SECTION 4. RISK ASSESSMENT

4.16 Vulnerability Summary

2018 HMP UPDATE CHANGES

- The 2013 HMP did not rank all hazards of concern based on the updated 2013 risk assessment; only the top five hazards were reported for each county. For the 2018 HMP Update, a hazard ranking methodology was developed to rank all hazards, both statewide and for each county. The methodology was expanded beyond an examination of impacts to include hazard event probability, warning time, spatial extent, duration, adaptive capacity, and future conditions.

44 CFR §201.4(c)(2)(ii): An overview and analysis of the state's vulnerability to the hazards [shall be summarized] …based on estimates provided in local risk assessments as well as the state risk assessment.

At the conclusion of the risk assessment update documented in Sections 4.2 through 4.15, the 14 hazards of concern were ranked to summarize statewide vulnerability. The results of the hazard ranking were presented at the Forum and public meetings held in March 2018 to collect feedback (refer to Section 2 – Planning Process and Appendix X – Planning Process Documentation). The results were carefully reviewed by the HI-EMA and the Forum, and adjusted as needed and appropriate, to ensure the hazard ranking aligned with the perceived statewide hazard risk.

2018 Hazard Ranking

- ✓ *The purpose is to summarize statewide vulnerability and guide the updated mitigation strategy.*
- ✓ *The hazard ranking is provisional. It may change with time as additional data and analyses become available, capabilities in the state change, and changes associated with climate change become realized and fully predictable.*
- ✓ *Overall, the 2018 hazard ranking represents a snapshot in time for the state based upon best available data.*

The following summarizes the methodology and results of the State of Hawaii's hazard ranking. Refer to Appendix X (State Profile and Risk Assessment Supplement) for the hazard ranking results developed for each county using the same methodology.

It is important to emphasize that all hazards evaluated in the 2018 HMP Update are considered hazards of concern. Medium- and low-ranked hazards are of concern to the State of Hawai'i and potential future losses resulting from these hazard events should be mitigated. Mitigation strategies are included in Section 6 (Mitigation Strategy).

4.16.1 2013 State and County Hazard Ranking

The HI-EMA reviewed the 2013 HMP and the methodology utilized to rank the hazards of greatest concern to the state and each county. Each county's top hazards were identified utilizing annualized losses that may be quantified. As a result, the 2013 HMP did not rank all hazards assessed in the plan; only the top five hazards for each county were reported; refer to Table 4.16-1 below for the 2013 HMP county hazard rankings. All four

counties have Tropical Cyclone (now called Hurricane in the 2018 HMP Update) as their highest ranked hazard risk.

Table 4.16-1. 2013 HMP Update Hazard Ranking

County of Kaua'i	City and County of Honolulu	County of Maui	County of Hawai'i
Tropical Cyclone	Tropical Cyclone	Tropical Cyclone	Tropical Cyclone
Tsunami	Tsunami	Tsunami	Earthquake
Coastal Erosion	Earthquake	Earthquake	Tsunami
Flood	Flood	Coastal Erosion	Lava Flow
Landslide and Rockfall	Landslide and Rockfall	Flood	Flood

Source: State of Hawai'i HMP 2013

In terms of a statewide hazard ranking, the 2013 HMP reported that the State Civil Defense Strategic Plan 2011 – 2015 conducted an independent assessment to rank hazards. Based on 'likelihood and effect on population and property' the top six highest risks were: 1) Hurricane, 2) Flash Flood, 3) Tsunami, 4) Earthquake, 5) Volcano/Lava, and 6) Landslide/Rockfall (State of Hawai'i HMP 2013).

4.16.2 2018 HMP Update Hazard Ranking

For the purposes of the 2018 HMP Update, an expanded and more holistic hazard ranking methodology was developed and utilized to evaluate the degree of risk for all identified hazards in the State of Hawai'i. It utilizes numerical values that allow identified hazards to be ranked against one another; the higher the relative risk factor calculated, the greater the hazard risk.

METHODOLOGY

The hazard ranking methodology designed for the State of Hawai'i includes risk factor categories that align with FEMA's State Mitigation Planning Key Topic Bulletin on Risk Assessment and FEMA's Comprehensive Preparedness Guide (CPG 101) risk analysis process. In addition, the methodology integrates the THIRA and State of Hawaii's capabilities into the evaluation.

