Climate Change Resiliency Assessments of Two Coastal Sites in Colombia in Preparation for Resilient Remedy Selection

9 May 2023

Sixth International Symposium on Bioremediation and Sustainable Environmental Technologies

Austin, Texas

The business of sustainability

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Agenda

Introduction – Sustainable and Resilient Remediation

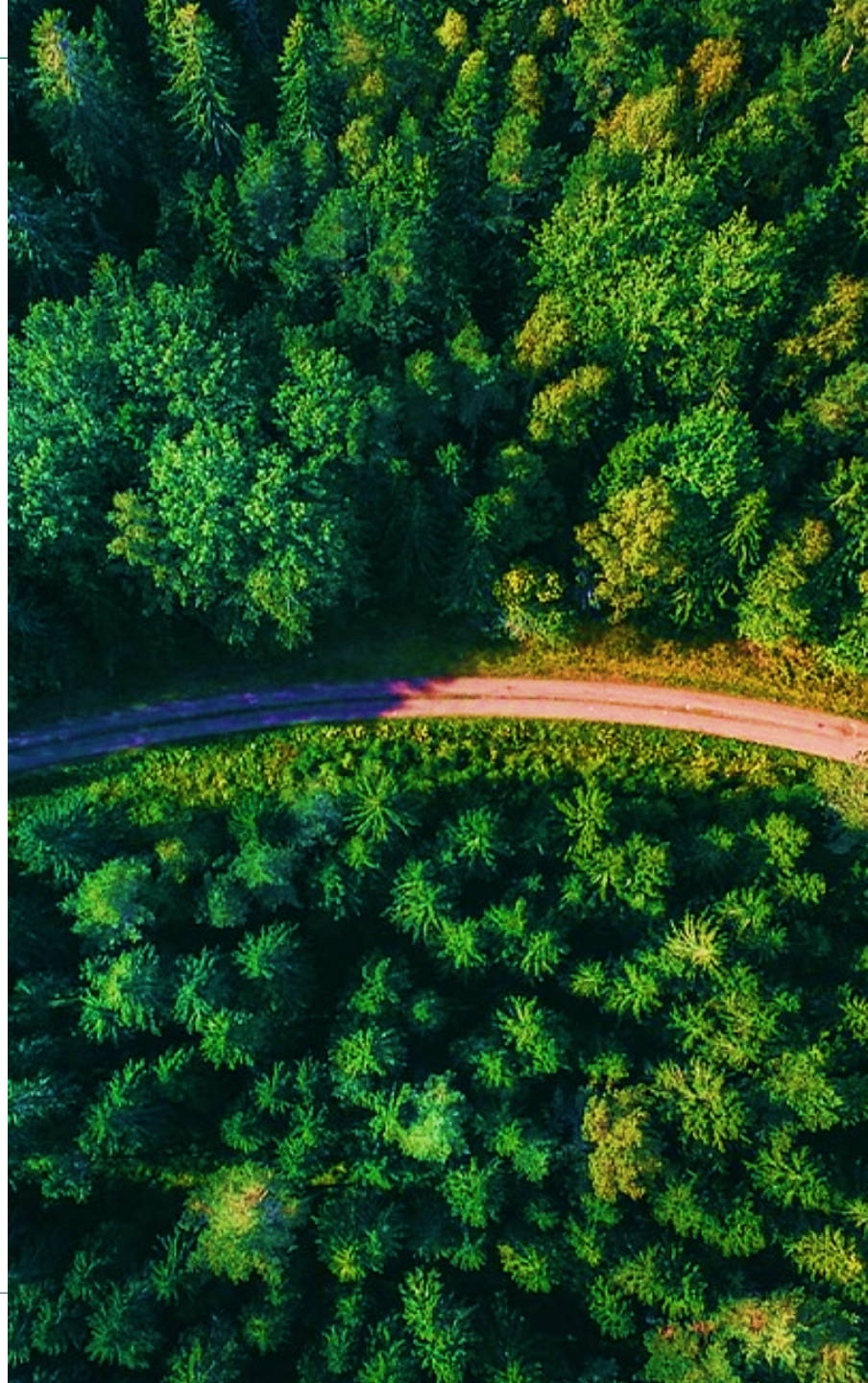
Why?

What is Remediation Resiliency?

How?

Why SRR?

Evolving environmental, economic and social justice related pressures, drivers and risks associated with managing environmental liabilities require organizations to adopt new sustainable and resilient approaches and methodologies to generate successful outcomes.



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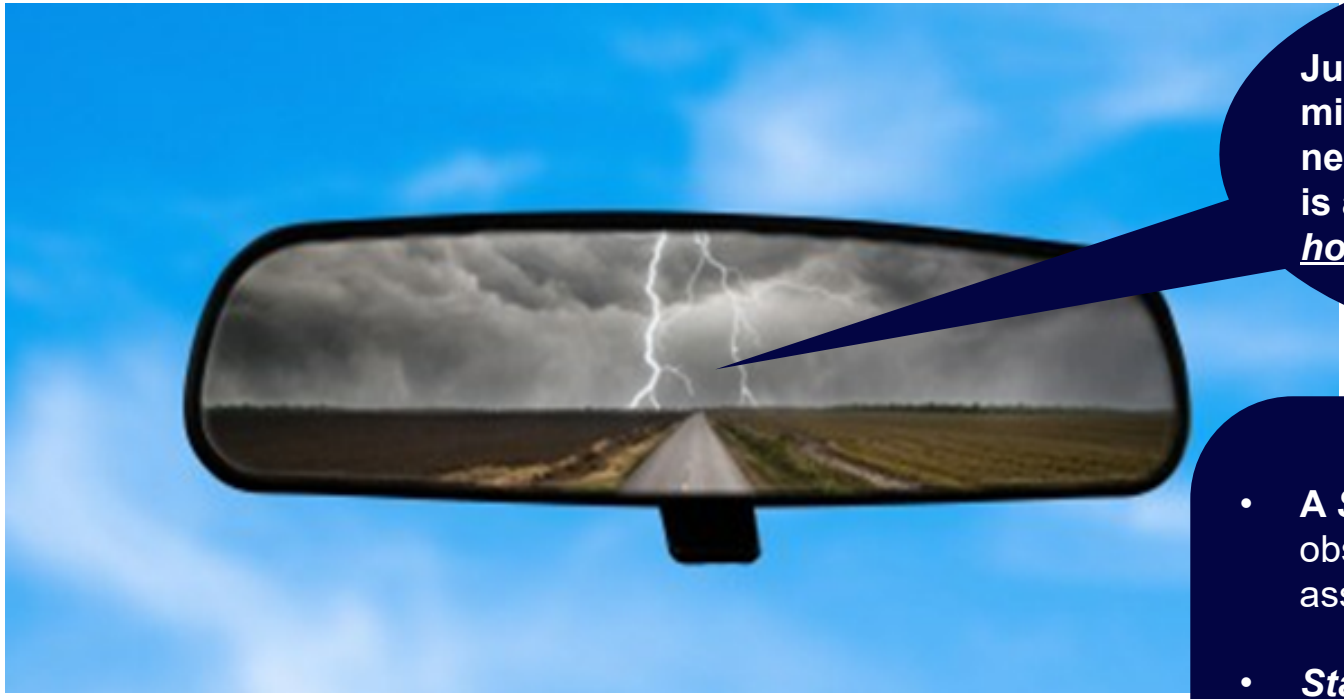
Introduction to Remediation Resiliency to Climate Change

