Panel 2. Paddling together to Accelerate Actions for Adaptation to Sea Level Rise[1]

Background: The situation in Hawai‘i—rising seas, less habitable land

Since record keeping began at the Honolulu Tide Station in 1905, local sea level has risen approximately 0.16 m (0.53 ft). The rate of local sea level rise, 1.48+/-0.21 mm/yr (0.058 in/yr), is about half the global mean, but is expected to accelerate over coming decades, and potentially exceed 7.6 mm/yr (0.3 in/yr) averaged over the second half of the century (Spada et al., 2013).

In the Fourth National Climate Assessment, Climate Science Special Report (USGCRP, 2017), six scenarios of sea level rise are provided through the year 2100 (Sweet et al., 2017). These have been developed to aid community planning with low end scenarios intended for projects with high risk tolerance, and high end scenarios intended for projects with little tolerance for risk. Scenarios range from a low-end of 0.3 m (1 ft), to a worst-case of 2.5 m (8.2 ft) of sea level rise by 2100.

Studies indicate this level of flooding will reshape the distribution of human communities, potentially stressing landlocked areas unprepared to accommodate a wave of coastal migrants (Hauer, 2017). Globally, by the year 2100, rising sea levels could force up to 2 billion people inland, creating a refugee crisis among one-fifth of the world’s population (Geisler and Currens, 2017). Worse yet, there won’t be many places for those migrants to go.

Researchers have identified three obstacles, or “barriers to entry,” that stand in the way of people driven inland from their homes by rising seas (Geisler and Currens, 2017). The first is that drought and desertification make some areas uninhabitable at worst, and incapable of sustaining a large influx of migrants at best. Second, if climate refugees flock to cities, the increasing urban sprawl might require land that was formerly used to grow food. Those communities could lose the ability to feed their inflated populations. Third, regions and municipalities might erect walls and post guards to prevent climate migrants from entering and settling down. This phenomenon is dubbed the “no-trespass zone.”

This pattern of population displacement is likely to be amplified among Pacific islands. Communities forced from low-lying atolls and remote coastal plains will seek accomodation among the high volcanic and limestone islands, which are already experiencing the negative impacts of sea level rise. Among the communities of a single island, displaced groups seeking asylum are likely to accentuate the socio-economic disparity that already characterizes these places.

[1] Disclaimer: This is a draft document produced for discussion purposes for the 2019 Climate Conference of the State’s Climate Commission. Since this is an emerging document, with gaps that need to be filled, if you have any information that would further its intent, please contact the Hawaii Climate Change Mitigation and Adaptation Coordinator, Anukriti Hittle at the following email: Anukriti.s.Hittle@hawaii.gov. Date of draft:January 7, 2019

Local Impacts: New storm tracks and increasing tsunami penetration

The foreseeable impacts of rising sea levels are of deep concern in Hawai‘i. There is consensus that adaptive measures should not result in further degradation of natural resources, infrastructure, or the economy. However, uncertainty remains regarding how to reduce such impacts as, at this point, measures employed in other coastal settings (i.e., buyouts, coastal hardening, and hydro-engineering) are generally costly, inequitable, and at-least partially ineffective.

Hawai‘i is acutely vulnerable to coastal hazards regardless of sea level rise. Globally, the zone of maximum winds related to tropical cyclones is already migrating away from the equator and toward the poles (Bender et al., 2012). In the North Central Pacific this would create more land-falling storms among the Hawaiian Islands. Specific modeling of hurricanes in this region indicates rising vulnerability to storm surge, high winds, and heavy rains associated with these storms (Li et al., 2018). More frequent tropical cyclones are projected for the waters near Hawai‘i. This is not necessarily because there will be more storms forming in the east Pacific; rather, it is projected that storms will follow new tracks that bring them into the region of Hawai‘i more often.

Hawai‘i is also no stranger to tsunami that can arrive from all points of the compass. Tsunamis are caused by sudden movement of the seafloor that generates a series of waves, that travel across the ocean until they reach a coast. Seafloor movements may include faulting, landsliding, or submarine volcanic eruptions. Tsunami occur as either large breaking waves, often largest around headlands where they are concentrated by wave refraction, or as rapidly rising ocean level like a flooding tide. As sea level rises over the course of the 21st Century, tsunami that previously might have been considered minor, will increase the distance they penetrate inland and thus, the damage they may potentially cause.