It is recognized that certain hazards have undergone more detailed analyses than others based upon the available data and hazard modeling methodologies available and/or conducted over the course of the 2018 HMP Update. Therefore, for some hazards, qualitative assessments and professional judgement were used to assign the most appropriate numeric value for each category evaluated.

As described in Section 4.1 (Risk Assessment) and summarized in Table 4.1-6, three different levels of analysis were used to estimate potential impacts: 1) historic loss/qualitative analysis; 2) exposure analysis; and 3) loss estimation. All three levels of analysis are suitable for planning purposes; however, with any risk analysis, there is underlying uncertainty resulting from assumptions used to describe and assess vulnerability and the methodologies available to model impacts. Impacts from any hazard event within the State will vary from the analysis presented here based on the factors described for each hazard of concern; namely location, extent, warning time, and mitigation measures in place at the time of an event. The hazard ranking methodology for

some hazards of concern is based on a scenario event, while others are based on the potential vulnerability to the state as a whole. In order to account for these differences, the quantitative hazard ranking methodology was adjusted using professional judgement and SME input and assumptions are included, as appropriate, in the following sections. The limitations of this analysis are recognized given the all scenarios do not have the same likelihood of occurrence; nonetheless, there is value in summarizing and comparing the hazards using a standardized approach to evaluate relative risk. The following categories were considered when evaluating the relative risk of the hazards of concern.

- **Probability of Occurrence**—The probability of occurrence of the scenario evaluated was estimated by examining the historic record and/or calculating the likelihood of annual occurrence. When no scenario was assessed, an examination of the historic record and judgement was used to estimate the probability of occurrence of an event that will impact the State.
- **Impact**—The following three hazard impact subcategories were considered: impact to people; impact to assets and the economy; and impact to environmental resources and cultural assets. The results of the 2018 HMP Update risk assessment and/or professional judgement were used to assign the numeric values for these three impact subcategories. For the statewide ranking, the impact to state assets and the overall state economy were considered. For the county-specific ranking, the impact to the general building stock and county economy were considered. A factor was applied to each subcategory, giving impact on population the greatest weight.
    - Population—Numeric value x 3
    - Assets/Economy—Numeric value x 2
    - Environment Resources/Cultural Assets—Numeric value x 1
- **Spatial Extent**—The area of impact was calculated in GIS for the hazards with a delineated spatial extent. For hazards that do not have a geographic extent, it was determined whether or not the hazard event would have local, regional or statewide impacts. Refer to Section 4.1 (Risk Assessment Overview), which describes the spatial datasets used.
- **Warning Tim**e—The lead time associated with the hazard event was researched, and the warning measures/systems in place to alert the state in advance of the event occurring were considered. Warning time is discussed in each hazard profile (refer to Sections 4.2 to 4.15).
- **Duration**—The duration was estimated by determining the approximate length a hazard event may last, and time until full recovery. An examination of the historic record was used as a point of reference.
- **Adaptive Capacity—**Adaptive capacity describes the State's current ability to protect from or withstand a hazard event. The State annually develops a State Preparedness Report (SPR) that rates the 32 core capabilities across five elements: planning, organization, equipment, training and exercises. Each core capability is rated on a scale of 1 to 5 across each element (5 indicating high proficiency in the capability). These ratings, conducted by the HI-EMA and supporting stakeholders, form the basis for the adaptive capacity assessment for each hazard of concern for the 2018 HMP update.

Adaptive Capacity

Describes the State's current ability to protect from or withstand a hazard event.

- **Changing Future Conditions—**Current climate change projections were considered as part of the hazard ranking to ensure the potential for an increase in severity/frequency of the hazard was factored into the hazard ranking. This was important to the HI-EMA to include because the hazard ranking helps guide and prioritize the mitigation strategy development, which should have a long-term future vision to mitigate the hazards of concern. The potential impacts climate change may have on each hazard of concern is discussed in Sections 4.2 through 4.15. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.

Table 4.16-2 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard. The relative hazard risk score was calculated for each hazard using the following formula. Using the weighting applied, the highest possible risk factor value is 6.75. The higher the number, the greater the relative risk.

