

SEA LEVEL RISE VULNERABILITY AND ADAPTATION IN HAWAII



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HAWAII CLIMATE CHANGE MITIGATION AND ADAPTION INITIATIVE

(Act 32, 2017; replaces Act 83, 2014)

- Hawaii becomes the first state to enact legislation that implements portions of the Paris climate agreement
- Establishes a Hawaii Climate Change Mitigation and Adaptation Commission
- Provide policy direction, coordination, and planning among agencies
- Establish climate change mitigation and adaptation strategies
- Complete the Sea Level Rise Vulnerability and Adaptation Report





- Adopted by the State Climate Commission December 2017.
- A technical report, not an adaptation plan.
- Assesses vulnerabilities to coastal hazards with sea level rise.
- Provides recommendations for improving resilience to coastal hazards.
- Provides a framework for assessing other climate change impacts.

THE HAWAII SEA LEVEL RISE VIEWER

Sea Level Rise : Hawai'i Sea Level Rise Viewer

O'ahu | Mokulē'ia

or use <Shift>-drag to zoom

Sea Level Rise Exposure Area
3.2 ft scenario

300 m
1000 ft

Google

Map data ©2018 Google Imagery ©2018, DigitalGlobe, U.S. Geological Survey, USGS Terms of Use Report a map error

opacity: 75%

BASEMAPS

EXPOSURE

- Sea Level Rise Exposure Area (SLR-XA) (a, b, and c combined area)
 - 0.5 ft
 - 1.1 ft
 - 2.0 ft
 - 3.2 ft
- a. Passive Flooding (all major islands)
- b. Annual High Wave Flooding (Kaua'i, Maui, and O'ahu only)
- c. Coastal Erosion (Kaua'i, Maui, and O'ahu only)

VULNERABILITY

- Potential Economic Loss
- Flooded Highways

OTHER OVERLAYS

[expand](#) • [collapse](#) • [clear](#) • [hide](#)

