Shoreline Impacts, Setback Policy

&

Sea Level Rise

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The Center for Island Climate Adaptation and Policy (ICAP) facilitates a sustainable, climate conscious future for Hawai‘i, the Pacific, and global island communities through innovative, interdisciplinary research and real-world solutions for island decision-makers in the public and private sectors. ICAP offers work product in the area of law, policy, planning, and science to mitigate and adapt to climate change while embracing the wisdom of local, traditional cultures.

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Executive Summary

The Center for Island Climate Adaptation and Policy (ICAP), located within the University of Hawaii's Sea Grant College Program, provides science-based policy and planning research for decision-makers in Hawai‘i and other island leaders. ICAP prepared this white paper at the request of Senator Shan Tsutsui, whose office sought a technical evaluation of Senate Bill 468 (relating to shoreline setbacks). ICAP finds that SB 468 as originally introduced would have a beneficial net impact on coastal resiliency for the State of Hawai‘i.

Creating coastal communities that are resilient to hazards (including tsunamis, hurricanes, flooding, erosion, and sea level rise) requires effective construction and siting measures. Construction standards through the National Flood Insurance Program and recent building code revisions have largely been scientifically based. Setbacks and siting policies, however, have traditionally been driven by social and political considerations, rather than technically based.

Setback policies are changing at the county level, as they now track the relevant science. The Maui Shoreline Setback Rule utilizes the Average Annual Erosion Rate ("AAER") developed by the University of Hawai‘i. The new Kaua‘i Shoreline Setback uses the AAER times a planning period of 70 to 100 years, which represents the life expectancy of structures. The Kaua‘i rule, also requires a 10% adjustment in the AAER for future sea level rise in some cases. Recently, Hawaii County also addressed future sea level rise by using the existing authority in their subdivision regulations to require design for subsidence and a two-foot rise in water level over the next 100 years.

A review of setback rules adopted by other US states is also provided in this report. The most significant rule, Maine's Dune Rules, requires that for structures greater than 2,500 square feet, the structure cannot be threatened by the future shoreline considering migration and a two-foot sea level rise in the next 100 years. SB 468, therefore, represents an opportunity for the State of Hawai‘i to join other states that adopt science-based setbacks and encourage coastal community resilience.

Sea levels are clearly rising, although we cannot be certain of the rate. Forward-thinking county and state-level jurisdictions are making today's planning decisions based on the best available scientific information. Because our state is so vulnerable to hazards, adaptation design should be addressed during all stages of development and as early as possible in the development process.

Senate Bill 468* is an effective vehicle for long-range coastal climate change adaptation as it calls for early planning for natural hazards. In the formulation of setbacks, ICAP suggests the counties: (i) extend the State shoreline setback to remove the maximum of 40 feet, (ii) include design considerations for hazards that trigger not only at the subdivision stage but for zoning and planning stages as well, and (iii) consider the average annual erosion rate and the life expectancy of structures when establishing setbacks.

To incorporate the best scientific information available early in the planning process, therefore, ICAP recommends that the legislature amend the bill as follows:

- § 205A-43(a):

  > "Setbacks along shorelines are established of not less than twenty feet ~~and not more than forty feet inland~~ from the shoreline."

- § 205A-45(c) (1):

  > "Use the shoreline setback as a tool to minimize the damage from coastal hazards, including tsunami, hurricanes, wind, waves, flooding, erosion, sea-level rise, subsidence, and point and nonpoint source pollution. Measures such as early planning <u>during zoning, general and community plan changes and subdivision</u>, variances for innovative design and minimum buildable areas shall be considered;"

- HRS § 205A-45(c) (2)(A):

  > "Any parcels created after the subdivision of an original parcel are sufficiently large to accommodate a shoreline setback based on average annual erosion rate<u>, and a life expectancy of the structure,</u> or other means to mitigate environmental damage and hazard exposure;"

The best estimate of sea level over the next century conservatively predicts a 1-meter (3 foot) rise. The inevitable impact on the State of Hawai'i requires greater scientific research for targeted policy, planning, and adaptation. The state should develop, support, and rely on a sound scientific database that it can use as a basis for future planning. SB 468 is an important first step towards developing standards that will make Hawai'i and her population more secure in the face of inevitable climate change impacts.

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* ICAP assesses the efficacy of SB 468 as originally drafted. SB 468 S.D. 1. ICAP does not analyze the impacts of the amended bill, SB 468 S.D. 1 H.D.1, excepting from the setback rules existing Waikiki beach structures and properties subject to Waikiki Beach Reclamation Agreement. ICAP can provide an analysis of potential impacts of the exemption upon request.