Land-Use and Policies: Only partially effective, and no recognition of sea level rise

The vulnerability to sea level rise in our coastal zones is the direct result of past land-use practices that allowed development and urbanization directly along shorelines and atop low-lying artificially-filled coastal plains. Urbanization occurred with virtually no consideration of shoreline change or episodic flooding events, such that valuable economic centers (e.g., Waikīkī, Honolulu) and critical infrastructure (e.g., Honolulu International Airport) are located within a few feet of the present day high-tide elevation.

Policies have since been implemented to attend to these shortcomings in land use, including adoption of the Coastal Zone Management Act in the mid-1970s that allowed the State to incorporate protective coastal regulations into State and county plans. While such policies have been partially effective towards regulating overall land use, the regulatory agencies have been largely unsuccessful in implementing actions such that they adequately protect both natural coastal resources and coastal development, favoring development in most cases.

An additional flaw of coastal policies is the lack of statutory recognition of sea level rise, and so, there is no obligation by agencies to consider serious impacts in planning and regulatory functions. While there has been some success in recognizing shoreline retreat in State and county planning and regulatory functions (i.e., COEMAP, Hawai‘i Sea Level Rise Mitigation and Adaptation Report, Kauai County General Plan, variable setbacks on Kauai and Maui, City and County of Honolulu SLR guidance), further action is necessary to protect communities and beach resources from coastal hazards.

It is imperative that the State and counties formally recognize sea level rise as a serious threat to coastal development and beach resources through statutory and administrative instruments (rules and ordinances) and provide means of support for robust sea level rise adaptation strategies for communities and public agencies that host or manage threatened infrastructure.

Coastal Realities: Beaches and sea walls do not mix well

While it is imperative policies and actions be strengthened, there remains the hard truth that in a regime of accelerating sea level rise, it is generally impossible to protect existing coastal development and beach resources concurrently (Summers et al., 2018). The two assets simply cannot coexist in a time of rising seas. Landward migration of the coastline in regions where coastal infrastructure and development are immovable will inevitably result in beach degradation, either by hardening of shorelines or by structural failure and demise of beachfront development. This raises the question of value--can Hawai'i stand to lose more beaches? How will isolated coastal communities be serviced without coastal roads? Is it even possible to live on a moving shoreline? These are difficult questions to answer in a State where the legal framework guarantees the right of public access to the ocean, the conservation of natural environments, and the preservation of open space (H.R.S. section 115-1). Hawai'i is also heavily dependent on tourism that largely hinges on dramatic beach landscapes, and a State that hosts some of the most highly valued coastal real-estate in the world.

Hawai'i, like other coastal regions, faces major challenges, and the path towards resolving these remains unclear. It is well understood that we will not escape the severe effects of sea level rise, regardless of actions to reduce global greenhouse gas emissions. The reality is that rising oceans, strengthening storms, and vulnerable coral ecosystems, will reshape our shorelines at a rate that exceeds our ability to fully adapt. That our community design, engineering, and place-making will struggle to maintain equilibirum with a migrating coast and changing climate, has already become a fundamental characteristic of our neighborhoods and infrastructure. This will continue throughout this century and beyond.

We will lose beaches, property, and coastal roads as coastal flooding and erosion becomes more severe and widespread. Governance will become even more complicated as multiple consequences begin to emerge – (e.g., property loss, reduced tax revenue, disrupted travel, narrowing and lost beaches, damage to expensive coastal infrastructure). On top of this, we must worry about increased storminess and other climate change related threats.