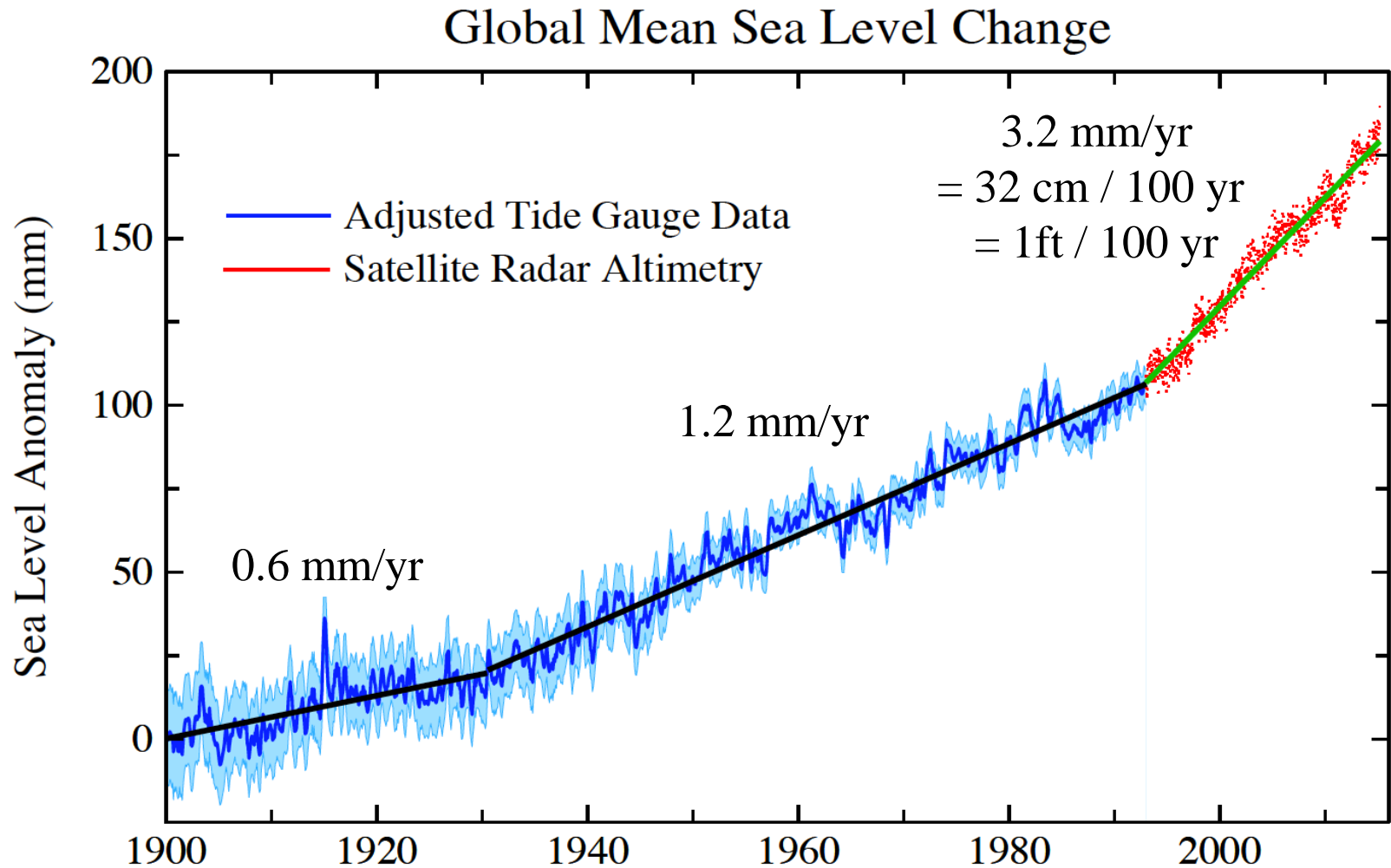
PacIOOS

[view full-screen map](#)

Funding provided by the National Oceanic and Atmospheric Administration (NOAA) through their 2016 Regional Coastal Resilience Grants Program.

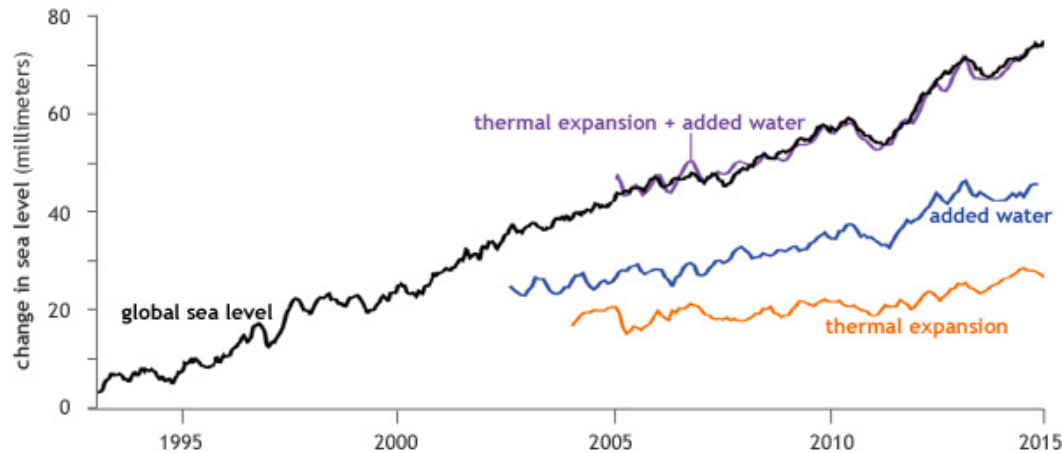
hawaiiisealevelriseviewer.org

INCREASING GLOBAL MEAN SEA LEVEL

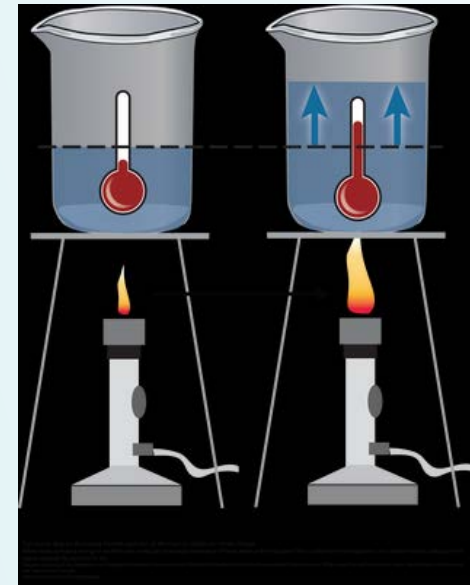


CONTRIBUTIONS TO SEA LEVEL RISE

Global mean sea level budget since 1993



Bulletin of the American Meteorological Society, *State of the Climate in 2014* report



Integration and Application Network,
University of Maryland Center for
Environmental Science

Sea level rise forecasts continue to evolve with the science.

- Recent studies on Antarctic and Greenland ice-sheet instability indicate that higher SLR forecasts are more likely than previously thought.
- NASA December, 2015: " Given what we know now about how the ocean expands as it warms and how ice sheets and glaciers are adding water to the seas, it's pretty certain we are locked into at least 3 feet of sea level rise, and probably more."

GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES



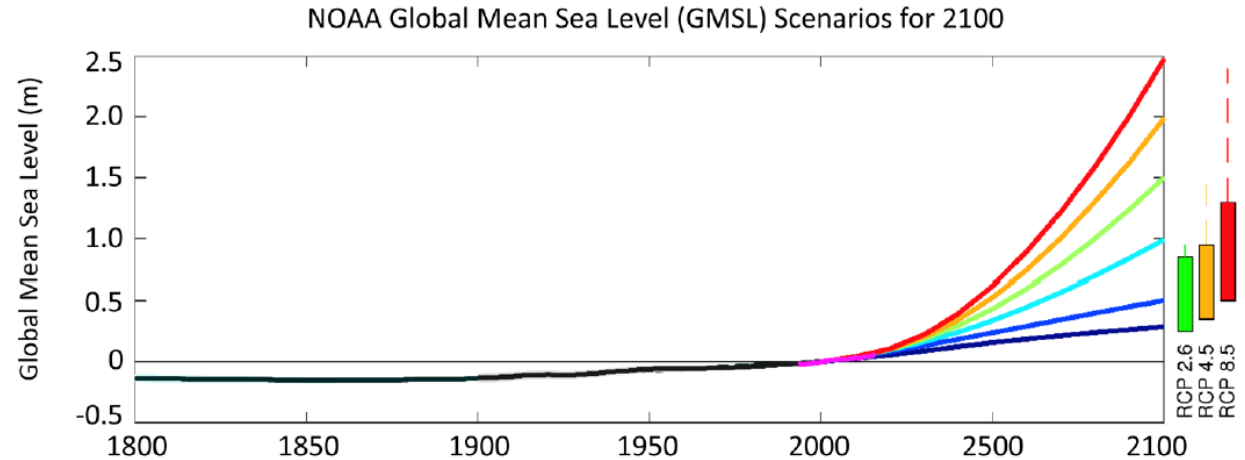
Photo: Ocean City, Maryland

Silver Spring, Maryland
January 2017



noaa National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

NOAA 2017 Global Mean SLR Scenarios



2030: 5-9 in (0.13-0.24 m)
Intermediate = 6 in (0.16 m)

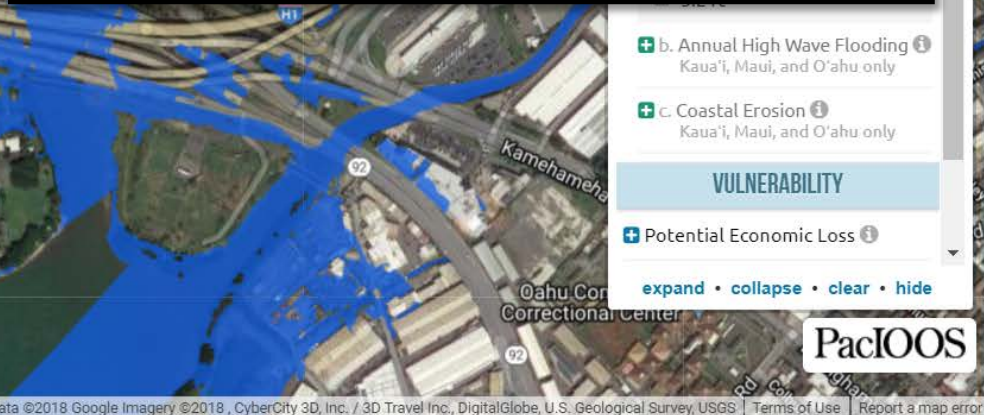
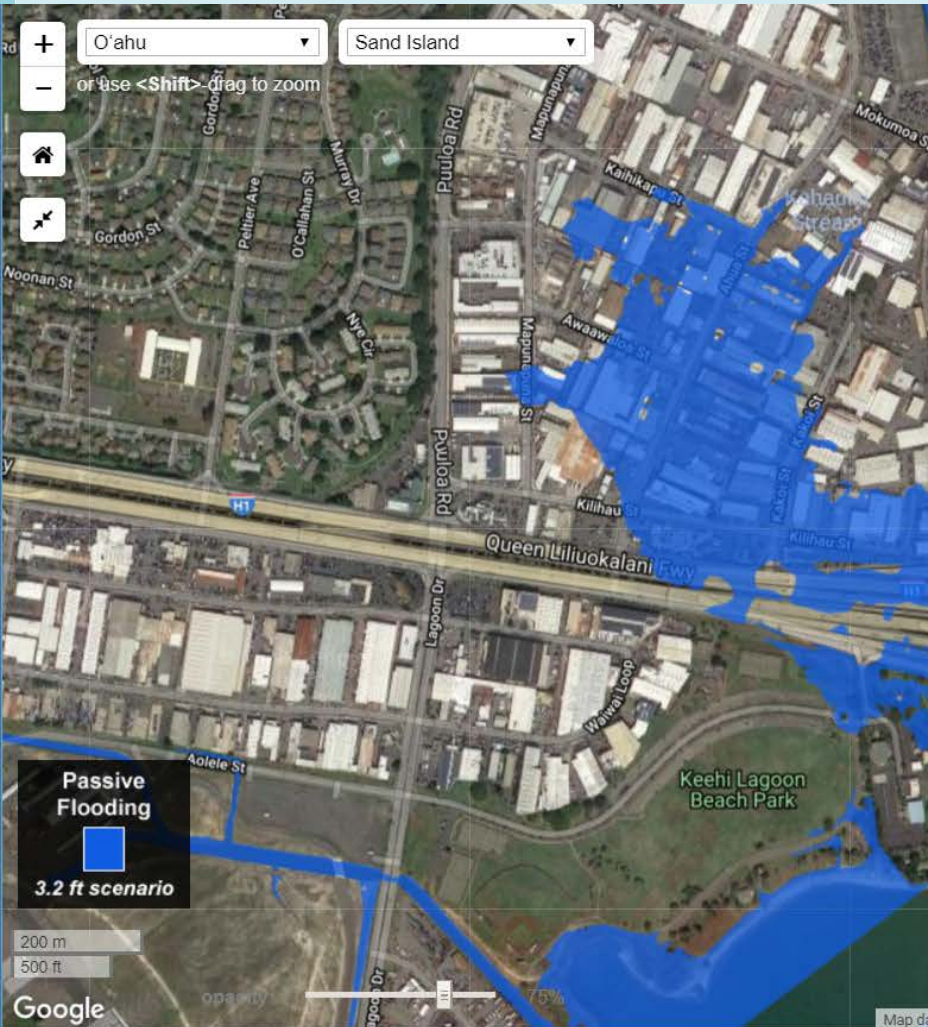
2045: 8-20 in (0.21-0.52 m)
Intermediate = 12 in (0.3 m)