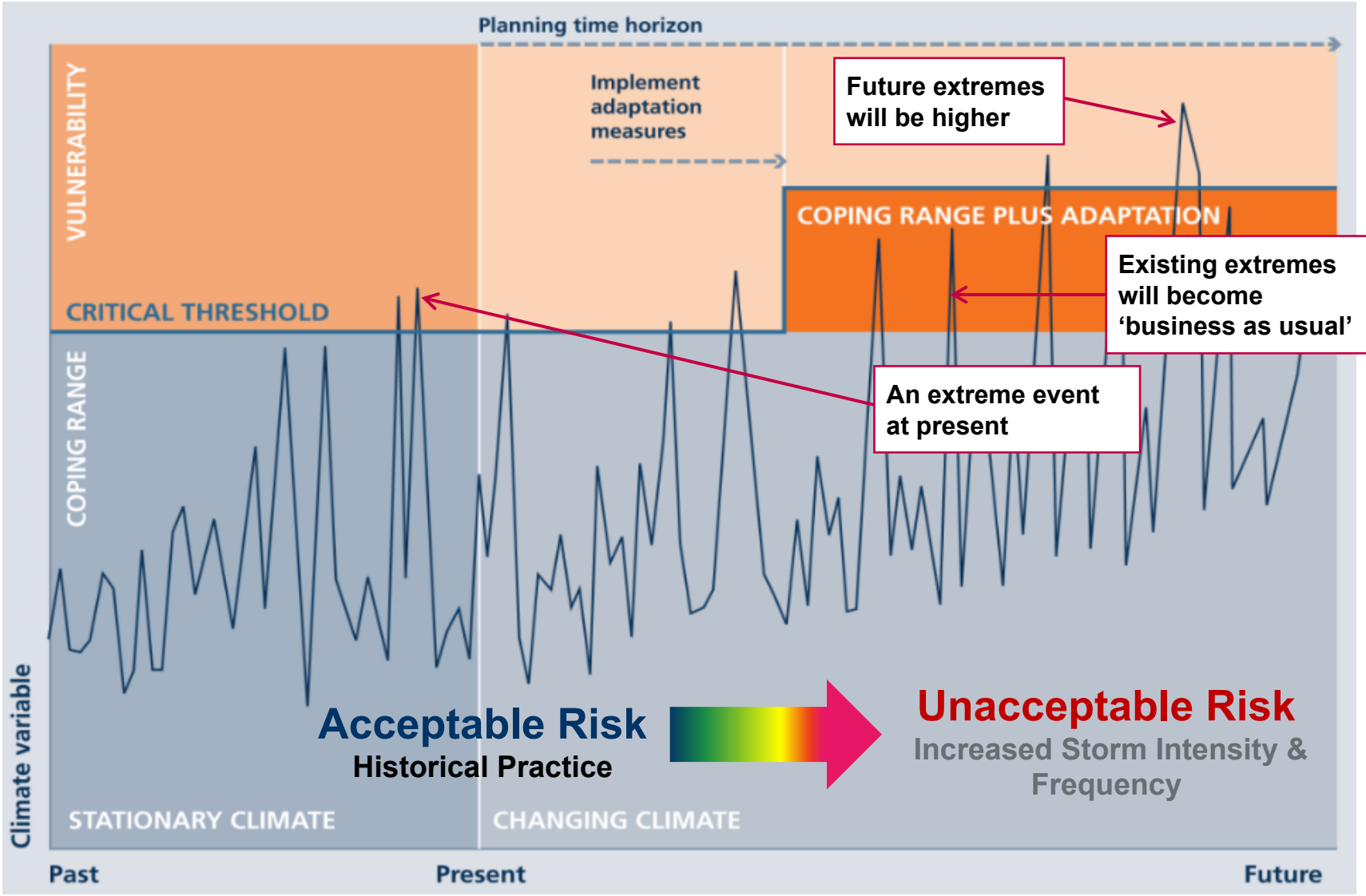
Traditional Approach vs Climate Change



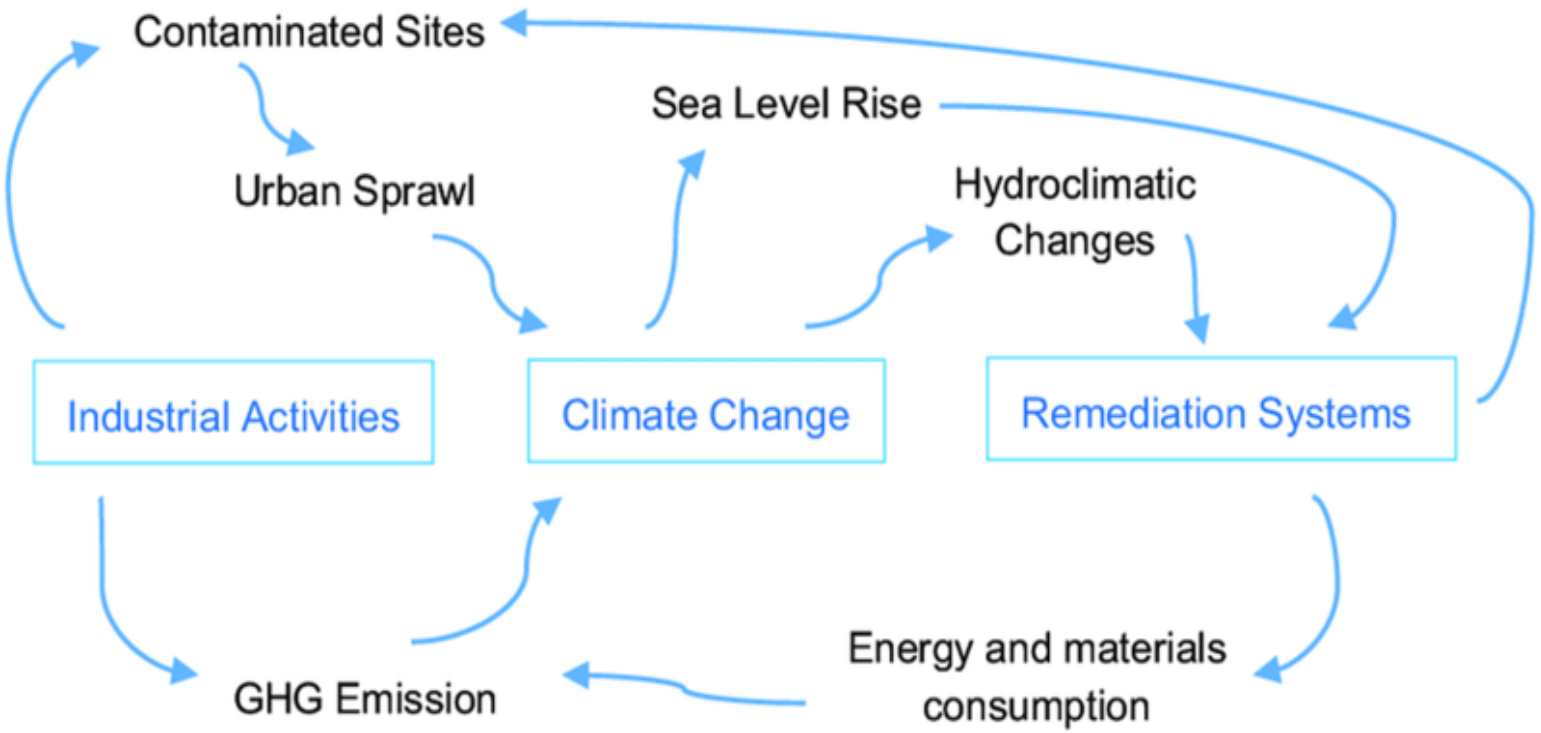
Just like looking in the rear view mirror, *stationary factors* will not necessarily help you predict what is ahead on the *non-stationary horizon*