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I. Introduction

This report reviews local laws related to sea level rise and shoreline setback policy for Hawai‘i and other mainland states and assesses Senate Bill 468, which deals with coastal hazards such as tsunamis, hurricanes, wind, waves, flooding, erosion, sea level rise and subsidence is provided. Policy solutions and strategies to enact measures are provided. ICAP concludes that Senate Bill 468,* specifically SB 468 S.D.1, will make coastal communities more resilient to hazards. The following three areas, however, require additional research: (i) the future acceleration of sea level through more refined prediction and monitoring (ii) the known, possible, or likely impacts of climate change on Hawai‘i,[i] and (iii) the best adaptation strategies for state and local governments.

A. Climate Change and Hawai‘i

As presented in the 2007 report of the Intergovernmental Panel on Climate Change, there is scientific consensus that the Earth's climate is unequivocally warming. Climate change and the increase of greenhouse gases into the environment have had the following impacts:

- Increased oceanic carbon dioxide has made the ocean waters more acidic, thereby negatively impacting corals, clams, shrimp and other marine organisms with calcium carbonate skeletons;[ii]
- Increased average air temperature;[iii]
- Increased water temperature at the sea surface leading to episodic deaths of marine organisms;[iv]
- Acceleration in sea level rise.

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There is a wide array of expected impacts from climate change[v] including those affecting:

(i) ecosystems such as wetlands, marine conservation, and marine protected areas;

(ii) industries such as fisheries, mariculture, and tourism;

(iii) the built environment, including buildings, development, renourished dunes and beaches;

(iv) disasters and hazards, including sea level rise, flooding and other hazards; and

(v) general planning and governance of the coastline.

There is a need to adapt to these anticipated changes. ICAP can assist governmental bodies in developing future climate change adaptation-related legislation by providing scientific information, technical guidance, policy suggestions and rule-making strategies for state and county agencies.

B. Sea Level Rise and Hawai‘i

According to the IPCC 2007 report, sea levels in the past have risen about 1.8 mm/yr, based on measurements from 1961-2003, with an average of 3.1mm/yr since 1993.[vi] Future sea level rise is likely to accelerate and estimates range from 18 to 59 cm (.59 to 1.9 ft) over the next 100 years.[vii] However these estimates do not include certain glacial melting factors. When these factors are included, estimates rise to 80 to 200 cm over the next 100 years. While more additional work needs to be conducted, a preliminary and conservative estimate of the amount of sea level rise that should be planned for is 1 meter over the next 100 years.[viii]

Sea level rise makes coastal areas even more susceptible to hazards such as flooding, wave inundation, or erosion from storms, hurricanes, and tsunamis. The trend on a national and state level is to plan for all hazards at one time during the design of mitigation measures. For example, a new coastal structure should address inundation for any hazard, whether it is tsunami

run-up, hurricane storm surge, or a winter high surf event. Consideration of sea level rise impacts is one of the many adaptation planning measures to protect life and property. Figure 1 depicts four hazard zones, including the erosion zone, wave zone, flood zone and inland zone. Structures in the erosion zone are at greatest risk from coastal hazards and subject to the forces of erosion, scour, wave inundation, flooding as well as wind. Sea level rise affects the erosion zone by moving the shoreline inland. It is generally felt that structures must be **properly sited** to address issues such as erosion and sea level rise in order to make the shoreline and community more resilient and sustainable. This differs from structures in the wave, flood, and inland zone, where the hazards are generally addressed through **construction methods.**

