

**Strengthening Community Flood Resilience:  
A Case Study of Ha‘ikū, Maui**

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## **Abstract**

Hawai‘i faces an increasing threat from the impacts of climate change, especially from the escalating risks associated with floods. In response to pressing challenges, vulnerable communities must strengthen resiliency and adaptation action. Resilience frameworks are increasingly being used to prepare for, adapt to, and withstand disturbances such as floods and other natural disasters. Motivated by the Hawaiian proverb, “*I kahiki ka ua, ako ‘ē ka hale. While the rain is still far away, thatch the house. **Be prepared***” (Pūkui), this research will explore ways for local communities to better prepare in the face of future flood events. Specifically, this proposed research aims to understand the collective concerns of a community in Ha‘ikū, Maui, which experienced flooding and a dam breach in 2018 and 2021. Employing a participatory approach, the study will weave community place-based knowledge with scientific insights to bridge knowledge gaps and strengthen resilience. Data collection based on triangulation methodology will support four different methods: climate data, participatory mapping, interviews, and a workshop. Documenting the climate history of rainfall, streams, and storms will be essential for future flood predictions. An outreach participatory mapping booth at a local festival will serve as a way to document past flood locations and have conversations with the broad public on general experiences or interests in this project. Interviews will provide more depth into individual concerns and the history of floods in the community. Both climate data, interviews, and participatory will provide a basis for conducting a community workshop on findings, comments, and future needs. Expected outcomes include an accessible website of research progress and findings, a community presentation, a stream clean-up day, and a recommendation report for governmental agencies. Short-term outcomes focus on enhancing community preparedness involvement and knowledge through educational content and outreach, while long-term outcomes aim to tailor future management decisions based on community needs. By fostering collaboration, capacity-building, and community empowerment, the proposed study seeks to enhance awareness, preparedness, and resilience in Ha‘ikū, and to serve as a model for other communities facing similar challenges statewide and globally.

**Keywords:** Climate Change, Collaboration, Preparedness, Place-Based Knowledge, Hawai‘i

## Motivation

*“I kahiki ka ua, ako ‘ē ka hale. While the rain is still far away, thatch the house. **Be prepared.**”*

Mary Kawena Pukui (Pukui, 1983)

Flood risks are expected to rise in the future due to climate change and land-use change (Visser, 2014). Flooding is driven by extreme weather events and is accelerated through land use change, invasive species, and climate change (Bertola, 2021). The increasing flooding threats from climate change and urbanization will test numerous community vulnerabilities. It is essential to recognize the urgency to safeguard lives, property, culture, and the environment in the face of extreme weather events (Fabiyyi, 2013). Specifically, it is crucial to fortify the adaptive capacity of communities to withstand and recover from the adverse impacts of floods, which will empower residents and hold the government accountable to become proactive in their safety and well-being by focusing on community resilience (Ferreira, 2023). Creating a collective understanding of flood risks and management through participatory research such as community interviews, surveys, and plans can aid in reaching specific place-based goals.

Climate change, urbanization, and insufficient infrastructure are some factors that determine the extent and impact of floods. Heavy rainfall events can trigger landslides, and tropical mountainous regions tend to have a greater risk (Naranjo, 2007). Pacific Islands, in particular, are expected to have more frequent and intense rainstorm events, leading to increased frequency and intensity of floods (Safeeq, 2011). Floods deeply affect Hawai‘i, resulting in considerable economic losses and even death (Huang, 2021). Hawai‘i government agencies provide mitigation and resilience plans at the State and County levels. Specifically, the County of Maui Hazard Mitigation Plan identified obstacles in flooding as outdated infrastructure, lack of funding, invasive species, and a knowledge gap among residents. This research aims to fill the gap by investigating an individual community's flood resilience needs and goals.