- **A *Stationary*** system assumes that historical observations can predict future conditions assuming a system is at equilibrium
- ***Stationary*** assumptions often ***underestimate uncertainty*** for future conditions
- Global climate change is shifting the atmospheric equilibrium - ***non-stationary***

Critical Threshold – Coping with Climate Change

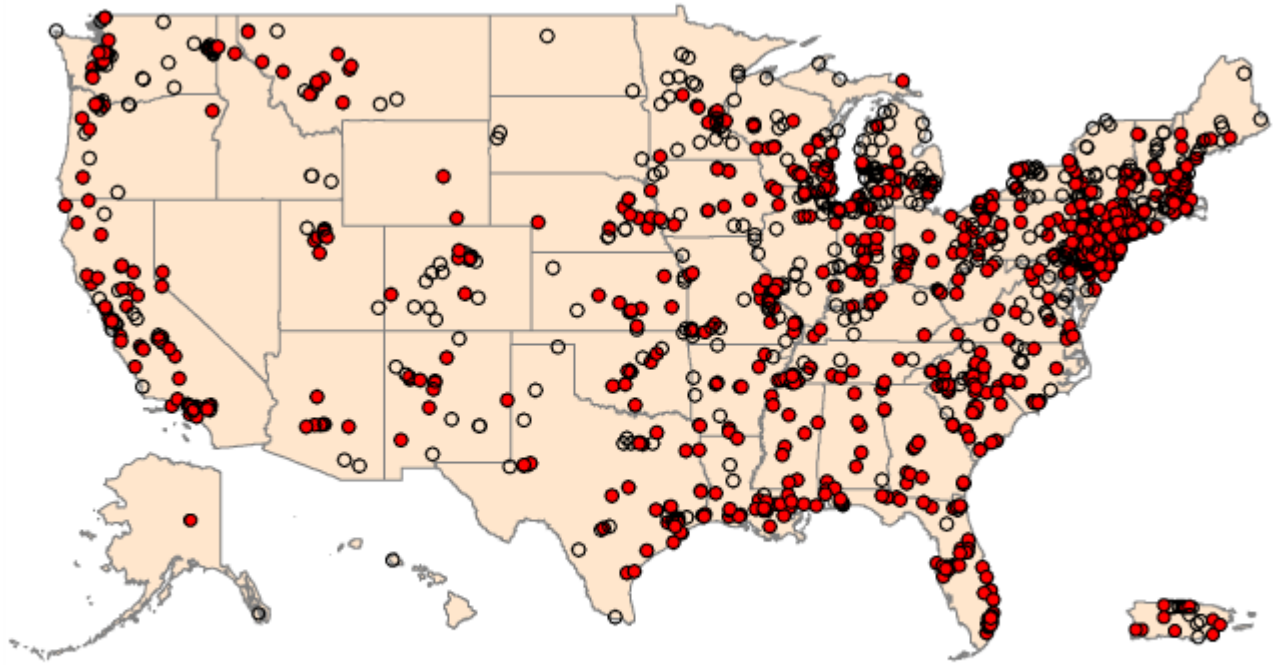


Climate Change and Remediation Feedback Loop



Remediation Resiliency to Climate Change?

- Following the 2017 extreme hurricane season EPA OLEMs' Office of Superfund Remediation and Technology Innovation (OSRTI), in collaboration with EPA Regions 2, 4, 6 created report on Remedy Resilience at Superfund NPL and SAA Sites: Analysis of 2017 Hurricane Season
- October 2019 US Government Accountability Office (GAO) writes - Superfund EPA Should Take Additional Actions to Manage Risks from Climate Change
- January 2021; Executive order 14008 - Executive Order on Tackling the Climate Crisis at Home and Abroad



Sources: GAO analysis of Environmental Protection Agency, Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, and U.S. Forest Service data; MapInfo (map). | GAO-20-73

