Pollution & Environmental Degradation Natural Disasters, Debris Management and Hazardous Substances

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CLIMATE CHANGE & CHEMICAL CONTAMINATION

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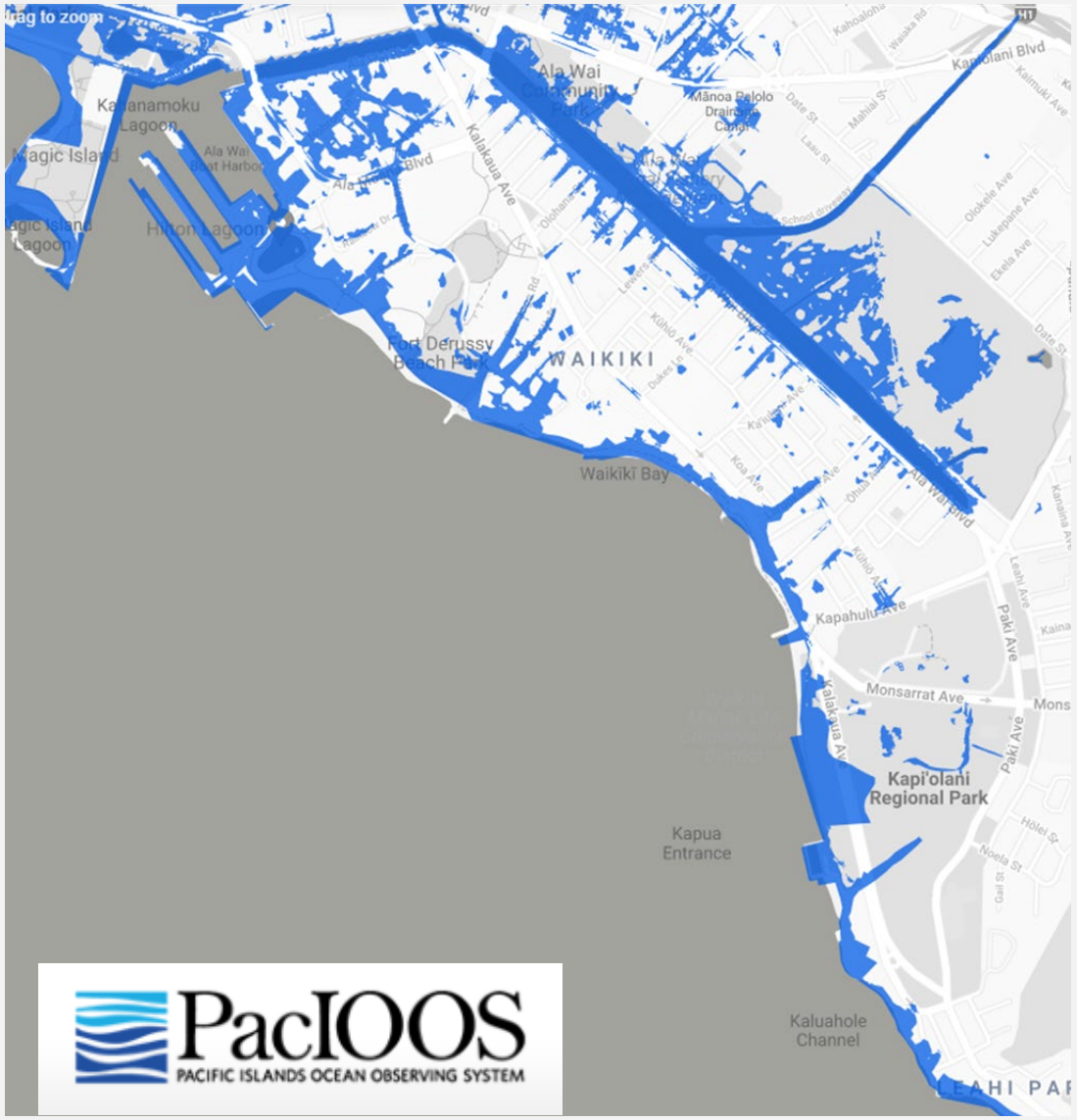
SEA LEVEL RISE

Meltwater from glaciers and ice sheets

Thermal expansion of seawater as it warms

How much do we plan for?