The town of Ha‘ikū in Maui County faces challenges associated with floods, largely as a result of outdated infrastructure, overgrown streamways, climate change, and land use change. According to the County of Maui Hazard Mitigation Plan (2020), the Pā‘ia-Ha‘ikū community has one thousand buildings in landslide-susceptible areas, the highest in the County. Furthermore, 13% of homes were built before 1950, predating modern building codes; this increases the risk and susceptibility to hazards and insurance. In August 2018, rainfall from Hurricane Lane caused significant damage in Ha‘ikū, leaving a neighborhood stranded. An

overwhelmed drainage system created a significant sinkhole, causing at least \$3 million in damages and at least ten reports of landslides. On March 8th, 2021, there was a breach in the Kaupakulua Dam in Ha‘ikū. The dam failure risk caused evacuations and \$14.3 million in damages. Nine homes were destroyed, an additional ninety-nine homes endured damage, and roads remain unfixed today (NOAA Storm Database, 2024).

## Background

### *Flood & Climate Change*

Ha‘ikū is a town located on the north-facing slopes of Haleakalā, Maui. The combination of steep terrain, dense vegetation, and frequent rainfall makes Ha‘ikū susceptible to flooding. Ha‘ikū receives approximately seventy inches of rainfall annually and, on average, has two extreme yearly rainfall events, with an increasing trend in the most recent decade (NOAA Storm Database, 2024). The Pacific Drought Knowledge Exchange (PDKE) created a climate change, variability, and drought portfolio for Ha‘ikū. Based on a single Hydro-Net Rainfall Station, the main findings highlight that Ha‘ikū ranks in the 82 percentile for rainfall across the whole state during the wet season. While the overall average rainfall is not stark, certain areas mauka (upward) receive significant amounts of rain, which is important information for this project.

### Monthly Rainfall: Haiku

Wet Season (NOV-APR) 10.2 in

Dry Season (MAY-OCT) 6.1 in

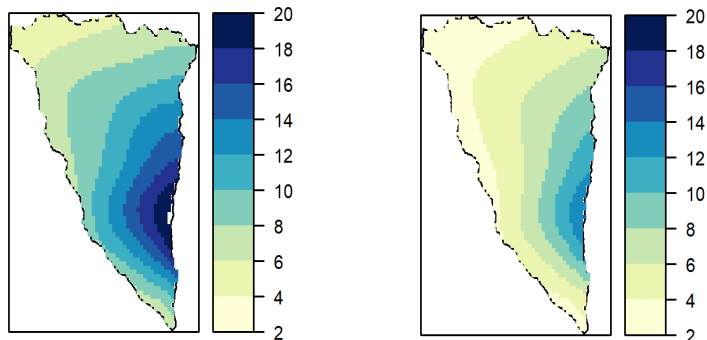


Figure 1: Average Monthly Rainfall Gradient for Wet and Dry Season in Ha‘ikū (PDKE).

### *Resilience Metrics*

Resilience frameworks are structures or models that guide individuals, organizations, communities, or systems to recover from adversity, cope with challenges, and adapt to change. Due to its interdisciplinary nature, resilience definitions vary across frameworks. From the

theory of resilience, Norris (2007) defines *resilience* as “a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance.” The State of Hawai‘i and its respective counties have climate adaptation plans that touch upon resilience with tailored definitions, such as the ability to survive, adapt, and thrive regardless of shocks or stresses (City & County of Honolulu, 2019). Addressing resilience through a community scope provides space for customized definitions with specific nuances about the local environment, community, and identity (Cretney, 2017). More so, implementing culturally grounded indicators of resilience in social-ecological systems is successful when addressing community wellbeing first (Sterling, 2017).

Incorporating local place-based knowledge into management plans can promote culture and uplift community voices, which may lead to a push for future collaborations and partnerships (Berkes, 2001). Lastly, resilience is subjective and carries different levels of importance to various stakeholders. Therefore, creating a shared understanding of resilience concerning specific places is fundamental from the beginning (Cutter, 2014). Hopefully, this project can uncover how Ha‘ikū values and defines resilience in relation to place, people, and well-being.

*Case Study: Ha‘ikū, Maui*

“*Ka ua pehi hala o Hāmākua*, The rain of Hāmākua that pelts the pandanus fruit clusters.”

