

# Multi-Hazard Mitigation and Resilience Plan

Volume 1 of 2



# County of Kaua‘i Multi-Hazard Mitigation and Resilience Plan

2026

## PREPARED FOR

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#### NOTE:

This document uses spelling for Hawaiian geographic names, including diacritical marks (‘okina or kahakō), as currently included in spreadsheets developed by the Hawai‘i Board of Geographic Names. These are available online at <https://planning.hawaii.gov/gis/hbgn/>

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## **Part 1. PLANNING PROCESS AND COMMUNITY PROFILE**

# 1. INTRODUCTION

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## 1.1 THE VALUE OF HAZARD MITIGATION PLANNING

Hazard mitigation is defined as any action taken to reduce or alleviate the loss of life, personal injury and property damage that can result from a disaster. It involves long- and short-term actions implemented before, during, and after disasters. Hazard mitigation activities include planning efforts, policy changes, programs, studies, improvement projects, and other steps to reduce the impacts of hazards.

The federal Disaster Mitigation Act (DMA) of 2000 emphasizes planning for disasters before they occur. The DMA requires state and local governments to develop hazard mitigation plans (HMPs) as a condition for federal disaster grant assistance. State plans allow access to all nonemergency Federal Emergency Management Agency (FEMA) assistance, Public Assistance (PA) and Hazard Mitigation Assistance (HMA) grants. Local plans allow access to HMA grants. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (CFR).

The responsibility for hazard mitigation lies with many, including private property owners, commercial interests, and local, state, and federal governments. The DMA encourages cooperation among state and local authorities in pre-disaster planning. The enhanced planning network called for by the DMA helps local governments to articulate accurate needs for hazard mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

The DMA also promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and address hazards and mitigation in the largest possible social and economic context. That means going beyond an assessment of dollar-value losses that result from hazard events to consider a broad range of benefits and costs, including social equity, environmental impact, and ways to make people and places more resilient in the face of the risks that hazards pose.

All residents and businesses of Kaua'i County are the ultimate beneficiaries of hazard mitigation planning. This 2026 County of Kaua'i Multi-Hazard Mitigation and Resilience Plan (MHMRP) Update identifies strategies and actions to reduce risk for those who live in, work in, and visit the county. It provides a viable planning framework for all foreseeable natural hazards. Key stakeholders' participation in development of the plan helps ensure that outcomes will be mutually beneficial. The plan's goals and recommendations lay groundwork for the development and implementation of local hazard mitigation activities and partnerships. The 2026 MHMRP Update became effective on May 1, 2026.

## 1.2 PREVIOUS PLANNING FOR THE COUNTY OF KAUA'I

The County of Kaua'i (County) prepared an HMP in compliance with the DMA in 2005 to help guide and coordinate mitigation and resilience activities throughout the county. That initial plan identified resources, information, and strategies for reducing risk from natural hazards. It was last updated in 2021, in compliance with federal requirements that communities update HMPs every 5 years to remain eligible for certain federal hazard-related funding programs (Tetra Tech 2021).

## 1.3 THE UPDATED PLAN

### 1.3.1 Why Update?

The County MHMRP is now undergoing its fourth comprehensive update in accordance with federal requirements. This 2026 MHMRP Update was developed to achieve the following objectives:

- Meet or exceed requirements of the DMA.
- Enable the County to continue to access FEMA grant funding to reduce risk through mitigation.
- Meet the needs of Kaua‘i County, as well as state and federal requirements.
- Create a risk assessment of local hazards.
- Coordinate existing plans and programs so that high-priority projects to mitigate possible disaster impacts are funded and implemented.

#### **Federal Eligibility**

Title 44 of the CFR stipulates that HMPs must present a schedule for monitoring, evaluating, and updating the plan. This provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. The Robert T. Stafford Act requires that jurisdictions have current HMPs to pursue and receive grant funding under the FEMA HMA grant programs.

#### **Planning Area**

The planning area was defined as all Kaua‘i County. For evaluation in this MHMRP, some analyses were broken down by district, using the boundaries defined for planning districts in the county. The Island of Ni‘ihau is also part of Kaua‘i County but, as in previous MHMRPs and in the 2018 *Kaua‘i Kākou—Kaua‘i County General Plan* (County General Plan), it is not analyzed due to its predominantly private ownership and management (County of Kaua‘i 2018).

#### **Changes in Development**

HMP updates must be revised to reflect changes in development within the planning area during the previous performance period of the plan. The plan must describe changes in development in hazard-prone areas that increased or decreased vulnerability since the last plan was approved. If no changes in development impacted overall vulnerability, then plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

#### KEY RESULTS OF THE 2026 COUNTY OF KAUA‘I MULTI-HAZARD MITIGATION AND RESILIENCE PLAN

##### (County of Kaua‘i 2026)

The 2026 MHMRP identifies the following key hazards of concern:

|                                      |               |
|--------------------------------------|---------------|
| • Tropical Cyclone, Other High Winds | • Landslide   |
| • Wildfire                           | • Dam Failure |
| • Inland Flood                       | • Earthquake  |
| • High Surf, Coastal Flood, Erosion  | • Drought     |
| • Tsunami                            | • Heat        |

Based on an assessment of risks, the 2026 MHMRP identifies 40 mitigation actions to address the identified hazards as follows:

- Multi-Hazard – 28 actions
- Tropical Cyclones and other High Winds – 1 action
- Inland Flood – 3 actions
- Drought – 1 action
- Wildfire – 3 actions
- Tsunami – 1 action

A forecast of development trends prepared for the County in 2024 estimated that about 2,234 new housing units would be built in the county between 2025 and 2040 (SSFMI International 2024). Between the time of the last MHMRP update in 2020 and the most recent available estimates from 2024, the county planning area experienced a small increase in population of about 550 people (U.S. Census Bureau 2025a).

In the past 5 years, no substantive development has been completed in the county that either decreased or increased hazard vulnerability; however, several notable developments are either underway or planned within the next 5 years. Nearly all, except for the Grove Farm Industrial Subdivision and the Coco Palms Resort project, are focused on housing. These developments comprise the following projects, broken down by planning district with housing unit estimates:

- **East Kauaʻi**
  - Mahelona Master Plan – 500 new housing units. This project is planned to begin in the next 5 years.
  - Hokua Place – 650 new housing units. The project has initiated a 201H process with the County Housing Agency. This provides a streamlined approval process for the development of affordable housing. If final approval is obtained, the project could commence construction within five years. However, the project has received considerable community pushback.
  - Coco Palms – 350 resort units. This project continues to generate interest and controversy and might begin in the next 5 years.
- **Līhuʻe Area**
  - Hanamāʻulu Village – 1,250 new residential units, 160 resort units, and commercial square footage. The project is still in the environmental review stages.
  - Grove Farm Industrial Subdivision – 137 acres of industrial-zoned lands. This project is currently under construction.
  - Former Central Pacific Bank Housing Project – 66 new residential units. This project is currently under construction.
  - Uahi Ridge (across the highway from the Kauaʻi County Department of Water) – 156 new residential units. This project is currently under construction.
- **South Kauaʻi**
  - Kōloa Village Housing – 74 new housing units. This project is currently under construction.
  - Royal Palms at Poʻipū – 164 new housing units. This project is planned to begin in the next 5 years.
- **West Kauaʻi**
  - Lima Ola – 550 new housing units. There are two phases to this project. Phase 1 comprises 155 units. At the time of preparation of this 2026 MHMRP Update, 141 units had been built, and the other 14 units of single-family homes were planned to be built and sold in the next year. Phase 2 of the project comprises 66 single-family units and 102 multifamily units—its development is planned to occur over the next 5 years.
  - ʻEleʻele Iluna Habitat for Humanity – 100 new housing units. This project is planned to begin in the next 5 years.
  - State Department of Hawaiian Home Lands (DHHL) Hanapēpē – 140 new housing units. Site preparation work for the project is currently underway.
  - Waimea 400 – ~300–400 new housing units. This project is planned to begin in the next 5 years.

- **North Kaua'i**
  - Kīlauea Town Expansion – 300 new housing units. Project planning is underway and could commence construction in the next 5 years.

These developments are predominantly being constructed or planned on undeveloped land adjacent to developed areas. All new developments are also regulated pursuant to local programs and codes, including those that mitigate vulnerability to current and anticipated future natural hazards. Thus, it is expected that hazard vulnerability will not increase or decrease as a result of these developments. The only exception is the Coco Palms project in East Kaua'i. This project would involve redeveloping a former resort that was significantly damaged by Hurricane Iniki and has been vacant since. The project is in a flood zone, tsunami evacuation zone, and the Sea Level Rise Constraint District. This development would increase the county's vulnerability to flooding, tsunamis, and sea level rise. Multiple attempts to acquire the property for conversion to open space have been unsuccessful. A more thorough examination of changes in hazard vulnerability due to this development would be required in future mitigation plans if the development proceeds.

More details on some of the development projects planned in the county for the next 5 years can be found in Appendix D.

### **New Analysis Capabilities**

The analysis capabilities used in the 2026 MHMRP Update generally align with those used in the 2021 MHMRP Update, though the development of several new data sources enhanced analysis capabilities. The 2026 MHMRP Update revises the information included in the previous plan on exposures and losses from each type of hazard. The process used to do so is the same as that used in the 2021 MHMRP Update; however, a more recent version of FEMA's Hazards U.S. (Hazus) software was used to conduct the vulnerability analysis for relevant hazards, and updated data were used where available (FEMA 2025a). The 2026 MHMRP Update additionally expands on the previous plan's discussion of climate change to integrate anticipated climate change impacts. Social vulnerability is also discussed in far greater detail in the 2026 MHMRP Update for each hazard. These updates were possible due to newly generated or updated data. Additional information on the differences between the 2021 MHMRP Update and 2026 MHMRP Update are provided in the following section.

### 1.3.2 What Is Different?

The County used the current update process to make meaningful changes to the format and content of the MHMRP that look beyond hazard profiles to evaluate the impacts of climate change as well as examine social vulnerability and equity. Some of the major differences between the current and previous plans are as follows:

- More detail added for the wildfire risk hazard in light of the 2023 Maui wildfires
- Integration of additional climate change analysis into each hazard
- More in-depth analysis of social vulnerability and equity
- Overview of Community Rating System (CRS) Class 8 designation
- Incorporation of Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program compliance
- New goals, objectives, and mitigation initiatives were developed for the updated plan to more readily align with existing County plans and programs and identified state priorities.
- The list of evaluated hazards was updated based on current community concerns and experiences over the past 5 years.
- A review was conducted of existing plans and programs that are relevant for hazard mitigation.
- The risk assessment was updated using the best available data, including updated hazard exposure areas where available.
- An updated discussion on existing land uses was included for each hazard that defined extents and locations.
- A new risk ranking protocol was employed to assist in establishing mitigation priorities.
- The protocol for prioritizing actions was simplified and included a cost-effectiveness review.
- The strategy for plan maintenance and implementation was revised and updated to encourage greater coordination and planning for hazard mitigation funding opportunities.

#### CONTENTS OF THIS UPDATED PLAN (2026)

This MHMRP is organized into three primary parts:

Part 1 – Planning Process and Community Profile

Part 2 – Risk Assessment

Part 3 – Mitigation Strategy

Each part includes elements required under federal guidelines. DMA compliance requirements are cited at the beginning of subsections as appropriate to indicate compliance. The appendices include information or explanations to support the main content of the plan.

Appendix A provides a list of abbreviations and references cited in this 2026 MHMRP Update.

## 1.4 PLAN UPDATE METHODOLOGY

### 1.4.1 Developing the Plan

The process followed to develop this Kaua'i County MHMRP Update had the following primary objectives:

- Form a Core Planning Team, referred to as either the Core Team or the Planning Team in the 2026 MHMRP Update, to lead the process and write the 2026 MHMRP Update.

- Define the planning area that will be evaluated in the plan and which hazard-related risks will be assessed.
- Establish a Steering Committee to provide community and stakeholder guidance for development of the plan.
- Coordinate with other agencies on issues of concern for local hazard mitigation planning.
- Review existing programs that are relevant to the updated plan's development.
- Engage the public in providing input needed to ensure that the updated plan addresses local priorities.

The County contracted SWCA Environmental Consultants (SWCA) to assist with development and implementation of the 2026 MHMRP Update. The SWCA project manager assumed the role of the lead planner, reporting directly to the County project manager. The Core Planning Team included staff from the Kaua'i Emergency Management Agency (KEMA); County Planning Department and Office of Economic Development (OED); and University of Hawai'i Sea Grant College Program (UH Sea Grant). The Steering Committee included representatives from the County Department of Public Works, Office of the Mayor, and Fire Department (KFD); Kaua'i Economic Development Board; County Housing Agency; Hawai'i State Department of Land and Natural Resources (DLNR) – Division of Forestry and Wildlife (DOFAW) and Division of Engineering; Kaua'i District Health Office (KDHO), Hawai'i State Department of Health; Hawai'i Visitors and Convention Bureau; DHHL; Kaua'i Island Utility Cooperative (KIUC), and land and infrastructure managers Kekaha Agriculture Association (KAA) and Gay and Robinson, as well as community connectors Kupa A'e Leadership Development and Hale Hālāwai.

Figure 1-1 outlines planning tasks and an associated timeline for the Core Team, Steering Committee, and community engagement.

Further detail on all these activities is provided below, and the Core Planning Team and Steering Committee meeting materials are provided in Appendix B.

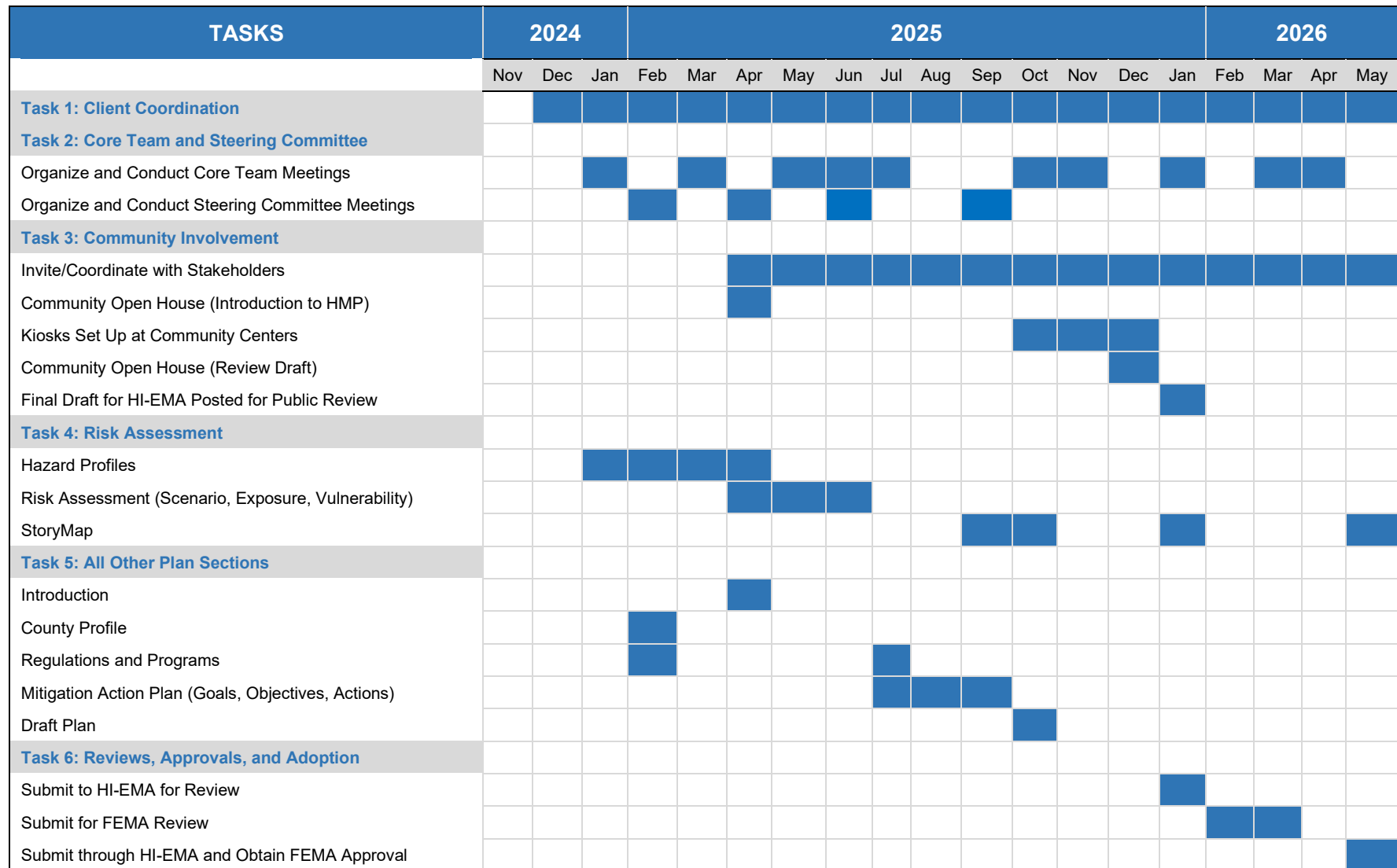


Figure 1-1. Planning schedule and related tasks.

## 1.4.2 Core Planning Team and Steering Committee

### Core Team

A Core Planning Team was formed to lead the planning effort. The Core Planning Team met five times throughout the planning process to provide direction and guidance. Table 1-1 identifies the Core Planning Team members. David Kennard, the KEMA Disaster Assistance Project Manager, led the Core Planning Team.

**Table 1-1. Core Team Members**

| Name              | Role/Title  | Agency                                  | Department                                   |
|-------------------|---|---|--|
| David Kennard*    | Disaster Assistance Project Manager                       | Kaua'i County                           | KEMA   |
| Sarah Louxz       | Emergency Management Staff Specialist                     | Kaua'i County                           | KEMA   |
| Sky Asio          | Emergency Management Staff Specialist                     | Kaua'i County                           | KEMA   |
| Padraic Gallagher | Emergency Management Staff Officer                        | Kaua'i County                           | KEMA   |
| Alisha Summers    | Long Range Planner  | Kaua'i County                           | Planning Department                          |
| Alan Clinton      | Disaster Assistance Recovery, Mitigation, and GIS Officer | Kaua'i County                           | Planning Department                          |
| Ruby Pap*         | UH Sea Grant Extension Agent                              | University of Hawai'i/<br>Kaua'i County | UH Sea Grant Program/<br>Planning Department |
| Ana Espanola      | Sustainability Specialist                                 | Kaua'i County                           | OED –Sustainability                          |
| Niki Kunioka-Volz | Agriculture Specialist                                    | Kaua'i County                           | OED – Agriculture                            |
| Christina Kaser   | Energy Specialist   | Kaua'i County                           | OED – Energy                                 |
| Solomon Kanoho    | Executive Officer   | Kaua'i County                           | KEMA   |

\*Participated in previous MHMRP updates.

The Core Planning Team acted as points of contact for county stakeholders; attended all committee meetings; provided edits and feedback on the draft MHMRP Update, approach, and process; provided reference materials; and was ultimately responsible for plan approval and integration into other local plans and programs.

### Steering Committee

A Steering Committee was formed to oversee all phases of the plan. The Steering Committee was made up of representatives from the County, State, quasi-governmental agencies, and community organizations. The members of this group included all Core Planning Team members, key County staff, subject matter experts (SMEs), and other stakeholders. The Core Planning Team assembled a list of candidates representing interests within the planning area that could have recommendations for the plan or be impacted by its recommendations. The team confirmed a Steering Committee of 16 members—nine representing government agencies and seven representing nongovernment interests or groups. Some members chose to designate representatives to attend on their behalf. Table 1-2 lists the Steering Committee members.

**Table 1-2. Steering Committee Members**

| <b>Name</b>        | <b>Role/Title</b>  | <b>Agency/Organization</b>                   |
|--------------------|--|--|
| Gina Belleau       | Dam Safety Engineer  | DLNR – Engineering, State Dam Safety Program |
| Mason Chock        | President  | Kupu A'e Leadership Development              |
| Kati Conant        | Chief Strategy Officer   | Hale Hālāwai                                 |
| Eli Jones          | Program Chief  | KDHO – Environmental Health                  |
| Jaclyn Kaina       | Executive Director   | Kaua'i Economic Development Board            |
| Sue Kanoho         | Executive Director   | Kaua'i Visitors Bureau                       |
| Roger Mills        | Deputy Fire Chief  | KFD  |
| Kialoa Mossman     | Planner  | DHHL   |
| Mapuana O'Sullivan | Forest Management Supervisor   | DLNR DOFAW                                   |
| Polly Phillips     | Policy Analyst   | Office of the Mayor                          |
| James Robinson     | Agriculture and Dam Safety/Operations Manager                            | Gay and Robinson                             |
| Brad Rockwell      | Chief of Operations  | KIUC   |
| Scott Sato         | Emergency Services Supervisor  | KIUC   |
| Adam Roversi       | Housing Director   | Kaua'i County Housing Agency                 |
| Koa Duncan         | Assistant Housing Director   | Kaua'i County Housing Agency                 |
| Elton Ushio        | Department Head Administrator  | KEMA   |
| Josh Uyehara       | President<br>(and General Manager,<br>Hartung Brothers Hawai'i Division) | KAA  |
| Bryan Wienand      | Regulatory and Construction Section, CE VI,<br>Floodplain Manager        | Kaua'i Department of Public Works            |

The Steering Committee provided edits and feedback on specific hazards and topics, provided reference materials, edits and feedback to the MHMRP Update, was responsible for plan integration into local plans and programs, and assisted with building support for the plan as well as distribution of information to and from the community. The Steering Committee included a representative from the State Dam Safety Program as required for compliance with FEMA's Rehabilitation of HHPD Grant Program (FEMA 2025b). More detail on this program can be found in Appendix G.

## **Meetings**

The Steering Committee met four times from February through September 2025. The February meeting was in person, and all other meetings were virtual. Below is a summary of the topics covered at each meeting.

- **Steering Committee Meeting 1:** Provide an overview of the mitigation planning process and introduce hazard screening.
- **Steering Committee Meeting 2:** Focus on the hazard profiles and introduce the risk assessment.
- **Steering Committee Meeting 3:** Focus on the risk assessment findings and introduce the mitigation strategy.
- **Steering Committee Meeting 4:** Focus on mitigation actions and the prioritization process. Introduce and get feedback on the plan maintenance strategy.

Meeting agendas, notes, and a timeline of plan milestones for the Core Team and Steering Committee are provided in Appendix B.

### **Subject Matter Experts**

SMEs provided data, gave advice, and offered feedback on the MHMRP drafts. The Core Team and Steering Committee relied on their input and institutional knowledge, as well as topic area expertise to help guide the plan. SMEs provided invaluable context for interpretation of data and the perspective of local communities. Table 1-3 identifies the SMEs.

**Table 1-3. Subject Matter Experts**

| <b>Name</b>         | <b>Agency/Organization</b>   | <b>Area of Expertise</b>  |
|---------------------|--|---|
| Alden Alayvilla     | Kaua'i County – Office of the Mayor  | Liaison with Mayor  |
| John Bravender      | National Oceanic and Atmospheric Administration (NOAA)<br>National Weather Service | Weather Forecasting   |
| Dr. Pao-Shin Chu    | University of Hawai'i  | Tropical Cyclones   |
| Eric Fujikawa       | Hawai'i Department of Transportation – Highways Division                           | Transportation  |
| Lauren Guest        | Kaua'i District Health Office  | Human Health  |
| Sarah Henly-Shepard | U.S. Agency for International Development,<br>Bureau of Humanitarian Assistance    | Disaster Response and Recovery  |
| Gary Hudson         | KFD  | Disaster Response and Recovery, Wildfire  |
| Dr. John Marra      | NOAA National Centers for Environmental Information                                | Climate Change  |
| Patrick Porter      | Kaua'i County Department of Parks and Recreation                                   | Parks, Recreation   |
| Matt Rosner         | North Shore Hydrological Services  | Hydrology, Flood Mitigation, Restoration  |
| Chris Shuler        | University of Hawai'i  | Hydrology, Flood Mitigation   |
| Joe Tait            | Kaua'i County Department of Water  | Water Resources   |
| Gwen Yamamoto       | State of Hawai'i Green Infrastructure Authority                                    | Hawai'i Commercial Property Assessed<br>Clean Energy and Resiliency<br>(HI C-PACER) |

### **1.4.3 Public Involvement**

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. Formally, the public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). For the 2026 MHMRP Update, the public was considered to be anyone not on the Core Team, Steering Committee, or listed as representing a stakeholder entity, as discussed below.

#### **Stakeholders**

Under federal requirements for hazard mitigation planning, opportunities for involvement in the planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and

nonprofit interests (44 CFR, Section 201.6(b)(2)).<sup>1</sup> The Steering Committee met this requirement in two ways. First, agency and organization representatives were invited to participate in the Steering Committee and contributed to MHMRP development as SMEs, as discussed in the previous section. Second, an additional group of stakeholders was engaged through the public involvement process. Stakeholders were considered to be the individuals, agencies, and jurisdictions that had a vested interest in the recommendations of the MHMRP. This group was considered to be separate from the general public.

All stakeholders identified by the Steering Committee were invited by direct email to review and comment on this plan during the public comment period (Table 1-4). They provided input based on local knowledge and community interests. Access to the draft plan was primarily through the MHMRP interactive web page, i.e., the StoryMap.

**Table 1-4. Stakeholders**

| <b>Name</b>                           | <b>Agency/Organization</b>  | <b>Stakeholder Type</b>          |
|---------------------------------------|---|----------------------------------|
| Pelika Andrade                        | Nā Maka Onaona  | Other Private/Nonprofit Entities |
| Kellyne Capuano                       | Pacific Missile Range Facility – Security Training Officer  | Local and Regional Agencies      |
| Christy (Kip) Cardelli                | Kaua'i County – Equal Employment Opportunity/<br>Americans with Disabilities Act – Coordinator/Investigator | Local and Regional Agencies      |
| Dennis Eguchi                         | E Ola Mau Na Leo O Kekaha   | Other Private/Nonprofit Entities |
| Daniel Hamada                         | Kaua'i Department of Education – Complex Area<br>Superintendent   | Academia                         |
| Emily Ishida                          | Kaua'i County Agency on Elderly Affairs – Department Head   | Local and Regional Agencies      |
| Nalani Kaneakua                       | Hosea Lovell Foundation – President   | Other Private/Nonprofit Entities |
| John Kaohelaulii                      | Kaua'i Native Hawaiian Chamber of Commerce  | Businesses                       |
| Amelia Kyewich-Kaneholani             | Hawai'i State Council on Developmental Disabilities   | Local and Regional Agencies      |
| Jeremie Makepa                        | Aina Alliance   | Other Private/Nonprofit Entities |
| Mark Perriello                        | Kaua'i Chamber of Commerce  | Businesses                       |
| Robin Pratt                           | Hawai'i Community Foundation  | Other Private/Nonprofit Entities |
| Stacy Sprout                          | Waipa Foundation  | Other Private/Nonprofit Entities |
| Kilipaki Vaughan                      | Papa Ola Lōkahi   | Other Private/Nonprofit Entities |
| Mehana Vaughan                        | Kīpuka Kuleana  | Other Private/Nonprofit Entities |
| Johnny Wichman                        | Hanalei Initiative  | Other Private/Nonprofit Entities |
| Emergency Management<br>Staff Officer | Hanalei Watershed Hui   | Other Private/Nonprofit Entities |

### **Public engagement activities**

The following activities were conducted to include the public in the 2026 MHMRP Update planning process.

- The MHMRP web page was updated to reflect the initiation of the 2026 MHMRP Update.
- A press release was distributed at the beginning of the planning process to introduce the update and encourage feedback on the 2021 MHMRP Update (County of Kaua'i 2025a).

<sup>1</sup> The neighboring communities stakeholder category is not considered appropriate for the Hawaiian Islands.

- The StoryMap was created to inform the public about the plan update and provide materials for review and a mechanism for feedback:  
<https://storymaps.arcgis.com/stories/41f9c2e49f254d05a15cf2b58998d1ce>  
(County of Kaua'i 2025b).
- KEMA included a public survey link on their website with the press release early in the update process, which allowed members of the public to provide feedback on the previous MHMRP.
- A press release was distributed in the middle of the planning process to encourage feedback on the 2026 MHMRP Update and participate in a community open house (County of Kaua'i 2025c).
- A community open house was held on December 10, 2025, to encourage feedback on the draft MHMRP Update. KEMA hosted the open house, and 23 community members attended.
- Informational flyers were available at community centers and provided an overview of the plan, open house announcement, and how to access the 2025 plan update feedback survey.
- A feedback survey was developed to solicit input on the draft MHMRP Update. The survey was available at the open house and online. A total of 26 respondents completed the survey. A summary of public feedback and the vetting process followed by the Core Team can be found in Appendix C.
- A press release was distributed to stakeholders prior to adoption to inform the community of a final opportunity to comment on the MHMRP Update.

For more detailed information on the public involvement process for the 2026 MHMRP Update, please see Appendix C.

### **Related Kaua'i Climate Adaptation and Action Plan Public Outreach**

The County conducted extensive public outreach as part of the development of the Kaua'i Climate Adaptation and Action Plan (KCAAP), which included conducting polls in 2022 and 2023, to gather community input on concerns about climate change impacts as well as the public's opinion on potential climate adaptation and action strategies (County of Kaua'i 2022a, 2025d). A similar level of public involvement is beyond the scope of the 2026 MHMRP Update; however, there is overlap between the KCAAP and 2026 MHMRP Update, thus the KCAAP survey results have been integrated into the MHMRP Update.

The County conducted three surveys/polls as part of the KCAAP public involvement. The first was a survey to determine which climate change impacts the public found most concerning and which assets they thought were most important to protect. Responses to this survey were considered in the hazard screening process for the 2026 MHMRP Update and integrated into the vulnerability assessment. The second was a poll that asked the public to rate their support for a series of climate adaptation strategies. These strategies are actions that focus on living with the impacts of climate change and minimizing damage associated with more intense or more frequent hazard events. Many of the strategies are also natural hazard mitigation actions and have been used to update the Action Plan component of the 2026 MHMRP Update with mitigations actions supported by the public (see Appendix P). The third poll collected public opinions about climate action strategies that focus on mitigating greenhouse gas emissions. These strategies will have a global-level effect on reducing climate change impacts but are not directly related to the 2026 MHMRP Update planning efforts. They have not been integrated into this 2026 MHMRP Update for this reason, though the global reduction of greenhouse gas emissions decreases the likelihood of worsening climate change impacts in the county (e.g., more intense and more frequent natural hazard events).

## 1.5 FOCUS ON EQUITY

### 1.5.1 Kaua'i County Equity Goals

Social equity is critical in promoting healthy and diverse communities on Kaua'i. It calls for expanding access to economic opportunity, quality education, affordable housing and health services, and ensuring that no racial or income group is unfairly disadvantaged. The County General Plan, a strategic roadmap for the county, outlines the following steps for equity (County of Kaua'i 2018):

- Celebrating Kaua'i's diversity by addressing equity issues
- Caring for the most vulnerable
- Strengthening community networks
- Protecting Native Hawaiian rights

### 1.5.2 Addressing Equity in Hazard Mitigation

The planning process for this MHMRP Update was designed to stimulate better, more effective, sustainable, and vital connections between stakeholders, toward the common objective of mitigating hazard risks to the community. The plan emphasizes equity to empower the county's most vulnerable people to play a role in building resilience. Equity was considered throughout the planning process, including in public outreach, the evaluation of risk, and the development of mitigation actions.

Through this broad engagement and focus on equity, the County seeks to reduce vulnerability to natural hazards for all communities so that the benefits of hazard mitigation, such as the following, can be shared by all:

- A faster recovery and return to normal life for neighborhoods after a hazard event
- Reduced stress on emergency responders and social services
- A faster return to work for workers after a hazard event, resulting in less economic disruption and fewer businesses closing
- Maintenance of the culture, diversity, and distinct neighborhoods of the county

The planning process sought to identify specific needs for targeted mitigation actions that can overcome traditional barriers and challenges to equity. Such actions should achieve the following objectives:

- Minimize the impacts of hazard events so that they do not become disasters.
- Provide a better quality of life to all groups and members of the whole community.
- Build trust and networks that can be relied upon for other developmental activity.
- Promote overall sustainability and resilience.

The risk assessments and hazard mitigation action plan in this MHMRP Update aimed for equity by considering the diversity of communities in the county and each community's access to resources (including information, knowledge, and technology) and social networks and connections and beliefs and customs, age, gender, race, health, and physical ability of its members.

Social vulnerability data was integrated into the vulnerability assessment for each hazard. The social vulnerability indicator (SVI) dataset from the KCAAP was used and overlaid with exposure areas for each hazard to assess where high levels of social vulnerability intersected with areas of hazard exposure. The SVI dataset integrated data from different categories of characteristics, such as household, socioeconomic status, race and ethnicity, and physical conditions. Figure 1-2 below shows a map of Kaua'i with SVI percentiles from the KCAAP Vulnerability and Equity Analysis (County of Kaua'i 2022b).

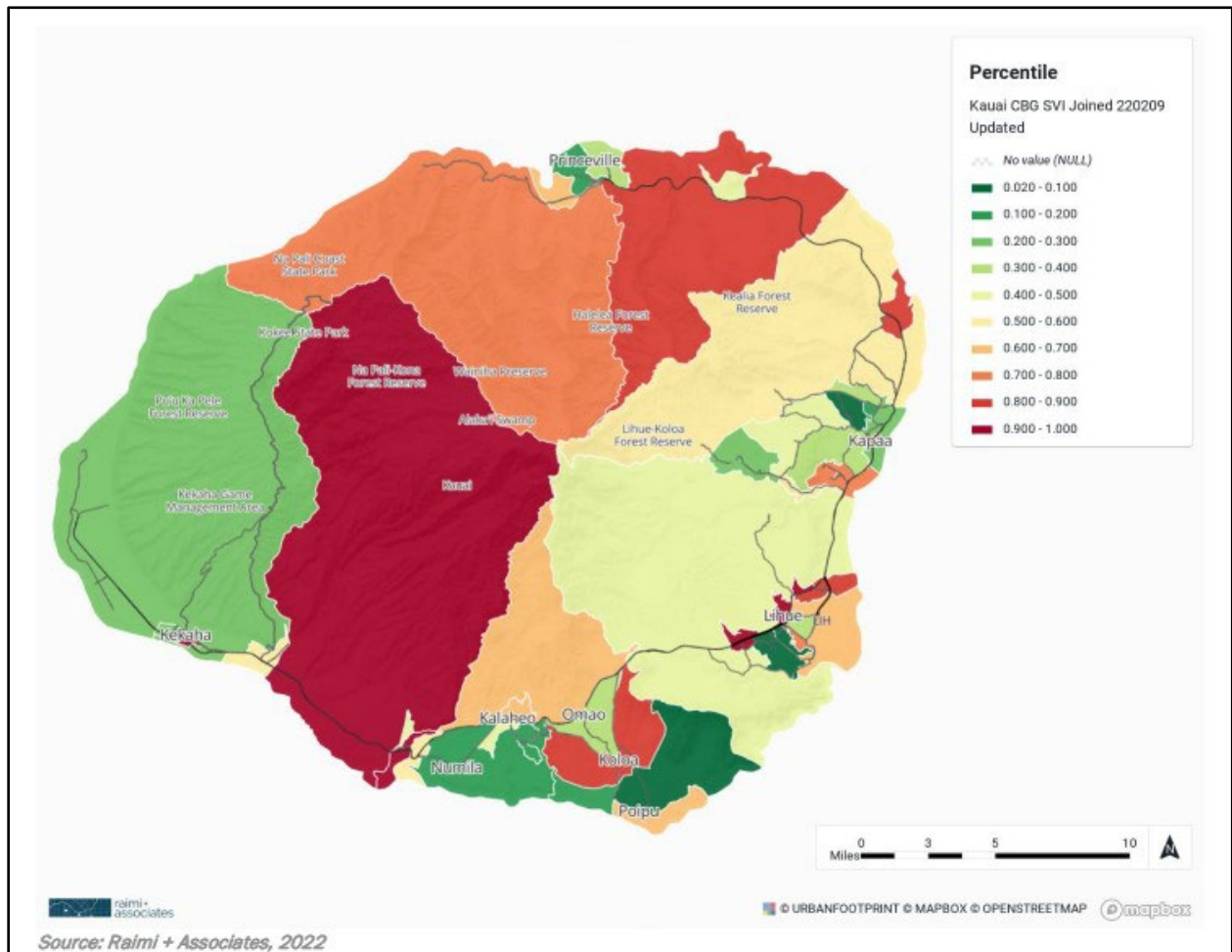


Figure 1-2. Kaua'i Social Vulnerability Index percentiles.

## 2. KAUAʻI COUNTY PROFILE

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### 2.1 GEOGRAPHIC OVERVIEW

The state of Hawaiʻi consists of eight major islands (Kauaʻi, Niʻihau, Oʻahu, Maui, Molokaʻi, Lānaʻi, Kahoʻolawe, and Hawaiʻi) and 129 small islands, reef, and shoals (Northwest Hawaiian Islands). The islands are divided into five counties—Kauaʻi, City and County of Honolulu (Oʻahu), Maui, Kalawao, and Hawaiʻi.

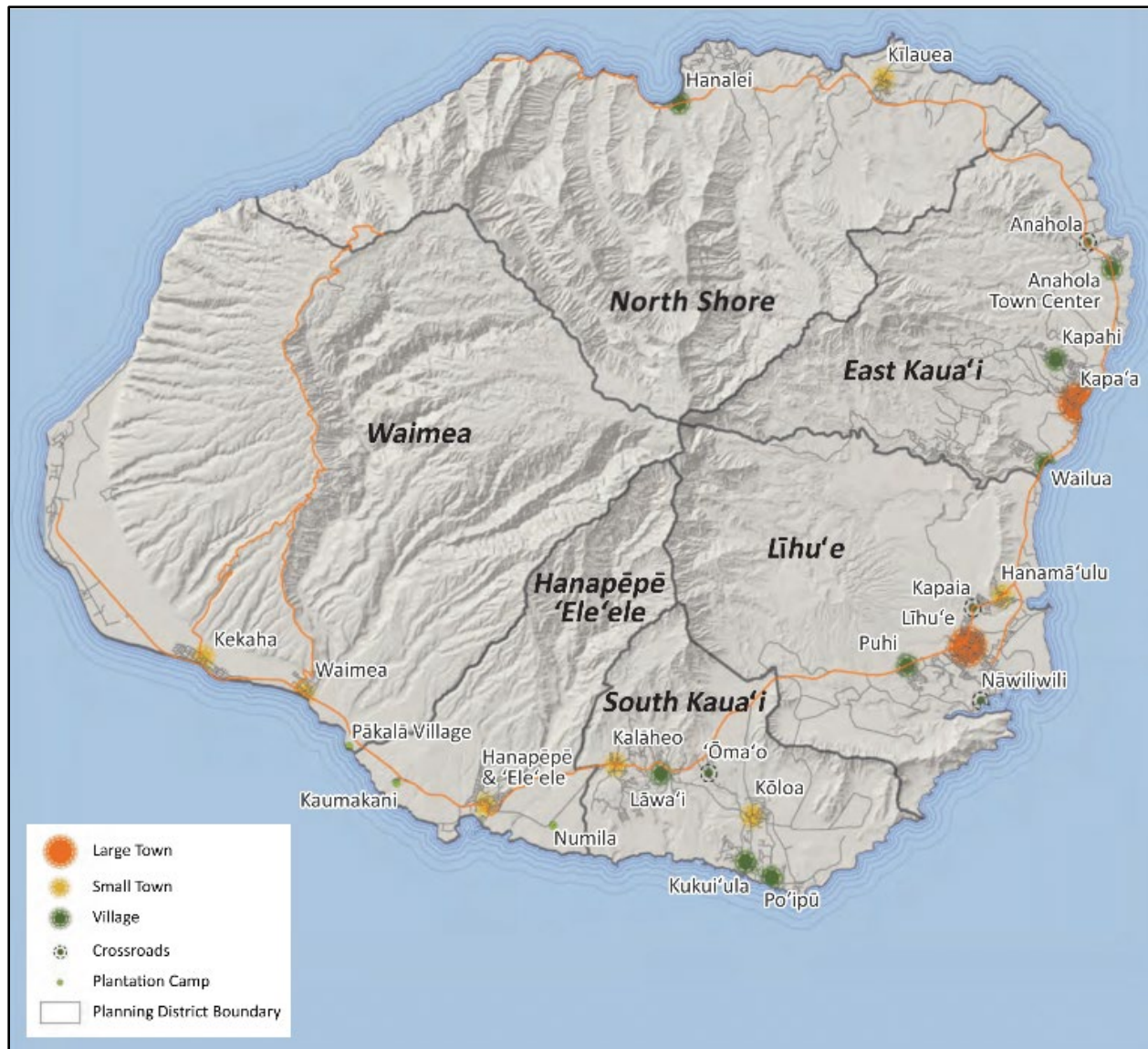
Kauaʻi is northwest of Oʻahu, and they are separated by the Kauaʻi Channel. Known as the Garden Isle, Kauaʻi is the northernmost and geologically oldest of the major Hawaiian Islands. Kauaʻi County includes Niʻihau Island (nearly 70 square miles) and the tiny uninhabited islets of Kaʻula and Lehua. These islands are volcanic in origin, although there are currently no active volcanoes in this county. The circular island of Kauaʻi rises 3 miles from the ocean floor and is roughly 550 square miles (County of Kauaʻi 2015a).

The Kauaʻi County seat is Līhuʻe. Other population centers are Hanalei, Kīlauea, Anahola, Kapaʻa, Kapahi, Wailua, Hanamāʻulu, Puhi, Kōloa, Poʻipū, Kukuiʻula, Lāwaʻi, Kalāheo, Hanapēpē, ʻEleʻele, Waimea, and Kekaha. Puʻuwai is the settlement on Niʻihau. The planning area for this MHMRP Update includes the entire island of Kauaʻi. For planning purposes and to assess potential losses from hazard events, the county’s six planning districts are used for analyses throughout this MHMRP Update. The Island of Niʻihau is also part of Kauaʻi County, but—as in the County General Plan—it is not analyzed in this MHMRP Update due to its predominantly private ownership and management Figure 2-1 shows the planning area and districts used for this plan (County of Kauaʻi 2018).

### 2.2 HISTORICAL OVERVIEW

The first Polynesian settlers may have arrived around 600 AD with an influx of new settlers in about 1200 AD. Manokalanipō, born in Wailua about 1350 AD, is credited with building significant agricultural projects and bringing generations of prosperity to Kauaʻi and Niʻihau (Kauaʻi Historical Society 2000; Young 2016). The arrival of Captain James Cook at Waimea in 1778 marked the first recorded encounter by Native Hawaiians with Europeans. Other Western explorers and settlers followed, and as a result, the island’s economy, land use system, form of government, population, culture, and lifestyle were forever changed.

Kauaʻi and Niʻihau were the last islands to join the Kingdom of Hawaiʻi. Kamehameha I attempted twice to invade Kauaʻi (Tetra Tech 2021). The first time in 1796 was thwarted by bad weather. In 1804 an outbreak of typhoid fever decimated the gathered forces on Oʻahu. Kauaʻi’s king, Kaumualiʻi, acknowledged Kamehameha as king of all Hawaiʻi in 1810 to avoid future bloodshed. When Kamehameha died in 1819, his successor, Kamehameha II (Liholiho), feared that Kaumualiʻi would sever Kauaʻi’s relationship with the Kingdom of Hawaiʻi. In September 1821, Kamehameha II sailed to Kauaʻi and invited Kaumualiʻi to dine on his ship. Kamehameha then sailed back to Oʻahu with Kaumualiʻi under house arrest. Kauaʻi remained passive until Kaumualiʻi’s death on Oʻahu in 1824. His son George Kaumualiʻi Humehume attempted to reestablish Kauaʻi’s independence. After a brief and unsuccessful rebellion on the island’s west side was brutally repressed, Kamehameha II installed Kaikioʻewa as Kauaʻi’s governor.



**Figure 2-1. Planning area communities and districts.**

Because of its location in the mid-Pacific, Hawai'i was an ideal stop for trade ships. Sandalwood trade dominated until 1830, when Kaua'i's forests became stripped of sandalwood. Whaling ships, stopping to reprovision at Waimea and Kōloa were common from 1820 to 1870. Kōloa Plantation was founded in 1835 with the setup of a simple sugar mill and became the first large-scale, commercial sugar plantation in Hawai'i. In the mid-1800s, coffee became the first successful new trade crop to be planted on Kaua'i. Livestock production and growing rice and pineapple also changed the local economy, but sugar, especially after the 1875 Reciprocity Treaty removed all duties on Hawaiian sugar imported to the United States, dominated as the primary agricultural and industrial activity for more than 120 years and greatly boosted the plantation system. By 1910, plantation towns populated by immigrants from China, Japan, the Philippines, and Portugal, were common.

In July 1887 a group of primarily American and European businessmen forced a new constitution on King David Kalākaua, which among other things disenfranchised two-thirds of Native Hawaiians and all Asian immigrants. In January 1893, a similar group, the Committee of Safety, deposed Queen Liliʻuokalani and established the Provisional Government of Hawaiʻi. The Provisional Government placed Liliʻuokalani under house arrest and established the Republic of Hawaiʻi in July 1894. The United States annexed Hawaiʻi in August 1898.

With a change of government following Hawaiʻi's annexation in 1898, Kauaʻi's modern territorial era began. Roads were built for the first automobiles that arrived in 1907. Cross-island telephone service started in 1911. Electricity, which had previously only been used by the sugar mills, became available to consumers in Līhuʻe, Kōloa, and Waimea. Airfields were built at Līhuʻe and Hanapēpē, and regular flight service was established in the 1920s. Tourism began to increase in the 1950s with the arrival of passenger jet flights to the islands. By 1970, the number of workers in the tourism industry outnumbered those working on sugar plantations, and by the end of the 1980s, more than 80% of Kauaʻi's income was dependent on tourism (Kauaʻi Historical Society 2000). In recent years, diversified agriculture has experienced a generally upward trend on Kauaʻi, with sunflower cultivation and processing scaling up, culturally significant taro being a staple crop, particularly in the Hanalei region, and the largest coffee plantation in the United States contributing significantly to Hawaiʻi's total agricultural output. Technology and defense also play important roles in the island's economy (Kauaʻi Chamber of Commerce 2025).

## 2.3 PHYSICAL SETTING

The Hawaiian archipelago consists of 137 volcanic islands, atolls, reef, and shoals in the North Pacific Ocean (State of Hawaiʻi Department of Business, Economic Development and Tourism [DBEDT] 2025a). Although the Hawaiian Islands were all formed by volcanic eruptions, only the islands of Hawaiʻi and Maui still have active volcanoes.

### 2.3.1 Geology and Topography

In the center of the island of Kauaʻi are Kawaikini Peak, rising 5,243 feet above mean sea level, and Mount Waiʻaleʻale, rising 5,148 feet above mean sea level. Mount Waiʻaleʻale is one of the rainiest spots on earth, with an average of up to 450 inches of rain per year. Many streams flow from these mountains to the sea through canyons in the volcanic rock. Waimea Canyon has colorful rock walls more than 3,000 feet deep. The Waimea River, at 20 miles, is the longest river in the state. The Wailua River is the state's only navigable waterway. Rugged cliffs along the northwest coast make it impossible to build a road around the whole island. Along its 90 miles of shoreline, Kauaʻi has more beaches per mile than any other island in the Hawaiian chain. Niʻihau is a private island owned by the Robinson family of Kauaʻi. Although the two largest freshwater lakes are present (Halulu Lake and Halāliʻi Lake), Niʻihau is semiarid with a dry climate. As with the other main Hawaiian Islands, it is the eroded remnant of a shield volcano (MacDonald; Smithsonian Institution 2013).

### 2.3.2 Climate

Kauaʻi's climate is tropical, with generally humid and stable conditions year-round, although weather phenomena and infrequent storms have caused instances of extreme weather. An average of fewer than 20 inches of precipitation falls on the leeward side of the island per year, and 370 to 450 inches per year fall at Mount Waiʻaleʻale. Summertime high temperatures in Līhuʻe can range from 78 degrees Fahrenheit (°F) to 85°F, whereas temperatures in the upper elevations of Kōkeʻe State Park can drop into the 40s and 50s °F (DBEDT 2023a; Smithsonian Institution 2013). Niʻihau is relatively arid because it

lies in the rain shadow of Kaua‘i and lacks the elevation needed to catch significant amounts of trade wind rainfall. It depends on winter Kona storms for rain, when more northerly weather systems intrude into the region. Therefore, Ni‘ihau is subject to long periods of drought (Tabrah 1987).

The tropical conditions of the eastern Pacific—warm ocean water near the equator combined with cyclonic spin—are ideal for hurricane formation. Because of its western location in the state, Kaua‘i has a slightly lower probability of tropical cyclone landfall, but devastating events have occurred. The Tropical Cyclones and Other High Winds hazard is profiled in Part 2 Section 6 of this 2026 MHMRP Update.

Table 2-1 summarizes normal monthly climate data at National Centers for Environmental Information weather stations across the planning area.

**Table 2-1. Normal Monthly Kaua‘i County Precipitation and Temperatures**

| Weather Station   | Precipitation (inches) | Temperature (°F) |         |         |
|---|------------------------|------------------|---------|---------|
|   |                        | Minimum          | Average | Maximum |
| LThu‘e Weather Service Office Airport 1020.1 (2020–2025)* | 2.9                    | 57.0             | 76.2    | 81.7    |
| Kōloa 936 (2010–2019)†                                    | 3.82                   | N/A              | N/A     | N/A     |
| Waimea 947 (2010–2017)†                                   | 2.95                   | 64.0             | 73.6    | 83.5    |
| Princeville Ranch 1117 (2017–2019)†                       | 6.48                   | 65.3             | 72.3    | 79.3    |

Notes:

°F = degrees Fahrenheit.

N/A = Not available.

\*NWS (2025a).

†Tetra Tech (2021). Data for Kōloa, Waimea, and Princeville Ranch were not accessible for 2020–2024.

## 2.4 SENSITIVE RESOURCES

### 2.4.1 Culturally Sensitive Resources

The Heritage Resources subsection of the County General Plan provides the following overview of heritage resources in the county:

Throughout Kaua‘i there is an abundance of archaeological, cultural, historic, and scenic resources. Together these resources document Kaua‘i’s storied past, cultivate a unique sense of place, and educate new generations about their history.

Historic buildings and structures are critical to preserving Kaua‘i’s unique history, town character, and sense of place. It is our kuleana to ensure that each community’s treasured structures are preserved and celebrated.

Wahi Pana and the resources that support cultural practices are the foundation of Kaua‘i’s identity. Culturally significant places and sites, once destroyed, cannot be replaced. These places and the stories behind them provide vital insight to how the ancient Hawaiians lived in harmony with the land and managed the use of natural resources in a sustainable manner. (County of Kaua‘i 2018)

The KCAAP states that “about 550 Hawaiian cultural sites are exposed to chronic flooding with a sea level rise of 3.2 ft” (County of Kaua‘i 2022a, 2025d). Culturally significant practices, such as gathering from nearshore fisheries, collection of timber and medicinal plants, and traditional agriculture practices,

will be affected by climate change impacts such as sea level rise, rising temperatures, and decline of native forests.

## 2.4.2 Beaches

Although Kauaʻi has only 11% of the state’s coastline, it has more than one-half of its beach sand, including the longest stretch of beach in Hawaiʻi. These beaches are heavily used and treasured by residents and visitors and are a significant attraction for the tourism economy; however, approximately 70% of Kauaʻi’s beaches are eroding, and Kauaʻi has lost an estimated 9% of its beaches over the past century (Anderson et al. 2015). Although erosion is a naturally occurring force, the human contribution to beach erosion includes coastal development and coastal armoring, which exacerbate sand loss and the narrowing of beaches. Kauaʻi has lost 4 miles of beach due to shoreline hardening structures (DeVillie 2020). Sea level rise, which is accelerating worldwide due to global warming, is another human contribution to beach erosion (County of Kauaʻi 2022a, 2025d).

## 2.4.3 Forests

Kauaʻi’s upper watershed and its forests are critical to the health and integrity of the island’s ecosystems. They provide the essential services of water quality protection, flood mitigation, and fire protection. These forests include the vestiges of Kauaʻi’s native forests and landscapes, which are the habitat for many endangered and at-risk species. The upper forests, which make up 50% of Kauaʻi’s land area, harbor rare and endangered plant and animal species and include native ecosystems that are relatively intact. They have to date survived the fate of native lowland forests—destruction by invasive species, wildfires, and incompatible uses by humans (County of Kauaʻi 2018).

## 2.4.4 Freshwater Resources

Water is a public trust resource in Hawaiʻi. Rainfall captured by Kauaʻi’s high peaks, such as Waiʻaleʻale and Kawaikini, sustains perennial streams and recharges the island’s aquifers, which are the primary source of domestic water. Kauaʻi’s groundwater is organized into three aquifer sectors comprising 13 systems. Average daily water demand is 13.69 million gallons per day (County of Kauaʻi 2025e), against an island-wide sustainable yield of 328 million gallons per day (Fukunaga & Associates, Inc. 2024). On a remote island, there are no practical substitutes for groundwater as the primary source of domestic water. Kauaʻi’s aquifers depend on continual recharge by seepage of rainfall and stream water through permeable ground surfaces. The quality and quantity of Kauaʻi’s groundwater relies on having a healthy watershed.

Kauaʻi has at least 61 perennial streams (National Park Service 1990). In 2022, 30 of 37 assessed perennial streams (81%) were listed as impaired by the State of Hawaiʻi Department of Health (DOH) (DBEDT 2023a:Table 5.08; DOH 2022). Historically, these streams provided pristine habitat for communities of *oʻopu* (native fish), insects, and snails, but stream diversions and introduced species, such as guppies and swordtail, have led to the decline of many native species. Kauaʻi’s drainage system is mostly natural—consisting of its streams and rivers; this system is augmented by structures such as irrigation ditch systems and flood protection levees along certain streams. Due to development in the mid-watershed, poor land use practices, and natural sources, polluted runoff flows to drainage systems and ends up impairing streams and nearshore coastal waters (County of Kauaʻi 2018).

## 2.4.5 Scenic Resources

Kaua'i County features a broad range of scenic resources, including the coastline and Pacific Ocean, sand dunes, coral reefs, jagged mountains, deep canyons, rolling grasslands, native forests, heavily vegetated valleys, rivers and waterfalls, agricultural features, and distinctive rural communities. The island is home to flora, fauna, and ecological communities that can be found nowhere else in the world. These natural resources face pressure from development, invasive species, natural hazards, and climate change.

- **Coastal Views:** Kaua'i County's varied, extensive coastline offers a wide range of scenic vistas from roads and highways, beaches, county and state parks, coastal access points, and heritage trails.
- **Forests:** Forestlands define much of the landscape of Kaua'i County. Nine State Forest Reserves and two Natural Area Reserves are all significant protected forests in the county (DOFAW 2025a, 2025b). Forestland is abundant, well beyond these protected areas. The scenic value of these natural resources, viewed from within or from outside, is of great importance.
- **Scenic Roadways and Multiuse Paths:** Many roads and paths in Kaua'i County have unique scenic qualities because of their natural setting. The federally recognized Holo Holo Kōloa Scenic Byway runs through Kōloa in South Kaua'i (County of Kaua'i 2018). The Ke Ala Hele Makalae multiuse path follows the eastern shoreline and will eventually be lengthened to about 17 miles (Kauai.com 2025).

## 2.4.6 Endangered Species

The federal lists of threatened and endangered species include 180 species on the island of Kaua'i—158 plant species and 22 animal species (U.S. Fish and Wildlife Service 2025). These resources are an integral part of the economy, sense of place, and Traditional culture of the island. They are impacted by natural hazards and can influence the way that hazards impact the built environment.

## 2.5 DEVELOPMENT PROFILE

To accurately evaluate ways to protect people and property from the potential impacts of natural and other hazards, hazard mitigation requires an understanding of how development has spread across the planning area and how it is likely to change in the future. Appendix D of this plan provides a detailed planning area development profile. The key findings of the review are as follows:

- **Current State Land Use Designations:** Hawai'i's State Land Use Commission defines four land use districts. The distribution of these districts in Kaua'i County is shown in Table 2-2.
- **Current County Land Use Designations:** Table 2-3 and Figure 2-2 summarize the area and location of current County-defined land uses in Kaua'i County. More than 56% of the county's land area is designated as natural land, and approximately 39% (139,044 acres) is designated for agriculture.
- **Building Counts, Uses, and Value:** Based on Hazus data, there are 26,502 buildings in the county, with an estimated total replacement value (for the building structure and contents) of \$24 billion. Residential buildings make up 89% of the total.
- **Critical Facilities:** Critical facilities are those that are essential to the health and welfare of the population. For this plan, the Steering Committee defined critical facilities as structures and infrastructure from which essential services and functions for victim survival, continuation of public safety actions, and disaster recovery are performed or provided. Table 2-4 summarizes the

number of critical facilities by category. General locations of critical facilities and infrastructure in the planning area are shown in Figure 2-3 and Figure 2-4.

The development review also identified likely future trends in development, as follows (SSFM International 2024):

- The county is expected to grow by approximately 0.5% to 0.7% each year to a population of 80,511 by 2035, with growth rates steadily decreasing over time. Seniors will make up 27% of the population by 2040, compared to approximately 21% in 2015.
- The rate of job growth in the civilian labor force is expected to be higher than population growth, with a growth rate ranging between 0.8% and 0.87% between 2030 and 2040.
- Housing units are forecasted to increase with growth rates ranging from 0.26% to 0.95% between 2025 and 2050. Growth rates slow considerably toward 2050, with a 0.65% growth rate in 2030, a 0.45% growth rate in 2040, and a 0.26% growth rate in 2050. Growth rates are expected to vary considerably by planning district. The number of housing units in the North Shore and West Kaua'i planning districts is expected to experience little change between 2025 and 2040. However, the Līhu'e, East Kaua'i, and Kōloa-Po'ipū-Kalāheo Planning Districts are each expected to experience an increase of several hundred housing units between 2025 and 2040.
- Visitor arrivals are projected to continue to grow through 2050, with visitors representing a larger share of the de facto population each decade. Despite a general increase, disrupting events, such as the COVID-19 pandemic, can contribute to significant ups and downs in the visitor industry. These shifts have historically been experienced every 5 to 10 years (Tetra Tech 2021).

**Table 2-2. State-Designated Land Use in the Planning Area**

| Land Use District | Description  | Area (acres)   | % of Total County Land Areas |
|-------------------|--|----------------|------------------------------|
| Urban             | Lands in urban use with sufficient reserve to accommodate foreseeable growth                 | 14,834         | 4.2%                         |
| Rural             | Small farms mixed with low-density residential lots that have a minimum lot size of 0.5 acre | 1,253          | 0.4%                         |
| Agriculture       | Lands with capacity for intensive cultivation and typical minimum lot size of 2 acres        | 139,044        | 39.3%                        |
| Conservation      | Lands in forest and water reserve zones  | 198,769        | 56.2%                        |
| <b>Total</b>      |  | <b>353,900</b> | <b>100%</b>                  |

Source: DBEDT (2023a).

Note: Sums may not be exact due to rounding.

**Table 2-3. County-Designated Land Use in the Planning Area**

| Land Use Category  | Designated Area (acres) |
|--------------------|-------------------------|
| Agricultural       | 61,627                  |
| Agricultural (IAL) | 36,720                  |
| Golf Course        | 2,197                   |
| Homestead          | 5,271                   |
| Industrial         | 255                     |
| Large Town         | 177                     |

| Land Use Category        | Designated Area (acres) |
|--------------------------|-------------------------|
| Military                 | 2,039                   |
| Natural                  | 215,414                 |
| Neighborhood Center      | 1,156                   |
| Neighborhood General     | 1,771                   |
| Parks and Recreation     | 14,882                  |
| Plantation Camp          | 168                     |
| Provisional Agriculture* | 570                     |
| Provisional Resort*      | 94                      |
| Residential Community    | 7,947                   |
| Resort                   | 1,833                   |
| Small Town               | 18                      |
| Transportation           | 1,027                   |
| University Zone          | 241                     |
| Urban Center             | 1,601                   |
| <b>Total</b>             | <b>355,010</b>          |

Source: County General Plan, including December 2020 adoption of the West Kaua'i Community Plan (County of Kaua'i 2018, 2020a).

Notes:

IAL = Important Agricultural Lands.

\*Provisional area means an area on the Land Use Map to be defined and designated via a future Community Planning process due to the sensitivity of its potential regional impact (County of Kaua'i 2018).

Sums may not be exact due to rounding.

**Table 2-4. Kaua'i County Critical Facilities**

| Type                        | Number of Facilities |
|-----------------------------|----------------------|
| Safety and Security         | 100                  |
| Food, Water, and Sheltering | 565                  |
| Health & Medical            | 30                   |
| Energy                      | 13                   |
| Communications              | 17                   |
| Transportation              | 67                   |
| Hazardous Materials         | 6                    |
| <b>Total</b>                | <b>798</b>           |

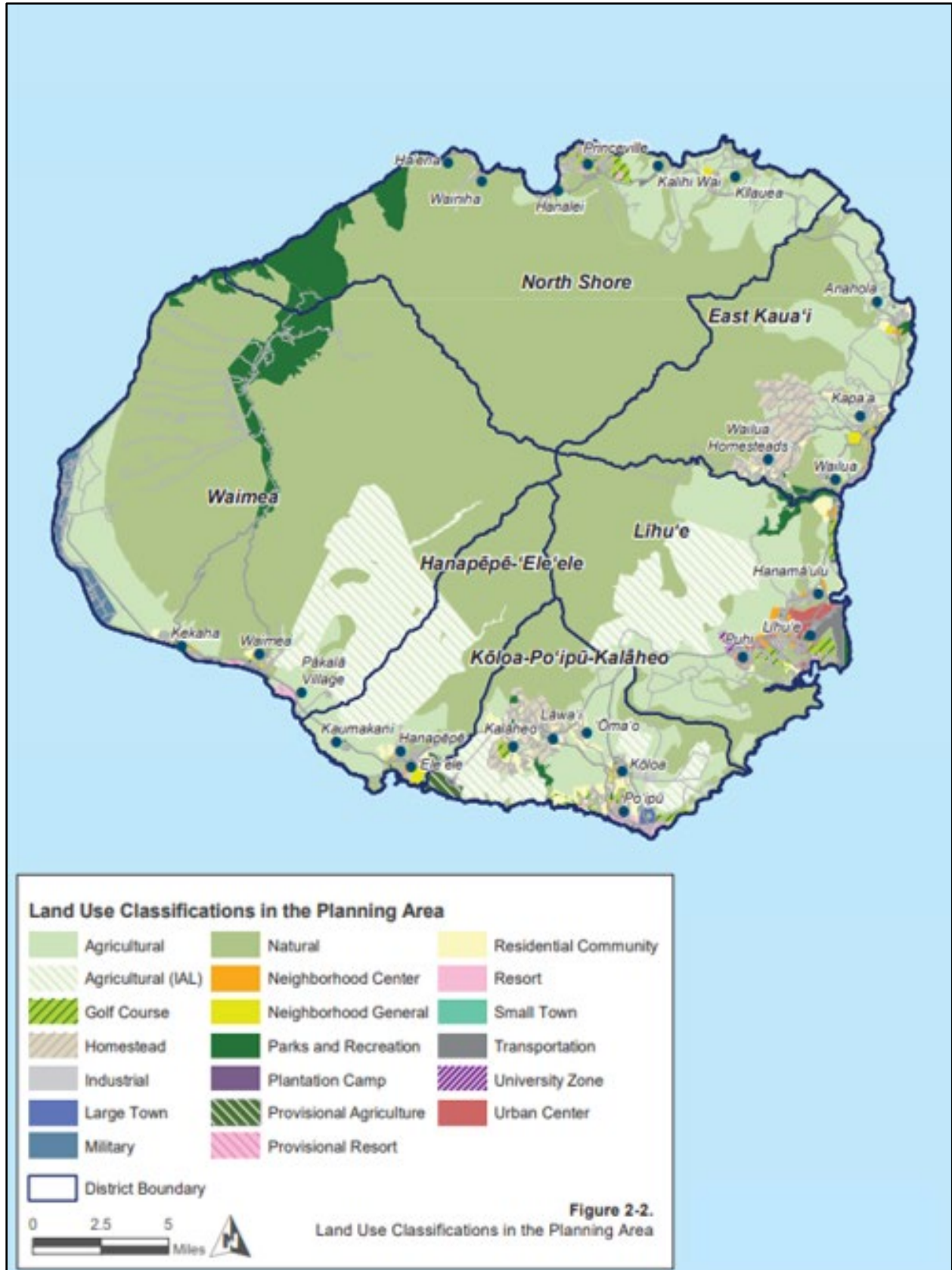


Figure 2-2. Land use classifications in the planning area.

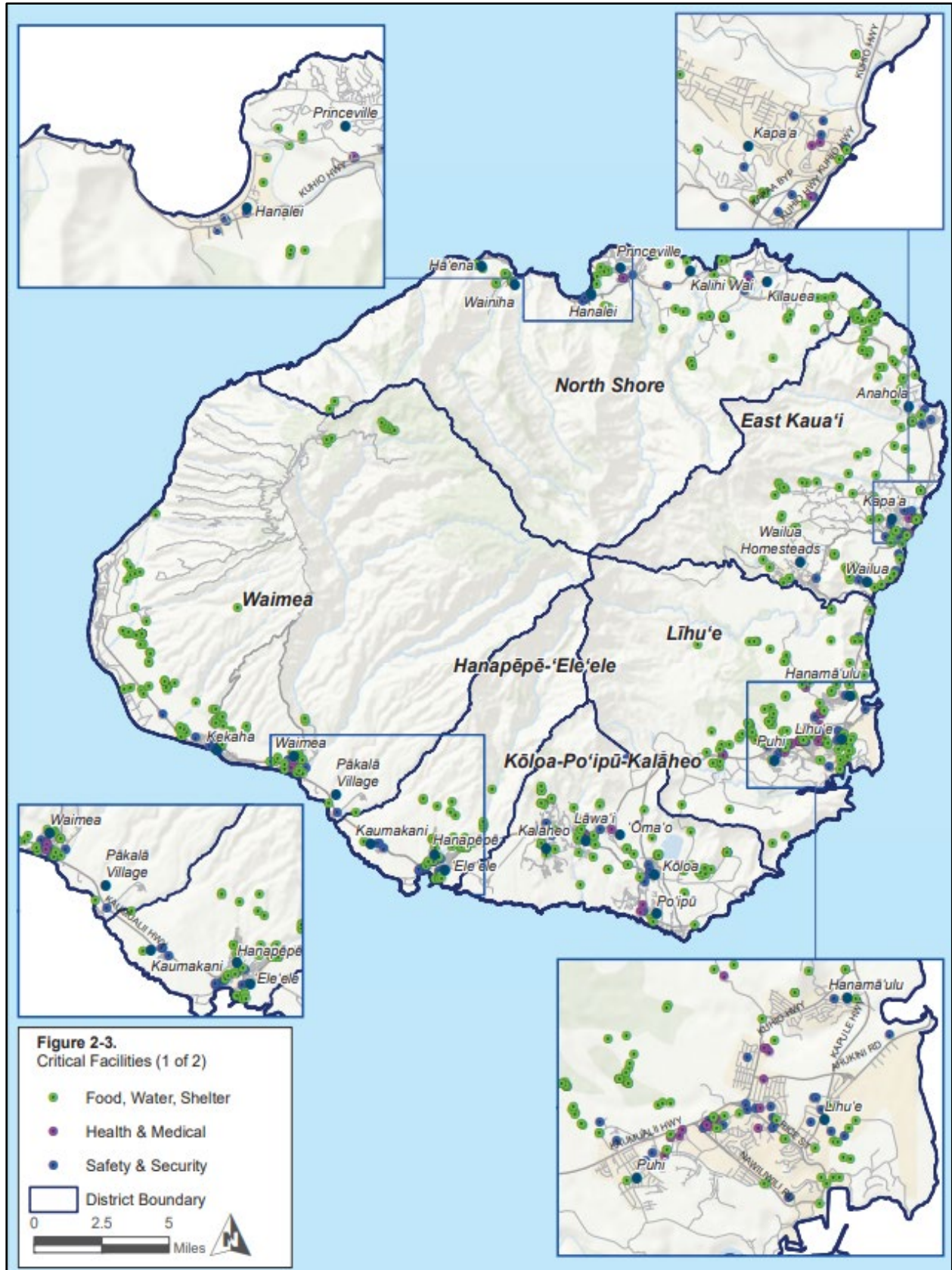


Figure 2-3. Critical facilities map (1 of 2).

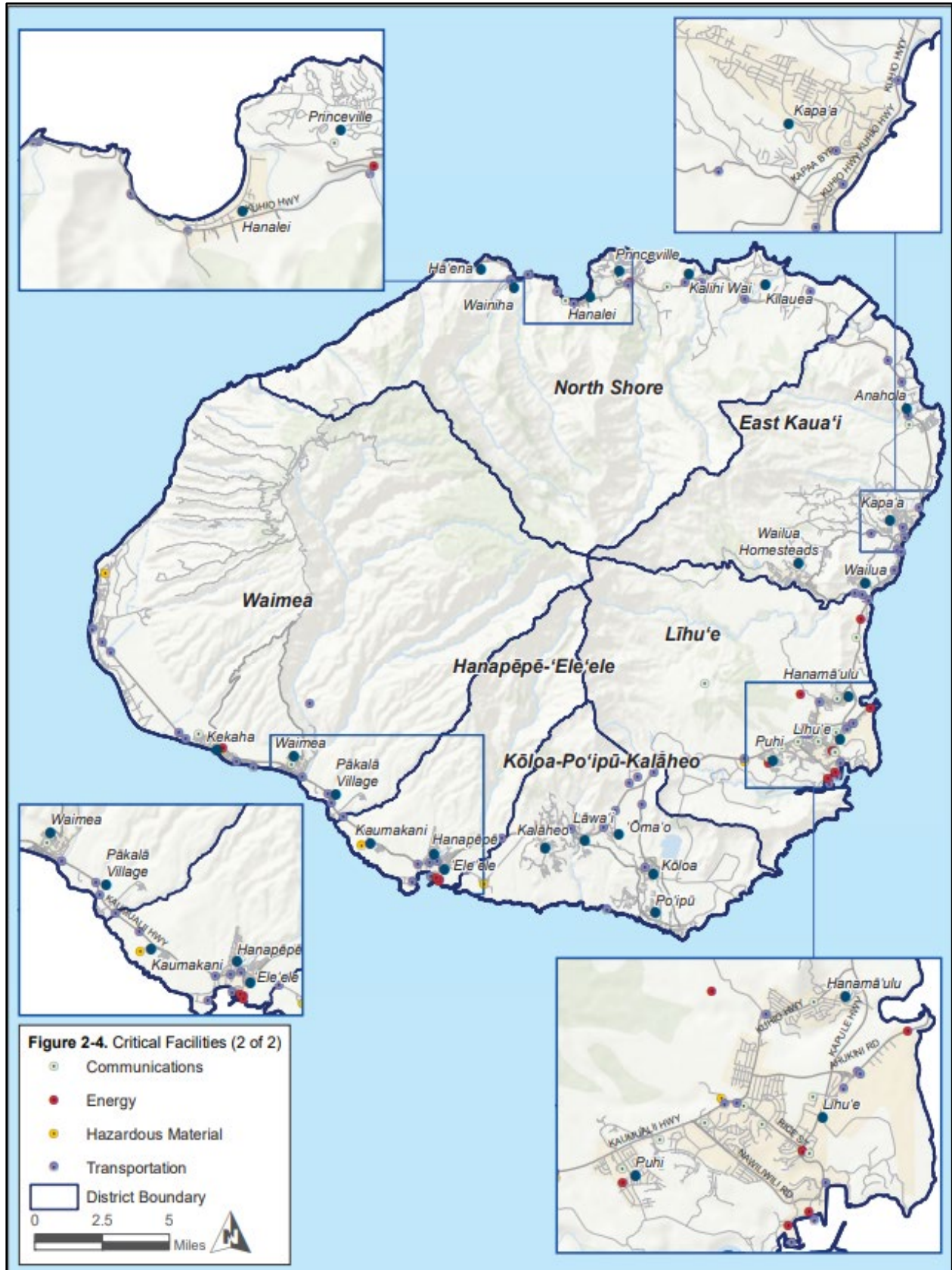


Figure 2-4. Critical facilities map (2 of 2).

## 2.6 DEMOGRAPHICS

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about hazard mitigation. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. The U.S. Census Bureau estimates the county's total resident population at 73,840 as of 2024 (U.S. Census Bureau 2025a). The average growth rate since 1980, for Kaua'i County and for the state, is shown on Figure 2-5. (DBEDT 2025b). The County's Long Range Forecast projects a population of 80,511 by 2035 (SSFM International 2024).

### COUNTY POPULATION CHARACTERISTICS

The following are significant demographic characteristics of the County's current population:

- 23.1% of the county's population is 65 or older, higher than the state average of 21.1%.
- 8.9% of the over-65 population has income below the poverty line.
- 17.5% of the population is 14 or younger, about the same as the state average of 18.1%.
- Children under the age of 18 account for 11.2% of individuals who are below the poverty line.
- The racial composition of the county is predominantly white, at just over 30%, and Asian, at just under 30%.
- The largest minority populations are Hispanic or Latino, at nearly 11%, and Native Hawaiian or other Pacific Islander, at approximately 10%.
- The planning area has a 14.6% foreign-born population.
- Other than English, the most commonly spoken languages in the planning area are Asian and Pacific Island languages.
- Persons with disabilities or with access and functional needs make up 12.1% of the total civilian noninstitutionalized population.