3.2 feet vs. 6 feet vs more



SLR IS MORE THAN JUST RISING SEAS….

- Surface of sea goes up causing flooding
- Higher ground water
- Coastal erosion
- Worse impacts from storm events

Habel et al. Sea-level rise induced multi-mechanism flooding and contribution to urban infrastructure failure. Nature Research Scientific Reports. 2020.

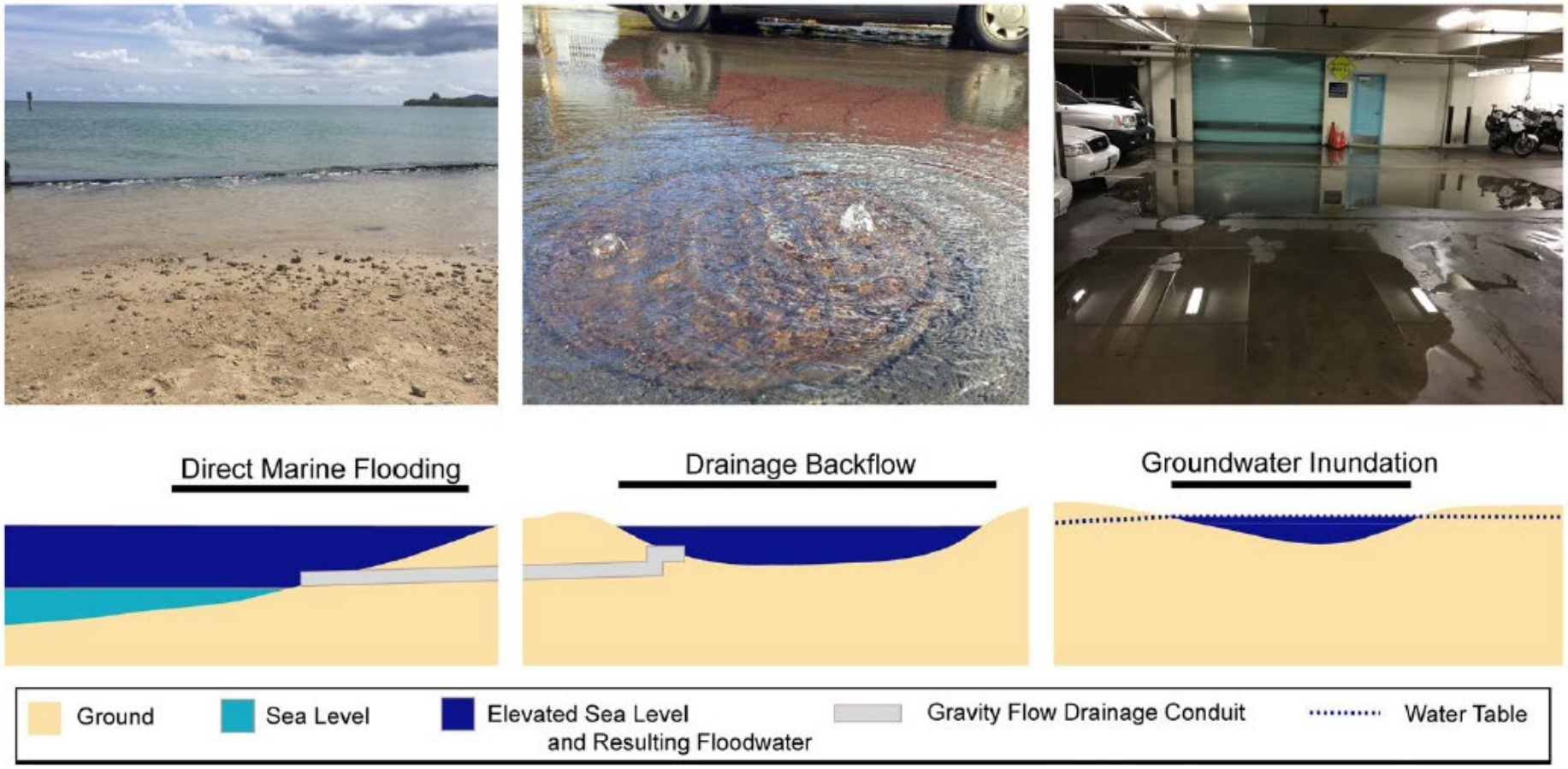


Figure 1. Observations and illustrations of direct marine flooding, storm-drain backflow, and groundwater inundation within Honolulu. Each mechanism of flooding has