In the past we have managed to "muddle through" catastrophic events (e.g., wars, famines, extreme weather events). We could rely on a certain acceptable and affordable frequency to disasters. Past events were always ephemeral, and there was always a general equilibrium to climate. Today however, climate change represents irreversible (at least for generations to come), accelerating, and amplified changes to our civilization. Not only do we have to change the way we design and engineer our communities and infrastructure, we must re-assess our most deeply rooted values regarding property rights, beach access, and the general quality of life in Hawai'i. The citizens, governments, and businesses within Hawai'i will need to continually determine and adjust how we organize ourselves for the challenges and tasks ahead, in the near term and for the "long haul". How will we best re-assess our values, plan better, maintain the necessary will, etc. to carry the results into effective action? This demands conscious attention and courageous action by the broadest possible range of citizens in the state, and should be supported by expanding local climate change research beyond its roots in the "hard sciences" and planning, to diverse subjects such as psychology, political science, economics, finance, law, organizational change, sociology, change management and other management.

As we enter the future, we embark on a trail that we have no choice but to blaze. Success will require efficiency, creativity, compromise, a common understanding of our shared risk, and, importantly, a deepening sense of aloha for this place, for one another, and for future generation. In a climate of rapid change, time becomes a precious commodity. Let us embark on this journey before the trail becomes more treacherous.

The main questions: Tradeoffs and their costs

We are surrounded by signs that our planning approach to climate change adaptation is either overwhelmed, or ineffective, or both – e.g., 1) unable to even address maintenance of existing infrastructure, and overwhelmed by persistent emergencies (some due to climate change), 2) watching the real estate industry spin up shoreline property values despite accelerating sea level rise; 3) adhering to antiquated land use polices and rules that continue to increase our vulnerability to sea level rise despite the fact that we have every reason to change.

1. Given the shortcomings of our present approach (reactionary, ad hoc, profit/application driven, etc.) what changes can we envision to prepare for the inevitable effects of sea level rise (see recommendations below for some examples)?
2. What are the top three things you would do to improve our chances of mitigating the effects of sea level rise?

3. How can Hawai'i's stakeholders best identify and agree upon priorities and approaches and at what scale?

4. How can Hawai'i consider nature-based solutions as part of the solution?

Current Recommendations for Sea Level Rise Adaptation:

In December 2017 the Hawai'i Climate Change Mitigation and Adaptation Commission accepted the Hawai'i Sea Level Rise Vulnerability and Adaptation Report. The report identifies areas that are susceptible to sea level rise impacts based on a 3.2-foot increase in sea level by the end of the century. The City and County of Honolulu promulgated guidance reaffirming this benchmark, and adding that high tide flooding would become disruptive by mid-century and that planning for projects with low tolerance for risk, should consider 6 feet of sea level rise by the end of the century.
The Hawai'i Sea Level Rise Vulnerability and Adaptation Report also included recommendations to state and county agencies based on emerging standards of practice to strengthen Hawai'i's overall readiness to face sea level rise and climate change.

Recommendations from the Hawai'i Sea Level Rise Vulnerability and Adaptation Report:

• Formally recognize the 3.2SLR-XA as a statewide vulnerability zone;
• Prioritize and incentivize smart urban development outside the SLR-XA and limit exposure within the SLR-XA;
• Incentivize improved flood risk management;
• Enable legacy beaches to persist with sea level rise;
• Preserve Native Hawaiian culture and communities with sea level rise;
• Develop innovative and sustainable financing and incentives to support adaptation to sea level rise;
• Promote collaboration and accountability for adapting to sea level rise.

Recommendations from the City and County of Honolulu Sea Level Rise Guidance:

