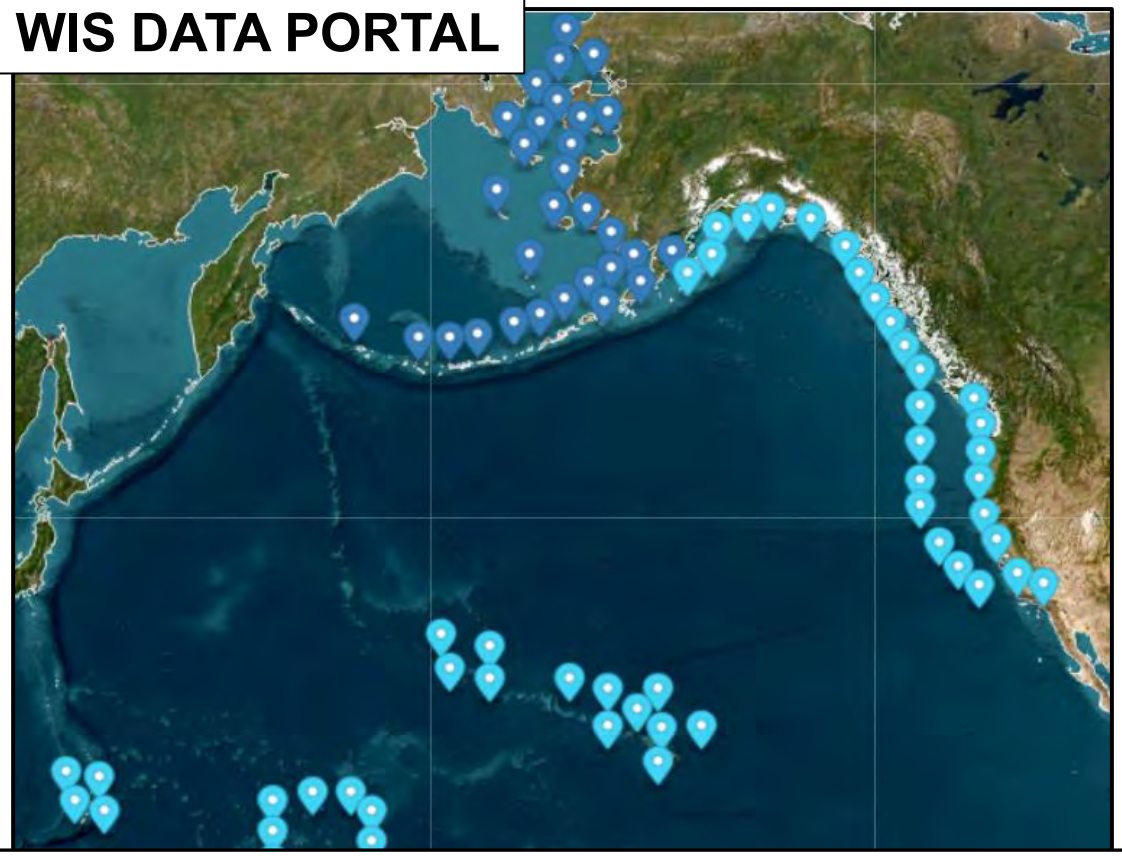
- **NOAA water level** and sea level change projections
- **WIS hindcast data**, windspeed data from airports
- **CDIP/PACIOOS/NDBC wave buoys, MOPS**
- **NOAA Wavewatch 3**, ETSURGE forecasts, USGS forecasted wave timeseries to 2100 at 10 m depth
- Bathymetry/topography/aerial mapping/**LIDAR/JABLTCX**, locally collected data

Many remote areas in POA and POA have atypical maritime and morphology conditions and are data deprived.

CDIP Wave Buoys



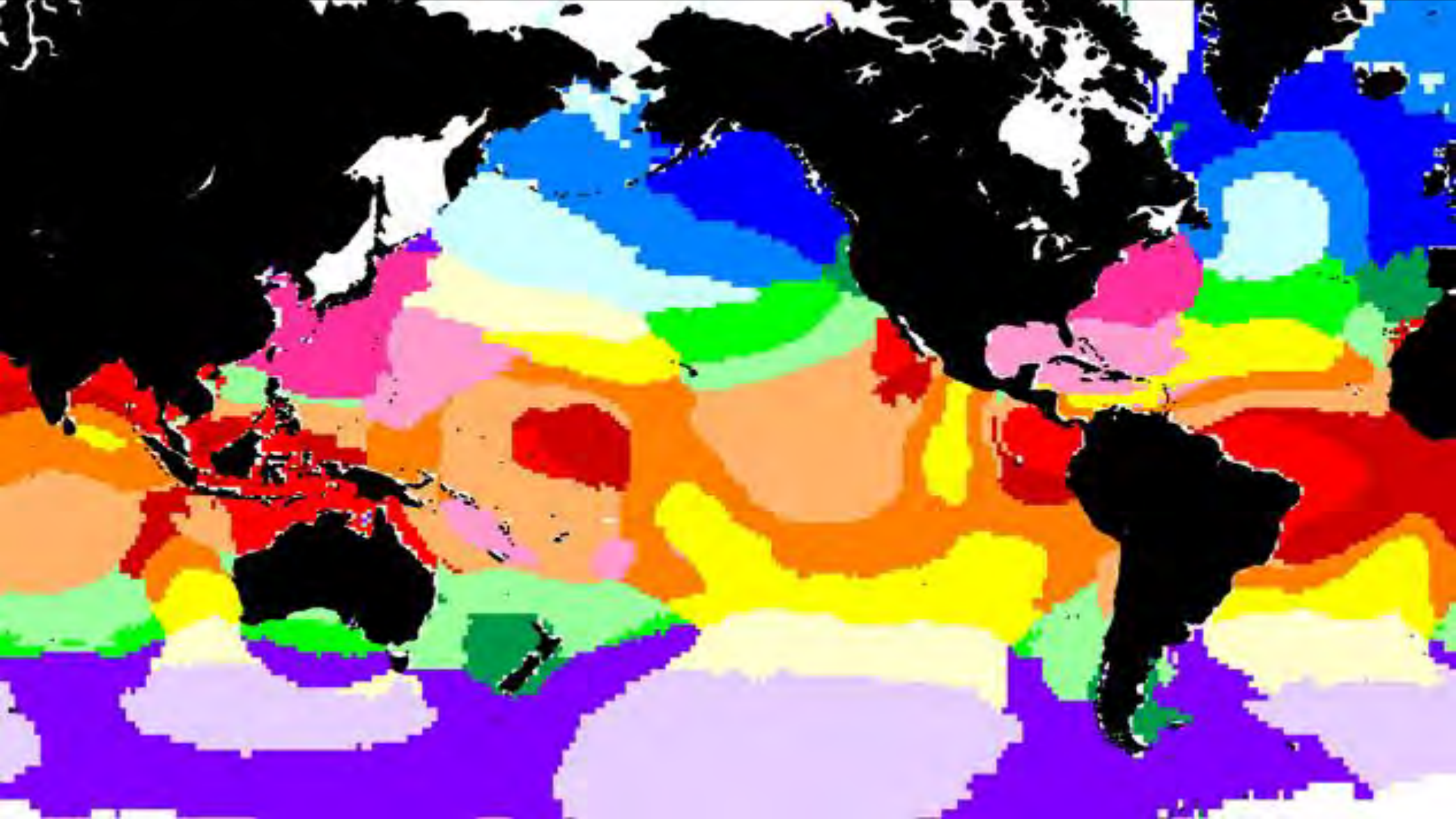
WIS DATA PORTAL



Important to not assume that this large, diverse region needs what other USACE regions have developed.

Research Needs

- Identification and description of **Pacific Ocean decadal cycles** that may impact more than one sub-region and assessment of relevant future changes.
- Description of **sub-region specific coastal processes and variables** including the identification of essential data or analysis tool gaps.
  - Understanding how **ETCs and long-period waves** affect nearshore waves, water levels, and circulation within various regions of the NE Pacific Basin.
  - Capturing and analyzing how **infragravity waves** contribute to combined hydrodynamic forcing and coastal processes.
  - Development of usable **boundary conditions** for more focused project area analysis.
- Investigation into **range of water level component combinations** that affect project loading – ranging from multiple times per year to infrequent events.
- Investigation into realizable values for **depth-limited waves** for the coastal zone.
- Improved insight into how NE-PAC coastal processes affect **sediment movement, morphology change**, **structure-morphology interaction**.
- Define Structure-morphology impacts on **navigation reliability at coastal entrances.**



Curt D. Storlazzi, Ph.D.

Curt is a senior research geologist in the U.S. Geological Survey's Coastal and Marine Hazards and Resources Program that specializes in coastal hydrodynamics and sediment dynamics on tropical coastlines. He presently leads a team examining the geologic and oceanographic processes that affect the growth and vitality of coral reefs, the hazard risk reduction they provide adjacent coastlines, and how climate change and sea-level rise will increase flooding hazards to and reduce the resiliency of coral reef-lined coasts and their associated communities.

Curt has published over 200 journal articles and reports that have been cited over 8000 times, being the first author on 12 papers each with more than 100 citations on topics ranging from sea-level rise impacts on atolls to sediment dynamics on coral reefs, coral reefs as nature-based solutions, sediment impacts on water column optics, and oceanographic controls on the geomorphology of coral and rocky coastlines.

Curt is currently a United Nation's Third World Ocean Assessment author and was an author on the U.S. 5th National Climate Assessment. He is on the steering committee for the U.S. Coral Reef Task Force and regularly contributes scientific review for the U.S. Department of the Interior, Department of State, and Department of Defense along with the U.S.' and other countries' National Science Foundations.

For the Department of Defense, Curt led the SERDP RC-2334 Project (*The Impact of Sea-Level Rise and Climate Change on Department of Defense Installations on Atolls in the Pacific Ocean*) that was noted in Section 335 "Report on the Effects of Climate Change on Department of Defense" of the 2018 National Defense Authorization Act. Previously, he was a co-PI on the SERDP RC-2622 Project (*Vulnerability of Military Installations in the Pacific Basin to Coastal Flooding Under a Changing Climate*) and led projects for the USACE-Engineering Research Development Center focused on fine-grained dredge disposal in the nearshore over rocky reefs in California and the USACE-Honolulu District on the impact of watershed restoration on adjacent coral reefs off Maui. Currently, Curt is a technical lead for DARPA's Reefense Program and a co-PI on the ESTCP CR21-5028 (*Assessment of Total Water Levels for Coastal Military Facility Readiness and Resilience*) and CR23-7797 (*Defense Regional Sea Level [DRSL] Database Update*) Projects.

In 2022, Curt was awarded only the fourth scientific achievement award by the US Coral Reef Task Force in its multi-decade history for his, *"...unwavering dedication to science, willingness to collaborate and consult with local managers, and exceptional communication of research in a way that makes [his] findings actionable."* Earlier this summer, he was granted the highest honor of the US Department of the Interior, the Distinguished Service Award, in *"…recognition of outstanding contributions in the development and delivery of a cutting-edge applied science to assess the role of the Nation's coral reefs in coastal hazard risk reduction."*

Climate Change, Sea-Level Rise, and Pacific Island Processes

Climate change and sea-level rise (SLR) will exacerbate the wave-driven flood and erosion hazards to infrastructure, freshwater supplies, agriculture, and habitats for threatened and endangered species on US and US-affiliated islands. Although absolute rates of sea-level rise (SLR) and projected 2100 global sea levels are still under deliberation, the models consistently forecast that eustatic sea level will be considerably higher by the end of the century and that SLR rates are especially accelerating for the western Pacific Ocean. On atoll islands and tropical high islands, typically most of the population, infrastructure, critical habitats, and regions of cultural significance are situated at low elevations (<4 m), near the shoreline and on coastal plains. Yet the amount of land and water available on these low-lying areas for human habitation, water and food sources, and ecosystems is limited and extremely vulnerable to wave-driven flooding during storms and inundation from SLR. Coral reefs that line most tropical Pacific Islands are effective natural barriers that protect adjacent coastlines from hazards such as erosion and storm-driven flooding. However, the projected rates of SLR far outstrip vertical coral-reef accretion rates, thus, reducing the coastal protection afforded to tropical islands by coral reefs. In addition, corals will be negatively affected by other climate change processes, such as thermal bleaching, ocean acidification, and disease outbreak, further impacting the ability of reefs to provide coastal protection.

I will first present on projected climate trends and their impacts on relevant coastal processes. I will then present on multidisciplinary, multi-institutional efforts to understand how SLR and climate change will likely impact atoll islands and tropical high islands' coastal plains in the Pacific Ocean using field observations, global climate model outputs, and coastal engineering models to drive coupled hydrodynamic, hydrogeologic, and sediment dynamic models for several SLR and climate change scenarios. SLR and climate change will reduce the ability of coral reefs to mitigate wave-driven flooding in the future, leading to more frequent, persistent, and extreme coastal flooding and erosion that would damage infrastructure, freshwater resources, and threatened habitats.

The degradation of coral reefs by not only global climate stressors, but also land-based local stressors, compromises their efficacy to protect against erosion and storm-driven flooding hazards, making coral reefs a target for restoration and enhancement as a nature-based solution. At present, there is little guidance on how and where to restore coral reefs for tropical coastal hazard risk reduction. I will present how a physics-based numerical coastal engineering model can be used to help identify areas – down to the centimeter scale – where coral reef restoration could help reduce the risk to, and increase the resiliency of, coastal communities and their associated infrastructure, freshwater resources, and protected habitats. I will then discuss how we're working on quantification and optimization of coral reef restoration efforts to cost-effectively reduce coastal flooding hazards. Such efforts will allow hazard risk reduction funding to be made available for coral reef restoration and, thus, also provide communities co-benefits such as biodiversity, food security, and tourism.

References in Presentation:

ARISE Project: https://www.plymouth.ac.uk/research-and-expertise/coastal-processes-research-group/arise

Cheriton, O.M., Storlazzi, C.D., Rosenberger, K.J., 2016. *Journal of Geophysical Research-Oceans*, 121, 3121-3140.

Gingerich, S.B.; Voss, C.I.; Johnson, A.G., 2017. *Journal of Hydrology*, 551, 76–688.

Maynard, J., van Hooidonk, R., Eakin, C.M., *et al.*, 2015. *Nature Climate Change*, 5, 688-694. doi: 10.1038/nclimate2625

Masselink, G., McCall, R., Beetham, E., *et al.*, 2021. *Journal of Geophysical Research–Earth Surface*, 126, e2020JF005749, doi: 10.1029/2020JF005749

Norris, B.K, Storlazzi, C.D., Pomeroy, A.W.M., *et al.,* 2023. *Coastal Engineering*, 184:104331, doi: 10.1016/j.coastaleng.2023.104331

Norris, B.K, Storlazzi, C.D., Pomeroy, A.W.M., and Reguero, B.G., 2024. *Journal of Marine Science and Engineering*, 12:768, doi: 10.3390/jmse12050768

Roelvink, F.E., Storlazzi, C.D., van Dongeren, A.R., and Pearson, S.G., 2021. *Frontiers in Marine Science*, 8:653945, doi: 10.3389/fmars.2021.653945

Meucci, A., Young, I.R., Trenham, C. *et al.*, 2024. *Scientific Data*, 11:100. doi: 10.1038/s41597-024-02932-x

Shope, J.B., and Storlazzi, C.D., 2019. *Frontiers in Marine Science*, 6:245, doi: 10.3389/fmars.2019.00245

Storlazzi, C.D., Gingerich, S.B., van Dongeren, A., *et al.*, 2018. *Science Advances*, 4, eaap9741, doi: 10.1126/sciadv.aap9741

Storlazzi, C.D., Reguero, B.G., Cole, A.D., *et al*., 2019. *U.S. Geological Survey Open-File Report 2019–1027*, 42 p., doi: 10.3133/ofr20191027.

Storlazzi, C.D., Reguero, B.G., Gaido L., C., *et al.*, 2024. *U.S. Geological Survey Data Report 1184*, 21 p., doi: 10.3133/dr1184

van Hooidonk, R., Maynard, J.A *et al.*, 2014. *Global Change Biology*, 20, 103–112.

Winter, G., Storlazzi, C., Vitousek, S., *et al.*, 2020. *Frontiers in Marine Science*, 7:199, doi: 10.3389/fmars.2020.00199

Climate Change, Sea-Level Rise, and Pacific Island Processes



Curt Storlazzi, PhD
US Geological Survey
Coastal and Marine Hazards and Resources Program
Pacific Coastal and Marine Science Center

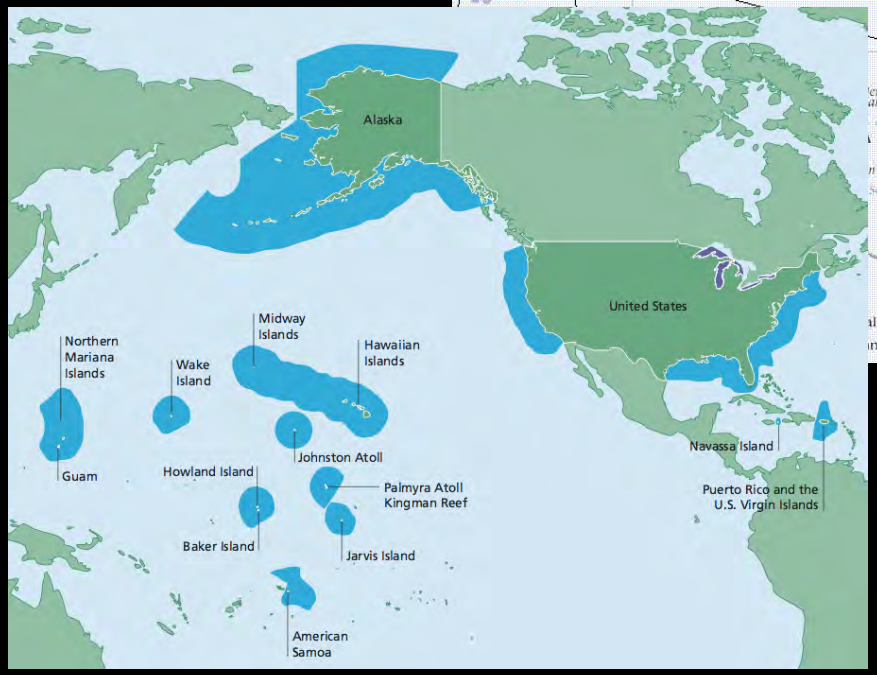
US and US-affiliated Assets in the Pacific Ocean

DOD facilities
DOI lands
EEZ *(Exclusive Economic Zones)*
- fisheries
- minerals

Compact Nations

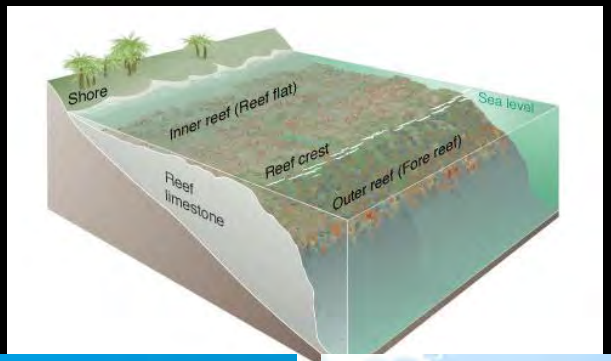


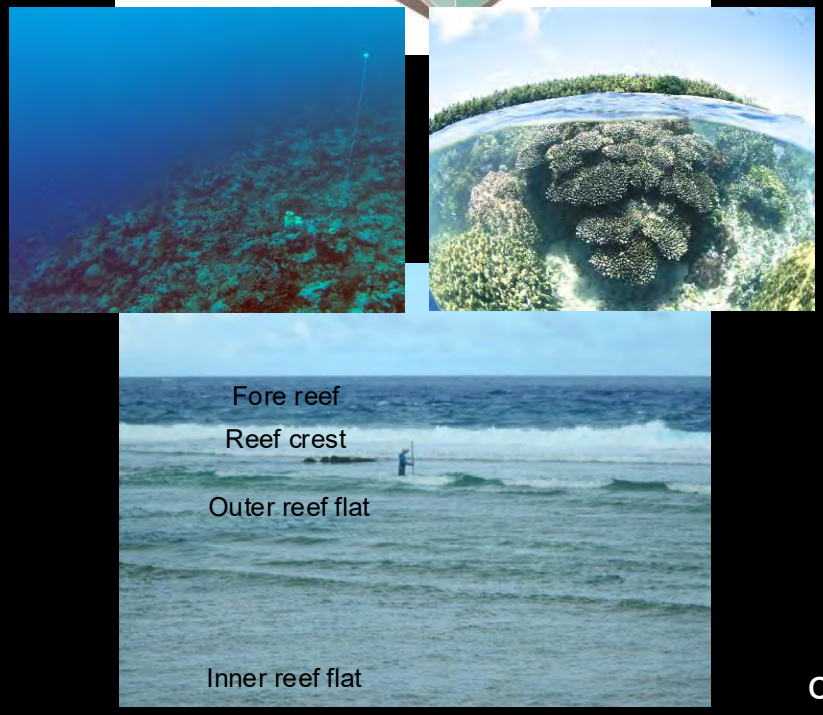
We have little to NO baseline data for most of these islands



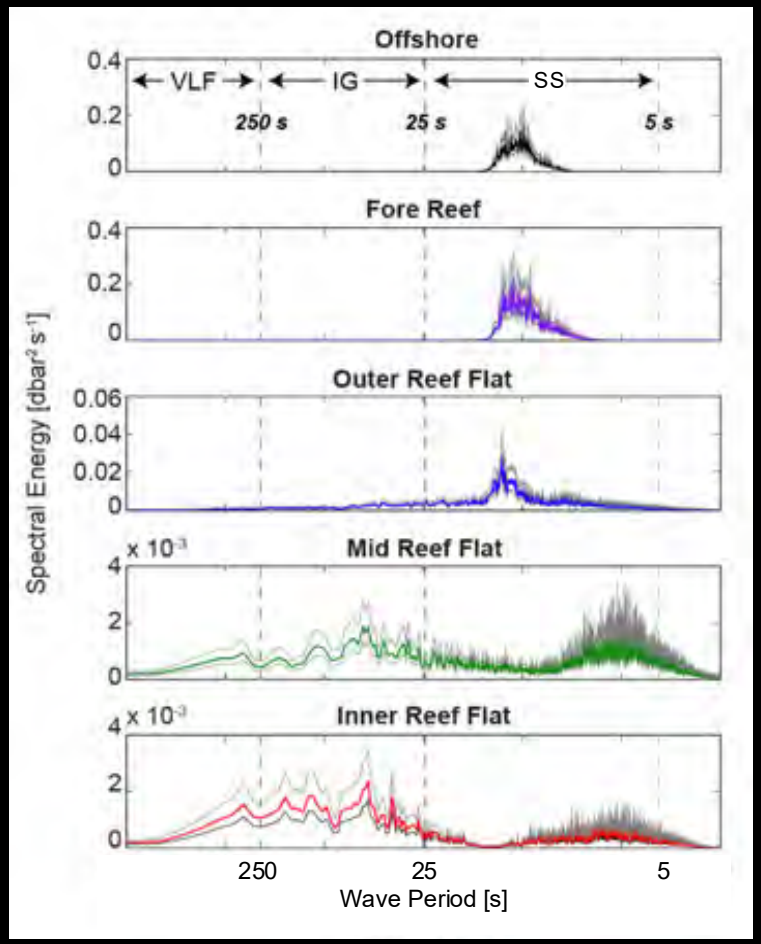


Reef Hydrodynamics





Cheriton et al. (2016)



Coastal run-up and resulting flooding is a function of wave period…thus importance of infragravity (IG) & very-low frequency (VLF) growth

Concern

On tropical islands, most of the population, infrastructure, and critical habitats are situated at low elevations protected by coral reefs.

Historically, large waves every 20-30 years flooded Pacific islands.

Now, wave-driven flooding events are happening multiple times a decade .







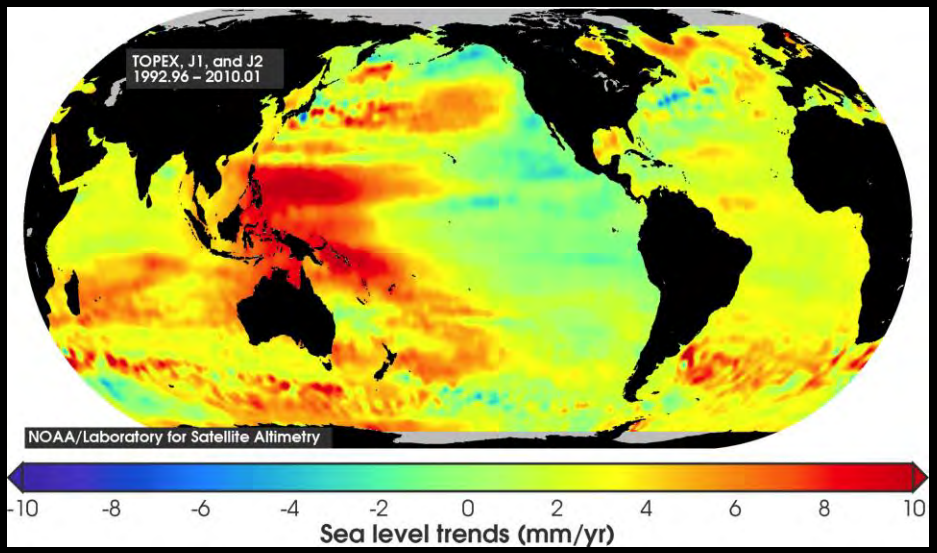




Sea-level Rise

Recent Trends:

Sea level in the western Pacific Ocean has been increasing at a rate 2-3 times the global average, resulting in up to 1 foot (0.3 m) of net rise since 1990.







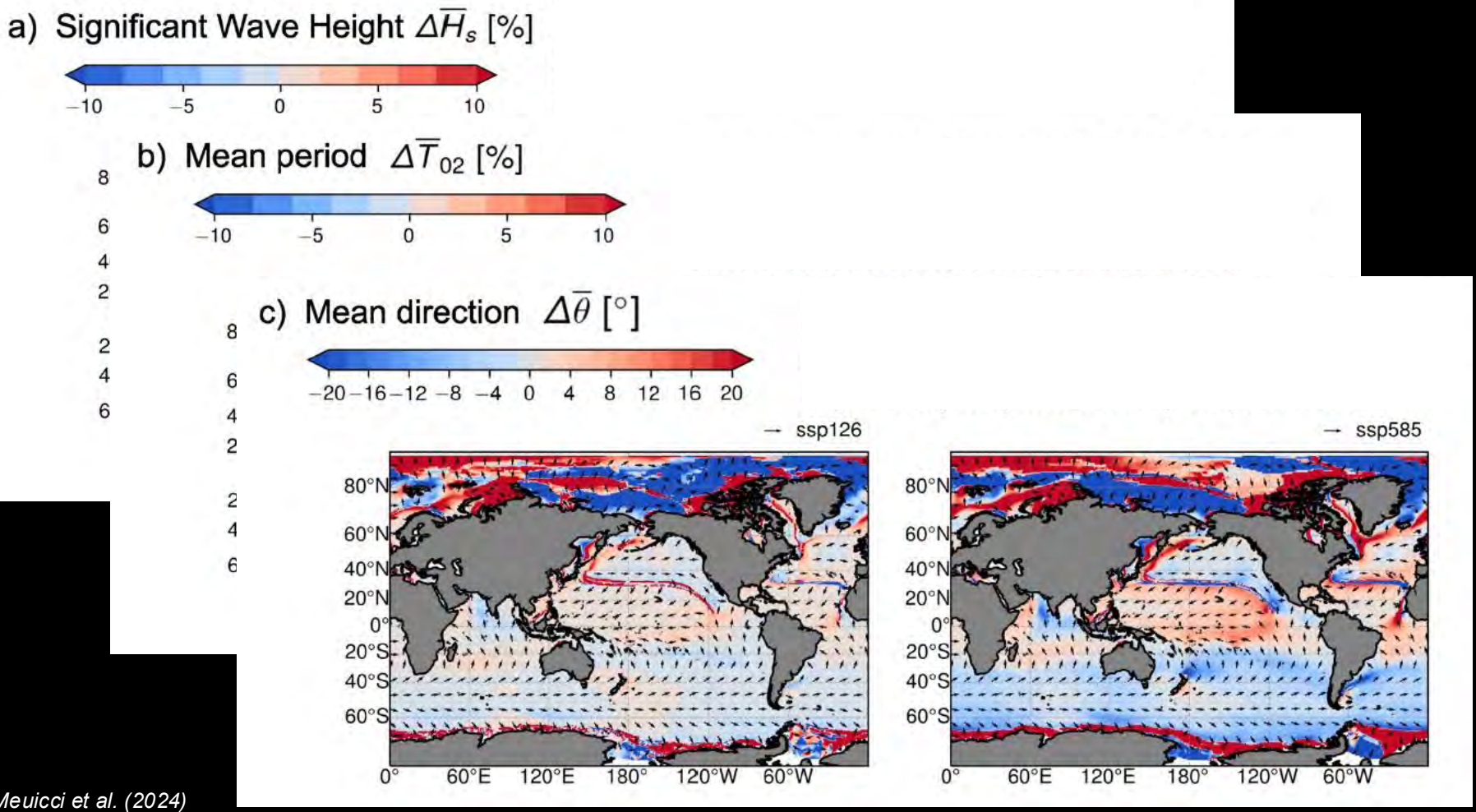
Average elevations of atolls and high-island coastal plains are 3-4 feet above sea level

Future Wave Projections

Shared Socioeconomic Pathways (SSPs) climate change scenarios

SSP1 - 2.6 *(reduced emissions)*

SSP5 - 8.5 *(unabated emissions)*

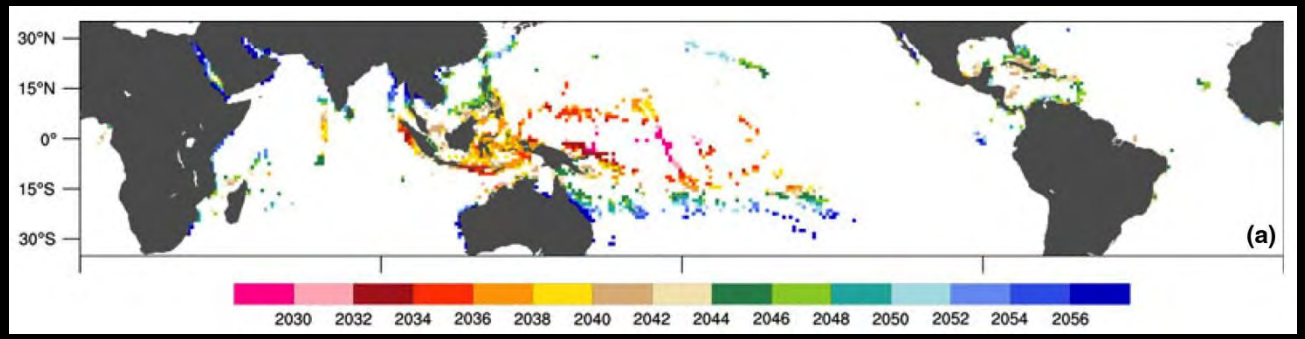


Meuicci et al. (2024)

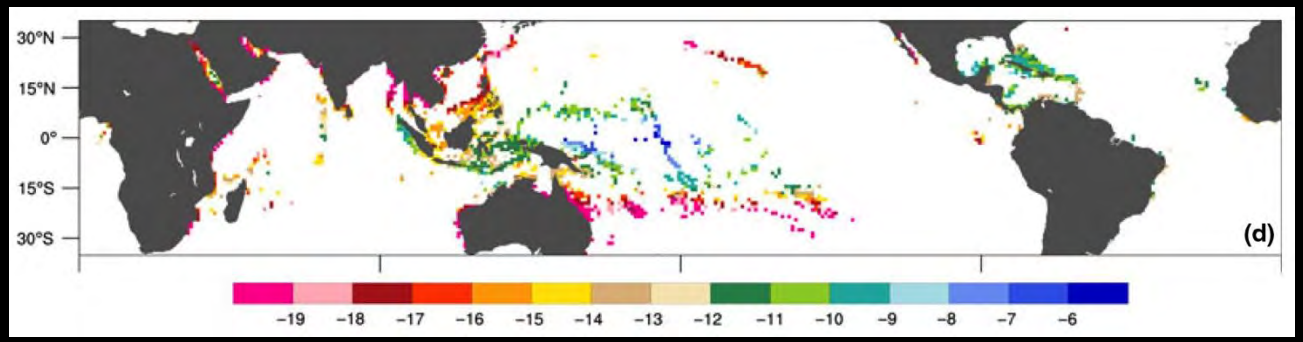
Climate Change Impacts to Corals

Temperature-driven bleaching

Hooidonk et al. (2014)

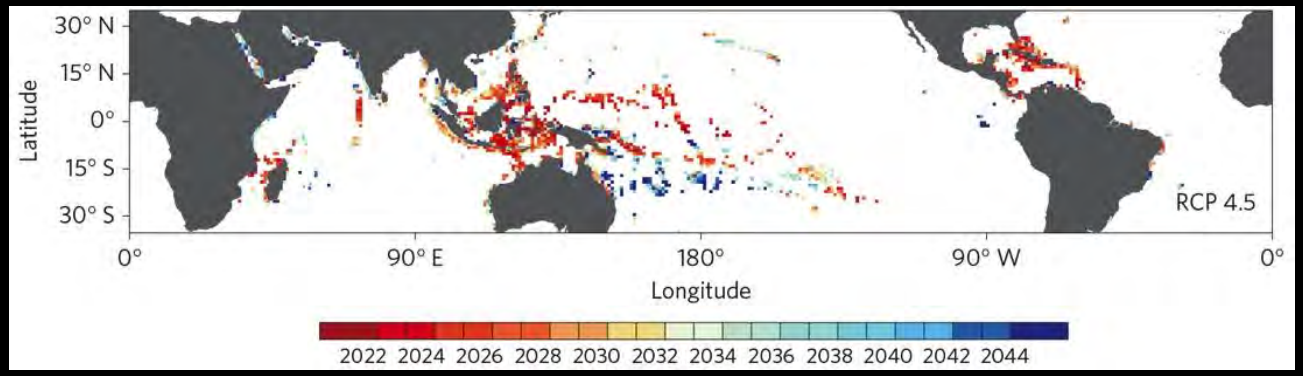


CO_2 - driven corrosion
(ocean acidification)



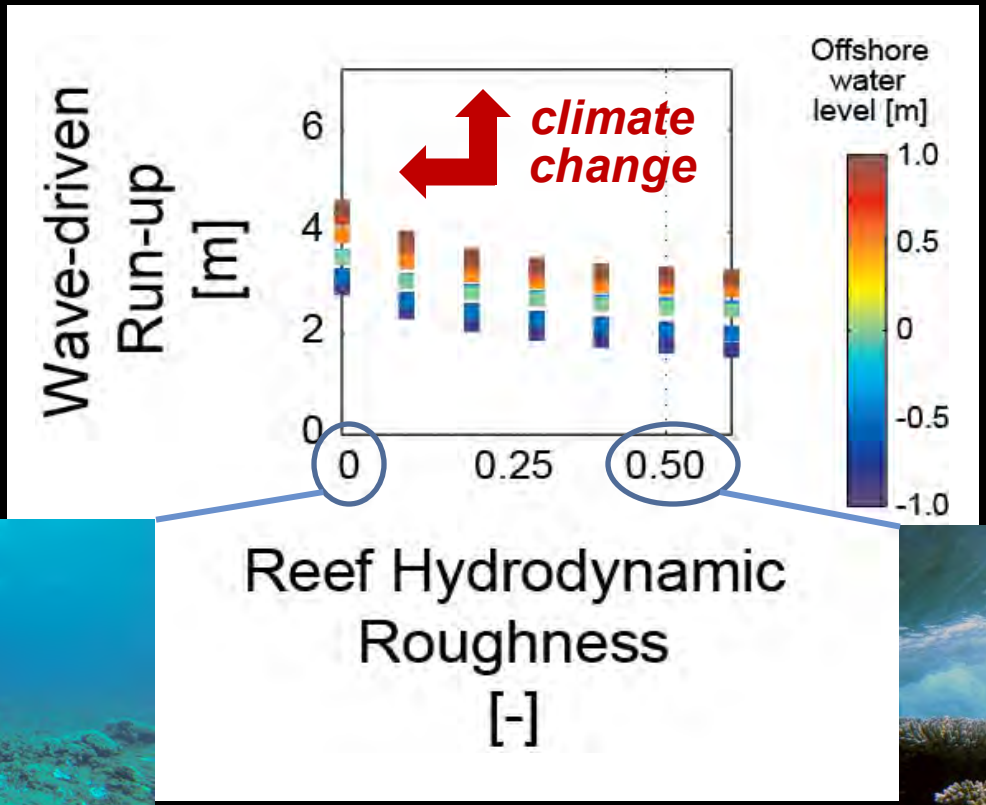
Temperature-driven disease outbreaks

Maynard et al. (2015)

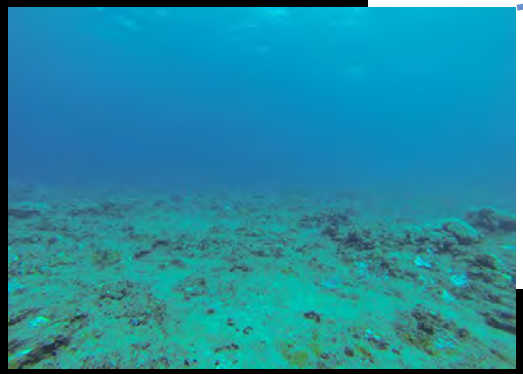


Climate Change Impacts on Waves & Run-up

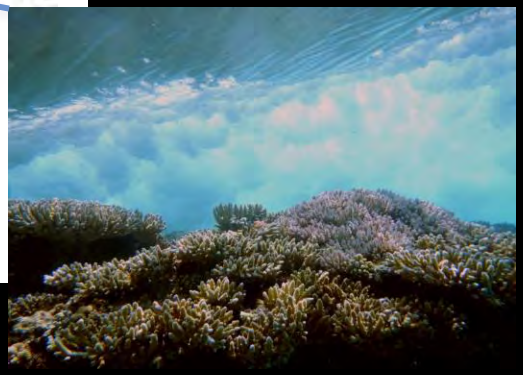




sea-level rise



reef degradation



Quataert et al. (2015)

Problem

Climate change and sea-level rise will exacerbate the wave-driven flood and erosion hazards to infrastructure, freshwater supplies, agriculture, and habitats for threatened and endangered species on US and US-affiliated islands.

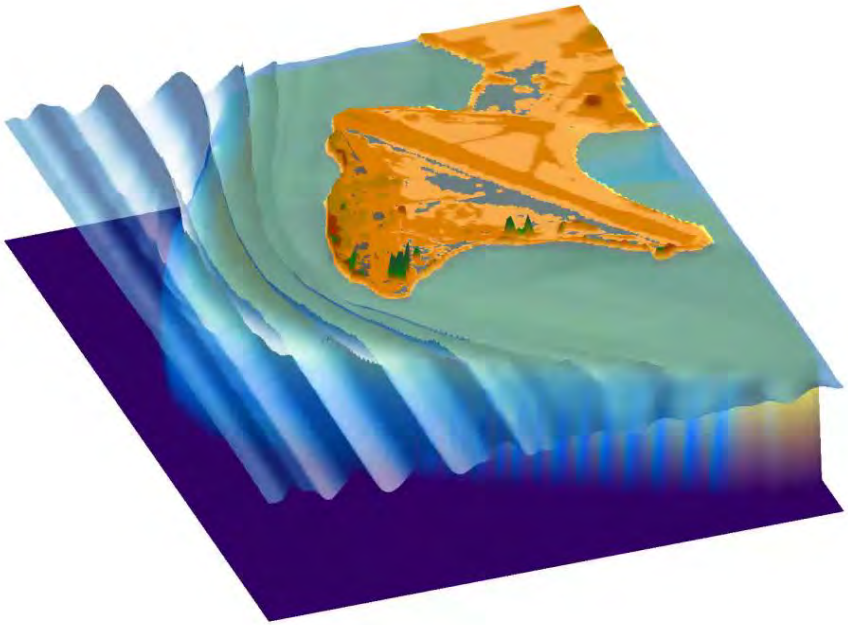


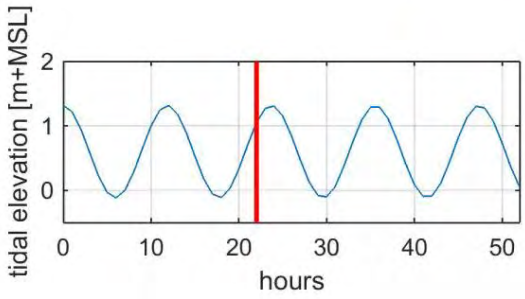


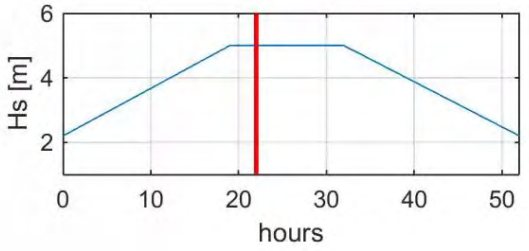


Wave-driven Flooding









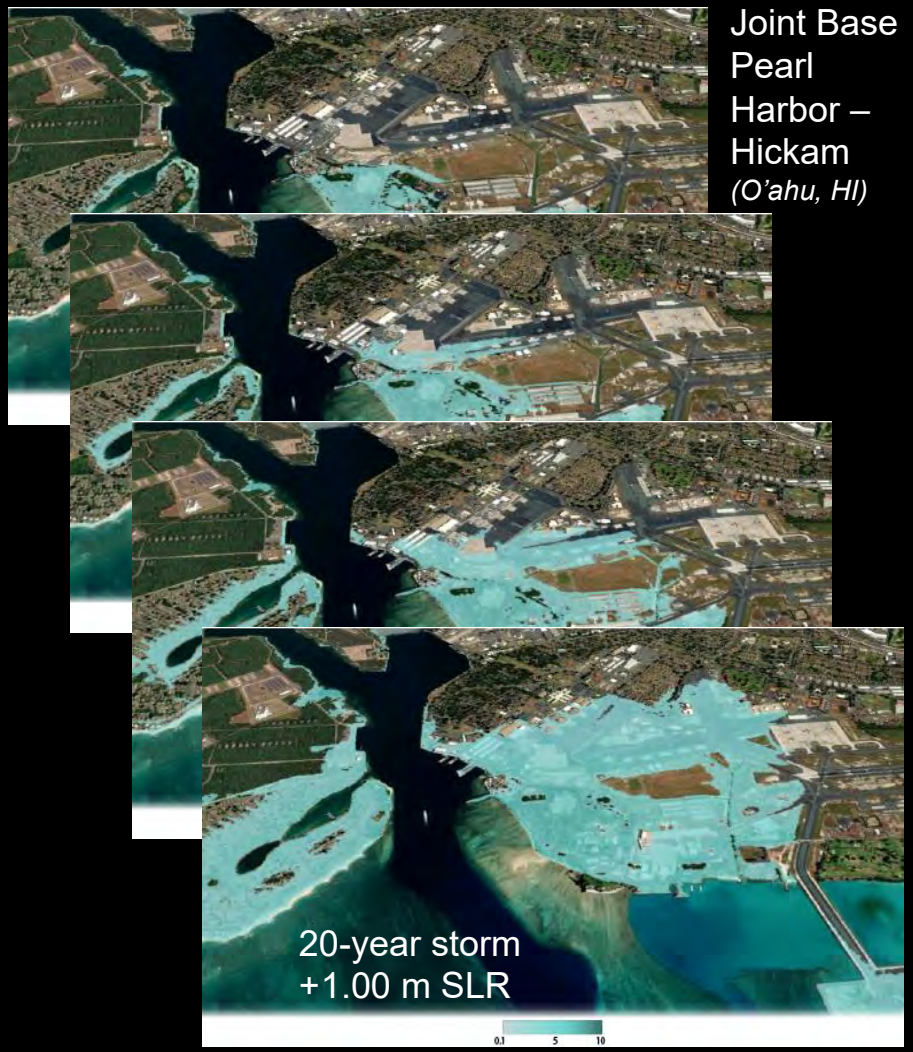
Model Simulation:

+0.5 m of sea-level rise with 5.2 m high waves at 15 s on Roi-Namur, Kwajalein Atoll, R.M.I.

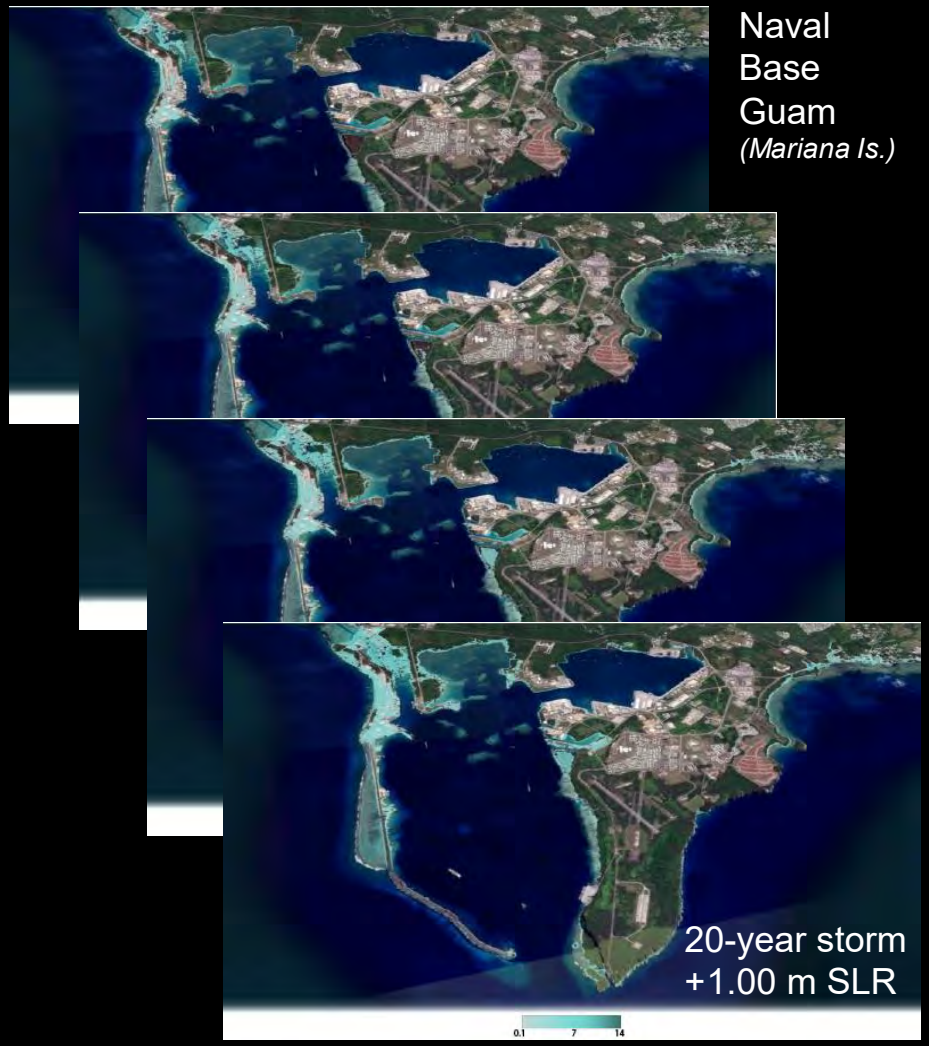
*(predicted to occur 18 hours per month during **average winter**)*

Storlazzi et al. (2018)

Wave- and Storm Surge-driven Flooding Projections via IPCC-AR6 global climate models



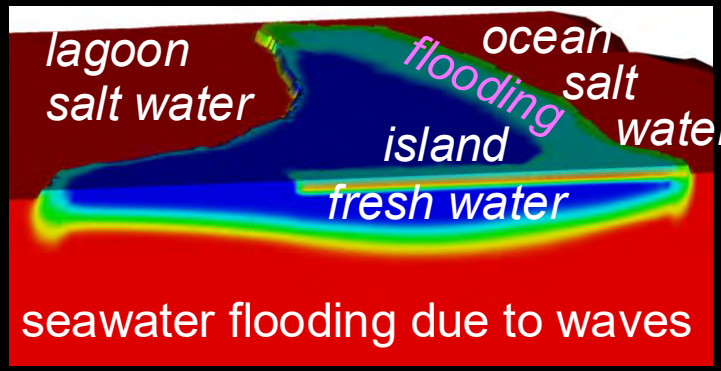
Joint Base Pearl Harbor – Hickam
(O'ahu, HI)

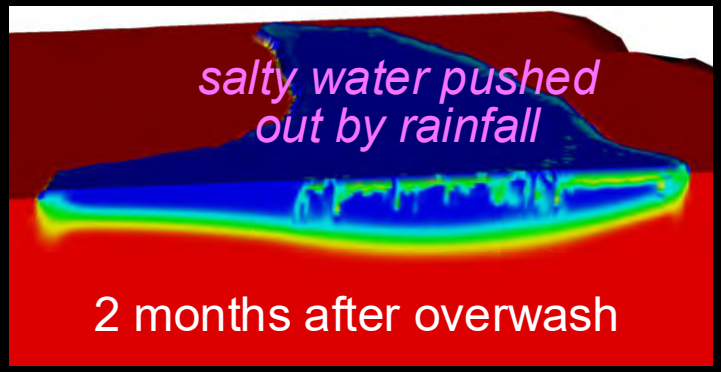


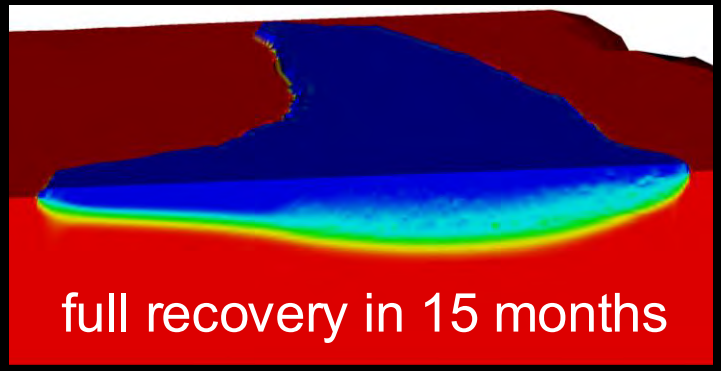
Naval Base Guam
(Mariana Is.)