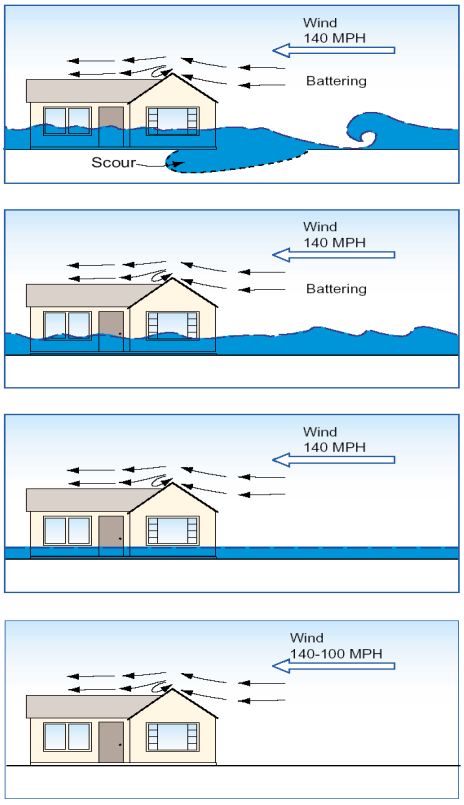

Figure 1 – Generalized schematic of the coastal hazard zones. The erosion zone (top box) is subject to erosion, scour, sea level rise, flooding, wave inundation, and wind. Proper siting of coastal structures is important in this zone. Structures in the wave zone (second from the top) are subject to wave inundation, flooding, and wind. Hazards are typically addressed by wave or v-zone construction under the National Flood Insurance Program ("NFIP"). Structures in the flood zone (second box from bottom) are subject to flooding and wind forces. Construction occurs with flood mitigation measures under the NFIP. For the inland zone (bottom box) the major force is wind and dealt with in local building codes, which apply to all four hazard zones. Adapted from the Texas Coastal and Marine Council, 1976 and the FEMA Coastal Construction Manual, 2000 (Hwang, 2005).

II. Legal Environment for Increased Shoreline Resilience

In Hawai‘i, there are numerous laws at the federal, state, and local level to address **proper construction.** At the federal level, the National Flood Insurance Program (NFIP) requires that the design of structures in the flood zone prevent floatation, collapse, and movement during flooding, usually by elevating the structure above the 100-year event and having openings in the supporting walls to allow entry and exit of water. In the wave or V zone, the NFIP requires elevation on piers or columns; further, walls cannot support the structure and must be able to breakaway. At the local level, many of the hazard issues in the inland zone are addressed through the building codes. All of the above methods described in the NFIP or local building codes are for proper construction and the standards are generally scientifically based.

Conversely, with regard to **proper siting**, the measures are generally set forth in the land use process for Hawai‘i, both at the state and local level. Due to property rights issues, the standards for siting historically have not been scientifically based. Therefore the standards have not protected for the shoreline or for coastal inhabitants (Figure 2). This has led to the undermining of structures, the hardening of the shoreline with seawalls and revetments, the loss of beach systems, and the loss of access to the beach as well as along the shore. The traditional method to deal with damage in the erosion zone is through a shoreline setback to create a buffer between the structure and anticipated impacts.

Figure 2 – Homeowners at Aliomanu Bay on Kaua‘i threatened by erosion. Since this photo was taken, the house has fallen in the water. Photo by Dennis Fujimoto – Garden Island News.

A. Shoreline Setbacks in Hawai‘i

1. Rules

Under the State Coastal Zone Management Law, the shoreline setback is not less than 20 feet and not more than 40 feet inland from the shoreline (HRS § 205A-43(a)). The counties are given the option of extending the shoreline by establishing setbacks at distances greater than 40 feet (HRS § 205A-45). All of the counties have extended their setbacks to a degree, realizing the 20-40 feet distance is not sufficiently protective. It should be noted that in many jurisdictions, when a structure is within 20 feet of the shoreline, it is treated as an emergency situation.[ix]

For Hawai‘i County, the shoreline setback is now at the minimum of 40 feet.[x] In many cases the Planning Department has imposed a much greater setback.[xi] On O‘ahu, the setback is 40 feet from the shoreline, except in the case of small lots for which the setback can be 20 feet. For new subdivisions, the setback is 60 feet.[xii] In 2003, and in later amendments, Maui recognized the importance of creating a more scientifically based setback and established a formula based on an annual erosion rate times a planning period of 50 years, plus a buffer of 25 feet.[xiii] The University of Hawai‘i produced the erosion rate data.[xiv]

In 2008, Kauaʻi passed the most scientifically based shoreline setback in the country, which was based on an annual erosion rate times a planning period of 70 years plus a buffer of 40 feet. The annual erosion rate is determined by guidelines laid out in the Hawaii Coastal Hazard Mitigation Guidebook[xv] or data from the University of Hawaiʻi. The 70-year period is based on engineering study to determine the life expectancy of coastal structures considering building materials, maintenance, water damage, habitability and other factors.[xvi] For larger structures, greater than 5,000 feet, the chances that the structure would be made of stone increased so the planning period was increased to 100 years. The Hawaii Coastal Hazard Mitigation Guidebook was incorporated by reference into the Kauaʻi rule and required that the annual erosion rate be adjusted for future sea level rise by a default value of 10%. This 10% default increase in the erosion rate applied to coastal areas susceptible to increased sea level rise.[xvii] Alternatively, the applicant can determine the likely increase that future sea level has in the area using the Bruun Rule, a geometric model, or another generally accepted coastal engineering method.