2100: 20-98 in (0.5-2.5 m)
Intermediate = 39 in (1.0 m)

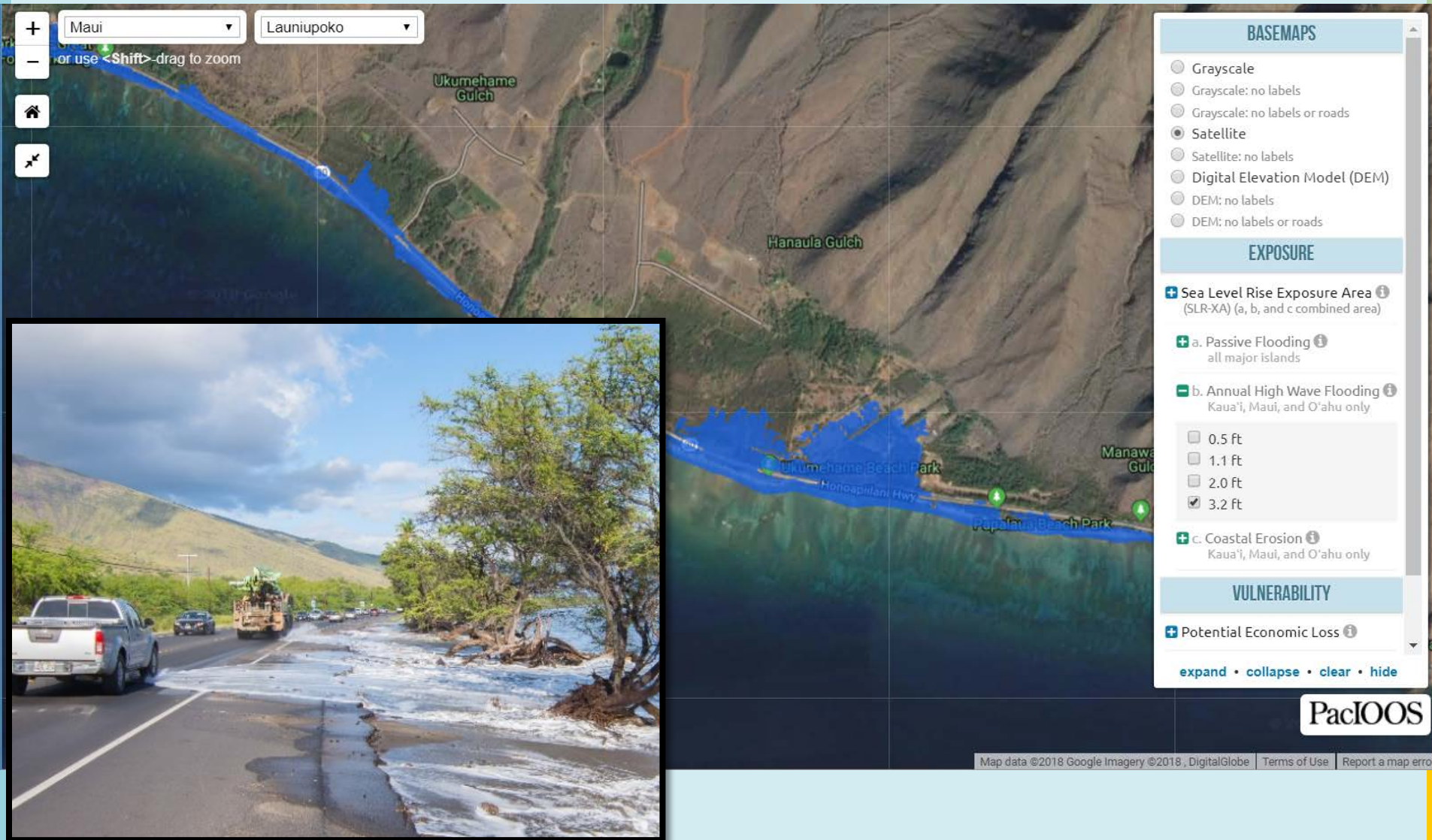
Table 5. GMSL rise scenario heights in meters for 19-year averages centered on decade through 2200 (showing only a subset after 2100) initiating in year 2000. Only median values are shown.

