Adapting to Sea Level Rise in Hawaii

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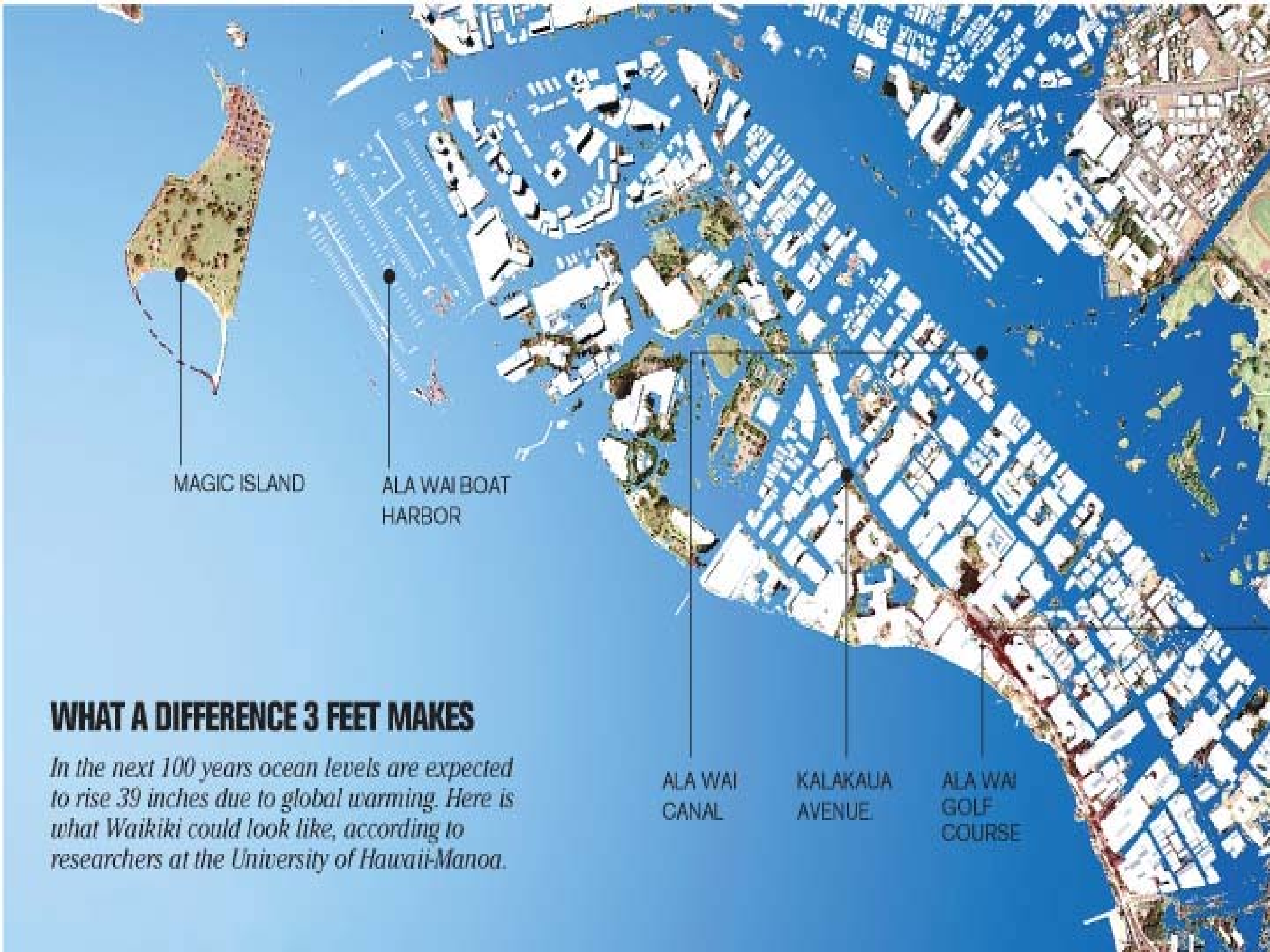
Estimates of Sea Level Rise in Hawaii

- .24 m by 2050; 1m by 2100
- Erosion multiplier of 150 [according to State of Hawaii Multi-Hazard Mitigation Plan, 2007]
- Hence, .24 m increase results in beach retreat of 36 m.