2. Land Use Processes

Besides shoreline setbacks, counties can properly site structures in the erosion zone in the land use process. Areas susceptible to sea level rise can be identified through scientific study and the counties can implement measures to mitigate impacts through the zoning, general planning and subdivision process. Recently the County of Hawaiʻi Planning Department was dealing with a serious flooding and subsidence problem at Kapoho, located in the southeast of the Big Island. In this area, residents of a subdivision experienced monthly flooding due to episodic subsidence, continuous subsidence, and sea level rise.[xviii] When a new subdivision was proposed in the adjacent area, the Director of the Planning Department required the area to be

above water 100 years in the future considering 3-4 feet of continuous subsidence, 2 feet of subsidence from a catastrophic event, and 2 feet of future sea level rise. The authority to require these measures is found in their subdivision regulation, which states:

> "A lot shall be suitable for the purposes for which it is intended to be sold. No area subject to periodic inundation which endangers the health or safety of its occupants may be subdivided for residential purposes." Hawaii County Code § 23-37.

All of the counties in Hawai'i have similar provisions in their regulations, which allow them to protect subdivision residents from future hazards, but the provision is not strongly utilized.[xix] This is in the existing authority of the county's land use laws.

B. Shoreline Setbacks in Other States

There are various approaches that states have taken to address shoreline impacts, coastal erosion and in some cases, sea level rise. States such as California, Connecticut, Mississippi, Louisiana, and Texas[xx] simply have no shoreline setback.[xxi] The lack of setbacks was one of many factors that led to the damage of coastal structures during recent hurricanes that hit the Gulf Coast in 2008 (Figures 3 & 4).

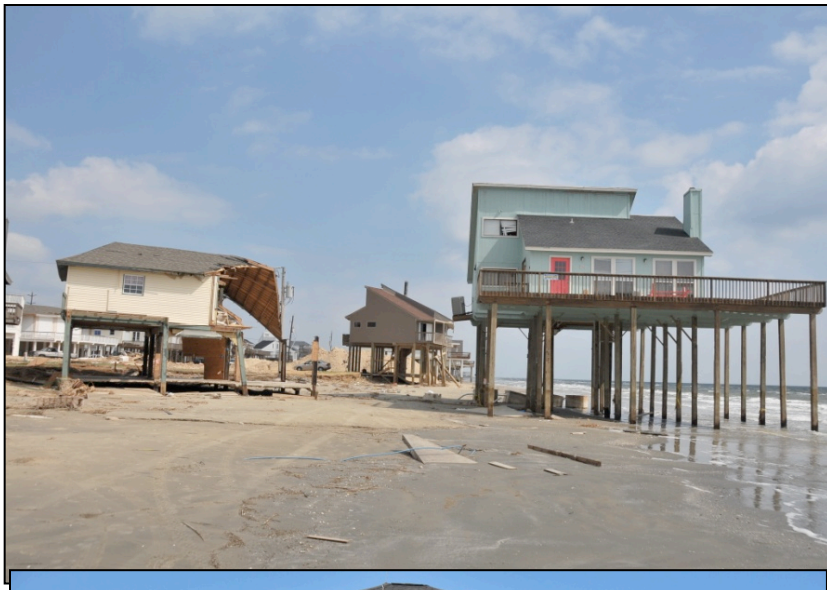

Figure 3 – Galveston Island, Texas after Hurricane Ike – October 2008. The house on the right is built to V-zone standards but has migrated into the waterline. The house on the left was also elevated, but not sufficiently high and was damaged. Texas has no shoreline setback.

Figure 4 – Bolivar Peninsula, Texas – March, 2009 – Damage to structure after Hurricane Ike. Although the structure was heavily engineered for wave action, it was too close to the shore. The storm surge exceeded design levels damaging the house. The structure is now encroaching on the beach. Migration is evidenced by the erosion and scour as shown by uncovering of the unpainted portion of the support columns.

Some states have set an arbitrary setback of a fixed certain distance from a coastal feature. For example, Alabama's policy is 40 feet from the dune crest while Maryland's is 100 feet from the Mean High Water Line. Although the Maryland setback appears larger, the fact that the Mean High Water Line can be significantly seaward of the vegetation line may make this standard less protective.