Storlazzi et al. (2024)

Impact of Flooding on Groundwater







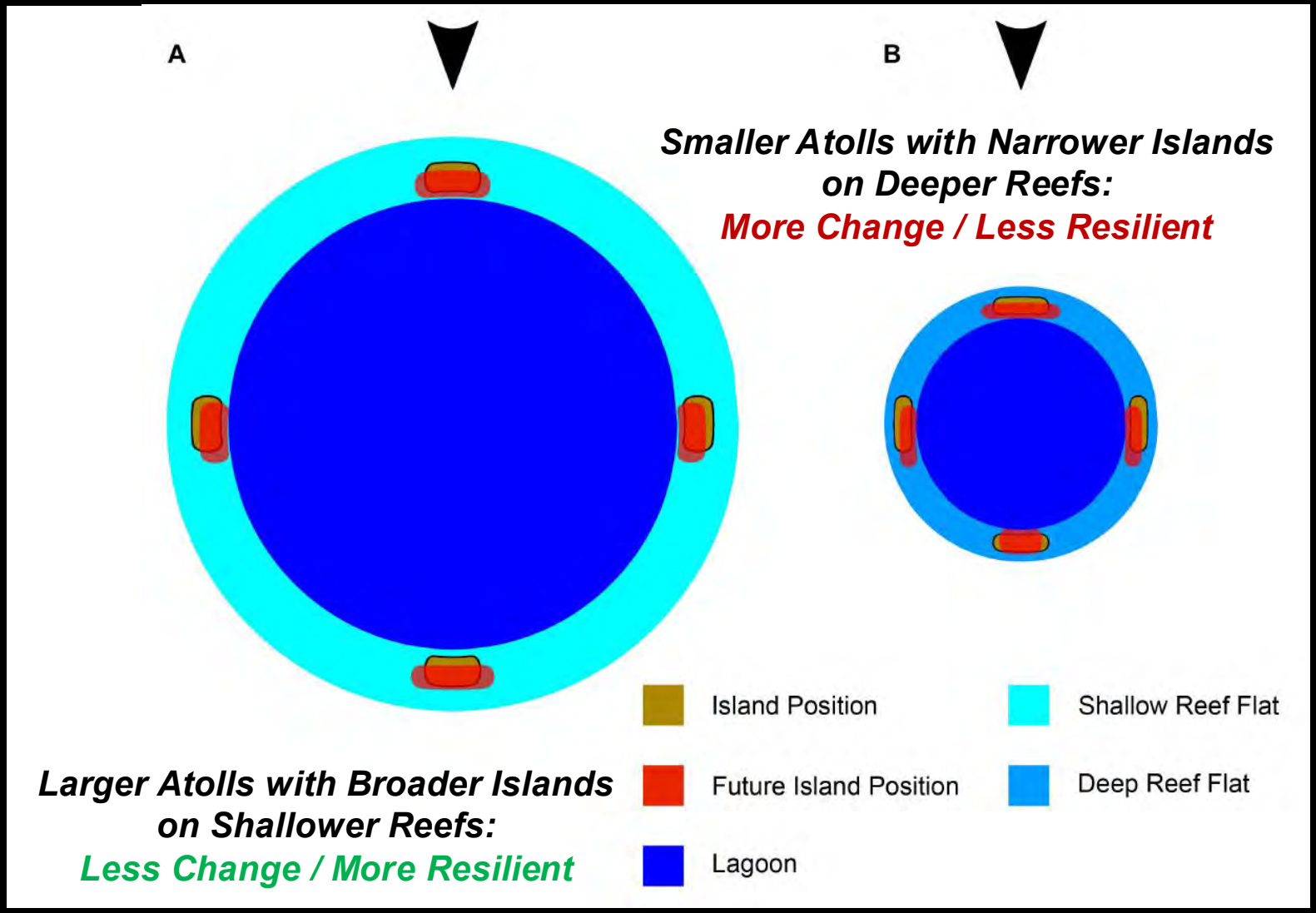
Red = saltwater, **Blue** = freshwater



Roi-Namur, Kwajalein Atoll,
R.M.I.,
late January 2024

Gingerich et al. (2017)

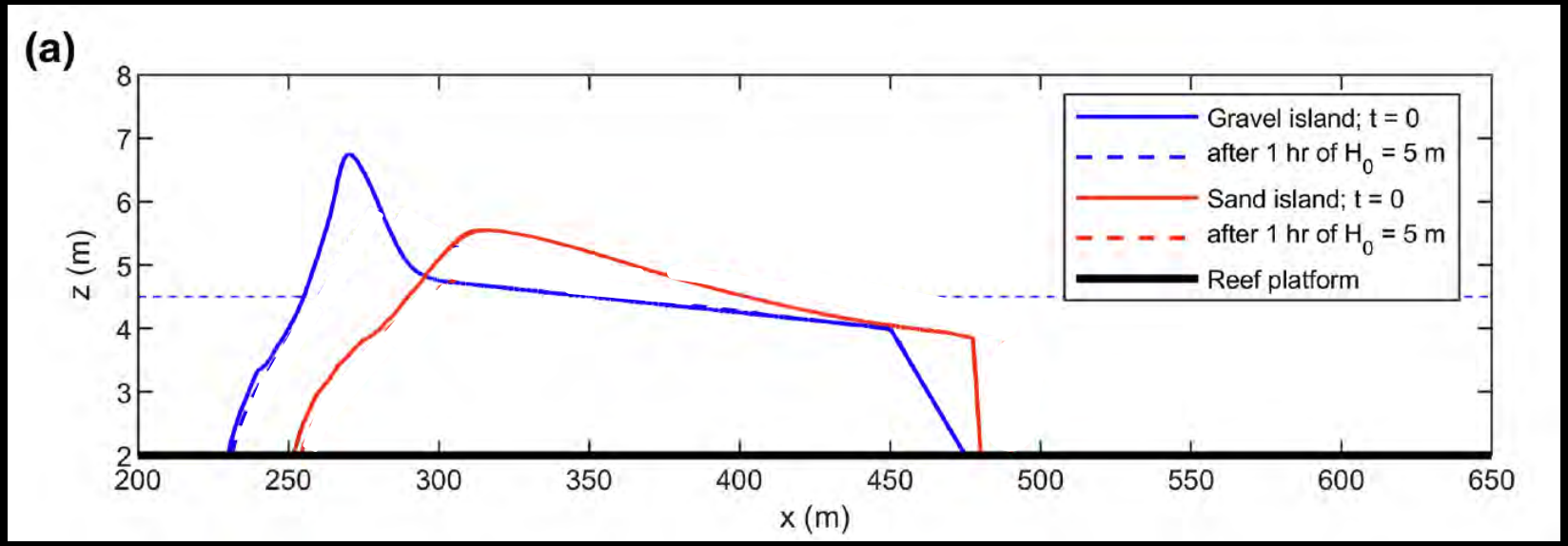
Projections – Island Evolution (spatial)



Shope & Storlazzi et al. (2019)

Projections – Island Evolution (cross-section)

Solid = initial conditions
Dashed = final conditions
Blue = Gravel island
Red = Sand Island



Gravel and sand islands decrease in elevation and thus are more susceptible to future flooding and erosion when subjected to large storm waves and sea-level rise

Masselink et al. (2021)

Projections – Island Evolution





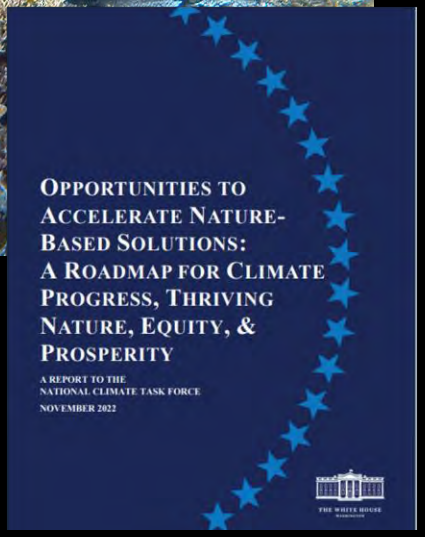
1.5 m at 5.8 s waves
in the flume
(@ 1:3 field scale)

ARISE Project (ongoing)

A Nature-based Solution (NbS): Reef Restoration



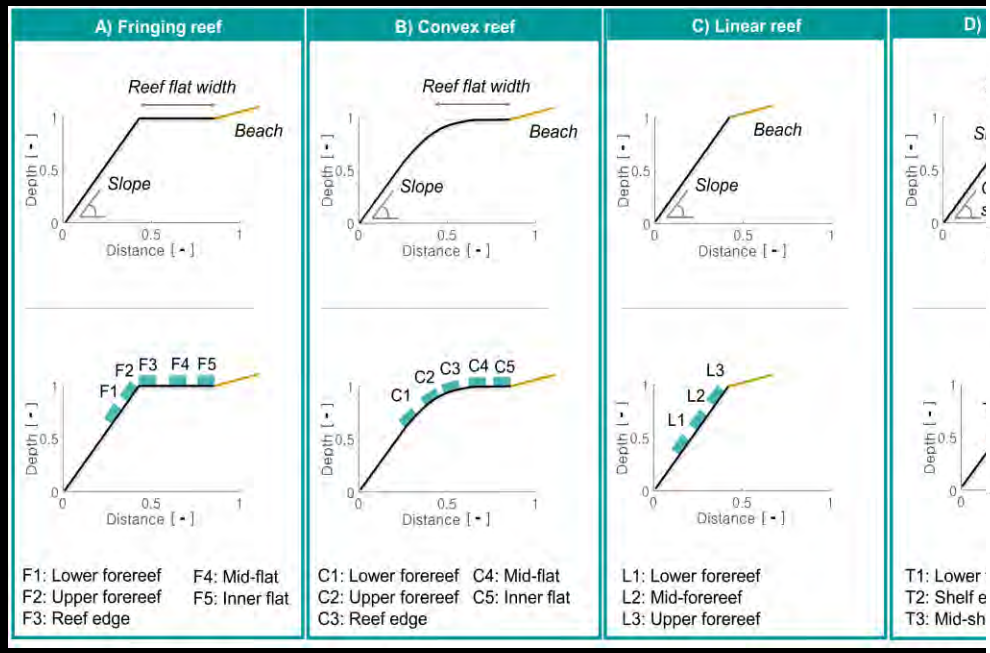


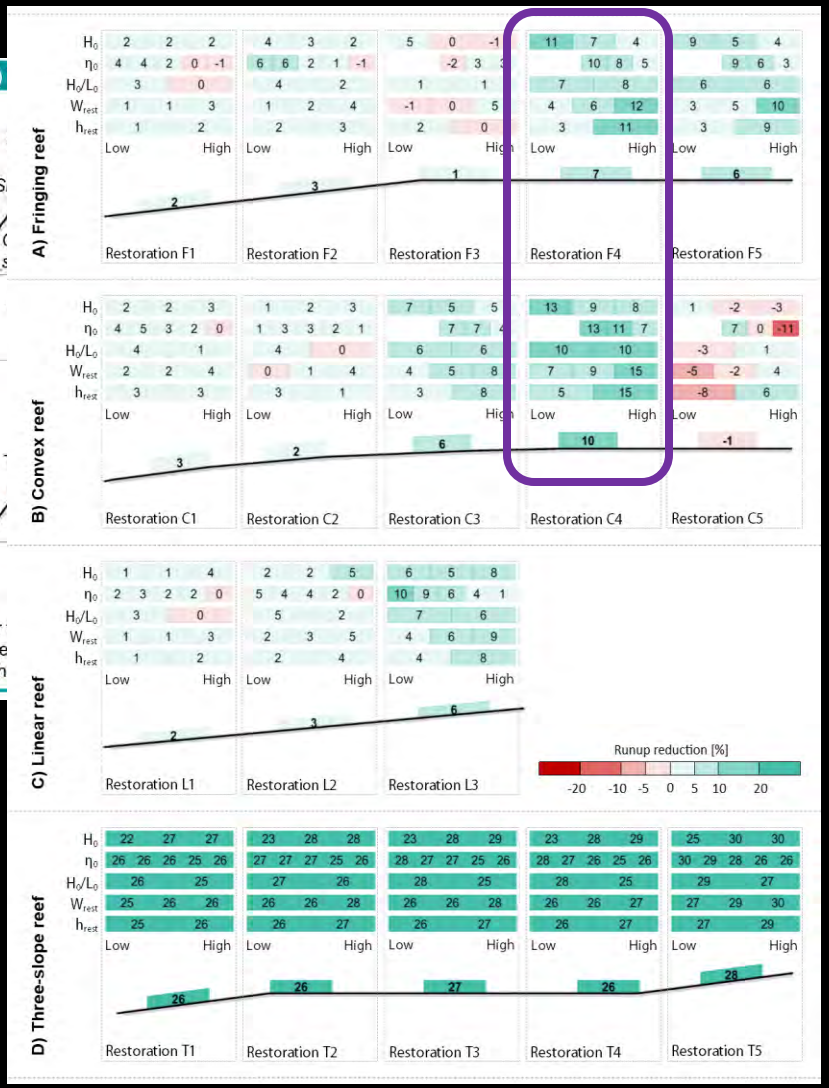


US Executive Order 14072: *Strengthening the Nation's Forests, Communities, and Local Economies*



Designing Restoration – meter scale

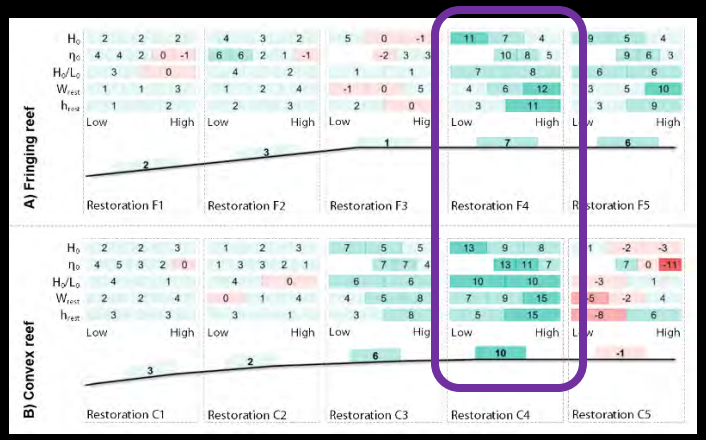


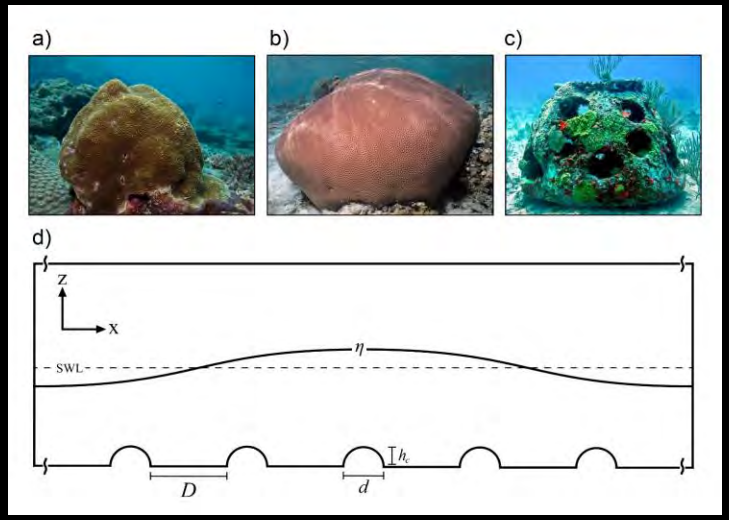


Goal: Optimize location of restoration on a given reef to maximize coastal flooding reduction

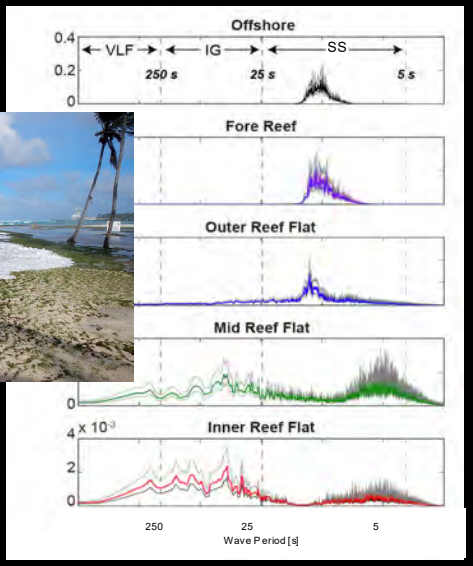
Roelvink et al. (2021)

Designing Restoration – centimeter scale







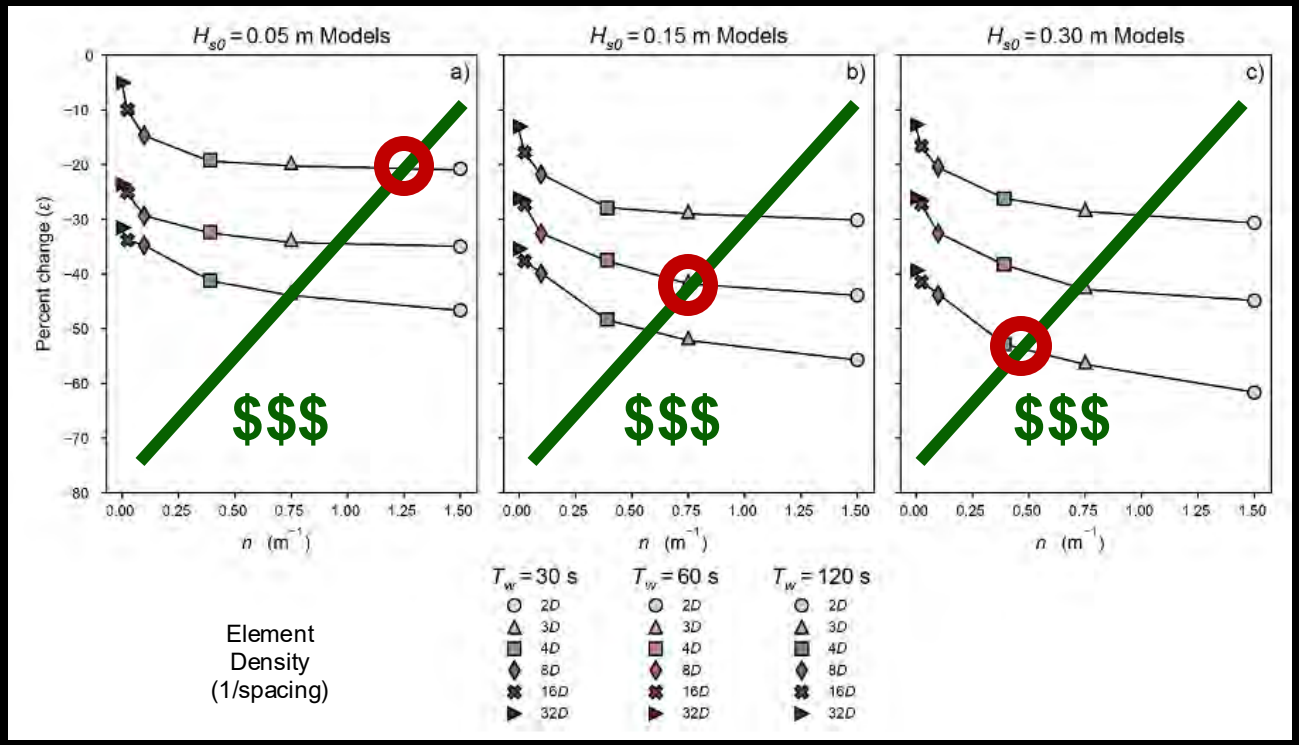




Norris et al. (2023, 2024)

Designing Restoration – centimeter scale

Time- and Space-averaged Turbulence



Columns: wave height

Colors: wave period

Shading: element spacing

Goal: Evaluate corals' energy dissipation to guide outplanting design

maximize energy dissipation (reduce **hazard**)
while minimizing size & number of elements (reduce **cost**)

Norris et al. (2024)

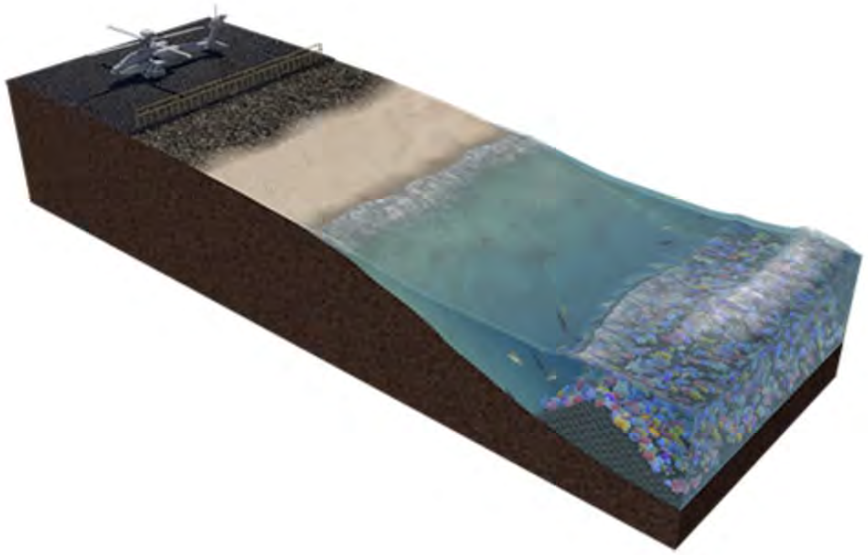
DOD Advancing Reef Restoration for Coastal Protection

Defense Advanced Research Projects Agency › DARPA Launches Program to Mitigate Coastal Flooding, Erosion and Storm Damage

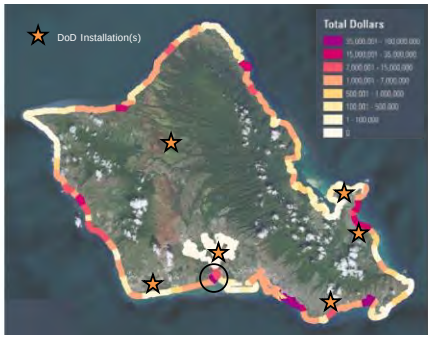
DARPA Launches Program to Mitigate Coastal Flooding, Erosion and Storm Damage

Reefense will integrate structural engineering, reef health and adaptive biology to address sea level rise

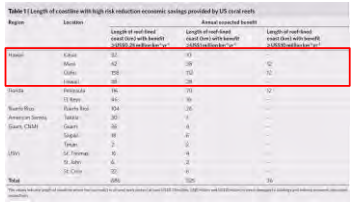
OUTREACH@DARPA.MIL
12/17/2020



DARPA Hazard Risk Reduction Benefits exceed $1.8 billion annually for US Reefs



The top 1 m of Reef can protect infrastructure



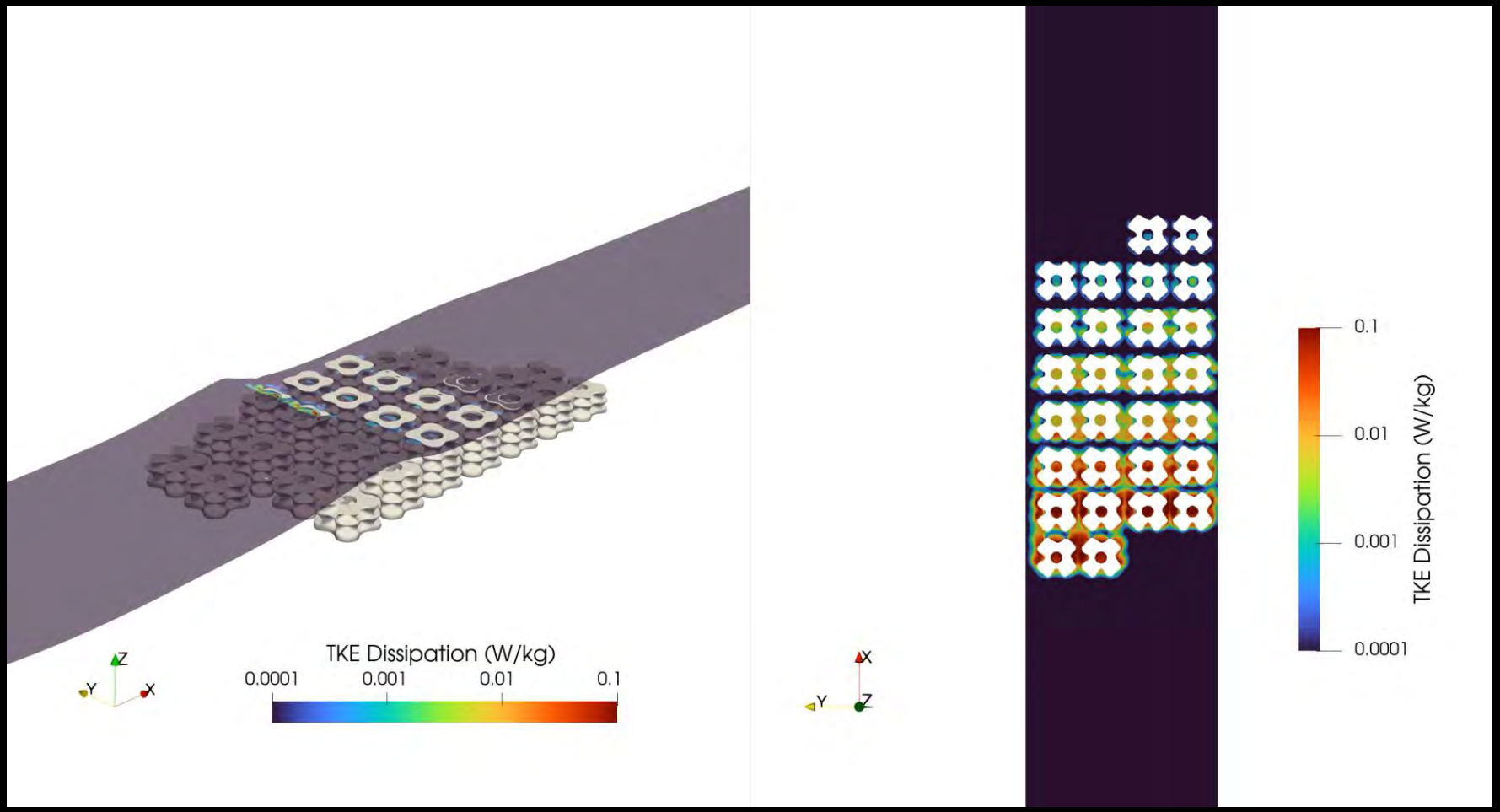
- These dollar figures represent the estimated cost savings per year by the top 1m of fringing coral reefs (Source: USGS 2019-1027 report and Reguero et al. 2021, Nature Sustainability)
- Protecting some areas in Hawaii (see circled area) could create large ROI where we have a lot of DoD Installations: (Joint Base Pearl Harbor, Hickman FTAC, Hickman AFB, NAVFAC Hawaii)
- There are 1,700 military installations in worldwide coastal areas that may be effected by sea level rise and storm surges
- It would cost $30M to replace the top 1m of reef in a km so some places have a return of investment in a year (see circled area)

Source Selection Information - See FAR 2.101 and FAR 3.104

1

~$60 million **program to develop methods to protect US tropical coastal military bases in face of climate change and sea-level rise via coral reef restoration**

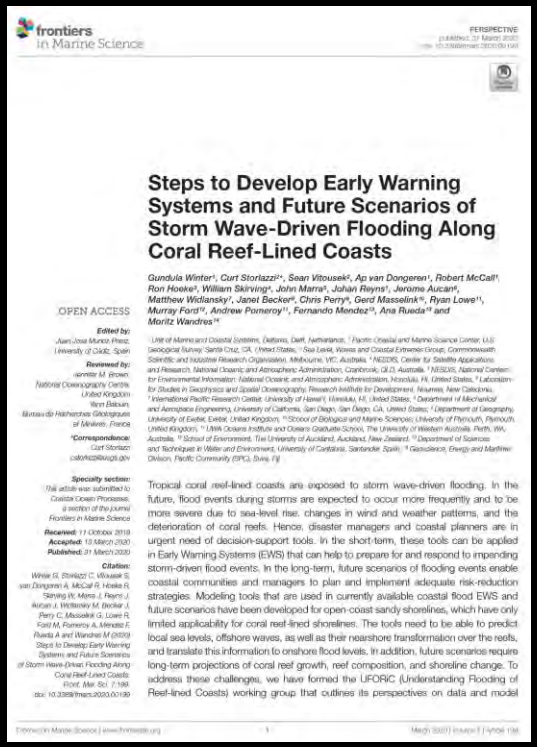
Designing Hybrid Restoration – centimeter scale



Reefense Project (ongoing)

R&D Gaps and Recommendations

- *Improved **downscaling techniques for offshore waves**, possibly through development of machine-learning algorithms, to downscale global wave projections*
- *Better estimates of **vertical reef growth rates** under different ecological states of the reef to project future water depth on the reef with sea-level rise*
- *Quantification of **carbonate sediment production and transport**, which is still little researched but important for projections of shoreline configurations.*
- *Physically-based **roughness parameterization from coral cover and reef benthic complexity** because current models simply scale friction formulations developed for sandy beds and do not account for energy dissipation within the coral canopy*
- *Better **understanding of wave breaking over reefs**, which has been little researched due to the difficult instrumentation of the surf zone on reefs*
- *Better understanding of the **importance of infragravity, very-low frequency waves, and seiching to flooding** along reef-lined coasts to inform the selection of an appropriate nearshore wave model*


frontiers in Marine Science

PERSPECTIVE

Steps to Develop Early Warning Systems and Future Scenarios of Storm Wave-Driven Flooding Along Coral Reef-Lined Coasts

Gundula Winter[1], Curt Storlazzi[2]*, Sean Vitousek[2], Ap van Dongeren[1], Robert McCall[1], Ron Hoeke[3], William Skirving[4], John Marra[5], Johan Reyns[1], Jerome Aucan[6], Matthew Widlansky[7], Janet Becker[8], Chris Perry[9], Gerd Masselink[10], Ryan Lowe[11], Murray Ford[12], Andrew Pomeroy[11], Fernando Mendez[13], Ana Rueda[14] and Moritz Wandres[14]

OPEN ACCESS

Edited by:
Juan Jose Munoz Perez, University of Cadiz, Spain

Reviewed by:
Jennifer M. Brown, National Oceanography Centre, United Kingdom
Yann Balouin, Bureau de Recherches Géologiques et Minières, France

*Correspondence:
Curt Storlazzi
cstorlazzi@usgs.gov

Specialty section:
This article was submitted to Coastal Ocean Processes, a section of the journal Frontiers in Marine Science

Received: 11 October 2019
Accepted: 18 March 2020
Published: 31 March 2020

Citation:
White G, Storlazzi C, Vitousek S, van Dongeren A, McCall R, Hoeke R, Skirving W, Marra J, Reyns J, Aucan J, Widlansky M, Becker J, Perry C, Masselink G, Lowe R, Ford M, Pomeroy A, Mendez F, Rueda A and Wandres M (2020) Steps to Develop Early Warning Systems and Future Scenarios of Storm Wave-Driven Flooding Along Coral Reef-Lined Coasts. Front. Mar. Sci. 7:199. doi: 10.3389/fmars.2020.00199

Tropical coral reef-lined coasts are exposed to storm wave-driven flooding. In the future, flood events during storms are expected to occur more frequently and to be more severe due to sea-level rise, changes in wind and weather patterns, and the deterioration of coral reefs. Hence, disaster managers and coastal planners are in urgent need of decision-support tools. In the short-term, these tools can be applied in Early Warning Systems (EWS) that can help to prepare for and respond to impending storm-driven flood events. In the long-term, future scenarios of flooding events enable coastal communities and managers to plan and implement adequate risk-reduction strategies. Modeling tools that are used in currently available coastal flood EWS and future scenarios have been developed for open-coast sandy shorelines, which have only limited applicability for coral reef-lined shorelines. The tools need to be able to predict local sea levels, offshore waves, as well as their nearshore transformation over the reefs, and translate this information to onshore flood levels. In addition, future scenarios require long-term projections of coral reef growth, reef composition, and shoreline change. To address these challenges, we have formed the UFORIC (Understanding Flooding of Reef-lined Coasts) working group that outlines its perspectives on data and model

Winter et al. (2020)

R&D Gaps and Recommendations

Data

- ***Tide gauges*** *with co-located GPS receivers that identify local tectonics*
- ***Wave buoys****, especially in the Southern Hemisphere*
- ***Nearshore bathymetry between the 100 m and 10 m isobaths*** *for regional wave modeling*
- *Direct* ***observations of wave run-up****, particularly during extreme events*
- *High (approximately 2 m horizontal) spatial resolution* ***bathymetry and topography between 10 m water depths and 10 m land elevations*** *for nearshore hydrodynamics and flood modeling*
- ***Historical analysis of flood events*** *and impacts to validate models*

Winter et al. (2020)



Questions?



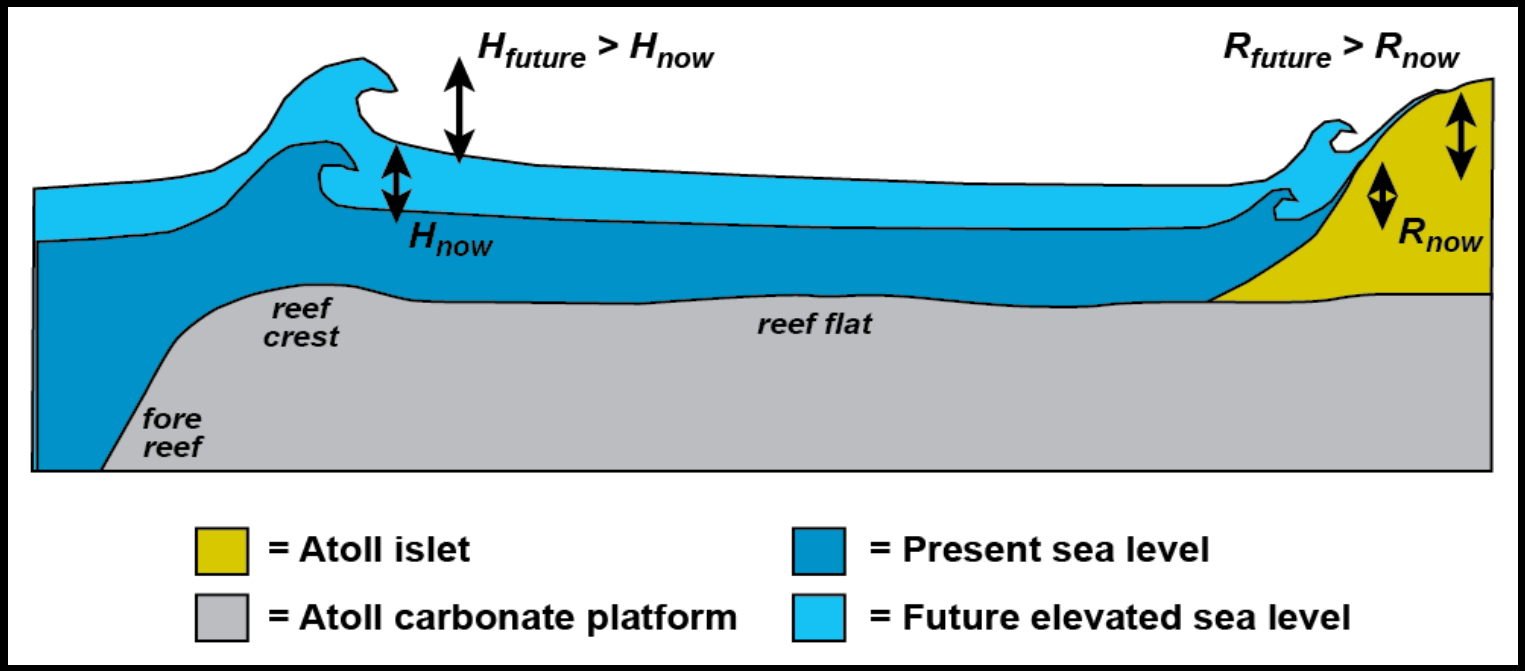
Curt Storlazzi cstorlazzi@usgs.gov

Back-up: Background

The projected rates of sea-level rise through 2100 are 2 to 10 times greater than optimal net vertical reef flat accretion rates --- thus sea level will increase over coral reef flats.

Waves in shallow water break when their height (H) is roughly equal to the water depth.

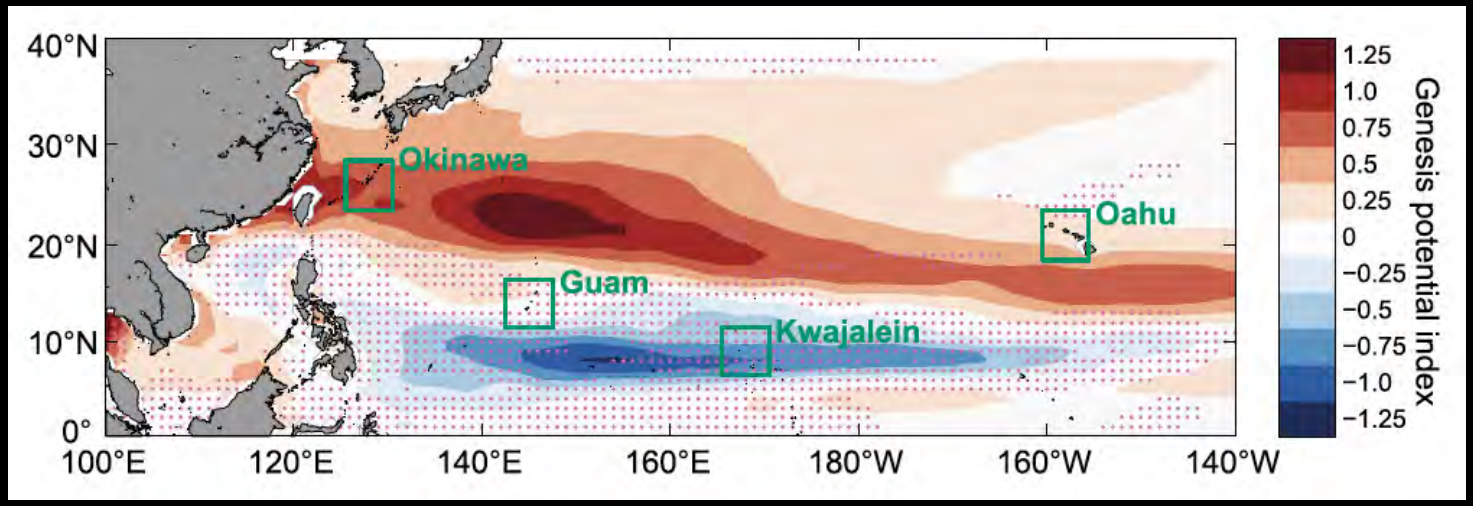
Run-up (R), the maximum elevation of wave uprush on the coast, scales with wave height.



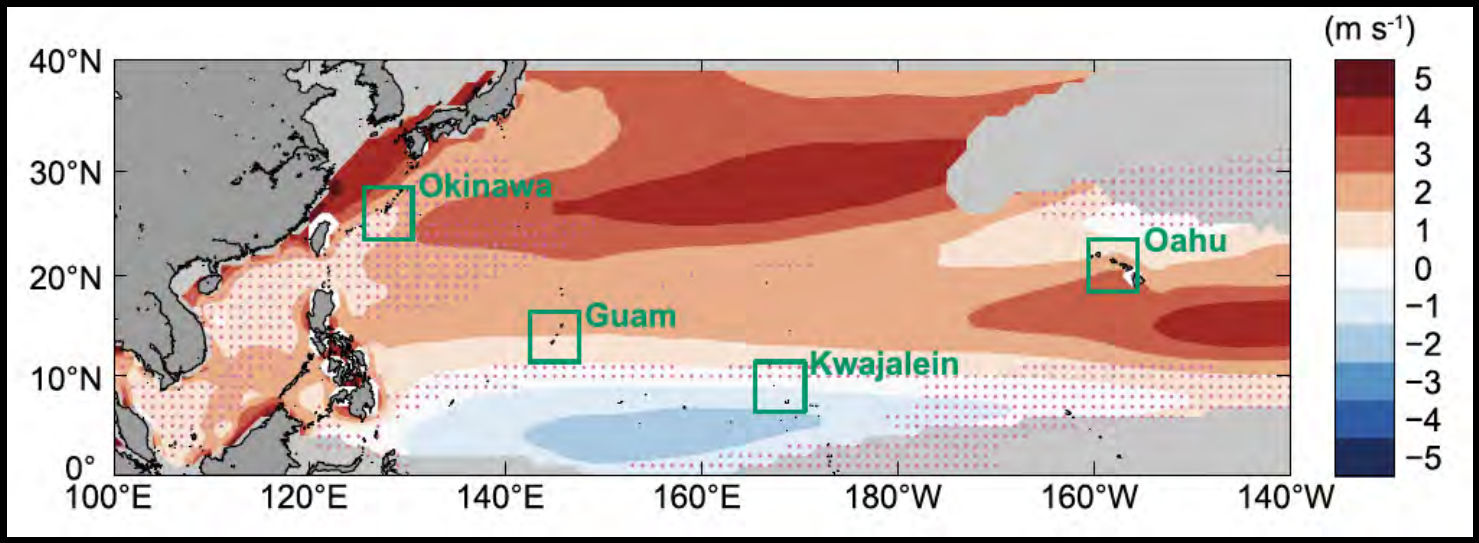
Sea-level rise = larger waves (H) = higher run-up (R) = greater marine flooding and resulting impacts

Storlazzi et al. (2018)

Back-up: Future Cyclone Projections



Likelihood of formation

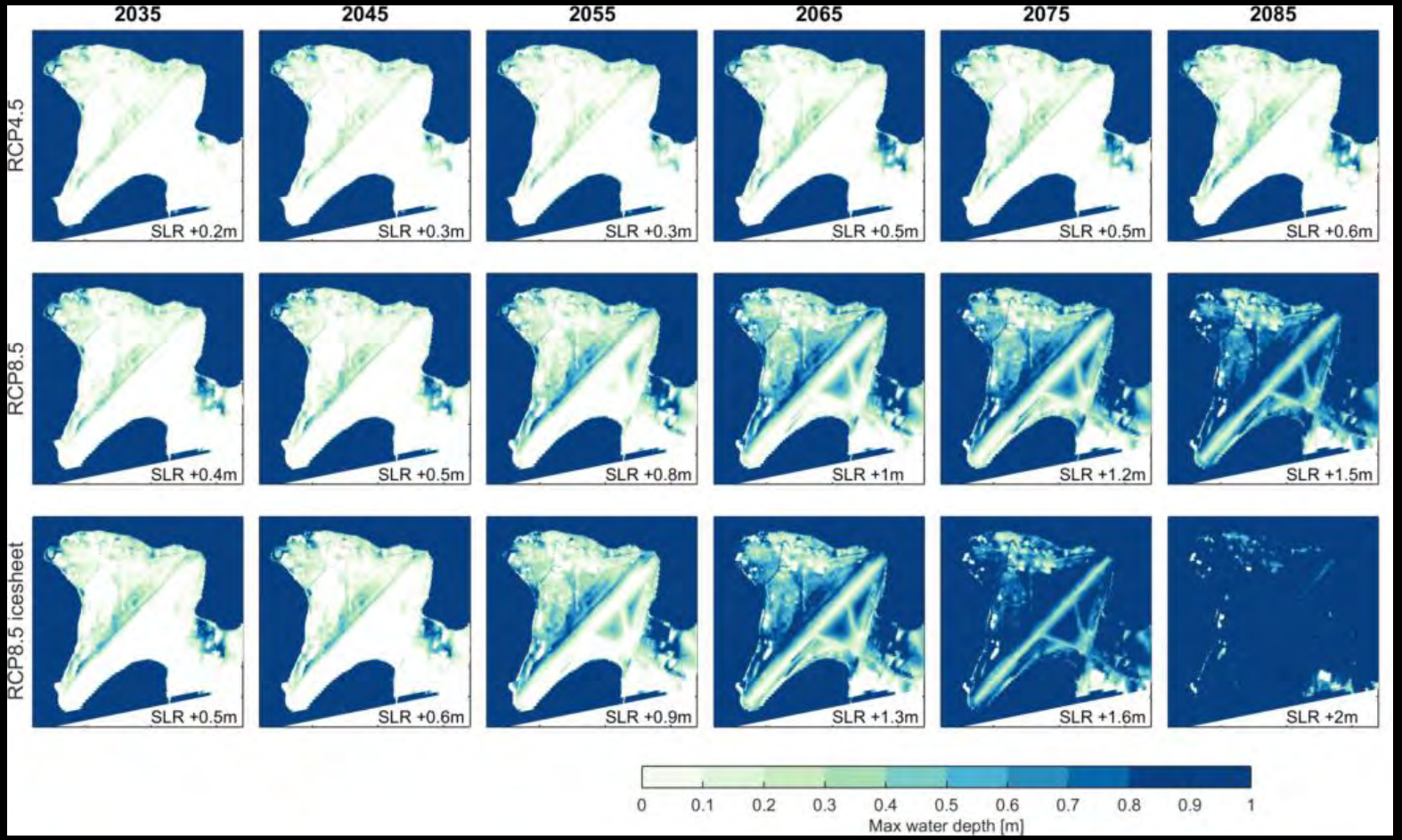


Intensity

Widlansky et al. (2019)

Back-up: Tipping Points

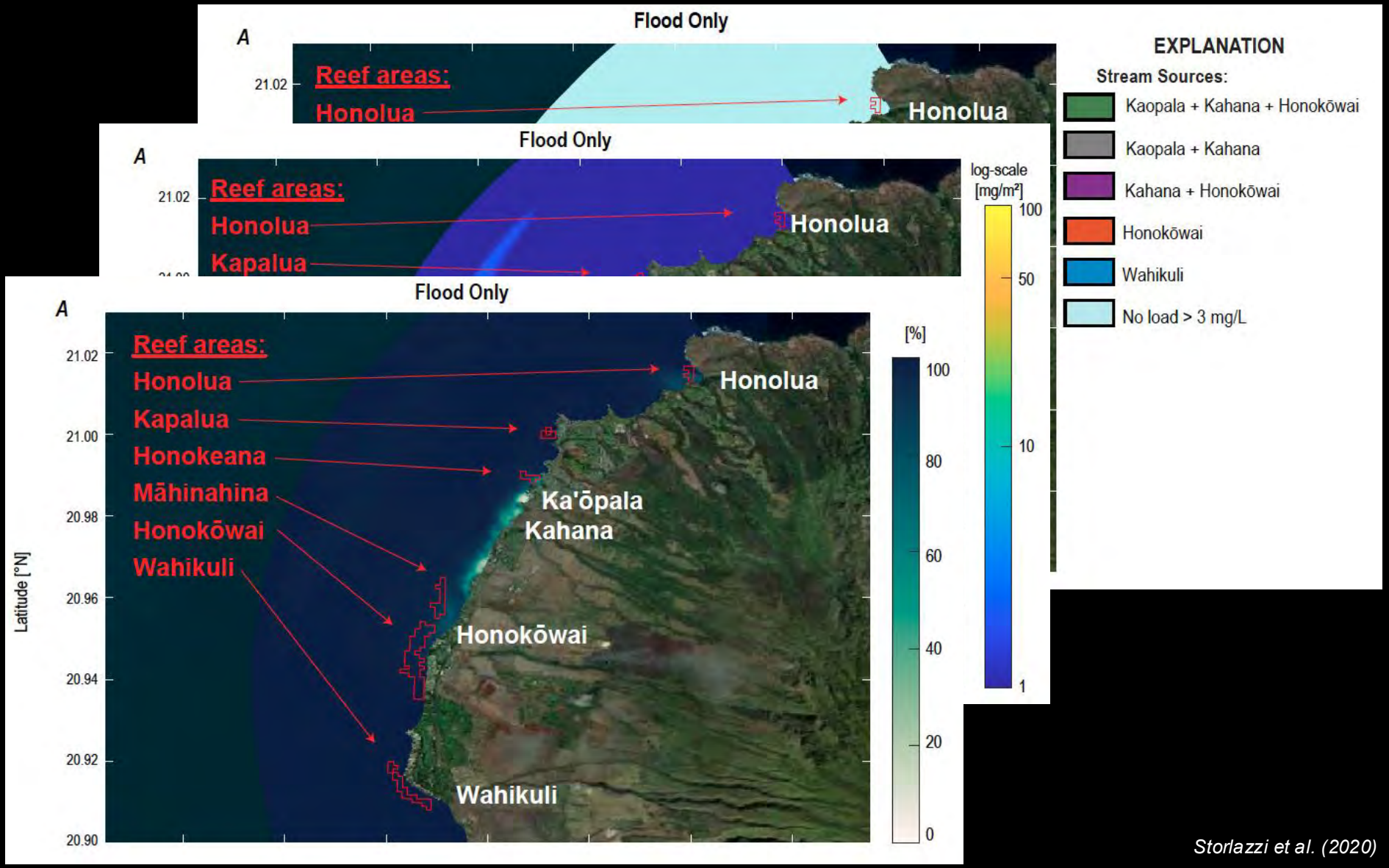
Wave-driven flooding projected to occur once every **12 months** on average



Map showing wave-driven overwash water depth on the island for different times in the future (columns) and for different climate scenarios (rows)

Storlazzi et al. (2018)

Back-up: Sediment Impacts to Coral Reefs



Storlazzi et al. (2020)

Jessica H. Podoski, PE

Ms. Jessica Podoski has been with the USACE Honolulu District since 2004 as a Coastal Engineer in the Civil Works Technical Branch. Her work has included navigation, coastal storm damage reduction, regional sediment management, and climate resilience studies within the Pacific Islands including Hawaii, Guam, the Commonwealth of the Northern Marianas, and American Samoa. She has also provided coastal engineering expertise on military construction projects located on Okinawa, Japan and Kwajalein Atoll. Prior to the Honolulu District, Ms. Podoski was a coastal engineer at the Portland District, working on many projects along the coast of Oregon.

Ms. Podoski is a cadre member for USACE-HQ civil works policy and legal compliance review team. She is subject matter expert for Regional Sediment Management, Coastal Navigation Design, and Climate Preparedness and Resilience. In 2019 she received recognition with the award of USACE Climate Champion. Jessica received a Bachelor of Science degree from the University of Florida in Civil Engineering in 1999. While completing her degree she worked for the government of Martin County, Florida focusing on coastal projects and inlet management. She received a Master of Engineering degree from the University of Florida in Coastal Engineering in 2001, researching crenulate bay formation and prediction. Ms. Podoski is a registered civil engineer in the state of Hawaii.

Pacific Island Coastal Engineering Challenges: Kwajalein Atoll

Jessica Podoski, Honolulu District

The Kwajalein Resiliency Project funded through the Military Construction program and supported by the US Army Space & Missile Defense Command (SMDC), US Army Garrison – Kwajalein Atoll (USAG-KA) and the US Army Installation Management Command (IMCOM) was initiated to provide recommendations (with construction-ready designs) that will improve mission resilience and readiness for the U.S. Military on Kwajalein Atoll. The Kwajalein Resiliency Project (KRP) provides recommended resiliency solutions for three major islands in the Kwajalein Atoll, the Republic of the Marshall Islands (RMI), namely the islands of Kwajalein, Roi-Namur, and Meck. The resiliency recommendations include improved drainage of floodwaters from rainfall and coastal inundation, as well as shoreline protection to minimize coastal inundation and reduce risk of wave-induced damage to mission facilities. The designs incorporate adaptation to climate changes including sea level rise.

Low elevations dominate the islands on Kwajalein Atoll exposing the landscape to significant damage from high water levels and waves. Periodic high-water levels in the nearshore result from many phenomena including tides, El-Nino & Southern-Oscillation variations in sea level, wave ponding and set-up, infragravity waves, and other very low frequency waves. These phenomena may contribute to water levels independently or in combination. In addition, the Defense Regional Sea-Level change database identifies an increase in sea levels into the future which will further increase water levels. The highest potential future water levels considered in this study are higher than significant portions of the islands.

The exposure of the Kwajalein Atoll to wave energy varies around the atoll. The wave energy reaching the atoll depends on the direction from which the waves are coming. Neighboring islands and atolls in the RMI shelter waves propagating through the region and partially shelter the Kwajalein Atoll from certain directions. Additionally, most of the Kwajalein Atoll's islands are surrounded by wide, fringing reefs that extend up to hundreds of feet offshore. The reefs are flat to mildly sloping and at the outer edge drop off rapidly to deepwater. Under most incident wave conditions, the reefs cause waves to break at the outer edge and dissipate substantial wave energy across the reef before reaching the shoreline. However, higher water levels due to astronomic tide, wave setup, ponding, and other non-tidal residual effects allow larger waves to propagate across the reef with lesser dissipation to reach the island's shorelines. High water levels and larger waves result in significant wave runup which can cause damage to structures, erosion of shorelines, and inundation flooding.

A coastal flooding event that occurred at Roi-Namur recently (January 2024) is an example of a well-documented phenomenon along island coastlines with fringing reefs, whereby wave breaking on the outer reef (which usually provides significant wave dissipation) causes a transfer of spectral energy into low-frequency (infragravity) and very low-frequency bands and causes a temporary (in this case 15 to 45 minute) elevation of water level over the reef that allows more typical wave energy (15 – 20 second period) to propagate freely to the coastline and cause severe tsunami-like inundation, flooding and destabilization of shore protection in front of critical military assets. This event (not the first of its kind on Roi-Namur) highlights the need for a non-traditional approach to coastal engineering design in Pacific Island environments such as Kwajalein Atoll. Design guidance generated by research and development is needed to determine what conditions cause these events, what is the probability of such an event for a particular location, how to design for the stability and performance of coastal structures in such an event, and how to balance cost and feasibility of construction with risk reduction in the current environment and expected future environment due to climate changes.



PACIFIC ISLAND DESIGN CHALLENGES: Kwajalein Atoll

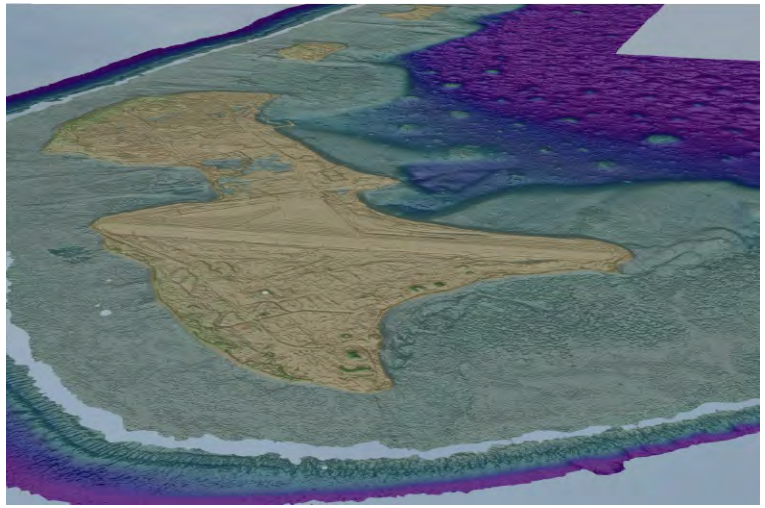
Jessica Podoski, P.E.
USACE Honolulu District

BCER 100th Meeting

August 14, 2024

Key Initiatives Championed by the BCER Used in the Kwajalein Resiliency Study

Chiefs Charge Addressing Coastal Systems Resilience (2013)



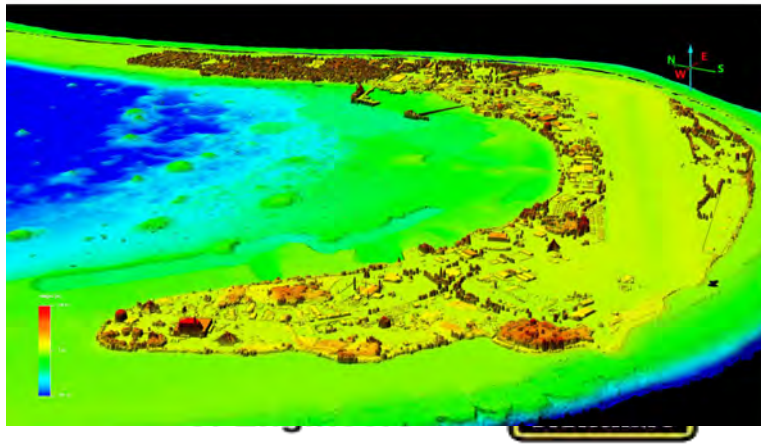
Guidance:

- Coastal Engineering Manual
- Shore Protection Manual

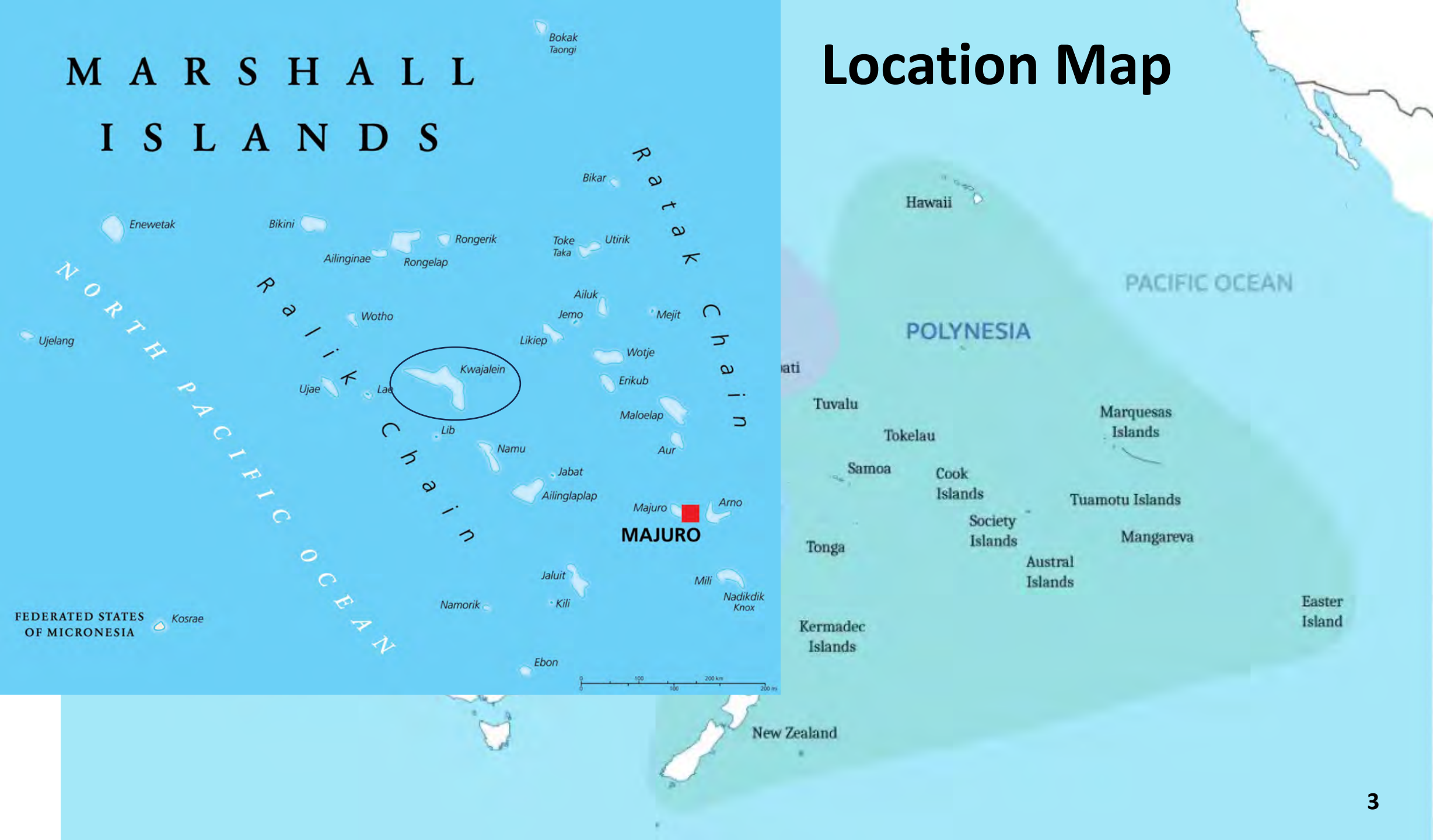
(and by extension BEB Technical Report #4 – Shore Protection Planning & Design)

Technology and Tools

- JABLTCX – Spring 2023: Airborne Topo/Bathy LiDAR, RGB Imagery and Hyperspectral Imagery
- AGC Buckeye – February 2024: Post-Event Airborne Topo/Bathy LiDAR
- Wave Information Study
- Numerical ocean and coastal modeling/Pacific Coastal Hazards System
- CHL digital technology modernization



Location Map



DoD Facilities in the Kwajalein Atoll (USAG-KA)