Hurricane Florence (2018): 1000-year Event

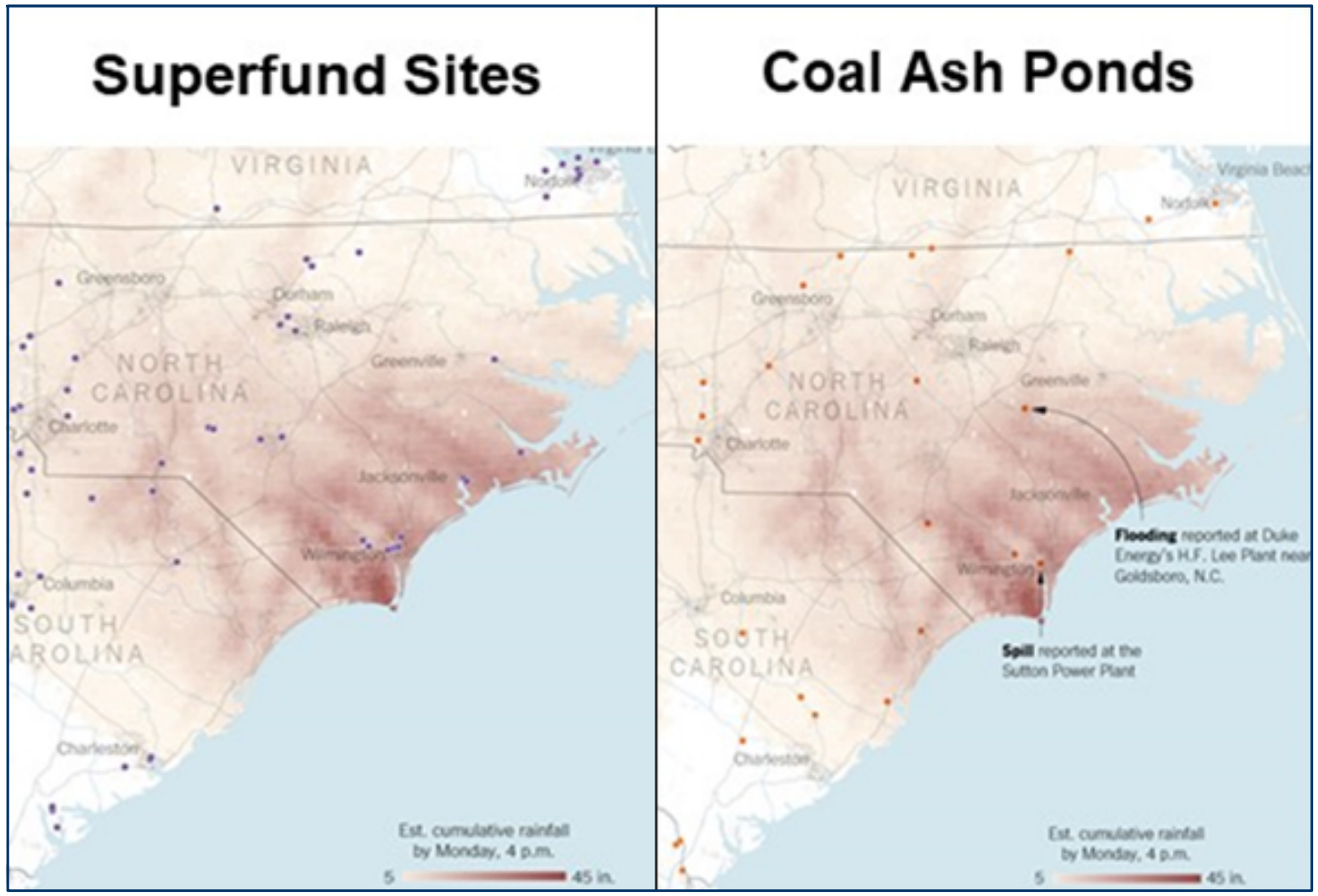
Pacific Standard

NEWS IN BRIEF ECONOMICS EDUCATION ENVIRONMENT SOCIAL JUSTICE FEATURES

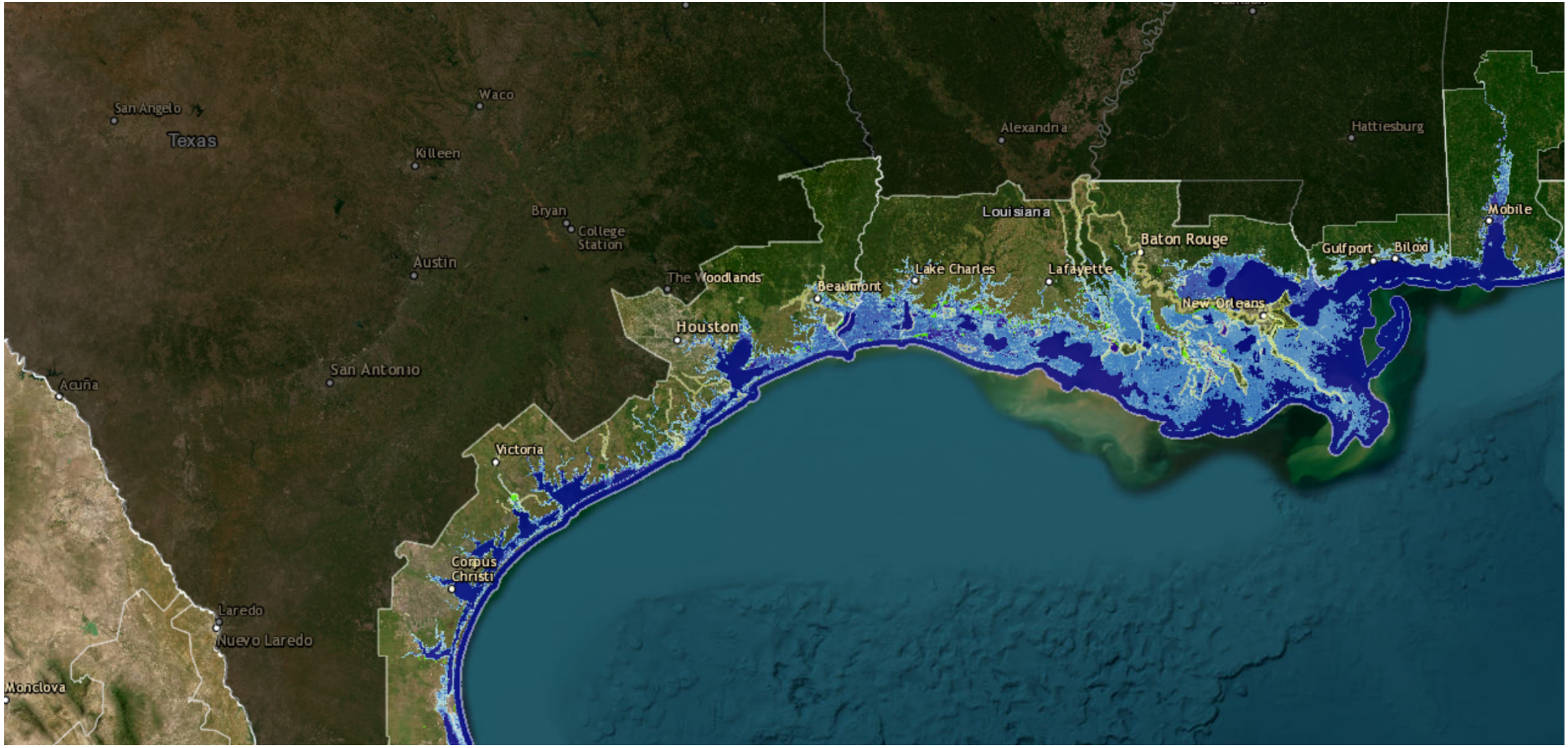
HURRICANE FLORENCE HAS ALREADY FLOODED PITS OF TOXIC WASTE IN NORTH CAROLINA

ENVIRONMENT

Still awaiting a proper cleanup, Superfund sites in eastern NC at risk from Hurricane Dorian



