Issue 5: Climate Change/Sea Level Rise

Overview: Hawaii's Changing Climate

According to the Intergovernmental Panel on Climate Change (hereafter, IPCC), global average temperatures have risen by 1.5°F since 1970 and can be expected to rise another 2-11°F by the end of the 21st Century, depending on future greenhouse gas emission levels. Scientific modeling suggests that the surface temperature will continue to increase beyond the year 2100 even if concentrations of greenhouse gases are stabilized by that time.[1]

Mounting evidence indicates that Hawaii's climate is changing in ways that are consistent with the influence of global climate change. Data show a rapid rise in air temperature in the past 30 years (averaging 0.3°F per decade), with a stronger warming at higher elevations (See Figure 5.1).[2] The increase in average annual temperature is largely due to an increase in minimum temperatures. This response to global climate change is consistent with similar trends observed in North America.[3]

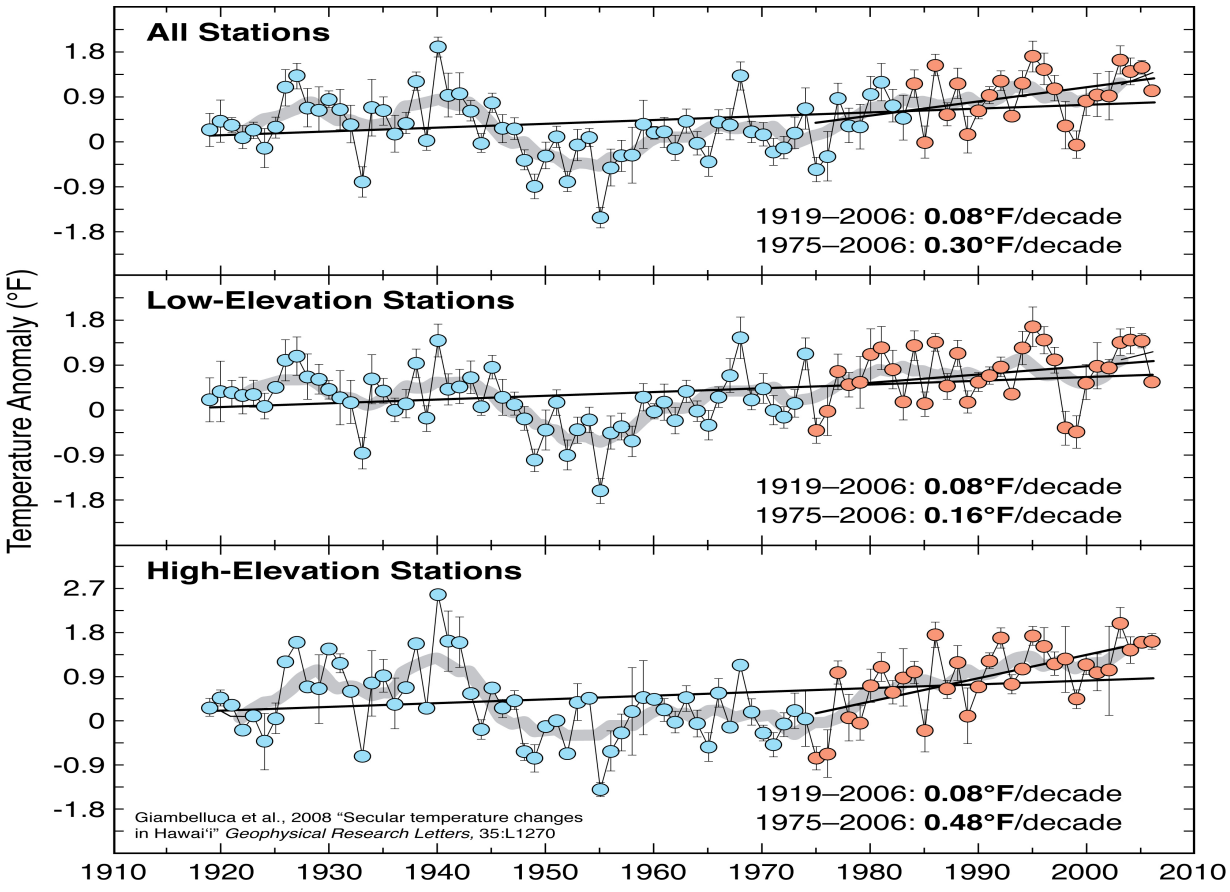


Figure.5.1: Data show a rapid rise in air temperature in the past 30 years (averaging 0.3°F per decade), with a stronger warming at higher elevations.