WHAT A DIFFERENCE 3 FEET MAKES

In the next 100 years ocean levels are expected to rise 39 inches due to global warming. Here is what Waikiki could look like, according to researchers at the University of Hawaii-Manoa.

Short Term Impacts of Sea Level Rise

- Beach erosion and retreat
- Increased flooding in coastal areas
- Reduced access to shoreline attractions
- Threats to key infrastructure including roads, sewers, storm drains, electrical lines
- Threats to freshwater aquifers

Beach Erosion is the Primary Initial Impact of Sea Level Rise

Kailua Beach Erosion

Beach Erosion

4 miles of beaches lost over the last 50 years

Flooded Highway

Selected Sea Level Rise Initiatives

- Hawaii Ocean Resources Management Plan
- Hawaii Greenhouse Gas Emissions Reduction Task Force
- Climate Change Task Force [2009]
- Center for Island Climate Adaptation and Policy, University of Hawaii
- Coastal Geology Working Group, University of Hawaii

Key Management Tools

- Beach nourishment
- Shoreline setbacks
- Special Management Area [ICM]
- Urban zoning
- Tsunami zones
- Flood zones

Beach Nourishment

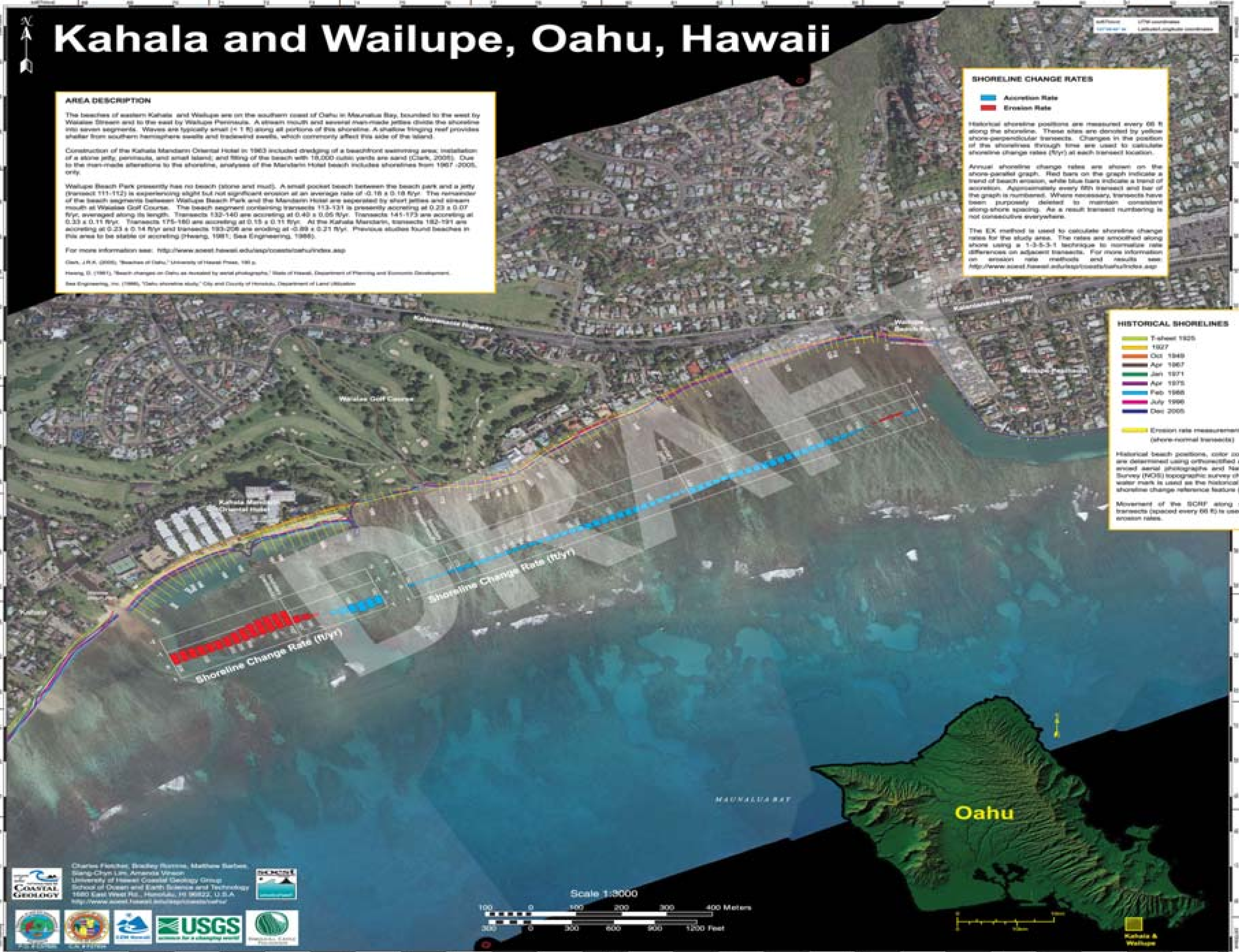
Waikiki cost $25 million over 5 years

Shoreline Setback

- Minimum 40’ setback line required by state law
- Variable setback lines on Maui and Kauai
- Variable line = [life expectancy of structures—generally 70-100 years] x erosion rate adjusted for sea level rise]
- No permanent structures within setback area

Lanikai Seawall

25% of sandy beaches on island of Oahu lost or narrowed because of shoreline hardening