SLR Vulnerability – NOAA SLR Viewer



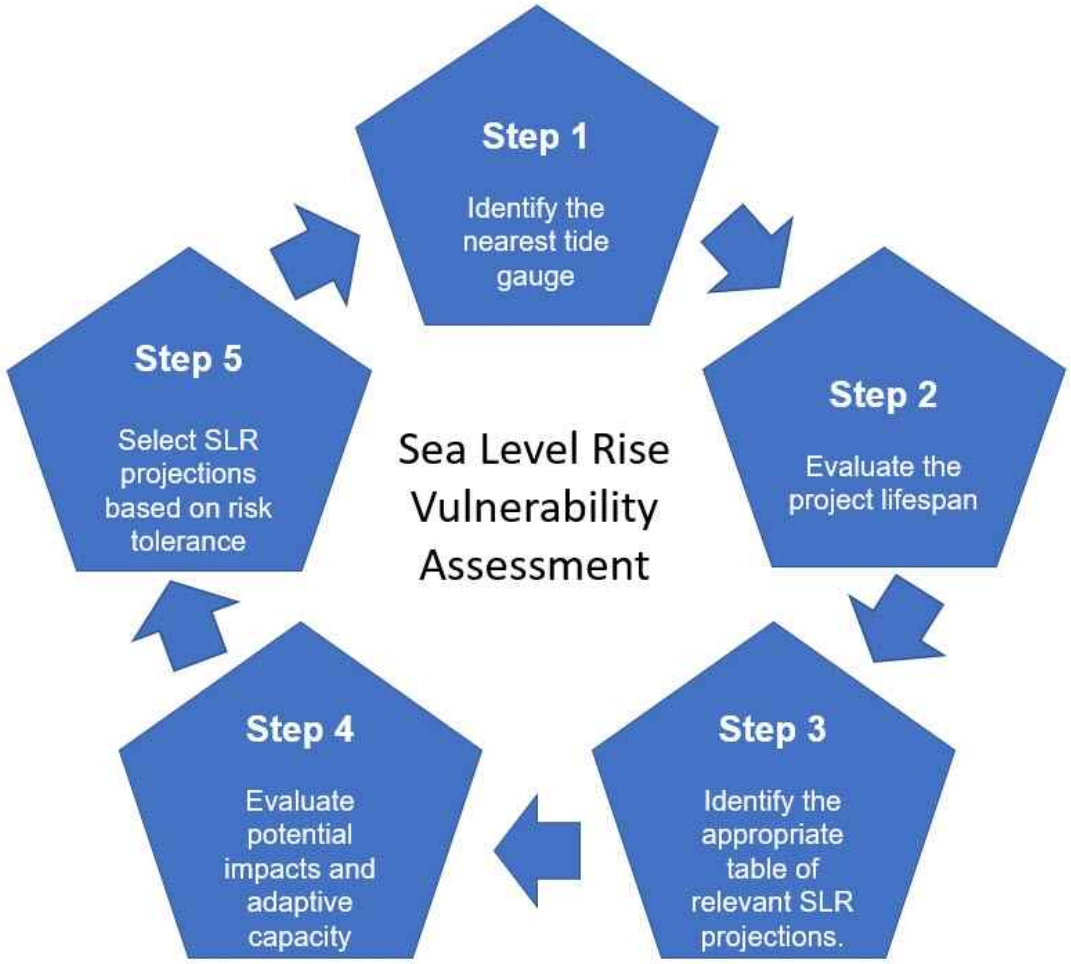
[Sea Level Rise Viewer (noaa.gov)]

California DTSC and SLR

DTSC requires a **SLR vulnerability assessment (SLRVA)** be conducted at each stage of the remediation process to specifically evaluate the resilience of the wastes and remedy at the site to future SLR impacts.

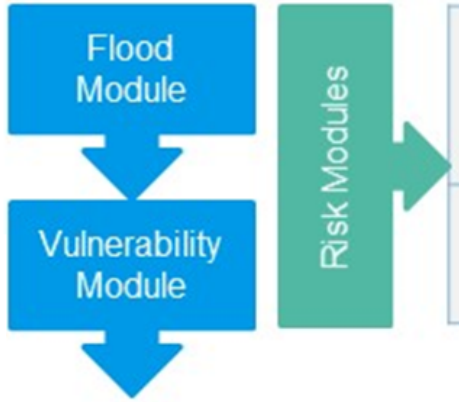
California SLR Action Plan (February 2022)

- preparation and planning for SLR across the entire California coastline,
- SLR adaptation planning with pathways to resiliency for SLR of 3.5 feet by 2050 and 6 feet by 2100,
- integration and prioritization of equity in SLR adaptation planning and projects,
- prioritization of nature-based solutions as feasible, and
- protection and preservation of coastal habitats.



Vulnerability/Risk Matrix

Composite Output for Each Scenario: Integrating Release and Exposure Factors



Consequences

Likelihood of Occurrence

		Environment	Within Fenceline	Poor Quality Habitat	Sensitive Habitats	Sensitive Habitats + Recreation	Sensitive Habitats + Recreation + T&E Species
		People	No Residences	Residences Near Fenceline	Residences + Parks	+ Schools + Hospitals	+ Water supplies
			Insignificant	**Minor**	**Moderate**	**Major**	**Severe**
It is expected to occur in most circumstances	Almost Certain		Medium	High	High	Very High	Very High
Will probably happen in most circumstances	Likely		Medium	Medium	High	High	Very High
Will occur in some circumstances	Possible		Low	Medium	High	High	Very High
May occur in some circumstances	Unlikely		Low	Low	Medium	Medium	High
May occur only in exceptional circumstances	Rare		Low	Low	Medium	Medium	Medium

Demo Client

Screening Level Physical Climate Change Risk Assessment

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Filters

Country
All

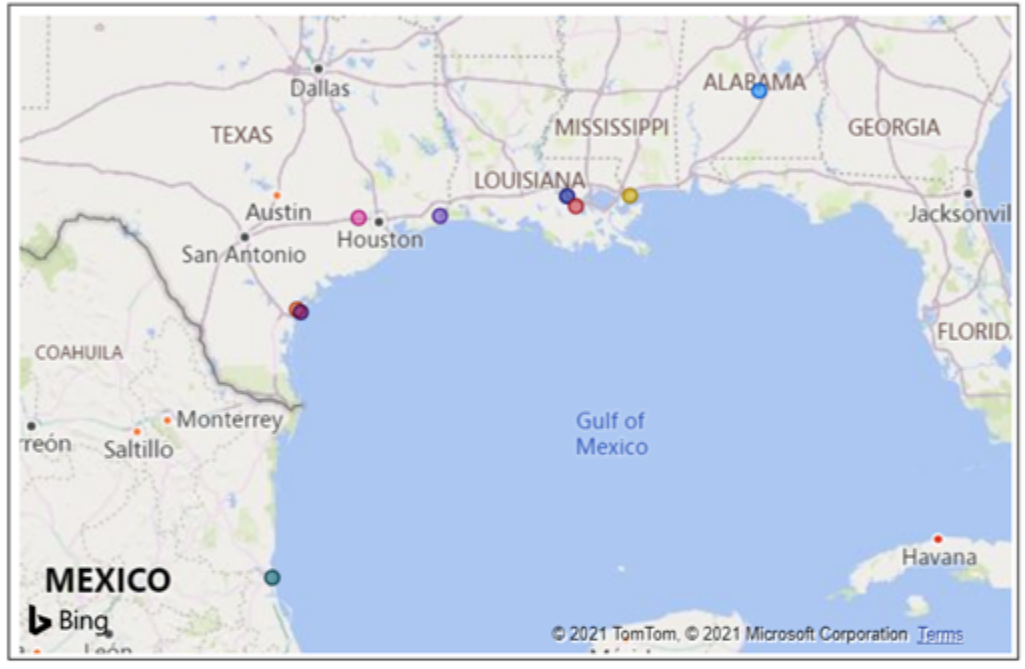
Location Type
Inland

Natural Hazard
- Select all
- Water Stress
- Riverine Flood
- Drought
- Cyclone
- Sea Level Rise
- Storm Surge
- Extreme Heat
- Landslides
- Coastal Flood