Along with an increase in surface air temperature, documented climate changes in Hawaii include:

1. decreased rainfall and stream flows,
2. increased rain intensity,
3. sea-level rise,
4. rising sea surface temperatures, and
5. ocean acidification.[4]

Because changes in Hawaii's climate will continue and intensify, scientists anticipate growing impacts to water resources, forests, marine systems, the economy, and coastal communities.

In Hawaii, based on current data and trends, climate change will:

- Reduce the amount of fresh water available
- Decrease Hawaii's forest health and biodiversity
- Increase the frequency, size, and intensity of wildfires
- Increase flash flooding, land slides, agricultural losses, and infrastructure damage
- Negatively impact beaches, coral reefs and key marine resources on which the State's economy depends

Although climate change threatens forest health, Hawaii's forest resources, appropriately managed, have the potential to mitigate global climate change and promote resilience for the islands. Mitigation involves actions to reduce emissions and enhance sinks of greenhouse gases, so as to lessen the impacts and effects of climate change.[5] Tropical forests sequester and store high amounts of carbon, and managing forests for maximum carbon sequestration can enhance forests' capacity to decrease atmospheric carbon dioxide levels. Though mitigation is essential to promote a productive global future, climate change is already impacting Hawaii. It is timely to consider facilitated adaptation, involving initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects.[6] Presently, Hawaii's forests offer many benefits that will help safeguard Hawaii's communities in a changing climate. Forests, however, are facing other stressors that severely limit their adaptive capacity. Healthy urban forests can provide cooling shade, lessen flooding, and offer natural protection during extreme weather events. Upland forests support the highest concentration of native terrestrial plant and animal species in Hawaii, and they generally represent the most intact portions of the watersheds upon which residents and visitors depend for ecosystem services, agricultural productivity, manufacturing, recreation, and household water consumption. Enhanced conservation of existing forests and facilitated adaptation will help preserve Hawaii's ecosystems and human communities.

In order to adapt resource management and forestry practices to the changing climate, there is a significant need for sustained and enhanced climate monitoring and assessment activities.

Assessing the vulnerability of key resources, infrastructure, and ecosystems can inform the process of setting goals, determining management priorities and deciding on appropriate adaptation strategies.

Given the broad spatial and temporal scales associated with climate change, implementing strategies for protecting forests and human communities requires a high level of collaboration and cooperation among state and local agencies, federal and community partners. It is critical to engage stakeholders, the public, educators and learners, and policy decision-makers because of the interconnections between human and natural systems.

Figure 5.2. The forested mountains play a key role in capturing rain and fog, mitigating flash flooding and recharging groundwater. Photo Chip Fetcher.

Threats & Trends

*Decreased rainfall has reduced the quantity of freshwater resources.*Perhaps nothing is more critical to life in the islands than rain, and in Hawaii, shallow cumulus clouds formed by trade winds are the most reliable and abundant source of rainfall. Atmospheric circulation in the tropical Pacific has decreased due to global warming, and while it is still unclear how Hawaiian trade winds will change in the future, the results of modeling studies indicate that rainfall will decrease. Indeed, studies of records confirm rainfall has steadily declined (about 15%) over the past two decades.[7] Global climate models predict that net precipitation at sea level near the Hawaiian Islands will decrease during the cool season (November though April) an additional 4-6% by 2100, with no significant change during the drier summer months (May through October).[8]

Rain recharges groundwater aquifers, which are the principal sources of municipal water supplies in Hawaii. Groundwater also feeds Hawaii's streams and provides water for agriculture and aquaculture systems. Base flow of streams supplied by groundwater discharge has declined around the state since the early 1940's likely due to decreased rainfall.[9]

Another concern is the potential for increased rates of evapotranspiration (the emission of water vapor through the leaves of plants) in the presence of higher air surface temperatures. Higher evapotranspiration rates would return more water to the atmosphere and reduce the amount going into steams and groundwater. Effects of warming on evapotranspiration are as yet unknown, but changes could further impact water resources already being affected by reduced rainfall.[10]

Rising air temperatures and decreased rainfall threaten forest health and biodiversity.