(Pukui, 1983)

The town of Ha‘ikū is located within the moku (land division) of Hāmākua. This ‘ōlelo no‘eau (Hawaiian proverb) refers to a type of rain known to this region. As I personally grew up in Ha‘ikū, one of my favorite sounds is the strong and hard rain coming in waves against the roof. Another type of rain in this region has a reddish hue named *Ulalena* (Wehewehe). Weaving Traditional Ecological Knowledge, Place-Based Knowledge, and Western Knowledge together provides an opportunity to bridge the gap between Western science, Indigenous knowledge, and communities, often those throughout Hawai‘i (Barker, 2019). The moku system in pre-contact Hawai‘i focused on community kuleana (responsibility) and ma uka (mountain) to ma kai (ocean) management, following the notion that everything is interconnected (Winters, 2018). Following western contact, resource management shifted to support intensive plantation sugarcane and pineapple agriculture, which reached Ha‘ikū in 1858 (Maclennan, 1997). Expansive irrigation and flood control infrastructure were created throughout Ha‘ikū, including ditches, reservoirs, and 17 dams (Maui County, 2020).

## **Objectives**

The overarching objective of this study is to explore how Ha‘ikū prepares for and responds to future heavy rainfall and flood events. This proposed research aims to understand the collective concerns raised by recent flooding and a dam breach in 2018 and 2021, respectively. The specific research questions of this proposed study are : (i) Why does it flood in Ha‘ikū? What is the history of floods? (ii) What are the current community vulnerabilities to floods? (iii) How can the Ha‘ikū community become more resilient to future floods? While this research aims to be case-specific, it has the potential to be applied in other communities across Hawai‘i and throughout the Pacific Island Region. In response to identified communal risks, this project will empower the community and embedded organizations to build capacity in education, networking, preparedness, and response (Pfefferbaum, 2016).

## **Approach**

This proposed project is intended to support the safety of Ha‘ikū residents and their resources in the face of flooding. Climate data from the Pacific Drought Knowledge Exchange and the United States Geological Survey stream gauges will be obtained to document stream and rainfall change over time. Ultimately, the essence of this research will come from qualitative data (King, 1994) collected primarily through community perspectives shared by interviews, focus groups, and surveys (Winter, 2021). Fostering collaboration between community members can create a more robust network to build resilience measures over time across different climate challenges (Hawken, 2023). Climate data will be used in conjunction with community knowledge to support claims or inform a knowledge gap.

## *Methodology*

### *Study Setting*

Ha‘ikū is located on the windward side of Haleakalā. It has abundant lush landscapes, diverse ecosystems, high cultural significance, and a vibrant community. Many ‘ōlelo no‘eau (Hawaiian proverbs) spoke of the many hala trees (*Pandanus tectorius*) that were lost to pineapple production and today are overtaken by Albizia (*Falcataria moluccana*) and African Tulip (*Spathodea campanulata*) trees. Many properties in Ha‘ikū are on agricultural land, allowing vast vegetation and livestock freedom. Regarding land cover, only 5% of the land is

developed, while 87% is grassland or tree cover (PDKE, 2024). The 2020 census reports a population of 8,595 residents, almost double the population from the 1990s. Both community and land have changed dramatically in recent years, providing a unique opportunity to document how floods have also changed.