already been observed during periods of extreme tide in various locations within the study area. Photo Credit, Hawai'i and Pacific Islands King Tide Project[17].

TYPES OF SITES WITH CHEMICAL CONTAMINATION IN HAWAI‘I

- Former industrial or agricultural areas
- Legacy contamination at construction sites
- Airports (jet fuel leakage, AFFF)
- Harbors (oil terminals, pipelines)
- Underground Storage Tanks
- Shipyards and Salvage Yards (Metals/PCBs)
- UXO

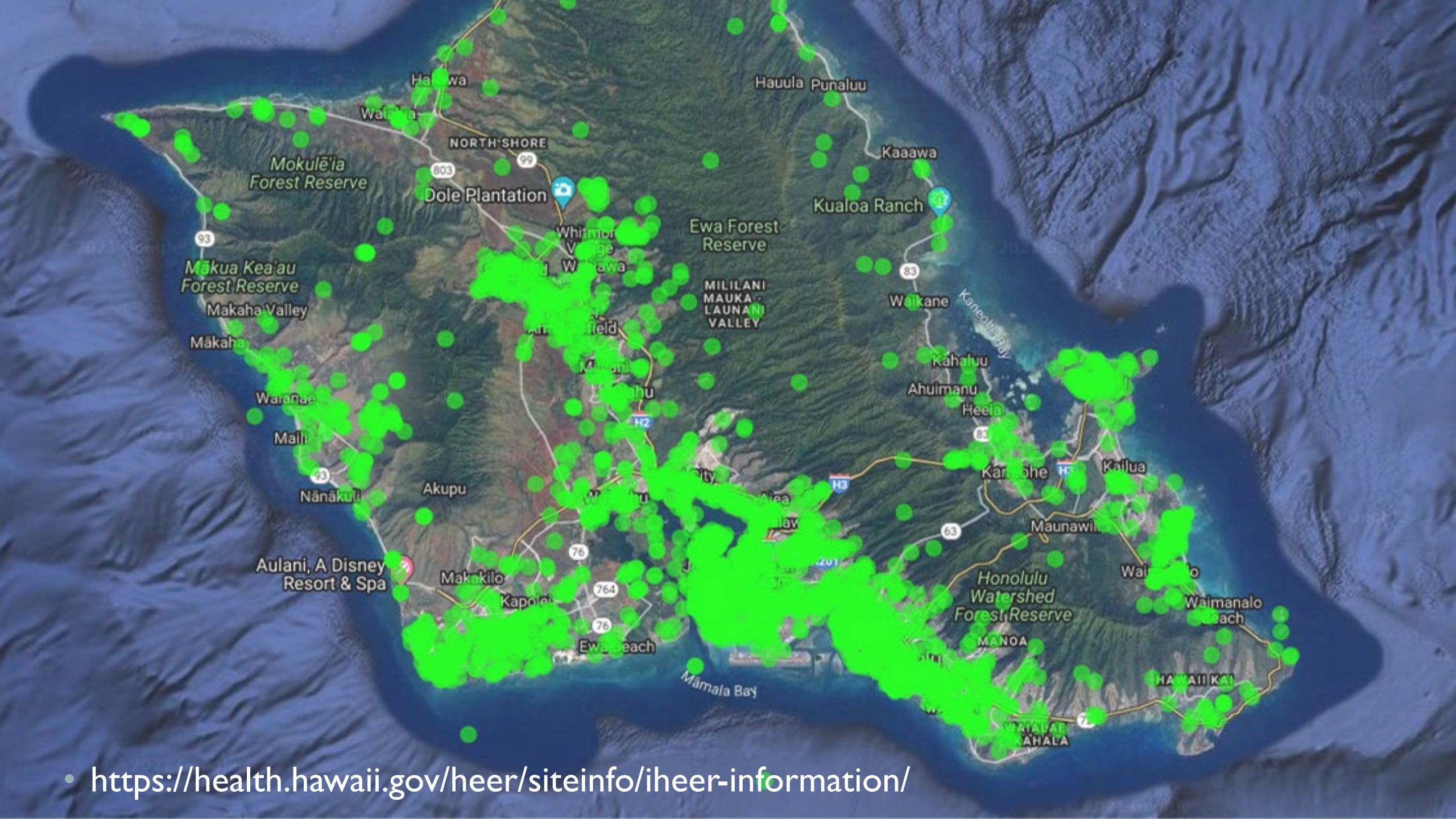
CLIMATE CHANGE & SLR IMPACTS ON CHEMICAL CONTAMINATION