| GMSL Scenario (meters) | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2080 | 2090 | 2100 | 2120 | 2150 | 2200 |
|------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Low | 0.03 | 0.06 | 0.09 | 0.13 | 0.16 | 0.19 | 0.22 | 0.25 | 0.28 | 0.30 | 0.34 | 0.37 | 0.39 |
| Intermediate-Low | 0.04 | 0.08 | 0.13 | 0.18 | 0.24 | 0.29 | 0.35 | 0.4 | 0.45 | 0.50 | 0.60 | 0.73 | 0.95 |
| Intermediate | 0.04 | 0.10 | 0.16 | 0.25 | 0.34 | 0.45 | 0.57 | 0.71 | 0.85 | 1.0 | 1.3 | 1.8 | 2.8 |
| Intermediate-High | 0.05 | 0.10 | 0.19 | 0.30 | 0.44 | 0.60 | 0.79 | 1.0 | 1.2 | 1.5 | 2.0 | 3.1 | 5.1 |
| High | 0.05 | 0.11 | 0.21 | 0.36 | 0.54 | 0.77 | 1.0 | 1.3 | 1.7 | 2.0 | 2.8 | 4.3 | 7.5 |
| Extreme | 0.04 | 0.11 | 0.24 | 0.41 | 0.63 | 0.90 | 1.2 | 1.6 | 2.0 | 2.5 | 3.6 | 5.5 | 9.7 |

Hawaii Sea Level Rise Report Hazard Modeling and Mapping: Passive Flooding



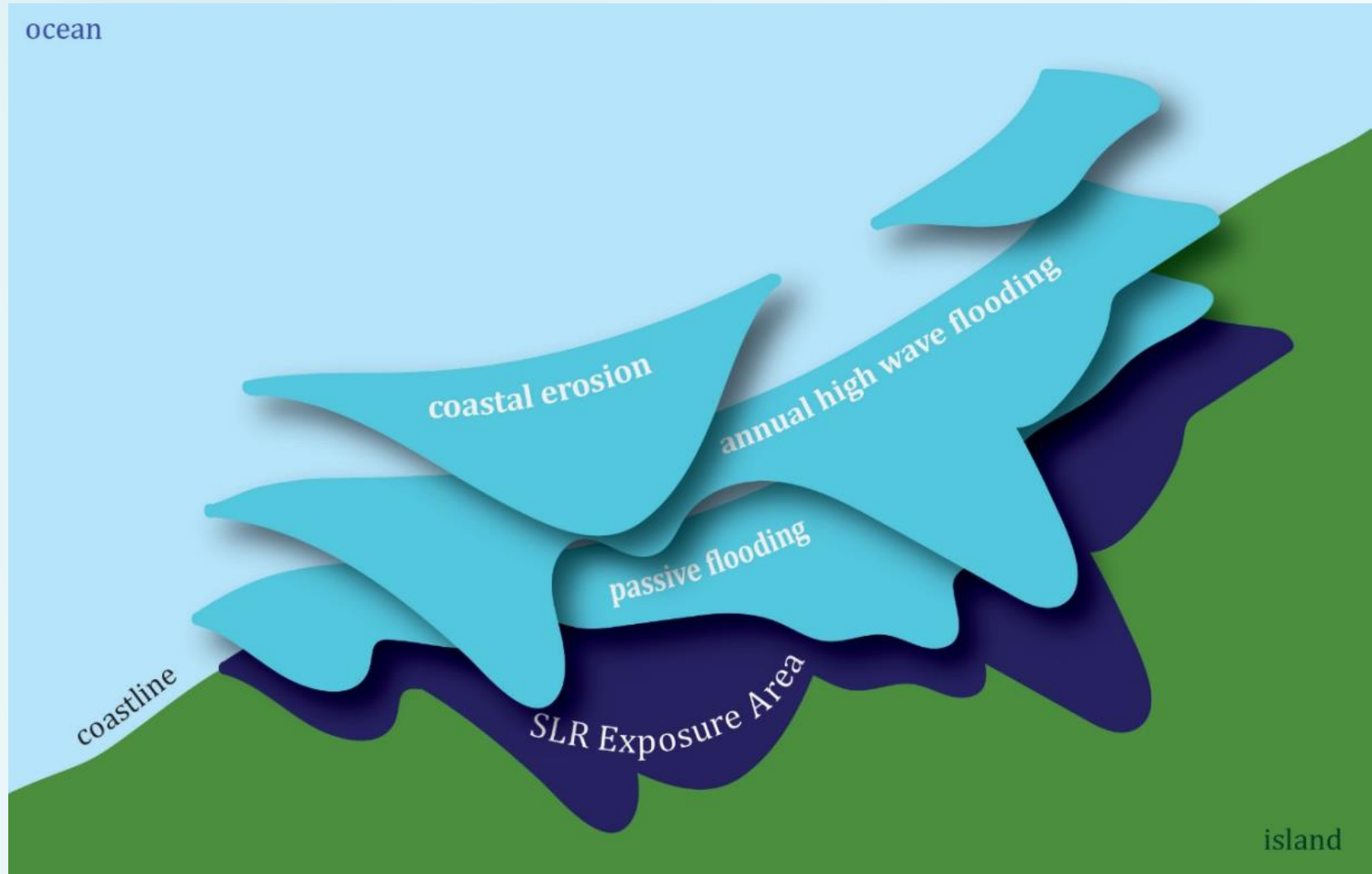
Hawaii Sea Level Rise Report Hazard Modeling and Mapping: Annual High Wave Flooding