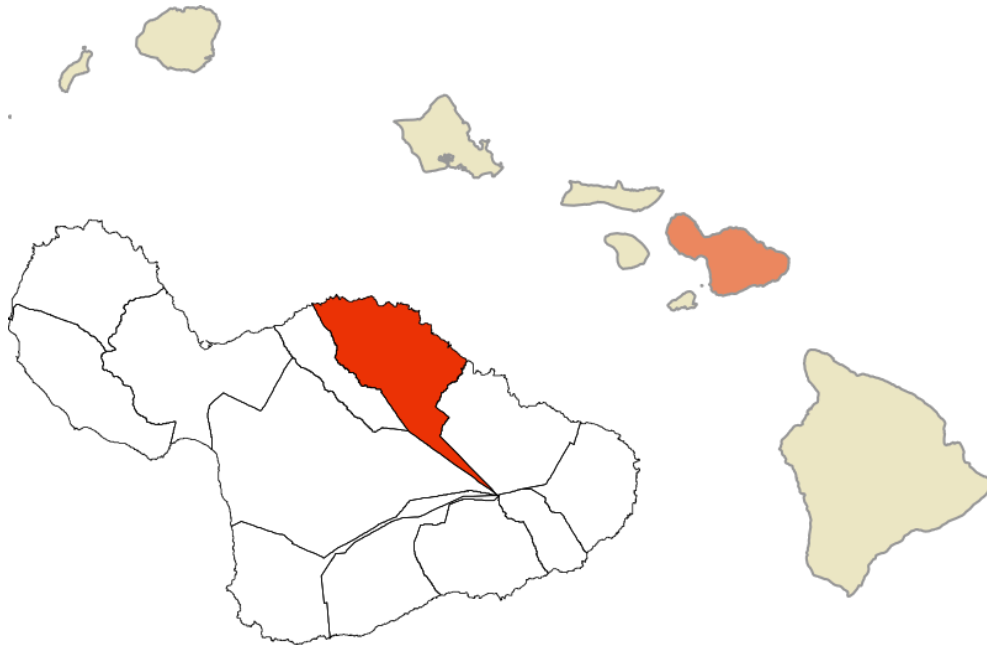


Fig. 2. The location of Ha'ikū in Moku of Hāmākualoa, Maui, where this case study takes place, is highlighted in red.

### *Participatory Mapping*

I would like to host a booth to conduct participatory mapping at an upcoming Kalo Festival event at Twin Falls in August of 2024. Depending on cellular service, I will either use a premade Esri map with a questionnaire or a physical map of Ha'ikū with post-it notes to involve attendees in conversation and recollection of past flood events and where they occurred (see Appendix C). This data could potentially be used for flood modeling. I would also be interested to learn about general changes in streams local to the area from kūpuna or long-time residents. This exercise can provide a general basis for overall experiences and concerns and can be directly used in outputs.

### *Interviews*

I plan to conduct 10-20 semi-structured interviews (see Appendix A) based on open-ended questions or themes and follow up with probing questions to allow the interviewee to expand or move on personally. Prioritizing diversity, inclusion, and transparency amongst community participants is paramount when working with communities. These participants will be chosen based on their connection to the place (genealogical ties, long-time resident, community leader), flood experiences (witness, concern, damage, loss), and community involvement (volunteer, relationships, awareness). I have compiled a list of potentially interested participants to invite to interview (see Appendix B), and will continue to reach out to participants with the snowball sample approach (Kirchherr, 2018). At the participants' discretion, interviews will be conducted virtually or in person at public spaces, volunteer days, homes, or flood sites. All interviews will be recorded (by audio or notes) and transcribed with participants' approval before data analysis.

### *Focus Group*

Following interviews, I propose to conduct 2-3 focus group sessions with 6-10 key identified stakeholders per session. Participants will be from government, private, or public organizations and the community. A moderator, most likely myself, will conduct an hour-long discussion guided by pre-determined questions (engagement, exploration, exit), which will be based on the themes or categories raised by interviews. Focus group participants will be recruited by nomination during interviews, word of mouth, or talk stories on work days. I will also advertise for volunteers in the community to participate in these sessions. Participants will be incentivized, but the details are yet to be determined. A notetaker will assist with making key observations, supporting comments, and recording conversations. Multiple sessions will be essential for drawing common themes or a wider spectrum of perspectives.

### *Data Analysis*

This project will cover four different methods: climate data, participatory mapping, interviews, and a workshop. Qualitative data collected through participatory mapping, interviews, and focus groups will be analyzed by method triangulation (Carter, 2014). The triangulation of data from multiple sources will enhance the validation of findings. Participatory



mapping data will provide a creative data output that can be compared to historical climate data, such as stream gauge trends and rainfall events. After all of the participants approve and finalize the transcripts, I will use an inductive approach to code the interview and focus group transcriptions, looking for broad patterns in themes to develop a theory or conclusion to explain themes (Soiferman, 2010). A complete and comprehensive document of themes, quotes, and general findings will guide outputs. Overall, this methodology employs a mixed methods approach that integrates qualitative and quantitative findings and climate data, aiming to provide the first comprehensive understanding of community flood resilience in Ha‘ikū.

