CLIMATE CHANGE AND DISASTER VULNERABILITY:

COMMUNITY-BASED SOCIO-ECOLOGICAL RESILIENCE

RESEARCH AND PLANNING IN HAWAIʻI

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DEDICATION

Working in this interdisciplinary, nascent field has its inherent rewards and challenges. I have encountered rich as well as difficult interactions with academics and professionals from different fields, that have disparate views of how research should be conducted, what the goals of the research should be, and who should be involved, where it is often (much to my continued dismay) the community that is uninvolved, uninvited, and misused. While diverse partnership is ideal for collaborative research and planning, it often presents conflicting goals, institutional norms, cultural and social values, and divergent attitudes and behaviors. Conflicts should, however, be seen as opportunities to problem-solve, to challenge dysfunctional attitudes and antiquated schools of thought, and rebuild relationships for solidarity and progress. It is critical to seek out and receive all forms of advice and criticism throughout our lives, to advance our understanding of humankind, re-invigorate our value-driven work, and continue to challenge us to question, to embrace a sense of childlike wonder and optimism, and to dream ideas and solutions that we are empowered to transform into reality. A greater need or opportunity has never existed before for youth, and all generations, to answer the call to be a catalyst for intergenerational equity, justice and empowerment of the vulnerable, in our homes, our communities and the world.

Intergenerational and collegial mentorship and solidarity is invaluable to mitigate professional discord, provide a springboard for feedback, and to help with navigating educational and professional choices and opportunities. I have been very fortunate to receive mentorship, both solicited and serendipitous, from inspirational people throughout the world, in academia, professional workplaces, communities and elsewhere, who have defended my work and championed my vision when faced with adversity and conflict. I am deeply grateful to my ʻohana, friends, mentors, the communities of North Shore Kauaʻi and Oʻahu, my friends and colleagues around the world living and working in humanitarian assistance, disaster relief and development, and my employers and committee members for their time, insight and unfailing support.

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ABSTRACT

Much of the ecological degradation, high urban density and hazard vulnerability in the world are found in coastal regions and islands, including the State of Hawai'i and Pacific Islands. Many of these areas are vulnerable to hazard events and climate change impacts, for which engineering solutions and infrastructure measures are not always feasible and may cause further damage to the environment. Issues of poverty and wealth inequalities, poor natural resource management, and human rights abuses further exacerbate physical, social and ecological vulnerabilities to disasters. Moving away from the antiquated reactionary relief model, a movement is underway to engage in disaster resilience, an interdisciplinary approach of proactive prevention, preparation, risk reduction and adaptation. Due to extreme geographic remoteness and high risk to multiple hazards, emergency managers, communities and resource managers in Hawai'i and the Pacific must develop long-term resilience-building strategies that increase environmental stewardship, social well-being, and food and water security, particularly in the face of potential impacts from climate change. The dissertation employed a community-based participatory research and learning approach to address these issues, collaborating with community and multi-sector stakeholders to build capacity for development of place-based, ecologically sound and socially-appropriate integrated disaster resilience plans. The research addressed critical theoretical and practical gaps by utilizing mixed quantitative and qualitative approaches and diverse tools. Adaptable community-based socio-ecological resilience frameworks promoted better linkages between socio-ecological systems, disaster preparedness, relief, recovery and sustainable development, and facilitated social learning and institutionalized resilience planning mechanisms to generate innovative solutions to the complex issues of climate change, socio-ecological vulnerability reduction and sustainable development.

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PREFACE

Autobiographical Sketch

For the last fifteen years, my path of academic, professional and service work has taken colorful and rich meanders throughout the world, in the fields of disaster preparedness, relief and recovery, public health, human rights, social justice, advocacy, social mobilization, environmental stewardship, community education and sustainable development. The diverse communities of people with whom I have lived and worked, like millions of others, are vulnerable. Due to circumstance or chance, they may be displaced by, or at risk to, political and economic instability, disasters and climate change impacts.

Often times I find myself struggling to strike a balance between encouraging realistic public health, resource management and development goals, while not losing focus and face towards the community's more immediate and basic needs of food, shelter, and human security. Such sobering realizations have served as pivotal, awakening challenges that produce clarity, focus and direction for my evolving career in disaster resilience. These invaluable experiences continually reinforce the reality that the most fundamental roots for community resilience and health are the upholding of basic human rights, access to shelter, food and water, education and health services, with local ownership, involvement and planning as the basis for all development and relief activities. As a public health and development practitioner and human rights advocate, I have seen and experienced first-hand the challenging effects that disparate poverty, neglect of human rights, and inequitable and unsustainable natural and human resource allocation and use can have on communities.

Contributions to the Field

The practice of measuring vulnerabilities and resilience of communities to disasters and underlying inequities is critical, yet as a field it is still relatively new and underdeveloped. A strong call for research-proven and community-based measures is now being heard to create better measures of vulnerability and resilience, in order to foster empowerment and sustained human and environmental security. Therefore, I pursued a Ph.D. in Natural Resources and

Environmental Management in order to understand how to leverage natural resources and features to protect people and places from natural hazards and encourage climate change adaptation. My dissertation research addresses bridging the gap between disaster relief and sustainable development, through community-based disaster resilience research and planning in Hawaiʻi with international implications. My continued drive to develop the field of disaster resilience stems from my desire and commitment to understand and address the root causes of vulnerability, disparity, poverty and injustice, in order to take informed and skilled action to make the most powerfully positive, sustained impact possible.

*Taken in part from (2012) Henly-Shepard, S. Empowering the "Vulnerable"—Intergenerational Solidarity for Rights-based Disaster Resilience. Reflections from the Field. *Journal of Intergenerational Relationships,* University of Pittsburgh. *In Review.*

CHAPTER 1. INTRODUCTION

1.   Dissertation structure

1.1   Organization and rationale

The dissertation is structured around the three papers that explore different facets of disaster resilience through distinct research topics. Each paper is constructed in a separate chapter of the dissertation (Chapters 3 through 5), offering relevant literature reviews, each with a unique research design, problem statement, research questions, objectives and methods, producing distinct scientific contributions. The papers each contribute to one or more of the critical gaps listed in section 3.2. Chapters 1 and 2 serve primarily to introduce the dissertation, provide an overview of the 3 papers, and generally discuss the approach and methodologies employed, with a concluding chapter summarizing lessons learned and best practices.

Due to the highly complex and underdeveloped field of climate change and disaster resilience, the dissertation, which focuses on community-based socio-ecological resilience research and planning, aims to examine resilience at three levels: 1) a theoretical grounding for a rights-based disaster resilience framework and indicators at the community-level (Chapter 3); 2) an analysis of resilience indicators at the household-level (Chapter 4); and, 3) an analysis of social learning, adaptive capacity and resilience of stakeholders at the group-level (Chapter 5). This multi-scale research dynamic is demonstrated in Figure 1.1. The following is a synopsis of the contributions and structure of each chapter.
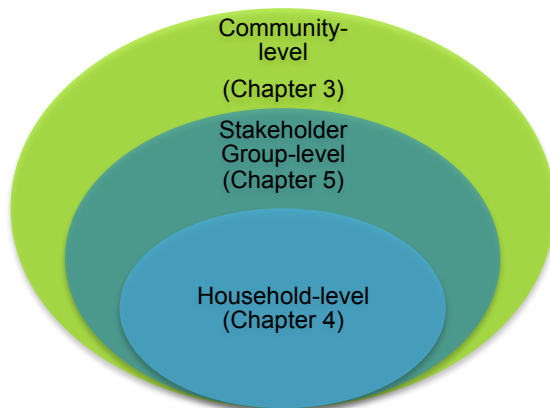
Figure 1.1 Research scale: Multi-level resilience dynamics.

1.2   Chapter contributions

The purpose of Chapter 1—*Introduction* is to: 1) discuss the background and rationale of the research including defining key concepts, providing an overview of natural disasters and climate change impacts and management strategies in Hawaiʻi; 2) outline the justification and relevance for the research including a historical recapitulation of the evolution of the field of disaster resilience from which theoretical and practical lacunas are identified; and finally, 3) provide an overview of the research including the scope, identified critical gaps which the dissertation builds upon through 3 discrete papers, the overarching goal, problem statement and hypothesis, and finally intended audience and users and anticipated outcomes, deliverables and significance.

Chapter 2—*Methods*, aims to provide an overview of the methods used across the three papers, including: 1) illustrate the research design, approach and introduce the community-based case studies; 2) describe three integrated dimensions addressing resilience from different facets and each detailing their proper sets of methodologies; and, 3) discuss the data management considerations.

Chapter 3—*Cultivating a human rights conscience: moving beyond reducing risk to build community resilience to disasters and climate change,* is the first of the three papers. Chapter 3 offers a theoretical examination of the disconnect between the intersecting fields of disaster resilience, and highlights the failure of institutions to use ethics, human rights and justice as the guidance for resilience research, planning, policy-making and practice, particularly at the community-level. This is achieved through: 1) introducing the challenge that disasters, development and climate change pose on humanity and the earth system; 2) utilizing methods including a tri-part literature review to research (and highlighting results that subsequently affirm) the stated gap; and, 3) propose a rights-based resilience conceptual model and potential indicators for consideration, discussing assumptions and critical recommendations.

Chapter 4—*Quantifying household resilience: a place-based approach in a rapidly changing community* identifies theoretical and practical gaps in addressing and measuring household-level resilience. This is addressed through: 1) a summary of relevant social resilience literature; 2) background of natural hazards and vulnerability in the Pacific Islands and introduction to the case

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study site; 3) a description of the methods used including adaptation of a framework for the household disaster resilience with proposed indicators; and, 4) an evaluation of the descriptive metrics as well as the research analyses for the resilience indices, concluding with discussion and recommendations for adaptation of this framework and methods for application elsewhere in the Pacific and internationally.

Chapter 5—*Resilience of who and what, to what…according to whom?: Facilitating place-based adaptation and resilience through anticipatory social learning,* highlights the use of decision-making tools and social learning methods and processes to build consensus and increase resilience within diverse stakeholder groups around issues of climate change adaptation, natural hazards and demographic shifts. As such, the paper provides: 1) an introduction to mental models, cognitive mapping, and social learning with regards to building adaptive capacity through community planning; 2) proposes hypotheses and methods to test them; 3) outlines the research design and case study participants, data collection and analysis procedures; and 4) presents the research results with planning and policy implications, a discussion of results and suggestions for application of the methods in other settings and locales.

Chapter 6—*Conclusions: Directions for Disaster Resilience* offers a review of the theoretical and critical gaps addressed throughout the dissertation, recapitulates the lessons learned regarding the applicability and adaptability of conceptual models, frameworks and place-based methods, as well as challenges and recommendations for addressing them. Research outcomes, deliverables and the significance at societal, policy and programmatic, institutional and scientific levels are outlined, and next steps are proposed for application of the frameworks and methods used both in the case study sites as well as internationally. Concluding personal reflections are offered around the ongoing learning facilitated by the research, the relationships made in creating place-based resilience processes and solutions, and the importance of continually assessing and addressing gaps with community as the convener, with rights, justice and equity as the baseline criteria for resilience research and development efforts.

2.   Background and rationale

2.1   Introduction

2.1.1   Summary

Much of the ecological degradation, high urban density, and hazard vulnerability in the world are found in coastal regions and islands. Many of these areas are vulnerable to events for which hard engineering solutions and infrastructure measures, such as sea walls and out-pumping of water, are not always realistic or feasible, and often cause further damage to the environment. Issues of poverty and wealth inequalities, poor resource management, and human rights abuses further exacerbate physical, social and ecological vulnerabilities to disasters.

Amidst an era of ecological degradation, global climate change and increasing intensity and frequency of natural hazards, pacific islands and the State of Hawaiʻi face increased risk. Located in the Pacific Ring of Fire, Hawaii's coastal storm hazard vulnerability is exacerbated by its geographical remoteness and large dependency on imported food and energy (Kaly, Pratt, & Howorth, 2002). Although native Hawaiians and long-term residents have a history of using resiliency-building strategies, change, fragmentation, globalization and modernity have compromised these traditions. Critical gaps in coastal storm hazard mitigation plans include climate change risk and vulnerability (food and water security), socio-economic risk and resiliency (demographics, poverty and health), secondary impacts to sectors such as the tourism industry, and community-level risk and vulnerability (HSCD, 2007).

Engaging in interdisciplinary, multi-sector, community-based research is critical to defining, understanding, measuring and enhancing disaster resilience for at-risk populations, communities and ecosystems. Therefore, the dissertation employed this approach, engaging in community-based participatory research and learning (CBPRL), using social science research methods and decision-support software tools designed to facilitate social learning and community planning (Chambers & Conway, 1992). This was done by incorporating diverse types of stakeholder knowledge, beliefs, and perceptions (e.g., place-based knowledge, and Western scientific knowledge) in a form that maintains the integrity of complex human understanding and is useful for collaborative decision-making. These decision-support tools will be developed in the context of

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building resilience to natural hazards which, given climate change predictions, are an area of growing concern to communities along Hawaii's coasts. The research employed a multi-hazard approach, with considerations for acute disasters (such as earthquake and tsunami) as well as chronic disasters (such as drought and sea level rise) and the need for diverse adaptation and planning strategies. The two at-risk communities chosen for the case studies in Hawaiʻi include North Shore, Kauaʻi and North Shore, Oʻahu.

2.1.2 *Key concepts*

Disaster is defined as a serious disruption of the functioning of a community or a society causing human, material, economic, livelihood or environmental damage or losses, which exceed the ability of the affected system to cope and recover using its own resources (UNISDR, 2004). Disaster is characterized as a function of the risk process, where risk is the result of the combination of the probability or likelihood of the incidence and severity of a natural hazard with the underlying vulnerabilities and deficient capacity to reduce risk (UNISDR, 2004; Wisner, Blaikie, Cannon, & Davis, 2004). Disaster events can be characterized by origin, whether due to natural hazards or biological phenomena, human-caused including intentional acts such as war and terrorism, unintentional acts including industrial, technological and transportation emergencies, as well as environmental degradation and finally complex humanitarian emergencies. Disasters may be characterized based on their spatial distribution being widespread or localized, as single or multiple source events, as well as temporal distribution including acute, mid- and long-term or chronic. From a disaster management perspective, an event is considered to be a disaster if at least one of the following criteria is fulfilled: 10 or more people reported killed; 100 people are reported affected; there is a declaration of a state of emergency, or an appeal for international assistance is issued (SPHERE, 2011).

The impacts of disasters range from immediate to long-term. Immediate impacts of disasters upon affected populations create or exacerbate basic survival needs. Long-term effects of disasters include social and cultural, economic, political, environmental and health impacts. Social impacts may be seen as amplified social inequalities or, cultural heritage areas and religious sites may have been disturbed. In addition, disasters lead to disruption of social

institutions, delaying social and psychological return to normalcy and long-term recovery. Economic impacts may include direct impacts on businesses and self-sufficiency. Significant infrastructure damage may occur, which can impact economic recovery, as funding may be prioritized for immediate relief efforts rather than long-term recovery or re-development. Less developed or resource-poor areas may take many years to resume full functionality. Many ecosystem features may provide buffering services to natural hazards, however these hazards can damage ecosystems and environmental features, and disrupt of critical ecosystem functions. Environmental impacts of disasters include environmental degradation, such as damage to coral reefs from tsunami due to physical stress of high-velocity waters as well as depositing of sand and debris on corals, and stripping of vegetation on forests from high wind and hurricane events. Disasters can significantly modify the environmental landscape, change the course of rivers, denude forests and erode beaches, as well as disrupt and rupture underground freshwater sources. The environment, however, is resilient to natural hazards and perturbations, as discussed in the socio-ecological resilience section in this chapter, and such natural capacity must be well understood and included in disaster resilience planning efforts.

Politics and governance also play a role in relief and response efforts, and if perceived as insufficient, social-political unrest can occur which can lead to unstable governments and complex humanitarian emergencies. Politics is often a reason for most vulnerable or marginalized groups to be ignored or underserved (Perrin, 1996). Public health effects of disasters range from challenges of sanitation, including sewage, waste and refuse disposal, spread of communicable diseases, lack of access to trauma care from injuries incurred, as well as health care services for chronic diseases, and access to adequate nutrition and potable, sufficient supplies of water (Perrin, 1996). Mental health issues, which are harder to recognize and thus are often overlooked, have a significant impact upon communities' ability to cope, adapt and recover from disasters (IOM, 2001).

Climate change may be defined as *"a statistically significant change in measurements of either the mean state or the variability of the climate for a place or region over an extended period, either directly or indirectly due to the impact of human activity on the composition of the global

atmosphere or due to natural variability" (Benson & Twigg, 2007). While many sophisticated

forecasting models are used to anticipate potential climate change scenarios, much uncertainty

still exists. Climate change is increasing the incidence and severity of natural hazards worldwide

(IPCC, 2012; UNDESA, 2012; UNU-EHS, 2012). Climate change will also intensify disaster risks

by potentially increasing the unpredictability, severity and intensity of weather and climate

hazards, as well as increasing the vulnerability of communities to natural hazards through

ecosystem degradation, reductions in water and food availability, causing displacement and

migration, and altering livelihoods (UN, 2010).

The term "natural disasters" is ambiguous in that distinguishing between "natural" and "man-

made" disasters is difficult. In Hurricane Katrina, for example, much of the devastation was due to

poor notification and evacuation procedures, inadequate planning, and flooding caused from

breaching of the levees, which was the result of errors in human engineering and judgment.

Some go so far as to argue that no "natural" disasters occur and a disaster is due to humans

living, unprepared, in areas prone to natural hazards, a result of human constructs of vulnerability

(Wisner et al., 2004). Human constructs that increase physical, social and ecological vulnerability

to hazards include: weak infrastructure and substandard building code standards and

enforcement; lack of preparedness and education/awareness; insufficient relief and response

efforts; low coping and adaptive capacity; lack of social cohesion and cooperation; poor land use

and natural resource management practices that degrade environment and reduce ecological

services that provide hazard protection; human rights abuses and conflict; socio-economic

vulnerabilities, poverty and wealth inequalities that reduce people's coping and adaptive

capacities to endure and recover from disasters (Birkmann, 2006; Jones, Ross, Lynam, Perez, &

Leitch, 2011; Wisner et al., 2004).

2.2   Overview of natural disasters and climate change vulnerability and impacts in Hawai'i

2.2.1 Historical review

Hawai'i is at risk for multiple natural hazards and climate change-related impacts, including

hurricane, flood, tsunami, earthquake, volcanic eruption, landslide, wildfire, drought,

tornado/water spout, extreme weather, high surf and high wind events, and sea level rise, among

others, as illustrated in Figure 1.2 (HSCD, 2007, 2010a). The short and long-term social,

environmental and economic impacts of chronic cumulative hazards such as drought,

compounded with the uncertainty of climate change, are difficult to identify and measure, calling

for a more pro-active, comprehensive resilience approach to hazard prevention and mitigation.

This research will employ a multi-hazard approach with considerations for the impacts of climate

change. A historical review of the incidence for the pertinent natural hazards in Hawaiʻi, the

social, ecological and economic impacts of the events, and how climate change is affecting or

may affect these phenomena will be included. To gather such data, the research will draw from

scientific literature, government and technical reports documenting these events, as well as

media briefings and community member accounts.
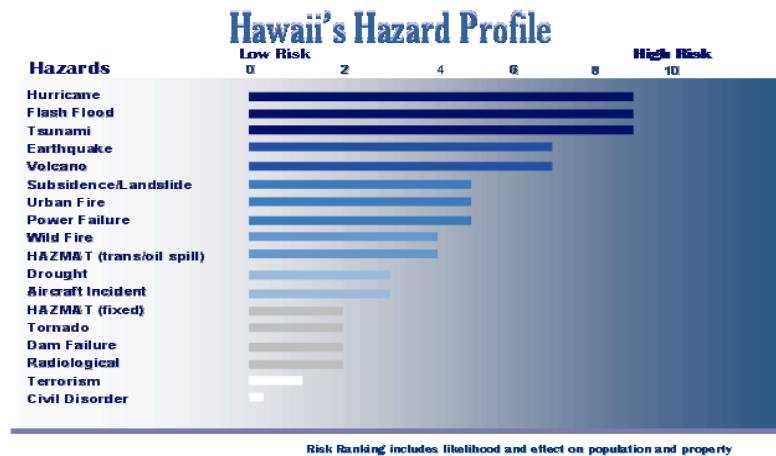
Figure 1.2. Hawaii's hazard profile (HSCD, 2010b).

2.2.2   Populations and sectors at risk

While the number of people who could be affected by natural hazards and climate change is not

currently known, much of the population is or will be affected to some extent due to the high

threat multiple hazards pose to the islands and their inhabitants (Kaly et al., 2002). In addition,

the risk level of all residents of Hawaiʻi is exacerbated by the geographic isolation of the islands,

urban crowding, rural isolation and the high dependency on imported foods and goods.

Individuals and communities that may experience a higher degree of vulnerability include those

that have a higher social or economic dependency on water and land-dependent activities.

In the event of extreme hazards necessitating emergency food or water delivery, special attention must be paid to vulnerable populations to ensure they have access to services. Such people may include: houseless residents, who may have issues with seeking temporary or long-term housing as well as access to food, water and basic services; migrant farmworkers and immigrants who may have language barriers and lack of access to information, resources and rights protections; those engaged in subsistence fishing, farming and other activities as they may be more exposed to and have higher sensitivity to climate change and natural disaster impacts upon the natural resources that they are dependent for their livelihoods and survival; vacationers and temporary or part-time residents who may not have as much familiarity with local hazards, preparedness procedures, nor have as strong social networks and resources; disabled and elderly, who may have health needs as well as mobility challenges critical to expeditious response and evacuations; populations with lower socio-economic status may have less access to material resources like stocked food, water supplies and generators; children; single-parent households; unemployed residents with lack of financial assets; non-English speaking residents; undocumented residents; as well as gender-specific issues, among others. These groups may be more vulnerable in time of disaster as they may have low coping and adaptive capacities, due to lack of access to information, resources, education, place-based knowledge sets, social networks, assets, livelihood diversity, and so forth. Vulnerable populations can also present potential financial, social and security burdens on local people and resources in the event of a disaster.

All residents regardless of their typographies have roles, responsibilities and/or impacts upon their communities, their natural resources and overall sustainability (Chapin III, Kofinas, & Folke, 2009). Therefore, all community members, with particular attention paid to vulnerable populations, should be encouraged to be active participants in disaster resilience planning (UNISDR 2008). To understand and foster improved community-level preparedness, representative groups of community members and leaders should be involved, wherein they assess the disaster risks, agree upon the necessary knowledge, skills and actions to combat this risk, and identify gaps to target (SPDRP, 2002). This may call for: disaster preparedness trainings

to increase local capacity; public awareness campaigns and open forums to clarify expectations of community, government and NGOs during disasters; and enhanced local emergency warning systems and procedures. At the regional or national level, community members should be involved on regional and national disaster planning committees, and pay due attention to building disaster resilience through prevention and preparedness measures as opposed to primarily reactive relief and reconstruction (Anderson, 2008; SPDRP, 2002; UNISDR, 2008b). Without representative input and involvement from different groups in a community, climate change adaptation and disaster resilience planning will not be equitable, sustainable or successful. All members of society should be empowered and well-positioned to develop locally-relevant and meaningful disaster resilience strategies.

The initial effects of a disaster such can be widespread, reaching rural as well as urban communities, and diverse, affecting agriculturalists, business owners and tourism. Risk hotspots occur when hazard exposure is concentrated in regions where large numbers of population and economic activities coincide with high levels of single or multiple overlapping hazards. Processes such as urbanization, growing population density and unregulated economic activities can play a key role in concentrating exposure in certain hazard-prone areas. The environmental degradation and land-use change that comes along with development can also increase the severity of the hazard itself, particularly climatic hazards. Development and land use activities, therefore, are key drivers of patterns of hazard exposure and unfolding risk (UNISDR, 2007). Other processes that drive certain hazard risks such as urbanization and environmental degradation will contribute to an increased exposure and vulnerability (Tomkins & Adger, 2003).

2.3   Overview of natural disasters and climate change management in Hawaiʻi

Hawaiians have a long history of cultural and social practices and institutions that incorporate resiliency-building strategies into resource management based on the *ahupuaʻa* land-to-sea land division system, managed under the *konohiki* political system which regulated land and fishing rights (Pukui & Elbert, 1986). However, changes in the ethnic, cultural, social, economic and ecological policies, practices and power structures over time have greatly compromised these resiliency-building practices. Operational frameworks, policies, strategies and methods that

impact local disaster and climate change management and adaptation practices include

international (i.e. the Hyogo Framework for Action, the Strategic Environmental Framework and

the Millennium now known as the Sustainable Development Goals), national-level (Federal

Emergency Management Agency), State and County hazard mitigation plans, non-governmental

organization plans, and community-based initiatives.

Key gaps in current mitigation plans have been recognized in the areas of climate change risk

and vulnerability (food and water security), socio-economic risk and resiliency factors

(demographics, poverty and health), secondary impacts to sectors such as the tourism industry,

as well as community-scale vulnerable populations (HSCD, 2007). Before engaging in community

meetings, discussions and disaster resilience planning, baseline demographic and disaster

preparedness data may be gathered in order to have an understanding for general preparedness,

vulnerable populations and areas, resources and needs. Identifying areas most at risk will help

inform and guide mitigation and planning efforts, and enhance protection of ecosystems and

communities in those areas. Paying particular attention to "differential vulnerability" will promote

understanding of the needs of the disadvantaged segments of society who are generally most

vulnerable to disasters (Cannon, 2008).

2.4   Justification and relevance

A systematic review of historical and cutting-edge international, national and regional-scale

theories, concepts, frameworks and practices, in order to identify critical gaps and limitations in

current theories and practices, which will be addressed by this research. The evolution of disaster

management to a focus on disaster resilience has principally taken place over nearly four

decades (Mileti, 1999), as illustrated and outlined in *Appendix A. A Brief Evolution of Disaster

Resilience Research* developed based on this literature review. In 1975, Gilbert White and

Eugene Haas published a ground-breaking report, *Assessment of Research on Natural Hazards*,

offering a detailed critique on the field of disaster research and the United States' ability to

endure, respond to and recover from natural disasters (Mileti, 1999). White and Haas illuminated

the fact that the field of disaster research was dominated by engineering and physical sciences,

pointing out the need to understand the economic, social and political ramifications of extreme

events (*ibid*). They worked to address this research void by calling on the social sciences to contribute to an interdisciplinary approach to hazard mitigation (*ibid*). As a result, the "hazards community" was born, and hazards research now encompasses a wide range of disciplines, such as climatology, economics, engineering, geography, geology, law, meteorology, planning, seismology, sociology among others, and draws from a variety of schools of thought, such as human ecology and the disaster research school (*ibid*). Decades later, such critiques and continuing hazards research led to conversations around the concept of *sustainable hazards mitigation* and the potential for developing *disaster resilient communities*, leading to a second assessment in the entitled *Disasters by Design, a Reassessment of Natural Hazards in the United States* (Mileti, 1999). This Reassessment provided a review of the inherent problems with the nation's reactive approach to disasters.

To improve upon these problems, the *Reassessment* called for the hazards community to move beyond existing epistemologies and approaches to: adopt a global systems perspective inclusive of the earth physical system, human systems and constructed systems; accept responsibility for hazards and disasters; anticipate ambiguity, constant change, uncertainty and surprise; reject short-term thinking and embrace a long-term planning perspective; embrace a broader, more generous view of contributing forces to hazards and disasters and the important role social factors play; and, promote the principles of sustainable development through hazards mitigation (Mileti, 1999).

Building upon the work of White and Haas, the Reassessment called for the nation to shift to a policy of "sustainable hazards mitigation", a concept that links wise management of natural resources with local economic and social resiliency (*ibid*). They proposed six objectives that must "simultaneously be reached to stop the national trend of increasing catastrophic losses: 1) maintain and enhance environmental quality; 2) maintain and enhance people's quality of life; 3) foster local resiliency and responsibility (where resiliency to disasters means a locale can withstand an extreme natural event with a tolerable level of losses); 4) recognize that vibrant local economies are essential; 5) ensure inter- and intra-generational equity; and 6) adopt local consensus building" (*ibid*).

In addition, the report stated that in order to foster and achieve local *sustainability*, defined here as the ability of a locality to "tolerate and overcome damage, diminished productivity, and reduced quality of life from an extreme event without significant outside assistance," communities must take responsibility for choosing where and how development proceeds; to do this, each community must "evaluate its environmental resources and hazards, chooses future losses that it is willing to bear, and ensure that development and other community actions and policies adhere to those goals" (*ibid*).

This approach warranted mitigation and research professionals' efforts to advance mitigation tools such as engineering projects, warnings, land use management, planning for response and recovery, and insurance and building codes, in order to enhance adaptation to natural hazards and reduce potential loss of life, injuries, economic costs and social, environmental and economic disruption (Mileti, 1999). A long-term, comprehensive *sustainable hazards mitigation plan* strives to "build local networks, capability and consensus; establish a holistic government framework; conduct a nationwide hazard and risk assessment; build national databases; and provide comprehensive education and training" (*ibid*).