Relative Risk = [(Probability × 0.25) + (Impact × 0.25) + (Spatial Extent × 0.15) + (Warning Time × 0.05) + (Duration × 0.1) + (Adaptive Capacity × 0.1) + (Changing Future Conditions × 0.1)]

Table 4.16-2. Summary of Hazard Ranking Approach and Associated Criteria

Category		Level	Degree of Risk/Benchmark Value	Numeric Value	Weight
Probability of Occurrence		Unlikely	Hazard event is unlikely to occur with less than a 1% annual chance probability	0	25%
		Rare	Between 1 and 10% annual probability	1	
		Occasional	Between 10 and 100% annual probability	2	
		Frequent	100% annual probability; may occur multiple times per year	3	
Impact ***(Sum of all 3)***	**Population (Numeric value x3)**	None	No anticipated displacement or injuries; minimal disruption on quality of life.	0	25%
		Low	Potential for measurable life safety impacts (displacement, injuries, fatalities) is less than 10% of the total population	1	
		Medium	Potential for measurable life safety impacts (displacement, injuries, fatalities) is 10-25% or less of the total population	2	
		High	Potential for measurable life safety impacts (displacement, injuries, fatalities) is greater than 25% of the total population	3	
	Assets/Economy (Numeric value x2)	None	No impact to minimal anticipated potential loss to property/assets; no anticipated economic impacts (interruption of services, businesses, jobs).	0	
		Low	Potential loss to property/assets is more than 10% of the total of all assets;	1	

Category		Level	Degree of Risk/Benchmark Value	Numeric Value	Weight
			impacts are localized affecting only a relatively small or isolated area; no interruption of services or business continuity.		
		Medium	Potential loss to property/assets is more than 25% of the total of all assets; impacts are local and regional; temporary shut-down of critical facilities, businesses/delivery of services/jobs	2	
		High	Potential loss to property/assets is greater than 50% of the total of all assets; impacts are regional/multiple counties; shutdown of critical facilities; interruption of business continuity/delivery of services/jobs	3	
	Environment Resources/ Cultural Assets [a] (Numeric value x1)	None	No loss is estimated from the hazard	0	
		Low	Potential loss to environmental resources/cultural assets is less than 10% of total of all assets.	1	
		Medium	Potential loss to environmental resources/cultural assets is 10-20% of total of all assets.	2	
		High	Potential loss to environmental resources/cultural assets is greater than 20% of total of all assets.	3	
Spatial Extent		None	No spatially-delineated hazard area	0	15%
		Small	A portion of one island	1	
		Medium	2 to 3 islands	2	
		Large	Entire State (all islands)	3	
Warning Time		More than 24 hours	Warning time is more than 24 hours	0	5%
		12 to 24 hours	Warning time is 12 to 24 hours	1	
		6 to 12 hours	Warning time is 6 to 12 hours	2	
		0 to less than 6 hours	Warning time is 0 to 6 hours	3	
Duration of Event		Minimal	Less than 6 hours	0	10%
		Low	Less than 24 hours	1	
		Medium	Less than 1 week	2	
		High	Greater than 1 week	3	
Adaptive Capacity		Complete	The State has mitigated all hazard risk through mitigation measures and in-house capabilities.	0	10%
		Low	Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; State has ability to recover quickly	1	

Category	Level	Degree of Risk/Benchmark Value	Numeric Value	Weight
		because resources are readily available and capabilities are high		
	Medium	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; State can recover but needs outside resources; moderate State capabilities	2	
	High	Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery	3	
Changing Future Conditions [b]	No	Studies and modeling projections indicate there is no evidence at this time to indicate conditions may change in the future	0	10%
	Uncertain	No local data is available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence)	1	
	Likely	Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence)	2	
	Highly Likely	Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods)	3	

[a] *The potential loss to environmental resources (critical habitat, wetlands, parks and reserves, reefs) and cultural assets (Hawaiian Home Lands) could not be estimated or monetized; therefore, the exposure analysis results in Sections 4.2 through 4.15 support this evaluation. It is recognized additional environmental resources and cultural assets may be impacted that were not included as part of the risk assessment.*

[b] *Similar to confidence levels outlined in the National Climate Assessment 2017*

In an attempt to summarize the confidence level regarding the input utilized to populate the hazard ranking, a gradient of certainty was developed. A certainty factor of high, medium or low was selected and assigned to each hazard to provide a level of transparency and increased understanding of the data utilized to support the resulting ranking. The following scale was used to assign a certainty factor to each hazard:

- High—Defined scenario/event to evaluate; probability calculated; evidenced-based/quantitative assessment to estimate potential impacts through hazard modeling.