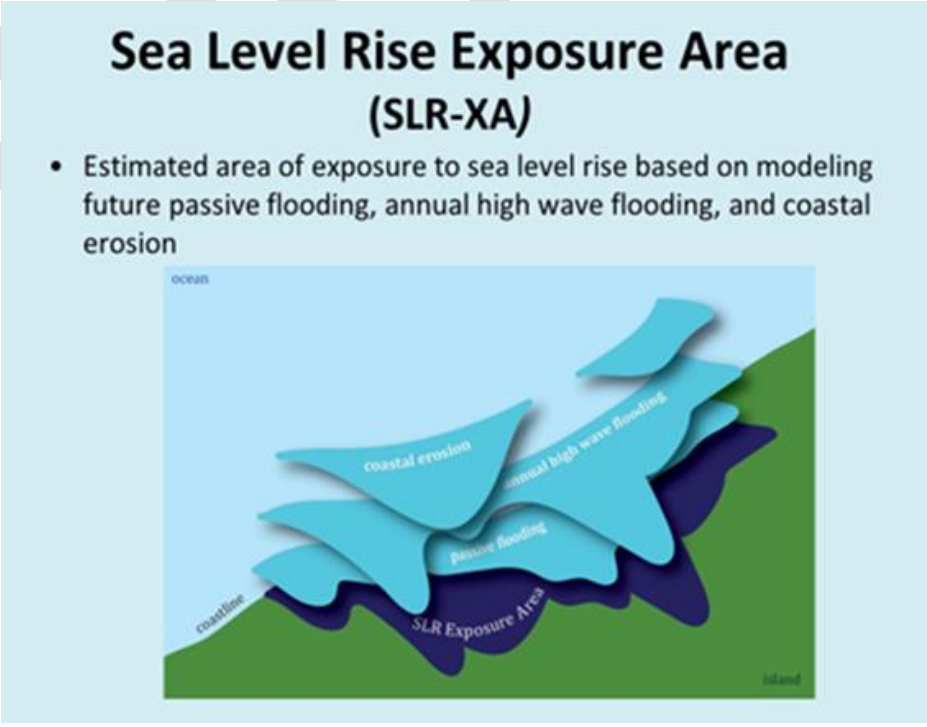
- Use the 2017 Hawai'i Sea Level Rise Vulnerability and Adaptation Report and online viewer, for baseline planning activity and infrastructure assessment and development with regard to sea level rise.
- Set 3.2 ft (~1 m; 3.2SLR-XA) of GMSL rise by the end of the century as a planning benchmark.

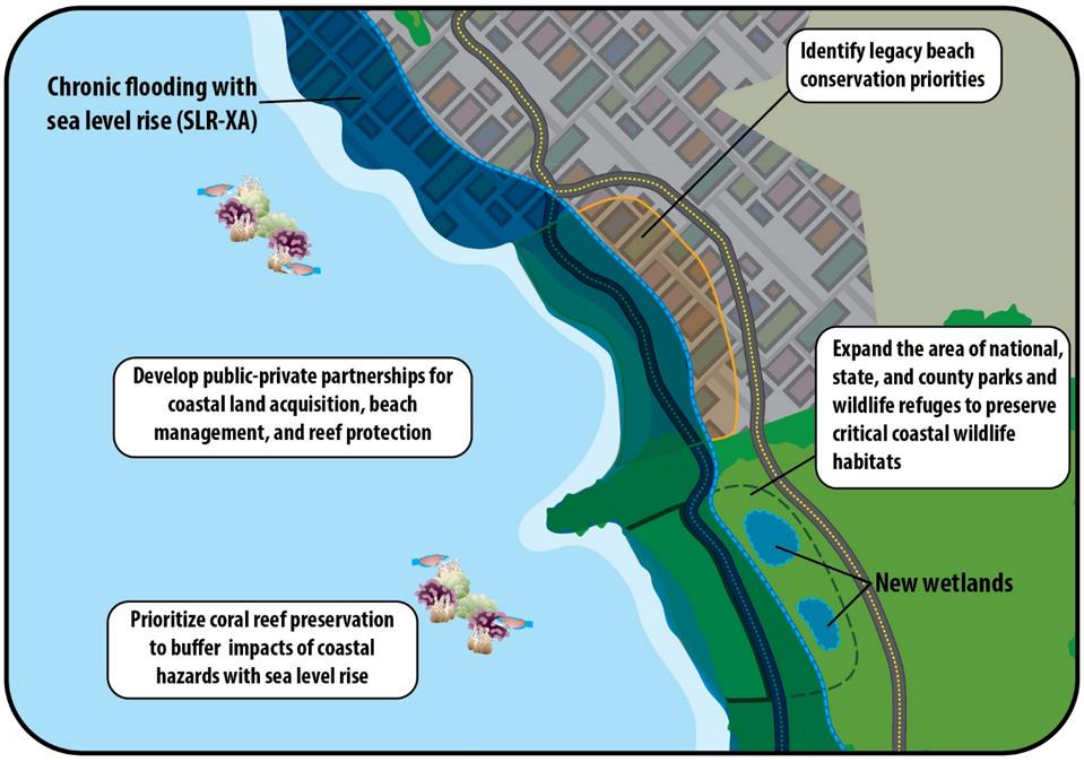
- High-tide flooding will arrive decades earlier and the 3.2SLR-XA will be an area experiencing chronic high tide flooding by mid-century.
- Because global emissions are currently on a warming pathway of over 5.4°F (3.0°C) by the end of this century, set 6 ft (1.8 m; 6SLR) of GMSL rise toward the end of 2100 and into 2200 as a planning benchmark.
- Critical infrastructure with long expected lifespans and low risk tolerance will want to plan accordingly, as the 6SLR will be an area experiencing chronic high tide flooding decades earlier.
- The Special Management Area (SMA) boundary should be revised to include parts of the 3.2SLR-XA that are not currently in the SMA.
- Disclosure of all lands should be required in the 3.2SLR-XA and 6SLR.
    - Disclosure on all real estate sales, City Property Information Sheets, and all other real estate transactions.
- The 3.2SLR-XA and 6SLR should be adopted as a vulnerability zone (hazard overlay) for planning by the City.
    - The hazard overlays should be used for planning purposes, for example in the general plan, all development plans, and sustainable community plans.
- City departments and agencies are directed to use the Report, the 3.2SLR-XA, and the 6SLR in their plans, programs, policies, and capital improvement decisions, to mitigate impacts to infrastructure and critical facilities related to sea level rise.
- All ordinances related to land development, such as policy plans and regulations should be reviewed and updated, as necessary.
- Relevant City departments and agencies should be supported with adequate resources and capacity to implement these recommendations and proactively plan for sea level rise, as it will rapidly become a major challenge to City functions.