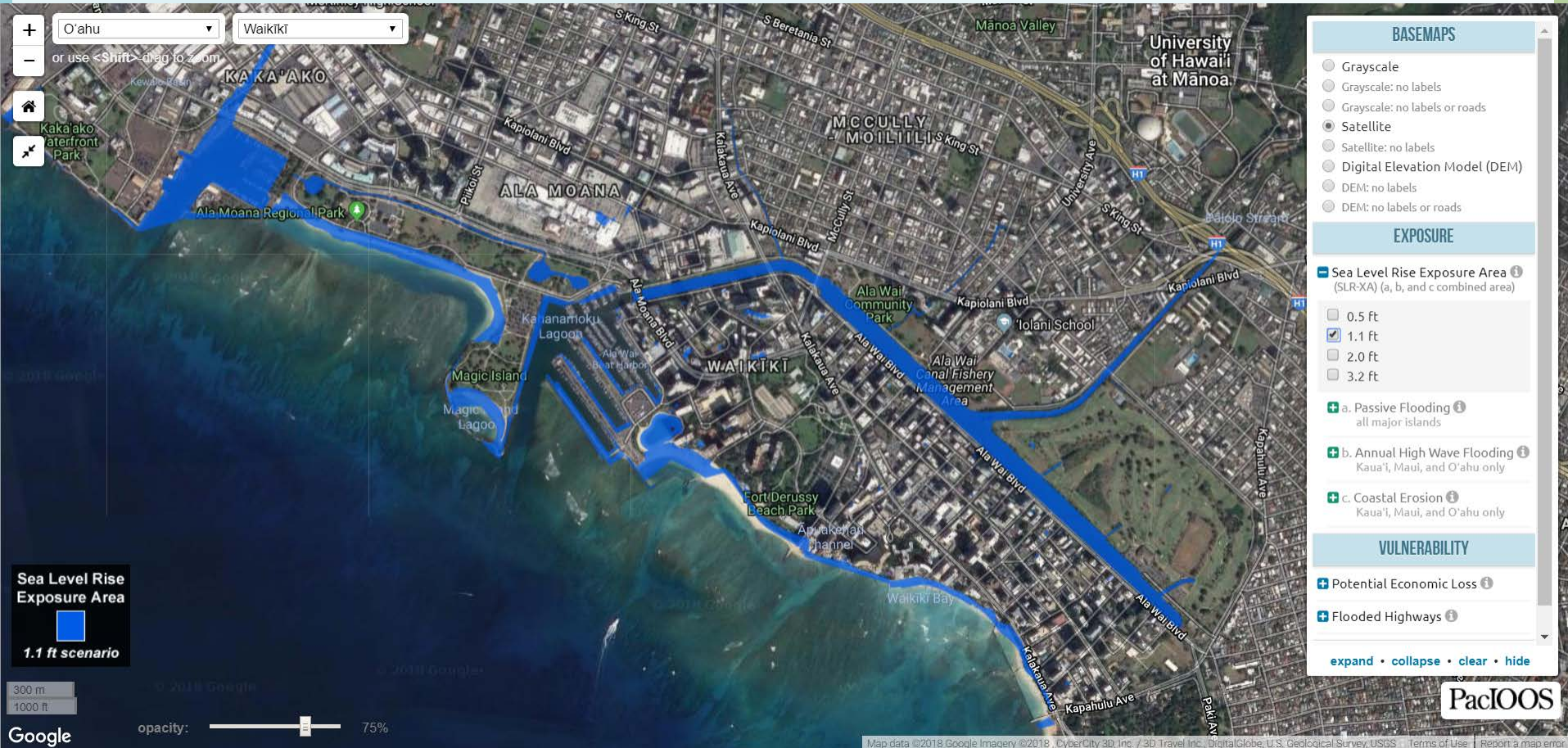
Hawaii Sea Level Rise Report Hazard Modeling and Mapping: Coastal Erosion



SEA LEVEL RISE EXPOSURE AREA (SLR-XA)