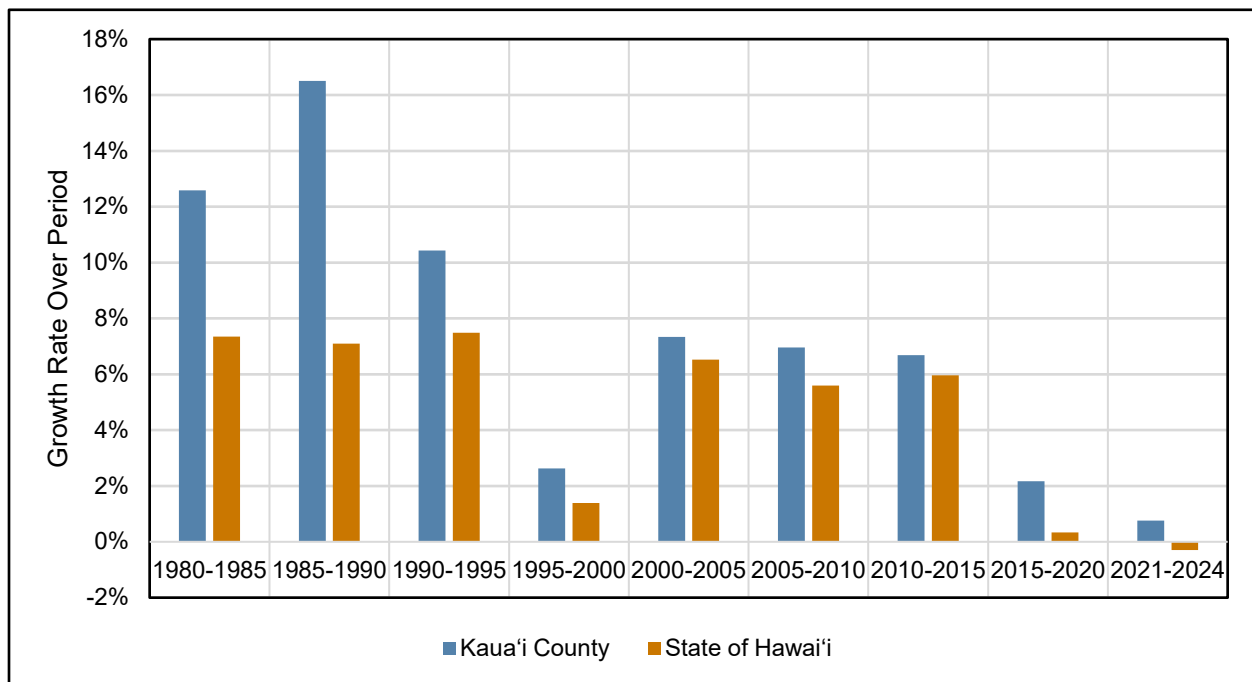


Figure 2-5. State of Hawai'i and Kaua'i County population growth.

Some populations are at greater risk from hazard events because of decreased resources or diminished physical abilities. People living near or below the poverty line, the elderly, individuals with disabilities, women, children, ethnic minorities, and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception; living conditions; access to information before, during, and after a hazard event; capabilities during an event; and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and in the geographically most vulnerable locations. The County General Plan identified “priority equity areas” with high populations of vulnerable and marginalized communities, as well as Census-designated places with high percentages of minority households and households experiencing poverty (Figure 2-6) (County of Kaua'i 2018).

Detailed demographic data for the planning area are provided in Appendix E.

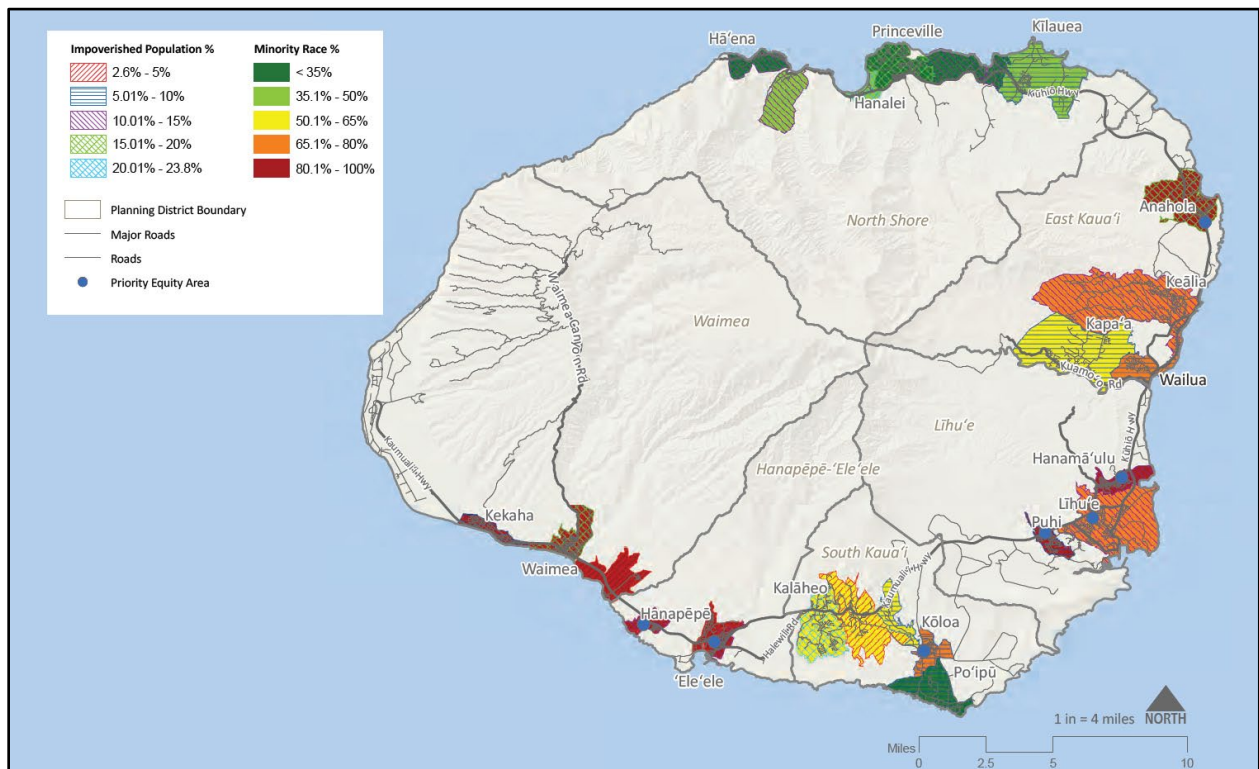


Figure 2-6. Kaua'i County social equity map.

## 2.7 ECONOMY

Kaua'i County is dependent on off-island sources for energy, food, construction materials, and common daily goods. The local community has expressed a desire for the county's agricultural economy to be more self-reliant (State of Hawai'i Office of Planning 2012), which would include expanding agriculture, aquaculture, manufacturing, and renewable-energy sectors. By working toward self-sufficiency, Kaua'i County's economy could diversify and offer additional opportunities for employment and income (State of Hawai'i Office of Planning and Sustainable Development [OPSD] 2025a).<sup>2</sup> The County OED works in partnership with the community to create economic opportunities for balanced growth in the county (County of Kaua'i 2025f).

Over the long term, Kaua'i County has a projected annual job growth rate of 0.6% (DBEDT 2024a). Tourism has made up 20% to 30% of all employment, but current growth projections in this sector are sluggish with construction continuing to be a source of strength (Economic Research Organization at the University of Hawai'i 2024). Despite the projected job growth, the high cost of living in the county offsets economic opportunity. Kaua'i's median household income is typically less than the state average, so many residents work multiple jobs, supplement income with homegrown food or cottage industries, and have long work commutes from neighborhoods with affordable housing (County of Kaua'i 2018).

Detailed economic data for the planning area are provided in Appendix F.

### COUNTY ECONOMIC CHARACTERISTICS

The following are significant economic characteristics of the County as of 2025:

- Median household income was \$93,612 in 2013.
- 6% of all families and 8.3% of individuals had income that fell below the poverty line.
- Based on U.S. Census Bureau data, the county's economy is strongly based in the accommodation and food service sector, followed by the health care and social assistance industry. Food and agriculture, sustainable technologies, sport and recreation, and arts and culture follow in number of private sector jobs.
- Service occupations, management/business/science/arts occupations, and sales/office occupations make up 20%, 33% and 25% of the jobs in the planning area, respectively.
- Hawai'i state data lists 14 employers in Kaua'i County with 250 or more employees as of December 2019.
- 62.9% of the county's population 16 and older is in the labor force.
- Since 2010, Kaua'i County's unemployment rate was highest in 2020, at 13.6%, largely due to the COVID-19 pandemic, it has since stabilized.

<sup>2</sup> As of July 2, 2021, the State of Hawai'i Office of Planning became the State of Hawai'i Office of Planning and Sustainable Development when Governor David Ige enacted Acts 152 and 153.

## 3. REGULATIONS AND PROGRAMS

### 3.1 RELEVANT AGENCIES, PROGRAMS AND REGULATIONS

Existing laws, ordinances, and plans at the federal, state, and local level can support or impact hazard mitigation initiatives identified in this plan. HMPs are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR Section 201.6(b)(3)). Local, state, and federal regulations and programs that need to be considered in hazard mitigation are constantly evolving. For this plan, a review was performed to determine which regulations and programs are currently most relevant to hazard mitigation planning. The Steering Committee reviewed the listing of reference materials that were used in the 2021 MHMRP Update. Modifications and updates to that listing are summarized in Table 3-1 through Table 3-3. Brief descriptions of the most relevant plans, programs, and reports are found in Appendix G.

The programs, plans, studies, reports, and regulations reviewed were incorporated into the narrative of the 2026 MHMRP Update where relevant. For instance, some sources provided important information about hazard risk that was incorporated into the risk assessment. Other sources enhanced capabilities to implement mitigation actions or helped define new mitigation actions.

**Table 3-1. Summary of Relevant Local Programs and Regulations**

| Agency, Program, or Regulation  | Relevance  |
|---|--|
| Kaua'i Kākou–Kaua'i County General Plan   | The 2026 MHMRP Update will align with programs established under the County General Plan to support wise land use with vital information on the risk associated with natural hazards in the planning area (County of Kaua'i 2018). |
| Community plans   | Community plans serve as a forum for community input into land use, delivery of government services, and any other matters relating to the planning area. There are six community plans for Kaua'i.                                |
| Kaua'i County Code  | The County Code establishes existing County capabilities and restrictions that can impact the implementation of hazard mitigation actions.   |
| Zoning Code (Chapter 8 of County Code)  | The zoning code draws upon information regarding location-specific hazards to establish guidelines for wise land use in the county.  |
| Kaua'i Sea Level Rise Constraint District Ordinance                             | The Sea Level Rise Constraint District ordinance mitigates future risk to properties from sea level rise exposure.   |
| Plantation Camp Districts Wildfire and Wildland Urban Interface (WUI) Ordinance | The Plantation Camp Districts Wildfire and WUI ordinance mitigates wildfire risk to properties in the plantation camp districts in West Kaua'i.  |
| Kaua'i County Capital Improvement Program                                       | The County General Plan calls for hazard mitigation projects to be prioritized in the County's capital improvement program.  |
| Kaua'i Climate Adaptation and Action Plan                                       | The KCAAP examines the impact of climate change on natural hazards and vulnerability and lays out adaptation and mitigation actions (County of Kaua'i 2022a, 2025d).   |
| Kaua'i Pre-Disaster Recovery Framework (PDRF)                                   | The PDRF plans for disaster recovery prior to occurrence to facilitate an easier recovery process (County of Kaua'i 2025g).  |
| Kaua'i Community Wildfire Protection Plan (CWPP)                                | The CWPP examines the county's wildfire risk and vulnerability and outlines strategies to mitigate wildfire risks (Hawaii's Wildfire Management Organization 2016).  |
| Water Use and Development Plan Update (WUDP)                                    | The WUDP analyzes current water sources in the county and impacts of anticipated development on these water sources and their use (Fukunaga & Associates, Inc. 2024).  |
| Waimea 400 Master Plan  | The Waimea 400 Master Plan lays out development plans for an approximately 417-acre lot of land owned by the County Kaua'i (PBR Hawai'i and Associates, Inc. 2022).  |

| Agency, Program, or Regulation                 | Relevance   |
|--|---|
| KIUC Strategic Plan 2022–2023                  | The plan lays out the utility’s strategies, challenges, and goals in providing electricity to the county, including efforts to mitigate natural hazards and climate change disruptions (KIUC 2023).   |
| Maui Fire Reports and Recovery Phases          | These documents lay out factors that contributed to the severity of the August 2023 wildfires in Maui and priorities for improving wildfire safety throughout the state (FEMA 2025c; Kerber and Alkonis 2024).                              |
| Waimea River Flood Control Modification Report | Only the Draft Feasibility Report was available for integration into the 2026 MHMRP Update (U.S. Army Corps of Engineers 2025a). The study initiates an examination of strategies to improve the flood control project on the Waimea River. |

**Table 3-2. Summary of Relevant State Agencies, Programs, and Regulations**

| Agency, Program, or Regulation                                   | Relevance   |
|--|---|
| Hawai'i Coastal Zone Management Program                          | Mitigation actions need to conform to the goals and policies of this program (OPSD 2025b).                                      |
| Hawai'i Hazards Awareness and Resilience Program                 | Provides a resource for hazard education measures.  |
| Hawai'i State Plan   | Mitigation actions need to conform to the goals and policies of this plan (OPSD 2025c).   |
| Hawai'i State Grants-in-Aid Capital Improvement Projects Program | This program provides a potential source of funding for implementing mitigation actions.  |
| Ocean Resources Management Plan                                  | Mitigation actions need to conform to the goals and policies of this plan (State of Hawai'i Office of Planning 2020).           |
| State Building Code and Design Standards                         | Mitigation actions need to comply with all state building code requirements.  |
| State General Flood Control Plan                                 | Flood mitigation actions should correspond to the goals and policies of this plan.  |
| State of Hawai'i Hazard Mitigation Plan                          | The state HMP provides information that is useful in developing local HMPs (State of Hawai'i Emergency Management Agency 2023). |
| State of Hawai'i Land Use Law                                    | Mitigation actions need to comply with all state land use requirements.   |
| Hawai'i Green Infrastructure Authority HI C-PACER Program        | Provides an avenue for financing mitigation actions at a property-level.  |

**Table 3-3. Summary of Relevant Federal Agencies, Programs, and Regulations**

| Agency, Program, or Regulation                                | Relevance   |
|---|---|
| Americans with Disabilities Act                               | FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.                             |
| Bureau of Land Management (BLM)                               | The BLM funds and coordinates wildfire management programs and structural fire management and prevention on BLM-administered lands. |
| Civil Rights Act of 1964                                      | FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.                             |
| Clean Water Act   | FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.                             |
| Community Development Block Grant Disaster Resilience Program | This program is a potential alternative source of funding for actions identified in this plan.                                      |
| CRS   | This voluntary program encourages floodplain management activities that exceed the minimum NFIP requirements.                       |
| DMA   | The DMA is the current federal legislation addressing hazard mitigation planning.   |

| Agency, Program, or Regulation   | Relevance   |
|--|---|
| Emergency Relief for Federally Owned Roads Program                     | This program is a possible funding source for actions identified in this plan.  |
| Emergency Watershed Program  | This program is a possible funding source for actions identified in this plan.  |
| Endangered Species Act   | FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.   |
| Federal Energy Regulatory Commission Dam Safety Program                | This program cooperates with a large number of federal and state agencies to ensure and promote dam safety.   |
| Federal Wildfire Management Policy and Healthy Forests Restoration Act | These documents mandate community-based collaboration to reduce risks from wildfire.  |
| Rehabilitation of HHPD Grant Program                                   | Part of FEMA's Dam Safety Program, this FEMA grant provides 'technical, planning, design, and construction' for the rehabilitation of eligible high hazard dams.  |
| HMA Grant Programs   | These programs are potential sources of funding for the implementation of mitigation actions recommended in this plan   |
| National Dam Safety Act  | This act requires a periodic engineering analysis of most dams in the country   |
| National Environmental Policy Act                                      | FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.   |
| National Fire Plan (2001)  | This plan calls for joint risk reduction planning and implementation by federal, state and local agencies.  |
| National Flood Insurance Program (NFIP)                                | This program makes federally backed flood insurance available to property owners in exchange for communities enacting floodplain regulations  |
| National Incident Management System                                    | Adoption of this system for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards is a prerequisite for federal preparedness grants and awards |
| Presidential Executive Order 11988–Floodplain Management               | This order requires federal agencies to avoid long- and short-term adverse impacts associated with modification of floodplains  |
| Presidential Executive Order 11990 – Protection of Wetlands            | FEMA hazard mitigation project grant applications require full compliance with applicable presidential executive orders.  |
| U.S. Army Corps of Engineers (USACE) Dam Safety Program                | This program is responsible for safety inspections of dams that meet size and storage limitations specified in the National Dam Safety Act.   |
| USACE Flood Hazard Management  | The USACE offers multiple funding and technical assistance programs available for flood hazard mitigation actions   |
| U.S. Fire Administration   | This agency provides leadership, advocacy, coordination, and support for fire agencies and organizations.   |
| U.S. Fish and Wildlife Service   | This service's fire management strategy employs prescribed fire throughout the National Wildlife Refuge System to maintain ecological communities.  |

## 3.2 CAPABILITY ASSESSMENT

The Core Planning Team and Steering Committee performed an inventory and analysis of existing capabilities. The full capability assessment is provided in Appendix N. It includes the following categories of capabilities: Legal and Regulatory, Development and Permitting, Fiscal, Administrative and Technical, National Flood Insurance Policy, Public Outreach Capability, and Adaptive Capability Related to Climate Change. The assessment evaluates the current capacity on a high to low scale. The assessment also includes how capabilities can be expanded or improved.

## **Part 2. RISK ASSESSMENT**

## 4. OVERVIEW

This section contains an analysis of how the selected hazards are likely to impact Kaua'i County. The selected hazards examined in this section are 1) Wildfire; 2) Tropical Cyclones and Other High Winds; 3) Tsunami; 4) Landslide; 5) Drought; 6) Inland Flooding; 7) High Surf, Coastal Flood, Erosion, and Sea Level Rise; 8) Dam Failure; 9) Heat; and 10) Earthquake. These hazards were selected by the Steering Committee as the most likely to impact the county, based on the hazard identification process described in Appendix H.

Each section provides the following information about the selected hazards:

- **Hazard profile:** Describes the hazard, including past events, location, frequency, severity (magnitude or extent), and warning time.
- **Vulnerability assessment:** Describes how a hazard may impact Kaua'i County, followed by a description of land use, population, property, infrastructure, and resources exposed to the hazard. Finally, an analysis is conducted to determine how vulnerable the population, exposed property, infrastructure, and other resources are to the hazard. A discussion of social vulnerability to a given hazard is also included in this subsection.
- **Issues:** Assesses how the county's development has overlapped with high-hazard areas in the past and how this may change in the future. Other relevant issues associated with each hazard are also discussed, including secondary hazard impacts.
- **Risk ranking:** Synthesizes all the information and data while providing a standard for comparison across all hazard types.

The methodology used to screen the hazard types, develop the hazard profiles, and prepare the vulnerability assessment is included in Appendix H.

### 4.1 HAZARDS TO BE MITIGATED

#### 4.1.1 Past Presidential Disaster Declarations

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can respond to and recover from without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal response and recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. Kaua'i County has experienced 16 events since 1955 for which presidential disaster declarations were issued. These events,

#### HAZARD PROFILES

In this MHMRP, hazard identification includes the following profile elements:

- **Past events**—A summary is provided of major episodes of the hazard that have previously occurred in the planning area
- **Location**—For hazards where the risk is not the same across the planning area, maps or descriptions are provided to indicate areas most at risk
- **Frequency**—Based on an assessment of previous hazard occurrences in the planning area, estimates are developed as to how often the hazard can be expected to occur in the future
- **Severity**—Based on an assessment of previous hazard occurrences in the planning area, a general discussion is provided of the types of damage and impact that can be expected in the planning area, along with numerical values of the scale of events in the planning area where such information is available
- **Warning time**—General descriptions are provided of how well hazard managers can predict a hazard event in advance and what systems are in place to notify the public of impending risk
- **Secondary hazards**—Other hazards are listed that have the potential to occur in response to each hazard evaluated

taken from Federal Emergency Management Agency (FEMA) records, are listed in Table 4-1 (FEMA 2025c).

**Table 4-1. Presidential Disaster Declarations for Hazard Events in Kaua'i County**

| Type of Event                                      | Declaration No. | Declaration Date |
|--|-----------------|------------------|
| Tidal Wave*  | DR-71           | 3/16/1957        |
| Hurricane Dot*                                     | DR-94           | 8/16/1959        |
| Tidal Waves*                                       | DR-101          | 5/25/1960        |
| Heavy Rains and Flooding*                          | DR-152          | 4/24/1963        |
| Heavy Rains and Flooding                           | DR-433          | 5/7/1974         |
| Hurricane 'Iwa                                     | DR-671          | 11/27/1982       |
| Hurricane Iniki                                    | DR-961          | 9/12/1992        |
| Severe Storms, Flooding, Landslides, and Mudslides | DR-1640         | 5/2/2006         |
| Severe Storms, High Surf, Flooding, and Mudslides  | DR-1743         | 02/6/2008        |
| Severe Storms and Flooding                         | DR-1814         | 1/5/2009         |
| Severe Storms, Flooding, and Landslides            | DR-4062         | 4/18/2012        |
| Severe Storms, Flooding, Landslides, and Mudslides | DR-4365         | 5/8/2018         |
| Hurricane Lane                                     | DR-4395         | 9/27/2019        |
| COVID-19 Pandemic                                  | DR-4510         | 4/1/2020         |
| Severe Storms and Flooding                         | DR-4549         | 7/9/2020         |
| Severe Storms, Flooding, and Landslides            | DR-4793         | 6/17/2024        |

Source: FEMA (2025c).

\*Prior to 1964, federal disaster declarations were not issued specific to counties; pre-1964 declarations listed in this table are for the entire state of Hawai'i, not Kaua'i County specifically.

Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on Kaua'i County's communities. These non-declared events are also important to consider in establishing recurrence intervals for hazards of concern.

Disaster declaration DR-4724 was issued on August 10, 2023, for Maui and Hawai'i Counties due to wildfires. These wildfires destroyed Maui's Lahaina community and caused extensive damage elsewhere. While no disaster declaration was made for Kaua'i, the county is at risk of a similar devastating event occurring. This is discussed further in Section 5 Wildfire.

#### 4.1.2 State Emergency Proclamations

The Governor of Hawai'i issues emergency proclamations to assist the state in preparations for a potential event or to support response and recovery following an event. Table 4-2 lists all emergency proclamations issued for Kaua'i County following a disaster between 2020 and 2025. The hazard events in April 2018 and March 2020 were also discussed in the 2021 Multi-Hazard Mitigation and Resilience Plan (MHMRP) Update (Tetra Tech 2021) but are included here, as they had supplementary emergency proclamations that extended beyond the data collection period of the 2021 MHMRP Update. Emergency proclamations from other counties are not included in the table.

**Table 4-2. State of Hawaii Emergency Proclamations Issued by the Governor for Natural Hazard Events in Kaua'i County, 2020–2025**

| Type of Event                            | Event Period                | Declaration Date | Total Proclamations Issued | Last Issued Supplementary Proclamation |
|--|-----------------------------|------------------|----------------------------|--|
| Flooding                                 | 4/14/2018 through 4/15/2018 | 4/15/2018        | 15                         | 7/21/2020                              |
| Flooding                                 | 3/27/2020 through 3/28/2020 | 4/21/2020        | 4                          | 10/18/2020                             |
| Wildfires*                               | 2023–Present                | 8/8/2023         | 26                         | 2/4/2024                               |
| Heavy Rain and Flooding                  | 4/11/2024 through 4/12/2024 | 4/12/2024        | 7                          | 12/17/2024                             |
| Low Pressure Weather System (High Winds) | 1/29/2025 through 1/31/2025 | 1/31/2025        | 1                          | Not applicable                         |

\*The first proclamation, issued for the Maui and Hawai'i 2023 August wildfires, was only for Maui and Hawai'i Counties. All following proclamations were for the entire state, and the 14th through 26th proclamations directly referenced Kaua'i due to four wildfires on the island.

Two state emergency proclamations were issued specifically for Kaua'i County following the occurrence of natural disasters between 2020 and 2025. Both events were associated with flooding and heavy rains. Additionally, heavy rainfall and flooding in April 2018 caused significant damage in Kaua'i, and supplementary proclamations were issued for this disaster into the summer of 2020 due to its lasting impacts.

Kaua'i County was also directly referenced in numerous emergency proclamations issued by the State of Hawai'i following the 2023 wildfires in Maui and Hawai'i Counties. 26 total proclamations have been issued as of October 2025 in response to these fires. Kaua'i County was included in supplementary proclamations 14 through 26. These proclamations are included in Table 4-2. Section 5 Wildfire discusses the possibility of wildfires similar to the 2023 Maui wildfires occurring on Kaua'i.

Several other state emergency proclamations of note have been issued within Hawai'i since 2020. There have been proclamations issued for the COVID-19 pandemic (18 total proclamations), homelessness, and a lack of affordable housing. While not natural hazards, these circumstances present risks to the population that can increase their vulnerability to natural hazards. Additionally, emergency proclamations were issued for all counties in Hawai'i in November and December of 2024 due to red flag warnings indicating high fire danger.

### 4.1.3 Identifying Hazards

#### Hazard Screening

The hazards profiled in the 2021 MHMRP Update were screened to determine the hazard events that have occurred since the 2021 MHMRP Update. At Steering Committee Meeting 1, a summary of the hazards included in the 2021 MHMRP Update and in the 2023 State Hazard Mitigation Plan (State of Hawai'i Emergency Management Agency [HI-EMA] 2023) was presented. Occurrences for each hazard type since the 2021 MHMRP Update were provided along with reported impacts and disaster declaration information. The Core Planning Team and Steering Committee filled out a Hazard Screening Form to identify the hazards that were to be included in the 2026 MHMRP Update. The Hazard Screening Form is included in Appendix H. The results of the hazard screening were vetted with the Kaua'i Emergency Management Agency (KEMA) and the Core Team and then presented to the Steering Committee for final approval at Steering Committee Meeting 2 (Appendix B).

The hazard screening resulted in identification of 10 hazards, presented below from highest risk to lowest. These hazards are discussed in this MHMRP Update following the same order. Changes in the risk

ranking of hazards from the 2021 MHMRP Update reflect shifting concerns and priorities associated with natural hazards in the county.

1. Wildfire
2. Tropical Cyclone and Other High Winds
3. Tsunami
4. Landslide
5. Drought
6. Inland Flood
7. High Surf, Coastal Flood, Erosion, and Sea Level Rise
8. Dam Failure
9. Heat
10. Earthquake

The hazard screening process also resulted in the following:

- Climate change is integrated into the narrative within each respective hazard section.
- Heat and drought are addressed as two separate hazards; the Drought hazard, in particular, warranted increased discussion due to its connection with the Wildfire hazard in the aftermath of the 2023 Lahaina wildfires.
- Several proposed hazards were identified through the Hazard Screening Form. Table 4-3 summarizes the proposed hazards and the Steering Committee’s approach to each one.

**Table 4-3. Proposed Hazards and Steering Committee Approach**

| Proposed Hazards                           | Action to be Taken  |
|--|---|
| Pandemic and disease                       | Summarize briefly in separate appendix*   |
| Food security                              | Summarize briefly in separate appendix*   |
| Structural failure of bridges, roads, dams | Analyze as infrastructure damages for each hazard; summarize harbor impacts in the context of food security briefly in separate appendix* |
| King tides                                 | Add narrative to High Surf, Coastal Flooding, Erosion, and Sea Level Rise profile   |
| Threat of missile activity                 | Deemed not a natural hazard and therefore not appropriate for the MHMRP Update  |

\* Discussed in Appendix M

**Risk Ranking**

The risk assessments provided data that were used to rank the hazards based on the probability of occurrence, potential impacts, area affected, duration, and warning time. This allowed for a comparison between the perceived risks associated with each hazard. The ranking methodology is described in this section. Based on that methodology, the identified hazards of concern were assigned risk scores and categories.

The risk ranking value was obtained for each hazard by assigning varying degrees of risk to seven categories for each hazard and then calculating an index value based on a weighting approach. The risk ranking value can be used to compare the relative importance of each hazard within Kaua'i County.

The 2021 MHMRP Update included a risk ranking index within Appendix F: Hazard Ranking Methodology (Tetra Tech 2021). The risk ranking methodology provided in this section replaces that appendix.

For the 2026 MHMRP Update, the Steering Committee revised the approach to the hazard risk ranking to develop new categories to reflect a more detailed picture of the risk posed to Kaua'i County by the selected hazards. The weighting approach for each category was determined by the Steering Committee. The categories used in the risk ranking are explained in the following paragraphs.

- **Probability:** Probability is the likelihood of the hazard occurring or recurring. It may be defined in historical frequencies, statistical probabilities, hazard probability maps and/or general descriptors (e.g., unlikely, likely, highly likely).

The probability of future occurrences was assessed based on the frequency of past occurrences over the planning period of approximately 5 years, from the last recorded event for each hazard in the 2021 MHMRP Update through December 31, 2024.

Four categories were used in the risk ranking for probability: 1) Unlikely, 2) Possible, 3) Likely, and 4) Highly Likely. The Steering Committee selected the probability for each hazard based primarily on the number of events that occurred since the 2021 MHMRP Update, although some consideration was also given to events over time based on available records from the 2021 MHMRP Update for each hazard. Placing an emphasis on the events that occurred in the past 5 years allowed for consideration of changing conditions due to climate change, particularly as historic conditions become less representative of the future. Based on the number of anticipated occurrences, the probability of the hazard occurring was placed in one of the four categories. Definitions of the criteria used to assign each category are given in Table 4-4.

- **Impact:** The impacts of the hazard are the consequences or effects of each hazard on property, critical facilities, and health services within the county. Impacts were categorized as 1) Minor, 2) Limited, 3) Critical, 4) Catastrophic. Property damage and critical facilities were assessed together based on the anticipated property damage and critical facility impacts discussed in the vulnerability assessment for a given hazard. A hazard could be categorized as having a given impact due to the anticipated shutdown of critical facilities or the anticipated property damage associated with the hazard. If the impacts on critical facilities and property differ, the more severe category was selected. For instance, if critical facility shutdowns were expected to fall in the limited impact category and property damage was expected to fall in the critical impact category, then the hazard would be assigned the critical impact category. Health service impacts were assessed in their own category based on fatalities and injuries associated with past events, anticipated populations displaced or requiring short-term shelter following an event, and general knowledge of the magnitude of a given hazard's impacts, including the proportion of the population that would be impacted. Definitions of the criteria used to assign each category are given in Table 4-4.
- **Social Vulnerability:** The effects of a given hazard on social vulnerability were determined by assessing the percentage of the socially vulnerable population in the county that is likely to be either displaced or have their quality of life disrupted by the hazard event. Social vulnerability was categorized as 1) Negligible, 2) Low, 3) Medium, and 4) High. Hazards were assigned to categories by comparing hazard exposure areas with the Social Vulnerability Index (SVI) developed for the KCAAP and applying the anticipated magnitude of the hazard to estimate the percentage of the socially vulnerable population likely to be displaced or have their quality of life disrupted by the hazard (County of Kaua'i 2022a, 2025d). Definitions of the criteria used to assign each category are given in Table 4-4.

- **Spatial Extent:** The spatial extent of each hazard is the geographic area of the county that may be impacted by the hazard event. Note this is a different concept than ‘extent’ as discussed in the hazard profiles with the meaning of magnitude or severity. Spatial extent was categorized as 1) Negligible, 2) Small, 3) Moderate, and 4) Large. Definitions of the criteria used to assign each category are given in Table 4-4.
- **Warning Time:** Warning time is the amount of time before a hazard’s occurrence that the community knows the event is anticipated. The categories used for warning time were 1) more than 24 hours, 2) 4:01 to 24 hours, 3) 1:01 to 4 hours, and 4) 1 hour or less. The 4-hour threshold for warning time between Categories 2 and 3 was selected because tsunamis take approximately 4 hours to reach Kaua’i from the Aleutian Islands, which is where some of the most devastating tsunamis to impact Kaua’i originated. These categories and the criteria used to assign them are also listed in Table 4-4.
- **Duration:** The duration is the amount of time the hazard is expected to occur in a specific community. Duration was categorized as 1) less than 6 hours, 2) less than 24 hours, 3) less than 1 week, and 4) more than 1 week. These categories and the criteria used to assign them are also listed in Table 4-4.

The example below illustrates how the risk ranking was applied. In this example, the Steering Committee assessed the Wildfire hazard as follows:

- Probability = Highly Likely (4)
- Impact – Property Damage and Critical Facilities = Critical (3)
- Impact – Health Services = Limited (2)
- Social Vulnerability=Medium (3)
- Spatial Extent = Moderate (3)
- Warning Time = 1:01–4 hours (3)
- Duration = Less than 1 week (3)
- Risk Ranking =  $[(4 \times 0.20) + (3 \times 0.10) + (2 \times 0.10) + (3 \times 0.20) + (3 \times 0.10) + (2 \times 0.10) + (3 \times 0.10)] = 3.10$

Table 4-4 shows the blank Risk Ranking Calculator template. Table 4-5 shows the risk ranking for each hazard, summarizing the justification for the risk ranking scores. More information on the probability, impacts, social vulnerability, spatial extent, warning time, and duration associated with the hazards can be found in their respective hazard profiles and vulnerability assessments.

**Table 4-4. Risk Ranking Calculator**

| RISK RANKING CALCULATOR |          |   |             |                 |             |                  |
|-------------------------|----------|---|-------------|-----------------|-------------|------------------|
| HAZARD                  |          |   |             |                 |             |                  |
| Category                | Level    | Criteria  | Index Value | Assigned Weight | Index Value | Calculated value |
| Probability             | Unlikely | No events anticipated for the 5-year planning period, based on recorded events and historic knowledge | 1           | 0.20            | 0           | 0.00             |

**RISK RANKING CALCULATOR**

**HAZARD**

| Category   | Level         | Criteria   | Index Value | Assigned Weight | Index Value | Calculated value |
|--|---------------|--|-------------|-----------------|-------------|------------------|
|  | Possible      | One event anticipated for the 5-year planning period, based on recorded events and historic knowledge                                | 2           |                 |             |                  |
|  | Likely        | Between two and four events anticipated for the 5-year planning period, based on recorded events and historic knowledge              | 3           |                 |             |                  |
|  | Highly Likely | Five or more events anticipated for the 5-year planning period, based on recorded events and historic knowledge                      | 4           |                 |             |                  |
| Impact (property damage and critical facilities) | Minor         | Less than 9.9% of property in affected area damaged or destroyed, OR shutdown of critical facilities for less than 1 day.            | 1           | 0.20            | 0           | 0.00             |
|  | Limited       | Between 10% and 24.9% of property in affected area damaged or destroyed OR complete shutdown of critical facilities for 1 to 6 days. | 2           |                 |             |                  |
|  | Critical      | Between 25% and 49.9% of property in affected area damaged or destroyed OR complete shutdown of critical facilities for 7 to 29 days | 3           |                 |             |                  |
|  | Catastrophic  | More than 50% of property in affected area damaged or destroyed OR complete shutdown of critical facilities for 30 days or more      | 4           |                 |             |                  |
| Impact (Health Services)                         | Minor         | A mix of minor to critical injuries, all manageable within existing local medical resources  | 1           | 0.10            | 0           | 0.00             |
|  | Limited       | Injuries can be managed by local medical resources with operational adjustments or reallocation of staff and supplies                | 2           |                 |             |                  |
|  | Critical      | Injuries and medical needs require significant external support to continue quality of care  | 3           |                 |             |                  |
|  | Catastrophic  | Unable to meet medical needs even with external support. May lead to lowering the quality of care.                                   | 4           |                 |             |                  |
| Social Vulnerability                             | Negligible    | Up to 9.9% of socially vulnerable population displaced or quality of life disrupted  | 1           | 0.10            | 0           | 0.00             |
|  | Low           | 10%–24.9% of socially vulnerable population displaced or quality of life disrupted   | 2           |                 |             |                  |
|  | Medium        | 25%–49.9% of socially vulnerable population displaced or quality of life disrupted   | 3           |                 |             |                  |
|  | High          | 50% or greater of socially vulnerable population displaced or quality of life disrupted  | 4           |                 |             |                  |

**RISK RANKING CALCULATOR**

**HAZARD**

| Category       | Level              | Criteria  | Index Value | Assigned Weight | Index Value | Calculated value |
|----------------|--------------------|---|-------------|-----------------|-------------|------------------|
| Spatial Extent | Negligible         | Less than 0.9% of area affected   | 1           | 0.20            | 0           | 0.00             |
|                | Small              | Between 1% and 9.9% of area affected  | 2           |                 |             |                  |
|                | Moderate           | Between 10% and 49.9% of area affected  | 3           |                 |             |                  |
|                | Large              | Between 50% and 100% of area affected   | 4           |                 |             |                  |
| Warning Time   | More than 24 hours | Amount of time from the notification of a potential event to the event occurring in the community | 1           | 0.10            | 0           | 0.00             |
|                | 4:01–24 hours      |   | 2           |                 |             |                  |
|                | 1:01–4 hours       |   | 3           |                 |             |                  |
|                | 1 hour or less     |   | 4           |                 |             |                  |
| Duration       | Less than 6 hours  | Maximum length of time the event could occur based on past events                                 | 1           | 0.10            | 0           | 0.00             |
|                | Less than 24 hours |   | 2           |                 |             |                  |
|                | Less than 1 week   |   | 3           |                 |             |                  |
|                | More than 1 week   |   | 4           |                 |             |                  |
|                |                    |   |             | <b>VALUE</b>    |             |                  |

Table 4-5. Hazard Risk Ranking

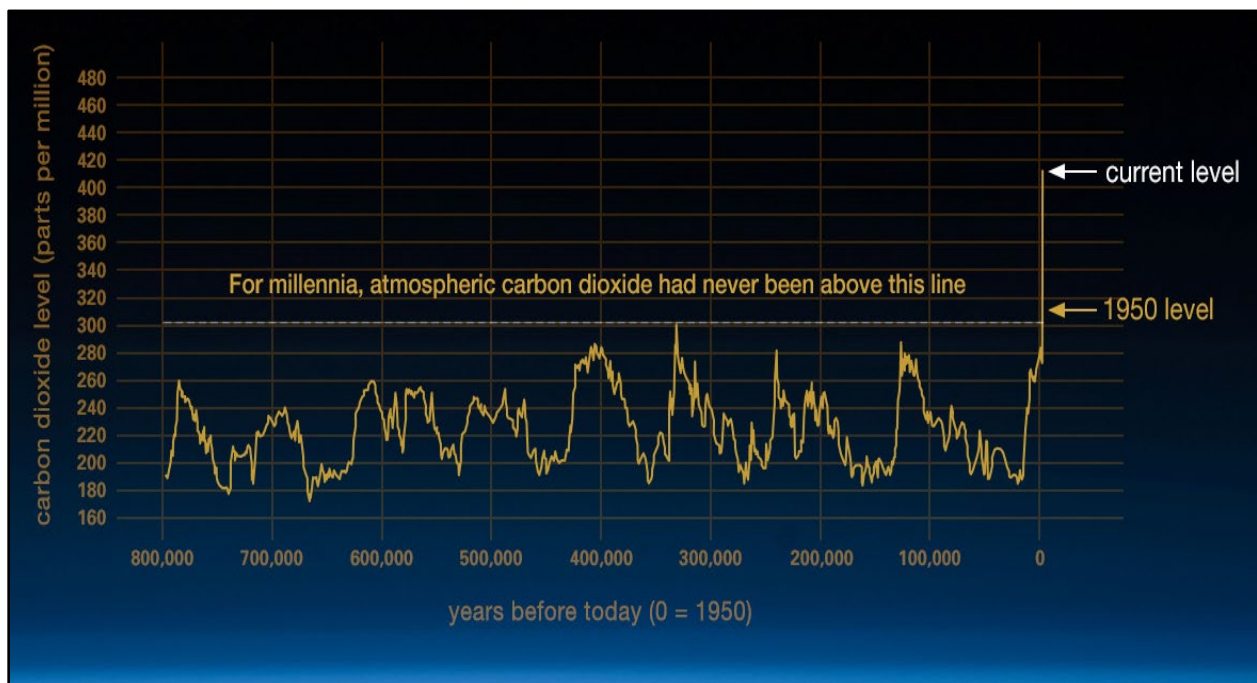
| Priority | Hazard Event  | Probability   | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time       | Duration           | Risk Score |
|----------|---|---------------|--|--------------------------|----------------------|----------------|--------------------|--------------------|------------|
| 1        | Wildfire  | Highly Likely | Critical   | Limited                  | Medium               | Moderate       | 1:01–4 hours       | Less than 1 week   | 3.1        |
| 2        | Tropical Cyclone and Other High Winds                 | Likely        | Critical   | Critical                 | High                 | Large          | More than 24 hours | Less than 24 hours | 3          |
| 3        | Tsunami   | Possible      | Catastrophic                                     | Critical                 | High                 | Moderate       | 1:01–4 hours       | Less than 24 hours | 3          |
| 4        | Landslide   | Likely        | Critical   | Minor                    | Medium               | Large          | 1 hour or less     | Less than 6 hours  | 2.9        |
| 5        | Drought   | Highly Likely | Minor  | Minor                    | Medium               | Large          | More than 24 hours | More than 1 week   | 2.7        |
| 6        | Inland Flood  | Likely        | Critical   | Limited                  | Medium               | Small          | 4:01–24 hours      | Less than 1 week   | 2.6        |
| 7        | High Surf, Coastal Flood, Erosion, and Sea Level Rise | Highly Likely | Limited  | Minor                    | Low                  | Small          | 4:01–24 hours      | Less than 1 week   | 2.4        |
| 8        | Dam Failure   | Possible      | Limited  | Critical                 | Low                  | Small          | 1 hour or less     | Less than 6 hours  | 2.2        |
| 9        | Heat  | Unlikely      | Minor  | Limited                  | Medium               | Large          | More than 24 hours | More than 1 week   | 2.2        |
| 10       | Earthquake  | Unlikely      | Minor  | Minor                    | Negligible           | Large          | 1 hour or less     | Less than 6 hours  | 1.7        |

## 4.2 CLIMATE CHANGE BACKGROUND

Climate change is affecting and will continue to affect the way natural hazards impact Kaua'i. A brief background is therefore provided in this section on climate, climate change, relevance to hazard mitigation planning, and projected climate change impacts. A more detailed discussion of how climate change is expected to impact specific natural hazards is included within each hazard profile.

Climate consists of the long-term weather patterns experienced in a place and is generally measured in averages (HI-EMA 2023). Climate change occurs when long-term weather patterns begin shifting. According to the KCAAP, “climate change refers to changes in the average and/or the variability of temperature, rainfall, and extreme weather that persist for an extended period” (County of Kaua'i 2022a, 2025d).

The well-established worldwide warming trend of the past century and its related impacts are caused by increasing concentrations of carbon dioxide (CO<sub>2</sub>) and other greenhouse gases in the earth's atmosphere. According to the National Aeronautics and Space Administration (NASA), CO<sub>2</sub> concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen dramatically since then, surpassing 400 ppm in 2013 for the first time in recorded history (Figure 4-1) (NASA 2023).



**Figure 4-1. Global CO<sub>2</sub> concentrations over time.**

The major scientific agencies of the United States—including NASA and the National Oceanic and Atmospheric Administration (NOAA)—have presented evidence that climate change is occurring. Key evidence includes a global temperature rise, warming and acidification of the oceans, shrinking ice sheets, reduced snow cover, glacial retreat, sea level rise, and an increasing prevalence of extreme weather events. For instance, 2024 was the warmest year recorded since record keeping began in 1850 and surpassed 2023; which had been the warmest year recorded. These temperatures are part of a larger trend with the past 10 years being the warmest ever recorded (NOAA 2025a). The impacts are further evidenced through increases in the severity and frequency of extreme weather events. In the United

States, the average number of weather-related or climate-related disasters causing \$1 billion dollars in damage has grown from an average of about three per year in the 1980s to an average of over 17 per year (Jay et al. 2023). These trends have significant impacts for hazard mitigation efforts, as increases in the severity and frequency of natural hazard events will require additional mitigation actions to protect people, infrastructure, property, and other resources.

The impacts of climate change are already being felt on Kauaʻi. According to the KCAAP, there have been recorded increases in drought and wildfire events along with a rise in temperature and sea level recorded throughout the entire state (County of Kauaʻi 2022a, 2025d). There have also been increases in the number of wet days in a row, which can contribute to flooding despite an overall increase in dry conditions (Bassiouni and Oki 2013; Kruk et al. 2015). At the same time, a global increase in large tropical cyclones (Categories 3–5) has been identified (Kossin et al. 2020). These factors indicate that Kauaʻi is already experiencing an increase in the frequency of natural hazard events due to the changing climate, which are predicted to continue worsening. The following section summarizes findings from the KCAAP that describe the past observed effects of climate change on Kauaʻi and the anticipated future impacts.

#### 4.2.1 Kauaʻi Climate Adaptation and Action Plan

In 2024, the County published the KCAAP, which outlines the anticipated impacts of climate change on Kauaʻi County (County of Kauaʻi 2025d). Table 4-6, adapted from a similar table in the KCAAP, outlines how climate change is expected to impact hazards profiled in this 2026 MHMRP Update. The first column, labeled "Hazard", outlines the hazards profiled in the 2026 MHMRP Update, and the second column, labeled "Climate Hazard", outlines the equivalent hazards profiled in the KCAAP. Increases in global disease is discussed as a separate climate hazard in the KCAAP. Whereas this hazard is worth noting, particularly following the COVID-19 pandemic, further analysis is beyond the scope of this MHMRP Update.

The anticipated effects of climate change on natural hazards discussed in the KCAAP has been integrated into this MHMRP Update along with the strategies laid out in the KCAAP for mitigating climate change impacts.

**Table 4-6. Climate Change Impacts on Hazards Profiled in the 2026 MHMRP Update**

| Hazard                                 | Climate Hazard        | Past Trend                     | Future Trend  | Confidence |
|--|-----------------------|--------------------------------|---|------------|
| Wildfire                               | Wildfire              | ↑ Increasing (last 50 years)   | ↑ Increasing with changing rainfall and temperature | High       |
| Tropical Cyclones and Other High Winds | Tropical cyclones     | ↑ Increasing (last 40 years)   | ↑ Increasing  | Moderate   |
| Drought                                | Drought               | ↑ Increasing length            | ↑ Increasing with changing rainfall and temperature | Moderate   |
|  | Trade winds           | ↓ Decreasing, turning easterly | ↑ Continuing  | Moderate   |
| Inland Flooding                        | Average rainfall      | ↓ Declining (last 100 years)   | ↓ Decreasing wet and dry season rain                | High       |
|  | Heavy rainfall events | ↑ Increasing (last 100 years)  | ↑ Increasing  | Moderate   |
|  | Stream flow           | ↓ Decreasing (last 20 years)   | ↓ Decreasing with declining rainfall                | Moderate   |

| Hazard   | Climate Hazard       | Past Trend                   | Future Trend                            | Confidence |
|--|----------------------|------------------------------|---|------------|
| Heat   | Average temperature  | ↑ Increasing (last 70 years) | ↑ Increasing                            | High       |
|  | Warm days and nights | ↑ Increasing (last 45 years) | ↑ Increasing                            | High       |
|  | Marine heatwaves     | ↑ Increasing (last 40 years) | ↑ Increasing                            | High       |
| High Surf, Coastal Flooding, Erosion, and Sea Level Rise | Sea level rise       | ↑ Increasing (last 65 years) | ↑ Increasing                            | High       |
|  | Tidal flooding       | ↑ Increasing                 | ↑ Increasing with higher sea level rise | High       |

Source: County of Kaua'i (2025d:10–11)

## 4.2.2 How Climate Change Affects Hazard Mitigation

Climate change will affect the people, property, economy and ecosystems of Kaua'i County in a variety of ways. The most important relevant aspect related to the mitigation plan update is that climate change is expected to impact the occurrence and severity of natural hazards events. Tropical cyclones, wildfires, flooding, sea level rise, drought, and heat are all hazards that are especially affected by climate change and increases in frequency, intensity, or both.

An essential aspect of hazard mitigation planning is estimating the likelihood of hazard events in the planning area; this is called 'frequency' in mitigation planning. Previous frequency is based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. For example, averages based on the past frequencies of tropical cyclones were used to estimate future frequencies. If Kaua'i experienced tropical cyclones three times in the past 5 years, then on average there is a 60% chance that a tropical cyclone will impact the county each year. Using this approach to predict future probability would assume that the likelihood of hazard events remains essentially unchanged over time.

For hazards that are affected by changing climate conditions, it is not valid to assume that future occurrence and intensity will be equivalent to past occurrence and intensity. For example, because inland flooding is generally associated with precipitation frequency, quantity, and duration, we anticipate these aspects of rain events to intensify due to climate change, which would result in more frequent floods with the potential to have more damaging impacts. In addition to flooding, tropical cyclones, drought, heat, sea level rise, and wildfire are all affected by climate patterns (County of Kaua'i 2025d). For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard probability, in addition to vulnerability of the built environment, human population, natural resources, and cultural resources.

However, providing projections of future climate change impacts for a specific district of Kaua'i is challenging. The further out a prediction reaches, the more subject to changing dynamics it becomes. Current modeling efforts are also unable to assess climate change at a resolution small enough to determine specific impacts for individual communities; however, generalized assessments of larger climatic regions can be used to determine impacts that are most likely to affect these communities. Qualitative assessments can then be made of potential impacts on hazard-related risks. In this MHMRP Update, more general regional estimates and localized analyses developed for the recent KCAAP have been used to assess the likely effect of climate change on each hazard. These assessments are provided within their respective hazard profiles.

### 4.2.3 Climate Change Mitigation and Adaptation

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but interrelated considerations: mitigation and adaptation. The term “mitigation” can be confusing, because its meaning changes across disciplines:

- Mitigation in emergency management—as generally addressed in this MHMRP Update—is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters.
- Mitigation in climate change discussions is defined as a human intervention to reduce impacts on the climate system. It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.

Unless otherwise specified in this plan, mitigation is primarily used in an emergency management context.

Adaptation refers to adjustments in natural or human systems in response to the actual or anticipated effects of climate change and associated impacts. These adjustments may moderate harm or exploit beneficial opportunities. Mitigation in the climate change context and adaptation are related, as the world’s ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions.

The County of Kauaʻi has undertaken a variety of efforts to adapt to climate change. One of the most recent is the KCAAP, which lays out countywide plans for reducing greenhouse gas emissions and adapting to the impacts of climate change (County of Kauaʻi 2025d). These efforts include hazard mitigation projects that will minimize the impacts of natural hazards on Kauaʻi residents. This 2026 MHMRP Update has integrated climate adaptation efforts laid out in the KCAAP into the mitigation actions proposed in the Action Plan (Part 3).

## 5. WILDFIRE

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A wildfire is any uncontrolled fire on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, downed powerlines, and arson. The potential for significant damage to life and property exists in areas designated as wildland urban interface (WUI) areas, where development is adjacent to densely vegetated areas. Fires in WUI areas tend to be more damaging than urban structural fires. They are often more difficult to control and behave differently from structural fires. When these fires erupt, people and structures must take priority, frequently at a devastating expense to natural resources. People who live in these areas often come directly from urban areas and may have little understanding of wildfire cycles and dangers. Homes and other structures are often built and maintained in a manner that leaves them and their occupants vulnerable. Thus, fire becomes a significant threat to both humans and natural resources.

Kauaʻi County has a Community Wildfire Protection Plan (CWPP) (Hawaiʻi Wildfire Management Organization [HWMO] 2016) to inform wildfire risk and mitigation measures. The plan had its last comprehensive update in 2016, with updates to priority actions in 2024. Another comprehensive update is under development. The update to the CWPP will be integrated into the next MHMRP planning cycle. Additional information about the Kauaʻi County CWPP is available in Appendix G.

According to the CWPP, several factors combine to create wildfire risk in Kauaʻi. The terrain of the area can be hard to navigate, which impedes fire suppression when wildfires do occur. Many communities encroach into the WUI. Vegetation is also frequently located too close to homes, and communities have internal open spaces that present fire hazards. The presence of easily ignited invasive species is also a problem (HWMO 2016). Invasive, fire-prone grasses, for example, benefit from and spread wildfire. They are the first to regrow after a burn, choking out diverse plant communities and increasing fire risk (North American Invasive Species Management Association [NAISMA] 2023). The intersection of these issues yields a risk of wildfire occurrence and damages to the county's communities and their natural, cultural, and economic resources (HWMO 2016).

Further, as wildfires become more prevalent in Hawaiʻi, the ecosystems they burn generally transition away from forests into grasslands and shrublands, which are the greatest fuel for wildfires in the state (University of Hawaiʻi Hilo 2018). There has also been a transition away from agriculture in places throughout the state, and these fields have been replaced with unmanaged vegetation that presents a fire risk. This creates an environment where wildfires are not only destructive but increase the likelihood of future damaging wildfires (HWMO 2016).

The Kauaʻi Fire Department (KFD) responds to wildland fires, brush fires, and wildfires almost exclusively. Structure fires are rare on the island of Kauaʻi. Initial response to the majority of wildfires is the responsibility of KFD from eight fire stations located around the island. The State of Hawaiʻi Department of Land and Natural Resources (DLNR)–Division of Forestry and Wildlife responds to wildfire events on state lands and provides additional wildland firefighting assistance when state lands are threatened. The KFD also participates in the Firewise USA program.

On August 8 and 9, 2023, four wildfires burned on the island of Maui causing devastation across the island, the worst of which was the destruction of the Lahaina community. The Lahaina wildfires resulted in 102 fatalities. These wildfires were the result of many factors, including inadequate planning, limited resources, dry conditions, and exceptionally high winds (Kerber and Alkonis 2024). Similar conditions can occur throughout the Hawaiian Islands, including Kauaʻi, emphasizing the need for hazard mitigation.

In the aftermath of this event, extensive collaboration and coordination efforts have been undertaken by the fire departments of each Hawaiian county to identify lessons learned from this disaster and begin planning for the prevention of a similar event happening again. The State of Hawai'i has identified 10 priorities to begin addressing this hazard. These priorities are focused on improving statewide planning, increasing the resiliency of infrastructure and warning systems, improving evacuation plans, wildfire education, emergency response preparedness, and vegetation and land management. These initial efforts are intended to begin mitigating risk associated with wildfires (Underwriters Laboratories [UL] Research Institutes 2024). A summary of the Lahaina Fire Incident Analysis Report and the State of Hawai'i's 10 priorities based on the Incident Analysis Report can be found in Appendix G. Additionally, the Kaua'i County Planning Department is prioritizing efforts to improve codes and standards to mitigate risk from the wildfire hazard.

Additional general information on the Wildfire hazard is provided in Appendix I.

## 5.1 HAZARD PROFILE

Table 5-1 summarizes the key elements of the Wildfire hazard profile for Kaua'i County. The August 2023 Maui wildfires are not included under past events as they were not experienced on Kaua'i. However, these events illustrated the potential severity of wildfires that may occur on Kaua'i and are discussed under severity in the table. Section 4 describes the elements in the hazard profile.

**Table 5-1. Wildfire Hazard Profile Summary**

|                    |  |
|--------------------|--|
| <b>Past Events</b> | <p>In the period since the 2021 MHMRP Update, there have been several significant wildfire events in the county. For the purpose of the 2026 MHMRP Update, significant wildfires are those that exceed the KFD normal response of 20 acres. See Appendix I for a description of KFD's wildfire mitigation and response capabilities.</p> <p>Four wildfires occurred in July 2024 and were referenced in multiple supplemental state emergency proclamations. The State of Hawai'i issued an initial emergency proclamation on wildfires in response to the August 2023 wildfires in Maui and Hawai'i Counties. A total of 20 emergency proclamations followed with the 14th (issued July 12, 2024) through the 20th (issued December 4, 2024) directly referencing Kaua'i. Additional information on past wildfire events in Kaua'i between 2020 and 2024, according to the KFD Chief, is included below (Kaua'i Fire Department Chief 2025):</p> <ul style="list-style-type: none"> <li>• On June 13, 2024, a brushfire along Waimea Canyon Drive led to a temporary road closure and 300 acres of fallow pastureland burning. No injuries, fatalities, or property damage were reported with this incident.</li> <li>• On July 11, 2024, two wildfires occurred that were referenced in the state emergency proclamations. One of the fires occurred near the Pacific Missile Range Facility ordnance gate and burned less than an acre with no associated injuries, deaths, or property damage. The other occurred near the Camp Kōke'e Boy Scout Camp with no recorded information on acreage burned, property damage, injuries, or fatalities.</li> <li>• On July 15, 2024, the Hanapēpē Heights brushfire burned 1,100 acres of land. The fires led to a temporary closure of the Kaunualii Highway, evacuations of the Kaumakani community, and caused approximately \$50,000 in property damage. No injuries or deaths were reported with the event.</li> <li>• On July 16, 2024, the Kapa'a Bypass brushfire burned 10 acres of land and threatened Kapa'a Middle School. The terrain made it difficult for the KFD to access the fire. No property damage, injuries, or fatalities were recorded for this event.</li> <li>• On July 18, 2024, the Kōke'e brushfire burned 1,600 acres and threatened various infrastructure. \$20,000 in property damage was reported. There were no injuries or deaths recorded for this event.</li> </ul> <p>There have been nine additional large brushfire events over 20 acres since 2020. These events burned a total of 650 acres.</p> <p>In addition to these larger fires, there have been numerous smaller brush fires in the county. There was an average of approximately 225 brushfires per year in Kaua'i from 2020 through 2024. Two of these brush fires resulted in damages greater than \$100 and caused a cumulative \$11,000 in property and content damage. Figure 5-1 is a map of brushfire incidents between January 2020 and December 2024.</p> <p>The 2021 MHMRP Update examined wildfire occurrences in Kaua'i from 2011 through 2019. The most significant events were the following:</p> <ul style="list-style-type: none"> <li>• In Kōloa in 2011, 50 acres of dry brush and two homes burned, three homes were damaged, and eight people were left homeless.</li> <li>• Near Kekaha in 2012, 3,000 acres of dry brush burned, and power poles were destroyed.</li> </ul> |
|--------------------|--|

- Near Anahola in 2014, 25 acres of dry brush burned, and residents were evacuated.
- 50 acres behind Līhu'e airport burned in 2015, requiring three flights to be diverted.
- In 2019, 500 acres of dry brush near Po'ipū burned, residents were evacuated, and roads were closed.

No recorded injuries or deaths are associated with any wildfire events in Kaua'i. Appendix I presents more detailed information on past wildfires impacting the county.

|                     |   |
|---------------------|---|
| <b>Location</b>     | <p>According to wildfire risk mapping prepared by the State of Hawai'i, communities on the north shores of Kaua'i have the lowest wildfire risk and those on the west shore have the highest. Communities on the east and south shores have medium to high risk levels. The location of wildfire potential in the county is largely unchanged from the 2021 MHMRP Update planning period. The wildfire risk mapping has only had minimal changes since the original map was produced in 2013. Figure 5-2 shows the location of wildfire risk to communities mapped throughout Kaua'i County (County of Kaua'i 2022a, 2025d). Additionally, the potential spatial extent and severity of wildfire events can depend on spatial extent and severity of drought which is shaped by the variance of rainfall across the planning area.</p> <p>However, climate change is increasing the likelihood of dry days throughout the county, which raises the risk of wildfire ignition and spread. This may lead to communities across the county experiencing higher levels of wildfire risk in the future, including those previously at low risk (see Section 5.1.1).</p>  |
| <b>Frequency</b>    | <p>From 2011 through 2024, 30 significant wildfires (see Table I-1 in Appendix I) were recorded in Kaua'i County, an average of 2.31 wildfires per year. The number of these larger wildfires in the county since the 2021 MHMRP Update was released has increased, with an average of three significant wildfires per year over the past 5 years. Numerous smaller brushfires (less than 20 acres) occur in the county each year. Between 2020 and 2024, an average of approximately 225 smaller brushfires occurred per year.</p> <p>Climate change may increase the frequency of wildfires in the coming years, as drought and the number of dry days experienced in the county is expected to increase. An increase in drought conditions will make it easier for wildfires to ignite and spread, increasing the potential for wildfires. Section 5.1.1 presents additional information.</p>  |
| <b>Severity</b>     | <p>The communities at risk from wildfire mapping (see Figure 5-2) estimates the severity of risk that communities are expected to face from wildfires. Across the county, risk ranges from low to high. The North Shore planning district has the lowest risk level with only a small portion of one community considered high risk and all others at low risk. About half the communities in Līhu'e and Kōloa Po'ipū-Kalāheo are at high risk from wildfires and half are at low to medium risk. Nearly every community in East Kaua'i is at high risk, with the exception of one at medium risk. Every community in Waimea and Hanapēpē-'Ele'ele is at high risk.</p> <p>In addition to the risk estimated for the communities at risk, wildfire severity can also be assessed for Kaua'i based on the damage and spatial extent of past events. Numerous wildfires burning 25 acres or more were recorded in Kaua'i County between 2011 and 2024. In 2012, 3,000 acres burned in a wildfire near Kekaha, which is the largest wildfire recorded in the county. The largest wildfire recorded since the 2021 MHMRP Update occurred on July 18, 2024, between Hanapēpē and Kaumakani, which was 1,500 acres and caused \$20,000 in damage. Another wildfire on July 15, 2024, burned fewer acres (1,100) but caused the greatest impacts of wildfires occurring since 2020, with \$50,000 in property damage and a structure destroyed. While not occurring on Kaua'i, wildfires with the severity of the Maui 2023 wildfires could occur on Kaua'i as similar weather conditions to those that contributed to the Maui wildfires are possible and may become more common due to climate change. The 2023 Maui wildfires burned over 6,700 acres, destroyed over 2,100 structures, and killed over 100 people (County of Maui Department of Fire and Public Safety 2024). A tragedy of this magnitude could result from a wildfire on Kaua'i.</p> <p>Climate change may also increase the severity of wildfires in future years. As dry days and drought conditions are expected to occur more frequently in Kaua'i County, it will be easier for wildfires to spread once ignited. This may result in more severe wildfires that burn greater acreages (see Section 5.1.1).</p> |
| <b>Warning Time</b> | <p>Humans often cause wildfires, intentionally or accidentally. High winds and low humidity conditions can warrant high fire danger warnings to the community. If a fire does break out and spread rapidly, residents may need to evacuate within days or hours.</p> <p>KEMA and KFD have systems in place to monitor weather conditions likely to lead to wildfire ignition and spread. KEMA is also working to integrate an automated alert system and community-based response plans to facilitate rapid evacuation when needed.</p> <p>This information is unchanged from the 2021 MHMRP Update.</p>  |

Figure 5-2 shows the Communities at Risk from Wildfire (CARW) mapping produced by the HWMO. CARW maps delineate communities that share similar environmental conditions, land use characteristics, fuel types, hazards, and general wildfire issues. HWMO provides ratings to characterize generalized hazards in each area. The CARW map was originally developed for Kaua'i in 2013. The version of the CARW map used for Figure 5-2 is taken from the KCAAP; it was most recently updated in 2022 (County of Kaua'i 2022c).

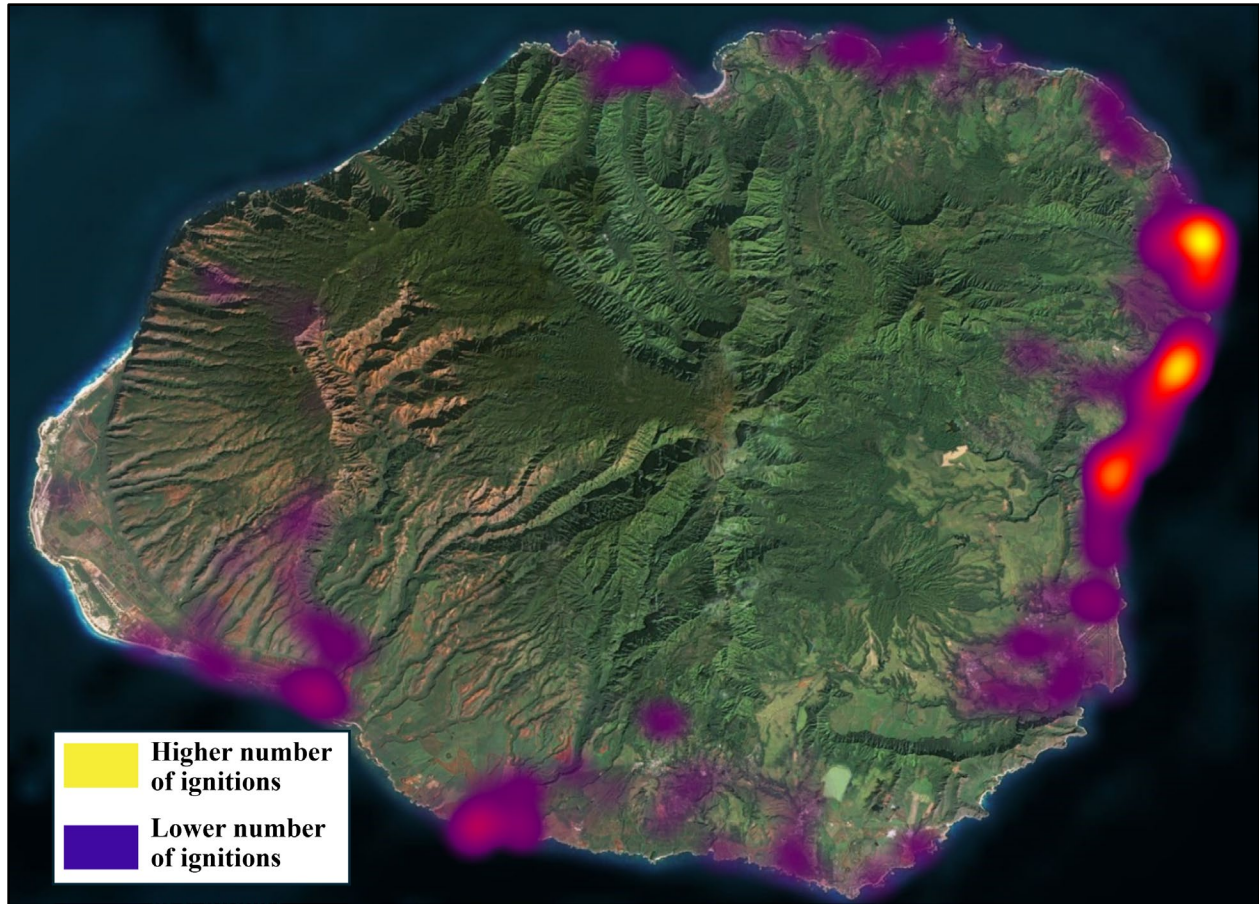


Figure 5-1. Brushfire incidents in Kaua'i County between January 2020 and December 2024.

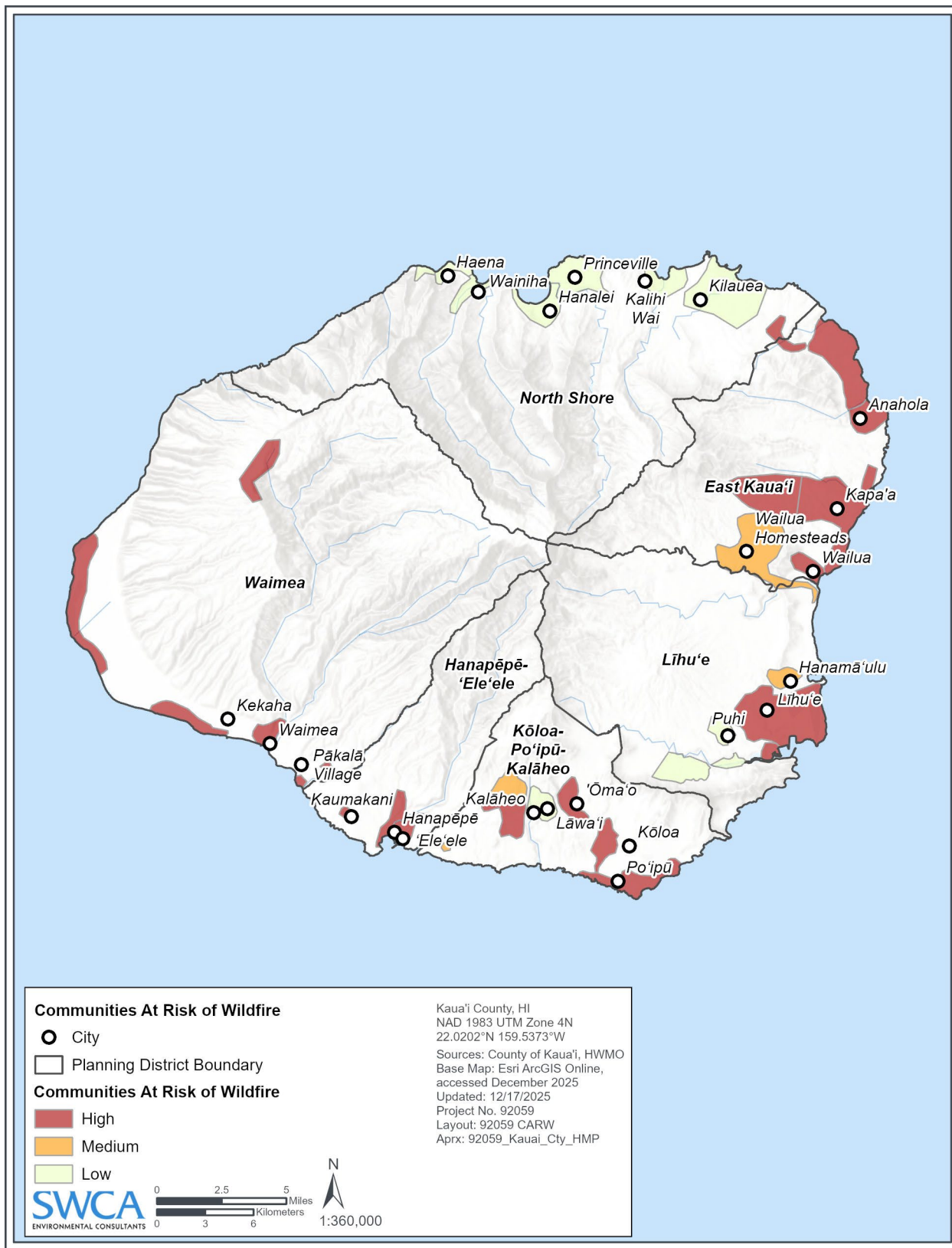


Figure 5-2. Kaua'i communities at risk of wildfire.

### 5.1.1 Future Conditions and Climate Change

Wildfire is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. An increase in temperature coupled with a noticeable decrease in precipitation exacerbates droughts and has the potential to contribute to an increased frequency of wildfire. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain and thus are more likely to expand into residential neighborhoods.

The driving force of this increase in wildfire likelihood is a higher prevalence of drought. Kaua'i experienced drought conditions across the entire county at some point each year between 2020 and 2024 (U.S. Drought Monitor [USDM] 2025a)—the latest in a decades-long trend of decreasing precipitation (State of Hawai'i 2025a). This trend is expected to continue as precipitation patterns continue to change and potential shifts in the trade winds occur across the state (County of Kaua'i 2025d). Even modeling that predicts a net increase in precipitation for the state predicts a decrease in certain parts of the year, resulting in abnormally dry seasons (Dhage and Widlansky 2022).

El Niño events fuel this trend as they bring instances of drought and heavy precipitation, and El Niño events are expected to occur with higher frequency due to climate change. The precipitation brought by these events is often not sufficient to offset the drought conditions as it occurs in a short period of time (State of Hawai'i 2025a). The increased likelihood of drought increases the risk of wildfires. A lack of rainfall can further reduce water storage needed in firefighting efforts if a wildfire occurs. Land burned by wildfires in Kaua'i has increased more than four times in just a few decades (Trauernicht and Pickett 2016). This trend is likely to persist in the coming decades.

These anticipated impacts of climate change in Kaua'i suggest that the location, severity, and frequency of wildfire events may increase in the coming years. A greater prevalence of dry days and drought conditions may increase the potential for wildfires to occur in locations where the likelihood used to be lower. Dry conditions throughout the county will also facilitate wildfire ignition and spread which will increase their frequency and severity.

## 5.2 VULNERABILITY ASSESSMENT

### 5.2.1 Scenario

A major conflagration in the planning area might begin in the wet season, contributing to extensive growth of grasses and similar flash fuels. A dry season could follow, exacerbated by dry hot winds. Carelessness with combustible materials, a tossed lit cigarette, or a sudden lightning storm could trigger multiple small, isolated fires.

Hot, dry winds could carry the embers from these smaller fires into forests and WUI zones. New small fires there would eventually merge. Fires that start in flat areas move slower, but wind can still facilitate their spread. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions. The response to a major wildfire on the island would be exclusively local and state resources. The County does not have real-time access to federal firefighting resources.

To further complicate this scenario, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitats and riparian areas. Such a fire followed by rain would release tremendous amounts of sediment into streams for years, modifying drainage ways and the capacity to store peak discharge during storm events. With trees no longer stabilizing soils throughout the watershed, stream and debris flows will increase exponentially along with the potential for injury and damaging property.

A modified version of the CARW mapping produced by the HWMO was used to conduct the vulnerability assessment for the Wildfire hazard (County of Kaua'i 2022c).

## 5.2.2 Exposure

### Population

Population was estimated using the residential building count in each mapped CARW hazard area and multiplying by the 2023 estimated average population per household (U.S. Census Bureau 2025b). Using this approach, the estimated population living in the high and medium CARW wildfire risk areas is 76% of the planning area population (55,250 people), as shown in Table 5-2. In addition to populations who reside in risk areas where fires may occur, hikers and campers may be exposed to wildfires. The entire population of the planning area has the potential to be exposed to smoke from nearby wildfires.

**Table 5-2. Population Exposure to the Wildfire Hazard**

| CARW Zone    | Population Exposed | % of Total Population |
|--------------|--------------------|-----------------------|
| High         | 45,826             | 63%                   |
| Medium       | 9,424              | 13%                   |
| <b>Total</b> | <b>55,250</b>      | <b>76%</b>            |

### Property

Property damage from wildfires can significantly alter entire communities. Structures in WUI areas and those not designed with fire-smart principles in mind are particularly vulnerable. The total replacement value of property including structures and contents in the high and medium CARW wildfire risk areas is \$13.3 billion, which is 65.4% of the planning area total value:

- High fire hazard:\$11.9 billion
- Medium fire hazard:\$1.4 billion

### Critical Facilities

Critical facilities in the medium and high wildfire risk zones represent 41% of the total critical infrastructure and facilities in the planning area. The breakdown of exposure by facility type is shown in Figure 5-3.