DOH HEER Office regulates over 1000 sites of chemical contamination statewide

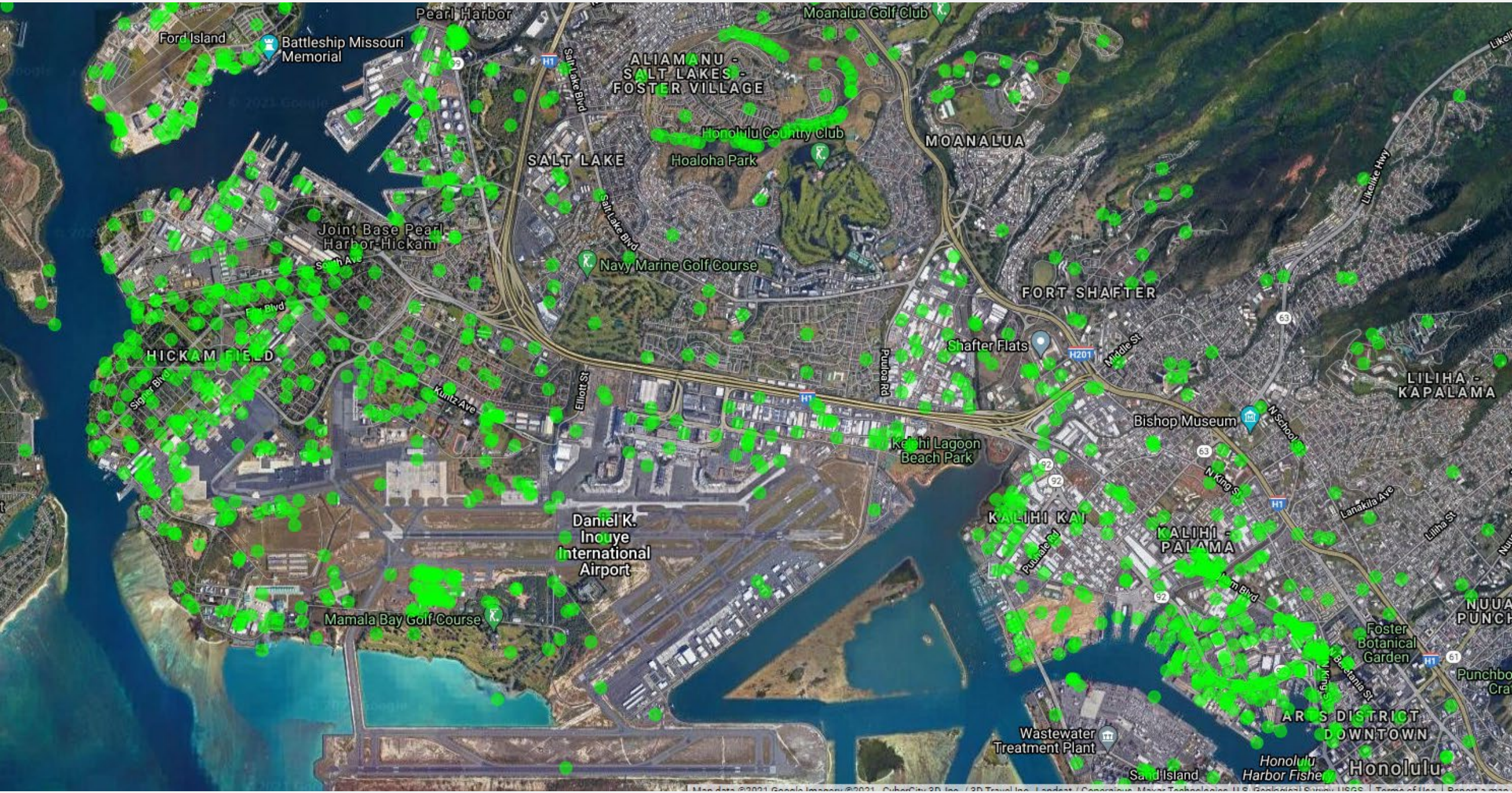
Contamination is generally the result of historical industrial and agricultural uses and releases