## **Outputs**

*“ ‘Ike ‘Aina, ‘Ike Wai: Know your home's history and place names, the past pathways and spirits of its water. Water always returns. ”*

Dr. Mehana Blaich Vaughan (Kānaka ‘Ōiwi Methodologies, 2016)

I propose to collate community concerns and localized climate change data to create educational content to present my findings at a community association meeting. The proposed outputs will directly address the need to fill the knowledge gap among residents in the Hazard Mitigation Plan, and this information will be publicly available.

Through an established relationship with Mālama Hāmākua, a local nonprofit organization, I propose to help orchestrate a community volunteer day, focusing on the short-term relief of invasive species and trash removal. Volunteer workdays will provide direct mitigation, resulting in clear stream pathways, and allow community members to learn place-based knowledge and strengthen connections to gain community input. To build upon ‘ike ‘āina, ‘ike wai, I will also create a website with information on local stream genealogy, including historical and cultural aspects, community knowledge, and research findings.

Finally, I will create a recommendations document with a plan and vision of how Ha‘ikū can be more resilient. This document will be presented to the community association, county politician members, and future identified members. The overall goal of the project outputs is to deepen place-based connection while simultaneously protecting community safety and well-being.

## Outcomes

This research project will increase awareness, preparedness, and community resilience in response to flooding in Ha‘ikū, Maui. Subsequently, the production of place-based knowledge about local streams, associated cultural stories, and past events will aid in the community's connection to their place, by having educational resources in the near and long-term. Ideally, county agencies can identify and improve infrastructure and support systems in response to the findings from this study, using this as a guide for medium-term management decisions. The approach and findings from this research can be translated to other communities hoping to achieve similar resilience goals. Synergistic efforts across Hawai‘i can use this data compared to other communities' flood response. On a broader level, I hope this resilience work can be redirected to other challenges this community will face as climate change continues.

## Timeline

This project comprises three phases and four broad categories: planning, data collection, data analysis, and outputs (Table 1). Data collection and analysis will be simultaneous. I will develop interviewees and questions in the first phase, as well as complete IRB processes and defend this proposal. Phase two will provide time to collect and begin to analyze data. Finally, I plan to share my results with the community of Ha‘ikū and similarly with synergistic partnerships with other research teams across Hawai‘i.

**Table 1.** Gantt Chart of proposed project timeline and components.

| Project Timeline   | Phase 1 |     |     |     | Phase 2 |     |     |     | Phase 3 |     |     |     |
|--|---------|-----|-----|-----|---------|-----|-----|-----|---------|-----|-----|-----|
|  | Mar     | Apr | May | Jun | Jul     | Aug | Sep | Oct | Nov     | Jan | Feb | Mar |
| Proposal<br>Interview Development<br>Proposal Presentation<br>IRB Approval   | ■       |     |     |     |         |     |     |     |         |     |     |     |
| Data Collection<br>Outreach Event<br>Interviews<br>Focus Groups              |         |     |     | ■   |         |     |     |     |         |     |     |     |
| Data Analysis<br>Transcription & Analysis<br>Create Maps, Website, Tool      |         |     |     |     | ■       |     |     |     |         |     |     |     |
| Outputs<br>Community Presentation<br>Capstone Presentation<br>Final Document |         |     |     |     |         |     |     |     | ■       |     |     |     |

**Resources**

A Hau‘oli Mau Loa Foundation graduate fellowship will fund this research. The development of this research requires established relationships, data access, and time. The ongoing cultivation of community relationships, supporting organizations, and local leaders is paramount and will be maintained through gifts such as baked goods or lei. Outreach materials, such as banners, flyers, and pamphlets, will be purchased through the professional development fund from the Hau‘oli Mau Loa Foundation. I will utilize online resources such as GIS, historical documents, climate data, and transcription services via the Internet or software services via computer. Communication with other research teams in Hawai‘i will provide insights into future resources that may be needed throughout this project.