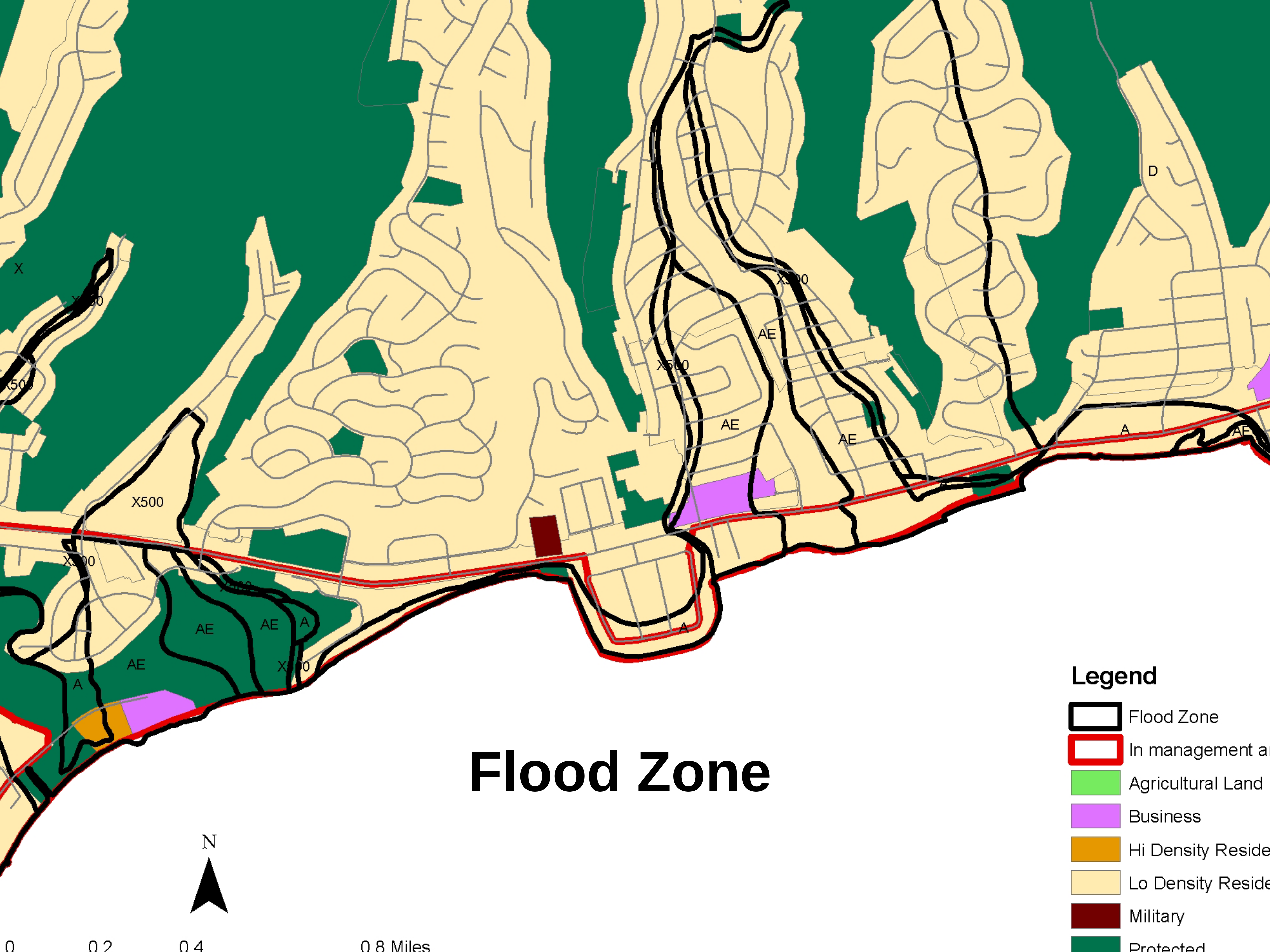

Kahala and Wailupe, Oahu, Hawaii
AREA DESCRIPTION
The beaches of eastern Kahala and Wailupe are on the southern coast of Oahu in Maunalua Bay, bounded to the west by Waialae Stream and to the east by Wailupe Peninsula. A stream mouth and several man-made jetties divide the shoreline into seven segments. Waves are typically small (< 1 ft) along all portions of this shoreline. A shallow fringing reef provides shelter from southern hemisphere swells and tradewind swells, which commonly affect this side of the island.
Construction of the Kahala Mandarin Oriental Hotel in 1963 included dredging of a beachfront swimming area; installation of a stone jetty, peninsula, and small island; and filling of the beach with 18,000 cubic yards are sand (Clark, 2005). Due to the man-made alterations to the shoreline, analyses of the Mandarin Hotel beach includes shorelines from 1967 -2005 only.
Wailupe Beach Park presently has no beach (stone and mud). A small pocket beach between the beach park and a jetty (transect 111-112) is experiencing slight but not significant erosion at an average rate of -0.16 ± 0.18 ft/yr. The remainder of the beach segments between Wailupe Beach Park and the Mandarin Hotel are seperated by short jetties and stream mouth at Waialae Golf Course. The beach segment containing transects 113-131 is presently accreting at 0.23 ± 0.07 ft/yr, averaged along its length. Transects 132-140 are accreting at 0.40 ± 0.05 ft/yr. Transects 141-173 are accreting at 0.33 ± 0.11 ft/yr. Transects 175-180 are accreting at 0.15 ± 0.11 ft/yr. At the Kahala Mandarin, transects 182-191 are accreting at 0.23 ± 0.14 ft/yr and transects 193-206 are eroding at -0.89 ± 0.21 ft/yr. Previous studies found beaches in this area to be stable or accreting (Hwang, 1981; Sea Engineering, 1988).
For more information see: http://www.soest.hawaii.edu/asp/coasts/oahu/index.asp
Clark, J.R.K. (2005), "Beaches of Oahu," University of Hawaii Press, 193 p.
Hwang, D. (1981), "Beach changes on Oahu as revealed by aerial photographs," State of Hawaii, Department of Planning and Economic Development.
Sea Engineering, Inc. (1988), "Oahu shoreline study," City and County of Honolulu, Department of Land Utilization.