Work by Wisner et al point out that the effects of disasters can be differential due to inequity. Poor people often inhabit hazardous areas putting their exposure higher, and with repeated hazards their coping and adaptive capacity and resources are degraded making them more sensitive and less resilient to future hazards, focusing on disaster risk reduction as a means to enhancing disaster resilience (Sudmeier-Rieux, Masundire, Rizvi, & Rietbergen, 2006; Wisner et al., 2004). *Disaster risk reduction* serves as a conceptual framework of elements that minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development (Bollin & Hidajat, 2006; UNISDR, 2007; Wisner et al., 2004). International human-rights law can also serve as an ethical foundation for risk-reducing development strategies, such as the Code of Conduct for the International Red Cross and Red Crescent Movement and Non-Governmental Organizations in Disaster Relief (1994) (Perrin, 1996; SPHERE, 2011) as will be explored in Chapter 3.

A movement is underway to engage in *disaster resilience*, an interdisciplinary approach of proactive prevention, preparation and adaptation to disasters and climate change through identifying and reducing vulnerabilities (Birkmann, 2006; UNISDR, 2005, 2008a). Contemporary work recognizes that building resilience requires long-term sustainable development that enhances coping and adaptive capacity of social, ecological, economic and political systems (Bollin & Hidajat, 2006; Chapin III, Kofinas, & Folke, 2009; Cutter, 2003). Disaster resilience includes treating the relief and reconstruction process as development opportunities to reduce vulnerabilities (UNISDR, 2005, 2008a). The United Nations International Strategy for Disaster Reduction (UNISDR) in its Strategic Environmental Framework (SEF) describes how "the shift in focus from hazards to underlying vulnerabilities has provided disaster managers with a richer understanding of the factors that reduce the coping capacities of communities and social systems (such that) environment plays a role in many of these factors" (*ibid*).

Therefore, in addition to identifying underlying factors of the fields of natural resource management, agro-ecology, hydrology and disaster resilience, disaster resilience plans and policies must carefully measure and improve the socioeconomic, cultural and other characteristics of communities. The consideration, promotion, and development of such assets for a community are critical to fostering sustainable development and disaster resilience (Birkmann, 2006; Cannon, Twigg, & Rowell, 2003; UNISDR, 2005, 2008a). Reducing vulnerability and enhancing disaster relief and recovery efforts depends on understanding sustainable livelihoods and the capacities, assets, and activities that lead to sustainability ((Adger, 2006; Chambers, 1994). The UNISDR makes clear the need to link sustainable development and risk reduction and supports disaster reduction strategies as one of these key components of sustainability (Birkmann, 2006).

2.5   Theoretical and practical lacunas

Historically, the approach to disasters and environmental degradation has been reactionary and fickle (Birkmann, 2006). This type of approach is unsustainable, unethical and is not cost-efficient. A comprehensive multi-sector resilience approach is needed to bridge disaster relief and sustainable development (Folke, 2002). Reducing vulnerability to natural disasters is complex

and challenging, and requires further research and exploration, particularly at the community level. Analysis of key physical, social, economic and environmental factors is critical in order to understand, identify and measure vulnerability. Understanding these key factors is also necessary to design and implement strategies that reduce vulnerability and enhance Socio-Ecological System (SES) resilience to disasters and climate change (Birkmann, 2006). Difficulties in using common methods in the diverse settings, as well as the challenges with relating spatial or other data that were gathered by different agencies at different times and potentially under different spatial parameters or projections are expected (Stallings, 2002). Measuring disaster resilience of a place or community is difficult, as it may require pre-disaster baseline data in various categories, in order to compare against the post-disaster State (Birkmann, 2006; Stallings, 2002). Resilience theory emphasizes that in order to understand and measure resilience of dynamic and interdependent systems, great knowledge of that system is needed, however this is often not feasible due to our ignorance in many fields (Folke, 2002). This ignorance and the limitations of our knowledge must be recognized. In addition, due to the unpredictability and constant changes in the world, resilience frameworks and measures cannot be fixed nor be expected to predict shifts, but instead must be adaptable to constant change and the unexpected (Chapin III et al., 2009; Holling, 1973). Challenges to defining, measuring and enhancing resilience of socio-ecological systems include: agreeing upon operational definitions, frameworks, theories and methods; balancing current and future human and environmental interests; adapting to climate change as well as the unpredictability of socio-ecological systems; and translating theory into practice in a meaningful, socially appropriate and ecologically sound way (Chapin III et al., 2009).

Despite the noted importance of integrating social components of vulnerability and resilience, the development of the field of social and cultural resilience remains mired by difficulties in identifying and measuring such nebulous concepts as well as how they interact with the other components of ecological, economic and physical resilience (Crane, 2010). Qualitative, locally defined measures of social and cultural resilience may prove the most effective and illustrative means to forge ahead. This research engages stakeholders to solicit their perspectives on what socio-

ecological characteristics make their communities resilient to climate change (Chambers & Conway, 1992; Crane, 2010). Environmental and natural resource management research methods can be qualitative in nature, including descriptive research or observational studies such as surveys, questionnaires and key informant interviews, as well as quantitative or experimental studies (Stallings, 2002). Unfortunately, many measures of coping and adaptive capacities are difficult to quantify and are particularly hard to express temporally or spatially (Birkmann, 2006; Bogardi & Birkmann, 2004). Several aspects of resilience are difficult to measure quantitatively, making validation of qualitative locally based valuation systems for such indices critical. In addition, caution must be used when applying a single framework to measuring disaster resilience in diverse communities (Carpenter, Walker, Anderies, & Abel, 2001; Walker et al., 2002).

Collaborative creation, adoption and implementation of international policy and programmatic frameworks like the Hyogo Framework for Action, are critical steps. However, despite theoretical and political trends for such integrated approaches to disaster risk reduction, the understanding of how to implement these frameworks and strategies is still poor (Carpenter et al., 2001; Crane, 2010). This translates to a lack of practical tools for on-the-ground implementation to reduce diverse vulnerabilities. In addition, the spatial-temporal complexity of socio-ecological resilience problems should be acknowledged. Finally, despite the evidence that preventive adaptation, mitigation and preparedness measures are financially more effective than reactive disaster relief, the disparity between the voiced political support and the actual funding provided must also be addressed (Alinovi, Hemrich, & Russo, 2008; Lewis, 1999; Mileti, 1999; Perrin, 1996; UNISDR, 2005). In conclusion, climate change and natural hazards are complex in both the contributing factors and the effects they ensue. Mitigating and adapting to these effects, therefore, takes a multi-disciplinary, multi-sector approach to address the diverse inputs and problems related to it. This research aims to use this approach and address critical gaps by engaging with local organizations, communities, businesses, and government entities to collaborate on an integrated multi disciplinary approach to climate change and disaster resilience.

3. Research overview

3.1 Research scope

The scope of the research explored in all three papers includes three schools of thought, including: 1) *socio-ecological systems resilience* theories, concepts and frameworks, including socio-ecological processes, the systems approach, coping and adaptation, with emphasis on applications with climate change, disasters and development; 2) *socio-cultural resilience* theories and concepts, including local and traditional ecological knowledge, hereafter referred to as *place-based knowledge* and integration with western science, social learning, networks and knowledge systems, intergenerational equity and social justice, human rights, and gender dimensions and mainstreaming; and, the convergence of various schools of thought into 3) *disaster resilience* theories, frameworks and practices, including the fields of disaster risk reduction, mitigation, response and relief, climate change adaptation, theories linking disaster relief and development, and a review of the evolution of the emerging field of disaster resilience (Figure 1.3).

Figure 1.3. Research scope: three schools of thought.

3.2 Critical gaps and original contributions

The following are identified as critical theoretical and practical gaps and challenges to addressing the complex issue of disaster resilience:

1) *Framing the issue*: vulnerability and resilience have multiple definitions, components, and are expressed in various measurements or frameworks, making standardized communication of these components difficult (Birkmann, 2006; Carpenter et al., 2001; Holling, 2001; UNISDR, 2005);

2) *Meaningful measurement*: although somewhat robust measurements of infrastructural,

economic and ecological vulnerability exist, there is a paucity of evidence for measuring social vulnerability to hazards (Birkmann, 2006; Carpenter et al., 2001; Crane, 2010; Wood, Church, Frazier, & Yarnal, 2007, Rev. 2008);

3) *Dynamic integration*: the lack of a comprehensive approach to measuring the various components of resilience, due to poor integration of the various components of vulnerability, theoretically and practically, leads to an unrefined understanding of how resilience components interact and are interrelated (Adger, 2006; Birkmann, 2006; Crane, 2010; Wood et al., 2007, Rev. 2008);

4) *Institutional limitations*: poor institutional integration of the interrelated fields of planning and development, disaster preparedness, mitigation, response and relief, climate change adaptation, issues of governance and policy creates silos of knowledge, divergence of resources and information, and inadequate services (Anderies, Janssen, & Ostrom, 2004; Lewis, 1999; UNISDR, 2005, 2008a);

5) *Recognizing place-based knowledge:* there is a lack of both the recognition of the inherent and scientific value of indigenous and local knowledge systems, as well as a lack of integration of scientific theory and methodologies with place-based knowledge for community-based adaptation and resilience capacity building; resilience must be defined, maintained and adapted locally by stakeholders through plans, programs or other conventions or institutions in order to be meaningful, relevant and sustainable (Andrade, 2008; Bollin & Hidajat, 2006; Sudmeier-Rieux et al., 2006; Tomkins & Adger, 2003);

6) *Moving beyond "do no harm":* scientists and planners too often use communities as research labs, leaving behind more harm than benefit; it is critical to collaborate with communities and stakeholders throughout the research process, in order to meaningfully translate research findings into locally-relevant sustainable resilience policies, programs and systems, as well as sharing best practices to enhance resilience of at-risk populations, communities, agencies, systems and ecosystems elsewhere (Andrade, 2008; Bollin & Hidajat, 2006; Chambers, 1994; Walker et al., 2002).

Each of the 3 papers explore specific critical gaps and expand on the above in much greater detail, offering specific and discrete research frameworks addressing different gaps through distinct problem statements, hypotheses, objectives, methods, and results. Table 1.1 identifies which critical gaps that are addressed by the respective papers.

Critical Gap	Chapter 3: Cultivating a human rights conscience: moving beyond reducing risk to build community resilience to disasters and climate change	Chapter 4: Quantifying household resilience: a place-based approach in a rapidly changing community	Chapter 5: facilitating social learning through mental models for anticipatory adaptation & resilience
1) Framing the issue	x	x	x
2) Meaningful measurement	x	x	x
3) Dynamic integration	x	x	
4) Institutional limitations	x		x
5) Recognizing place-based knowledge	x	x	x
6) Moving beyond "do no harm"	x	x	x

Table 1.1. Critical gaps addressed.

Critical gap 1—*Framing the issue* is addressed by all three papers: Chapters 3 and 4 address this gap by providing a review of different definitions and constructing frameworks with defined components in order to clarify terminology and communication around these frameworks; Chapter 5 employs place-based cognitive maps that model stakeholder resilience as defined and interpreted by participants. Critical gap 2—*Meaningful measurement* is also addressed by all three papers: Chapter 5 uses cognitive mapping to develop models of community perceptions of resilience so the models are meaningful and relevant at the individual, stakeholder and local levels, as they are measured based on individual and group stakeholder perceptions, knowledge and expertise; the conceptual resilience frameworks of Chapters 3 and 4 offer an indices for measuring resilience at the community and household levels, to try and better standardize definitions and their components as well as to illustrate and measurably link the various components, which in turn syncs with Critical gap 3—*Dynamic integration*. Critical gap 4—

Institutional Limitations is discussed in detail in Chapter 3 through highlighting key failures of institutions, policies and programs, proposing recommendations and a resilience framework that is built upon the foundation of rights and justice; in addition, Chapter 5 addresses this gap through engagement of multiple sectors to address institutional limitations through collaborative planning and decision-making. In support of the dissertation focus on community-based socio-ecological resilience research & planning, Gap 5—*Recognizing place-based knowledge* is discussed in all three papers: Chapter 3 does this through identifying this challenge via a literature review and formulating recommendations in support of this; and Chapters 4 and 5 integrate place-based knowledge into the community-based participatory research and learning (CBPRL) approach, engaging local stakeholders and soliciting their knowledge, experiences and expertise for integration with Western science. Finally, Critical gap 6—*Moving beyond no harm* is addressed in all three papers: Chapter 3 addresses the need for ethically-founded resilience practices and research approaches to encourage rights and justice for all; and, Chapters 4 and 5 offer research processes and deliverables that improve household, stakeholder and ultimately community resilience as well as are adaptable for application in other communities.

3.3   Goal

The goal of this research is to serve as a pioneering step to understand and address issues of climate change, hazards, and resilience building, by developing 3 unique papers addressing the identified theoretical and practical gaps.

3.4   Problem statement

Human-induced and natural degradation of coastal and surrounding ecosystems, coupled with underlying vulnerabilities, contributes directly and indirectly to increased vulnerability to natural hazards and impacts from climate change.

3.5   Hypothesis

In order to address this complex issue, resource managers must engage in a proactive, multi-disciplinary collaborative approach to measure and reduce ecological degradation, enhancing hazard resilience through sustainable development, conservation initiatives and policy implementation. Physical, social, economic and environmental factors are critical to

understanding, identifying and measuring vulnerability and to designing and Implementing

strategies that reduce vulnerability and enhance Socio-Ecological System (SES) resilience to

disasters and climate change impacts (Birkmann, 2006). Social science methods and tools that

incorporate stakeholder knowledge into community decision-making will improve the community's

effort to build resilience. Community participation in order to improve communication and

collaboration will result in a higher degree of community empowerment.

3.6   Audience and Users

The primary stakeholders and users of the research are the two at-risk coastal communities, as

well as the community-based organizations that offer local facilitation of the resilience advisory

board efforts. Secondary users and stakeholders include local businesses and local-to-regional

organizations, agencies and institutions that assist communities in this effort, which are also

impacted by local preparedness and recovery capacities. These include emergency managers

and hazard mitigation officers (State Civil Defense, Kaua'i Civil Defense, City and County of

Honolulu Department of Emergency Management); natural resource management institutions

(Hawaiian Islands Humpback Whale National Marine Sanctuary) and local practitioners; land use

planners (Kaua'i Department of Planning); local and regional government officials and politicians;

Chambers and Departments of Commerce (North Shore Chamber of Commerce); Homeowners

and Community/Tribal Associations and Organizations (Hanalei to Ha'ena Community

Association); Academic and/or research communities (University of Hawai'i College of Tropical

Agriculture and Human Resources Extension Program, University of Hawai'i Coastal Storms

Program, and NOAA); and public education systems (Hanalei School and the Department of

Education). The broader audience of local and regional practitioners, institutions and agencies

involved in disaster risk reduction, response, relief and recovery will gain experience and

guidance from the community case studies evaluation and information dissemination process.

The research aimed to produce information useful for disaster resilience planning for individuals,

households and communities, as well as to inform Non-Governmental Organizations, community-

based organizations and groups, and governmental agencies in Hawai'i as well as internationally.

As such, the dissertation has the potential to produce multiple deliverables beyond scientific

manuscripts, including informing County and State hazard mitigation and recovery plans, as well as local community resilience and disaster preparedness plans.

3.7   Anticipated outcomes, deliverables and significance

The dissertation will contribute to community-building processes, institutions and programs, which ultimately lead to improved adaptive capacity and resilience to coastal storms hazards and related impacts from climate change. This will provide the means for communities to continually self-assess vulnerabilities in order to maintain long-term resilience planning efforts. Community organization, training and capacity-building for coastal storm hazards and climate change will provide decision-making opportunities to minimize exposure, improving the critical emergency response and shortening the post-disaster recovery period. The project aims to enhance scientific literacy and promote interdisciplinary multi-sector communication and collaboration around common goals of reducing risk and vulnerability of key populations, sectors and ecosystems to hazards. The dissertation will produce information useful for disaster resilience planning for individuals, households and communities, as well as to inform Non-Governmental Organizations, community-based organizations and groups, and governmental agencies in Hawaiʻi as well as internationally. As such, the dissertation will have the potential to produce multiple deliverables beyond scientific manuscripts, including informing County and State hazard mitigation and drought plans, as well as local community resilience and disaster preparedness plans. This work is expected to produce a more standardized approach that can be used and compared across diverse communities in a variety of geographic and cultural locales, and contribute to advancing the fields of disaster resilience, climate change adaptation and risk reduction.

A Brief Evolution of Disaster Resilience Research

1.   Socio-Ecological Systems Resilience

1.1   Resilience (1973)

First described in the field of ecology and natural resource management

- Defined by Holling in 1973 as "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables"

- Such disturbances include phenomena of natural and human-induced hazards like ecological degradation & poor land use practices

1.2   Linking Resilience & Vulnerability (1974-2009)

Socio-Ecological Systems approach

- Recognizes connectedness of social-ecological systems

- Recognizes various stages of adaptive cycles and cross-scale linkages within them (panarchy), and in which stages socio-ecological systems are most vulnerable to change (conservation phase) (Holling & Gunderson, 2002; Adger, 2005; Berkes, 2005; Turner, 2003; Walker, 2006; Folke 2005)

1.3   Resilience-based Ecosystem Stewardship

Stewardship focus

- Recognizes managers as integral components of ecosystems and their responsibility for its state (Gunderson 1995; Chapin, Adger, Folke & Kofinas, 2009)

- Not a new approach (stewardship, Leopold 1948; many indigenous peoples have historically understood and maintained the importance of stewardship)

Shift from steady-state resource management to resilience approach

- Fundamental shift from steady-state resource management approach (which attempts to reduce variability and prevent change), to a resilience approach, that respond to and shape a constantly changing world in ways that benefit society (resilience approach)

2.   Disaster Management

2.1   Reactive Relief (pre-1975)

- Field of disaster management models based on reactive, post-war time disaster relief

2.2   Paucity of Research

- Research was dominated by engineering and physical sciences

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- Call for Interdisciplinary Approach & Social Science Research (1975): Gilbert White & Eugene Haas published a ground-breaking report, Assessment of Research on Natural Hazards
- Recognition of importance of social sciences & interdisciplinary approach
- "Hazards community" of researchers born

2.3 Defining & Measuring Disasters (1998)

- Henry Quarantelli's What is a Disaster? Perspectives on the Question
- Collective of various disciplines' perspectives on philosophical & practical definitions, interpretations & applications

3. Linking Development & Disasters

3.1 Sustainable Hazards Mitigation (1999)

- Linking natural resource management with local economic and social resiliency, viewing hazard mitigation as an integral part

3.2 Mileti's Disasters by Design

- A Reassessment of Natural Hazards in the United States through collected Natural Hazard Workshop developments
- Call for addressing gaps in knowledge:
  - Advancements in recovery and reconstruction theory and practice
  - Technology to identify risk and vulnerability
  - Enhanced policy and research efforts to integrate and share existing knowledge and prioritize gaps

3.3 Linking Disaster Risk Reduction & Development

Mainstreaming Risk Reduction (2003)

- Disaster Risk Reduction Mainstreaming Framework, UNISDR

- A functional way to build collaboration between stakeholders in order to reduce the impact of natural disasters by integrating disaster risk reduction measures into development policies

Linking Poverty & Vulnerability (2004)

- At Risk by Wisner & Blaikie: offers theoretical & practical analytical frameworks and tools to link, understand and address poverty and vulnerability

~CONVERGENCE OF TOPICS, PARADIGM SHIFT~

4.   Disaster Resilience

4.1   Applying a Socio-Ecological Systems Approach to Disasters & Development (2005-2006)

Linking Natural Resource Management & Disaster Resilience

- "Environmental management and community-based resource management can promote more resilient communities through supporting sustainable livelihoods, conflict prevention and strengthening cooperation for good governance" (SEF, UNISDR, 2005)

Shifting focus from hazards to underlying vulnerabilities

- Provides disaster managers with a richer understanding of the factors that reduce the coping capacities of communities and social systems (such that) environment plays a role in many of these factors (Hyogo, UNISDR, 2005)

Relating poverty, development & degradation to disaster risk

- There is a strong causal relationship between poverty, a degraded environment and higher disaster risk (SEF, UNISDR, 2005; MEA; MDGs)

- Reducing vulnerability and enhancing disaster relief and recovery efforts depends on understanding sustainable livelihoods and the capacities, assets, and activities that lead to sustainability (Adger, 2006)

4.2   Climate Change Adaptation

IPCC & UNFCC (2007)

- Monitor GHG emissions by country
- Monitor and project climate change impacts
- Identify populations and areas vulnerable to potential impacts
- Suggest strategies to avoid, mitigate or adapt to potential impacts

5.   Future Directions

5.1   Applied community-based disaster resilience research & planning

5.2   Addressing Gaps in Knowledge & Practice

REFERENCES

Adger, W.N. (2006). Vulnerability. *Global Environmental Change, 16*, 268-281.

Alinovi, L., Hemrich, G., & Russo, L. (Eds.). (2008). *Beyond Relief: food security in protracted crises*. UK: Practical Action Publishing, FAO.

Anderies, J. M., Janssen, M. A., & Ostrom, E. (2004). A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society, 9(1)*(18).

Anderson, Cheryl L. (2008). The gendered dimensions of disaster risk management and adaptation to climate change -Stories from the Pacific. In UNDP-AusAID (Ed.): UNDP-AusAID.

Andrade, C. (2008). *Haʻena: Through the Eyes of the Ancestors*. Honolulu: University of Hawaiʻi Press.

Benson, C., & Twigg, J. (2007). Tools for Mainstreaming Disaster Risk Reduction: Guidance Notes for Development Organisations. Geneva: Provention Consortium Secretariat.

Birkmann, J. (Ed.). (2006). *Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient Societies*. New York: United Nations University.

Bogardi, J., & Birkmann, J. (2004). Vulnerability Assessment: The First Step Towards Sustainable Risk Reduction. In D. Malzahn & T. Plapp (Eds.), *Disaster & Society -- From Hazard Assessment to Risk Reduction* (pp. 75-82). Berlin: Logos Verlag Berlin.

Bollin, Christina, & Hidajat, Ria. (2006). Community-based risk index conceptual framework. In J. Birkmann (Ed.), *Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient Societies* (pp. 257). New York: United Nations University.

Cannon, T. (2008). Reducing People's Vulnerability to Natural Hazards. Research Paper No. 2008/34. Helsinki: World Institute for Development Economics Research.

Cannon, T., Twigg, J., & Rowell, J. (2003). Social Vulnerability, Sustainable Livelihoods and Disasters. Report to DFID Conflict and Humanitarian Assistance Department (CHAD) and Sustainable Livelihoods Support Office. UK: Natural Resources Institute, University of Greenwich.

Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: Resilience of what to what? *Ecosystems*(4), 765-781.

Chambers, R. (1994). The Origins and Practice of Participatory Rural Appraisal. *World Development, 22*(7), 953-969.

Chambers, R., & Conway, G. (1992). Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discussion paper 296. Brighton, UK: Institute of Development Studies, University of Sussex.

Chapin III, F. Stuart, Kofinas, Gary P., & Folke, Carl (Eds.). (2009). *Principles of Ecosystem Stewardship, Resilience-Based Natural Resource Management in a Changing World*: Springer.

Crane, T.A. (2010). Of models and meanings: cultural resilience in social–ecological systems. *Ecology and Society, 15*(4).

Cutter, S.L., B.J. Boruff, W.L. Shirley. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly, 84*(1), 242-261.

Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C.S Holling, B. Walker. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *Ambio, 31*(5), 437-440.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annu Rev Ecol Syst*(4), 1-23.

Holling, C. S. (2001). Understanding the complexity of economic, ecological and social systems. *Ecosystems*(4), 390-405.

HSCD. (2007). State of Hawaiʻi Multi-Hazard Mitigation Plan, 2007 Update: Prepared by Cheryl Anderson, Hazards, Climate, & Environment Program, University of Hawaiʻi Social Science Research Institute.

HSCD. (2010a). Hawaiʻi Hazard Profile: State Civil Defense.

HSCD. (2010b). State of Hawaiʻi Multi-Hazard Mitigation Plan, 2010 Update (pp. 32): Hawaii State Civil Defense.

IOM. (2001). Health and Behavior: The Interplay of Biological, Behavioral, and Societal Influences *Stress, Health, and Disease* (pp. 40-60). Washington, D.C.: National Academy Press.

IPCC. (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change
Adaptation. Summary for Policymakers. . In C. B. Field, V. Barros, T. F. Stocker & Q.
Dahe (Eds.). Cambridge/New York: Intergovernmental Panel on Climate Change, World
Health Organization, United Nations Environment Programme.

Jones, N., Ross, H., Lynam, T., Perez, P., & Leitch, A. (2011). Mental Models: An Interdisciplinary
Synthesis of Theory and Methods. *Ecology and Society, 16*(1:46).

Kaly, U.L., Pratt, C.R., & Howorth, R. (2002). Towards Managing Environmental Vulnerability in
Small Island Developing States (SIDS). *SOPAC Miscellaneous Report 461*, 16; 11
appendix, 13 tables.

Lewis, J. . (1999). *Development in Disaster-prone Places: Studies of Vulnerability*. London:
Intermediate Technology Publications.

Mileti, D. (1999). *Disasters by Design: A Reassessment of Natural Hazards in the United States*.
Washington, D.C.: Joseph Henry Press.

Perrin, P. (1996). *War and Public Health, A Handbook*. Geneva: International Committee of the
Red Cross (ICRC).

Pukui, Mary Kawena, & Elbert, Samuel H. (1986). *Hawaiian Dictionary*. Honolulu: University of
Hawaii Press.

SPDRP. (2002). Gender, households, community and disaster management: case studies from
the Pacific Islands *SOPAC Technical Report 282. South Pacific Disaster Reduction
Programme*.

SPHERE. (2011). *The Sphere Project: Humanitarian Charter and Minimum Standards in Disaster
Response* (2011 ed.). Geneva, Switzerland: The Sphere Project.

Stallings, R. (Ed.). (2002). *Methods of Disaster Research*. USA: International Research
Committee on Disasters.

Sudmeier-Rieux, K., Masundire, H., Rizvi, A., & Rietbergen, S. (Eds.). (2006). *Ecosystems,
Livelihoods and Disasters: An integrated approach to disaster risk management*. Gland,
Switzerland & Cambridge, UK: The World Conservation Union (IUCN).

Tomkins, E.L., & Adger, W.N. (2003). *Building resilience to climate change through adaptive management of natural resources*. Tyndall Centre for Climate Change Research. Norwich.

UN. (2010). The Millennium Development Goals Report. New York: United Nations.

UNDESA. (2012). Issues Brief 8: Disaster Risk Reduction and Resilience Building. New York: United Nations Department of Economic & Social Affairs.

UNISDR. (2004). Terminology of Disaster Risk Reduction (under revision) *Taken from the Millennium Ecosystem Assessment, 2005. Retrieved April 2011, from* http://www.unisdr.org/terminology. Geneva, Switzerland: UNISDR.

UNISDR. (2005). Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters *Extract from the final report of the World Conference on Disaster Reduction, Kobe, Hyogo, Japan. Retrieved May 2011, from* http://www.unisdr.org/we/inform/publications/1037. Geneva, Switzerland: UNISDR/A/CONF.206/6.

UNISDR. (2007). Disaster Risk Reduction (DRR) *Global Review. Retrieved May 2011, from* http://www.unisdr.org/we/inform/publications/1130 (pp. 98). Geneva, Switzerland: UNISDR.

UNISDR. (2008a). Environment and Disaster Risk, Emerging Perspectives *Prepared on behalf of the ISDR Working Group on Environment and Disaster Reduction, 2nd edition. Retrieved May 2011, from* http://www.unisdr.org/we/inform/publications/624 (pp. 50). Geneva, Switzerland: UNISDR.

UNISDR. (2008b). Gender Perspectives: Integrating Disaster Risk Reduction into Climate Change Adaptation, Good Practices and Lessons Learned *Retrived August 2011, from* http://www.unisdr.org/we/inform/publications/3391 (pp. 76). Geneva, Switzerland: UNISDR.

UNU-EHS. (2012). World Risk Report 2012. Berlin: United Nations University Institute for Environment & Human Security, The Nature Conservancy, Alliance Development Works.

Walker, B., Carpenter, S., Anderies, J., Abel, N., Cumming, G., Janssen, M., . . . Pritchard, R.

    (2002). Resilience management in social-ecological systems: a working hypothesis for a

    participatory approach. *Conservation Ecology, 6*(1), 14.

Wisner, Ben, Blaikie, P., Cannon, T., & Davis, I. (2004). *At Risk: Natural Hazards, People's*

    Vulnerability and Disasters (2nd ed.). London & New York: Routledge.

Wood, Nathan, Church, Alyssia, Frazier, Tim, & Yarnal, Brent. (2007, Rev. 2008). Variations in

    community exposure and sensitivity to tsunami hazards in the State of Hawai`i: U.S. U.S.

    Geological Survey Scientific Investigation Report 2007-5208 (pp. 38): USGS.