Roi-Namur

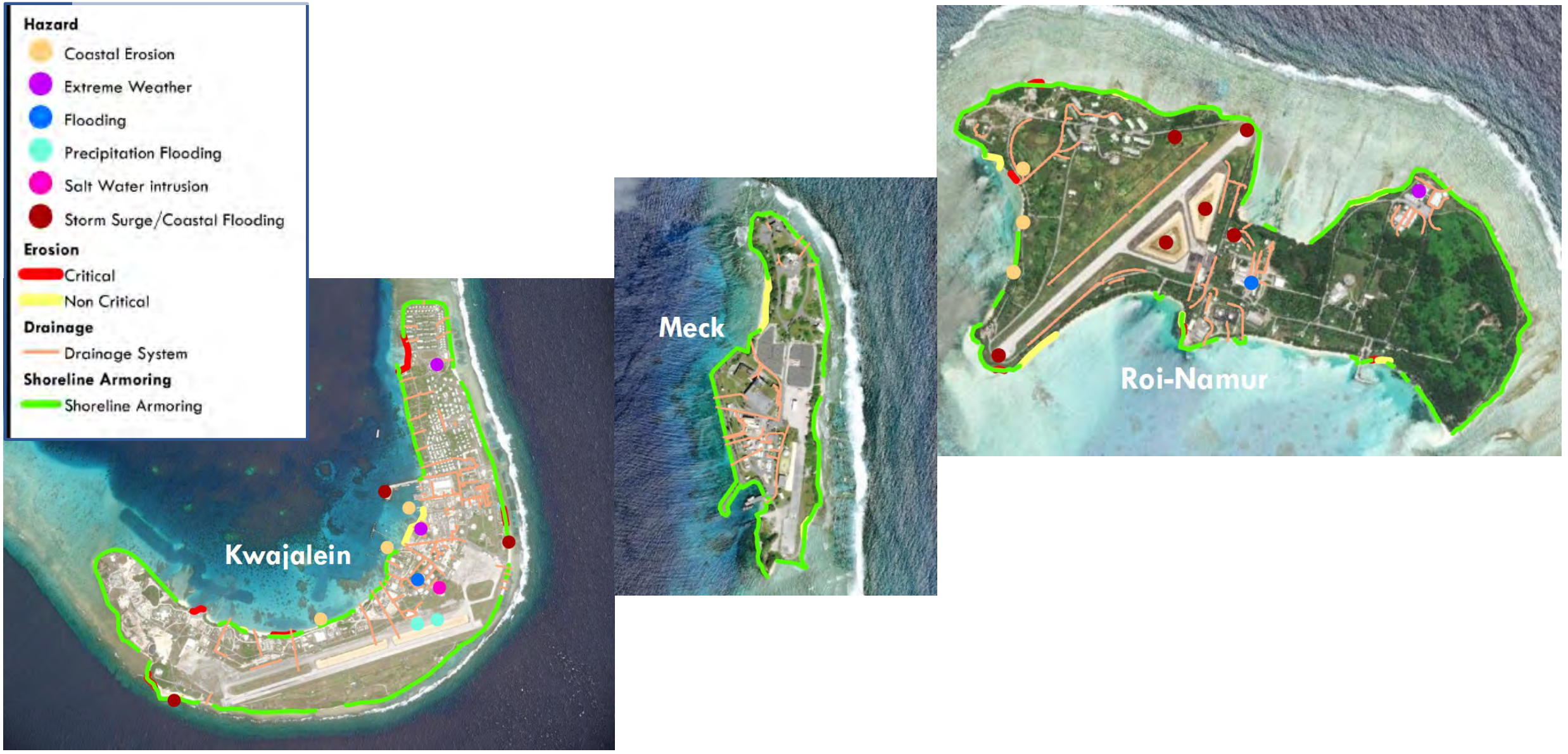


Meck



Kwajalein

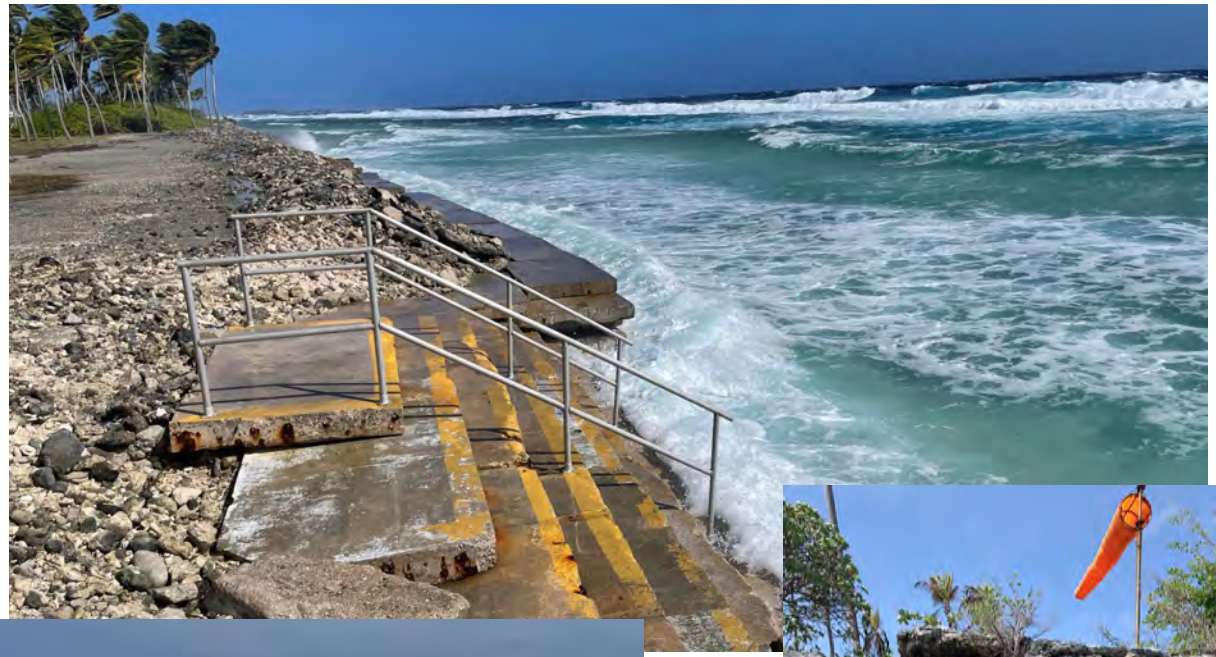
Hazard Exposure Areas

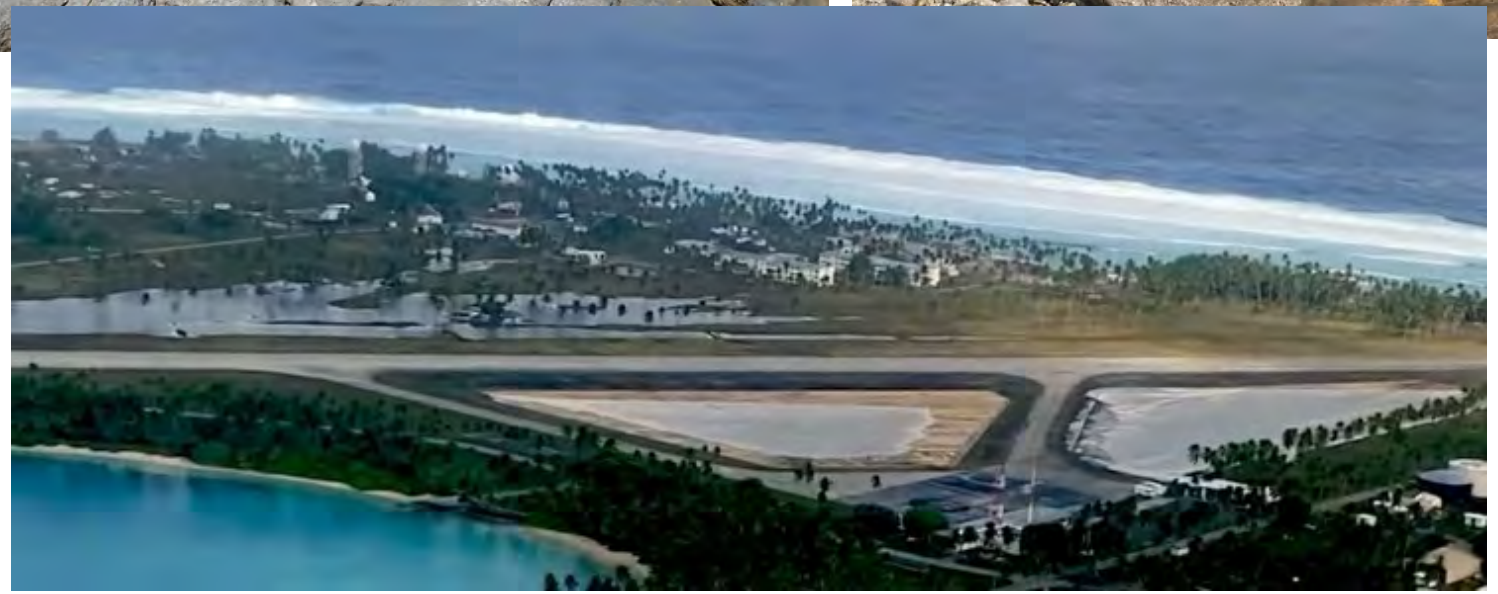


Reproduced from USAG Kwajalein Atoll Resilience Development Plan – July 2021

Existing Conditions







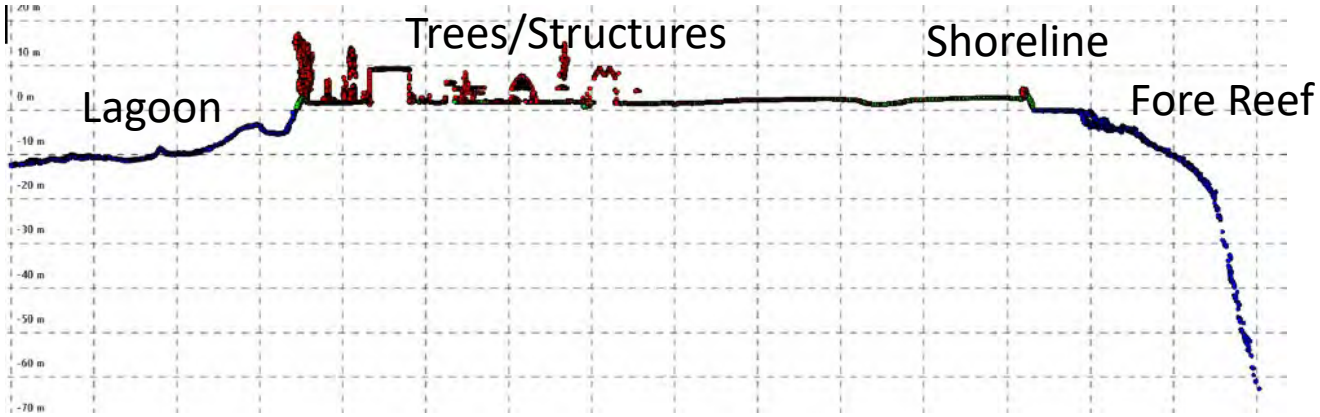


Kwajalein Resiliency Project

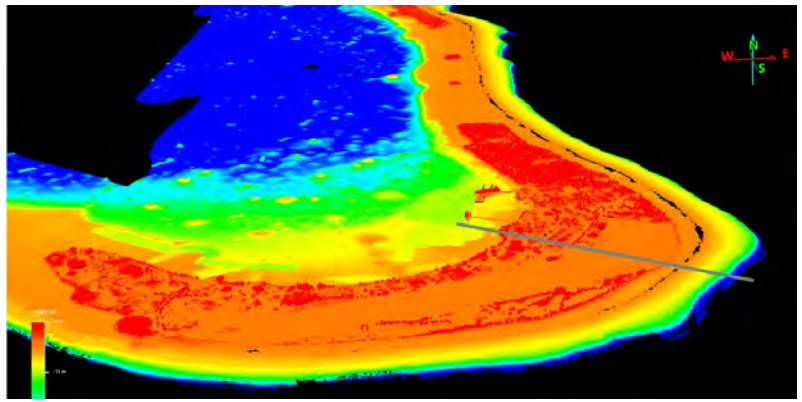
- Initiated in 2023 (funded by MILCON) to evaluate groundwater, storm water drainage, and shore protection for three of the atoll's islands with DoD assets.

Proceeded using traditional coastal engineering methods for revetment design

- Evaluated a regional WIS dataset to determine 50- and 100-yr deep water wave height
- Assigned a modal periods to each of the selected wave heights.
- Obtained future water levels including projected SLR from the DRSL (Defense Regional Sea Level) Database
- Transformed waves to atoll using spectral wave model and then to each island with nested grids
- Transformed waves across reefs and also examined depth-limited wave heights for the design (water level including tide, NTR, ponding, wave setup).
- Applied standard EM (and CEM) guidance for armor unit sizing for revetment.



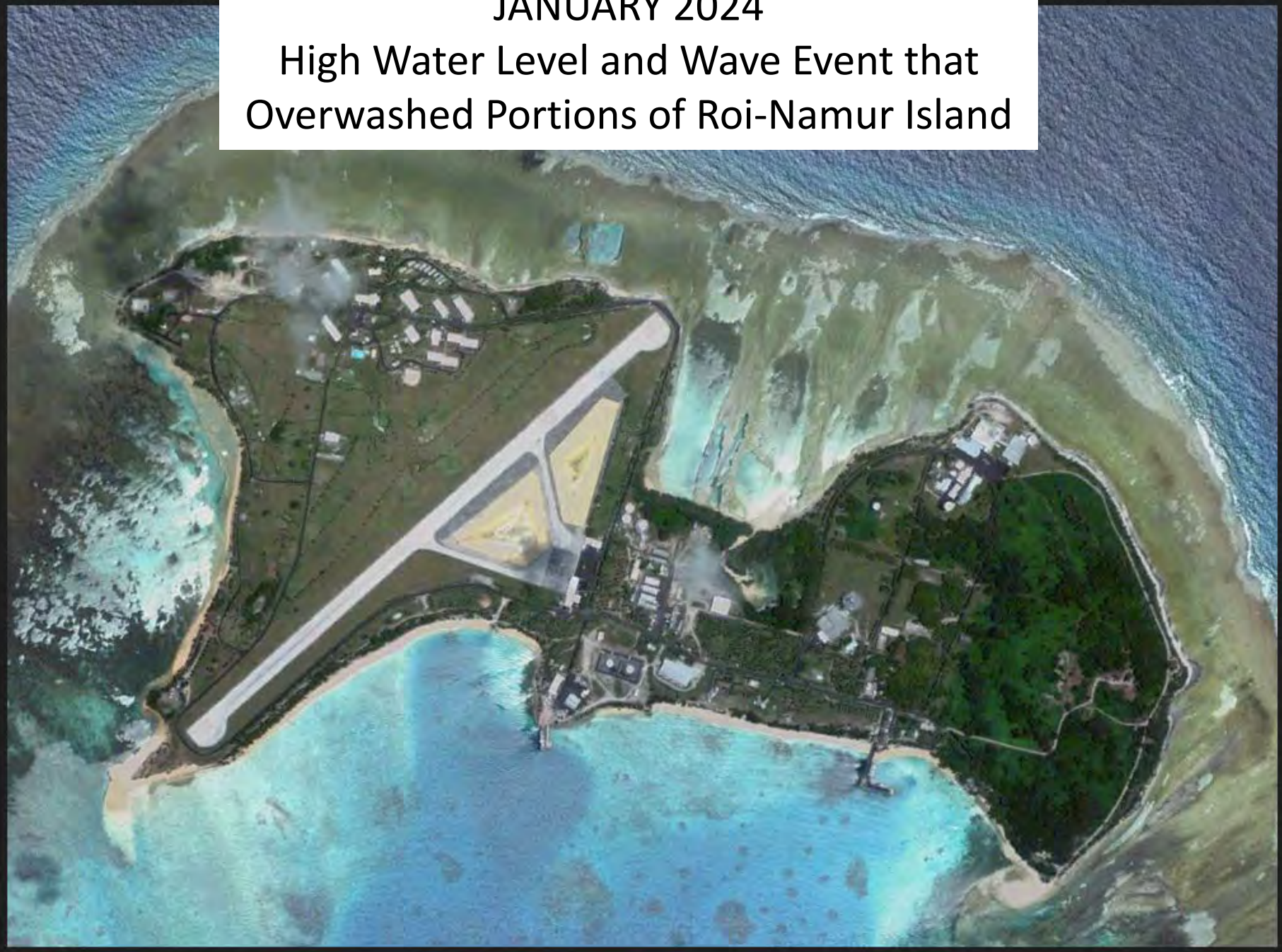
Typical Cross-Shore Profile (As measured with Airborne LiDAR)



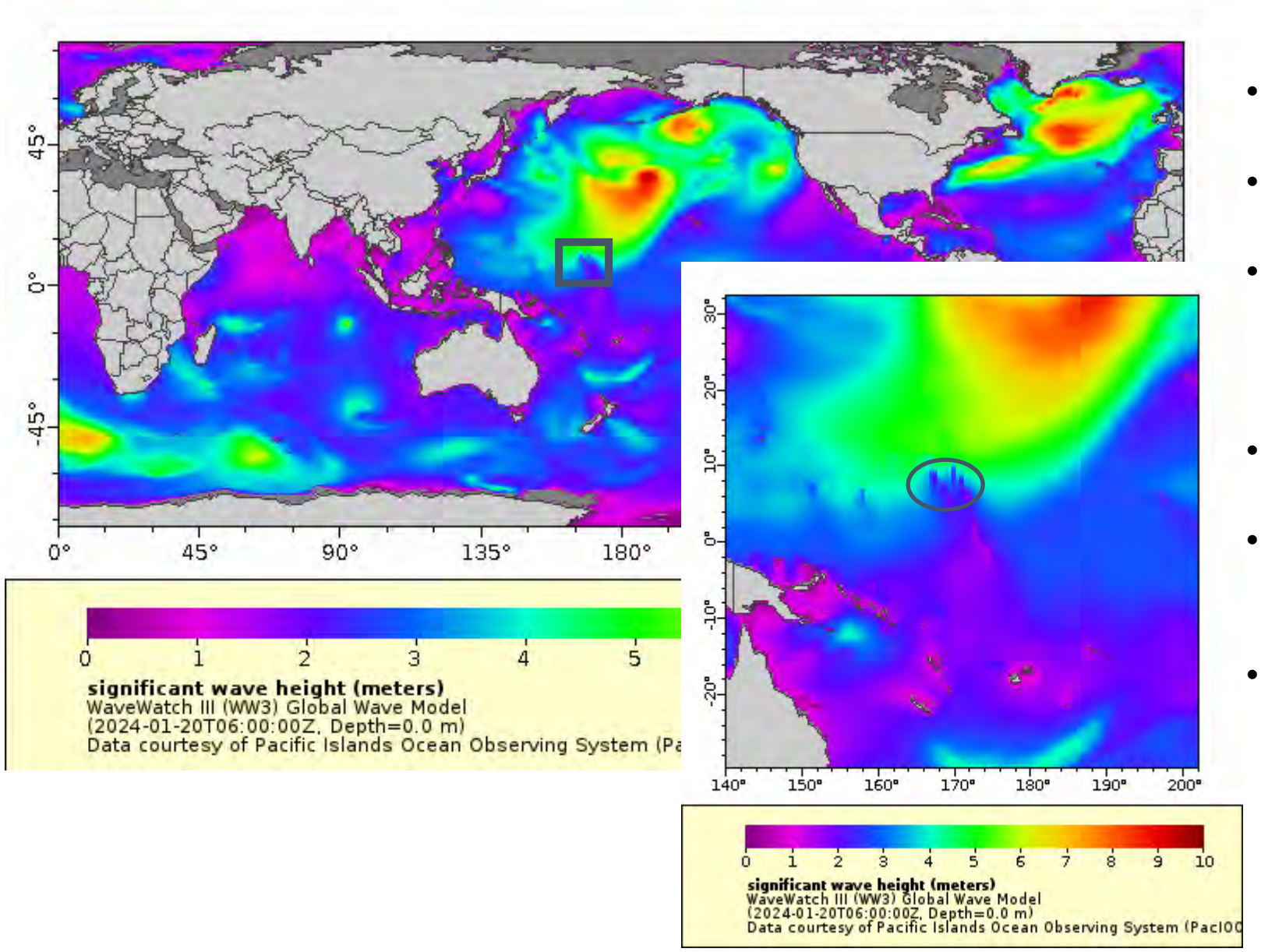
US Army Corps of Engineers ®

U.S.ARMY

JANUARY 2024
High Water Level and Wave Event that Overwashed Portions of Roi-Namur Island



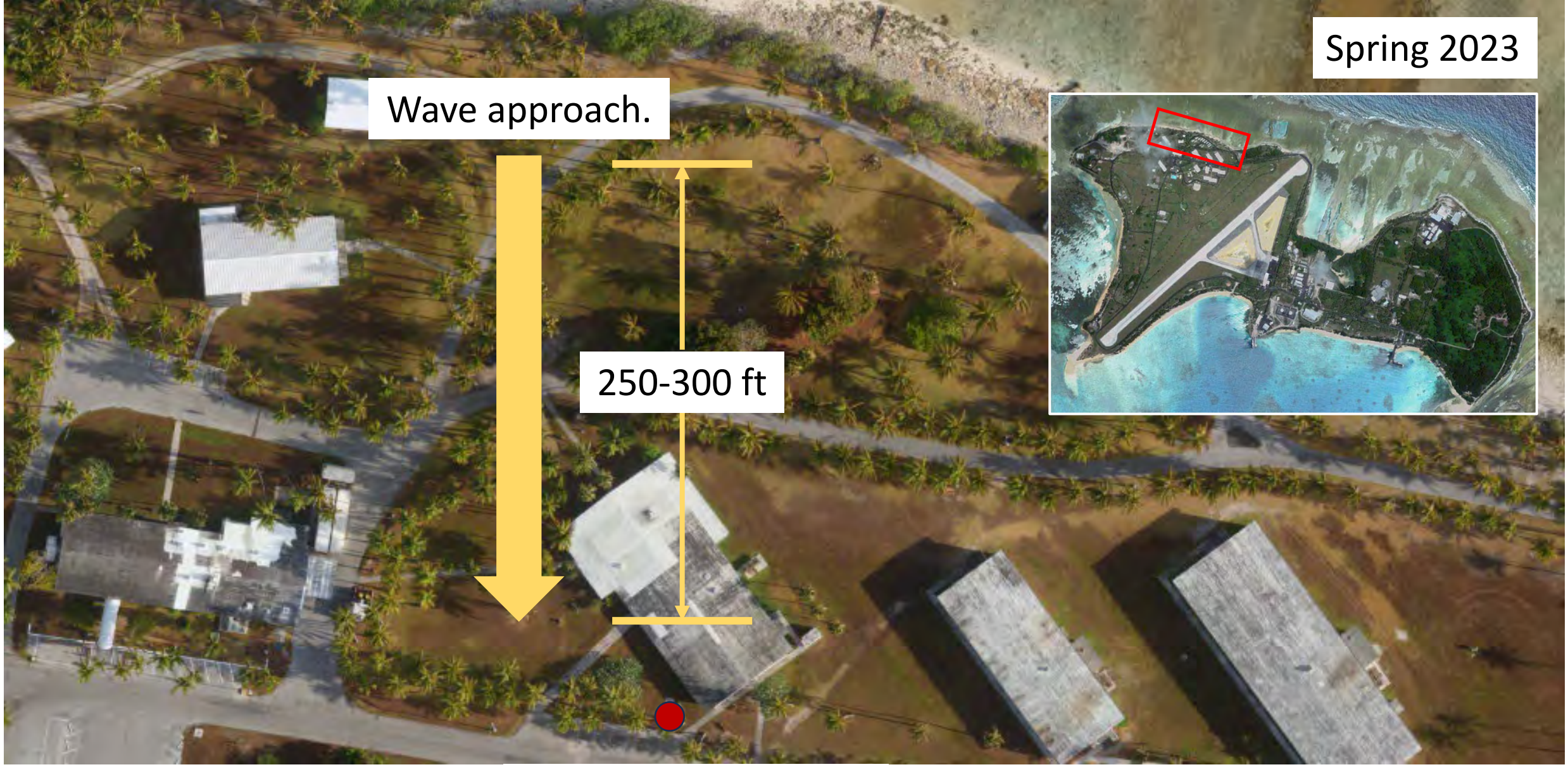
JANUARY 2024 WAVE/FLOODING EVENT



- Large Extratropical Swell Event in the North Pacific 20 Jan 24
- Maximum Wave Height of 9 to 10 meters (~30 ft) at center of storm
- Waves offshore of Kwajalein estimated in the 3-5 m (10-15 ft) range with wave periods of 18 - 20 seconds and from NNW
- Occurred on a rising (but relatively low) tide
- Similar to March 2014 flood/wave event documented by USGS to be caused by infragravity/VLF waves
- Approx 2 – 10 year event

US Army Corps of Engineers ®

U.S.ARMY



Outrigger Bar & Grill.

JANUARY 20, 2024
Roi-Namur Island,
Kwajalein Atoll

Outrigger Bar &
Grill
Video



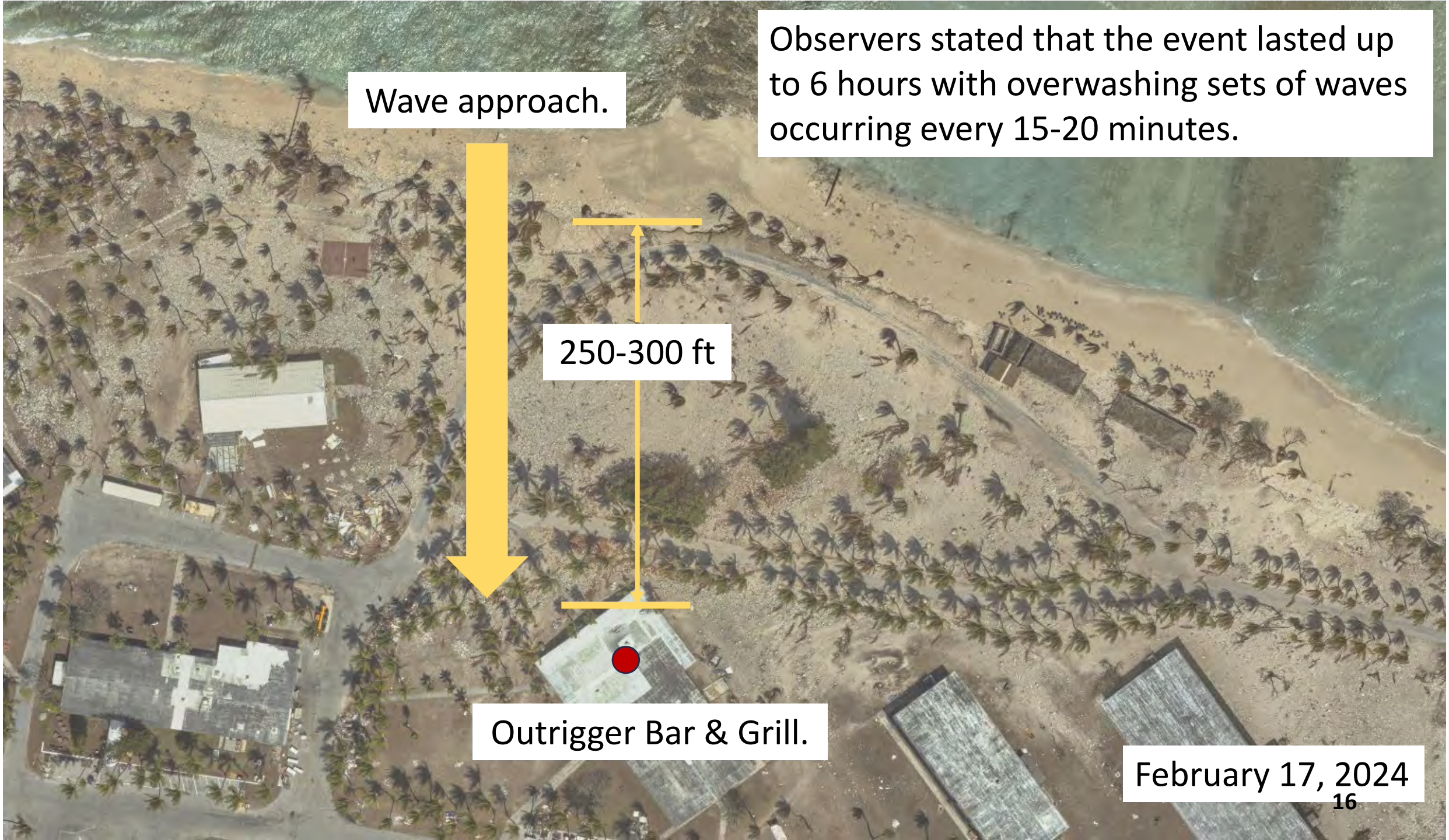

Angle of water entering doorway shows that wave hit building obliquely.
0:05


Water depth between wave crests is ~ 1 ft.
Faint image of second wave splashing as it approaches.



Second Wave: Second wave (pictured above) was larger than the first. Estimate of actual wave heights at building for first and second waves are 2-4 ft. (Height of second wave appears higher because of upward thrust of water as it strikes building.) Second wave arrived 18 seconds after the first indicating the wave period.


Spring 2023
Wave approach.
250-300 ft
Outrigger Bar & Grill.


Observers stated that the event lasted up to 6 hours with overwashing sets of waves occurring every 15-20 minutes.
Wave approach.
250-300 ft
Outrigger Bar & Grill.
February 17, 2024





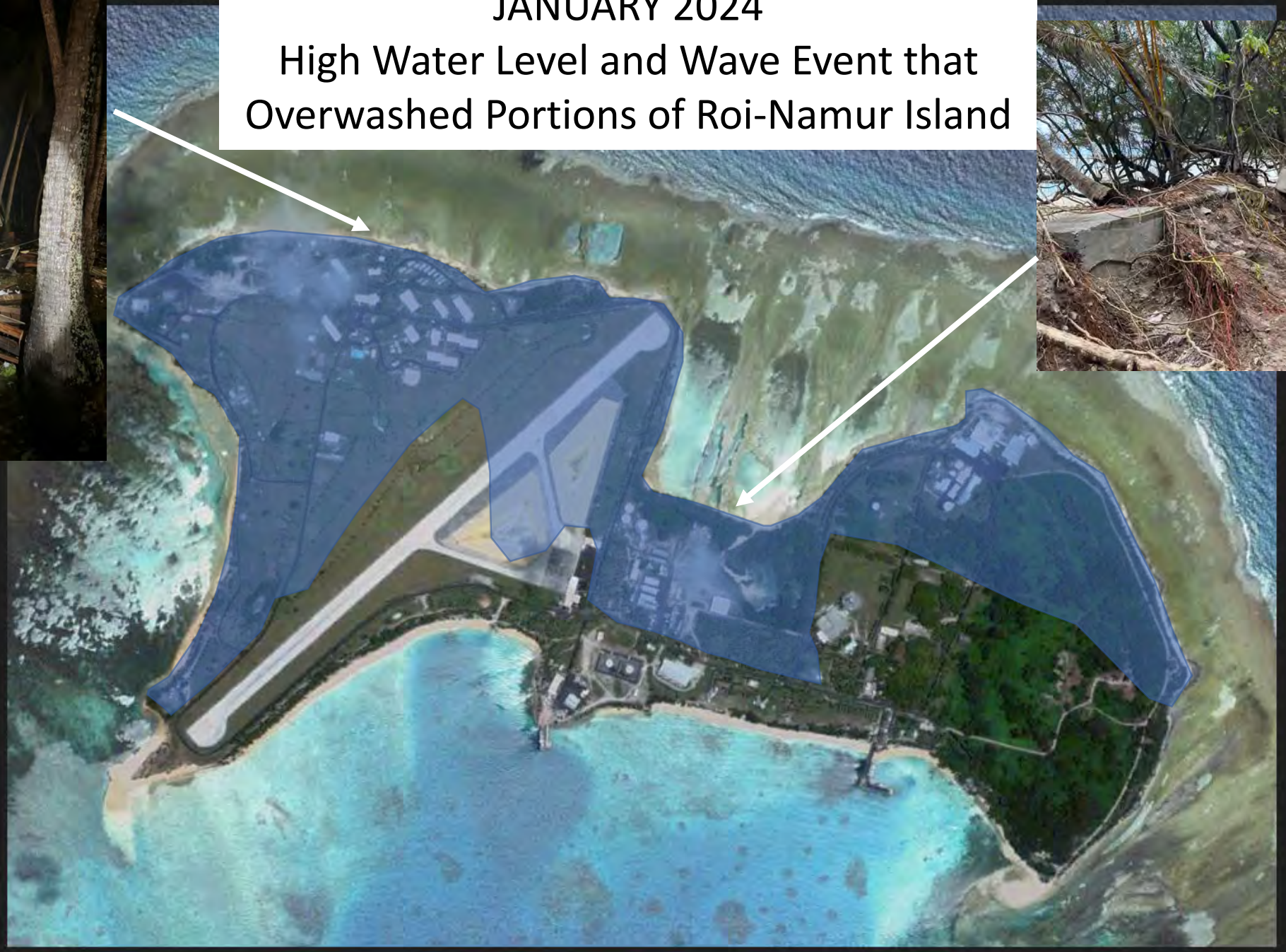
- Row of toe stone: 4-6 ton each
- Slope stone: 2-4 ton each
- Smaller stones at top for a splash apron



- Many of the toe stones moved out of place. (Not keyed into limestone.)
- Sections of slope stone moved.
- Splash apron significantly damaged

JANUARY 2024
High Water Level and Wave Event that Overwashed Portions of Roi-Namur Island





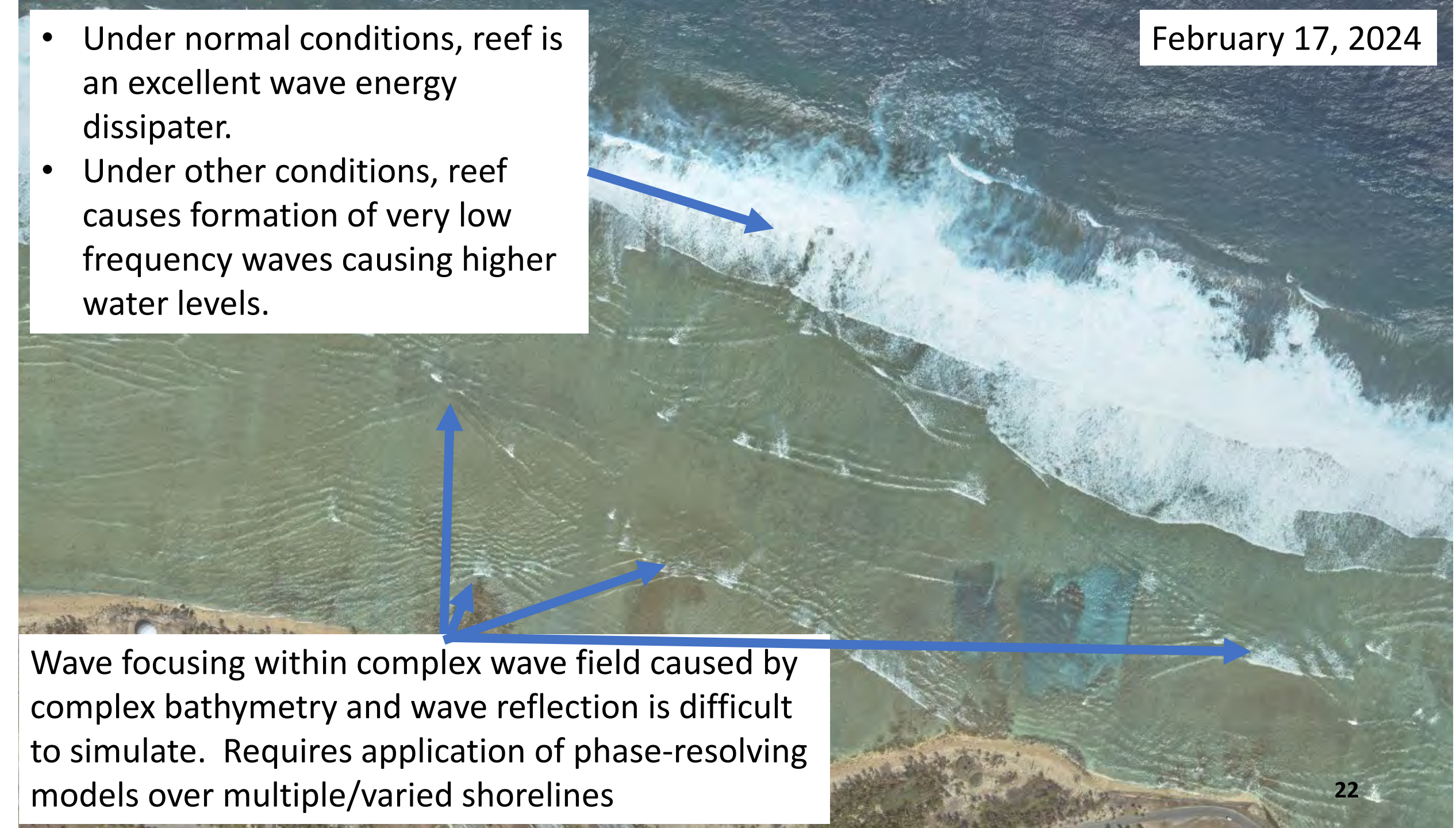


JANUARY 2024 WAVE/FLOODING EVENT

- Estimated or Presumed Parameters for January Event:
  - Low portion of the tidal cycle: -1 ft to 0.3 ft MSL
  - Wave Period: 18 seconds
  - Wave Height @ Buildings: 2-4 ft (possibly higher)
  - Reported Deepwater Wave Height: 10-16 ft
  - Possible IG/VLF Wave Period: 900 – 1200 seconds (15 – 20 Minutes)
  - Estimated short-term SWL: +10 ft LMSL (includes tide, IG/VLF, ponding, setup)
  - Ground elevation at buildings: +9 ft LMSL
  - Duration of event: Up to 6 hours







- Under normal conditions, reef is an excellent wave energy dissipater.
- Under other conditions, reef causes formation of very low frequency waves causing higher water levels.

February 17, 2024

Wave focusing within complex wave field caused by complex bathymetry and wave reflection is difficult to simulate. Requires application of phase-resolving models over multiple/varied shorelines

Pacific Island Coastal Engineering Challenges and R&D Recommendations

Challenge: Uncertainty in frequency and conditions that will generate IG conditions for use in probabilistic design

(10-year IG recurrence >> 100-year wave + calculated water level on reef?)

R&D: Better define probabilistic forcings for coastal protection design on reef-fringed islands exposed to distant long-period waves

- **Coastal Modeling/Pacific CHS** incorporating extratropical events and phase resolving models for low frequency wave increase to nearshore water level
- Determine combination of conditions (wave parameters, water level, reef width) that will generate an IG wave event
- More efficient phase resolving models designed for wide-scale applications to reef-fringed islands

US Army Corps of Engineers ®

U.S.ARMY

Pacific Island Coastal Engineering Challenges and R&D Recommendations

Challenge: How to incorporate temporary increases in water levels (due to IG and VLF wave energy) in combination with long period swell waves into design of coastal structures? Do established empirical formulas (Hudson, Melby, etc.) apply for stability?

R&D: Account for the effects of long wave period waves and sustained overwash more fully in structural design formulations

- Empirical stability equation (incorporating momentum flux) validation in physical models or CFD modeling
- Verification of empirical ponding equations and wave setup/runup calculations for use in design
- Develop scaleable approaches to approximate hydrodynamics and forces on rigid structures

US Army Corps of Engineers ®

U.S.ARMY

Pacific Island Coastal Engineering Challenges and R&D Recommendations

Challenge: What is balance between size of shore protection versus flood-proofing facilities or other inland measures to manage flooding on an island?

R&D: Investigate comprehensive solutions to coastal inundation where space, materials, equipment are limited and construction costs are high

- Approaches differ for coastal infrastructure, erosion protection, inland flooding of assets
- Combined offshore reef enhancement + coastal protection + flood proofing/drainage
- Balance risk reduction for these large episodic events with future potential adaptations for sea level rise (high variability on annual/decadal scale in the Pacific)

US Army Corps of Engineers ®

U.S.ARMY

Acknowledgements and Discussion



Jack Davis – Former ERDC Technical Director and Current Kwajalein Tech Lead



Dr. Bob Dean – “OG” Beach Erosion Board and CERB Member 1968-1980; 1993-1998

Danielle Mieler, P.E.

Danielle Mieler, P.E. is the Sustainability and Resilience Manager for the City of Alameda where she is responsible for equitably implementing the City's Climate Action and Resilience Plan to reduce greenhouse gas emissions and adapt to climate change. Danielle co-chairs the Oakland Alameda Adaptation Committee (OAAC), a coalition of local, regional, state and federal stakeholders and community-based organizations working to co-create a coordinated and inclusive future-looking action plan and sub-regional organizational structure to accelerate sea level rise adaptation, protect and restore water quality, recreation and habitat, and promote community resilience.

Danielle brings extensive experience to this work from her past roles in local and regional resilience planning. She previously managed San Francisco's Lifelines Council, Earthquake Safety Implementation Program and Tall Buildings Study, and the Association of Bay Area Government's Resilience Program. She received a B.S. and M.S. in Civil Engineering from UC Berkeley and a B.A. in Sociology from UC Santa Cruz. Danielle is an active member of the Earthquake Engineering Research Institute where she previously served as Director and Vice President.

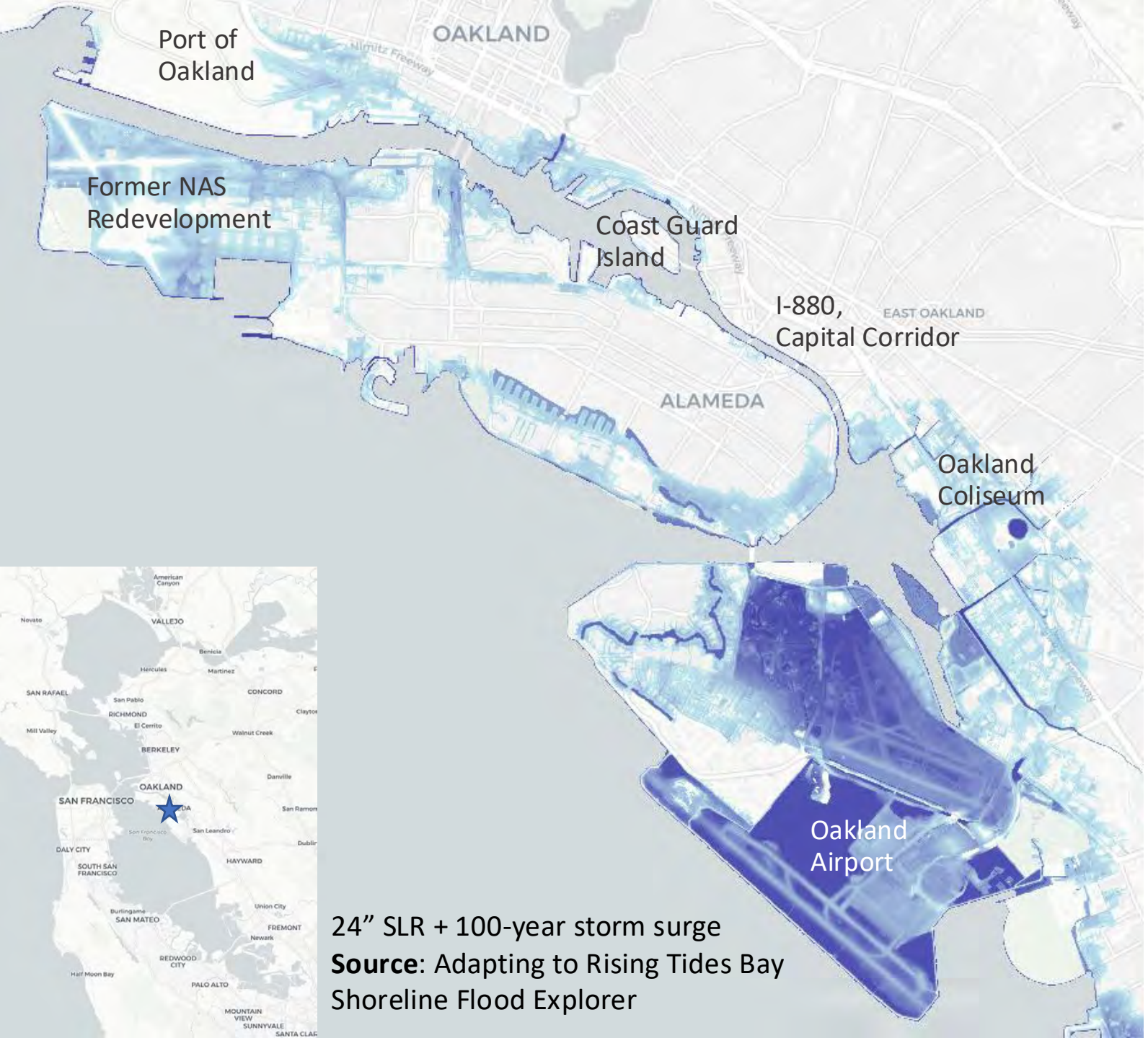
Keta Price

Keta Price is a third generation East Oakland native passionate about the intersections of racial and economic justice in city planning and development. Throughout four community planning processes, Keta co-developed community engagement and outreach plans that met residents where they were. From leveraging trending Tik Tok challenges, hosting backyard events, cultivating a resident leadership cohort to collaborating with local BIPOC artists and the tech industry, Keta has committed the past five years exploring organic and creative ways to engage low-income Black and POC residents in neighborhood planning and development. Keta obtained an A.S in Mathematics and Natural Science from Merritt College, Home of the Black Panthers.



Multi-jurisdictional and Community-Focused Sea Level Rise Adaptation Planning: OAAC example

August 14, 2024



The **Oakland Alameda Adaptation Committee (OAAC)** coordinates flood and sea level rise adaptation projects, protects and restores water quality, habitat and community resilience for the Oakland Alameda sub-region.

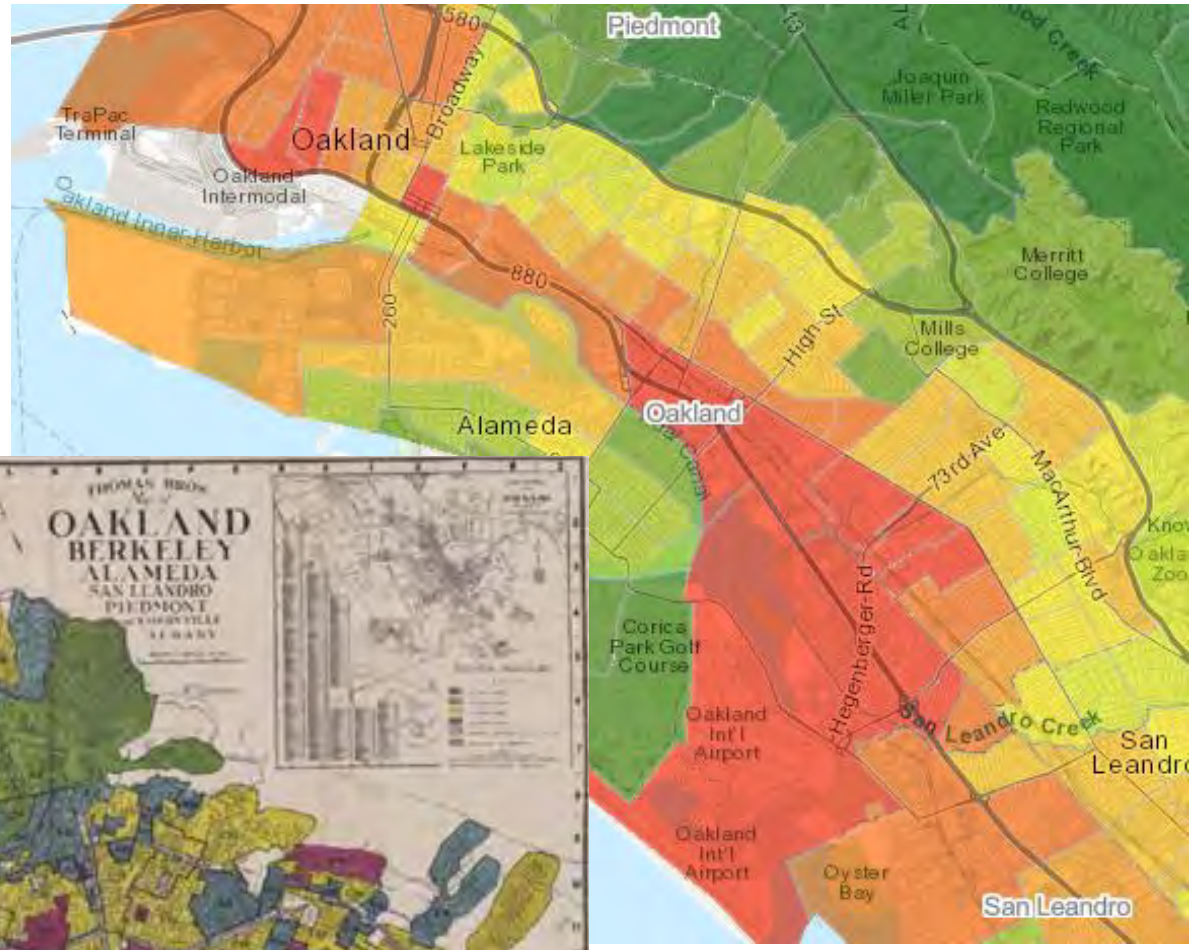


Multiple Hazards

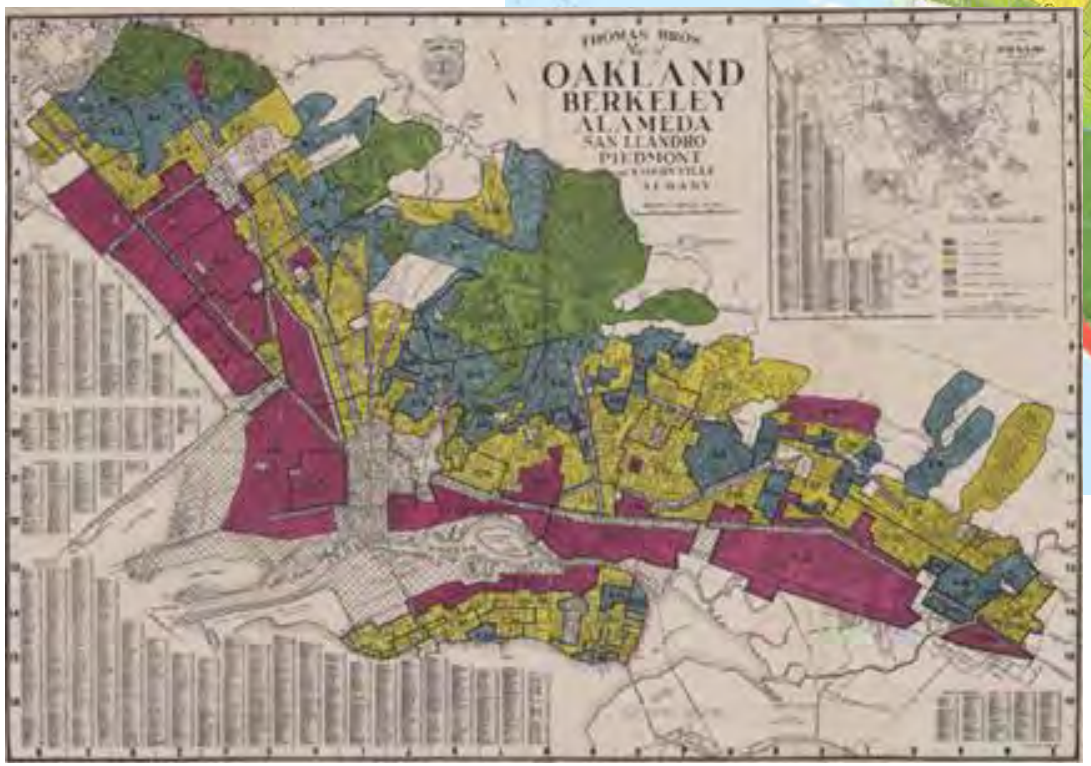
- **Sea level rise driven coastal flooding**
- **Rainfall-driven flooding**
- **Rising and emergent groundwater**
- **Liquefaction**

Vulnerable Communities

- Acknowledge historic injustices and collective loss
- Consider who will suffer and who could lose out
- Address today's issues and community priorities



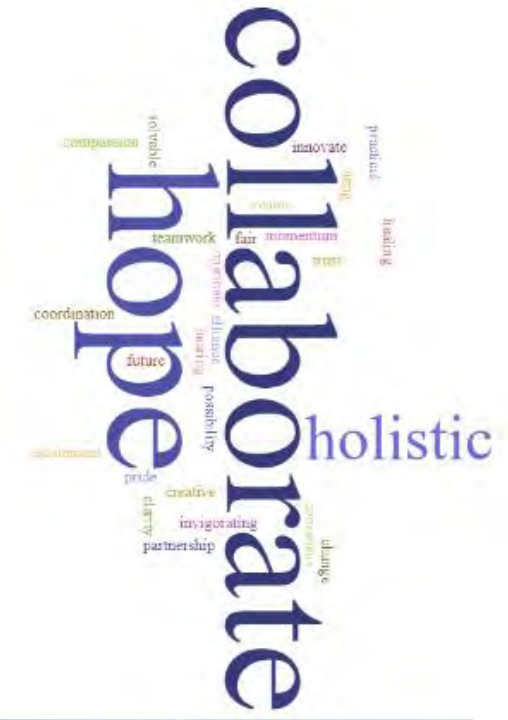
Socially Vulnerable Communities
Source: CalEnviroScreen 4.0



Historic Redlining Map

Benefits of Subregional Solutions

- Water does not respect jurisdictional boundaries
- Collaborating not competing
- Expedited and consensus-driven
- Increases grant funding
- Allows for prioritized state funding due to SB 272





OAAC Goals: Holistic Shoreline Planning Approach

- Address **sea level and groundwater rise, inland flooding and liquefaction**
- Identify **multi-benefit** adaptation strategies
- Avoid negatively affecting **neighboring subregions**
- Use **adaptation pathways** approach to identify near, mid, and long-term strategies
- Enhance **transportation, recreation, bay access**
- Preserve and increase **open space**
- Improve habitat with **nature-based solutions**
- Improve **air quality**



OAAC Steering Committee

Agencies

- Caltrans
- City of Alameda
- City of Oakland
- East Bay Regional Park District
- Port of Oakland
- S.F. Bay Regional Water Quality Control Board
- Alameda County Flood Control Agency

Community Partners

- Community Action for a Sustainable Alameda
- Greenbelt Alliance
- Hood Planner/East Oakland Neighborhood Initiative
- Sogorea Te' Land Trust
- West Oakland Environmental Indicators Project

Governance Options

Current

Non-binding MOU

- Consensus building
- Project prioritization
- Community and stakeholder engagement
- Allows greatest CBO participation

Near-term

Legally-binding MOU

- Govern implementation of funded projects with multiple entities
- Works as long as projects implemented one at a time

Long-term?