In Hawaii, rainfall and extreme topography result in unique ecosystems that support a diversity of plants and animals. The combination of decreased rainfall and rising air temperatures threatens these ecosystems and the diversity they support. The potential effects of climate change to the state's biodiversity are of particular concern considering many of Hawaii's endemic species are specialists, and many are restricted to small geographic areas with limited populations.

In Hawaii, temperature increases are not consistent at all elevations. For example, at elevations below 2600 feet, the recorded increase per decade of 0.16°F is less than the global rate of about 0.36°F per decade; however, the increase per decade at elevations above 2600 feet, 0.48°F per decade, is greater than the global rate. The rapid warming trend at high elevations is a significant threat for a number of reasons. First, most remaining intact native forest occurs at higher elevations. Second, most native land birds are restricted to cool high elevation forests, which are inhospitable to the non-native diseases and their vectors, which have devastated the Hawaiian avifauna at lower elevations. Finally, this pattern will likely result in lower rainfall at higher elevations because of a reduction in the width of the inversion layer, or cloud zone, which is a source of rain and fog drip. The second will result in a reduction in disease-free forest and the latter will prevent the establishment of forest above the current tree line[11]. Thus, only those plants that can tolerate drier conditions will persist. Micro-habitats that support rare plants and animals are often isolated and natural migration (without human intervention), in many cases, is unlikely.

A warmer, drier climate puts Hawaii at risk for larger and more frequent wildfires.

Although it remains unclear how wildfire behavior and frequency will change in Hawaii as a result of climate change, studies in the western mainland U.S. have found that warmer temperatures are increasing the frequency, intensity and duration of large fires.[12] Warmer, dryer weather causes fires to spread more quickly, particularly when associated with high winds. In Hawaii, rainfall is expected to decrease during the winter and early spring months (historically, the rainy season), a change which may lead to a longer wildfire season. Such an increase in the duration of wildfire season has already been observed in western states.[13] In addition to the increased suppression costs and potential economic damages, changes in fire severity would affect vegetation distribution and forest condition, and increase the risk to property, natural resources, and human life.

Figure 5.3. Healthy coral reefs are vital to our economy, our environment and our culture. Photo Chip Fletcher.

More severe tropical storms and increasing rain intensity pose challenges for disaster mitigation and management.

Figure 5.3 Unusually high tides, like this one in Waikiki Beach will become more frequent as set level rises. Photo Chip Fletcher.

While global climate change will result in a reduction in freshwater, rain and storm intensity will likely increase. Typhoons and hurricanes will become more forceful, with larger peak wind speeds and greater precipitation.[14] Warming will cause the global averaged intensity of tropical cyclones to increase by 2–11% by 2100. Modeling consistently projects decreases in the global averaged frequency of tropical cyclones, by 6–34%, although the frequency of the most intense cyclones is predicted to increase.[15] Such storms can devastate forests, as well as threaten Hawaii's communities and infrastructure. Damage from high winds associated with hurricanes will exacerbate changes to forest structure and species composition, spread exotic species, affect critically endangered plants and animals, reduce carbon storage, and elevate vulnerability to fire.[16] In 1992, Hurricane Iniki forceful demonstrated the destructive force of cyclones on Hawaii when it struck the island of Kauai with sustained winds of 130 mph and caused over $2.3 billion in property damage.[17]

Rain intensity is also increasing. Between 1958 and 2007, the amount of precipitation in the heaviest 1% of all rainstorm events in Hawaii has increased approximately 12%.[18] Intense rains result in flash flooding, mudslides and debris flows, road and business closure, infrastructure damage, and loss of public services especially to isolated communities. In March 2006, 41 straight days torrential rains caused over $80 million dollars of damage in Manoa Valley and Laie on Oahu, cut off town of the town of Hana from the rest of Maui for weeks, and swept houses off their foundations in Hilo, Hawaii. While these events cannot be directly tied to global warming, they illustrate the severe impacts associated with intense rains.[19]

Sea-level is rising, impacting beaches, coastal forests, and human communities.

Long-term sea-level rise will exacerbate coastal erosion, coastal flooding, and drainage problems, all of which are occurring in Hawaii. Sea level in Hawaii has risen at approximately 0.6 inches per decade over the past century[20] and probably longer.[21] This long-term trend has increased the effects of short-term fluctuations in coastal sea level and tides, leading to episodic flooding and erosion along the coast.[22] Shoreline retreat, larger storm surges, and water-table salinization will likely diminish the health and integrity of forests and wetlands close to sea level.[23]

Although coastal erosion occurs for a variety of reasons, and is not uniquely tied to climate change, high sea levels will likely exacerbate this problem. Waves, currents, and human structures are the principal causes of erosion. Sea-level rise increases erosion, potentially affecting beaches that were previously stable. Chronic erosion of developed lands has led to seawall construction resulting in beach loss.[24] Approximately 25% of beaches on Oahu have been narrowed or lost because of seawall construction. Losses are similar on other islands, where the average long-term rate of coastal erosion is about one foot per year.[25] On Kauai for instance, 72% of beaches are chronically eroding and 24% of these are accelerating.