Contamination is often "managed in place" in a manner that protects human health and the environment (usually by limiting exposure)

Effects from climate change and rising sea levels will disrupt previously "stable" chemical contamination creating new hazards



- https://health.hawaii.gov/heer/siteinfo/iheer-information/


Pearl Harbor
Ford Island
Battleship Missouri Memorial
Moanalua Golf Club
ALIAMANU - SALT LAKES - FOSTER VILLAGE
Salt Lake Blvd
H1
Honolulu Country Club
Hoaloha Park
SALT LAKE
MOANALUA
Likelike Hwy
Joint Base Pearl Harbor-Hickam
Navy Marine Golf Course
FORT SHAFTER
HICKAM FIELD
Shafter Flats
H201
Middle St
Puuloa Rd
Elliott St
Kuntz Ave
Bishop Museum
LILIHA - KAPALAMA
N School St
Keehi Lagoon Beach Park
N King St
Lanakila Ave
Liliha St
KALIHI KAI
KALIHI - PALAMA
Puuhale Rd
Daniel K. Inouye International Airport
Mamala Bay Golf Course
Foster Botanical Garden
Punchbowl
ARTS DISTRICT DOWNTOWN
Wastewater Treatment Plant
Sand Island
Honolulu Harbor
Honolulu

www.pacioos.hawaii.edu/shoreline/slr-hawaii

coast.noaa.gov/digitalcoast/tools/slr.html

HONOLULU HARBOR

- Yellow areas are properties with chemical contamination
- Blue shading shows 3.2 ft SLR
- Purple shading shows 1% flood risk with 3.2 ft SLR

BIGGEST CONCERNS

Movement of contaminants

Changing chemical and physical conditions

CONTAMINANT MOVEMENT WAIANAE HIGH

- Used for air riflery practice for many years
- High levels of lead in the soil
- Less than 3 ft above sea level and very close to the ocean

CONTAMINANT MOVEMENT KEAHI LAGOON

- Lead and PAHs from prior asphalt facility and historical dumping.
- Currently low risk because no human access and contamination stable.
- Significant impact from SLR with potential movement of contaminants increasing risk of human exposure and exposure to coral reefs.

The Mapunapuna neighborhood is one of the first areas in Honolulu, on the Hawaiian island of O'ahu, to experience increased flooding linked to sea level rise. Photo courtesy of Hawaii Sea Grant King Tides Project, 2019

Hakai Magazine 2019

coastalscience.noaa.gov/project/effects-climate-change-chemical-contaminant-toxicity/

- Standard Eco Risk assessment toxicity tests done under standard conditions
- Climate change variations in water temperature, salinity, pH,
- Studied the effects of increased temperature and salinity on toxicity of pesticides to estuarine grass shrimp (US Atlantic coast and Gulf of Mexico)
- Toxicity of tested pesticides increased with high temp, salinity, acidification
- Similar findings with other species, other common contaminants, and different expected conditions