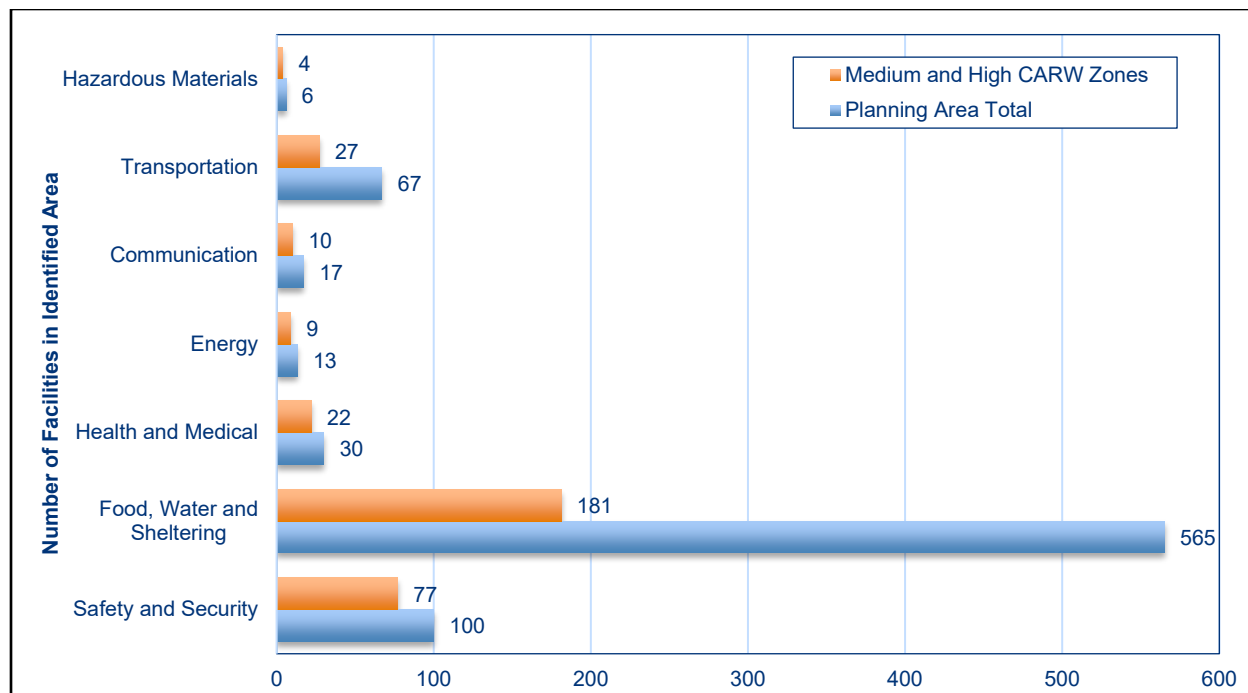


Figure 5-3. Critical facilities in medium and high CARW zones and countywide.

**Environment**

All natural areas within the mapped CARW medium and high wildfire risk zones are exposed to the Wildfire hazard.

**5.2.3 Vulnerability**

**Population**

Potential losses from wildfire include impacts to human health, structures, other infrastructure, natural resources, and cultural resources (HWMO 2016). The most extreme impacts are loss of life. Fire warning and response are generally sufficient so that the likelihood of injuries and casualties caused directly by a wildfire are reduced; however, smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. First responders are exposed to risks from the initial incident and after-effects from smoke inhalation and heat stroke.

All people exposed to the Wildfire hazard are potentially vulnerable to wildfire impacts (County of Kaua'i 2025d). People with access and functional needs, the elderly, and very young may be especially vulnerable. They may be more vulnerable to a wildfire itself if there is not adequate warning time for them to evacuate, or if evacuation routes are limited. They also may be more vulnerable to the smoke and air pollution associated with wildfires along with those who have respiratory and cardiovascular diseases. While mapped areas of wildfire risk show where exposure to the hazard may be greatest and where damages can be anticipated, people outside the mapped risk areas are susceptible to health hazards associated with smoke and air pollution from wildfires. In addition, wildfires threaten the health and safety of those fighting the fires.

In addition to the direct health effects that wildfires pose to the population, they can have negative impacts on cultural and natural resources. This can include economic losses from agriculture, fishing, or tourism; reduced food supply; fewer recreational spaces; and loss of places with spiritual significance. Additionally, in the aftermath of a wildfire, critical facilities, homes, places of employment, and other necessary facilities may be temporarily inaccessible.

**Social Vulnerability**

There are several communities in Kaua‘i where medium or high wildfire risk intersects with high social vulnerability (County of Kaua‘i 2022b). These are areas where communities are especially vulnerable to wildfires due to lower capacity to mitigate and respond. The overlap of high social vulnerability with medium or high wildfire risk is given by community (defined as census-designated places) within Kaua‘i County in Table 5-3. Only areas that experience the high and highest levels of social vulnerability, which are categorized as the 61st percentile or higher, and experience medium or high wildfire risk are shown in the table. Notably, social vulnerability is measured by census block groups, which do not align perfectly with each community. Social vulnerability can also vary within a given community. For example, within Anahola, the eastern area falls within the highest social vulnerability level and is in the 84th percentile when compared with all other block groups in the county. This area of Anahola also overlaps a high wildfire risk zone.

The “Community” column identifies areas within each community that fall into the high or highest levels of social vulnerability (above the 61st percentile), provided any part of the area overlaps with a hazard exposure zone. For example, if a community is classified with a high social vulnerability level and only a portion of it intersects with a hazard exposure area, the entire community is included in the table, even though only a smaller section is actually exposed to the hazard. While this method may overestimate vulnerability, it offers a broadly accurate overview of community risk. It is important to recognize that social vulnerability and hazard exposure can vary within each community, but this analysis was unable to capture that variability.

Additionally, there are socially vulnerable populations throughout the planning area who may face increased risk from hazards, even in communities categorized as having lower levels of social vulnerability than those listed in Table 5-3. This analysis focused on the highest levels of social vulnerability defined by the SVI developed for the KCAAP (County of Kaua‘i 2022b). Therefore, several communities have been excluded from this analysis due to lower levels of social vulnerability, including Wailua Homesteads, ‘Ele‘ele, Waimea, and Princeville. To examine the overlap of hazard exposure areas with these communities, please use the Hazard Mapping Tool on the Kaua‘i MHMRP 2026 Story Map (County of Kaua‘i 2025b).

**Table 5-3. Communities with High Social Vulnerability or Above in Medium or High CARW Zones**

| <b>Community:<br/>High Social Vulnerability Areas with (at least partial) Hazard Exposure</b> | <b>Social Vulnerability<br/>(Percentile)</b> | <b>Wildfire Risk</b> |
|---|--|----------------------|
| Anahola:<br>Eastern area of the community   | Highest (0.84)                               | High                 |
| Wailua:<br>Nearly entire community  | High (0.75–0.78)                             | High                 |
| Kapa‘a:<br>East-central area of the community   | High (0.76)                                  | High                 |
| Hanamā‘ulu:<br>Entire community   | Highest (0.86–1)                             | Medium               |

| Community:<br>High Social Vulnerability Areas with (at least partial) Hazard Exposure | Social Vulnerability<br>(Percentile) | Wildfire Risk |
|---|--------------------------------------|---------------|
| Līhu‘e:<br>Northern, western, eastern, and part of the central area of the community  | High–Highest (0.67–0.92)             | High          |
| Po‘ipū:<br>Southern area of the community   | High (0.61)                          | High          |
| Kōloa:<br>Entire community  | Highest (0.82–0.88)                  | High          |
| ‘Ōma‘o:<br>Northern area of the community   | High (0.69)                          | High          |
| Kalāheo:<br>Northern area of the community  | High (0.65)                          | Medium        |
| Hanapēpē:<br>Southeastern to northeastern area of the community                       | Highest (0.96)                       | High          |
| Kaumakani:<br>Entire community  | Highest (0.98)                       | High          |
| Pakala Village:<br>Entire community   | Highest (0.98)                       | High          |
| Kekaha:<br>Central area of the community  | Highest (0.94)                       | High          |

The ways in which social vulnerability may impede a community’s ability to mitigate and respond to a hazard event are described in the following paragraphs for each social vulnerability category and indicator included in the County’s SVI developed for the KCAAP (County of Kaua‘i 2022b).

**Household characteristics**, which include the population under the age of 17 and over age 65 as well as the population with a disability, can impact the ability of individuals to mitigate and respond to wildfires. These groups may be more likely to have difficulty evacuating from a wildfire if they are unable to operate a vehicle, navigate public transportation, move quickly, or access emergency notifications. Additionally, homeowners who are over the age of 65 or have a disability may have a harder time caring for their properties resulting in vegetation overgrowth and a lack of defensible space. This would put these properties at greater risk of damage during a wildfire event. Additionally, children, older individuals, and people with some preexisting health conditions can be at higher risk from the air pollution caused by wildfire smoke (Centers for Disease Control and Prevention [CDC] 2024a).

**Socioeconomic status** also impacts the ability of a population to mitigate and respond to wildfire events. These factors include household income, the population with a bachelor's degree, and the population of outdoor workers. These factors can shape exposure to a hazard, the ability to mitigate against it, and the ability to respond to it. Households with higher incomes are more likely to have additional resources to implement home-hardening measures that minimize the risk of property damage associated with wildfires. Additional resources can also facilitate evacuation in the event of a hazard through access to a personal vehicle and the ability to pay for lodging over the hazard's duration. Exposure to the hazard can also be greater if homes or rental units cost less in areas with higher wildfire risk; this could result in higher concentrations of low-income groups in the higher risk zones. Finally, outdoor workers can be exposed to the impacts of the Wildfire hazard more than the general population. The fires themselves may not have a disproportionate impact on outdoor workers, but outdoor workers would be exposed to a higher amount of smoke and poor air quality than individuals who work indoors, leading to poor health outcomes.

**Race and ethnicity**, which includes the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well), are also related to wildfire

impacts. In Kaua'i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events including wildfires (County of Kaua'i 2022b). Additionally, linguistic isolation increases vulnerability to wildfires due to inability to access evacuation notices and procedures. It also may lead to an inability to access information on mitigating wildfire occurrence or severity such as through home-hardening measures, putting people's health, lives, and property at risk.

**Physical conditions** also impact a community's mitigation and response capacity to wildfires. Physical conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units can increase vulnerability to wildfires because renters may not have the authority to implement wildfire mitigation actions on their residences and landlords may not be incentivized to allocate resources for these efforts to rental properties. Similarly, rent-burdened households may not have sufficient resources to devote to wildfire mitigation or evacuation if needed. Houses built before the 1970s are vulnerable to wildfires because they may not be built to the necessary codes to reduce wildfire risk. One of the many factors contributing to the severity of the 2023 Lahaina wildfires was older housing that was able to ignite more easily (Kerber and Alkonis 2024). Similarly, mobile homes built in the 1970s and prior to the development of federal standards are not sufficiently prepared for wildfire events (Curran-Groome et al. 2025). Lack of access to a vehicle also increases vulnerability as it can inhibit evacuation during a wildfire event and increase the risk of injuries and fatalities.

### **Property**

All property exposed to the Wildfire hazard is vulnerable. Structures that were not constructed to standards designed to protect a building from a wildfire may be especially vulnerable. Loss estimations for the Wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, estimates of potential loss were developed representing 1%, 10%, 30%, and 50% of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50% is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 5-4 shows the general building stock loss potential estimates in the high and medium CARW wildfire risk areas (County of Kaua'i 2022c). Appendix H, Table H-1 provides additional information about the data sources used in the analysis.

**Table 5-4. Loss Potential for High and Medium CARW Wildfire Risk Areas**

| <b>Loss Potential</b>       | <b>Exposed Value<br/>(Structures and Contents)</b> | <b>Loss Value</b> | <b>Loss as % of Total Planning<br/>Area Replacement Value</b> |
|-----------------------------|--|-------------------|---|
| Loss = 1% of Exposed Value  | \$13.3 billion                                     | \$133 million     | Less than 1%  |
| Loss = 10% of Exposed Value |  | \$1.3 billion     | 6.5%  |
| Loss = 30% of Exposed Value |  | \$4 billion       | 19.6%   |
| Loss = 50% of Exposed Value |  | \$6 billion       | 32.7%   |

### **Critical Facilities**

Damage to critical facilities during a wildfire event is likely to vary. Critical facilities of wood frame construction are especially vulnerable during wildfire events. Most roads would be without damage except in the worst scenarios. Power lines are particularly at risk from wildfires because most poles are made of wood and susceptible to burning. Fiber optic cables can also burn during wildfire events. Damage to power lines, fiber optic cables, or other forms of communication infrastructure would be

especially dangerous as it can hinder evacuation and recovery efforts. Fires can also create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfires typically do not have a major direct impact on bridges but can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and, in some cases, to isolated neighborhoods.

Critical facilities containing hazardous materials are of concern during wildfire events as well because they can lead to a dangerous series of cascading issues. The hazardous materials contained in these facilities are often flammable. A wildfire in close proximity may cause these materials to ignite or containment structures to fail. This could provide substantial fuel for wildfires, causing rapid spread and escalating the fire to possibly catastrophic levels. The interaction of a wildfire with hazardous material facilities could exacerbate the severity of the fire causing significantly more damage. Dangerous chemicals can also be released into the air when hazardous materials burn, which increases the already present public health risk from wildfire smoke (Hewitt 2025). In addition, hazardous materials could leak into surrounding areas, saturate soils, and enter surface waters. The combined impacts of the initial wildfire, worsened by fuels from these facilities, and contamination from hazardous material spread could have a disastrous effect on the environment, public health, and complicate cleanup efforts after the wildfire.

## **Environment**

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, affecting the types, structure, and spatial extent of native vegetation. However, wildfire presents considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of watershed ecology, wildlife habitat, cultural resources, and scenic vistas in addition to the health hazards associated with smoke and fire. Long-term effects could include modified drainage ways, reduced water quality due to post-wildfire debris, access to affected recreational areas, and decreased economic resources like smaller timber harvests. More specific impacts are described below:

- **Damaged fisheries:** Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- **Soil erosion impact on marine ecology:** When wildfires remove vegetation from an area, it becomes highly susceptible to erosion. This can lead to large amounts of sediment being transported downstream and eventually to the coast. Abnormally high sediment quantities entering the ocean can have significant negative effects on reefs and fisheries (HWMO 2016).
- **Spread of invasive plant species:** Nonnative woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes and become difficult and costly to control.
- **Decreased water infiltration:** Wildfires contribute to a decrease in water absorption by soil in two ways. First, wildfires can change soil properties in areas that have been burned causing the soil to be less able to absorb water. Second, wildfires in the state of Hawai'i are causing forests to transition to grasslands post-wildfire. These grasses absorb more water than the trees before them and lead to less water entering the soil (HWMO 2016).
- **Disease and insect infestations:** Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed endangered species habitat:** Wildfires can have negative consequences for endangered species by degrading their habitat.

- **Soil sterilization:** Some wildfires burn so hot that they can sterilize the soil. Topsoil exposed to extreme heat can become water-repellent, and soil nutrients may be lost.
- **Reduced agricultural resources:** Wildfires can have disastrous consequences on agricultural resources, removing them from production and necessitating lengthy restoration programs.
- **Damaged cultural and historical resources:** The destruction of cultural and historic resources may occur, scenic vistas can be damaged, and access to recreational areas can be reduced.

## 5.3 ISSUES

### 5.3.1 Development in High-Hazard Areas

Land use is determined by the County’s zoning code and zoning map, also known as the Comprehensive Zoning Ordinance. Zoning controls the density and intensity of development as well as its form and character. Changes to the zoning code are guided by the General Plan, which is adopted by the Kauaʻi County Council. Although the General Plan is not regulatory like the zoning code or other land use entitlements, it guides district and zone amendments through its Future Land Use Map, which is a spatial representation of how Kauaʻi should accommodate and manage future growth. The community plans for West Kauaʻi (including Waimea-Kekaha and Hanapēpē-ʻEleʻele), South Kauaʻi, Līhuʻe, East Kauaʻi, and North Shore help to implement the General Plan and provide more detailed information for the specific planning district. The General Plan and community plans establish policies to protect communities from hazards, such as wildfires. Development in the planning area is also regulated by building standards and performance measures.

The CARW mapped areas naturally overlap the populated areas of the county because the maps indicate where communities are at risk. As areas within the county continue to develop, the risk of wildfires occurring can increase. The risk of wildfire exposure is often low in urbanized areas due to high amounts of impervious surfaces and the low amounts of vegetation that can serve as fuel allowing wildfires to ignite and spread. It is often the outer edges of urbanized areas in the WUI that are at the greatest risk from wildfires due to their proximity to significant amounts of potential fuel. Development in urban areas can create the potential for expansion into wildland areas, increasing exposure to the Wildfire hazard and putting communities at risk. While there is generally greater wildfire concern in the WUI than in urban areas, the 2023 Lahaina Wildfires have demonstrated the devastation wildfires can pose to urban areas. Urban environments that contain buildings with wooden or non-wildfire-resistant components, high amounts of vegetation, and structures located close together and close to vegetation can allow wildfires to spread quickly even in an urban setting as was the case in the 2023 Lahaina Wildfires (Kerber and Alkonis 2024).

The expansion of WUI areas and urban development can be managed with strong land use and building codes. Further, an ordinance was passed in Kauaʻi County in September 2025 to increase wildfire mitigation in the WUI through permitting and zoning. The ordinance was particularly focused on wildfire mitigation in West Kauaʻi’s plantation camp districts and updated the West Kauaʻi Community Plan (County of Kauaʻi 2025h).

Figure 5-4 shows the land use distribution by area in high and medium CARW severity zones. Agricultural and natural uses make up about 34% of these zones. Most homes and facilities are in areas designated urban center, neighborhood center, neighborhood general, or residential community. Approximately 30% of the hazard area is highly developed.

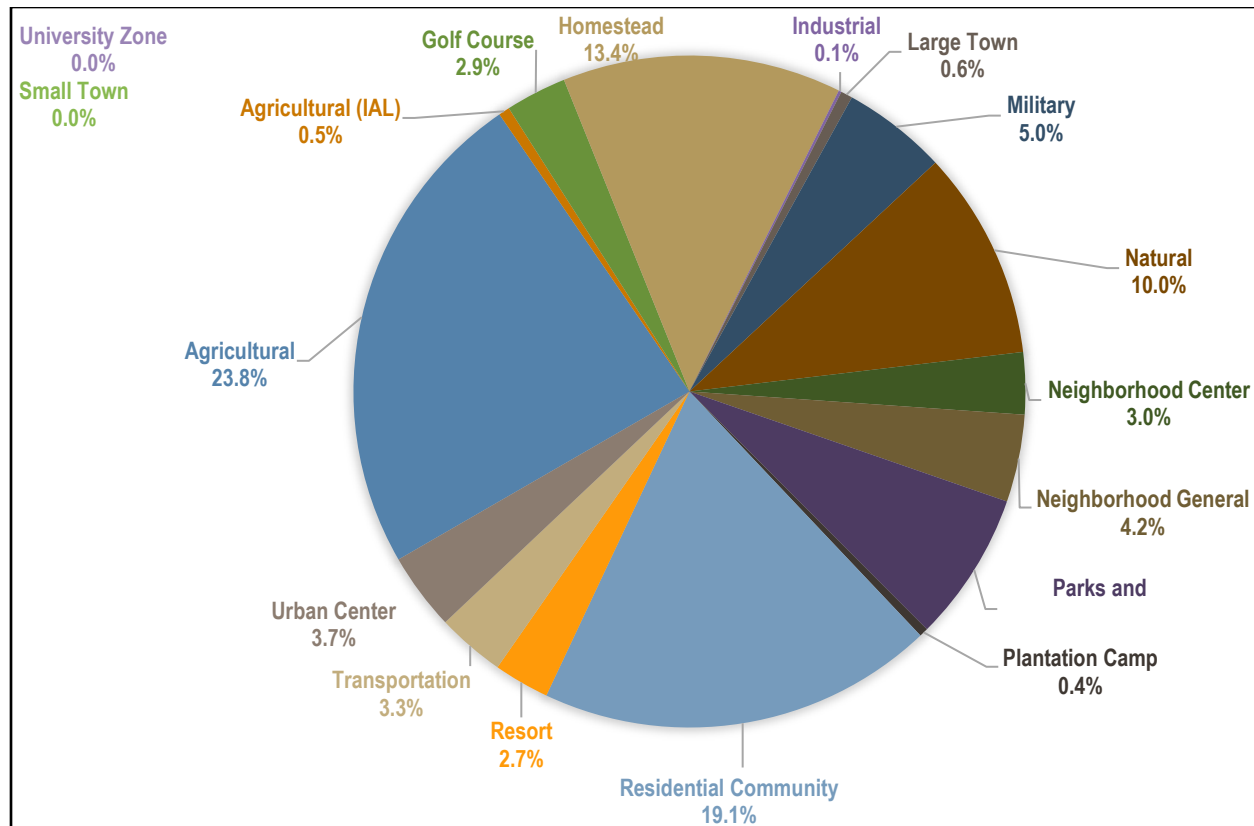


Figure 5-4. Land use distribution by area in the high and medium CARW severity zones.

### 5.3.2 Other Issues

The following issues have been identified related to the Wildfire hazard in the planning area:

- Cascading hazard event potential:** Wildfires may contribute to landslides and flooding as vegetation that would normally absorb flood waters or stabilize soil has been burned away and there is an increased imperviousness of the ground. This is particularly dangerous on steep slopes or in ravine areas. Wildfires strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Vulnerability to flooding increases due to the destruction of watersheds. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding. Additionally, increased runoff carried by flood waters poses environmental and water quality issues when it enters local watersheds.
- Economic loss:** Economic impacts due to wildfires include costs and losses due to burned agricultural crops, damaged public infrastructure and private property, interrupted transportation corridors, and disrupted communication lines. They also include diminished real property values and thus tax revenues, loss of retail sales, and relocation expenses of temporarily or permanently displaced residents. Currently there is no measure in place to quantify the potential economic impacts due to wildfires besides historical data.

- **WUI public information:** Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- **Management of development:** Future growth into WUI areas should continue to be managed with special development considerations.
- **Continued responder training:** Area fire districts need to continue to train on WUI events.
- **Vegetation management activities:** Such activities would include enhancement through expansion of the target areas as well as additional resources. Controlled burns of former sugar cane fields would continue to be monitored to mitigate against potential major uncontrolled conflagrations.
- **Responder qualifications:** Expand certifications and qualifications for fire department personnel. Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.
- **Continuity of operations:** Critical facility owners should be encouraged to include wildfire considerations in their continuity of operations plans, using the information on risk and vulnerability contained in this plan.
- **Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- **Personal planning resources:** Additional information on emergency shelters as well as emergency management resources can be found on the KEMA Facebook page and website: <https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency> (KEMA 2025).
- **Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by wildfires. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people’s safety during evacuations and in community shelters (County of Kaua’i 2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua’i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf)

The risk ranking summary for the Wildfire hazard, based on the hazard profile and vulnerability assessment, is given in Table 5-5.

**Table 5-5. Risk Ranking Summary for Wildfire**

| Priority | Hazard Event | Probability   | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time | Duration         | Risk Score |
|----------|--------------|---------------|--|--------------------------|----------------------|----------------|--------------|------------------|------------|
| 1        | Wildfire     | Highly Likely | Critical   | Limited                  | Medium               | Moderate       | 1:01–4 hours | Less than 1 week | 3.1        |

## 6. TROPICAL CYCLONES AND OTHER HIGH WINDS

Three types of high winds affect the Kaua'i County, including tropical cyclones. Each one, summarized below, can pose a threat to the county. The hazard profile (Section 6.1) breaks these events into two categories: tropical cyclones and other high wind events.

- Trade winds:** Trade winds are the most common winds over Hawaiian waters, blowing 70% of the time from the northeast or east-northeast and generally ranging from 10 to 25 miles per hour (mph). Occasional extreme events reach 40 to 50 mph when a subtropical high-pressure cell north of the islands intensifies. Trade winds occur up to 90% of the time in summer (June through August) and 50% of the time in winter (December through January).
- Kona winds:** Kona winds are rain-bearing winds that blow over the islands from the southwest or south-southwest. The south or west sides of the islands become windward during Kona winds, as the trade wind pattern is reversed. Kona winds are light and variable during winter when trade wind circulation diminishes, but strong, generally southerly, winds when storm systems move across Hawaiian waters. Strong Kona winds are most likely when a system with an unusually low pressure is within 500 miles northwest of the islands. Kona storms move erratically with a slow tendency toward the west.
- Tropical cyclones:** Tropical cyclones are among the most dramatic, damaging, and potentially deadly events that occur in the Hawaiian Islands. In the United States, forecast centers classify tropical cyclones according to their maximum sustained winds (measured over 1 minute); however, wind is only one of three risks that tropical cyclones pose to the county; they also generate storm surge along coastlines and inland flooding due to heavy rainfall.

The Central Pacific experiences four to five tropical cyclones most years, usually between June 1 and November 30. In the United States, forecast centers classify tropical cyclones according to their maximum sustained winds (measured over 1 minute). The classification of tropical cyclones based on wind speed is shown in Table 6-1. A hurricane is a type of tropical cyclone that receives a hurricane designation when wind speeds reach 74 mph or greater. More detailed information on the types of wind events experienced in Kaua'i can be found in Appendix I.

**Table 6-1. Tropical Cyclone Classification Based on Wind Speed**

| Storm Classification | Maximum Sustained Wind Speed | Storm Classification | Maximum Sustained Wind Speed |
|----------------------|------------------------------|----------------------|------------------------------|
| Tropical Depression  | <39 mph                      | Category 3 Hurricane | 111–129 mph                  |
| Tropical Storm       | 39–73 mph                    | Category 4 Hurricane | 130–156 mph                  |
| Category 1 Hurricane | 74–95 mph                    | Category 5 Hurricane | > 156 mph                    |
| Category 2 Hurricane | 96–110 mph                   |                      |                              |

Source: National Weather Service (NWS) (2025b).

Wind pressure, which increases exponentially as wind speed increases, is the primary cause of damage during high wind events (Warning Coordination Meteorologist 2025). The pressures exerted by wind can result in substantial damage to walls, windows, shutters, and roofs. Windborne debris also causes damage. Debris includes flying objects, such as tree limbs, outdoor furniture, signs, roofs, gravel, and loose building components (Warning Coordination Meteorologist 2025).

Tropical cyclones pose two additional threats beyond those associated with high wind: storm surge (water that is pushed toward the shore by the force of the storm's winds); and rainfall-caused flooding. Storm

surge levels are determined by modeling water depth, wind speed, vegetative cover and other factors to determine the “wave run-up” (how far inland waves will reach) and “wave setup” (the height, speed, and slope of waves and how they differ from the still-water elevation). Waves and storm surges normally hit coasts ahead of high winds, as waves move faster than a hurricane advances. Locally intense rainfall may occur as the hurricane makes landfall; however, heavy rain may also occur far from the center (Warning Coordination Meteorologist 2025).

More detailed information on the Tropical Cyclones and Other High Winds hazard is provided in Appendix I.

## 6.1 HAZARD PROFILE

Table 6-2 summarizes the key elements of the Tropical Cyclones and Other High Winds hazard profile for Kaua'i County. See Section 4 for a description of elements included in the hazard profile and Section 6.3.2 for a brief discussion of cascading hazard event potential. See Appendix I for a more detailed description of tropical cyclones and other high winds.

**Table 6-2. Tropical Cyclones and Other High Winds Hazard Profile Summary**

|                    | Tropical Cyclone   | Other High Windstorms   |
|--------------------|--|---|
| <b>Past Events</b> | <p>Since 1950, 15 hurricanes have passed within 150 miles of the state of Hawai'i with varying amounts of damage. The state of Hawai'i was used as the unit of analysis for tropical cyclone tracks to maintain consistency with the 2021 MHMRP Update. Figure 6-1 depicts storm tracks in the vicinity of Hawai'i from 1950 to through the end of 2024 (NOAA 2025b). Hurricane Iniki in 1992 was the most destructive hurricane to strike Hawai'i in this period, with estimated peak winds over Kaua'i of between 130 and 160 mph. The hurricane destroyed over 1,400 homes, caused major damage to over 5,000 homes, and impacted 14,000 homes. It also destroyed much of the green vegetation on the island, uprooted trees, and brought down half of the utility poles (National Weather Service [NWS] 1993). Hurricane Lane in 2018 also produced intense rainfall and caused severe flooding. According to NOAA's National Centers for Environmental Information (NCEI) database, the flooding from the hurricane resulted in a fatality and \$1.5 million in damages (NOAA 2025c).</p> <p>Since the 2021 MHMRP Update was released, four tropical cyclones have come near the Hawaiian Islands. Of these four storms, two reached a hurricane classification around the Hawaiian Islands. Hurricane Douglas in 2020 (Category 1) caused precipitation and high surf but no damages, injuries, or fatalities were reported (NOAA 2025c). Hurricane Hone in 2024 (Category 1) did not cause damages, injuries, or fatalities in the county but did cause widespread impacts elsewhere in the state. For a more detailed list of past tropical cyclones to impact the state, refer to Appendix I.</p> | <p>Since 2005, 19 high wind events have affected the planning area. None of the events resulted in fatalities, and only one event in 2014 resulted in an injury.</p> <p>In the period since the 2021 MHMRP Update, there have been two high-wind events, two thunderstorm wind events, and a funnel cloud in Kaua'i County. The most damaging event occurred on January 30, 2025, resulting in at least \$480,583 in damage; \$385,000 in damage was reported by the Kaua'i Island Utility Cooperative, and \$95,583 in damage was reported by the Hawai'i Department of Transportation – Airports Division (Kaua'i Emergency Management Agency Staff Specialist 2025). This event also resulted in power outages, with extended outages in the Wainiha and Kīlauea communities as well as Wilcox Memorial Hospital. The hospital is the largest on the island and had to go on a generator. Additionally, roads were temporarily blocked by debris. Additional damages to private and public property resulting from this event have not yet been quantified. This event resulted in a state emergency proclamation being issued.</p> <p>Of the other events that have occurred since the 2021 MHMRP Update, one of the thunderstorm wind events and the funnel cloud caused no damage. The other thunderstorm wind event and the high wind event caused minimal damage of \$1,000 and \$2,000 respectively (NOAA 2025c); however, the thunderstorm wind event on April 12, 2024, was part of the storm that led to flooding and landslides in Kaua'i, resulting in a major disaster declaration (DR-4793) and state emergency proclamations. The severity of the storm was primarily due to heavy precipitation and flooding, not winds (NOAA 2025c). For a list of high wind events that occurred prior to the 2026 MHMRP Update planning period, see Appendix I:Figure I-5 and Table I-3.</p> |

|                   | Tropical Cyclone  | Other High Windstorms   |
|-------------------|---|---|
| <b>Location</b>   | <p>Tropical cyclones spin counterclockwise in the northern hemisphere and most tropical cyclones have passed the Islands to the south, so east-facing Hawaiian coastlines usually receive the brunt of strong onshore winds.</p> <p>South and west coastlines feel onshore winds as the storms pass to the west.</p> <p>The highest wind speeds may occur on the side opposite the storm approach, as downdrafts accelerate downslope over mountainous terrain.</p> <p>Coastal areas are at additional risk from tropical cyclones due to storm surge (HI-EMA 2023).</p> <p>The location of tropical cyclone impacts in the planning area has not changed in the period since the 2021 MHMRP Update as the entire island can still be impacted by tropical cyclones with coastal areas facing an additional threat from storm surge (Figure 6-2 and Figure 6-3).</p>  | <p>High-wind storms can happen anywhere in the planning area, but topography impacts where events are more severe, with mountainous areas experiencing generally higher wind speeds.</p> <p>The location of high-wind impacts in the planning area has not changed in the period since the 2021 MHMRP Update. The entire island can still be impacted by high winds, with more mountainous areas experiencing higher wind speeds.</p>   |
| <b>Frequency*</b> | <p>The same tropical cyclone mean return period (MRP) is used in the 2026 Plan update as in the 2021 MHMRP Update. Fourteen hurricanes have come within the state of Hawai'i since 1950, an average of 0.09 hurricane events per year.</p> <p>The hurricane events experienced in the Hawaiian Islands between 2020 and 2024 indicate a slight change in event frequency with one event occurring over the 5-year period. This is an average of 0.20 hurricane events per year during this period. The frequency of tropical cyclone events, including those reaching hurricane status, is expected to increase as a result of climate change (see Section 6.1.1).</p> <p>A 2014 study found that MRPs for precipitation events, though not specifically tropical cyclones, should be considered dynamic. This is due to climate change driving shifts in weather patterns that reduce the applicability of historic conditions to the future in the state of Hawai'i (Chen and Chu 2014). A 1998 study for Hawai'i found that the MRP for an Iniki-strength hurricane (Category 4) was 137 years, which represents about a 0.7% chance of an event occurring in a given year (Chu and Wang 1998); however, the methodology and analysis used in the study are now outdated. According to the Hawai'i State Climatologist, additional research is needed to further refine the MRP for tropical cyclones in Hawai'i, particularly in the context of climate change (Hawaii State Climatologist 2025).</p> <p>Hurricanes typically pass to the south of Hawai'i; however, climate change is shifting the locations where these storms occur northward. This shift means the state is expected to experience more hurricane-force windstorms in future years (Hawaii State Climatologist 2025). However, research is not yet available to quantify anticipated increases.</p> | <p>There has been an average of one nontropical cyclone high-wind event per year from 2020 through 2024. This represents a slight increase from the average of 0.95 events over the past 20 years. The previous planning period examined wind events going back to 2005, and this 2026 MHMRP Update examines events through 2024 with the exception of the significant high wind event that occurred in January 2025. Climate change may also cause shifts in the trade winds that reduce the predictability of extreme weather events such as high wind (see Section 6.1.1) (HI-EMA 2023).</p> |

|                     | Tropical Cyclone  | Other High Windstorms   |
|---------------------|---|---|
| <b>Severity</b>     | <p>Hurricane storm tracks from 1950 to 2024 indicate that 14 storms of Category 1 or higher have come within 150 nautical miles of the state of Hawai'i. Hurricane Iniki had winds equivalent to a Category 4 hurricane and is the most severe hurricane on record to have impacted Hawai'i. This information has not changed since the 2021 MHMRP Update. Based on this historic record, we anticipate the severity to range from Category 1 to Category 4; however, climate change is expected to increase the severity of tropical cyclone events which raises the likelihood of Kaua'i experiencing stronger hurricanes in the future. Additional information on the impacts of climate change on future tropical cyclone events in Kaua'i or the state can be found in Section 6.1.1.</p>  | <p>Windstorms in the planning area have been known to cause damage to utilities, trees, boats, homes, and other structures and buildings. Kaua'i County is in FEMA Wind Zone II, with speeds up to 160 mph. This information has not changed since the 2021 MHMRP Update. It is unclear how climate change may increase the severity of other high winds storms in the future for the county (HI-EMA 2023). Additional detail on how climate change could impact future high wind events in Kaua'i or the state was not available at the time this 2026 MHMRP update was prepared, and it is unknown when such data may be available.</p>   |
| <b>Warning Time</b> | <p>Accurate warnings up to days in advance of tropical cyclones are possible, with modeling offering possible storm movement up to a week prior. NOAA offers the following tools:</p> <ul style="list-style-type: none"> <li>• Tropical Cyclone Public Advisory: A list of all current watches and warnings on a tropical or subtropical cyclone</li> <li>• Tropical Cyclone Forecast/Advisory: Current tropical cyclone latitude and longitude, intensity, and system motion</li> <li>• Tropical Cyclone Discussion: Explains the reasoning for the analysis and forecast of a tropical or subtropical cyclone</li> </ul> <p>Watches, warnings, and advisories can be found at the NWS website for the Honolulu Forecast Office, which is available at the following link: <a href="https://www.weather.gov/hfo/">https://www.weather.gov/hfo/</a> (NWS 2025c).</p> <p>The warning time information for tropical cyclones is unchanged from the 2021 MHMRP Update.</p> | <p>Meteorologists can often predict the likelihood of a severe storm. The NWS Forecast Office in Honolulu issues the following watches, warnings, and advisories:</p> <ul style="list-style-type: none"> <li>• High Wind Watch: Issued when sustained winds exceeding 40 mph and/or frequent gusts over 60 mph are likely to develop in the next 24 to 48 hours.</li> <li>• High Wind Warning: Issued when sustained winds exceeding 40 mph and/or frequent gusts over 60 mph are occurring or imminent.</li> <li>• Wind Advisory: Issued when sustained winds of 30 to 39 mph and/or frequent gusts to 50 mph or greater are occurring or imminent.</li> <li>• Small Craft Advisory: Issued for coastal waters when winds of 25 to 33 knots and seas 10 feet or higher are occurring or forecast.</li> <li>• Gale Warning: Issued for coastal, offshore, and high seas areas when winds of 34 to 47 knots not associated with a tropical cyclone are occurring or forecast.</li> </ul> <p>Watches, warnings, and advisories can be found at the NWS website for the Honolulu Forecast Office, which is available at the following link: <a href="https://www.weather.gov/hfo/">https://www.weather.gov/hfo/</a> (NWS 2025c).</p> <p>The warning time information for high winds is unchanged from the 2021 MHMRP Update.</p> |

Note:

\*MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event.

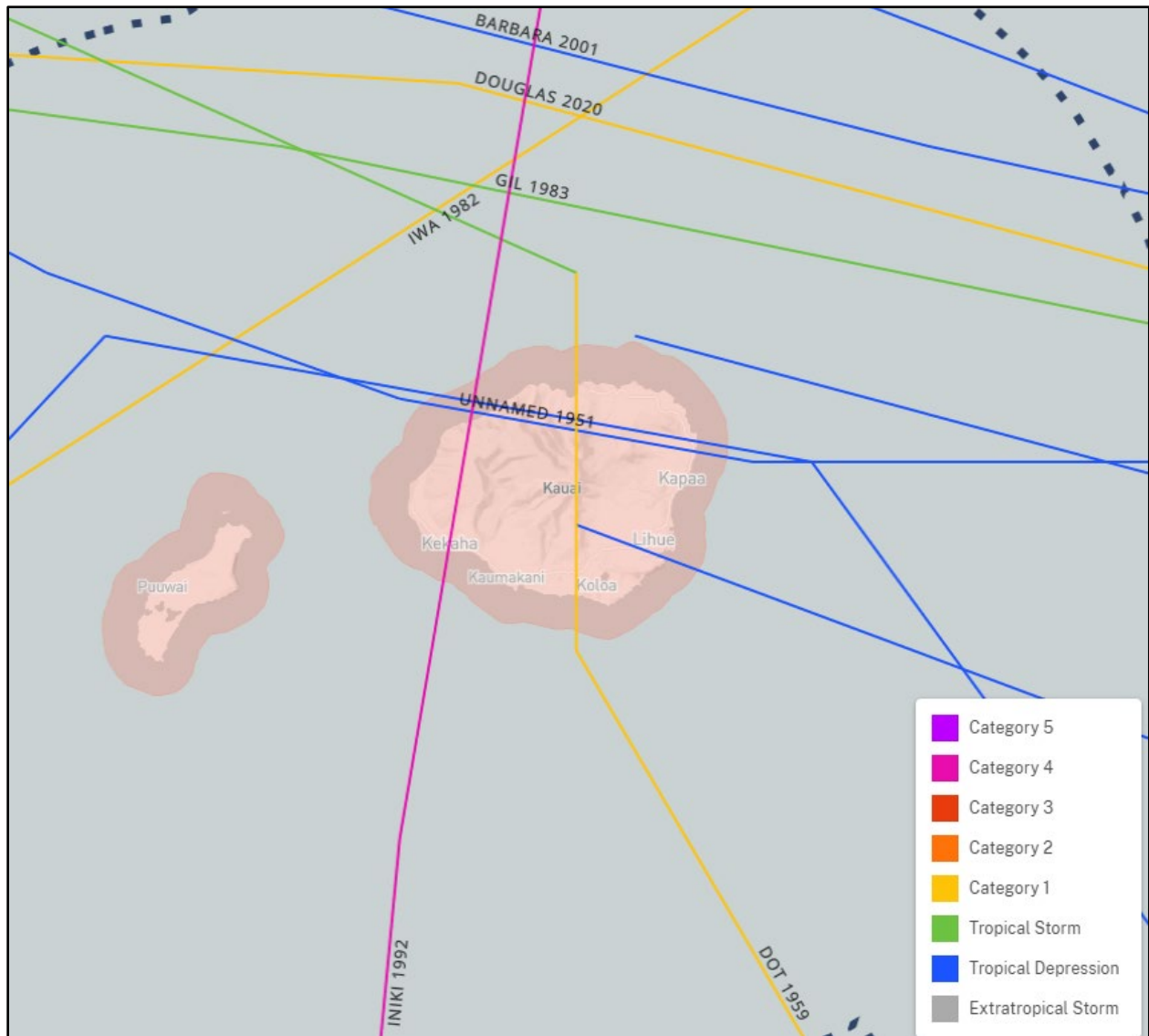


Figure 6-1. Historical tropical cyclones within approximately 50 miles of Kaua'i, 1950 to 2024 (NOAA 2025b).

### 6.1.1 Future Conditions and Climate Change

Climate change is expected to impact the way tropical cyclones and high wind events affect Kaua'i. Tropical cyclones are anticipated to increase in intensity and possibly frequency as a result of climate change. Tropical cyclones have also been observed migrating poleward, which increases Kaua'i's likelihood of being in a storm's path (Sharmila and Walsh 2018). Furthermore, tropical cyclones can be coupled with El Niño events which are projected to increase (Cai et al. 2014). These factors mean the damages and population exposed to tropical cyclones are likely to grow in the coming decades. Increases in tropical cyclone events will be compounded by rising sea levels. Higher sea levels will allow the storm surge from these events to inundate farther inland. More frequent storms will also cause greater coastal erosion, which coupled with sea level rise will result in future storms moving further inland (HI-EMA 2023).

A tropical cyclone's strong winds and intense low pressure can generate storm surges along coastal communities. Whereas not all tropical cyclones have devastating impacts or create significant levels of storm surge, the surge index record shows a significant positive trend between warmer years and extreme events (i.e., Category 5 hurricane events). One study found that Category 4 and 5 hurricanes could increase up to 81% in frequency with a temperature increase of only 2.5 degrees Celsius (°C). Although surge levels will vary because of situational factors, projected changes in hurricane surge levels above mean sea level in Hawai'i are more likely to increase than decrease with global warming (results range from a 10% reduction to 50% increase with a 2.8°C temperature increase).

Climate change may also cause shifts in the trade winds over Hawai'i leading to greater uncertainty as to how storms will behave in the future (HI-EMA 2023). Shifts in the direction of trade winds over the Hawaiian Islands have already been recorded in recent decades with increases in the number of days with northeastern trade winds and increases in the number of days with eastern trade winds (Garza et al. 2012). These changes in wind patterns are expected to increase the prevalence of dry days and droughts (County of Kaua'i 2025d). This will result in conditions that easily facilitate wildfires spread. The changes in wind patterns may also result in worsened air quality and extreme heat events (HI-EMA 2023).

The anticipated effects of climate change in Kaua'i suggest there will be an increase in the severity and possibly the frequency of tropical cyclones, while it is less clear how the severity and frequency of other high wind events will be affected. Climate change is expected to impact the trade winds, which will increase uncertainty with storm behavior, but how this will likely affect the severity and frequency of high wind events is unclear. Climate change is also unlikely to cause a change in the location of tropical cyclone or other high wind impacts in the county. The entire county can experience the impacts of tropical cyclones and high wind events. Coastal areas are often hit harder by tropical cyclones than other areas due to the high surf and storm surge they bring, which will likely continue to be the case with an increase in storm severity and frequency. Based on research conducted for this plan update, climate change is unlikely to change the location of tropical cyclone impacts to shift from historic patterns.

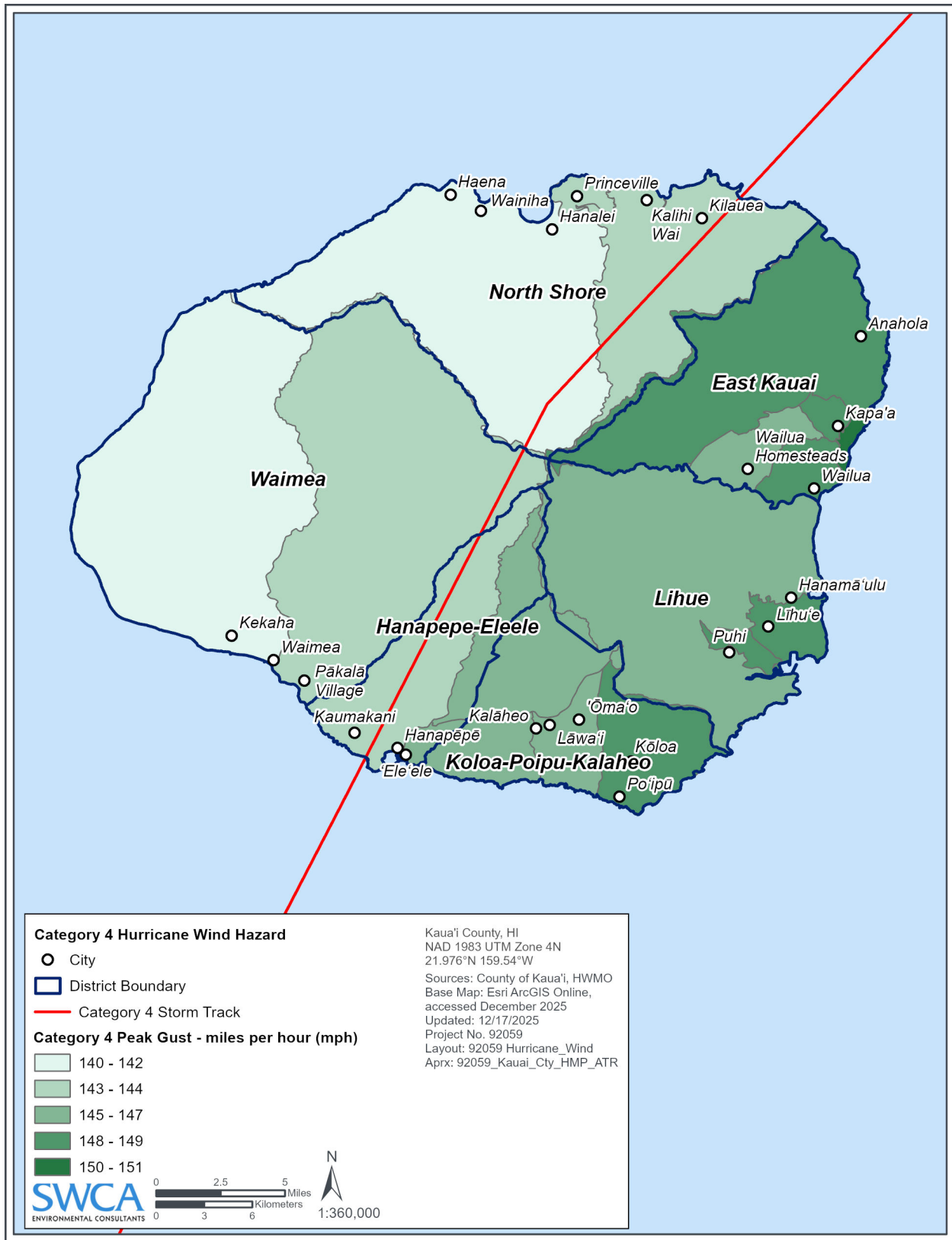


Figure 6-2. Category 4 hurricane wind hazard, including Hurricane Iniki's storm track.

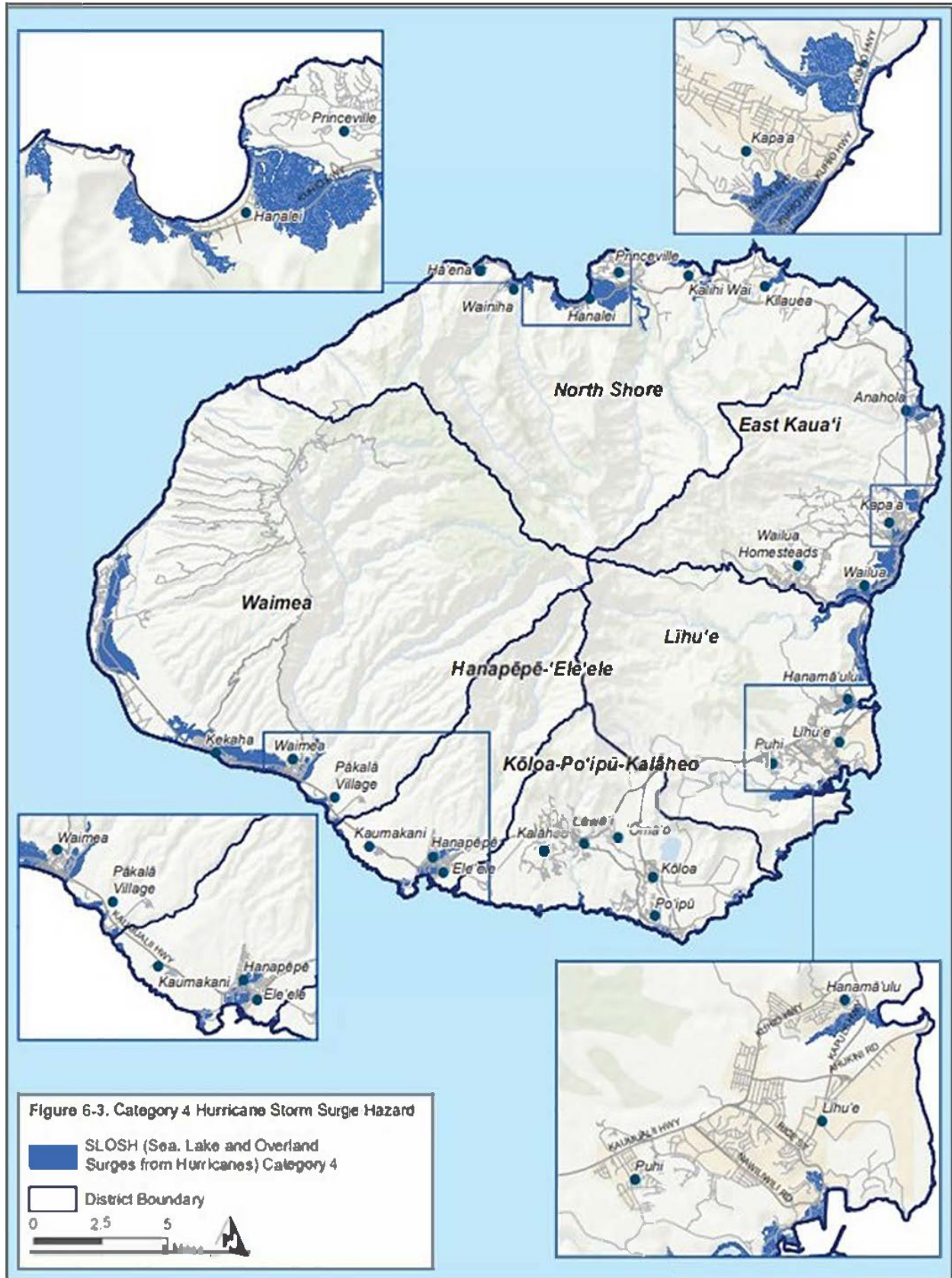


Figure 6-3. Category 4 hurricane storm surge hazard.

## 6.2 VULNERABILITY ASSESSMENT

### 6.2.1 Scenario

The tropical cyclone scenario used for the quantitative risk assessment is a Category 4 hurricane, tracking south-southwest by northeast across the planning area, though it is worth noting that a hurricane could take other paths across the island. This scenario was intended to replicate a present-day occurrence of a storm similar to Hurricane Iniki (see Table 6-2 and Appendix I for more information on Hurricane Iniki). Two types of impacts were modeled for a Category 4 hurricane scenario event: wind and storm surge; however, FEMA's Hazus software (FEMA 2025a) is not able to model the combined effects of hurricane winds and storm surge for the state of Hawai'i and analyzes them as two separate events (FEMA 2025a). Therefore, the reported results should be read as anticipated exposure and damages associated with a Category 4 hurricane storm surge and the anticipated exposure and damages associated with Category 4 hurricane winds (as opposed to the anticipated exposure and impacts of storm surge and wind from a single Category 4 hurricane event). Figure 6-2 and Figure 6-3 show the likely extent and location of these two components for the hurricane hazard.

Another significant threat associated with hurricanes is heavy and prolonged precipitation. A hurricane bringing heavy rainfall could result in significant damage in the county, in addition to the damage from the storm surge and winds (University of Hawai'i [UH] Sea Grant Extension Agent 2025). While hurricane rainfall poses a threat, Hazus is unable to assess the potential impacts from hurricane rainfall. For this reason, this event was not assessed quantitatively.

A worst-case high windstorm event would involve prolonged high winds. This event was not assessed quantitatively.

### 6.2.2 Exposure

The entire population, property, critical facilities, and environment in Kaua'i County are exposed to the wind impacts of tropical cyclones and other high windstorms to some degree. Certain areas are more exposed due to geographic location and local weather patterns.

Tropical cyclone storm surge impacts were assessed using storm surge inundation mapping for a Category 4 hurricane, as determined using the NOAA National Hurricane Center's Sea, Lake and Overland Surges from Hurricanes (SLOSH) methodology.

#### People and Property

The level 2 Hazus analysis determined that all people and property within the planning area are exposed to high winds associated with a hurricane, totaling about 73,000 people and structures with a value of approximately \$24.6 billion dollars.

Table 6-3 summarizes the estimated population exposed to a Category 4 storm surge inundation area and the estimated property exposure, based on the level 2 Hazus analysis.

**Table 6-3. Exposed Population and Property in Category 4 Storm Surge Inundation Area**

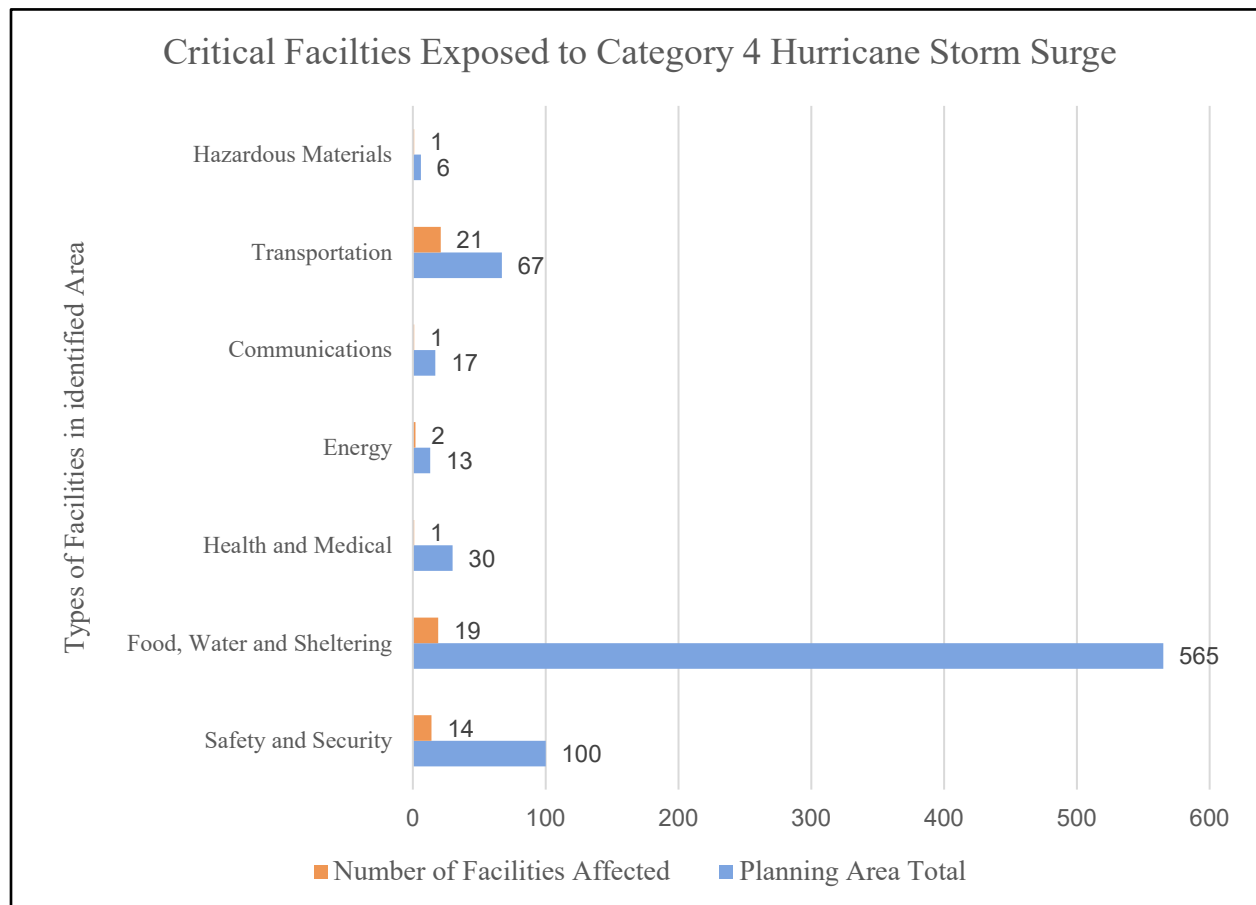
| Population                          |        |
|-------------------------------------|--------|
| Population Exposed                  | 19,902 |
| % of Total Planning Area Population | 27.2%  |

| Property  |                  |
|---|------------------|
| Number of Buildings Exposed                     | 8,799            |
| Value of Exposed Residential Structures         | \$6,091,844,000  |
| Value of Exposed Structures                     | \$10,328,575,000 |
| Total Exposed Value as % of Planning Area Total | 42.0%            |

**Critical Facilities**

All critical facilities in the planning area (approximately 800) would be exposed to the high winds from a hurricane.

Figure 6-4 summarizes the critical facilities in the Category 4 storm surge inundation zones of the planning area. Critical facilities located just beyond the storm surge zones may be exposed if previous high-surf or storm events destroy the beach buffer. Coastal transportation routes also may be exposed. These routes are often located in areas where coastal erosion has gradually worn away the beach buffer, causing the potential for roadway inundation during high-surf events.



**Figure 6-4. Critical facilities in the Category 4 storm surge inundation zones.**

## **Environment**

The high winds associated with tropical cyclone events can affect all environments in the county as they may occur anywhere. Additionally, all coastal areas may be exposed to storm surge from tropical cyclone events.

### **6.2.3 Vulnerability**

#### **Population**

The planning area is densely populated along its coastal shores and thus vulnerable to storm surge. Downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Residents may be displaced or require temporary sheltering. Populations living in areas with large stands of trees or power lines, especially at higher elevations, may be more susceptible to wind damage and power blackouts. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

The level 2 Hazus analysis resulted in the following estimated impacts in the planning area for the Category 4 hurricane wind:

- Number of displaced population: 11,378
- Number of persons requiring short-term shelter: 20,733

The level 2 Hazus analysis resulted in the following estimated impacts in the planning area for the Category 4 hurricane storm surge:

- Number of displaced population: 6,048
- Number of persons requiring short-term shelter: 744

#### ***Social Vulnerability***

Every community in Kaua'i with high social vulnerability may be affected by tropical cyclones and other high winds. The storm surge associated with hurricane events will only directly impact socially vulnerable communities on the coast; however, high winds, associated with a hurricane or otherwise, can impact any part of the county and may have the largest impact on communities with high social vulnerability. These communities may be especially vulnerable due to lower capacity to mitigate and respond. The overlap of high social vulnerability with the tropical cyclone and other high wind hazard is given by community (defined as census-designated places) within Kaua'i County in Table 6-4. Only areas of a community that are classified as having the high and highest levels of social vulnerability (i.e., the 61st percentile or higher) are included in the table. As high winds can occur across the county, all communities with the high or highest levels of social vulnerability are listed in the table along with a description of whether they are impacted by the high wind hazard, storm surge, or both. For example, in Wailua, nearly the entire community falls within the highest social vulnerability level and is in the 75th to 78th percentile compared with all other census block groups in the county. Wailua is also exposed to high winds.

The "Community" column identifies areas within each community that fall into the high or highest levels of social vulnerability (above the 61st percentile), provided any part of the area overlaps with a hazard exposure zone. For example, if a community is classified with a high social vulnerability level and only a portion of it intersects with a hazard exposure area, the entire community is included in the table, even though only a smaller section is actually exposed to the hazard. While this method may overestimate

vulnerability, it offers a broadly accurate overview of community risk. It is important to recognize that social vulnerability and hazard exposure can vary within each community, but this analysis was unable to capture that variability.

Additionally, there are socially vulnerable populations throughout the planning area who may face increased risk from hazards, even in communities categorized as having lower levels of social vulnerability than those listed in Table 6-4. This analysis focused on the highest levels of social vulnerability defined by the SVI developed for the KCAAP (County of Kaua'i 2022b). Therefore, several communities have been excluded from this analysis due to lower levels of social vulnerability, including Wailua Homesteads, 'Ele'ele, Waimea, and Princeville. To examine the overlap of hazard exposure areas with these communities, please use the Hazard Mapping Tool on the Kaua'i MHMRP 2026 Story Map (County of Kaua'i 2025b).

**Table 6-4. Communities with High Social Vulnerability or Above Impacted by Hurricane Hazards (High Winds or Storm Surge)**

| <b>Community:<br/>High Social Vulnerability Areas with (at least partial) Hazard Exposure</b>   | <b>Social Vulnerability<br/>(Percentile)</b> | <b>Hurricane Hazards<br/>(i.e., High Winds,<br/>Storm Surge)</b> |
|---|--|--|
| Anahola:<br>Eastern area of the community   | Highest (0.84)                               | High winds, storm surge  |
| Wailua:<br>Nearly entire community  | High (0.75–0.78)                             | High winds, storm surge  |
| Kapa'a:<br>East-central area of the community   | High (0.76)                                  | High winds, storm surge  |
| Hanamā'ulu:<br>Entire community   | Highest (0.86–1)                             | High winds   |
| Līhu'e:<br>Northern, western, eastern, southern, and part of the central areas of the community | High–Highest (0.67–0.92)                     | High winds, storm surge  |
| Puhi:<br>Northern area of the community   | Highest (0.90)                               | High winds   |
| Po'ipū:<br>Southern area of the community   | High (0.61)                                  | High winds, storm surge  |
| Kōloa:<br>Entire community  | Highest (0.82–0.88)                          | High Winds   |
| 'Ōma'o:<br>Northern area of the community   | High (0.69)                                  | High winds   |
| Kalāheo:<br>Northern area of the community  | High (0.65)                                  | High winds   |
| Lāwa'i:<br>Northern, southern, and part of the central areas of the community                   | High–Highest (0.69–0.82)                     | High winds   |
| Hanapēpē:*<br>Southeast to northeast areas of the community                                     | Highest (0.96)                               | High winds, storm surge  |
| Kaumakani:<br>Entire community  | Highest (0.98)                               | High winds, storm surge  |
| Pakala Village:<br>Entire community   | Highest (0.98)                               | High winds, storm surge  |
| Kekaha:*<br>Central area of the community   | Highest (0.94)                               | High winds, storm surge  |
| Hā'ena:<br>Entire community   | High (0.73)                                  | High winds, storm surge  |

| Community:<br>High Social Vulnerability Areas with (at least partial) Hazard Exposure | Social Vulnerability<br>(Percentile) | Hurricane Hazards<br>(i.e., High Winds,<br>Storm Surge) |
|---|--------------------------------------|---|
| Wainiha:<br>Entire community  | High (0.73)                          | High winds, storm surge                                 |
| Hanalei:<br>Entire community  | High (0.63–0.73)                     | High winds, storm surge                                 |
| Kalihiwai:<br>Entire community  | High (0.8)                           | High winds, storm surge                                 |
| Kīlauea:<br>Northern, eastern, and southwestern areas of the community                | High (0.8)                           | High winds  |

\*Nearly all the socially vulnerable areas of Hanapēpē and Kekaha would be submerged by storm surge.

The ways in which social vulnerability may impede a community’s ability to mitigate and respond to a tropical cyclone or high wind event are described in the following paragraphs for each social vulnerability category and indicator included in the County’s SVI developed for the KCAAP (County of Kaua‘i 2022b).

**Household characteristics** include the population under the age of 17 and over age 65 as well as the population with a disability. These factors reduce the ability of individuals to mitigate and respond to tropical cyclones and other high wind events. These groups may have more difficulty evacuating from a hurricane if they are unable to operate a vehicle, move quickly, access emergency notifications, wade through water, or require outside assistance. Members of these groups may also be more likely to require medical attention on a regular basis that could become unavailable due to isolation during a storm event. High winds additionally present a risk of power outages that could become life-threatening to those requiring electricity for life support. Additionally, mitigation measures such as installing hurricane shutters, boarding up windows, and installing roof ties (University of Hawai‘i Hilo 2025), can help protect property but could be difficult for those over the age of 65 or with a disability to implement particularly if mobility is limited.

**Socioeconomic status** also impacts the ability of a population to mitigate and respond to tropical cyclones and high wind events. These factors include household income, the population with a bachelor's degree, and the population of outdoor workers. These factors can shape the ability to mitigate and respond to a hazard. Households with higher incomes are more likely to have additional resources to implement tropical cyclone and high wind mitigation measures to minimize the risk of property damage. Additional resources can also facilitate evacuation in the event of a tropical cyclone through access to a personal vehicle and the ability to pay for lodging during an event and the subsequent recovery. Outdoor workers would be more vulnerable to high wind events if high winds approached suddenly and there was insufficient time to take shelter. Forecasting for tropical cyclones generally provides plenty of warning time for outdoor workers to take shelter, which means they are not necessarily more vulnerable to tropical cyclones themselves. However, workers involved in the cleanup of debris may experience an increased threat due to the presence of materials that may be contaminated with toxic or hazardous waste, mildew and mold, or sewage, especially in areas that were flooded.

**Race and ethnicity** impact the ability of a community to mitigate and respond to a tropical cyclone or high wind event. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua‘i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events including tropical cyclones and other high winds (County of Kaua‘i 2022b). Additionally, linguistic isolation raises vulnerability to as it can create a barrier to accessing evacuation

notices and procedures if these notices are not widely distributed in languages other than English. It also may lead to an inability to access flood mitigation resources.

**Physical conditions** also impact a community's mitigation and response capacity to tropical cyclones and other high wind events. Physical conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units can increase vulnerability to tropical cyclones and high winds because renters may not have the authority to implement mitigation measures (e.g., roof ties, storm shutters, sump pumps) that would reduce the impacts of tropical cyclones (including high winds, storm surge, and flooding) and high winds on their residences. Landlords may also not be incentivized to allocate resources for these efforts to rental properties. Similarly, rent-burdened households may not have sufficient resources to devote to mitigation or evacuation if needed. Houses built before the 1970s are especially vulnerable to tropical cyclones and high winds as they may not be built to the necessary codes to reduce risk. Homes built even into the early 1990s are at higher risk from high winds as the roofs of these homes may not be sufficiently attached to the rest of the house to remain affixed with hurricane-strength winds. This was a problem with Hurricane Iniki, which caused many roofs to detach from their homes and resulted in widespread damage (University of Hawai'i Hilo 2025). Similarly, mobile homes built in the 1970s and prior to the development of federal standards are not sufficiently prepared for flood events (Curran-Groome et al. 2025). Lack of access to a vehicle also increases vulnerability as it can inhibit evacuation from tropical cyclones and increase the risk of injuries and fatalities.

### **Property**

All property is vulnerable during high windstorms, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Structures that were built before the building code incorporated provisions for wind load are particularly vulnerable. Those in higher elevations and on ridges may be more prone to wind damage. Buildings under or near overhead lines or near large trees may be vulnerable to falling lines or trees.

The following estimates of property damage were developed through the Level 2 Hazus analysis for the Category 4 hurricane wind:

- Losses to structures: \$5,522,917,000
- Losses to contents: \$2,826,705,000
- Total losses: \$8,349,623,000
- Structure debris to be removed: 1,274,674 tons (50,987 truckloads)

The following estimates of property damage were developed through the Level 2 Hazus analysis for the Category 4 hurricane storm surge:

- Losses to structures: \$261,392,000
- Losses to contents: \$361,858,000
- Total losses: \$623,250,000
- Structure debris to be removed: 23,548 tons (942 truckloads)

Detailed results for all districts are provided in Appendix K.

## **Critical Facilities**

A hurricane event of the assumed scenario magnitude would result in widespread damage to private and public property, including critical facilities. Long-term power outages would be expected, with potential loss of utilities such as potable water and wastewater systems. Damage to power lines, fiber optic cables, or other forms of communication infrastructure would be especially concerning, as this can hinder evacuation and recovery efforts. Transportation lifelines are also vulnerable to storm surge and cascading effects such as flooding, falling debris, etc. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs. Loss of transportation facilities, such as the harbor and airport, would tax already limited resources and further isolate the island from response and recovery resources. Many facilities and structures would require months or years to return to pre-event functionality. Long-term impacts on tourism, supporting industries, and the local tax base would be expected.

For the worst-case high windstorm event, temporary structures and structures unable to resist sustained wind speeds may collapse, posing an immediate threat to those within or around the structure. Long-term effects may include the removal of collapsed buildings and the removal of debris from waterways. Downed power lines can cause blackouts, which can impact business operations and heating or cooling provision to citizens (including the young and elderly, who are particularly vulnerable to temperature-related health impacts). High winds and hurricane storm surge can block roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas, the elderly, and those in need of medical services. Appendix L provides an analysis of roads in the Category 4 hurricane storm surge hazard area.

High wind events pose a problem for facilities that house hazardous materials as well. Such facilities often depend on electricity and other utilities to maintain safe operations. While most of these facilities have a backup power source to ensure continued operations, backup power can only be used for a finite time; prolonged power disruption could have dire consequences.

Hazus was used to estimate the probability that critical facilities may sustain damage as a result of Category 4 hurricane winds and Category 4 hurricane storm surge. Table 6-5 summarizes the results into five categories: 1) no damage, 2) minor damage, 3) moderate damage, 4) severe damage, and 5) complete damage or destruction.<sup>3</sup> The thresholds used for classification into these categories within the Hazus model can vary by building type; however, the first category generally means a building experienced no or very little damage. The minor damage category refers to small amounts of damage on the scale of a broken window or door. Moderate damage can include significant amounts of roof failure, interior water damage, and multiple broken windows. Severe damage can include widespread broken windows and roof cover failure, extensive interior damage, or the failure of a wall. Buildings that experience severe damage are not usable prior to repair. Finally, complete damage refers to buildings that have experienced such extensive damage that they are destroyed.

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<sup>3</sup> The Hazus hurricane wind module does not analyze the following types of facilities: county park, boat harbor, bridge, water pump, or well.

**Table 6-5. Damage to Critical Facilities from a Category 4 Hurricane Wind**

| Category                   | Number of Facilities Affected | Estimated Damage Levels to Facilities |           |           |            |           |
|----------------------------|-------------------------------|---------------------------------------|-----------|-----------|------------|-----------|
|                            |                               | None                                  | Minor     | Moderate  | Severe     | Complete  |
| Safety and Security        | 86                            | 12                                    | 7         | 22        | 42         | 3         |
| Food, Water and Sheltering | 130                           | 22                                    | 12        | 26        | 67         | 3         |
| Health and Medical         | 31                            | 2                                     | 3         | 8         | 17         | 1         |
| Energy                     | 13                            | 2                                     | 1         | 3         | 6          | 1         |
| Communications             | 16                            | 2                                     | 2         | 4         | 7          | 1         |
| Transportation             | 6                             | 1                                     | 1         | 1         | 3          | 0         |
| Hazardous Materials        | 6                             | 0                                     | 0         | 2         | 1          | 3         |
| <b>Total</b>               | <b>288</b>                    | <b>41</b>                             | <b>26</b> | <b>66</b> | <b>143</b> | <b>12</b> |

A tropical cyclone's storm surge accelerates coastal erosion by pushing wave energy higher on the beach profile (USGS 2013). After cyclones, freshwater runoff alters salinity and studies show temporary pH depressions at reefs, compounding stress on corals. A change in salinity and pH levels of the ocean after a tropical cyclone affects coral reefs (Manzello et al. 2013; NOAA AOML 2013; Turton 2025). Flooding caused by tropical cyclones has the potential to upset the natural balance of ecosystems, which is of particular concern when dealing with the compounding effects of multiple events in a single season.

Natural habitats such as streams and trees are exposed to the elements during a high windstorm and risk major damage and destruction including downed debris, uprooted trees, and debris-blocked rivers and streams. High winds affect natural vegetation across the planning area, including downed trees and blocked waterways.

## 6.3 ISSUES

### 6.3.1 Development in High-Hazard Areas

The distribution of general land use types in the Category 4 storm surge inundation areas is shown in Figure 6-5. Agricultural land and natural areas make up the greatest extent of exposed areas. Most homes and facilities are located in areas designated as urban center, neighborhood center, neighborhood general, or residential community. In all, 13.5% of the Category 4 storm surge inundation area is highly developed.