Climate Scenario
- RCP 4.5
- RCP 8.5

Time Frame
- Baseline
- 2030
- 2050
- 2080

Hazard Summary



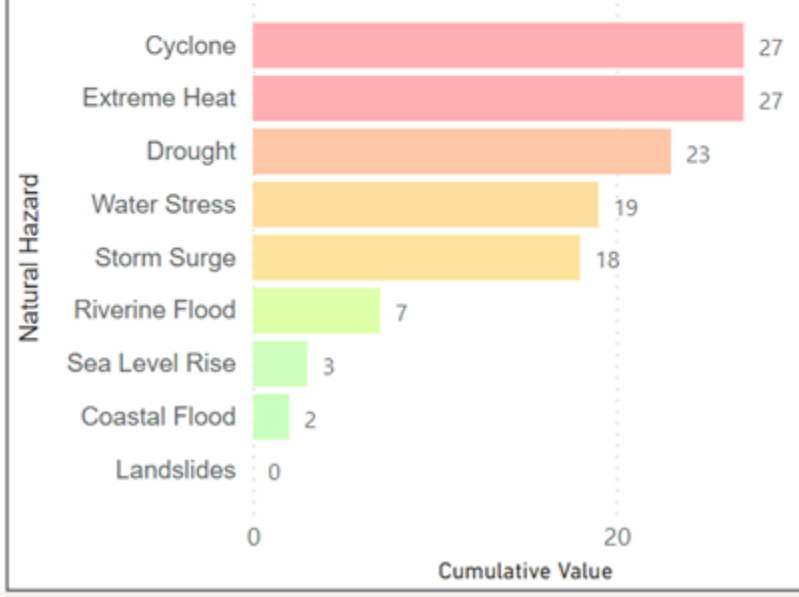
Natural Hazard	Coastal Flood	Cyclone	Drought	Extreme Heat	Landslides	F
Asset	2030	2030	2030	2030	2030	
Burkville_AL	None	High	Medium	High	None	N
Geismar_LA	None	High	Medium	High	None	L
Gregory_TX	None	High	High	High	None	N
Ingleside_TX	None	High	High	High	None	N
Katy_TX	None	High	High	High	None	N
Port-Arthur_TX	Low	High	High	High	None	L

Vulnerability Assessment

Asset Ranking

Climate Scenario	RCP 8.5
Asset	2030
Port-Arthur_TX	17
Tampico	17
Port-Bienville_MS	15
Ingleside_TX	14
St-James-Parish_LA	14

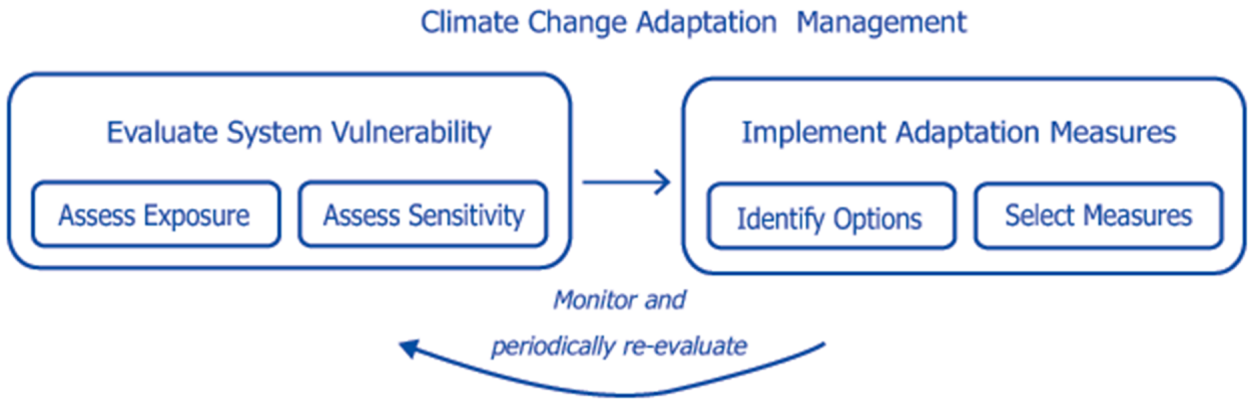
Hazard Ranking



How?

Available Assessment Guidance

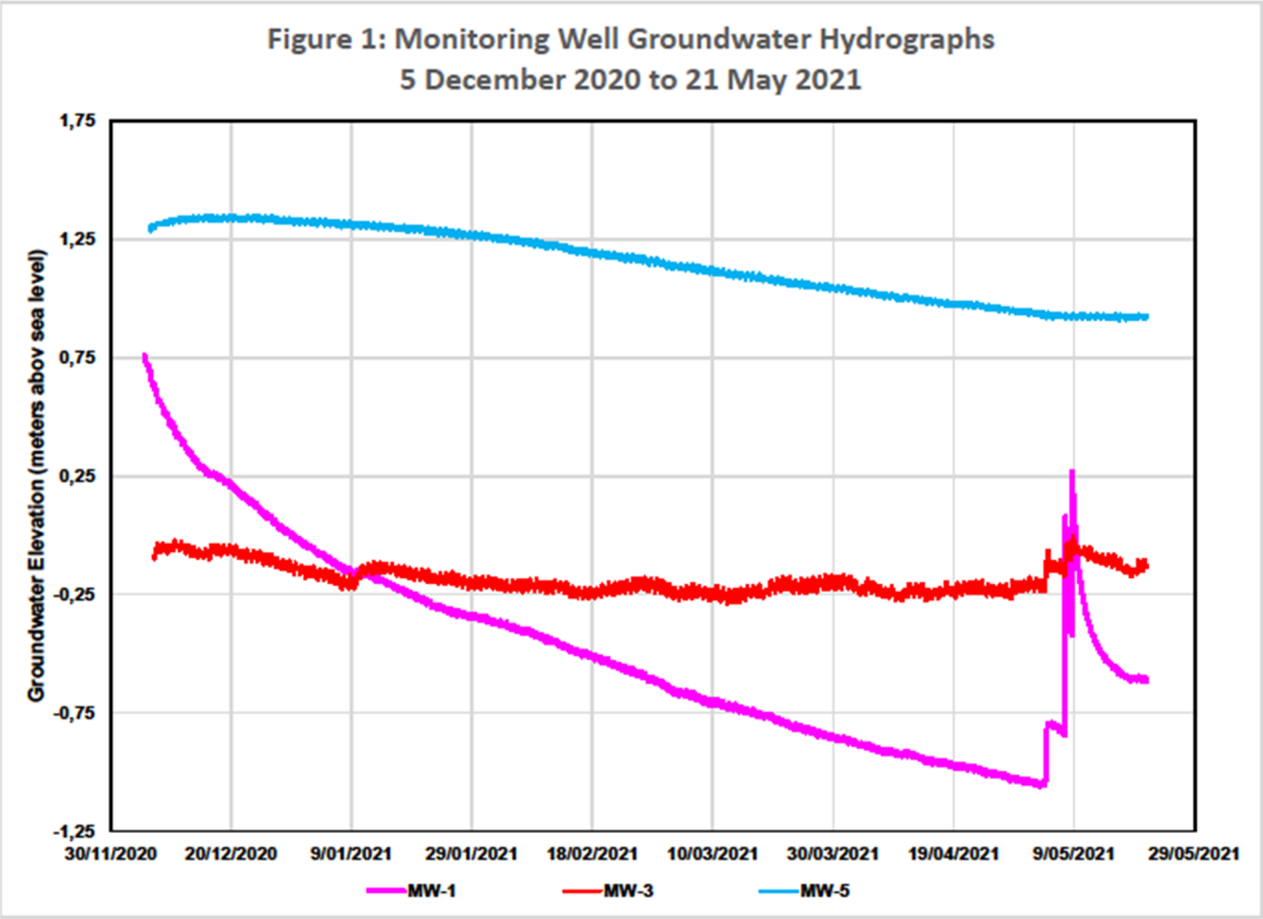
- ITRC – SRR April 2021
  - Provides basic guidance and reference material for resiliency assessments building on previous 2011 GSR guidance
- ASTM 3249-21
  - *"All stages of remediation planning and implementation should consider and address potential climate and extreme weather impacts, such as flooding and wildfires, that may affect remedy sustainability, continued protection of human and ecological receptors, the surrounding community, and the environment."*
- USEPA Climate Adaptation Management