Many states have erosion rate based setbacks, but to have a technically based setback, both the annual average erosion rate and the planning period should be scientifically determined. This is because the setback is the product of two numbers, an annual average erosion rate times and the planning period in years. The various planning period in years utilized by other States include: Virginia (20), Florida, Michigan, and Ohio (30), New Jersey, North Carolina, and Rhode Island (30 to 60), South Carolina (40), and Pennsylvania (50 – residential, 75 – commercial, 100 – industrial).

Two interesting formulations of the setback include those for Maine and Delaware. Delaware has a 100-foot setback from the seaward most 10-foot contour – in the Atlantic, and a 75-100 foot setback from the 7-foot contour interval in the Delaware Basin. This is really a fixed setback with the elevation contours designed to approximate the location of specific dune features. The setback is for dune protection and does not factor in the shifting shorelines, either in the past or the future.[xxii]

However in Maine, the state has recently adopted new rules in 2006 that account for 2 feet of sea level rise in the next 100 years. For structures greater than 2,500 square feet, which are less likely to be moved, no permits are allowed if a 2 foot rise in sea level over 100 years would result in changes to the shoreline that are reasonably expected to erode property and cause severe damage to the project.[xxiii] It is up to the applicant to prove this future shoreline using the Bruun Rule, a geometric model, or another generally accepted coastal engineering model.[xxiv] At the time of this writing, the Maine Geological Survey is also in the process of defining the method to determine applicable Erosion Hazard Areas, which factors in long-term erosion, short-term erosion events such as storms, and 100-year flooding events. It does not include long-term erosion, after sea

level rise, which is up to the applicant to determine. Thus the Maine program relies on data from an independent scientific source plus that supplied from the applicant. Note the similar characteristics of this rule with that for Kaua‘i.

To summarize the setback laws for Hawai‘i and elsewhere, most States do not have regulations in place to address sea level rise. Regulations are in place to address erosion and other setbacks and they can readily be modified to address sea level rise. The most relevant applications have been for Kaua‘i, Maui and Hawai‘i Counties and for the State of Maine. Even if a state does not have specific regulations in place, jurisdictions have taken action to address sea level rise through the development of specific plans and policy, as well as gathering the necessary scientific information for planning. This will be covered in Section IV.

III. Assessment of Senate Bill 468

Senate Bill 468* facilitates greater resilience to all hazards, including sea level rise for the shoreline, coastal development, and coastal communities. Hawai‘i has been fortunate with regard to hazards. From 1819 to 1975, there were 26 damaging tsunamis in the state, or one every 6-7 years. Since 1975, more than 34 years ago, there has not been a significant event.[xxv] With regard to hurricanes, our last two events, Iwa (1982) and Iniki (1992), unfortunately struck Kaua‘i twice. However, if the more populated islands of Maui, Hawai‘i and O‘ahu were hit, property damage would have been 2 to 8 times as great.[xxvi] Even a tropical storm hitting O‘ahu could cause major damage. With anticipated sea level rise and migration of the shoreline, our coastal structures will be at even greater risk during future events.

Senate Bill 468 requires early planning for all natural hazards along the coast. By early planning builders and developers design for the proper siting and construction measures during zoning, community planning, and the subdivision stages of the development process (Figure 5). This is to prevent the creation of small lots, which could create a regulatory takings issue when scientifically based setbacks are utilized. Historically, hazards have not been planned for, as evidenced by the state shoreline setback that allows houses within 20 feet of the shore because the lots are too small. Many jurisdictions consider this kind of setback to be an emergency or threatened situation.

* SB468 S.D.1.