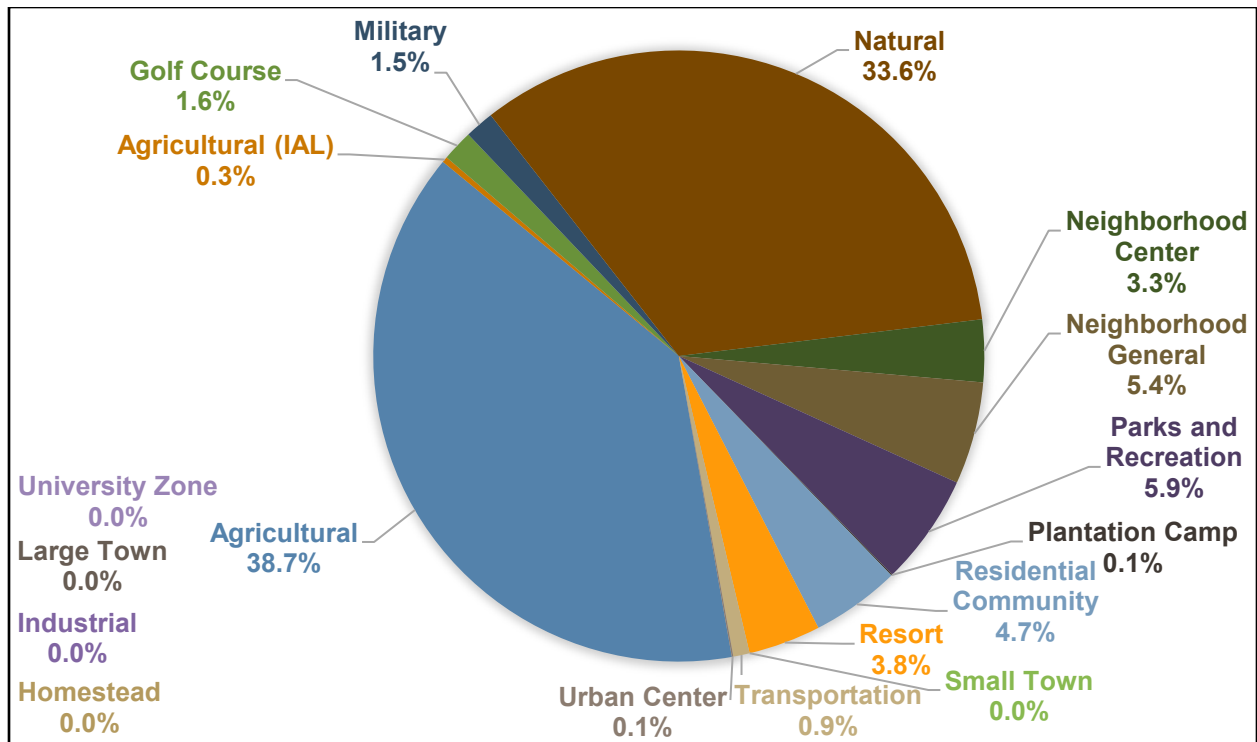


Figure 6-5. Land use distribution by area in Category 4 storm surge inundation zone.

All future development in Kaua'i County will be affected by high windstorms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of current codes and regulations for new construction. The State of Hawai'i design wind pressures have changed over the years with different editions of the Uniform Building Code (UBC) and International Building Code (IBC). Design wind pressures, typical construction type (single or double wall), and use of hurricane uplift resistance can all be determined by the year built based on the corresponding version of the UBC or IBC in effect at the time.

The current Kaua'i County building code includes specific provisions for current and future development regarding wind-resistant construction. Kaua'i County adopted the 2018 IBC, International Residential Code, International Existing Building Code, and International Energy Conservation Code, along with local amendments to these codes in October 2024. Kaua'i County also uses the Hawai'i State Building Code Council wind maps to identify wind speeds for given locations, which affect new construction design considerations. The State Building Code Council is not expected to meet for the foreseeable future, which means it is unlikely there will be new state-amended code adoptions that would apply to the wind-resistance of structures. These codes are equipped to deal with the impacts of high windstorms. Land use policies identified in general plans within the planning area also address secondary impacts of high windstorms. With these tools, Kaua'i County is well equipped to deal with future growth and the associated impacts of high windstorms.

### 6.3.2 Other Issues

The following issues have been identified related to the Tropical Cyclones and Other High Winds hazard in the planning area:

- **Cascading Hazard Event Potential:**

- **Tropical cyclones:** The heavy rains brought by this hazard may lead to landslides, flooding, and dam failure. Further, the high winds associated with the event can cause a storm surge that results in high surf and coastal erosion.
- **High wind events:** These events can lead to high surf and coastal erosion. Additionally, high wind events that coincide with dry conditions can facilitate wildfire spread or ignition if embers are carried by winds to ignitable surfaces.
- **Emergency shelter wind speed capability assessment:** Because of the secondary hazards associated with tropical cyclones, emergency shelters are often needed to house residents displaced by collapsing houses or rising flood waters. The County should continue testing potential emergency shelters to the Best Available Refuge Area (BARA) standard.
- **Vulnerable trees:** There is significant tree exposure to hurricane wind forces within the planning area. The vulnerability of these trees to wind forces should be monitored by the County to pre-identify potential problem areas prior to pending storms.
- **Debris management:** The scenario event modeled for this assessment estimated a significant amount of post-event debris accumulation. The ability to manage this amount of debris should be considered by the County prior to a pending event.
- **Power and water interruption:** Long-term loss of power is likely to be a major impact from the scenario event modeled for this assessment. Energy assurance planning should be considered for the planning area. Additionally, access to potable water may be interrupted if water treatment plants and other water utilities are damaged. Alternative strategies should be considered for providing residents with potable water should water utility systems be temporarily unavailable.
- **Review of building stock:** Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to windstorms. The County could conduct a study within the planning area to identify at-risk buildings and investigate options for bringing them up to code.
- **Alternate power supply:** Redundancy of power supply must be evaluated to ensure continuity of power at critical facilities throughout the planning area.
- **Public outreach for isolated population centers:** Depending on the severity of the storm, isolated population centers could become stranded from the rest of the island. As such, community-based organization and training should be done to inform isolated population centers about what to do if they become stranded. This could include public information on sheltering in place, tips on developing a personal go-kit, and instructions on developing a personal emergency plan.
- **Continuity of operations:** Critical facility owners should be encouraged to include tropical cyclone and other high wind considerations in their continuity of operations plans, using the information on risk and vulnerability contained in this plan.
- **Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Only 17% of households in Kaua'i had sufficient supplies of both food and water to last 14 days in 2025 (Kallas et al. 2025). Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.

- Personal planning resources:** Additional information on emergency shelters as well as emergency management resources can be found on the KEMA Facebook page and website: <https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency> (KEMA 2025).
- Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by tropical cyclones and other high wind events. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people’s safety during evacuations and in community shelters (County of Kaua‘i 2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua‘i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the Tropical Cyclone and Other High Winds hazard, based on the hazard profile and vulnerability assessment, is given in Table 6-6.

**Table 6-6. Risk Ranking Summary for Tropical Cyclone and Other High Winds**

| Priority | Hazard Event                          | Probability | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time       | Duration           | Risk Score |
|----------|---------------------------------------|-------------|--|--------------------------|----------------------|----------------|--------------------|--------------------|------------|
| 2        | Tropical Cyclone and Other High Winds | Likely      | Critical   | Critical                 | High                 | Large          | More than 24 hours | Less than 24 hours | 3          |

## 7. TSUNAMI

A tsunami consists of a series of high-energy waves that radiate outward like pond ripples from an area where a generating event occurs, such as an earthquake, landslide, or submarine volcanic explosion. The waves arrive at shorelines over an extended period. Tsunamis are typically classified as local or distant, based on the proximity of the generating event. Locally generated tsunamis have minimal warning times, leaving little time for response. They may be accompanied by damage resulting from the triggering earthquake through ground shaking, surface faulting, liquefaction or landslides. Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement more detailed evacuation plans.

The first visible indication of a tsunami may be a rapid rise or fall in water level that is not related to the tide (Tetra Tech 2021). The advancing tsunami can resemble a strong surge increasing the sea level like the rising tide, but the tsunami surge rises faster and often does not break as a normal wave. Additionally, this surge of water does not stop at the shoreline and pushes above normal sea level tidal reach. This phenomenon is called “run-up” (Figure 7-1) (United Nations Educational, Scientific, and Cultural Organization 2015). Even if the run-up appears to be small—3 to 6 feet for example—the strength of the accompanying surge can be deadly and cause much damage to infrastructure and the surrounding environment. Tsunamis often last for hours, and large tsunamis could occur over multiple days (National Weather Service [NWS] 2025d).

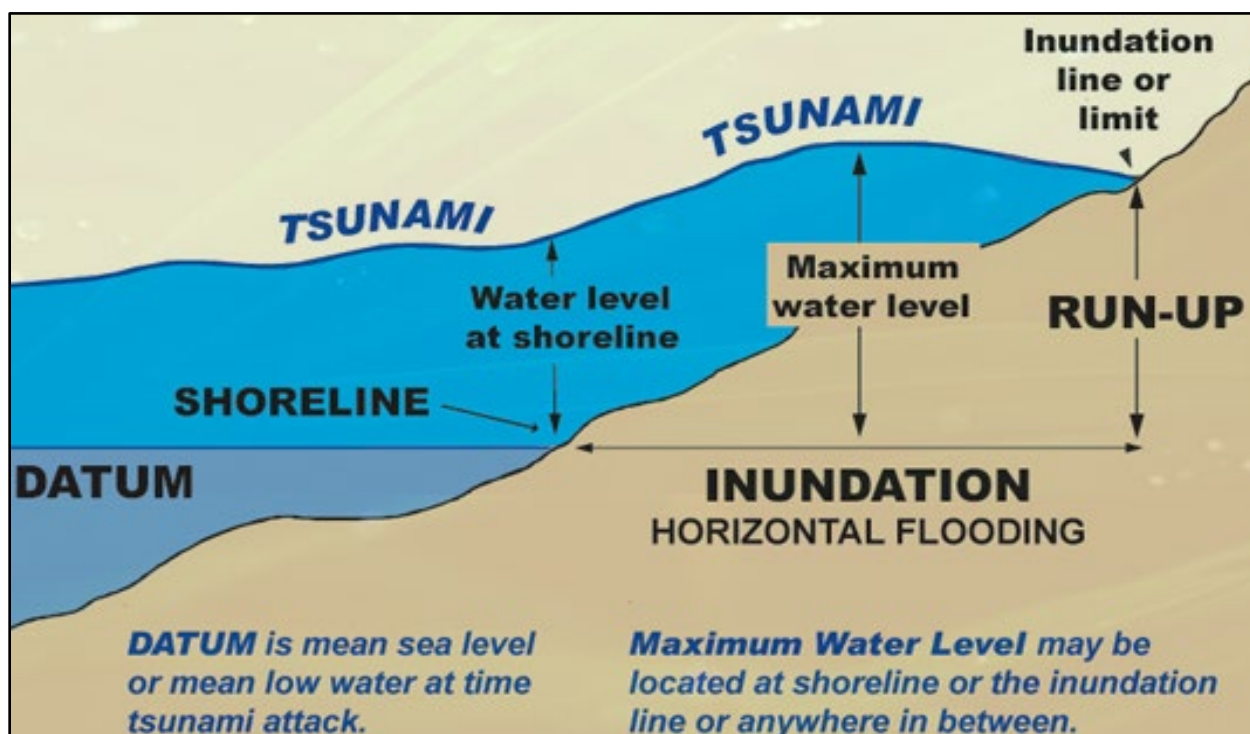


Figure 7-1. Run-up distance and height in relation to the datum and shoreline.

Waist-high surges can cause strong currents that float cars, small structures, and other debris. Boats and debris are often carried inland by the surge and left stranded when the water recedes. Floating debris carried by a tsunami can endanger human lives and impact inland structures. Breakwaters and piers can

collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the waves.

According to the National Tsunami Hazard Mitigation Program’s *National Tsunami Hazard Assessment*, Hawai‘i as a whole is classified as a high-hazard area for tsunamis. The state has experienced the highest number of tsunami-associated deaths in the country (Dunbar and Weaver 2008). Additional general information on the Tsunami hazard is provided in Appendix I.

## 7.1 HAZARD PROFILE

Table 7-1 summarizes the key elements of the Tsunami hazard profile for Kaua‘i County. Additional details are provided in Appendix I.

**Table 7-1. Tsunami Hazard Profile Summary**

|                     |   |
|---------------------|---|
| <b>Past Events</b>  | <p>On April 1, 1946, a tsunami with wave heights of up to 13.7 meters resulted in 17 deaths, destroyed homes, trees, boat launch, shifted buoys, and washed tug against breakwater. On March 9, 1957, a tsunami with wave heights up to 16.2 meters destroyed bridges, disabled sampans, and flooded highways. Homes were also destroyed or badly damaged. These were the largest tsunami events to impact Kaua‘i on record and both originated in the Aleutian Islands. Between 1819 and 1975 another 24 larger tsunami events with run-ups greater than 3 feet impacted Kaua‘i. Notably, not all of these events caused significant damage (U.S. Geological Survey [USGS] 2002). There has only been one additional tsunami event with a run-up greater than 3 feet since 1975; it occurred on March 11, 2011, and reached a height of 5.18 meters, causing minor damage.</p> <p>Since the 2021 MHMRP Update, five tsunami run-ups have been recorded on Kaua‘i. None of these events caused recorded damage, injuries, or fatalities in the county. All run-ups were less than 1 meter. A run-up of 1 meter or approximately 3 feet or more was determined to be the cut-off for large tsunami events, as this is considered the size at which tsunamis are expected to cause more significant damage (NOAA 2023a; USGS 2002).</p> |
| <b>Location</b>     | <p>FEMA has mapped tsunami inundation zones along the coastline for the entire state of Hawai‘i. Figure 7-2 shows the tsunami inundation mapping for the planning area.</p> <p>The location likely to be impacted by tsunamis is unchanged since the 2021 MHMRP Update. However, the area exposed to the Tsunami hazard is likely to increase in coming years as a result of climate change. Higher sea levels will allow tsunami run-ups to inundate further inland than they have historically.</p>   |
| <b>Frequency</b>    | <p>27 tsunami events with run-ups of 3.2 feet or more occurred in Kaua‘i between 1819 and 2024; an average of 0.13 events per year or one event about every 7 years. Based on past recorded tsunami events (see Appendix I:Table I-4), large (i.e., greater than 3.2 feet) distant tsunamis have an annual probability of affecting Hawai‘i of roughly 11%. Large local tsunami events occur with a roughly 2% probability in a year.</p> <p>In the time since the 2021 MHMRP Update, the planning area has experienced five tsunami events. All events had run-ups under 3.2 feet on Kaua‘i and resulted in no recorded fatalities or damages. As such, these five recent events are not included in the frequency equations above. Based on occurrence since the 2021 MHMRP Update, Kaua‘i can expect to experience no events with a run-up of 3.2 feet or more compared to an average of 0.13 events per year over past 205 years of recorded tsunami activity.</p>  |
| <b>Severity</b>     | <p>Tsunamis have been recorded on Kaua‘i with run-up heights up to 45 feet in 1946 at Hā‘ena and 53 feet in 1957 at Wainiha Bay. According to the National Tsunami Hazard Mitigation Program, tsunami events with run-ups of more than 1 meter (about 3 feet) are the most likely to be dangerous to people and property (NWS 2025e). Several events with run-ups higher than 1 meter have also occurred.</p> <p>This information is unchanged since the 2021 MHMRP Update.</p>   |
| <b>Warning Time</b> | <p>The Pacific Tsunami Warning System begins to function when a Pacific basin earthquake of magnitude 6.5 or greater triggers an earthquake alarm (NWS 2025e). This system is not considered to be effective for communities close to the tsunami-generating source because the first wave would arrive before the data were analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.</p> <p>Warnings, advisories, watches, and threats associated with tsunamis are reported by NOAA and the NWS and can be accessed at the following link: <a href="https://tsunami.gov/">https://tsunami.gov/</a> (NWS 2025e).</p>  |

See Section 4 for a description of elements included in the hazard profile.

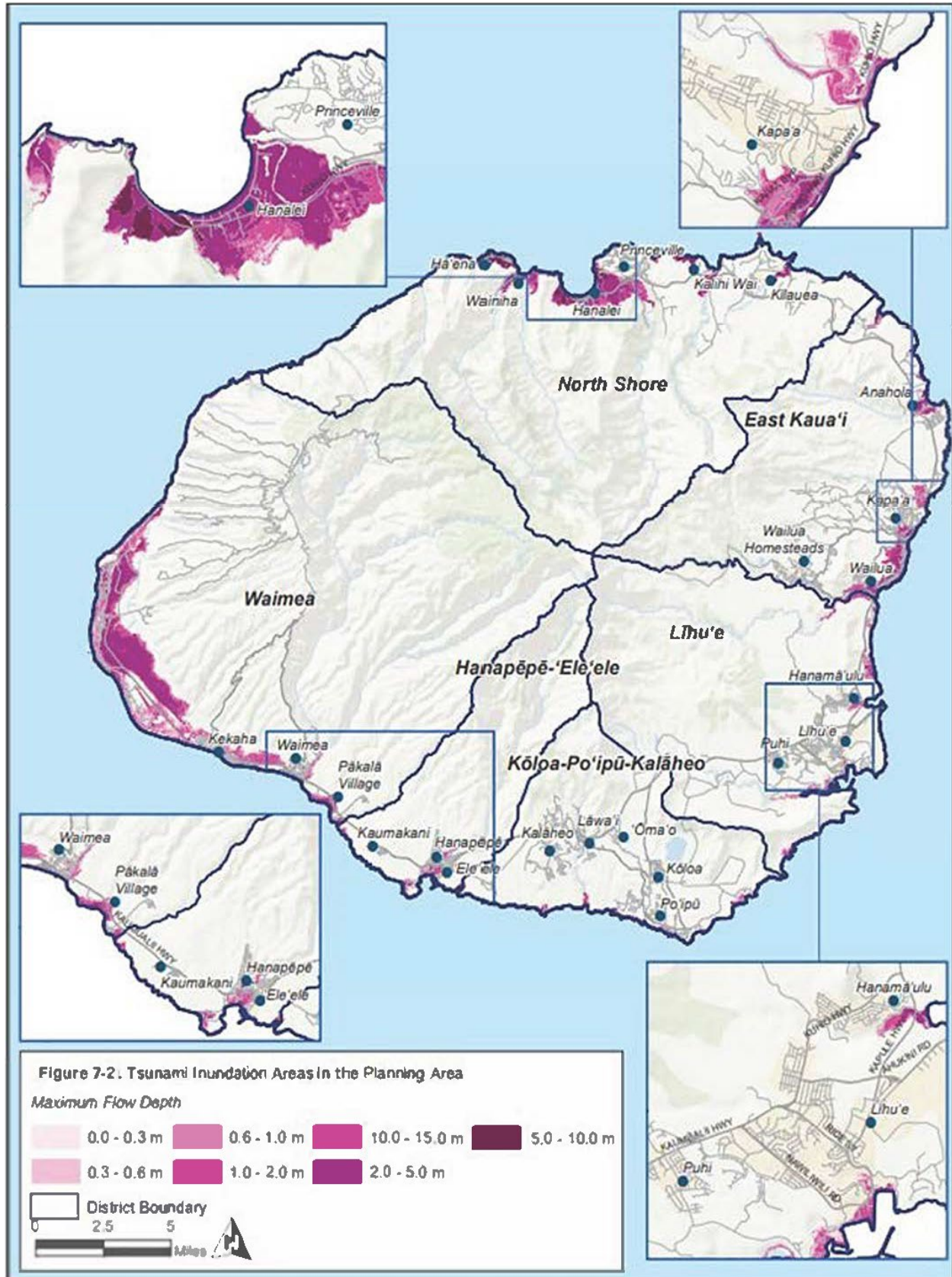


Figure 7-2. Tsunami inundation areas in the planning area.

## 7.1.1 Future Conditions and Climate Change

The most concerning interaction between climate change and tsunamis is that sea level rise resulting from climate change could increase the risk to coastal communities exposed to the Tsunami hazard. Ocean waves and surge could reach further inland resulting in more damage to infrastructure and increased safety concerns, especially in communities that have historically been outside tsunami inundations zones and may not be prepared for the hazard.

Some studies suggest climate change could impact the future frequency of tsunamis as melting glaciers and shifting water pressure in the earth's oceans may trigger earthquakes and associated tsunamis (HI-EMA 2023). However, this understanding is developing and is far less established in scientific literature than the impacts of climate change on other natural hazards. There may also be an increase in tsunamis generated by landslides if tsunamis are triggered by an increased frequency of heavy precipitation events (HI-EMA 2023). While these studies suggest climate change may increase tsunami frequency, it is unknown whether climate change will impact the severity of tsunami events.

## 7.2 VULNERABILITY ASSESSMENT

### 7.2.1 Scenario

A tsunami in Hawai'i can be generated by a nearby or distant landslide, earthquake or volcanic explosion. Several scenarios could create large tsunami events and impact Kaua'i County. The scenario used for the risk assessment of this plan was based on the aggregate 2009 Hawai'i Tsunami Mapping Project data, which includes the 1946 Aleutian, 1952 Kamchatka, 1957 Aleutian, 1960 Chile and 1964 Alaskan tsunami events. This scenario does not model the most probable tsunami event but models the most realistic worst-case scenario likely to impact Kaua'i.

It is worth noting that the 2023 State Hazard Mitigation Plan used three different scenarios to model tsunami risk. The Great Aleutian Tsunami Scenario was one of these three models with a 1,500-year mean return period or a 0.07% annual chance of occurrence. While this tsunami would be more destructive than the one modeled, it would also be less likely to occur. For this reason, the Steering Committee agreed not to use the model for the 2026 MHMRP Update vulnerability assessment as it represents a more severe but less realistic worst-case scenario.

Exposure and vulnerability estimates are based on tsunami inundation maps that were created for the 2009 Hawai'i Tsunami Mapping Project. The maximum flow depth area was computed from historical (distant) tsunami events in 1946, 1952, 1957, 1960, and 1964. The value of exposed buildings in the tsunami inundation zone within the planning area was generated by overlaying the inundation areas on the general building stock. The population living in tsunami hazard zones was estimated using the demographic data stored in Hazus. Detailed results by district are provided in Appendix K; results for the total planning area are presented below.

### 7.2.2 Exposure

#### Population and Property

Table 7-2 summarizes the estimated population living in the evaluated tsunami inundation areas and the estimated property exposure. The populations that would be most exposed to this type of hazard are those along beaches, low-lying coastal areas, tidal flats and stream deltas that empty into ocean-going waters. People recreating in these areas would also be exposed.

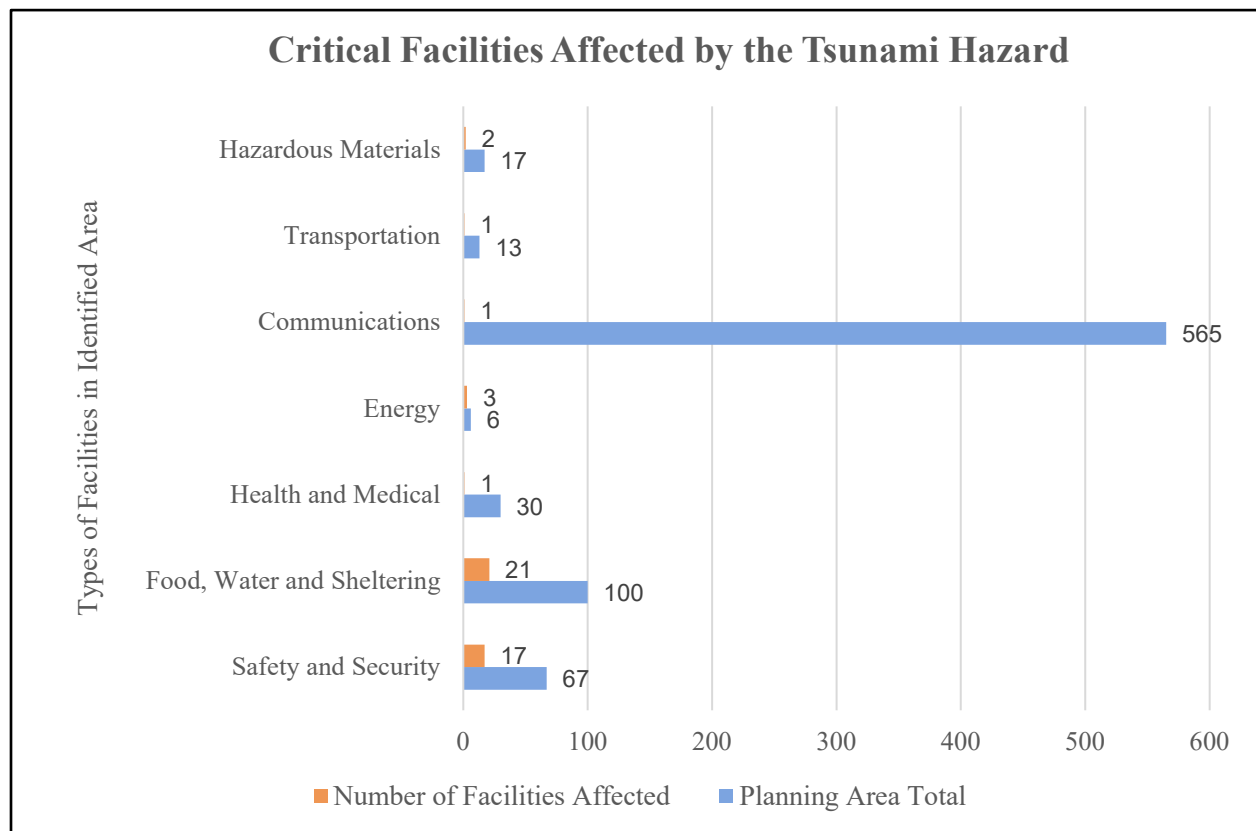
**Table 7-2. Exposed Population and Property in the Tsunami Inundation Zone**

| <b>Population</b>   |                  |
|---|------------------|
| Population Exposed  | 20,740           |
| % of Total Planning Area Population                           | 28.4%            |
| <b>Property*</b>  |                  |
| Number of Buildings Impacted                                  | 9,308            |
| Value of Buildings Impacted                                   | \$11,110,142,000 |
| Total Value of Impacted Buildings as % of Planning Area Total | 45.2%            |

\*Hazus estimates that all buildings exposed to the Tsunami hazard will be damaged to some extent due to the force associated with the event. Due to this, the buildings exposed to the hazard do not differ from the buildings damaged or impacted by the hazard.

**Critical Facilities**

Figure 7-3 provides an estimate of the number and types of critical facilities exposed to the Tsunami hazard. The sections below summarize exposure to specific types of critical facilities.



**Figure 7-3. Critical facilities in tsunami inundation areas.**

## **Roads**

Appendix L presents a detailed analysis of roads in tsunami inundation areas. Based on the mapped tsunami inundation areas, the following major roads may be impacted by tsunami events:

- Ahukini Road
- Alae Road
- Kapa'a Bypass
- Kapule Highway
- Kaumuali'i Highway
- Kekaha Road
- Kōke'e Road
- Kuamo'o Road
- Kūhiō Highway
- Kukui Street
- Malu Road
- Nāwiliwili Road
- Olohena Road
- Rice Street
- Wa'apa Road

This list of roads should not be misinterpreted as possible evacuation routes for tsunami events. Evacuation routes are identified in emergency response plans.

## **Bridges**

Hazus modeling is unable to analyze bridges as part of the tsunami model.

## **Ports / Fuel Farms**

In general, due to their locations, all ports and fuel farms within Kaua'i County are exposed to the Tsunami hazard.

## **Water/Sewer/Utilities**

All water, sewer, stormwater, power, and communications facilities within the limits of the tsunami inundation zone, whether aboveground or below, are exposed to the Tsunami hazard.

## **Hazardous Material Facilities**

Two facilities with hazardous materials are located in the tsunami inundation area.

## **Environment**

All waterways would be exposed to the effects of a tsunami. All wildlife inhabiting the area is also exposed. Depending on the size and associated force of a tsunami event, Kaua'i County's coral reefs may be exposed to increased pressure caused by an incoming tsunami or to hazardous materials washed offshore into the ocean as the tsunami recedes.

The aquatic habit and associated ecosystems would be most exposed in low-lying areas close to the coastline. Areas near gas stations, industrial areas and hazardous material containing facilities would be vulnerable due to potential contamination from hazardous materials.

## 7.2.3 Vulnerability

### Population

The populations most vulnerable to the Tsunami hazard are the elderly, the disabled, the very young and the homeless who reside or recreate near beaches, low-lying coastal areas, tidal flats and stream or river deltas that empty into ocean-going waters. Visitors recreating in or around inundation areas would also be vulnerable as they may not be as familiar with residents on appropriate responses to a tsunami or ways to reach higher ground. In the event of a local tsunami generated in or near the planning area, there would be little warning time, so more of the population would be vulnerable. The degree of vulnerability of the population exposed to the Tsunami hazard is based on a number of factors:

- Is there a warning system?
- What is the lead time of the warning?
- What is the method of warning dissemination?
- Will the people evacuate when warned?
- Are there multiple evacuation routes or only one?

For this assessment, the population vulnerable to possible tsunami inundation is considered to be the same as the exposed population.

### ***Social Vulnerability***

Tsunamis have the potential to affect many communities in Kaua'i with high social vulnerability. These communities may be disproportionately impacted by the hazard due to lower capacity to mitigate and respond. The overlap of high social vulnerability with the tsunami inundation areas is given by community (defined as census-designated places) within Kaua'i County in Table 7-3. Only areas of a community that are classified as having the high and highest levels of social vulnerability (i.e., the 61st percentile or higher) and that overlap with tsunami inundation zones are included in the table. For example, within Hanalei, the entire community falls within the high social vulnerability level and is in the 63<sup>rd</sup> to 73<sup>rd</sup> percentile compared with all other census block groups in the county. Nearly the entire community is also exposed to tsunami inundation areas.

The "Community" column identifies areas within each community that fall into the high or highest levels of social vulnerability (above the 61st percentile), provided any part of the area overlaps with a hazard exposure zone. For example, if a community is classified with a high social vulnerability level and only a portion of it intersects with a hazard exposure area, the entire community is included in the table, even though only a smaller section is actually exposed to the hazard. While this method may overestimate vulnerability, it offers a broadly accurate overview of community risk. It is important to recognize that social vulnerability and hazard exposure can vary within each community, but this analysis was unable to capture that variability.

Additionally, there are socially vulnerable populations throughout the planning area who may face increased risk from hazards, even in communities categorized as having lower levels of social vulnerability than those listed in Table 7-3. This analysis focused on the highest levels of social vulnerability defined by the SVI developed for the KCAAP (County of Kaua'i 2022b). Therefore, several communities have been excluded from this analysis due to lower levels of social vulnerability, including Wailua Homesteads, 'Ele'ele, Waimea, and Princeville. To examine the overlap of hazard exposure areas

with these communities, please use the Hazard Mapping Tool on the Kaua‘i MHMRP 2026 Story Map (County of Kaua‘i 2025b).

**Table 7-3. Communities with High Social Vulnerability or Above Located in Tsunami Inundation Area**

| <b>Community:<br/>High Social Vulnerability Areas with (at least partial) Hazard Exposure</b> | <b>Social Vulnerability (Percentile)</b> |
|---|--|
| Anahola:<br>Eastern area of the community   | Highest (0.84)                           |
| Wailua:<br>Nearly entire community  | High (0.75–0.78)                         |
| Kapa‘a:<br>East-central area of the community   | High (0.76)                              |
| Līhu‘e:<br>Nawiliwili Harbor area   | High–Highest (0.67–0.71)                 |
| Po‘ipū:<br>Southern area of the community   | High (0.61)                              |
| Hanapēpē:<br>Low-lying areas  | Highest (0.96)                           |
| Kekaha:<br>Central area of the community  | Highest (0.94)                           |
| Hā‘ena:<br>Entire community   | High (0.73)                              |
| Wainiha:<br>Entire community  | High (0.73)                              |
| Hanalei:*<br>Entire community   | High (0.63–0.73)                         |
| Kalihiwai:<br>Entire community  | High (0.8)                               |
| Kīlauea:<br>Low-lying areas   | High (0.8)                               |

\*Nearly the entire community of Hanalei is within the tsunami inundation zone. If the modeled tsunami were to occur, almost the whole community would be submerged.

The ways in which social vulnerability may impede a community’s ability to mitigate and respond to a tsunami event are described in the following paragraphs for each social vulnerability category and indicator included in the County’s SVI developed for the KCAAP (County of Kaua‘i 2022b).

The following discussion of social vulnerability is focused on the ways in which social vulnerability can impede the ability of a community to evacuate a tsunami with less emphasis placed on mitigating potential property damages. Tsunamis are highly destructive and there are not many strategies individuals can implement to protect their properties from these disasters. Tsunami mitigation resources focus on quickly moving people out of the tsunami inundation area to avoid fatalities along with community-level mitigation strategies (NOAA 2023b). The discussion of social vulnerability is thus focused on how these social vulnerability factors may impede evacuation.

**Household characteristics** can reduce the ability of individuals to mitigate and respond to tsunamis. These characteristics include the population under the age of 17 and over age 65 as well as the population with a disability. These groups may be at disproportionate risk from the Tsunami hazard if they are unable to operate a vehicle, move quickly, access emergency notifications, or require outside assistance to evacuate. Any impediments to evacuating from a tsunami put people’s lives at increased risk. Tsunamis

can also generate debris that blocks or damages roads and bridges. The limited ingress and egress routes into communities in Kaua'i may result in communities becoming stranded following a tsunami. Individuals over the age of 65 and with a disability may be more likely to require medical attention on a regular basis that could become unavailable due to isolation following a tsunami resulting in adverse health outcomes with the potential to become life-threatening.

**Socioeconomic status** also impacts the ability of a population to mitigate and respond to tsunamis. These factors include household income, the population with a bachelor's degree, and the population of outdoor workers. These factors can shape the ability to mitigate and respond to a hazard. Households with higher incomes are more likely to have additional resources to facilitate evacuation in the event of a tsunami through access to a personal vehicle and the ability to pay for lodging during an event and the subsequent recovery. Outdoor workers are more vulnerable to tsunami events as they are less likely to be in a sheltered location, especially if the tsunami approaches quickly with minimal warning time. Workers involved in the cleanup of debris may also experience an increased threat due to the presence of materials that may be contaminated with toxic or hazardous waste, mildew and mold, or sewage.

**Race and ethnicity** impact the ability of a community to mitigate and respond to a tropical cyclone or high wind event. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua'i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events including tsunamis (County of Kaua'i 2022b). Additionally, linguistic isolation raises vulnerability to tsunamis as it can create a barrier to accessing evacuation notices and procedures if these notices are not widely distributed in languages other than English.

**Physical conditions** include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. These factors can influence the ability of a community to mitigate and respond to a hazard event. Pre-1970s housing and mobile homes may be more vulnerable to the Tsunami hazard as they are not built to current building codes or are impermanent making them less able to withstand the force of a tsunami. However, even new construction built to updated building codes would be damaged by inundation from a larger tsunami. Renter-occupied households are not necessarily more vulnerable to the Tsunami hazard than the general population as renting versus owning a residence does not impede the ability to evacuate from a tsunami. In terms of evacuation, households without access to a vehicle have increased vulnerability to the Tsunami hazard as it can inhibit evacuation and increase the risk of injuries and fatalities. Rent-burdened households may also have higher vulnerability to tsunamis as these households may not have sufficient resources for evacuation such as a vehicle; to pay for lodging; or to begin clearing debris and rebuilding.

While not an indicator listed in the SVI, unhoused people within the county are particularly vulnerable to tsunamis. These individuals, especially those living in coastal areas, are vulnerable as they would be in the tsunami inundation area and may not have the means to evacuate.

## **Property**

All structures along beaches, low-lying coastal areas, tidal flats, and stream or river deltas would be vulnerable to a tsunami, especially in an event with little or no warning time. The impact of the waves and the scouring associated with debris that may be carried in the water could be damaging to structures in the tsunami's path. Those who would be most vulnerable are those located in the front line of tsunami impact and those that are structurally unsound. Table 7-4 shows the general building stock loss in the tsunami inundation areas.

**Table 7-4. Loss Impact for Tsunami in the Planning Area**

|   |                 |
|---|-----------------|
| <b>Buildings Impacted</b>                         | 9,308           |
| <b>Total Value Damaged (Structure + Contents)</b> | \$4,099,593,000 |
| <b>Damage as % of Total Value</b>                 | 16.7%           |

### **Critical Facilities**

A more in-depth analysis of the mitigation measures taken by critical facilities in the tsunami inundation area to prevent damage from tsunami events should be done to determine if they could withstand the impacts of a tsunami. Vulnerability of specific types of critical facilities is generally as follows:

- **Roads:** Roads are the primary resource for evacuation to higher ground before and during a tsunami event. Roads that are blocked or damaged can isolate residents and prevent access for emergency service providers. Roads often act as flood control facilities in low-depth, low-velocity flood events by acting as levees or berms and diverting or containing flood flows.
- **Bridges:** Bridges washed out or blocked by tsunami inundation or debris also cause isolation. Bridges can be extremely vulnerable due to forces transmitted by wave run-up and by the impact of debris carried by waves.
- **Ports and fuel farms:** Depending on the strength and location of the tsunami, ports and fuel farms could sustain damage from water and debris that would render them out of commission for months, exacerbating the disaster.
- **Utilities:** Water and sewer systems can be flooded or backed up, causing further health problems. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by flood debris, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastes to spill into homes, neighborhoods, rivers, and streams. The forces of tsunami waves can impact aboveground utilities by knocking down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by both the impact of the wave action and the inundation of floodwaters. Underground utilities can also be damaged during flood events.
- **Hazardous materials sites:** If damaged by a tsunami, a facility containing toxic chemicals could release chemicals that cause cancer or other significant adverse human health effects, as well as significant adverse environmental effects (U.S. Environmental Protection Agency [EPA] 2016). During a tsunami event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment and people.

### **Environment**

Inundation of natural surface waters and the introduction of foreign debris could be hazardous to the environment. Coral reefs may be vulnerable to increased pressure caused by an incoming tsunami or to hazardous waste and other materials pulled into the ocean by retreating waters. Millions of dollars spent on habitat restoration and conservation in the planning area could be wiped out by a significant tsunami. There are currently no tools available to measure these impacts. However, it is conceivable that the potential financial impact of a tsunami event on the environment could equal or exceed the impact on property. Community planners and emergency managers should take this into account when preparing for the Tsunami hazard.

## 7.3 ISSUES

### 7.3.1 Development in High-Hazard Areas

Figure 7-4 shows the land use distribution by area within the tsunami inundation areas. About 71% of the lands in these areas are agricultural lands or natural areas. Most homes and facilities are in areas designated urban center, neighborhood center, neighborhood general, or residential community. In all, 9.2% of the tsunami inundation area is highly developed.

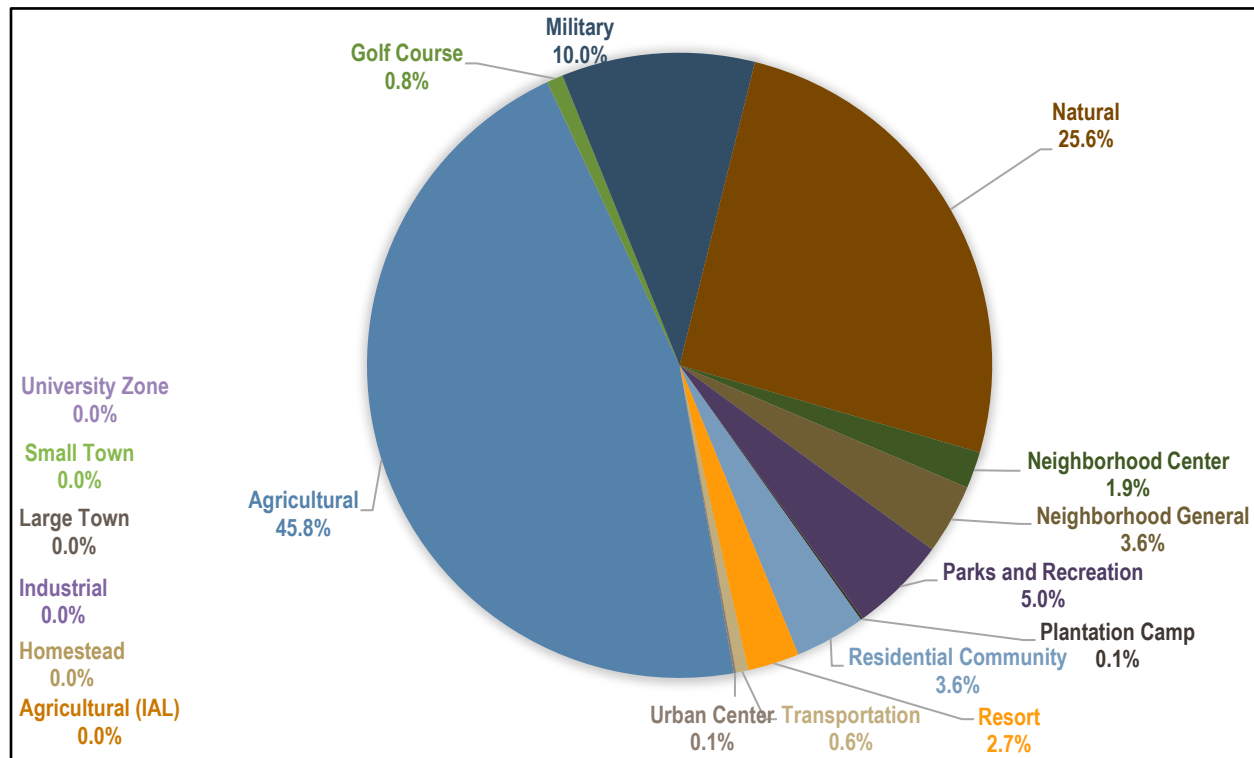


Figure 7-4. Land use distribution by area in the tsunami inundation area.

The County has some regulatory provisions for areas identified as at risk to tsunamis. According to an SME from the Hawai'i Earthquake and Tsunami Advisory Committee (HETAC), Kaua'i County adopted the 2018 IBC in 2024. This applies American Society of Civil Engineers (ASCE) 7-16 tsunami loads for Risk Category III and IV buildings within the planning area. It also includes high-resolution design maps that are available from a recent project funded by the Hawai'i Coastal Zone Management program. In addition to these provisions, the flood insurance rate maps (FIRMs) for the county include tsunami risk per the National Flood Insurance Act (42 United States Code 4101), and FEMA has statutory authority to identify flood-prone areas and rates of probable loss. However, with historical run-up levels on the island of Kaua'i reaching as much as 45 feet, standard floodplain development regulations may not provide adequate risk protection for new development. Kaua'i County may want to consider higher regulatory provisions for new development in high-risk tsunami inundation areas as deterministic data and science are developed that can be applied to official mapping with assigned probabilities of occurrence.

### 7.3.2 Other Issues

The following issues have been identified related to the Tsunami hazard in the planning area:

- **Cascading hazard event potential:** Tsunamis can cause erosion which decreases shoreline buffer and allows coastal flooding, high surf, sea level rise, and storm surge from tropical cyclones to inundate farther inland.
- **Economic Impacts:** Coastal areas are most heavily impacted by tsunamis. The economic backbone of these areas is often port facilities, naval facilities, fishing fleets, and public utilities, which are also the resources that generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, utilities restored, and fishing fleets reconstituted, communities may find themselves without fuel, food and employment. Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.
- **Hazard identification:** To best evaluate the probable impacts of tsunamis on the planning area, additional mapping and modeling could be conducted to assess the impacts of other possible tsunami scenarios.
- **Building code revisions:** Present building codes and guidelines do not adequately address the impacts of tsunamis on structures, and current tsunami hazard mapping is not adequate for code enforcement.
- **Enhancement of current capabilities:** As tsunami warning technologies evolve, the tsunami warning capability within the planning area will need to be enhanced to provide the highest degree of warning.
- **Vulnerable populations planning:** Special attention must be paid to vulnerable communities in the tsunami zone and to public hazard mitigation education and outreach. This may be especially true for visitors to Kaua'i County.
- **Debris accumulation:** Significant debris would be produced as a result of a major tsunami impacting the planning area and could be exacerbated by damage caused by the earthquake that preceded it.
- **Continuity of operations:** Critical facility owners should be encouraged to include tsunami considerations in their continuity of operations plans, using the information on risk and vulnerability contained in this plan.
- **Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- **Tsunami evacuation:** For personal planning reference, additional information on evacuation zones and areas can be found at the KEMA Facebook page and website: <https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency> (KEMA 2025).
- **Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by tsunamis. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people's safety during evacuations and in community shelters (County of Kaua'i

2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua‘i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the Tsunami hazard, based on the hazard profile and vulnerability assessment, is given in Table 7-5.

**Table 7-5. Risk Ranking Summary for Tsunami**

| Priority | Hazard Event | Probability | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time | Duration           | Risk Score |
|----------|--------------|-------------|--|--------------------------|----------------------|----------------|--------------|--------------------|------------|
| 3        | Tsunami      | Possible    | Catastrophic                                     | Critical                 | High                 | Moderate       | 1:01-4 hours | Less than 24 hours | 3          |

## 8. LANDSLIDE

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A landslide is a mass of rock, earth or debris moving down a slope, caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Landslides can be initiated by storms, earthquakes, fires, or volcanic eruptions and may be affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it.

Rivers of rock, earth, organic matter and other soil materials saturated with water can develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall. Water pressure in the porous spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud. The material can travel miles from its source, growing as it descends, picking up trees, boulders, cars and anything else in its path. These slides may pack many times the hydraulic force of water due to the mass of material included in them. They can be some of the most destructive events in nature.

Landslides can be influenced by any the following factors, whether natural or human-caused: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, weathering of rocks, and changing the amount or type of vegetation on slopes. In general, geologists look for the following land characteristics to identify landslide hazard areas with higher risk of downhill movement of material:

- A slope greater than 33%
- A history of landslide activity or movement during the last 10,000 years
- Stream or wave activity that has caused erosion or cut into a bank to make the surrounding land unstable
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, mixed with granular soils such as sand and gravel.

Landslides are often triggered by other natural hazards such as heavy rain, floods, wildfires, or earthquakes so landslide occurrence is often related to these other hazards. Kaua'i County is susceptible to all of these factors that trigger landslides. Tropical cyclone events are more likely during the Pacific cyclone season. Heavy rain may result from cyclonic storms or seasonally rainy weather. During storm-related landslide events, the ground must be saturated prior to the onset of a major storm for significant landslides to occur. Earthquakes may occur at any time of the year.

Additional general information on the Landslide hazard is provided in Appendix I.

### 8.1 HAZARD PROFILE

Table 8-1 summarizes the key elements of the Landslide hazard profile for Kaua'i County.

**Table 8-1. Landslide Hazard Profile Summary**

|                     |   |
|---------------------|---|
| <b>Past Events</b>  | <p>There have been 11 landslide events on Kaua'i since 2007. These events are listed in Appendix I, Table I-5, and none involved injuries or fatalities.</p> <p>A significant landslide event was associated with the torrential rainfall and severe flooding that impacted Kaua'i in April 2018, resulting in numerous landslides over north Kaua'i west of Hanalei that cut off access to Wainiha and Hā'ena for more than 2 weeks (NWS 2025f).</p> <p>Since the 2021 MHMRP Update, there have been two notable landslide events. One occurred on March 6, 2021, and was the result of heavy precipitation and flash floods. The event caused \$3,900,000 in damages including the destruction of nine homes and damage to nearly 100 others (NOAA 2025c). Additionally, vehicular access to Kaua'i's North Shore was blocked until a portion of the road could be cleared, and communities could only be accessed by boat or helicopter. There were no deaths or injuries associated with the event. The other landslide event occurred due to heavy precipitation and flash flooding on April 12, 2024 (NWS 2025g). A major disaster declaration (DR-4793) was issued for severe storms, flooding, and landslides on Kaua'i (FEMA 2025d). The NOAA National Centers for Environmental Information (NCEI) database did not have an entry for the landslides associated with this event but did have an entry for the flooding and no injuries or deaths were associated with this event (NOAA 2025c; NWS 2025f).</p> |
| <b>Location</b>     | <p>Soil avalanches or landslides generally take place on the west or north sides of Kaua'i. Areas generally more prone to landslides are those located at:</p> <ul style="list-style-type: none"> <li>• Previous landslides areas</li> <li>• Base of slopes</li> <li>• Base of minor drainage hollows</li> <li>• Base or top of an old, filled slope</li> <li>• Base or top of a steep, cut slope</li> <li>• Developed hillsides with leach-field septic systems</li> </ul> <p>Work associated with development in valleys can also trigger landslides.</p> <p>These areas include sections on the highway past Anahola, Lumaha'i, Kalāheo, Lāwa'i, and Kuamo'o Road. The significant historical landslides have occurred along the highway and coastal roads.</p> <p>This information is generally unchanged since the 2021 MHMRP Update. The location-based factors that contribute to landslide susceptibility are unchanged. However, there have been improvements in landslide susceptibility modeling. Figure 8-1 shows landslide susceptibility throughout the county.</p>   |
| <b>Frequency</b>    | <p>Between 2007 and 2024, there were eleven recorded landslide events in Kaua'i according to data compiled from NASA's Global Landslide Catalog (NASA 2020a), NOAA's NCEI Storm Events Database (NOAA 2025c), and major disaster declarations. This equates to an average of 0.65 events per year.</p> <p>The frequency of landslide events in Kaua'i decreased slightly between 2020 and 2024 with an average of 0.4 events occurring per year. Additionally, increases in severity of precipitation events brought about by climate change are likely to increase the frequency of landslide events in Kaua'i in the future.</p>  |
| <b>Severity</b>     | <p>Recent landslides in Kaua'i have been rated as small or medium by NASA, indicating few or no fatalities and minimal or moderate damage to infrastructure. Small landslides impact small areas or a single hillside and yield little damage to infrastructure. They may cause a small number of fatalities or none at all. Medium landslides are one or more landslides that move a substantial amount of material, yield a medium amount of damage to infrastructure, and may cause a small number of fatalities or none at all (NASA n.d.).</p> <p>Giant, catastrophic landslides are recorded as occurring in the planning area once every few tens of thousands of years but are associated with an earlier geologic time. The USGS characterizes giant Hawaiian landslides as a major but infrequent hazard (USGS 2014); in practice, mitigation planning typically prioritizes the more frequent landslide types that drive day-to-day risk.</p> <p>This information is unchanged since the 2021 MHMRP Update.</p>  |
| <b>Warning Time</b> | <p>Assessing the geology, vegetation and amount of predicted precipitation for an area can help in identifying susceptibility to landslides; however, there is no practical warning system for individual landslides.</p>   |

See Section 4 for a description of elements included in the hazard profile.

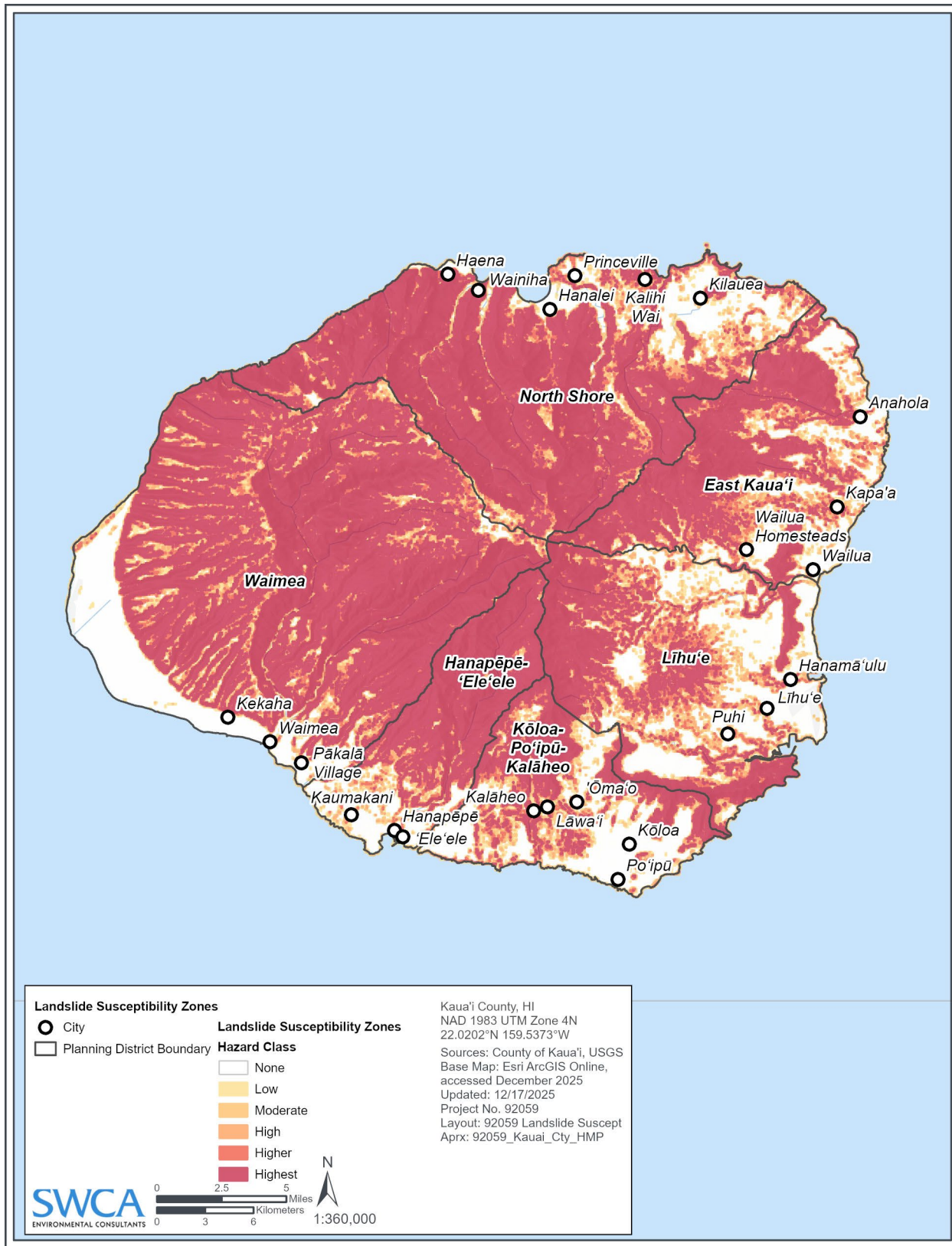


Figure 8-1. Landslide susceptibility.

## 8.1.1 Future Conditions and Climate Change

Heavy precipitation, wildfires, flooding, and earthquakes can all trigger landslides. Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increased intensity or frequency of precipitation events and associated flooding result in a higher likelihood of landslides occurring as soil saturation causes instability. Additionally, increases in droughts conditions due to climate change can increase the risk of wildfire. Both drought itself and wildfires can cause vegetation to die and reduce slope stability, which can cause landslide risk to be even higher when floods follow a period of drought or wildfire (HI-EMA 2023). Some studies suggest climate change may also trigger earthquakes as melting glaciers and changing ocean currents shift the distribution of weight on the earth's crust. This in turn could increase the likelihood of landslides on Kaua'i.

## 8.2 VULNERABILITY ASSESSMENT

### 8.2.1 Scenario

Landslides in the planning area occur as a result of soil conditions that have been affected by severe storms, groundwater, or human development. After heavy rains or even a short intense storm, soils can become saturated with water and shift resulting in landslides. Additionally, the groundwater table can rise as rains continue which may add to the weakening of the slope. Gravity, poor drainage, a rising groundwater table, poor soil, and ground shaking can all exacerbate hazardous conditions in the county leading to landslides.

There is no current modeling available to assess specific landslide scenarios. For this reason, a single landslide scenario was not modeled for this section. Instead, the population, property, critical facilities, and environment in areas susceptible to landslides were broadly assessed to consider the value of buildings.

### 8.2.2 Exposure

#### Population and Property

Private and public property, including infrastructure, can be affected by landslides in areas susceptible to their occurrence. A landslide could also affect bridges that pass over ravines and knock out transportation routes throughout the planning area. Landslides can cause road obstructions which can and have created isolation problems for residents and businesses. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may also cause a break in utility lines, cutting off power and communication access to residents.

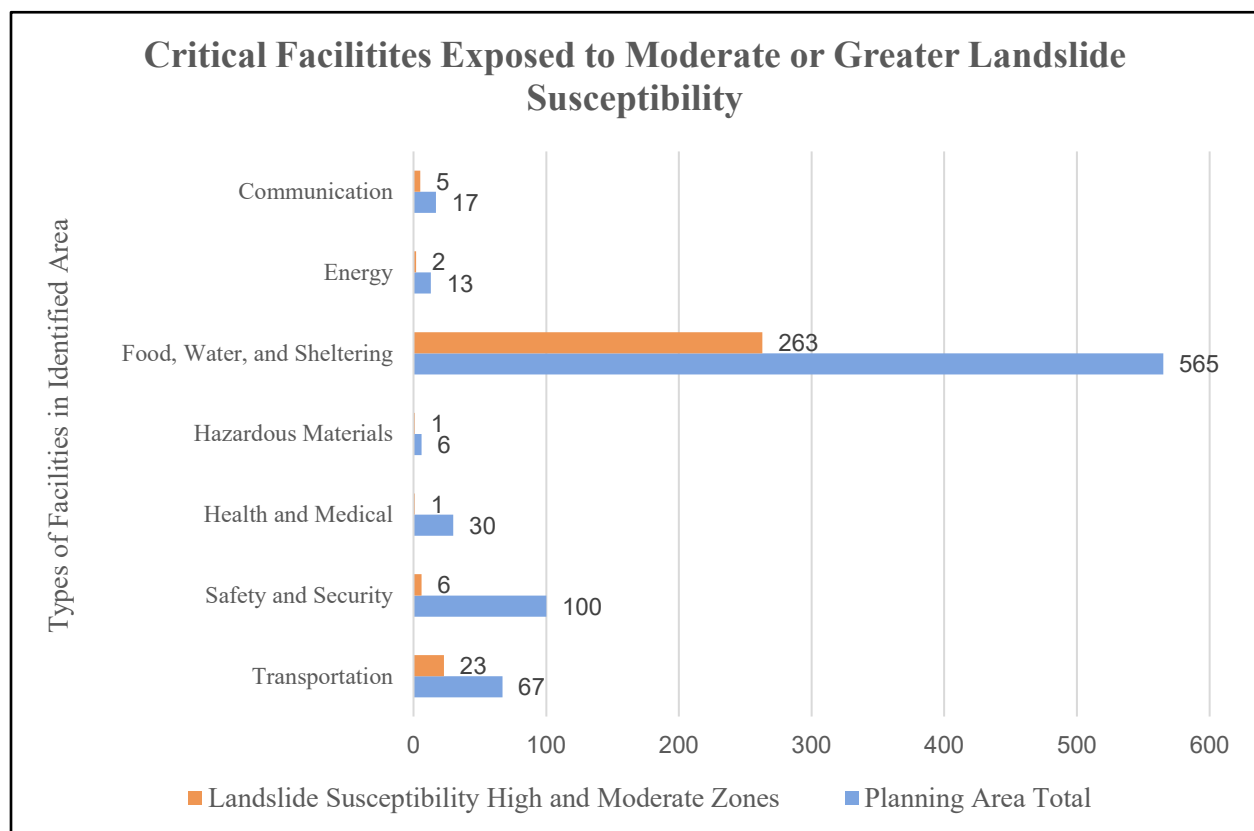
A quantitative assessment of exposure to the Landslide hazard was conducted using a landslide susceptibility dataset produced by the U.S. Geological Survey (USGS). More information on this dataset and the approach taken to designate areas as low, medium, high, higher, or highest risk can be found in Appendix H. Population exposure was estimated by calculating the number of buildings in the hazard area (moderate landslide susceptibility or higher) and multiplying this value by the average household size for the county. Property exposure was calculated by determining the number of buildings located in the hazard area and their values. Table 8-2 summarizes the estimated population living in the mapped landslide risk areas and the estimated property exposure. Detailed results by district are provided in Appendix K.

**Table 8-2. Exposed Population and Property in Mapped Landslide Hazard Zones**

|   | Moderate Landslide Susceptibility Zone | High or Greater Landslide Susceptibility Zones |
|---|--|--|
| <b>Population</b>                               |  |  |
| Population Exposed                              | 7,892                                  | 8,820  |
| % of Total Planning Area Population             | 11%                                    | 12%  |
| <b>Property</b>                                 |  |  |
| Number of Buildings Exposed                     | 3,528                                  | 3,943  |
| Value of Exposed Structures                     | \$1,675,519,575                        | \$1,896,437,234                                |
| Value of Exposed Contents                       | \$913,906,578                          | \$1,086,958,032                                |
| Total Exposed Property Value                    | \$2,589,426,153                        | \$2,983,395,266                                |
| Total Exposed Value as % of Planning Area Total | 13%                                    | 15%  |

**Critical Facilities**

Figure 8-2 summarizes the critical facilities within the high and moderate landslide susceptibility zones.



**Figure 8-2. Critical facilities in mapped landslide susceptibility high and moderate zones.**

A significant amount of infrastructure can be exposed to mass movements:

- **Roads:** Access to major roads is crucial after a disaster event for response and recovery operations. Landslides can block egress and ingress on roads, isolating neighborhoods, causing

economic losses for businesses, and leading to traffic problems and delays for public and private transportation. The county has experienced multiple landslides that blocked roads and isolated communities.

- **Bridges:** Landslides can significantly impact bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- **Power lines:** Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

## **Environment**

All natural areas within the high and moderate susceptibility zones for a landslide are considered to be exposed to the hazard.

### **8.2.3 Vulnerability**

#### **Population**

In general, all people exposed to moderate or greater landslide susceptibility areas are considered vulnerable to the hazard. However, socially vulnerable populations may be particularly impacted by landslide events.

#### ***Social Vulnerability***

Many communities in Kaua'i with high social vulnerability may be affected by landslides. The overlap of high social vulnerability with landslide susceptibility is given by community (defined as census-designated places) within Kaua'i County in Table 8-3. Only areas of a community that are classified as having the high and highest levels of social vulnerability (i.e., the 61st percentile or higher) that overlap partially with moderate or greater landslide susceptibility are included in the table. For example, within Wainiha, the entire community falls within the high social vulnerability level and is in the 73<sup>rd</sup> percentile compared with all other census block groups in the County. Wainiha is also exposed to moderate and greater landslide susceptibility.

The "Community" column identifies areas within each community that fall into the high or highest levels of social vulnerability (above the 61st percentile), provided any part of the area overlaps with a hazard exposure zone. For example, if a community is classified with a high social vulnerability level and only a portion of it intersects with a hazard exposure area, the entire community is included in the table, even though only a smaller section is actually exposed to the hazard. While this method may overestimate vulnerability, it offers a broadly accurate overview of community risk. It is important to recognize that social vulnerability and hazard exposure can vary within each community, but this analysis was unable to capture that variability.

Additionally, there are socially vulnerable populations throughout the planning area who may face increased risk from hazards, even in communities categorized as having lower levels of social vulnerability than those listed in Table 8-3. This analysis focused on the highest levels of social vulnerability defined by the SVI developed for the KCAAP (County of Kaua'i 2022b). Therefore, several communities have been excluded from this analysis due to lower levels of social vulnerability, including Wailua Homesteads, 'Ele'ele, Waimea, and Princeville. To examine the overlap of hazard exposure areas

with these communities, please use the Hazard Mapping Tool on the Kaua‘i MHMRP 2026 Story Map (County of Kaua‘i 2025b).

**Table 8-3. Communities with High Social Vulnerability or Above Overlapping Landslide Susceptibility**

| <b>Community:<br/>High Social Vulnerability Areas with (at least partial) Hazard<br/>Exposure</b>  | <b>Social Vulnerability<br/>(Percentile)</b> | <b>Landslide Susceptibility:<br/>Moderate, High, or Greater</b> |
|--|--|---|
| Anahola:<br>Eastern area of the community  | Highest (0.84)                               | Moderate and greater  |
| Wailua:<br>Nearly entire community   | High (0.75–0.78)                             | Moderate and greater  |
| Kapa‘a:<br>East-central area of the community  | High (0.76)                                  | Moderate and greater  |
| Hanamā‘ulu:<br>Entire community  | Highest (0.86–1)                             | Moderate and greater  |
| Līhu‘e:<br>Northern, western, eastern, southern, and part of the central areas<br>of the community | High–Highest (0.67–0.92)                     | Moderate and greater  |
| Puhi:<br>Northern area of the community  | Highest (0.90)                               | Moderate and greater  |
| Po‘ipū:<br>Southern area of the community  | High (0.61)                                  | Moderate and greater  |
| Kōloa:<br>Entire community   | Highest (0.82–0.88)                          | Moderate and greater  |
| ‘Ōma‘o:<br>Northern area of the community  | High (0.69)                                  | Moderate and greater  |
| Kalāheo:<br>Northern area of the community   | High (0.65)                                  | Moderate and greater  |
| Lāwa‘i:*<br>Northern, southern, and part of the central areas of the community                     | High–Highest (0.69–0.82)                     | Moderate and greater  |
| Hanapēpē:<br>Southeast to northeast areas of the community   | Highest (0.96)                               | Moderate and greater  |
| Kaumakani:<br>Entire community   | Highest (0.98)                               | Moderate and greater  |
| Pakala Village:<br>Entire community  | Highest (0.98)                               | Moderate and greater  |
| Hā‘ena:.*<br>Entire community  | High (0.73)                                  | Moderate and greater  |
| Wainiha:.*<br>Entire community   | High (0.73)                                  | Moderate and greater  |
| Hanalei:<br>Entire community   | High (0.63–0.73)                             | Moderate and greater  |
| Kalihiwai:.*<br>Entire community   | High (0.8)                                   | Moderate and greater  |
| Kīlauea:<br>Northern, eastern, and southwestern areas of the community                             | High (0.8)                                   | Moderate and greater  |

\*Approximately 50% or more of the socially vulnerable areas of the community are located in high or greater landslide susceptibility areas

The ways in which social vulnerability may impede a community's ability to mitigate and respond to a landslide event are described in the following paragraphs for each social vulnerability category and indicator included in the County's SVI developed for the KCAAP.

**Household characteristics** include the population under the age of 17 and over age 65 as well as the population with a disability. These factors can reduce the ability of individuals to mitigate and respond to landslides. These groups may have more difficulty evacuating from a landslide if they are unable to operate a vehicle, move quickly, or require outside assistance. An inability to access emergency notifications can also increase vulnerability as forecasts can predict when weather situations make landslide events more likely and high susceptibility areas can be avoided. Additionally, Kaua'i County has experienced multiple landslides that cut off road access and temporarily isolated communities. Isolation is particularly dangerous for individuals who need regular access to medical care, and members of these groups are likely to require these services more frequently than the general population. Additionally, mitigation measures such as slope stabilization can help protect roads and infrastructure, along with private property if located in an area with high landslide susceptibility. It could be difficult for some over the age of 65 or with a disability to implement if their mobility is limited or funding is not available.

**Socioeconomic status** also impacts the ability of a population to mitigate and respond to landslide events. These factors include household income, the population with a bachelor's degree, and the population of outdoor workers. Households with higher incomes located in areas susceptible to landslides are more likely to have the resources to implement mitigation measures to minimize the risk of property damage. Additional resources can also facilitate recovery and repair after a landslide event. Conversely, a lower household income and lack of resources can make recovery following a landslide event more difficult and may leave people without a safe place to stay. Outdoor workers could be more vulnerable to the Landslide hazard if they were working on a slope when it collapsed and did not have time to seek shelter. However, because landslides have most frequently been generated in Kaua'i County by heavy precipitation events, it is likely that outdoor workers would seek shelter from the precipitation prior to a landslide occurring. However, as with many other hazards, workers involved in the cleanup of debris following a landslide would be at increased risk due to working on potentially unstable ground and possible exposure to dangerous materials released in the landslide.

**Race and ethnicity** impact the ability of a community to mitigate and respond to a landslide event. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua'i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events including landslides (County of Kaua'i 2022b). Additionally, linguistic isolation raises vulnerability as it can create a barrier to accessing evacuation notices and procedures as well as mitigation resources if these notices are not widely distributed in languages other than English.

**Physical conditions** also impact a community's mitigation and response capacity to landslide events. Physical conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units may have increased vulnerability to landslides if properties are located in landslide-susceptible areas and renters do not have the authority to implement mitigation measures such as slope stabilization that would reduce impacts on their residences. Rent-burdened households also may not have sufficient resources to devote to mitigation, evacuation, or recovery if needed. Houses built before the 1970s are vulnerable to landslides as they may not be built to the necessary codes to reduce risk. Mobile homes are also vulnerable because they do not have a foundation to stabilize them. Additionally, mobile homes built in the 1970s and prior to the development of federal standards are not sufficiently prepared for hazard events (Curran-Groome et al. 2025). Lack of access to a vehicle could increase vulnerability as well if it inhibits evacuation from

landslide-prone areas during weather events likely to trigger landslides, which can increase the risk of injuries and fatalities.

### **Property**

Loss estimations for the Landslide hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 1%, 10%, 30%, and 50% of the replacement value of exposed structures. This allows emergency managers to select a range of economic impacts based on an estimate of the percentage of damage to the general building stock. Damage in excess of 50% is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 8-4 shows potential losses in the areas with the highest degree of landslide susceptibility (high and moderate zones).

**Table 8-4. Loss Estimation for Landslide (High and Moderate Susceptibility Zones)**

|                             | <b>Exposed Value<br/>(Structures and Contents)</b> | <b>Loss Value</b> | <b>Loss as % of Total Planning<br/>Area Replacement Value</b> |
|-----------------------------|--|-------------------|---|
| Loss = 1% of Exposed Value  | \$5,572,821,419                                    | \$55,728,214      | 0.3%  |
| Loss = 10% of Exposed Value |  | \$557,282,142     | 2.7%  |
| Loss = 30% of Exposed Value |  | \$1,671,846,426   | 8.2%  |
| Loss = 50% of Exposed Value |  | \$2,786,410,710   | 13.7%   |

### **Critical Facilities**

No loss estimation of critical facilities was performed due to the lack of established damage functions for the Landslide hazard.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer, and power infrastructure. Highly susceptible areas of the planning area include mountain and coastal roads and transportation infrastructure. Many roads in the planning area are single-lane highways that if blocked would cause a significant impact to the areas they serve. Highways blocked by a landslide could isolate communities for a significant amount of time. All infrastructure and transportation corridors identified as exposed to the Landslide hazard are considered vulnerable. See Appendix L for a detailed analysis of roads in the Landslide hazard area.

### **Environment**

Environmental problems as a result of landslides can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat and degrade water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods of time due to landslides.

Landslides that occur along coastal areas pose a particular threat to Kaua'i County's coastal coral reefs. As massive amounts of land falls into surrounding ocean waters, tides and waves may draw the earthen sediment to the reef area, choking the natural habitat. Natural cyclical processes normally remove earthen sediment and clean the coral reef area. However, a large landslide may produce too much sediment to be removed by natural processes (Piniak 2004, as cited in Crane 2011).

## 8.3 ISSUES

### 8.3.1 Development in High-Hazard Areas

Land use is determined by the County’s zoning code and zoning map, also known as the Comprehensive Zoning Ordinance. The General Plan and community plans establish policies to protect communities from hazards. Development in the planning area is also regulated by building standards and performance measures. The distribution of general land use types in the landslide hazard areas is shown in Figure 8-3. Agricultural and conservation land make up the greatest extent of exposed areas. In all, about 1% of the area exposed to moderate or higher landslide susceptibility is highly developed.

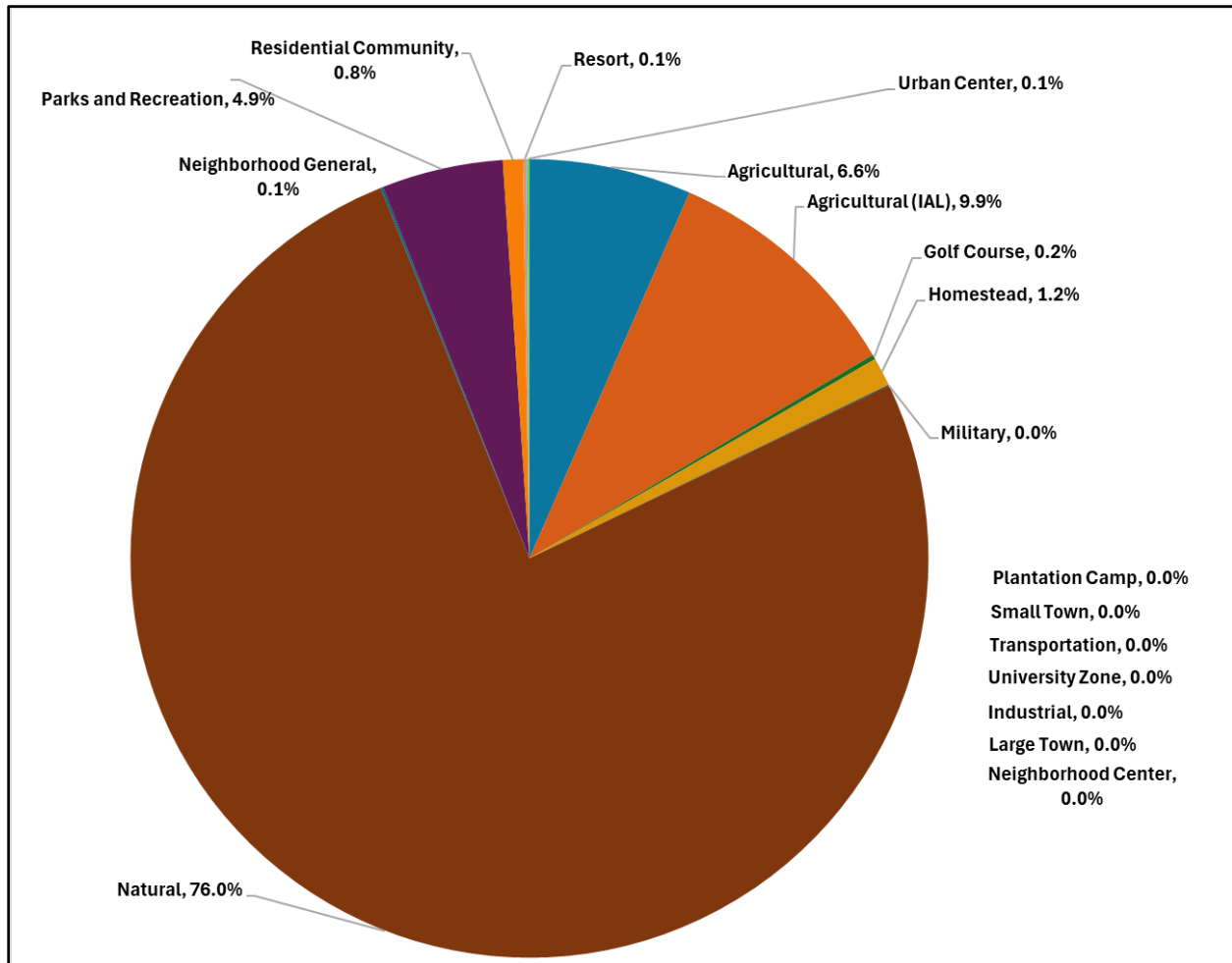


Figure 8-3. Land use distribution by area in moderate or higher landslide susceptibility zones.

### 8.3.2 Other Issues

The following issues have been identified related to the Landslide hazard in the planning area:

- Cascading hazard event potential:** Landslides may lead to flooding if debris from a landslide blocks a river or stream. Depending on where the landslide occurred, it could also cause a partial or full dam failure if the debris flow hit the dam itself or if the excess debris flowing into the reservoir caused the dam to exceed capacity. As landslides have frequently occurred in

conjunction with heavy rains in Kaua'i, there is added concern that flooding would complicate the problem further. As emergency response resources may be expended on flooding concerns, there may be insufficient resources available to assist with landslides occurring throughout the planning area.