Because of global climate change, sea level rise is expected to continue, and accelerate, for several centuries. Research indicates that sea level may exceed three feet above the 1990 level by the end of the 21st century.[26] Continued sea-level rise will increase marine inundation of coastal roads and communities. Saltwater intrusion will intensify in coastal forests, wetlands and groundwater systems, agricultural land, estuaries, and elsewhere. While extreme tides already cause drainage problems in developed areas, Hawaii's communities located at the confluence of intensifying storm runoff and rising ocean waters will endure increased flooding.[27]

Combined, the effects of climate change add to pressure on resources important to recreation and tourism.

The State's largest industry, tourism, depends on scenic beach parks, coral reefs, fisheries, and unique montane forest and coastal ecosystems. Higher sea levels, as well as accelerated beach erosion, greater damage from sea surges and storms, and reduced water supply will likely impact coastal tourism.[28] Two additional climate-related factors, increasing sea surface temperature and ocean acidification, are likely to affect marine ecosystems and, thus, the economy.

Marine researchers at the University of Hawaii and cooperating institutions have measured an increase of sea surface temperature of 0.22°F per decade. Because of global climate change, this rate is likely to rise, exposing marine ecosystems to negative impacts, including coral bleaching.[29]

Increasing ocean acidification is another threat to coral reef and marine ecosystems. As rising carbon dioxide in the atmosphere mixes with seawater, the ocean acidifies. Measurements taken at station ALOHA over two decades document that the surface ocean around Hawaii has grown more acidic.[30] Increases in seawater acidity reduce the availability of dissolved carbonate, vital to shell and skeleton formation in corals, shellfish, and other marine organisms, putting at risk the entire ocean food web. This rapidly emerging issue has raised concerns across sectors because declining coral reefs will impact coastal communities, tourism, fisheries, and overall marine biodiversity.

<u>Benefits of Forestry</u>

If managed properly, Hawaii's forests will help to mitigate the effects of climate change and promote adaptation and resilience for Hawaii's communities.[31]

Climate Change Mitigation

Tropical forests, such as those on Pacific islands, can help curtail climate change by sequestering carbon from the atmosphere and storing it in trees, under-story vegetation, and soil. Globally, forests contain 1.2 trillion tons of carbon, just over half the total in all terrestrial vegetation and soils.[32] Forests take in carbon at a rate that is determined by a number of factors, including the type of forest, its location, and its age. Tropical forests are able to take-in and store carbon at a greater rate than boreal forests. The IPCC estimates that about 65% of the total mitigation potential of all forests is located in the tropics and about 50% of this total could be achieved by reducing deforestation.[33]Although deforestation is not a major source of greenhouse gas emissions in Hawaii, the state could develop sound sustainable forestry strategies that maximize carbon sequestration and storage and share these best practices with other Pacific islands. *(See Issue 8: Forest Products and Carbon Sequestration and Issue 9: Multi-State Issues for additional information.)*.

Climate Change Adaptation

Healthy forests and sustainable forest management can decrease the vulnerability of Hawaii's communities to the impacts of climate change. Tropical deciduous forests have been shown to regulate floods associated with cyclones. A long-term ecological study in the Chamela Region on the Pacific Coast of Mexico reports that, in tropical deciduous forests, a constant leaf litter layer on the forest floor protects the soil from the direct impact of raindrops associated with cyclones that regularly hit the area.[34] The leaf litter helps maintain high infiltration rates in the soil, preventing runoff and soil erosion, thus reducing floods. Studies also suggest that loss of forest vegetation increases vulnerability of human populations to landslides and storm surges during tropical cyclone events.[35]

Healthy forests and wetlands help protect coastal communities and infrastructure in other, less obvious ways as well. Forests can rehabilitate degraded land and maintain water quality by trapping sediments, taking up nutrients, and immobilizing toxic substances. Thus, forests and wetlands help reduce land-based sources of marine pollution, which are the primary causes of coral reef ecosystem degradation. Coral reefs are a source of subsistence fishing and harvesting, as well as vital tourist income for island destinations, and are frequently essential in protecting low-lying islands, such as those in the Pacific and Indian Oceans, from storm surges even where man-made protection is unlikely to succeed.