"the chemicals tested thus far were generally more toxic under climate stress conditions"

ANTICIPATED PROBLEM AREAS

SITES	SOURCE	EXAMPLES
Coastal landfills	Leachate Debris	Kaka'ako Beach Park Lihue Airport, Kauai
Harbors and Airports	Historic petroleum releases Active or abandoned fuel terminals, Pipelines, AFFF	Arizona Memorial Honolulu Harbor Kahului Airport
Extensive Contaminated Fill	Fill	Honolulu shoreline
Capped or abandoned large industrial sites	Soil, Sediment	Waiakea Pond, Hilo Campbell Industrial Park
Small commercial sites	Gas stations, Dry cleaners	Numerous

HOW BIG OF A PROBLEM IS THIS?

Island	Chemically Contaminated Sites in 3.2 ft SLR zone (not including 1% flood zone)	Chemically Contaminated Sites in 1% flood zone with 3.2 ft SLR
Hawaii	42	71
Kauai	21	70
Lanai	1	5
Maui	54	79
Molokai	23	34
Oahu	307	814

European Commission

Science for Environment Policy

Floods due to rising sea levels may mobilise arsenic from contaminated soils

New research has shown that flooding of soils contaminated with arsenic, which may occur as sea levels rise due to climate change, could lead to the mobilisation of this toxic element in the environment. The study shows that arsenic is more stable in soil flooded with saltwater, compared to river water, as salt stabilises mineral oxides and could inhibit microbial activity. However, microbes that transform arsenic into water-soluble forms may adapt to saline conditions, and the risk of arsenic entering waters due to rising sea levels should receive further attention.

25 January 2018
Issue 501

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Source: LeMonte, J.J.,

THE IMPACTS OF SEA-LEVEL RISE ON THE CALIFORNIA COAST BY HEBERGER ET AL OF THE CALIFORNIA CLIMATE CHANGE CENTER 2009

Table 14. U.S. EPA-regulated sites within areas vulnerable to 100-year flood event in 2000 and with a 1.4 m sea-level rise

County	Sites currently at risk	Risk with 1.4 m sea-level rise
Alameda	6	63
Contra Costa	4	22
Del Norte	1	3
Humboldt	10	13
Los Angeles	13	26
Marin	1	6
Monterey	1	1
Napa	1	2
Orange	4	16
San Diego	-	13
San Francisco	-	4
San Luis Obispo	-	1
San Mateo	39	78
Santa Barbara	1	5
Santa Clara	41	53
Santa Cruz	5	6
Solano	2	5
Sonoma	-	2
Ventura	5	13
Total	**134**	**332**

Data Source: EPA Geospatial Data Access Project 2008
Note: Table combines risk for those counties along the San Francisco Bay and Pacific

Climate Adaptation and Contaminated Site Management

EPA programs work with communities to ensure the proper management of hazardous and non-hazardous wastes now and in the future.
More intense and frequent storms increase the likelihood of flooding to Superfund, corrective action actions sites, Brownfields sites, landfills and underground storage tanks. Also, greater frequency and intensity of drought can affect water-intensive remedies and site stability.

Contaminated Site Management Adaptation Strategies for Climate Change

The adaptation strategies below offer selected strategies and actions that have been identified within EPA resources as having the potential to be used for climate adaptation.

Potential Adaptation Strategy

By Adaptation Action

- Site Containment
- Operations & Infrastructure
- Groundwater Remediation
- Contaminated Site Remedy
- Engineered Structures