CHAPTER 2. METHODS

Overview

The dissertation presents one theoretical paper (Chapter 3) proposing a rights and justice-based disaster resilience framework, followed by two papers (Chapters 4 and 5) exploring three integrated dimensions of resilience research methods and strategies applied in community case study sites of Hanalei, Kauaʻi, and North Shore, Oʻahu, Hawaiʻi. Climate change and natural hazards are complex, in both the contributing factors and the effects they ensue. Mitigating and adapting to these effects, therefore, takes an interdisciplinary, multi-sector approach to address the diverse inputs and problems related to it. The dissertation operationalizes this approach in Chapters 4 and 5 by engaging in community-based participatory research and learning (CBPRL) with local organizations, communities, businesses and government entities to collaborate on issues relevant to climate change and disaster resilience, with focus paid to socio-ecological systems, intergenerational equity and social justice, social learning, and human rights. This chapter offers a review of the approach employed across the three independent papers, as well as a summary of the methods and strategies used, which is explained in greater detail citing theoretical underpinnings within each chapter.

1.   Research design

1.1   Approach

1.1.1   Multi-sector collaboration

Due to the interconnected and interdependent nature of social, ecological, economic, political and built systems, an interdisciplinary approach is critical to address pressing resource management and sustainability issues throughout the world. As such, disaster resilience is a highly interdisciplinary field, drawing from the social (sociology, urban and regional planning, psychology, anthropology, etc.) and natural (forestry, hydrology, oceanography, geography, geology, botany, zoology, etc.) sciences, and demanding collaboration from various sectors in order to address complex socio-ecological issues. The consideration, promotion, and development of these assets for a community are critical to fostering sustainable development and disaster resilience (Birkmann, 2006; Cannon, 2008; HSCD, 2007).

Therefore, disaster resilience research, plans and policies must carefully measure and develop the socioeconomic, or social, cultural, livelihood, and other related factors alongside the communities affected.

Figure 2.1. Research approach.

1.1.2   Socio-ecological systems thinking

The interdependency of social, political, economic and ecological systems requires a *systems approach* to address reducing vulnerability within and between systems, requiring an understanding sustainable livelihoods and the capacities, assets, and activities that lead to sustainability (Adger, 2006; Chambers & Conway, 1992). An understanding of these various disciplines, as well as an appreciation for the Socio-Ecological Systems (SES's) approach, is critical to creating cross-sector common language, theoretical and operational frameworks, methods, tools and strategies to address complex resource management issues (Chapin III, Kofinas, & Folke, 2009).

1.1.3 Multi-hazard, climate change scope

Based on the complexity of addressing ecological degradation, social vulnerability, climate change and hazard risk, a multi-hazards approach to natural disasters and climate change is needed to guide resource management, development and hazard mitigation efforts (Sudmeier-Rieux, Masundire, Rizvi, & Rietbergen, 2006; UNEP, 2005). Many methods can be used to measure ecological degradation, hazard vulnerability and resilience independently or with

particular application to a site or scientific method, however such tools are often segregated and sector-specific (UNISDR, 2008). Some more innovative, integrated measurement tools and methods include: (1) ecosystem-inclusive vulnerability indices; (2) scenario-based decision making and risk-modeling tools; (3) GIS hazard, degradation, poverty and population density mapping; (4) community-based participatory research; (5) collaborative networks sharing best practices and information; and (6) integrated urban and regional planning and development with natural resource management considerations (Lacambra S., Moller, & Spencer, 2008, p. 9). The more interdisciplinary and integrated the measurement tools are with each other, the more likely the management solutions developed will be comprehensive and appropriate.

1.1.4   Integrating diverse knowledge systems: place-based practices

Place-based knowledge and practices in Hawai'i have long facilitated adaption to and survival amidst climate variation and changes, as well as natural disasters and famine (Handy, Craighill, & Pukui, 1972; HSCD, 2007). Such knowledge systems and networks were integrated into the community-based research and planning through formal and informal talk-story sessions, and participatory workshops with visual displays of risk and vulnerability maps to determine entry points for risk reduction and adaptation measures.

Particular effort was put to rebuilding solidarity within the community and rural-urban areas, by reconnecting people to place and the environment, rebuilding and strengthening social networks, increasing knowledge sharing, encouraging youth empowerment and participation in the plan, and actively seeking to improve intergenerational, gender, social, cultural, economic, racial and environmental justice and equity through reducing vulnerabilities to disaster. Integration of knowledge and ideas at the local level was facilitated through the community-based local resilience networks, supported by a local-to-regional resilience network bridging both communities and offering broader collaboration and resource sharing opportunities.

1.1.5   Community-based participatory research and learning

The dissertation employed an interdisciplinary social science, multi-sector approach, and engaged in a community-based participatory research and learning (CBPRL) process involving stakeholders and community residents. The CBPRL approach is increasingly used in order to

ensure more sustainable community programs (ACOSA, 2005; Chambers, 1994; Chambers & Conway, 1992) and is an ideal approach to disaster resilience (FEMA, 2011). The CBPRL approach to research, planning, and policy formulation, is increasingly used in order to ensure more equitable, sustainable community programs (ACOSA, 2005; Chambers, 1994; Chambers & Conway, 1992). This is an ideal approach to development and disaster resilience, as local preparedness (such as enhanced food and water security, emergency supplies and disaster contingency plans) enhances local resiliency to disasters, where community members will be the first to respond to the needs of their neighbors (FEMA, 2011).

In addition to hazard preparedness, important areas of resource management that strengthen the overall risk management system (HSCD, 2007) can be addressed by incorporating the roles and capacity of communities to plan and organize mitigation and recovery projects. CBPRL techniques facilitate a forum for residents to develop self and inter-community reliance and resilience, by assessing their individual and community capacities, assets, needs and vulnerabilities through workshops, focus groups, community planning meetings, and drawing maps (ACOSA, 2005; Chambers, 1994; Chambers & Conway, 1992). The results include stronger community connectedness and enhanced communication, empowerment, and shared responsibility, as well as improved natural resource management, increased knowledge of climate change and disaster risk reduction strategies, development of local disaster contingency plans, and implementation of policies that support these results.

The research for Chapters 4 and 5 was carried out in two communities in Hawaiʻi that are vulnerable to natural disasters and potential impacts of climate change. The following identifies the criteria for site selection, followed by an introduction to each site including participants and partners.

1.2   Community-based case studies

1.2.1 Study site selection

Community case study sites were determined based on the following criteria:

1.   Physical vulnerability to climate and natural hazards (DBEDT, 2011; Fletcher III, Grossman, Richmond, & Gibbs, 2002);

2. Desire of community members, leaders and stakeholders to engage in a community-based participatory research and planning process.

3. Potential for community participation and engagement and cross-scale intersectoral collaboration;

4. Degree of involvement of community members in agriculture, resource management, disaster preparedness, or similar fields;

5. Potential for community-based resource and information network development, with the dynamic for local-to-regional networking and collaboration between both community sites;

6. Potential for adaptation of the project to and sharing of resources with communities and stakeholders elsewhere in Hawaiʻi and the Pacific; and,

The two study sites for this project are: 1) Hanalei, Kauaʻi; and, 2) the North Shore Oʻahu, which includes the area between the towns of Waialua to Sunset, classified as the City and County of Honolulu Evacuation Zone 1 (HSCD, 2010). Both sites are located on different islands with diverse geologic, economic, ecologic, social and cultural characteristics, but that experience similar physical isolation and vulnerability to hazards and climate change. Community-based participatory research and planning was conducted with stakeholders in each case study site, each offering a site-specific set of stakeholders and partners, locally-appropriate methods and mutual objectives, as deemed most appropriate for the communities' characteristics and interests. A summary of each study site addresses: 1) an introduction to the community or area and rationale for the site's selection; 2) partners with whom the research and planning was conducted.

1.2.2   Case study site: Hanalei, Kauaʻi

Hanalei is located on the North Shore of the island of Kauaʻi, and is geographically isolated and vulnerable to many natural hazards and impacts from climate change including sea level rise. Sitting at sea level in valley surrounded by steep mountains, the primary road is coastal, and the only exits are one-lane bridges that close in the event of flood, tsunami and hurricane, making expeditious evacuation difficult if not impossible. Seasonal flooding is expected and is part of life, however changes in the intensity and duration of rainfall in recent years have caused acute flooding. Due to these characteristics, local capacity to adapt to and recover from disasters is

critical to ensuring protection of property, lives and livelihoods.

Hurricane Iniki in 1992 was the most recent destructive disaster to hit the North Shore of Kaua'i. While the island of Kaua'i was ill prepared for this devastating Class III/IV storm, Hanalei residents adapted and coped well during and after the hurricane, showing strong resilience due to close familial and social support networks, self-organization and self-sufficiency, material preparedness and experience and knowledge of past disasters. As a result of local preparedness, and high coping and adaptive capacities, community members turned away much of the external disaster relief. Since Iniki however, Hanalei has experienced many drastic demographic, social, environmental and economic changes that have created community fracture, which many residents fear have weakened the community's cohesion, resilience and adaptive capacity. These shifts have lead long-time residents to question whether the place-based knowledge and practices that once preserved ecosystems and provided community resiliency, still remain. Small family homes have been replaced by gated vacation rentals, reducing the number of permanent and long-term residents and replacing them with temporary vacationers or empty residences. Concern exists that while contributing in part to the local economy, vacationers are ill prepared for natural hazard events, and thus will be a burden on local people and resources in the event of a disaster or common flood.

Participants, partners

The research includes the following stakeholder partnerships and participants: Hanalei Watershed Hui (HWH), the Hanalei to Ha'ena Community Association (HHCA), Waipa Foundation (Waipa), Kaua'i Civil Defense (KCD), Kaua'i Visitors Bureau (KVB), government officials, Kaua'i County Fire (KCF) and Police Departments (KPD), Hanalei School (HS), the Hawai'i Community Stewardship Network (HCSN), local businesses and residents. These stakeholders each contributed unique roles to the North Shore Kaua'i local advisory board, including the following: informing and adapting community and culturally-appropriate processes for the project (HWH, HHCA, HCSN, Waipa); the role and capacity of schools to prepare for and respond to disasters (HS); the role, assets and needs of community residents and businesses within disaster preparedness, response and recovery (local businesses and residents); guidance

around disaster response, evacuation and recovery training and capacity building, resources, protocols and plans (KCD, KCF, KPD, government officials); the role of land owners and farmers in disasters with respect to food and water security, and adaptive capacity to climate change impacts and natural hazards (Waipa, HCSN); and, the issues and special considerations needed for preparedness and response for visitor populations as an at-risk population (KVB). The aforementioned local resilience network communication and collaboration efforts were facilitated by: a community bulletin board and distribution of flyers for sharing information and announcing meetings; distribution of meeting handouts to support discussions and recording of notes to document the community process; summary of informational materials at the conclusion of the process and coordination with the County of Kauaʻi and related agency stakeholders, for publication of public information related to disaster preparedness.

1.2.3   Case study site: North Shore, Oʻahu

The North Shore of the island of Oʻahu is at risk to multiple hazards (HSCD, 2010) and quickly becomes isolated as access roads become inundated, making local disaster preparedness critical. Since 2010 I have been a member of the Shelter Committee of the North Shore Disaster Preparedness Steering Committee via the Hawaiʻi Red Cross. This grassroots community group formed to **"**enhance the ability of our community to mitigate, prepare for, respond to, and recover from disasters, thus ensuring that human needs inherent in a disaster situation are evaluated and addressed; It uses community disaster education, hazard analysis, training exercises, community leadership classes, local emergency management plans, and the expertise of its members to bring holistic disaster awareness to its community" (NSDPC, 2011). The group is a collaborative working group of public, private, and not-for-profit agency representatives in which all the participants are equal partners united by the common goal of emergency response and disaster relief. The goal of the NSDP is to strengthen area-wide disaster coordination by sharing programs, policies, information, joint planning and training. The group is based in Waialua and Haleiwa, and also includes stakeholders from the North Shore communities of Pupukea and Sunset Beach to Turtle Bay, in order to create a regional disaster resilience plan in collaboration with this research.

Participants, partners

For North Shore Oʻahu, some of the agencies that were involved in the community-based resilience advisory board (hereafter referred to as community advisory board) have worked together for over four years as the North Shore Disaster Preparedness Advisory Steering Committee (NSDPC), formed in 2008 after a major flood event. The following are the current Committee participants: North Shore Chamber of Commerce (NSCC), State Civil Defense (SCD), Department of Emergency Management (DEM), Hawaiʻi Red Cross (HRC), Honolulu Police Department (HPD), North Shore Neighborhood Board (NSNB), Waialua Community Association (WCA), Coast Guard's Auxiliary (CGA), Once a Month Church to represent churches and homeless, landowners (KSBE & Dole/Castle & Cooke), government officials, Honolulu Fire Department (HFD), and local Lifeguards. The NSDPC will continue to build and strengthen its community advisory board with local emergency personnel, SCD and HRC among others, through leveraging existing disaster preparedness courses and trainings. These agencies each bring their specific roles, duties and resources relevant to the local resilience network efforts, including: guidance around disaster response, evacuation and recovery training and capacity building, resources, protocols and plans (SCD, DEM, HPD, HFD, CGA, ARC, government officials and lifeguards); the role and capacity of small and large businesses in disaster preparedness and recovery (NSCC); the role, assets and needs of community residents within disaster preparedness, response and recovery (WCA, NSNB); the role and capacity of faith-based and other organizations in assisting at-risk and underserved populations in a disaster; and, the role of land owners and farmers in disaster evacuation and adaptive capacity to climate change and natural hazards.

2.   Methods

2.1   Integrated dimensions

U.S. and international development and relief agencies increasingly recognize the need for combined qualitative and quantitative approaches to disaster research and preparedness efforts(Adger, 2006; Liverman, 1990). Multiple stakeholder networks were engaged to collect socioeconomic and livelihood data related to natural hazards and climate change. Culturally and

context appropriate protocols and guidelines were developed for sharing and integrating data to understand the components, relationships and driving forces impacting vulnerability change. Updated climate projections with downscaled impacts for Hawaiʻi were used to develop climate and natural hazard event scenarios. Multi-hazard mitigation planning officers were provided this information to inform best practices and strengthen resilience of communities to cope with impacts from natural hazards and climate change. The project employed a "bottom up" process to facilitate community planning, adaptation and resilience, using three integrated dimensions consisting of diverse methods.

2.1.1 *Dimension I: Social science methods for integration of knowledge, data collection and analysis*

The first dimension is a suite of social science methods. Engaging in a CBPRL approach facilitates the union of Western science with TEK and LEK, facilitates culturally-relevant processes that encourage citizen science, demonstrates respect for cultural values and practices, and results in sustainable processes, outcomes and impacts. Through establishment of community advisory boards, the CBPRL approach empowers residents from diverse backgrounds to develop self and inter-community reliance and resilience, by assessing their individual and community capacities, assets, needs and vulnerabilities through workshops, focus groups, community planning meetings, drawing maps, networking, and sharing of ideas and resources (ACOSA, 2005; Chambers, 1994; Chambers & Conway, 1992). Interviews and surveys were also used to gauge community structure, leadership roles, knowledge, education, adaptive and coping capacities, experience in disasters, and perceptions of risk associated with natural hazards and climate change. Additional methods include conducting a Gap Analysis to identify populations and areas at risk, as well as to illustrate strengths and weaknesses in community, multi-sector preparedness and recovery capacities, knowledge and training, and access to information and resources (Chapter 4: Appendix D). The methods used in the community-based case studies needed to be appropriate, respectful of and useful for each unique community. Dependent upon each community's characteristics, objectives and interests within the disaster resilience collaborative research platform, as well as the resources available to conduct the research, the

data specifications and collection procedures varied. Thus the data sources and collection procedures included the following: literature review; household surveys; key informant interviews; policy and programmatic needs/assets assessment for gap analysis and recommendation development. Many of these methods were employed to explore household resilience in one case study site, discussed in detail in Chapter 4.

Literature review

Literature and programmatic reports were reviewed to better understand the 3 schools of thought (socio-ecological systems, disaster resilience and socio-cultural resilience) from which the research identified critical gaps addressed through three original research papers. Each paper developed for Chapters 3-5 explores particular areas of the literature, identifying lacunas and providing theoretical and practical insight on potential solutions. Chapter 3 in particular offers a theoretical argument for implementing a rights-based resilience framework that integrates systems thinking, diverse knowledge systems, and provides a moral code for disaster resilience research and practice, utilizing a modified PRISMA (2009) process for the literature review as a key method (Moher, Liberati, & Altman, 2009).

Household surveys

Detailed household surveys constructed from an adapted version of the *Conceptual Framework to Identify Disaster Risk* (Bollin & Hidajat, 2006) were employed in Hanalei for Chapter 4. The survey included the following components of community resilience: (1) demographic information; (2) perceptions of community and preparedness; (3) perceptions of risk and vulnerability; (4) coping and adaptive capacity; (5) education; (6) livelihoods (including subsistence and commercial farming and fishing); (7) employment and financial information; (8) organizations and community involvement; and (9) qualitative feedback on various aspects of community, NGO and governmental disaster preparedness. The household survey incorporated questions to gain quantitative and qualitative data around the disaster risk framework indicators mentioned, to gain a broad and multi-disciplinary perspective of current community vulnerabilities as indicators of critical gaps in family and community-level hazard resilience.

Key informant interviews

Qualitative talk-story style interviews of key stakeholders in the community were implemented in Hanalei if appropriate and valuable to local resilience planning. Key stakeholders were identified by consultation with networks of community leaders, associations and residents. The interview content varied by site, but included open-ended questions around the following topics: (1) sense of community and home; (2) perception of and experience with natural hazards and climate change in the community; (3) livelihood structure; (4) coping and adaptive capacity; (5) additional locally-specific questions.

Needs/Assets assessments for gap analysis

The assessments gathered Hanalei data from previously mentioned methods as well as focus groups, town meetings, and resilience workshops, provided a qualitative and quantitative description of gaps in resources, information and services at the household, neighborhood and community levels. Defined in part by community stakeholders, categories included the following areas: evacuation; food and water security; energy; communication; information; special populations; infrastructure; shelter; education; leadership and local capacity building; early warning systems; emergency services among others.

2.1.2   Dimension II: Mental modeling of socio-ecological systems for decision-making

Novel decision-support software tools designed to facilitate community planning are used to support CBPRL. A software tool used called *Mental Modeler,* which builds upon the processes and data developed from social science methods, allows community planners and researchers to easily collect and standardize individual and community knowledge through simple modeling tasks done in interviews and workshops (Gray, Zanre, & Gray, 2012). The second dimension involves the use of *Mental Modeler* in community stakeholder workshops to facilitate anticipatory social learning, consensus-building, and to guide immediate and long-term decision-making (Gray, Chan, Clark, & Jordan, 2011). *Mental Modeler* allows users to develop dynamic/predictive conceptual models utilizing Fuzzy-Logic Cognitive Mapping (FCM) and graph theory. Mental Modeler is intended to characterize complex human understanding and beliefs in a more systematic way than many traditional social science methods, and gives considerable insight into

the "mental models" which underlie each person's perceptions and behaviors (Pahl-Wostl & Hare, 2004). More detailed methods and results from the mental modeling processes and data analyses conducted in North Shore, Oʻahu are provided in Chapter 5.

2.1.3 Dimension III. Leveraging partnerships for cross-scale resilience

The third dimension consisted of forging significant partnerships in order to identify and share culturally appropriate resources and tools, by developing and leveraging stakeholder networks consisting of local resilience advisory bodies. Processes used for the network development include: participation of elected community and interagency stakeholders from both local networks in the local-to-regional network; formation of informal and formal outlets for communication of project developments between both local networks; and, discussion of appropriate forums for collaboration across areas of similar activities conducted in both sites. Formal collaborative network mechanisms through the relationship with County agency partners were also needed to offer avenues for participation with their State and Federal agency counterparts, such as through the State Hazard Mitigation Forum, understanding County and State-level hazard mitigation plans and how to integrate planning efforts, and identifying opportunities for multi-level policy implementation to reduce community-level risks not previously addressed.

3.   Data management

The types of primary data potentially collected in the project include: quantitative and qualitative household and community survey data; qualitative key informant interview responses; workshop-generated materials; and, planning recommendations. The participatory processes used in the project assisted in developing guidelines and data sharing protocols. Special identifiers were not linked to individuals that may in any way reveal the identity of the respondents, as data was aggregated. Survey data included results collected through household surveys, key informant interviews, community surveys and workshop-generated materials. Transparency through verbal and written explanations on what the data could be used for and how, and confidentiality of the respondents was emphasized consistently. Household surveys, key informant interviews and community surveys were administered along with a confidentiality statement that explains the

rights of the respondent and the purpose of the survey instrument. Participants in the research

portions of the project were required to be at least 18 years of age, be informed of the

confidentiality terms, and submit a verbal or written agreement. The basis for the data

management standards is derived from the University of Hawaiʻi @ Mānoa (UHM) data

management and access policies on the dissemination and sharing of research data results, and

more extensive standards are available upon request. The project's research component involves

participation of human subjects, and was granted Exempt status. Data and information gathered

from research activities were shared with collaborators, as deemed necessary and appropriate,

with an established formal memorandum of understanding.

REFERENCES

ACOSA. (2005). Journal of Community Practice: Organizing, Planning, Development, and
Change (Vol. 12): Sponsored by the Association for Community Organization and Social
-Administration (ACOSA).

Adger, W.N. (2006). Vulnerability. *Global Environmental Change, 16*, 268-281.

Birkmann, J. (Ed.). (2006). *Measuring Vulnerability to Natural Hazards—Towards Disaster
Resilient Societies*. New York: United Nations University.

Bollin, Christina, & Hidajat, Ria. (2006). Community-based risk index conceptual framework. In J.
Birkmann (Ed.), *Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient
Societies* (pp. 257). New York: United Nations University.

Cannon, T. (2008). Reducing People's Vulnerability to Natural Hazards. Research Paper No.
2008/34. Helsinki: World Institute for Development Economics Research.

Chambers, R. (1994). The Origins and Practice of Participatory Rural Appraisal. *World
Development, 22*(7), 953-969.

Chambers, R., & Conway, G. (1992). Sustainable rural livelihoods: practical concepts for the 21st
century. IDS Discussion paper 296. Brighton, UK: Institute of Development Studies,
University of Sussex.

Chapin III, F. Stuart, Kofinas, Gary P., & Folke, Carl (Eds.). (2009). *Principles of Ecosystem
Stewardship, Resilience-Based Natural Resource Management in a Changing World*:
Springer.

DBEDT. (2011). Hawai'i Statewide Geographic Information System Program.   Retrieved March
2011, from http://www.state.hi.us/dbedt/gis

FEMA. (2011). Federal Emergency Management Agency. Are You Ready? Basic Preparedness.
Retrieved March 2011, from http://www.fema.gov/areyouready/basic_preparedness.shtm

Fletcher III, C., Grossman, E., Richmond, B., & Gibbs, A. (2002). Atlas of Natural Hazards in the
Hawaiian Coastal Zone: U.S. Geological Survey Geologic Investigations Series I-2761.
Prepared in cooperation with University of Hawaii, State of Hawai'i Office of Planning,
and National Oceanic and Atmospheric Administration.

Gray, S., Chan, A., Clark, D., & Jordan, R. C. (2011). Integrating stakeholder knowledge in social-ecological system decision-making: Benefits and limitations to knowledge diversity. *Ecological Modelling, In press*.

Gray, S., Zanre, E., & Gray, S. (2012). Fuzzy Cognitive Maps as representations of mental models and group beliefs. In E. I. Papageorgiou (Ed.), *Fuzzy Cognitive Maps for Applied Sciences and Engineering – From fundamentals to extensions and learning algorithms*.

Handy, E. S., Craighill, Elizabeth Handy, & Pukui, Mary Kawena. (1972). *Native Planters in Old Hawaii: Their Life, Lore, and Environment* (Rev. edition 1991 ed.). Honolulu: Bishop Museum Press.

HSCD. (2007). State of Hawaiʻi Multi-Hazard Mitigation Plan, 2007 Update: Prepared by Cheryl Anderson, Hazards, Climate, & Environment Program, University of Hawaiʻi Social Science Research Institute.

HSCD. (2010). State of Hawaiʻi Multi-Hazard Mitigation Plan, 2010 Update (pp. 32): Hawaii State Civil Defense.

Lacambra S., C., Moller, I., & Spencer, T. . (2008). The Need for an Ecosystem-Inclusive Vulnerability Index for Coastal Areas in Colombia. In H.-G. Bohle & K. Warner (Eds.), *Megacities: Resilience and Social Vulnerability*: UNU-EHS. SOURCE No. 10/2008.

Liverman, D.M. (1990). Drought Impacts in Mexico: climate, agriculture, technology, and land tenure in Sonora and Puebla. *Annals of the Association of American Geographers*(80), 49-72.

Moher, D, Liberati, A, & Altman, DG. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *The PRISMA Group (2009). PLoS Med 6(6): e1000097*(doi:10.137/journal.pmed1000097).

NSDPC. (2011, January 28, 2011). North Shore Disaster Preparedness Committee website. from http://www.nsdisasterplan.org/

Sudmeier-Rieux, K., Masundire, H., Rizvi, A., & Rietbergen, S. (Eds.). (2006). *Ecosystems, Livelihoods and Disasters: An integrated approach to disaster risk management*. Gland, Switzerland & Cambridge, UK: The World Conservation Union (IUCN).

UNEP. (2005). Assessing Coastal Vulnerability: Developing a global index for Measuring Risk

Retrieved June 2011, from

http://www.unep.org/dewa/products/publications/2006/CVI_PM65_Final_05.pdf. Nairobi,

Kenya: UNEP/DEWA/RS.05-1.

UNISDR. (2008). Indicators of Progress: Guidance on Measuring the Reduction of Disaster Risks

and the Implementation of the Hyogo Framework for Action *Retrieved May 2011, from*

http://www.unisdr.org/we/inform/publications/2259 (pp. 50). Geneva, Switzerland:

UNISDR.

CHAPTER 3. CULTIVATING A HUMAN RIGHTS CONSCIENCE: MOVING BEYOND REDUCING RISK TO BUILD COMMUNITY RESILIENCE TO DISASTERS AND CLIMATE CHANGE

Abstract

The fundamental roots of preventing, mitigating and adapting to disasters and climate change are entwined with the affirmation of human rights as set forth in the Universal Declaration of Human Rights. The inextricable link between human and environmental security makes employment of rights-based frameworks and strategies essential to move beyond disaster risk reduction and toward long-term resilience-building. An integrated approach to risk reduction and development is supported by only a few international institutions; however they fail to adequately address human rights, justice and equity. This paper offers a review of relevant scientific and gray literature with a focus on human rights-based models and frameworks, analyzes policies and institutions that address resilience to disasters and climate change Findings indicate a paucity of publications in both the scientific and gray literatures, a lack of adequate linkages between the two bodies of literature, and an inadequate representation of human rights, justice and equity in resilience research conceptual models and frameworks. An integrative *Rights-based Resilience Conceptual Model* and potential indicators to operationalize the model, are proposed to address the identified gaps in science, practice and policy-making. The model is designed to enable accountability and transparency of policies and programs at achieving resilience and human rights, through offering benchmarks that can be iteratively measured to evaluate resilience of community systems through locally-validated qualitative and quantitative variables, as well as construction of a composite index for an overall resilience score.

1. Introduction

1.1 The storm upon us

Disasters affect hundreds of millions of people each year, leave tens of millions displaced and/or houseless, contribute to hundreds of thousands of deaths and result in billions of dollars (USD) in economic losses (UNU-EHS, 2012). In the last decade alone (2002-2011), 4130 disasters were reported worldwide, resulting in economic damages of $1.195 (USD) billion and causing more

than a million deaths (UNU-EHS, 2012). The increasing incidence, severity and impacts of disasters over the last 20 years is due to: climate change impacts and climate variability; human vulnerability from poverty, human rights abuses and socio-economic inequity; increasing population growth and density, especially in hazard-prone areas including coastal zones; and, environmental degradation and poor land use (IPCC, 2012; UNDESA, 2012; UNU-EHS, 2012; UNU, 2012).

1.2   The natural disaster fallacy

Natural hazards are not disasters. Rather, the nature of the hazard, including the type, frequency, magnitude, duration, intensity and rate of onset, coupled with the characteristics of the people as reflected in the ability of local officials and communities to absorb, respond to and recover from the hazard's impacts, determines whether the event overwhelms local capacity and becomes a disaster (Annan, 2003; Birkmann, 2006; S. L. Cutter and others, 2008). The impact that human actions, systems and institutions have on constructing and exacerbating social, economic, ecological and physical vulnerabilities to natural hazards is recognized (Birkmann, 2006; Cardona, 1993; van Ginkel, 2005; Wisner and others 2004). The World Conference on Disaster Reduction *Hyogo Framework for Action 2005—2015* defines disaster resilience as: "the starting point for reducing disaster risk and promoting a culture of disaster resilience lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face" (UNISDR, 2005). Contemporary work recognizes that building resilience requires long-term sustainable development that addresses root causes of vulnerability and enhances coping and adaptive capacity of social, ecological, economic and political systems (Bollin and Hidajat, 2006; Chapin III and others 2009; S. L. Cutter and others 2003). Despite this recognition, current frameworks and institutions fail to identify and address the issues of human rights, justice and equity as integral causes or drivers of resilience.