Although forests and other ecosystems have the potential to reduce the impacts of climate change on human communities, many of Hawaii's ecosystems are currently threatened by a number of stressors, including invasion by non-native species and expanded human development. Continued and improved efforts to promote biodiversity and forest health may help facilitate ecosystem adaptation to climate change. For example, eliminating invasive weed species and reestablishing native plants will help preserve freshwater availability in forests, as well as

prevent the spread of avian diseases.[36] *(See Issue 2: Forest Health: Invasive Species, Insects and Disease and Issue 6: Conservation of Native Biodiversity for additional information.)*

Priority Areas and Issues for Climate Change/Sea Level Rise

The large-scale nature of climate change, combined with the importance of coordinating management at an ecologically meaningful scale, indicates that coordination within and between state and federal agencies will need to improve. Although growing evidence of a changing climate has catalyzed new discussions among state and local agencies, non government organizations (NGOs), scientists, universities, and federal partners regarding the need to collaborate to develop workable solutions to climate change, adaptation and mitigation planning is still in the earliest stages in Hawaii.

The Hawaiian islands are relatively small, with population centers located along the flat coastal areas. Most economic activity also occurs in close proximity to the ocean; Waikiki Beach is by far the most important source of employment and revenue in the state; the commercial shipping facilities and Honolulu International Airport are all located on the coast; and some of the nation's most strategically important .assets including Kaneohe Bay Marine Corps Base, Pearl Harbor Naval Station and Pearl Harbor Naval Shipyard. The emerging consensus in Hawaii and the Pacific islands is that we will face a suite of challenges due to climate change; but the most immediate threat, and the one that we can most directly address is sea level rise.

The State of Hawaii's Ocean Resources Management Plan (ORMP) Working group, an interdisciplinary group established by the Office of Planning and the Coastal Zone Management Program, has recently directed efforts to climate change adaptation. Though ORMP is ocean-focused, its members include a range of stakeholder groups, including county planning departments, some state departments and offices, federal partners, and the Hawaii Conservation Alliance. The Center for Island Climate Adaptation and Policy at the University of Hawaii works in partnership with the ORMP working group to support their efforts. In November 2009, the Group released a collaborative document, A Framework for Climate Adaptation in Hawaii,[37] to encourage and facilitate the adaptation planning process. The document initially identifies planning areas relevant to climate change and describes some potential climate change impacts and considerations for each area. The ORMP working group is innovative and represents the kind of partnerships essential to a coordinated approach to climate change adaptation and mitigation. However, the group does not encompass all sectors and program areas vulnerable to climate change. It also lacks adequate resources to complete a comprehensive vulnerability assessment and implement a statewide adaptation plan.

Another example of collaboration that will enhance Hawaii's capacity to adapt to climate change is a partnership between the Hawaii Conservation Alliance (HCA), and the newly formed Pacific Islands Climate Change Cooperative (PICCC). See Map 5.1 for the PICCC region. Together, HCA and PICCC are developing scientific assessments of climate change impacts on physical and ecological systems at a scale relevant to conservation planning.[38]

With additional support and collaboration, state and local entities, federal and community partners, can develop statewide adaptation strategies and adjust management practices to ensure a productive future for Hawaii. As climate changes, it will be difficult or even impossible to achieve forest management and resource conservation goals that are dependent on static conditions. Future goals and decisions should therefore be informed by current data and projected future climate conditions and explicitly address whether they aim to lessen the impacts of climate change on natural and human systems, promote resilience, accommodate changing conditions, and/or mitigate climate change. Because of the uncertainty and complexity of climate change, the process should be iterative to allow for informed decisions and early implementation of adaptive strategies. Where there is a high level of uncertainty about specific impacts, agencies should focus on "no regrets" conservation actions likely to be beneficial regardless of future climate conditions. These can include reducing non-climate forest stressors, managing for ecological function and biodiversity, and maintaining and restoring coastal resources.[39]