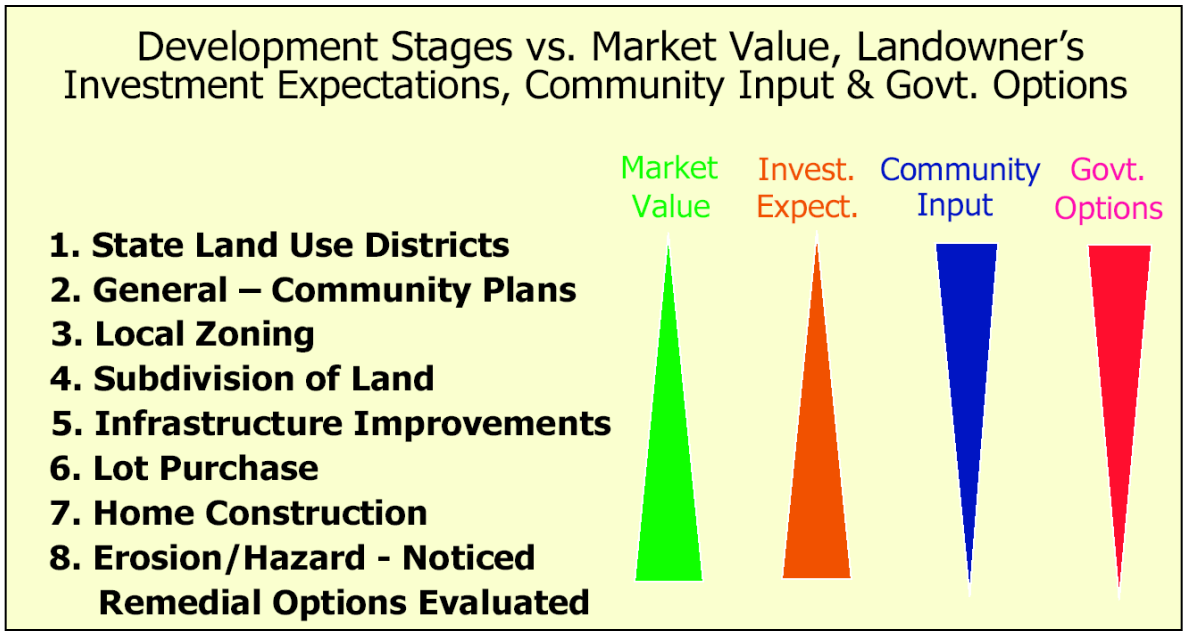

Figure 5 – A generalized schematic of the stages of development for Hawai'i. With each stage of development, the landowner puts more time and money into the project and increases the market value of the property, as well as the reasonable investment backed expectations of the landowner (related to property rights). This will result in the community having less input into the project and the government having fewer options to address issues such as an encroaching shoreline from sea level rise. Addressing the issue as early as possible in the development process will allow the implementation of scientifically based and protective standards (Hwang, 2005).

Senate Bill 468 should not raise any constitutional takings issues, since the purpose of the measures is to protect life and property and there are numerous safeguards through the variance process and minimum buildable area provisions. Senate Bill 468 can lead to a safer coastline; however, ICAP suggests the following changes to further improve resiliency.

- HRS § 205A-2(c) (6). Consider removing point and non point source pollution from the section since it is not a coastal hazard. Suggestions have been made to remove subsidence, but this process should be left in since it is an important hazard that, like sea level rise, can change the shoreline position. Subsidence is a serious concern in Hawai'i County.

- HRS § 205A-43. Setbacks at the state level should not be capped at 40 feet but should be larger to account for structures that may need to be setback in the Conservation District. Therefore § 205A-43(a) should be amended as follows:

> "Setbacks along shorelines are established of not less than twenty feet ~~and not more than forty feet inland~~ from the shoreline."

- HRS § 205A-45(c) (1). To address hazards earlier in the development process, changes to zoning and general, comprehensive, and community plans[xxvii] should also assess future shoreline migrations and hazards. This provision is built into the Kaua'i Shoreline Setback rule. Because substantial investment backed expectations can be built up by the time a subdivision is being processed, the Kaua'i rule had this earlier trigger. It is recommended that § 205A-45(c) (1) be amended as follows:

> "Use the shoreline setback as a tool to minimize the damage from coastal hazards, including tsunami, hurricanes, wind, waves, flooding, erosion, sea-level rise, subsidence, and point and nonpoint source pollution. Measures such as early planning <u>during zoning, general and community plan changes and subdivision</u>, variances for innovative design and minimum buildable areas shall be considered;"

- HRS § 205A-45(c) (2)(A). Counties should consider the life expectancy of coastal structures. Without it, a completely arbitrary planning period can be selected that will allow the structure to be undermined during its useful life, even when a scientifically based erosion rate is utilized. With minimum buildable areas, and by applying this standard early in the land use process, legislators can mitigate economic impacts and avoid property rights issues. Therefore § 205A-45(c) (2)(A) should be amended as follows:

"Any parcels created after the subdivision of an original parcel are sufficiently large to accommodate a shoreline setback based on average annual erosion rate, and a life expectancy of the structure, or other means to mitigate environmental damage and hazard exposure;"

IV. Policy Solutions and Strategies to Enact Better Measures

ICAP recommends the following policy strategies to implement or enact the proper hazards protections, including those related to Senate Bill 468.