The impacts from climate change and disasters are neither equal nor homogeneous (Bankoff and others, 2004) due in large part to differential vulnerability between and within countries and regions that results from inequitable distribution of wealth and resources (deFur and others, 2007; Morrow, 2008). Developing countries have greater vulnerability to climate change and disasters

due to high dependency on natural resources that may be impacted as a result; this is

compounded by underdevelopment, poverty and low coping capacity due to inequitable division

of assets, financial support and networks within society (Ikeme, 2003; Thomas and Twyman,

2003). Key variables affecting differential vulnerability include gender, sex, age, race, ethnicity,

class, social status, education, livelihood, religion, income, culture and other socio-economic

characteristics (Bankoff and others, 2004). These should be addressed as they may result in

greater vulnerability of certain populations, including issues of rights abuses, inequity and

injustice (Anderson, 2008; SPDRP, 2002).

1.3   Human rights, justice and equity: forgotten beacons

Human rights are universal, in that they are rights for all, all the time, including in times of

disasters and are complemented by international humanitarian law for times of war (Kent, 2012;

Marks, 2006; Perrin, 1996). International human rights law obligates States with the responsibility

to respect, protect and fulfill the rights of all those living within their jurisdictional boundaries at all

times, inclusive of provisioning preventive and mitigative measures to hazards and protecting

them from human rights violations throughout the disaster relief, recovery and reconstruction

stages (United Nations, 2009). As the duty-bearers, governments are also obligated to encourage

capacity-building, self-determination and community development for increased community health

and resilience (United Nations, 2005). Minimum standards for human rights are derived from the

1948 Universal Declaration of Human Rights (UDHR), the 1966(a) International Covenant on Civil

and Political Rights (ICCPR), the 1966(b) International Covenant on Economic, Social and

Cultural Rights (ICESCR), the 1989 Convention on the Rights of the Child (CRC), the 1999

Committee on the Elimination of Discrimination Against Women (CEDAW) among others

(SPHERE, 2011; United Nations, 1948, 1966a, 1966b, 1989, 1999). These standards include: the

right to life with dignity (ICCPR, 6) liberty and security of person (UDHR, Article 3); adequate and

secure housing (ICESCR, 12); means of subsistence (ICESCR, 1); the right to sufficient quality

and quantity of safe potable water (CEDAW, 14); the right to a standard of living adequate for

health (ICESCR, 12) and well-being (UDHR, 25); the right to education (UDHR Article 26;

ICESCR, 13); cultural rights (ICCPR, 27); and, property rights (UDHR, 17), with local

empowerment, self-determination (ICCPR, ICESCR, 1) and dignity as the basis for all activities (UDHR 1, 22, 23) (SPHERE, 2011; United Nations, 1948, 1966a, 1966b, 1989, 1999). Challenges exist to the application of such frameworks and integrated approaches particularly at the community level and the field of disaster resilience is mired in epistemological discord and fracture between disciplines. A disconnect exists between the scientific literature, which focuses on resilience theory and often lacks in real-world application and that of the gray literature, which focuses on policies, frameworks and fieldwork which often lack sound guidance from scientific findings.

A review of historical disaster situations, humanitarian crises and environmental degradation reveals that at the core of human and environmental insecurity are underlying vulnerabilities due to insufficient respect, protection and fulfillment of human rights, justice and equity. International frameworks and institutions that acknowledge and address intersections of ecological degradation, vulnerability to hazards and climate change, risk reduction and development, include: (1) the Strategic Environmental Framework (SEF); (2) the Hyogo Framework for Action (HFA); (3) the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC); (4) the Millennium Ecosystem Assessments (MEA); (5) the Millennium Development Goals (MDG) and the updated Sustainable Development Goals (SDG); (6) the SPHERE Project Humanitarian Charter and Minimum Standards in Disaster Response; and, (7) the Code of Conduct for the International Red Cross and Red Crescent Movement and Non-Governmental Organizations in Disaster Relief (Perrin, 1996; SPHERE, 2011; UNISDR, 2008a). Although disaster relief agencies employ human rights frameworks for meeting minimum standards in humanitarian assistance (Perrin, 1996; SPHERE, 2011), regrettably current international platforms and frameworks pursuing resilience, risk reduction and development fail to adequately recognize and address human rights, justice and equity as root causes of vulnerability (UNISDR, 2011; UNU-EHS, 2012). The HFA Midterm Review 2011 recognizes this, noting that global consensus of disaster risk reduction is unlikely unless it is based in universally accepted principles of justice and equity (UNISDR, 2011; UNISDR and WMO, 2012). The emerging climate change adaptation discourse seems to be

paying greater attention to embracing a just, ethics-based approach (Ikeme, 2003; Morin and Patino, 2010) than that of the disaster resilience field, though it remains insufficient at the sub-regional and local level (Thomas and Twyman, 2003). Intersections of disasters and climate change provide a logical transition for a rights-based approach to development, risk reduction and resilience-building (Morin and Patino, 2010).

Despite improvements in interdisciplinary collaboration, challenges continue with the integration of ecological, social, economic and physical sciences, in both the theoretical and practical sense. Practitioners often do not base their fieldwork on scientifically-founded evidence and researchers often poorly connect their results with real-world applications (Kalin, 2011; UNISDR and WMO, 2012). This paper explores both facets of this problem: 1) the failure of current institutions and frameworks to adequately address the root causes of vulnerability of human rights, justice and equity; and, 2) the need for improved collaboration between disciplines as well as between researchers and practitioners to advance rights-based resilience. The paper reviews and compares relevant rights and justice-based resilience frameworks and models from the scientific literature, United Nations official documents and gray literature, identifies gaps and proposes a *Rights-based Resilience Conceptual Model* to address lacunas and explore opportunities for new research and development with an ethical compass.

2.   Methods

2.1   Problem statement

Despite building theoretical and political support for integrated collaborative approaches to disaster risk reduction, resilience and adaptation to climate change, an understanding of how to implement these frameworks and strategies at regional and local levels is lacking. Current development efforts often fail to integrate disaster risk reduction measures and conversely risk reduction practices rarely address the root causes of vulnerability and insecurity of human rights, justice and equity. Improved intersectoral collaboration and the development and employment of a comprehensive multi-sector rights-based resilience conceptual model is needed to bridge the disconnect between disaster risk reduction, resilience and sustainable development (Folke, 2002).

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2.2　　Hypothesis and research questions

This paper postulates that past and present literature and fieldwork do not adequately address the intersecting issues of human rights, justice and equity-based disaster resilience, calling for the development of new conceptual models, tools and interdisciplinary approaches to bridge this gap. A review of scientific and gray literature will be used to address the following research questions and inform development of an integrative conceptual model:

1. What is the level of interest being paid to this topic (in the form of publications over the past two to three decades)?

2. What conceptual models or frameworks exist, that address human rights, justice or equity approaches to resilience to disasters and climate change?

3. If such models exist, are they able to be operationalized in the field?

2.3　　Methodology

2.3.1　Scientific literature

To investigate the hypothesis and research questions, a systematic search was conducted of peer-reviewed literature published between January of 1980 and October of 2012 in the search engine *ISI Web of Knowledge, Web of Science* from 22 October 2012 to 14 November 2012. The method used for the scientific literature review followed a modified PRISMA (2009) process, including: 1) identification of literature through database queries utilizing specific keyword search terms (Table 3.1); 2) screening, including removal of duplicates and reading the title, abstract and keywords to determine potential eligibility for inclusion; 3) eligibility, including assessing full text articles for use of keywords and relevance to the topic; and, 4) inclusion of eligible literature records to review (Moher, Liberati, and Altman, 2009). Answering the hypothesis and research questions required a targeted keyword search strategy in order to specifically identify rights or justice-based conceptual frameworks or models that address resilience to disasters, hazards, risk and/or climate change.

Four categories of terms were included: rights, disaster, resilience and conceptual (Table 3.1). The resilience term was fixed in all searches, the human rights terms keywords were mandatory and to qualify for screening the article needed to have at least three of the four terms in the title.

However, search method exceptions were made if the title used similar terms that were deemed

highly relevant to the topic. Keywords for the four terminology groups were searched by topic,

generating 16 total search combinations. Articles that passed the Identification phase were

cleaned through removal of duplicates. Then the abstracts were screened by excluding those

without at least three of the four search terms included in the abstract. Full-text articles were

reviewed for eligibility, using the search terms. Papers were reviewed to identify whether or not

an actual resilience framework or model was presented, if it was rights or justice-based and if it

addressed disasters, hazards, risk and or climate change. Articles eligible for inclusion were also

assessed to identify whether applied, practical solutions were presented.

Rights Terms (Mandatory)	Disaster Terms	Resilience Term	Conceptual Terms
"right*"	"disaster*"	"resilien*"	"framework*"
"justice"	"hazard*"		"model*"
	"risk*"		
	"climate change"		

Table 3.1. Literature review search terms.

2.3.2   *Gray literature*

The gray literature was divided into two types: 1) United Nations official documents; and, 2) other

books, publications, policy briefings, manuals and reports. The United Nations official documents

review was conducted using the same search terms as the scientific literature review, utilizing the

online database *Official Documents System of the United Nations* (UN-ODS) which includes all

official United Nations documentation since 1993 (UN-ODS, 2012). The semi-structured gray

literature search was conducted from 22 October 2012 to 14 November 2012 using the same

search terms, through accessing libraries and the online databases *PreventionWeb*

(PreventionWeb, 2012) and *Google Scholar* (Google, 2012). Results of both reviews produced

thousands of results, so the first 20 results were sorted by relevancy using the same criteria and

were reviewed based on the requirement that at least three of the four the keywords be found in

the title and/or description. The table of contents and index for additional hardcopy resources

were reviewed for relevant papers that incorporated three of the four keywords. Limitations of the

literature review include: the database used for the scientific literature may be limited with regards

to its utilization of social science journals; the high number of publications generated by the

search relative to the low number that were found to be relevant may have been improved by

more specific search terms or requirements, including adding vulnerability and risk to the list of

resilience terms; the large amount of UN-ODS documents generated resulting in a search of the

top 20 documents may have biased the study on the most relevant but most recent articles; and

finally, implementing a semi-structured, non-quantifiable literature search was difficult to analyze

in a comparable way to the other searches.

3.   Results

The results of the literature review provided the following insight in response to the research

questions. Of the articles that met the eligibility criteria, all were entered into a database by:

author, title, year of publication and whether practical applied solutions were offered. The

scientific literature review yielded 599 articles generated by the database under the given search

criteria. After screening and removal of duplicates, 26 articles (4.34 per cent of the initial sample)

were found eligible for full-text review, 13 (2.17 per cent) of which met the criteria for the full text

review and were included for analysis. Of these 13 articles, only three (23.01 per cent) provided a

conceptual model of resilience including justice or human rights in some capacity (Brodsky and

others, 2011; Eggerman and Panter-Brick, 2010; Lebel and others, 2006) that were operational to

some degree in the research and two additional papers specifically addressed property rights

(Coleman, 2011) and water rights (Langridge, Christian-Smith, and Lohse, 2006) and resilience.

All 13 papers included recommendations and practical solutions relevant to the topic, linking in

science with practice and seven (53.85 per cent) included a framework mentioning rights or

justice.

Of the publications reviewed in the gray literature review, the UN-ODS search generated a total of

22,781 documents and of these a total of 49 (0.22 per cent) were found relevant and eligible for

full text review. Of these 49 documents, all discussed a framework that was potentially

operational (mostly as guiding legislative norms and laws), none provided conceptual models, all

offered practical solutions, recommendations or observations and nine (30 per cent) included

support from scientific findings, showing a lack of scientific support for the creation of human

rights and justice-based laws, norms and covenants. The semi-structured review of other gray

literature yielded 33 publications including several additional scientific papers, books, manuals,

white papers among other documents. Of these, all included a framework, 30 (90.91 per cent)

contained practical applications, 10 (30.3 per cent) of which provided conceptual models and 17

(56.67 per cent) of which were based to some extent on scientific findings. This offers further

support for highlighting the disconnect between informing resilience policy and programs through

science.
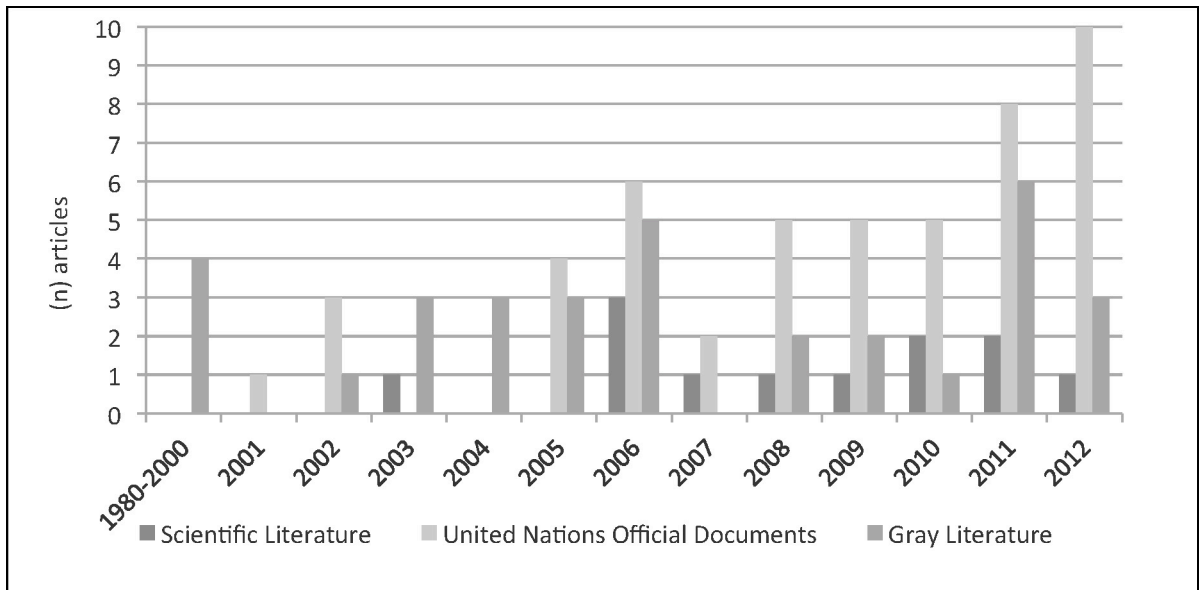
Figure 3.1. Number of articles for all sets of literature addressing the topic.

In response to the research questions posed, regarding the level of interest being paid to the

topic, the data demonstrated few total articles (n=94) across all literature on the topic in the past

20-30 years, calling for more attention to developing this field. A slight increase over time in

publications on this topic (Figure 3.1) was observed, with the majority of documents produced by

the United Nations (n=49), followed by the gray literature (n=33) and the scientific literature

(n=12). Addressing the final two research questions concerning conceptual models that illustrate

the intersections of human rights, justice or equity with resilience and operationalizing them, the

reviews found only 13 (14.13 per cent) with conceptual models, all which have been or could be

applied to some degree in research. These models were primarily focused on rights having to do

with access to property and natural resources, or justice and equity as they relate to climate

change impacts and adaptation. These findings reaffirm the need for the development of a new conceptual representation of the link between human rights, justice and equity with development, disaster relief, recovery, resilience and climate change.

4.   Conceptual model

The literature review results support the need for development of a *Rights-based Resilience Conceptual Model,* to address gaps in knowledge and practice through integration of human rights, justice and equity into the resilience concept (Figure 3.2). Based in theory and constructed in support of the international human rights and humanitarian assistance frameworks, the model is amenable to application and measurement of resilience via qualitative and quantitative indicators. The following section outlines the approach, structure and components of the conceptual model, and explains the research-based rationale and potential applications and limitations of the model.

4.1   Explanation

The conceptual model illustrates the interdependency and intersections of climate change, development, disaster response and relief, disaster risk reduction, hazards, conflict and the resilience construct with human rights, justice and equity. This approach is supported by the understanding that resilience to disasters and climate change is strongly correlated with relief and recovery, sustainable development, capacity-building, the ability to enjoy human rights and equity and justice within economic, environmental, health and social realms (Adger, 2006; Birkmann, 2006; Chambers and Conway, 1992; Eakin and Luers, 2006; Mustafa, 1998; NRC, 2011; United Nations, 1994, 2009). Drawing from the framework of international human rights law coupled with the fundamental principles of international humanitarian law, all human rights are interdependent and indivisible (Marks, 2006) and a rights-based approach to resilience assumes that rights are mandatory, that the approach addresses root causes and that a clear public, political and legal responsibility, obligation and duty exists (Cantwell, 2005).
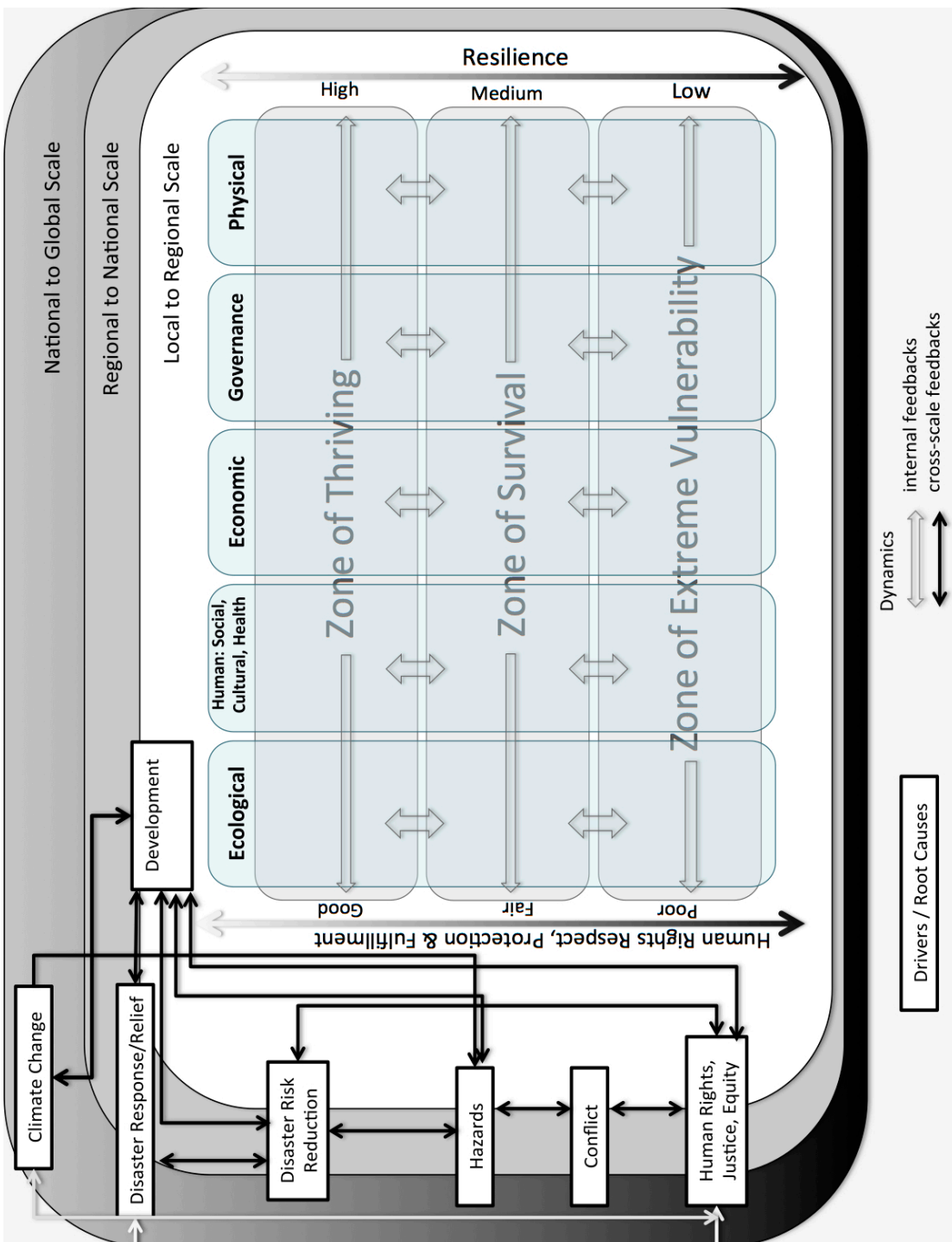
Figure 3.2. Rights-based resilience conceptual model

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The conceptual model represents the spectrum of resilience across five system components starting at the local system of interest within the local-to-regional scale and nested within the regional-to-national and national-to-global scales, acknowledging the interconnectedness of place (Turner and others, 2003). Recognition of the challenge that diverse cultural, social, political and other attributes of people, places and their constantly changing contexts may raise for the definitions and interpretations of well-being, rights, equity and justice (Handmer, 2001), makes the case for developing truly participatory, place-based community-level approaches (S. L. Cutter and others, 2008; Kasperson and Dow, 2005) and the adaptable application of the conceptual model at the local level. The three dimensions are classified as zones of resilience (characterized by degree of coping and adaptive capacity, access and ability to enjoy rights) ranging from the lowest dimension, *Extreme Vulnerability* (i.e. high human insecurity, poverty, severe environmental degradation, poor health and little to no access to basic services), to *Survival* (i.e. basic security and access to basic services) and the highest, *Thriving* (i.e. healthy environment, high quality of life and well-being of people, economic prosperity, equity and just governance). This illustrates resilience as a continuum, such that at any given time, the system of interest may be in varying states of resilience within each component, under the ideology that resilience is both a state of being as well as an ever-evolving process (S. L. Cutter and others, 2008).

The five system components include: Ecological, Human (which includes social, cultural and health domains), Economic, Governance (i.e. institutional) and Physical (i.e. built environment and infrastructure). The components represent the main sub-systems of the place-based system of interest, much like the socio-ecological systems resilience approach (Adger, 2006; Holling, 2001) illustrating the interconnectedness and interdependency of everything within a system, with the five components providing a more comprehensive scope. Table 3.2 offers a non-exhaustive list of rights-based candidate indicators proposed for each system component.

The system dynamics include feedback loops, functioning internally within each system component and across the three dimensions, between the system components and from the place-based system across all scales, illustrating the interactive and interdependent nature of the components and drivers (Holling, 2001; Turner and others, 2003). Though other drivers or root

causes are illustrated in the model, human rights respect, protection and fulfillment is explicitly included as a key driver and determinant of resilience within the nested suite of place, such that as human rights protection is poor, so is ecological health, human well-being, economic stability, governance and so forth (United Nations, 1994). Apart from global climate change, all of the drivers impact place-based resilience of the system components at the local-to-regional scale and many overlap into the regional to national scale, illustrating the interdependent nature of the system components and their interactions (Turner and others, 2003).

Climate change is an external driver of environmental change originating from the global level with impacts extending to all scales, affecting the nature, intensity and severity of hazards (IPCC, 2012; Solomon and others, 2007; UNU-EHS, 2012) and having direct and indirect implications for enjoyment of human rights and a disproportionately adverse affect on populations that are already vulnerable (United Nations, 1994, 2009; UNU-EHS, 2012), particularly climate refugees who face complex issues of sovereignty and cultural displacement (Barnett and Adger, 2003). Development is a driver of climate change and reciprocally is impacted by climate change, such that mitigation and adaptation strategies are required (Barnett and Adger, 2003; IPCC, 2012). The increase in disaster risks and vulnerable populations have consequences for human rights, requiring disaster risk reduction to be incorporated into strategies for adaptation to climate change, in conjunction with respect for human rights (Prieur, 2009), as well as measures to address climate change should be informed and strengthened by international human rights standards and principles (United Nations, 2009). Development is highly correlated with human rights, justice and equity issues and impacts disaster response, relief and disaster risk reduction activities (Batra and Chaudry, 2005; Jerneck and Olsson, 2008; Perrin, 1996; SPHERE, 2011; UNU-EHS, 2012; Zhang, 2010). Hazards often incite issues of natural resource management crises and conflict, which influence human rights abuses, injustices and inequity, particularly in areas already economically and political fragile (Batra and Chaudry, 2005; O'Brien, Hayward, and Berkes, 2009; Perrin, 1996; SPHERE, 2011; UNISDR, 2008b; UNU-EHS, 2012).

Component	Candidate Indicators
Ecological	Resource rights
	Equity of community-based management rights for stewardship
	Natural hazard buffering capacity of ecosystems
	Sea level rise inundation zone projections
	Right to secure, healthy, sound environment
Human	Ability to live a life with dignity
	Ability to be protected and secure
	Access to humanitarian assistance
Cultural	Ability to enjoy freedom of cultural practices
	Freedom of religion
	Protection of culturally valued areas
Social	Connection with place/Sense of place
	Access to social networks
	Access to free public education
	Access to disaster preparedness information
	Access to justice system
	Gender equity
	Experience in past disasters, ability to learn and anticipate
Health	Quality of life/Level of well-being
	Access to affordable, safe housing
	Access to affordable, adequate healthcare
	Access to affordable, safe food
	Access to adequate quality and quantity of potable water
	LGBTQ mainstreaming into disaster plans
Economic	Property rights
	Labor rights
	Right to development
	Ability to engage in livelihoods
	Poverty rate
	Economic equity
	Level of sustainability and risk reduction of development
	Intergenerational job equity
Governance	Disaster risk reduction policies integrated with planning and development
	Inter-agency hazard mitigation, response and recovery plans
	Participation of residents in governance and disaster planning
	Social contracts monitoring human rights, justice and equity
Physical	Building codes and standards (particularly public buildings like schools, hospitals, government services)
	Proximity of critical infrastructure to hazardous areas
	Contingency planning and capacity of critical services

Table 3.2. Rights-based resilience indicators.

As the model is rights-based and draws on methods for integration of justice and equity, the majority of the indicators are based on universal human rights standards, laws and covenants, however certainly other indicators will be included that are not rights-oriented (e.g. for the ecological component, additional indicators may include measures of ecological redundancy, elasticity and malleability, functionality of ecosystem services, per cent native species, etc.). The indicators for each component range from low to high across the three dimensions, from very low to low in the Zone of Extreme Vulnerability, low to medium in the Zone of Survival and medium to high in the Zone of Thriving, measures which may be easily quantifiable. Scoring of indicators will vary based on whether the indicator is determined to have a negative or positive influence on resilience. Indicators will be quantifiable through development of variables that may be used to measure resilience within that component, as well as via construction of a composite resilience index across all components. As the model is community-oriented, indicators must reflect local relevance through participation and buy-in and the model is adaptable to adjust to changing conditions and concerns over time. Further research for identification of variables for these indicators is a primary next step for operationalizing the model.

4.2   Critical Assumptions

The *Rights-based Resilience Conceptual Model* is a novel attempt to conceptualize a rights-based resilience framework with qualitative and quantitative indicators to guide resilience research and planning at the local level. Justice, rights and equity are not recognized as one in the same, but rather as symbiotic elements of a unified resiliency model which will be further refined with indicators that clarify this distinction while illustrating their connections. Noted challenges and assumptions of this model include the following: 1) hesitancy or resistance of governments or agencies to employ the model due to fear of recrimination or loss of funding, such that incentivizing may be needed; 2) difficulty in collecting data or gaining access to populations in situations of extreme conflict and human rights abuses; 3) difficulty of funding for multiple iterations; 4) the need for validation of the model and inclusion of qualitative measures (Stallings, 2002) to complement quantitative indices; 5) the model adaptability needed by different populations and environmental characteristics over time; and, 6) the model scalability needed to

capture diversity of different populations within communities in order to identify differential

vulnerability and root causes between groups. The model and the proposed indicators will benefit

from expert stakeholder reviews and critique. Further research is needed to identify appropriate

variables and metrics for the indicators, in order to operationalize and test the model. Next steps

for applying the model at the community-level and potential avenues for its validation and

implementation are proposed in the following section.

5.   Discussion and recommendations

The literature review and conceptual model reinforce that resilience-building must embrace a

moral compass for all scientific and applied efforts to meet the minimum standards for basic

human rights, facilitate human security and survival and motivate stakeholders toward more

progressive norms of human well-being, thriving and health. They also highlight that much needs

to be done, in research, practice and policy. In this light, the following recommendations are

offered.

5.1   Recommendation 1: Re-assert the legal commitment of governments to human rights, justice and equity

Communities are urged to forge a new social contract with their governments, insisting that

development and disaster efforts be participatory and focus on standards of improving human

rights, justice and equity. The international community must support communities in this effort, to

challenge and improve upon current human rights laws, policies and practices and their

implementation. Employing a rights-based planning mechanism such as the model proposed here,

would offer a simpler platform to translate roles and responsibilities of rights-holders, duty bearers

and encourage accountability and transparency (Kent, 2012).

5.2   Recommendation 2: Connect science, practice and policy

Enhancing linkages between the scientific and gray literature could greatly improve disaster

resilience strategies and programs, by providing scientifically-supported methodologies,

strategies, tools and evaluation processes to ensure that standards and benchmarks are met.

This includes improved collaboration and sharing of data and best practices, integration of

indigenous, local and scientific knowledge and place-based resilience-building strategies.

Development professionals should identify and embrace targets to reduce vulnerability and enhance resilience of systems, focusing on human rights, justice and equity. Disaster relief professionals should identify drivers of vulnerability and assist developers and communities to integrate disaster risk reduction into relief, recovery and re-development, focusing on improving human rights, justice and equity. Caution should be paid to subscribing to the mindset that expeditious recovery and particularly recovery back to the pre-disaster state, is equivalent to a resilient system. Resilience is not forged hastily; it is cultured through rich learning processes and mechanisms by which the recovery, re-development and re-invention occur, hopefully towards more equitable and just alternative states particularly for those whose pre-disaster state was one of poverty, injustice and poor human rights.