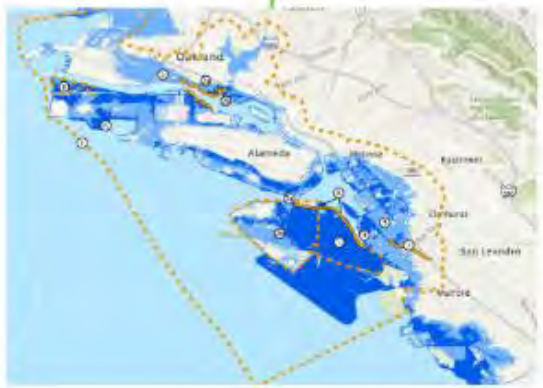
Special Purpose District

- Long-term governance solution
- Requires state legislation
- Allows for CBO representation
- OneShoreline example

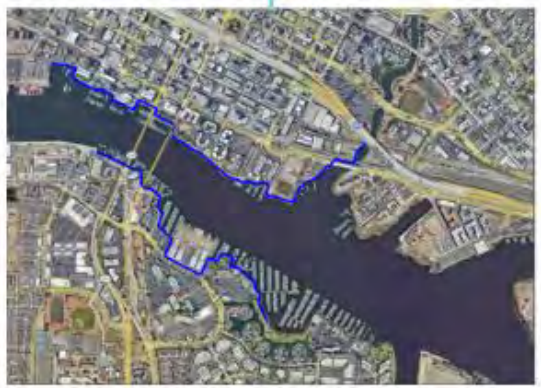
OAAC: Funded Projects (2023-2025)

Oakland-Alameda Adaptation Committee Projects

Sub-regional Adaptation Plan



Oakland-Alameda Estuary Adaptation Project



Bay Farm Island Adaptation Project



Project Partners

- Consultant team selected by OAAC Steering Committee
- Paid community partners
- City of Alameda as fiscal sponsor and project manager
- Robust community engagement process



GREENBELT ALLIANCE

HOOD PLANNING GROUP

Ninth Root

REAP CLIMATE CENTER

SOGOREA TE' LAND TRUST
LED BY URBAN INDIGENOUS WOMEN

CASA
Community Action for a Sustainable Alameda

Subregional Adaptation Plan

- **Purpose**: Identify actions over time as the shoreline changes to protect communities
- **Timeline:** 2024 – Oct 2025
- **Budget**: $840,000
- **Key partners:** Oakland, Alameda, Port, Caltrans, East Bay Regional Park District, community partners

www.alamedaca.gov/AdaptationLongTermPlan

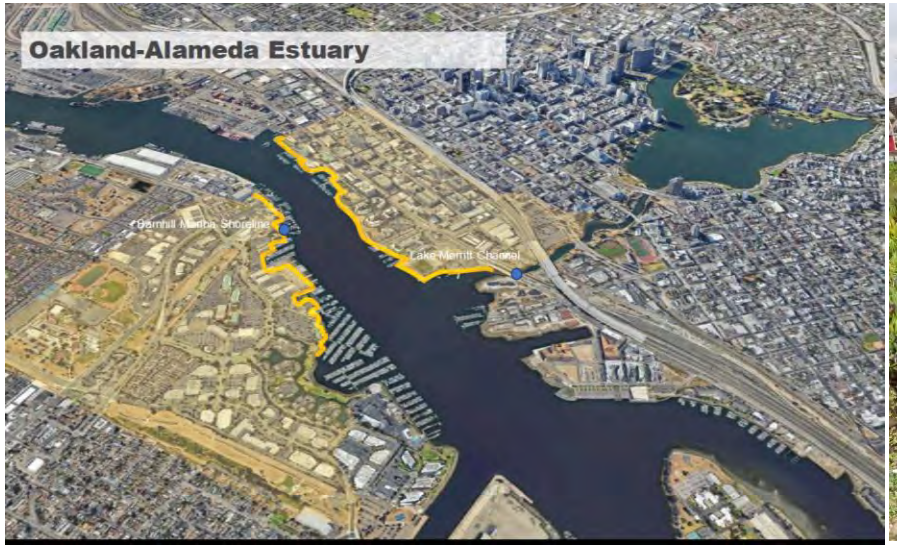


San Francisco ESTUARY PARTNERSHIP

NATIONAL FISH AND WILDLIFE FOUNDATION NFWF

Oakland-Alameda Estuary Adaptation Project

- **Purpose**: Develop concept design to protect Jack London District and Alameda's Posey-Webster Tubes
- **Timeline:** 2024 – Feb 2025
- **Budget**: $500,000
- **Key partners:** Oakland, Alameda, Port, Caltrans, community partners
- **Next steps:** Congressional earmark and WRDA request







www.alamedaca.gov/AdaptationEstuary

Bay Farm Island Adaptation Project

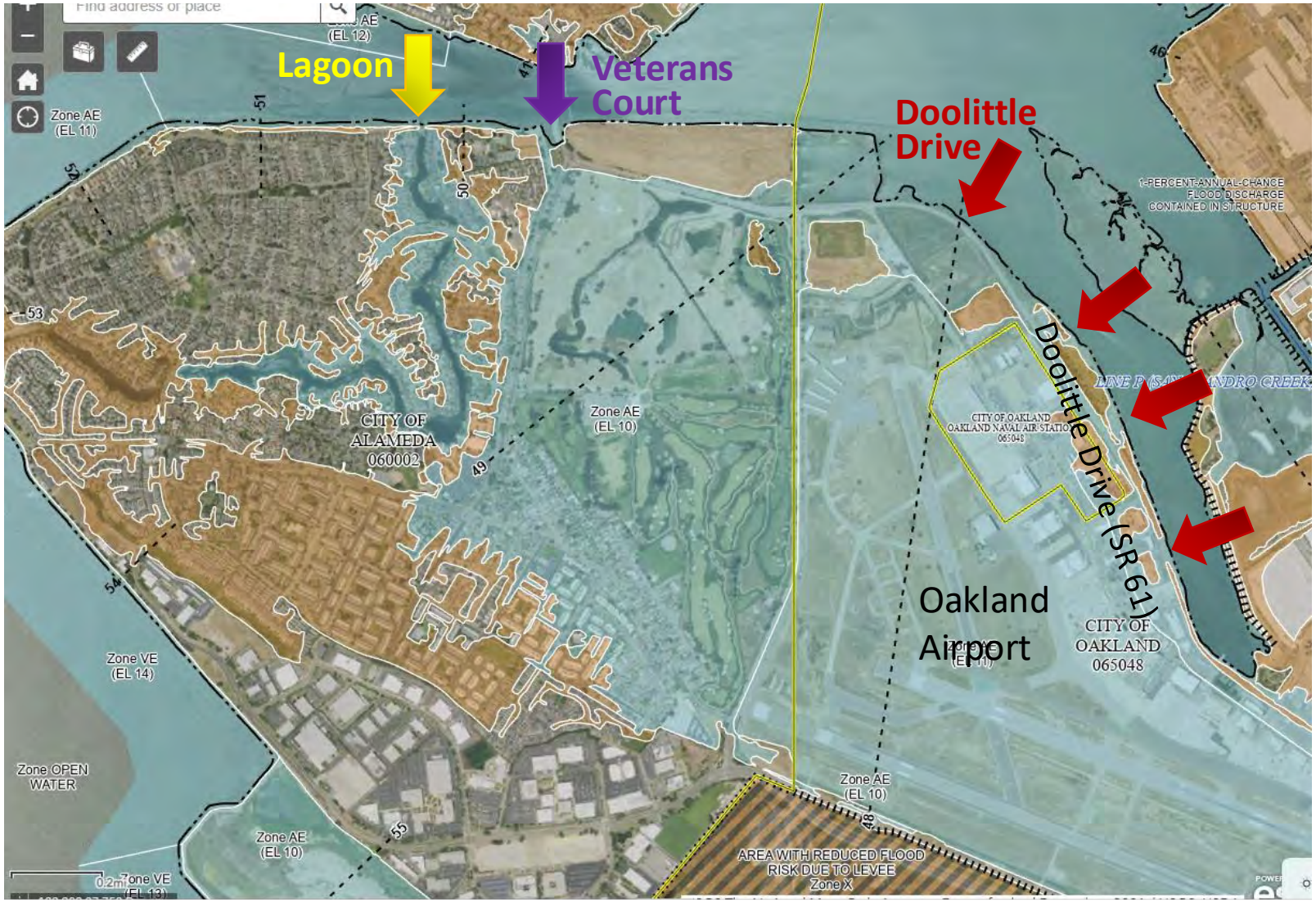
- **Purpose**: Develop design for short-term fixes and long-term plan for northern shoreline Bay Farm Island
- **Timeline:** 2022 – mid 2025
- **Budget**: $2 million (Rep. Barbara Lee federal earmark)
- **Key partners:** Oakland, Alameda, Caltrans, Port, East Bay Regional Parks, community partners

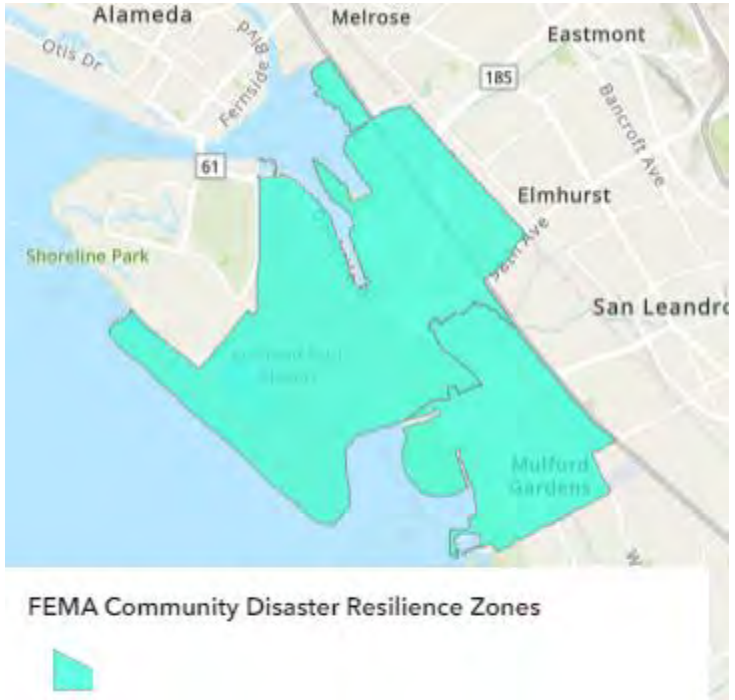


FEMA

www.alamedaca.gov/AdaptationBayFarmIsland

BFI Adaptation Project





BFI/Airport CDRZ: BRIC Request



BRIC federal: $50 m (90%)

Non-federal: $5.5 m (10%)

Total: $55.5 m

Start: 2025

Construction: 2028

Research and Development Gaps and Recommendations

- Align local priorities with Federal processes
- Accomplish holistic adaptation and resilience planning
- Develop best practices for nature-based solutions in urban environments
- Work with USACE on projects, including:
  - Beneficial use of Dredged Material for nature-based features
  - Congressional authorizations/appropriations
- Arrowhead Marsh replenishment & Southshore Alameda beaches
  - Pursue best practices
  - Secure dredge material
  - Expedite permitting to accelerate solutions



Thank you!

Keta Price, OAAC Co-Chair
Hood Planning Group
eohoodplanner@gmail.com

Danielle Mieler, OAAC Co-Chair
City of Alameda
dmieler@alamedaca.gov



Dave Halsing

The South Bay Salt Pond Restoration Project is the largest tidal wetland restoration project on the West Coast. When complete, the Project will restore 15,100 acres of former industrial salt ponds to a rich mosaic of tidal wetlands and other habitats, while adding public access features and maintaining or improving flood risk management capabilities.

Dave Halsing has been a part of the South Bay Salt Pond Restoration Project for over 13 years, the last 5 of which as the Executive Project Manager. In that role, he coordinates and participates in the planning and execution of the design, permitting, implementation, science & monitoring, stakeholder collaboration, public outreach & engagement, and fundraising. Before taking on this role, at firms including Environmental Science Associates, AECOM, and URS, he worked on multiple aspects of the Restoration Project, including its Phase 2 alternatives development, design, environmental clearance documents, and permitting.

More generally, in a consulting career approaching two decades, Dave's project work also focused on environmental and infrastructure projects in and around San Francisco Bay and other coastal settings. His specialty has become project management, especially for projects involving the interface of public infrastructure with habitat restoration and enhancement. His greatest technical interests are in developing and screening alternatives for multi-benefit projects, negotiating regulatory permits, and seeking the more efficient implementation possible.

Before working in consulting, he was a research scientist at the U.S. Geological Survey in Menlo Park. His work focused on integrating economics, spatial data, and decision sciences into the natural and physical sciences that were the USGS' primary focus. Though his inherent attention span problems limited his efforts to be a productive scientist, he was able to publish a few things on cost-effective salmon recovery actions, the economic benefits in use of geospatial data and improved data distribution systems, and land use management in the Lake Tahoe basin.

Dave has a Bachelor's Degree in Biology from Stanford University and a Master of Science in Natural Resource Policy from the University of Michigan's School of Natural Resources and Environment.

Progress and challenges of the tidal marsh restoration effort in San Francisco Bay: The South Bay Salt Pond Restoration Project

The South Bay Salt Pond Restoration Project began in 2003 when, under the leadership of Senator Dianne Feinstein, 15,100 acres of salt-production ponds were acquired from Cargill, Inc. The Restoration Project is the largest tidal wetland restoration project on the West Coast. When complete, the Project will restore these former industrial salt ponds to a rich mosaic of tidal wetlands and other habitats, while adding public access features and maintaining or improving flood risk management capabilities.

The Project was initially conceived of being implemented over 50 years in several phases to allow for adaptive management to guide each successive phase of restoration based on acquired knowledge, as well as to balance the competing habitat needs marsh species and pond-dependent wildlife. That gradual restoration plan depends heavily on scientific monitoring, applied studies, modeling, and data integration plans to inform future actions and improve ongoing management.

The Project is thus one of the earliest large-scale multi-benefit wetland restoration projects and one of the first to develop and implement long-term science and adaptive management plans. In its 21-year history, the Restoration Project has restored thousands of acres of tidal and muted tidal marsh, enhanced hundreds of acres of managed ponds to benefit many species and guilds of birds, and installed multiple miles of new trails, viewing areas, and interpretive signage. Phase 1 was completed in 2014, and Phase 2 is complete in some locations and actively underway in others.

The Restoration Project's work is guided by a multi-agency Project Management Team and a broad network of partners and stakeholders from all levels of government, utilities, the private sector, non-environmental profits, local community groups, and other organizations. The U.S. Army Corps of Engineers has been one of those team members since the outset of the project, and there are several important cooperative efforts between the Corps and the other partner entities.

Despite the successful completion of several thousand acres of tidal marsh restoration and managed pond enhancements, addition of many miles of public access trails and installation of viewing areas, as well as implementation of collaborative flood risk management projects with local flood control districts, challenges and barriers remain, some of which are also challenges to the Corps of Engineers and some of which might also be ones the Corps could help address.

This presentation, "Progress and challenges of the tidal marsh restoration effort in San Francisco Bay: the South Bay Salt Pond Restoration Project" will summarize the history, goals, and achievements of the project. It will discuss the way it uses a shared governance structure to make decisions and the role of a long-standing Adaptive Management Plan and a Science Program to flexibly design and implement phases of the project in an increasingly difficult setting.

The presentation will include a description of the challenges that large multi-benefit/multi-objective projects face in a dense urban environment. These challenges are large when the projects also cross jurisdictional and property ownership boundaries, which both this project and the overlapping Corps of Engineers-led South San Francisco Bay Shoreline Project do. Finally, the presentation will explore a few ideas for how the Corps of Engineers and its Board of Coastal Engineering Research could evaluate R&D priorities to help address these shared challenges.

South Bay Salt Pond Restoration Project

Restoring the Wild Heart of the South Bay



Briefing to USACE Board on Coastal Engineering Research

Dave Halsing, Executive Project Manager

August 14, 2024

Project overview

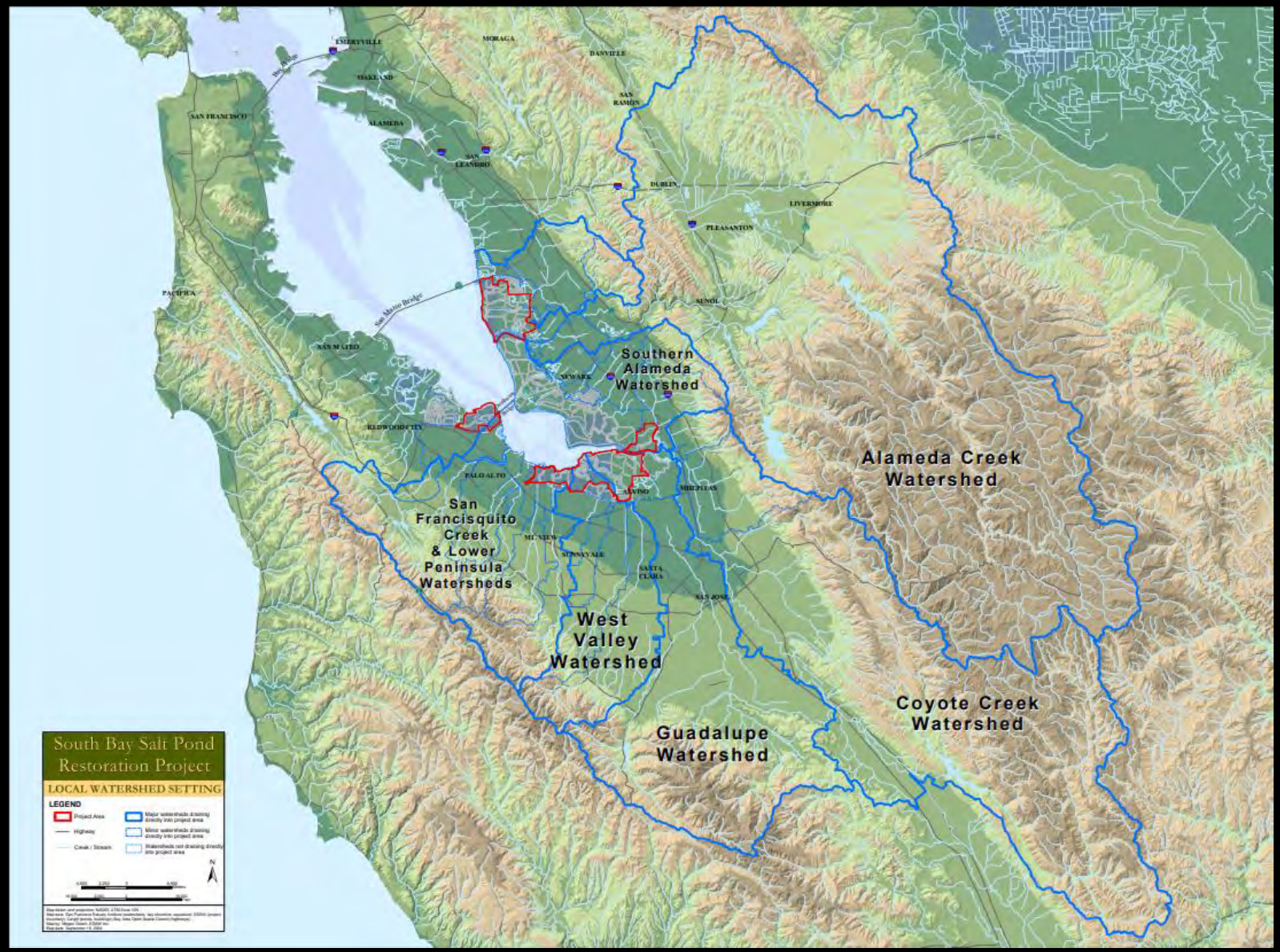
USACE collaborations

Successes

Challenges

BCER benefits

R&D data gaps

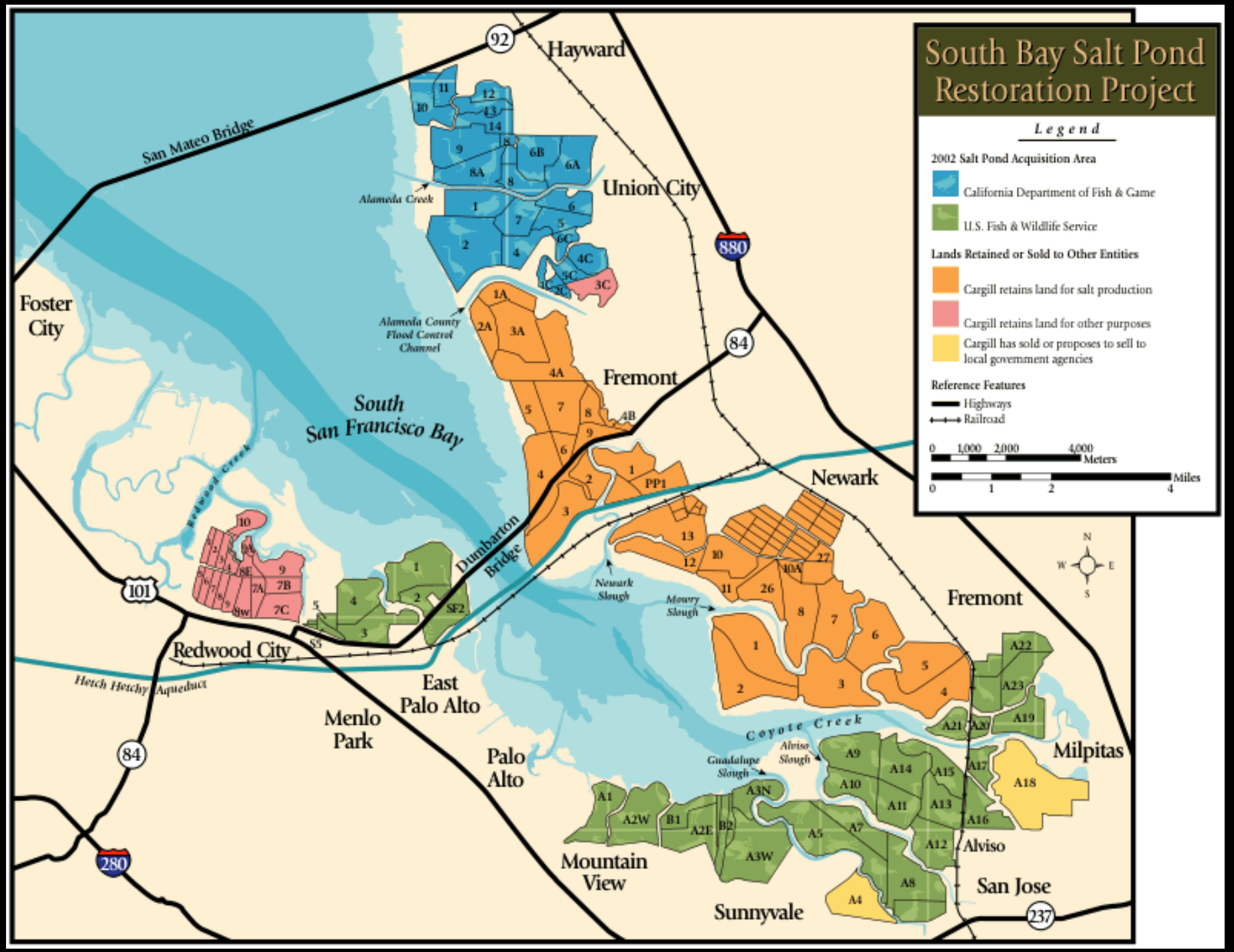


SBSP Restoration Project

- Began in 2003
- Acquisition of 15,100 acres from Cargill
- Time to build program 2003-2007
  - Science Program / Adaptive Mgmt Plan
- Phase 1 → 2007-2014
- Phase 2 planning 2012
  - Underway now






South Bay Salt Pond Restoration Project
Legend
2002 Salt Pond Acquisition Area
California Department of Fish & Game
U.S. Fish & Wildlife Service
Lands Retained or Sold to Other Entities
Cargill retains land for salt production
Cargill retains land for other purposes
Cargill has sold or proposes to sell to local government agencies
Reference Features
Highways
Railroad
0 1,000 2,000 4,000 Meters
0 1 2 4 Miles
N
W E
S
San Mateo Bridge
Hayward
Union City
Foster City
Alameda Creek
Alameda County Flood Control Channel
South San Francisco Bay
Fremont
Newark
Dumbarton Bridge
Redwood Creek
Redwood City
Menlo Park
East Palo Alto
Palo Alto
Mountain View
Sunnyvale
Milpitas
Alviso
San Jose
Newark Slough
Mowry Slough
Coyote Creek
Alviso Slough
Guadalupe Slough
Hetch Hetchy Aqueduct
92
880
84
101
280
237
SF2
PP1

Three Project Goals

Habitat Restoration



Judy Irving, Pelican Media





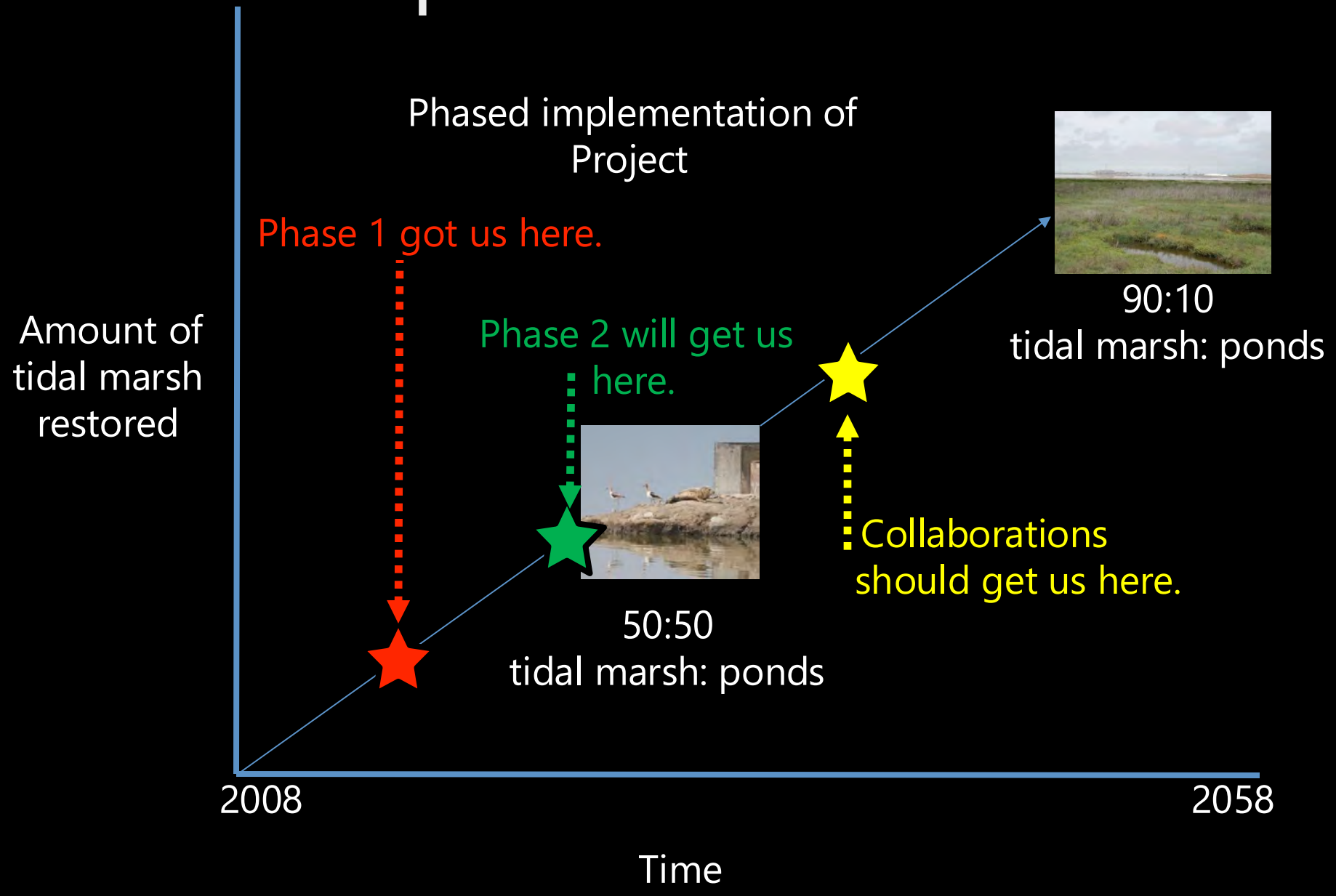




Flood Risk Management

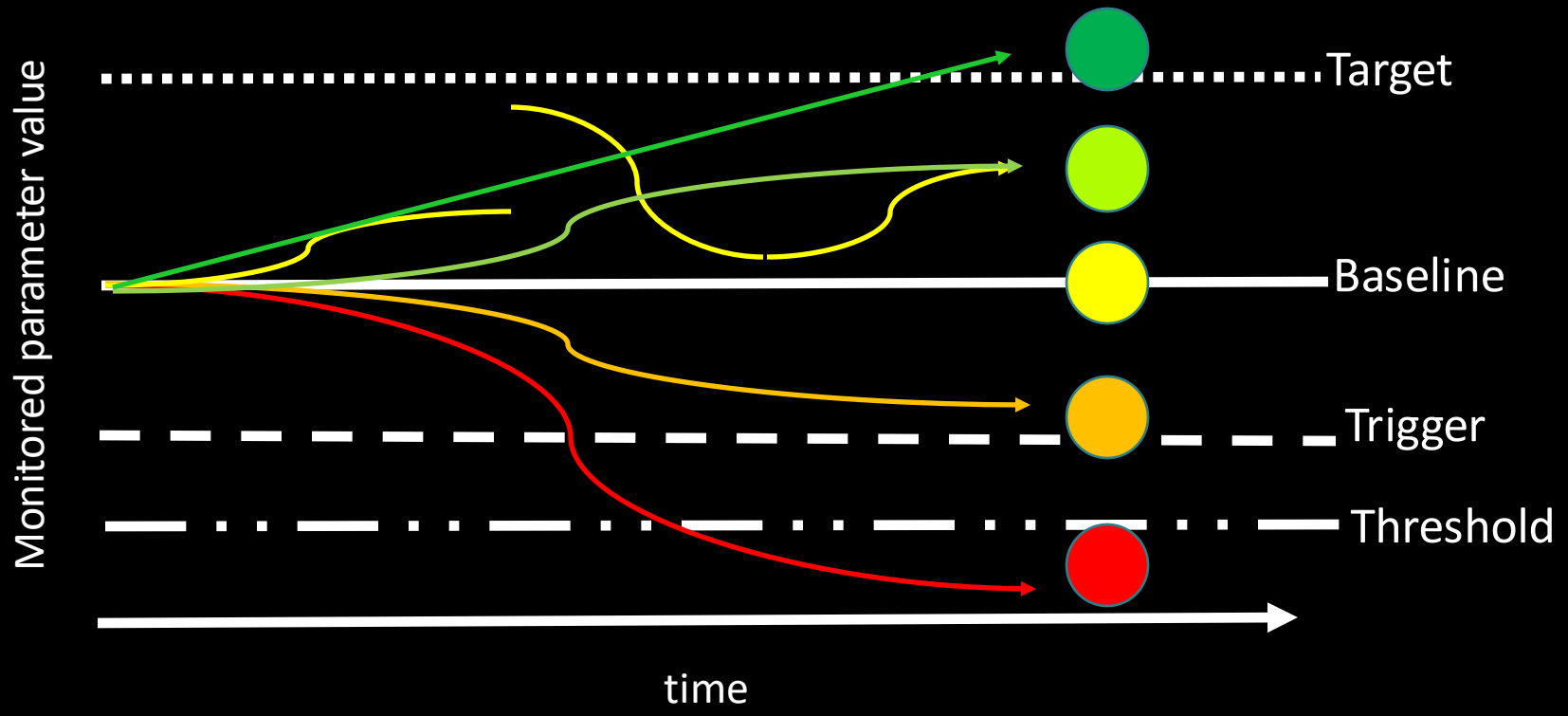
Public Access & Recreation

Adaptive Restoration

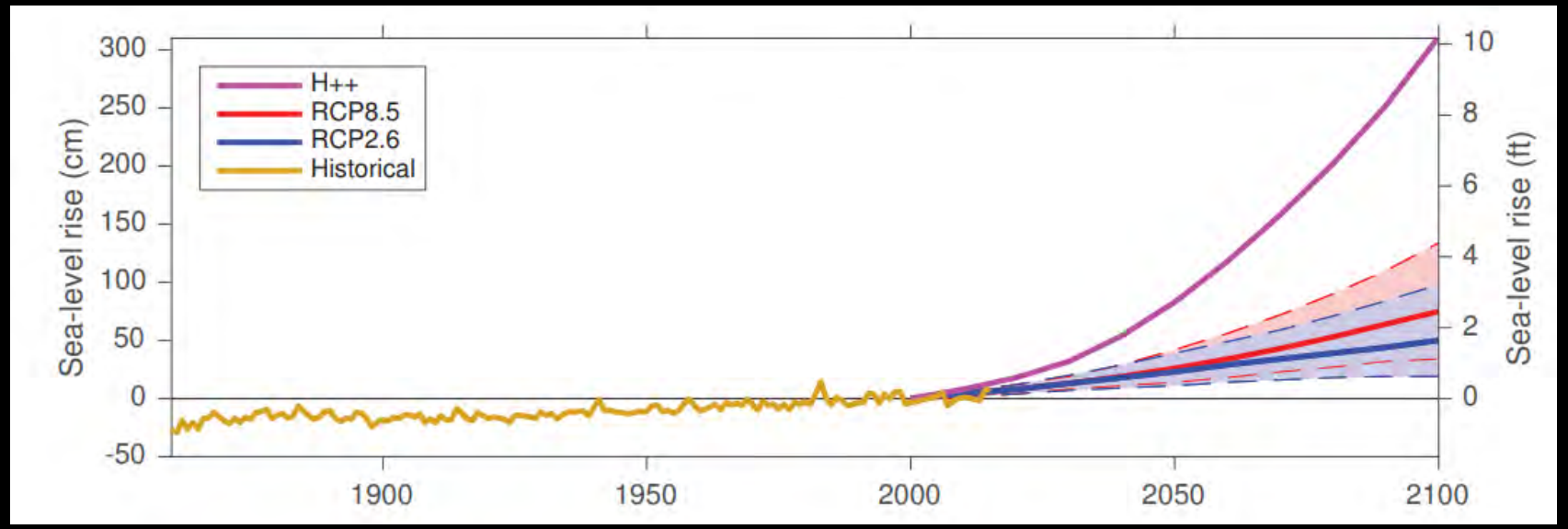


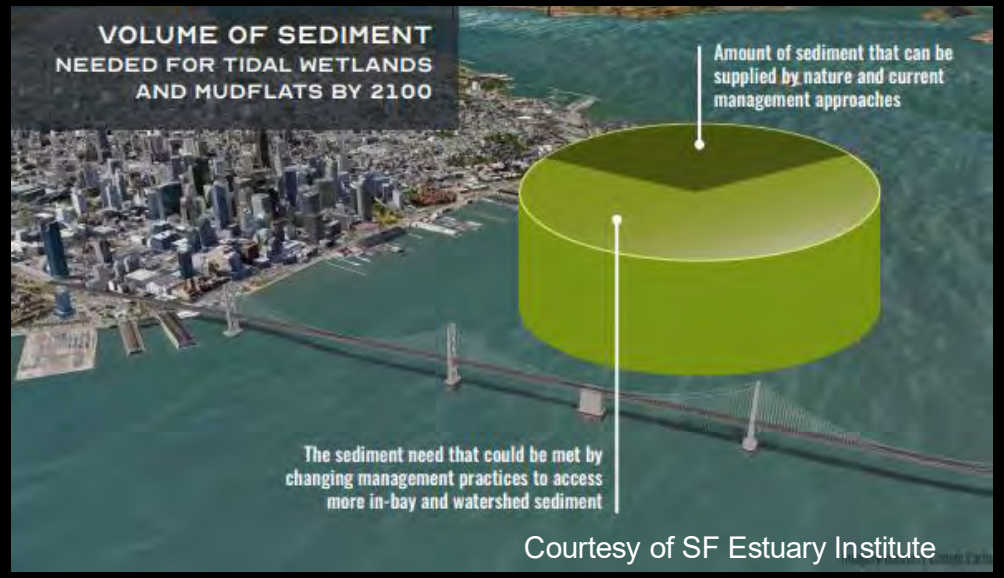
Adaptive Management In Action





Sea-Level Rise & Sediment





Time isn't on our *side*

Phase 1 Outcomes



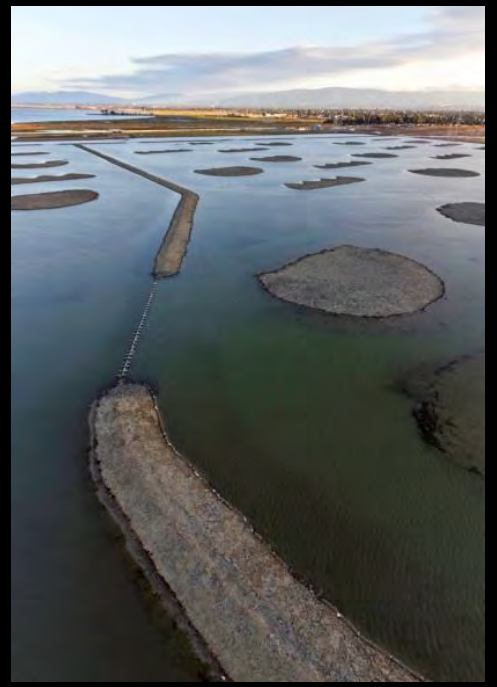




Photo by Jen McBroom,
Invasive Spartina Project

3,000 acres of tidal & muted tidal restoration;
700 acres managed ponds

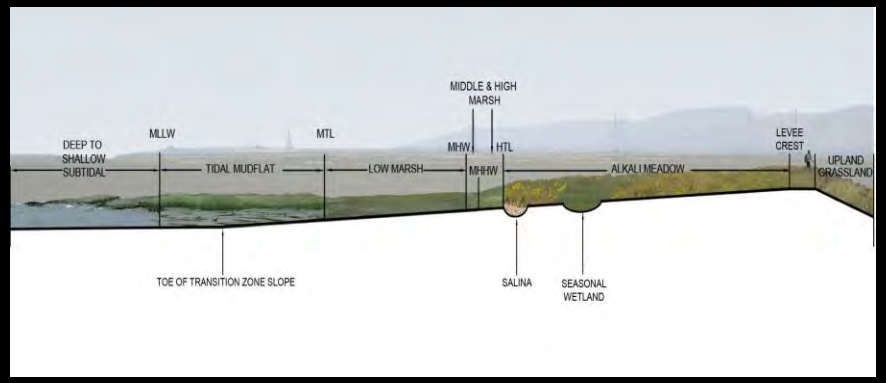
7 miles of new trails
Kayak launch
Viewing platforms

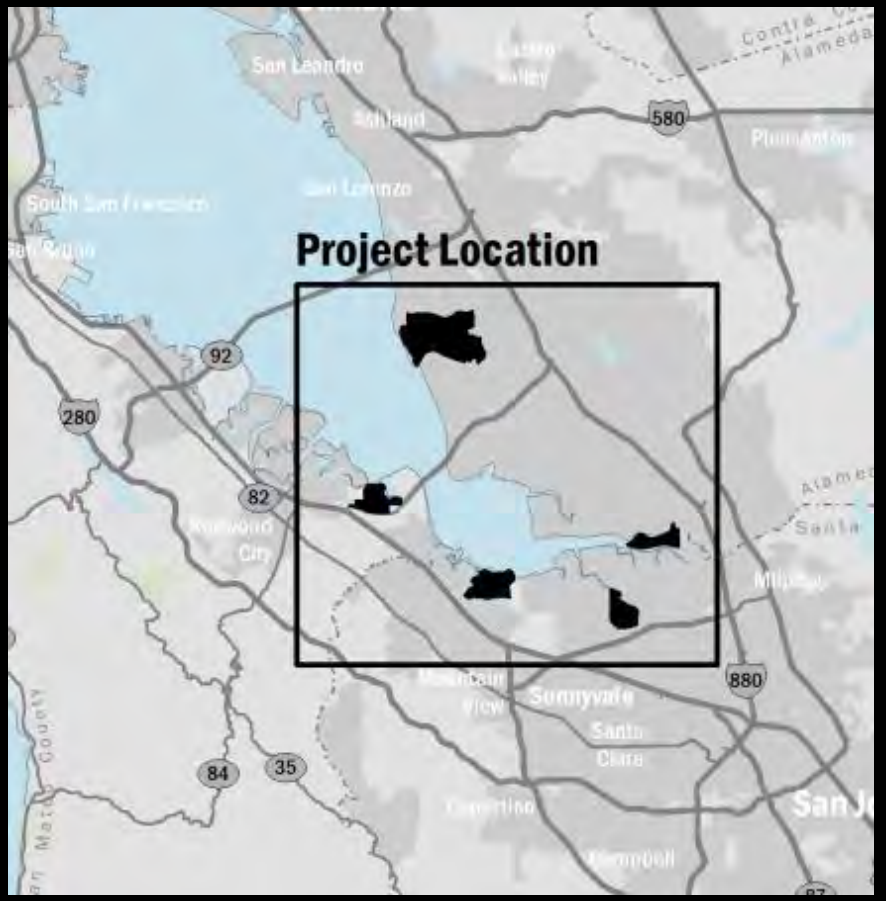


Kite aerial photos by Cris Benton

Phase 2 Actions

- 5 locations (2 complete)
- 2,300 acres tidal marsh
- 1,150 acres enhanced ponds
- 5.5 miles of trail
- 6-8 viewing areas
- Modifying 2 Phase 1 sites





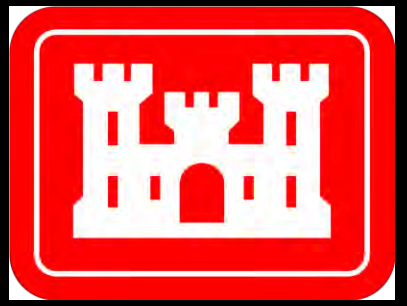
Partnerships & Roles

Project Management Team















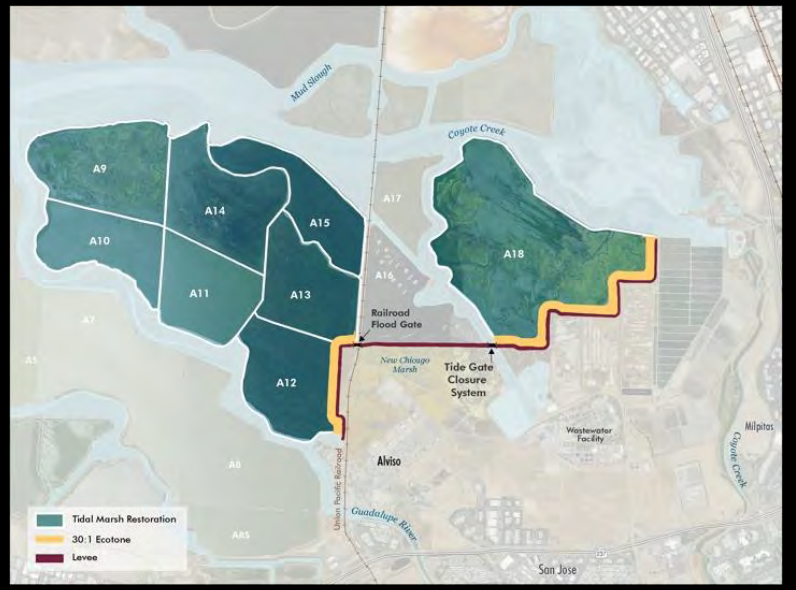




USACE Collaborations

- USACE South Bay Shoreline Projects & Studies
- Strategic sediment placement project
- Beneficial material reuse
  - Environmental screening limits
- Federal standard to keep more in bay





Challenges to Multi-Benefit Projects

- Competing habitat goals
- Mixing in public access
- Work in urban areas
- Env. permitting
- Clean sediment demand
  - Dredge *and* upland sources
- Monitoring requirements
- **Funding for science…collaboration can help**



USACE - BCER Benefits

- LiDAR bathymetry
- Nature-based Solutions guidance
- Use of comprehensive benefits in B:C calculations for multi-benefit projects
- Modeling of sediment dynamics

- Shared monitoring efforts & costs
- Ecotoxicology / risk analysis of reuse

Summary of R&D Gaps & Recommendations

- Strategies to increase beneficial reuse
  - Research to identify optimal ESLs
  - Make beneficial use the Federal standard
- Identify & fund added pilot projects
  - e.g. strategic sediment placement
- Explore ways to leverage regional collaborative funding for monitoring & data management
-

Thank You!



Dave Halsing

650-814-0588

dave.halsing@scc.ca.gov

www.southbayrestoration.org

Follow us on Facebook





Kite Photo by Cris Benton

Tiffany Cheng, P.E.

Tiffany K. Cheng, PE is a coastal engineer at the San Francisco District of the US Army Corps of Engineers (USACE). Ms. Cheng brings over 10 years of professional experience in nature-based infrastructure projects in the coastal zone, climate change and sea level rise adaptation and habitat restoration, with a focus on Northern and Central California. Ms. Cheng was a co-author on the “Toward Natural Infrastructure to Manage Coastal Change in California”, which was published as part of the California’s Fourth Climate Change Assessment. She earned her M.S. in Coastal & Ocean Engineering from Oregon State University, B.S. in Environmental Engineering from MIT and is a native of Jamaica Bay, NY.

Presentation Title: Innovations in Beneficial Use for Ecosystem Resilience (Section 1122 Shallow Water Placement and Sediment Pulse Dredging)

Narrative Briefing:

USACE San Francisco District (SPN) is leading two innovative beneficial use of dredged material (BUDM) pilots: 1) Section 1122 Strategic Shallow Water Placement pilot project by Eden Landing, CA and 2) Strategic Sediment Pulse Delivery pilot study in Marin County, CA, funded by the Floodplain Management Services Program (FPMS). The two efforts leverage natural processes (e.g. tidal action, wave resuspension, fluvial flows) to transport dredged material to support multi-benefit outcomes, including regional marsh and mudflat resiliency to local sea level rise, flood risk reduction and sustaining sediment supply in the Bay Area estuary. Both the shallow water placement and sediment pulse dredge approaches represent innovations in process and, if found effective, would support future implementation elsewhere in the Bay. A brief summary of the two separate efforts is described below:

Section 1122 Strategic Shallow Water Placement: The shallow water placement pilot project, funded by WRDA 2020 Section 1122 was implemented in Winter 2023 by SPN offshore of Hayward, CA, under close collaboration with project partners California Coastal Conservancy and San Francisco Bay Regional Water Quality Control Board. Through 2022, the team conducted in-depth hydrodynamic and sediment transport modeling to inform site selection for shallow water placement, evaluate sediment transport/fate and pilot design. 90,000 cy of clean dredged material were dredged from Reaches 1 and 2 of the Port of Redwood City through December 2023 and transported to the placement area 2 miles offshore of the Eden Landing Ecological Reserve. The dredged material was deposited in shallow mounds on the Bay bottom over 169 placements. The project is currently undergoing monitoring through December 2024, including tracking of magnetic tracers post-placement to measure spatial and temporal trends in deposition.

FPMS Strategic Sediment Pulse Delivery: Since Summer 2023, USACE SPN and Marin County Public Works have been exploring the efficacy of sediment pulse dredging for silted-in tidal channels. Sediment pulse dredging proposes the intentional use of hydrodynamic dredge (e.g. water injection dredging) prior to or following high wind/storm events to disturb/suspend sediments at the channel bottom, such that elevated tidal currents and flows can transport the sediment downstream when the system is naturally experiencing elevated turbidity. SPN and ERDC have developed a regional hydrodynamic and sediment transport model (AdH), refined to the pilot site of Gallinas Creek, to simulate the dredge approach and evaluate potential flood risk reduction to the surrounding community and sediment transport to local marsh/mudflat complexes. The final study report will be released in September 2024, when the study concludes.

INNOVATIONS IN BENEFICIAL USE FOR ECOSYSTEM RESILIENCE: SECTION 1122 AND SEDIMENT PULSE DREDGING


Section 1122 Shallow Water Placement

BCER 100th Annual Meeting
14 AUG 2024

Tiffany K. Cheng, PE, Coastal Engineer
CESPN-ECE-EW


Photo: Cris Benton



U.S. ARMY

US Army Corps of Engineers

PROBLEMS

- Limited **sediment supply** regionally + **sea-level rise**
  - Marsh drowning and erosion
  - **Habitat loss** for endangered and threatened species
  - Increased **flood risk** for low-lying communities



OPPORTUNITY

Reuse dredged material in innovative ways to support existing bayland ecosystems

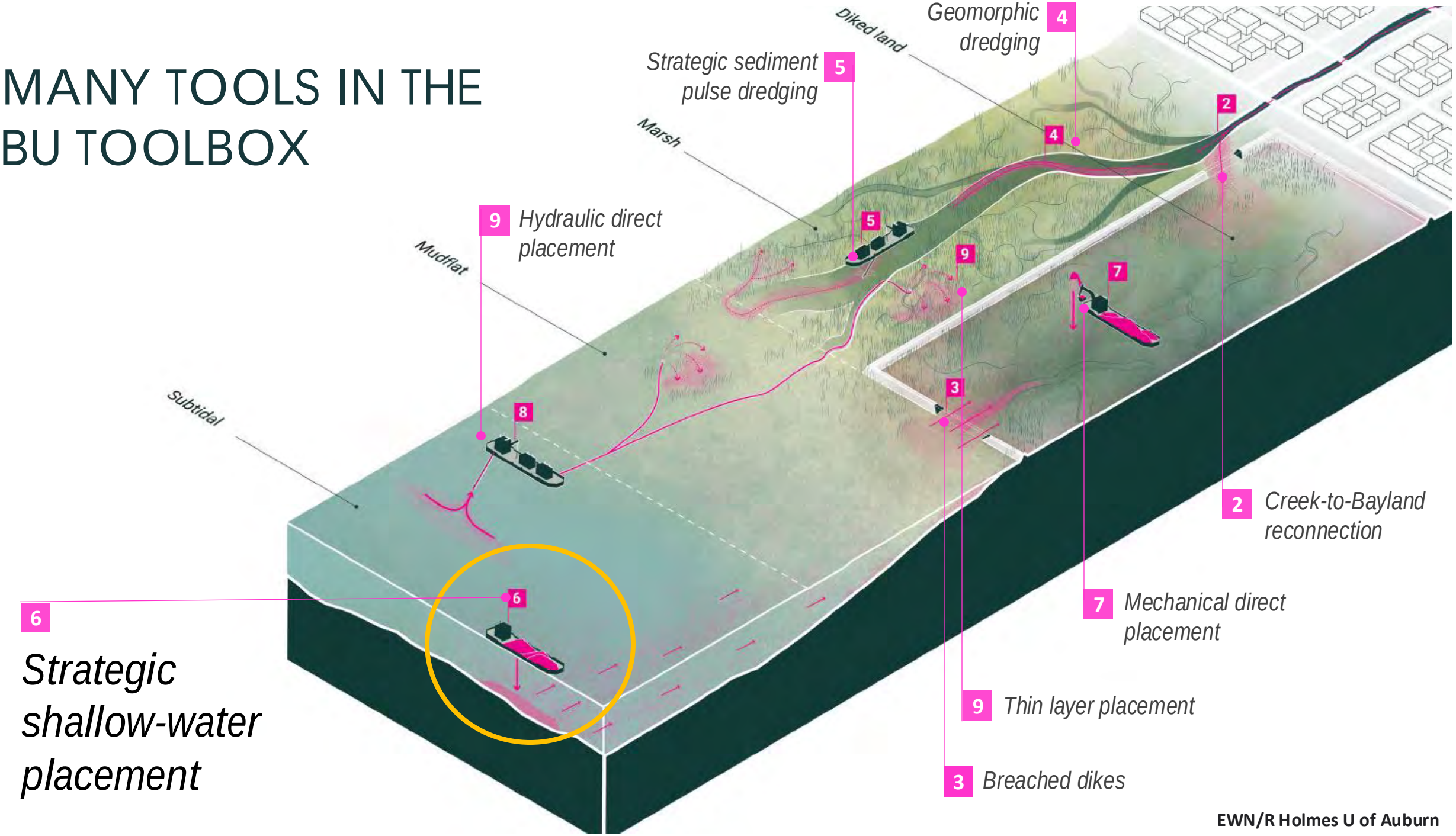
Leverage dredged material from navigation channels

– Beneficial Use: Direct Placement

– **Novel EWN Methods (e.g., Strategic Placement, Sediment Pulse Dredging)**



MANY TOOLS IN THE BU TOOLBOX



6

Strategic shallow-water placement

EWN/R Holmes U of Auburn

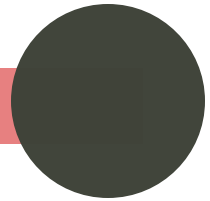
SECTION 1122 SHALLOW WATER PLACEMENT


Peter Mull


Tiffany Cheng, PE


Julie Beagle


Arye Janoff

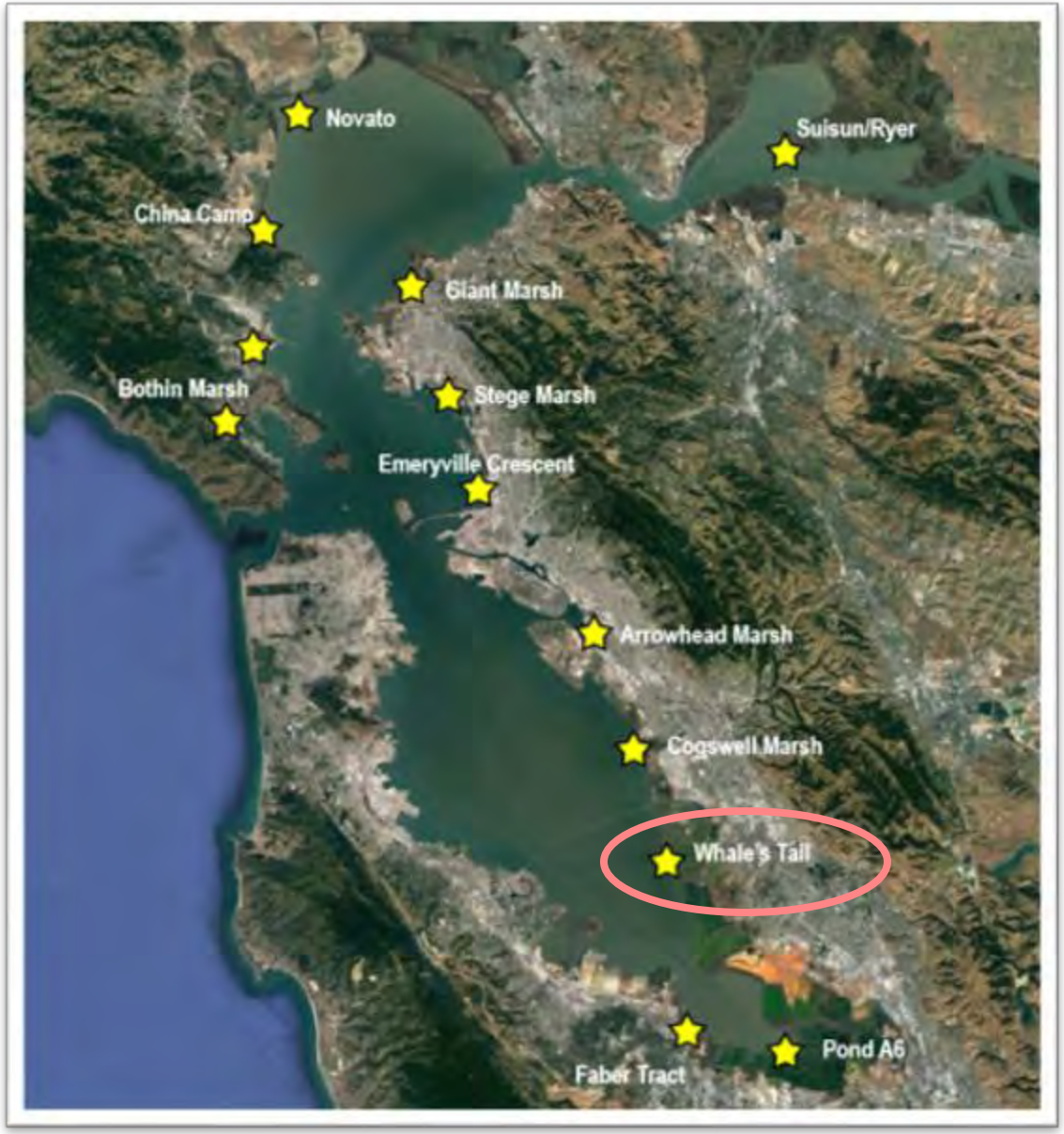

John Dingler

Modeling: Michael MacWilliams, Aaron Bever (AnchorQEA)
Project Partners: CA Coastal Conservancy, SF Bay Regional Water Quality Control Board
Monitoring: USGS
Study Duration: 2021-2023, Modeling/P&S/Permitting
Implementation: December 2023, Monitoring through 2024
Total Budget: $1.3 million

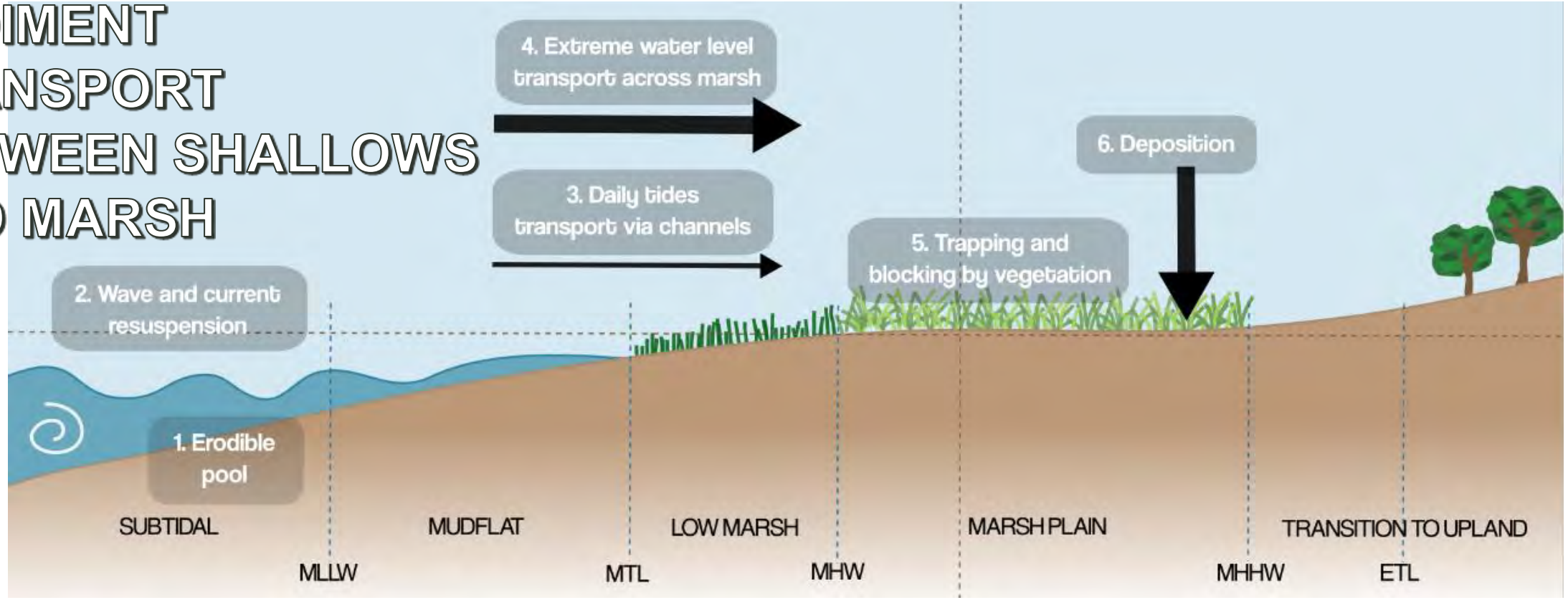
Proposed Approach: Strategic placement of clean dredged material within the Bay where wave resuspension and tidal action can transport sediment onto marsh/mudflat complexes

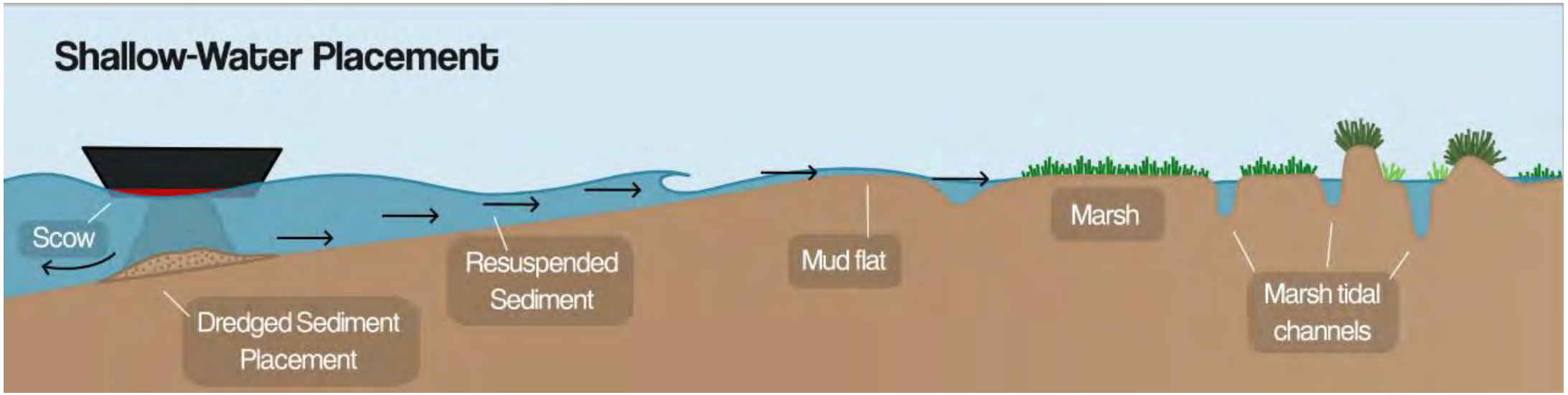
Site selection criteria:

- Eroding or drowning marsh, lack of natural sediment supply
- Sufficient wind-wave action to resuspend sediment placed
- Open to tidal exchange
- Wind-wave shore-normal approach
- Deep water close to shore
- Avoiding large eelgrass beds/nearshore reef projects
- Flood protection for EJ/disadvantaged communities



SEDIMENT TRANSPORT BETWEEN SHALLOWS AND MARSH





Shallow Water Placement
December 2023



- **90,000 CY** dredged from the Port of Redwood City, Reach 1 and 2 from DEC 06 - 31
- Loaded **into shallow-draft scows** (1600 CY and 300 CY)
- **169 placements** offshore of Eden Landing









INNOVATIONS IN MONITORING

- Monitoring is an integral component of showing the success of a pilot and paving the way for additional projects.
- High permitting demand on pilots makes a **robust monitoring design** non-negotiable.
- Key monitoring questions for BU/EWN projects:

1

What are the potential impacts on the benthos and ecological communities nearby?