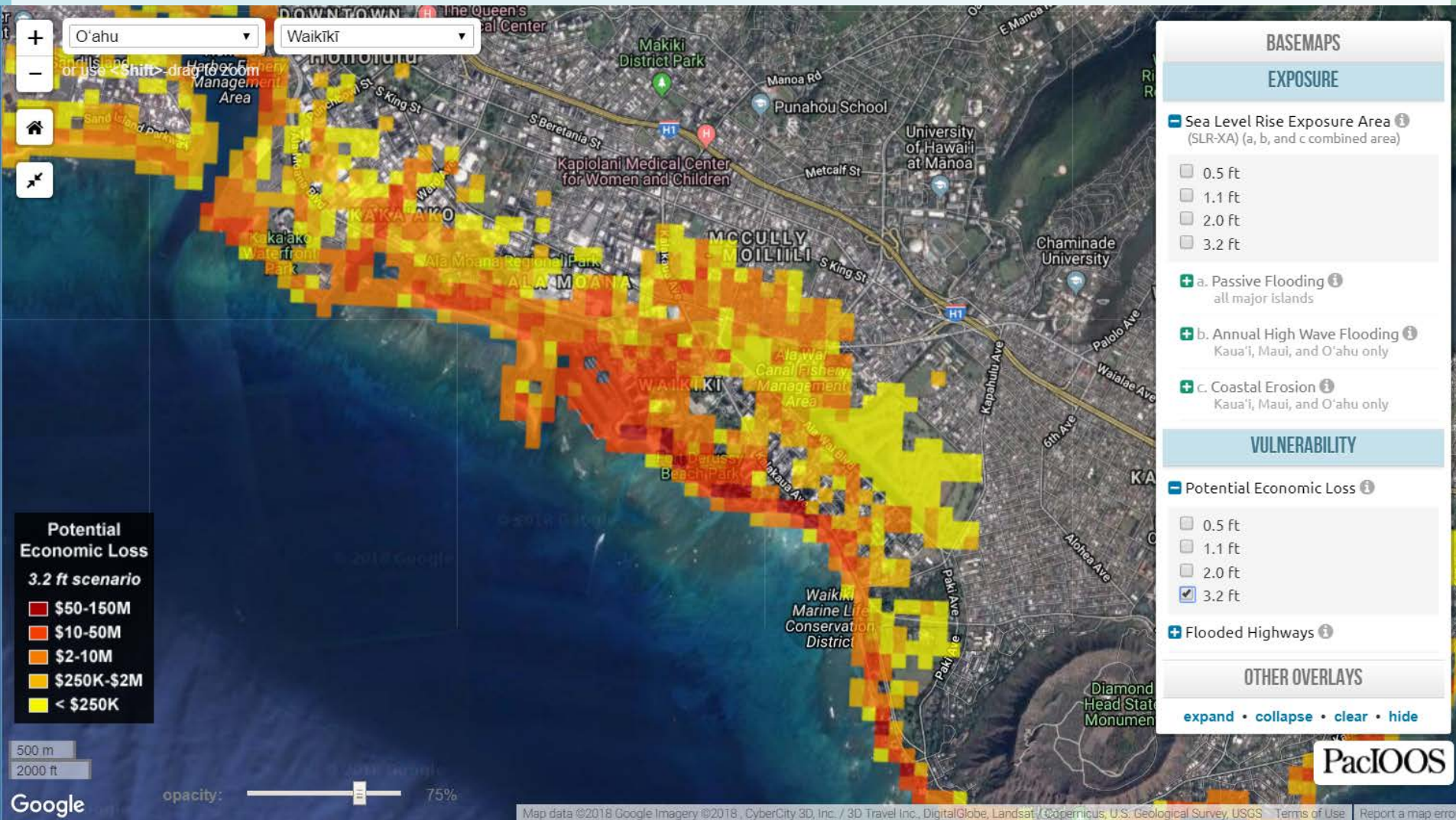
Example: Waikiki SLR-XA @ 1.1 ft (0.34 m) SLR 2030s (NOAA extreme) - 2050 (NOAA intermediate)



Example: Waikiki SLR-XA @ 3.2 ft (1 m) SLR 2060s (NOAA extreme) - 2100 (NOAA intermediate)