By Projected Climate Threat

- Temperature
- Precipitation
- Wind
- Sea Level Rise
- Wildfires

United States Environmental Protection Agency

Office of Superfund Remediation and Technology Innovation

EPA 542-F-19-003 October 2019 Update

Climate Resilience Technical Fact Sheet: Contaminated Sediment Sites

Figure 1. Climate Change Adaptation Management

Table 2. Examples of Climate Resilience Measures

	Climate Change Effects					Potential Climate Resilience Measures for a Contaminated Sediment Remedy
	Temperature	Precipitation	Wind	Sea Level Rise	Wildfires	
Submerged or Subsurface Components	◆	◆	◆	◆		**Armor enhancement for in situ cap** *Emplacing additional stone and gravel above a sand base layer to withstand scouring forces of more intense waves and currents or more frequent development of ice jams*
	◆	◆	◆			**Amendment scheduling optimization** *Applying materials intended for long-term contaminant binding or destruction far in advance of (or after) seasons that typically bring low temperatures, high winds or high precipitation, to maximize the time available for amendment-sediment mixing without interference from conditions such as more intense tidal action or ice scour*
		◆		◆		**Deposition controls** *Building engineered structures such as dams to control the flow of flood-related deposition in settings where increased underwater deposition enhances remedy performance*
	◆	◆	◆	◆		**Modeling expansion for MNR and EMNR** *Incorporating additional subsurface parameters and sampling devices in monitoring plans to gauge the potential for resuspension of contaminated sediment under more extreme weather and changing climate scenarios*

www.epa.gov/sites/default/files/2019-12/documents/cr_sediment_sites_fact_sheet_update.pdf

Profiles of Climate Adaptation

EPA is compiling site profiles that illustrate how climate adaptation is integrated into the Superfund program. Each profile describes assorted processes and tools that were used to design, operate and maintain remedies and associated infrastructure in practical and innovative ways addressing the site's specific climate vulnerabilities.

- Climate Adaptation Profile: Allen Harbor Landfill, Davisville Naval Construction Battalion Center
- Climate Adaptation Profile: American Cyanamid Co.
- Climate Adaptation Profile: Continental Steel Corp.
- Climate Adaptation Profile: General Motors (Central Foundry Division)
- Climate Adaptation Profile: Iron Mountain Mine
- Climate Adaptation Profile: Port Hadlock - Site 10 North End Landfill
- Climate Adaptation Profile: Rocky Mountain Arsenal
- Climate Adaptation Profile: Solvents Recovery Service of New England, Inc.
- Climate Adaptation Profile: Wyckoff Co./Eagle Harbor

Climate Adaptation Profile: Port Hadlock – Site 10 North End Landfill

Naval Magazine Indian Island, Washington

Site Description

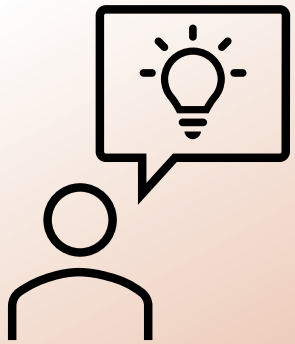
Port Hadlock's Site 10 borders Port Townsend Bay, a marine inlet at the northeastern extreme of the Olympic Peninsula in Washington. Site 10 formerly served as a landfill for residential and industrial waste, which resulted in soil or groundwater contamination from chemicals including polychlorinated biphenyls, polycyclic aromatic hydrocarbons and metals such as arsenic and lead. Marine waters north of Site 10 are major spawning and nursery areas for fish such as herring and salmon, and certain shellfish inhabit beaches near Site 10.

Location of Site 10 North End Landfill.

Remediation Activities

EXAMPLES

WHAT CAN WE DO ABOUT IT?
RAISE AWARENESS



- Get people thinking about this as one more issue related to climate change
- Climate and environmental justice
- Economic, infrastructure concerns
- Learn from current examples of flooding coastlines

WHAT CAN WE DO ABOUT IT
REMEDIATION PLANS

- Incorporate potential effects into management plans
- Consideration in Remedy Selection
- Evaluation of Prior Remedies

WHAT CAN WE DO ABOUT IT
PLANNING

- Sustainability plans
- Permitting process
- Redevelopment plans
- Hazard mitigation and disaster planning

WHAT CAN WE DO ABOUT IT
REGULATIONS

Criteria for high-risk sites

Guidance, policies and regulations to address impacts and mitigate adverse impacts

Encourage responsible parties to be proactive in reducing climate change related risks

QUESTIONS?

Photo: Daniel Davila

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