- *How long do the effects last?*
- *How far do the effects spread?*
- *What about eelgrass in the area?*

2

Where does the sediment end up? How do physical processes (tides and waves influence its transport?

- *Repeat bathymetric surveys*
- *What wave conditions move sediment?*
- *Use of a particle tracking study*
- *Understanding deposition in mudflats, marshes, breached ponds*

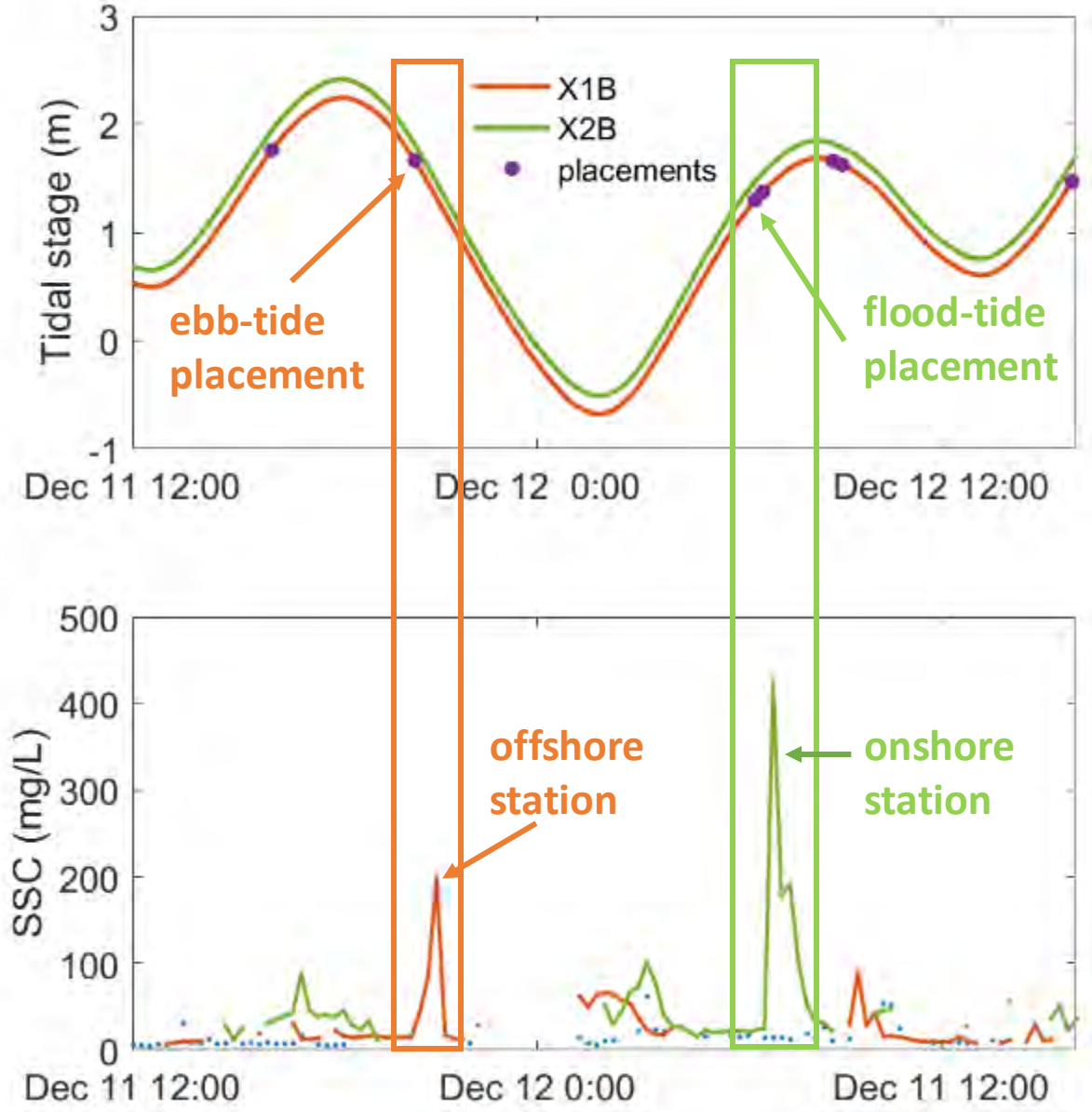
7

SSC DURING PLACEMENT

Increased SSC reduces light penetration, a concern for eelgrass and phytoplankton

- Spikes in SSC occurred after many placement events
- Duration typically 1-1.5 hours
- Observed at ‘closest’ station in direction of tidal currents
- During wave events, SSC at all stations reached 150-300 mg/L for >12 hours

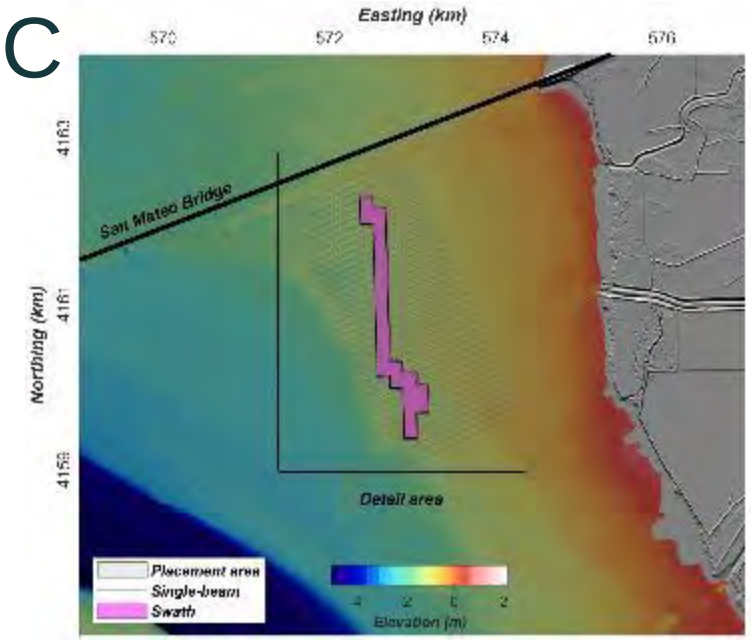
Placement increased SSC for short periods, without exceeding levels that occur naturally

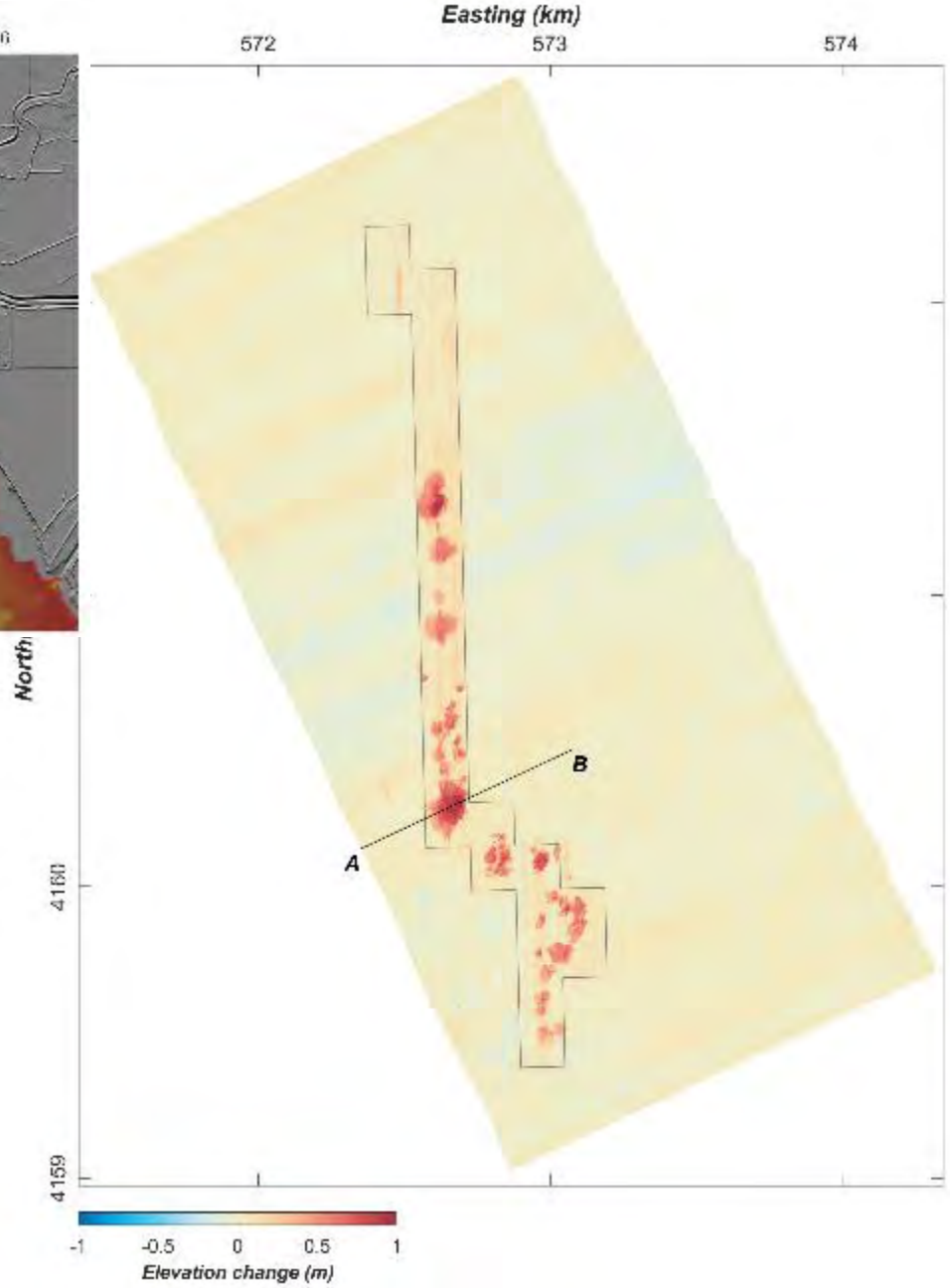


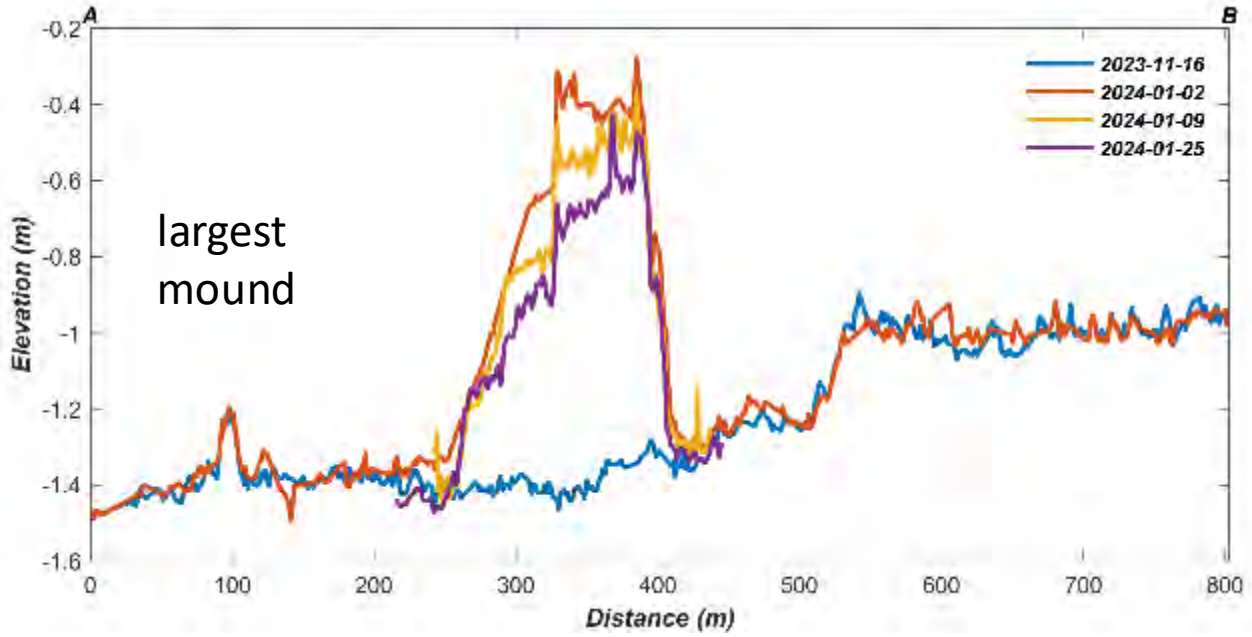
Potential impacts

REPEAT BATHYMETRIC MAPPING:

- Multiple mounds
- Varying size
- Height and volume gradually decreasing







Sediment fate and transport

How long does it take for the dredged material to disperse?

TRACER STUDY

- 1,000 kg of fluorescent, magnetic coated silt particles (tracer)
- Deployed January 11, 2024
- One location in the placement area

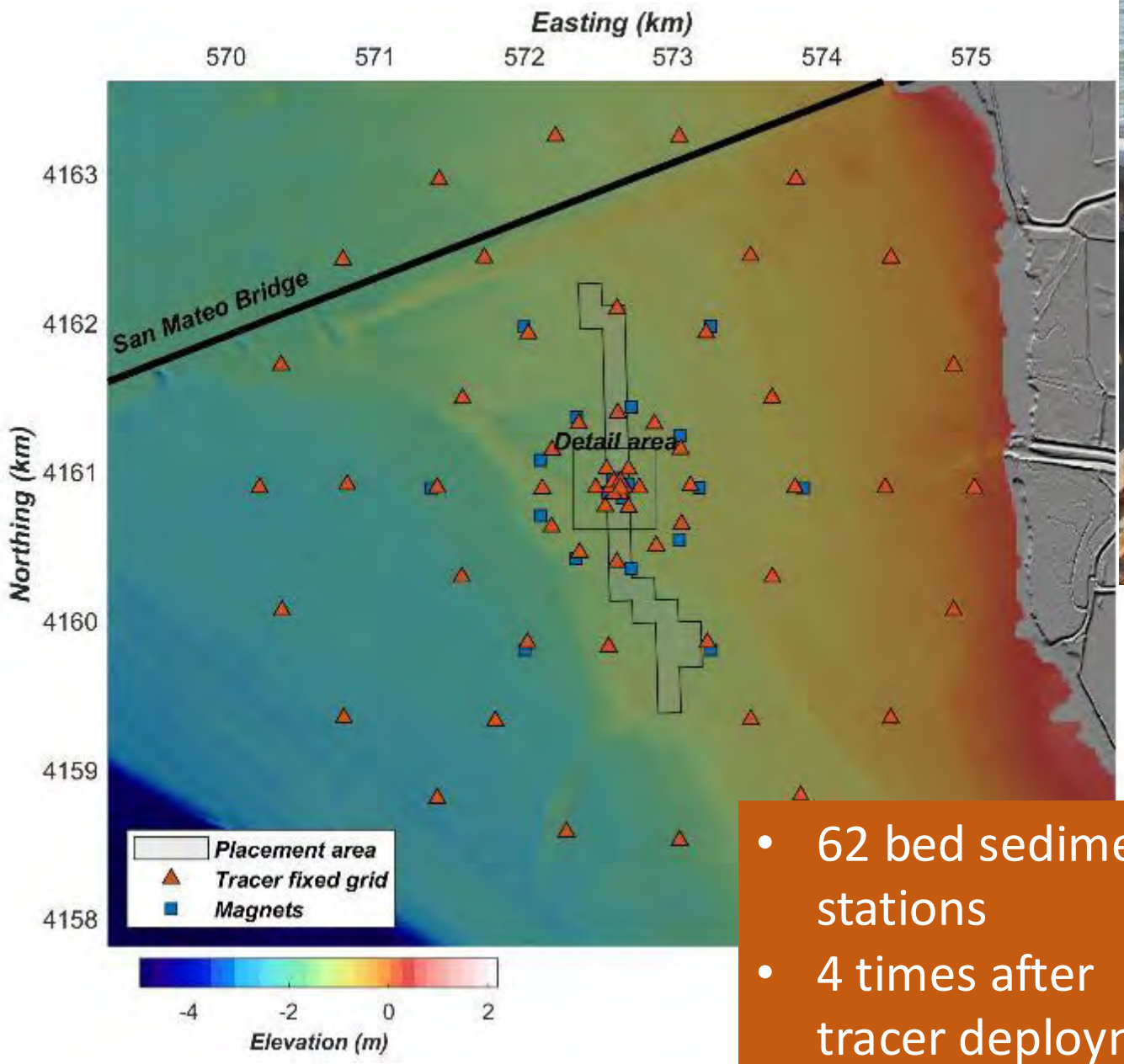




- What are the primary directions of transport from the placement area?
- Where does sediment from the placement area end up?
- How does that change over time?

Sediment fate and transport

TRACER SAMPLING IN THE SHALLOWS









19 magnet stations, one day after tracer deployment

- 62 bed sediment stations
- 4 times after tracer deployment

Sediment fate and transport

MARSH AND RESTORATION AREA

Monthly from Nov 2023 to Dec 2024:

- Magnets deployed in tidal creeks to capture tracer
- Transects of sediment pads across marsh (6) and restored areas (6) to measure deposition



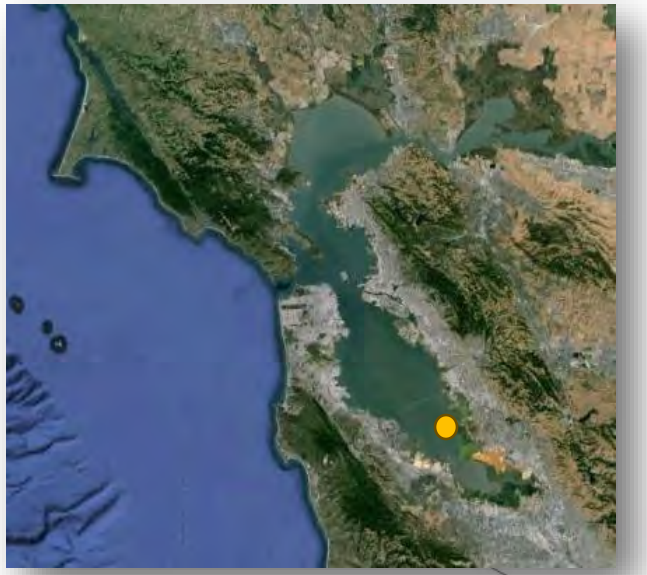
USGS WERC: Thorne, Buffington



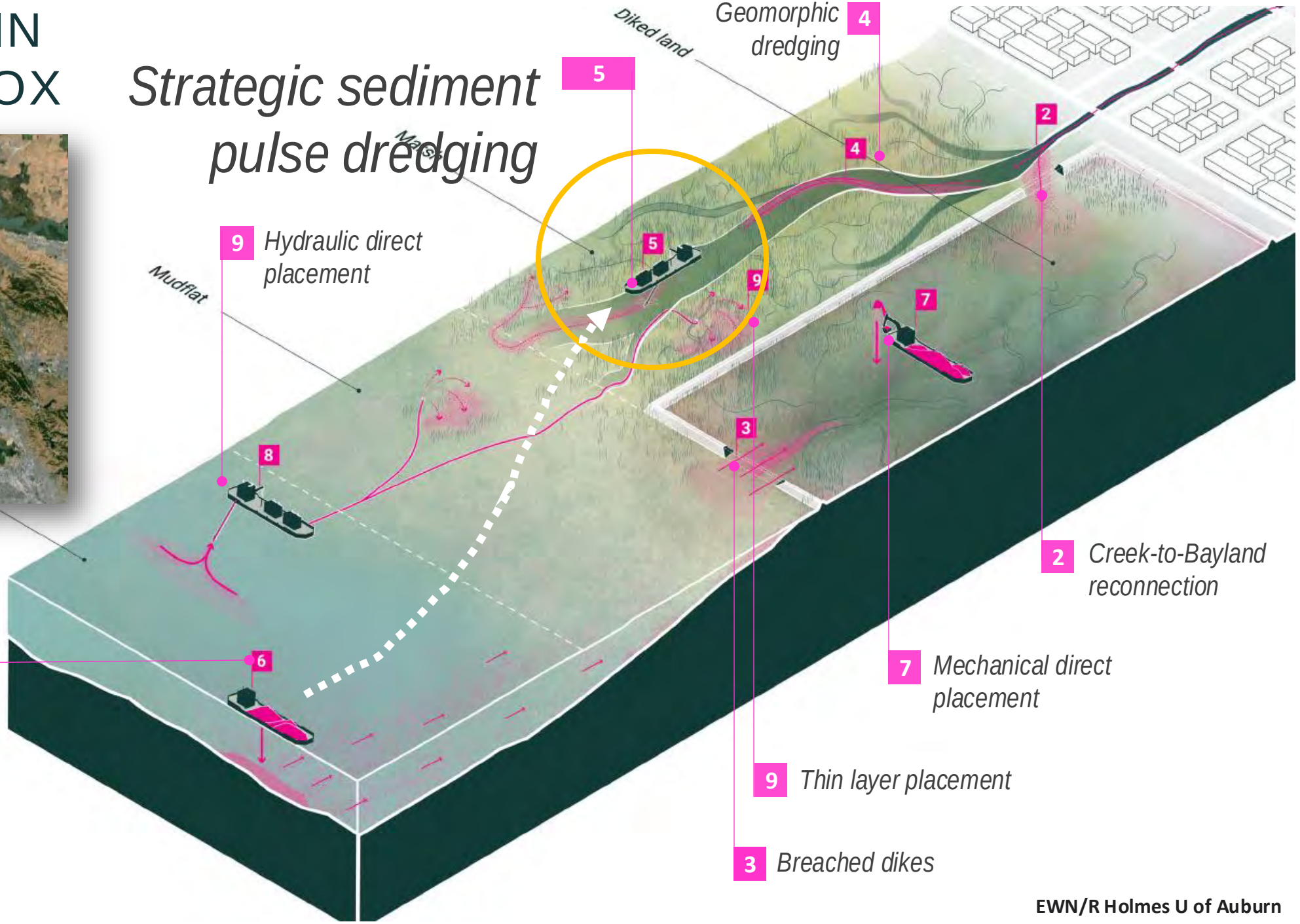
Magnet stations in tidal creeks

Sediment fate and transport

MANY TOOLS IN THE BU TOOLBOX



Strategic sediment pulse dredging



EWN/R Holmes U of Auburn

FPMS Strategic Sediment Pulse Delivery Pilot Study


Roger Leventhal, PE


Tiffany Cheng, PE


Jessica Ludy


Julie Beagle


Seongjun Kim


Jade Ishii


Jared Mcknight

Program: USACE Floodplain Management Services
NFS + Project Partners:
Marin County Public Works, USACE ERDC
Study Duration: AUG 2023 – SEPT 2024
Total Budget: $250,000 for pilot study

Problem Statement: Traditional dredge approach in flood control tidal channels are cost-prohibitive and highly impactful, resulting in elevated flood risk to neighboring communities and up to 10% of Bay Area sediment supply trapped in out-of-compliance channels.

Proposed Solution: Low cost and low carbon hydrodynamic dredge method during times when Bay is naturally turbid (e.g. pre/post extreme event, summer high tides) **to achieve flood risk resilience by flood control tidal channels** and **feed Bay-wide sediment supply, which would bolster marsh and mudflat resilience to SLR.**


Ex.) Water Injection Dredge Vessel

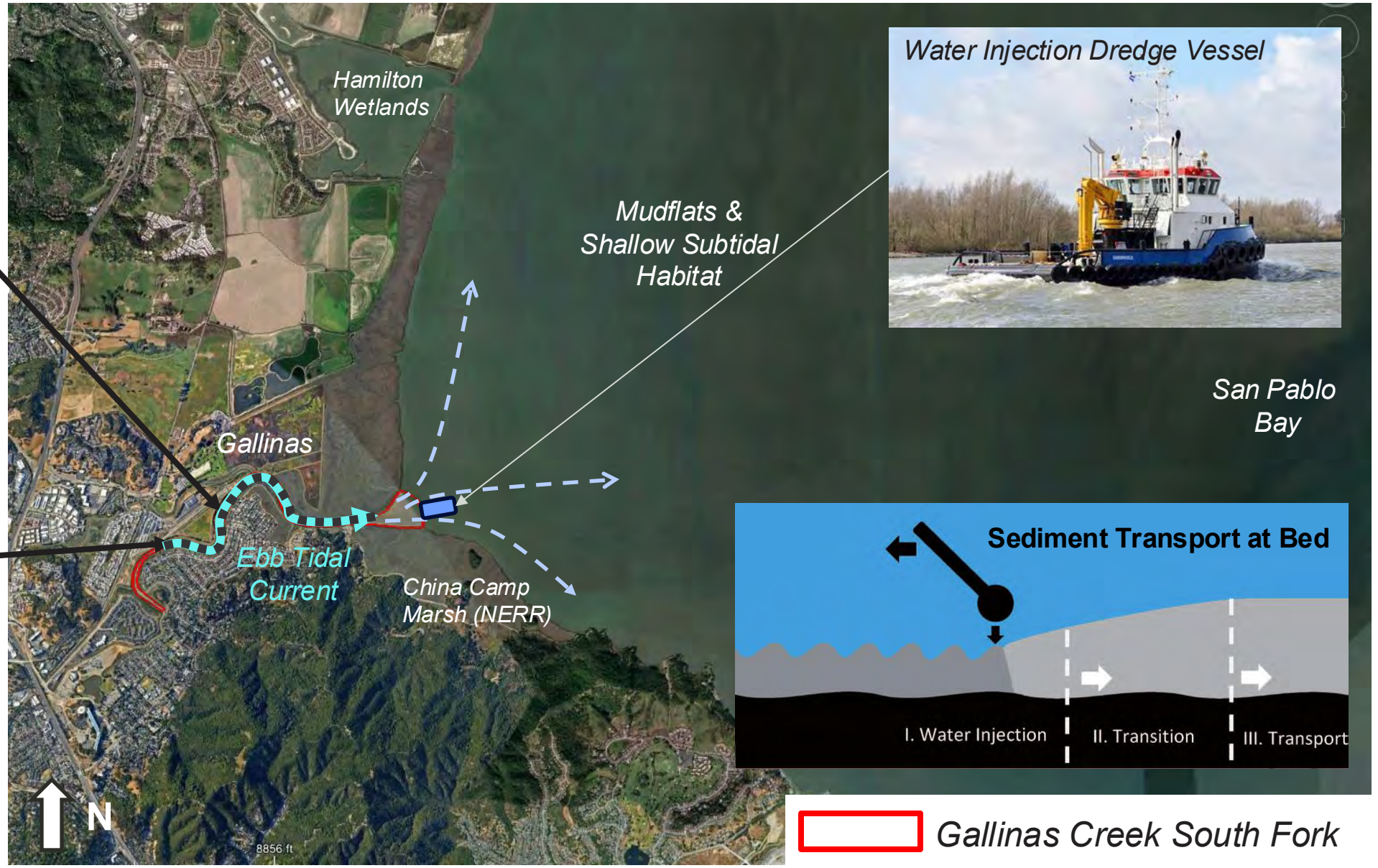
15

FPMS Strategic Sediment Pulse Delivery Pilot Study

Excessive sedimentation in existing flood control channel

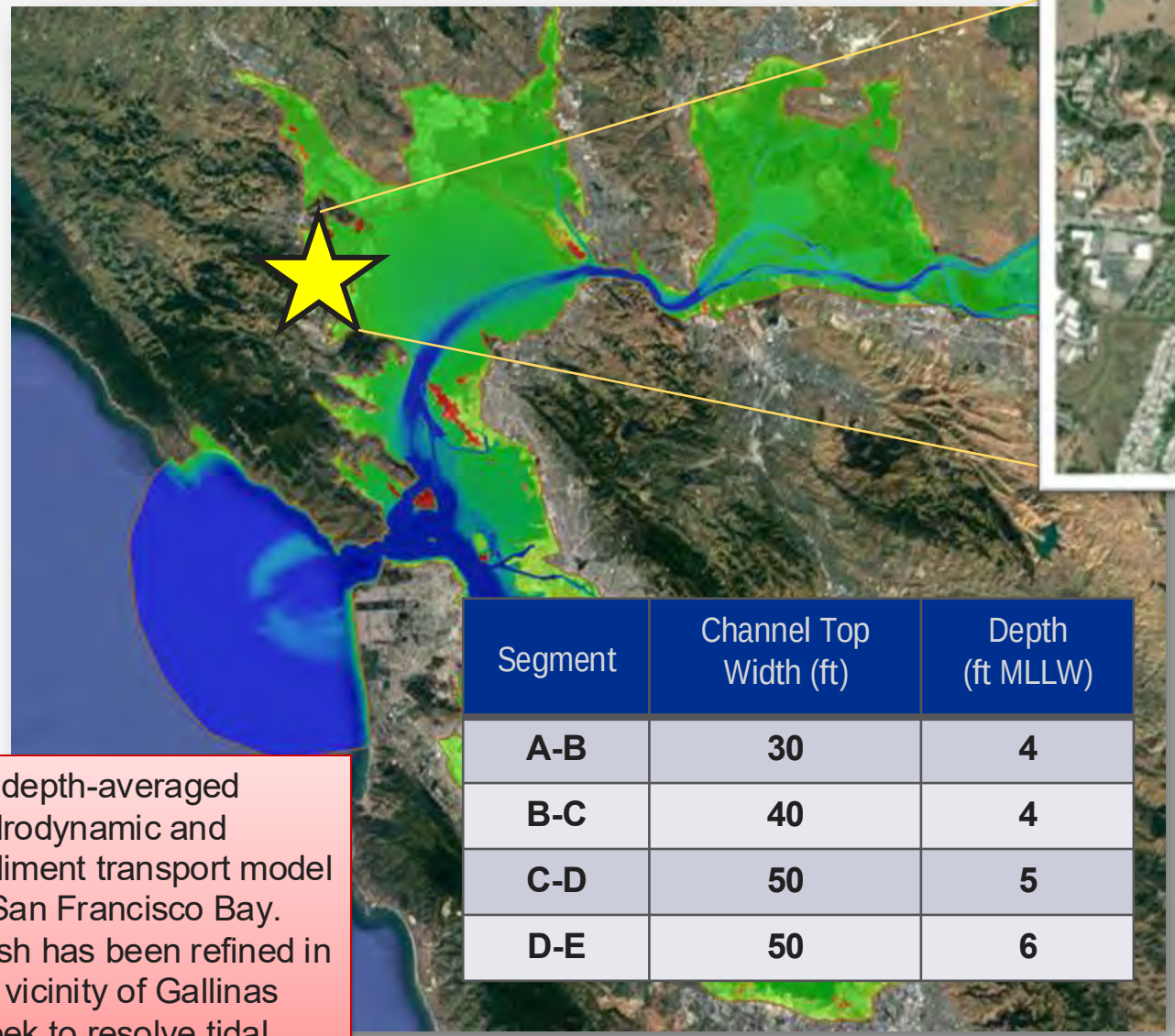


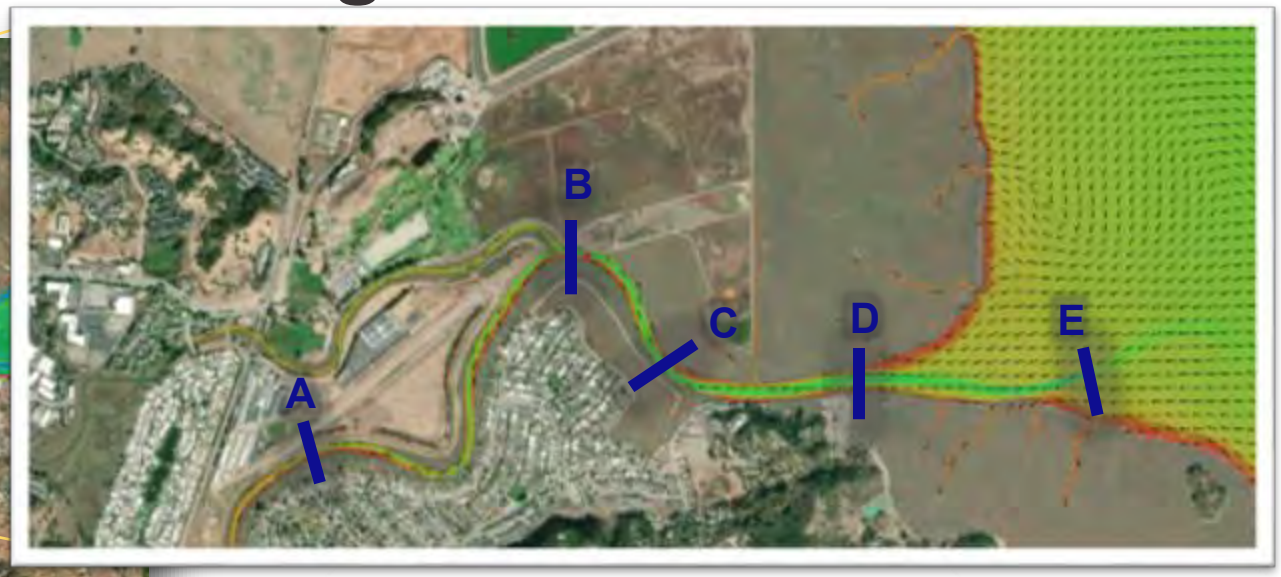




Gallinas Creek South Fork

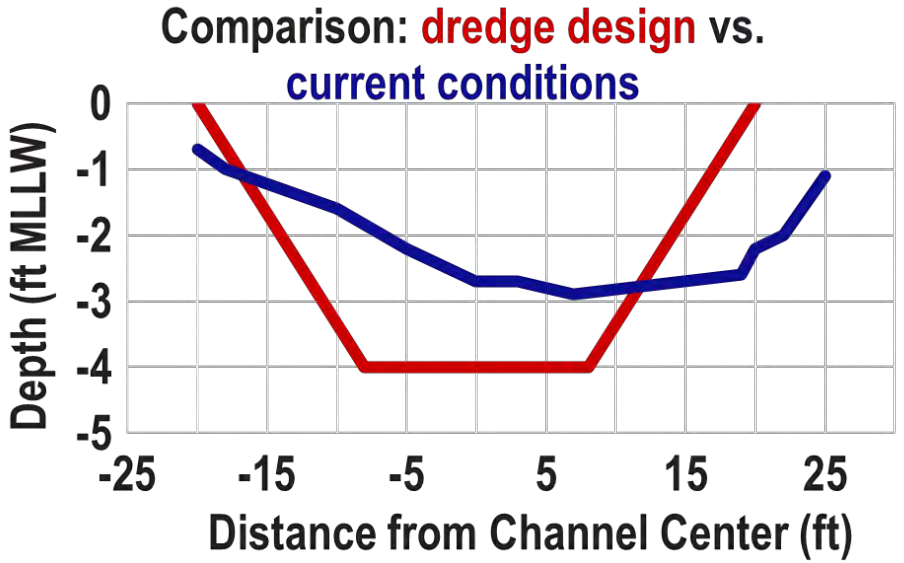
AdH Model – Sediment Pulse Dredge





Segment	Channel Top Width (ft)	Depth (ft MLLW)
A-B	30	4
B-C	40	4
C-D	50	5
D-E	50	6

2D depth-averaged hydrodynamic and sediment transport model of San Francisco Bay. Mesh has been refined in the vicinity of Gallinas Creek to resolve tidal channel.



AdH Model – Sediment Pulse Dredge

- Innovative Modeling of Hydrodynamic Dredge
  - Shear Stress Time Series – simulating dredge pass over channel bed, based on industry vessel specs
  - Materials – based on soil data at site

- Simulations
  - Winter storm event - AEP 50%, 10%, 1% Events (aka. Q2, Q10, Q100)
  - Summer king tides – base flows





R&D GAPS AND RECOMMENDATIONS

- Recommend dedicated funding for pilot projects and R&D related to BU
- Recommend development of shallow-draft dredge technology for USACE applications
  - Absence of shallow-draft hydrodynamic dredge technology. Wide applicability to range of sediment management problems in tidal channels, reservoirs, lakes, shallow coastal areas
  - SPN Submittal - RSM FY25 Proposal
- Recommend R&D in monitoring technologies/methods for BU projects
  - Robust monitoring methods are an integral part of demonstrating pilot success to resource agencies/permitting entities
  - Cost-effective tracer technology as a key part of pilot design



U.S. ARMY

US Army Corps of Engineers

Dr. Lewis E Link

Dr. Link is a senior research engineer and research professor in the Department of Civil and Environmental Engineering at the University of Maryland. He teaches in the Honors College where his area of emphasis is disaster risk and resilience.

Prior to being on the faculty at Maryland, he spent 34 years with the U S Army Corps of Engineers, culminating in the position of Director of Research and Development and Chief Scientific Advisor for the Agency. Previously he served as the Director of the U S Army Cold Regions Research and Engineering Laboratory in Hanover, NH and Deputy Chief of the Corps of Engineers Coastal Engineering Research Center in Vicksburg, MS. He has authored over 100 technical papers and reports and was Certified as a Professional Hydrologist.

Dr. Link served as Director of the Interagency Performance Evaluation Task Force that conducted the Post Katrina forensic analysis in New Orleans, leading to the immediate repair of the flood defenses and construction of a much enhanced $15B risk reduction system that is now in place. He was also a member of the International Advisory Commission for the Netherlands, using risk and scenario based planning for examining long term adaptation strategies for climate change and sea level rise. This work resulted in a new adaptive strategy for coping with the large uncertainties of climate and sea level changes for the future. He served on the CoastSmart Advisory Council for the Governor of Maryland and currently serves on the Board of Coastal Engineering Research for the Corps of Engineers.

He has participated in multiple National Academy of Engineering, the American Society of Civil Engineers and FEMA Special Studies concerning Dam and Levee Safety, Risk and Resilience, Unified National Strategy for Floodplain Management and Critical Infrastructure. Dr. Link received both the Engineering News Record Award of Excellence and the Army Engineer Association Gold Order of the Defleury Medal and was elected to the National Academy of Construction. He received a BS degree in Geological Engineering from N C State University, a MS in Civil Engineering from Mississippi State University and a PhD in Civil Engineering from Penn State University.

The Enigma and Stigma of Basic Research: A Historical Perspective

Lewis E Link, PhD
University of Maryland

Summary

As we enter an increasingly uncertain and challenging future, it is imperative that we anticipate and prepare for it, now! This requites new insights with respect to societal needs and the knowledge and capabilities necessary to navigate this changing domain. While public policy is a critical element in this preparation, so too is the generation of more sophisticated understanding of the underlying processes and conditions that the future may represent. While the overall R&D investments of the nation have been increasing, the
Over the past decade basic research remains roughly 15 % of all R&D funding. The federal government provides approximately 40 % of basic funding, Industry provided 36%, higher education 12.6% and non-profits 9%. Execution of basic research was dominated by higher education (46%) and business (34.4%), followed by the federal government (10%) and non-profits (10%).

Within the federal government, DoD accounts for approximately 46% of R&D funding (~ $96 of $209 B in 2024). The basic research budget for DoD is ~ $2.6 B. The Department of Health and Human Services receives the second highest research budget of $50.9 B, which includes a government leading basic research budget of $23.2 B. The Department of Energy ($24.2B), NASA ($14.0 B), and National Science Foundation ($9.3B) round out the top five. In addition, DOE received $7.0, NASA received $5.8 B and NSF received $7.1 B for basic research. Department of Interior, home of both NOAA and USGS, received $1.48 B in total research which included $121 M for basic research. The Corps of Engineers Civil Works budget included approximately $175 M (FY23) for applied research and technology support with no investment in basic research.

Of the above resources NSF, NASA, Corps of Engineers and DOI programs support research of direct relevance to coastal engineering and coastal processes. There are some military initiatives that have significant relevance to coastal issues, particularly those efforts focus on littoral operations. While there is no specific Civil Works investment in basic research, there have been a few Civil Works investments that have indirectly supported basic research that was essential to advancing capabilities of high importance to the Civil Works mission. The development of Coastal Lidar and the Advanced Circulation Model (ADCIRC) are key examples. There is little evidence of the private sector funding research relevant to Coastal engineering and processes, it is almost exclusively a government investment. Higher Education is the dominant performer of basic research (46%) with industry at 34% (with industry focused on HHS programs) and government performing 9.9 %.

The Landscape of Coastal Related R&D

A review of ongoing multi-year investments in coastal related research reveals that the nature of those investments has evolved dramatically from dominantly government funded efforts to industry domination of funding and execution coupled with a shift to outcomes related to the marketplace. This has diminished the resources and emphasis on topics fundamental to knowledge of the environment we live in and our ability to adapt to its dynamics in conjunction with the dynamics of society. This is especially true in the areas relevant to our coastlines. We have demonstrable gaps in our knowledge and engineering capabilities critical to meeting future change. It is imperative that these gaps be addressed. Current new investments relevant to coastlines are focused on the end game; impacts and responses (aka resilience, equity). The biggest unfunded gap in the coastal portfolio is basic research concerning the physical and dynamic processes that govern the water-sediment domain that underpins our ability to assess impacts and achieve appropriate responses.

Why are we in this situation?

Almost all major advances in engineering are enabled by significant advances in new knowledge and understanding. Yet basic research and discovery is commonly at the bottom of resource investments and public and political advocacy. It is easier to ignore (or deny) what you do not know than ignore burning issues that dominate current programs and projects. While this can be conveniently traced to our rapt attention to the near term and infatuation with optimization, it remains a barrier to our ability to address changing conditions and associated societal needs. Practice commonly attempts to neutralize significant sources of risk and uncertainty while research must embrace them to enable exploration of new ideas and approaches. One is focused on efficacy of current practice and the other on reinvention of the practice.

Success boils down to achieving a balance between short- and long-term needs.

The operating world typically has evolved a reasonable capability to deal with their major challenges which is only exposed to be inadequate when conditions change, or a markedly better capability comes along. In contrast to a focus on incremental enhancements to current methods and tools, major game changing advances occupy a different orbit. In the world of academia and research, current methods are viewed as a given and the major focus is on new knowledge and potentially disruptive capabilities. Too often these domains do not sufficiently overlap. Ironically, each domain is essential to the other. Practitioners have unique insights with respect to what would be suitable for future practice and researchers have unique insights with respect to potential new knowledge and capabilities.

Balance requires mutual understanding and collaboration.

Our current national investment in research is heavily weighted towards the applied, exploiting available and emerging knowledge and capabilities to augment and enhance current practice. This is consistent with a desire for near term return on investment. Yet the potential for major

advances and game changing capabilities, lies shadowed of the less hyped and more modestly funded basic research world. This is a symptom of a risk averse culture with a short-term bias. Unfortunately, this trend in investments is growing despite the increasing need for major advances in science and engineering to meet the more complex and uncertain challenges of the future.

The Research and Development Landscape

Total U S funding for R&D in 2021 was $789 B; $118.6 B was for Basic (15%), $144B was for Applied (16%) and $526.4 B was for Engineering Development (67%). The source of funding came from industry (75%), government (18.6%), higher education (3%), and non-profits (2.6%%). Performance of R&D was dominated by industry (77%), with the government (8.5%), higher education (11%) and non-profits (3.4%) rounding out the dominant performers. While federal funding in actual dollars has increased over the past decade, the percentage of the total federal investment has declined markedly from 31 % in 2010 to about 18% today.

Dominant new investments in this area are focused on community resilience, equity, climate and environmental observation. There are sizable investments being made in both applied and basic efforts. NSF has provided new grants of $51 M for their Coastlines and People initiative, $19.3 M for reducing climate risks with equitable Nature Based solutions, 10.8 M for Coastal Hazards, Equity and Economic Prosperity and an additional amount for Enhancing Resilience and Equity in Urban Coastal Communities. NOAA is funding grants for Community Coastal Resilience projects ($189 M), Climate Resilience Regional Challenges ($575 M) and $251 M for Ocean Coastal and Great Lakes research (partially via Sea Grant). USGS is investing a total of $128 M for Climate Adaptation and Land Change Programs, $226 M for their Natural Hazards program (earthquakes, floods), $313 M in their Water Resources program and another $368 M in core science systems (satellite imaging, data acquisition and analysis). The Corps of Engineers Civil Works R&D applied research and technology support for Coastal Engineering is approximately $68 M (FY23). The Corps efforts are the primary resources emphasizing the physics of the water-sediment environment, tools for modeling and simulation and application of the tools to project planning and formulation.

In comparison to the new basic and applied resources focused on community resilience, equity, environmental observations and climate, there is a major gap in funding for basic research in the mechanics and dynamics of the water-sediment domain. Ironically, knowledge of the mechanics/dynamics of the water-sediment domain form the essential underpinning for better understanding climate impacts, resilience alternatives, and equity. Without expanded resources in the Corps' R&D investments, to include a basic research component this represents a major limitation in achieving the tools needed to cope with a significantly more challenging future.

The dominant Corps (ERDC) basic research funding has come from the DoD and Army basic research programs. These efforts are largely focused on long-term requirements derived from

DoD concepts for future operational needs. The Corps also receives basic research funding from the Office of Naval Research (littoral zone and hydrodynamics, ice dynamics), Homeland Security (relevant to emergency operations and threat protection) and NSF (largely in cold regions science and polar engineering). One of the major military responsibilities of military engineers is the understanding of the terrain and operating environment and its potential impact on the performance of systems and engineer operations in theatre. This knowledge impacts the design of equipment, tactics and training. It also supports the sustainable management of military installations and training lands. The common ground with Civil Works is in environmental sciences and dynamics of the environment. There are also spinoffs from materials science, structure behaviors, computational capabilities, and others. Largely, Civil Works applied research can exploit the new knowledge from these efforts for specific civil needs. The fundamental flaw in this business model is that military derived opportunities for applying research results to Civil Works needs is largely serendipitous.

You must have Skin in the game

The bottom line is that you must pay to play. While admirable, serendipity is hard to forecast and even more difficult to incorporate in long term development programs. Without a basic research investment within the Civil Works domain, it is difficult to leverage the resources (intellectual and financial) of others in a way that can be a stable part of major capability development efforts. Also, without ongoing basic research in priority areas, it is difficult to capture the intellectual capital needed to be an effective research partner, or a smart funder of research in academia. The major glowing success in the Corps program has been the Field Research Facility in Duck, NC. This unique facility has drawn top scientists and engineers globally to participate in joint experiments and analyses. This has been an enormous benefit to the Corps and the larger coastal community. This is a good model for partnering and leveraging for the good of all involved, and it is not limited to observational initiatives.

Historically, the strength of Corps research in applied science and engineering and the national and international scope of the Corps water resources and environmental missions has allowed ERDC to form many productive partnerships. This, however, remains an inefficient mechanism for creating the knowledge base and breakthrough technical tools needed to address the Corps' and societies challenges in the future. A dedicated and stable basic research effort focused on the Corps strategic long term needed in Civil Works would be an enormous advantage over serendipity.

What to Do Now?

Successful R&D is a team sport. Collaboration allows sharing of financial resources, talent, special experimental facilities and field programs into the mix, allowing more comprehensive and productive efforts. The success of the FRF has demonstrated this concept in spades. Collaboration is enhanced by having something to contribute and share. While many organizations are anxious to receive funding, few will offer to partner/share their physical, financial and intellectual capabilities unless they respect you for your knowledge and

capabilities in the research to be accomplished. This is especially true in highly technical fields like coastal engineering. Basic research demands unique intellectual and physical assets that can add value to an effort. If you do not have a respect for your organizations ability to play in that game, few are interested in being on the same team. To attract basic research funds or partners, you must have a good reputation in the research in question. This typically means a critical mass of ongoing quality research by individuals recognized for their capabilities. This requires a consistent source of funding and associated research facilities that are value added to the research effort. The Corps has no basic research funding in the coastal domain and but has maintained a quality reputation through competing for funds from other sources, adapting advances created in companion programs (like military coastal related efforts) and having unique physical and computational assets to facilitate research. To solve big and strategic issues, however, you cannot afford to scrounge for resources - consistent, reliable funding is essential to be productive and impactful. The good news is that basic research is relatively low cost compared to applied research and enormously more productive than ignorance. In addition, the authorities exist to allow it to be funded from existing or new funding.



Historical Perspective on Basic Research Relevant to the Coastal Domain

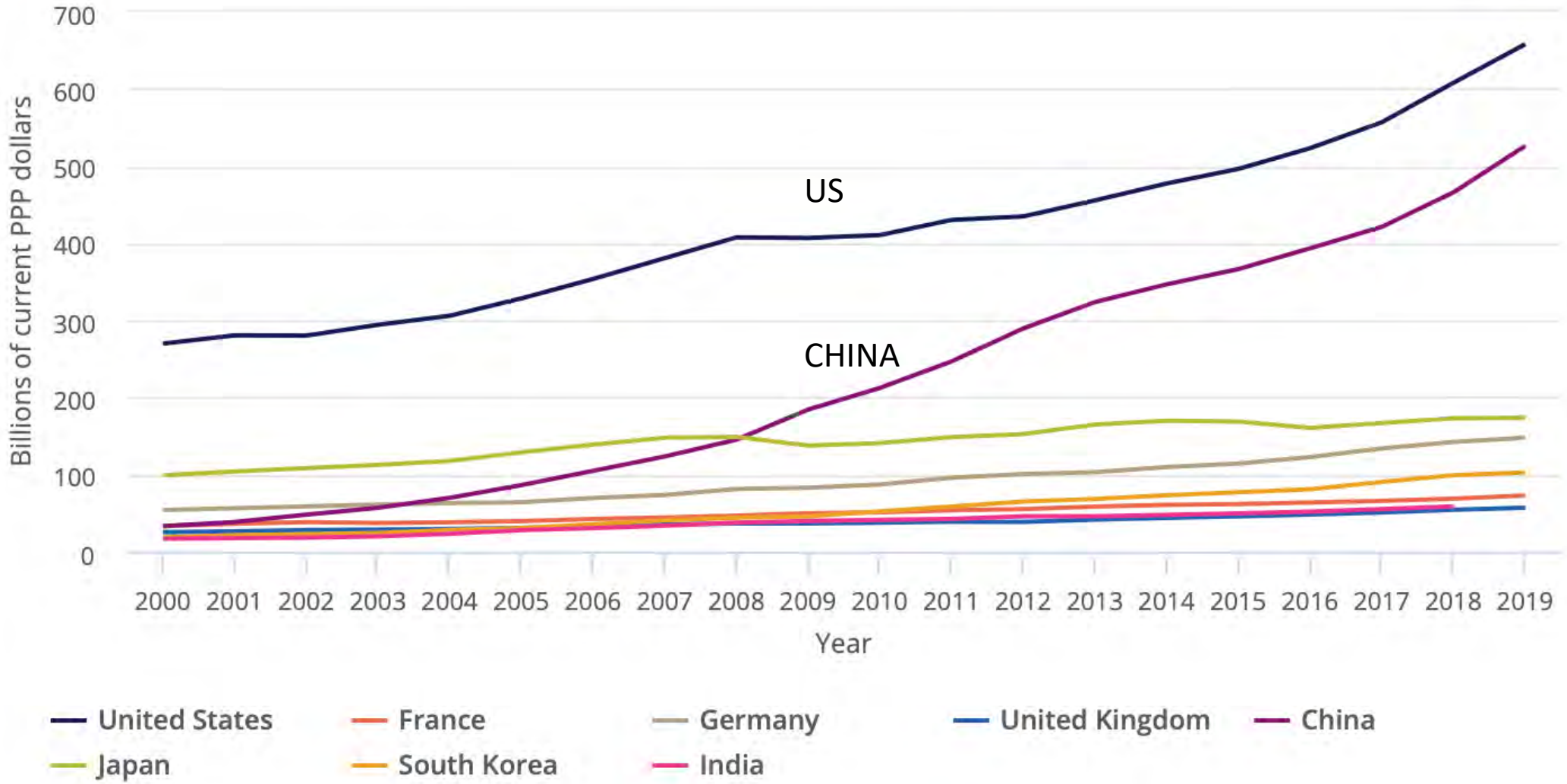
Lewis E Link, PhD
University of Maryland

Historical Perspective on **Foundational** Research in Relation to the Coastal Domain

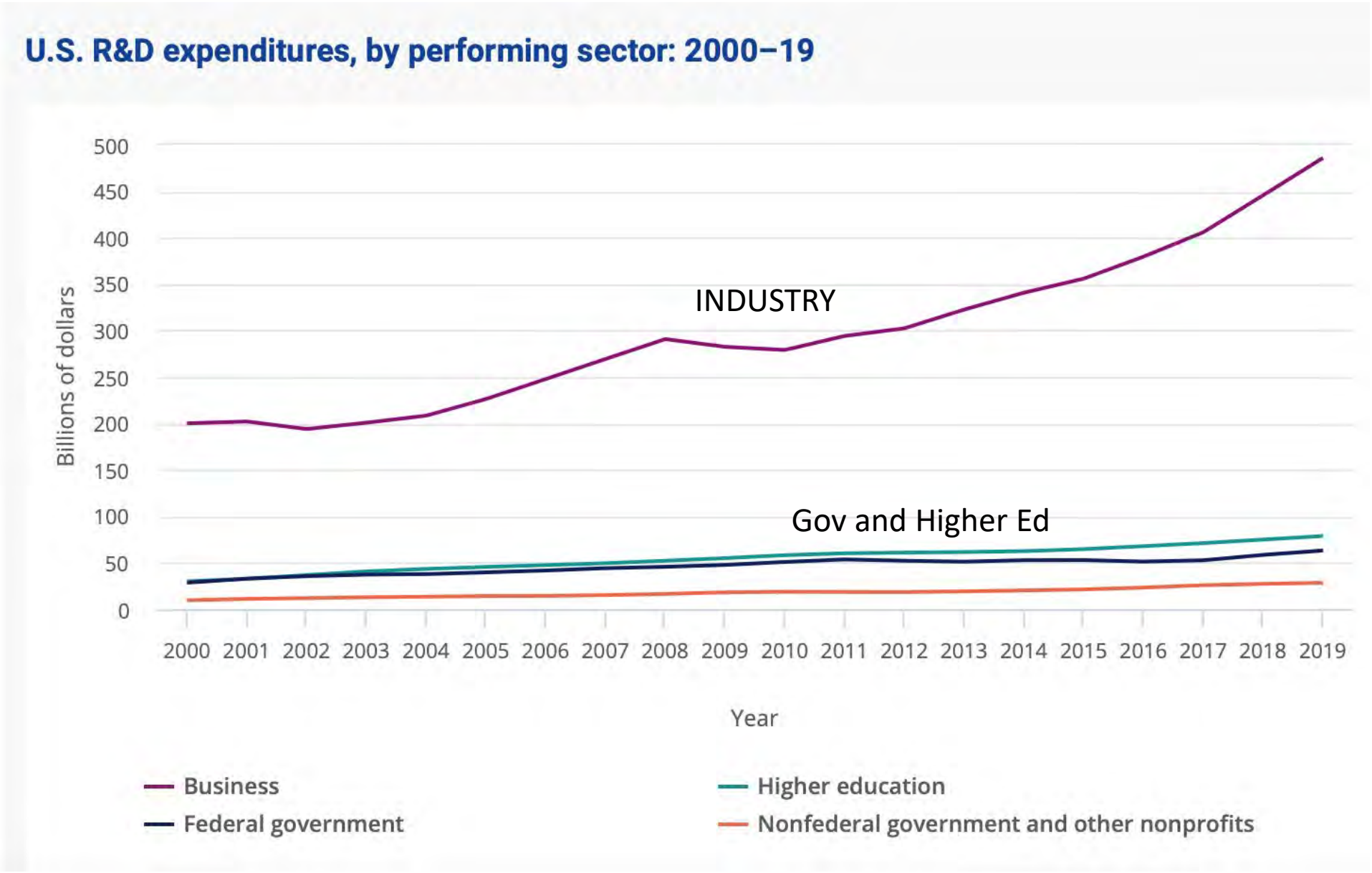
- **The R&D Landscape**
  - Who funds and performs R&D?
  - How much Basic Research is ongoing?
  - How Productive is Foundational Research?
- **The Coastal R&D Landscape**
  - Who is funding and performing coastal R&D?
  - Foundational Research Funding and Initiatives
  - Gaps with respect to the future?