- Moderate—Defined scenario/event or only a hazard area to evaluate; estimated probability; combination of quantitative (exposure analysis, no hazard modeling) and qualitative data to estimate potential impacts.
- Low—Scenario or hazard area is undefined; there is a degree of uncertainty regarding event probability; majority of potential impacts are qualitative.

Table 4.16-3 summarizes the hazard scenario or hazard area evaluated; highlights key impacts to population, state assets and environmental resources/cultural assets; and lists the associated certainty factor assigned for each hazard to convey the level of confidence in the data used. This table is not intended to be a complete and comprehensive list of all hazard impacts determined in the risk assessment and considered for the hazard ranking exercise. Refer to Sections 4.2 to 4.15 for a complete summary of all estimated statewide impacts for each hazard.

Table 4.16-3. Overview of the Hazard Scenario and Associated Estimated Impacts Considered in the Hazard Ranking

Hazard	Category				Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Statewide Impacts			
		Population [d]	State Assets	Environment Resources/ Cultural Assets [a]	
Climate Change and Sea Level Rise	SLR-XA-3.2 and 1%CFZ-3.2	SLR-XA-3.2: 19,830 people displaced 1%CFZ-3.2: 145,948 people exposed	SLR-XA-3.2: 55 state buildings ($55.8M), 39.2 miles of state roads and 33 critical facilities ($675M) lost; 1%CFZ-3.2: 642 state buildings ($2.2B), 101.1 miles of state roads and 229 critical facilities exposed	SLR-XA-3.2: 79.3 sq.mi. of environmental resource areas and 1.1 sq.mi. of HHL lost; 1%CFZ-3.2: 105.7 sq.mi. of environmental resource areas and 3.8 sq.mi. HHL exposed	High
Chronic Coastal Flood	SLR-XA-1.1	4,160 people displaced	8 state buildings ($30.8M), 15.2 miles of state road and 8 critical facilities ($156.6M) lost	70.1 sq.mi. of environmental resource areas and <1 sq.mi. of HHL exposed	High
Dam Failure	Inundation area for all dams with spatial delineation	14,862 people exposed [b]	232 state buildings ($1.2B), 30 miles of state road and 91 critical facilities ($1.9B) exposed	2.6 sq.mi. of environmental resources areas and 3.2 sq.mi. of HHL exposed	Moderate
Drought	Drought event	Entire state population exposed; impacts to health and safety of individuals are estimated to be minimal.	Critical facility functionality may be impacted (e.g., water source for fire services); overall impacts to structures are low.	Environmental damages; increased wildfire risk; agricultural losses ($661M Market value exposed)	Low
Earthquake	100-Year Mean Return Period Event	Entire population exposed; 1,737 displaced households; 1,158 people need short-term sheltering	$754M state building damages; $517M critical facility damages	Impacts to environment from hazardous materials release; induced flooding/landslides; poor water quality	High

Hazard	Category				Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Statewide Impacts			
		Population [d]	State Assets	Environment Resources/ Cultural Assets [a]	
Event-Based Flood	1% Annual Chance Flood	95,216 people exposed	$78.9M state building damages; 84.4 miles of state road exposed; $306M critical facility damages	42.1 sq.mi. environmental resource areas and 3.9 sq.mi. HHL exposed	High
Hazardous Materials [c]	Release at a NPL site	Population impacted will depend on the type of material and scale of the incident. May include population within small radii of site.	The degree of damages to state asset depends on the scale of the incident.	The degree of damages depends on the scale of the incident.	Low
Health Risks	Pandemic Flu	Entire state population exposed	Loss of state services; Potential temporary closure of ports of entry impacting import/export of goods and vital resources	Livestock and poultry may become infected; impacts to food supply and water supply	Low
High Wind Storms	100-Year wind event	Entire state population exposed	All state buildings and critical facilities exposed; utility outages may cause disruption in services	All environmental resources and HHL exposed; potential agricultural losses and debris.	Low
Hurricane	Category 4 storm surge (SLOSH)	155,426 people exposed to storm surge (Category 4); all exposed to wind	654 state buildings ($3B); 77.4 miles of state road; 217 critical facilities ($4.4B) exposed	28.1 sq.mi. environmental resource areas and 2.4 sq.mi. HHL exposed	High
Landslide and Rockfall	High landslide susceptibility areas	54,239 people exposed	357 state buildings ($1.8B); 150.4 miles of state road; 95 critical facilities ($1.4B) exposed	602 sq.mi. environmental resource areas and 118 sq.mi. HHL exposed	Moderate
Tsunami	Great Aleutian Tsunami	236,357 people exposed	1,175 state buildings ($4.4B); 183 miles of state road; 388 critical facilities ($7.8B) exposed	46.6 sq.mi. environmental resources areas and 6.7 sq.mi. HHL exposed	High
Volcano (Lava flow and vog)	Lava Flow Zones (1-4 for County of Hawai'i; 1-2 for County of Maui)	161,024 people exposed	1,116 state buildings ($3B); 240.5 miles of state road; 239 critical facilities exposed (nearly $5B)	1,826 sq.mi. environmental resource areas and 70.2 sq.mi. HHL exposed	Moderate
Wildfire	High Wildfire Risk Hazard Area [e]	630,047 exposed	2,895 state buildings($6.9B); 336.4 miles of state road; 694 critical facilities ($16B) exposed	80 sq.mi. environmental resource areas, 18.2 sq.mi. of DOFAW-managed land; 29,961 sq.mi. watershed partnership area; and 40 sq.mi. HHL exposed	Moderate