- **Identification and development of geospatial landslide hazard layers:** Data for determining landslide areas has been developed to consider factors such as slope, seismicity, and precipitation in areas at risk for landslides (NASA 2025).
- **Use of best available data and scientific studies for stabilization:** Methods of hillside stabilization along roadways should be improved for effective project implementation.
- **Native species introduction:** Native species planting and care along with invasive species removal could have a stabilizing effect on soils in landslide areas.
- **Collection of detailed information:** Existing homes and transportation corridors are situated in areas susceptible to landslides throughout the planning area. The degree of vulnerability of these structures depends on the codes and standards used in their construction, but additional information is needed to increase understanding of this topic.
- **Monitoring of future development:** Future development could lead to more homes in landslide-susceptible or potentially isolated areas. By continuing to monitor land use and development, Kaua'i County could play an integral part in minimizing development in known landslide risk areas or areas prone to isolation due to blocked transportation corridors by landslides.
- **Water quality degradation:** Landslides may cause negative environmental consequences, including water quality degradation. The County must continue to monitor water quality during potentially impactful landslide events.
- **Multi-hazard mitigation measures:** The risk associated with the Landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- **State transportation projects:** The State Department of Transportation tries to address landslide and rock fall problems through its maintenance budget. Data regarding the frequency and severity of landslide events (see Appendix I: Table I-5) can be used to direct funding efforts. However, more chronic problem areas require capital improvement project funding.
- **Continuity of operations:** Critical facility owners should be encouraged to include landslide considerations in their continuity of operations plans, using the information on risk and vulnerability contained in this plan.
- **Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- **Personal planning resources:** Additional information on emergency shelters as well as emergency management resources can be found on the KEMA Facebook page and website: <https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency> (KEMA 2025).

- Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by landslides. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people’s safety during evacuations and in community shelters (County of Kaua’i 2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua’i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the Landslide hazard, based on the hazard profile and vulnerability assessment, is given in Table 8-5.

**Table 8-5. Risk Ranking Summary for Landslide**

| Priority | Hazard Event | Probability | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time   | Duration          | Risk Score |
|----------|--------------|-------------|--|--------------------------|----------------------|----------------|----------------|-------------------|------------|
| 4        | Landslide    | Likely      | Critical   | Minor                    | Medium               | Large          | 1 hour or less | Less than 6 hours | 2.9        |

## 9. DROUGHT

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A drought is a period of abnormally dry weather. Drought diminishes natural stream flow and depletes soil moisture, which can cause social, environmental and economic impacts. In general, the term “drought” is reserved for periods of moisture deficiency that are relatively extensive in both space and time. The demand that society places on water systems and supplies—such as expanding populations, irrigation, and environmental needs—contributes to drought impacts.

According to the *Water Resource Protection Plan, 2019 Update* (State of Hawai'i Commission on Water Resource Management 2019), drought can lead to difficult decisions regarding the allocation of water, stringent water use limitations, water quality problems, and inadequate water supplies for fire suppression (State of Hawai'i 2019). There are also issues such as growing conflicts between agricultural uses of surface water and in-stream uses, surface water and groundwater interrelationships, and the effects of growing water demand on traditional and cultural uses of water. Though droughts may cause many negative impacts, the potential to fuel wildfires is one of the most dangerous.

The El Niño and La Niña cycles play an important role in shaping drought conditions on Kaua'i. Records show that there is an approximately 70% chance of drought in Hawai'i during the wet season following an El Niño event. Many severe Hawaiian drought events are associated with the El Niño phenomenon (DLNR 2025). The most severe droughts impacting the Hawaiian Islands have been associated with the El Niño phenomenon and persistent zones of high-pressure systems throughout the islands (Frazier et al. 2022).

The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand. The impacts of drought vary between sectors of the community in both timing and severity:

- **Water supply:** The water supply sector encompasses urban and rural drinking water systems that are affected when a drought depletes ground water supplies due to reduced recharge from rainfall.
- **Agriculture and commerce:** The agriculture and commerce sector includes the reduction of crop yield and livestock sizes due to insufficient water supply for crop irrigation and maintenance of ground cover for grazing.
- **Environment, public health, and safety:** The environmental, public health, and safety sector focuses on wildfires that are both detrimental to the forest ecosystem and hazardous to the public. It also includes the impact of desiccating streams, such as the reduction of in-stream habitats for native species.

### 9.1 HAZARD PROFILE

Table 9-1 summarizes the key elements of the hazard profile for drought in Kaua'i County. Additional details are provided in Appendix I.

**Table 9-1. Drought Hazard Profile Summary**

|                     |   |
|---------------------|---|
| <b>Past Events</b>  | <p>Between 2020 and 2024, the U.S. Department of Agriculture (USDA) declared three drought-related disasters for Kaua'i: one in 2020 approved on November 18, 2020 (designation number: S4870), one in 2022 approved on August 15, 2022 (designation number: S5253), and one in 2024 approved on September 30, 2024 (designation number: S5793) (USDA 2025).</p> <p>According to the USDM, Kaua'i County experienced the following drought conditions between 2020 and 2024 (see Appendix I for a description of each drought classification) (USDM 2025a):</p> <ul style="list-style-type: none"> <li>• 2020: D0 to D2 conditions</li> <li>• 2021: D0 to D2 conditions</li> <li>• 2022: D0 to D3 conditions. The entire county was under D1 or worse for 2 months out of the year. For 2 weeks in August to September, the entire county was under D2 conditions or worse.</li> <li>• 2023: D0 to D2 conditions: The entire county was briefly under D1 conditions in January.</li> <li>• 2024: D0 to D3 conditions: The entire county was under D1 conditions briefly at two points during the year.</li> </ul> <p>USDM dry and drought conditions are shown for Kaua'i from 2020 through 2024 in Figure 9-1 (USDM 2025a). The entire county was under abnormally dry conditions with certain areas experiencing worse drought conditions for a period of time every year from 2020 to 2025. Additionally, the entire county experienced moderate drought conditions or worse for a period of time in 2022, 2023, and 2024. For additional information on drought events impacting Kaua'i, including those prior to 2020, see Appendix I.</p> |
| <b>Location</b>     | <p>In Hawai'i, droughts can threaten all the islands in any given year. Any place on Kaua'i can experience drought, though the southern portion of the island appears to be most often affected in recent years (USDM 2025b). This leeward side of Kaua'i is generally drier and is anticipated to continue becoming drier (County of Kaua'i 2022a). The spatial extent and severity depend on the variance of rainfall across the planning area. Although drought conditions can occur across the island and throughout the year, Kaua'i tends to experience its driest conditions between June and September (Warning Coordination Meteorologist 2025).</p> <p>In the period since the 2021 MHMRP Update, drought conditions have occurred across the entire county. However, the southern portion of the island and particularly the southwest corner generally experiences dry or drought conditions more frequently and more severely than other parts of the island (USDM 2025b).</p>   |
| <b>Frequency</b>    | <p>Instances of the entire county being under abnormally dry conditions are common in the planning area. The average percentage of the county that was abnormally dry between 2000 and 2024 was 41%.</p> <p>A drought event for the purpose of the 2026 MHMRP Update was considered to be a consecutive 4-week period where any portion of the county, including the county as a whole, was under a severe drought designation (D2) or higher. This determination was based on data from the USDM (USDM 2025c). Based on this description, there were 18 drought events between August 2020 (at the end of data collection for the 2021 MHMRP Update) and December 2024. This is an average of approximately four severe drought events per year.</p> <p>Kaua'i County has experienced an increase in drought events. Records from the USDM going back to 2000 show there were 49 drought events on Kaua'i between 2000 and 2024, which is an average of only about two events per year (USDM 2025a).</p> <p>Additionally, climate change is expected to increase the length and frequency of droughts as El Niño events occur more frequently. See Section 9.1.2 for more information.</p>   |
| <b>Severity</b>     | <p>Kaua'i County has experienced drought conditions ranging from moderate to extreme drought, as classified by the USDM (USDM 2025a). Occurrences of extreme drought (D3) have been infrequent, and the county has not had a recorded instance of exceptional drought D4. The severity of drought has not been as bad as in other islands (Commission on Water Resource Management 2003). Figure 9-1 depicts drought severity in the county from 2020 through the end of 2024.</p> <p>Additionally, climate change is increasing the severity of droughts on Kaua'i as total precipitation decreases and droughts last longer. See Section 9.1.2 for more information.</p>  |
| <b>Warning Time</b> | <p>Scientists may be able to predict El Niño/Southern Oscillation events more than a year in advance. Since El Niño events are closely linked to drought conditions in Hawai'i, this may help produce more reliable forecasts that can reduce risks in economic sectors most sensitive to drought.</p>  |

See Section 4 for a description of elements included in the hazard profile.

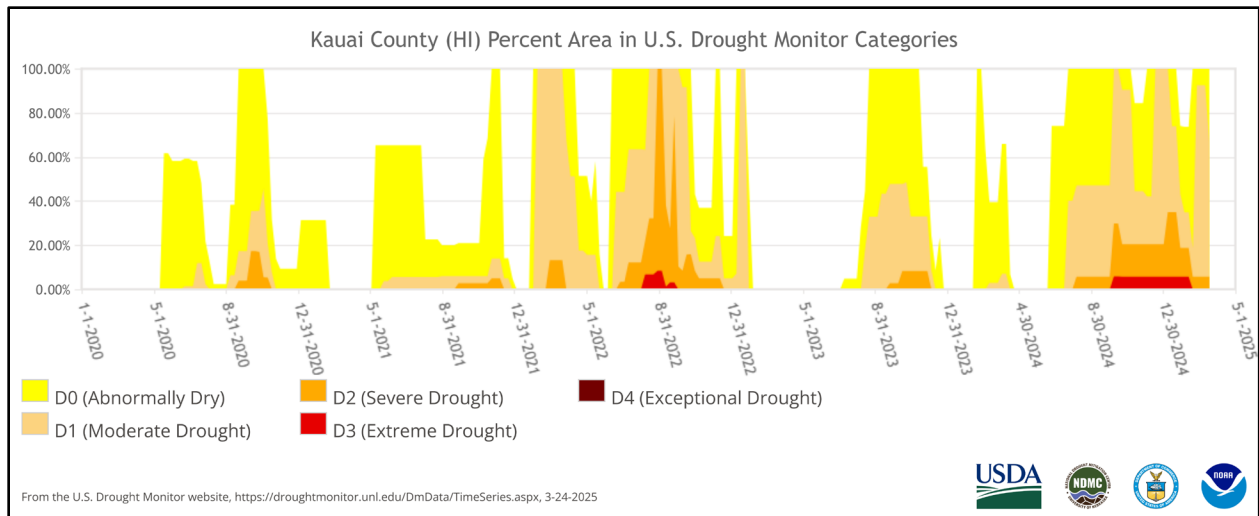


Figure 9-1. Percent of Kaua'i County affected by each USDM rating, 2020–2025.

### 9.1.1 Location and Severity

The USDM and Standardized Precipitation Index (SPI) are two indices applicable to Hawai'i. The USDM provides a map that is updated weekly and shows the location and intensity of drought as well as time series data (USDM 2025b). The USDM uses a five-category system:

- D0: Abnormally Dry
- D1: Moderate Drought
- D2: Severe Drought
- D3: Extreme Drought
- D4: Exceptional Drought

Data collection for the 2026 MHMRP Update ended at the end of calendar year 2024. Figure 9-2 shows the categories in Kaua'i County as of December 2024 and provides an example of the data that the USDM reports. On that date, abnormally dry or drought conditions had been reported over most of Kaua'i for 4 consecutive months. Moderate drought was indicated over most of the northeastern half of the county, severe drought conditions affected much of the southwest portion of the island, and extreme drought affected the southwest coast including Kekaha, Waimea, and Port Allen.

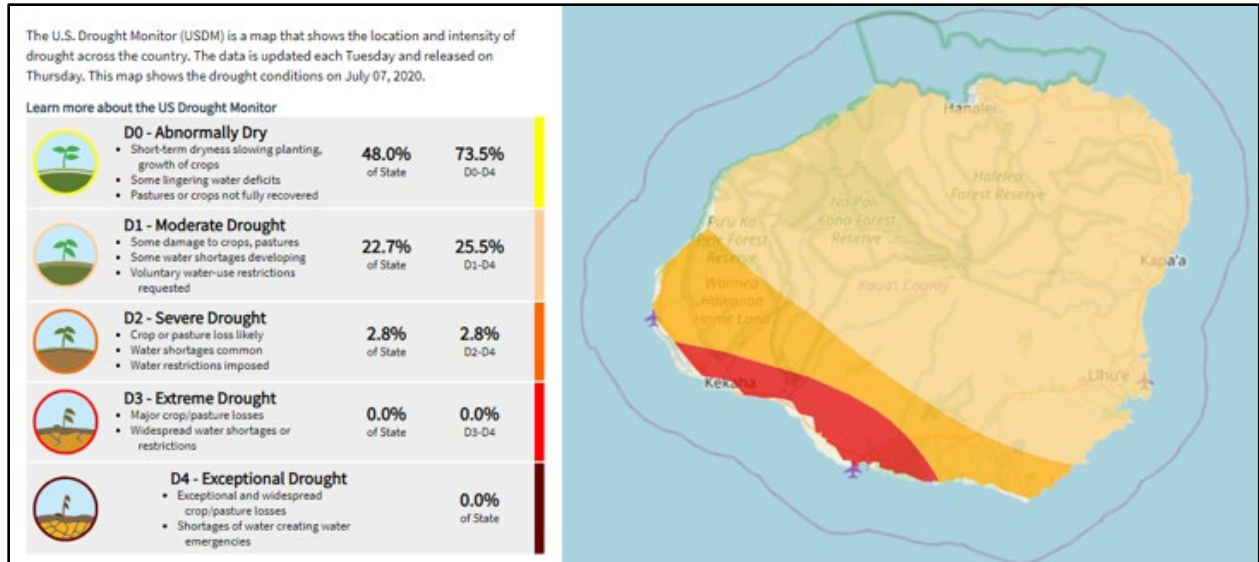


Figure 9-2. Island of Kaua'i U.S. Drought Monitor map as of December 24, 2024.

The SPI considers only precipitation. An index value of zero represents the median precipitation amount, and the index is negative for drought and positive for wet conditions. SPI values can be generated for multiple time scales, which is useful for monitoring because the effects of droughts occur over wide ranges of time scales. SPI values are as follows:

- 2.00 and greater: Extremely Wet
- 1.50 to 1.99: Very Wet
- 1.00 to 1.49: Moderately Wet
- 0.99 to -0.99: Near Normal
- -1.00 to -1.49: Moderately Dry
- -1.50 to -1.99: Very Dry
- -2.00 and less: Extremely Dry

Additional general information on the Drought hazard as well as more detailed information on drought monitoring is provided in Appendix I.

Figure 9-3 shows examples of SPI maps for Kaua'i as of January 2025 (NWS 2025h). The county at that time fell within the Near Normal to Extremely Dry categories, depending on the selected timeframe.

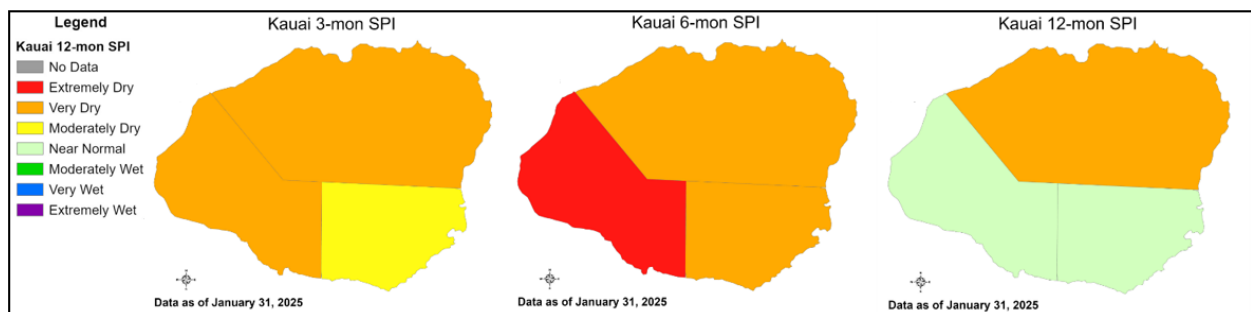


Figure 9-3. Island of Kaua'i 3-, 6-, and 12-month SPI maps, as of January 2025.

## 9.1.2 Climate Change

Climate change is causing drought events to increase in frequency with droughts lasting longer and becoming more intense (County of Kaua'i 2025d). This is resulting in a decrease in the amount and quality of water available in Kaua'i with significant impacts on agriculture and wildfire suppression efforts. These trends are evident across the state with the state of Hawai'i experiencing longer droughts on all the populated islands from 1980 to 2011 than from 1950 to 1970 (University of Hawai'i 2014). Lower quantities of rainfall have also been documented (Frazier and Giambelluca 2017). These trends are expected to continue as climate change leads to a higher frequency of El Niño events (Cai et al. 2014; Wang et al. 2017). As these events are associated with dry conditions, they will increase the frequency of drought occurrence on Kaua'i.

Increases in wildfire occurrence and intensity are the most pressing concerns related to drought. These changes have unfortunately already been documented in Hawai'i (Trauernicht et al. 2015). The August 2023 Maui wildfires further illustrate the threat that climate change induced dry conditions pose. Increasing drought frequency will thus necessitate significant mitigation efforts to reduce wildfire threats.

Drought also poses a substantial problem for water resource managers who can be faced with challenging situations when water becomes scarce. One strategy for alleviating future stress is to start addressing current stresses on water supplies and building flexibility and robustness into any system. Flexibility helps to ensure a quick response to changing conditions, and robustness helps people prepare for and survive the worst conditions. The County of Kaua'i is already striving to do this through its water use and development plan update (Fukunaga & Associates, Inc. 2024) and *Water Plan 2020* (County of Kaua'i 2020b), which advocate for water conservation and using alternative water sources where applicable. Continuing to integrate this approach across the county will help water system managers better adapt to the impacts of climate change and the stresses it may place on water resources.

The Hawai'i Climate Data Portal contains additional data that can be used to examine the impacts of drought in Kaua'i County (University of Hawai'i 2025). While this data was not integrated into the 2026 MHMRP Update, it should be included in the next plan update.

## 9.2 VULNERABILITY ASSESSMENT

### 9.2.1 Scenario

An extreme drought with a combination of low precipitation and unusually high temperatures could occur over several consecutive years. Such a drought would strain water supply systems, dry out vegetation, and potentially cause damage to structures. There may also be adverse public health impacts associated with drought as air quality decreases. If such conditions persisted for years, Kaua'i County could experience damage to critical facilities and other structures, negative impacts to the population, environmental damage, and economic setbacks, especially in water-dependent industries such as agriculture.

Drought may also affect Kaua'i County by priming conditions for severe wildfires to break out and spread across the county. Wildfire is the most concerning secondary hazard related to drought. For more information on vulnerability associated with wildfires, see Section 5.2.

## 9.2.2 Exposure

Drought can occur anywhere across the county, although the southern area of the island has experienced more severe drought conditions in recent years. For this reason, all people, property, and environments in the planning area are exposed to some degree of drought and its impacts.

## 9.2.3 Vulnerability

### Population

Kaua'i County may be able to minimize the impacts on residents and water consumers during dry years because current water use is fairly sustainable. The 2024 Kaua'i County water use and development plan (Fukunaga & Associates, Inc. 2024) indicates that the county's water stores are in good standing, with the water use in the county's 13 aquifer system areas projected to be sustainable with anticipated future development laid out in Kaua'i's General Plan and zoning (County of Kaua'i 2018). The plan still encourages conserving water and using alternative water sources to best protect the resource going forward.

However, a prolonged drought may still impact the county's economy, cause potential adverse health impacts, and possibly damage residential buildings. These concerns are discussed below, but it is significant to note that the biggest hazard threat to the population associated with the Drought hazard does not come from drought directly but from increased wildfire risks due to drought.

### ***Social Vulnerability***

As was done for the other hazards in the 2026 MHMRP Update, the impacts of drought on socially vulnerable populations in the county based on the SVI developed for the KCAAP are discussed below; however, in the case of the Drought hazard, it is particularly notable to consider the impact of droughts on agricultural workers since they are the ones most directly impacted by the Drought hazard. There are approximately 525 farms on Kaua'i and the total farm-related income equals \$10.6 million countywide. The average farm-related income per farm was approximately \$100,000 (USDA 2022). This represents a notable portion of the county's economy and constitutes the livelihoods of hundreds of people. These individuals are the most vulnerable to drought as drought is a significant driver of agricultural losses in Hawai'i (Frazier et al. 2022). Additionally, the economic impacts of drought can heighten mental health risks for agricultural workers, as drought-related livelihood stress is tied to adverse mental health outcomes (National Integrated Drought Information System [NIDIS] 2025a, Berman et al., 2021). Hawaiians who produce their own food for personal consumption would also be negatively impacted by drought and associated lower crop yields, which may increase food insecurity.

While droughts can have more significant impacts on socially vulnerable communities, these impacts are more indirect than for other hazards outside of impacts tied to agriculture and food security concerns. Every community in Kaua'i with high social vulnerability may be affected by drought since the entire county is exposed to the hazard. Table 9-2 shows communities (defined as census-designated places) with higher social vulnerability that are exposed to the Drought hazard. As drought can occur across the county, all communities with the high or highest levels (i.e., the 61st percentile or higher) of social vulnerability are listed in the table. For example, within Kaumakani, the entire community falls within the highest social vulnerability level; is in the 98th percentile compared with all other census block groups in the county; and is exposed to the Drought hazard.

It is significant to note that there are socially vulnerable populations throughout the planning area who would be at increased risk from the hazard, including in communities that are classified as having lower

levels of social vulnerability than those listed in Table 9-2. This analysis focused on the highest levels of social vulnerability defined by the SVI developed for the KCAAP (County of Kaua'i 2022b). Therefore, several communities have been excluded from this analysis due to lower levels of social vulnerability, including Wailua Homesteads, 'Ele'ele, Waimea, and Princeville. To examine the overlap of hazard exposure areas with these communities, please use the Hazard Mapping Tool on the Kaua'i MHMRP 2026 Story Map (County of Kaua'i 2025b).

**Table 9-2. Communities with High Social Vulnerability or Above Impacted by Drought**

| <b>Community:<br/>High Social Vulnerability Areas with (at least partial) Hazard Exposure</b>   | <b>Social Vulnerability (Percentile)</b> |
|---|--|
| Anahola:<br>Eastern area of the community   | Highest (0.84)                           |
| Wailua:<br>Nearly entire community  | High (0.75–0.78)                         |
| Kapa'a:<br>East-central area of the community   | High (0.76)                              |
| Hanamā'ulu:<br>Entire community   | Highest (0.86–1)                         |
| Līhu'e:<br>Northern, western, eastern, southern, and part of the central areas of the community | High–Highest (0.67–0.92)                 |
| Puhi:<br>Northern area of the community   | Highest (0.90)                           |
| Po'ipū:<br>Southern area of the community   | High (0.61)                              |
| Kōloa:<br>Entire community  | Highest (0.82–0.88)                      |
| 'Ōma'o:<br>Northern area of the community   | High (0.69)                              |
| Kalāheo:<br>Northern area of the community  | High (0.65)                              |
| Lāwa'i:<br>Northern, southern, and part of the central areas of the community                   | High–Highest (0.69–0.82)                 |
| Hanapēpē:<br>Southeast to northeast areas of the community                                      | Highest (0.96)                           |
| Kaumakani:<br>Entire community  | Highest (0.98)                           |
| Pakala Village:<br>Entire community   | Highest (0.98)                           |
| Kekaha:<br>Central area of the community  | Highest (0.94)                           |
| Hā'ena:<br>Entire community   | High (0.73)                              |
| Wainiha:<br>Entire community  | High (0.73)                              |
| Hanalei:<br>Entire community  | High (0.63–0.73)                         |
| Kalihiwai:<br>Entire community  | High (0.8)                               |

| Community:<br>High Social Vulnerability Areas with (at least partial) Hazard Exposure | Social Vulnerability (Percentile) |
|---|-----------------------------------|
| Kilauea:<br>Northern, eastern, and southwestern areas of the community                | High (0.8)                        |

The ways in which social vulnerability may impede a community’s ability to mitigate and respond to a drought event are described in the following paragraphs for each social vulnerability category and indicator included in the County’s SVI developed for the KCAAP (County of Kaua‘i 2022b). As there are few direct impacts of drought on people, the following paragraphs focus on the impacts of poor air quality as a result of drought and potential economic impacts that can be associated with the hazard. Drought can worsen air quality by increasing ozone near the Earth’s surface and increasing particulate matter, including particulate matter 10 microns (PM<sub>10</sub>) and 2.5 microns or less in diameter (PM<sub>2.5</sub>), which can all contribute to adverse health outcomes (West et al. 2023; CDC 2025). Ozone increases because plants take less out of the atmosphere during drought conditions and PM<sub>2.5</sub> concentrations increase as creeks, rivers, lakes, and soil start to dry up, making it easier for dust to enter the air (West et al. 2023; CDC 2025). Additionally, if drought conditions lead to wildfires, the smoke from these fires will further worsen air quality.

**Household characteristics** include the population under the age of 17 and over age 65 as well as the population with a disability. Children and older adults (over 65) are both more vulnerable to poor air quality. Additionally, people with certain cardiovascular and respiratory diseases can be at increased risk as poor air quality can worsen the preexisting conditions (EPA 2025a). Prolonged drought events may also cause water or food costs to rise if crops are damaged or there are increased costs associated with water treatment due to reduced water quality. Members of these groups may be more likely to be on a fixed income and face a greater burden from higher costs.

**Socioeconomic status** includes household income, the population with a bachelor's degree, and the population of outdoor workers, which are factors that can shape the ability to mitigate and respond to a hazard. Households with higher incomes are more likely to have additional resources to buffer any economic impacts of a drought. Poor air quality outside can affect the air quality inside, so efforts to improve indoor air quality through the use of air filters and purifiers can mitigate adverse health impacts. Individuals with higher income levels are more likely to have sufficient resources to purchase and utilize air filters and purifiers plus absorb increase in food costs. Additionally, soil shrinkage associated with drought conditions can cause foundation damage, which can cost between a few thousand dollars up to \$50,000 to repair and is often not covered by homeowners insurance (American Planning Association [APA] 2013; Olgetree and Brooks 2024). Outdoor workers are also more vulnerable to the Drought hazard as they are more exposed to the poor air quality brought on by a drought than individuals working indoors.

**Race and ethnicity** impact the ability of a community to mitigate and respond to drought events. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua‘i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events including drought (County of Kaua‘i 2022b). Additionally, linguistic isolation raises vulnerability as it can create a barrier to accessing notifications about the hazard event, such as poor air quality notices, if this information is not widely distributed in languages other than English.

**Physical conditions** also impact a community’s mitigation and response capacity to drought. Physical conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units may increase vulnerability to the

poor air quality associated with drought as renters may have less control over air quality in their residences. For instance, renters may not have access to their heating, ventilation, and air conditioning (HVAC) systems to regularly change filters. Similar to lower-income households, rent-burdened households may not have sufficient resources to purchase and use air filters and purifiers. If poor water quality in conjunction with crop damage raises the cost of food and water, rent-burdened households will face an increased burden from these higher costs as well. Additionally, drought can cause soil to shrink which can damage foundation structures (HI-EMA 2023). Houses built before the 1970s or mobile homes may be more vulnerable to this process if their foundations are weaker or already damaged due to age or were built prior to the development of stronger building codes. Unlike many of the other hazards in this 2026 MHMRP Update, lack of access to a vehicle does not notably increase vulnerability to the Drought hazard.

### **Property and Critical Facilities**

Both property and critical facilities may be vulnerable to foundation damage associated with drought. Soil shrinks as it loses moisture and then expands when it becomes saturated with water again. This process of expanding and shrinking, and the more severe shrinking associated with drought in particular, can cause damage to the foundations of structures (HI-EMA 2023). As drought conditions have been worse on the south side of Kaua'i over the past several years (USDMA 2025a), critical facilities and other structures on this side of the island may be more vulnerable to the impacts of drought. While droughts can cause direct damage to structures, the damage is relatively minimal compared to most of the other hazards discussed in this 2026 MHMRP Update (excluding extreme heat). Drought also increases the risk of wildfire in the county, which would put both critical facilities and structures at risk. For more information on the impacts of wildfires on property and critical facilities, see Section 5.2.

Although all critical facilities are vulnerable to the Drought hazard because it can occur anywhere in the county, certain types of critical facilities are more vulnerable than others, particularly those that are part of the water infrastructure system. Wastewater treatment plants, wastewater pump stations, water pumps, water tanks, and wells are all pieces of critical infrastructure more vulnerable to the Drought hazard. Water tanks and wells may run low on water supplies or dry up during a drought; which may lead to wells needing to be dug deeper or relocated. Additionally, less water moves through the wastewater infrastructure when there is a drought. This can result in increased concentrations of pollutants and human waste because there is less water to dilute everything swept into the systems, which requires increased efforts to properly handle the wastewater (APA 2013). While not a specific piece of critical infrastructure examined in this plan, stormwater drains can suffer from drought conditions because larger pieces of trash, such as rags, can accumulate in drains if there is not sufficient water pressure from rains to push this debris through to the wastewater treatment plants (APA 2013).

Outside of damage to structures, drought conditions along with water supply demands can stress the county's water resources. The State Kōke'e Water System has experienced decreased shallow well capacity due to reduced recharge of perched groundwater and increased system water demand due to increased development and population. The Waimea Water System well has shown increased salinity due to heavier pumping and decreased groundwater recharge. The Kaua'i County Department of Water and several private water systems have recorded declining capacity of water sources due to decreased groundwater recharge and increased pumping to meet a higher water demand (USGS 2005; Wilson Okamoto Corporation 2012). These trends have continued into 2025 according to a representative from the Department of Water. These factors indicate prolonged drought conditions could stress the county's water supply, particularly in conjunction with increased salination brought by rising sea levels. Kaua'i County's water systems are also being exposed to increasing wildfire risk as drought conditions increase (see Section 5, Wildfire), which puts water systems at risk as wildfires can decrease water quality.

## Environment

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat; poor air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity.

## 9.3 ISSUES

### 9.3.1 Development in High-Hazard Areas

The core capability assessment for this plan identified the County of Kaua'i's strong commitment to the adoption of uniform codes and standards that will position the planning area well to manage risk for future development. The 2017 Hawai'i drought plan update (State of Hawai'i 2017), *2024 Kaua'i County Water Use and Development Plan Update* (Fukunaga & Associates, Inc. 2024), and *Water Plan 2020* (County of Kaua'i 2020b) provide the capability at the state and local level to respond to and develop long- and short-term mitigation strategies for the impacts of drought.

### 9.3.2 Other Issues

The following issues have been identified related to the Drought hazard in the planning area:

- **Cascading hazard potential:** Areas that have experienced long-term drought may be more vulnerable to wildfires—the most concerning secondary hazard related to drought. High temperatures and prolonged lack of precipitation can dry out vegetation, making it increasingly prone to ignition as warm, dry weather persists.
- **Drought-tolerant landscape designs are not adequately encouraged:** Incorporating drought-tolerant or xeriscaping practices into landscape ordinances, providing incentives for xeriscaping, and encouraging permeable driveways and surfaces will reduce dependence on irrigation.
- **Groundwater recharge techniques are not used:** During non-drought periods, recharging groundwater to stabilize the groundwater supply should be a regular practice. By ensuring groundwater remains stable, the impacts of future drought occurrences will be minimized.
- **Active water conservation even during non-drought periods needs to be promoted:** Active conservation during non-drought periods serves as a tool to anticipate how entities will use water during drought periods. If conservation is practiced during non-drought periods, needed conservation during drought periods will minimize the impact on the county and mitigate against overuse of minimal water supply. The challenge associated with this particular initiative is encouraging residents to adhere to water conservation. Public outreach initiatives regarding this issue must emphasize the need for water conservation during non-drought periods.
- **Continuity of operations:** Critical facility owners should be encouraged to include drought considerations in their continuity of operations plans, using the information on risk and vulnerability contained in this plan.
- **Personal planning resources:** Additional emergency management information can be found on the KEMA website and Facebook page and website:  
<https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency> (KEMA 2025).

- Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by drought. Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua’i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the Drought hazard, based on the hazard profile and vulnerability assessment, is given in Table 9-3.

**Table 9-3. Risk Ranking Summary for Drought**

| Priority | Hazard Event | Probability   | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time       | Duration         | Risk Score |
|----------|--------------|---------------|--|--------------------------|----------------------|----------------|--------------------|------------------|------------|
| 5        | Drought      | Highly Likely | Minor  | Minor                    | Medium               | Large          | More than 24 hours | More than 1 week | 2.7        |

## 10. INLAND FLOODING

This 2026 MHMRP Update distinguishes inland flooding—caused by overflowing rivers and streams or extreme rainfall that causes inundation of urban areas—from coastal flooding that results from high surf and storm surge. This section provides a risk assessment for the inland flooding hazard; the risk assessment for coastal flooding is included in Section 11, High Surf, Coastal Flood, Erosion, and Sea Level Rise.

Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states). There are several types of events that may cause flooding in Kauaʻi County. These events are Kona storms, frontal storms, upper-level lows, and tropical cyclones. Kona storms approach the island from the south and generally bring rains that fall even across the islands. These storms provide precipitation to the drier side of the island. Frontal storms move eastward across the island and can bring hours of continuous rainfall leading to landslides and flash floods. Upper-level lows occasionally produce heavy precipitation and flash floods if they combine with the marine layer but often tend to have little negative impact. Tropical cyclones bring heavy precipitation, storm surge, and high winds to the island leading to flooding along with other negative impacts. Kona and frontal storms tend to occur in the winter and spring while upper-level lows can occur year-round and tropical cyclones are most common in the summer and fall. Rain bombs or microbursts also occur in Kauaʻi and result from a sudden concentrated downburst of wind and rain that may result in flash flooding. Overland sheet flows are also experienced when poorly drained low-lying areas flood. The lack of drainage means flooding may occur even when rainfall is not heavy.

These storms can lead to several types of flooding throughout the county. Kauaʻi County can experience riverine floods when a river or stream receives too much water and the excess flows over its banks inundating adjacent low-lying areas. The county also experiences flash flood when a substantial amount of rain is received in a short time period with little warning (less than 6 hours) before an area experiences flood conditions. The county can also experience dam failure events resulting in the inundation of downstream areas with water (see Section 12 and Appendix I).

Additional general information on the Inland Flooding hazard, including floodplain ecosystems and human development within floodplains is provided in Appendix I.

### 10.1 HAZARD PROFILE

Table 10-1 summarizes the key elements of the Inland Flooding hazard profile for Kauaʻi County. This section also includes a list of the principal flooding sources on Kauaʻi, a description of the impacts of

#### FLOOD PROBABILITIES AND FLOOD MAPS

Riverine flooding is measured based on the probability that a certain flow will be equaled or exceeded in a 365-day period. The area that is flooded by a river flow that has a **1% annual chance** of occurrence (also called the **base flood**) is mapped in the **special flood hazard area (SFHA)**.

This area is commonly used to assess risk, and many communities have maps that show the extent and likely depth of flooding for the base flood. These maps, developed by FEMA, are called **flood insurance rate maps (FIRMs)** because the rates that property owners pay for flood insurance under the National Flood Insurance Program (NFIP) depend on the property's location relative to the mapped special flood hazard areas. A structure located within a 1% annual chance floodplain has a 26% chance of suffering flood damage during the term of a 30-year mortgage.

FIRMs also show areas flooded by 0.2% annual chance river flows. They also indicate regulatory **floodways**, which are areas where development is restricted or prohibited because of the immediate flood risk and because of the potential impact of development in these zones on flooding in surrounding areas. More detailed information on FEMA flood zones can be found in Appendix I.

climate change on the Inland Flooding hazard, and a discussion of the County's participation in the Federal Flood Program.

**Table 10-1. Inland Flooding Hazard Profile Summary**

|                    |  |
|--------------------|--|
| <b>Past Events</b> | <p>The National Climatic Data Center's Storm Events Database lists 101 flood events in the planning area between 2005 and 2024. Notable recent floods are as follows:</p> <ul style="list-style-type: none"> <li>• December 1991—Flash floods resulting from a storm that dropped over 20 inches of rain in 12 hours over Anahola, caused five deaths, intense flooding, bank failures, erosion, and slides, totaling more than \$5 million in property damage.</li> <li>• October/November 2006—Two systems caused heavy rainfall, especially along windward sections, which received over 15 inches of rain. Some locations received over 3 inches in 1 or 2 hours. The excessive rain produced flooding over windward portions of Kaua'i.</li> <li>• April 2018—Heavy rain generated historic flash flooding conditions. A 24-hour rainfall total of 50 inches was recorded near Hanalei. The deluge, mainly over northern Kaua'i but also affecting east O'ahu, damaged or destroyed farms and structures, including 532 homes. The storm downed trees and power lines, flooded homes, businesses and vehicles, and closed and damaged numerous roadways. Highway and road repairs were estimated at \$35 million. The Hawai'i state legislature approved \$125 million in relief aid. A major disaster declaration (DR-4365) was issued, with over \$11 million in Public Assistance and \$1.6 million for Individual Assistance.</li> <li>• March 2020—Heavy rainfall led to severe flooding. Kūhiō Highway was closed near the Hanalei Bridge as the Hanalei River overflowed along the roadway. Kūhiō Highway was also closed in Wailua as debris piled up against the Wailua River Bridge. A major disaster declaration (DR-4549) was issued to assist with recovery.</li> </ul> <p>In the period since the 2021 MHMRP Update, there have been 20 flood or flash flood events in Kaua'i County. No fatalities or injuries resulted from any of these events. Most of the events resulted in no property damage as well. Only two of the flood/flash flood events caused recorded damage, though these damages were substantial. A flash flood from March 9 to March 10, 2021, caused over \$30 million in recorded property damage. Roads, bridges, and nine homes were destroyed, and approximately 100 other homes were damaged across the state (NOAA 2025c). A major disaster declaration (DR-4604) was issued for this event for Maui County, but not for Kaua'i County; however, there was no major disaster declaration issued for this disaster. Another flash flood on April 12, 2024, caused \$13.5 million in property damage along with evacuations and road closures (NOAA 2025c). The flooding caused by this event along with associated landslides led to the issuing of a major disaster declaration (DR-4793) and numerous state emergency proclamations.</p> |
| <b>Location</b>    | <p>The mapped 1% annual chance floodplain covers approximately 3% of the entire county (7,358 acres). The districts with the greatest areas of mapped floodplain are Waimea (4,375 acres), North Shore (2,063 acres), and East Kaua'i (1,538 acres). Figure 10-1 shows the FEMA-mapped flood hazard areas for inland and coastal flooding. Note that this information is based on the November 26, 2010, FIRMs and 2019 preliminary FIRMs that show the decertified levees on the Waimea River and Hanapēpē Stream. These levees have been decertified; however, the County is taking steps to obtain recertification (see Section 10.1.3). The levees are still physically present and provide some element of flood control, but the decertification means they are no longer fully compliant with FEMA requirements.</p> <p>A limitation of Figure 10-1 is that it shows inland and coastal flooding in a single map. Separating the FEMA-mapped flood areas into a map for inland flooding and coastal flooding presents an opportunity to improve understanding of the spatial extent of each hazard in the next MHMRP Update. It is also significant to note that areas outside of FEMA's mapped floodplains have experienced flooding (UH Sea Grant Extension Agent 2025). Additional mapping efforts, such as those described in Section 10.1.3, are needed to improve understanding of the specific spatial extent of flood events in the county.</p> <p>FEMA has identified 45 repetitive loss and severe repetitive loss properties that are within repetitive loss areas.</p> <p>Climate change is increasing the frequency and severity of flooding events as heavy precipitation events become more likely. This may expand the area that has previously been exposed to flood events.</p>   |

|                               |   |
|-------------------------------|---|
| <b>Frequency</b>              | <p>The planning area can expect an average of five minor flooding events (i.e., events not leading to a federal disaster declaration) per year based on all past recorded events included in this 2026 MHMRP Update. The planning area can expect a flood causing sufficient damage to lead to a major disaster declaration once about every 8 years or 0.13 event per year.</p> <p>In the period since the 2021 MHMRP Update, flooding events have occurred with a slightly decreased frequency. There have been 4 minor flooding events recorded on average per year. There has also been one major disaster declaration (DR-4693) in the past 5 years. Further, there have been three major disaster declarations issued in the past decade for flooding in Kaua'i, which is an average of one event every 3.33 years or 0.3 major flooding events per year. This indicates the frequency of these events may be increasing. Furthermore, climate change is expected to increase the frequency of heavy precipitation events in Kaua'i, which will lead to more flooding events than historically observed (see Section 10.1.2).</p> |
| <b>Severity</b>               | <p>Floods that cause millions of dollars in damage or lead to major disaster declarations are not uncommon in the planning area. At least five such events have been recorded since 2000.</p> <p>In the period since the 2021 MHMRP Update, there have been two events leading to millions of dollars in damage. This represents an increase in the severity of flooding events as two of the five events causing over \$1 million in damage over the past 24 years have occurred in the past 5 years. The frequency of flooding events leading to major disaster declarations has also been increasing over the past decade, indicating a growing severity of flooding events. This severity will continue to rise as climate change makes heavy precipitation events more likely on Kaua'i, which will lead to an increase in flooding (see Section 10.1.2).</p>  |
| <b>Warning Time</b>           | <p>Due to the sequential pattern of weather conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger. Watches, warnings, and advisories can be found at the NWS website for the Honolulu Forecast Office, which is available at the following link: <a href="https://www.weather.gov/hfo/">https://www.weather.gov/hfo/</a> (NWS 2025c)</p>  |
| <b>Repetitive Loss Status</b> | <p>Kaua'i County has 45 FEMA-identified repetitive loss properties and is classified as a Category B repetitive loss community (1–49 properties) under FEMA's Community Rating System (CRS) program. See Section 10.1.3 (Repetitive Loss Properties) for more information.</p>  |

See Section 4 for a description of elements included in the hazard profile.

### 10.1.1 Principal Flooding Problems

Principal problems for inland flooding on the island of Kaua'i, as identified in the 2021 FEMA Flood Insurance Study (FIS), include the following streams (FEMA 2021a):

- Hanalei River
- Kapa'a Stream
- Mo'ikeha Canal
- Waika'ea Canal
- Kekaha Drainageway
- 'Ōpaeka'a Stream
- 'Ōpaeka'a Tributary
- Nāwiliwili Stream
- Puali Stream
- Hanapēpē River
- Hikiula Gulch
- Anahola Stream
- Waikomo Stream
- Wainiha River
- Moloa'a Stream
- Halaulani Stream
- Waimea River

Appendix I presents a more detailed description of flooding in specific local areas.

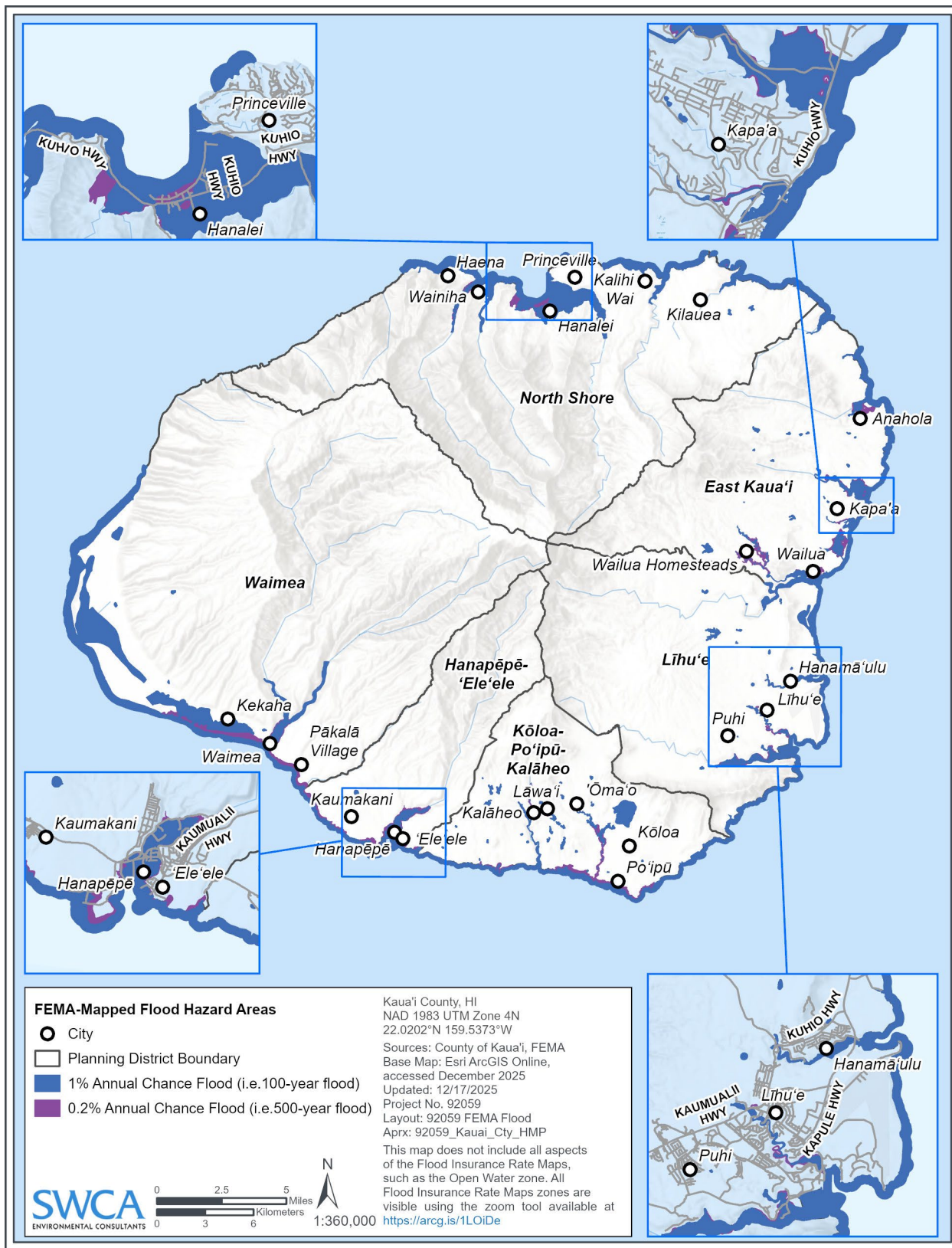


Figure 10-1. FEMA-mapped inland and coastal flood hazard areas (FEMA 2021b).

## 10.1.2 Climate Change

Historical hydrologic data has long been used to design and operate water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast runoff for water supply. This method of forecasting assumes the climate of the future will be similar to the period of historical record. However, the hydrologic record cannot be used to predict changes in the frequency and severity of future floods as climate change is causing a substantial deviation from the historical record. Going forward, modeling must happen more frequently, new forecast-based tools must be developed, and a standard of practice that directly considers climate change must be used. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

High frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Scientists project greater storm intensity, resulting in more runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. As hydrology changes, what is currently considered a 100-year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

Climate change has the potential to drastically increase the severity, location, and frequency of flooding in Kaua'i County. A decrease in average precipitation is expected in the state as a result of climate change. However, the intensity and frequency of precipitation events is simultaneously expected to increase. Climate change is expected to make heavy precipitation events more intense and frequent (Chen and Chu 2014; HI-EMA 2023). Changes in the La Niña and El Niño cycles as a result of climate change are also expected to make heavy precipitation events and the flooding they cause more frequent in the state (Cai et al. 2014; Chen and Chu 2014; State of Hawai'i 2025a). Increases in the quantity and frequency of precipitation will expand the area and number of people impacted by flooding.

## 10.1.3 National Flood Insurance Program

### National Flood Insurance Program

Kaua'i County participates in the National Flood Insurance Program (NFIP) and has adopted and enforced floodplain management regulations that meet or exceed the requirements of the NFIP. Kaua'i County's floodplain management ordinance was also reviewed and approved by FEMA as a condition of the 2021 FIRM updates (State NFIP Coordinator 2025). At the time of the preparation of the 2026 MHMRP Update, the County is in good standing with NFIP requirements (FEMA 2025e). Full compliance and good standing under the NFIP are application prerequisites for all FEMA grant programs for which participating jurisdictions are eligible under this plan.

In participating communities, structures permitted or built in the planning area before NFIP and related building code regulations went into effect are called pre-FIRM structures, and structures built afterward

are called post-FIRM. The insurance rate is different for the two types of structures. Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 Code of Federal Regulations (CFR) 60.3, but not less stringent. The Kaua'i County Code (Chapter 15) requires at least 1 foot of freeboard above the base flood elevation for new structures, substantial improvements, or substantially damaged structures within a special flood hazard area (SFHA), as required for Community Rating System (CRS) participation. In some very specific instances, 2 feet of freeboard is required in these areas per the ASCE (2024).

The first FIRMs in the planning area were available in November 1981. The most recent FIRMs used for the vulnerability assessment in Section 10.2 are dated February 26, 2021, and are the current effective FIRMs for the county. Coastal flooding is discussed in detail in Section 11, High Surf, Coastal Flood, Erosion, and Sea Level Rise, and the FIRMs for coastal flooding have not been updated by FEMA since the 2021 MHMRP Update. Table 10-2 lists flood insurance statistics for Kaua'i County (FEMA Emergency Management Mitigation Specialist 2025; Kaua'i Floodplain Manager 2025).

**Table 10-2. Flood Insurance Statistics**

|  |                 |
|--|-----------------|
| <b>Date of Entry Initial FIRM Effective Date</b>             | 11/04/1981      |
| <b>No. of Flood Insurance Policies as of August 12, 2025</b> | 3,818           |
| <b>Insurance In Force</b>                                    | \$1,013,807,000 |
| <b>Total Annual Premium</b>                                  | \$3,974,921     |
| <b>Claims, as of August 12, 2025</b>                         | 1,549           |
| <b>Value of Claims Paid, as of August 12, 2025</b>           | \$48,014,692    |
| <b>Average Payment per Claim, as of August 12, 2025</b>      | \$30,997        |

### **Levees**

Table 10-3 lists the levees in Kaua'i County for the NFIP. FEMA only recognizes levees that meet minimum design, operation, and maintenance standards. 44 CFR Section 65-10 describes the information needed for FEMA to determine if a levee provides protection from the 1% annual chance flood. This information must be supplied to FEMA by the community or other party when a flood risk study or restudy is conducted, when FIRMs are revised, or upon FEMA's request. In 2010, Kauai's three levees, Waimea River (right bank) and Hanapēpē River (right bank and left bank) were de-accredited (Disaster Assistance Project Manager 2025). When the provisional accreditation agreement expired, FEMA undertook a new FEMA Flood Study, and the "new" 2021 FIRMs show the areas behind the levees as not being protected from the 1% annual chance flood and in a Special Flood Hazard Area (SFHA). While the levees do not currently meet the U.S. Army Corps of Engineers (USACE) and FEMA accreditation standards, they do provide an amount of flood control. The County is investigating what is necessary to bring the levees back up to USACE and FEMA accreditation standards.

FEMA also coordinates with the USACE to inspect and verify that levees meet maintenance and operation standards. Under Public Law 84-99, USACE has the authority to supplement local efforts to repair flood control projects that are damaged by floods.

The County has partnered with USACE to evaluate the feasibility of bringing the Waimea River (right bank) and Hanapēpē River (right bank and left bank) levees back up to the USACE and FEMA accreditation standards. All three levees were de-accredited in 2010, and the current FIRMs show the communities behind the levees in a SFHA. The USACE Risk Management Center began working on a Semi-Quantitative Risk Assessment (SQRA) of all three levees in the summer of 2025, and the USACE Honolulu District Office is conducting a Flood Control Modification Study of the Waimea River levee.

These studies will provide the County with a series of actions that can lead to re-accreditation of all three levees, possibly within the upcoming 5-year MHMRP planning cycle. Descriptions of the levees are followed by a discussion of the draft preliminary Waimea River levee and Hanapēpē River levees SQRA results and the preliminary Waimea River Flood Control Modification Study.

**Table 10-3. Levees in Kaua'i County**

| Flood Source    | Levee Location | Levee Owner                              | USACE Levee ID | FIRM Panels  | Levee Status as of 2021 |
|-----------------|----------------|--|----------------|--|-------------------------|
| Hanapēpē Stream | Left Bank      | County of Kaua'i Public Works Department | 3205052301     | 1500020287F<br>1500020289F                               | Decertified             |
| Hanapēpē Stream | Right Bank     | County of Kaua'i Public Works Department | 3205052302     | 1500020287F  | Decertified             |
| Waimea River    | Right Bank     | County of Kaua'i Public Works Department | 3205052401     | 1500020257E<br>1500020259F<br>1500020258F<br>1500020256F | Decertified             |

### ***Hanapēpē Stream – Left Bank and Right Bank***

According to the National Levee Database (NLD), the USACE conducted a risk assessment of the Hanapēpē River left bank and right bank levee systems. This risk assessment raised several concerns. First, the levees were built in 1966, and those design standards and regulations are now outdated. Efforts have been taken to maintain the levee systems, but they do not meet current design standards and regulations. The levees have also experienced embankment erosion. The levee design capacity has not been tested by a flood event in recent years. However, it has maintained adequate functioning during less severe flood events that did not reach the levee system's design capacity (USACE 2025a, 2025b).

### ***Waimea River – Right Bank***

The USACE also conducted a risk assessment of the Waimea River right bank levee, and it raised similar concerns. The current levee configuration was completed in 1984 and is expected to function adequately as long as the levee is not overtopped (USACE 2017). The levee does not meet current accreditation requirements of containing the 1% annual chance flood, and FEMA also de-accredited it in 2016 (Disaster Assistance Project Manager 2025). Additionally, there have been reports of sunny-day flooding in the Menehune Road area behind the Waimea River levee, which is likely due to water escaping through a ditch and a faulty flap gate (Disaster Assistance Project Manager 2025, UH Sea Grant Extension Agent 2025). Rectifying this issue is a possible mitigation project for a future MHMRP update.

### ***Semi-Quantitative Risk Assessment***

The SQRA results confirmed the concerns raised in earlier studies. Although early results indicate the Hanapēpē Rivers could contain the 1% annual chance flood, there remain significant concerns with some of the internal piping and with the flood barrier on the old Hanapēpē bridge. In addition, the levees would fail catastrophically under a "rain-bomb", 0.2% annual chance flood event. The Waimea River levee did not appear to contain the 1% flood event, in addition to failing catastrophically under the 0.2% annual chance flood event (Disaster Assistance Project Manager 2025). The overtopping of the levees would put all people and property behind the levees at risk from floodwaters up to 9 feet, leading to injuries and fatalities as well as extensive property damage (USACE 2025a). The communities behind the levees lack

a sufficient flood warning system for the flash flooding potential in both watersheds (Disaster Assistance Project Manager 2025).

### ***USACE Waimea River Flood Control Modification Report***

The USACE Honolulu District is in the process of producing the Waimea River Flood Control Modification Report. The draft Feasibility Report (USACE 2025c) is expected to be released for public review in January 2026, with the Agency Decision Meeting anticipated to occur in August 2026. This 2026 MHMRP Update will undergo public review in the fall of 2025 and therefore includes only a summary of the Feasibility Report (problem, objectives, opportunities, measures and alternatives).

The Waimea River Flood Control Project is intended to minimize flood risk for over 400 structures and 1,000 people. However, there are some current problems with the project. Notably, initial modeling suggests that overtopping of the Waimea River levees can occur with the 1% annual chance flood event. This presents the risk of injuries and fatalities to those behind the levee if it overtops, as well as the potential for significant infrastructure damage. There have also been reports of flooding behind the levee during typical rain events. Therefore, the objectives of conducting this study are to decrease threats to people, property, and infrastructure associated with flooding in Waimea, as well as the number of times that areas behind the levee flood.

There are several key opportunities associated with this study. One opportunity is to lower the risk of flooding to the Waimea community, which will increase community safety and lower potential damage to property and critical facilities and infrastructure. Another opportunity is to improve management of the Waimea River flow, leading to increased water quality. This study presents the opportunity to also lower sedimentation in the Waimea River, which may help water move through the channel more quickly and reduce flooding. Another opportunity is to better the drainage systems behind the levee to address flooding. Finally, this study offers the Waimea community the opportunity to increase flood resilience and grow awareness of flood risk.

There were also several constraints placed on the study. These included keeping risk to human safety within tolerable levels and not causing flooding on properties next to the study area. It also included avoiding negative impacts on environmental and cultural resources as well as on cultural and recreational activities in the study area. The project was additionally required to ensure the Highway 50 bridge continued to offer access to the study area.

At this time, only a list of the alternatives being considered is available. There is no additional information on the selected alternative. According to the Draft Feasibility Report, one or more of the following are being considered:

- **Levee raising:** Achieves primary study flood risk reduction and life safety objectives by raising the levee, thereby avoiding instances of overtopping.
- **Dredging:** Dredges sediment buildup in the river to increase efficiency of water conveyance, supporting achievement of primary study flood risk reduction and life safety objectives.
- **Levee raising and dredging:** Deliberately raises levee and dredges river to achieve primary study flood risk reduction and life safety objectives.
- **Levee raising and sediment minimization using natural features:** Raises levee and implements natural and nature-based features (i.e., native vegetation plantings) to minimize sediment build up; thereby achieving primary study flood risk reduction and life safety objectives.
- **Nonstructural flood risk reduction:** Uses nonstructural measures (i.e., elevation of homes) to achieve study flood risk reduction and life safety objectives.

- **Interior flooding management:** Implements specific measures (i.e., upsizing of pump station, dredging of interior drainage channel) to achieve study objectives to reduce instances of interior flooding.”

A similar USACE report is expected for the levees on Hanapēpē Stream, but the USACE has not yet initiated the report.

### **FEMA Risk Mapping, Assessment, and Planning Program**

The DLNR is a Cooperating Technical Partner in FEMA’s Risk Mapping, Assessment, and Planning (MAP) Program and worked with a consultant to provide improved best available data to better understand flood risk. The modeling uses recent LiDAR and local USGS gauge information to create Base Level Engineering analyses. The deliverables included peak flow calculations for the 10%, 4%, 2%, 1%, 0.2%, 1% plus and 1% minus annual chance flood events, one-dimensional hydraulic models using the Hydrologic Engineering Center’s River Analysis System (HEC-RAS) models, draft flood hazard areas, areas of mitigation interest, and depth grids. Most relevant to hazard mitigation planning will be the ability to use depth grids for impact analysis, mitigation options identified through the project, and outreach with Kaua’i County about the details of the analysis.

The deliverables are considered nonregulatory products, as revisions to the county's FIRMs and FIS are not included in the scope; however, the data may be used in the future to update regulatory products. Final deliverables were not included in the 2026 MHMRP Update as they were finalized after the 2026 MHMRP Update risk assessment was completed. At the final drafting of the 2026 MHMRP Update, these deliverables were complete and may be obtained by request from FEMA, the County of Kaua’i, or DLNR. This data may be integrated into a future MHMRP update.

Additionally, the project includes outreach with Kaua’i County about the studies and mitigation options.

### **Repetitive Loss Properties**

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of \$1,000
- Two paid losses in excess of \$1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

FEMA has identified 45 repetitive loss properties in the planning area as of the writing of the 2026 MHMRP Update; 84% of these structures are residential, and the rest are commercial (Kaua’i Floodplain Manager 2025). There have been no changes to the reported repetitive loss properties since the 2021 MHMRP Update, including the average loss claims. None of these properties have been identified as being mitigated. The probable causes of flooding for all properties in identified repetitive loss areas has been determined to be commensurate with the risk reflected in the SFHA mapping.

The repetitive loss property summary analysis includes the following findings:

- Fourteen of the 45 repetitive loss properties have average loss claims of less than \$10,000. Such losses are generally associated with localized flood events resulting from urban drainage issues or other smaller scale occurrences such as a water main break.
- Two of the properties incurred flood damage twice prior to the 1990s but have not filed a claim since.

- The remainder of the properties appear to have losses that correlate to the flood depths reflected in the FEMA mapping, so the losses are likely associated with the flood risk reflected in the mapping.

Efforts are being undertaken to further understand factors contributing to the repetitive loss of properties in the county. FEMA Region IX initiated the Risk MAP analysis of Kaua'i previously described, which will provide new tools to examine flood risk. The State of Hawai'i has also applied for a FEMA Swift Current grant that will analyze the County's repetitive loss properties and identify possible mitigation actions. These two efforts will look at the probable causes of flooding relative to the SFHA mapping and develop strategies for the county to begin to address its repetitive loss properties.

### **Community Rating System**

Kaua'i County went through CRS review in 2022, and, as of January 16, 2023, Kaua'i County is participating in the CRS with a Class 8 rating. CRS is a voluntary program for NFIP participating communities focused on reducing flood damages to insurable property and encouraging a comprehensive approach to floodplain management. The CRS provides incentives in the form of insurance premium discounts to communities that exceed the minimum floodplain requirements.

A Class 8 CRS rating qualifies NFIP policy holders for a 10% discount on NFIP premiums for most policies issued or renewed after April 1, 2023. The County has implemented 13 different activities that are in addition to the federal national standards for participation the NFIP. Many of the mitigation actions identified in this plan are creditable activities under the CRS program, including optional public involvement activities. Therefore, successful implementation of this plan offers the potential to enhance the CRS classification.

To earn a Class 8 Rating, the County met requirements across the following activities:

- Activity 310: Construction Certificate Management
- Activity 330: Outreach Projects
- Activity 340: Hazard Disclosure
- Activity 350: Flood Protection Information
- Activity 410: Floodplain Mapping
- Activity 420: Open Space Preservation
- Activity 430: Higher Regulatory Standards
- Activity 440: Flood Data Maintenance
- Activity 450: Stormwater Management
- Activity 502: Repetitive Loss Category
- Activity 510: Floodplain Management Planning
- Activity 630: Dams
- Activity 710: County Growth Adjustment

The County has the opportunity to expand and improve its CRS rating through the procurement of the Forerunner software. Forerunner can display both the applicable Floodplain Base Flood Elevation and Sea Level Rise Constraint District elevation in a side-by-side, public, user-friendly interface. The Department

of Public Works, which houses the Floodplain Manager, is in the process of getting the new software, which will be a valuable tool for analyzing and displaying NFIP/CRS-related data. This will help the County and residents better understand and mitigate inland flooding, coastal flooding, and sea level rise.

Table 10-4 shows the alignment between FEMA 4 Phase Guidance (FEMA 2025f), CRS planning steps, FEMA local mitigation tasks and federal code, and the 2026 MHMRP Update.

**Table 10-4. Mitigation Planning Process Used to Develop the 2026 MHMRP Update**

| FEMA 4 Phase Guidance                      | CRS Planning Steps (Activity 510)      | FEMA Local Mitigation Planning Handbook Tasks and 44 CFR 201.6   | Location in Plan   |
|--|--|--|--|
| Phase 1: Organize Resources                | Task 1: Organize Resources             | 1: Determine the Planning Area and Resources 44 CFR 201.6(c)(1)  | Section 1.3.1: Why Update?   |
|  |  | 2: Build the Planning Team 44 CFR 201.6(c)(1)  | Section 1.4.2: Core Planning Team and Steering Committee, Appendix B: Steering Committee Meeting Materials   |
|  | Task 2: Involve the public             | 3: Create an Outreach Strategy 44 CFR 201.6(b)(1)  | Section 1.4.3: Public Involvement, Section 15.5.2: Plan Maintenance Strategy   |
|  | Task 3: Coordinate with other agencies | 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)  | Section 1.4.2: Core Planning Team and Steering Committee, Section 1.4.3: Public Involvement, Section 3.1: Relevant Agencies, Programs, and Regulations, Appendix G: Relevant Agencies, Programs, and Regulations |
| Phase II: Assess Risks                     | Task 4: Assess the hazard              | 5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(iii) & (iiii)                          | Section 10.1: Hazard Profile   |
|  | Task 5: Assess the problem             |  | Section 10.2: Vulnerability Assessment, Section 10.3: Issues   |
| Phase III: Develop the Mitigation Strategy | Task 6: Set goals                      | 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(iii); and 44 CFR 201.6(c)(3)(iii) | Section 15.3: Goals and Objectives   |
|  | Task 7: Review possible activities     |  | Section 15.2: Mitigation Best Practices, Section 15.4: Mitigation Actions, Appendix O: Mitigation Best Practices Catalog, Appendix P: Action Plan Detail   |
|  | Task 8: Draft an action plan           |  | Section 15.1: Capabilities Assessment, Section 15.4: Mitigation Actions, Appendix N: Detailed Capabilities Assessment, Appendix P: Action Plan Detail  |
| Phase IV: Adopt and Implement the Plan     | Task 9: Adopt the plan                 | Review and Adopt the Plan  | Appendix Q: Adoption and Approval  |
|  | Task 10: Implement, evaluate, revise   | 7: Keep the Plan Current   | Section 15.5.2: Plan Maintenance Strategy  |
|  |  | 9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)  | Section 15.5.2: Plan Maintenance Strategy  |

## 10.2 VULNERABILITY ASSESSMENT

### 10.2.1 Scenario

The quantitative risk assessment for the Inland Flooding hazard was conducted for a 1% annual chance and a 0.2% annual chance riverine flood (Figure 10-2 and Figure 10-3). The flood zones used for the quantitative risk assessment presented in this 2026 MHMRP Update are based on the 2021 FIS and associated FIRMs. The spatial extent of the flood zone used is generally the same as that used in the 2021 MHMRP Update, which included primarily effective digital FIRMs (DFIRMs) dated November 26, 2010, and September 16, 2005, combined with what at the time were preliminary DFIRMs (PFIRMs) dated May 24, 2019. A series of maps that were PFIRMs at the time of the 2021 MHMRP Update became effective DFIRMs on February 26, 2021, to account for decertified levees on the Waimea River and the Hanapēpē River (County of Kaua'i 2020c). Additional detailed results of the risk assessment can be found in Appendix K.

### 10.2.2 Exposure

#### Population and Property

Detailed results for exposed populations and properties are provided by planning district in Appendix K; Table 10-5 summarizes the results for the entire planning area for the 1% annual chance flood and Table 10-6 summarizes the results for the 0.2% annual chance flood. Population exposure was taken from the Hazus estimates of the population exposed to the 1% and 0.2% annual chance flood zone.

**Table 10-5. Exposed Population and Property in Mapped 1% Annual Chance Riverine Flood Zone**

| <b>Population</b>                               |                  |
|---|------------------|
| Population Exposed                              | 29,536           |
| % of Total Planning Area Population             | 40.4%            |
| <b>Property</b>                                 |                  |
| Number of Buildings Exposed                     | 12,210           |
| Value of Exposed Residential Buildings          | \$7,314,169,000  |
| Value of Exposed Buildings                      | \$12,083,611,000 |
| Total Exposed Value as % of Planning Area Total | 49.1%            |

**Table 10-6. Exposed Population and Property in Mapped 0.2% Annual Chance Riverine Flood Zone**

| <b>Population</b>                               |                  |
|---|------------------|
| Population Exposed                              | 32,544           |
| % of Total Planning Area Population             | 44.5%            |
| <b>Property</b>                                 |                  |
| Number of Buildings Exposed                     | 12,597           |
| Value of Exposed Residential Buildings          | \$7,476,828,000  |
| Value of Exposed Structures                     | \$12,430,814,000 |
| Total Exposed Value as % of Planning Area Total | 50.5%            |

## **Critical Facilities**

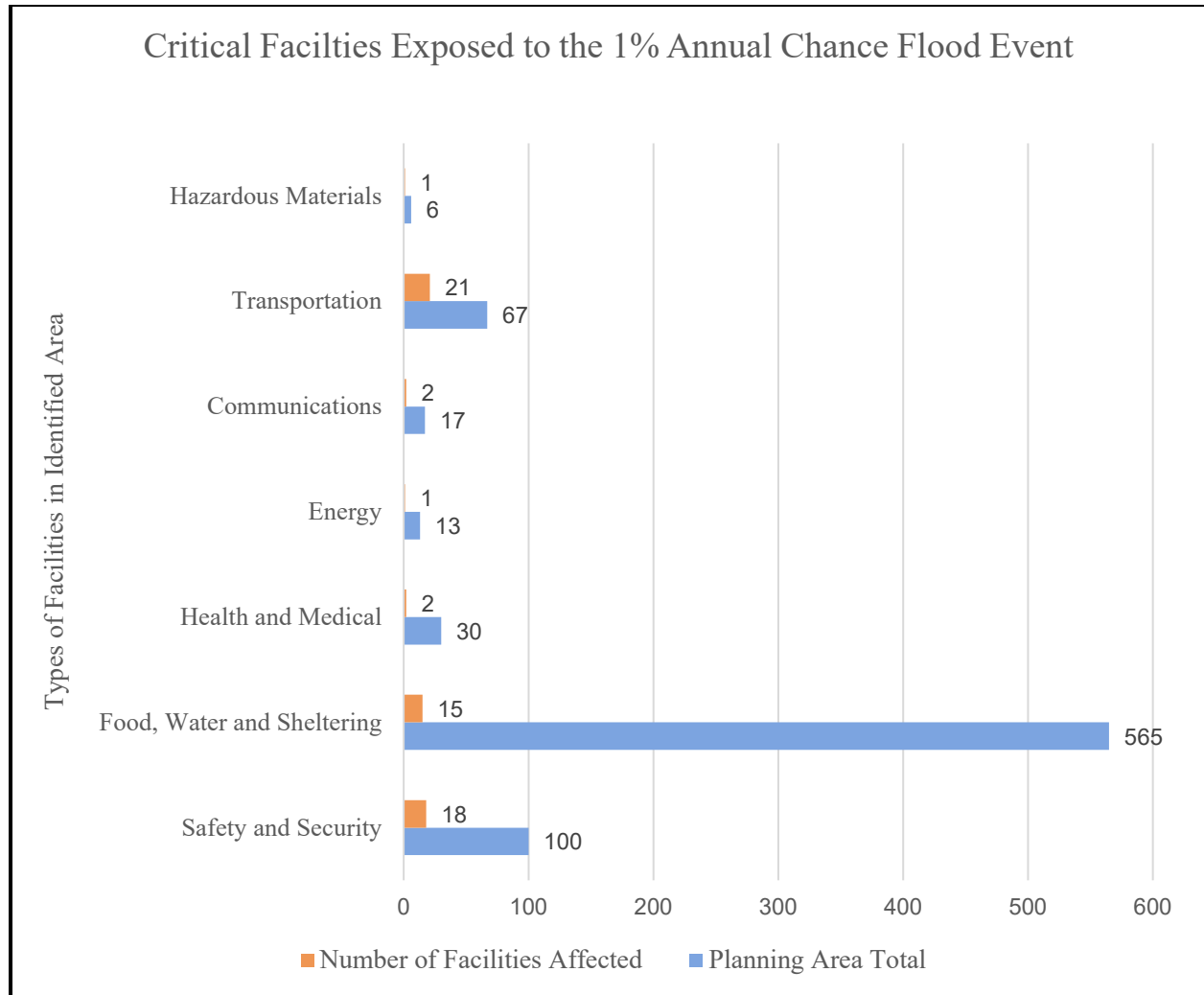
Critical facilities exposed to the 1% annual chance flood hazard represent 7.5% (60 facilities) of the total critical facilities in the planning area. Critical facilities exposed to the 0.2% annual chance flood hazard represent 8.6% (69 facilities) of the total critical facilities in the planning area. The breakdown of exposure by facility type is shown in Figure 10-2 and Figure 10-3, respectively.

The exposure of specific types of critical facilities has been quantified as follows:

- **Roads**—A complete analysis of roads in the inland (riverine) flood area can be found in Appendix L. The following major roads in the planning area pass through the 1% annual chance flood zone and thus are exposed to flooding:
  - Ahukini Road
  - Ala Kinoiki Road
  - Alae Road
  - Kamalu Road
  - Kapa'a Bypass
  - Kapule Highway
  - Kaumuali'i Highway
  - Kekaha Road
  - Kōke'e Road
  - Kōloa Road
  - Kuamo'o Road
  - Kūhiō Highway
  - Maluhia Road
  - Po'ipū Road
  - Rice Street
- **Bridges:** Flooding events can significantly impact road bridges. The risk assessment identified 20 bridges that are in or cross over the 1% annual chance flood zone, which all have a 98.8% chance of remaining functional during such an event. The risk assessment also identified 21 bridges that are in or cross over the 0.2% annual chance flood zone, which all retain a 97.5% probability of being functional during this type of an event.
- **Toxic Release Inventory Reporting Facilities:** Toxic Release Inventory facilities are known facilities that use certain chemicals above minimum thresholds. During a flood event, containers holding these materials can rupture and leak. The Hazus analysis identified one facility with hazardous materials within the 1% annual chance flood zone and the 0.2% annual chance flood zone.

## **Environment**

All environment within the 1% annual chance mapped floodplain is exposed to the flood hazard. Similarly, all environment within the 0.2% annual chance mapped floodplain is exposed to the hazard from the 0.2% annual chance flood.