Example: Waikiki Property Loss @ 3.2 ft (1 m) SLR

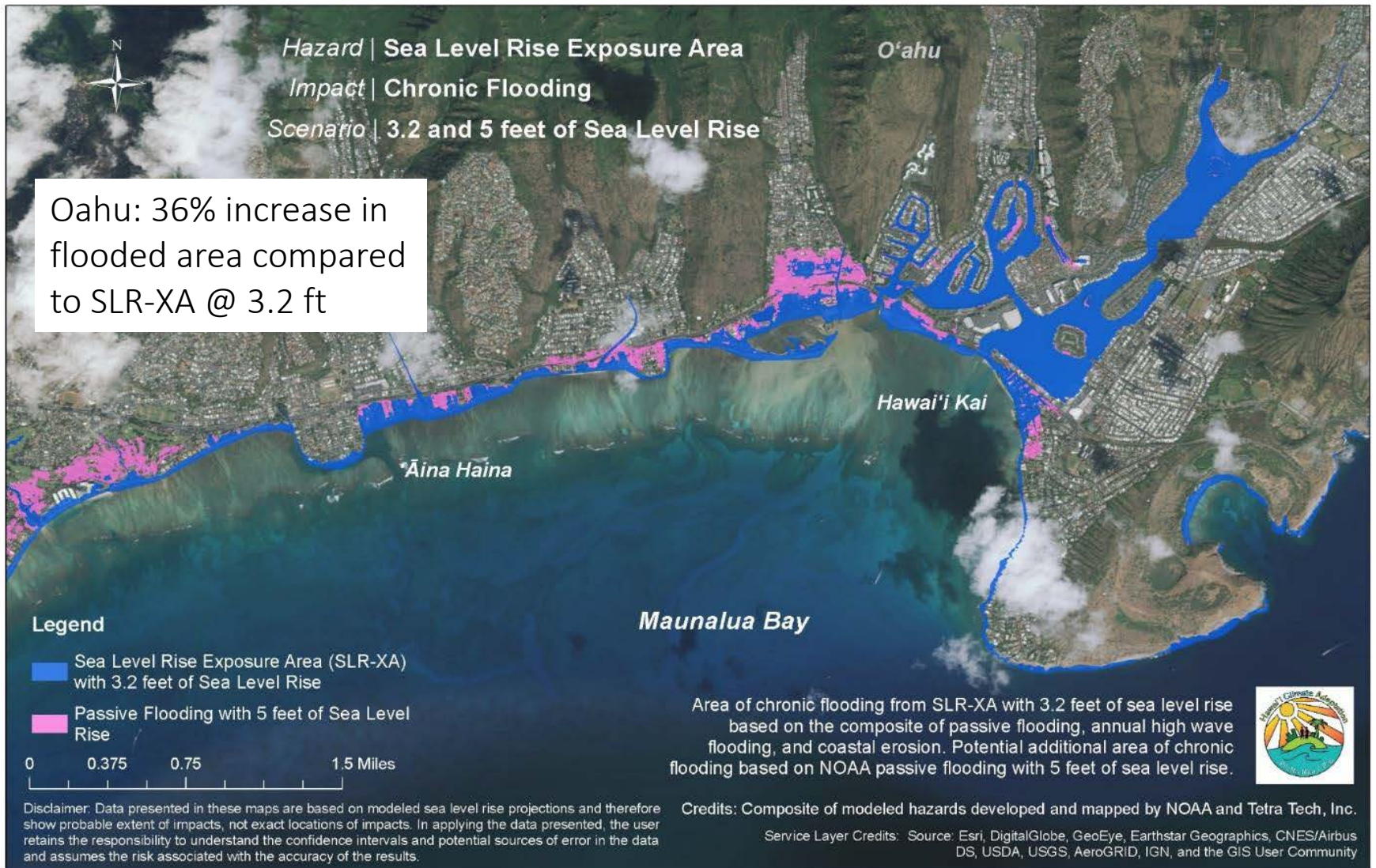


STATE-WIDE VULNERABILITY

@ 3.2 FEET OF SEA LEVEL RISE (ca. 2060-2100)

- \$19 billion in loss of land and structures
- 116 miles of major road and coastal highway flooded
- 6,500 structures flooded
- 19,800 people displaced
- ?? billion in loss of critical infrastructure
- Oahu stands out as the most impacted island

COMPARISON OF POTENTIAL CHRONIC FLOODING WITH 3.2 & 5 FEET OF SLR



HAWAII SEA LEVEL RISE REPORT RECOMMENDATIONS

Begin planning for 3 ft of SLR after mid-century

Recognize the SLR-XA as a state-wide vulnerability zone

Community Planning Area

Strive to balance managed retreat strategies from vulnerable urban areas with preservation of agriculture and conservation lands by relying on state planning act policies and tools and the State Land Use Commission boundary review process

Develop shoreline protection and preservation priorities

Chronic flooding with sea level rise (SLR-XA)

Develop guidance for integrating coastal resilience in state, county, and community plans

Conduct an inventory of existing lands designated for urban use that are located outside of the SLR-XA and prioritize these areas for new development

Consider higher SLR scenarios for critical infrastructure

Sea Level Rise Adaptation Strategies

- **Avoidance:** ensure development does not take place in areas subject to coastal hazards associated with sea level rise.
- **Protection:** prioritize protecting people, property, and infrastructure in its current location using hard and soft defensive measures.
- **Accommodation:** allow continued development but require that structures be built or retrofit to be more resilient to sea level rise.
- **Retreat:** withdraw, relocate or abandon private or public assets at risk due to sea level rise and associated coastal hazards.
- **Preservation:** preserve and enhance lands for natural resource and habitat values allowing wetlands and beaches to migrate inland with sea level rise

Mahalo!

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