5.3   Recommendation 3: Mainstream rights, justice and equity as baseline standards for resilience

Operationalizing the *Rights-based Resilience Conceptual Model* will require the use of indicators that are designed such that they are amenable to translation as benchmark targets, for the threefold purpose of: 1) measuring resilience of each system component; 2) measuring resilience across all components as a composite score; and, 3) highlighting drivers or determinants (negative and positive) of resilience in order to inform disaster risk reduction, development and human rights initiatives. These benchmark indicators have several benefits. First, they may be used over multiple iterations to measure change in resilience over time, as well as longitudinally over hazard events or other perturbations. Second, they can be used to measure the success or failure of specific development, risk reduction or human rights initiatives in improving resilience within a component or across the entire system. Third, they can indicate whether a development, disaster relief, recovery or resilience effort was successful at meeting the human rights, justice and equity standards quantified in the indicators, potentially through development of a scoring system. In addition to improved integration of research and development, this framework facilitates quality control and transparency and identifies which efforts are most efficacious in increasing resilience and upholding human rights, justice and equity. By operationalizing the model and implementing a scorecard system, these tools may act as a scientifically-based

accountability mechanism to hold governments and professionals responsible for violating rights as well as praise them if they are meeting benchmark targets and improving rights, justice and equity.

5.4   Recommendation 4: Advance qualitative and quantitative measures of resilience

To enhance community resilience, household information such as roles, responsibilities, opportunities, knowledge, perceptions and attitudes should be investigated (Anderson, 2008; Reduction, 2008; SPDRP, 2002). The research and development processes must be participatory, engaging diverse stakeholders in the process to empower them to assess their own risks and develop place-based methods and strategies to identify and target gaps (SPDRP, 2002). Such assessments will be mixed methods gathering qualitative and quantitative data, and may include: focus groups and household surveys to gather much of the information mentioned on roles, responsibilities, opportunities and knowledge, from which data may be disaggregated by sex, age and socio-economic categories in order to reveal varying influences on or determinants of disaster vulnerability (Byrne, B and S. Baden 1995 from SPDRP 2002). Plans and policies must carefully measure, quantitatively and qualitatively, the socio-economic, social, cultural, livelihood and other related factors in order to inform place-based management strategies.

5.5   Recommendation 5: Think globally, act locally

To support these strategies for mainstreaming rights, justice and equity into formal and informal measures for disaster resilience and climate change adaptation, tools should be community-based and participatory across scales. National, regional and local disaster resilience-related legislature, policies and programs should draw from and offer support for international strategies such as the SEF, HFA and MDG/SDG. This includes activities such as: engaging in effective interdisciplinary community-based participatory research, monitoring and analysis; promoting risk reduction awareness and education; engaging youth and vulnerable populations in community-building, disaster risk reduction and environmental awareness activities; sharing information and best practices; developing early warning systems; protecting ecosystems; and developing socio-economic adaptation and coping capacity. At the local and regional levels, men and women should be involved on disaster planning committees, paying attention to building disaster

resilience through prevention and preparedness measures as opposed to primarily reactive relief and reconstruction (Anderson, 2008; UNISDR, 2008c; SPDRP, 2002).

6.   Conclusions

This paper offers a summary of rights-based related literature and highlights the failure of science and development to adequately address human rights, justice and equity in resilience frameworks and models. This may be due to an error of omission, negligence or oversight, or the result of misplaced importance on other factors like economics and politics. Regardless, perhaps the most important challenge upon us is to forge a new social contract between communities, governments and professionals in the field of development, disaster relief and resilience, to always prioritize human rights, justice and equity as our duty and obligation.

Due to the multiplicative nature of disasters, climate change and human and environmental security, human rights frameworks, tools and collaborative strategies must be used to measure and reduce the root vulnerabilities of people and places at risk. The baseline principles of disaster resilience must be to protect, respect and fulfill the universal human rights owed to all human beings. Beyond the fulfillment of basic human rights, however, the ultimate goal of research and development should be to enhance the resilience and well-being of the physical, governance, economic, ecological and human systems by targeting and alleviating rights abuses, injustices and inequity. Construction of a *Rights-based Resilience Conceptual Model* is a first step at providing a framework for collaborative, integrative resilience research and planning that identifies and addresses root causes of human rights, justice and equity.

REFERENCES

Adger, W.N. (2006). Vulnerability. *Global Environmental Change*, vol. 16, No. 3 (August) pp. 268-281.

Anderson, Cheryl L. (2008). The gendered dimensions of disaster risk management and adaptation to climate change-Stories from the Pacific. In UNDP-AusAID (Ed.): UNDP-AusAID.

Annan, Kofi (2003). *Message for the International Day for Disaster Reduction 8 October 2003*. Available from http://www.unisdr.org/eng/public/aware/world_camp/2003pa-camp03-sg-eng.htm.

Bankoff, Greg, Georg Frerks and Dorothea Hilhorst (Eds.) (2004). *Mapping Vulnerability*. London and Sterling, VA: Earthscan.

Barnett, J., and W.N. Adger (2003). Climate dangers and atoll countries. *Climatic Change*, vol. 61, No. 3 (December), pp. 321-337.

Batra, Bikram Jeet, and Shivani Chaudry (2005). International Human Rights Standards on Post-disaster Resettlement and Rehabilitation: Compilation by the Habitat International Coalition-Housing and Land Rights Network and PDHRE-People's Movement for Human Rights Learning in collaboration with the United Nations Special Rapporteur on Adequate Housing. New York: PDHRE.

Birkmann, J. (Ed.) (2006). *Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient Societies*. New York: United Nations University.

Bollin, Christina, and Ria Hidajat (2006). Community-based risk index conceptual framework. In J. Birkmann (Ed.), *Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient Societies* (pp. 257). New York: United Nations University.

Brodsky, Anne E., and others (2011). Between Synergy and Conflict: Balancing the Processes of Organizational and Individual Resilience in an Afghan Women's Community. *American Journal of Community Psychology*, vol. 47, No. 3-4 (January), pp. 217-235.

Cantwell, Nigel (2005). From the Convention on the Rights of the Child to a Rights-Based

    Approach to Children. Paper presented at the Child Rights and Resilience Conference.

    Geneva, June.

Cardona, O.D. (1993). Evalucacion de la Amenaza, la Vulnerabilidad y el Riesgo. In A. Maskrey

    (Ed.), *Los Desastres No son Naturales, La Red*. Bogota: Tercer Mundo Editores.

Chambers, R., and G. Conway (1992). Sustainable rural livelihoods: practical concepts for the

    21st century. IDS Discussion paper 296. Brighton, UK: Institute of Development Studies,

    University of Sussex.

Chapin III, F. Stuart, Gary P. Kofinas, and Carl Folke (Eds.) (2009). *Principles of Ecosystem

    Stewardship, Resilience-Based Natural Resource Management in a Changing World*.

    New York: Springer.

Coleman, Eric A. (2011). Common property rights, adaptive capacity, and response to forest

    disturbance. *Global Environmental Change-Human and Policy Dimensions,* vol. 21, No. 3

    (April), pp. 855-865.

Cutter, S. L., and others (2008). A place-based model for understanding community resilience to

    natural disasters. *Global Environmental Change*, vol. 18 (July), pp. 598-606.

Cutter, S.L., B.J. Boruff, and W.L. Shirley (2003). Social Vulnerability to Environmental Hazards.

    Social Science Quarterly, vol. 84, No. 1 (June), pp. 242-261. South Carolina:

    Southwestern Social Science Association.

deFur, Peter L., and others (2007). Vulnerability as a function of individual and group resources in

    cumulative risk assessment. *Environmental Health Perspectives*, vol. 115, No. 5 (May),

    pp. 817-824.

Eakin, Hallie, and Amy Lynd Luers (2006). Assessing the vulnerability of social-environmental

    systems. *Annual Review of Environment and Resources*, vol. 31 (July), pp. 365-394.

Eggerman, Mark, and Catherine Panter-Brick (2010). Suffering, hope, and entrapment:

    Resilience and cultural values in Afghanistan. *Social Science and Medicine*, vol. 71, No.

    1 (March), pp. 71-83.

Folke, C., and others (2002). Resilience and Sustainable Development: Building Adaptive
    Capacity in a World of Transformations. *Ambio, 31*(5), 437-440.

Google (2012). Google Scholar. Available from http://scholar.google.com. Accessed 22 October
    to 14 November 2012.

Handmer, John (2001). Human rights and disasters: Does a rights approach reduce vulnerability?
    Paper presented at the Natural Hazards Workshop, University of Colorado, Boulder.
    Colorado, July.

Holling, C. S. (2001). Understanding the complexity of economic, ecological and social systems.
    Ecosystems, vol. 2001, No. 4 (March), pp. 390-405.

Ikeme, Jekwu (2003). Equity, environmental justice and sustainability: incomplete approaches in
    climate change politics. *Global Environmental Change*, vol. 13, Issue 3 (October), pp.
    195-206.

Intergovernmental Panel on Climate Change (IPCC). (2012). Managing the Risks of Extreme
    Events and Disasters to Advance Climate Change Adaptation. Summary for
    Policymakers. In C. B. Field, V. Barros, T. F. Stocker and Q. Dahe (Eds.).
    Cambridge/New York: Intergovernmental Panel on Climate Change, World Health
    Organization, United Nations Environment Programme.

Jerneck, Anne, and Lennart Olsson (2008). Adaptation and the poor: development, resilience and
    transition. *Climate Policy*, vol. 8, No. 2, pp. 170-182.

Kalin, Walter (2011). A human rights-based approach to building resilience to natural disasters.
    Paper presented at the Nansen Conference on "Climate Change and Displacement in the
    21st Century", Oslo, Norway, June.

Kasperson, R.E., and K. Dow (2005). Chapter 6: Vulnerable People and Places. In R. Norgaard
    and D. Rapport (Eds.), *Ecosystems and Human Well-being: Current State and Trends,
    Findings of the Condition and Trends Working Group, Millennium Ecosystem
    Assessment,* vol. 1, pp. 143-164. Washington: Island Press.

Kent, George (2012). Rights-based disaster planning. Paper presented at the East-West Center
    Spring 2012 Evening Seminar, University of Hawaiʻi. Honolulu, February.

Langridge, Ruth, Juliet Christian-Smith, and Kathleen A. Lohse (2006). Access and resilience: Analyzing the construction of social resilience to the threat of water scarcity. *Ecology and Society,* vol. 11, No. 2, Article 18.

Lebel, Louis, and others (2006). Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society*, vol. 11, No. 1, Article 19.

Marks, Stephen P. (Ed.) (2006). *Health and Human Rights: Basic International Documents* (2nd ed.). Cambridge, Massachusetts: François-Xavier Bagnoud Center for Health and Human Rights, Harvard University Press.

Moher, D, Liberati, A, and DG Altman (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. The PRISMA Group (2009). PLoS Med vol. 6, No. 6*.*

Morin, Anne, and Lorena Patino (2010). Background Paper on Climate Change, Well-being and Human Rights: Government of Canada, Policy Research Initiative. Canada: Her Majesty the Queen in Right of Canada.

Morrow, Betty Hearn (2008). Community Resilience: A Social Justice Perspective. CARRI Research Report 4. Miami: Community and Regional Resilience Initiative.

Mustafa, Daanish. (1998). Structural Causes of Vulnerability to Flood Hazard in Pakistan. *Economic Geography,* vol. 74, No. 3, (July), pp. 289-305.

National Research Council (NRC) (2011). Building Community Disaster Resilience through Private-Public Collaboration: Committee on Private-Public Sector Collaboration to Enhance Community Disaster Resilience, Geographical Science Committee, National Research Council. National Academies Press.

O'Brien, Karen, Bronwyn Hayward, and Fikret Berkes (2009). Rethinking Social Contracts: Building Resilience in a Changing Climate. *Ecology and Society,* vol. 14, No. 2, Article 12.

Perrin, P. (1996). *War and Public Health, A Handbook*. Geneva: International Committee of the Red Cross (ICRC).

PreventionWeb (2012). Website from United Nations International Strategy for Disaster Reduction. Available from

http://www.preventionweb.net/english/professional/publications/. Accessed 22 October to

    14 November 2012.

Prieur, Michel (2009). Ethical Principles on Disaster Risk Reduction and People's Resilience: Eur-

    opa Major Hazards Agreement, Council of Europe. Strasbourg: Council of Europe.

Solomon, S., and others (2007). IPCC 2007: Climate Change 2007: The Physical Science Basis.

    Contribution of Working Group I to the Fourth Assessment Report of the

    Intergovernmental Panel on Climate Change (pp. 996). Cambridge, UK and New York,

    USA: Cambridge University Press.

South Pacific Disaster Reduction Programme (SPDRP) (2002). Gender, households, community

    and disaster management: case studies from the Pacific Islands. SOPAC Technical

    Report 282.

SPHERE (2011). *The Sphere Project: Humanitarian Charter and Minimum Standards in Disaster

    Response* (2011 ed.). Geneva: The Sphere Project.

Stallings, R. (Ed.) (2002). *Methods of Disaster Research*. USA: International Research

    Committee on Disasters.

Thomas, David S.G., and Chasca Twyman (2003). Equity and justice in climate change

    adaptation amongst natural-resource-dependent societies. *Global Environmental Change,*

    vol. 15, No. 2005 (November), pp. 115-124.

Turner, B.L., and others (2003). A framework for vulnerability analysis in sustainability science.

    Proceedings of the National Academy of Sciences, vol. 100, No. 14 (February), pp. 8074-

    8079.

United Nations (1994). *United Nations Draft declaration of principles on human rights and the

    environment 1994*. UN Doc., No. E/CN.4/Sub.2/1994/9, Annex, 16 May 1995.

_____ (2012). Official Document System of the United Nations. Available from

    http://documents.un.org. Accessed 22 October 2012 to 14 November 2012.

United Nations, Committee on the Elimination of Discrimination Against Women (CEDAW) (1999).

    *CEDAW General Recommendation No. 24: Article 12 of the Convention (Women and

    Health) 1999.* UN Doc., No. A/54/38/Rev.1, chap. I.

United Nations, Department of Economic and Social Affairs (UNDESA) (2012). *Issues Brief 8: Disaster Risk Reduction and Resilience Building 2012*. New York. Available from http://www.uncsd2012.org/rio20/content/documents/225ib8.pdf. Accessed 19 November 2012.

United Nations, Economic and Social Council (2005). Key Developments And Activities at The Regional Level: Emerging Social Issues. UN Doc., No. E/ESCAP/1358, 5 April 2005.

United Nations, General Assembly (1948). *Universal Declaration of Human Rights*. 10 December 1948. 217 A (III).

_____ (1966a). *International Covenant on Civil and Political Rights.* 16 December 1966. United Nations Treaty Series, vol. 999, p. 171.

_____ (1966b). *International Covenant on Economic, Social and Cultural Rights.* 16 December 1966. United Nations Treaty Series vol. 993, p. 3.

_____ (1989). *Convention on the Rights of the Child*. 20 November 1989. United Nations Treaty Series vol. 1577, p. 3.

_____ (2009). *Report of the Representative of the Secretary-General on the Human Rights of Internally Displaced Persons.* Walter Kälin - Addendum - Protection of Internally Displaced Persons in Situations of Natural Disasters. UN Doc., No. A/HRC/10/13, Add.1, 3 May 2009.

United Nations, General Assembly, Human Rights Council (2009). *Annual report of the united nations high commissioner for human rights and reports of the office of the high commissioner and the secretary-general: Report of the Office of the United Nations High Commissioner for Human Rights on the relationship between climate change and human rights.* UN Doc., No. A/HRC/10/61, 15 January 2009.

United Nations International Strategy for Disaster Reduction (UNISDR) (2005). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, Extract from the final report of the World Conference on Disaster Reduction, Kobe, Hyogo, Japan.* Geneva, Switzerland: UNISDR/A/CONF.206/6. Available from http://www.unisdr.org/we/inform/publications/1037. Accessed 5 November 2012.

_____ (2008a). *Environment and Disaster Risk, Emerging Perspectives.* Prepared on behalf of the ISDR Working Group on Environment and Disaster Reduction, 2nd edition. Available from http://www.unisdr.org/we/inform/publications/624. Accessed 5 November 2012.

_____ (2008b). *Indicators of Progress: Guidance on Measuring the Reduction of Disaster Risks and the Implementation of the Hyogo Framework for Action.* Available from http://www.unisdr.org/we/inform/publications/2259. Accessed 5 November 2012.

_____ (2008c). *Gender Perspectives: Integrating Disaster Risk Reduction into Climate Change Adaptation, Good Practices and Lessons Learned.* Available from http://www.unisdr.org/we/inform/publications/3391. Accessed 5 November 2012.

_____ (2011). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, Mid-Term Review 2010-2011.* Available from http://www.preventionweb.net/files/18197_midterm.pdf. Accessed 5 November 2012.

United Nations International Strategy for Disaster Reduction, and World Meteorological Organization (2012). United Nations system task team on the post-2015 UN Development Agenda *Disaster risk and resilience: thematic think piece*. Available from http://www.unisdr.org/files/27462_20120607unttpostmdgthinkpieceondrra.pdf. Accessed 5 November 2012.

United Nations University Institute for Environment and Human Security (UNU-EHS), and The Nature Conservancy (2012). World Risk Report 2012. Berlin: Alliance Development Works.

United Nations University (2012). *The Millennium Development Goals Report 2012.* Sales No. E.12.I.4.

van Ginkel, H. (2005). Introduction Speech regarding the Expert Workshop *"Measuring Vulnerability", 23-24 January 2005*. Kobe, Japan: in UNU-EHS Working Paper No. 1, Bonn: UNU-EHS.

Wisner, Ben, and others (2004). *At Risk: Natural Hazards, People's Vulnerability and Disasters* (2nd ed.). London and New York: Routledge.

Zhang, Yang (2010). Residential Housing Choice in a Multihazard Environment: Implications for Natural Hazards Mitigation and Community Environmental Justice. *Journal of Planning Education and Research*, vol. 30, No. 2 (September), pp. 117-131.

CHAPTER 4. QUANTIFYING HOUSEHOLD SOCIAL RESILIENCE:

A PLACE-BASED APPROACH IN A RAPIDLY TRANSFORMING COMMUNITY

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Abstract

In an era of ecological degradation, global climate change, demographic shifts and increasing intensity and frequency of natural hazards, the Pacific Islands including the State of Hawai'i face heightened risk. The link between human and environmental well-being coupled with the growing demand to develop science-based solutions makes linking the applied sciences of natural hazard preparedness, relief and recovery with resilience theories and applications critical. However, these fields remain mired in epistemological silos, and the operationalization of these theories has been slow, particularly at the community level. The paper discusses the challenges of bridging the intersecting fields contributing to social resilience and explores solutions for these lacunas in a community-based case study in Hawai'i. Results from household surveys constructed from an adapted conceptual framework, reveal community characteristics and composition to highlight demographic changes including a high visitor to resident ratio, low longevity of residence and predominantly mainland residents. Residents exhibit medium to high coping and adaptive capacities with diverse local knowledge, skills and resources, and a sense of preparedness and willingness to assist one another in a disaster. In particular, social resilience metrics highlight differential coping and adaptive capacities amongst different households, which

offer targets for resilience planning. A gap analysis developed from a qualitative analysis of open-ended survey questions highlights key sectors or areas perceived as having gaps in preparedness and resilience, coupled with ideas for solutions which centered around local capacity building and improved knowledge and awareness. Results inform the development of a long-term disaster resilience planning initiative to provide targets for addressing gaps in vulnerable sectors and populations.

Keywords: adaptation, climate change, community, demographic shift, hazard, resilience, transformation

1.   Introduction

The concept of resilience has gained increasing traction in policy and planning spheres for its applicability to understanding social and environmental changes and the factors that lead to rapid and sometimes catastrophic shifts in these linked systems (Folke et al., 2010; Walker & Salt, 2006). Resilience research to date has focused primarily on theoretical frameworks that articulate the concept and behavior of social-ecological systems, with a focus on processes such as feedback between social and ecological systems, adaptive capacity and transformability (Folke et al., 2010; Olsson, Folke, Galaz, Hahn, & Schultz, 2007). In practice, resilience holds the potential to foster understanding about how to move linked social-ecological systems toward more sustainable states.

The social dimensions of resilience theory remain largely undefined and the connection of social sciences with resilience theory is underdeveloped compared to the ecological sciences. Many resilience-like concepts exist in social science, but the diversity in social science disciplines and theory has led to many different conceptions of social resilience. Adger has defined social resilience as the ability of groups or communities to cope with external stresses and disturbances manifested as social, political and environmental change (W. Neil Adger, 2000). This has also been defined as "adaptive capacity" by various researchers (W. N. Adger, 2003; Berkes, Colding, & Folke, 2003; Fazey et al., 2007; Gallopín, 2006; Yohe & Tol, 2002). Almedom and Tumwine have drawn on coherence models (A. Antonovsky, 1979; Aaron Antonovsky, 1987) to define

resilience as a multi-dimensional social construct (Almedom & Tumwine, 2007). Gunderson has

also defined social resilience as being comprised of the key components of learning, trust and

engagement (Gunderson, 2003). In addition, social and cultural capital are also posited to be the

mechanisms that provide resilience by maintaining the pathways for adaptation and learning

through cultural transmission of information (W. Neil Adger, 2000; Berkes et al., 2003; Berkes,

Folke, & Colding, 1998; Robbins, 2007). The plurality of definitions for social resilience that have

been advanced are attributed in part to the different intellectual traditions from which researchers

draw (Gallopín, 2006).

Social scientists have begun to explore operational ways of assessing social resilience and

resilience-like attributes. Cinner and colleagues, for example, developed an index of adaptive

capacity for coastal communities, using survey-based data sources from community members

and independent attributes of community capacity such as infrastructure (Cinner et al., 2009;

McClanahan et al., 2008). Similarly, Marshall and Marshall created a composite index for social

resilience in surveys with Australian fishers (Marshall & Marshall, 2007). Other researchers have

also relied on this approach to assess social resilience in resource user populations (Lédée,

Sutton, Tobin, & De Freitas, 2012; Sutton & Tobin, 2012). Measures for comparison of adaptive

and coping capacity indices at the household level remain understudied.

Coping capacity is the shorter-term ability of socio-ecological systems and their sub-systems or

components (i.e. people, systems and organizations) to manage after a disaster, emergency or

other adverse event, and includes access to material goods, assets, resources and networks,

critical to improving resilience. Adaptive capacity is the longer-term ability to recover from and

adapt to a disaster or long-term transformations like climate change consist of utilizing

knowledge, skills, social memory and expertise. Social capacity or social resilience is comprised

of coping and adaptive capacity, which are components of socio-ecological system resilience.

Recent work has focused on developing indicators for social resilience, although evidence from

social science literature suggests that indicators are most successful when they are developed by

or with those who will use them for explicit decision-making (TRIAMS, 2006). Quantifying social

resilience for short and long-term challenges, in addition to social perturbations or shifts requires

consideration of the context and nuances specific to a given place and scale. Developing a place-based approach to quantifying social resilience remains a key challenge that needs to be met if the concept is to be used successfully in planning and policy. This research links disaster hazards, risk and social resilience and adaptive capacity literature through an applied case study, in order to understand, measure, and increase disaster resilience and adaptive capacity of people and the environment of Hanalei. A method for quantifying social resilience is presented here, along with place-based measures of community-based resilience, using household surveys done in the Hanalei, Kaua'i community as empirical evidence.

2. Background

2.1 Islands, natural hazards and vulnerability

Pacific Island communities are hotspots for many natural hazards, and are at heightened risk to hazards associated with climate change (UNU-EHS, 2012). In Hawai'i, for example, climate change is predicted to increase the frequency and intensity of natural disasters such as droughts, floods and possibly hurricanes (HSCD, 2007). The State of Hawaii and its counties have well-developed hazard mitigation plans that identify hazard risk, monitoring activities, and projects to mitigate natural hazards. Key gaps in current hazard mitigation plans have been recognized in the areas of climate change risk and vulnerability (food and water security), socioeconomic risk and resiliency factors (demographics, poverty, livelihood alternatives, and health), as well as secondary impacts to sectors such as the tourism industry, including hotels and resorts. This project engaged in community-based participatory research and planning to fill these information gaps, through collaborating with local hazard mitigation and policy efforts, and ultimately fostering the development of hazard and climate change resilient communities.

2.2 Study Site

Located on the North Shore of the Island of Kaua'i, Hanalei is geographically isolated and vulnerable to many natural hazards including sea level rise associated with climate change. Resting at sea level in a valley surrounded by steep mountains, the only exit has one-lane bridges that close in event of flood, tsunami & hurricanes. Seasonal flooding is a part of life in Hanalei. Changes in the intensity and duration of rainfall in recent years have caused acute

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damaging floods. Local social resilience is critical to ensuring protection of property, lives and livelihoods. Hurricane Iniki in 1992 was the most recent destructive disaster to hit Hanalei. Discussions with community leaders revealed that although Hanalei had no formalized disaster resilience programs or policies in place during Iniki, residents report having coped during and adapted well after the hurricane, due to close familial and social support networks, self-organization and self-sufficiency, material preparedness and experience and knowledge of past disaster. As a result, community members turned away much of the external disaster relief aid.

However, since 1992 Hanalei has experienced changes that many residents fear have weakened the community's social capacity (Coffman & Noy, 2009). Small family homes have been replaced by gated vacation rentals, replacing permanent and long-term residents with temporary visitors or empty residences. Currently the daily average visitors count of 10,000 to the entire North Shore of Kauaʻi (including the towns from Hanalei to Haʻena) compared to the resident count of 450, produces a visitor to resident ratio of 22:1 (HTA, 2010) (Figure 4.1). The high daily visitor count creates traffic congestion, utility and infrastructural overload as well as degradation of natural and cultural resources. Visitors are ill prepared for natural hazard events and become a burden on local residents and resources, even during common floods, which result in bridge closure for multiple days. Based on community concerns of compromised resilience, a community-based request to engage in research and planning to understand current community demographics and resilience characteristics initiated the research described in this paper.
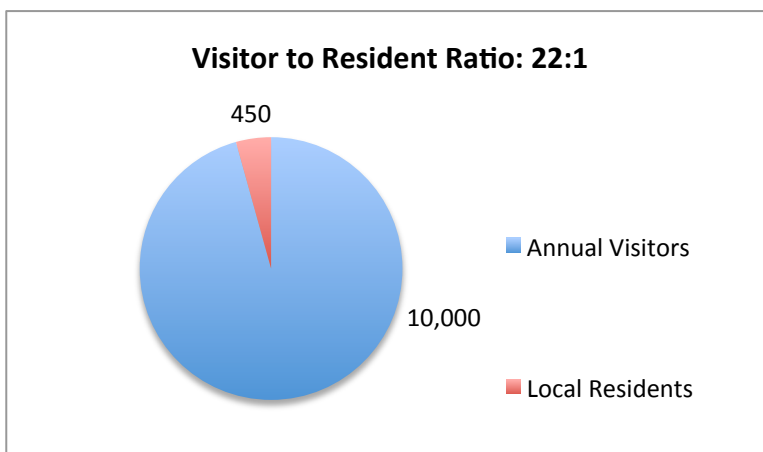
Figure 4.1. Annual visitor count to resident population ratio.

3.   Methods and research design

3.1   Approach

The World Conference on Disaster Reduction "Hyogo Framework for Action 2005—2015" defines disaster resilience as "the starting point for reducing disaster risk and promoting a culture of disaster resilience lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face" (UNISDR, 2005). Therefore, plans and policy must carefully measure and develop the socio-economic, or social, cultural, livelihood and other related factors in the affected communities. The development of such assets for a community is critical to fostering sustainable development and disaster resilience (HSCD 2007). The research team collaborated with community leaders to identify the elements for the household survey that they felt reflect "What resilience looks like for us," since indicators are most successful when they are developed with those who will implement them for decision-making (TRIAMS 2006).