SHORELINE CHANGE RATES
Accretion Rate
Erosion Rate
Historical shoreline positions are measured every 66 ft along the shoreline. These sites are denoted by yellow shore-perpendicular transects. Changes in the position of the shorelines through time are used to calculate shoreline change rates (ft/yr) at each transect location.
Annual shoreline change rates are shown on the shore-parallel graph. Red bars on the graph indicate a trend of beach erosion, while blue bars indicate a trend of accretion. Approximately every fifth transect and bar of the graph is numbered. Where necessary, transects have been purposely deleted to maintain consistent along-shore spacing. As a result transect numbering is not consecutive everywhere.
The EX method is used to calculate shoreline change rates for the study area. The rates are smoothed along shore using a 1-3-5-3-1 technique to normalize rate differences on adjacent transects. For more information on erosion rate methods and results see: http://www.soest.hawaii.edu/asp/coasts/oahu/index.asp
HISTORICAL SHORELINES
T-sheet 1925
1927
Oct 1949
Apr 1967
Jan 1971
Apr 1975
Feb 1988
July 1996
Dec 2005
Erosion rate measurement locations (shore-normal transects)
Historical beach positions, color coded by year, are determined using orthorectified and georeferenced aerial photographs and National Ocean Survey (NOS) topographic survey charts. The low water mark is used as the historical shoreline, or shoreline change reference feature (SCRF).
Movement of the SCRF along shore-normal transects (spaced every 66 ft) is used to calculate erosion rates.
Kalanianaole Highway
Wailupe Beach Park
Wailupe Peninsula
Waialae Golf Course
Kahala Mandarin Oriental Hotel
Kahala
Shoreline Change Rate (ft/yr)
Shoreline Change Rate (ft/yr)
DRAFT
MAUNALUA BAY
Oahu
Kahala & Wailupe
Scale 1:3000
100 0 100 200 300 400 Meters
300 0 300 600 900 1200 Feet
Charles Fletcher, Bradley Romine, Matthew Barbee, Siang-Chyn Lim, Amanda Vinson
University of Hawaii Coastal Geology Group
School of Ocean and Earth Science and Technology
1680 East West Rd., Honolulu, HI 96822, U.S.A.
http://www.soest.hawaii.edu/asp/coasts/oahu/
Coastal Geology
USGS