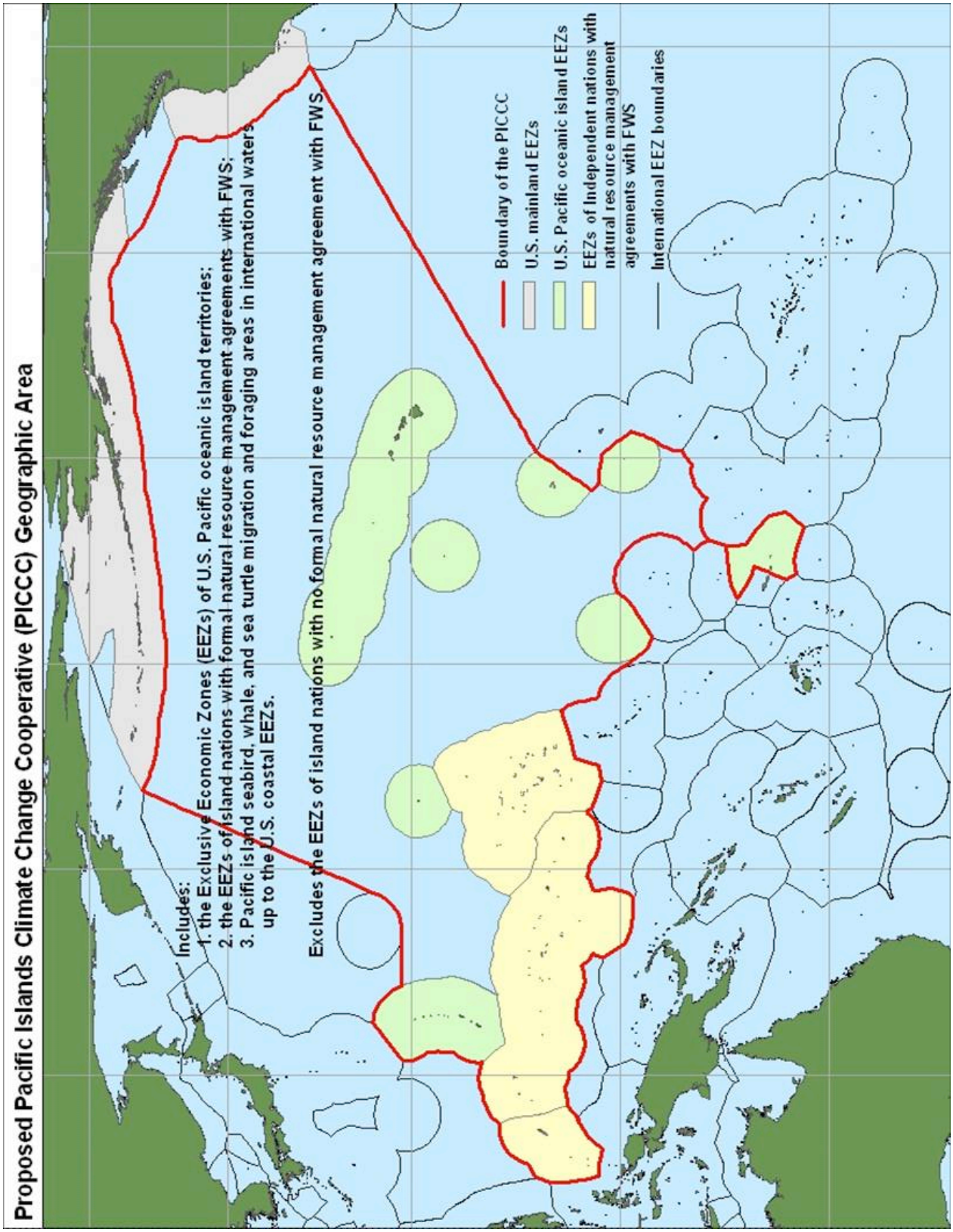
Since the potential for uncertainty and controversy associated with climate change could be high, state agencies should consider public participation planning and strive to improve the public's understanding of the impacts of climate change. Gaining public support or acceptance is prerequisite for making successful adjustments in management plans and policies as a result of observed or anticipated climate changes.

Data Gaps

Despite the certainty that climate change is currently underway and having an impact on natural resources, there are still many unanswered questions about how these climate effects will play out at local, state and regional scales and how ecosystems will respond to those changes. Successful adaptation strategies in Hawaii will require intimate knowledge of the local economies, culture and ecosystems and attention to less obvious changes such as carrying capacities, wildfire, climate-driven immigration, disease-vectors and invasive species. Determining which natural and human systems are most at risk from climate change can guide our future management decisions.