**Figure 10-2. 2021 FIRMs – Critical facilities in the 1% annual chance flood zone and total critical facilities in the planning area.**

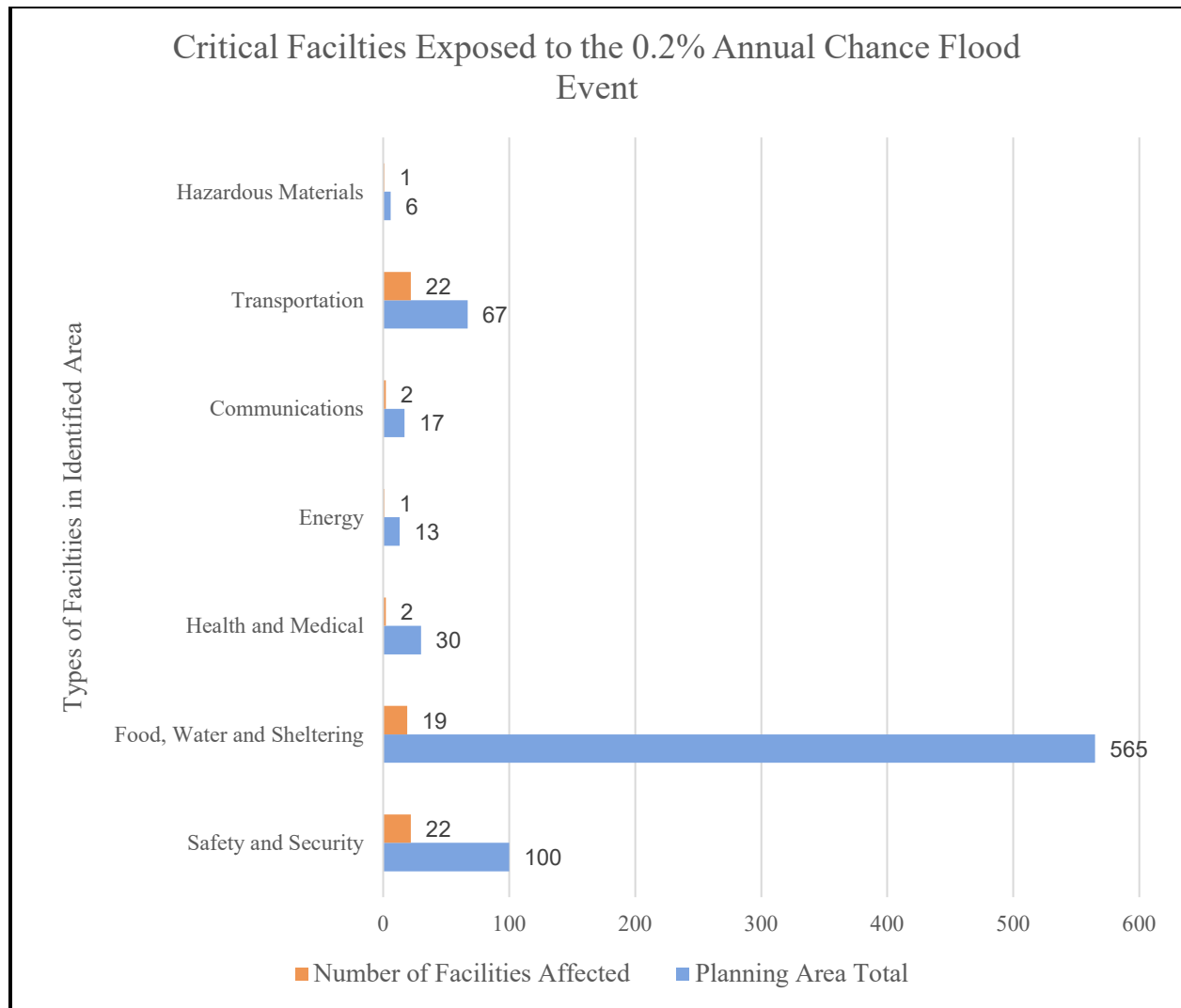


Figure 10-3. 2021 FIRMs – Critical facilities in the 0.2% annual chance flood zone and total critical facilities in the planning area.

### 10.2.3 Vulnerability

This section describes vulnerabilities for the total planning area in terms of population, property, critical facilities, and the environment. Detailed results by district are provided in Appendix K.

#### Population

##### ***Impacts on Persons and Households***

The Hazus analysis of impacts on persons and households in the planning area estimated that 6,624 people could be displaced by the 1% annual chance flood event and that 1,010 people would need sheltering. Hazus analysis also estimates that the 0.2% annual chance flood event could result in 8,113 people being displaced and 1,053 people requiring sheltering.

## ***Public Health and Safety***

Floods and their aftermath present the following threats to public health and safety:

- **Unsafe food:** Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat.
- **Contaminated drinking and washing water and poor sanitation:** Flooding impairs clean water sources with pollutants. The pollutants also saturate into the groundwater. Flooded wastewater treatment plants can be overloaded, resulting in backflows of raw sewage.
- **Mosquitoes and animals:** Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools. The public should dispose of dead animals that can carry viruses and diseases only in accordance with guidelines issued by local animal control authorities.
- **Mold and mildew:** Excessive exposure to mold and mildew can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases.
- **Carbon monoxide poisoning:** In the event of power outages following floods, some people use small gasoline engines, stoves, generators, lanterns, gas ranges, charcoal or wood for heating or cooking in enclosed or partly enclosed spaces. Carbon monoxide from these sources can poison people and animals.
- **Hazards when reentering and cleaning flooded homes and buildings:** Flooded buildings can pose significant health hazards to people entering them. Electrical power systems can become hazardous. Gas leaks can trigger fire and explosion. Flood debris may cause injuries.
- **Mental stress and fatigue:** People who live through a devastating flood can experience long-term psychological impacts. The expense and effort required to repair flood-damaged homes place severe financial and psychological burdens on the people affected.

## ***Social Vulnerability***

In many communities in Kaua'i, the 1% or 0.2% annual chance flood zone intersects with high social vulnerability. Communities may be especially vulnerable to flooding in these areas due to lower capacity to mitigate and respond. The overlap of high social vulnerability with the 1% or 0.2% annual chance flood zone is given in Table 10-7 by community (defined as census-designated places) within Kaua'i County. Only areas of a community that are classified as having the high and highest levels of social vulnerability (i.e., the 61st percentile or higher), and overlap at least partially with the 1% or 0.2% annual chance flood zone are included in the table. Notably, social vulnerability is measured by census block groups which do not align perfectly with each community. Social vulnerability can also vary within a given community. For example, within Kapa'a, a portion of the community which is in the center of the eastern side of the county falls within the high social vulnerability level and is in the 76th percentile compared with all other census block groups in the County. Kapa'a also contains 1% and 0.2% annual chance flood zones.

The "Community" column identifies areas within each community that fall into the high or highest levels of social vulnerability (above the 61st percentile), provided any part of the area overlaps with a hazard exposure zone. For example, if a community is classified with a high social vulnerability level and only a portion of it intersects with a hazard exposure area, the entire community is included in the table, even though only a smaller section is actually exposed to the hazard. While this method may overestimate vulnerability, it offers a broadly accurate overview of community risk. It is important to recognize that

social vulnerability and hazard exposure can vary within each community, but this analysis was unable to capture that variability.

Additionally, there are socially vulnerable populations throughout the planning area who may face increased risk from hazards, even in communities categorized as having lower levels of social vulnerability than those listed in Table 10-7. This analysis focused on the highest levels of social vulnerability defined by the SVI developed for the KCAAP (County of Kaua'i 2022b). Therefore, several communities have been excluded from this analysis due to lower levels of social vulnerability, including Wailua Homesteads, 'Ele'ele, Waimea, and Princeville. To examine the overlap of hazard exposure areas with these communities, please use the Hazard Mapping Tool on the Kaua'i MHMRP 2026 Story Map (County of Kaua'i 2025b).

**Table 10-7. Communities with High Social Vulnerability or Above in 1% or 0.2% Annual Chance Flood Zone**

| <b>Community:<br/>High Social Vulnerability Areas with (at least partial) Hazard Exposure</b> | <b>Social Vulnerability<br/>(Percentile)</b> | <b>Annual Percent<br/>Chance Flood</b> |
|---|--|--|
| Anahola:<br>Central area  | Highest (0.84)                               | 1%, 0.2%                               |
| Wailua:<br>Some Houselots, some Homesteads  | High (0.75–0.78)                             | 1%, 0.2%                               |
| Kapa'a:<br>East-central area of the community   | High (0.76)                                  | 1%, 0.2%                               |
| Līhu'e:<br>Some central and coastal areas   | High–Highest (0.67–0.92)                     | 1%, 0.2%                               |
| Po'ipū:<br>Southern area of the community   | High (0.61)                                  | 1%, 0.2%                               |
| Kōloa:<br>Around stream   | Highest (0.82–0.88)                          | 1%, 0.2%                               |
| Kalāheo:<br>Around stream   | High (0.65)                                  | 1%, 0.2%                               |
| Lāwa'i:<br>Northern, southern, and part of the central areas of the community                 | High–Highest (0.69–0.82)                     | 1%, 0.2%                               |
| Hanapēpē:<br>Southeast to northeast area of the community                                     | Highest (0.96)                               | 1%, 0.2%                               |
| Kekaha:<br>Central area of the community  | Highest (0.94)                               | 1%, 0.2%                               |
| Hā'ena:<br>Entire community   | High (0.73)                                  | 1%, 0.2%                               |
| Wainiha:<br>Entire community  | High (0.73)                                  | 1%, 0.2%                               |
| Hanalei:<br>Entire community  | High (0.63–0.73)                             | 1%, 0.2%                               |
| Kalihiwai:<br>Entire community  | High (0.8)                                   | 1%, 0.2%                               |
| Kīlauea:<br>Northern, eastern, and southwestern areas of the community                        | High (0.8)                                   | 1%, 0.2%                               |

The ways in which social vulnerability may impede a community's ability to mitigate and respond to a flood event are described in the following paragraphs for each social vulnerability category and indicator included in the County's SVI developed for the KCAAP. A 0.2% annual chance flood event would

expose more people and their property to the flood hazard; however, social vulnerability will lower a community's capacity to mitigate and respond to a flood similarly whether a 1% annual chance flood event or a 0.2% annual chance flood event occurs. Therefore, the remainder of the social vulnerability information is discussed for flooding in general and is not broken down by a 1% or 0.2% annual chance flood event.

**Household characteristics** include the population under the age of 17 and over age 65 as well as the population with a disability. These factors reduce the ability of individuals to mitigate and respond to floods. These groups may have more difficulty evacuating from flood waters if they are unable to operate a vehicle, move quickly, access emergency notifications, or wade through water. Older populations (over age 65) have been found to experience higher rates of accidental deaths during flood events such as from falling or drowning relative to the rest of the population. However, younger populations have been found to experience higher rates of non-accidental fatalities from flooding (e.g., deaths linked to flooding that includes cardiovascular, respiratory, or mental health-related issues) (Ban et al. 2023). Additionally, homeowners who are over the age of 65 or have a disability may have a harder time implementing flood mitigation measures on their properties, such as rain gardens or rain barrels. These groups may also have a harder time clearing out flood debris and ensuring areas subjected to flood waters are appropriately cleaned if a flood event were to occur, which may increase exposure to mold, mildew, and other contaminated materials.

**Socioeconomic status** factors include household income, the population with a bachelor's degree, and the population of outdoor workers. These factors can shape the ability to mitigate and respond to a hazard. Households with higher incomes are more likely to have additional resources to implement flood mitigation measures to minimize the risk of property damage from a flood. Additional resources can also facilitate evacuation in the event of a flood through access to a personal vehicle and the ability to pay for lodging during a flood and the subsequent recovery period. Exposure to the hazard can also be greater if homes and rental units in flood zones cost less in areas. This can result in higher concentrations of low-income groups in the higher risk zones. Outdoor workers are not necessarily more vulnerable to the flood hazard itself. However, workers involved in the cleanup of flood debris experience an increased threat due to the presence of materials that may be contaminated with toxic or hazardous waste, mildew and mold, or sewage.

**Race and ethnicity** impact the ability of a community to mitigate and respond to a flood event. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua'i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events including floods (County of Kaua'i 2022b). Additionally, linguistic isolation raises vulnerability to floods as it can create a barrier to accessing evacuation notices and procedures if these notices are not widely distributed in languages other than English. It also may lead to an inability to access flood mitigation resources.

**Physical conditions** also impact a community's mitigation and response capacity to flood events. Physical conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units can increase vulnerability to floods because renters may not have the authority to implement mitigation measures (e.g., forms of green infrastructure, sump pumps, gutter repairs) that would reduce the impacts of flooding on their residences. Landlords may also not be incentivized to allocate resources for these efforts to rental properties. Similarly, rent-burdened households may not have sufficient resources to devote to flooding mitigation or evacuation if needed. Houses built before the 1970s are vulnerable to flooding because they may not be built to the necessary codes to reduce flood risk. Similarly, mobile homes built in the 1970s

and prior to the development of federal standards are not sufficiently prepared for flood events (Curran-Groome et al. 2025). Lack of access to a vehicle also increases vulnerability as it can inhibit evacuation from flood waters and increase the risk of injuries and fatalities.

### **Property**

Table 10-8 and Table 10-9 summarize Hazus estimates of flood damage in the planning area. The debris estimate includes only structure debris, foundation debris, and building finishes. It does not include additional debris that may result from a flood event, such as from trees, sediment, building contents, or utility lines.

**Table 10-8. Estimated Damage from a 1% Annual Chance Flood Event in the Planning Area**

|   |                               |
|---|-------------------------------|
| <b>Debris Generated (Tons)</b>                    | 4,642 (186 25-ton truckloads) |
| <b>Buildings Impacted (1% damage or greater)</b>  | 429                           |
| <b>Total Value (Structure + Contents) Damaged</b> | \$100 Million                 |
| <b>Damage as % of Total Value</b>                 | 0.4%                          |

**Table 10-9. Estimated Damage from a 0.2% Annual Chance Flood Event in the Planning Area**

|   |                               |
|---|-------------------------------|
| <b>Structure Debris Generated (Tons)</b>          | 7,009 (280 25-ton truckloads) |
| <b>Buildings Impacted</b>                         | 542                           |
| <b>Total Value (Structure + Contents) Damaged</b> | \$134.4 million               |
| <b>Damage as % of Total Value</b>                 | 0.5%                          |

### **Critical Facilities**

Hazus was used to estimate the loss potential to critical facilities exposed to the flood risk, using depth/damage function curves to estimate the percent of damage to the buildings Table 10-10 shows the results for the 1% annual chance flood event, and Table 10-11 shows the results for the 0.2% annual chance flood event. Bridges exposed to the flood hazard are included in Figure 10-2 and Figure 10-3 but are excluded from Table 10-10 and Table 10-11, because Hazus cannot apply the same damage models to bridges (FEMA 2025a).

**Table 10-10. Estimated Impact of a 1% Annual Chance Flood Event on Critical Facilities**

| <b>Facility Type</b>       | <b>Number Affected</b> | <b>% of Building Damaged</b> |               |                |
|----------------------------|------------------------|------------------------------|---------------|----------------|
|                            |                        | <b>0–10%</b>                 | <b>10–20%</b> | <b>&gt;21%</b> |
| Safety and Security        | 18                     | 18                           | –             | –              |
| Food, Water and Sheltering | 15                     | 12                           | 3             | –              |
| Health and Medical         | 2                      | 2                            | –             | –              |
| Energy                     | 1                      | 1                            | –             | –              |
| Communications             | 2                      | 2                            | –             | –              |
| Transportation             | 1                      | 1                            | –             | –              |
| Hazardous Materials        | 1                      | 1                            | –             | –              |
| <b>All Facilities</b>      | <b>40</b>              | <b>37</b>                    | <b>3</b>      | <b>–</b>       |

**Table 10-11. Estimated Impact of a 0.2% Annual Chance Flood Event on Critical Facilities**

| Facility Type              | Number Affected | % of Building Damaged |          |          |
|----------------------------|-----------------|-----------------------|----------|----------|
|                            |                 | 0–10%                 | 10–20%   | >21%     |
| Safety and Security        | 22              | 22                    | –        | –        |
| Food, Water and Sheltering | 19              | 12                    | 6        | 1        |
| Health and Medical         | 2               | 2                     | –        | –        |
| Energy                     | 1               | 1                     | –        | –        |
| Communications             | 2               | 2                     | –        | –        |
| Transportation             | 1               | 1                     | –        | –        |
| Hazardous Materials        | 1               | 1                     | –        | –        |
| <b>All Facilities</b>      | <b>48</b>       | <b>41</b>             | <b>6</b> | <b>1</b> |

A major storm during the rainy season that occurs during high tide could flood numerous areas in a short time, overwhelming the response and floodplain management capability within the planning area. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, Kaua'i County would not be able to make repairs quickly enough to restore critical facilities.

### **Environment**

Flooding can harm the environment. Pollution from roads can wash into rivers and streams. Stream bank erosion due to flooding can cause rivers and streams to migrate into nonnatural courses. Fish can wash into roads or flooded fields. Loss estimation platforms such as Hazus are not equipped to measure the environmental impacts of flood hazards. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing such data from future events could aid future assessments of the environment's vulnerability.

## **10.3 ISSUES**

### **10.3.1 Development in High-Hazard Areas**

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land. Figure 10-4 shows the distribution of land use types in the flood zones. The dominant land uses are open areas and agricultural uses, which are considered to be lower-risk uses for the floodplain. Most homes and facilities are in areas designated urban center, neighborhood center, neighborhood general, or residential communities. In all, 11.2% of the inland flooding hazard area is highly developed.

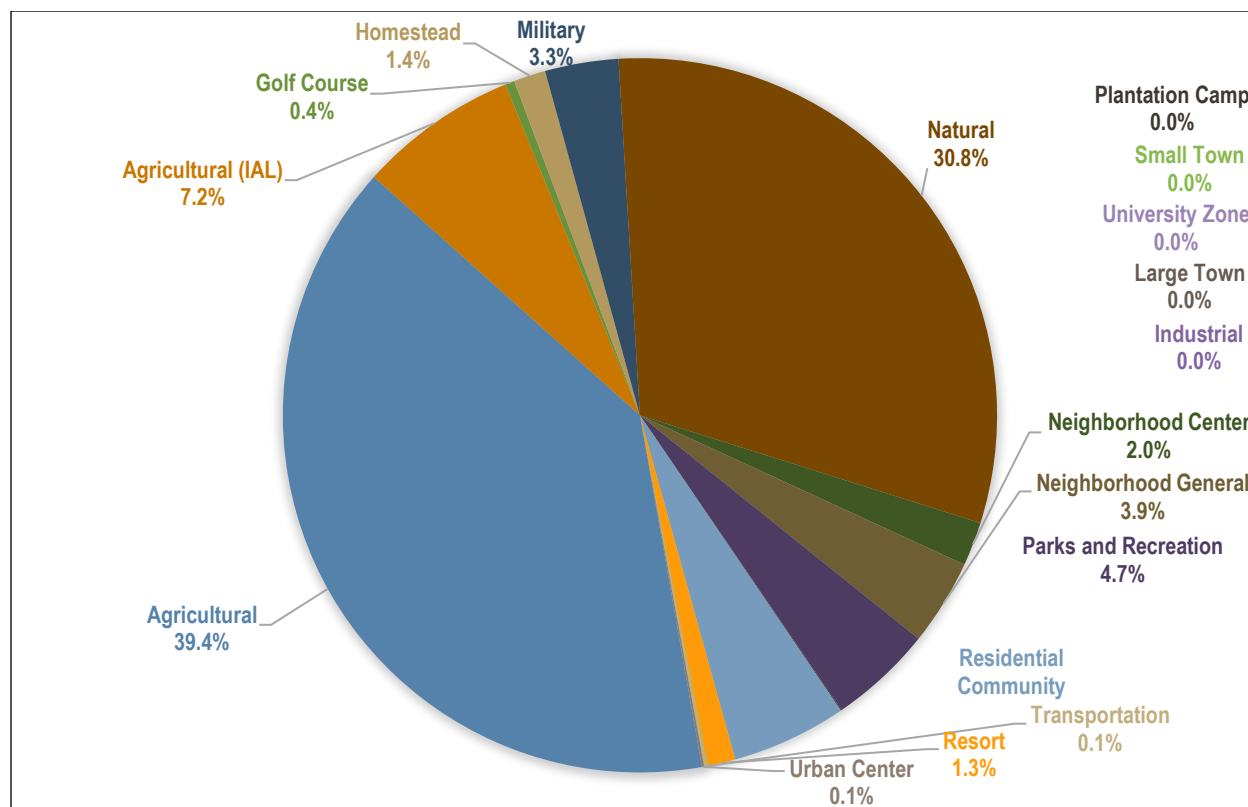


Figure 10-4. Land use distribution by area in the 1% annual chance riverine flood hazard area.

The U.S. Census Bureau 2024 Population Estimates Program (PEP) estimates that Kaua'i County has a population of 73,840. The population is also expected to grow by 1% each year, reaching over 88,000 people by 2035 (County of Kaua'i 2018). Kaua'i County is equipped to handle future growth within flood hazard areas. The County participates in the NFIP and has adopted a flood damage prevention ordinance in response to its requirements. Kaua'i County has committed to maintaining its good standing under the NFIP through initiatives identified in this plan. Linking the County's general plan and community plans to this 2026 MHMRP Update will create an opportunity for wise land use decisions as future growth impacts flood hazard areas.

### 10.3.2 Other Issues

The following issues have been identified related to the Inland Flooding hazard in the planning area:

- Cascading hazard event potential:** Flooding poses a substantial problem on its own but can also be a devastating component of cascading hazard events. Bank erosion can occur as a result of flooding. This is especially dangerous in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Landslides can also become more frequent as increases in heavy rainfall saturate the soil and decrease its stability. A wildfire or drought preceding a heavy rainfall event makes the likelihood of landslides even greater (HI-EMA 2023). Potential increases in the frequency and intensity of wildfires due to climate change, also increases the potential for more floods following fire, which increase sediment loads and water quality impacts. Heavy rain events may also increase the risk of dam failure or dams overflowing. Finally, hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers.

- **Visitor awareness for flooding:** Visitors are often unaware of the flooding dangers in the areas of their accommodations and activities. Public awareness campaigns could target visitor accommodations to inform visitors of the flood risks.
- **Hiker outreach for flash flooding:** Tourists hiking Kauaʻi County’s numerous trails are not always cognizant of issues associated with flash flooding. The County could develop a tourism outreach program specifically designed to inform hikers about the danger and potential for flash flooding.
- **Levee renovation:** Older levees are subject to failure or do not meet current building practices for flood protection. The County should discuss and investigate the resources needed to bring these levees up to date and reaccredited.
- **Multi-hazard mitigation techniques:** The risk associated with the flood hazard overlaps the risk associated with other hazards such as hurricanes and landslides. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- **Risk-based analysis:** Collect more information on flood risk to support the concept of risk-based analysis of capital projects.
- **Historical data collection:** There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the effectiveness of future mitigation.
- **Funding identification:** Ongoing flood hazard mitigation will require funding from multiple sources.
- **Resident education:** Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- **Residual risk:** Residual risk (the risk that remains after all mitigation actions and risk reduction actions have been completed) associated with the flooding hazard is high due to the topography and nature of flooding in Kauaʻi County. The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.
- **Continue emphasizing the value of flood insurance:** As a flood-prone area, Kauaʻi County understands the importance and power of educated residents. The County should continue the promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events.
- **Upholding land use regulations:** Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the planning area during times of moderate to high growth.
- **Proactive floodplain management:** The economy affects a jurisdiction’s ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management. The County should proactively manage current and future floodplains during affluent times to ensure self-sustainment of floodplains during budget cuts and personal losses.
- **Repetitive loss properties:** Several repetitive loss properties are located outside of FEMA-mapped flood zones. Additional investigation and outreach should be conducted to determine likely sources of flood damage for these properties.
- **Continuity of operations:** Critical facility owners should be encouraged to include inland flood considerations in their continuity of operations plans, using the information on risk and vulnerability contained in this plan.

- Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- Personal planning resources:** Additional information on emergency shelters as well as emergency management resources can be found on the KEMA Facebook page and website (KEMA 2025). The state website also includes a link to the DLNR Flood Hazard Assessment Tool: <https://fhat.hawaii.gov/> (DLNR DOFAW 2025c).
- Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by inland floods. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people’s safety during evacuations and in community shelters (County of Kaua’i 2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua’i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the Inland Flooding hazard, based on the hazard profile and vulnerability assessment, is given in Table 10-12.

**Table 10-12. Risk Ranking Summary for Inland Flood**

| Priority | Hazard Event | Probability | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time  | Duration         | Risk Score |
|----------|--------------|-------------|--|--------------------------|----------------------|----------------|---------------|------------------|------------|
| 6        | Inland Flood | Likely      | Critical   | Limited                  | Medium               | Small          | 4:01–24 hours | Less than 1 week | 2.6        |

## 11. HIGH SURF, COASTAL FLOOD, EROSION, AND SEA LEVEL RISE

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The greatest number of fatalities, injuries, and rescues in the Hawaiian Islands are from high waves breaking at the shoreline. High surf, resulting from dangerous and damaging waves, is typically described as waves ranging in height from 10 feet to 20 feet or more. These waves result from storms passing across the higher latitudes of the Northern and Southern Hemispheres in addition to storms passing across the Central Pacific in proximity to the Islands. The hazards associated with high surf include debris overwash, flooding, erosion, high wave energy and turbulence in the near shore zone, and strong currents. These high wave events threaten lives, coastal property, and infrastructure.

Coastal floods are characterized by the inundation of normally dry lands by ocean waters. This flooding is often caused by storm surge that occurs during severe storms, tsunamis, or extreme high tide events (sometimes called king tides, which are described in more detail below) that result in shallow flooding of low-lying coastal areas. Coastal floods typically result in coastal erosion, salinization of freshwater sources, and contamination of water supplies. These floods are also responsible for significant agricultural losses, loss of life and damage to public and private structures and infrastructure. To assist in planning for coastal flooding events and assessing the risks associated with them, coastal hazard zones are included on FIRMs, and flood elevations for Kaua'i County include locations with wave heights estimated to be greater than 3 feet.

King tides, which are scientifically referred to as perigean spring tides, are extreme tides that occur as a result of the gravitational pull of the sun and the moon on the Earth. These tides occur when the moon, sun, and Earth are aligned and as close together as possible, so the gravitational pull of both the sun and moon is particularly strong on the Earth. This results in extreme high and low tides. King tides generally occur on Kaua'i in the summer and winter months. These tides are not a result of climate change. However, when the high tides associated with king tide events co-occur with storms or high-surf events, the damage can be particularly devastating. In these circumstances, waters that were already high are pushed farther inland by these storms, which are anticipated to become more intense due to climate change. Additionally, rising sea levels mean that future high tide events will reach farther inland due to higher mean sea levels (University of Hawai'i Sea Grant College Program 2025). The king tides currently experienced on Kaua'i might become the future mean sea level for the county. The University of Hawai'i and the Pacific Islands King Tides Project are currently undertaking an effort to assess the current impacts of king tides with an understanding that they could reflect future mean sea levels.

Coastal erosion along Kaua'i's shores takes two forms. One is long-term, chronic coastal erosion, where high tides and currents, along with chronic sea level rise, contribute to sand loss and erosion (UH Sea Grant Extension Agent 2025). The other is event-based coastal erosion that occurs when a particular event of high surf or coastal flooding wears away rocks, soil, and sand along a coastline. In Hawai'i, approximately 70% of beaches are undergoing long-term erosion, and about 13 miles of beaches have been completely lost, with ~3.7 miles lost on Kaua'i (Fletcher et al. 2012; Romine and Fletcher 2012). Sand loss is further accelerated by human development, particularly hard structures on land and sea walls (UH Sea Grant Extension Agent 2025). Coastal erosion is concerning as beaches serve as a buffer between wave action and the land. Without this buffer, coastal erosion has the potential to exacerbate high-surf or tsunami/run-up incidents along coastal flood zones subject to wave action. Additionally, beaches are a crucial piece of Hawai'i's social fabric and economy (County of Kaua'i 2022b).

Additional general information on the High Surf, Coastal Flood, Erosion, and Sea Level Rise hazard is provided in Appendix I.

## 11.1 HAZARD PROFILE

Table 11-1 summarizes the key elements of the High Surf, Coastal Flood, Erosion, and Sea Level Rise hazard profile for Kaua'i County (NOAA 2025c). The frequency and severity of flooding for coastal systems are measured using wave heights. See Section 4 for a description of elements included in the hazard profile.

**Table 11-1. High Surf, Coastal Flood, Erosion, and Sea Level Rise and Sea Level Rise Hazard Profile Summary**

|                    |  |
|--------------------|--|
| <b>Past Events</b> | <p>In February 2016, high surf of 55 feet resulted in beach erosion, damage to roadways, and one fatality at Queen's Bath. In November 2016, high surf of 25 to 40 feet resulted in one death east of Kīlauea. In January 2017, swells of 15 to 30 feet were recorded and led to one fatality.</p> <p>According to NOAA's National Centers for Environmental Information (NCEI) database, 80 high-surf events have occurred on Kaua'i since the 2021 MHMRP Update. None of these events resulted in injuries or fatalities on Kaua'i. There was a high-surf event on Kaua'i's south side from July 13, 2022, through July 19, 2022, that resulted in \$7,000 in damages. This event caused damage to Hoone Road in Po'ipū that required emergency repairs. However, none of the other high-surf events resulted in recorded damages.</p> <p>It is important to note that not all costs associated with high-surf events are recorded in the NCEI database. For instance, erosion is not considered in damage estimates, though high-surf events may cause erosion that put waterfront property and crops at greater risk of future damages. Additionally, there are costs associated with cleanup from high-surf events that are not captured in the NCEI database. Information about the monetary damage and other costs related to high-surf events beyond that recorded in the NCEI database is not currently available.</p>  |
| <b>Location</b>    | <p>All Kaua'i's coasts may experience high surf, coastal flooding, and erosion. North and west-facing shores tend to experience the highest recorded surf levels in Hawai'i, generally in winter. East-facing shores can experience trade wind swell-induced waves, and south-facing shores are exposed to Kona storms and southern swells. While north- and west-facing shores can experience the highest swells, these shorelines are also better equipped to handle high surf due to the geologic processes that have shaped them (NWS 2025i). Storms, including tropical cyclones, may impact any of Kaua'i's shoreline leading to coastal flooding. Additionally, long-term erosion of sandy beaches affects many parts of the island with 78% of east beaches and 76% of north beaches experiencing erosion. South beaches (63%) and west beaches (64%) are also experiencing erosion (Fletcher et al. 2012).</p> <p>The highest swells occur in most cases on north- and west-facing shorelines in Hawai'i where north Pacific swells arrive in the winter with regularity in heights exceeding 12 feet that can reach up to 40 feet. Sets of these large waves are characterized by rapid onset so that within a few seconds they can double in size, often catching unaware swimmers, fishermen, and hikers walking along the shoreline. The water level on the coast increases with these large waves, and rip currents are generated as excess water surges seaward. However, other shores can be less prepared to experience high surf like that observed on the north and west sides of islands as this level of high surf rarely occurs and a greater severity of damage may result (NWS 2025i).</p> <p>A higher percentage of sandy beaches on the north and east sides have experienced erosion. However, data examining the rates of erosion along Kaua'i's shoreline have not been updated since the 2021 MHMRP Update. More information about the location of high-surf, coastal flooding, erosion, and sea level rise hazards can be found in Appendix I.</p> <p>FEMA also designates coastal SFHAs as part of the NFIP FIRMs. These are areas at particular risk from coastal flooding and include areas where floods are likely to result in waves greater than 3 feet in addition to the 1% annual flood elevation for still water. Areas where waves are likely to be less than 3 feet have a different designation, though waves less than 3 feet and greater than 1.5 feet can cause substantial damage to infrastructure that was not built to endure coastal hazards. Figure 10-1 in Section 10, Inland Flooding, includes these FEMA-mapped coastal flood zones. Notably, coastal SFHAs were not developed to show where high-surf events occur but provide an estimate of the area that is at risk.</p> <p>As all Kaua'i's coasts can experience high surf, coastal flooding, and erosion, it is concluded the location of areas exposed to these hazards has not significantly changed since the 2021 MHMRP Update; however, climate change will likely expand the area experiencing the effects of high surf, coastal flooding, and erosion in the future. An increase in tropical cyclone intensity may increase the severity of high-surf events that inundate farther inland, leading to additional coastal flooding and erosion. Rising sea levels will also contribute to higher erosion rates. The combination of these two factors may increase the spatial extent of high-surf events and coastal flooding to areas that had not previously experienced them as seawater inundates further inland.</p> |

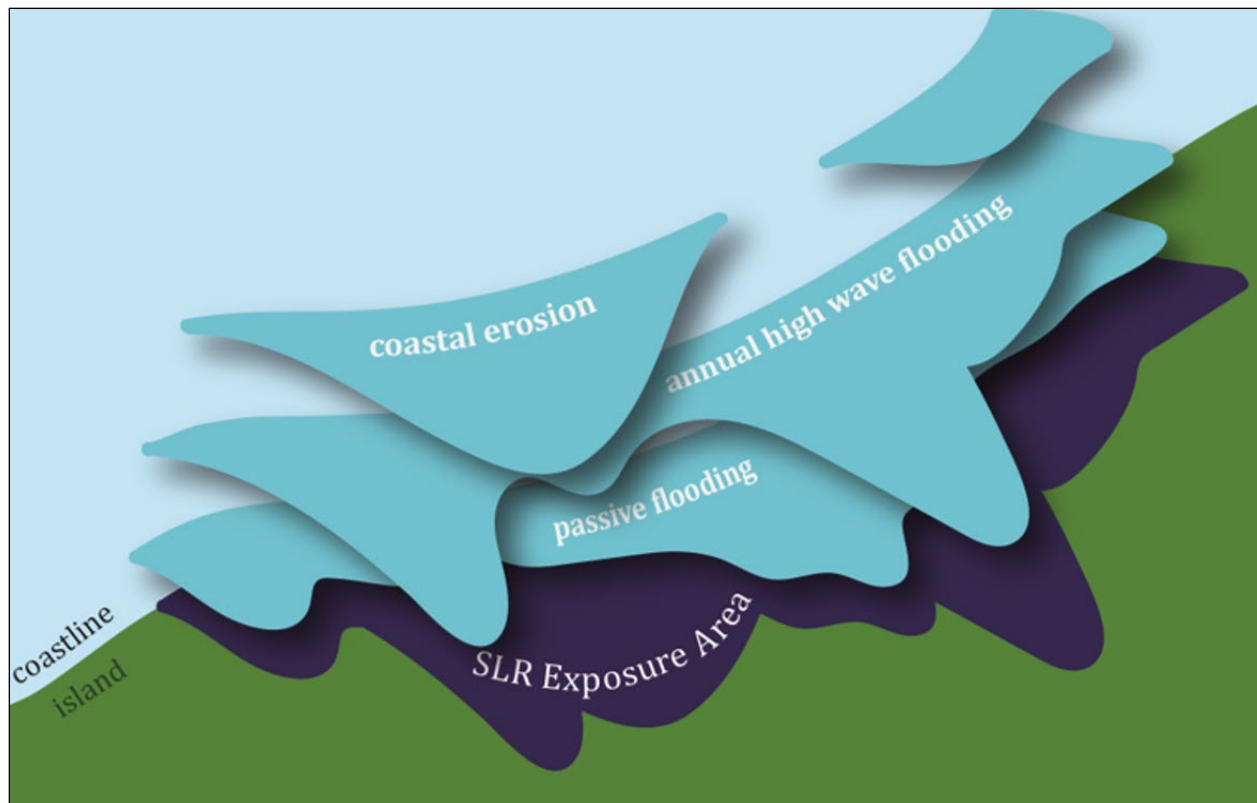
|                     |  |
|---------------------|--|
| <b>Frequency</b>    | <p>From January 2018 through December 2024, 175 high-surf events occurred on Kaua'i on all coasts of Kaua'i County, an average of approximately 29 events per year. This period covers all high-surf events recorded in the 2021 MHMRP Update (2018 through 2020) and events that have occurred since the 2021 MHMRP Update (2020 through 2024).</p> <p>Between 2020 and 2024, there were 80 high-surf events recorded. On average, 16 events have occurred each year. This represents a decrease in the number of events experienced per year from the average recorded between 2018 and 2024 of 29 events per year. Table I-13 in Appendix I contains a record of these events.</p> <p>Climate change is also likely to impact the frequency of high-surf, coastal flooding, and erosion events. There is a chance that potential changes in the trade winds and the uncertain weather patterns these changes may decrease the predictability of high-surf events; however, these winds are less influential over the occurrence of high-surf events than extratropical distant swells. Similarly, there is a chance that climate change increases the frequency of tropical cyclones leading to a higher number of associated high-surf events, but the impact of climate change on the frequency of tropical cyclone events is uncertain. The likelihood of coastal flooding and subsequent erosion of the shoreline will also increase due to sea level rise and additional high-surf events. See Section 11.1.2 for more information about the impacts of climate change on these coastal hazards.</p> |
| <b>Severity</b>     | <p>The wave zone of impact generally coincides with FEMA's V and VE FIRM zones for coastal flooding. These zones are subject to flooding and high velocity wave action (although some action identified is from tsunami events). The inland extent of the wave impact zone is expected to be much greater than the erosion zone. Base flood elevations that include wave height range from 5 to 26 feet for a 1% annual chance event in the planning area (FEMA 2021a: 54-62). More detailed information on high-surf and coastal flooding events can be found in Appendix I.</p> <p>The severity of high surf, coastal flooding, and erosion is largely unchanged since the 2021 MHMRP Update; however, climate change may increase the severity in the future. Tropical cyclone events affecting Kaua'i are expected to increase in intensity due to climate change which could lead to an increase in accompanying high-surf event severity (i.e., larger swells). Increases in sea level rise and high-surf events will likely cause higher erosion rates. Coastal flooding may then occur at greater depths or cover a larger spatial extent as storm events become more severe with the potential for higher storm surge and as sea level rise and erosion reduce the buffer between the ocean and property, infrastructure, crops, and other resources.</p>   |
| <b>Warning Time</b> | <p>The timing of individual waves cannot be predicted; however, general forecasting can be made about surf conditions. High-surf warnings and high-surf advisories are issued by the NWS.</p> <p>Watches, warnings, and advisories can be found at the NWS website for the Honolulu Forecast Office, which is available at the following link: <a href="https://www.weather.gov/hfo/">https://www.weather.gov/hfo/</a> (NWS 2025c). More information on warnings is found in Appendix I.</p>   |

### 11.1.1 Sea Level Rise

Kaua'i is highly vulnerable to sea level rise as an island, especially because high surf, coastal flooding, erosion, and sea level rise compound upon one another to pose a greater threat to Kaua'i's coastlines. This section discusses sea level rise, sea level rise exposure in Hawai'i, and how these factors are integrated into the 2026 MHMRP Update. It is significant to note that, unlike the other hazards described in the 2026 MHMRP Update, sea level rise is a chronic condition. Increases in sea level do not subside or revert to lower levels that were once experienced (UH Sea Grant Extension Agent 2025).

Sea levels provide a key to understanding the coastal impacts of climate change. Long-term sea level records capture changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity. Current estimates predict the Hawaiian Islands will experience 0.6 to 1.5 feet of sea level rise by 2050 (Sweet et al. 2022). This puts coastal communities at increasing risk from coastal hazards (floods, storm surges, and coastal erosion).

The *Sea Level Rise Vulnerability and Adaptation Report* prepared by the Hawai'i Climate Change Mitigation and Adaptation Commission in 2017 and updated in 2022 (Hawai'i State Climate Commission 2022) provides a statewide assessment of Hawai'i's vulnerability to sea level rise. The assessment is based on an aggregate of hazard data defining the "chronic sea level rise exposure area" (SLR-XA). The SLR-XA includes passive flooding, coastal erosion, and annual high wave run-up with sea level rise (Figure 11-1).



**Figure 11-1. Hazard data used to determine chronic sea level rise exposure area (SLR-XA).**

The *Sea Level Rise Vulnerability and Adaptation Report* outlines recommendations to reduce exposure and sensitivity to sea level rise and increase capacity to adapt (Hawai'i Climate Change Mitigation and Adaptation Commission 2017). The report's recommendations are based on emerging good practices and framed through extensive stakeholder consultations. A sea level rise risk assessment for this 2026 MHMRP Update used data from the report for Kaua'i County and from the Hawai'i Statewide Geographic Information System (GIS) Program (Hawai'i Climate Change Mitigation and Adaptation Commission 2017; Tetra Tech 2022). The data provide a preliminary, generalized overview of the potential impacts of one facet of climate change for the planning area. It should be noted that all sea level rise exposure data is based on projections that contain uncertainties as to future conditions in the planning area. The next MHMRP update may have new data that improves upon the sea level rise projections in this 2026 MHMRP Update.

As sea level rise is interconnected to high surf, coastal flooding, and erosions, two factors of sea level rise risk were identified and integrated into the risk assessment for this hazard:

- **Chronic sea level rise exposure area (SLR-XA):** The chronic sea level rise exposure area is the area predicted to be inundated under ongoing normal conditions in the future. For the 2026 MHMRP Update risk assessment, a sea level rise scenario of 3.2 feet of rise was evaluated. 3.2 feet of sea level rise by the end of the century was considered to be a mid-range estimate in the 2017 Sea Level Rise Vulnerability and Adaptation Report (Hawai'i State Climate Mitigation and Adaptation Commission 2017). The area of future chronic exposure for this estimate is shown in Figure 11-2. A more recent projection places the mid-range estimate of sea level rise for Hawai'i at a 3.6-foot rise (Sweet et al. 2022). However, data is not yet available for this scenario. The University of Hawai'i Coastal Research Collaborative is working on next-generation modeling that will likely update the best available sea level rise exposure data in the state

(UH Sea Grant Extension Agent 2025). As of the final drafting of the 2026 MHMRP Update, the data available for 3.2 feet of sea level rise exposure constitutes the best available data.

- **Event-based sea level rise exposure area:** The event-based inundation area is the area that would be exposed to 3.2 feet of chronic sea level rise combined with inundation from a 1% annual chance coastal flood event (Coastal Flood + SLR). This area is shown in Figure 11-3. Coastal flooding refers to event-based coastal flooding as opposed to chronic coastal flooding in this 2026 MHMRP Update.

### 11.1.2 Future Conditions and Climate Change

The coastal areas of Kaua'i are likely to be heavily impacted by climate change due to the combined effects of sea level rise, coastal flooding, high surf, and erosion. Increases in sea level rise will expand the spatial extent of coastal flooding and erosion, which will progressively expose more area to flooding. Changes in the frequency and intensity of storms, increases in precipitation, and warmer ocean temperatures will also impact the shorelines of Kaua'i. According to NASA, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion. The combined impacts of these events occurring at the same time and compounded by climate change could result in a much higher rate of coastal erosion and flood frequency than previously experienced (Ruggiero 2008).

As an island, Kaua'i County is particularly sensitive to the impacts of climate change on coastal erosion. According to the Intergovernmental Panel on Climate Change (IPCC), small islands can anticipate the following effects of climate change (IPCC 2023):

- Inundated and displaced wetlands and lowlands
- Eroded shorelines
- Exacerbated coastal storm flooding
- Increase in salinity of estuaries, threatening freshwater aquifers and otherwise impairing water quality
- Alteration of tidal ranges in rivers and bays
- Alteration of sediment depositional patterns.

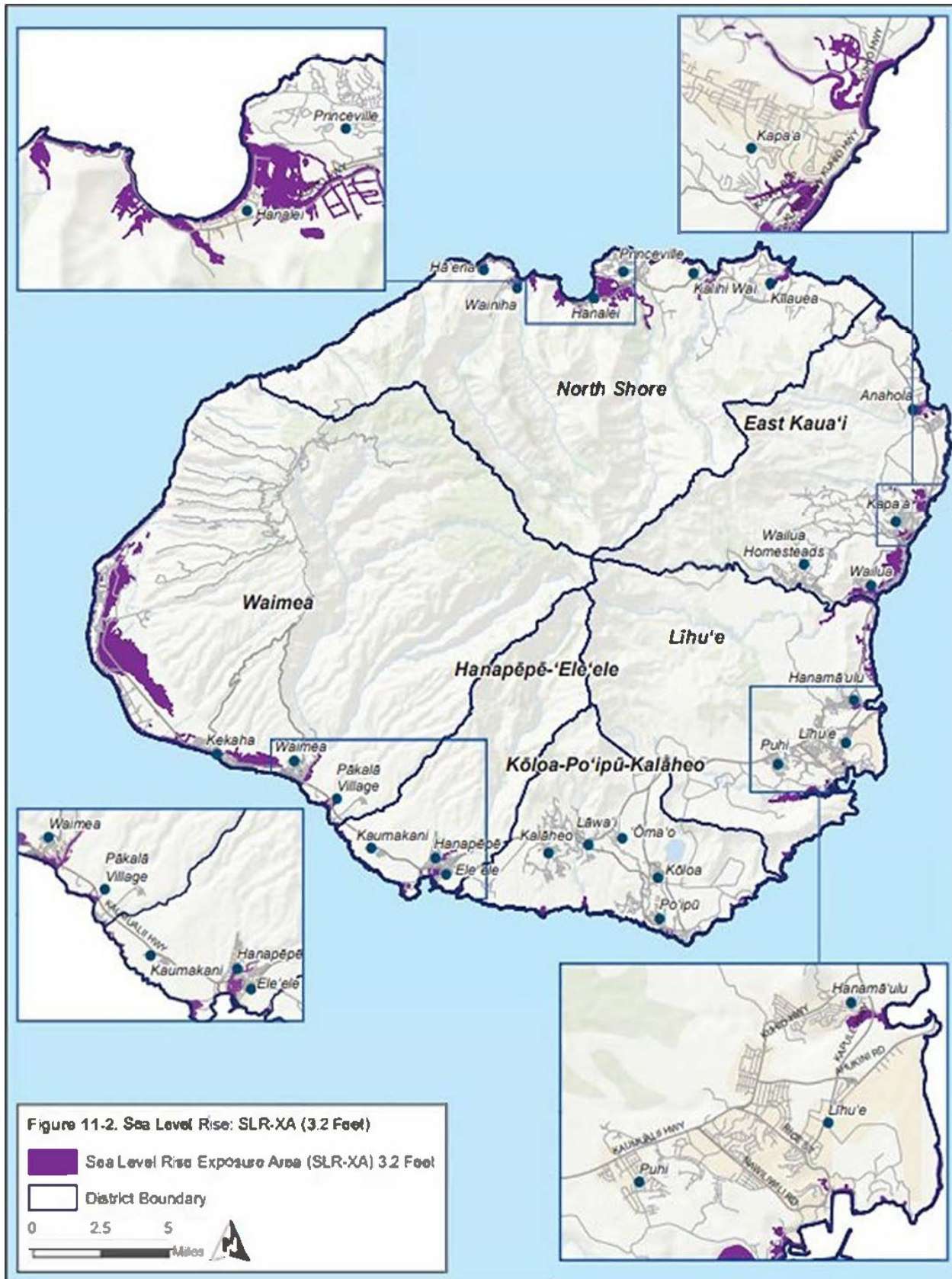


Figure 11-2. Sea level rise: SLR-XA (3.2 feet).

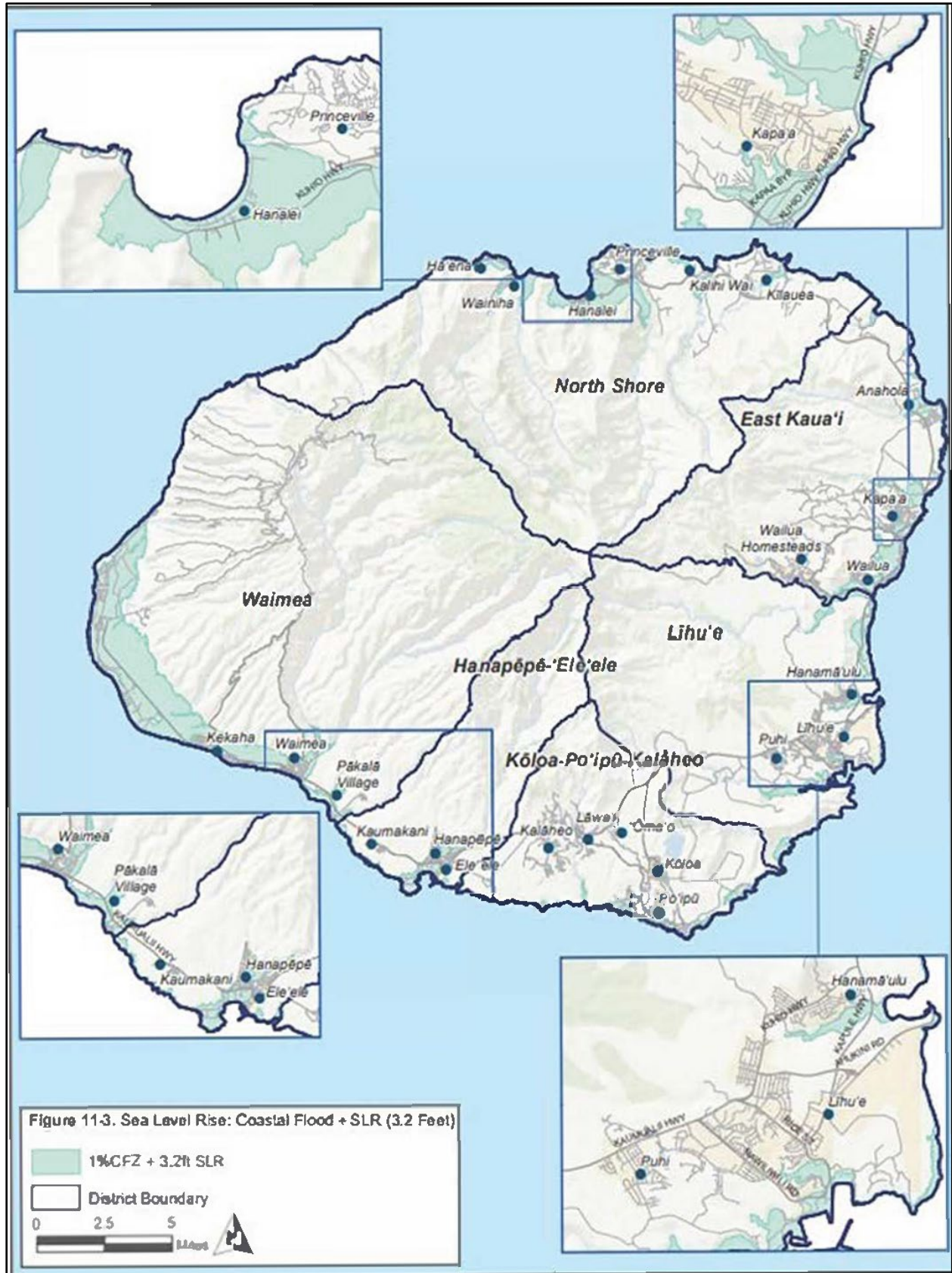


Figure 11-3. Sea level rise: coastal flood + SLR (3.2 feet).

Sea level has risen over the last century on each island in Hawai'i at rates of 0.5 to 1.3 inches per decade (Hawai'i Climate Change Mitigation and Adaptation Commission 2017). Globally, rates of sea level rise are projected to continue to accelerate (Nerem et al. 2022). Figure 11-4 shows predicted global mean sea level rise through the end of the century under different greenhouse gas emission scenarios. Modeling efforts have been completed for the state of Hawai'i to estimate sea level rise exposure areas, along with the combined impacts of coastal flooding, high-wave flooding, and coastal erosion. Sea level rise of up to 3.2 feet was considered under this modeling.

However, while a 3.6-foot rise has been projected as an intermediate estimate for the end of the century, high estimates place the potential rise at up to 7.5 feet of rise (Sweet et al. 2022). The scenario of 3.2 feet of sea level rise was still used for the 2026 MHMRP Update due to the variety of data available at the state level for this estimate. Another high-end of potential sea level rise estimates for Kaua'i suggests the county could experience approximately 6 to 8 feet of sea level rise by the end of the century (Figure 11-5) (NOAA 2018). It should be noted that Figure 11-5 presents a bathtub model of sea level rise only without considering the combined impacts of sea level rise, erosion, and wave inundation that will drive the impacts of sea level rise further inland than depicted in the figure (UH Sea Grant Extension Agent 2025). Future planning efforts should consider the potential for this more severe sea level rise scenario to occur. For a more detailed visualization of sea level rise exposure, please visit the Kaua'i County Sea Level Rise Constraint District web page (County of Kaua'i 2025i).

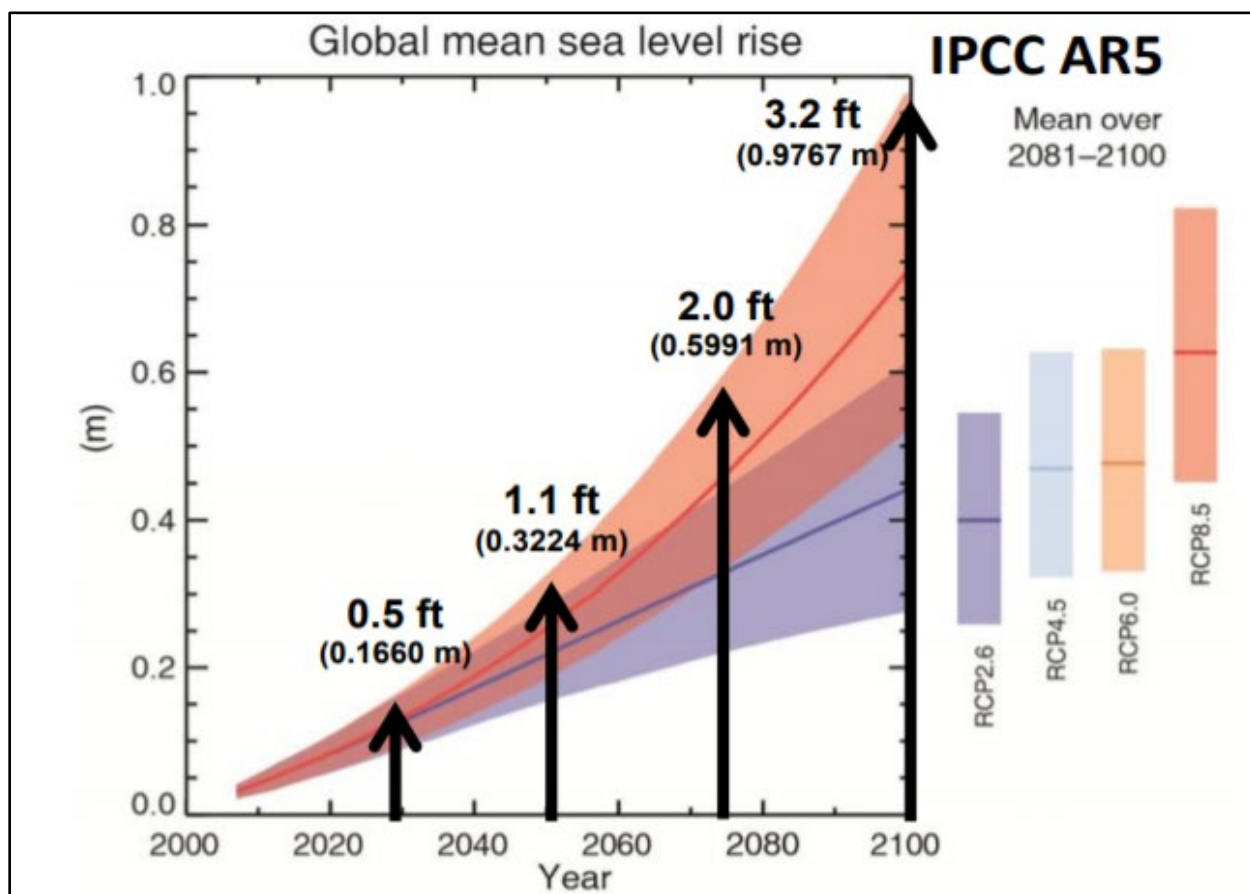


Figure 11-4. Projected rate of global sea level rise under different emissions scenarios.

Sea level rise, coupled with high water levels caused by tropical and extratropical storms, will incrementally increase coastal flooding and erosion, damaging coastal ecosystems, infrastructure, and

agriculture, and negatively affecting tourism (Leong et al. 2014). These changes can create several secondary, negative impacts and vulnerabilities, including loss of important coastal habitats, increased coastal erosion, safety and property risks, and more severe coastal flood events that inundate farther inland with greater damage.

Sea level rise is the predominant factor driving accelerated coastal erosion in Hawai'i. By 2050, coastal erosion in the state is expected to have almost doubled over the rates that would have been anticipated historically due to sea level rise (Anderson et al. 2015). Losses of land from erosion accompanying 3.2 feet of sea level rise are expected to be considerable in Kaua'i (Hawai'i Climate Change Mitigation and Adaptation Commission 2025). There will be a major impact on the county's shorelines, resulting in a large amount of the built environment along the coast needing to be relocated (UH Sea Grant Extension Agent 2025). This loss of land will be a permanent condition that decreases Kaua'i's buffer to other coastal natural hazard events. A possible mitigation action for a future MHMRP update would be to conduct a study to better understand and estimate the impacts of accelerating erosion due to sea level rise in Kaua'i County.



**Figure 11-5. Estimated exposure area of 6 feet of sea level rise.**

There is also evidence to suggest that climate change is resulting in more intense storm events, including storm surge and precipitation brought by tropical cyclones (County of Kaua'i 2022c). Figure 11-6

provides a visual representation of the number of Katrina-magnitude surge events per decade in the past and projected changes. Each line shows the results based on different modeling techniques and data contributions. Although there is some variation depending on the model, the results show an overall positive correlation between temperature increase and storm surge frequency (Grinsted et al. 2013). Although this study focused on hurricanes in the Atlantic Ocean, which are not directly comparable to the tropical cyclone events that impact Hawai'i, the results still highlight how a small temperature change can significantly increase damage and vulnerability. Kaua'i is anticipated to not only see an increase in the intensity of tropical cyclone events but is also expected to experience these events more frequently than they have historically. The increase in average global temperatures is shifting the areas in which tropical cyclones form toward the poles, which puts the state of Hawai'i at greater risk of being hit by tropical cyclones that historically would have passed to the south of the islands (County of Kaua'i 2022c). Increases in the intensity or frequency of tropical cyclone occurrence will be accompanied by coastal flooding, high surf, and erosion that these events bring.

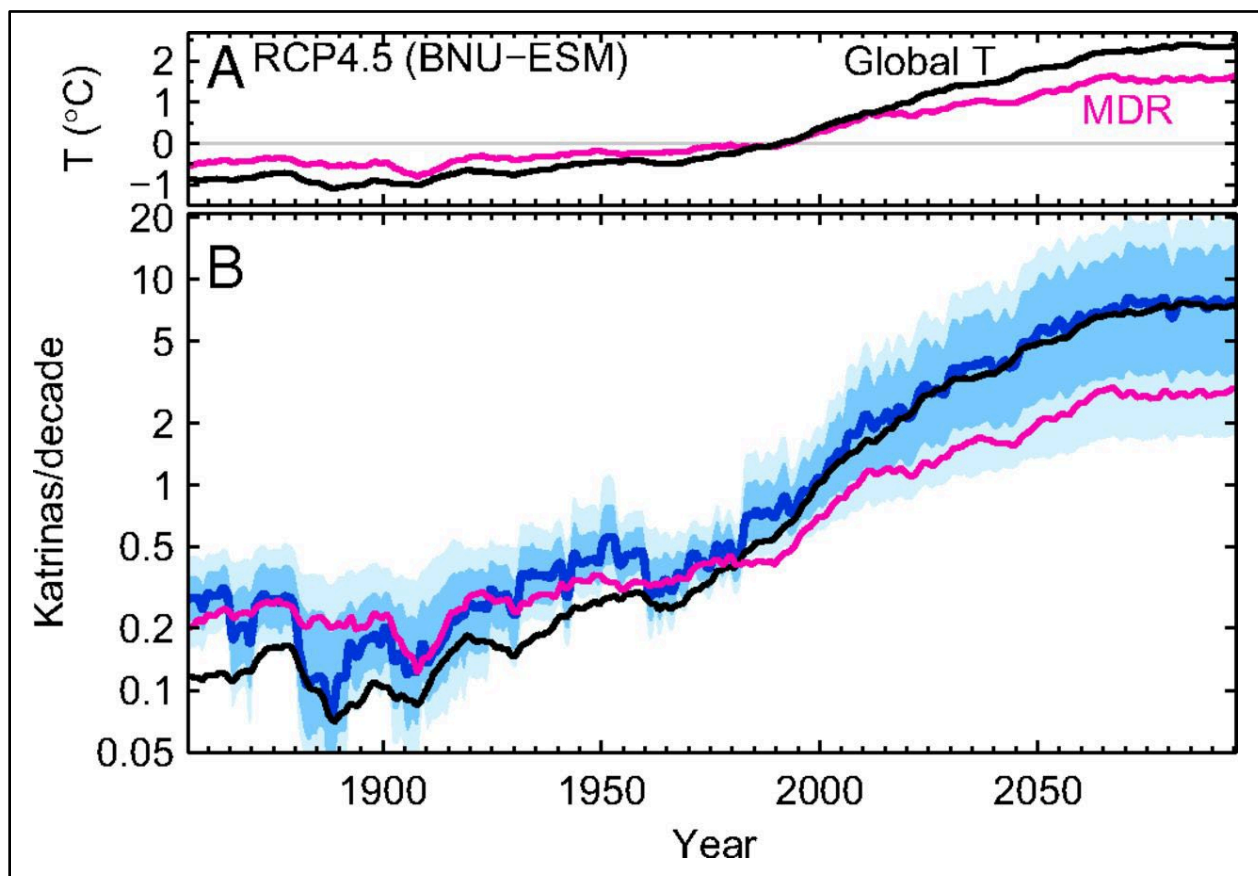


Figure 11-6. Surge event frequency over time and climate changes.

Rising sea levels will contribute to high-surf event-based coastal flooding, and erosion extending further inland, but will additionally contribute to chronic coastal flooding as sea levels are consistently higher on a normal basis. Areas will be flooded regularly outside of storm events that were not flooded historically, particularly during king tide and other high-tide events. This can contribute to additional erosion. Additionally, chronic sea level rise can cause saltwater to inundate into the groundwater through a process called saltwater intrusion. As saltwater inundates this freshwater source, it can reduce or eliminate its ability to be used for drinking water, agriculture, and all other potable water purposes. Saltwater intrusion into the groundwater can cause the water table to rise as well. This can lead to increased flooding as high

groundwater can prevent floodwater from draining into the ground, which can result in damage to property and infrastructure, especially anything located below ground (Interagency Sea Level Task Force 2025). On Kaua'i, Nāwiliwili has already seen an observed increase in minor high tide flood days, with 23 events observed from 2010 to 2020, which was up from two events observed from 1970 to 1980. Nāwiliwili is also expected to experience up to 130 minor high tide flood event days each year, defined as high tide events that cause flooding disruptions with only small amounts of damage, by 2050 if an intermediate amount of sea level rise occurs (Interagency Sea Level Task Force 2025).

Based on the discussion above, climate change is expected to increase the severity of high surf, coastal flooding, and erosion while also expanding the locations exposed to the hazards. An increased intensity of storms, including tropical cyclones, will likely raise the severity of high-surf events and coastal flooding, which in turn will contribute to greater amounts of erosion. Sea level rise, combined with more severe high-surf and coastal flooding events, will also accelerate erosion and expand the areas exposed to these hazards. These factors may lead to areas experiencing more frequent coastal flooding as land buffers that used to protect them erode or are submerged under rising sea levels.

## 11.2 VULNERABILITY ASSESSMENT

### 11.2.1 Scenario

High surf, coastal flooding, erosion, and sea level rise can all interact to negatively impact Kaua'i, resulting in damage to property and putting people at risk. The worst-case scenario for the planning area would likely be a high-surf and coastal flooding event caused by a tropical cyclone in conjunction with a high tide. A storm of a severe magnitude that co-occurred with a king tide would be especially damaging as high water levels combined with storm surge and high surf could inundate exceptionally far inland. Such a scenario extends beyond the capacity of current models. For this reason, exposure and vulnerability estimates were not made for this scenario, though individuals and properties alike would be potentially impacted by the event itself and the erosion it would likely cause.

The scenarios described throughout the vulnerability assessment include a 1% annual chance coastal flood, 3.2 feet of sea level rise, and the 1% annual chance coastal flood combined with 3.2 feet of sea level rise. It is significant to note that the 1% annual chance coastal flood represents a flooding event that would subside. However, the 3.2 feet of sea level rise is a chronic condition (UH Sea Grant Extension Agent 2025). These scenarios are intended to assess the county's vulnerability to coastal flooding, sea level rise, high surf, and erosion as the areas exposed to sea level rise and coastal floods provide an approximation of areas at risk from high surf and erosion.

Both Hazus and GIS analysis outside of Hazus were used to assess the vulnerability associated with this hazard. Exposure to the 1% annual chance coastal flood event was examined through Hazus and potential losses were assessed through Hazus damage functions. Hazus does not have the capabilities to conduct these analyses for sea level rise and sea level rise in conjunction with the 1% annual chance coastal flood. For sea level rise, exposure was assessed using GIS, and loss estimates were developed representing the replacement value of exposed structures at losses of 1%, 10%, 30%, and 50% of the total value. This allows emergency managers to select a range of economic impacts based on an estimate of the percent of damage to the general building stock.

Based on 8-12.5 and 15-1.3 of the County Code (Sea Level Rise District and Floodplain Management Ordinances respectively), substantial damage "means damage of any origin sustained by a structure whereby the cost of restoring the structure to its pre-damaged condition would equal or exceed 50% of the market value of the structure before the damage occurred". For this reason, 50% was the maximum potential loss estimate shown. Damage over 50% is considered to be 'substantial' by most building codes

and typically requires total reconstruction of the structure. Substantial damage requires substantial improvements to structures, which, depending on their location, may need to fulfill the requirements of the Kaua'i County Sea Level Rise Constraint District Ordinance (Ordinance 1134) in their reconstruction. Whether a structure has been substantially damaged or whether substantial improvements will be made is based on the determination of Kaua'i County's Public Works Engineering.

There are limitations for the sea level rise analyses that should be considered when interpreting the results of the risk assessment. First, sea level rise is not a single event but a chronic condition. Damages would not happen all at once, but over time. Recovery in exposed areas would also not be possible, as these areas would remain submerged. Second, the sea level rise scenarios show the projected future sea level rise exposure areas for the latter half of the century overlaid with current infrastructure, structures, and population distributions in the county (UH Sea Grant Extension Agent 2025). Structure values are not adjusted for future inflation, structure numbers are not adjusted for future development, and the population exposed to sea level rise is based on the county's current population size and distribution. An analysis of sea level rise exposure that examines population growth, future structure development, and inflation estimates for the latter half of the century may be a possible mitigation action for a future MHMRP update to better assess the impacts of sea level rise. These limitations should be considered when interpreting the risk assessment results.

Detailed results by district are provided in Appendix K for the 1% annual chance coastal flood, sea level rise, and sea level rise combined with the 1% annual chance coastal flood. The analysis of sea level rise on roads in the planning area can be found in Appendix L. This assessment assumes that these sea level rise impacts occur in present-day Kaua'i County rather than occurring gradually over years or decades. Additional information about potential economic losses associated with sea level rise beyond that presented in the vulnerability assessment can be found at the Pacific Islands Ocean Observing System's State of Hawai'i Sea Level Rise Viewer (Hawai'i Climate Change Mitigation and Adaptation Commission 2025).

## 11.2.2 Exposure

Although FEMA's coastal flood zones were not developed exclusively to address the impacts of high surf, they do provide an approximate delineation of areas that may be at risk. FEMA-mapped coastal flood zones thus form the basis of the high surf hazard exposure and vulnerability assessment. A quantitative assessment was made of exposure in these zones. Detailed results by district are provided in Appendix K; results for the total planning area are presented below. The coastal zones in Hawai'i also include tsunami inundation risk in some areas, so these zones are likely to overestimate the risk from high-surf impacts alone.

### Population and Property

Table 11-2 summarizes the estimated population living in the mapped coastal flood zone and the estimated property exposure. The population at greatest risk for exposure to the high surf hazard is individuals along the affected beachfront areas, whether they live, work, or recreate there. Surfers are potentially at risk, as they will pursue their sporting activity during times when surf conditions are high.

**Table 11-2. Exposed Population and Property in the 1% Annual Chance Coastal Flood Zone**

| <b>Population</b>                   |       |
|-------------------------------------|-------|
| Population Exposed                  | 5,550 |
| % of Total Planning Area Population | 7.6%  |

| <b>Property</b>                                 |                 |
|---|-----------------|
| Number of Buildings Exposed                     | 3,773           |
| Value of Residential Structures                 | \$3,797,800,000 |
| Value of Exposed Structures                     | \$5,703,032,000 |
| Total Exposed Value as % of Planning Area Total | 23.2%           |

Table 11-3 summarizes the estimated population and buildings exposed to 3.2 feet of sea level rise and to 3.2 feet of sea level rise combined with the 1% annual chance coastal flood zone. Please note that population, building, and structure and content values reflect present-day conditions and are not adjusted for population growth, the addition of new buildings, or inflation that would occur by the latter half of the century when 3.2 feet of sea level rise is projected to occur.

**Table 11-3. Estimated Exposure for Coastal Flood + Sea Level Rise and Sea Level Rise Chronic Flooding**

|   | <b>Coastal Flood + SLR</b> | <b>SLR-XA</b> |
|---|----------------------------|---------------|
| <b>Population</b>   |                            |               |
| Population Exposed  | 18,971                     | 2,805         |
| % of Total Planning Area Population                       | 26%                        | 4%            |
| <b>Property</b>   |                            |               |
| Number of Buildings Exposed                               | 8,448                      | 1,254         |
| Value of Exposed Structures                               | \$3,259,000,000            | \$328,787,395 |
| Value of Exposed Contents                                 | \$2,045,000,000            | \$209,308,135 |
| Total Exposed Property Value                              | \$5,304,000,000            | \$538,095,530 |
| Total Exposed Structure Value as % of Planning Area Total | 26.0%                      | 2.6%          |

### **Critical Facilities**

Figure 11-7 summarizes the critical facilities in the coastal flood zone for the planning area, and Figure 11-8 summarizes the critical facilities in the combined area exposed to an anticipated 3.2 feet of sea level rise and the 1% annual chance coastal flood event. Critical facilities just beyond the coastal flood zones may be exposed to these hazards if previous high-surf or storm events destroy the beach buffer. In addition to facilities that may be exposed to high surf, coastal transportation routes may be exposed. These routes are often in areas in which coastal erosion has gradually worn away the beach buffer, causing the potential for roadway inundation during high-surf events. See Appendix L for a detailed analysis of roads in the coastal flood hazard area.

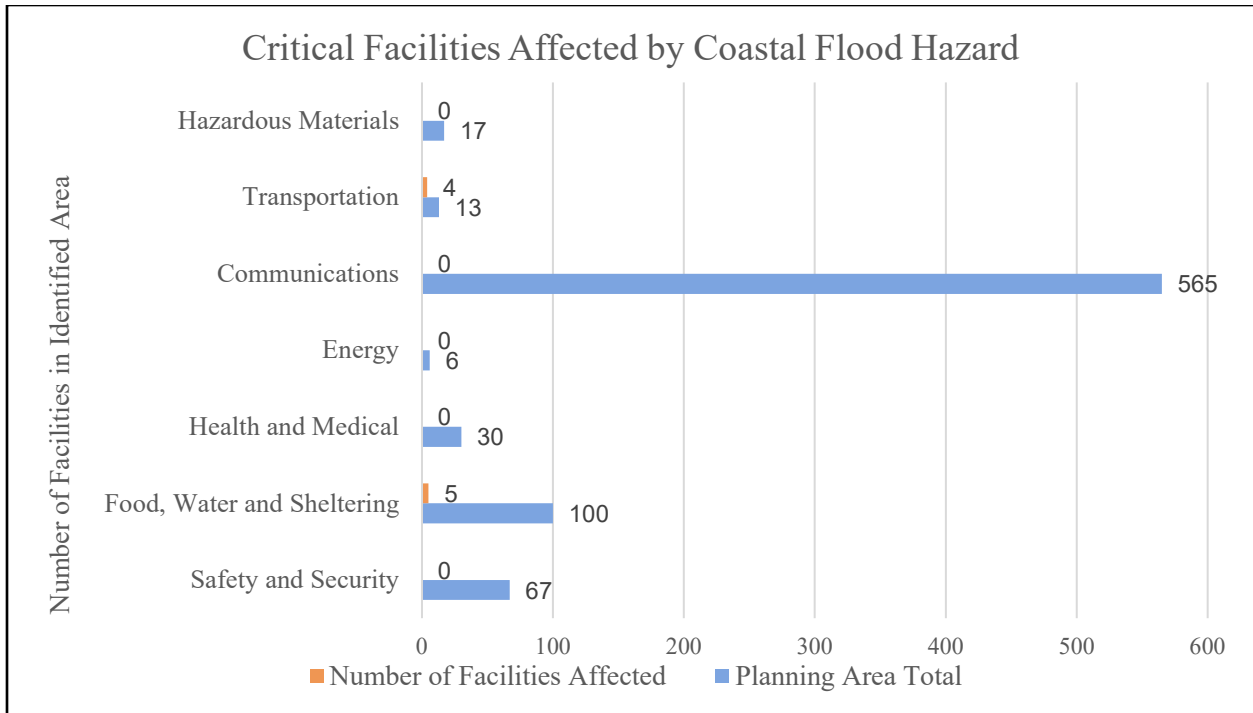


Figure 11-7. Critical facilities in mapped coastal flood zone.