Notes:
State building values are based on structure replacement cost; for SLR-XA-1.1 and SLR-XA-3.2 losses do not include land value.
[a] *Environmental resources include critical habitat, wetlands, parks and reserves and reefs. There may be overlap with the Hawaiian Home Land area calculated.*
[b] *Located in the 12 dam failure inundation areas selected for the county analysis (three per county); does not represent total population located in the total dam failure inundation areas in the state.*
[c] *The impacts and vulnerability from a hazardous materials event are greatly dependent on the material and its physical and chemical properties, the quantity released, weather conditions, micro-meteorological effects of buildings and terrain, maintenance/mechanical failures, and distance and related response time for emergency response teams.*
[d] *All population estimates do not include visitors.*
[e] *Statewide exposure is examined; however, it is highly unlikely that a wildfire event would take place across all islands at the same time. Therefore, the input to the risk ranking was adjusted to reflect this.*

Exposed	=	*This refers to the number of assets located in the hazard area; all of which may not incur losses as a result of the event.*
1%CFZ-3.2	=	*The 1% annual chance coastal flood zone (V zones only) with 3.2 feet of sea level rise was used to assess mid- to late century event-based coastal flooding.*
B	=	*Billion*
HHL	=	*Hawaiian Home Lands*
M	=	*Million*
SLR-XA-1.1	=	*Current or near-term exposure to coastal flood hazards is assessed using the Sea Level Rise Exposure Area with 1.1 feet of sea level rise.*
SLR-XA-3.2	=	*To assess mid- to late century sea level rise on chronic coastal flooding, the Sea Level Rise Exposure Area with 3.2 feet of sea level rise is used.*
sq.mi.	=	*Square miles*

Hazard Ranking Results

State Hazard Ranking

Table 4.16-5 provides the statewide hazard ranking for the 2018 HMP Update. The four highest ranked hazards for the State of Hawai'i when examining statewide risk are:

- Climate Change and Sea Level Rise
- Hurricane
- Tsunami
- Earthquake

Overall, the State of Hawaii's vulnerability to the identified hazards of concern have not drastically changed since the 2013 HMP. This makes sense to the HI-EMA and Forum because these statewide high-risk hazards require a long-term vision and mitigation strategy to reduce overall risk. Table 4.16-4 compares the 2013 top six highest ranked hazards to the 2018 top six-scoring hazards using the total Risk Factors. It is interesting to note that Climate Change and Sea Level Rise were not presented as a top hazard of concern in 2013 and is the highest-ranked hazard in 2018. This may be due to the advancements in climate science and the availability of data and studies conducted over the performance period of the 2013 plan to support a more detailed and quantitative assessment of this hazard for the 2018 HMP Update. Further, flash flood appeared in the 2013 top hazard list, however chronic coastal flood and event-based flood appear as medium-ranked hazards in 2018. The definition of the 'flash flood' hazard as defined by the State Civil Defense Strategic Plan 2011 – 2015 was not available. It is assumed to be a flood triggered by intense rainfall.