We can no longer plan based solely on historical data because climate change is a moving target, requiring continuous monitoring. Observing trends and modeling the future impacts of climate change on forest systems and resources requires localized data collection. it is imperative to set up instrumentation to fill existing climate and biodiversity data gaps and monitor climate and ecosystem variables in the future.

Though some climate models exist for the Pacific region, the diversity of microclimates in Hawaii presents a challenge for predicting future climate impacts on landscapes. We need down-scaled models that anticipate climate change scenarios at specific locations and microclimates, such as urban and coastal zones, and areas that support unique native ecosystems and species, such as dry forests and anchialine pools. In addition, to find the most effective management solutions, it is important to assess the effects of climate change over multiple climate scenarios.



Map 5.1 Proposed PICCC Geographic Area

Complex systems, in particular, need improved modeling. Fire is a major mediator of terrestrial climate, yet there are presently few models that predict the impacts of climate change on wildfire and suppression effectiveness in Hawaii. Likewise, we have little information about how changes in climate will affect the threat of invasive species and our strategies for control. Another example of a complex, changing system that requires careful monitoring and improved modeling efforts is sea level rise. This complexity is due, in part, to the fact that winds and ocean currents affect sea level, and all of those are changing as well.[40]

Using climate scenario modeling and ecological knowledge, we can identify potential climate change impacts on natural systems, community and environmental infrastructure, operations across planning sectors, and key resources on which Hawaii's residents and communities depend. It is necessary to: (1) determine the degree to which natural and built systems are directly or indirectly affected by changes in climate conditions; and (2) assess their ability to accommodate changes in climate with minimum disruption or minimum additional cost. A vulnerability assessment, conducted collaboratively, would accomplish these two goals and indicate the susceptibility of systems to harm from climate change impacts. This type of assessment would help in the process of prioritizing areas on which to focus climate adaptation efforts and funding.

Because no one agency can collect the variety and amount of data necessary to monitor climate and ecosystem changes, sharing information among partners is important in planning for climate change adaptation and coordinating landscape-scale conservation. A central clearinghouse of current climate change data and publications documenting best management practices for climate adaptation could serve as a tool for managers in many sectors of government, NGOs, and community groups.

Strategy for Issue 5: Climate Change/Sea Level Rise

To effectively understand and respond to climate change, Pacific Islands need climate modeling and ecological knowledge in order to identify how climate change impacts are affecting natural systems, encourage community and environmental infrastructure operations across planning sectors, and utilize key resources that enable change at many levels. Because no one agency can collect the variety and amount of data necessary to monitor climate and ecosystem changes, sharing information among partners and the public is mandatory in planning for climate change adaptation and coordinating landscape-scale conservation.

Climate Change: Identify Missing Data, Assess Trends & Develop Adaptation Strategies							
Long Term Strategy	**Priority Landscape Areas**	**Secondary Issues Addressed**	**Program Areas that Contribute**	**Key Stakeholders**	**Resources Available & Partners**	**Measures of Success**	**Supports National Objectives**
1) Develop and implement a coordinated Statewide Instrumentation Improvement Strategy (SIIS) to identify data gaps and enhance data collection and monitoring systems.	Statewide	Affect future policy pertaining use practices in upland, coastal and marine areas. Focus broad environmental education messages.	Fire & Aviation, Forest Health Protection, UCF, Conservation Education, schools, volunteer groups, FSCG	HCA, Pacific Islands Climate Change Cooperative (PICCC), USFWS, NPS, USDA, HDOA, DOT, TNC, NOAA Office of Ocean & Coastal Resource Management, DOD, CWRM, UHSOG, USGS, NWHI, EPA, USACE	USFWS (on NWHI), USGS, UHSOG, NOAA and National Weather Service, NASA, USDA Forest Service, IPIF, USACE, CAO, DAR	New instrumentation for improving the evaluations of local and regional trends in climate and ecosystems; New monitoring that fills existing gaps in baseline knowledge of Hawaiian biodiversity; Monitoring systems are sufficient for assessing the effectiveness of management activities designed to facilitate climate adaptation.	3.7 3.6
2) Assess the vulnerabilities, risks, and opportunities for important resources, infrastructure, and ecosystems using knowledge of trends and future scenarios of climate change.	Urban and coastal zones; targeted upland areas.	Affect future policy pertaining use practices in upland, coastal and marine areas. Material for better grant applications.	UCF, Forest Health Protection, Watershed Partnerships, Fire & Aviation, EQIP, WHIP, FLP, FSP, FSCG	HCA, NOAA Pacific Services Center, OHA, DOD, HTA, USFWS, NPS, DOT, HDOA, TNC, DPCH, DPCM, DPCK, BWS, C&CH, DOH, MCZAC US Army Corps of Engineers, UHSG	PICCC, IPIF, Center for Island Climate Adaptation and Policy (ICAP) at UH, DOFAW staff, DAR	Describe exposure, sensitivity, and capacity to adapt to climate change scenarios for ecosystems, resources, and landscapes; Prioritize actions among program areas with the most beneficial outcomes based on assessments of and management activities.	3.7 3.6