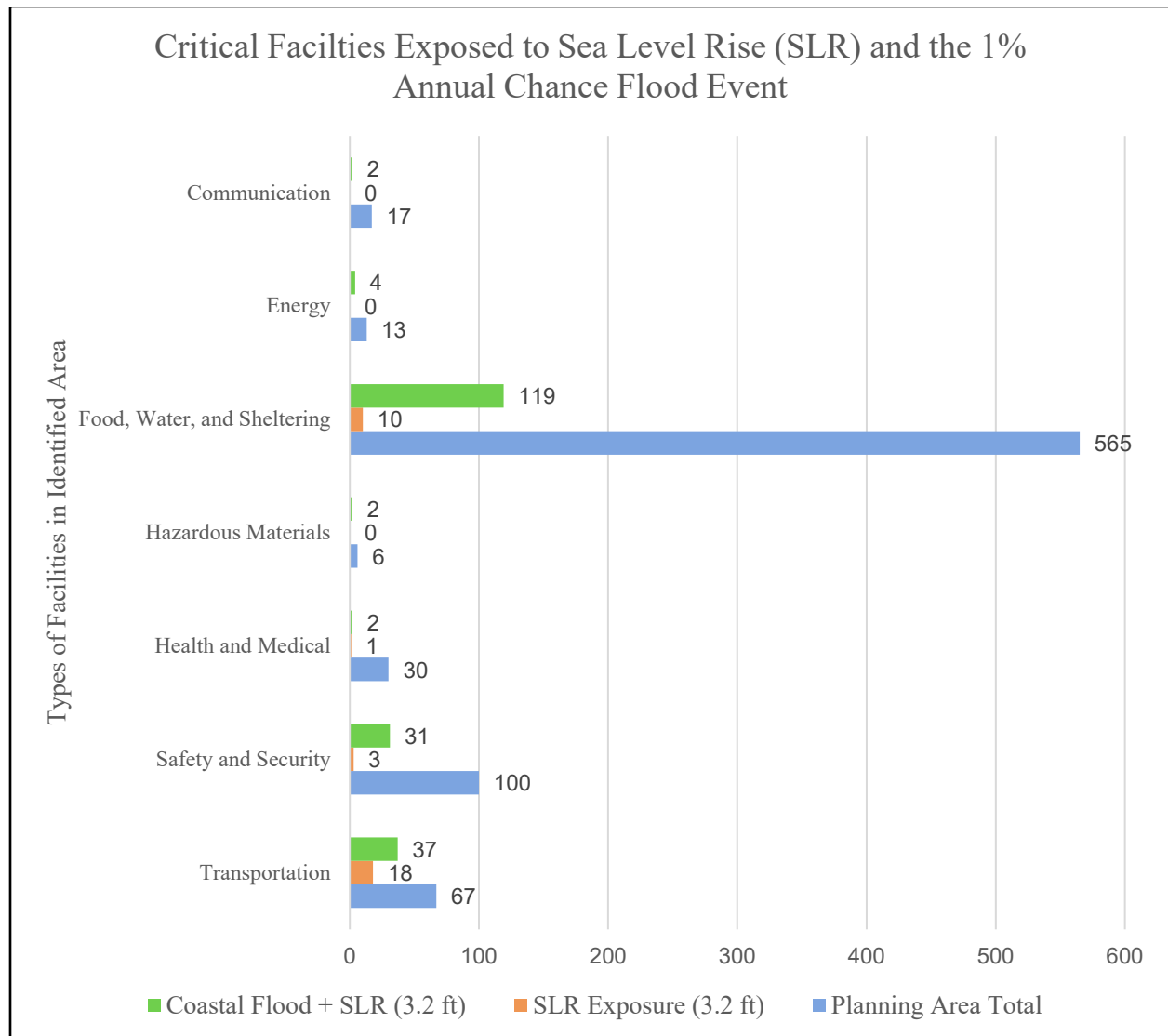


Figure 11-8. Critical facilities in SLR-XA and coastal flood + SLR.

**Environment**

All beaches are vulnerable to the effects of high-surf events and chronic erosion. Beaches provide important habitat for sea birds, shore birds, sea turtles, monk seals, native dune vegetation, insects, and invertebrates. Coral reefs, in addition to providing habitat to a wide range of species, can reduce as much as 97% of incident wave energy, which can mitigate coastal flooding and erosion (Pacific Coastal and Marine Science Center 2022). Natural reef formations can also provide comparable wave attenuation benefits to those provided by artificial means, such as breakwaters (Ferrario et al. 2014). Coral reefs not only provide protection from wave energy but also are a source of sand for beaches (USACE 2018).

## 11.2.3 Vulnerability

### Population

The population most vulnerable to high-surf events and strong currents are beachgoers, swimmers, fisherman, and hikers along the shoreline. The unhoused population that gathers in beach parks is especially vulnerable to high surf and coastal flood. A particular population vulnerable to the high surf hazard is surfers. High surf indicates larger waves, which many amateur and professional surfers actively seek. As a result, warnings and advisories may cause the opposite effect for these populations. This requires beach patrols and first responders to remain on alert during days when surfers may ignore warnings and advisories in an effort to catch large waves.

### **Social Vulnerability**

Many communities in Kaua'i with high social vulnerability may be affected by high surf, coastal flooding, erosion, and sea level rise. As these hazards are all coastal, they will only directly impact socially vulnerable communities on the coast. Communities with the highest social vulnerability are likely to be especially impacted due to lower capacity to mitigate and respond to these coastal hazards. The overlap of high social vulnerability with the hazards is given by community (defined as census-designated places) within Kaua'i County in Table 11-4. Only areas of a community that are classified as having the high and highest levels of social vulnerability (i.e., the 61st percentile or higher) are included in the table. For example, within Kekaha, the entire community falls within the highest social vulnerability level and is in the 94th percentile compared with all other census block groups in the County. Kekaha is also exposed to high surf, coastal flooding, erosion, and sea level rise.

The "Community" column identifies areas within each community that fall into the high or highest levels of social vulnerability (above the 61st percentile), provided any part of the area overlaps with a hazard exposure zone. For example, if a community is classified with a high social vulnerability level and only a portion of it intersects with a hazard exposure area, the entire community is included in the table, even though only a smaller section is actually exposed to the hazard. While this method may overestimate vulnerability, it offers a broadly accurate overview of community risk. It is important to recognize that social vulnerability and hazard exposure can vary within each community, but this analysis was unable to capture that variability.

Additionally, there are socially vulnerable populations throughout the planning area who may face increased risk from hazards, even in communities categorized as having lower levels of social vulnerability than those listed in Table 11-4. This analysis focused on the highest levels of social vulnerability defined by the SVI developed for the KCAAP (County of Kaua'i 2022b). Therefore, several communities have been excluded from this analysis due to lower levels of social vulnerability, including Wailua Homesteads, 'Ele'ele, Waimea, and Princeville. To examine the overlap of hazard exposure areas with these communities, please use the Hazard Mapping Tool on the Kaua'i MHMRP 2026 Story Map (County of Kaua'i 2025b).

**Table 11-4. Communities with High Social Vulnerability or Above Impacted by High Surf, Coastal Flooding, Erosion, or Sea Level Rise**

| <b>Community:<br/>High Social Vulnerability Areas with (at least partial)<br/>Hazard Exposure.</b> | <b>Social Vulnerability<br/>(Percentile)</b> | <b>Coastal Hazards:<br/>1% Annual Chance Coastal Flood Zone,<br/>3.2 Feet of SLR Exposure,<br/>3.2 Feet SLR Exposure<br/>+ 1% Annual Chance Coastal Flood, or All</b> |
|--|--|---|
| Anahola:<br>Low-lying, coastal areas   | Highest (0.84)                               | All   |
| Wailua:<br>Low-lying, coastal areas  | High (0.75–0.78)                             | All   |
| Kapa'a:<br>East-central area of the community  | High (0.76)                                  | All   |
| Līhu'e:<br>Low-lying, coastal areas  | High (0.67–0.71)                             | All   |
| Po'ipū:<br>Southern area of the community  | High (0.61)                                  | All   |
| Hanapēpē:.*<br>Southeast to northeast area of the community  | Highest (0.96)                               | All   |
| Kekaha:<br>Central area of the community   | Highest (0.94)                               | All   |
| Hā'ena:<br>Entire community  | High (0.73)                                  | All   |
| Wainiha:<br>Entire community   | High (0.73)                                  | All   |
| Hanalei:.*<br>Entire community   | High (0.63–0.73)                             | All   |
| Kalihiwai:<br>Entire community   | High (0.8)                                   | All   |
| Kīlauea:<br>Low-lying, coastal areas   | High (0.8)                                   | All   |

\* The entirety or nearly the entirety of the socially vulnerable area of each of these communities would be flooded in the scenario combining 3.2 feet of sea level rise with the 1% annual chance coastal flood event.

The ways in which social vulnerability may impede a community's ability to mitigate and respond to the High Surf, Coastal Flooding, Erosion, and Sea Level Rise hazard are described in the following paragraphs for each social vulnerability category and indicator included in the County's SVI developed for the KCAAP (County of Kaua'i 2022b).

**Household characteristics** include the population under the age of 17 and over age 65 as well as the population with a disability. These factors reduce the ability of individuals to mitigate and respond to the coastal hazards discussed in this section. These groups may have more difficulty evacuating from a flood or high-surf event if they live along the coast. Additionally, an inability to operate a vehicle, move quickly, access emergency notifications, or a need for outside assistance may impede movement away from hazard areas to a safe location outside the flood zones. Members of these groups may also be more likely to require medical attention regularly, which could become unavailable if roads are washed out and communities are left isolated. As sea levels rise, one strategy to reduce individuals' exposure to the hazard and risk of property damage or injuries is to relocate inland. However, older individuals or those with a disability may have added difficulty moving to a new residence if their mobility is limited or they are unable to relocate due to a fixed income combined with an inability to sell a house located in a high-risk area.

**Socioeconomic status** also impacts the ability of a population to mitigate and respond to coastal floods, erosion, high surf, and sea level rise. These factors include household income, the population with a bachelor's degree, and the population of outdoor workers. Households with higher incomes are more likely to have additional resources to implement mitigation measures to minimize the risk of loss associated with these coastal hazards. For instance, relocating to a property further inland, a process called managed retreat, can help protect individuals and families. There are often political and community challenges to managed retreat, but even if people would like to relocate, it is often cost-prohibitive (State of Hawai'i Office of Planning and Sustainable Development [OPSD] 2025d). Additionally, if these coastal hazard events necessitate evacuation, resources such as access to a personal vehicle and the ability to pay for lodging can facilitate safe evacuation. Outdoor workers could also be more vulnerable to these coastal hazards if they occurred suddenly with little warning, and outdoor workers along the coast did not have time to seek shelter. Outdoor workers involved in the cleanup of debris following a damaging coastal flood or high-surf event could also be more vulnerable due to the presence of materials that may be contaminated with toxic or hazardous waste, mildew and mold, or sewage.

**Race and ethnicity** impact the ability of a community to mitigate and respond to high-surf, coastal flooding, erosion, and sea level rise events. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua'i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events including the coastal hazards discussed in this section (County of Kaua'i 2022b). Additionally, linguistic isolation raises vulnerability as it can create a barrier to accessing evacuation notices and procedures if these notices are not widely distributed in languages other than English. It also may lead to an inability to access mitigation or planning resources.

**Physical conditions** also impact a community's mitigation and response capacity to high surf, coastal flooding, erosion, and sea level rise. Physical conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units can increase vulnerability to coastal hazards because renters may not have the authority to implement mitigation measures that would help protect their residences. Landlords may also not be incentivized to allocate resources for these efforts to rental properties. Similarly, rent-burdened households may not have sufficient resources to devote to mitigation or evacuation if needed. Houses built before the 1970s located along the coast might be vulnerable if they were not built up to sufficient codes to withstand flood events. This is especially true if they were built in the coastal floodplain or near the coastal floodplain as erosion and sea level rise will likely increase the area exposed to future coastal flood and high-surf events. Similarly, mobile homes built in the 1970s and prior to the development of federal standards are not sufficiently prepared for flood events (Curran-Groome et al. 2025). Lack of access to a vehicle could also increase vulnerability if it prevents evacuation from coastal flood or high-surf events.

It is also significant to note that communities located along the coast must consider the combined impacts of coastal flooding, sea level rise, erosion, and high-surf events. The combination of these hazards means future coastal flooding and high-surf events will reach further inland than they have historically. While future development in these areas can be avoided, communities that are located within them are vulnerable. Social vulnerability can compound increasing exposure to these hazards for the reasons previously discussed in this section. For instance, the combined coastal flood and sea level rise scenario analyzed shows that nearly the entire socially vulnerable community (high or highest classification) in Hanapēpē and Hanalei would be submerged under this situation.

## Property

Loss estimations for this hazard are made based on available models. Damages associated with coastal flooding, sea level rise, and coastal flooding in conjunction with sea level rise are presented. However, there are no models that assess the high surf hazard without taking into consideration other hazards such as hurricanes and tsunamis. Therefore, damages are not presented for high surf specifically; however, coastal flood zones provide an approximation of the areas that can be impacted by high surf. Table 11-5 shows the general building stock loss estimates in FEMA-mapped coastal zones. Table 11-6 shows the estimated building losses given 3.2 feet of sea level rise in present-day Kaua'i County. Please note that loss values reflect present-day conditions and are not adjusted for the addition of new buildings or inflation that would occur by the latter half of the century when 3.2 feet of sea level rise is projected to occur. An analysis was also not conducted on the loss potential for 3.2 feet of sea level rise combined with the 1% annual chance coastal flood event, but this analysis is recommended for inclusion in a future MHMRP update.

**Table 11-5. Loss Potential for 1% Annual Chance Coastal Flood Zone**

| Damage Type                                | 1% Annual Chance Coastal Flood |
|--|--------------------------------|
| Debris (Tons)                              | 3,600                          |
| Buildings Impacted                         | 115                            |
| Total Value (Structure + Contents) Damaged | \$98,522,000                   |
| Damage as % of Total Value                 | 0.4%                           |

**Table 11-6. Loss Potential for 3.2 Feet of Sea Level Rise Exposure**

| Loss Potential              | Exposed Value<br>(Structures and Contents) | Loss Value    | Loss as % of Total Planning<br>Area Replacement Value |
|-----------------------------|--|---------------|---|
| Loss = 1% of Exposed Value  | \$538,095,530                              | \$5,380,955   | Less than 1%  |
| Loss = 10% of Exposed Value |  | \$53,809,553  | Less than 1%  |
| Loss = 30% of Exposed Value |  | \$161,428,659 | Less than 1%  |
| Loss = 50% of Exposed Value |  | \$269,047,765 | 1.3%  |

## Critical Facilities

Hazus was used to estimate the loss potential to critical facilities exposed to the coastal flood risk, using depth/damage function curves to estimate the percent of damage to critical facility buildings.<sup>4</sup> This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. Table 11-7 shows the results for the 1% annual chance coastal flood event.

<sup>4</sup> Analysis of transportation infrastructure damage is not supported by Hazus.

**Table 11-7. Estimated Impact of a 1% Annual Chance Coastal Flood Event on Critical Facilities**

| Critical Facility Type     | Number of Facilities Affected | % of Building Damaged |         |      |
|----------------------------|-------------------------------|-----------------------|---------|------|
|                            |                               | <10%                  | 10%–20% | >21% |
| Safety and Security        | 0                             | 0                     | 0       | 0    |
| Food, Water and Sheltering | 5                             | 4                     | 0       | 1    |
| Health and Medical         | 0                             | 0                     | 0       | 0    |
| Energy                     | 0                             | 0                     | 0       | 0    |
| Communications             | 0                             | 0                     | 0       | 0    |
| Transportation             | 4                             | N/A                   | N/A     | N/A  |
| Hazardous Materials        | 0                             | 0                     | 0       | 0    |
| All Facilities             | 9                             | 4                     | 0       | 0    |

Areas important for tourism and commerce, lying between Wailua and Kapa‘a and along the North Shore, are situated on low coastal plains, and so experience periodic wave overwash, which causes rapid erosion and temporarily disrupts transportation.

In addition to the potential impacts of the 1% annual chance coastal flood, the projected increase in sea level rise has the potential to increase risk of storm surge-related flooding along the coast. This will expand areas at risk of coastal flooding; increase the vulnerability of energy facilities located in coastal areas; flood transportation and telecommunication facilities; and cause saltwater intrusion into some freshwater supplies near the coasts. High water levels, strong winds, and heavy precipitation resulting from severe coastal storms already cause billions of dollars in damage and disrupt transportation and utility distribution systems. Sea level rise will lead to more frequent and extensive coastal flooding. Warming ocean waters raise sea levels through thermal expansion and have the potential to strengthen the most powerful tropical cyclones.

## **Environment**

Erosion and secondary hazards associated with high-surf events will likely have some of the most damaging effects on the environment. A combination of wave height and a long duration of swells impacting the shoreline can increase beach erosion, damage homes and infrastructure, as well as blocking coastal highways with sand, debris, and water (Meiers 2014). Coastal habitats are critical to the natural environment, society, and economy of Hawai‘i, and their loss has compounding effects on the vulnerability of the community at large.

Coral reefs play a large role in the dissipation of wave energy that affects beach areas and can reduce wave energy by an average of 97%, with reef crests alone dissipating most of the energy. This suggests reef formations can provide comparable wave attenuation benefits to those provided by artificial means, such as breakwaters (Ferrario et al. 2014).

## **11.3 ISSUES**

### **11.3.1 Development in High-Hazard Areas**

Development in Kaua‘i County is guided by the General Plan, community plans and the Kaua‘i County Code. This guidance includes requirements pertaining to development in coastal hazard areas, which would include areas that are susceptible to coastal flooding, high surf, sea level rise, and erosion.

Some land uses are more vulnerable to high surf and coastal erosion, such as single-family homes, while others are less vulnerable, such as agricultural land or recreation areas. Figure 11-9 shows the distribution of land use by area in the FEMA coastal zones. Natural and agricultural lands make up nearly half of these zones. Most homes and facilities are in areas designated urban center, neighborhood center, neighborhood general, or residential community. In all, 6.3% of the coastal hazard zones are highly developed.

Figure 11-10 shows the distribution of land use in sea level rise exposure areas. The top pie chart shows the land use of the area exposed to 3.2 feet of chronic sea level rise. The bottom pie chart shows exposure to 3.2 feet of chronic sea level rise in conjunction with an event-based 1% annual chance coastal flood. In this second scenario, after the coastal flood event passed, the 3.2 ft of chronic sea level rise would still persist.

Natural and agricultural lands make up the vast majority of land use exposed to the sea level rise exposure areas. However, there are residential communities, neighborhood centers, neighborhood general, and urban center land use areas exposed, which puts homes and facilities at risk from the hazard. There is also a small amount of resort and golf course land areas exposed. In all, 5.6% of the chronic sea level rise exposure area is highly developed and 9.1% of the event-based sea level rise exposure area (3.2 feet of sea level rise exposure in conjunction with the 1% annual chance of coastal flooding) is highly developed. There was a shift of 1 acre in the area covered by the chronic sea level rise exposure model between the 2021 MHMRP Update and the 2026 MHMRP Update. This change was considered insignificant and is not reflected in Figure 11-10.

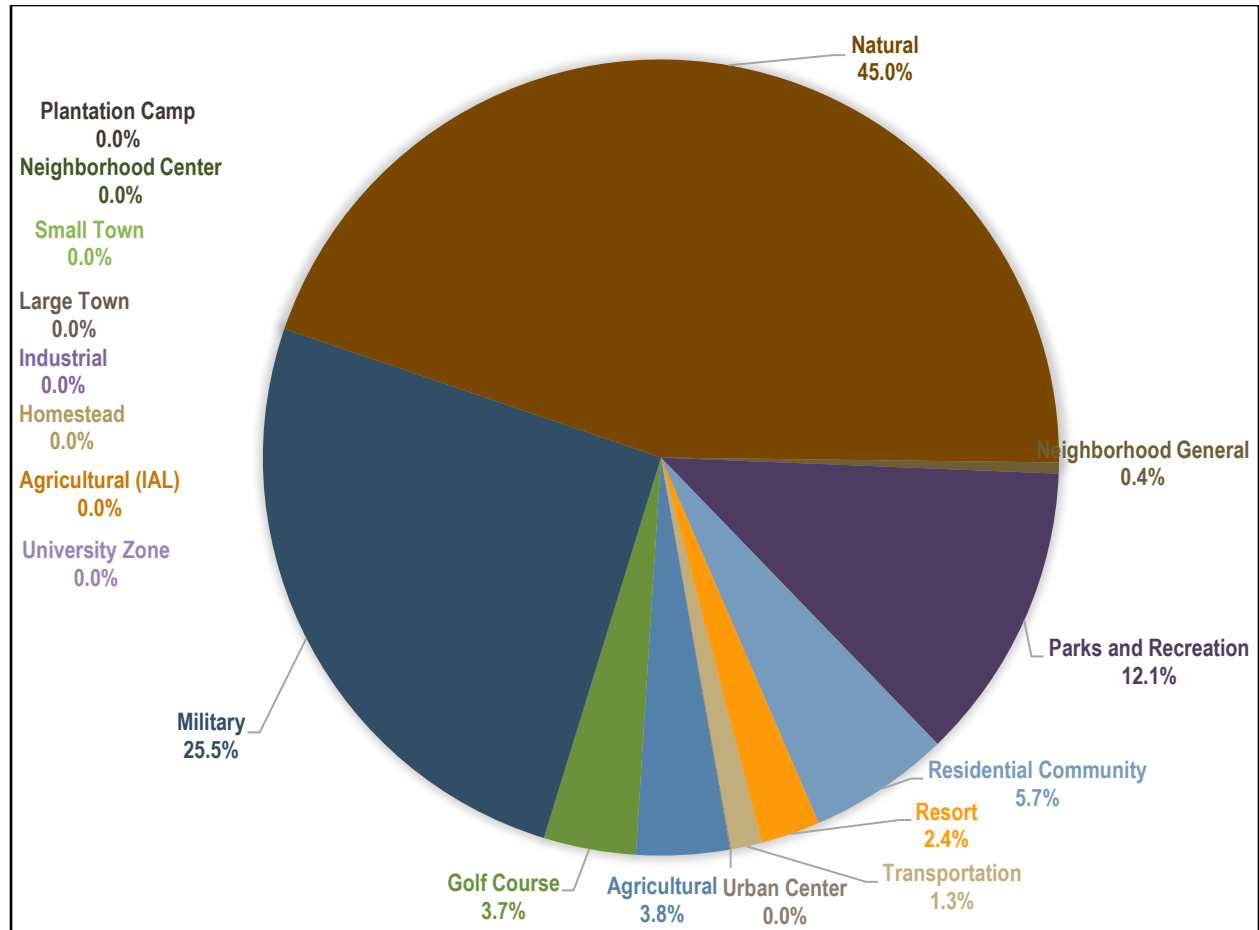


Figure 11-9. Land use distribution by area in the 1% annual chance coastal flood zone.

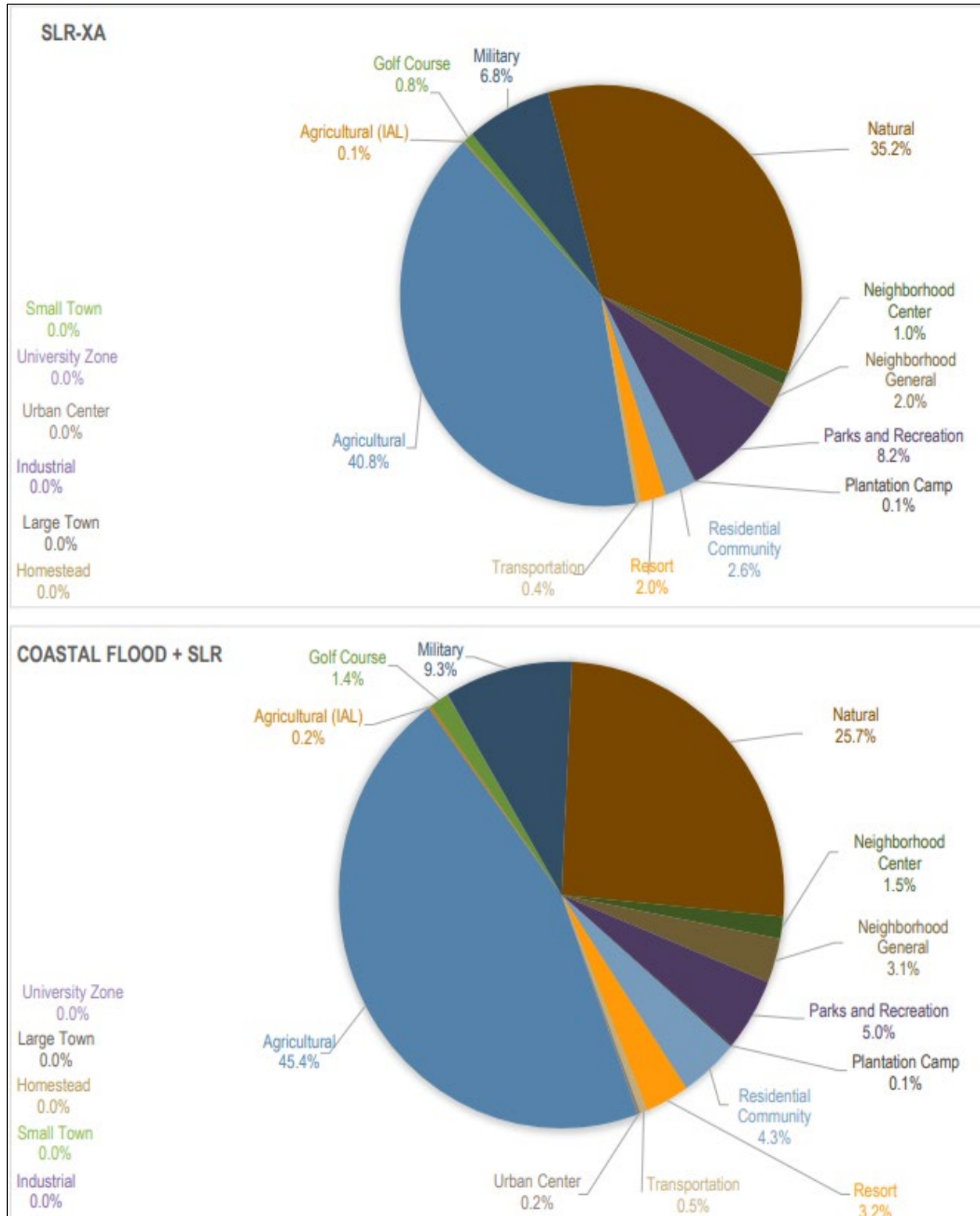


Figure 11-10. Land use distribution by area in sea level rise exposure areas.

### 11.3.2 Other Issues

The following issues have been identified related to the High Surf, Coastal Flood, Erosion, and Sea Level Rise hazard:

- **Cascading hazard potential:** Strong currents from the coastal hazards discussed in this section may cause debris overwash, flooding, high wave energy and turbulence in the nearshore zone. Sea level rise, loss of beaches due to erosion, high-surf events, and coastal flooding can also result in cascading hazard events among themselves as high surf and coastal flooding cause erosion, which along with sea level rise allows future high surf and coastal flooding events to inundate further inland. This can result in a dangerous and damaging cycle.
- **Coastal reefs:** Sewage and siltation are among the most significant contributions to human-caused degradation of coral reef and other natural coastal systems in Hawai'i (Bijlsma et al. 1996). Additionally, as coral reefs surrounding Kaua'i die off due to increasing ocean acidity, pollution and heatwaves, they will stop providing a buffer to the shoreline resulting in more high-surf events and erosion.
- **Economic loss:** Kaua'i County may experience temporary economic impacts associated with disrupted transportation infrastructure along coastal areas. Long-term economic impacts may also result as high surf, coastal floods, erosion, and sea level rise compound upon one another to impact the island's shoreline, which could affect ecosystems, native species, cultural and historical sites, recreation, subsistence practices, and tourism.
- **High surf public information:** Those most prone to high surf are individuals who choose to be in areas that are impacted by high surf, whether for recreation or because they are unfamiliar with their surroundings. The County should consider developing pamphlets and other messaging about the dangers of high surf and distributing in hotels, tourist venues, and high schools.
- **Future development impact studies:** High surf events are particularly destructive when natural processes are unable to replenish beaches due to development, causing high surf to impact infrastructure. Building on eroding coasts increases vulnerability to shoreline hazards. The county should work to ensure that future development does not contribute to coastal erosion, and subsequently, harmful high-surf events.
- **Coastal AE zone building standards:** Coastal AE zones, which are landward of coastal high-hazard zones (VE zones), have the potential to become affected by waves spilling over from the coastal high-hazard zones. Such flooding results in greater stressors for current and future development. Kaua'i County does not currently have FEMA-mapped coastal AE flood zones. However, if this data becomes available, it should be integrated into the risk assessment of a future MHMRP.
- **Potential impacts from sea level rise:** Rising sea levels are very likely to have significant impacts on the frequency and severity of high-surf events. Areas not typically exposed to this type of event may become exposed, increasing vulnerability to this hazard of concern. Studies indicate that chronic coastal erosion rates will have doubled by 2050 due to sea level rise (Anderson et al. 2015).
- **Continuity of operations:** Critical facility owners should be encouraged to include high surf, coastal flooding, sea level rise, and erosion considerations in their continuity of operations plans if exposed to these hazards, using the information on risk and vulnerability contained in this plan.
- **Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Education programs are currently in place to facilitate

the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.

- Personal planning resources:** Additional information on emergency shelters as well as emergency management resources can be found on the KEMA website and Facebook page. The website also has additional information about king tides:  
<https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency> (KEMA 2025).
- Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by high surf, coastal flood, erosion, and sea level rise. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people’s safety during evacuations and in community shelters (County of Kaua‘i 2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua‘i 2022d):  
[https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the High Surf, Coastal Flood, Erosion, and Sea Level Rise hazard, based on the hazard profile and vulnerability assessment, is given in Table 11-8.

**Table 11-8. Risk Ranking Summary for High Surf, Coastal Flood, Erosion, and Sea Level Rise**

| Priority | Hazard Event  | Probability   | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time  | Duration         | Risk Score |
|----------|---|---------------|--|--------------------------|----------------------|----------------|---------------|------------------|------------|
| 7        | High Surf, Coastal Flood, Erosion, and Sea Level Rise | Highly Likely | Limited  | Minor                    | Low                  | Small          | 4:01-24 hours | Less than 1 week | 2.4        |

## 12. DAM FAILURE

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There are generally three types of dams: detention, diversion, and storage dams. All dams on Kaua'i are storage dams. These dams impound water during periods of surplus, supplying water during dry periods for crop irrigation, livestock watering, municipal or industrial water uses, or electricity generation.

Many dam failures in the United States have been secondary results of other disasters. The most common causes are earthquakes, landslides, extreme storms, equipment malfunctions, structural damage, foundation failures, and sabotage. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of larger facilities must plan for; these threats are under continuous review by public safety agencies.

Partial or full failure of dams can cause massive destruction to the ecosystems and communities located downstream. Partial or full failure can occur as a result of one or a combination of the following reasons (FEMA 2015):

- Overtopping caused by floods that exceed the dam's capacity (inadequate spillway capacity)
- Piping and internal erosion of soil in embankment dams
- Prolonged periods of rainfall and flooding
- Deliberate acts of sabotage (terrorism)
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Inadequate or negligent operation, maintenance, and upkeep
- Failure of upstream dams on the same waterway
- Earthquake (liquefaction/landslides).

All 47 regulated dams on Kaua'i are earth embankment dams. The most common reasons earthen embankment dams fail are overtopping and piping. While the other types of dam failures listed above can occur, they would more likely lead to overtopping or piping than cause failure on their own, according to a Dam Safety Unit Engineer with the DLNR Engineering Division.

The potential for catastrophic flooding due to dam failures led to the passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

Regulatory oversight for dam safety includes the following:

- **USACE:** Safety inspections of some federal and nonfederal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act.
- **Federal Energy Regulatory Commission:** Cooperates with a large number of federal and state agencies to ensure and promote dam safety. Notably, the USACE and the Federal Energy Regulatory Commission do not have oversight of dam safety in Kaua'i.

- **State of Hawai'i's 2010 Dam Safety Act (13 Hawai'i Administrative Rules [HAR] 7, Chapter 190.1):** Administered by the DLNR, the Dam Safety Act was established to reduce the potential of full or partial failures.

The DLNR Dam Safety Program reviews and approves plans and specifications for the construction of new or modified dams. Any individual or entity seeking to construct, alter, repair, or remove an existing dam must fill out the DLNR's Application for Approval of Plans and Specifications for Construction, Enlargement, Repair, Alteration, or Removal of Dam (DLNR Engineering Division 2025a). HAR Chapter 190.1 defines a state-regulated dam as any artificial barrier, including appurtenant works, that impounds or diverts water and has one of the following characteristics:

- Is 25 feet or more high from the natural bed of the stream or from the lowest elevation of the outside limit of the barrier if it is not across a stream
- Has an impounding capacity at maximum water storage elevation of 50 acre-feet or more
- Has two or more reservoirs that operate or function as a single facility or are connected with an uncontrolled conduit, which shall be construed to be one dam or reservoir
- Is a natural structure that retains water and has been altered by the addition of an outlet works and has a maximum storage volume greater than 50 acre-feet

For more information on regulatory oversight, see Appendix I.

At the time of writing the 2026 MHMRP Update, the State of Hawai'i was implementing the FEMA Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program. This program provides federal funding through grants for technical, planning, design, and construction assistance related to the rehabilitation of high-hazard potential dams (FEMA 2025b). The State of Hawai'i has determined that all regulated high-hazard dams in Kaua'i County are considered to be high-hazard potential dams and qualify for HHPD funding. Because the State and County are interested in pursuing funding under the HHPD Grant Program for the high-hazard dams in the county, the 2026 MHMRP Update complies with all HHPD requirements. As part of this compliance, the County consulted with the State Dam Safety Unit Engineer representing the State Dam Safety Program in the development of this plan and incorporated information shared throughout the MHMRP planning process. For the hazard profile and associated appendices, this included a summary of characteristics for each high-hazard dam. For the vulnerability assessment and associated appendices, this included a narrative summary of impacts to the community and population, plus an analysis of the inundation zone impacts on critical facilities for all high-hazard dams in the county.

## 12.1 HAZARD PROFILE

Table 12-1 summarizes the key elements of the Dam Failure hazard profile for Kaua'i County. Additional details are provided in Appendix I.

**Table 12-1. Dam Failure Hazard Profile Summary**

|                    |  |
|--------------------|--|
| <b>Past Events</b> | Unusually heavy rainfall contributed to the March 14, 2006, Ka Loko Dam failure. Almost 400 million gallons of water came crashing down from the reservoir into Kīlauea Bay, wiping out everything in its path and taking the lives of seven people (Godbey 2007). The event was part of FEMA Major Disaster Declaration DR-1640. For more information about this disaster, see Appendix I.<br><br>There have been no other dam failures on Kaua'i since 2006, including the period since the 2021 MHMRP Update. |
|--------------------|--|

|                     |  |
|---------------------|--|
| <b>Location</b>     | <p>Kaua'i County has 44 high-hazard dams and one undetermined dam that the DLNR Engineering Division has indicated is almost certainly a high-hazard dam. There are additionally two low-hazard dams in the county. All of these dams are earth dams, and their locations are shown on Figure 12-1. The inundation zones for these dams represent the location of greatest risk for the Dam Failure hazard in the planning area. Inundation mapping is discussed further in Section 12.2. More detailed information is provided in Appendix I.</p> <p>The locations of high-hazard dams on Kaua'i have changed slightly since the 2021 MHMRP Update, as four high-hazard dams have been removed. No additional high-hazard dams have been built.</p>   |
| <b>Frequency</b>    | <p>Given the increased monitoring procedures enacted following the 2006 Ka Loko Dam breach, the probability of a dam failure anywhere in the state of Hawai'i has been significantly reduced. A major dam failure is a rare event for which there is no defined recurrence interval. However, failure potential does exist, especially during an extreme rainfall event or major earthquake. The probability of failure is higher at any unmaintained or under-maintained location, though even a well-maintained facility could fail. This is especially true if the dam's spillway is undersized, which is true of all regulated dams on Kaua'i, according to a Dam Safety Unit Engineer with the State DLNR Engineering Division (Dam Safety Unit Engineer 2025). More detailed information is provided in Appendix I.</p> <p>This information is unchanged from the 2021 MHMRP Update. However, climate change is increasing the frequency and severity of heavy precipitation events, which may increase the risk of dam failure, especially if mitigation measures are not undertaken.</p> |
| <b>Severity</b>     | <p>Kaua'i County has 44 high-hazard dams in addition to one undetermined dam that is almost certainly high-hazard. According to the Hawai'i Dam Safety Act, high-hazard dams "are those where failure would probably cause loss of human life". More detailed information is provided in Appendix I.</p> <p>As some dams have been removed since the 2021 MHMRP Update, there are now fewer high-hazard dams on Kaua'i. However, there remains a high number of dams where failure would likely result in loss of life. Additionally, as the severity of extreme precipitation events due to climate change increases, the risk of dam failure may increase. A dam failure event that results from extreme precipitation may be particularly severe if downstream areas are already flooded and are then further inundated by water from the dam.</p>  |
| <b>Warning Time</b> | <p>Warning time for dam failure depends on the cause of the failure. In the event of extreme precipitation, evacuations can be planned with sufficient time. In the event of a structural failure due to an earthquake, there may be little warning time. More detailed information is provided in Appendix I.</p> <p>This information is unchanged from the 2021 MHMRP Update.</p>  |

See Section 4 for a description of elements included in the hazard profile.

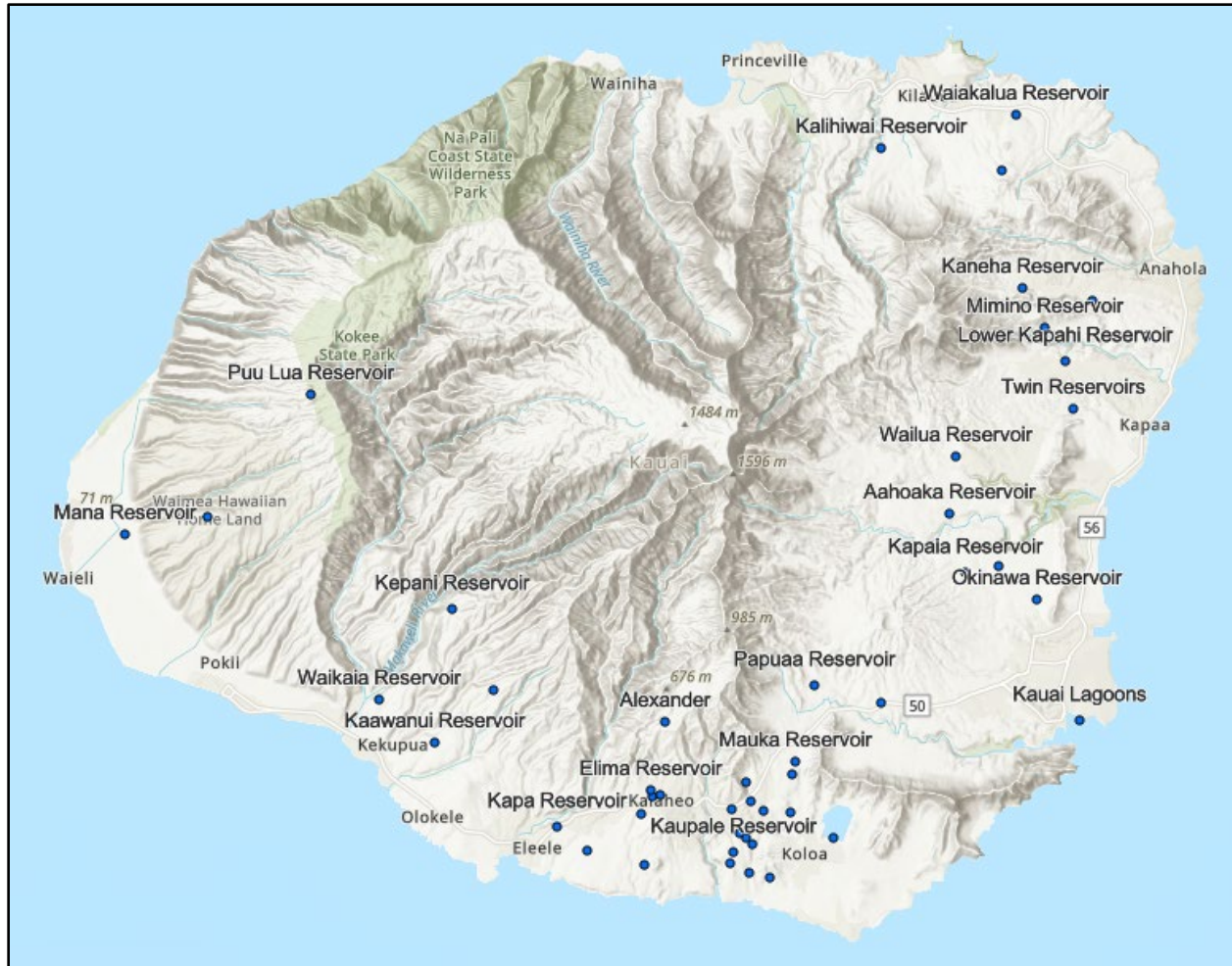


Figure 12-1. Locations of dams in Kaua'i County.

### 12.1.1 Climate Change and Future Conditions

Increases in heavy precipitation events due to climate change may cause dams to fail if proper mitigation measures are not undertaken. Dams constructed for flood control must contend with the impacts of changing precipitation patterns on dam design and operation, including discharge rates. None of the dams on Kaua'i were built specifically for flood control, though some fill this need as a secondary purpose. They may need to modify release rates in response to precipitation events to minimize the risk of failure. Increased discharge rates may increase the probability and severity of flooding downstream.

More intense heavy precipitation events may also lead to landslides, which in turn can cause dam failures as abnormally large quantities of debris enter the reservoir and place stress on the dam. Some studies also suggest that the shifting of water mass on Earth's surface as global ice sheets melt due to climate change may trigger earthquakes (HI-EMA 2023). This interaction is far less established than the relationship between climate change and increases in heavy precipitation events. However, if more frequent earthquakes were to occur, it would increase the risk of earthquake-induced dam failures.

## 12.2 VULNERABILITY ASSESSMENT

### 12.2.1 Scenario

For this 2026 MHMRP Update, the inundation maps for the 47 dams were integrated into one GIS layer for analysis purposes. One dam lacks an inundation map but is completely within the inundation area of another dam, so exposure to the Dam Failure hazard remains accurately reflected in the risk assessment. The inundation maps for these dams were provided by the State DLNR Engineering Division (Dam Safety Unit Engineer 2025). The GIS layer included the 44 high-hazard dams in the county, an undetermined dam that is almost certainly high hazard, and two low-hazard dams. The data and narrative presented throughout this section include the vulnerabilities, impacts, and risk associated with all regulated high-hazard dams in the county. However, more information about the specific vulnerabilities, impacts, and risk associated with each regulated dam in Kaua'i County can be found in Appendix J.

A quantitative assessment of exposure to the Dam Failure hazard was conducted through Hazus using the inundation mapping for the regulated dams and data on the critical facilities, population, and property within the county. The mapping assumes the complete failure of each dam on a day with dry stream conditions and with the dam's reservoir full. A qualitative assessment of factors influencing population vulnerability in Kaua'i to dam failure events was also conducted. Appendix K provides results by district, and results for the total planning area are presented below.

While this analysis provides a comprehensive examination of the potential damage associated with the Dam Failure hazard, including high-hazard dams, there are two notable limitations that may be rectified in future analyses. First, the analysis conducted using Hazus assumed all regulated dams in the county failed at the same time. This is not a realistic representation of the type of dam failure event that could occur. Future vulnerability assessments may address this deficiency by analyzing the impacts on the population, structures, and critical facilities if each dam, especially high-hazard dams, were to fail individually. The second limitation is that the inundation zones used in this analysis were mapped in 2009 and were 16 years old as of the time of this 2026 MHMRP Update. This was the best available data for the analysis but constitutes a limitation given that the mapped inundation zones are based on conditions from 16 years prior. This deficiency in the data may be addressed for future vulnerability assessments by conducting updated assessments of the inundation mapping for each of the dams in the county, particularly the high-hazard dams. Despite these limitations, the damage estimates presented in Section 12.2.3 provide useful insight into the assets that could be damaged across the county by dam failure.

### 12.2.2 Exposure

#### Population and Property

Table 12-2 summarizes the estimated population living in the evaluated dam failure inundation zones and the estimated property exposure, which include all regulated high-hazard dams in Kaua'i. However, any individuals in these areas at the time of a dam failure event would be exposed to the hazard.

**Table 12-2. Exposed Population and Property in Evaluated Dam Failure Inundation Zones**

| Population                          |        |
|-------------------------------------|--------|
| Population Exposed                  | 14,344 |
| % of Total Planning Area Population | 19.6%  |

| Property  |                 |
|---|-----------------|
| Number of Buildings Exposed                     | 5,682           |
| Value of Exposed Structures                     | \$5,759,275,000 |
| Total Exposed Value as % of Planning Area Total | 23.4%           |

**Critical Facilities**

Figure 12-2 shows critical facilities located in the dam failure inundation zones, which include the inundation zones of all regulated high-hazard dams in Kaua'i, by facility type. The following sections summarize exposure to specific types of critical facilities.

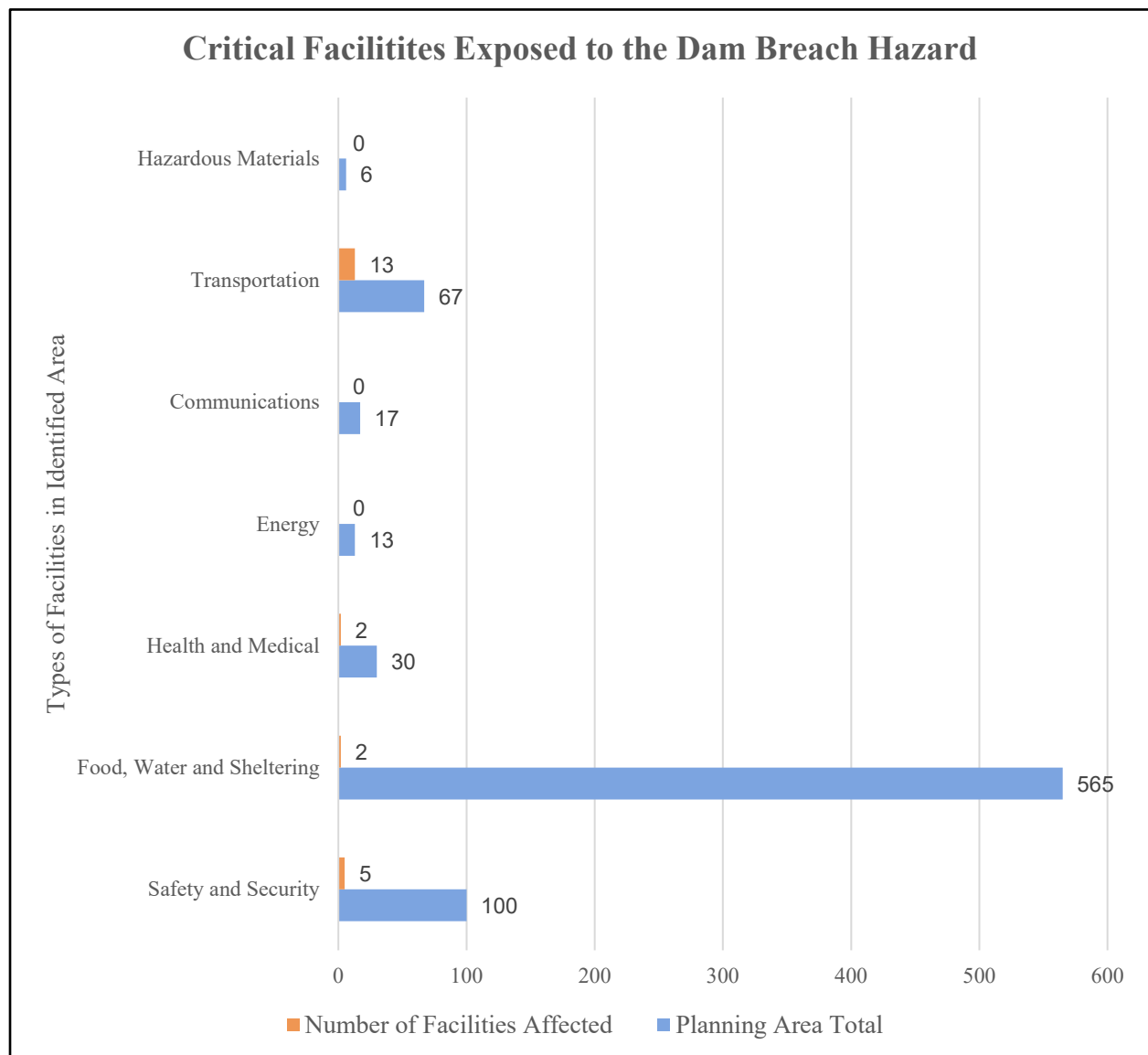


Figure 12-2. Critical facilities in dam inundation areas and county-wide.

## ***Bridges***

There are 13 bridges exposed to the Dam Failure hazard. All of these bridges retain a 96.3% chance of remaining functional in the event of a dam failure.

## ***Water/Sewer/Utilities***

Water, sewer, stormwater, power, and communications facilities within the dam inundation areas are exposed to the hazard.

## ***Hazardous Material Facilities***

There are no recorded hazardous material facilities in the dam failure inundation areas.

## **Environment**

All areas of the environment within the boundaries of the mapped dam failure inundation zones are considered exposed to the Dam Failure hazard.

## **12.2.3 Vulnerability**

### **Population**

Vulnerable populations are all those downstream from dam failures, especially those downstream of high-hazard dams, that are incapable of escaping the area quickly, though communities with high social vulnerability may be more heavily impacted. The social impacts of a dam failure event, focused on the individuals most likely to be impacted, are discussed throughout this section and apply to all regulated high-hazard dams in the county. These impacts are particularly relevant for high-hazard dams as their failure is likely to cause fatalities. The potential for loss of life during a dam failure is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. Populations adversely affected by a dam failure may also include those beyond the disaster area who rely on the dam for potable water.

As was done for the other hazards in the 2026 MHMRP Update, the impacts of dam failure events on socially vulnerable populations in the county, based on the SVI developed for the KCAAP, are discussed in the following subsection. However, in the case of the Dam Failure hazard, it is also important to consider the impact of the hazard on transient populations, particularly tourists. There is notable overlap between dam failure inundation zones and areas and hotels frequented by tourists. Tourists may be particularly vulnerable to this hazard, despite generally having higher income levels, because they may lack access to a vehicle, have a language barrier or mobility issues, or be unfamiliar with warning processes and evacuation protocols in the dam inundation zones.

### ***Social Vulnerability***

The Dam Failure hazard could affect many socially vulnerable communities in Kaua'i. These communities may have a lower capacity to mitigate and respond to the hazard. The overlap of high social vulnerability with the dam inundation areas is given by community (defined as census-designated places) within Kaua'i County in Table 12-3. Only areas of a community that are classified as having the high and highest levels of social vulnerability (i.e., the 61st percentile or higher) and that overlap with dam inundation zones are included in the table. For example, within Kōloa, the entire community falls within the highest social vulnerability levels (the 82nd to 88th percentile compared with all other census block groups in the county), and approximately half of the community overlaps with dam inundation areas.

The “Community” column identifies areas within each community that fall into the high or highest levels of social vulnerability (above the 61st percentile), provided any part of the area overlaps with a hazard exposure zone. For example, if a community is classified with a high social vulnerability level and only a portion of it intersects with a hazard exposure area, the entire community is included in the table, even though only a smaller section is actually exposed to the hazard. While this method may overestimate vulnerability, it offers a broadly accurate overview of community risk. It is important to recognize that social vulnerability and hazard exposure can vary within each community, but this analysis was unable to capture that variability.

Additionally, there are socially vulnerable populations throughout the planning area who may face increased risk from hazards, even in communities categorized as having lower levels of social vulnerability than those listed in Table 12-3. This analysis focused on the highest levels of social vulnerability defined by the SVI developed for the KCAAP (County of Kaua'i 2022b). Therefore, several communities have been excluded from this analysis due to lower levels of social vulnerability, including Wailua Homesteads, ‘Ele‘ele, Waimea, and Princeville. To examine the overlap of hazard exposure areas with these communities, please use the Hazard Mapping Tool on the Kaua'i MHMRP 2026 Story Map (County of Kaua'i 2025b).

**Table 12-3. Communities with High Social Vulnerability or Above in Dam Inundation Areas**

| Community: High Social Vulnerability Areas with (at least partial) Hazard Exposure | Social Vulnerability (Percentile) |
|--|-----------------------------------|
| Anahola:<br>Eastern area of the community  | Highest (0.84)                    |
| Wailua:<br>Nearly entire community   | High (0.75–0.78)                  |
| Kapa'a:<br>East-central area of the community                                      | High (0.76)                       |
| Hanamā'ulu:<br>Entire community  | Highest (0.86–1)                  |
| Līhu'e:<br>North, east, and part of the southern area of the community             | High–Highest (0.67–0.92)          |
| Po'ipū:<br>Southern area of the community  | High (0.61)                       |
| Kōloa:*<br>Entire community  | Highest (0.82–0.88)               |
| Kalāheo:<br>Northern area of the community   | High (0.65)                       |
| Lāwa'i:<br>Northern, southern, and part of the central area of the community       | Highest (0.82)                    |
| Hanapēpē:<br>Southeast to northeast area of the community                          | Highest (0.96)                    |
| Kalihiwai:<br>Entire community   | High (0.8)                        |
| Kīlauea:<br>Eastern area of the community  | High (0.8)                        |

\*Approximately half of the community is exposed to the Dam Failure hazard.

The ways in which social vulnerability may impede a community’s ability to mitigate and respond to a dam failure event are described in the following paragraphs for each social vulnerability category and indicator included in the County’s SVI developed for the KCAAP.

**Household characteristics** include the population under the age of 17 and over age 65 as well as the population with a disability. These factors may reduce the ability of individuals to respond to dam failure events as these groups may have more difficulty quickly evacuating out of the dam inundation zone if they are unable to operate a vehicle, move quickly, access emergency notifications, or require outside assistance. While many of the hazards discussed in the 2026 MHMRP Update can require evacuations, the ability to evacuate from a dam failure event is especially important to prevent loss of life or injuries as there is generally very little notice before a dam failure occurs. Dam failure events can also wash out or otherwise damage roads and isolate communities, which is particularly dangerous for any individual who requires medical attention on a regular basis. Individuals with a disability or over the age of 65 are generally more likely to need access to these services.

**Socioeconomic status**, which includes household income, the population with a bachelor's degree, and the population of outdoor workers, also impacts the ability of a population to mitigate and respond to dam failure events. Households with higher incomes are more likely to have a vehicle and the ability to pay for lodging, which can help them escape a dam failure event and have a safe place to stay in the subsequent recovery period. Additionally, some households in dam inundation areas may be less likely to purchase flood insurance if they are not in the floodplain as well. Lower-income households may be less likely to allocate additional resources to flood insurance in the event of a dam failure than those with more expendable income, which would significantly impede recovery efforts. Outdoor workers in dam inundation areas can also be more vulnerable to the hazard since there is generally little warning time prior to a dam failure event, and they may be unable to seek shelter in time. Additionally, outdoor workers involved in cleanup efforts following a dam failure event may be disproportionately exposed to toxic or hazardous waste, mildew and mold, or sewage.

**Race and ethnicity** impact the ability of a community to mitigate and respond to dam failure events. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua'i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events, including dam failures (County of Kaua'i 2022b). Additionally, linguistic isolation raises vulnerability as it can create a barrier to accessing evacuation notices and procedures if these notices are not widely distributed in languages other than English. This is particularly dangerous due to the short warning time before a dam failure event occurs.

**Physical conditions** also impact a community's mitigation and response capacity to dam failures. These conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units are not necessarily more vulnerable to the Dam Failure hazard if buildings are properly maintained and repaired following a dam failure event. However, rent-burdened households may not have sufficient resources to devote to evacuation and recovery following a dam failure event. Additionally, houses built before the 1970s are less likely to be built to sufficient standards to withstand the surge of water that comes with a dam failure event. Similarly, mobile homes built in the 1970s and prior to the development of federal standards are not sufficiently prepared for flood events (Curran-Groome et al. 2025), including dam failures. Lack of access to a vehicle also increases vulnerability as it can inhibit evacuation from a dam failure and increase the risk of injuries and fatalities, especially if access to a vehicle is needed to escape the hazard due to reduced mobility.

## Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Table 12-4 shows the Hazus loss estimates for the dam failure scenario evaluated.

**Table 12-4. Loss Estimates for Dam Failure**

|   |                               |
|---|-------------------------------|
| <b>Structure Debris Generated (Tons)</b>          | 6,089 (244 25-ton truckloads) |
| <b>Buildings Impacted</b>                         | 342                           |
| <b>Total Value (Structure + Contents) Damaged</b> | \$172,002,000                 |
| <b>Damage as % of Total Value</b>                 | 0.7%                          |

## Critical Facilities

Hazus estimates of damage to buildings that are critical facilities in the dam failure inundation areas are summarized in Table 12-5. General impacts on critical facilities include the following:

- Transportation routes could be wiped out, creating isolation issues, including all roads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Appendix L contains the analysis of roads in the combined dam failure hazard area.
- Utilities such as overhead power lines, cable, and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundated areas.

**Table 12-5. Estimated Damage to Critical Facilities from Dam Failure**

| Critical Facility          | Number of Facilities Affected | % of Building Damaged |        |      |
|----------------------------|-------------------------------|-----------------------|--------|------|
|                            |                               | 0–10%                 | 10–20% | >21% |
| Safety and Security        | 5                             | 1                     | 4      | 0    |
| Food, Water and Sheltering | 2                             | 0                     | 0      | 2    |
| Health and Medical         | 2                             | 2                     | 0      | 0    |
| Energy                     | 0                             | 0                     | 0      | 0    |
| Communications             | 0                             | 0                     | 0      | 0    |
| Transportation             | 0                             | 0                     | 0      | 0    |
| Hazardous Materials        | 0                             | 0                     | 0      | 0    |
| All Facilities             | 9                             | 3                     | 4      | 2    |

## Environment

The environment would be vulnerable to several risks in the event of a dam failure. The inundation of water from a dam failure event can cause erosion and increases in water turbidity due to the influx of soil carried downstream, which may have long-lasting negative impacts (Dam Safety Unit Engineer 2025). The inundation could introduce soil and other foreign elements into local waterways, resulting in the destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species and delicate coral ecosystems. The inundation of water into ecosystems that are not accustomed to flooding could also cause habitat damage. Additionally, the surge of water could displace

aquatic life and leave it stranded on land as the waters recede. These environmental impacts may occur due to a failure of any dam in the county, including all regulated high-hazard dams.

## 12.3 ISSUES

### 12.3.1 Development in High-Hazard Areas

Land use is determined by the County’s zoning code and zoning map, also known as the Comprehensive Zoning Ordinance. The General Plan and community plans establish policies to protect communities from hazards. Development in the planning area is also regulated by building standards and performance measures. The distribution of general land use types in the dam inundation areas is shown in Figure 12-3. Agricultural lands make up most of the area (about 57%), followed by natural lands (21.2%), and residential communities (8.1%).

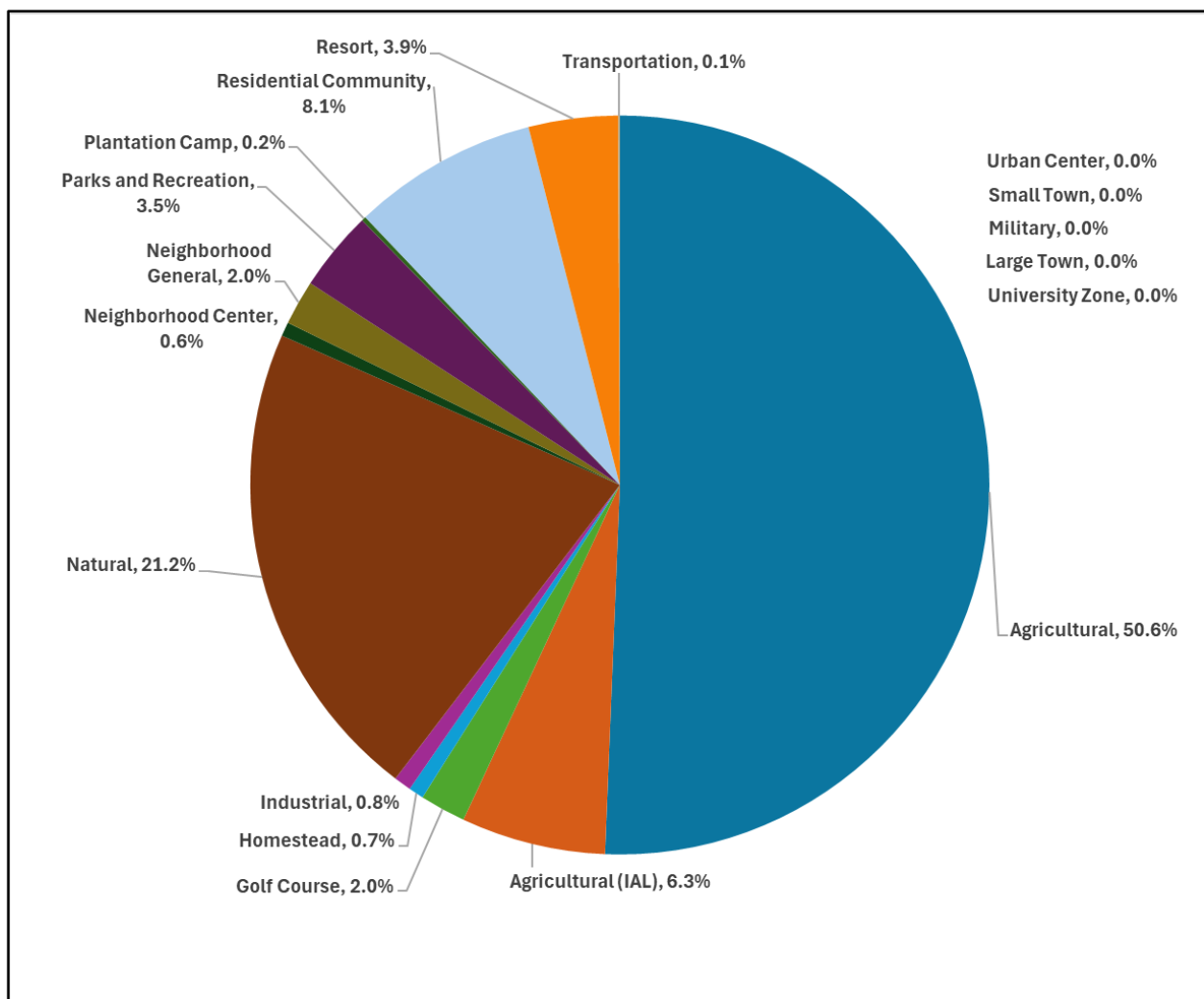


Figure 12-3. Land use distribution by area in the aggregate dam inundation areas.

The Public Safety & Hazards Resiliency section of the General Plan establishes standards and policies for the protection of the community from hazards. Dam failure is currently not explicitly addressed in the countywide policy plan or many of the older community plans. Many of these plans are currently in the

update process, and the results and recommendations of this MHMRP Update will be incorporated into updated policies and planning actions.

### 12.3.2 Other Issues

The following issues have been identified related to the Dam Failure hazard in the planning area:

- **Cascading hazard event potential:** Dam failure may cause several other hazard events to occur, depending on the magnitude of the failure. The sudden release of a large quantity of water from a dam can lead to severe downstream flooding, landslides around the reservoir perimeter, and destruction of downstream habitat. It can also cause erosion along streams or riverbanks as water rushes downstream. There is also the potential for a dam failure to contribute to losses due to drought by releasing water that might have been used as an irrigation or potable water source. Finally, a dam failure may be triggered by intense precipitation events leading to upstream flooding and pressure on the dam. A dam failure occurring in this way would be particularly devastating as downstream areas would likely already be flooded and would receive a further influx of water from the dam. These cascading hazard events could impact all dams in the county. However, cascading hazard events involving the 44 high-hazard potential dams are particularly concerning as they are more likely to lead to fatalities.
- **Lack of sufficient data:** There is insufficient research on the predicted impacts and damages of dam failures triggered by intense precipitation events, where downstream areas are already flooded and are further hit with water from the dam. Future research should consider the potential for this cascading hazard event to occur, especially as heavy precipitation events increase in frequency and severity. Additionally, the dam failure inundation zones used for this analysis were developed in 2008, and updates to these models may be useful in further defining risk from dam failure events.
- **Economic impacts:** All businesses located within the dam inundation zones, including the inundation zones of high-hazard dams, are at risk from disruptions to their operations due to dam failure events. Depending on the severity of the dam failure event, and whether a full or partial failure occurred, disruptions may be short-term or long-term. Disruptions may include loss of business due to limited access routes or power outages as cleanup efforts occur, floodwaters recede, and critical infrastructure returns to functioning. Additionally, any businesses that are damaged by floodwaters from the dam may experience a long-term disruption to their business with associated economic losses. Any individuals working in businesses located in dam inundation zones may have to temporarily stop working if they are unable to work from another location while recovery efforts are underway. This may lead to substantial socioeconomic issues if individuals are unable to work due to the dam failure event.
- **Warning time:** There is often limited warning time for dam failures. Failures are frequently associated with other natural hazard events such as earthquakes, landslides, or tropical cyclones, which limits their predictability and increases the risk of cascading hazard events.
- **Residual risk:** The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- **Security:** Addressing dam security concerns while keeping the public informed of the risk associated with dam failure is a challenge for public officials.
- **Flood insurance coverage:** A significant number of the structures located in the dam inundation zone are outside of SFHAs, meaning that they are not constructed to withstand floodwaters and are less likely to be covered by flood insurance. Even structures that have been designed with

flood hazards in mind may not be able to withstand the height and velocity of flow from a dam failure event.

- **Continuity of operations:** Critical facility owners should be encouraged to include dam failure considerations in their continuity of operations plans if exposed to the hazard, using the information on risk and vulnerability contained in this plan.
- **Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- **Personal planning resources:** Additional information on emergency shelters as well as emergency management resources can be found on the KEMA website and Facebook page. The website also includes links to dam evacuation maps and more dam safety information: <https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency>
- **Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by a dam failure. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people’s safety during evacuations and in community shelters (County of Kaua’i 2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua’i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the Dam Failure hazard, based on the hazard profile and vulnerability assessment, is given in Table 12-6.

**Table 12-6. Risk Ranking Summary for Dam Failure**

| Priority | Hazard Event | Probability | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time   | Duration          | Risk Score |
|----------|--------------|-------------|--|--------------------------|----------------------|----------------|----------------|-------------------|------------|
| 8        | Dam Failure  | Possible    | Limited  | Critical                 | Low                  | Small          | 1 hour or less | Less than 6 hours | 2.2        |

# 13. HEAT

According to the KCAAP, “Extreme heat is defined as temperatures that hover around 10 degrees Fahrenheit (°F) or more above the average high temperature for the region, last for prolonged periods of time, and are often accompanied by high humidity” (County of Kaua‘i 2022b:8). Extreme heat can pose a significant risk to human health, diminishing the body’s ability to maintain a normal temperature. Studies have shown that a significant rise in heat-related illness occurs when excessive heat persists for more than 2 days. The definition of extreme heat sets a fairly high bar for events to be categorized as extreme heat events, and it should be noted that heat can cause illnesses and fatalities before reaching the extreme heat classification. Based on this, events will at times be referred to as heat events if they produced dangerous conditions without reaching an extreme heat designation.

-The heat index measures how hot it feels when relative humidity is factored in with actual air temperature (Figure 13-1). Extreme heat has not been considered a significant hazard on the island due to its temperate environment; however, the high relative humidity levels that Kaua‘i experiences can cause weather conditions to quickly enter dangerous heat index levels as extreme heat events become more frequent with climate change (see Figure 13-1) (County of Kaua‘i 2024). The NWS issues an alert when the heat index is anticipated to be between 105°F to 110°F or higher in a given climate for 2 days in a row or more (NWS 2025j).

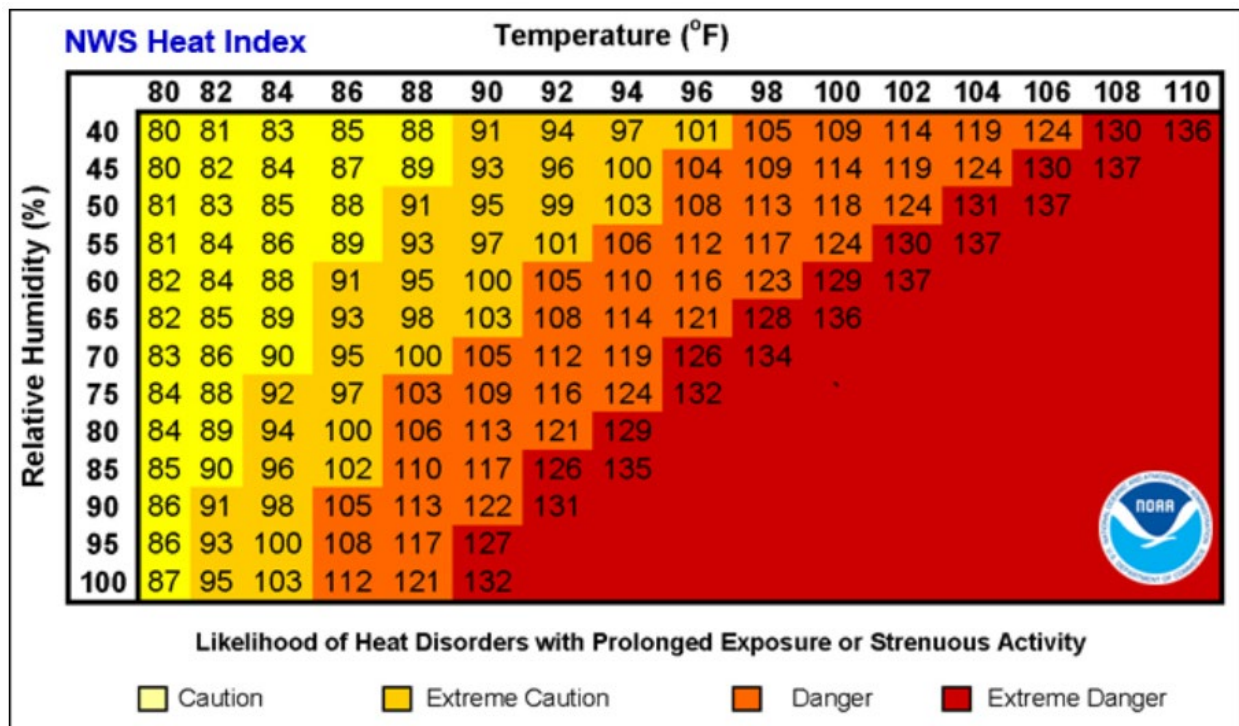


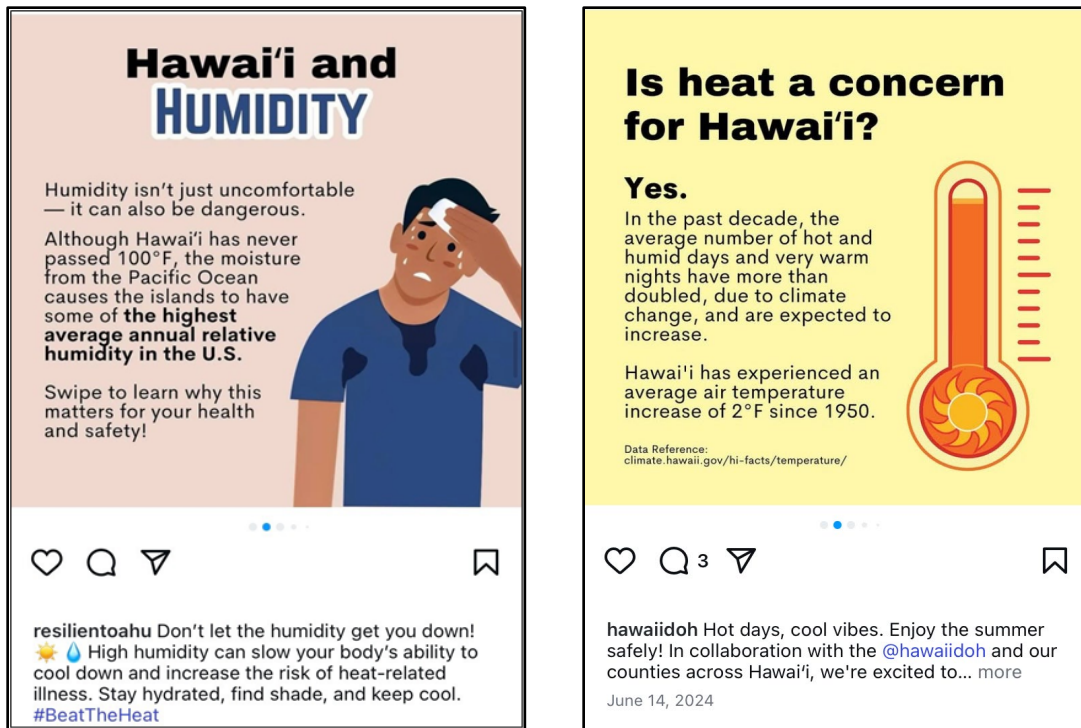
Figure 13-1. NWS heat index chart (NWS 2025j).

Extreme heat can pose a significant risk to human health, diminishing the body's ability to maintain a normal temperature. Coupled with too much fluid or salt loss through dehydration or sweating, extreme heat compounds health risks. Studies have shown that a significant rise in heat-related illness occurs when excessive heat persists for more than 2 days. The following are symptoms of heat exhaustion and heat stroke:

- Heat exhaustion:
  - Faint or dizzy
  - Excessive sweating
  - Cool, pale, clammy skin
  - Nausea or vomiting
  - Rapid, weak pulse
  - Muscle cramps
- Heat stroke:
  - Throbbing headache
  - No sweating
  - Body temperature above 103°F
  - Red, hot, dry skin
  - Nausea or vomiting
  - Rapid, strong pulse
  - May lose consciousness

Heat is one of the leading weather-related killers in the United States, resulting in hundreds of fatalities each year and even more heat-related illnesses. Toddlers are especially vulnerable if left or trapped in a parked car. Seniors in residences without air conditioning are also more at risk of heat illness and death during excessive heat waves.

Although extreme heat has not been a significant historic concern in Hawai'i, rising temperatures in conjunction with high relative humidity levels are increasing the threats associated with heat-related illness (County of Kaua'i 2024). The state, on average, is about 2°F hotter today than in the 1950s, and residents have begun looking to strategies to keep themselves cool during warmer months of the year. These strategies have included spending time on air-conditioned buses and in libraries; installing air conditioners in homes; taking cold showers; and heading to higher elevations. These strategies are complicated by high energy costs and stressed water systems. Extreme heat is posing a mounting challenge in the state and presenting a risk to human health (Combs 2025). One way the State of Hawai'i has responded to this threat is through a heat awareness campaign (Figure 13-2).



**Figure 13-2. Summer 2024 Instagram posts from the City and County of Honolulu’s Office of Climate Change, Sustainability, and Resiliency (left) and State of Hawai’i Department of Health (right) to raise awareness about the dangers of extreme heat in Hawai’i as part of a Statewide Heat Awareness Campaign.**

### 13.1 HAZARD PROFILE

Table 13-1 summarizes the key elements of the hazard profile for heat in Kaua’i County (USDM 2025a). Section 4 provides a description of elements included in the hazard profile, and additional details are provided in Appendix I.