3.2   Conceptual framework

A conceptual framework adapted from Bollin and Hidajat's (2006) *Conceptual framework to identify disaster risk* was used as the basis of the household survey construction (see Appendix B: Hanalei Household Resilience Survey) (Bollin & Hidajat, 2006). The framework illustrates a place-based interpretation of resilience, entitled *Conceptual framework of community-based household disaster risk* (Figure 4.2) (Birkmann, 2006; Bollin & Hidajat, 2006; Wood, Church, Frazier, & Yarnal, 2007, Rev. 2008). A question or set of questions quantitatively or qualitatively measured each variable or set of variables within the social vulnerability and resilience or social capacity components of the framework, to allow for exploration of specific objectives (see Appendix C: Hanalei Household Resilience Survey Indicators). The objectives were to: 1) identify populations with varying levels of social resilience in the community; 2) conduct a gap analysis between resources and needs, to inform a community-based long-term resilience and recovery plan to increase social, economic and ecological resilience to hazards and climate change; and 3) understand what social vulnerability or social capacity components are determinants of a household's perceived preparedness, adaptive capacity and coping capacity.
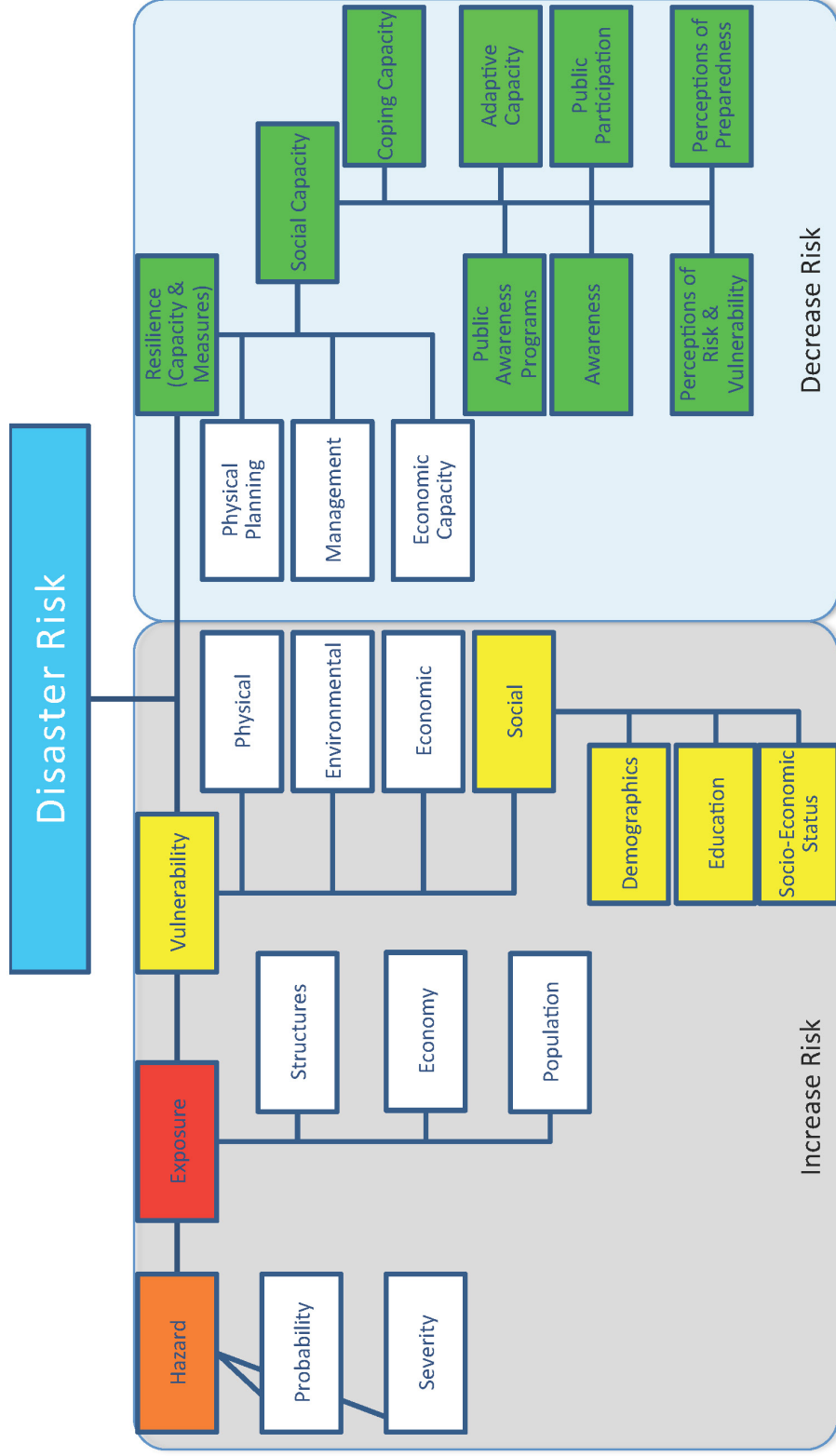
Figure 4.2. Conceptual framework of community-based household disaster risk (Source: Authors, adapted from Bollin et al, 2006 Conceptual framework to identify disaster risk).

A door-to-door household survey was conducted to access long-term residents, part-time residents and visitors, with the latter group having a shorter version of the survey (Appendix B). The household survey incorporates questions to gain quantitative & qualitative data for particular components of the conceptual framework. Within the vulnerability component, indicators were captured as categorical variables measured by questions regarding demographics, education, and socio-economic status. The resilience component was measured through categorical variables and composite indices for various social capacity indicators, including public awareness programs, coping and adaptive capacity, public participation, awareness, and perceptions of preparedness, risk and vulnerability. The conceptual framework indicators measured through the household survey facilitate a broad and multi-disciplinary perspective of current community vulnerabilities as indicators of critical gaps in family and community-level hazard resilience.

All 279 households in the community were visited twice, and leaflets were left to offer the opportunity to take the survey online or be contacted for an in-person survey. Of the 279 houses visited, only 82 had someone home, including 60 residents as well as 22 vacation rentals. The decline rate was relatively low, with nearly 62% (37/60) of long-term residents and 91% (20/22) of visitors completing the survey. The majority of houses (70.6%) visited were not surveyed, due to 28.3% (79/279) being inaccessible due to locked gates, guard dogs or no trespassing signs, and 42.3% (118/279) with no one home, which raises critical issues with adequate representation of the diverse community interests and needs.

3.4   Data analysis procedures

A Gap Analysis identifies the perceived current gaps in resilience using a qualitative review of open-ended questions and summarizing overarching themes by category (i.e. communications, evacuation, and food and water security), listing of identified problems or gaps, followed by mitigative and adaptive solution proposals (see Appendix D. Gap Analysis and Recommendations). The quantitative analysis focused on understanding determinants of the following outcomes: self-reported perceived preparedness; coping capacity via construction of a composite index; adaptive capacity via construction of a composite index.

To examine *perceived household preparedness*, several independent variables were tested to determine which were predictors of preparedness, including. The independent variables examined included, per the conceptual framework, the following: various socio-economic variables, demographics, education, sex, and social capacity measures including awareness of public education programs, participation in public activities and governance, awareness of disasters, coping and adaptive capacity and perceptions of risk and vulnerability.

To examine *coping capacity,* a composite index was constructed using 18 equally weighted variables. They included access to: community or family garden, farmland, livestock, hydroponics or aquaponics systems (fish), land ownership, housing ownership, safe place to evacuate, community resources, social support network/communication tree, stocked food/water supplies/emergency rations including an emergency kit and family emergency plan, generators, car, truck or off road vehicle, tractor, groundwater well and whether they know of evacuation routes & safe places as well as knowledge of disaster aid resources. Financial level (low, medium, high) although typically a component of coping capacity, was left out of the coping capacity index, but included in regression analyses to determine if financial status influences coping capacity. For every variable of coping capacity the respondent answered "Yes" to, this was added to the composite total score. The index was calculated as the proportion of coping variables the household had access to, out of the 18 possible variables selected, and therefore ranged between 0 and 1. The independent variables tested included the following variables: sex, perceived degree of preparedness and willingness to assist others in a disaster, perceived degree of community preparedness, origin, longevity of residence, education, financial level (low, medium or high) and public participation.

To examine *adaptive capacity,* a composite index was constructed using 11 equally weighted categorical variables, including knowledge of and/or skills in: emergency preparedness, traditional medicine, traditional ecological knowledge, food preservation, fishing, hunting, raising livestock, gardening/farming and construction, and whether they have heard stories of or had experiences in disasters that they feel better prepared them to adapt to future disasters (contributes to social memory), as well as whether they feel knowledgeable enough about disasters to be able to

prepare and adapt in the future. Similar to the coping index, for every variable of adaptive

capacity the respondent answered "Yes" to, a value of one was added to the composite total

score, and the index was the fraction of adaptive variables out of the possible 11. The

independent variables tested to determine which were determinants/predictors of adaptive

capacity included: sex, perceived degree of preparedness and willingness to assist others in a

disaster, perceived degree of community preparedness, origin, longevity of residence, education,

financial level (low, medium or high) and public participation.

All responses were entered into Survey Monkey and downloaded into Microsoft Excel. Qualitative

answers were used in the Gap Analysis & Recommendations (Appendix D). All quantitative data

was then imported into the statistical analysis software package STATA v.11 for statistical

analyses. Due to a small sample size of visitors (n=20) and residents (n=37) and the large

number of explanatory variables, options for statistical analyses were limited. Multi-regression

analyses using Probit and Logit produced unreliable results, so linear probability modeling via

ordinary least squares was run using STATA v.11. Caution was paid to not include too many

explanatory variables, as this can falsely make the model look like a good fit and inflate the R-

squared value, so the adjusted R-squared value was used. Any results with adjusted R-squared

values less than 30% were not included in the results.

4.   Results

<u>4.1   Descriptive metrics</u>

4.1.1   Community structure and demographic shifts

Of the visitors surveyed (n=20), 90% are from the mainland U.S. and 10% are from other

countries. Most (75%) visitors stay over a week and are repeat visitors (63%), raising the concern

that if a significant disaster affects the area, arranging logistics for the evacuation and expedited

travel of such visitors may prove difficult. The increasing influx of visitors and new residents over

the past few decades (Colburn and Jepson 2012) has changed the demographic profile of

Hanalei, such that 73% of the resident respondents are not from Hanalei or Kauai and 86% of the

population is Anglo (Figure 4.3). A transition from long-term affordable residential housing to high-

cost homes, rentals and legal and illegal temporary vacation rentals has occurred (Figure 4.4).

These shifts appear to have severed social-ecological linkages at the community level by diminishing the proportion of residents that have detailed knowledge of the region's ecosystems and resources and fracturing the sense of community and social networks that prove critical during disasters.
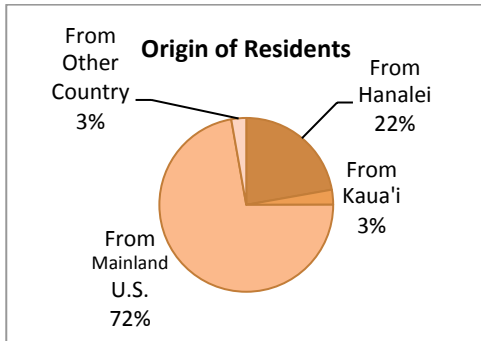
Figure 4.3. Origin of residents.
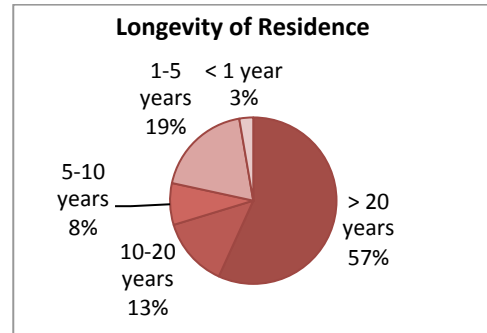
Figure 4.4. Longevity of residence.

4.1.2   Perceptions of community & disaster preparedness, willingness to help each other

Figure 4.6 illustrates that resident respondents feel prepared (77.1%) due to having heard stories and personal experiences in disasters (91.2%) and having strong levels of knowledge and understanding of disasters to prepare and adapt (91.9%). However, only 54.1% feel that the community, as a whole, is prepared for disaster, qualitatively reported as due in large part to the strain that unprepared, vulnerable and dependent visitors place on resident during and after disasters such that ninety percent of visitors surveyed indicated that they are not prepared and will need to turn to the community for support.
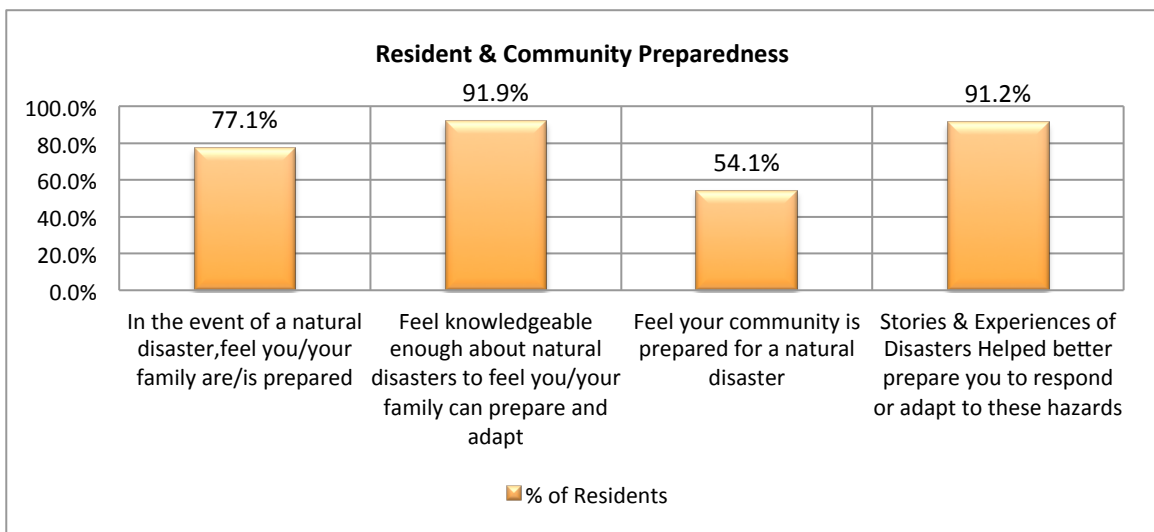
Figure 4.5. Resident and community preparedness.

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Figure 4.5 illustrates residents' and visitors' self-perceived preparedness for disasters and willingness to assist others. Many residents responding to the survey report an ability and willingness to help neighbors (24.3%), community members (21.6%) and visitors or anyone in need (21.6%), which indicates an overall high level of capacity and desire to support fellow community members in a time of need, an attribute critical to social resilience. In addition, 64.7% of respondents say they receive fish as a gift from local fisherman or family members, a long-held tradition of sharing natural resources and foods with family and community. While 91.9% of resident respondents know of community meeting areas or safe refuges to evacuate to, only 87.5% would evacuate in the event of hurricane or tsunami. Many stated that although they perceive this risk they accept it rather than not being able to get back to their homes if the bridge or roads are closed. The lack of desire to evacuate may increase loss of lives, injuries, health emergencies, and required that additional considerations are called for in the development of the disaster resilience plan and Gap Analysis (Appendix D).
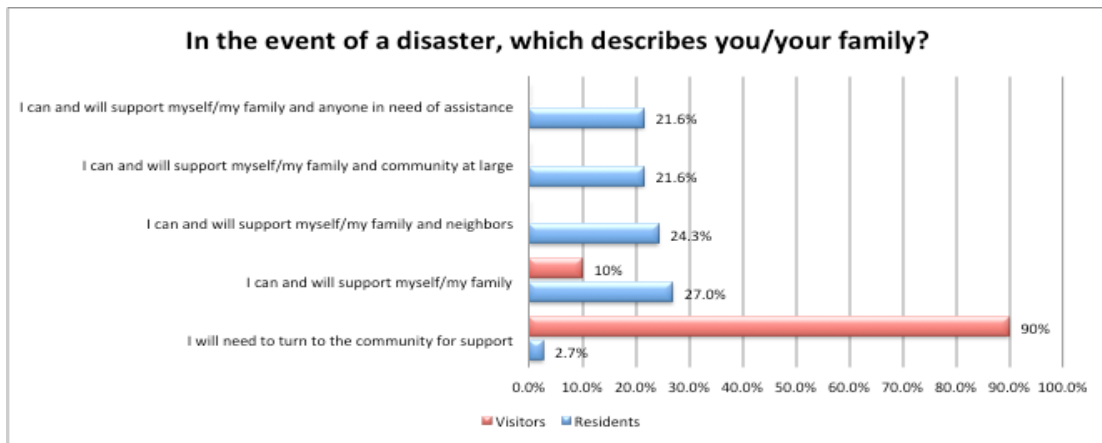
Figure 4.6. Visitor vs. resident preparedness.

After the household survey was conducted, a major flood occurred over the course of 4 days in Hanalei, closing the 1-lane bridges, and causing multiple points of isolation from landslides and flooded roads. Initial post-flood interviews found that residents and business owners were more unprepared than they originally communicated. Local health emergencies occurred and first responders had difficulty with staging and accessing populations, evacuation of tourists was inadequate and led to multiple tourists becoming trapped on store porches or in their rental cars for days without food, water, shelter or bathroom facilities. Some residents cared for them,

offering provisions that began to run short for residents. Many residents are not willing or able to help tourists (21.6%), and feel tourists are not a part of community.

4.1.3   Perceptions of risk and vulnerability

The hazards of greatest concern to respondents included tsunami (97.2%) ranked as the one first by 52.8%, hurricane (94.4%) ranked first by 11% and flood (77.8%) ranked first by 30.6% (see Figure 4.7). Experience recall of these hazards ranged from once (18.5%) for new resident respondents, to 2 to 3 times (25.9%), 4 to 5 times (14.8%), more than 7 times (18.5%) and 22.2% unsure. A large majority of resident respondents (93.5%) report hearing stories of these hazards, and collective knowledge gained from hearing stories and direct experiences has better-prepared them (91.2%) to adapt to future disasters. Residents respondents reported the following impacts: agriculture or crop loss (6.9%); cattle health impacts and death (6.9%); water scarcity/water rationing (20.7%); change in rainfall amount/patterns (13.8%); loss of life (41.4%); loss of property (69.0%); loss of jobs/livelihood (69.0%); school/community facilities (62.1%); public health (20.7%); social (13.8%); culture (6.9%); environment (31.0%); well-being (10.3%); food/water insecurity (44.8%); and recreation (3.4%). This illustrates the multi-faceted impacts disasters and hazards have on this community, and the challenge of creating a multi-sector approach to build resilience.
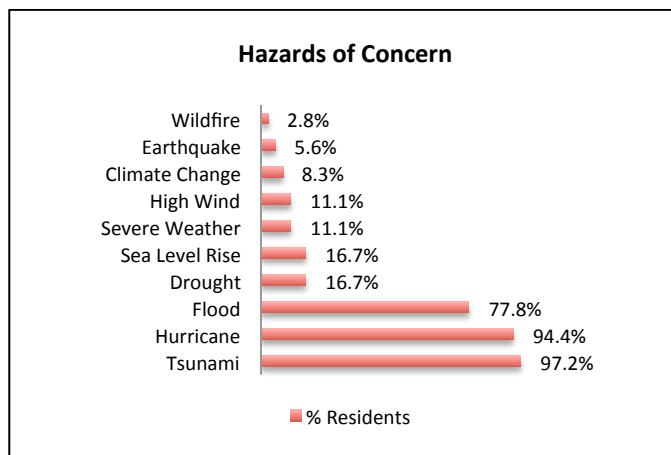
Figure 4.7. Hazards of concern.

Asymmetry of knowledge and awareness of hazards seems to exist. For example, while many residents informally discuss that floods are not a threat to Hanalei, flood was still one of the top hazards of concern. In addition, while only 16.7% of respondents felt drought is an issue, all

counties in the State of Hawaiʻi have been declared a disaster area by the U.S. Department of Agriculture due to drought since January 2008 (CWRM, 2012; NIDIS, 2012). If certain hazards, such as drought, are not perceived as a threat, then people act inappropriately, potentially increasing risk. A desire to receive more disaster information and education exists, particularly around plans and protocols to address the needs of the visitor population. Reliance on fishing and farming exists in Hanalei. On the one hand, this creates more resilient populations and practices due to interconnectedness with nature and place-based resource management, while on the other, vulnerability from overdependence upon these resources may also be created.

4.1.4   Community involvement, governmental roles and expectations

Many (70.3%) resident respondents are members of or participate in a range of community or volunteer groups, with 79.2% participating frequently and 12.5% participating often, indicating enhanced social cohesion and recovery. Many resident respondents (32.4%) expect no assistance from government or relief agencies, while , 13.5% expect provision of basic services (evacuation, food, water, shelter) only for those most in need; and 51.4% expect provision of basic services *for all residents including visitors*; 21.6% expect job protection and/or financial support; 51.4% expect assistance with cleanup & reconstruction, and; 40.5% expect provision of emergency health services. Additional assistance expected by the community includes upholding safety and public order as well as protect public property. Many residents also discussed the need for their community members to come together, collaborate with one another and be self-sufficient in the recovery process.

Regarding awareness of public informational programs, 73% of resident respondents report exposure to at least one including governmental and non-governmental agencies, community members, families, radio, newspapers, Internet, television and other sources. All residents were aware of the early warning systems, however 5.6% rated them Not Effective due to lack of audibility of sirens in some places, 27.8% rated them Somewhat Effective due to insufficient coverage of sirens as well as slow repair of broken sirens. The majority (66.7%) of resident respondents rated the early warning system as "very effective" though some still report

dysfunctional sirens and late warnings, and visitors or new residents may still be unaware of what the tsunami warnings indicate and where to evacuate to.

4.1.5   *Coping and adaptive capacity*

Resilient populations, defined as households with high adaptive and coping capacities, were found to be local residents. Access to resources during and post-disaster help households absorb the shock of the disaster and the resulting impacts of damage to or loss of housing, livelihoods and employment, and the inability to access basic services and goods. Access to savings and other liquid assets enables households to continue to make payments for basic needs despite a lag or loss of employment income or inability to access banks. Ownership of or access to farms, gardens, livestock, hydroponic systems and stocked food and water supplies allows for provision of food and water to enable survival. Social networks enable households to shelter or seek other temporary resources or support until they are able to recover on their own, and home ownership and insurance facilitate repayment of losses and the ability to rebuild. Coping capacity principally concerns the timeframe of pre-disaster, during and short-term post-disaster, as resources will eventually become depleted or strained if normal services and productivity aren't resumed.

As illustrated in Figures 4.8 and 4.9, local residents exhibit medium to high coping capacity, as demonstrated by material preparedness, access to resources as well as social networks and financial assets, and also show strong adaptive capacity due to knowledge, expertise and skills sets in diverse fields.

Coping Capacity: Resources & Networks

Legend:
- Community or family garden
- Farmland
- Livestock
- Hydroponics or Aquaponics systems (fish)
- Land ownership
- Housing ownership
- Safe place to evacuate
- Community resources
- Social support network/communication tree
- Stocked food/water supplies/emergency rations
- Emergency Kit
- Family emergency plan
- Generators
- Car/truck/ORVs
- Tractor
- Groundwater well
- Access to Savings
- Financially Comfortable

Values shown: 59.5%, 32.4%, 24.3%, 2.7%, 21.6%, 54.1%, 83.8%, 45.9%, 73.0%, 67.6%, 73.0%, 70.3%, 29.7%, 81.1%, 10.8%, 5.4%, 100.0%, 83.8%

Figure 4.8. Household coping capacity characteristics.

The longer-term dynamic of recovery and resilience approaches adaptive capacity, which is often resource-independent and relies more on knowledge, expertise, social memory and legacy effects, and other practices, which enable self-sufficiency and adaptation despite disruption in normal services and functions. Community perceptions of resilience hinge greatly upon what is important in community. Dynamics that compromise these community characteristics are seen as direct threats to their resilience.
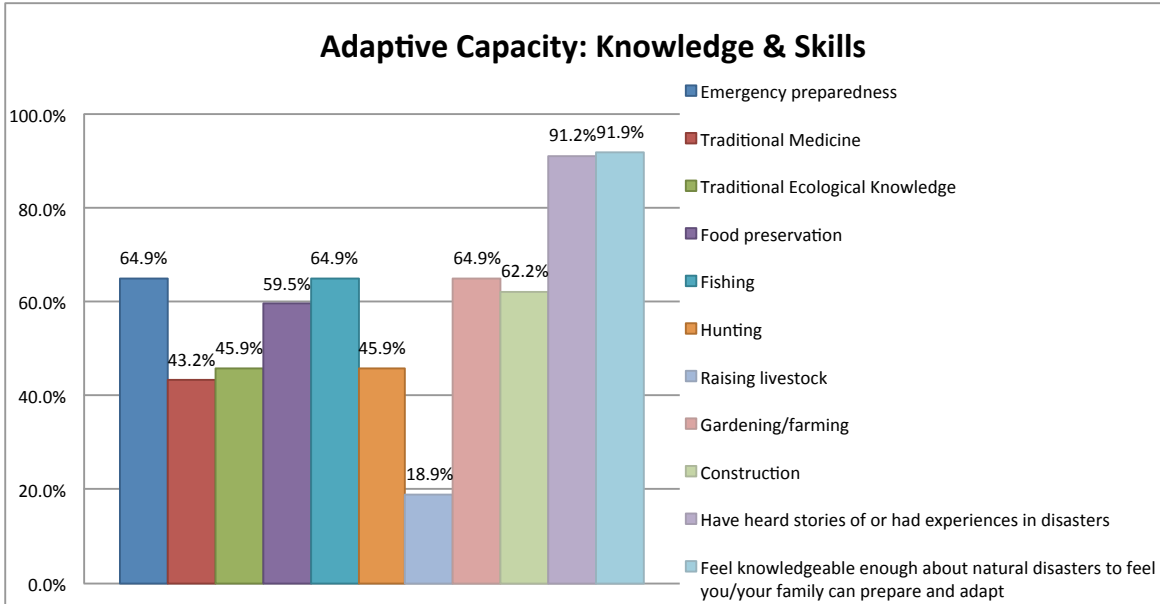
Figure 4.9. Household adaptive capacity characteristics.

4.2   Gap analysis

The qualitative responses targeted at identifying existing gaps in resilience at the population, infrastructural, governance and systems-level, coupled with proposed solutions for mitigation and adaptation, are provided in Appendix D. In summary, the congruent categories of concern listed by resident respondents included gaps with evacuation, food and water, energy and continuity of services, communication and information systems, special populations, the visitor or tourist population, infrastructure, sheltering and mass care, education, leadership and local capacity building, early warning systems and emergency services. The majority of needs or gaps reflected upon the lack of awareness and education, asymmetry of information from governmental and community regarding plans and protocols and expectations of assistance, and inadequate physical or infrastructural measures.

Recommendations to address these vulnerabilities centered primarily around community-based capacity-building and leadership development to increase community-wide disaster preparedness, knowledge, awareness and contingency planning, which will inform community-based resilience plan action items and strategies. These efforts will be targeted for collaboration and integration with parallel non-governmental, community group and governmental efforts and plans, in order to address cross-sector gaps such as infrastructural issues with evacuation routes

and management, early warning systems and mass care coordination.

4.3   Determinants of perceived preparedness

Correlations between preparedness and other variables were examined to identify potential collinearity, and to understand how sense of preparedness is related to other household characteristics. As is to be expected, visitors as well as resident respondents who report they will not need to turn to the community for assistance during a disaster and will be able to support themselves among others, are 79.5% more likely to feel prepared (p = 0.002) than those who report feeling prepared. Female-headed households and feeling prepared are weakly negatively related (Pearson's r = -0.2619), whereas male-headed households and feeling prepared weakly positively related (Pearson's r = 0.2619). This relates to the lower coping and adaptive capacity score for females versus males, discussed in the following sections. No significant difference exists in feeling prepared between households that rented or owned.

	Dependent Variable: Perceived Household Preparedness			
	Specifications			
	1	**2**	**3**	**4**
Female	0.012 (0.202)	-0.105 (0.151)	0.0613 (0.193)	-0.184 (0.187)
Rental	-0.218 (0.357)	---	---	---
Owned	-0.310 (0.325)	---	---	---
Know how to fish	-0.018 (0.228)	---	---	---
Know how to preserve food	0.255 (0.189)	---	---	---
Origin: Mainland	-0.0495 (0.187)	---	---	---
< 1 year residence	---	---	---	---
1-5 years residence	---	---	---	---
5-10 years residence	---	-0.667 (0.172)***	-0.836 (0.267)***	-0.681 (0.262)**
10 - 20 years residence	---	0.276 (0.205)	---	-0.287 (0.288)
> 20 years of Residence	0.009 (0.147)	-0.060 (0.120)	---	-0.131 (0.179)
Trade fish	0.051 (0.174)	---	---	---
Profession of Teacher	-0.924 (0.375)**	-1.264 (0.309)	---	---
Have a safe place to evacuate to	0.216 (0.336)	0.559 (0.211)**	0.442 (0.304)	---
Know of safe places to evacuate to	0.476 (0.395)	---	---	0.956 (0.323)***
Know of public awareness programs	0.146 (0.218)	0.099 (0.131)	-0.004 (0.176)	-0.061 (0.242)
Think early warning systems are very effective	-0.061 (0.164)	---	---	---
Think early warning systems are somewhat effective	---	---	---	0.062 (0.174)
Have experienced or heard stories of disasters	---	0.357 (0.258)	0.804 (0.409)*	---
Age group 25-34	---	0.037 (0.196)	-0.069 (0.262)	-0.021 (0.301)
Age group 35-49	---	-0.039 (0.148)	-0.255 (0.185)	-0.351 (0.233)
Age group 50-64	---	0.0597 (0.144)	0.004 (0.188)	-0.004 (0.236)
Finance group: Medium level	---	---	-0.277 (0.259)	---
Finance group: High level	---	---	-0.069 (0.201)	---
Participation in a Community Group	---	0.009 (0.131)	---	---
Race: Asian	---	---	---	-0.640 (0.516)
Race: Native American	---	---	---	0.040 (0.403)
Race: Native Hawaiian	---	---	---	0.391 (0.408)
Race: White	---	---	---	-0.731 (0.445)
Adjusted R-squared	0.427	0.710	0.475	0.371
Constant	0.252 (0.420)	0.002 (0.211)	0.079 (0.318)	0.927 (0.607)

*=p<10%; **=p<5%; ***=p<1%

Table 4.1. Predictors of household perceived preparedness.