Urban Zoning

- Multiple categories of land use including residential, commercial, industrial, public facilities—and hazard and open space
- Control over location, density, building height and lot siting
- Creates presumption of right to build
- May be expensive to down-zone for purposes of creating open space

Special Management Area

- Coastal zone management area extending a minimum of 300 ft. landward from shoreline
- Land use requires an SMA permit from county--subject to coastal policies
- Coastal policies require adequate shoreline access, consistency with county land use plans, no substantial adverse environmental impacts, minimal alteration of landforms, no alteration of beach size etc.



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Legend
Flood Zone
In management a
Agricultural Land
Business
Hi Density Reside
Lo Density Reside
Military
Protected
N
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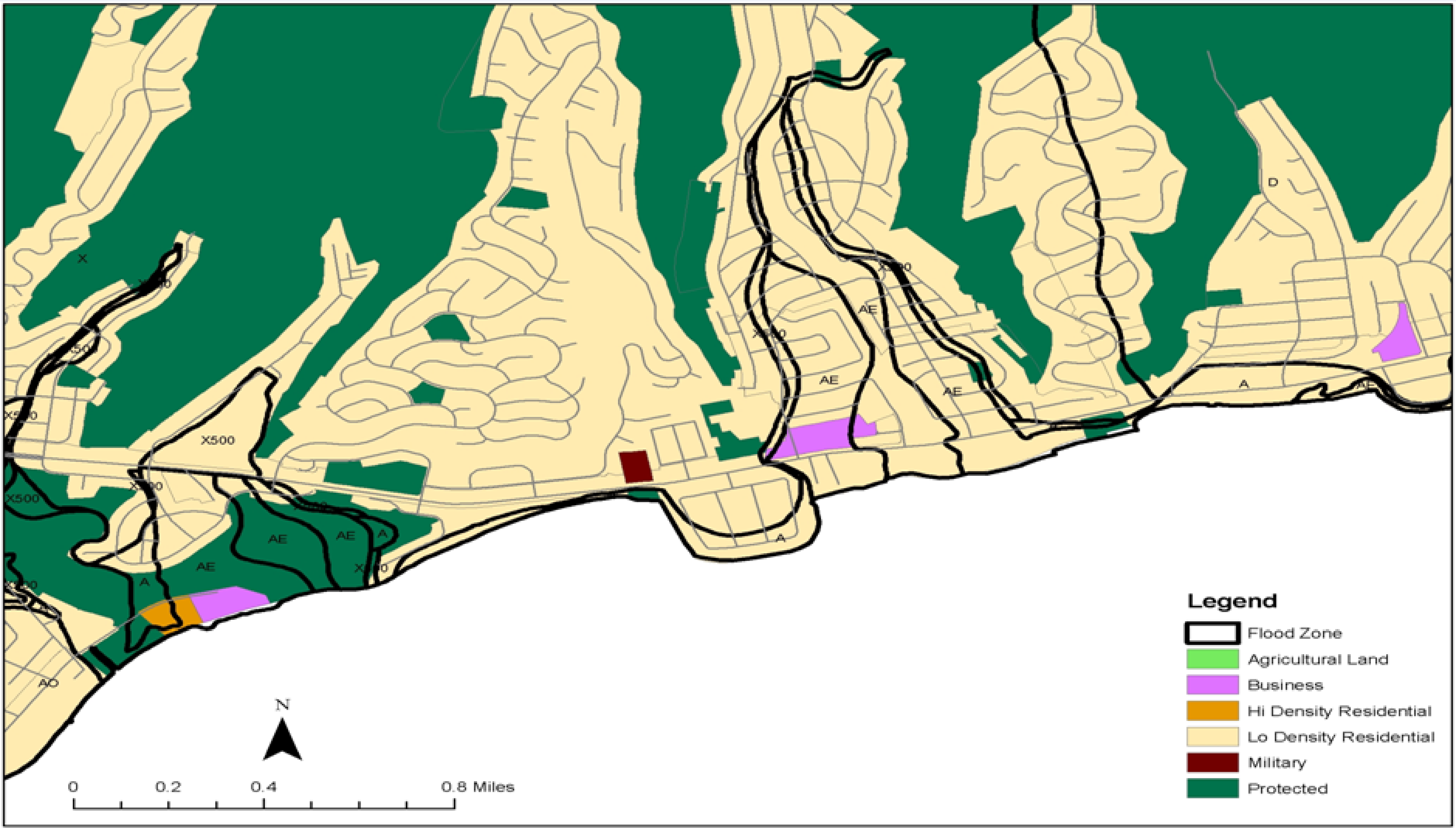
0.2
0.4
0.8 Miles

Flood Zone

Designated Flood Zones

- Communities required to identify flood risk zones based on history, hydrology
- Federal subsidies for rebuilding for those who have flood insurance
- Multiple types of zones identified including 100 year flood
- Hawaii maps include tsunami zones and historic hurricane data

Designated Flood Insurance Zones, East Honolulu



Building Codes in Flood Zones

What's next in Hawaii's Adaptation Efforts?

Possible “No Regrets” Adaptation Initiatives for Next Decade

- Stricter enforcement of illegal seawalls regulations
- More beach protection plans [with increased community involvement]