NOTE: Foundational Research = Basic Research focused on a high priority mission need

Gross domestic expenditures on R&D, by selected country: 2000–19

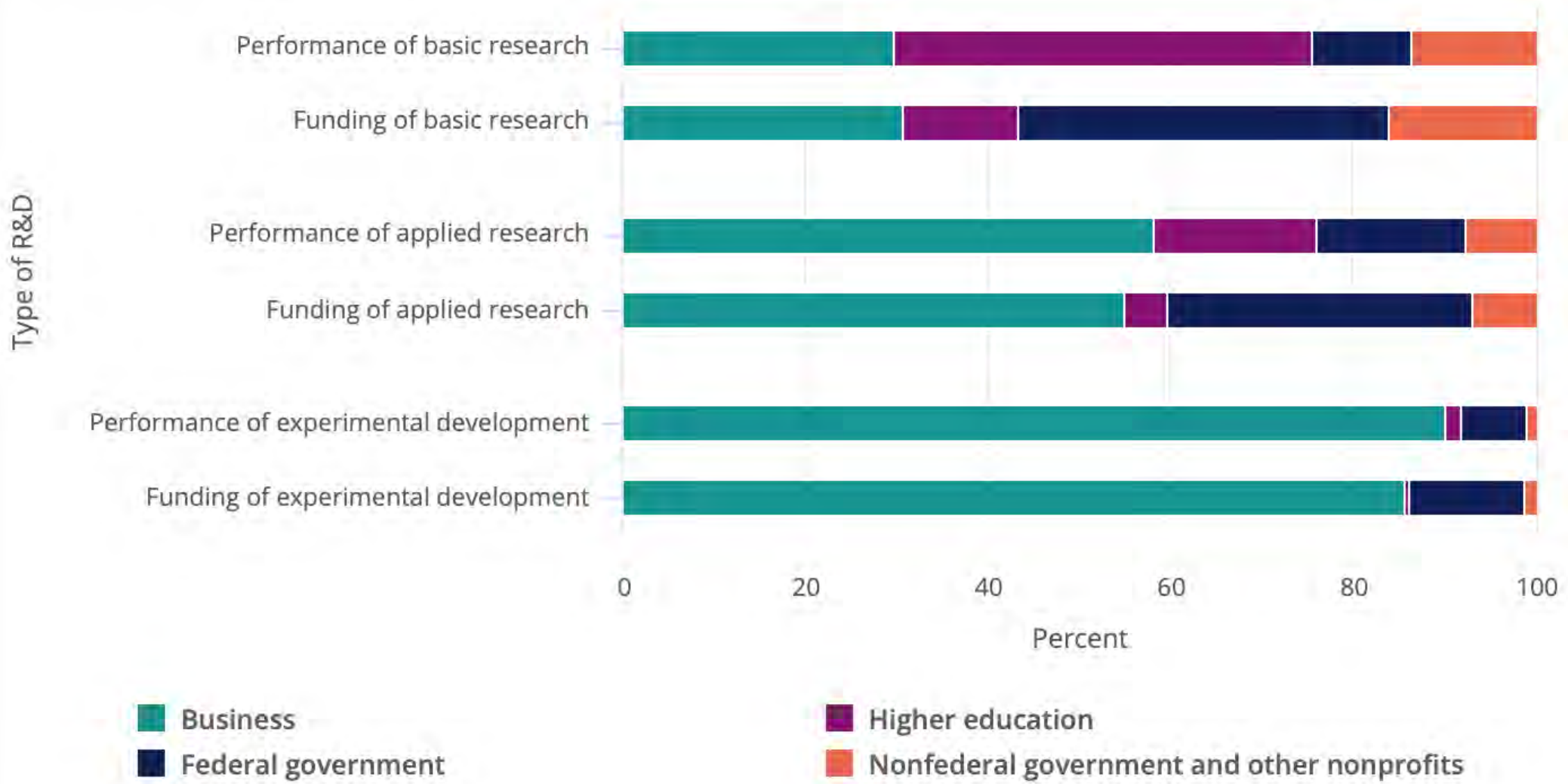


Source: Congressional Research Service



Source: Congressional Research Service

U.S. R&D performance and funding, by type of R&D and sector: 2019



Source: Congressional Research Service

DOD

FY24 Total = $95,986 M

Figure 4. Title IV RDT&E Funding by Character of Work, FY1996-FY2022

obligational authority, in billions of constant FY2022 dollars

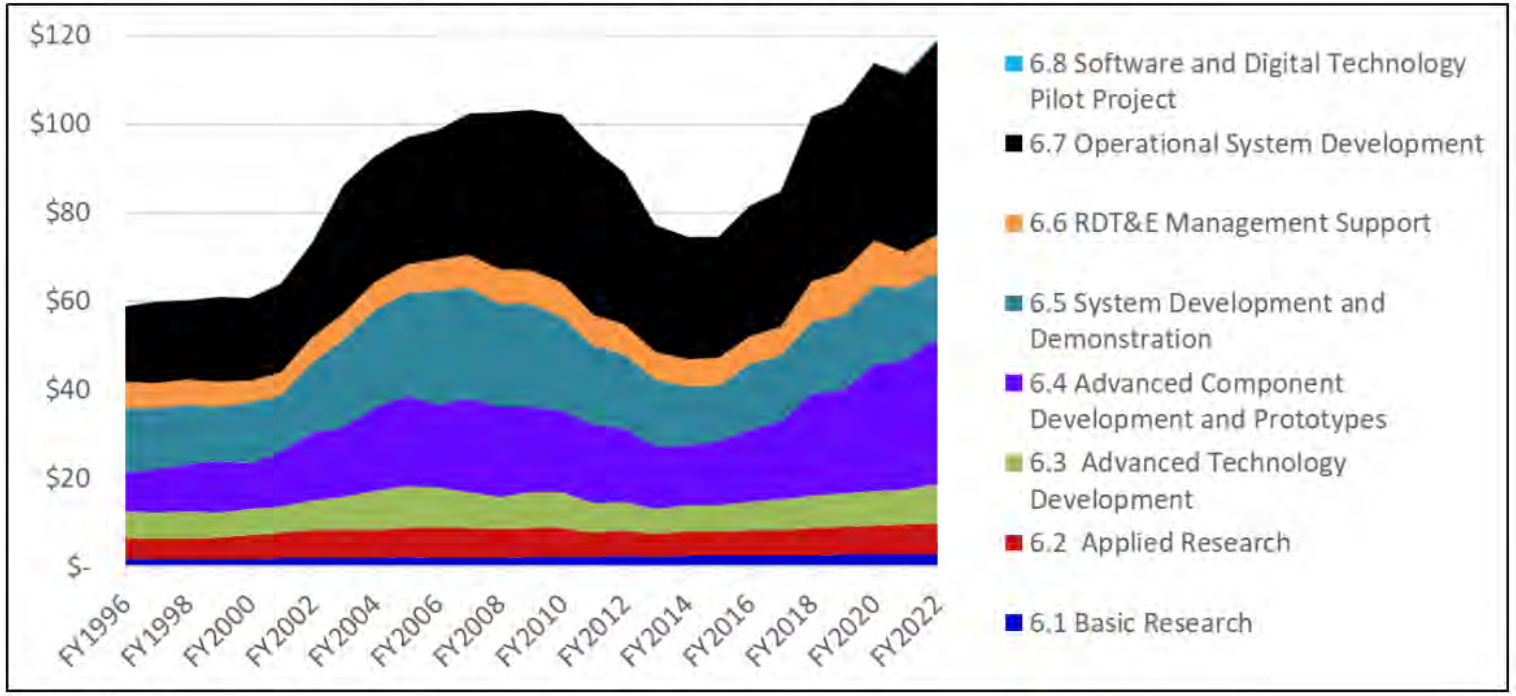
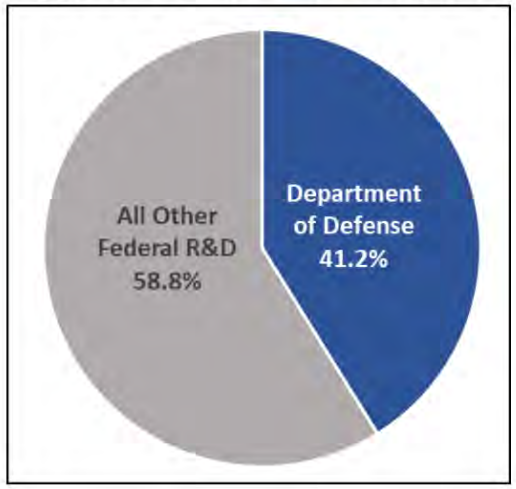


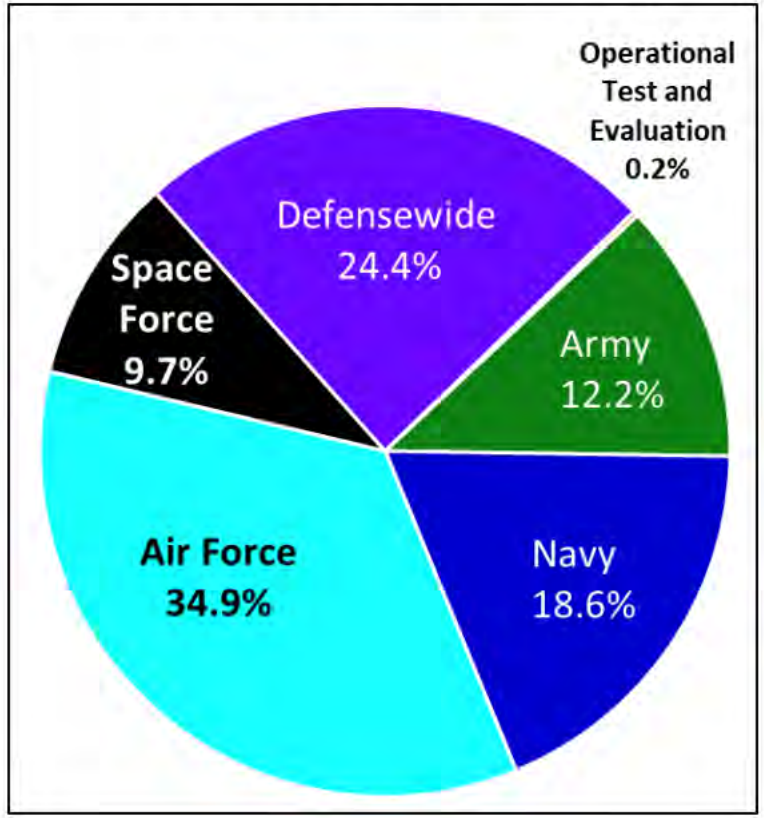
Figure 1. DOD Share of Federal R&D



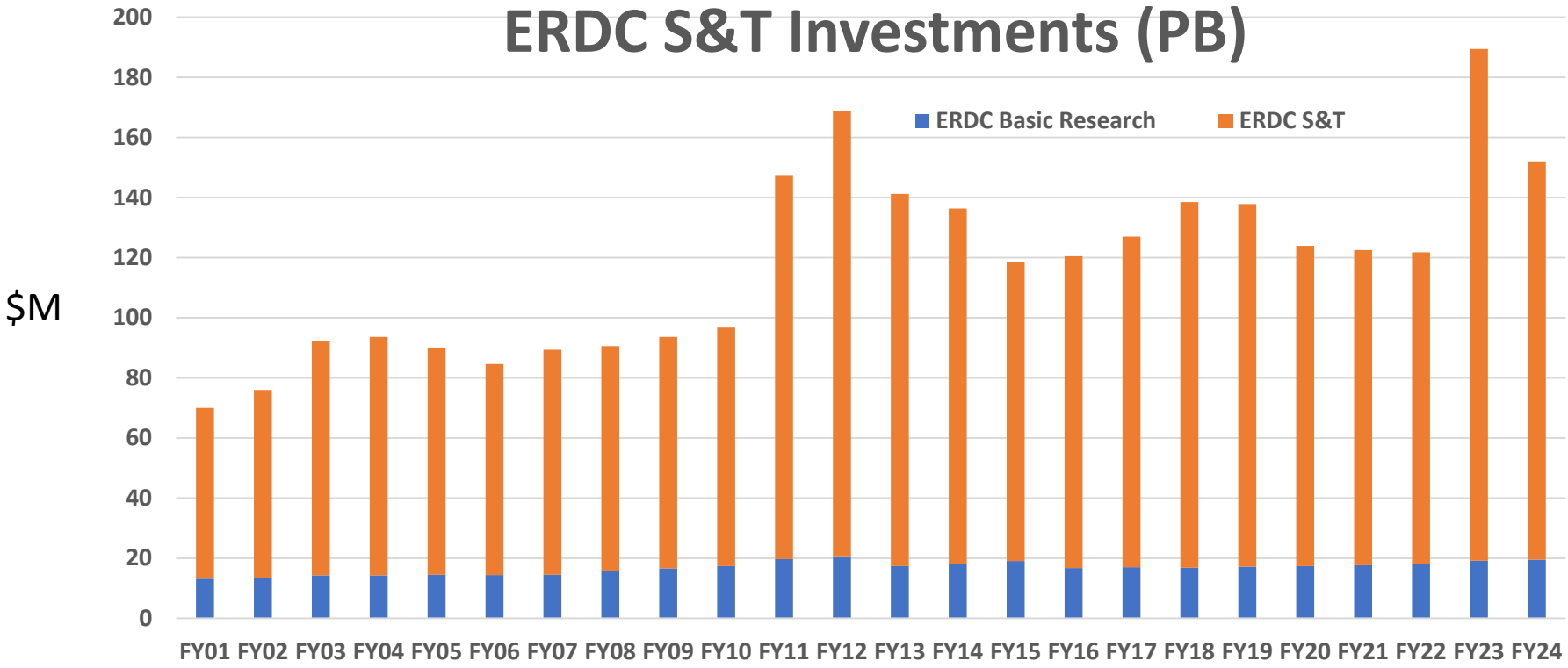
FY24 DOD Basic = $2,519 M

HHS = $23,207 M
NSF = $ 7,014 M
NASA = $ 5,820 M

.Title IV FY2022 RDT&E Funding by Organization

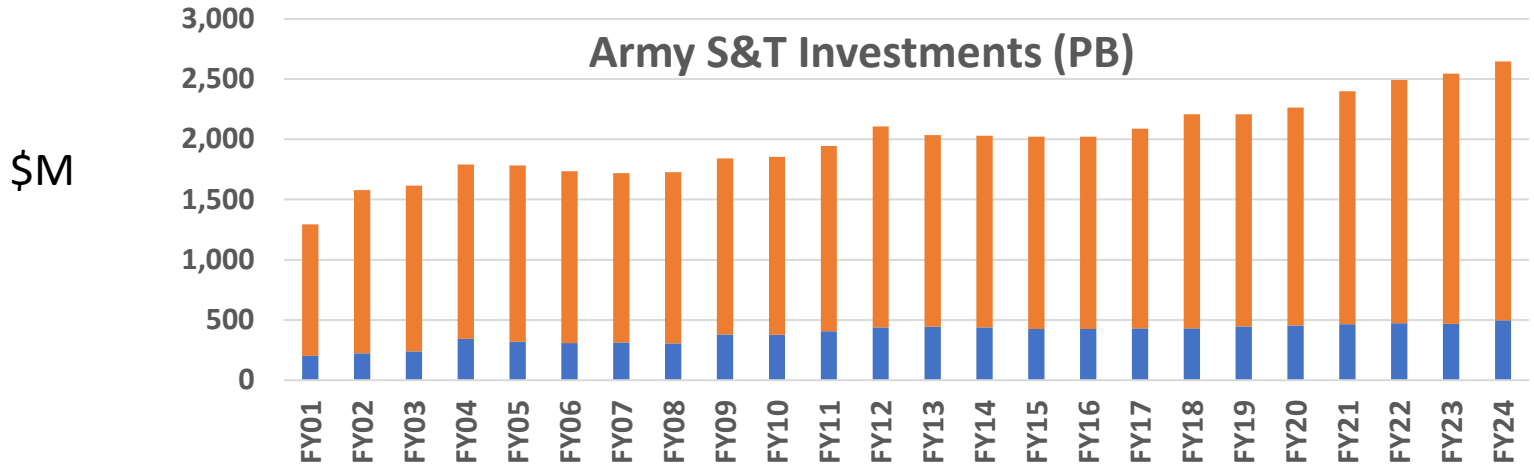


Source: Congressional Research Service



FY24 Army 6.1 = 500 M

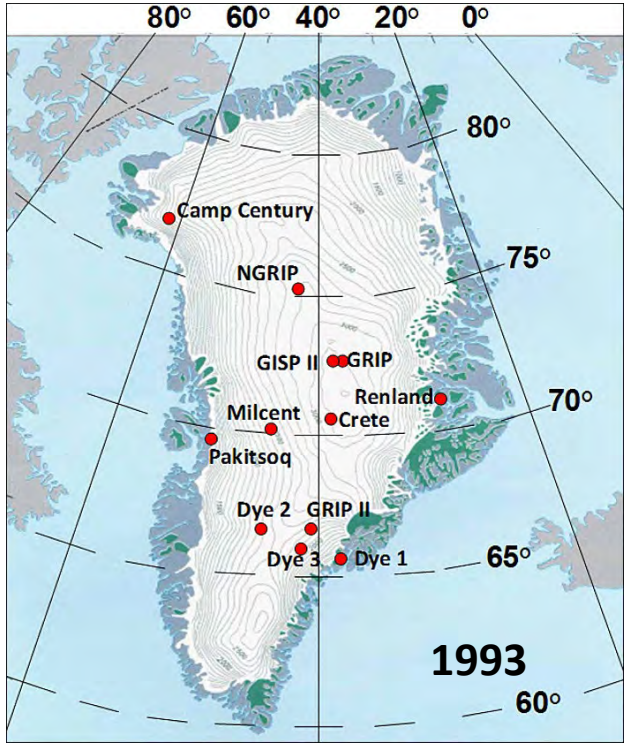
FY24 ERDC 6.1 = $20 M

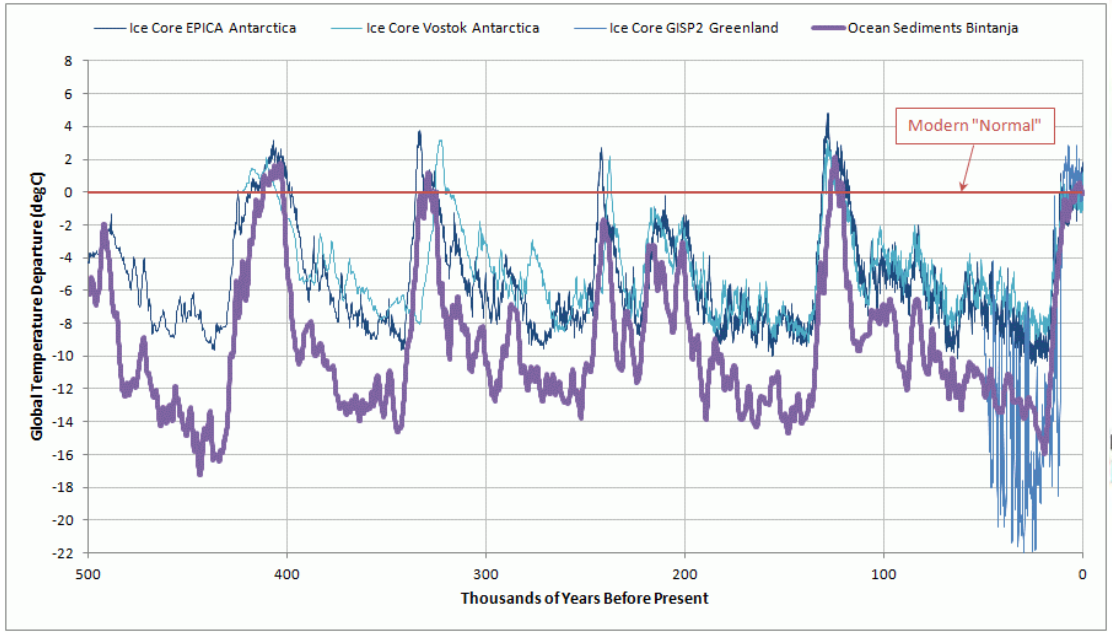


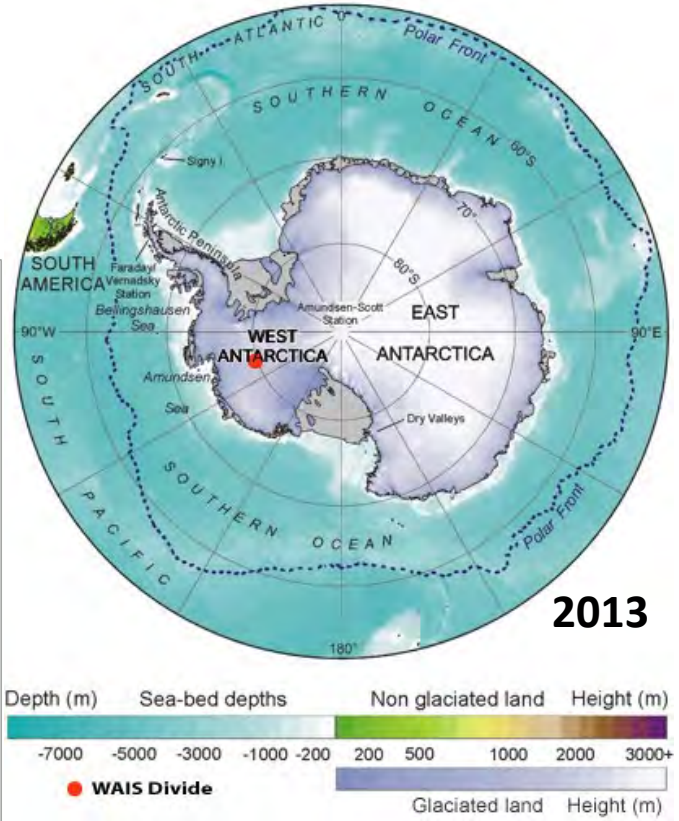
Source: ERDC

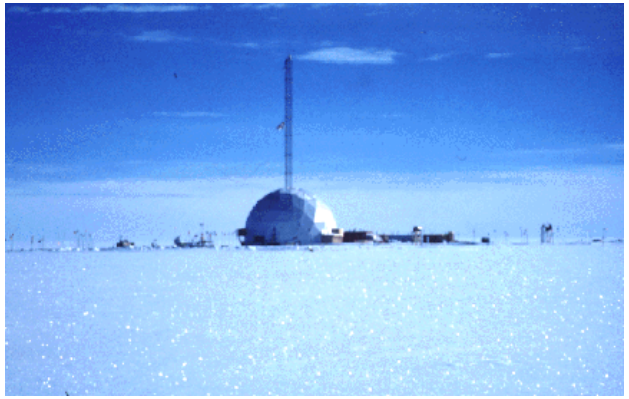
Basic R&D Example – Other Agency $

Deep Ice Core Drilling

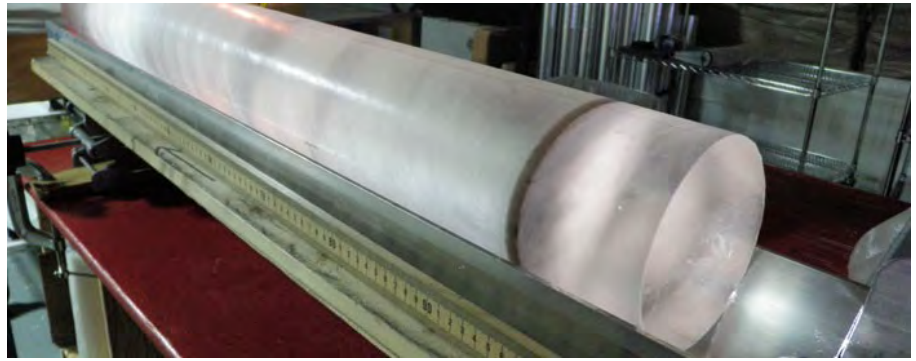








Funding: Navy, NSF, USGCRP



Basic R&D Example – Military $

Lightweight Modular Causeway



A bridge from shore to shore

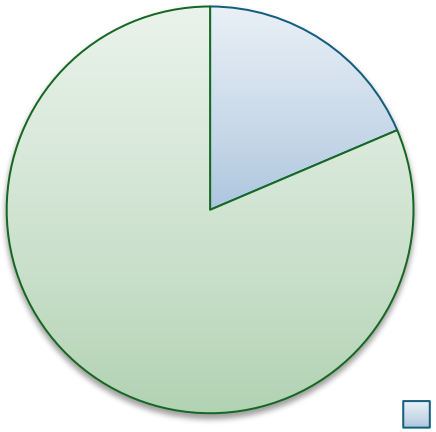


A bridge from ship to shore

Initial Funding – RDTE, Department of Homeland Security

Trends in Corps' CW Total RD&T and Coastal Funding

FY20 Civil Works RD&T Funding



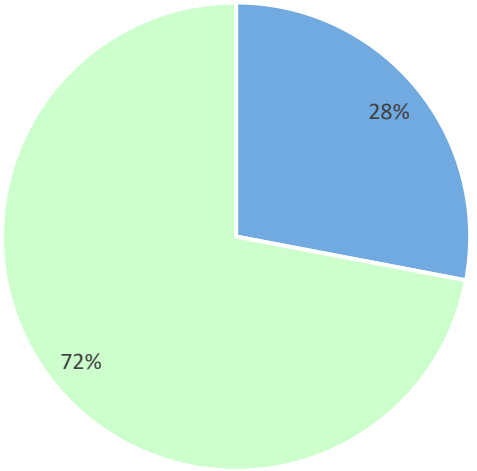
Total $107M

Coastal $24.4M, 23 %

Coastal RD&T

Other RD&T

FY23 Civil Works RD&T Funding



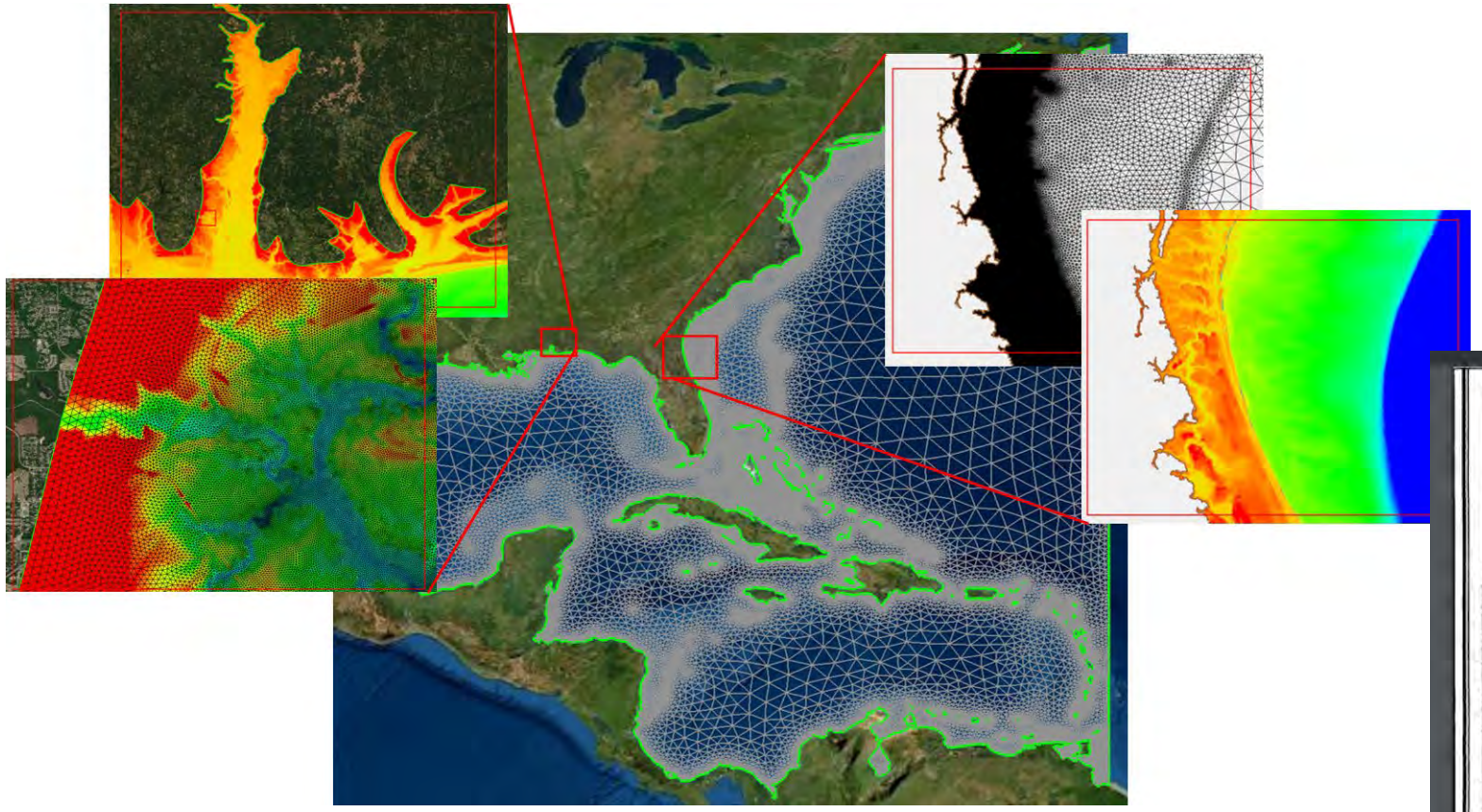
Coastal RD&T $68.1M, 28%

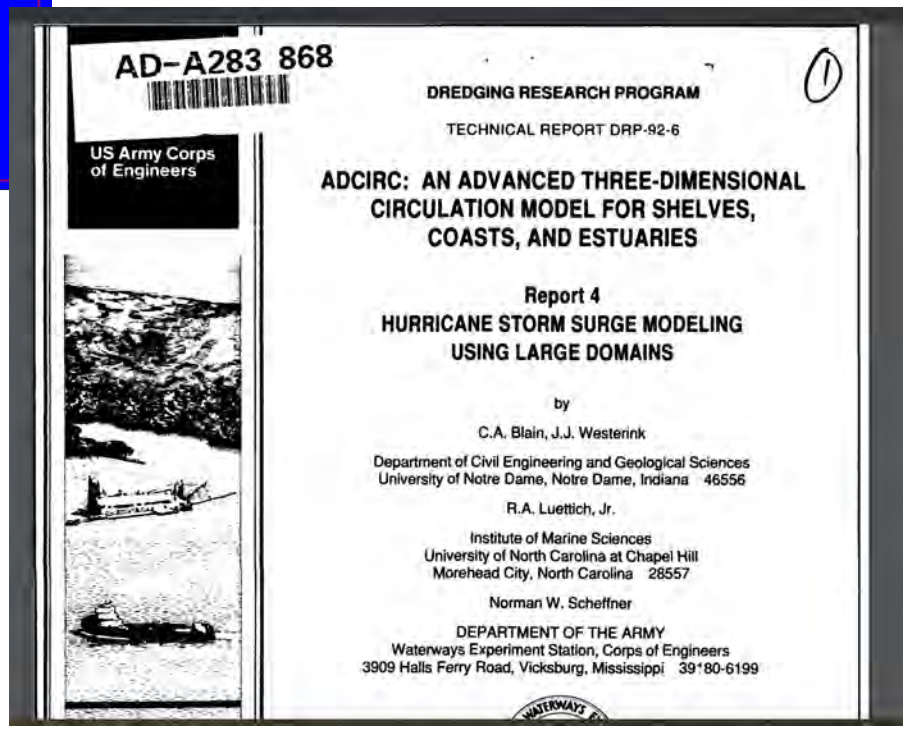
Total FY23 CW RD&T Funding $175M

Note: All funds Applied and Technology, No Basic

Basic R&D Example – Civil Works $

ADCIRC “Advanced Circulation Model”





AD-A283 868

DREDGING RESEARCH PROGRAM

TECHNICAL REPORT DRP-92-6

US Army Corps of Engineers

ADCIRC: AN ADVANCED THREE-DIMENSIONAL CIRCULATION MODEL FOR SHELVES, COASTS, AND ESTUARIES

Report 4
HURRICANE STORM SURGE MODELING USING LARGE DOMAINS

by

C.A. Blain, J.J. Westerink

Department of Civil Engineering and Geological Sciences
University of Notre Dame, Notre Dame, Indiana 46556

R.A. Luettich, Jr.

Institute of Marine Sciences
University of North Carolina at Chapel Hill
Morehead City, North Carolina 28557

Norman W. Scheffner

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

Initial Funding: Dredged Materials Research Program

Transformative Research Example

Discovery & Development of terrestrial lidar uses in coastal processes R&D

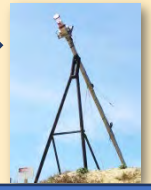
2010 | POLICY CHANGE | 2013 | 2016 | 2019 | 2022

Brand new tech, what can we do with it?

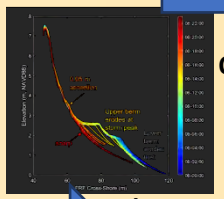




Can it measure Waves? Yes!

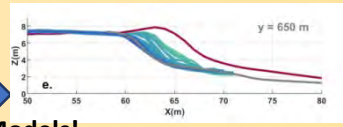


Let's collect it all the time!



What can new lidars do?

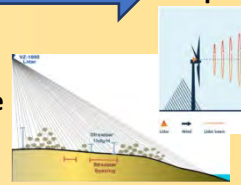
Validate Models! Observe processes at new scales!



What else can we use lidar for?







Improved CShore model; BeachFX/CHART

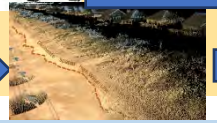
Arctic Wave-Ice Interactions



Aeolian Sediment Transport

Vessel-Based Sensing for Littoral Operations

Wave Breaking Physics



Beach Nourishment Evolution

What about mapping?



What about adding other sensors?

Internal IRIP

CFDC Remote Sensing – continuous measurements

$150K investment

CODS Remote Sensing of Coastal Morphodynamics

CODS OCPP

CIRP Coastal Dune Evolution

F&CS Resiliency of Dunes

IMPACT

- **Transformative R&D takes time, Funds, Partners!**
  - 2010 – 2015 focused on understanding & evaluating
  - 2015 – 2020 true applications began
- **Lidar is now a widely accepted tool in coastal wave observations**

SMALL INVESTMENT / BIG RETURN

Source: ERDC

Coastal Research Landscape

Organization	Traditional Focus	New Investments/Emphasis
NOAA	Weather/Climate Sea Grant	Climate Resilience Fund Coastal Resilience Fund SLR/Inundation External Research Sea Grant Hazard Preparedness Coastal and Great Lakes
USGS	Natural Hazards (EQ dominant) Information acquisition and synthesis (EQ and Water)	Natural Hazards (Coastal) Climate Resilience Fund Coastal Resilience Fund
NSF	Basic Research Engineering / Sciences	Coast & People (5 Hubs) Reducing Climate Risk with NNB Coastal Hazards Equity/Resilience
NASA	Earth Observation and Analysis	Update to Observation Platforms
Corps	Coastal Structures Coastal Processes Modeling and Simulation	Same Legacy Components plus Strategic Focus Areas (Applied)

Conclusions

Good News:

- R&D Investments in General Are Increasing
- Funding Focused on Coastal Issues is Rising
- New Emphasis on Resilience, Equity, NNB, Climate are Important
- Basic Research is Relatively Low-Cost Investment

Not So Good News:

- Industry Funding Dominance Shifts Emphasis Toward Markets
- Investments mostly focused on impacts and responses
- Foundational Efforts in Physical Processes Limited to Government
- Serendipity is Not a Long-Term Strategy

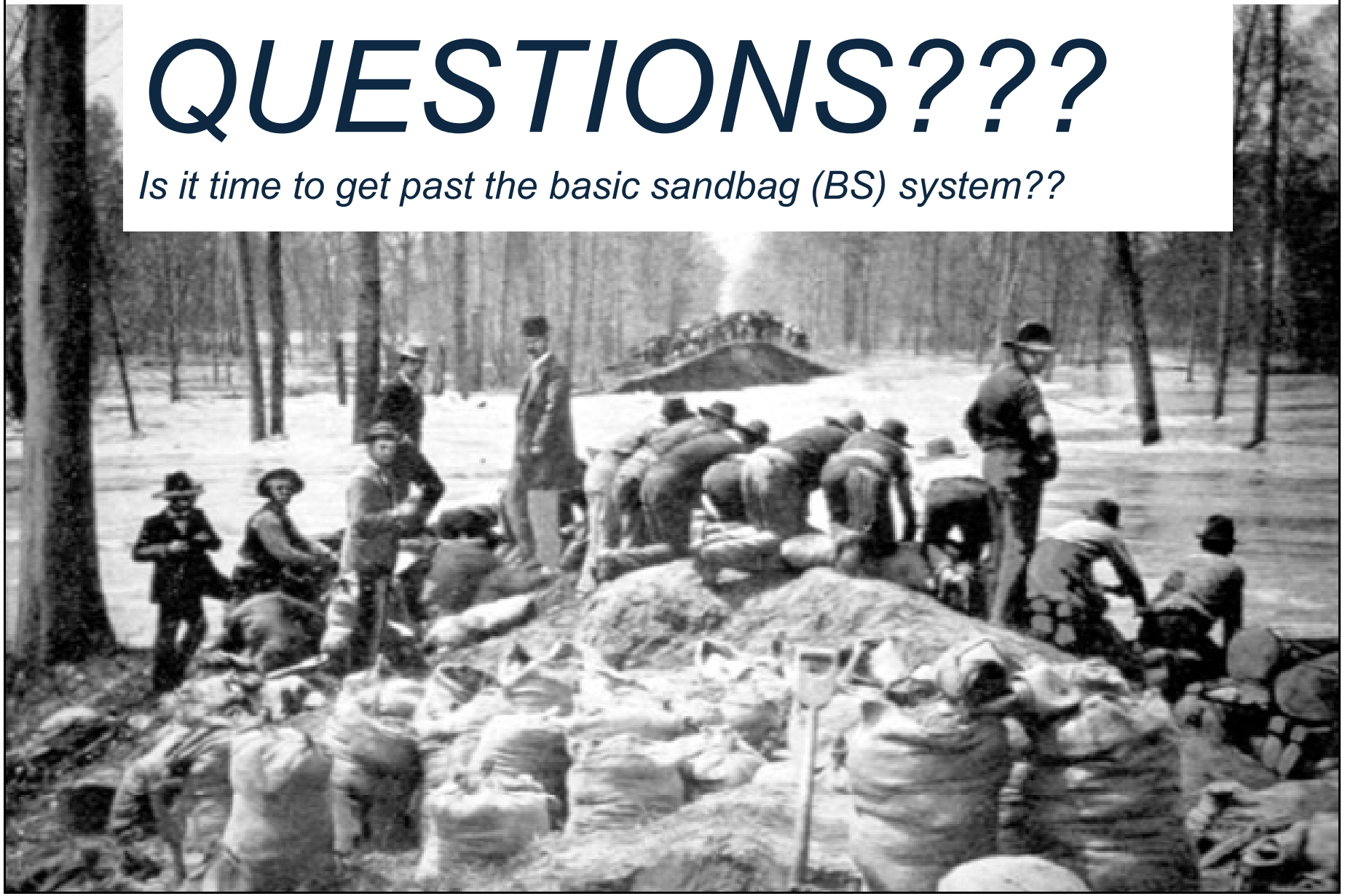
GAPS (From Corps Perspective)

- Lack of Focused Foundational Research in Water--Sediment Processes
- Need for Foundational Research Advocacy, Policy and Management Strategy
- Need for Strategic Plan for Foundational Research Investment Priorities/Partners/Returns

Tying the ends of a levee to prevent further collapse.

QUESTIONS???

Is it time to get past the basic sandbag (BS) system??



Robert A. Holman, Ph.D.

Dr. Holman received his BSc degree in 1972 from the Royal Military College of Canada in Honors Mathematics and Physics, followed by his PhD degree in Physical Oceanography from Dalhousie University in 1979. He then joined the faculty of the College of Oceanography at Oregon State as an Assistant Professor, working his way up to Full Professor in 1991 with Adjunct status in the College of Engineering. Dr. Homan is currently Professor Emeritus in what has now become the College of Earth, Ocean and Atmospheric Sciences at Oregon State University.

Dr. Holman has an extensive record of community and external service including 1.5 years at the Office of Naval Research helping develop a nearshore processes program, five years in MEDEA, ten years working with Navy Special Projects, six years with Ocean Studies Board and seven years with the Coastal Engineering Research Board. In 2003 he was named as the ninth ever SECNAV/CNO Chair of Oceanography for the Navy, representing increased Navy interest in littoral warfare and nearshore remote sensing.

Dr. Holman's research interests focus on nearshore processes including fluid dynamics on a wave-driven sloping beach and the associated morphological response (including erosion), as well as remote sensing approaches to sampling and characterizing the problem. Dr. Holman was the lead developer of the Argus Program of nearshore optical remote sensing and the head of the Coastal Imaging Lab (CIL) at Oregon State University. He has participated in field experiments at the Duck Field Research Facility since 1981 and is a strong supporter of the FRF.

Dr. Holman has extensive international connections, largely related to his research in nearshore remote sensing through the Argus Program. He was the Belle van Zuylen Chair in Oceanography at the University of Utrecht in 1995 and has had long-term relationships with Dutch, British, Italian and Australian coastal researchers.

Implementation of a Basic Research Program in USACE Civil Works

Rob Holman

July 17, 2024

1.0 Background:

From 1963 to 1983, USACE was home to a world class research program in the Coastal Engineering Research Center (CERC), based in Ft. Belvoir, VA[1]. In May, 1976, CERB reviewed CERC, concluding that "The Corps is the major United States researcher in coastal engineering and has long been a recognized world leader in the field."[1]. However, the forced relocation of CERC to Vicksburg, MS, in 1983 gutted the program with only 24 of the 83 scientists and engineers relocating[1]. None of the leading engineers moved (e.g. Saville, Savage, Sorenson, Weggel, Jeff Williams) including all the lead authors of the Shore Protection Manual, the bible of coastal engineering at the time. There was a precipitous loss of corporate knowledge and research culture and the funding soon followed suit.

It has been a high priority of the recent BCER board to recover an understanding of and passion for basic R&D as a path to innovation and solution to the growing coastal engineering challenges that the nation faces. In February, 2020, arguments about basic R&D were captured in a short white paper, "Research and Development Strategies in USACE Civil Works" which was generated by BCER members, circulated through ERDC management and delivered to James Dalton, recently the Director of Civil Works, and General Scott Spellmon, the Chief of Engineers. The arguments seemed to resonate, and through a series of high-level efforts, there appears to be a path to increases in research funding.

The challenge we face now is to live up to the promise of and national need for a foundational research program that includes intentional investment in basic research in nearshore fluid dynamics, sediment transport, and other core disciplines. It has been several generations since basic R&D on fundamentals has been part of the CW culture and that lack of connection will likely be an obstacle to implementation of any new program.

2.0 The Challenges of Implementation:

The attitude to research in Civil Works is unique among Department of Defense R&D organizations. Military (tactical) forces embrace the need for research in a set of levels from basic (6.1 or TRL1) to very applied. In contrast, **CW supports almost no basic R&D**. Almost all of the small research investment is short-term tactical, mostly driven by Statements of Need, or more recently to some level aligned with six strategic goals, although the connection of these strategic goals to basic science and engineering roots is opaque. Fundamental progress is incremental and innovation highly unlikely without a solid foundation in basic science and engineering.

There are a number of desirable characteristics of strong research programs:

- Portfolio investment is required spanning from basic to applied research,
- Connections of basic results to applied solutions is primarily the responsibility of a competent middle layer of management, not of the basic researchers,

[1] History of the Coastal Engineering Research Center, 1963-1983, Volume 1, WES Laboratory History Series

- Risk must be embraced in basic research. Fear of failure is a recipe for innovation failure,
- Payback times on basic research are long. Only small increments happen quickly,
- Significant partnering and outreach are necessary to connect USACE efforts to those in the broader research community,
- Committee R&D funding decisions will be conservative. Recommendations by strong engineers and scientists, rather than a committee of managers, will lead to more innovation and better outcomes.

3.0 Implementation Suggestions:

The following are some suggestions to build and execute an effective R&D program and return CW to a culture of research innovation:

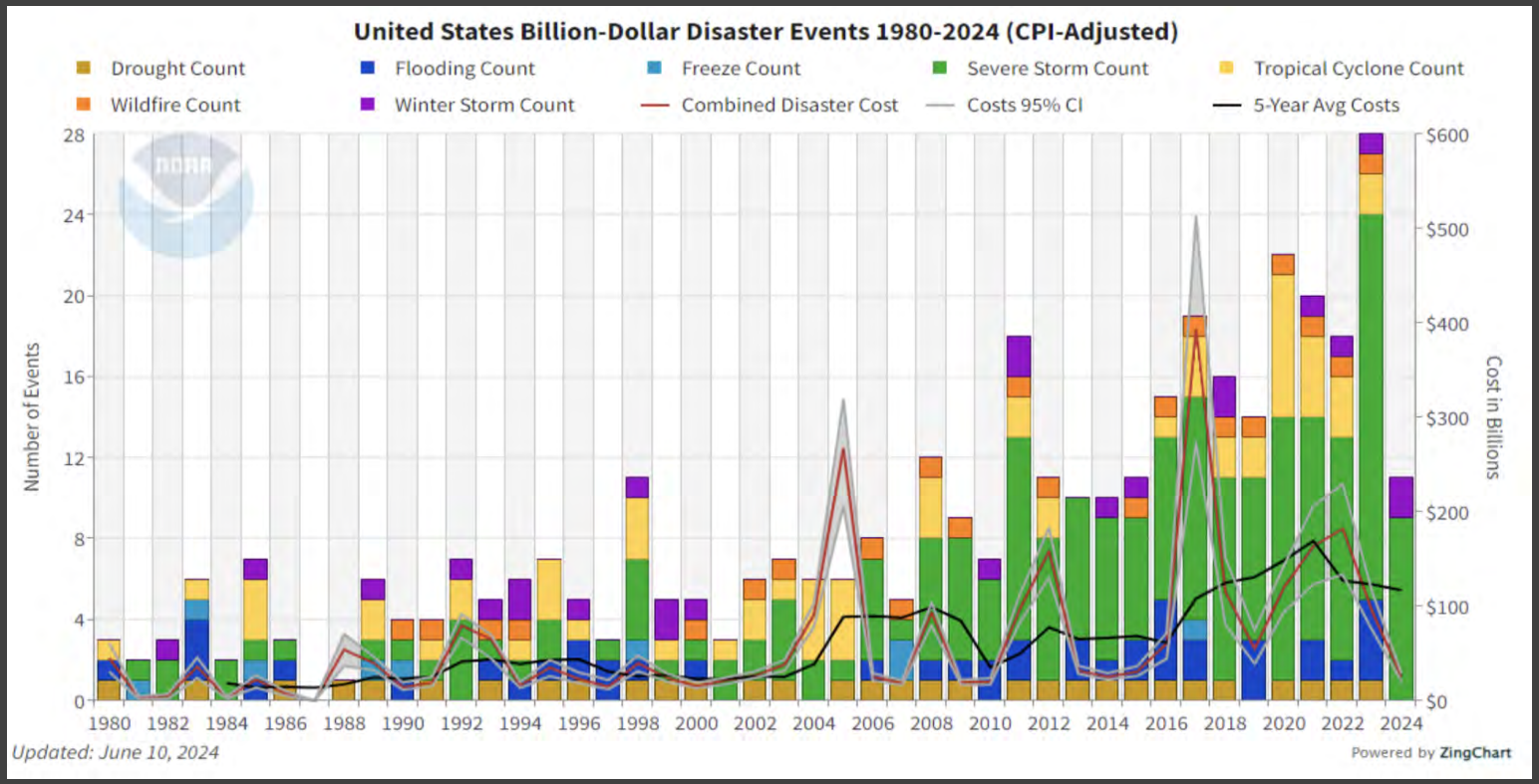
- Within six months, the historical benefit of R&D investment should be documented and presented at the Chief level with a one-time base level review of major research contributions, decade by decade for the past 50 years, that have shaped CW engineering capabilities.
- R&D funds should be managed by the R&D program. The director of R&D should be responsive to business line needs by identifying and supporting the required underlying research. The R&D program office should be responsible for coherence among funded work units and should seek continual advice from respected engineers and scientists.
- Input from respected scientists and engineers is needed to help design the important components of a foundational R&D program. Within one year there should be a review of the prospective program goals and review/decision making processes. After implementation, the program should be reviewed on a biennial basis by a high-level advisory board that includes leading academics, USACE senior active scientists and other respected scientists and engineers.
- The important past innovations were the result of sustained investment and acceptance of risk. Basic research requires time. Growing a new program should not be judged on a short trial investment but should include a commitment of a decade of predictable, R&D funding.
- The most sensible funding basis for a long-term effective R&D program is as a percentage of budget (or the project components of budget). This will be a major change that must be agreed upon at high levels including OMB. BCER may be able to help, but leadership and negotiation skill must come from senior USACE personnel.

Implementation of a Basic Research Program in USACE Civil Works

Rob Holman
(Oregon State University)
CERB - Emeritus

- The need for basic R&D in CW
- Current status
- Desired status
- Steps to success

The Current Situation in Coastal Hazards



A.R. Siders

- Sea levels and storminess are worsening
- Infrastructure passing design lifetime
- We can only protect 13% of our coastlines
- We are behind and losing ground
- We can no longer be reactive!

The Need for Basic R&D

- All DOD supports basic-to-applied research chain EXCEPT USACE-CW (no basic)
- Love of basic research has been driven by national security threats – failure unacceptable
- Basic research is key to discovery, invention and innovation.
- Basic research provides opportunity and ensures applied research is properly aimed
- A vibrant R&D program attracts and retains good people

Basic R&D in USACE-CW

- USACE-CW has been the national home of coastal engineering forever
- Peak basic program was at CERC, 1963-83
- 1983 move to Vicksburg, MS, drove loss of 75% of talent, forced rebuilding
- 1995, MG Hunter reported that administration was “no longer in the shore protection business”
- 1997 changed to business line funding model, abandoning hope of coherent R&D planning

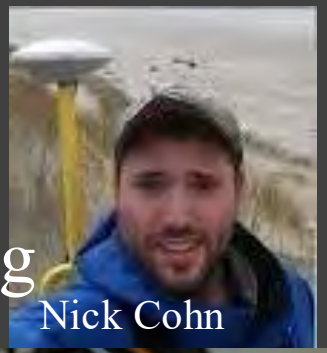
Major Issues

- No basic research program (underlying roots)
- Until recently only tactical focus through Statements of Need
- Strategic Focus Areas (SFAs) recent improvement but not well connected to basics
- Decisions and program design by committee
- Funding by business line

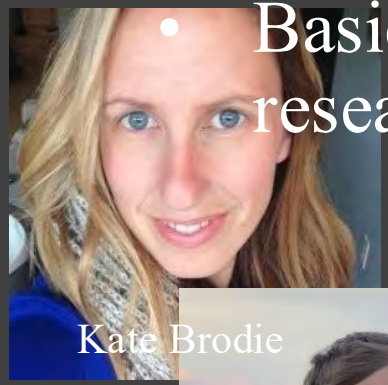
No longer a basic R&D culture in CW

Young Talent

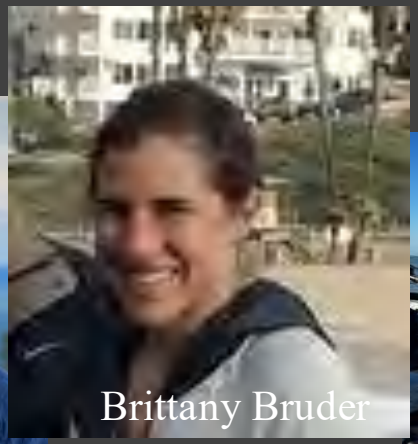
- Talent is critical to results
- USACE has hired very well recently
- Current R&D program is frustrating to young PIs and may drive them away.
- Basic R&D serves as magnet to world researchers that enrich the science environment.


Nick Cohn


Liz Holzenthal


Kate Brodie


Dylan Anderson


Brittany Bruder


Alex Simpson


David Honegger


Annika O'Dea

Does ERDC Need To Do Basic R&D?

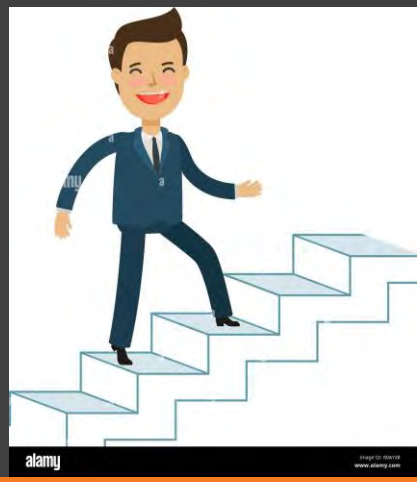
- Importance of basic research is a hypothesis that can be tested.
- Need a **Chief's Review Board**, akin to Navy CNO Executive Board (CEB)
- Demonstrate how Coastal Engineering practice has developed over the past 50 years and where major leaps have come from
- Execute within six months

Desirable Characteristics of an R&D Program

- Portfolio investment spanning from basic to applied
- Embrace risk
- Expect extended (not rapid) payback times
- Significant partnering with broader research community
- Funding decision ownership (not by committee)
- Connections of basic to applied community should not fall on basic research PIs

Implementation Steps

- **Return funding to R&D program that is responsive to business lines**
- Design a coherent program with input/review from leading scientists and engineers
- Get feedback from young bright folk
- Review on a biennial basis with heavy science and engineering input.
- Plan for a decade initial effort to allow development of a culture



Where Does the Money Come From?

- CW budgets around $11B now, likely to grow in future.
- Define a target mean percentage for all R&D
- Define fraction of total R&D budget that is Basic
- This is beyond CERB/BCER level, although we would be happy to help.