The majority of explanatory variables regressed against all three outcomes, self-reported preparedness, coping and adaptive capacity indices, were not found to be statistically significant. Results listed in Table 4.1 are the findings from each regression specification. Teachers were

92.4% less likely to feel prepared (p=0.025) however this was one person and likely not representative of all teachers. Respondents who know of community meeting areas or safe places to evacuate to in the event of a disaster are 95.6% (p = 0.009) more likely to feel prepared than those who do not. Similarly, respondents who have a safe place to evacuate to are 55.95% more likely to feel prepared than those who do not (p = 0.016). Respondents who have lived in Hanalei 5-10 years are 66.66% less likely to feel prepared than those who have lived there 1-five years (p = 0.001) which is unexpected, where those with longer residence are expected to be more prepared than new residents, again likely due to small sample size and inability to generalize results. Respondents who have heard stories of and/or had experiences in disasters and feel these experiences have helped them better prepare to respond or adapt to hazards, are 80.4% more likely to feel prepared (p = 0.065) than those who haven't. Finally, residents who have a safe place to evacuate to are 55.96% more likely to feel prepared (0.016) than those who do not.

4.4   Determinants of coping capacity

Female respondents have a 0.31 (p = 0.005) lower coping capacity index as compared with males (p=0.005), indicating female-headed households may have lower coping capacity than male-headed households or are reporting less resources and networks than men. Resident respondents who have lived in Hanalei 1-5 years have a reduced coping index by 0.23 compared to those who have lived there more than 20 years (p=0.014), which supports the notion that as residency longevity increases so does coping capacity. Residents who feel the community is prepared have a 0.16 (p=0.056) higher index than those who do not. In addition, residents who are members of or participate in a community or volunteer group have a 0.18 (p=0.035) higher coping capacity index than those who do not.

	Dependent Variable: Household Coping Capacity	
	Specifications	
	1	2
Perceived as Prepared	0.0933 (0.076)	0.133 (0.078)
Feel the community is prepared	0.101 (0.074)	0.155 (0.077)*
Female	-0.129 (0.0848)	-0.034 (0.081)
Origin: Mainland	-0.185 (0.218)	-0.002 (0.167)
Origin: Kauai	-0.341 (0.206)	---
Origin: Hanalei	-0.148 (0.215)	-0.011 (0.167)
< 1 year residence		-0.167 (.0217)
1-5 years residence	-0.228 (0.082)***	-0.146 (0.076)
5-10 years residence	-0.022 (0.119)	-0.021 (0.118)
10 - 20 years residence	-0.092 (0.092)	-0.118 (0.101)
Highest education achieved: High school diploma or equivalent	-0.147 (0.172)	---
Highest education achieved: Some college	0.069 (0.094)	---
Highest education achieved: Associate's degree	0.075 (0.109)	---
Highest education achieved: Bachelor's degree	0.031 (0.088)	---
Finance group: Medium level	0.168 (0.111)	---
Finance group: High level	-0.007 (0.095)	---
Participation in a Community Group	0.176 (0.075)**	---
Adjusted R-squared	0.4917	0.3176
Constant	0.451 (0.259)	0.3795002

*=p<10%; **=p<5%; ***=p<1%

Table 4.2. Determinants of household coping capacity composite scores.

4.5   Determinants of adaptive capacity

Respondents that report being self-sufficient and able to take care of themselves and their family

in event of a disaster have a 0.60 (p=0.006) higher adaptive capacity index as compared to those

who cannot. Respondents that report being able to support themselves as well as anyone in need

of assistance have a 0.50 (p=0.023) higher adaptive capacity index than those who cannot.

Respondents that report being able to support themselves and the community at large have a

0.60 (p=0.006) higher adaptive capacity index compared with those who cannot. Similar to the

results in coping capacity, respondents who have lived in Hanalei 1-5 years have a 0.35

(p=0.039) higher adaptive capacity score, as compared with respondents with less than a year of

residence. Also similar to the coping capacity results, respondents involved in community or

volunteer groups have a 0.28 (p=0.005) higher adaptive capacity score over those who do not.

	Dependent Variable: Household Adaptive Capacity
Female	-0.306 (0.093)***
I can and will support myself/my family	0.599 (0.185)***
I can and will support myself/my family and anyone in need of assistance	0.495 (0.194)**
I can and will support myself/my family and community at large	0.595 (0.185)***
Feel the community is prepared	0.031 (0.097)
Origin: Mainland	0.081 (0.167)
Origin: Kauai	-0.077 (0.265)
Origin: Hanalei	-0.033 (0.174)
1-5 years residence	0.351 (0.154)**
5-10 years residence	-0.174 (0.131)
> 20 years residence	0.182 (0.129)
Finance group: Medium level	-0.283 (0.154)
Finance group: High level	-0.165 (0.105)
Participation in a Community Group	0.275 (0.082)***
Adjusted R-squared	0.604
Constant	-0.152 (0.282)

 *=p<10%; **=p<5%; ***=p<1%
Table 4.3. Determinants of household adaptive capacity composite scores.

Coping and adaptive capacity indices were strongly positively correlated (Pearson's r = 0.5819).

This dual relationship is illustrated in the following table and graphs which compare average

coping and adaptive capacity indices for various demographic, socio-economic and other

characteristics of residents.

Variable	N	Average Coping Capacity Index	Average Adaptive Capacity Index
Longevity of Residence			
< 1 year residency	1	0.50	0.45
1- 5 year residency	6	0.33	0.59
5-10 year residency	3	0.56	0.39
10-20 year residency	4	0.46	0.57
> 20 residency	17	0.56	0.61
Origin			
Kauai	1	0.50	0.45
Mainland	23	0.47	0.55
Hanalei	6	0.57	0.68
Hawaii	1	0.67	0.73
Race			
Asian	2	0.36	0.59
Native American	1	0.56	0.82
Native Hawaiian	1	0.83	0.82
White/Anglo	28	0.51	0.58
Mixed	1	0.83	0.82
Other	2	0.25	0.36
Financial Category			
Low	5	0.32	0.49
Medium	7	0.52	0.62
High	19	0.54	0.58
Sex			
Female	7	0.37	0.42
Male	24	0.54	0.63
Age			
25-34	3	0.352	0.424
35-49	7	0.563	0.649
50-64	15	0.489	0.576
65 and over	6	0.528	0.576
Group Involvement			
Participates	23	0.55	0.60
Doesn't Participate	8	0.37	0.50
Average Score	31	0.5	0.58

Table 4.4. Comparative average coping and adaptive capacity composite scores.
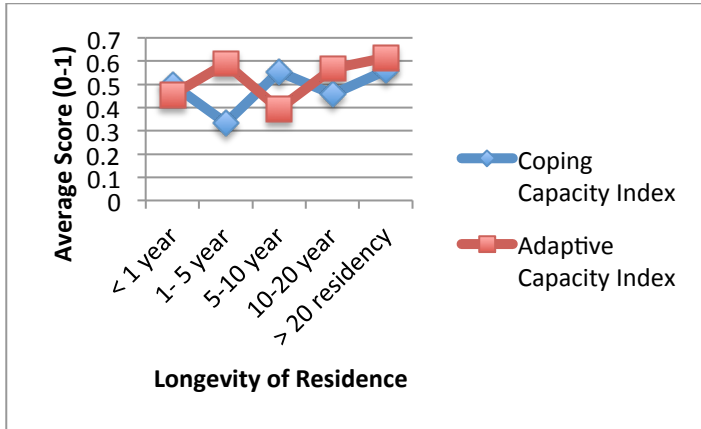
Figure 4.10. Coping and adaptive capacity index comparison by longevity of residence.

These results contradict the notion that with increased longevity in a place, coping and adaptive capacity would also increase, and asymmetry exists between coping and adaptive capacity. These results may be biased by the fact that only one respondent fell into the category of less than a year of residence, and only three respondents were in the category of 5-10 years, and these respondents may not be representative, exhibiting higher than expected adaptive and coping capacity.
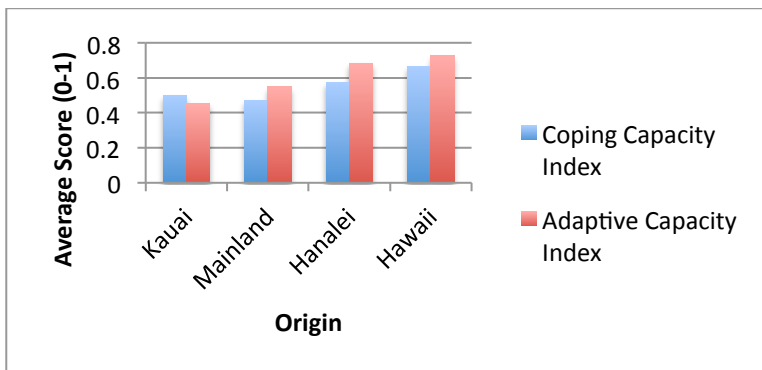
Figure 4.11. Coping and adaptive capacity index comparison by origin.

Coping and adaptive capacity indices seem to correspond across origin categories, though respondents exhibit higher adaptive capacity for all origins except for Kauai (sample size is 1 and may not be representative). Residents of mainland origins have the lowest coping capacity and second lowest adaptive capacity after residents with origins of Kauaʻi, with those from Hanalei and other islands from the State of Hawaii having the highest adaptive and coping capacity.

These results support the findings that familiarity with place, establishment of extended family and friend networks and resources due to origin in Hanalei and the State of Hawaiʻi, support increased coping and adaptive capacity.
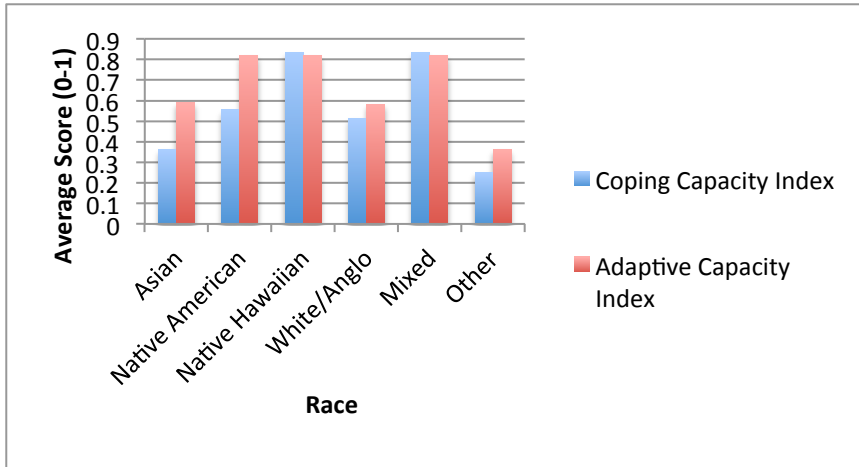
Figure 4.12. Coping and adaptive capacity index comparison by race

Again, coping and adaptive capacity indices seem to correspond very closely across all respondent races save for Asian and Native American, where coping is lower than adaptive capacity. Although biased by certain racial categories that had very low sample sizes (for instance, Native American and Native Hawaiian included only one respondent), the respondents with highest coping and adaptive capacity include Native American, Native Hawaiian and Mixed, followed by White/Anglo, Asian and Other.
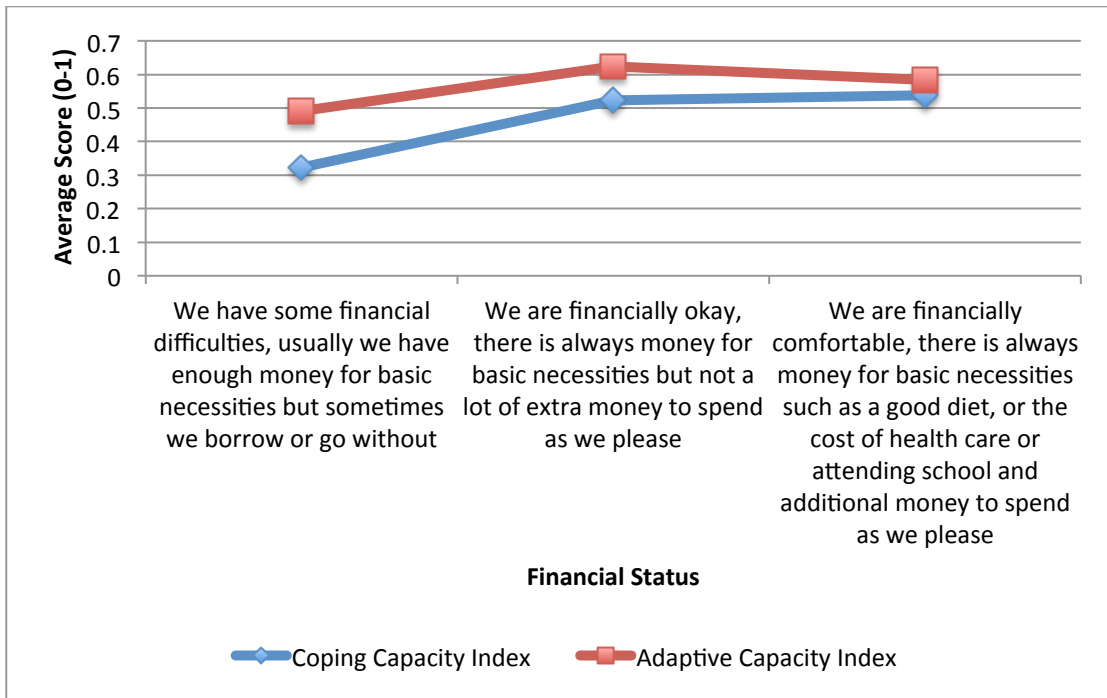
Figure 4.13. Coping and adaptive capacity index comparison by financial status category.

These results support the literature that coping capacity increases with increases in acquisition of financial assets and financial security. However adaptive capacity does not necessarily increase as a result of finances, as can be seen with decreasing adaptive capacity from the mid to high financial status category, as well as the observation that persons in the lowest financial status bracket still exhibit comparable adaptive capacity to those in the highest financial bracket. These findings are relative to the fact that cost of living in Hanalei is very high and thus only accessible to those of higher economic brackets with greater financial resources and assets.
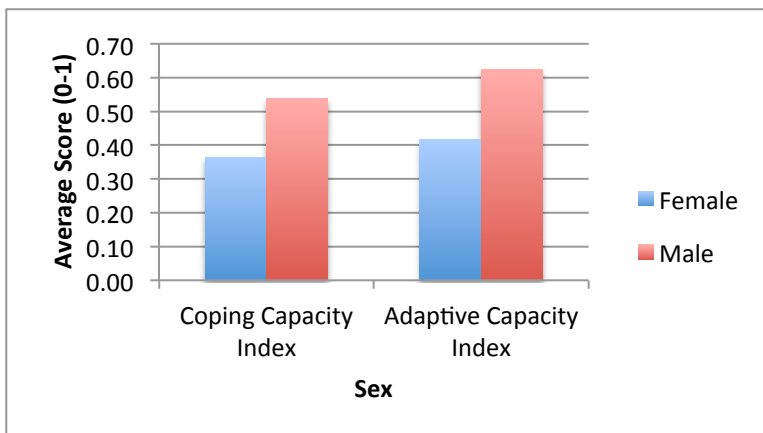
Figure 4.14. Coping and adaptive capacity index comparison by sex.

Females exhibit a lower coping and adaptive capacity index that males, which may be a reflection of lack of equity of access to resources and networks as well as differential knowledge sets and experiences. This differential capacity may be addressed through targeting females to improve their coping capacity through increasing access to resources like emergency materials and supplies, improved social networking through recruiting them for engagement in the disaster resilience planning committee work, and improved adaptive capacity through increasing knowledge and training through disaster education, awareness and coursework.
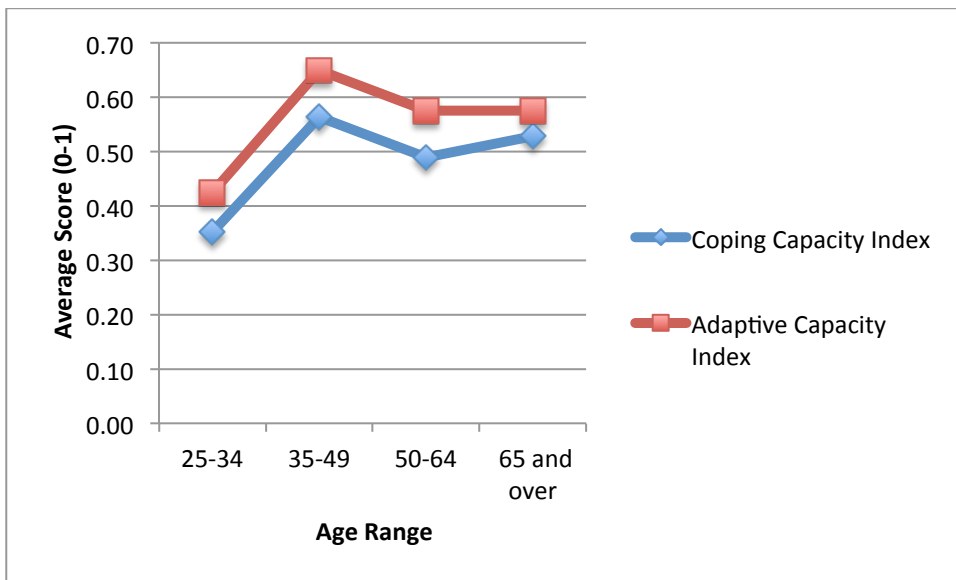
Figure 4.15. Coping and adaptive capacity index comparison by age category.

Although adaptive capacity is expected to increase over time due to accumulated knowledge and experience, there is no noticeable trend in change of index scores by age group, likely because of small sample size of certain age groups that are not representative, as well as the fact that the data was organized as categorical and not continuous data.
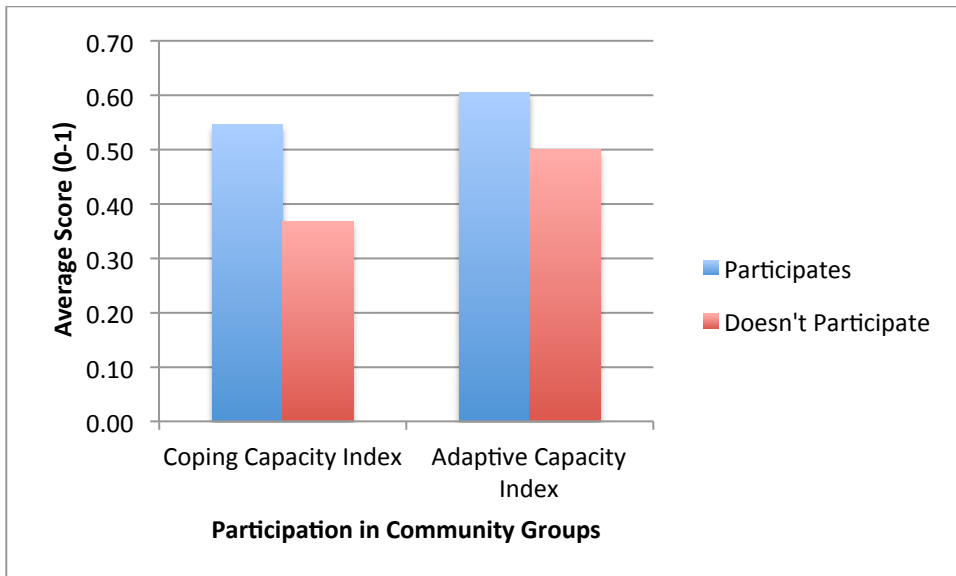
Figure 4.16. Coping and adaptive capacity index comparison by participation in community groups.

Residents who participate in community groups have higher scores in both indices, so targeting those who are not involve in groups may be a priority to understand how can we leverage social networks to engage uninvolved groups and increase their access to the resources, knowledge and training opportunities.

5.   Discussion

The varying responses to mixed qualitative and quantitative measurement tools could be due to many variables. Bias generated by self-selection could also be a source of variation. Respondents that self-select may be more organized and may have higher social network connectivity, making them less vulnerable to disasters than residents who chose not to participate. Additional bias at the household level may arise from lack of adequate community representation due to difficulty reaching people who were not home at the time of surveying, inaccessible areas, or declined interviews. Concern that a representative sample of this diversity was not captured is recognized. Consideration of this issue was discussed and mitigated as much as is possible through identifying and reaching out to underrepresented populations in the resilience research and planning process.

Defining "community" and capturing representative input from diverse stakeholders in the community is challenging, and critical to defining and addressing place-based resilience.

Identifying community characteristics that serve as direct and indirect measures of aspects of resilience are important to developing place-based resilience frameworks for measure and action, including formulation of assets and needs inventory such as through gap analyses. Such mixed approaches validate the quantitative and qualitative experiences, expertise and concerns of community members, with clear value-added implications for integrated management and planning schemes, and place-based policy and programmatic recommendations.

6.   Conclusions

In addition to identifying current gaps in resilience and highlighting community-based action for reducing vulnerabilities and increasing coping and adaptive capacity, collaborative support should be given to local initiatives and organizations already working in enhancing local resilience. Disaster preparedness and relief agencies positioned to offer trainings, education and resources should be leveraged. Staging of resources and training of local residents enhances local resilience and capacity to recover. Rebuilding the sense of community is key to enhancing coping capacity, and attention must be paid to underrepresented populations and geographic areas. This includes considerations for significant numbers of unprepared visitor populations who will necessitate additional considerations for early warning, evacuation and relocation, and mass care including temporary sheltering and feeding. Enhancing natural resource management knowledge and practices also enhances coping and adaptive capacity through resource knowledge sharing and environmental stewardship practices. Many long-term residents and the few remaining indigenous individuals have historically developed and maintained various hazard risk mitigation and adaptation techniques. Linking cultural resources and passing down of traditional ecological and other knowledge systems helps build adaptation mechanisms and resilience within communities. Enhanced food security can be achieved through supporting such initiatives as the farmer's markets, local food production and consumption, sustainable agriculture & fishing, and local food kitchens. Organizations and planning efforts potentially contributing to the sense of community as well as working to build adaptive capacity to disasters should be involved.

APPENDIX B: HANALEI HOUSEHOLD RESILIENCE SURVEY

Hanalei Community Resilience Survey

Informed Consent:

[TO BE READ ALOUD]   Aloha/Hello. My name is _____, and I am representing the Hazards, Climate & Environment Program at the Social Science Research Institute at the University of Hawaii Manoa. The purpose of this survey is to learn about the social and economic impacts of hazards, drought, and climate-affected communities of Hawaii. Your household has been selected to participate and we would like to ask some questions. If you decide to participate your name will not be recorded and participation is completely voluntary. We expect that the interview will take approximately 30-40 minutes.   You can decline to answer any question or stop the interview at any time. You will not receive anything for participating in this survey, but it may benefit the disaster-affected populations and businesses by providing information that will guide the community to better prepare for and respond to local issues of disaster, drought, and climate impacts, and to build resilience to these impacts. If you do not want to participate, you are free to decline the interview. If you have any questions you can contact Cheryl Anderson at 808-956-3908.

Are you 18 years of age or older? [ ] Yes   [ ] No

If No, is there anyone in the household that is 18years of age or older that can be interviewed?

If Yes, proceed. If No, end interview.

Do you wish to be interviewed? [ ] Yes   [ ] No

Interviewee Signature: _____   Date: _____

Interviewer Name_____

Location
      County _____
      City   _____
      Community_____
      Household Survey Number_____
      GPS coordinates _____

Section 1: Background Information

1. Respondent Sex: [ ] Male   [ ] Female

2. Respondent Age:
  a. [ ] 18-24
  b. [ ] 25-34
  c. [ ] 34-49
  d. [ ] 50-64
  e. [ ] Over 65

3. Where do you live?
  a. Community Name_____
  b. Neighborhood Name_____

A household member is someone who shares a dwelling and at least one meal per day. The head of household is the person who makes the majority of decisions.

4. Are you the head of household?
    a. [ ] Yes
    b. [ ] No
    c. [ ] Don't know

5. If no, is the current head of your household male or female?
    a. [ ] Male   b. [ ] Female

6. What is the age (category) of the head of household?
    a. [ ] 18-24
    b. [ ] 25-34
    c. [ ] 34-49
    d. [ ] 50-64
    e. [ ] Over 65

7. How many people live at this location?
    a. _____ Total #
    b. _____ # of male adults
    c. _____ # of female adults
    d. _____ # of male children (<18yrs)
    e. _____ # of female children (<18yrs)

8. Of those living at this location, how many are:
    a. Children or Spouses
    b. Other relatives

9. Which of the following best describes the residence?
    a. [ ] Owned
    b. [ ] Rental
    c. [ ] Vacation
    d. [ ] Other _____

If residence is owned, rental or other, skip to Section 3
If a vacation rental, please ONLY answer the following questions in Section 2

Section 2: Vacationers Breakout Survey

10. Where are you/your family originally from?
    a. [ ] This community
    b. [ ] This region
    c. [ ] This Island
    d. [ ] This State
    e. [ ] Mainland U.S.
    f. [ ] Another Country
11. How long do you live at this location during the year?
    a. [ ] < 1 week/yr
    b. [ ] 1 –2wk /yr
    c. [ ] 3 – 4wk/yr
    d. [ ] >4wk/yr

12. How many years have you lived in this vacation rental?
    a. [ ] <1yr
    b. [ ] 1 -2 yrs

c. [ ] 2-5 yrs
d. [ ] > 5yrs
13. Would you consider the community where you live to be:
   a. [ ] Suburb
   b. [ ] Rural
   c. [ ] Tourist Area
   d. [ ] Traditional/Ahupua'a
   e. [ ] Urban
   f. [ ] Don't know
   g. [ ] Other_____

14. Do you consider yourself a part of this community?
   a. [ ] Yes   If yes, why? _____
   b. [ ] No   If no, why not?_____

15. In the event of a natural disaster, do you feel you are prepared?
   a. [ ] Yes
   b. [ ] No

16. In the event of a natural disaster, which of the following describes you/your family?
   a. [ ] I will need to turn to the community for support
   b. [ ] I can and will support myself/my family
   c. [ ] I can and will support myself/my family and neighbors
   d. [ ] I can and will support myself/my family and community at large
   e. [ ] I can and will support myself/my family and anyone in need of assistance

<END OF SURVEY FOR VACATION RENTERS>

If residence is owned, rental or other, continue the survey
Section 3: Perceptions of Community & Preparedness
The purpose of this section is to understand communities' perceptions of "community," their expectations & willingness to help themselves each other, and to understand communities' awareness & perceptions of planning and preparedness for climate-related hazards (household, community & government/institutional)

17. What does community mean to you and your family?

18. Do you consider yourself a part of this community?
   a. [ ] Yes   If yes, why? _____
   b. [ ] No   If no, why not?_____
   c. [ ] Don't know

19. In your opinion, who is (and isn't) part of your community and why?

20. In the event of a natural disaster, do you feel you/your family are/is prepared?
   a. [ ] Yes
   b. [ ] No
   c. [ ] Don't know

21. Do you feel knowledgeable enough about natural disasters to feel you/your family can prepare and adapt?
   a. [ ] Yes
   b. [ ] No
   c. [ ] Don't know

22. In the event of a natural disaster, which of the following describes you/your family?
    a. [ ] I will need to turn to the community for support
    b. [ ] I can and will support myself/my family
    c. [ ] I can and will support myself/my family and neighbors
    d. [ ] I can and will support myself/my family and community at large
    e. [ ] I can and will support myself/my family and anyone in need of assistance
    f. [ ] Don't know
    g. [ ] Other_____

23. Do you feel your community is prepared for a natural disaster?
    a. [ ] Yes   If yes, why?_____
    b. [ ] No   If no, why not? _____
    c. [ ] Don't know

24. Do you know of community meeting areas or safe places to evacuate to in the event of a disaster?
    a. [ ] No
    b. [ ] Yes   If yes, would you use these places?
                  [ ] No   i. If no, why not? _____
                  [ ] Yes

25. Do you know of community resources, groups or organizations that can assist in the event of a disaster?
    a. [ ] No
    b. [ ] Yes   If yes, who? _____
                  If yes, would you use these resources?
                  a. [ ] No   If no, why not? _____
                  b. [ ] Yes

26. Do you know of a community or neighborhood representative that speaks for you/your family and your interests? e.g. government, elders, community representatives, grassroots groups
    a. [ ] Yes
    b. [ ] No

Perceptions of Risk & Vulnerability
This purpose of this section is to understand communities' perceptions of and experience with risk/vulnerability to climate-related hazards.