**Table 13-1. Heat Hazard Profile Summary**

|                    |  |
|--------------------|--|
| <b>Past Events</b> | <p>2014: High temperatures recorded at the Līhu’e airport broke a record 5 out of the 7 days starting October 10.</p> <p>2019: Every day between August 24 and September 12, high record temperatures were set or surpassed in Līhu’e. Sixteen nights stayed above 80°F.</p> <p>2020: In Līhu’e, 83 days from July 1–October 18 exceeded normal high temperatures.</p> <p>This information is unchanged from the 2021 MHMRP Update. According to the National Centers for Environmental Information (NCEI) database, there have been no extreme heat events since the 2021 MHMRP Update. However, the NCEI database only records an extreme heat event if temperatures are abnormally high for an extended period of time. For instance, the three events recorded above are not listed as extreme heat events in the NCEI database.</p> <p>While extreme heat events were not recorded between 2020 and 2024, temperatures above normal high temperatures were regularly observed in Kaua’i (NWS 2025k); however, these temperatures were not sufficiently high enough to be classified as extreme heat events.</p> |
| <b>Location</b>    | <p>All areas of Kaua’i County are susceptible to extreme heat. The effects of heat are likely to be exacerbated in cities, due to the urban heat island effect, but the nonurban communities can also be disrupted during periods of unusually hot weather.</p> <p>This information is unchanged from the 2021 MHMRP Update.</p>   |

|                     |  |
|---------------------|--|
| <b>Frequency</b>    | <p>Between 2014 and 2020, which is the time period covered in the 2021 MHMRP Update, three multi-day extreme heat events occurred that exceeded previous records.</p> <p>There have been no recorded extreme heat events between 2020 and 2024 according to NOAA's NCEI Storm Events Database (NOAA 2025c). Based on these 5 years of data, Kaua'i County can expect to experience no extreme heat events per year. This represents a decrease in the average number of events from 0.3 per year, considering all events recorded in the 2021 MHMRP Update through 2024.</p> <p>However, climate change is causing extreme heat events to become more common, which will likely increase the frequency of these events in the coming years. See Section 13.1.1 for more information.</p> |
| <b>Severity</b>     | <p>Kaua'i has experienced record highs surpassing 90°F. Coupled with humidity, the heat index has soared well into the Extreme Caution range (see Figure 13-1). Therefore, the entire planning area can expect to experience heat up through the "Extreme Caution" range. This information is unchanged from the 2021 MHMRP Update.</p> <p>However, climate change is increasing the likelihood of extreme heat events. High temperatures coupled with the high relative humidity levels found throughout the state of Hawai'i can make these events particularly dangerous (County of Kaua'i 2025d). See Section 13.1.1 for more information.</p>   |
| <b>Warning Time</b> | <p>The NWS issues Excessive Heat Warnings within 12 hours of the onset of extremely dangerous heat conditions (NWS 2025j). Heat Watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. A Heat Advisory is issued within 12 hours of the onset of extremely dangerous heat conditions. Excessive Heat Outlooks are issued when the potential exists for an excessive heat event in the next 3 to 7 days.</p>  |

### 13.1.1 Climate Change

Climate change is causing extreme heat events along with heat-related illnesses and deaths to increase in frequency. From 1979 through 2022, heat exposure caused 14,000 deaths in the United States not accounting for those that were indirectly caused by extreme heat (EPA 2021). Extreme heat is a real danger to human health, with events projected to become more frequent, longer-lasting, and more severe. Hawai'i is already experiencing the dangers of extreme heat with climate change the cause of 82% of fatalities from heat in Honolulu (CDC 2024b). Average temperatures across Hawai'i, including Kaua'i, have increased by approximately 1°F since the early twentieth century, whereas the entire U.S. has seen years with an average temperature over 2°F above long-term averages (EPA 2025b; McKenzie et al. 2019). Continued increases in the frequency of extreme temperatures are raising the risk of heat-related illnesses and deaths in Kaua'i (CDC 2024c).

## 13.2 VULNERABILITY ASSESSMENT

### 13.2.1 Scenario

A heat wave can cause significant health problems for the population, including heat exhaustion, heat stroke, or dehydration. Extensive use of air conditioners puts a strain on the power grid and can lead to blackouts. Many residential properties do not have air conditioning, so crowds may form in air-conditioned public buildings as community members try to escape the heat. Extended heat events may affect water supplies as needs are increased to support people, crops, and livestock.

### 13.2.2 Exposure

All people, property, and environments in the planning area would be exposed to some degree to the impacts of extreme heat. Temperatures are generally cooler at higher elevations, so areas near sea level may be more exposed to heat. At the same time, people at higher elevations who are not used to high temperatures may be vulnerable due to a lack of acclimation. The Urban Heat Island (UHI) effect means that urban areas tend to be hotter than rural areas surrounding them due to the amount of impervious surfaces and buildings that absorb heat, which results in urban areas generally being exposed to more heat.

## 13.2.3 Vulnerability

### Population

#### ***Social Vulnerability***

Every community in Kaua'i may be affected by heat. The impacts of the Heat hazard may be largest within socially vulnerable communities as social vulnerability leads to a lower capacity to mitigate and respond to hazard events. High temperatures can occur anywhere in the county, so every community is vulnerable. The County's SVI developed for the KCAAP provides an indication of where social vulnerability is highest in the county (County of Kaua'i 2022b). It is significant to note that there are socially vulnerable populations throughout the planning area who would be at increased risk from the hazard, including in communities that are classified as having lower levels of social vulnerability in the SVI. The ways in which social vulnerability may impede a community's ability to mitigate and respond to a heat event are described in the following paragraphs for each social vulnerability category and indicator included in the County's SVI developed for the KCAAP (County of Kaua'i 2022b).

**Household characteristics** include the population under the age of 17 and over age 65 as well as the population with a disability. These factors reduce the ability of individuals to mitigate and respond to high-heat events. Children are less able to regulate their body temperature than adults, which makes them more vulnerable to high temperatures. They also may not be aware of the need to stay cool and hydrated unless directed to do so by an adult (National Integrated Heat Health Information System [NIHHIS] 2025). Individuals over the age of 65 and those with a disability can be more vulnerable to high temperatures as well. These groups of people may have preexisting conditions or take medications that make heat-related illnesses more likely to occur. Individuals who are cognitively impaired or have high physical mobility constraints may not be able to move to cooler locations without the assistance of others (EPA 2021; NIHHIS 2025). Older individuals are also more likely to live alone, which increases vulnerability to extreme heat as there are no other people present to recognize the signs of heat-related illness and help prevent adverse outcomes (NIHHIS 2025). Additionally, those who are unable to drive a vehicle, either due to the effects of age or a disability, may not be able to access cooling centers, which is particularly important as only about 57% of homes in the state of Hawai'i have air conditioning (U.S. Energy Information Administration [EIA] 2023). During high heat events, everyone needs to be able to access cool spaces to prevent heat-related illness.

**Socioeconomic status** also impacts the ability of a population to mitigate and respond to heat events. These factors include household income, the population with a bachelor's degree, and the population of outdoor workers. Households with higher incomes are more likely to have additional resources to purchase and run air conditioning systems. Conversely, households with lower incomes are more vulnerable to high temperatures because they may not be able to afford to install air conditioning systems or pay the increased electricity costs to run the systems they already have. Outdoor workers are more vulnerable to heat events as well because they work outside without shelter from the heat, especially if shade is scarce. Outdoor workers are also generally involved in physical activity that can increase the risk of heat-related illnesses, and they may have to wear personal protective equipment that prevents heat escaping and keeps their body temperature high (NIHHIS 2025).

**Race and ethnicity** impact the ability of a community to mitigate and respond to a heat event. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua'i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events, including high temperatures (County of Kaua'i 2022b). Additionally, linguistic isolation raises

vulnerability as it can create a barrier to accessing information such as heat advisories, the location of cooling centers, or strategies for staying cool if these notices are not widely distributed in languages other than English.

**Physical conditions** also impact a community's mitigation and response capacity to heat events. Physical conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units can increase vulnerability to heat events because strategies to cool a residence are within the control of landlords as opposed to people living in the residences. For instance, landlords may not be incentivized to install central air conditioning in rental properties. There are still strategies renters can implement within their purview to cool their homes, but they are more limited. Apartments are also less likely to use air conditioning than other housing types in the U.S., and renters represent a greater share of the households that do not run air conditioning than homeowners (EIA 2022). Similar to lower-income households, rent-burdened households may not have sufficient resources to devote to cooling their homes. For instance, households may choose to avoid running their air conditioners to avoid increased utility bills. Houses built before the 1970s are also vulnerable to high temperatures because they are generally less likely to have air conditioning (EIA 2022). Similarly, mobile homes built in the 1970s and prior to the development of federal standards are not sufficiently prepared for heat events (Curran-Groome et al. 2025). Older mobile homes have been found to be poorly insulated, making them hotter during heat events and more costly to cool (Bernard and Proano 2022; Convergence of Climate-Health Vulnerabilities 2025). Lack of access to a vehicle also increases vulnerability as it can pose a barrier to accessing cooling centers if people are not able to cool down in their homes.

### **Property and Critical Facilities**

Heat events are not known for causing significant damage to property and critical facilities relative to the other hazards discussed in the 2026 MHMRP Update; however, extreme heat can cause some amount of damage to property and critical facilities as high temperatures can lead to materials expanding or degrading (EPA 2025c; Gold 2023; U.S. Cybersecurity and Infrastructure Security Agency [CISA] 2025). For instance, concrete may dimple or crack in extreme heat events (CISA 2025; EPA 2025c). Additionally, roads, runways, and rail lines can all buckle under high temperatures, which then requires repairs and restricts transportation (EPA 2025c; Liban et al. 2023).

Powerlines are the type of critical infrastructure most vulnerable to heat events. People are more likely to run air conditioners and fans during periods of high temperatures, which strains the electric grid. At the same time, high temperatures can cause powerlines to sag which reduces their efficiency. The combination of lower efficiency and higher demand can stress these systems (Zamuda et al. 2023). In severe instances, high electricity demand can cause power outages, which is particularly dangerous during high heat events because it prevents people from cooling their homes. It also puts the lives of any individuals who are dependent on electric medical devices at risk. Power outages could also have cascading impacts on other pieces of critical infrastructure, such as wastewater pumps and cooling centers, if they do not have generators to keep them running for the duration of the outage.

### **Environment**

Kaua'i's ecosystems are sensitive to high temperatures. Marine heatwaves are particularly dangerous because they can harm coral reefs. High temperatures in the ocean around coral reefs cause algae that the coral needs to survive to die off. This leads to coral bleaching and often causes coral to die (EPA 2016). As coral reefs die, fisheries that are dependent on the reefs disappear, which harms people who use those fisheries as a food source. Reefs also buffer storm surge and coastal flooding. Without the reefs, future storms and king tides will reach further inland, leading to more erosion and water inundating even further

inland in following events. Coral reefs also provide a source of recreation and generate income from tourism, which would be adversely impacted by marine heatwaves (State of Hawai'i 2025b). In addition to these other factors, coral reefs have substantial cultural significance (DLNR Division of Aquatic Resources 2025).

On land, a single extreme heat event is not expected to cause notable damage; however, a sustained increase in higher temperatures is causing the range of species to shift. Invasive species are spreading as higher temperatures make it easier for them to expand into areas that previously held native species (Kaua'i County 2022a). Many of these invasive species pose a greater wildfire risk than native vegetation (NAISMA 2023). Increased temperatures are also expanding and shifting mosquito habitat, which will expose people to more vector-borne diseases (State of Hawai'i Department of Health Hazard Evaluation and Emergency Response Office 2025), which is also expected to lead to higher rates of avian malaria that could have impacts on the tourism industry (State of Hawai'i 2025b).

Extended periods of extreme heat can also impact crops and agriculture in Kaua'i. Increases in the number of days with extreme high temperatures can reduce crop yields. These can also harm livestock and reduce the production of dairy cows (EPA 2025c; Wilson et al. 2023). In more severe cases, extreme heat can lead to livestock fatalities if mitigation measures are not taken to reduce exposure through cooling systems (Wilson et al. 2023).

## 13.3 ISSUES

### 13.3.1 Development in High-Hazard Areas

Land use in Kaua'i County is determined by the County's zoning code and zoning map, also known as the Comprehensive Zoning Ordinance. The General Plan and community plans establish policies to protect communities from hazards. However, the county does not currently have policies in place related to extreme heat and development due to the emerging nature of this threat in Kaua'i and its presence across the entire county. While there are no specific policies associated with development, future development within urban areas should consider the UHI and that expanding impervious surfaces and buildings will increase temperatures. Potential future development should also consider enabling widespread access to cooling centers.

### 13.3.2 Other Issues

The following issues have been identified related to the Heat hazard in the planning area:

- **Cascading hazard potential:** Heatwaves can burden health and emergency services and increase strains on water, energy, and transportation resulting in power outages. Food and livelihood security may be strained if people lose their crops or livestock due to extreme heat. Marine heatwaves may additionally cause coral reefs to die and lead to additional coastal erosion and flooding (HI-EMA 2023; Kaua'i County 2022b). High temperatures are also most likely on Kaua'i at the same time of year as hurricanes. A heatwave following a hurricane would be particularly devastating for the county as infrastructure to keep people cool would be in disrepair and resources would be stretched too thin (Kaua'i County 2022a).
- **Cooling centers are not currently in use:** During periods of extreme heat, cooling centers located in strategic areas around the island may be an effective strategy to protect the public from high temperatures. While urban areas can be at risk from increased exposure to extreme heat due to UHIs, rural areas may also be at risk if cooling centers are inaccessible and homes lack air conditioning. There are currently no designated cooling centers in the county.

- Data inaccuracies in recording heat-related deaths:** Fatal heat events are notoriously underrepresented due to the way that deaths are recorded. Heat can worsen preexisting health conditions and place strain on the body. This results in fatalities with a primary and secondary cause of death because the fatality likely would not have occurred without the high temperatures. Heat is not always recorded as an underlying or secondary cause of death in these circumstances, which leads to substantial undercounting (EPA 2021; Snow and LaFleur 2023).
- Continuity of operations:** Critical facility owners should be encouraged to include extreme heat considerations in their continuity of operations plans, using the information on risk and vulnerability contained in this plan.
- Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- Personal planning resources:** Additional information on emergency shelters as well as emergency management resources can be found on the KEMA Facebook page and website: <https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency> (KEMA 2025).
- Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by heat events. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people’s safety in community shelters (County of Kaua’i 2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua’i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the Heat hazard, based on the hazard profile and vulnerability assessment, is given in Table 13-2.

**Table 13-2. Risk Ranking Summary for Heat**

| Priority | Hazard Event | Probability | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time       | Duration         | Risk Score |
|----------|--------------|-------------|--|--------------------------|----------------------|----------------|--------------------|------------------|------------|
| 9        | Heat         | Unlikely    | Minor  | Limited                  | Medium               | Large          | More than 24 hours | More than 1 week | 2.2        |

## 14. EARTHQUAKE

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An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of the crust, a volcanic eruption, or a volcano mass settling on the ocean floor. Dislocations of the crust cause more destructive quakes than does volcanic activity. Proximity of the built environment to the epicenter determines the amount of damage. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called seismic waves are generated. These waves travel outward from the source of the earthquake at varying speeds.

According to the USGS Earthquake Hazards Program, an earthquake hazard is anything associated with an earthquake that may affect resident's normal activities. This includes the following:

- **Surface faulting:** Displacement that reaches the earth's surface during slip along a fault. Commonly occurs with shallow earthquakes, those with an epicenter less than 20 kilometers.
- **Ground motion (shaking):** The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface.
- **Landslide:** A movement of surface material down a slope.
- **Liquefaction:** A process by which water-saturated sediment temporarily loses strength and acts as a fluid. Earthquake shaking can cause this effect.
- **Tectonic deformation:** A change in the original shape of a material due to stress and strain.
- **Tsunami:** A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major submarine slides, or violent underwater volcanic eruptions.

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity. Magnitude is commonly expressed by ratings on the moment magnitude scale ( $M_w$ ), the most common scale used today (USGS 2024a, Tetra Tech 2021). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved, and the force required to move it). The scale is as follows:

- **Great:**  $M_w > 7.9$
- **Major:**  $M_w = 7.0 - 7.9$
- **Strong:**  $M_w = 6.0 - 6.9$
- **Moderate:**  $M_w = 5.0 - 5.9$
- **Light:**  $M_w = 4.0 - 4.9$
- **Minor:**  $M_w = 3.0 - 3.9$
- **Micro:**  $M_w < 3$

The most commonly used intensity scale is the modified Mercalli intensity scale, which is generally represented visually using shake maps. The USGS Earthquake Hazards Program produces ShakeMaps which map ground motion and shaking intensity following significant earthquakes. ShakeMaps focus on the ground shaking caused by the earthquake, rather than on characteristics of the earthquake source, such as magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a

range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the variation of ground shaking in a region immediately following significant earthquakes (USGS 2025a).

Earthquake hazard assessment is also based on expected ground motion. During an earthquake when the ground is shaking, it also experiences acceleration. The peak acceleration is the largest increase in velocity recorded by a particular station during an earthquake. Estimates are developed of the annual probability that certain ground motion accelerations will be exceeded; the annual probabilities can then be summed over a time period of interest.

The most commonly mapped ground motion parameters are horizontal and vertical peak ground acceleration (PGA) for a given soil type. PGA is a measure of how hard the earth shakes, or accelerates, in a given geographic area. PGA is measured in g (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). Instruments called accelerographs record levels of ground motion, including PGA, due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity. Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the IBC. Building codes with seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake.

Another concern associated with the Earthquake hazard is soil liquefaction, which occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people.

Additional general information on the Earthquake hazard is provided in Appendix I.

## 14.1 HAZARD PROFILE

In addition to posing a life safety hazard, earthquakes are destructive to Kaua'i County's infrastructure, including buildings, roads, bridges, and utilities. The seismic hazard is often characterized in terms of the probability of PGA, which is measured as a percent of Earth's gravitational acceleration (%g) within a fixed time period. The county has the lowest expected ground acceleration in the state (Figure 14-1). A PGA of 100%g can cause significant impacts as described in Table 14-1. Engineers use this information to develop building codes and design earthquake resistant structures.

According to the USGS, one problem in assigning seismic hazard zones to the island is that the ground shaking during a strong earthquake may vary within a small area. This variation is due to the nature of the underlying ground, for example, whether the ground is mainly lava bedrock or soil. Two homes in the same neighborhood may suffer different degrees of damage depending on the properties of the ground upon which they are built. In addition, local topography strongly affects earthquake hazards. Steep slopes composed of loose material may produce large landslides during an earthquake (USGS 2023).

Each year thousands of earthquakes occur in Hawai'i, with the majority of them too small to be felt except by highly sensitive instruments; however, there have been earthquakes that jolted the islands. The island of Hawai'i has experienced numerous earthquakes of magnitude 5 or greater; however, no large earthquakes have been recorded on Kaua'i. Even though there has not been a significant earthquake in

Kaua'i, it is important to note that tremors anywhere in the state could result in a tsunami (HI-EMA 2023).

**Table 14-1. Seismic Hazard Zones Reflecting Intensity and Probability of Shaking**

| SDC* | Map Color    | Earthquake Hazard  | Potential Effects of Shaking†  |
|------|--------------|--|--|
| A    | White        | Very small probability of experiencing damaging earthquake effects.                    | None   |
| B    | Green        | Could experience shaking of moderate intensity.  | Moderate shaking – Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.   |
| C    | Yellow       | Could experience strong shaking.   | Strong shaking – Damage negligible in buildings with good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built structures.   |
| D0   | Dark Yellow  | Could experience very strong shaking (the darker the color, the stronger the shaking). | Very strong shaking – Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures.  |
| D1   | Light Orange |  |  |
| D2   | Orange       |  |  |
| E    | Red          | Near major active faults capable of producing the most intense shaking.                | Strongest shaking – Damage considerable in specially designed structures; frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. Shaking intense enough to completely destroy buildings. |

Source: Reproduced from FEMA (2023a).

\* SDC = Seismic design category

† Abbreviated descriptions from the Modified Mercalli Intensity Scale

It should be noted that larger magnitude earthquakes are often accompanied by smaller earthquakes. These can be aftershocks of foreshocks. Aftershocks are smaller earthquakes that follow a larger earthquake. Foreshocks are smaller earthquakes that precede a larger earthquake (USGS 2025b). Aftershocks and foreshocks occur around the place on a fault as the main earthquake (USGS 2025c). Following a larger magnitude earthquake, aftershocks are predicted by the USGS. These predictions are made for the state of Hawai'i when an earthquake with a magnitude greater than 5 occurs (USGS 2025b). As previously mentioned, as well as discussed in Table 14-2, earthquakes of this magnitude have not been recorded for the island of Kaua'i.

Table 14-2 summarizes the key elements of the Earthquake hazard profile for Kaua'i County. Additional details are provided in Appendix I.

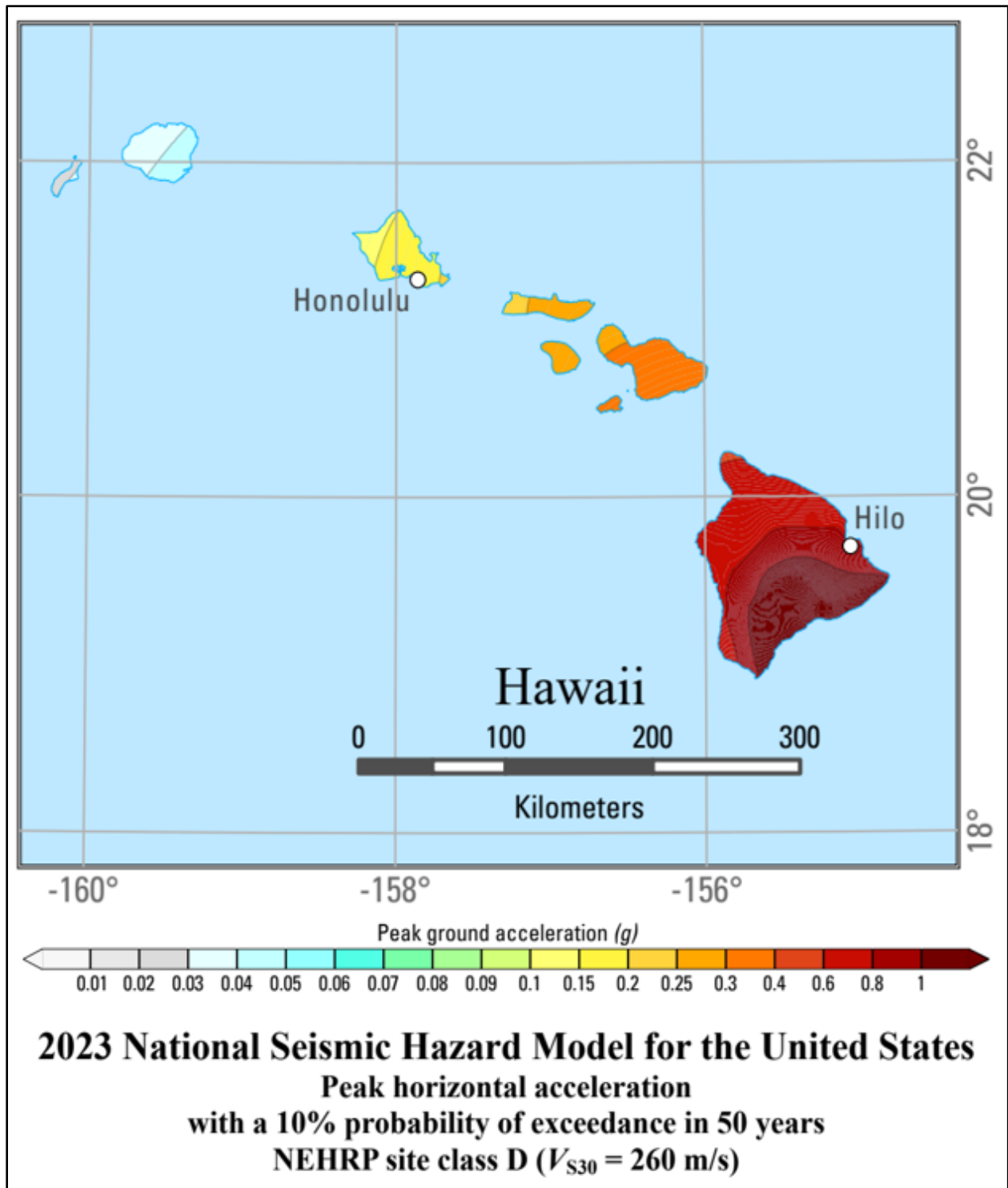


Figure 14-1. Peak acceleration (%g) with 10% probability of exceedance in 50 years (Petersen et al. 2023).

**Table 14-2. Earthquake Hazard Profile Summary**

|                     |  |
|---------------------|--|
| <b>Past Events</b>  | <p>No large earthquakes have occurred on Kaua'i. However, the island of Hawai'i has experienced numerous earthquakes of magnitude 5 or greater.</p> <p>In the period since the 2021 MHMRP Update, there have been five earthquakes of magnitude 5 or greater all of which occurred on or directly off the coast of the island of Hawai'i. The effects of these earthquake events were not strong enough to cause damage on Kaua'i. One event reached a sufficient intensity in Kaua'i to cause weak to light shaking (USGS 2025d).</p>   |
| <b>Location</b>     | <p>No mapping of fault lines or earthquake-sensitive soil classifications has been done for the island of Kaua'i. Exposure areas are based on floodplains, which typically contain soft soils.</p> <p>Kaua'i can experience shaking resulting from an earthquake, but the epicenter of the earthquake is most likely to be near the islands of Hawai'i or Maui, where volcanic and tectonic processes generate seismic activity in the state (Chair of the Hawaii Earthquake &amp; Tsunami Advisory Council 2025). These tectonic and volcanic processes are due to a hotspot in the Earth's crust. As Kaua'i is the oldest major Hawaiian Island, at approximately 5.5 million years old, movement of the Earth's crust has since moved Kaua'i off this hotspot that originally formed the island. The hotspot is now predominantly beneath the island of Hawai'i. For this reason, Kaua'i has relatively low tectonic seismic activity compared to the younger islands of Maui and Hawai'i, with Hawai'i being the youngest (Chair of the Hawaii Earthquake &amp; Tsunami Advisory Council 2025).</p> <p>This information is unchanged from the 2021 MHMRP Update.</p> |
| <b>Frequency</b>    | <p>Due to a lack of volcanic activity and historical occurrence of earthquakes, Kaua'i County can expect earthquake activity to be minimal. Kaua'i County has a less than 25% chance, and in many areas of the county, a less than 5% chance, of experiencing an earthquake with damaging shaking in the next 100 years. Note that for the island of Hawai'i, there is over a 95% chance of experiencing an earthquake with damaging shaking in the next 100 years (Petersen et al. 2023).</p> <p>According to an SME from HETAC, the mean return period for an earthquake with a 0.1 PGA, which is sufficient to trigger liquefaction, is 2,500 years. This represents a frequency of approximately 0.0004 earthquake events per year that would yield strong ground motions.</p>   |
| <b>Severity</b>     | <p>The USGS-estimated PGA in Kaua'i County with a 10% exceedance chance in 50 years is less than 0.1 g (Petersen et al. 2023). (Fractions of g represent the acceleration due to Earth's gravity, equivalent to g-force. Objects become airborne at 1 g.) Figure 14-1 shows PGA with 10% probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas.</p> <p>Seismic design categories (SDCs) are used to determine the probable shaking that earthquakes will cause in a place and the impacts and damages expected from the shaking (FEMA 2025g). Figure 14-2 shows the mapped SDC rating for the state of Hawai'i, and Table 14-1 explains the anticipated impacts of earthquakes at each SDC rating. The SDC map shown in Figure 14-2 was developed for the 2024 International Residential Code (IRC) and was based on Hawai'i's 1998 NSHM (FEMA 2023b). Not all SDC maps for a given area will be the same, and SDC maps for Hawai'i created with the updated 2023 NSHM for Hawai'i are not yet available.</p>  |
| <b>Warning Time</b> | <p>There is currently no reliable way to predict when an earthquake will occur at any given location. Potential warning systems could give several to tens of seconds of notice before strong shaking occurs (Chair of the Hawaii Earthquake &amp; Tsunami Advisory Council 2025).</p>   |

See Section 4 for a description of elements included in the hazard profile.

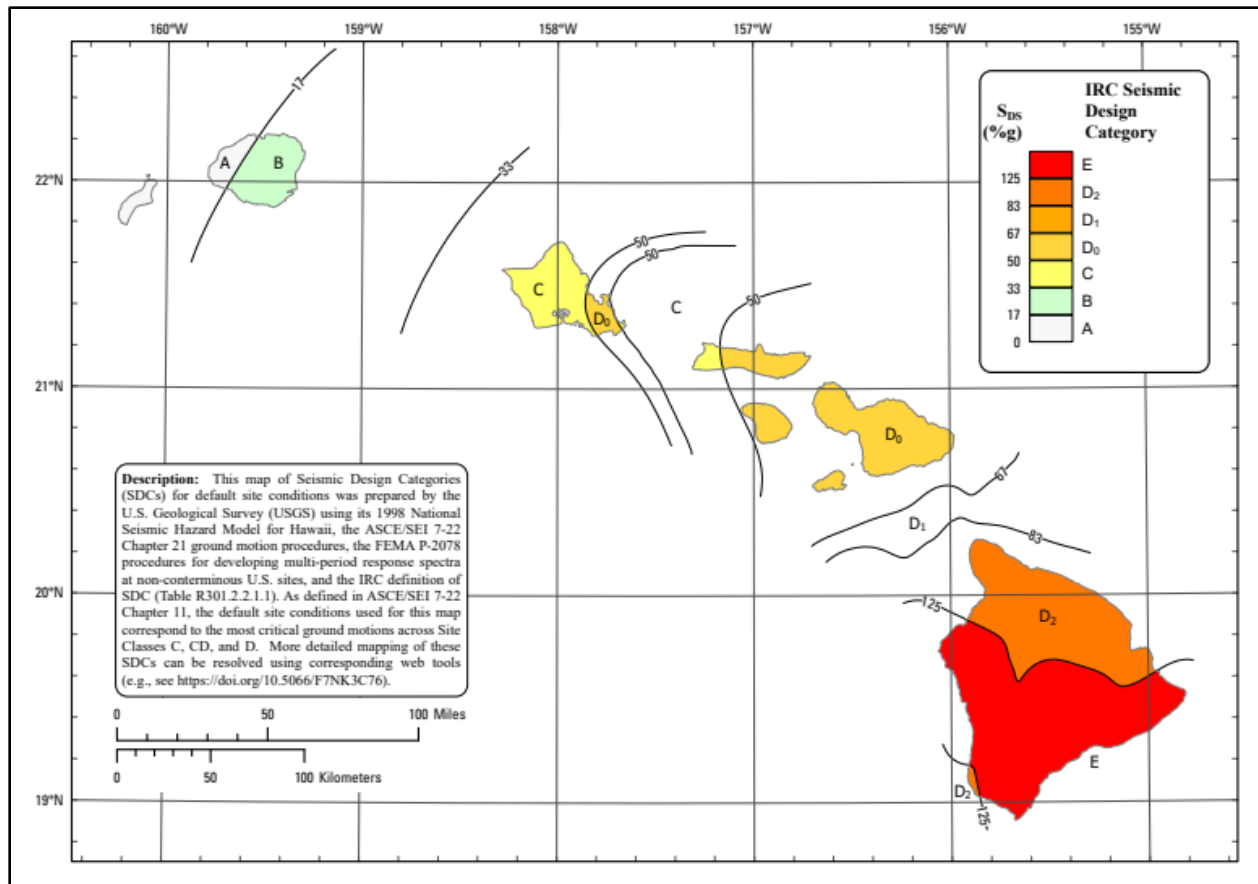


Figure 14-2. Seismic design categories across Hawai'i developed for the International Residential Code (FEMA 2023b).

### 14.1.1 Climate Change and Future Conditions

The interaction of global climate change and earthquakes in Kaua'i is unknown. Secondary impacts of earthquakes could be magnified by climate change. For instance, soils saturated by repetitive storms could experience liquefaction or an increased propensity for slides during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. Wildfires ignited by downed electrical lines or a gas leak following an earthquake could be particularly devastating due to dry conditions. There are currently no models available to estimate these impacts.

Additionally, some scientists suggest the repositioning of water mass on Earth's surface as the glaciers melt and water flows into the oceans may trigger tectonic activity due to Earth's plates shifting with the changing mass (HI-EMA 2023; Pearce 2012). For instance, a 2010 study found that seismic activity increased following El Niño cycles in the Pacific over the 40-year period they examined, which may be attributed to slight changes in sea level brought about by the event (Guillas et al. 2010). Changing sea levels due to climate change may lead to similar occurrences. However, understanding of the relationship between earthquakes and climate change is still preliminary and uncertain.

## 14.2 VULNERABILITY ASSESSMENT

### 14.2.1 Scenario

The scenario used for the vulnerability assessment was a 500-year probabilistic earthquake or an earthquake with a 500-year mean return period. Such an earthquake could result in power outages lasting hours to days depending on whether the extent of the damage is limited to tripped circuits or downed lines. Levees and revetments built on poor soils may fail, representing a loss of critical infrastructure. The shaking associated with the earthquake may also cause damage to buildings and critical infrastructure. These events could lead to secondary hazards, including landslides that would further damage structures.

### 14.2.2 Exposure

#### Population

The entire population of the planning area is exposed to direct and indirect impacts from earthquakes and may have to deal with the consequences of earthquakes to some degree. Populations that suffer no direct damage from an event itself could be affected by business interruptions that keep people from working, road closures that isolate populations, or a loss of utility functions.

#### Property

All 26,502 buildings in the planning area are exposed to the Earthquake hazard. These structures are estimated to have a total replacement value of \$24.6 billion.

#### Critical Facilities

All critical facilities in the planning area are exposed to this hazard as an earthquake may affect any part of the county. However, certain facilities may be more heavily impacted. Critical facilities that store hazardous materials may be at risk from ruptures or leaks that lead to negative impacts on the surrounding environment and complicate recovery efforts following the earthquake. Additionally, transportation facilities may be vulnerable if the earthquake damages roads. This could lead to the isolation of communities and restrict access to critical facilities.

Critical facilities constructed on floodplain soils are particularly at risk from strong seismic events. Floodplain soils generally tend to be silty or sandy which are the soil types more prone to liquefaction (National Geographic 2023; Seed et al. 2003). However, according to an SME from HETAC, the likelihood of an earthquake of a sufficient magnitude to trigger liquefaction is extremely low for Kaua'i. If such an earthquake were to occur, critical facilities in the floodplain would likely be more vulnerable to damage, but this occurrence is highly unlikely.

#### Environment

All natural areas are exposed to the Earthquake hazard.

### 14.2.3 Vulnerability

Earthquake vulnerability data for the risk assessment was generated using a Hazus Level 2 analysis for a 500-year probabilistic earthquake in the planning area. Hazus estimates the intensity of the ground shaking, the number and value of buildings damaged, the number of critical facilities damaged, the

number of people displaced from their homes, and the debris generated. The analysis results are summarized in the sections below, and more detailed information broken down by district can be found in Appendix K.

## **Population**

The degree of vulnerability of people in the planning area is dependent on many factors, including the age and construction type of the structures they live in, the soil types their homes are constructed on, the intensity of the earthquake, etc. A Level 2 Hazus analysis for the 500-year probabilistic earthquake event showed that no residents would be displaced or require short-term shelter. Effects on the population were not conducted for seismic activity originating on neighboring islands.

## ***Social Vulnerability***

Every community in Kaua'i may be affected by earthquakes. Socially vulnerable communities can be more heavily impacted by these events due to lower capacity to mitigate and respond. The County's SVI developed for the KCAAP provides an indication of where social vulnerability is highest in the county (County of Kaua'i 2022b). It is significant to note that there are socially vulnerable populations throughout the planning area who would be at increased risk from the hazard, including in communities that are classified as having lower levels of social vulnerability in the SVI. The ways in which social vulnerability may impede a community's ability to mitigate and respond to an earthquake event are described in the following paragraphs for each social vulnerability category and indicator included in the County's SVI developed for the KCAAP (County of Kaua'i 2022b).

**Household characteristics** include the population under the age of 17 and over age 65 as well as the population with a disability. These factors may reduce the ability of individuals to mitigate and respond to earthquakes. For instance, members of these groups may have more difficulty moving into a safer position during an earthquake, such as under a sturdy desk or table. Additionally, those under the age of 17, especially younger children may be unaware of the actions to take in the event of an earthquake to protect themselves. It is also common for contents in buildings to fall during earthquakes (FEMA and National Earthquake Hazard Reduction Program [NEHRP] 2023; USGS 2025e). Members of these groups with mobility issues may have difficulty moving into a safer position during an earthquake or getting to a safe location following an earthquake if they have to maneuver around obstacles to safely exit a building. Members of these groups may also require regular medical attention more frequently than the general population and could be isolated from the care they need by blocked roads and downed powerlines.

**Socioeconomic status** also impacts the ability of a population to mitigate and respond to earthquake events. These factors include household income, the population with a bachelor's degree, and the population of outdoor workers. Households with higher incomes are more likely to have additional resources to prepare for an earthquake. It is recommended for households to have sufficient supplies for a minimum of 3 days and ideally up to 2 weeks (FEMA and NEHRP 2023). This level of preparation is especially important on Kaua'i since the risk of communities being isolated is higher due to limited ingress and egress. However, lower-income households may not have the means to stock up on sufficient resources (Johnson et al. 2021). Outdoor workers could be more vulnerable to the Earthquake hazard if they are caught near trees, buildings, powerlines, or other structures that may fall on them during an earthquake. Though notably, indoor workers face similar risks if they are not near a sturdy table or desk to take shelter underneath (FEMA and NEHRP 2023). Workers involved in the cleanup following an earthquake may also be more vulnerable to the impacts of the hazard due to the presence of dangerous materials such as sewage, downed powerlines, and toxic or hazardous waste.

**Race and ethnicity** impact the ability of a community to mitigate and respond to an earthquake event. Race and ethnicity in the SVI include the population identifying as Native Hawaiian or Pacific Islander and those with linguistic isolation (i.e., those who speak English less than well). In Kaua'i, the combined effects of structural and institutional racism and colonization have led to Native Hawaiian communities being disproportionately burdened by factors that lower the ability to prepare and respond to hazard events including earthquakes (County of Kaua'i 2022b). Additionally, linguistic isolation raises vulnerability as it creates a barrier to accessing resources such as procedures on what to do in the event of an earthquake if this information is not widely distributed in languages other than English.

**Physical conditions** also impact a community's mitigation and response capacity to earthquakes. Physical conditions include renter-occupied housing units, rent-burdened households, pre-1970s housing, mobile homes, and households without vehicles. Renter-occupied housing units may have increased vulnerability to earthquakes because there is less information available to them about their residence and its ability withstand the hazard than is available to homeowners (Brechtwald et al. 2015). Similar to low-income households, rent-burdened households may not have sufficient resources to adequately prepare for an earthquake event. Houses built before the 1970s are especially vulnerable to earthquakes as building codes have strengthened over time to ensure buildings are better able to withstand the hazard (FEMA 2023b). For instance, the NEHRP, which is tasked with protecting people and property from earthquakes was not established until 1977. This program works to improve seismic building codes and identifies areas where soil types increase earthquake risk (National Institute of Standards and Technology 2025). Buildings built before this program and other provisions were in place face increased vulnerability. Similarly, mobile homes built in the 1970s and prior to the development of federal standards are not sufficiently prepared for hazard events (Curran-Groome et al. 2025). Lack of access to a vehicle does not contribute to vulnerability as significantly for earthquakes as for other hazards where evacuation is possible; however, lack of access to a vehicle may further isolate households, especially if transportation resources are limited following an earthquake.

### **Property**

All property in the county is vulnerable to earthquake events. However, structures built on the typically soft soils in floodplains are likely to be more vulnerable to seismic activity. Loss estimates and debris estimates for the Earthquake hazard scenario are summarized in Table 14-3 and additional information by planning district can be found in Appendix K.

**Table 14-3. Estimated Impact of 500-Year Probabilistic Earthquake Event in the Planning Area**

| <b>Damage Type</b>                         | <b>500-year Probabilistic Event</b> |
|--|-------------------------------------|
| Structure Debris (Tons)                    | 3.0                                 |
| Total Value (Structure + Contents) Damaged | \$6,120,000                         |
| Damage as % of Total Value                 | Less than 1%                        |

Minimal damage is expected to structures on Kaua'i due to earthquake events relative to most other hazards examined in the 2026 MHMRP Update. According to an SME from HETAC, Kaua'i would only be anticipated to experience light to moderate ground shaking, but this could be sufficient to damage highly vulnerable structures. For instance, older posts or piers located on slopes may be damaged even with light or moderate shaking.

## Critical Facilities

Hazus classifies the vulnerability of critical facilities to earthquake damage into five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign an expected damage level to critical facilities in the planning area, with the exception of those unable to be analyzed by Hazus. Table 14-4 summarizes the results. There are no structures expected to experience moderate, extensive, or complete damage in the earthquake scenario, so only a moderate or greater category is shown on the chart.

**Table 14-4. Estimated Damage to Critical Facilities from 500-Year Probabilistic Earthquake Event**

| Category                   | Number of Critical Facilities | Number of Buildings at Given Damage Levels |          |                     |
|----------------------------|-------------------------------|--|----------|---------------------|
|                            |                               | None                                       | Slight   | Moderate or Greater |
| Safety and Security        | 86                            | 85   | 1        | 0                   |
| Food, Water and Sheltering | 130                           | 129  | 1        | 0                   |
| Health and Medical         | 31                            | 31   | 0        | 0                   |
| Energy                     | 13                            | 13   | 0        | 0                   |
| Communications             | 16                            | 16   | 0        | 0                   |
| Transportation             | 6                             | 6  | 0        | 0                   |
| Hazardous Materials        | 6                             | 6  | 0        | 0                   |
| <b>Total</b>               | <b>288</b>                    | <b>286</b>                                 | <b>2</b> | <b>0</b>            |

## Environment

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat including coral reefs. Earthquakes can result in underwater avalanches, which can damage the reefs surrounding the island. Streams may be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. Streams fed by groundwater may dry up because of changes in underlying geology.

## 14.3 ISSUES

### 14.3.1 Development in High-Hazard Areas

Kaua'i has very low seismic hazard, much lower than Hawai'i Island or O'ahu. The Kaua'i General Plan and community plans establish policies to protect communities from hazards such as earthquakes. Development in the planning area is also regulated by building standards and performance measures.

### 14.3.2 Other Issues

The following issues have been identified related to the Earthquake hazard in the planning area:

- **Cascading hazard potential:** Earthquakes can trigger the occurrence of several other hazard events expanding the damage and impacts of the initial earthquake. Landslides can occur as river and stream valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction can also turn the ground into a pudding-like liquid. Building and road

foundations can lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released as well, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and their failures can be considered secondary risks from earthquakes. Fire may also occur from broken gas lines or downed electric wires. Additionally, tsunamis and run-ups may result from earthquakes, leading to potential coastal flooding and coastal erosion.

- **Continuity of operations:** Critical facility owners should be encouraged to include earthquake considerations in their continuity of operations plans, using the information on risk and vulnerability contained in this plan.
- **Standardization of future development:** Current building codes and standards (International Building and Residential Codes) are sufficient to account for the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- **Continued public education:** HI-EMA recommends that citizens be self-sufficient up to 14 days following a major disaster without government response agencies, utilities, private sector services, and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business disaster preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- **Personal planning resources:** Additional information on emergency shelters as well as emergency management resources can be found on the KEMA Facebook page and website: <https://www.kauai.gov/Government/Departments-Agencies/Emergency-Management-Agency> (KEMA 2025).
- **Health and Wellness Concerns:** There are health and wellness concerns that extend beyond the direct threats posed by tropical cyclones and other high wind events. A process of asking questions about sexual assault and domestic violence should be established prior to a hazard event and conducted in a safe and normalized way to protect people’s safety in community shelters (County of Kaua’i 2022d). Hazard events can also generate considerable stress, anxiety, and trauma with long-term effects. A coordinated response should be applied following such events to address this concern among both adults and children. More information can be found in the KCAAP’s Talk Story Summary document (County of Kaua’i 2022d): [https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary\\_051322.pdf](https://kauaiadaptation.com/wp-content/uploads/2022/05/KCAP-Talk-Story-Summary_051322.pdf).

The risk ranking summary for the Earthquake hazard, based on the hazard profile and vulnerability assessment, is given in Table 14-5.

**Table 14-5. Risk Ranking Summary for Earthquake**

| Priority | Hazard Event | Probability | Impact (Property Damage and Critical Facilities) | Impact (Health Services) | Social Vulnerability | Spatial Extent | Warning Time   | Duration          | Risk Score |
|----------|--------------|-------------|--|--------------------------|----------------------|----------------|----------------|-------------------|------------|
| 10       | Earthquake   | Unlikely    | Minor  | Minor                    | Negligible           | Large          | 1 hour or less | Less than 6 hours | 1.7        |

## **Part 3. THE ACTION PLAN**

# 15. HAZARD MITIGATION STRATEGY

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## 15.1 CAPABILITIES ASSESSMENT

The Core Planning Team performed an inventory and analysis of existing authorities and capabilities called a capability assessment. A capability assessment creates an inventory of a jurisdiction's mission, programs, and policies and evaluates its capacity to carry them out. This process identifies potential gaps in the jurisdiction's capabilities. Any gap in capability was considered as a possible mitigation action in this plan, as required under 44 Code of Federal Regulations (CFR) 201.6(c)(3). The sections below describe the categories of capabilities evaluated as part of the assessment. The specific capabilities evaluated within each category are presented in Appendix N. For the Capability Ranking, the following definitions apply.

- **High:** Solid capability
- **Medium:** Some capability with improvements that can be made
- **Low:** Little capability

As a component of the capabilities assessment, the County of Kaua'i (County) has identified several ways they may continue to expand and improve on the capabilities identified within this section. Primarily, Kaua'i Emergency Management Agency (KEMA) and other County agencies could expand their public outreach capabilities to better prepare the public for hazard events. They also plan to continue to strengthen capabilities related to climate change adaptation as identified in the KCAAP (County of Kaua'i 2025d) and summarized in this Capability Assessment.

### 15.1.1 Legal and Regulatory Capabilities

Jurisdictions have the ability to develop policies and programs and to implement rules and regulations to protect and serve residents. Local policies are typically identified in a variety of community plans, implemented via a local ordinance, and enforced through a governmental body.

Jurisdictions regulate land use through the adoption and enforcement of zoning, subdivision and land development ordinances, building codes, building permit ordinances, floodplain and stormwater management, and other ordinances. When effectively prepared and administered, these regulations can lead to hazard mitigation. A summary assessment of existing state and local legal and regulatory capabilities relevant to hazard mitigation is presented in Table N-1 in Appendix N. An assessment of development and permitting capabilities is presented in Table N-2 in Appendix N.

### 15.1.2 Fiscal Capabilities

Assessing a jurisdiction's fiscal capability provides an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees. An assessment of fiscal capabilities is presented in Table N-3 in Appendix N.

### 15.1.3 Administrative and Technical Capabilities

Legal, regulatory, and fiscal capabilities provide the backbone for successfully developing a mitigation strategy; however, without appropriate personnel, the strategy may not be implemented. Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all

the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers. An assessment of administrative and technical capabilities is presented in Table N-4 in Appendix N.

### **15.1.4 National Flood Insurance Program Compliance**

Community participation in the National Flood Insurance Program (NFIP) creates an opportunity for additional grant funding associated specifically with flooding issues. Assessment of current NFIP status and compliance provides planners with a greater understanding of the local flood management program, opportunities for improvement, and available grant funding opportunities. General information on the NFIP compliance is presented in Table N-5 in Appendix N. The primary NFIP discussion is in Section 10.1.3 National Flood Insurance Program.

### **15.1.5 Public Outreach Capability**

Regular engagement with the public on issues regarding hazard mitigation provides an opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members, which opens a two-way dialogue that can result in a more resilient community based on education and public engagement. An assessment of education and outreach capabilities is presented in Table N-6 in Appendix N.

### **15.1.6 Adaptive Capacity Related to Climate Change**

The County views all core jurisdictional capabilities as fully adaptable to meet its needs. Every code can be amended, and every plan can be updated. Such adaptability is considered to be an overarching capability. An adaptive capacity assessment evaluates the ability to anticipate impacts from future conditions. By looking at public support, technical adaptive capacity, and other factors, jurisdictions identify their core capability for resilience against issues such as sea level rise. The adaptive capacity assessment provides an opportunity to identify areas for improvement by ranking such capacity as high, medium, or low. The County's adaptive capacity for the impacts of climate change is presented in Table N-7 in Appendix N.

## **15.2 MITIGATION BEST PRACTICES**

Mitigation actions in this plan were selected from various sources. One source was the best management practices presented in mitigation action catalogs (see Appendix O). Other sources included actions defined in other relevant plans as well as those defined by KEMA and the Steering Committee based on the results of the risk assessment and knowledge of community needs. All mitigation actions are consistent with the established goals and objectives and are within the County's capabilities to implement.

The mitigation action catalog's purpose was to provide a list of what could be considered to reduce the risk of natural hazards in the planning area. Some practices in the catalogs are not feasible for this plan. Those that are not included in the action plan were not selected for one or more of the following reasons:

- The action is not feasible.
- The action is already being implemented.
- There is an alternative that appears to be more cost-effective.
- The action does not have public or political support.

- There is very little development in the planning area that is exposed to the hazard that the action addresses.

Appendix O also identifies potential actions to create, keep, or enhance adaptive capacity, which is defined as “the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (Intergovernmental Panel on Climate Change [IPCC] 2014). Whereas the 2026 Multi-Hazard Mitigation and Resilience Plan (MHMRP) Update mitigation actions do not directly address adaptive capacity, implementation of many of the actions will build capacity for adapting to both current and future risks to increase the county’s resilience.

## 15.3 GOALS AND OBJECTIVES

HMPs must identify goals for reducing long-term vulnerabilities to identified hazards. As part of the plan update process, the Core Team reviewed the goals and objectives of the 2021 MHMRP Update (Tetra Tech 2021) and revised them to more fully align with other community objectives and priorities. For the 2026 MHMRP Update, the Steering Committee agreed to the following definitions:

- Goals describe what the community wants to achieve as its desired future state.
- Objectives identify the key outcomes or concepts that must be accomplished to achieve the goals.
- Actions are the specific activities that need to be carried out to accomplish the objectives.

The following are the updated mitigation goals for this plan:

1. Reduce the county’s long-term vulnerability to natural hazards while preserving the county’s natural, historical, and cultural assets.
2. Promote the county’s long-term resilience and the capacity of the entire community to adapt to climate change, thrive in a changing environment, and respond to acute shocks by:
  - a. Strengthening public and private partnerships and leveraging existing resources and capabilities to identify, assess, and reduce the impact of hazards.
  - b. Using local knowledge and state-of-the-art methods and technology to identify and analyze hazards and assess the County’s capabilities to reduce the impact of those hazards.
  - c. Promoting public awareness of hazard risks and public actions that can reduce those risks.
  - d. Providing a framework for robust community hazard mitigation and resilience planning and strategy implementation in alignment with this 2026 MHMRP Update.
  - e. Increasing the County’s capabilities and capacity to prepare for, respond to, recover from, and mitigate the impacts of hazards.

The updated objectives are as follows:

1. Engage the whole community to develop a shared science-based understanding of hazard and climate change risks and vulnerabilities to inform risk-reduction measures, preparedness, response, recovery, and adaptation strategies. Include visitors and vulnerable populations, such as keiki, kupuna, low-income and disadvantaged communities; individuals with chronic illnesses and disabilities; and those for whom English is not their first language.
2. Reduce risk to and increase the resilience of vulnerable infrastructure and community lifelines.

3. Reduce repetitive and new property losses due to floods, erosion, high winds, tsunamis, fire, and sea level rise by incorporating mitigation measures in acquisition, retrofitting, design, updated construction, nature-based solutions (NbS), and land use regulations.
4. Evaluate and document potential climate change impacts, including greenhouse gas emissions, for proposed repairs, major alterations, new development, and redevelopment projects.
5. Leverage limited financial and human resources by prioritizing multifunctional projects that provide co-benefits—addressing social equity, disaster mitigation, and greenhouse gas reduction.
6. Create financial and regulatory incentives for development and land use techniques to motivate homeowners, private sector businesses, and nonprofit community organizations to mitigate hazards and risk.
7. Establish and maintain public-private partnerships among all levels of government, community groups, the private sector, and institutions of higher learning to promote hazard mitigation, disaster preparedness, and recovery programs.
8. Prioritize investment and support efforts to improve the resilience of community lifelines in socially vulnerable communities.
9. Proactively manage and care for natural infrastructure and resources such as mountain slopes, river and stream channels and mouths, beaches, and reefs to enhance their ability to withstand natural disasters and minimize public safety risks.
10. Recognize and support the disaster resilience inherent in host culture traditions and practices, including traditional knowledge, kilo, and adaptation, *mālama 'āina* (care for the land), holistic watershed management, community connectivity, and local ahupua'a-based decision-making.
11. Create supply chain diversity and improved resilience by supporting local food and energy production and increased multimodal transportation.
12. Improve warning and emergency communications systems and increase public education of systems.
13. Enhance community capacity to develop community-based disaster resilience plans that incorporate education and risk-reduction measures; and integrate them into County planning documents.
14. Maintain, exercise, and routinely revisit the County's Pre-Disaster Recovery Framework (County of Kaua'i 2025g) and implement the recommendations of the Disaster Recovery Working Group Strategic Way Forward Report (County of Kaua'i et al. 2025) to guide streamlined, resilient decision-making post-disaster.
15. Align the hazard mitigation plan (HMP) with state mitigation plans; County general, community, and capital improvement plans; and climate action, resilience, and adaptation plans.

## 15.4 MITIGATION ACTIONS

The Steering Committee analyzed a comprehensive range of mitigation actions and projects to select the 2026 MHMRP Update mitigation actions. The 2026 MHMRP Update actions were selected based on the results of the risk assessment, the defined hazard mitigation goals and objectives, mitigation actions identified in other relevant plans, the catalogs of hazard mitigation alternatives, knowledge of local needs, and considerations of equity in project selection and implementation. All 2026 MHMRP Update mitigation actions can be found in Appendix P, along with the status of actions from the 2021 MHMRP Update. For the 2026 action list, actions that apply to all hazards or multiple hazards are listed first in priority order, starting with the highest priority. Similar actions (e.g., infrastructure, NBS, education/outreach) are listed together within each prioritized category. Then, all actions that apply to a single hazard are listed. Actions applicable to a single hazard are grouped first by hazard type and then in priority order.

Part of the selection of mitigation actions for the 2026 MHMRP Update was an assessment of all 49 mitigation actions from the 2021 MHMRP Update. The Core Team analyzed the 2021 MHMRP Update actions to determine whether each action had been completed, was in progress, or had not yet been started. Incomplete actions were reviewed to determine whether they should be carried over to the 2026 update or removed from the plan due to a change in priorities, capabilities, or feasibility. The Steering Committee made the final determination on each action's status. The process used to assess actions carried into the 2026 MHMRP Update was similar to that used in the 2021 MHMRP Update.

Twelve of the 2021 MHMRP Update actions (24%) have been completed, two were withdrawn (4%), and the rest (35 [72%]) were carried over or combined into actions in the 2026 MHMRP Update. The two withdrawn actions were removed because their outcomes were achieved through different projects other than those laid out in the 2021 MHMRP Update. Table P-1 in Appendix P lists the actions in the 2021 MHMRP Update that were not carried over into the 2026 MHMRP Update, as well as a justification for their removal. Many of the prior actions carried over into the 2026 MHMRP Update were reframed and re-prioritized to meet the county's needs at the time of drafting the 2026 MHMRP Update. Each action in the 2026 MHMRP Update lists any incorporated actions that were part of the 2021 MHMRP Update (Table P-2 in Appendix P).

Several key accomplishments have resulted from the implementation of 2021 MHMRP Update mitigation actions. First, the County attained a Community System Class 8 rating and developed the KCAAP. Additionally, Kaua'i War Memorial Conventional Hall is in the process of conducting a wind retrofit project for which it has secured funding and completed planning and design work. A Best Available Refuge Area needs assessment has been completed, and a risk assessment has been completed by U.S. Army Corps of Engineers (USACE) for levee reaccreditation. Dam safety workshops have also occurred. Finally, grant applications have been submitted for projects related to beach and dune restoration, geographic information system (GIS) capability enhancement, emergency power redundancy, and a fire station high-wind retrofit.

The factors used to analyze and describe the selected mitigation actions for the 2026 MHMRP Update differed from those used for the 2021 MHMRP Update actions, which was done primarily to simplify the charts and descriptions used in the 2026 MHMRP Update while reducing duplication and increasing efficiency for plan readers. The mitigation actions in the 2021 MHMRP Update were listed in three separate charts. There was an action number, a description, action details, new or existing assets, hazards mitigated, objectives met, lead and supporting agencies, cost-benefit rating, sources of funding, a timeline, related building codes, a space to include plan integration or references, implementation priority rating, and a grant pursuit priority rating associated with each action; however, different pieces of information for a single action were included in charts in different parts of the plan. For the 2026

MHMRP Update, the charts of the mitigation actions and the factors used to analyze each action were consolidated into a single chart in Appendix P. Additionally, the cost-benefit analysis and prioritization processes used in the 2021 MHMRP Update were simplified for the 2026 MHMRP Update. The processes used in the 2026 MHMRP Update are described later in this section.

Additionally, an effort was made to integrate NbS to address hazard risk reduction and resiliency building for the selected mitigation actions carried over from the 2021 MHMRP Update. NbS weave natural features and processes into a community's landscape through planning, design, and engineering. NbS not only have many hazard mitigation benefits but also can help a community meet its social, environmental, and economic goals. Communities across the country are finding NbS to be a highly effective way to provide public services that were traditionally met with structural or "gray" infrastructure.

The Core Team assessed the selected mitigation actions for the 2026 MHMRP Update using the following categories:

- **Priority:** The priority for implementation by the County.
- **Hazards Mitigated :**The hazards that will be mitigated through the County's implementation of the action.
- **Lead Agency and Supporting Agencies:** The main agency driving action implementation and all agencies likely to support implementation.
- **Timeline:** The anticipated timeline for implementation of the action.
- **Sources of Funding:** The funding sources that will be pursued and/or used to implement the action.
- **Cost-Effectiveness:** An assessment of whether the benefits associated with the implementation of an action outweigh the costs associated with it.
- **2021 Action Status:** This category states whether an action was carried over from the 2021 MHMRP Update or if it is a new action. If the action was carried over from the 2021 MHMRP Update, the 2021 Action number is included as a reference.

Additional descriptions for timeline, cost-effectiveness, and prioritization are discussed in the following sections.

### 15.4.1 Timeline

The timeline for implementing mitigation actions could be either short term, long term, ongoing, or dependent on funding (DOF). The Steering Committee used the following descriptions to determine the length of time needed to complete each mitigation action:

- **Short Term:** To be completed in 1 to 5 years
- **Long Term:** To be completed in 6 to 10 years
- **Ongoing:** Currently being funded and implemented under existing programs
- **DOF:** To be implemented depending on funding

### 15.4.2 Cost-Effectiveness

The mitigation actions in the Action Plan must be evaluated and prioritized, taking into consideration a benefit/cost analysis of the proposed actions (44 CFR 201.6(c)(3)(iii)). Therefore, an assessment of the

apparent benefits versus the apparent costs of each action was performed. The benefit/cost analysis was not of the detailed variety required by Federal Emergency Management Agency (FEMA) for project grant eligibility under the Hazard Mitigation Grant Program and Pre-Disaster Mitigation grant program. A less formal approach was used because some actions may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Based on this, an evaluation of the cost-effectiveness of each action was performed.

To determine the cost-effectiveness of proposed actions, a qualitative assessment was performed by the Steering Committee of the anticipated costs relative to the anticipated benefits of each action. The parameters for assigning ratings (high, medium, and low) were relatively subjective and followed the guidelines below:

- **Low:** Benefits may not equal the costs of action completion.
- **Medium:** Benefits are estimated to equal the costs of action completion.
- **High:** Benefits are estimated to exceed the costs of action completion.
- **More Research Needed (MRN):** More research is needed to determine whether the benefits are estimated to equal the costs of action completion.

### 15.4.3 Action Prioritization

The actions were also prioritized using Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLE+E) criteria, which evaluate actions based on their fulfillment of STAPLE+ criteria. Actions that meet the most criteria have the highest priority ranking. Definitions of each STAPLE+E criterion are presented in Table 15-1. The prioritization process factored in the cost-effectiveness of each action by determining whether the economic parameter of the STAPLE+E criteria was met. Additionally, all actions pertaining to high-hazard potential dams were prioritized according to the same metrics as all other actions.

The parameters for priority rankings (low, medium, and high) were relatively subjective, and the Steering Committee determined the priority ranking for each action through a qualitative assessment. The parameters used for the ranking are presented below:

- **Low:** Meets or supports two or three of the STAPLE+E criteria
- **Medium:** Meets or supports four or five of the STAPLE+E criteria
- **High:** Meets or supports six or more of the STAPLE+E criteria

During Steering Committee Meeting #4, an interactive exercise was conducted to determine which STAPLE+E categories supported each action. The Steering Committee agreed that the process described above was a reasonable approach for prioritization of the 2026 actions.

The Action Plan and associated appendices present a range of action items for reducing loss from hazard events. The County has prioritized actions and can begin to implement the highest-priority actions over the next 5 years. The effectiveness of the HMP depends on the successful implementation and incorporation of the outlined action items into existing County plans, policies, and programs. Some action items do not require implementation through regulation but can be achieved through the creation of new educational programs, continued interagency coordination, or enhanced public participation. KEMA will have lead responsibility for overseeing the plan implementation and maintenance strategy.

**Table 15-1. STAPLE+E Category Definitions**

| Category       | Description   | Evaluation Criteria   |
|----------------|---|---|
| Social         | Public support of the overall implementation strategy and specific mitigation action, including addressing vulnerable populations         | Action is compatible with present and future community values<br>Positive impact on cultural values or resources*<br>Positive impact on a specific segment of the population, including vulnerable populations*<br>Positive impact on established neighborhoods, voting districts, or relocation impact*  |
| Technical      | Action presents a reasonable solution, given the technological requirements of the proposed project                                       | Action is technically feasible<br>The solution is long-term<br>Action results in a reduction of natural hazard impacts (either primary or secondary impacts)  |
| Administrative | Availability of anticipated administrative capabilities, including staffing, funding, and maintenance requirements of the action          | Current staffing and/or technical experts are available (or can be readily obtained) to plan for and implement the action<br>Oversight staffing is available to meet the requirements of funding mechanisms such as grants or loans<br>Action "readiness" is close to complete (implementation process or design drawings can move forward readily)   |
| Political      | Current community and state political support related to the environment, economic development, safety, emergency management, and similar | Political support for implementation and monitoring<br>Local champion or proponent of the action to ensure the action is successful<br>Support by decision-makers to provide a lead department, agency, or representative to oversee the action to completion   |
| Legal          | Legal authority at the local, state, and/or federal level to implement the action   | The primary assigned entity has the legal authority to implement or partner to accomplish the action<br>The action meets (or can readily meet) all local, state, and federal requirements<br>Anticipated legal challenges or liability should be considered when considering if the action has "legal" support  |
| Economic       | Cost-effectiveness of the action and availability of funding for the action   | Costs seem reasonable considering likely benefits (costs equal or exceed monetary and non-monetary benefits)<br>The financial burden placed on the tax base or local economy to implement this action is reasonable<br>Positive contribution to other community economic goals, such as capital improvements or economic development*<br>Funding can be readily obtained or is possible through competitive opportunities from outside sources of funding<br>It is anticipated that the community can meet the match requirements for outside funding sources |
| Environmental  | Impact to the natural environment and cultural resources, plus consistency with concepts of resiliency                                    | Maintains or has a positive impact on natural and cultural resources*<br>Maintains or has a positive contribution to the community's ability to return to normal function after a hazard event*<br>Consistent with the community's environmental goals<br>Consistent with applicable environmental laws   |

Note:

\*Positive impact or contribution means a reduction in risk from natural hazards and/or improvement to quality of life.

## 15.5 PLAN ADOPTION AND MAINTENANCE

### 15.5.1 Plan Adoption

After the Core Planning Team and Steering Committee integrated public comment, the complete draft plan was sent to the Hawai'i Emergency Management Agency (HI-EMA) along with a draft FEMA Plan Review Tool. The Plan Review Tool identifies the location in the plan that shows compliance for each federal requirement (FEMA 2025h). After HI-EMA approved the plan, it was forwarded to FEMA Region IX for review and Approval Pending Adoption. An HMP must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan. Once Approval Pending Adoption was provided by FEMA, the County formally adopted the plan. A copy of the FEMA approval letter and Plan Review Tool, as well as the County resolution adopting this plan, are found in Appendix Q.

### 15.5.2 Plan Maintenance Strategy

Plan maintenance is the formal process for achieving the following:

- Ensuring that the MHMRP remains an active and relevant document and that the County maintains its eligibility for applicable funding sources
- Monitoring and evaluating the plan in year 2 and producing an updated plan in 5 years
- Integrating public participation throughout the plan maintenance and implementation process
- Incorporating the mitigation strategies outlined in this plan into existing planning mechanisms, activities, and programs, such as any relevant comprehensive land-use planning process, capital improvement planning process, and building code enforcement and implementation.

The 2021 MHMRP Update was maintained through regular meetings of the Core Planning team as part of the KCAAP planning process. Additionally, public participation was maintained through a website and an online interactive mapping site. Plan maintenance and implementation resulted in 12 mitigation actions being completed (Tetra Tech 2021).

As with the 2021 MHMRP Update maintenance strategy, KEMA will coordinate with the Core Planning Team as needed to monitor and evaluate the progress of the MHMRP and communicate periodic updates to the Steering Committee. Additionally, public participation will continue following the adoption of the 2026 MHMRP Update through an updated online StoryMap. The StoryMap will be updated with milestone accomplishments, and these accomplishments will be shared on social media as well. KEMA, the Core Planning Team, and the Steering Committee will also ensure relevant sections of the 2026 MHMRP Update are included in updates to other county and community planning documents.

As part of the 2026 MHMRP Update maintenance strategy, KEMA, the Core Planning Team, and the Steering Committee will also complete a brief survey in year 2 following the adoption of the 2026 MHMRP Update to evaluate its implementation thus far and any edits that may be needed. KEMA will prepare a summary of the feedback generated from this survey to share with the Core Planning and Steering Committee. This is the primary difference between the plan maintenance strategy proposed in the 2021 MHMRP Update and that proposed in the 2026 MHMRP Update.

Table 15-2 summarizes the plan maintenance strategy for the 2026 MHMRP Update. Each element is described in more detail below.

**Table 15-2. Plan Maintenance Matrix**

| <b>Plan Element</b>                        | <b>Approach</b>  | <b>Timeline</b>   |
|--|--|---|
| Plan Monitoring                            | Track the implementation of actions over the performance period of the plan.   | Continuous over the 5-year performance period of the plan   |
| Plan Evaluation                            | Review the status of previous actions.<br>Assess changes in risk.<br>Evaluate success of integration.                    | Upon initiation of HMP update, comprehensive general plan update, or major disaster   |
| Grant Monitoring and Coordination          | As grant opportunities present themselves, consider options to pursue grants to fund actions identified in this plan.    | As grants become available  |
| Plan Update                                | At least every 5 years, the County will guide a comprehensive update of the plan.  | Every 5 years or upon comprehensive update to general plan or major disaster; funding and organizing for plan update will begin in FY 2021/2022 |
| Continuing Public Participation            | Maintain the hazard mitigation StoryMap over the course of the plan.<br>Review status of projects, update strategy, etc. | Continuous over the 5-year performance period of the plan   |
| Integration into Other Planning Mechanisms | Relevant sections, data, and analysis from the HMP will be included in plans and programs as identified below.           | Continuous over the 5-year performance period of the plan   |

### **Plan Monitoring**

KEMA will be the lead agency responsible for monitoring the plan and will monitor plan implementation by continually tracking the status of all recommended mitigation actions in the action plan over the next 5-year planning cycle. Action items may be implemented through regulation and capital projects as well as the creation of new educational programs, interagency coordination, or improved public participation.

### **Plan Evaluation**

The plan will be evaluated by how successfully the implementation of identified actions has helped to achieve the plan goals and objectives of reducing risk and vulnerabilities while increasing resilience. This includes incorporating hazard mitigation concepts from the 2026 MHMRP Update into other County plans, policies, and programs. The Steering Committee recommends that equity analysis and screening be carried forward as actions are implemented. KEMA will assume lead responsibility for planning and facilitating plan evaluation meetings. KEMA will also distribute a survey in the second year after the 2026 MHMRP Update is adopted to assess progress thus far and any adjustments that may be needed. Review of the 2026 MHMRP Update at the plan meetings can include the following:

- Discussion of any hazard events that occurred during the prior year and their impact on the planning area
- Impact of potential grant opportunities on the implementation of mitigation actions
- Reevaluation of the action plans to determine if the timeline for identified actions needs to be amended (such as changing a long-term action to a short-term action because of funding availability)
- Recommendations for new actions
- Impact of any other planning programs or initiatives that involve hazard mitigation.

## **Grant Monitoring and Coordination**

KEMA will identify grant funding opportunities for implementing the recommended plan actions. Once these opportunities are identified, staff will pursue a strategy to capture that grant funding.

## **Plan Update**

Federal regulations require that local HMPs be reviewed, revised if appropriate, and resubmitted to remain eligible for benefits awarded under the Disaster Mitigation Act (44 CFR 201.6.d(3)). This plan's format allows the County to review and update sections when new data becomes available. New data can be easily incorporated, resulting in a plan that will remain current and relevant. The County intends to update the plan on a 5-year cycle from the date of plan approval. This cycle may be accelerated to less than 5 years based on the following triggers:

- A presidential disaster declaration that impacts the planning area
- A hazard event that causes loss of life
- A full update of the County General Plan

It will not be the intent of the update process to develop a completely new HMP. Based on needs identified by the Core Team, the update process will, at a minimum, include the following elements:

- The process will be convened through a new steering committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using the best available information and technologies.
- Action plans will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or County policies identified under other planning mechanisms (such as the County General Plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The County will adopt the updated plan.

Because plan updates realistically take 18 months to complete, KEMA will initiate efforts to update the plan before it expires. KEMA will consider applying for funding to update the plan in the fiscal year 2028/2029 grant cycle or will identify an alternate source of funding for the plan update to begin the update process in spring 2029.

## **Continuing Public Participation**

The public outreach strategy used during the development of this plan can be adapted for ongoing public outreach through the plan maintenance process. A steering committee similar to the one involved in developing this HMP update will be put in place to provide stakeholder input on plan maintenance activities.

The public will continue to be apprised of hazard mitigation activities through the website and reports on successful hazard mitigation actions provided to the media. KEMA will keep the website maintained, including monitoring the email address where members of the public can submit comments to the Core Team. This site will house the final plan and will be a one-stop shop for information regarding the plan and its implementation.

Upon initiation of the next plan update process, a new public involvement strategy will begin, with guidance from the new steering committee. This strategy will be based on the needs and capabilities of the County at the time of the update. At a minimum, it will include the use of local media outlets.

### **Incorporation into Other Planning Mechanisms**

Integrating relevant information from this HMP into other plans and programs where opportunities arise will be the ongoing responsibility of the County. For hazard mitigation planning, “integration” means that hazard mitigation information is used in other relevant planning mechanisms, such as general planning and capital facilities planning, and that relevant information from those sources is used in hazard mitigation. This section identifies where such integration is already in place, and where there are opportunities for further integration in the future.

The County has committed to maintaining and creating linkages between the 2026 MHMRP Update, the general plan, and similar plans identified in the capability assessment. The action plan includes mitigation actions to maintain and create such linkages. By adopting a general plan and zoning ordinances, the County has planned for the impact of natural hazards, and these documents are integral parts of this 2026 MHMRP Update. The hazard mitigation planning process provided an opportunity to review and expand on policies contained within these documents, based on the best science and technology available at the time this plan was prepared. The County should use its general plan, KCAAP, and 2026 MHMRP Update as complementary documents to achieve the goal of reducing risk exposure to residents of the planning area.

A list of local plans and programs already containing some level of integration with local hazard mitigation planning is presented below. Many of these documents integrated concepts and information from the county’s past MHMRPs as the documents were developed and revised. As the 2026 MHMRP Update, along with these plans and programs, are updated, they should be further integrated into one another:

- Kauaʻi Kākou–Kauaʻi County General Plan (County of Kauaʻi 2018)
- Kauaʻi Climate Adaptation and Action Plan (County of Kauaʻi 2022a, 2025d)
- East Kauaʻi Community and Circulation Plan (County of Kauaʻi 2025k)
- North Shore Community Plan (County of Kauaʻi 1980)
- West Kauaʻi Community Plan (County of Kauaʻi 2020a)
- South Kauaʻi Community Plan (County of Kauaʻi 2015b)
- Līhuʻe Community Plan (County of Kauaʻi 2015c)
- Kauaʻi County Code
  - Comprehensive Zoning Ordinance
  - Sea Level Rise Constraint District Ordinance
  - Plantation Camp Districts Wildfire and Wildland Urban Interface Ordinance
  - Capital Improvement Program
- Island of Kauaʻi Community Wildfire Protection Plan (Hawaiʻi Wildfire Management Organization 2016)
- Kauaʻi Department of Water – Water Systems Investment Plan (County of Kauaʻi 2025k)
- Waimea 400 Master Plan (Kauaʻi County Housing Agency 2022)

- Kaua'i Pre-Disaster Recovery Plan (County of Kaua'i 2025g)
- Waimea River Flood Control Modification Report (USACE 2025c)
- Kaua'i Island Utility Cooperative Strategic Plan Update (Kaua'i Island Utility Cooperative 2023)

There are also various planning mechanisms, either currently used in the county or that may be used in the future, that would benefit from integration with the natural hazard mitigation information from the 2026 MHMRP Update to better address hazard risk in the county. A list of these plans is presented below:

- Capital Improvement Plan
- Disaster Debris Management Plan
- Floodplain/Watershed Plan
- Stormwater Plan
- Urban Water Management Plan
- Habitat Conservation Plan
- Economic Development Plan
- Shoreline Management Plan
- Emergency Operations Plan
- Threat and Hazard Identification and Risk Assessment
- Post-Disaster Recovery Plan
- Continuity of Operations Plan
- Public Health Plan
- Other community plans and vulnerability assessments