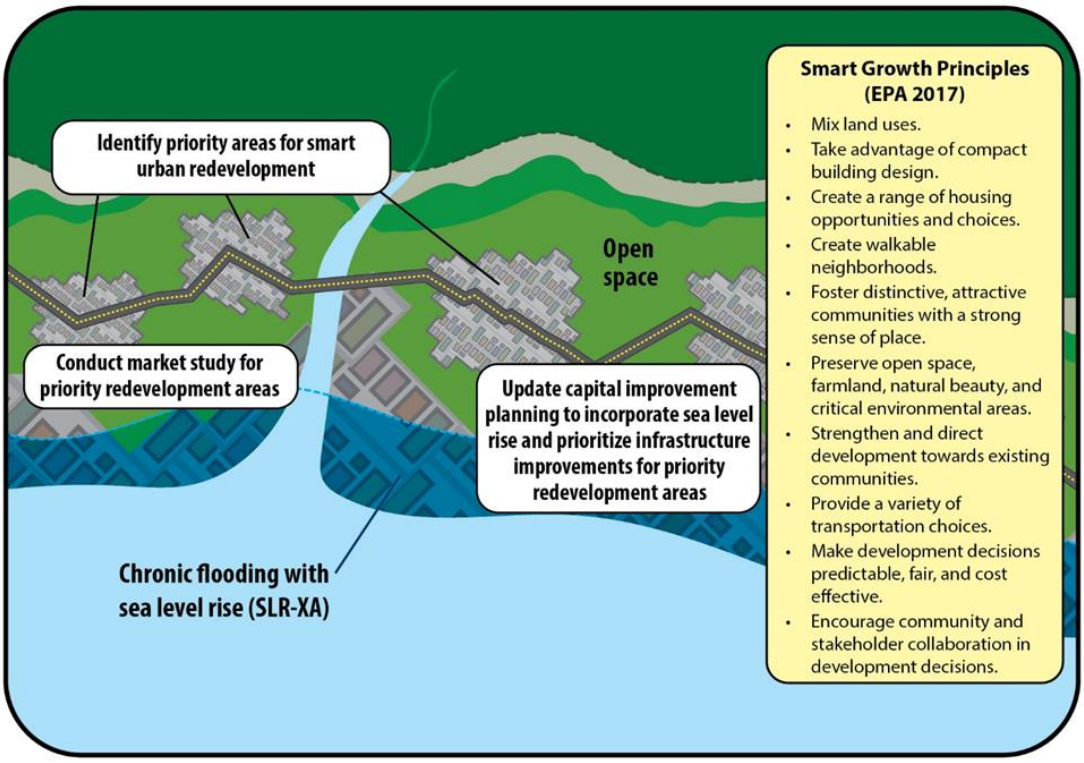
Supplementary Information

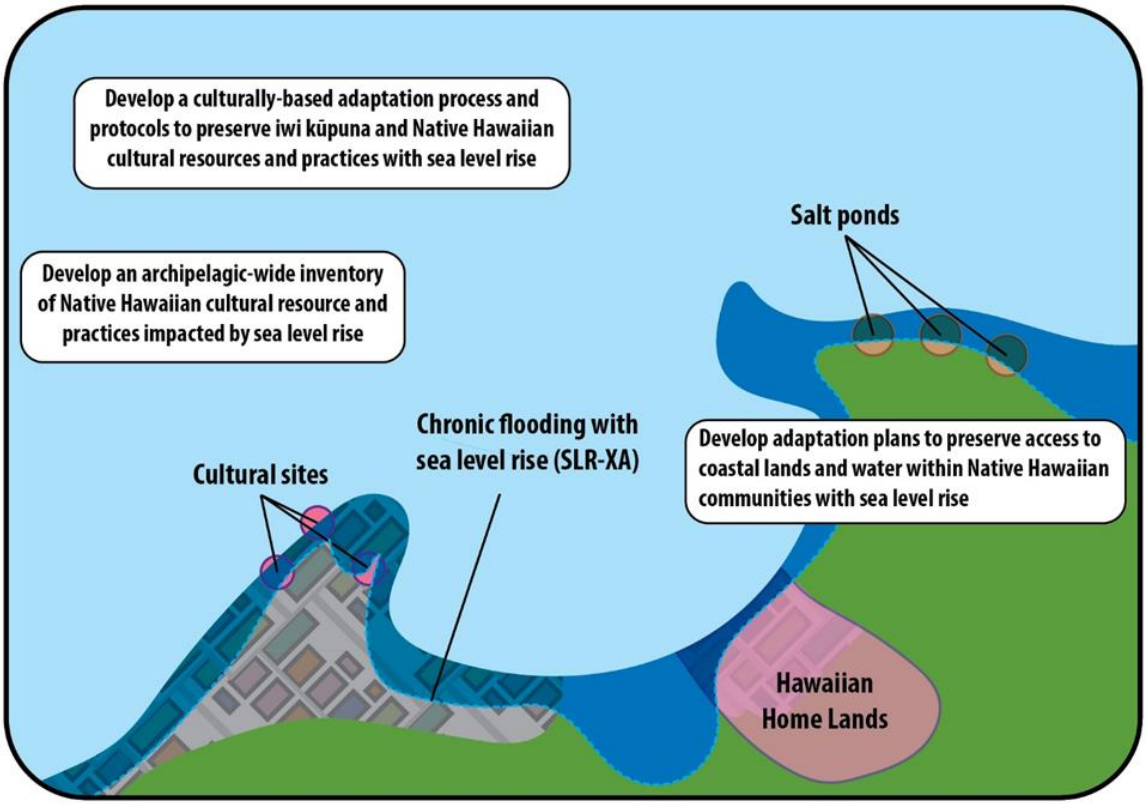
Table 1: The Fourth National Climate Assessment Climate Science Special Report scenarios of sea level rise in meters relative to 2000, broken into decadal stages, that can offer planners a time frame for assessing appropriate adaptation strategies based on the risk tolerance and planned life span of projects. All values are 19-year averages of global mean sea level centered at the identified year (Sweet et al., 2017). Low and Intermediate Low scenarios are likely obsolete with continued acceleration of sea level rise.