Table 4.16-4. Comparison Between the 2013 and 2018 HMP Update Statewide Hazard Rankings

Numeric Rank	2013 Hazard Rank Order [a]	2018 Hazard Rank Order
1	Hurricane	Climate Change and Sea Level Rise
2	Flash Flood	Hurricane
3	Tsunami	Tsunami
4	Earthquake	Earthquake
5	Volcano/Lava	Volcanic (Laval flow; vog)
6	Landslide/Rockfall	Wildfire and Landslide/Rockfall [b]

Notes:

a According to the 2013 HMP which reported that the State Civil Defense Strategic Plan 2011 – 2015 conducted an independent assessment to rank hazards; it is assumed the order in which they were presented is the order of descending risk.

b The wildfire and landslide/rockfall hazards have the same calculated risk factor score and are therefore listed together for the sixth ranked hazard for the 2018 HMP Update.

Table 4.16-5. 2018 HMP Update Hazard Ranking Results

Hazard Rank	Hazard	Category									Relative Risk Factor
		Probability	Impact			Spatial Extent	Warning Time	Duration	Adaptive Capacity	Changing Future Conditions	
			Population	Assets/ Economy	Environmental Resources/ Cultural Assets						
High	Climate Change and Sea Level Rise	3	1	3	2	2	0	3	2	3	4.6
High	Hurricane	2	2	2	1	3	0	3	2	3	4.5
High	Tsunami	1	2	2	1	2	3	3	2	3	4.3
High	Earthquake	1	2	2	1	3	3	3	2	1	4.2
Medium	Volcanic (Laval flow; vog)	2	1	2	3	2	1	3	2	1	4.0
Medium	Wildfire	2	2	1	1	2	1	2	2	3	3.8
Medium	Landslide/Rock fall	2	1	1	3	2	3	3	2	3	3.8
Medium	Health Risks	1	3	0	0	3	3	3	2	0	3.6
Medium	Event-Based Flood	1	1	2	1	2	1	3	2	3	3.4
Medium	Chronic Coastal Flood	3	1	1	1	2	0	3	2	3	3.4
Medium	Drought	2	1	1	1	3	0	3	2	3	3.3
Medium	High Wind Storm	2	1	1	1	3	0	3	2	2	3.2
Low	Dam Failure	1	1	1	1	2	2	3	2	2	2.9
Low	Hazardous Materials	2	1	1	1	1	3	1	2	0	2.6

Note: Relative Risk Factor Scores - High: > 4.0; Medium: 3.0 to 4.0; Low < 3.0

County Hazard Ranking

An updated hazard ranking was also conducted for each county; refer to Appendix X (State Profile and Risk Assessment Supplement) for each county's results. The following summarizes the county(ies) at greatest risk to each hazard based on the potential impacts to population and the built environment presented in Sections 4.2 through 4.15.

It is important to note that there is a difference in thought process when evaluating statewide risk, and risk for a particular county. Due to the state's geography, some hazards are contained by island; therefore, their statewide risk is lower compared to the risk presented to a specific county. For example, the hurricane hazard may be ranked high for all counties and the state because a hurricane event may impact all islands a result of the same event, leading to a potential disaster declaration. In comparison to a wildfire hazard, where a wildfire event is more than likely to be isolated to one island and not impact the state as a whole at the same time. Therefore, each county may have a high wildfire hazard ranking because impacts are measured relative to their individual county; whereas the statewide wildfire ranking is a medium because a wildfire event is not likely to impact multiple counties at the same time.

Table 4.16-6. Summary of Counties at Greatest Risk to the Hazards of Concern

Hazard	Summary of Most Vulnerable Counties and Estimated Impacts to Population and Buildings

Climate Change and Sea Level Rise	• All counties are vulnerable with millions to billions in estimated potential loss.
	• SLR-XA-3.2
	  • The County of Kaua‘i has the greatest percent of population displaced relative to the total county population (5%).
	  • The City and County of Honolulu has the highest estimated displaced population (13,3000 people) and economic loss (3,800 structures; $12.9B in structure and land value).
	• 1%CFZ-3.2
	  • The County of Kaua‘i has highest percent population exposed (16% of total population).
	  • The City and County of Honolulu has the greatest estimated potential loss to buildings ($120B) to 1%CFZ-3.2.