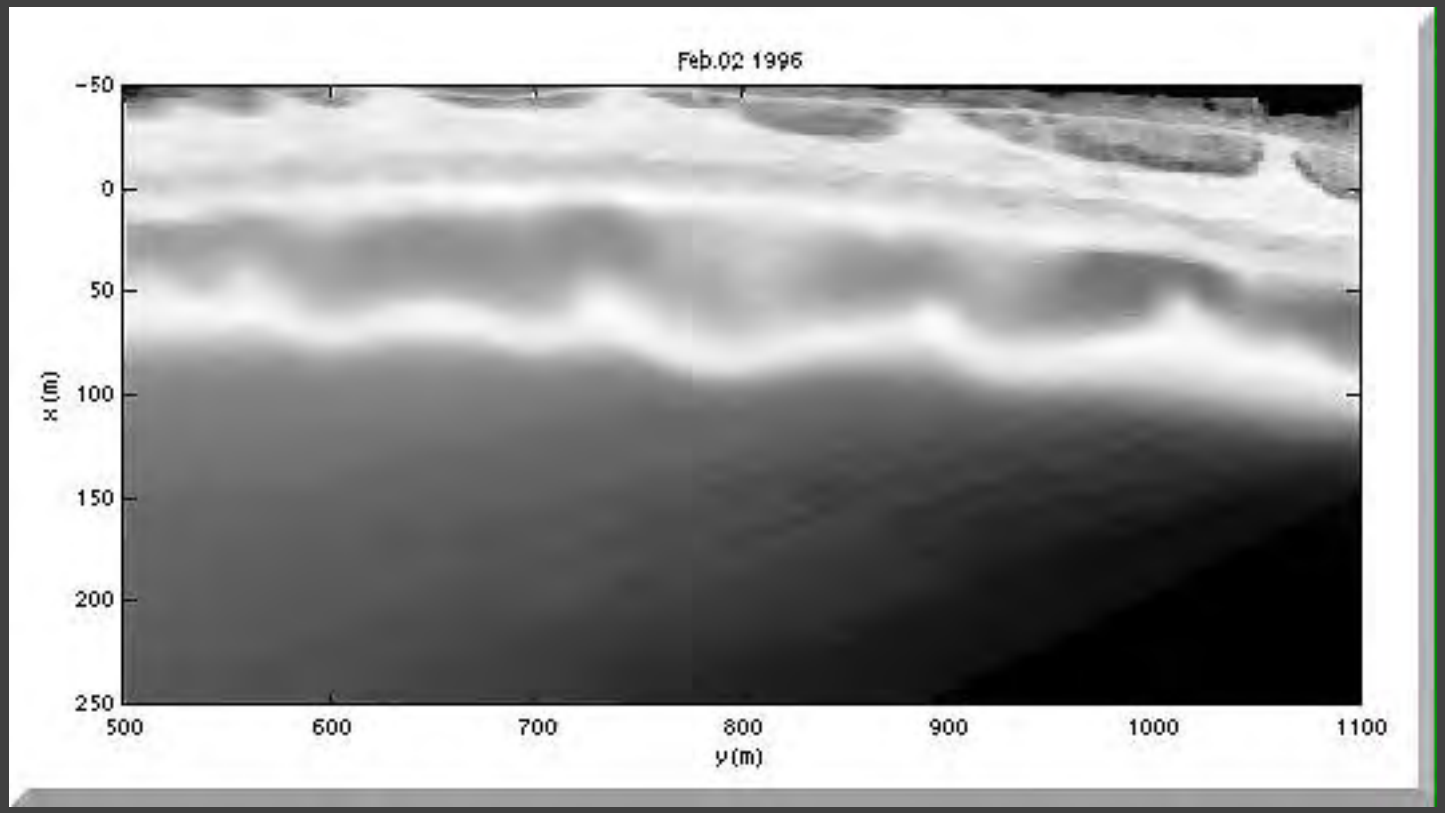


Summary

- This is a NOW problem – NOT business as usual
- Examine contribution of basic research through Chief's Review Board in six months
- Put R&D funding back in R&D program, responsive to business needs
- Design coherent basic program with input from research heavy hitters
- Review on biennial basic
- Allow a decade to mature
- Treasure your young talent!!

Example Scientific Problem:
Sand bar morphodynamics on ocean beach

Time exposure movie, Palm Beach, Australia, 1996



Jack A. Puleo Ph.D.

Dr. Jack A. Puleo is a Professor and Chair of the Department of Civil, Construction, and Environmental Engineering at the University of Delaware. He previously served as the Associate Chair for the Department of Civil, Construction, and Environmental Engineering and the Director for the Center for Applied Coastal Research. As a faculty member, he is generally interested in physical processes occurring near the shoreline. Specifically, he focuses on small-scale hydrodynamic and sediment transport processes. Other areas of research interest consist of nature-based and nature-inspired solutions for coastal disaster mitigation, developing remote sensing and in situ sensing capabilities for coastal research, and Department of Defense based applications of coastal engineering and coastal processes.

He has significant experience and interest in mentoring early career faculty and young professionals. To that end, he initiated, organized, chaired, and fundraised for the Young Coastal Scientists and Engineers Conference – Americas; just completing its 10^{th} yearly conference. Puleo is the recipient of the NSF Career Award, US Fulbright Award, Two University of Delaware Excellence in Teaching Awards, the Robert G. Dean Coastal Academic Award, and a SERDP Project of the Year Award. He holds a B.S. in Oceanography from Humboldt State University, a M.Sc. in Physical Oceanography from Oregon State University, and a PhD in Coastal Engineering from the University of Florida.

The Next Big Leap in Coastal Engineering – Sediment Transport

Jack A. Puleo
University of Delaware
Newark, DE

Sediment Transport: The quantity (usually volume) of material moved via fluid flow as a function of time.

Morphodynamics: The change in bed elevation over time as a function of changes in sediment transport magnitude and/or direction.

The US Army Corps of Engineers (USACE) has numerous thrusts of oversight including civil works where there is need for knowledge and predictive capability in sediment transport processes. Specifically, lack of knowledge could impact negatively shore protection, coastal flooding, community access, channel maintenance, and ecosystem protection. The USACE is ultimately concerned with morphodynamics resulting from sediment transport gradients, for example, how much sediment has infilled a channel, the fate of a submerged berm or beach nourishment, or the elevation behavior of the area surrounding a nature-based feature. Simple empirical equations through to advanced hydrodynamic – sediment transport models are used to predict coastal morphodynamics. Yet, predicting morphodynamics is difficult because the physics underpinning sediment transport are incomplete, sediment transport measurements are rare and difficult to obtain, and the resulting bed elevation change is due to the small difference in large signals. In fact, the sediment transport aspect of the models is often oversimplified or parameterized to account for the lack of physical understanding. The results of the preceding are:

1) Models must be tuned to morphodynamic measurements, not sediment transport measurements.

2) Model tuning tends to be site specific.

3) Model tuning may be event specific *even* at a specific site.

4) Inaccuracies in model coupling between hydrodynamics and sediment transport tend to amplify over time leading to less predictive skill on engineering times scales.

The impacts are:

1) Error bars on sediment transport prediction far exceed the net sediment transport magnitude.

2) Merely predicting the net sediment transport direction and/or sign of bed elevation change are often considered “victories”.

3) Incorrect “rules of thumb” may be used given high fidelity model inaccuracies.

Researchers and USACE personnel have provided documentation and presentations at numerous CERB meetings (including this one) indicating a dire need to improve sediment transport and morphodynamics capabilities and for a secured, long-term investment in such capabilities. The same message is delivered in this brief where several tangible action items for improving morphodynamic modeling are presented. Our recent history has shown that significant success is possible with CERB guidance and USACE vision and leadership. The Field Research Facility (FRF) was established in 1977 as a

means to gather routine data for hydrodynamic and morphodynamic scientific inquiry and model validation. Many system and technology prove-outs have also occurred at the facility. The FRF has prodcued a 45+ year long data set used by international researchers, been the site of numerous focused international field experiments, and efforts there have led to over 1000 scientific/engineering products.

The USACE and international researchers have identified lack of understanding of sediment transport as a continued impediment to engineering-level predictions of morphodynamics. A new approach is recommended where discussion and ideas are taken to action. A Sediment Transport Initiative (STI) led by the USACE is presented that enables observation, discovery, and innovation and places emphasis across the knowledge spectrum from theory to test beds. Importantly, the STI becomes a strategic, securely funded focus of the USACE as a partnership with other organizations. Outcomes of the long-term initiative include 1) A Sediment Transport Summit at ERDC overseen by a science and engineering leadership team. We will document present status and action items to achieve the main goal of developing engineering level morphodynamics prediction. 2) Ensure USACE – academic (and other industry, NGO) partnerships to support workforce development. 3) Develop several new test beds akin to the FRF to broaden the parameter space where the USACE conducts CW operations. 4) Provide the test bed data in a standardized, easily searchable, downloadable format for broad use. 5) Run predictive models relentlessly using calibrated and blind testing of objective and unified performance metrics.

BCER (CERB) Meeting – August 14, 2024

The next big leap needed in coastal engineering

Jack A. Puleo
University of Delaware

Moonshot → Strategic Focus



MG Graham challenged CERB (Aug 2020; 97th meeting) to imagine what the next breakthrough should be

- Leap in capability and innovation
- High risk, difficult problem
- Focus on Corps priorities / needs
  - Strategic goal(s)
  - Major advance in knowledge
  - Broad significance to coastal communities

Moonshot → Strategic Focus

Typical protocol:

"That's a really great idea", "We should do that"
→ Do not speak about it again
→ Rekindle the idea from meeting to meeting

We need to break the cycle and **go from idea to action**!

…and it was done before with an idea originating with CERB

Example: USACE FRF

Problem: Deficit in knowledge of field-based coastal hydrodynamics and other coastal processes relevant to Corps needs

Solution: Develop the Field Research Facility (1977)

Output: Extensive data set on waves, hydrodynamics, and morphodynamics for process understanding, model development, and tool development for coastal design and construction

Connection to, and respect of, world's best scientists and engineers

Example: USACE FRF

- 45+ year time series
- Models tested
- Sensors/technology tested
- Remote sensing developed
- Hydro/Sed transport/Morpho
- Field studies (intl participants)
- Over 1000 papers/reports/presentations



DUCK82, DUCK85, SUPERDUCK, DELILAH, DUCK94, SANDYDUCK, DUCK98, SHOWEX, HOLEX, DUNEX…

UNIVERSITY OF DELAWARE
ENGINEERING

Corps (Core) Areas of Importance

Coastal Commanders' Decadal Challenges (Mar 2024)

	LRD	MVD	NAD	NWD	POD	SPD	SAD	SWD	Total	KEY: # Districts in Division with Challenge
Assessment of **Value**/Impact of NNBF	3	1	5	1	1	0	5	0	16	
All Things **Sediment** (influence of CC, Erosion, modeling, transport/tracking	2	0	5	1	1	2	3	0	14	5
Holistic Assessment of Study Areas and Surround (**Watershed**/region)	3	0	4	1	2	1	3	0	14	4
Strategies for Addressing Decreasing Sustainability of Coastal **Infrastructure**	2	1	4	1	1	1	2	1	13	3
Compound **Flooding** Modeling and Assessment Capabilities	2	1	1	1	1	1	5	0	12	2
Incorporating **Adaptive** Strategies in Project Planning (methods & policy)	0	1	2	2	1	2	1	1	10	1
Workforce: Supporting a large & talented enough workforce to meet CSRM demand	1	0	2	0	2	2	3	0	10	0
Partnering with Non-Federal Sponsors (increased authority)	0	0	2	2	1	1	1	1	8	
Benefits: Methods to Assess Other Social Effects and Environment	0	0	1	0	1	0	0	0	2	
Districts responding per division	3	1	5	2	2	2	5	1		

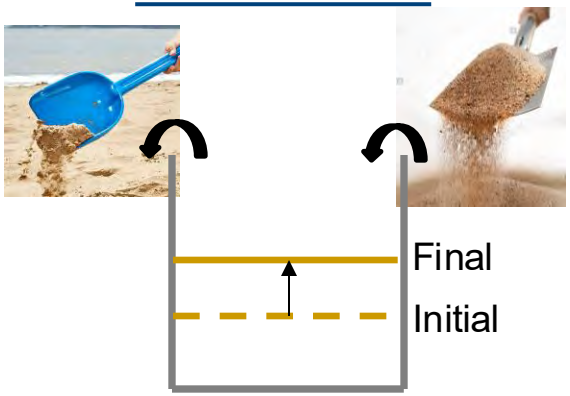
Compiled by Bianca Charbonneau

Definitions

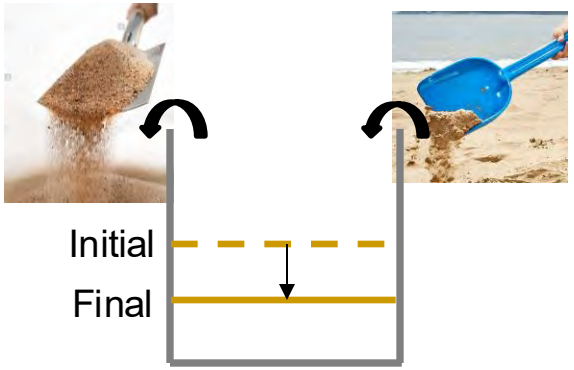
Sediment Transport: Sediment volume per time advected by fluid

Morphodynamics: The change in elevation over time due to gradients in sediment transport

Accretion



Erosion



Overview of Present State

- Hydrodynamic prediction 
- Morphodynamic prediction 
- Sediment transport prediction 
- Sediment transport measurements 
- Engineering models largely based on simplistic theory
- Models tuned to morphodynamics, not sediment transport
  - Tuning coefficients vary by site; possibly by event
- Duck ≠ other beaches or environments

Impact on USACE

- Sediment is a resource!
- Dredging operations (2M to 5M yd^3 per year)
- BUDM: 70% by 2030
- Offshore placement (where, when, how big, how deep)
- Beach nourishments (1.5B yd^3 over last century)*
- Billions spent on sediment management
- Nature-based approaches

* Not all USACE

Strategic Focus Area – Sediment Management

Goal: Sediment Transport Initiative: Right Model, Any Location, Correct Elevation

Guiding Principles:

Observation → discovery → innovation
Theory to test bed
End member sites
Magnet for research talent (international)
Data collection used by numerous researchers/engineers
Identify weaknesses → solve problems

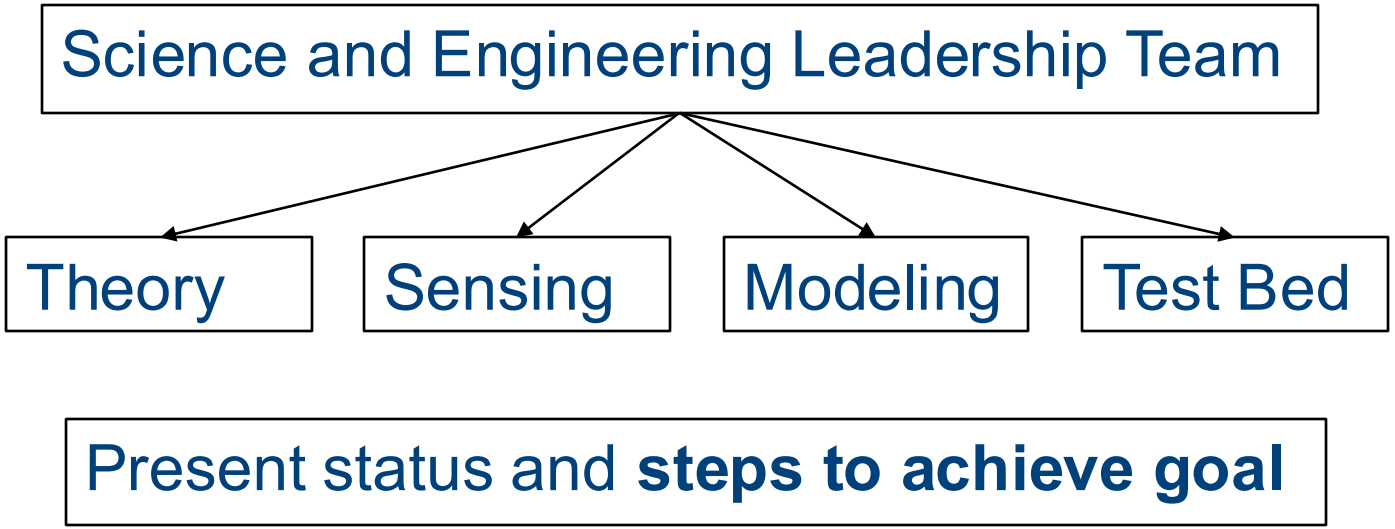
Strategic Focus

How:

- International effort to revolutionize sediment transport knowledge
- USACE - academic partnership → workforce development
- Dedicated / securely-funded program
- Technology development
- Test beds

USACE – Sediment Transport Initiative

1) **Sediment Transport Summit** at ERDC



PhD Student and Post-doc participation → workforce

USACE – Sediment Transport Initiative

2) Government – Academic partnership

- Direct collaboration between Corps, academics, industry, NGOs
- Corps initiative-specific funding (well beyond USCRP)
- SMART-like scholarships for graduate students → workforce development
- Mendenhall-like scholarships for post docs → workforce development

Reinforces partnership

USACE – Sediment Transport Initiative

3A) Test beds: International Coastline Observing Network (ICON)

Ultimately must improve Corps prediction capability of **morphodynamics**

- Non-Duck locations
- Dissipative beach
- Reflective beach
- CSRM beach with dunes and NBS
- Barrier Island breaching
- Estuarine / inlet location
- Navigation channel shoaling
- Dredging / beneficial use
- ...

Part of task 1
Prioritize
Establish Consensus

USACE – Sediment Transport Initiative

3B) Test bed development

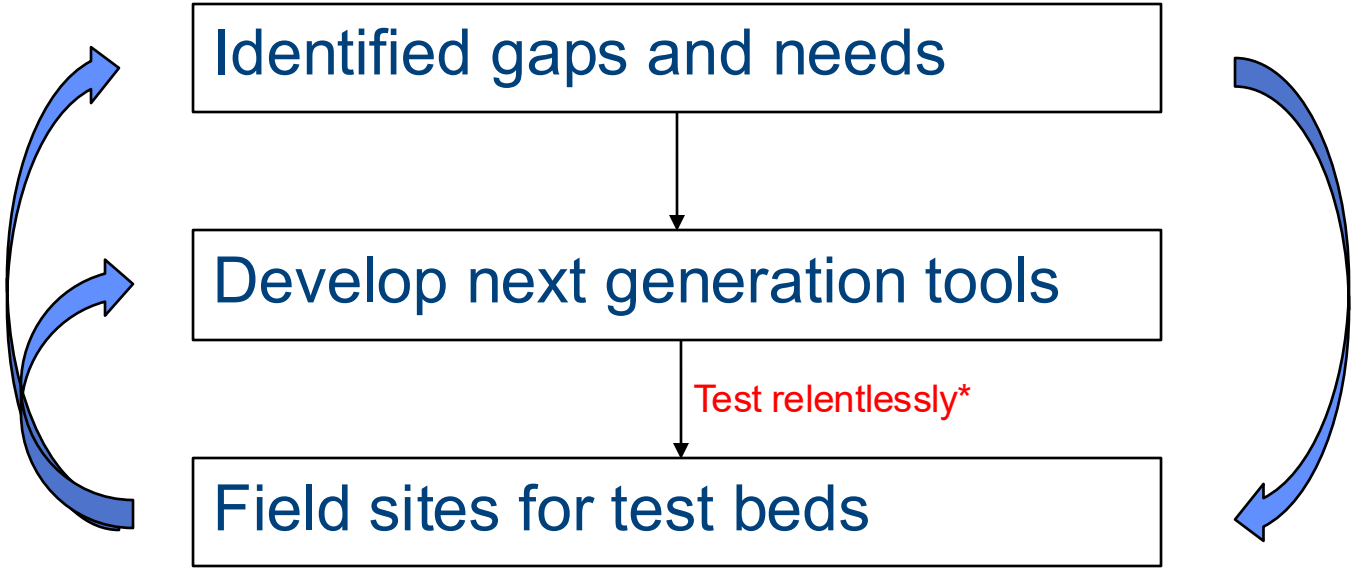
- All data QA/QC'ed
- Standardized format
- Open source and web-searchable / downloadable
- Advertise broadly, encourage use and feedback

USACE – Sediment Transport Initiative

4) Numerical modeling

- Test models relentlessly
- Automate use where possible
- Objective and unified performance metrics
- Routine model improvement
- Incorporate use of physics-informed AI/ML

Closing The Innovation Loop



*Must include training and blind testing

Summary

- Morphodynamics and sediment transport processes affect most Corps CW projects
- Understanding and predictive capability is weak
- Expert opinion and project conditions and constraints indicate a step change in capabilities is needed
- Corps becomes the catalyst and leader for this difficult challenge

Tangible Products:
- 3-4 new supported test beds
- Accurate prediction of engineering-level morphodynamics
- Support next generation of ERDC personnel in a Corps critical area

"Imperfect action is better than perfect inaction
--Harry Truman

Jane McKee Smith, PE, PhD

Smith is an Emeritus Senior Research Scientist at US Army Corps of Engineers, Engineer Research and Development Center (ERDC) in Vicksburg, MS. She earned a PhD from University of Delaware, in Civil Engineering with an emphasis in Coastal Engineering. Her research focus is on coastal hydrodynamics, including nearshore waves and currents, shallow-water wave processes, and storm surge. Her projects include theoretical and numerical studies as well laboratory and field experimentation. Smith has 200 professional publications. Smith is also a Research Professor at University of Florida, and she has served on MS and PhD Committees at the University of Florida, Louisiana State University, Texas A&M University, and Mississippi State University. Smith is a Professional Engineer and Coastal Engineering Diplomate (Academy of Coastal, Ocean, Port and Navigation Engineers), and a member of the National Academy of Engineering. Her honors include 2022 International Coastal Engineering Award, ERDC Gallery of Distinguish Employees, ASCE Distinguish Member, ASCE Government Civil Engineer of the Year, Waterways Experiment Station Woman of the Year, Army Achievement Medal for Civilian Service, ERDC R&D Achievement Award, and Army Superior Civilian Service Award.

Summary of Pacific Coast R&D Gaps

Jane McKee Smith, PE, PhD and Julie Dean Rosati, PE, PhD
ERDC, Coastal and Hydraulics Lab

The 100th Board on Coastal Engineering Research (BCER) meeting provides an opportunity to celebrate the BCER's successes while also identifying priority existing and future coastal engineering challenges with focus on Pacific Coast processes. San Francisco Bay area projects highlight successes and challenges found throughout the US:

- Sediment management (dredging innovation, beneficial use of dredged material, dam removal, ecosystem restoration)
- Urban coastal flood risk reduction (compound flooding, climate change, water management)
- Collaborative adaption planning that empowers communities (environmental justice, multi-jurisdictions and agencies, inclusion of social and environmental benefits)
- Application of nature-based solutions (NBS) and a continuum of adaptation measures (Engineering with Nature proving ground, guidance, adaption, buy in)

The area also has challenges associated with seismic activity, wildfire impacted sediments, extensive bay wetland restoration efforts, a complex riverine-bay-coastal system, and dense urban development. These challenges point to the criticality of holistic engineering approaches. The broader US Pacific coast also has unique challenges due to strong extratropical storms creating extreme waves, surges, long waves, and runup which drive sediment transport and morphology change impacting navigation and coastal erosion. Natural features like reefs provide protection for many Pacific islands, but reefs are subject to degradation under climate change, and understanding reef ecologic and hydrodynamic function under non-stationary environmental forcing is key to risk assessment and restoration efforts. Recent flooding of a military facility on Kwajalein provides an example of the impact of knowledge gaps related to extreme flooding due to reef/long-wave interaction. Finally, lack of data to better understand fundamental processes, validate models, and inform guidance was identified as an issue both regionally and Pacific-basin wide.

The multi-agency US Coastal Research Program (USCRP) has identified priority coastal challenges that align with the *Commanders' Decadal Changes* presented in the Spring 2024 BCER. The USCRP community identified the next challenges as:

- Coastal flooding and extreme events
- Sediment transport and morphologic change
- Adaption
- Ecosystem restoration and water quality (sustainability)

USCRP funds university researchers and students to focus on these multi-agency challenges and in the process helps build the future coastal engineering work force. BCER civilian members discussed barriers to coastal engineering advances (lack of fundamental research and development funding, sharp focus on tactical research, need to expand partnerships) and recommended an initiative focused on sediment transport, one the of *Commanders' Decadal*

Challenges. The proposed initiative would focus on observation, discovery, and innovation advancing theory, sensing, and modeling, supported by diverse testbeds.

A summary of the overall identified research and development needs fall under three categories which align with the top *Commanders' Decadal Challenges*: all things sediment, compound flooding/watershed modeling and assessment capabilities, and assessment of value and impact of natural and nature-based solutions, including hybrid solutions with sustainable infrastructure. These needs fit within the Civil Works R&D Strategic Plan including Strategic Focus Area R&D targeted for Sediment Management, Water Modeling, Ecosystems, and Infrastructure.

- **All Things Sediment Transport:** A strategic BCER initiative that focuses on improvements to theory, sensing (including tracer methods), and modeling based on diverse testbeds (**data**) is required to rapidly advance tools and guidance. As the USACE advances to the goal of 70% beneficial use of dredged material, improving understanding of the transport of fine sediments and sediments impacted by wildfire were identified as needs.
- **Pacific Coast Processes (Compound Flooding and Watershed Assessments):** A key requirement voiced by presenters was the need for expansion of the Coastal Hazards System to the Pacific basin. These wave and water levels will provide a robust, probabilistic climatology to support USACE planning and design. Infragravity waves are a key driver of water level variation, runup, and overtopping, and improved quantification and modeling of infragravity waves are required to improve design to reduce flood risk. The complex San Francisco Bay area with compounding flood drivers and coupled ecological systems demonstrate the need for integrated watershed (including surge, waves, rainfall, and groundwater), sediment, and ecological models.
- **Nature-Based Solutions**: Robust NBS tools (including a continuum of hybrid solutions with built and nature-based infrastructure) are needed **now** to evaluate flood risk, project life-cycle performance, and the full range of comprehensive benefits. Data sets and testbeds are needed to develop and validate models. Guidance for NBS design, monitoring, and adaption should be a high priority.

Summary of Pacific Coast R&D Gaps

Celebrating Accomplishments of the BCER in 100 Meetings and Setting the Stage for the BCER's Future

Jane McKee Smith, PE, PhD
Julie Dean Rosati, PE, PhD
Coastal and Hydraulics Laboratory (CHL)

Board on Coastal Engineering Research
August 14th, 2024





U.S. ARMY
US Army Corps of Engineers
ERDC CHL COASTAL & HYDRAULICS LABORATORY

Coastal Commanders' Decadal Challenges	LRD	MVD	NAD	NWD	POD	SPD	SAD	SWD	Total	KEY:% Responding Districts in Division with Challenge
Assessment of **Value**/Impact of NNBF	100%	100%	100%	50%	50%	0%	100%	0%	76%	
All Things **Sediment**	67%	0%	100%	50%	50%	100%	60%	0%	67%	100%
More Holistic Assessment of Study Areas and Surround (**Watershed**/region)	100%	0%	80%	50%	100%	50%	60%	0%	67%	80%
Strategies for Addressing Decreasing Sustainability of Coastal **Infrastructure**	67%	100%	80%	50%	50%	50%	40%	100%	62%	60%
Compound **Flooding** Modeling and Assessment Capabilities	67%	100%	20%	50%	50%	50%	100%	0%	57%	40%
Incorporating **Adaptive** Strategies in Project Planning (methods & policy)	0%	100%	40%	100%	50%	100%	20%	100%	48%	20%
Workforce: Supporting a large & talented workforce to meet CSRM demand	33%	0%	40%	0%	100%	100%	60%	0%	48%	0%
Partnering with Non-Federal Sponsors (increased authority)	0%	0%	40%	100%	50%	50%	20%	100%	38%	
Benefits: Methods to Assess Other Social Effects and Environment	0%	0%	20%	0%	50%	0%	0%	0%	10%	
Districts responding per division	3	1	5	2	2	2	5	1	21	

SF Bay Modeling & Dredged Material Management

- **Challenges**
  - Regional sediment management
  - Beneficial Use of dredged material
  - Use of nature-based solutions (NBS)



- **Research Needs - Foundational**
  - ★ **Sediment Processes**
    - Response of fine/cohesive sediment (natural & anthropogenic processes)
    - Sediment characteristics and processes impact by wildfires
  - ★ **Ecological Processes**
    - Wetland response and engineering properties of NBS
    - Nonlinear & cascading effects of nonstationary (ocean & upland)
  - ★ **Hydrodynamic and Hydrological Processes**
    - Fine-scale processes → groundwater, water supply, salinity intrusion

SF Bay Engineering with Nature (EWN) Proving Grounds

Pajaro River, CA



Residents in Pajaro, Calif., were forced to evacuate in the middle of the night after an atmospheric river surge broke a Pajaro River levee and sent floodwaters flowing into the community on Saturday.
Josh Edelson/AFP via Getty Images

- **Challenges:**
  - Integrating EWN R&D with application/ education
  - Environmental Justice ~ empowering communities
  - Partnering for design, decision making, and communication
  - Adaptation planning via a continuum of measures
- **Research Needs:**
  - ★ **Develop methods to evaluate NBS in planning and design**
  - ★ **Develop engineering and construction guidance for NBS**
  - ★ **Support teams with EWN research in planning & design project phases**

Dam Removal on the West Coast

- **Challenges**
  - Lack data on removal of large-scale dams
    - Most removals small/low sediment impact
    - Few removals studied in detail
  - Model accuracy
- **Research Needs:**
  - Monitoring data sets
  - ★ **Sediment model improvement and validation with field data**
  - Klamath dam removal ~ modeling and monitoring opportunity (OR and CA, 4 dam removals)



Photo Credit : EcoFlight
Iron Gate Reservoir
https://klamathrenewal.org/photos/

US Coastal Research Program

- **Priority Coastal Challenges:**
  - ★ **Coastal flooding and Extreme Events**
  - ★ **Sediment transport & morphologic change**
  - ★ **Adaptation**
  - ★ **Ecosystem restoration and water quality (sustainability)**
- **Programmatic needs:**
  - Federal agencies defining common purpose and goals; **multi-agency tools and resources**
  - BCER champion
  - 2025 strategic implementation plan



SF Bay and Waterfront



- **Challenges:**
  - Regional, long-term, collaborate planning approaches
  - Advance regional nature-based adaption practice, transfer knowledge
  - Urban coastal flood risk reduction
    - Seismically active zone
    - Range of SLR projections (aligning Federal agencies)
- **Research Needs:**
  - ★ **Regional engineering guidance for NBS approaches**
  - ★ **Methods to assess benefit of alternative shoreline approaches**
  - Methods to assess effectiveness of projects
  - ★ Urban design guidance: overtopping rates, steep shorelines, uncertainty management, **compound flooding** (rainfall, groundwater, surge)
  - ★ **Pacific Coastal Hazards System**

NE Pacific Basin Coastal Processes

- **Challenges:**
  - Significant differences in Pacific Basin (climate, exposure, trends)
    - Extratropical storms dominate (big waves, moderate surge)
    - Infragravity energy is critical to estimate hazards & response
    - Hydrodynamic transformation to complex coastlines
  - Project needs differ by mission area (Nav focus) and project type
- **Research Needs:**
  - Quantification of Pacific Ocean decadal cycles
  - Coastal Hazard System for Pacific (extratropic forced)
    - Sub-region processes understanding
    - Infragravity waves
  - ★ Quantification of water level contributions & depth-limited processes
  - ★ Improved sediment, morphology, and structure-morphology interaction
  - Navigation reliability at coastal structures



Climate, Sea Level Change and Pacific Islands

- **Challenges:**
  - More frequent, persistent & extreme wave-driven flooding and erosion
  - Environmental impacts
  - Coral reef degradation
  - Little to no baseline **data** for most islands
- **Research Needs:**
  - ★ **Guidance: coral reef restoration/enhancement**
  - ★ **Quantify/optimize restoration & co-benefits**
  - ★ **Interdisciplinary modeling: reef, waves, flooding, low-frequency waves**
  - **Data: water levels, waves, bathymetry, runup, historic flood events, reef roughness**





Pacific Island Modeling (Kwajalein)



- **Challenges:**
  - Lack of data
  - Uncertainty in occurrence/driving conditions for IG/long-wave events
  - Applying design guidance in reef/low-frequency wave environments
- **Research Needs:**
  - Coastal modeling/Pacific Coastal Hazards System
    - Extratropical events
    - Phasing resolving models → infragravity wave generation/propagation
  - ★ **Quantify conditions that generate flooding events** (waves, WL, reef)
  - Efficient phase-resolving models for design in reef environments
  - Design guidance (overtopping, wave forces, structural stability) including probabilistic forcing w/ low-freq waves and reef environments
  - Comprehensive inundation solutions for remote locations

Sea Level Rise Adaption Planning – Oakland Alameda Subregion



- **Challenges:**
  - Multiple hazards (SLR, rainfall, emergent groundwater, liquefaction)
  - Vulnerable communities (environmental justice)
  - Holistic shoreline planning
  - Alignment of local priorities and Federal processes
  - Coordinate/collaborate with USACE projects



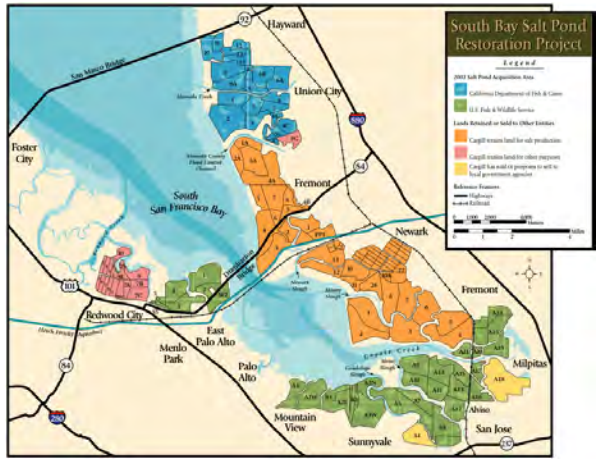
- **Research Needs:**

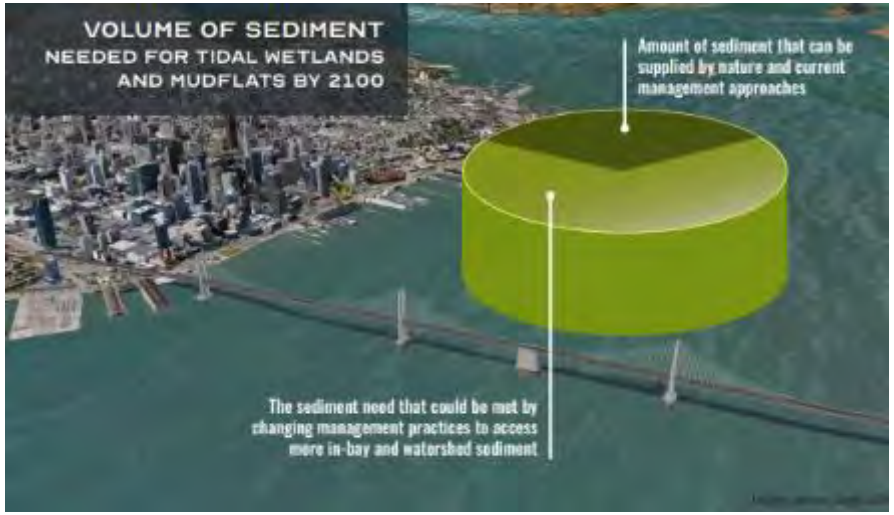
★ **Guidance/best practices on NBS and Beneficial Use in urban environments**

★ **Holistic adaption and resilience planning**

South Bay Salt Pond Restoration in SFB

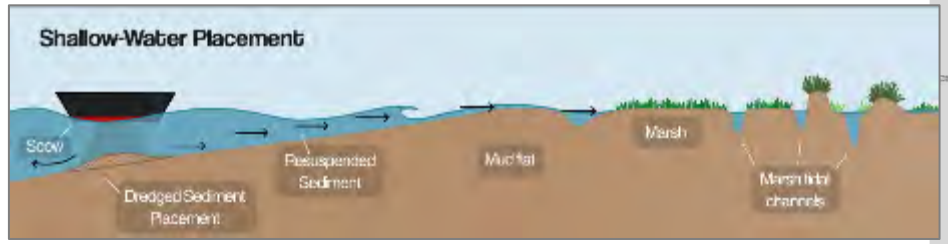
- **Challenges:**
  - Dense urban environment
  - Holistic, multi-objective, competing goals
  - Cross jurisdictional boundaries/owners
  - Clean sediment demand
- **Research Needs:**
  - ★ **Strategies to increase Beneficial Use**
  - ID optimal Environmental Screening Limits
  - Monitor BU pilot projects





Beneficial Use (BU) for Ecosystem Resilience

- **Challenges:**
  - Limited sediment supply regionally + SLR
    - Marsh erosion and drowning
    - Habitat loss for threated & endangered species
    - Increased flood risk
  - Pilot project monitoring of sediment movement & impacts



- **Research Needs & Recommendations:**
  - ★ **Dedicated funding for BU pilots projects and R&D**
  - ★ **Development of shallow-draft dredge technology** (tidal channels, reservoirs, lakes, shallow coastal areas)
  - ★ **Develop robust monitoring methods and cost-effective tracer technology**

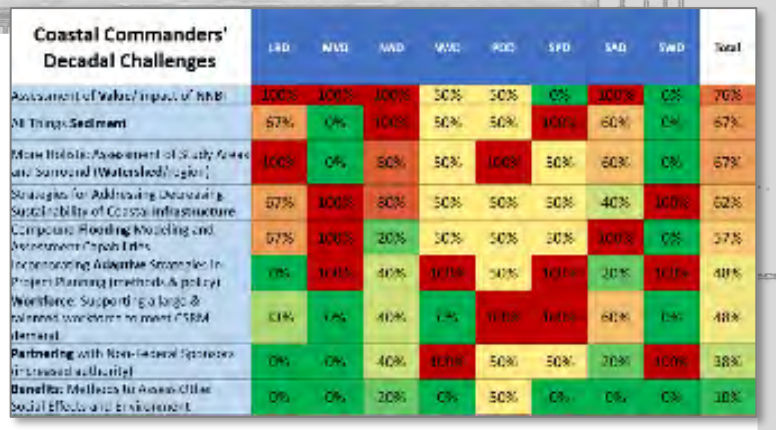
Future BCER Success



- **Challenges:**
  - Lack of fundamental R&D funding
  - Civil Works culture has shifted to tactical research
  - Expanding partnerships in the broader research community
  - Developing/implementing strategic focus
- **Research Needs & Recommendations:**
  - Document historical benefit of R&D investments
  - Establish long-term CW basic R&D funding
  - Develop basic R&D advisory/peer review advisory panel
  - ★ **Sediment transport initiative**
    - Observation → discovery → innovation
    - Theory, sensing, modeling, testbed
    - Magnet for research talent



Summary of R&D Needs



★ All Things Sediment Transport:

- Strategic initiative
  - Observation → discovery → innovation
  - Theory, sensing (tracer), modeling, testbeds (**data**), morphology
- Beneficial Use: fine sediments, wild-fire impacts



★ Pacific Coast Processes (Compound Flooding):

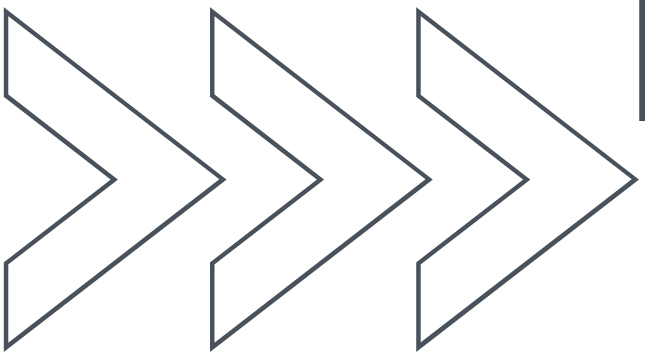
- Pacific Coastal Hazard System
- Quantification/modeling of IG waves → design & climatology
- Robust compound flooding/watershed models: surge, waves, rain, groundwater

★ Nature-Based Solutions

- Nature-based solution tools: scoping, robust models (long/short term, coupling to econ/eco/social models, testbeds)
- Provide monitoring and adaption methods/guidance
- Sustainable infrastructure



★ Commander Decadal Challenge



BOARD ON COASTAL ENGINEERING RESEARCH

Presentations Day 3

Duncan Bryant, Ph.D., P.E.

Dr. Duncan Bryant is a senior research hydraulic engineer in the Coastal and Hydraulics Laboratory. He currently leads a diverse group of researchers conducting over $12 Million a year in laboratory studies and models on topics such as Natural and Nature Based Features performance, lock and dam design, coastal structures, and military engineering solutions for force projection. Dr. Bryant is Professional Engineer in the State of Mississippi and an Adjunct Professor at Lamar University in Texas.

Dr. Bryant received his Bachelor of Science in Civil Engineering from Clemson University in 2005 with an emphasis in structural engineering. He received his Master of Science in Civil Engineering from Clemson University in 2006. In 2010, he obtained his Ph.D. from Texas A&M University in Ocean Engineering with a dissertation on coherent turbulent structures in multiphase and coastal flows.

Dylan Anderson, Ph.D.

Dylan L. Anderson received his B.A. in geophysics from Boston College, Chestnut Hill, MA, USA, in 2012, and his Ph.D. in coastal engineering from the School of Civil and Construction Engineering at Oregon State University in Corvallis, OR, USA, in 2019. In July, 2019, Dr. Anderson became an Oak Ridge Institute for Science and Education post-doctoral scholar at the U.S. Army Engineer Research and Development Center (ERDC)'s Coastal and Hydraulics Laboratory (CHL), located at the Field Research Facility (FRF) in Duck, NC, USA. After a subsequent post-doc in 2021 in North Carolina State University's Coastal Engineering Lab, Dr. Anderson returned to the FRF in 2022 to begin his current position as a Research Civil Engineer. His research interests are in coastal change prediction on short- and long-term timescales, with experience using multiple remote sensing platforms, numerical models, and machine learning methods. Dr. Anderson's recent research projects have focused on developing a climate emulator for stochastic coastal modeling and hazard prediction, including applications to shoreline change prediction, life-cycle modeling of natural and nature-based features, and multi-decadal retreat of Arctic tundra and permafrost bluffs. His data-informed workflows are also trained by his projects focusing on observations of coastal change, which include space-based bathymetry and shoreline change observations, as well as shore-based lidar and camera deployments. Dr. Anderson is an original member of the Coastal Imaging Research Network's Software Committee, a collaborator with leading academics worldwide, and has published in Geophysical Research Letters, Earth's Future, the Journal of Geophysical Research, and Remote Sensing.

Update on CHL's Artifical Intelligence/Machine Learning in Coastal Engineering Activities

Dr. Dylan Anderson (ERDC-CHL)

The Board on Coastal Engineering Research (BCER) was recently briefed on "Machine Learning and Artificial Intelligence in Coastal Applications" in August 2023. The brief introduced typical artificial intelligence (AI) and machine learning (ML) use cases and highlighted three examples of ML use within CHL through the SandSnap, CoastSat, and Coastal Hazards System (CHS) work units. In the last year, the use of AI and ML within CHL, ERDC, the Department of Defense (DoD), and the broader scientific community has continued to expand. The DoD released a *Data, Analytics and Artificial Intelligence Adoption Strategy* in November 2023, recognizing the importance of such workflows in future military and civilian mission spaces.[1] ERDC's *R&D Strategy: Connecting the Dots to Innovation* was similarly released in 2023 and emphasized the use of AI and ML for revolutionizing and accelerating decision making across the organization.[2] A draft charter is actively being written for an ERDC "AI/ML Community of Interest", with representatives across ERDC labs.

With respect to the specific discipline of coastal engineering, the use of AI/ML workflows has increased exponentially in the last decade.[3] USACE-CHL presently supports several research programs actively developing and deploying such workflows. Specific applications within CHL include a non-exhaustive list of shoreline extraction from imagery, stream flow model calibration, rapid storm water level flooding predictions, estimating dredging needs in shoaling inlets, probabilistic dune evolution, nearshore wave downscaling, and remotely-sensed bathymetry prediction. The uses of ML within these efforts notably also span a range of implementations; metamodeling (slower numerical models are replaced by a more efficient emulator), object detection and feature extraction from remotely sensed products, multi-sensor and multi-model data fusion, super-resolution from sparse information, and process-based inferences from big data. These workflows are improving efficiency either by increasing processing speed or by removing the need for costly human perception.

Several mature tools experienced further enhancement in the last year. This includes a peer-reviewed publication of a update to the SandSnap tool, which is an interactive web app that automates the measurement of grain size distributions from citizens and USACE employees alike.[4] Another peer-reviewed publication demonstrated an automated extraction of wave runup time series from LiDAR data, removing what would have required thousands of hours of manual digitization and quality control.[5] A tool known as the Satellite Shoreline Mapper (SSM) was disseminated to district users at the November 2023 Coastal Working Group, which uses an ML image segmentation classifier as the core functionality in extracting frequent shorelines from publicly available satellite databases. Advances to this tool included an ML-classifier to identify quality shoreline extractions, which removed the need for a human to inspect each image and enabled its distribution to non-expert users within the Littoral Zone Maneuver Support Tool (LZMST). Manuscripts were also submitted for an ML-enabled rapid calibration of streamflow model parameters,[6] as well as an efficient framework for stochastic modeling of future dune evolution that uses an

ML model to generate synthetic future waves and winds.[7]

Ongoing workflow developments include super resolution satellite image enhancements, sediment load forecasting for dredging in ungauged watersheds, gap-filling of legacy USACE records, decision tools to support autonomous robotic deployments, segmentation of synthetic aperture radar satellite data to see shorelines through clouds, and data-informed predictive models for beach morphology change. Forecasting efforts are working on probabilistic predictions of stream flow, wave and water level time series, as well as multi-decadal Arctic tundra and permafrost retreat. Physics-informed metamodels are being developed to imitate numerical process-based circulation models, and the CHS team is developing ML methods to use sub-domains that would greatly reduce the compute cost for district projects.

ML and AI will continue grow in their presence within CHL's coastal engineering activities. CHL is particularly well suited for taking advantage of data-informed insights gained by applying ML; the Field Research Facility is recording a wealth of extended observations of complex phenomena (550 TB), and the Coastal Hazards System has 7 PB of synthetic data. More broadly, engineers will use AI such as the Army-specific large-language model CAMO-GPT released in May 2024 to accomplish daily tasks ranging from writing, debugging, and explaining code to harvesting data from the database of historical USACE dredge reports.

Despite this momentum, the use of ML is nascent and there are numerous questions surrounding its use in CHL. It is recommended that dedicated efforts develop documentation for proper use and governance of ML within CHL workflows. This includes internal standards for evaluating ML model quality that are analogous to terms used to evaluate process-based models, as well as training in the ethical use of ML outputs. It is also recommended that effort is dedicated to updating current CHL tools to languages that enable a wider range of ML abilities. For instance, CHS is seeking funds to translate Matlab codes to Python workflows to remove memory limitations, enable cloud computing, and take advantage of open-source ML architectures. Recruitment of new employees with the skill sets to develop ML workflows, or to understand the under-lying methods before using their outputs, will be critical.

References

[1] United State of America Department of Defense. *Data, Analytics, and Artificial Intelligence Adoption Strategy: Accelerating Decision Advantage*. 27 June 2023.

[2] Buchanan et al. *ERDC RD Strategy: Connecting the Dots to Innovation*. 2023.

[3] Abouhalima et al. *Mach. Lear. in Coastal Eng.* JMSE, 12(4), 2024.

[4] McFall et al. *SandSnap: Measuring Beach Grain Size*. Coast Eng, 104554, 2024.

[5] Collins et al. *Automated ... Wave Runup*. IEEE Tran on Remote Sens, 61, 2023.

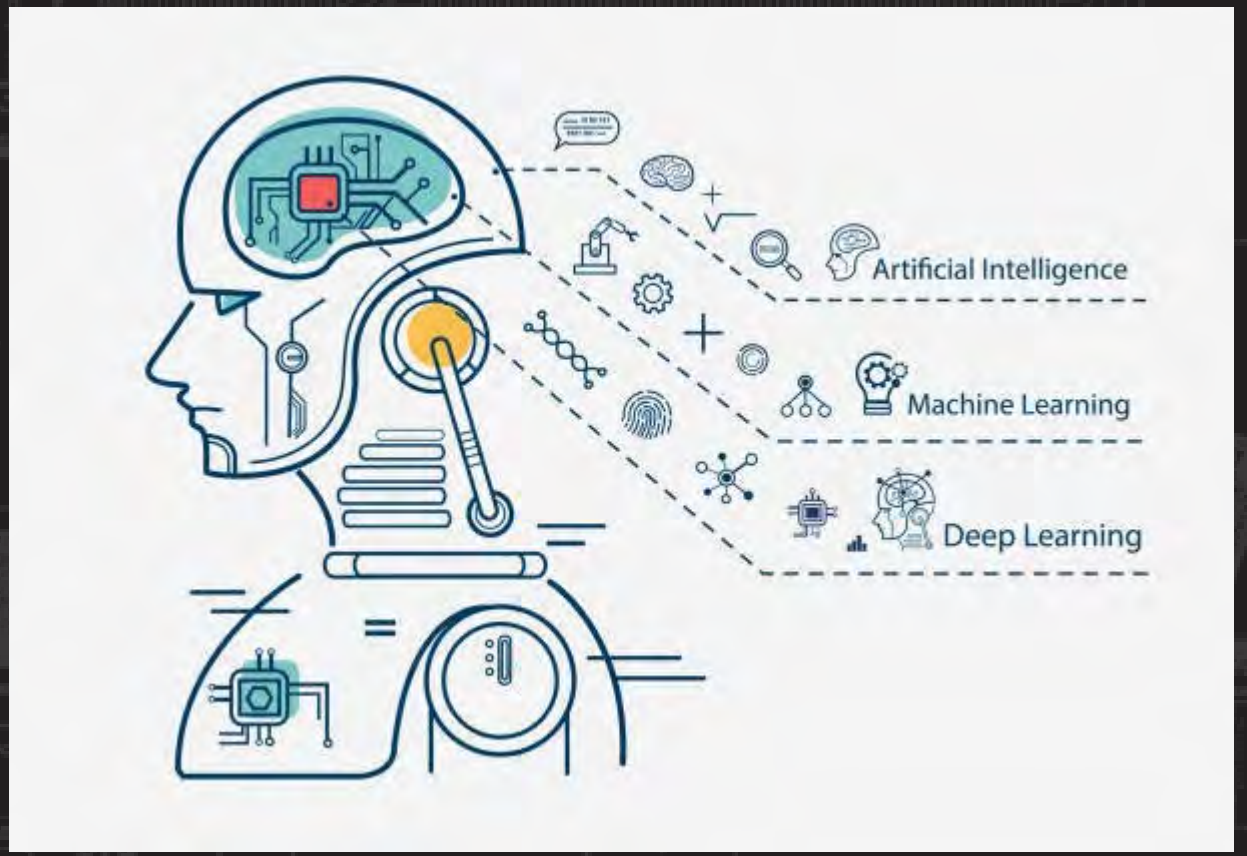
[6] Zhao et al. *ML-enabled ... calibration*. J. of Hydroinformatics, Submitted.

[7] Cohn. *Projecting coastal foredunes*. JGR:Earth Surface, Submitted.

UPDATE ON CHL'S ARTIFICIAL INTELLIGENCE & MACHINE LEARNING IN COASTAL ENGINEERING ACTIVITIES

Dr. Dylan Anderson
Dylan.L.Anderson@usace.army.mil

15 AUG 2024



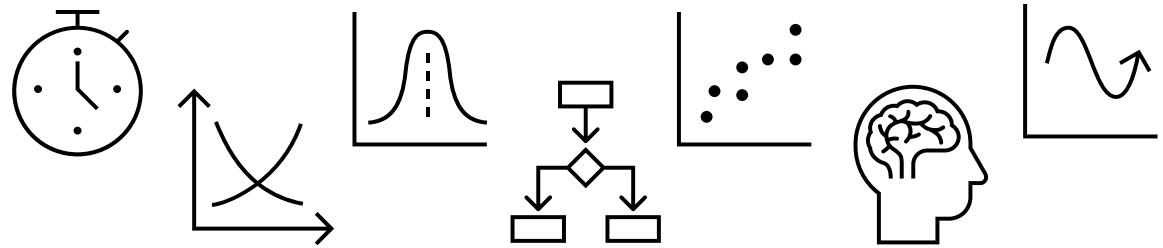


U.S. ARMY
US Army Corps of Engineers
ERDC

USE CASES & IMPLEMENTATIONS

BLUF: Chris Massey's presentation at the Aug 2023 BCER introduced ML algorithms. How are CHL researchers using and applying these workflows?