Data Collection

- Weather meta data limited and difficult to obtain
- Last 10 years of data compiled from both Cartagena and Barranquilla Sites
- Includes data from Cartagena Bay and Magdalena River
- Also includes groundwater elevation data collected by pressure transducers placed in monitoring wells
- Data will be incorporated in groundwater models that will by synchronized with surface water data

Pressure Transducer Data - Cartagena

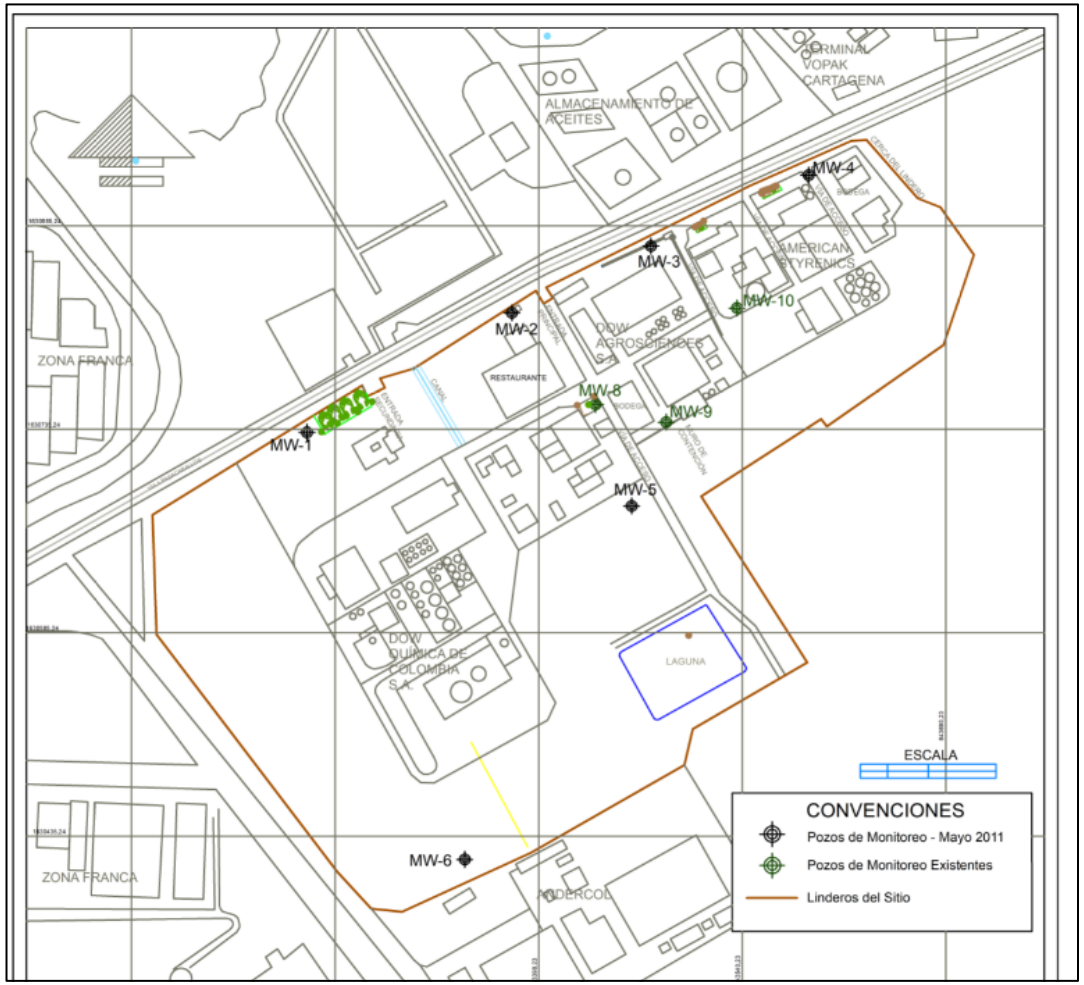


Biogeochemical Data

- Data collected included the following:
  - Alkalinity
  - Chloride
  - Total and dissolved iron
  - Total and dissolved manganese
  - Methane
  - Total organic carbon (TOC)