Strategy for Issue 5: Climate Change/Sea Level Rise

Climate Change: Develop Adaptation Strategies & Outreach Activities							
Long Term Strategy	**Priority Landscape Areas**	**Secondary Issues Addressed**	**Program Areas that Contribute**	**Key Stakeholders**	**Resources Available & Partners**	**Measures of Success**	**Supports National Objectives**
1) Develop and implement facilitated adaptation strategies for forest and resource conservation management; monitor effectiveness; continually incorporate new information; and, adjust actions as needed.	Urban and coastal zones; targeted upland areas.	Development of Best Management Practices for Climate Change Remediation.	UCF, Forest Health Protection, Watershed Partnerships, Fire & Aviation, EQIP, WHIP, FSP, FLP, HAWP, FSCG	HCA, NOAA Office of Ocean & Coastal Resource Management, NOAA Pacific Services Center, OHA, DOD, HTA, USFWS, NPS, DOT, HDOA, TNC, MCZAC, DOH, US Army Corps of Engineers, UH Sea Grant Program, DPCH, DPCM, DPCK, BWS, C&CH	ICAP, PICCC, FWS, UHSOE, IPIF, HCA, IPIF,	Adoption of a Statewide climate change adaptation plan; Implement actions intended to prevent serious disruptions in forests and ecosystem services due to changing climate; Implement actions that take advantage of man-made or natural disturbance events to facilitate adaptation to future climate; Re-iterative processes, continual monitoring and the use of new science into planning, policies and decisions.	3.7 3.6 2.2 1.1
2) Help landowners, conservation managers, and the public understand changing conditions; and, establish strong alliances and partnerships with other programs, agencies, and stakeholders to ensure a coordinated and collaborative approach to climate change adaptation.	Statewide	New and creative incentive programs for private landowners.	Conservation Education, Forest Heath Protection, Urban & Community Forestry, Fire & Aviation, EQIP, WHIP, FSP, FSCG, UCF	Coastal industries, landowners, schools, HTA, HCA, NOAA Office of Ocean & Coastal Resource Management, NOAA Pacific Services Center, USFWS, NPS, US Army Corps of Engineers, TNC, UHSG	FSP, Conservation Education, PICCC, UH, NRCS, FWS, HCA, HFIA, ELP	Number of trained individuals specializing in climate change adaptation and mitigation; increased, # of educated landowners; More public support for implementation of innovative approaches for adaptation; Strategies, policies, and actions for addressing climate change are integrated across all programs areas.	3.7 3.6 2.2

Acronyms Used:

1. UCF – Urban & Community Forestry
2. HCA – Hawaii Conservation Alliance
3. PICCC -Pacific Islands Climate Change Cooperative
4. UHSOE - University of Hawai‘i School of Ocean & Earth Sciences
5. HTA - Hawai‘i Tourism Authority
6. TNC - The Nature Conservancy

7. MCZAC - Marine & Coastal Zone Advocacy Council
8. BWS - Board of Water Supply
9. C&CH - City and County of Honolulu
10. DPCH - Department of Planning for County of Hawai‘i
11. DPCM - Department of Planning for County of Maui
12. DPCK - Department of Planning for County of Kauai
13. CAO – Carnegie Airborne Observatory
14. FWS – Fish & Wildlife Service
15. EQIP – Environmental Quality Program
16. WHIP – Wildlife Enhancement Program
17. FSP – Forest Stewardship Program
18. FSCG – Forest Service Competitive Grants
19. IPIF – Institute of Pacific Island Forestry
20. HFIA – Hawaii Forest Industry Association
21. DAR – Department of Aquatic Resources
22. ELP – Environmental Literacy Plan
23. UHSG - Seagrant

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