1) **Early Planning.** Address hazard impacts as early as possible in the development process (Figure 5). This would include at the community planning, zoning, and subdivision stage. Early planning allows for fairness, objectivity, reasonableness, and notice to the homeowner. It will also reduce the risk of any regulatory takings claims.
2) **Plan for Hazard Impacts at all Stages of Development.** Every project will be in a different stage of development, but hazards are serious and significant such that a jurisdiction should address them throughout the entire development cycle. Thus, siting issues are critical during zoning, planning and subdivision. Notice to potential buyers of property of hazard risk is vital during lot purchase (Stage 6).[xxviii] Home construction needs strong building codes are needed during (Stage 7). Even at Stage 8, homeowner's should be aware of hazard risks at their location and what they can do to retrofit or strengthen their house.[xxix]
3) **Utilize Scientific Standards for Protection**. Scientific standards should be used for hazard mitigation protection. If a standard is too difficult to implement, rather than relax the standard to a non-protective measure, it is be better to relax how it is implemented. For example, if a planning period of 70 years is too difficult to implement at the home construction stage (Stage 7 in Figure 5) rather than relax the standard to a 30 year period, either provide a more lenient minimum buildable area if needed, or move up the development stage and make the standard applicable there (for example at Stages 1 though 4).
4) **Utilize a Flexible Approach to Implement Hazard Mitigation Measures.** There are many elements to implementing a program for hazard mitigation and coastal resiliency based on knowledge, planning information, guidance, policy, industry standards, existing authority and new regulations and laws. All of these elements are important and form a continuum or sliding scale, which allows for many flexible options (Figure 6). The remaining recommendations relate to these elements of implementation and how they interact.

Figure 6 – The elements of implementation (knowledge, information, guidance, standards, policy, existing authority and new regulations) are interrelated and form a continuum or sliding scale (Hwang, 2005). Recognizing this will allow a jurisdiction to develop more flexible programs with many more options. Since the elements are interrelated, they should serve as a goal in their development. For instance knowledge of sea level rise through research is developed sufficiently so that it can be used as planning information, which can be later used to develop guidance. The elements can be used alone but are best used in combination. Each element is important.

5) **Gather the Relevant Scientific Information for Planning Purposes.** Even those states that do not yet have regulations on sea level rise realize the need to gather the basic scientific information through research. Research is needed to monitor past sea levels and estimate future changes. It is also needed to estimate the hazard response, in terms of erosion, inundation and increase flooding from events ranging from high surf to simple rainstorms. The environmental impacts such as saltwater intrusion, rising water tables, corrosion are also significant. The goal is to get basic knowledge through research on sea level rise and translate it into better planning information. More accurate predictions of sea level rise are of great importance.[xxx] The UH School of Ocean Science Earth and Technology conducts research in this area.
6) **Create Guidance.** Based on planning information, organizations such as the Center for Island Climate Adaptation and Policy can provide guidance on the best way to manage hazards. Guidance takes scientific information and puts it into a readily utilized form.[xxxi] An example is the Hawaii Coastal Hazard Mitigation Guidebook, a product of the

University of Hawai‘i Sea Grant College Program. On sea level rise, ICAP can create a Coastal Adaptation Guidebook addressing the full range of climate change issues such as those listed in the USAID report, “Adapting to Coastal Climate Change: A Guidebook for Development Planners”.

7) **Combine Guidance and Policy.** When combined, policy and guidance form a powerful tool to strengthen existing authority. For example, the Hawai‘i County Planning Department used guidance from a Subsidence Report and policy that disallowed adjacent areas to be flooded, thereby using their existing authority for a new subdivision to address the hazards of subsidence and sea level rise. ICAP formulates policy for climate change adaptation and can facilitate the use of guidance and policy to improve Hawaii’s adaptive capacity.
8) **New Regulations and Laws.** New regulations and laws will need to address hazards amplified by the changing climate. Senate Bill 468, specifically SB468 S.D.1, is such a bill and is the first of many that can make Hawai‘i coastlines more resilient in the face of climate change.
9) **Use the Scientific Information Currently Available**. Even though at best we can only bracket estimated changes, this does not mean we cannot act until we are 100% certain of all of the changes. As an example, the Maine’s new Dune Rules require planning for 2 feet of sea level rise over the next 100 years. The Hawai‘i County Planning Department used a projection of 2 feet in the next 100 years for the Kapoho area.