Results

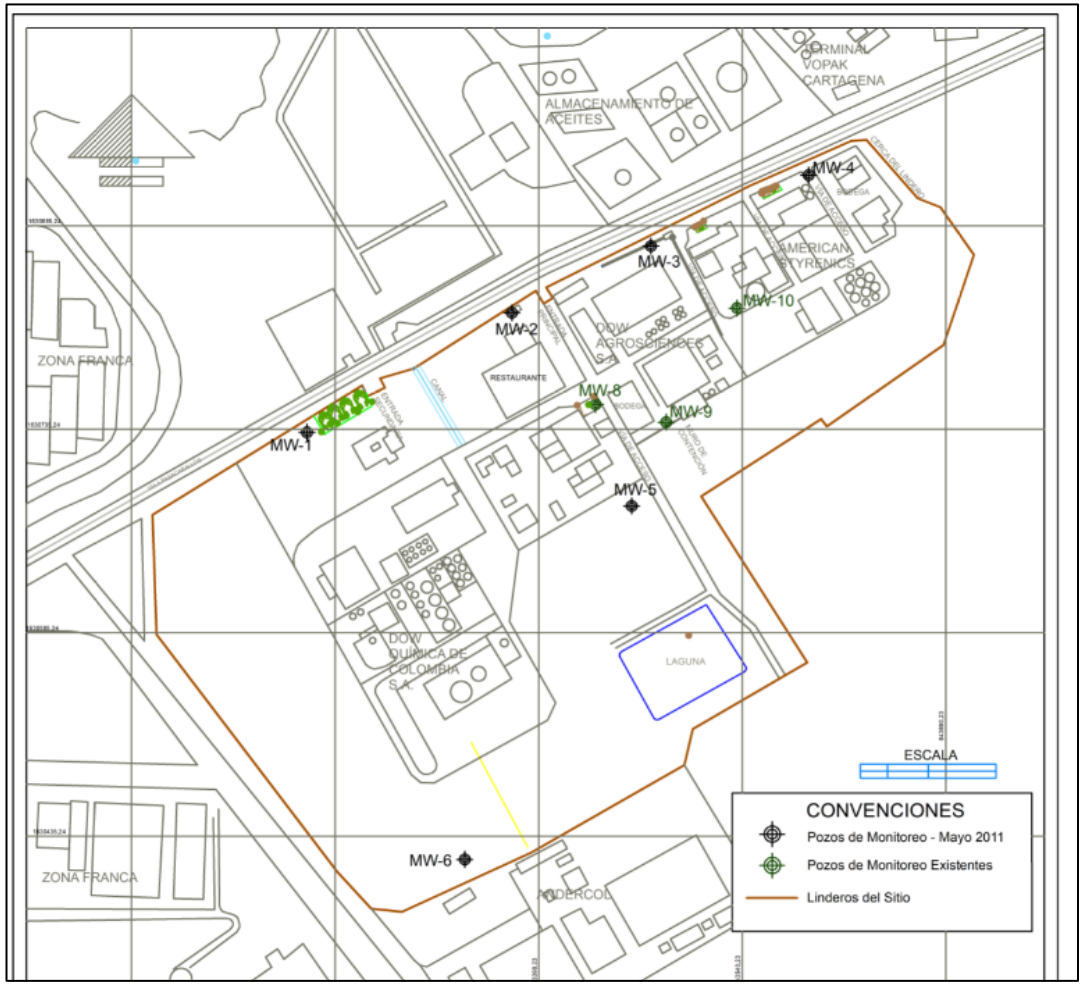
- Total organic carbon (TOC) was detected at all monitoring locations, ranging from 1.9 to 45 mg/L,
- Dissolved methane was detected at all wells, ranging from 0.0017 to 0.081 mg/L
- Elevated chloride was detected at all monitoring locations, ranging from 320 to 20,000 mg/L with the lowest detections at the wells farthest from the Bay (upgradient)
- dissolved manganese ranging from 0.75 to 4.8 mg/L observed in all wells except the most upgradient and farthest from the Bay



Initial Assessment

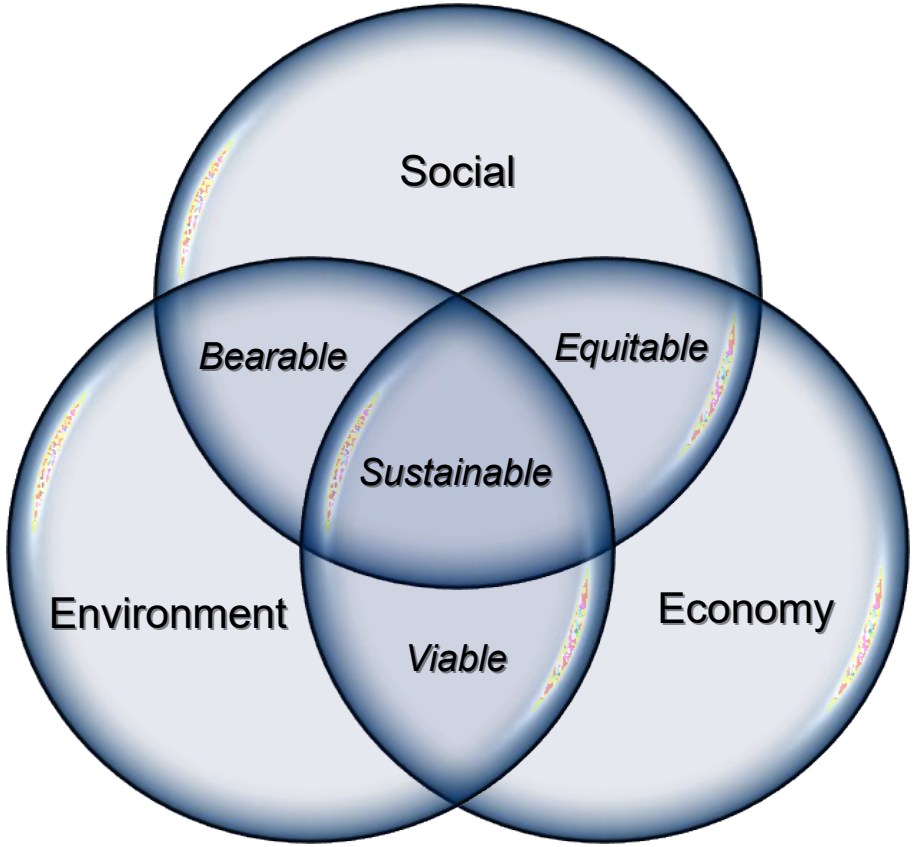
- Multiple lines of evidence, including observations from plant personnel, SLR, pressure transducer and chloride data indicate that the downgradient half of the Site groundwater exhibits salt water intrusion from the Bay and that the majority of Site groundwater is a mixing zone of fresh water from upgradient on the hillside and salt water from the Bay;

- After delineation of impacts is completed and if risk assessment identifies the need for remediation to mitigate risk, remedy selection will include the findings of the initial assessment to determine the most climate change resilient remedial strategies



Site specific implementation – Lessons Learned

- Persistence required to identify and obtain weather meta data not readily available online
- Holistic surface water and groundwater and fate and transport modelling will provide crucial data to complete resiliency assessment
- Multiple lines of evidence needed to develop comprehensive CSM and potential impacts from climate change related weather events
- SLR making the most headlines but other climate change related weather also need to be assessed
- Dashboards can provide engagement tool and provides transparency in decision making – can help with reporting, regulatory and stakeholder engagement



Summary

- Sustainable and resilient remediation continues to evolve and must include climate change considerations
- Alignment of SRR with broader corporate sustainability goals is likely to increase as industry incorporates SDGs, ESG and climate change considerations and policies flow down
- Potentially significant cost savings while meeting remedial goals as well as SDGs, ESGs and reduced CC risk and avoiding potential costly remediation rebuilds due to impacts from climate change weather related events
- The recent extreme weather related events continue to highlight the importance of incorporating resilience into remedy selection and implementation

Thank you!

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