Scenario	2020	2030	2050	2100
Low	0.06	0.09	0.16	0.30
Intermediate-Low	0.08	0.13	0.24	0.50
Intermediate	0.10	0.16	0.34	1.0
Intermediate-High	0.10	0.19	0.44	1.5
High	0.11	0.21	0.54	2.0
Extreme	0.11	0.24	0.63	2.5




Chronic flooding with sea level rise (SLR-XA)
Identify legacy beach conservation priorities
Develop public-private partnerships for coastal land acquisition, beach management, and reef protection
Expand the area of national, state, and county parks and wildlife refuges to preserve critical coastal wildlife habitats
New wetlands
Prioritize coral reef preservation to buffer impacts of coastal hazards with sea level rise


Identify priority areas for smart urban redevelopment
Open space
Conduct market study for priority redevelopment areas
Update capital improvement planning to incorporate sea level rise and prioritize infrastructure improvements for priority redevelopment areas
Chronic flooding with sea level rise (SLR-XA)
Smart Growth Principles (EPA 2017)
• Mix land uses.
• Take advantage of compact building design.
• Create a range of housing opportunities and choices.
• Create walkable neighborhoods.
• Foster distinctive, attractive communities with a strong sense of place.
• Preserve open space, farmland, natural beauty, and critical environmental areas.
• Strengthen and direct development towards existing communities.
• Provide a variety of transportation choices.
• Make development decisions predictable, fair, and cost effective.
• Encourage community and stakeholder collaboration in development decisions.


Develop a culturally-based adaptation process and protocols to preserve iwi kūpuna and Native Hawaiian cultural resources and practices with sea level rise
Salt ponds
Develop an archipelagic-wide inventory of Native Hawaiian cultural resource and practices impacted by sea level rise
Chronic flooding with sea level rise (SLR-XA)
Develop adaptation plans to preserve access to coastal lands and water within Native Hawaiian communities with sea level rise
Cultural sites
Hawaiian Home Lands

Massachusetts Sea Level Rise Background[2]:

- MA by the numbers: 1,500 miles of coastline, 78 coastal communities (of 351 municipalities), extreme winter storms and hurricanes, precipitation averages 44+ inches per year, highly developed and populated (top ten in U.S. for both coastal population density and percentage), vulnerable coastal populations include seniors and those living in poverty.
- The Commonwealth of Massachusetts has a wide range of policies, programs, and other capabilities to mitigate natural hazards and adapt to a changing climate. Many of these capabilities do so explicitly (e.g., providing funding for specific mitigation/adaptation projects), while others do so more implicitly (supporting the protection of natural resources in ways that provide ancillary or co-benefits of risk reduction). MA unique coastal approaches include:
  - Strong laws administered by multiple state agencies and local officials which protect natural resources and their functions that enhance safety, avoid costs and benefit both people and nature by constraining development of natural resources such as coastal areas (barrier beaches), wetlands, rivers and floodplains.
  - State Building Code that incorporates or exceeds the Federal Emergency Management Agency's National Flood Insurance Program standards.
  - CZM StormSmart Coasts Program and the tools they provide:
    - to homeowners to better understand strategies they might employ to reduce coastal erosion and storm damage,
    - to local officials to interpret and apply policies and regulations related to erosion, floodplain management, and development
    - To encourage integration of SLR into planning activities via the Coastal Resilience Grant Program, and tools, data and information such as the MA SLR and Coastal Flooding viewer and other resources to assess vulnerability of coastal areas and properties.
  - The Municipal Vulnerability Preparedness Program provides communities with the technical assistance to employ the Community Resiliency Building framework and stakeholder process to help choose climate change priorities by identifying hazards and considering strengths and vulnerabilities to society, infrastructure and the environment.
  - Capital and Operating Budget funding that supports state agencies, municipalities and non-profit partners efforts with an emphasis on nature-based solutions to accomplish multiple ways to address climate change: enhancing resiliency, promoting adaptation and reducing carbon pollution.
  - State Hazard Mitigation and Climate Change Adaptation Plan in September 2018 which includes a very helpful summary of these public policies/programs/capabilities in chapter 6 of the Plan: "State Capability and Adaptive Capacity Analysis"

[2] Stephen Long, The Nature Conservancy-Massachusetts. January 2019.

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