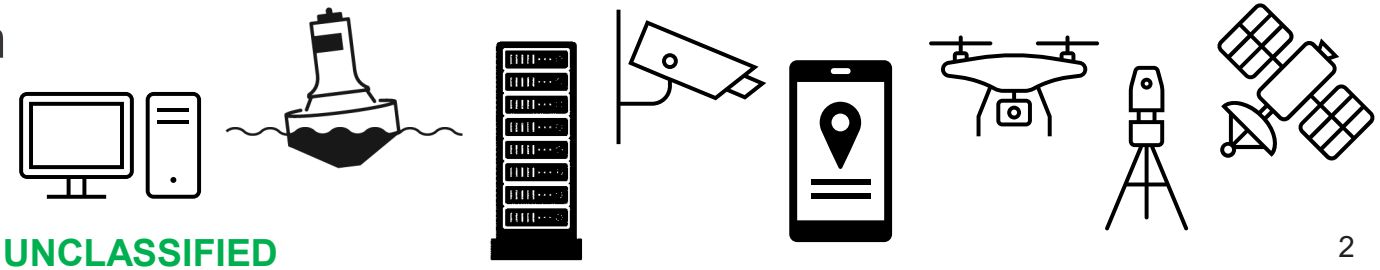
- Computation efficiency, defining uncertainty, signal-in-the-noise, forecasting, downscaling, calibration, hierarchical choices, human decisions:



- Flooding, streamflow, waves, circulation, dredging needs, shoreline change:



- A wide range of training data sources both observational and synthetic (models):



UNCLASSIFIED

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Traditional problem solving is an exact mapping:

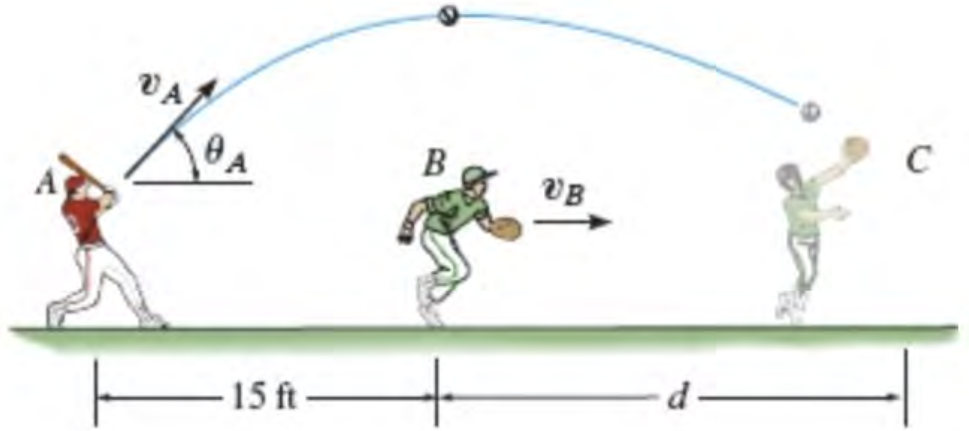
Inputs:
Forces
Boundary Conditions

→

Physics:
Laws of Motion

→

Outputs:
Predictions



ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

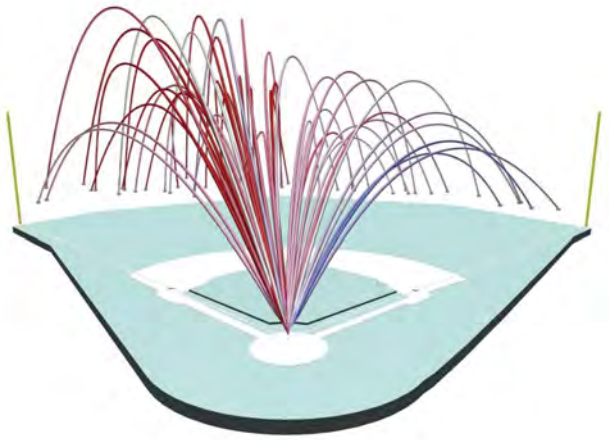
But alternate “mappings” can be inferred:

Inputs:
Forces
Boundary Conditions

→ Physics:
Laws of Motion →

Outputs:
Predictions

↘ Learned Experience ↗



ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

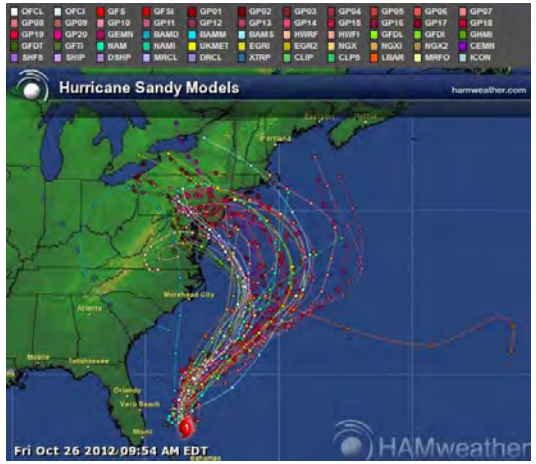
ERDC

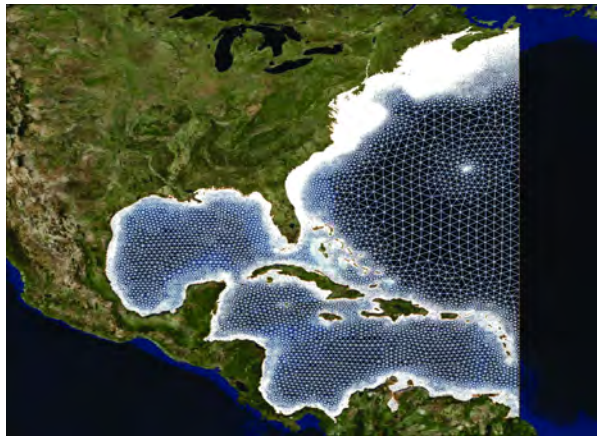
With efficiency compounding for large problems:

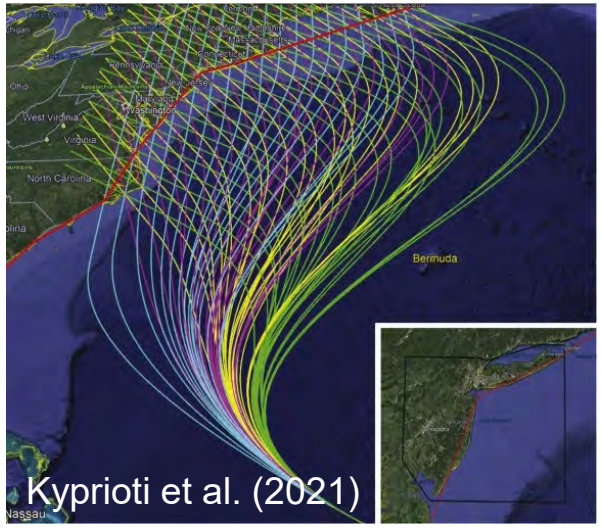
Inputs:

Forces

Boundary Conditions

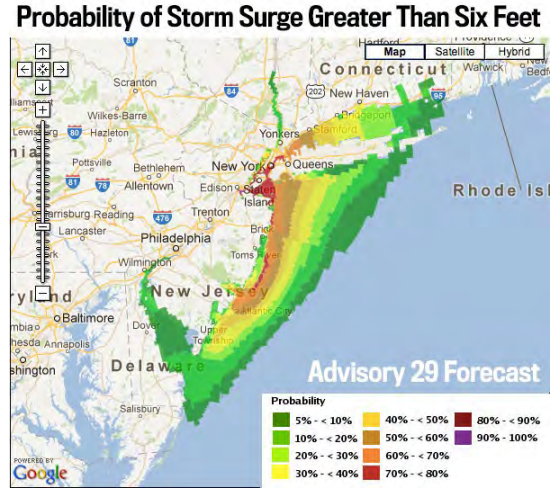






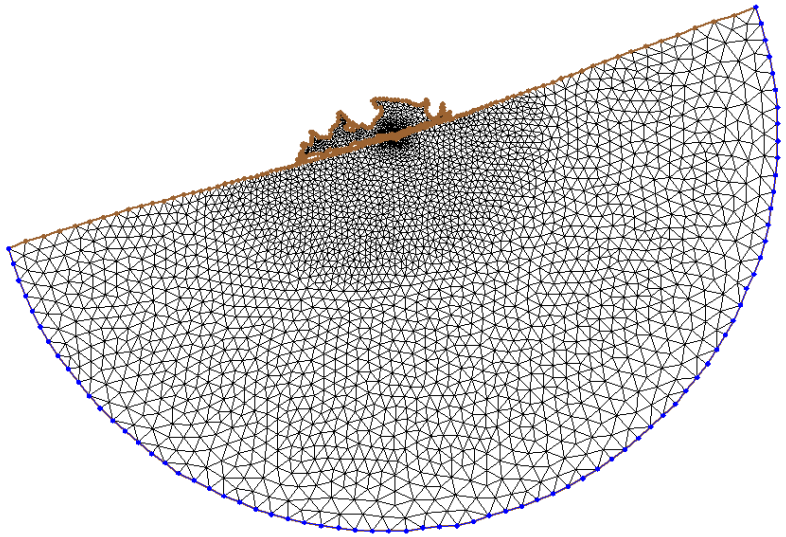
Outputs:

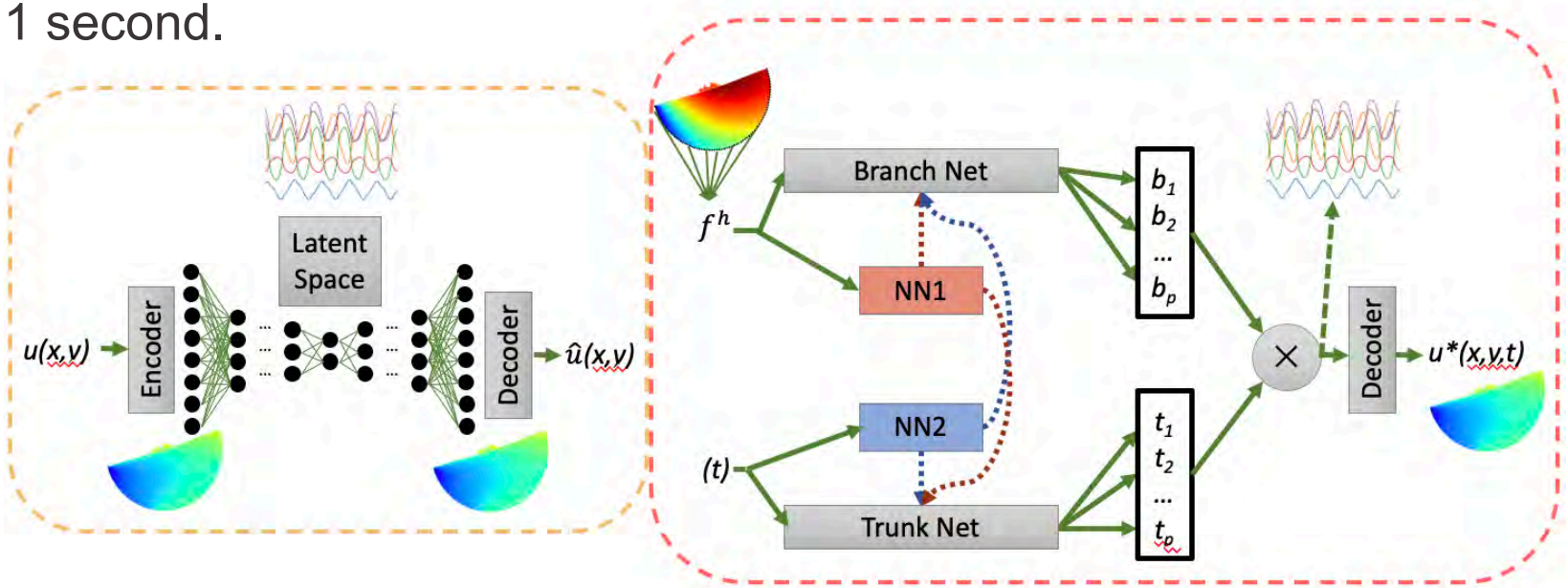
Predictions



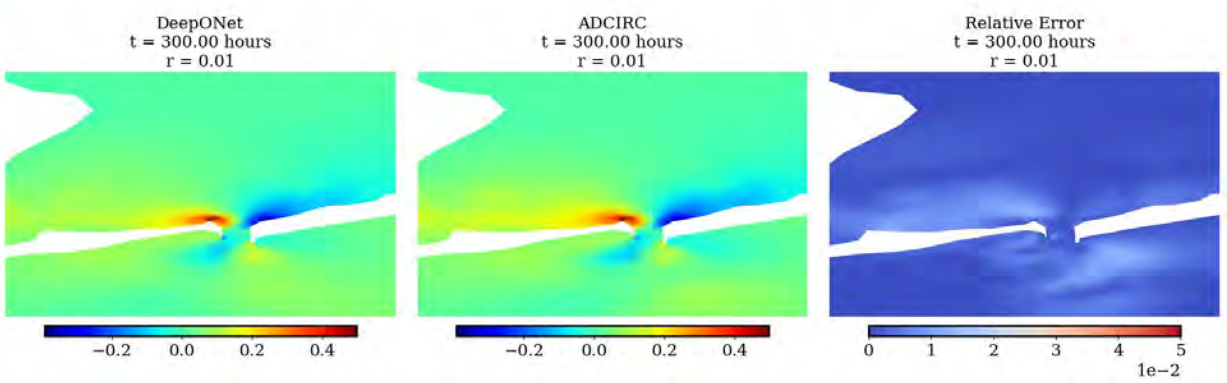
METAMODELS: COMPLEX CIRCULATION

- Intermediary steps learn solution to equations of motion at every node in the model domain
- Reduces hours of computation to 1 second.
- Reconstructing full resolution of U, V, and water level.





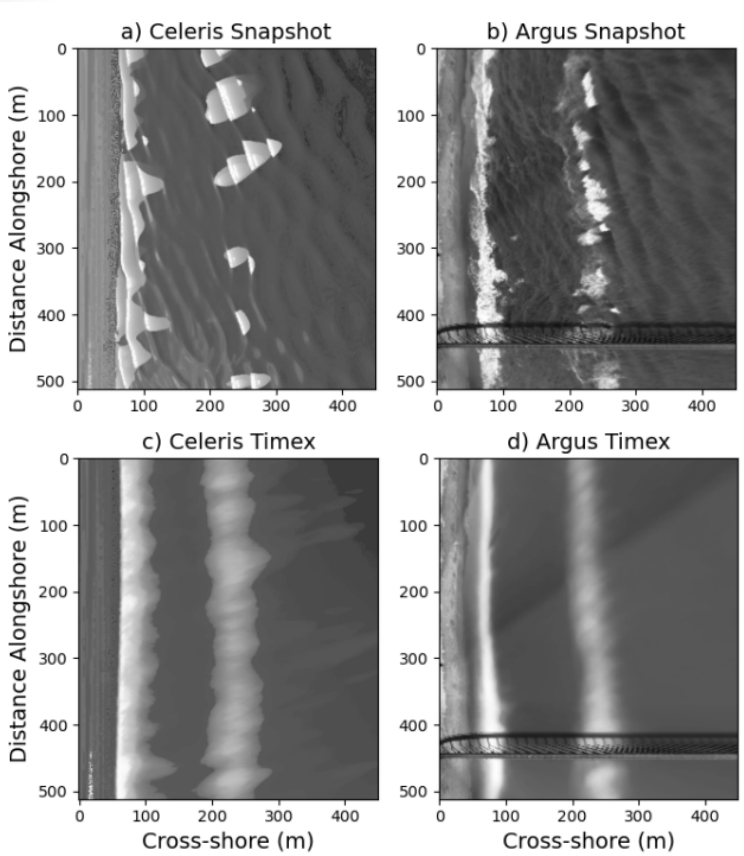
U - Velocity



Matthew Farthing (Matthew.W.Farthing@usace.army.mil)
Sourav Dutta (Sourav.Dutta@usace.army.mil)
Peter Rivera-Casillas (Peter.G.Rivera-Casillas@usace.army.mil)

METAMODELS: BATHYMETRY INVERSION

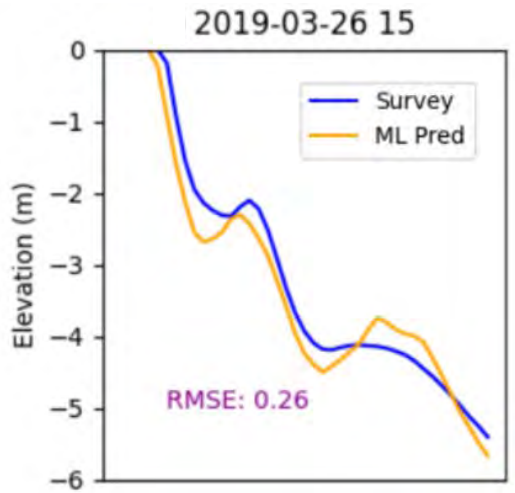
- Trained an ML-model that takes synthetic “images” created by nearshore process-based model Celeris and maps to the underlying bathymetry. Can be deployed to District monitoring efforts.

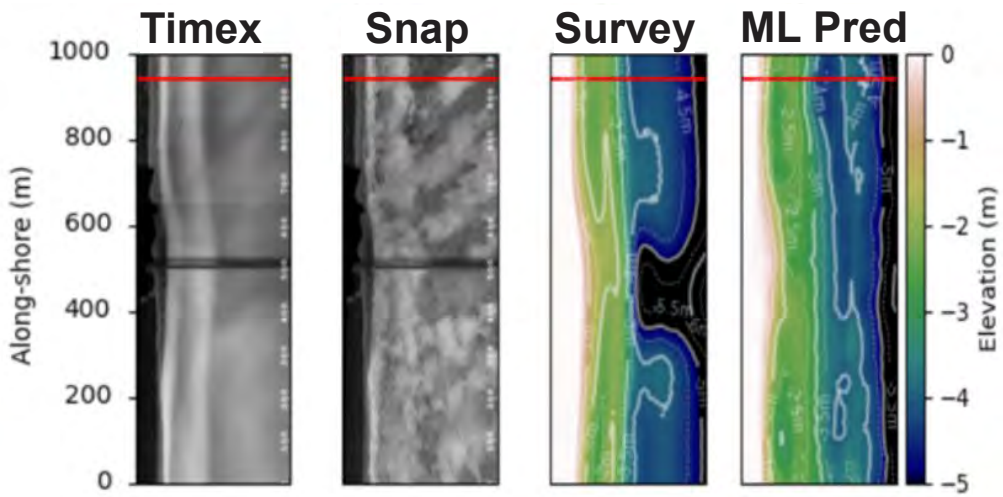


Article

Bathymetric Inversion and Uncertainty Estimation from Synthetic Surf-Zone Imagery with Machine Learning

Adam M. Collins [1,2,*], Katherine L. Brodie [1], Andrew Spicer Bak [1], Tyler J. Hesser [3], Matthew W. Farthing [3], Jonghyun Lee [4] and Joseph W. Long [2]





METAMODELS: SHOALING DATA

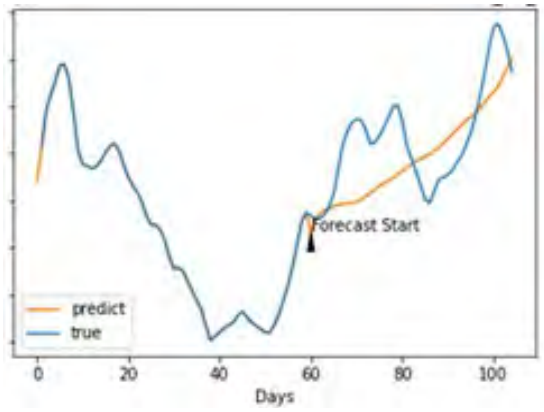
- Given enough historical observations, short-term dredging needs can be predicted based on up-river conditions

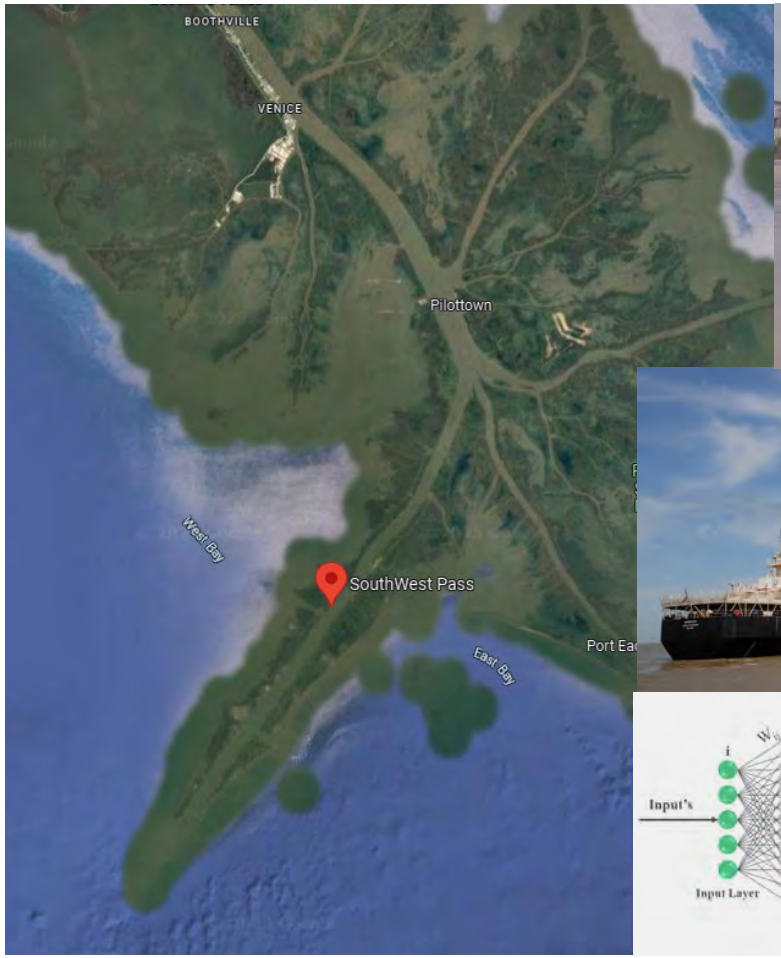
- 69 Stations observed for Stage, Discharge, Turbidity, Air & Water Temperature, Relative Humidity, Precipitation



- 48 Potential model input variables from 38 stations are available moving forward

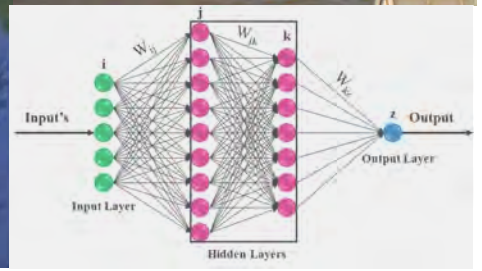
45-day shoaling prediction:









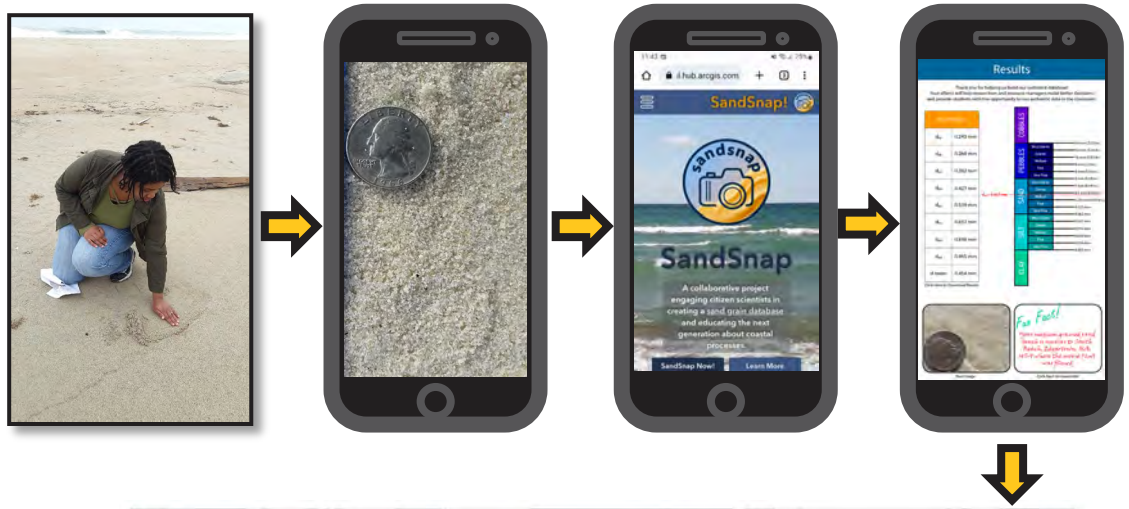


Ned Mitchell (Kenneth.N.Mitchell@usace.army.mil)
Magdalena Asborno (Magdalena.Asborno@usace.army.mil)
Michael Hartman (Michael.A.Hartman@usace.army.mil)
Lauren Dunkin (Lauren.M.Dunkin@usace.army.mil)

SEGMENTATION: SANDSNAP

- Interactive web app. for citizen science to measure grainsize distributions with two ML algorithms.
- Publication in *Coastal Engineering*'s March 2024 issue.

Brian McFall (Brian.C.McFall@usace.army.mil)
David Young (David.L.Young@usace.army.mil)



Coastal Engineering 192 (2024) 104554

Contents lists available at ScienceDirect

Coastal Engineering

journal homepage: www.elsevier.com/locate/coastaleng

SandSnap: Measuring and mapping beach grain size using crowd-sourced smartphone images

Brian C. McFall [a,*], David L. Young [b], Shelley J. Whitmeyer [c], Daniel Buscombe [d], Nicholas Cohn [b], Jacob B. Stasiewicz [e], Janelle E. Skaden [b,1], Brooke M. Walker [a], Shannon N. Stever [a]

[a] Coastal & Hydraulics Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS, USA
[b] Coastal & Hydraulics Laboratory-Field Research Facility, U.S. Army Engineer Research and Development Center, Duck, NC, USA
[c] James Madison University, Harrisonburg, VA, USA
[d] Marda Science, LLC, Santa Cruz, CA, USA

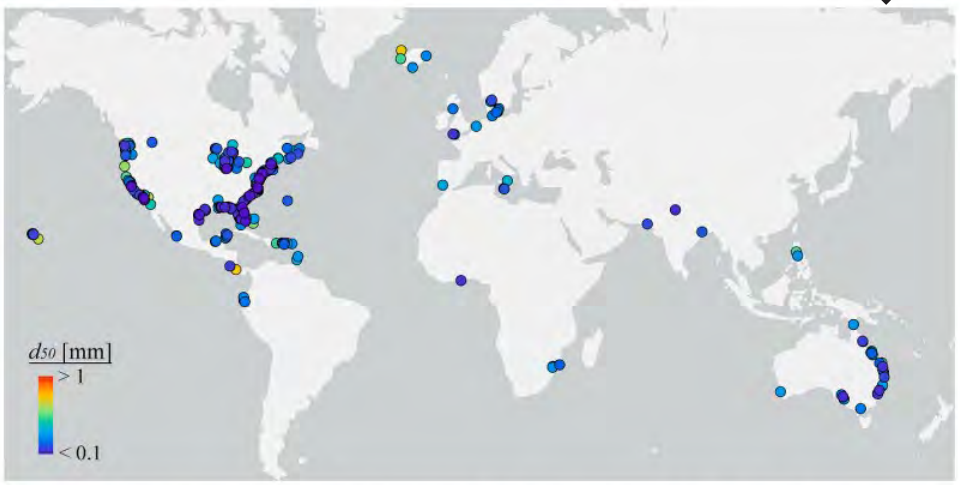


Fig. 6. Locations of SandSnap submissions in the global database as of 24 March 2024.

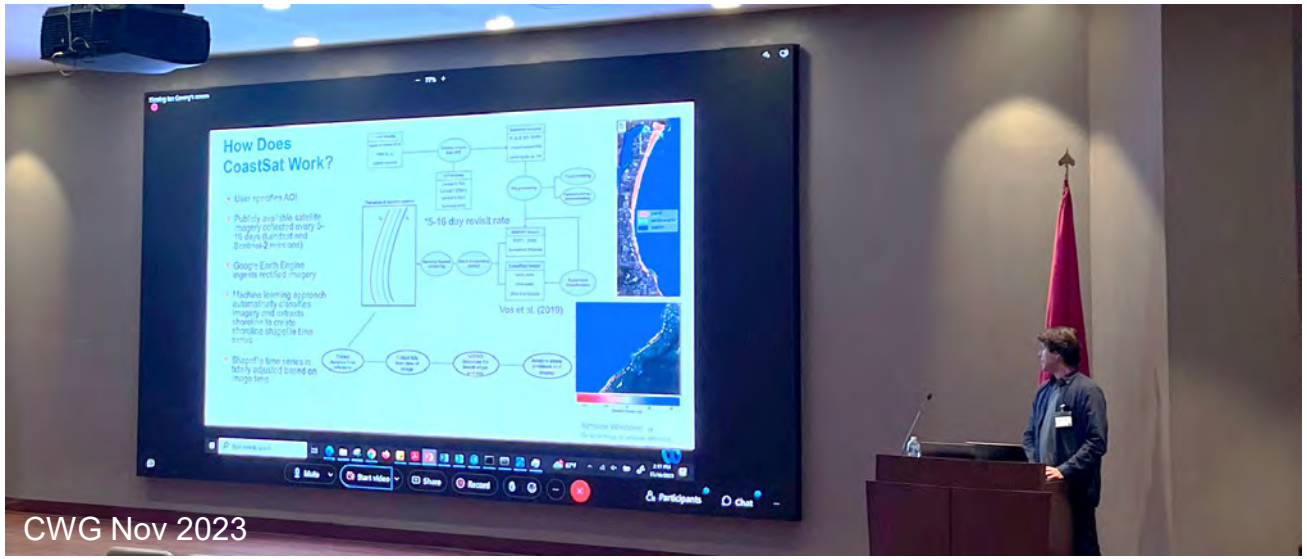
sandsnap-erdcchl.hub.arcgis.com

SEGMENTATION: COASTSAT

- Automated segmentation of satellite images.

- Distribution of the *Satellite Shoreline Mapper* (SSM) tool to USACE Districts. Presented at the *Coastal Working Group* in November 2023.

Ian Conery (Ian.W.Conery@usace.army.mil)
Shannon Brown (Shannon.M.Brown@usace.army.mil)





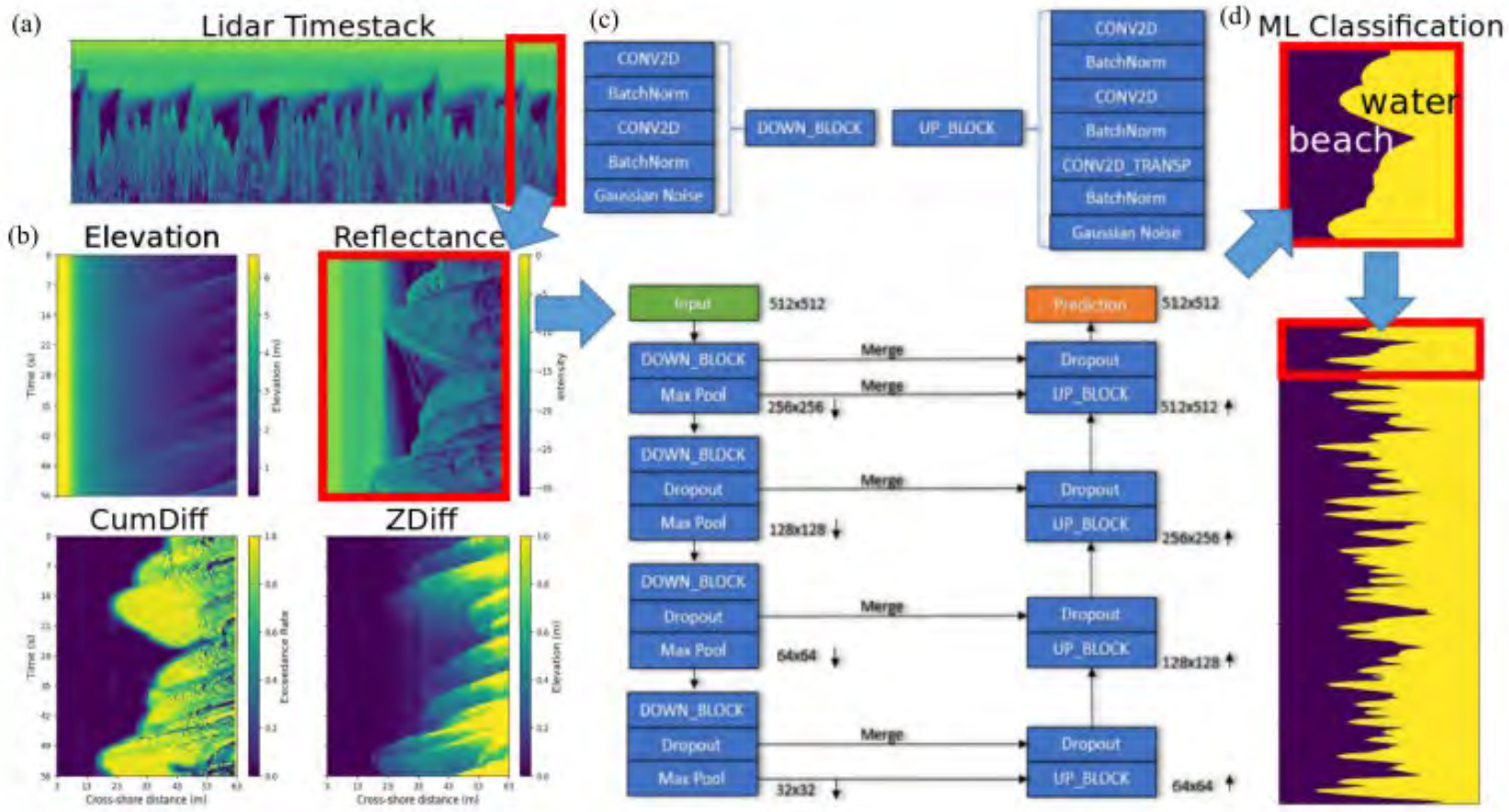
- Integrated into the *Littoral Zone Maneuver Support Tool* (LZMST) with a second ML model to remove the need for human judgement of a "good" shoreline.

Adam Collins (Adam.M.Collins@usace.army.mil)

SEGMENTATION: RUNUP PROCESSING

- Removing the human perception needed to QA/QC the true line between wave runup and wet sand within the swash zone.
- Saving 1000s of hours of back processing and enabling live products pushed to the public server.

Adam Collins (Adam.M.Collins@usace.army.mil)
Katherine Brodie (Katherine.L.Brodie@usace.army.mil)
Ty Hesser (Tyler.Hesser@usace.army.mil)
Spicer Bak (Spicer.Bak@usace.army.mil)
Matthew Farthing (Mathew.W.Farthing@usace.army.mil)

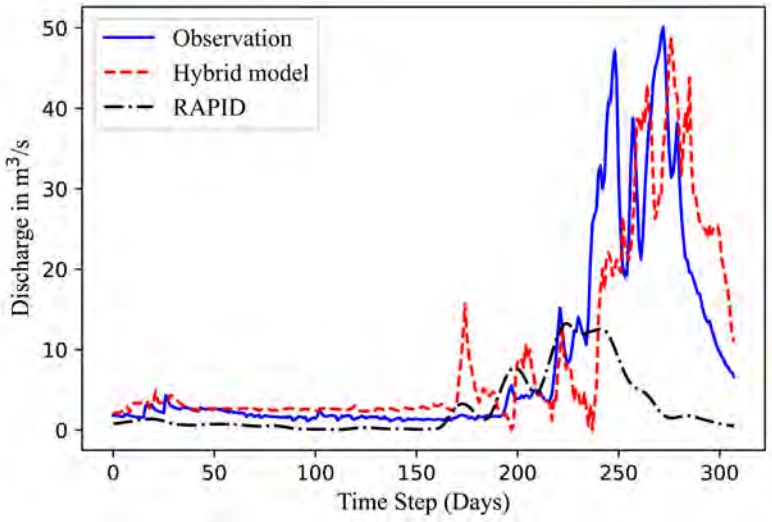


UNCLASSIFIED

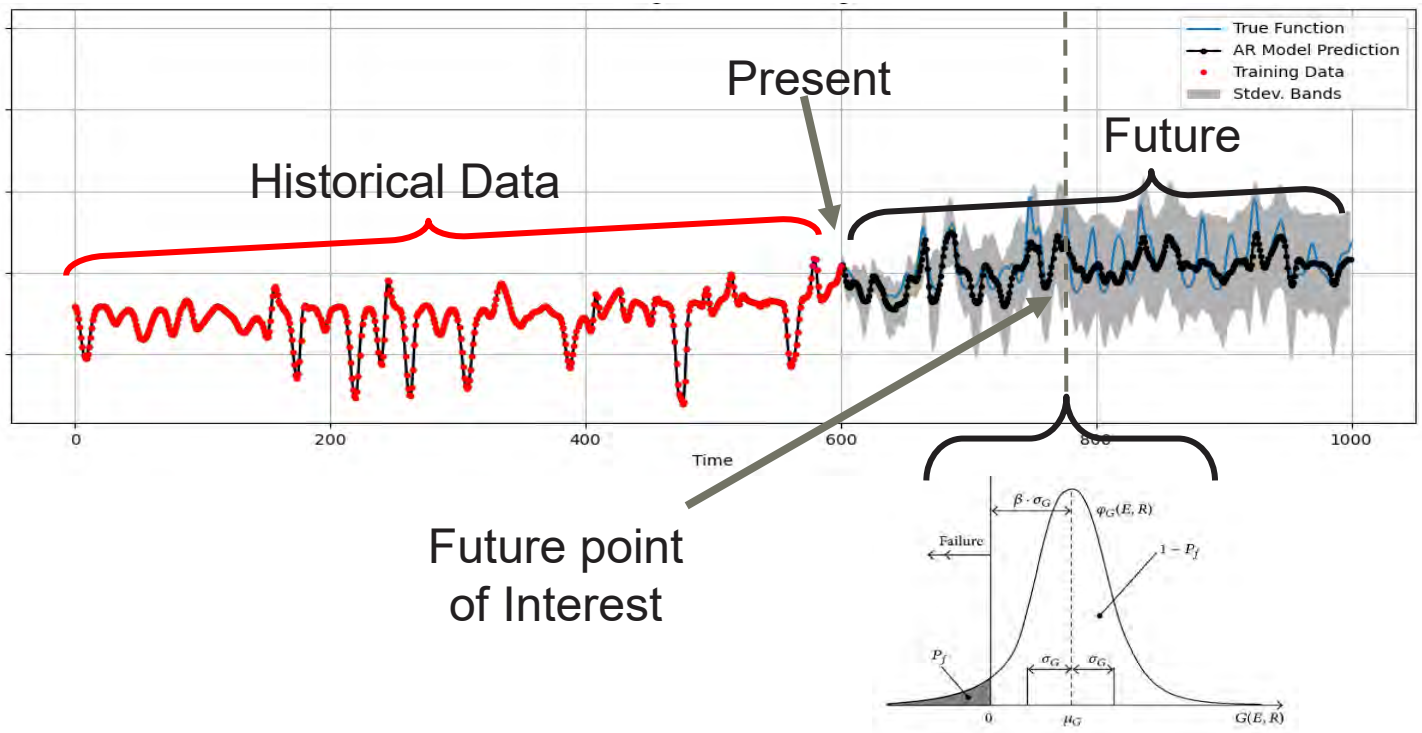
FORECASTING: STREAMFLOW

Large discrepancy between physics-based RAPID prediction and real-world observations leads to non-optimal decision making and thus economic losses.

ML-enable calibration of RAPID model parameters coupled with hybrid modeling to recover unresolved physics



Probabilistic predictions including uncertainty

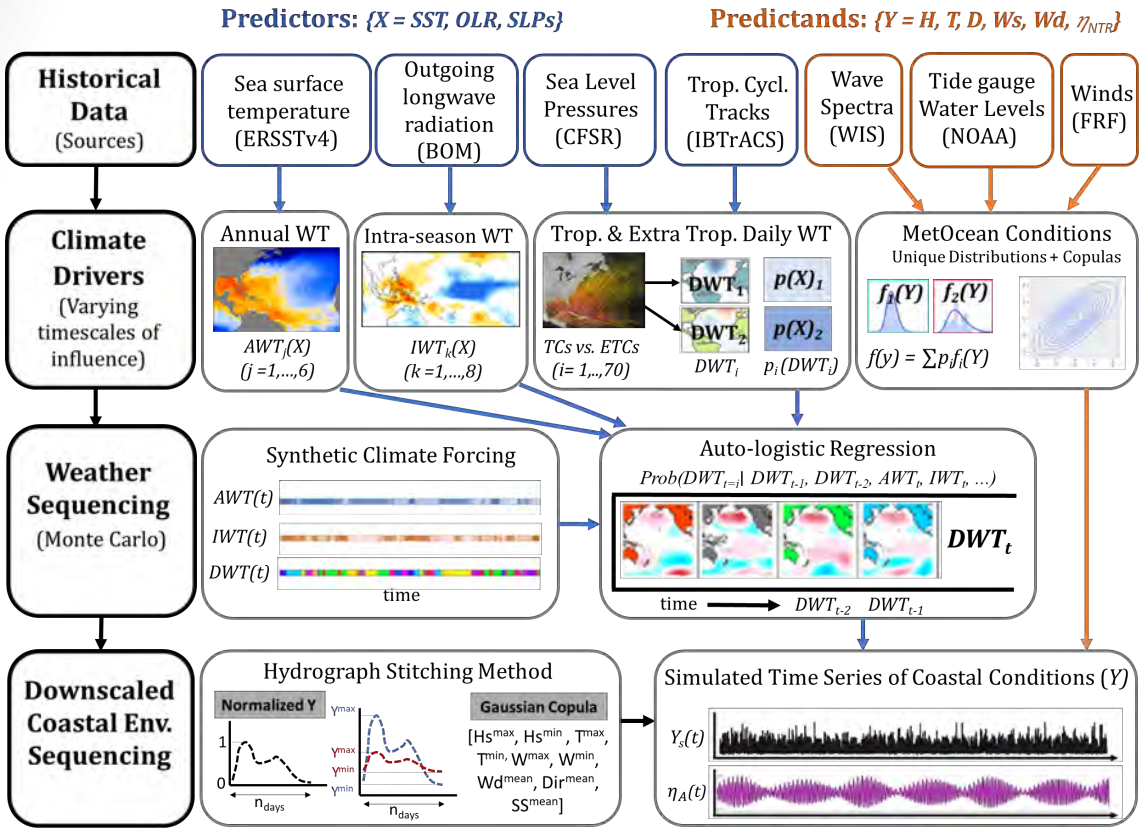


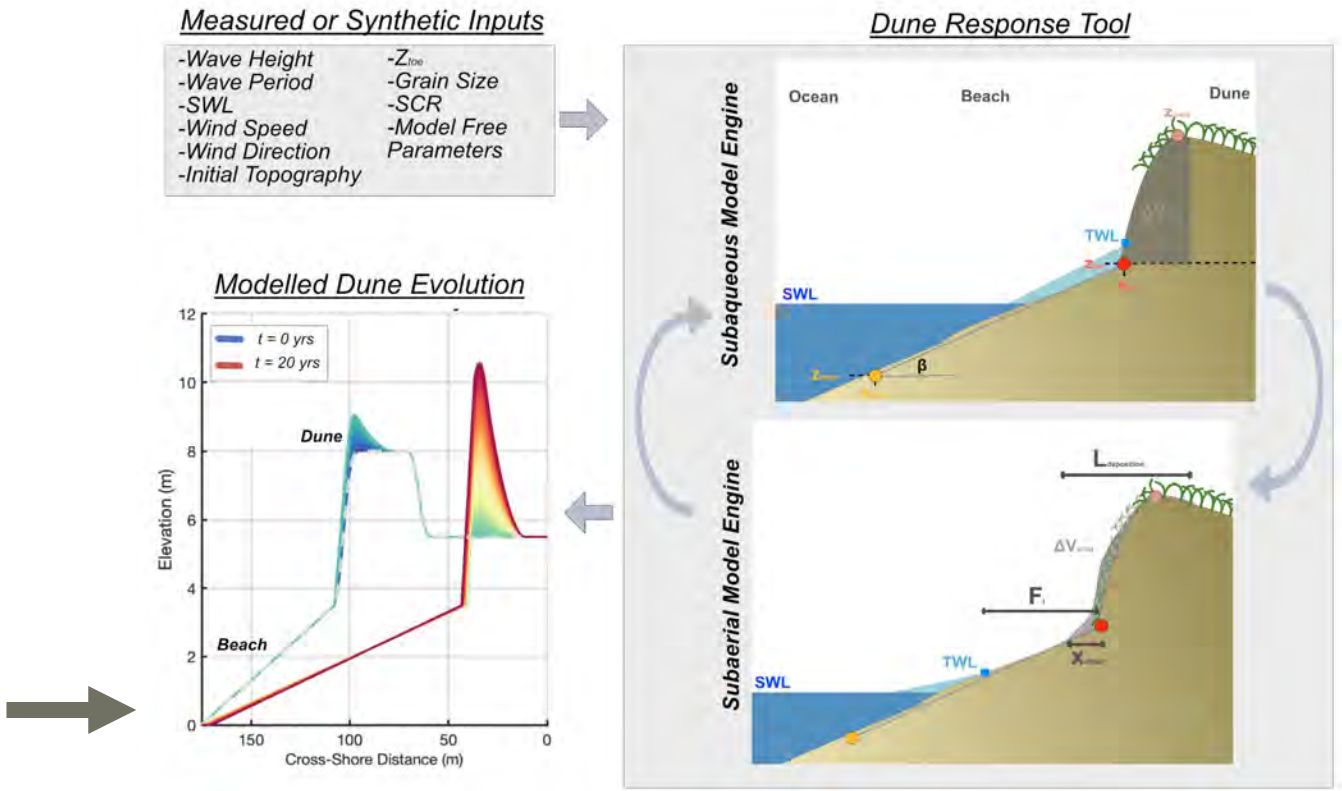
Gaurav Savant (Gaurav.Savant@usace.army.mil)
Jared McKnight (Charles.J.McKnight@usace.army.mil)
Natalie Memarsadeghi (Natalie.P. Memarsadeghi @usace.army.mil)
Julia Zimmerman (Julia.B.Zimmerman@usace.army.mil)

FORECASTING: DUNE EVOLUTION

- Stochastic dune evolution driven by synthetic time series of met-ocean conditions. Can be useful in understanding the longevity of NNBF efforts.

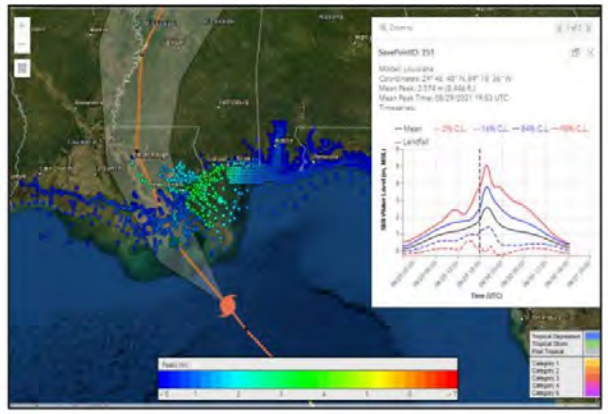
Nicholas Cohn (Nicholas.T.Cohn@usace.army.mil)
Dylan Anderson (Dylan.L.Anderson@usace.army.mil)





COASTAL HAZARDS SYSTEM

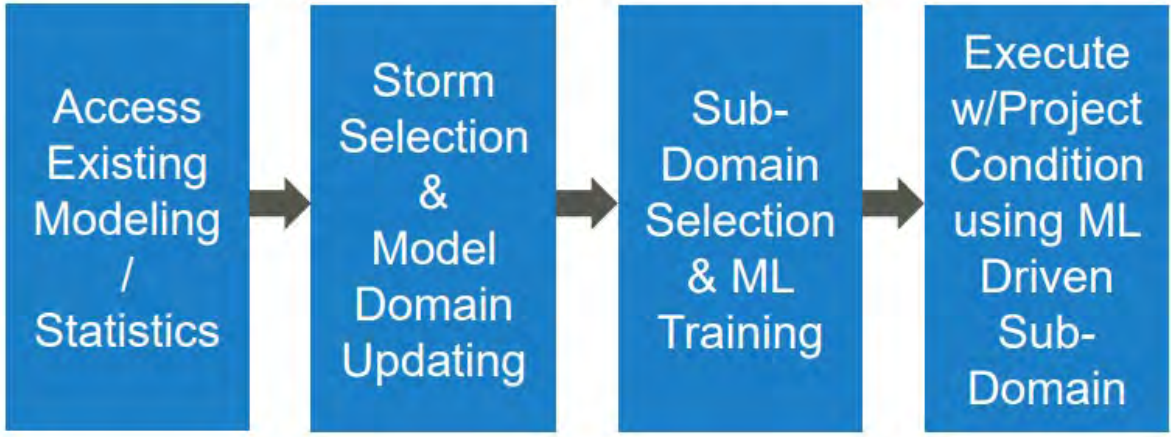




Working on a Rapid Prediction WEBTOOL:

- On the fly prediction of hurricane impacts.
- Relies on surrogate models trained on the database of storm simulations within CHS.
- ML models enable output at all nodes
- Output will be applicable to other applications (i.e. coupling to downscaled consequence models)

Future ML Enabled CSRM Workflow



- Future goal of ML-enabled sub-domain models to reduce the compute cost of project needs.
- Significant push to modernize code architecture by moving from Matlab to Python:

- Overcome memory constraints
- Enable cloud computing

OTHER EFFORTS…

Research teams are actively working on:

- **Super-resolution** in time and space (enhancing the data we do have).
- **Satellite image segmentation** to Synthetic Aperture Radar (SAR) for use through clouds and in high latitudes.
- **Rapid Downscaling** of WIS waves to nearshore locations for inputs to GENCADE, CSHORE, etc.
- Surface and underwater **autonomous robotic deployment** and data collection.
- Reduced-physics for **beach recovery**.
- **Bed classification** from imagery.
- **Streamflow prediction** in watersheds without gauges.
- Automated **data harvesting** from USACE's historical dredging records with LLMs.



SUMMARY OF R&D GAPS AND RECOMMENDATIONS

CHL is ideally placed to take advantage of the "AI revolution"

- **Data fusion** and **data-informed** models:
  - 500 TB of real-world observations collected at the Field Research Facility, Duck, NC
  - 7 PB of CHS model simulations
  - Exponentially growing data volumes from increase in affordable technology.

All future researchers will encounter AI/ML in their day-to-day job!

- CAMOGPT - Army's Artificial Intelligence Integration Center (AI2C) Large Language Model will help with emails, coding, reports, and much more...

But it's still early…

- A draft charter for ERDC's AI/ML "Community of Interest" is being written…
- Traditional tools will need to be modernized to take advantage of AI/ML capabilities.

Need guidance on proper use/governance:

- Consistent language/metrics to evaluate the accuracy of ML models prior to transfer to end-users.
- Training on the ethical development of ML, and the ethical use of ML outputs

Need dedicated recruitment of AI/ML/Data scientists to support the rapidly growing project needs.

Jeff Strahan

Currently, Jeff serves as a senior economic policy advisor at the headquarters for the US Army Corps of Engineers with 25 years of service. He is responsible writing policy, developing implementation guidance and advises several HQ level committees and boards including the Change Control Board and various steering committees. He also meets with outside organizations including the National Academies, NAFSMA and AAPA.

Prior to working as a policy advisor, he worked in the Office of Water Project Review, as the Economics Team Leader conducting policy and legal compliance reviews on decision documents. He was a member of the Dam Safety Oversite Group, FDA steering committee (still is) and advised the Change Control Board (still does). Jeff also served as an Economics Regional Technical Specialist in the Norfolk District within the North Atlantic Division before working at HQ. His duties included economic analyses, project management and plan formulation for deep draft navigation, flood risk management, coastal storm damage reduction, and ecosystem restoration. He also served on agency technical review teams as a reviewer and leader. He is a member of the 2008 Planning Associates class.

Jeff earned a Bachelor's of Arts in Economics from the University of South Alabama in Mobile, Alabama. He lives with his wife, son and daughter in Woodbridge, VA. His hobbies include playing golf, brewing beer, fishing, boating and traveling with his family.

BCER - AGENCY SPECIFIC PROCEDURES UPDATE

Jeff Strahan
Senior Economic Policy Advisor
HQUSACE







U.S. ARMY

US Army Corps of Engineers®

HOW DID WE GET HERE?

Key laws and policies in the evolution of national water resources planning

1903 Rivers and Harbors Appropriations Act

Consider benefits of water resources investments to their costs

1936 Flood Control Act

Improve navigable waters/tributaries for flood control if benefits exceed the costs

1965 Water Resources Planning Act

Principles, standards, and procedures for Federal participants in the preparation of comprehensive regional or river basin plans and for the formulation and evaluation of Federal water and related land resources projects

1973 Principles and Standards

Introduced two objectives of National Economic Development and Environmental Quality

1983 Principles and Guidelines

Contribute to national economic development – constrained by environmental protection and compliance

What are the Principles, Requirements and Guidelines?

Goals

Together the Principles and Requirements (2013) and Interagency Guidelines (2014) are called the **Principles, Requirements and Guidelines**.

Emphasize that water resources projects should

- **maximize economic development**,
- **avoid the unwise use of floodplains**, and
- **protect and restore natural ecosystems**.

Support water infrastructure projects with the **greatest public benefits (economic, environmental, and social benefits)**.

Section 110 of the Water Resources Development Act of 2020 directs the Army to issue its final Agency Specific Procedures necessary for the USACE Civil Works program to implement the PR&G.

Why are “We” Pursuing Rulemaking?

In 2014 the Council on Environmental Quality directed the development of agency specific procedures by water resources agencies.

USDOI, USDOA, USDOC, EPS, FEMA, and TVA have Agency Specific Procedures.

The Assistant Secretary of the Army for Civil Works has proposed a rule to create Agency Specific Procedures for the Corps to implement the Principles, Requirements & Guidelines

The draft rule responds to congressional direction provided in authorizing language in the **Water Resources Development Act of 2020 (Section 110)**.

> *“PUBLIC REVIEW, NOTICE, AND COMMENT.—In issuing, reviewing, and revising the procedures required by this section, the Secretary shall—*
>
> *(1) provide notice to interested non-Federal stakeholders of the Secretary’s intent to revise the procedures;*
>
> *(2) provide opportunities for interested non-Federal stakeholders to engage with, and provide input and recommendations to, the Secretary on the revision of the procedures; and*
>
> *(3) solicit and consider public and expert comments.*

- Pursuing rulemaking **demonstrates a commitment** to the Principles, Requirements & Guidelines
- The rulemaking process **ensures robust and meaningful Tribal and public engagement**
- Rulemaking makes the implementing procedures more durable

ROLL-OUT STRATEGY: ACTIONS TO INTRODUCE THE AGENCY SPECIFIC PROCEDURES

Purpose	Intent	Actions	Timing
U.S. ARMY **Introduce the Framework**	Describe the new procedures and set the context of how planning is evolving.	Announce the Agency Specific Procedures in multiple venues: • Publications (Hot Topics, Planning Ahead, Staff Notes, and Toolbox) • Webinars (PCoP series) • PCOP email from Mr. Bush • Learning sessions (office hours, book clubs) • Meetings (PAB, Sr. Formulators, Env Chiefs, Econ Sub-CoP, MSC calls).	Late 2023
Build Awareness of the Framework	Create an understanding of the new planning procedures. **WE ARE HERE**	Present webinars and publish articles to explain the changes in planning procedures, define new terms, and reinforce expectations and intended outcomes. This element of the strategy needs to outline the timing of events to introduce and apply the new framework.	Spring 2024
Issue New Guidance to Support Application of the Framework	Synchronize planning guidance with the new framework.	The rulemaking will require the Corps to update many guidance documents to conform with the new framework's requirements. Guidance to be updated includes ER 1105-2-103, the new Engineer Pamphlets with business-line planning procedures, & various manuals. The large volume of guidance may warrant the issuance of interim guidance to support teams while more detailed revisions are developed.	Fall 2024
Educate and Train Corps Teams	Provide planners the understanding and skills to apply the procedures.	Employ a full suite of training activities and methods to deliver insight and create expertise. Use standing venues such as webinars, workshops, and sub-CoP meetings to spread knowledge. Produce a series of podcasts and short video vignettes to convey training information.	Winter 2024
Set Implementation Timeframes	Establish a schedule for planners to begin using the procedures.	Clearly detail the timing of actions to begin applying the new procedures. The time required for formal rulemaking creates uncertainty that needs to be addressed and managed.	2025 (Implementation begins on rule effective date)
Assess Knowledge and Adapt	Gauge awareness across the Corps, determine needs, and adjust actions to improve.	Analyze results at three phases within the execution of the communications strategy: introduction, implementation, and initial outcomes. Assess effectiveness using metrics. Adjust the communications plan as needed.	Ongoing w/ Phase Reporting

WHAT WILL REMAIN THE SAME?

Enduring planning concepts.

SMART Planning principles

Six Steps of Planning

Planning fundamentals

Methods of Analysis

Evaluation criteria

Compliance with laws, Executive Orders and other policies

U.S. ARMY

WHAT IS CHANGING?

New Terminology and Planning Considerations

Federal objective

The federal objective of contributing to national economic development consistent with protecting the Nation's environment is changing. The Agency Specific Procedures describe the Federal objective as reflecting national priorities, encouraging economic development, & protecting the environment.

Full and Equal Consideration of Benefits

Rather than primarily focusing on national economic values in the alternatives analysis, the proposed procedures require all three categories to be considered fully and equally. Consideration of benefits includes environmental, social, and economic benefit categories across both a national and regional analysis, with equal consideration given to each category and each scale.

Ecosystem Services

Direct or indirect contributions, including economic, environmental, and social effects, which ecosystems make to the environment and human populations.

WHAT IS CHANGING?

New Terminology and Planning Considerations

Indigenous Knowledge

A body of observations, oral & written knowledge, innovations, practices, & beliefs developed by Tribes & Indigenous Peoples through interaction & experience with the environment. It is applied to phenomena across biological, physical, social, cultural, & spiritual systems. It can be developed over millennia, continues to develop, & includes understanding based on evidence acquired through direct contact with the environment & long-term experiences, as well as extensive observations, lessons, & skills passed from generation to generation.

Public benefits

Encompasses environmental, economic, and social goals, include monetary and non-monetary effects and allow for the inclusion of quantified and unquantified measures. The benefits are considered at both the national and regional scale. Benefits to Tribal Nations are also to be specifically identified and considered in the assessment, when applicable, and contribute to the fulfillment of Federal Tribal trust responsibilities.

> *The Corps shall strive to maximize public benefits, with appropriate consideration of costs. Public benefits encompass environmental, economic, and social goals, include monetary and non-monetary effects, and allow for the consideration of both quantified and unquantified measures. In addition, there is no hierarchy among the three goals of environmental, economic, and social.*



9



Questions?

BCER Outstanding Action Items as of August 2024

Executive BCER Norfolk, VA, 19-20 March 2024

NUMBER	ACTION ITEM / RECOMMENDATION	Due	POC(s)	Status
2024-Exec-1	Develop agenda for 100th BCER meeting to be held in San Francisco, CA, to include a summary of BCER past successes and recommended future priorities.	2024 100th BCER	J.Rosati	Completed
2024-Exec-2	Use the Coastal Commander Decadal Challenges to create BCER Moonshot challenges in the form of short, authentic vision statements for review by the BCER at the 100th Meeting.	2024 100th BCER	J.Rosati	In Process
2024-Exec-3	Provide an update on ongoing Artificial Intelligence/ Machine Learning activities in ERDC-CHL.	2024 100th BCER	D. Anderson	In Process
2024-Exec-4	Develop a Sediment R&D Strategy and Roadmap including Test Bed opportunities centered around USACE project types.	2025 Exec BCER	K. Brodie, D. Bryant, Jarrell Smith	In Process
2024-Exec-5	Share summary of Civil Works R&D Weekly Communications with BCER Civilian Board.	Apr-24	T.Wamsley	Completed

BCER Outstanding Action Items from 2023
Executive BCER: Chicago, IL, 28-29 March 2023 and 99th BCER: Miami, FL, 15-17 August 2023

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	2025 Exec BCER	Wamsley, Rosati	In Process
2023-Full-3	Identify basic research gaps and drivers across enterprise and identify who our academic and industry partners are.	2024 100th BCER	BCER	In Process
2023-Full-5	At the next BCER meetings, invite key decision makers from the Assistant Secretary of the Army, Civil Works, and USACE HQ Program Integration Division and their staffs to engage with the BCER's preparations for 100th Meeting and provide funding and policy perspectives.	2024 100th BCER	Chair, BCER	In Process

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
100th	San Francisco, CA	SPD	August 2024