    Scientific study suggests that we plan for 1 meter (3 feet of sea level rise) because the best estimates show that sea level is unlikely to rise significantly less than 3 feet and may rise significantly more.[xxxii] The University and ICAP can continue to monitor the latest scientific knowledge on sea-level rise

V. Conclusion

To reduce impacts to the shoreline and make the environment and community more resilient it is necessary to plan for all hazards, particularly those amplified by climate change, through proper construction and siting measures. This will require planning with the use of scientific standards throughout the development cycle.

While many questions remain unanswered with regard to climate change impacts it is still possible – and imperative – to utilize the best information currently available to make sound land use decisions, as Hawai‘i County, Kaua‘i County and Maine have done. Senate Bill 468* calls for early planning of natural hazards, and with the recommended changes, it can occur as early as the zoning, planning and subdivision stages of development.

Ultimately, Hawai‘i additional research and monitoring to ascertain the upper limits of sea level rise. A comprehensive assessment of climate change affects on its ocean and coastal resources is a vital first step to ensure adequate preparation and increased adaptive capacity for the state. This assessment will focus necessary research and strengthen our planning to make the shoreline and coastal communities more resilient. ICAP encourages the legislature to begin in earnest the process of building resilience well in advance of dangerous changes to climate.

* SB 468 S.D.1.

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[i] The Florida Oceans and Coastal Council conducted a similar assessment for the State of Florida in 2009.

[ii] Florida Oceans and Coastal Council, 2009.

[iii] Id.

[iv] Id.

[v] USAID, 2009, Draft Report.

[vi] IPCC, 2007.

[vii] Id.

[viii] Fletcher, 2008.

[ix] On Maui, structures within 20 feet of the shoreline are considered threatened and variances to the setback for erosion control structures maybe considered. In North Carolina, the 20-foot threshold determines if emergency measures can be considered (Interview with Spencer Rogers, North Carolina Sea Grant) (Hwang, 2005).

[x] Planning Department Rules of Practice & Procedure – Rule 11-5.

[xi] Interview with Larry Brown of the Hawai‘i County Planning Department.

[xii] Revised Ordinances of Honolulu § 23-1.4.

[xiii] Norcross-Nu'u *et al.* 2009.

[xiv] Fletcher *et al.* 2003.

[xv] Hwang, 2005.

[xvi] Anderson, 1978.

[xvii] Fletcher *et al.* 2002.

[xviii] Hwang *et al*, 2007.

[xix] Hwang, 2005.

[xx] Texas does have a rolling easement concept where structures are allowed close to the shore, but once they migrate onto the beach, they are to be removed. However the State has wound up having to pay the homeowners to remove their houses from the dry sand beach.

[xxi] Compilation by Ayesha Genz, University of Hawai‘i Sea Grant and School of Ocean and Earth Science and Technology, 2006.

[xxii] Interview with Wendy Carey, Delaware Sea Grant.

[xxiii] Code of Maine Rules, Chapter 355.

[xxiv] Interview with Peter Slovinsky, Maine Geological Survey.

[xxv] Fletcher et al, 2002 – The power of a tsunami was demonstrated on December 26, 2004, when a massive earthquake in the Indian Ocean caused a series of destructive waves which led to the eventual loss of approximately 200,000 lives with more than 100,000 still missing. USAID: Earthquake and Tsunami Reconstruction. January 3, 2008.

[xxvi] Based on number of single-family homes on each island – From the Hazard Mitigation Study for the Hawaii Hurricane Relief Fund – December 2001. In August of 2005, Hurricane Katrina struck Louisiana and Mississippi, destroying more than 200,000 homes. Louisiana Recovery Report covering one-year anniversary of event.

[xxvii] In Florida, the City of Punta Gorda adopted city comprehensive plan policies related to climate change that are now being worked into an Adaptation plan for the city. In San Francisco, a sea-level rise plan for the San Francisco Bay Region was created that covers areas prone to sea level rise impacts, areas where it may be beneficial to remove structures and areas where it may be best to remain undeveloped.

[xxviii] Eversole and Norcross-Nu'u, 2003.

[xxix] Hwang & Okimoto, 2007.

[xxx] Alaska is determining whether to relocate or protect coastal communities from sea level rise and climate change. Part of their policy determination is whether to use a conservative, mid-level, or extreme sea-level projection.

[xxxi] In Delaware, the Partnership for Delaware Estuary is creating guidance on the best measures to control erosion along tidal marshes degraded in part by sea-level rise.

[xxxii] Fletcher et al, 2009.

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