- Stricter building code requirements in flood prone areas
- Reduced insurance subsidies for new or re-built structures in most flood-prone areas
- Identification of potential 75-100 year sea level rise “impact zones” on each island

Key Assumptions about Longer Term Inundation Scenarios

- Many of the questions associated with sea level rise are primarily technical
- However, identifying some of the impacts of sea level rise and designing strategies to address them will create winners and losers--and is likely to be intensely political.
- Developing solutions that are regarded as both effective and legitimate will require both technical analysis and transparent deliberative processes involving experts, managers, politicians and citizens.

Possible Interventions for 2050 and Beyond

- Identification of areas at high risk of frequent flooding—including existing residential and commercial areas
- Identification of specific infrastructure or infrastructure systems [e.g. highways or sewage treatment plants] for protection or relocation
- Expanded no-build zones, flood-protection infrastructure, relocation of homes, businesses and infrastructure

How Do We Choose Among Possible Interventions?

Possible Criteria for Choosing among Possible Interventions

- Construction and maintenance costs
- Community risk—is strategy appropriate for anticipated sea level rise?
- Economic efficiency—benefits greater than if resources applied to other approaches?
- Equity—who benefits and who pays in direct costs and dislocations?
- Institutional feasibility—acceptable to the public? Does it require new institutions to implement?


What kind of future will we create?