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## Appendix A: Interview Guide

|              |   |
|--------------|---|
| Introduction | Aloha. My name is Lilia Davis, and I am from ‘Ōpana, Ha‘ikū, Maui. Mahalo, thank you for taking the time to talk to me; I genuinely appreciate it. Today's interview is part of my research to understand community flood resilience in Ha‘ikū as part of my master's project with UH Manoa.<br>This interview should last between thirty minutes to one hour, depending on how |
|--------------|---|

|                   |   |
|-------------------|---|
|                   | <p>much you are willing to share. To ensure our conversation is captured in its entirety, is it okay to record with my device? If not, I will take notes as we speak. The information you share with me today will be kept anonymous, and any attribution quotes will be handled by ____.</p> <p>Our discussion today will ultimately help our community prepare and adapt to floods. During this interview, I will ask questions about your connection to Ha‘ikū and your experience with climate change. Please share what feels natural, take as much time as you need to answer, and let me know if you have questions or concerns. Before we begin, do you have any questions?</p>   |
| Goals             | <ul style="list-style-type: none"> <li>- Understand community experiences, perceptions, and collective place-based knowledge about flooding in Ha‘ikū</li> <li>- Envision ways to move forward in terms of community strength and resiliency</li> </ul>   |
| Guiding Questions | <p>Introduction</p> <p>Can you share your name?</p> <p>Where are you from? How long have you lived in Ha‘ikū?</p> <p>What are your earliest memories? Favorite activity here?</p> <p>Experiences</p> <p>Can you share your connection to this place?</p> <p>Have you noticed any environmental changes over the past __ years that you have lived here?</p> <p>Do you remember any flood or heavy rain events? When and where were you? How did this impact your life?</p> <p>Did you feel educated and prepared?</p> <p>What can you tell me about the March 2021 floods? Impact?</p> <p>Future</p> <p>How do you feel about the possibility of floods in the future?</p> <p>What would make you feel more prepared?</p> <p style="padding-left: 40px;">What/who/how/by when?</p> <p>Closing</p> <p>Would you like to expand or add anything that did not come up?</p> <p>Is there anything we discussed today that you do not feel comfortable sharing beyond this interview?</p> |



|            |   |
|------------|---|
| Conclusion | Mahalo for your time and mana‘o today. The information you shared with me will be used to _____. According to your wishes, your identity will/will not be revealed in any product or presentation resulting from this effort. If you have any questions or concerns, please contact me. I expect to conclude the results by December 2024 and plan to present my results at Ha‘ikū Community Association Meeting in December 2024/March 2025. Once again, mahalo for your time. |
|------------|---|

## Appendix B: List of Potential Participants

| Name                | Experience   |
|---------------------|--|
| *Lucienne de Naie   | Chairperson, Sierra Club of Maui                           |
| *Ikaika Nakahashi   | Cultural Historian, Department of Land & Natural Resources |
| *Suzie Aguirre      | President, *Ha‘ikū Living Legacy Project                   |
| *Chris Schuler      | Hydrologist, University of Hawaii Water Research Center    |
| *Roni Panzarini     | Loss from 2018 Floods                                      |
| *Alexander ‘Ohana   | Loss from 2021 Floods                                      |
| *Ramana Sawyer      | *Friends of Twin Falls at Wailele Farms                    |
| *Amber Starr-Cook   | Land Asset Manager, *Kamehameha Schools                    |
| Diego Sanchez-Gomez | Floodplain Manager, County of Maui                         |
| Sara Tekula         | Director of Programs, *The Merwin Conservancy              |
| Amos Hewett         | Administrator, Maui Emergency Management Agency            |

*\*Ha‘ikū Resident or Organization*

## Appendix C: Participatory Map Questions

|              |   |
|--------------|---|
| Introduction | <p>Aloha! Would you be interested in community participatory mapping of floods?</p> <p>If yes: My name is Lilia Davis and I am from ‘Opana or Ha‘ikū. I am a graduate student at UH Mānoa in the Natural Resources and Environmental Science Department, and I am researching how floods affect communities, particularly Ha‘ikū. I would love to hear about your experiences in Ha‘ikū.</p> <p>Your response will be anonymous</p> |
|--------------|---|

|                   |  |
|-------------------|--|
| Guiding Questions | Is there a particular rain or flood event you remember?<br>Where were you? General, landmark, street, address—let's mark it on the map!<br>When did this take place? Year, season, month, date.<br>Did anything happen to you or your property?<br>How high was the water? One step, knee, plant height? |
| Conclusion        | Mahalo for participating! This map will be a great baseline of floods to this area and can help in future mitigation efforts. If you would like to be up to date on my research project, please sign up for my email list.<br>Mahalo   |