Chronic Coastal Flood	• The City and County of Honolulu has the highest estimated displaced population (2,000 people) and economic loss ($4.1B in structure and land value). • The County of Maui has the greatest number of structures permanently inundated (732). • The County of Kaua‘i has the greatest percent of population displaced relative to the total county population (1.5%).
Dam Failure	• All counties have high hazard dams and delineated dam failure inundation areas. • The Counties of Maui and Kaua‘i have the greatest number of dams, of all hazard levels (56 and 53, respectively) and total square miles of land located in dam failure inundation area. [b]
Drought	• All counties are vulnerable to droughts. • The Counties of Hawai‘i and Kaua‘i have the largest areas with the highest water supply drought risk (rainfall catchment). • All counties have high agricultural drought risk.
Earthquake	• The majority of earthquakes occur on and around the County of Hawai‘i, especially in the southern districts of the island.

Hazard	Summary of Most Vulnerable Counties and Estimated Impacts to Population and Buildings
	• The County of Hawai‘i has the greatest estimated shelter requirements and potential estimated loss to buildings ($1.8B) based on the 100-year probabilistic earthquake event.
Event-Based Flood	• All counties are vulnerable. • The County of Kaua‘i and City and County of Honolulu have the greatest percent population and building exposure. • The City and County of Honolulu has the greatest number of repetitive loss properties and greatest estimated potential damages to buildings ($1.9B).
Hazardous Materials [a]	• All counties are vulnerable. • The City and County of Honolulu is the only county with NPL sites. • The City and County of Honolulu has the greatest number of hazardous materials releases reported to the HEER Office. • There are petroleum and gas transmission lines in the City and County of Honolulu, and petroleum gas transmission lines in the County of Hawai‘i
Health Risks	• All counties are vulnerable to health risks. • Locations with higher density populations are more susceptible to outbreaks, as the disease can be transmitted more easily. The City and County of Honolulu has the greatest number of people per square mile compared to the other counties. • The Port of Honolulu may close due to a pandemic having cascading impacts statewide.
High Wind Storms	• All counties are vulnerable to high wind storms. Strong Kona storms bring wind, rain high wave heights and can cause extensive damage to south- and west-facing shores of all islands.
Hurricane	• All counties are vulnerable to hurricane winds and storm surge. • The City and County of Honolulu has the greatest number of square miles that may be inundated by storm surge (SLOSH categories 1 through 4).
Landslide and Rockfall	• All counties have high landslide susceptibility areas. • The County of Hawai‘i has the largest area, 944.9 square miles or 23.5% of the county, located in the high landslide susceptibility area compared to the other counties. • The County of Hawai‘i, followed by the City and County of Honolulu, has the greatest number of people and buildings exposed.
Tsunami	• All counties have population and buildings in the GAT inundation area. • The City and County of Honolulu has the greatest population (185,389 people; this estimate does not include visitors) and buildings ($58 B) exposed; and greatest estimated potential loss of $6B). • The County of Maui has the greatest percent of the buildings damaged (11.2% of the county total).
Volcano (Lava flow and vog)	• Five active volcanoes are located in the County of Hawai‘i, and one is located in the County of Maui. • The County of Hawai‘i has the largest area (2,645 square miles) located in high lava flow hazard area (Zones 1 through 4). • All counties may be impacted by vog, with greatest risk to the County of Hawai‘i, County of Maui and City and County of Honolulu populations.
Wildfire	• All counties are vulnerable to wildfire. • The City and County of Honolulu has the greatest number of people and greatest building value ($65B) located in the high wildfire risk hazard area.

Hazard	Summary of Most Vulnerable Counties and Estimated Impacts to Population and Buildings
	• The County of Maui has the highest percent of their total population (60.7%) and building stock (64.4%) located in the high wildfire hazard area relative to the county totals followed by the County of Kaua‘i.

[a] The impacts and vulnerability from a hazardous materials event are greatly dependent the material and its physical and chemical properties, the quantity released, weather conditions, micro-meteorological effects of buildings and terrain, and maintenance failures. The severity of a hazardous material incident is dependent on these factors as well as the distance and related response time for emergency response teams.

[b] Analysis is based on spatially-delineated dam failure inundation areas available for the 2018 HMP Update.

B = Billion
HEER = State Department of Health Office of Hazard Evaluation and Emergency Response
NPL = National Priority List
SLOSH = Sea, Lake and Overland Surges from Hurricanes