27. Do you think your community is affected by natural hazards?
    a. [ ] No
    b. [ ] Yes
        If yes, **please indicate which hazards, and the top three that concern you most** (1=highest concern, 2=second highest concern, 3=3rd highest concern):

	Of Concern? [X]	**Ranking (1-3)**
a.	[ ] Climate change	_____
b.	[ ] Sea level rise	_____
c.	[ ] Earthquake	_____
d.	[ ] Tsunami	_____
e.	[ ] Flooding	_____
f.	[ ] Severe weather	_____
g.	[ ] High wind events/tornados	_____
h.	[ ] Hurricanes/Typhoons	_____
i.	[ ] Drought	_____
j.	[ ] Wildfires	_____
k.	[ ] Volcanic eruptions/VOG	_____

l.   [ ] Other _____   _____

28. If drought is listed as a hazard, how has it affected you/your community?
    a. [ ] Agriculture (crop loss)
    b. [ ] Cattle (cattle death)
    c. [ ] Wildfires
    d. [ ] Water scarcity/water rationing
    e. [ ] Change in rainfall amount/patterns
    f. [ ] Change in temperature
    g. [ ] Loss of life
    h. [ ] Loss of property
    i. [ ] Jobs/livelihood
    j. [ ] School/community facilities
    k. [ ] Public health
    l. [ ] Social
    m. [ ] Culture
    n. [ ] Environment
    o. [ ] Well-being
    p. [ ] Food/water insecurity
    q. [ ] Recreation
    r. [ ] Other _____

29. How many times do you recall experiencing drought?
    a. [ ] 0-1
    b. [ ] 1-2
    c. [ ] 3-4
    d. [ ] 5-6
    e. [ ] > 6
    f. [ ] Don't know

30. Do you remember hearing stories of drought and if so, what did they do to adapt?
    a. [ ] Yes
    b. [ ] No
    c. [ ] Don't know

31. Have these stories/experiences better prepared you to respond or adapt to drought?
    a. [ ] Yes, & how so? _____
    b. [ ] No
    c. [ ] Don't know

32. If other hazards are listed, what aspects of the family or community were affected?
    a. [ ] Agriculture (crop loss)
    b. [ ] Cattle (cattle death)
    c. [ ] Wildfires
    d. [ ] Water scarcity/water rationing
    e. [ ] Change in rainfall amount/patterns
    f. [ ] Change in temperature
    g. [ ] Loss of life
    h. [ ] Loss of property
    i. [ ] Jobs/livelihood
    j. [ ] School/community facilities
    k. [ ] Public health
    l. [ ] Social
    m. [ ] Culture
    n. [ ] Environment
    o. [ ] Well-being

p.   [ ] Food/water insecurity
q.   [ ] Recreation
r.   [ ] Other _____

33. How many times do you recall experiencing these hazards?

34. Do you remember hearing stories of these hazards and if so, what did they do to adapt?

35. Have these stories/experiences better prepared you to respond or adapt to these hazards?
   a.   [ ] Yes
   b.   [ ] No
   c.   [ ] Don't know

Coping & Adaptive Capacity
This section is to understand community coping & recovery capacity to climate-related impacts including traditional knowledge systems.

36. Please select which of the following you and/or your family has access to:
   a.   [ ] Community or family garden
   b.   [ ] Farmland
   c.   [ ] Livestock
   d.   [ ] Hydroponics or Aquaponics systems (fish)
   e.   [ ] Land ownership
   f.   [ ] Housing ownership
   g.   [ ] Safe place to evacuate
   h.   [ ] Community resources
   i.   [ ] Social support network/communication tree
   j.   [ ] Stocked food/water supplies/emergency rations
   k.   [ ] Emergency Kit
   l.   [ ] Family emergency plan
   m.   [ ] Generators
   n.   [ ] Car/truck/ORVs
   o.   [ ] Tractor
   p.   [ ] Groundwater well

37. Please select which of the following you and/or your family has knowledge of:
   a.   [ ] Emergency preparedness
   b.   [ ] Traditional Medicine
   c.   [ ] Traditional Ecological Knowledge
   d.   [ ] Food preservation (e.g. salting or smoking fish, drying fruits/vegetables, preserves, etc.)
   e.   [ ] Fishing
   f.   [ ] Hunting
   g.   [ ] Raising livestock
   h.   [ ] Gardening/farming
   i.   [ ] Construction
   j.   [ ] Other _____

38. Are there any other adaptive practices, experiences or knowledge that you feel make you better prepared for drought or other disasters?

39. Would you like to find out more information regarding emergency preparedness and disaster adaptation?

Section 4: Demographics

This section is to understand basic demographic information about your household and community, like origin, location, ethnicity, livelihood & economics information, etc.

40. Where are you/your family originally from?
    a. [ ] This community
    b. [ ] This region
    c. [ ] This Island
    d. [ ] This State
    e. [ ] Mainland U.S.
    f. [ ] Another Country

41. If not originally from this community, why did you move to this location (please check all that apply)?
    a. [ ] Employment
    b. [ ] School
    c. [ ] Family
    d. [ ] Cultural
    e. [ ] Environmental
    f. [ ] Other_____

42. Would you consider the community where you live to be (please check all that apply):

    a. [ ] Suburb
    b. [ ] Rural
    c. [ ] Tourist Area
    d. [ ] Traditional/Ahupuaʻa
    e. [ ] Urban
    f. [ ] Don't know
    g. [ ] Other_____

43. How long have you lived at this location?
    a. [ ] < 1 yr
    b. [ ] 1—5yrs
    c. [ ] 5—10yrs
    d. [ ] 10—20yrs
    e. [ ] >20yrs

44. If you have moved in the last 5 yrs, please check all reasons that apply
    a. [ ] Property taxes too high
    b. [ ] Rental cost too high
    c. [ ] Other economic reasons
    d. [ ] Safety concerns
    e. [ ] To be closer to school/work
    f. [ ] Family
    g. [ ] Other_____

Education
45. What is the highest level of education you have completed?
    a. [ ] Some Primary school
    b. [ ] Primary school
    c. [ ] Some Middle school
    d. [ ] Middle school
    e. [ ] Some high school
    f. [ ] High school or GED
    g. [ ] Some college
    h. [ ] Associate's degree
    i. [ ] Bachelor's degree

j.   [ ] Master's degree
k.   [ ] Doctoral Degree
l.   [ ] Other Professional Degree (JD, DDS, MD)
m.   [ ] Technical/Vocational Degree
n.   [ ] Certificate

46. What is the highest level of education the head of household has completed (if not you)?
   a.   [ ] Some Primary school
   b.   [ ] Primary school
   c.   [ ] Some Middle school
   d.   [ ] Middle school
   e.   [ ] Some high school
   f.   [ ] High school or GED
   g.   [ ] Some college
   h.   [ ] Associate's degree
   i.   [ ] Bachelor's degree
   j.   [ ] Master's degree
   k.   [ ] Doctoral Degree
   l.   [ ] Other Professional Degree (JD, DDS, MD)
   m.   [ ] Technical/Vocational Degree
   n.   [ ] Certificate

47. What **race/ethnicity** do you consider yourself/your family to be?
   a.   [ ] Asian
   b.   [ ] Black/African American
   c.   [ ] Hispanic/Latino
   d.   [ ] Native American
   e.   [ ] Native Hawaiian
   f.   [ ] Other Indigenous
   g.   [ ] White/Anglo
   h.   [ ] Mixed Race
   i.   [ ] Don't know

Livelihoods & Economics

48. What is your (or Head of Household) type of occupation? (put a 1 for primary occupation, 2 for secondary, etc.)
   a.   [ ] Faith-based
   b.   [ ] Farmer
   c.   [ ] Fisher
   d.   [ ] Government
   e.   [ ] Homemaker
   f.   [ ] Industrial/Factory
   g.   [ ] Non-governmental organization
   h.   [ ] Personal Business/Self-Employed
   i.   [ ] Rancher
   j.   [ ] Student
   k.   [ ] Teacher
   l.   [ ] Tourism/Service Industry
   m.   [ ] Traditional Practices
   n.   [ ] Carpenter/Construction

48. Do you ever get fish from Hanalei or surrounding areas?
   a. [ ] purchased from local fish market
   b. [ ] purchased from local fisherman
   c. [ ] received seafood as a gift from a local fisherman or family

d. [ ] traded other materials or services for seafood
e. [ ] Other; List:_____
f. [ ] Film/Entertainment Industry

49. Do you fish in Hanalei Bay or the surrounding areas?
    a. [ ] Yes (proceed to Section 5, below)
    b. [ ] No (skip to Section 7)

If Farmer or Rancher, Skip to Section 6
If Fisher, Proceed to Section 5

Section 5: Fisher Breakout Survey

50. If you answered Yes to question X above, please complete the following questions:

When you or other household members go fishing, what equipment is involved?

Gear	Check if gear is used	# Trips per week (Average)	# People you fish with on a trip	Gear Description (net length, net mesh size, etc.)
Hand line Shallow/deep				
Trolling line (trolling from boat)				
Gill/Lay net				
Throw Net				
Spear gun				
Fish or Crab trap				
Shore fishing w/ Pole				
Others:				

Note: If more than one fisher in household, circle main gear of respondent above

51. What is your daily catch using your main gear (in lbs)?

	Bad day	Average day	Good day	10 years ago
Catch (lbs):				
Daily effort (hrs per trip):				

52. What typically happens to the fish/seafood that are caught/gathered (check all that apply)?
a. [ ] consumed by immediate family
b. [ ] given away to extended 'ohana
c. [ ] sold
d. [ ] traded
e. [ ] other; List:_____

53. For an average day, how much of your catch is consumed, how much is sold, how much is given away?   a. %Consumed:_____   b. %Given Away:_____   c. %Sold:_____
d. % Other:_____

54. If you sell your catch, where do you sell to most often?
   a.   [ ] Local restaurants and markets in the N. Shore region of Kaua'i
   b.   [ ] Local families or residents in the N. Shore region of Kaua'i
   c.   [ ] Markets and restaurants elsewhere on Kaua'i
   d.   [ ] Businesses, markets or people in Hawai'i but not on Kaua'i
   e.   [ ] Businesses, markets or people not in Hawai'i

55. On a really good day, if you sell fish, what is the total value of a typical daily catch using your main gear?   Value in US$ per average catch:_____

56. For seafood that is not consumed or sold, who do you most often give seafood to?
   a.   [ ] immediate family in household (family in your own home)
   b.   [ ] immediate family in the community (family in other houses in the community)
   c.   [ ] extended 'ohana (kinship network) in the community (Hanalei)
   d.   [ ] extended 'ohana in the region (Halele'a)
   e.   [ ] extended 'ohana on the island (Kaua'i)
   f.   [ ] other; List:

57. Where does the seafood go? (Check all that apply?)
   a.   [ ] stays in the community (Hanalei)
   b.   [ ] stays in the region (Halele'a)
   c.   [ ] stays on the island (Kaua'i)
   d.   [ ] goes off-island

If farmer or rancher, please answer the following additional questions:

Section 6: Agriculture Breakout Survey
58. How long have you worked in farming or ranching?
   a.   [ ] < 1 yr
   b.   [ ] 1—5yrs
   c.   [ ] 5—10yrs
   d.   [ ] 10—20yrs
   e.   [ ] >20yrs

59. How do you think the agriculture or ranching industry has changed since you have worked in it?

60. Have drought or other natural hazards affected your work?
   a.   [ ] No
   b.   [ ] Yes
   c.   If yes, select how (all that apply):
   d.   [ ] Loss of livestock
   e.   [ ] Crop loss/crop death
   f.   [ ] Loss of productive farmland/rangeland
   g.   [ ] Increased operations/production cost
   h.   [ ] Less availability of rainwater
   i.   [ ] Compaction of soil
   j.   [ ] Changed water table
   k.   [ ] Dust storms
   l.   [ ] Wildfires
   m.   [ ] Other

61. What is the biggest challenge you are facing as a farmer/rancher?

(Continued from previous section)
Section 7: Employment & Financial Section
This section asks about employment financial information which helps us understand economic preparedness and ability to respond and adapt in the event of a disaster and economic hardship. You may decline to answer any of these questions at any time.

62. Where do you work?
    a. City _____
    b. Community _____

63. Would you consider the area where you work to be:
    a. [ ] Suburb
    b. [ ] Rural
    c. [ ] Tourist Area
    d. [ ] Industrial
    e. [ ] Traditional/Ahupua'a
    f. [ ] Urban
    g. [ ] Don't know
    h. [ ] Other_____

64. How long have you worked at this location?

    a. [ ] < 2 yrs
    b. [ ] 2 -3 yrs
    c. [ ] 4-5 yrs
    d. [ ] > 5yrs

65. How many household members (including yourself if applicable) are currently employed outside the home and earning income? _____

66. How many adult household members (including yourself if applicable) desire outside employment but are not currently working outside the home? _____

67. What is the average monthly household employment income?
    a. [ ] $0-$500
    b. [ ] $500-$1000
    c. [ ] $1000-$1500
    d. [ ] $1500-2000
    e. [ ] >$2000

68. How much money does your household currently have in savings?
    a. [ ] $0-$500
    b. [ ] $500-$1000
    c. [ ] $1000-$1500
    d. [ ] $1500-2000
    e. [ ] >$2000

69. Has your household spent savings on any of the following in the last 6 months? Check all that apply.
    a. [ ] Food
    b. [ ] Gas/Transportation
    c. [ ] Rent/ mortgage payments/ housing
    d. [ ] Medical care / medications
    e. [ ] Basic household necessities/expenses (education, clothes, etc.)

f.   [ ] Rebuilding / construction
g.   [ ] Replacement of assets lost in a disaster
h.   [ ] Repayment of debts/loans
i.   [ ] Other _____

70. In the last 6 months, has your household borrowed money?
   a. [ ] No
   b. [ ] Yes   if yes, how much? _____

71. In the last 6 months, has your household sold any assets?
   a. [ ] No
   b. [ ] Yes   c. if yes, why? _____
   d. What was the total income from asset sales?_____

72. Which of the following statements best describes the financial situation of your household in the past 6 months?
   a.   [ ] We are financially comfortable, there is always money for basic necessities such as a good diet, or the cost of health care or attending school and additional money to spend as we please
   b.   [ ] We are financially okay, there is always money for basic necessities but not a lot of extra money to spend as we please

   c.   [ ] We have some financial difficulties, usually we have enough money for basic necessities but   sometimes we borrow or go without

   d.   [ ] We are in a difficult financial situation, we live with relatives/others because we cannot afford to live independently and/or have difficulty providing for basic necessities

Organizations & Community Involvement
In this section, we want to identify community-led efforts/groups (volunteer, NGOs, not-for-profits, etc.) to understand household planning and preparedness for climate-related hazards.

73. Are you a member of or participate in a community or volunteer group?
      a. [ ] No
      b. [ ] Yes
      c. If yes, what kind of group? _____
      d. If yes, how often do you participate?
            i. [ ] Rarely (once per yr)
            ii. [ ] Somewhat (2-3 times/yr)
            iii. [ ] Often (4-6times/yr)
            iv. [ ] Frequently (>6 times/yr)

In this section, we want to identify County/State/Federal government-based efforts with defined roles & responsibilities of planning & preparedness climate-related risk reduction

74. Do you have contact with government institutions in your community?
      a. [ ] No
      b. [ ] Yes
            i. If yes, which institution/s or department/s?
_____

      c. If yes, how often do you have contact with these government institutions/departments in your community?
            i.   [ ] Never
            ii. [ ] Rarely (once per yr)
            iii. [ ] Somewhat (2-3 times/yr)

        iv.   [ ] Often (4-6times/yr)
        v.   [ ] Frequently (>6 times/yr)

75. What are your expectations of government or other agencies in the time of drought or other climate hazards/disasters? (check all that apply)
   a. [ ] No expectations
   b. [ ] They should provide basic services (evacuation, food, water, shelter) for those most in need
   c. [ ] They should provide basic services (evacuation, food, water, shelter) for local community members (not vacationers)
   d. [ ] They should provide basic services (evacuation, food, water, shelter) for all residents (including vacationers)
   e. [ ] They should provide job protection and/or financial support
   f. [ ] They should provide cleanup & reconstruction
   g. [ ] They should provide emergency health services
   h. [ ] Other _____

76. Have you heard of any public awareness programs such as community emergency plans, disaster/risk information, etc. from any governmental or non-governmental agencies, community members, families, radio, newspapers, internet, television or other sources?
   a. [ ] No
   b. [ ] Yes
   c. If yes, what kind of program or information?
      _____
   d. From what kind of source? _____

77. How effective do you think the early warning systems are in your community?
   a. [ ] Don't know of any early warning systems
   b. [ ] Not effective
   c. [ ] Somewhat effective
   d. [ ] Very effective
   e. Please explain your answer: _____

78. How would you like to see this survey information used in your community or state?

79. That completes the survey, do you have any questions?

Thank you for your time and participation, we greatly appreciate it.

<END OF SURVEY>

APPENDIX C: HANALEI HOUSEHOLD RESILIENCE SURVEY INDICATORS

Key: V=Visitor only relevant questions, **R=Resident** only relevant questions, otherwise if not indicated, applies to R populations only
*Fisher & Ag specific questions in household survey not included yet in this list

Component	Indicator Name	Indicator	Question in Survey Pertains To
VULNERABILITY			
Social	Education	Highest level of education	45,46
	Demographics	Ethnicity	47
		Place of Origin	V10, R40
		Residency Status	V11,12,R43
		Sense of belonging	V14, R18
		Age (respondent)	2
		Sex (respondent)	1
	Socio-Economic Status	Single-headed households	4 & 7
		Household Size	7
		Type of Residence	9
		Migration	44
		Head of Household Occupation	78
		Employment/Unemployment	65,66
		Income	67
CAPACITY & MEASURES			
Social	Public Awareness Programs	Awareness of programs	76
		Perceived efficacy of early warning systems	77
	Public Participation	Have representation @ community-level	26
		Community involvement	73
		Contact with government institutions	74
	Perceptions of Preparedness	Perceived Household Preparedness	V15, R20
		Preparedness & Willingness to Help	V16, R22

Awareness

Perceived Community Preparedness — 23
Expectations of Government/Relief Agencies in disaster — 75
Know of Safe Places — 24
Know of relief groups/resources — 25

Perceptions of Risk & Vulnerability

Perceived risk to hazards — 27
Experience in hazards — 28-34
Adaptive learning from experiences or stories — 31,35

Coping & Adaptive Capacity

Material resource access — 36
Knowledge & skills, adaptive practices — 37,38
Savings — 68
Recent use of Savings — 69
Borrowing — 70
Selling assets — 71
Financial security status — 72

APPENDIX D: GAP ANALYSIS AND RECOMMENDATIONS

CATEGORY	CONCERNS/NEEDS	POTENTIAL ACTIONS
EVACUATION	SOME RESIDENTS DO NOT KNOW WHERE/HOW TO EVACUATE	EVACUATION SIGNAGE, EDUCATION & INSTRUCTIONS ON PROCEDURES
	HANALEI IS ISOLATED AND EVACUATION ROUTES ARE QUICKLY CLOGGED OR CLOSED	ALTERNATE/BETTER EVACUATION ROUTES ON STATE OR PRIVATE LANDS
	DON'T KNOW WHERE SAFE ZONES ARE	MORE EDUCATION & PUBLIC AWARENESS AROUND NEW INUNDATION ZONES, EVACUATION ROUTES AND EVACUATION CENTERS OR SAFE PLACES
	UNSURE OF EVACUATION ROUTES FOR STUDENTS IN SCHOOL	CLARIFY ROUTES WITH MAPS AND INSTRUCTIONS
	TOURISTS UNSURE OF EVACUATION ROUTES OR PROCEDURES	NEED TOURIST EVACUATION PLAN (ESPECIALLY FOR THOSE WITHOUT CARS)
FOOD/WATER	UNSURE OF AVAILABILITY AND LOCATION OF WATER/FOOD RESOURCES	MORE EDUCATION & PUBLIC AWARENESS ON REALITIES OF SUCH RESOURCES AS WELL AS EXPECTATIONS FOR LOCAL PREPAREDNESS (E.G. BRINGING OWN FOOD/WATER SUPPLIES FOR 3-5 DAYS IN EVACUATION SHELTERS)
	UNSURE OF CONTINGENCY PLAN FOR WATER RESOURCES	DEVELOPMENT OF A COMMUNITY-BASED WATER CATCHMENT SYSTEM FOR WATER SECURITY
ENERGY	NEED FOR ELECTRICITY FOR BASIC SERVICES (FEAR A REPEAT OF INIKI'S GENERATOR WARS)	POTENTIAL RESOURCE MAPPING OR STAGING OF COMMUNITY GENERATORS FOR SHARING BETWEEN NEIGHBORS
COMMUNICATION/ INFORMATION	COMMUNICATION IS QUICKLY LOST IN DISASTERS YET IS CRITICAL TO RECOVERY	BETTER COMMUNICATION SYSTEM IN PLACE (IF TELEPHONE CELL TOWERS ARE OUT) INCLUDING A DESIGNATED "INFORMATION" PLACE TO GO TO IN THE COMMUNITY THAT PEOPLE KNOW AHEAD OF TIME AND CAN USE TO POST AND SHARE INFORMATION
		TRAINING FOR LOCAL HAMM RADIO OPERATORS
SPECIAL POPULATIONS	PERSONS WITH DISABILITIES WILL HAVE EVACUATION CHALLENGES AND SPECIAL NEEDS	PUBLIC AWARENESS AND OUTREACH TO THESE POPULATIONS ON PLANNING CONSIDERATIONS FOR THEM INCLUDING TRANSPORTATION
	LOWER SOCIO-ECONOMIC POPULATIONS MAY NOT HAVE ACCESS TO AS MANY RESOURCES	ADDITIONAL SUPPORT AND CONSIDERATIONS FOR THESE POPULATIONS IN PLANS
TOURIST POPULATION	TOURISTS IN HANALEI & HAʻENA HAVE SPECIAL NEEDS THAT NEED TO BE ADDRESSED	REQUIRE WELL DISPLAYED AND WELL COMMUNICATED DISASTER EDUCATION MATERIALS FOR TOURISTS IN HOTELS AND VACATION RENTALS
	TOURISTS DO NOT KNOW WHERE OR HOW TO EVACUATE	EDUCATION AND PUBLIC AWARENESS MATERIALS FOR TOURISTS ON EVACUATION ROUTES AND PROCEDURES

TOURIST POPULATION	TOURISTS ARE UNAWARE OF NATURAL HAZARDS IN AREA; HAVE LACK OF RESOURCES AND PREPAREDNESS	IF AT A VACATION RENTAL SHOULD HAVE EMERGENCY PREPAREDNESS INFORMATION
		INFO ABOUT VACATION RENTALS/MONITORED BETTER
		TOO MANY VACATIONERS AND EMPTY HOUSES PUSH UP PRICES SO THERE'S NOT ENOUGH AFFORDABLE HOUSING SO LONG TIME RESIDENTS CAN'T AFFORD TO STAY
	TOURISTS CREATE SOCIAL ISSUES	USE INFO TO REZONE HANALEI AND GET RID OF VACATION RENTALS AND MAKE IT A RESIDENTIAL COMMUNITY--NO MORE "RURAL WAIKIKI"
INFRASTRUCTURE	ONE-LANE BRIDGES AND LOW-LAYING ROADS VULNERABLE TO HAZARDS AND QUICKLY CUT OFF IN DISASTER	UPGRADE BRIDGES, RAISE ROADS; EDUCATE PUBLIC ON CONTINGENCY PLAN IF BRIDGES ARE LOST OR COMPROMISED
		EMERGENCY ACCESS ONLY ROAD (SHOULD BE ON) HIGHER GROUND TO PROHIBIT ISOLATION
SHELTER	NO LOCAL SHELTER THAT IS OUT OF INUNDATION ZONE	ALTERNATE EVACUATION SAFE PLACE IN HANALEI ON PRIVATE/STATE LANDS
	PEOPLE DON'T KNOW WHERE THE SHELTERS ARE	MORE EDUCATION & PUBLIC AWARENESS AROUND
EDUCATION	INCREASE LOCAL KNOWLEDGE OF DISASTER PREPAREDNESS	CREATE A DISASTER PREPAREDNESS EDUCATION VIDEO TO SHOW ON CHANNEL 6 OR CREATE A DISASTER HANDBOOK THAT IS PART OF HOUSE
		EDUCATION ON PREPAREDNESS (FOR HOMEOWNERS, AS THEY HAVE A RESPONSIBILITY TO MANAGE THEIR OWN PROPERTY)
		MORE CONTINUING EDUCATION ON EMERGENCY PREPAREDNESS TO KEEP SHORT-TERM MEMORY, COMMUNITY ASSUMES GOVERNMENT WILL HELP ESPECIALLY WITH FOOD/WATER SUPPLIES
		MORE DISASTER EDUCATION AND TRAININGS
LEADERSHIP/ LOCAL CAPACITY BUILDING	NEED STRONGER COPING PRE & POST-DISASTER SKILLS ON FAMILY AND COMMUNITY LEVELS	DO'S AND DON'TS OF WATER FILTRATION CHLORINE ETC., SOLVING PROBLEMS COLLECTIVELY WITH COMMUNITY LIKE IN PRESENTATION
		WANT ADVANCED TRAINING ON LOCAL DISASTER PREPAREDNESS
		CROSS TRAIN LIFEGUARDS UP AS EMTS/FIRST RESPONDERS (HAVE VEHICLES BUT NEED MORE TRAINING)
		MORE COMMUNITY PARTICIPATION
		PEOPLE FORGET PREPAREDNESS INFORMATION SO NEED TO KEEP REMINDING THEM (LIKE ONCE PER MONTH TELEVISION SHOW ON HOW TO DO CPR; NEED CPR AND DISASTER CLASSES IN HANALEI)
	NEED STRONGER COPING PRE &	SHOULD HAVE A DISASTER PLAN TO SEND TO COMMUNITY MEMBERS OR POST LOCALLY IN BUSINESSES AND TEACH EMERGENCY PREPAREDNESS SKILLS

LEADERSHIP/ LOCAL CAPACITY BUILDING	POST-DISASTER SKILLS ON FAMILY AND COMMUNITY LEVELS	MAKE PEOPLE AWARE OF PROBLEMS AND RISKS/VULNERABILITIES (PHYSICAL, PSYCHOLOGICAL, ETC.) TO HOPEFULLY SPUR PEOPLE TO ACT ON THESE PROBLEMS (SHOULD MOTIVATE PEOPLE TO TAKE ACTION TO RESOLVE THEIR PROBLEMS)
		NEED LOCAL BACKUP PLANS FOR FOOD/WATER DELIVERY
		NEED A PORTFOLIO THAT IS PROFESSIONALLY DONE (SMALL MAIL-OUT/CLIPBOARD SIZE) INCLUDING: MAP OF EVACUATION ROUTES (ALL AND BACKUPS) COLOR CODED; UPDATED PHONE NUMBERS FOR EMERGENCY SERVICES; RESIDENTIAL EMERGENCY PHONE TREE TEMPLATE FOR RESIDENTS TO FILL OUT; SHELTER LIST (COURTHOUSE? KILAUEA GYM?); PAMPHLETS (SHORT CONCISE DIRECTIVES WITH LARGE PRINT); SHOULD BE STUCK NEXT TO PHONE/VISUALLY OBVIOUS PLACE
	CERTAIN (LONG-TIME RESIDENTS) ETHNIC GROUPS DON'T STEP UP AND LEAD, JUST KEEP TO THEMSELVES AND TAKE CARE OF THEMSELVES FIRST BASED ON THEIR HISTORY	NEED TO ACCESS THESE POPULATIONS FOR INFORMATION AND FEEDBACK INTO PLANNING
	INCREASE IN EMERGENCY/DISASTER RESPONSE TRAINED LOCALS TO HAVE TEAMS	NEED A LOCAL (UPDATED) PLAN FOR DISASTER PREPAREDNESS WITH RESPONSIBLE CONTACTS AND LEADS
EARLY WARNING SYSTEMS	SOME PEOPLE DO NOT GET EARLY WARNINGS ON TV	ALTERNATIVE ALERTS LIKE ON THE COMPUTER (EMAIL, TEXTING) ARE BETTER FOR PEOPLE WHO DON'T WATCH TV
	SOME REMOTE AREAS DO NOT HEAR SIRENS	NEED BETTER COVERAGE FOR TSUNAMI SIRENS IN RURAL/REMOTE AREAS
EMERGENCY SERVICES	NO EMS STATION	NEED AN AMBULANCE/MEDICAL STATION IN HANALEI LIKE A VOLUNTEER FIRE DEPARTMENT LIKE AT THE NEW NEIGHBORHOOD COMMUNITY CENTER

REFERENCES

Adger, W. N. (2003). Social aspects of adaptive capacity. In J. Smith, R. Klein & S. Huq (Eds.), *Climate change, adaptive capacity and development* (pp. 29-49). London, UK: Imperial College Press.

Adger, W. Neil. (2000). Social and ecological resilience: are they related? *Progress in Human Geography, 24*(3), 347-364. doi: 10.1191/030913200701540465

Almedom, A. M., & Tumwine, James K. (2007). Resilience to disasters: a paradigm shift from vulnerability to strength. *African Health Sciences, 8*, S1-S4.

Antonovsky, A. (1979). *Health, stress and coping*. San Francisco: Jossey-Bass Publishers.

Antonovsky, Aaron. (1987). *Unraveling the mystery of health: how people manage stress and stay well*. San Francisco: Jossey-Bass Publishers.

Berkes, F., Colding, J., & Folke, C. (2003). *Navigating social-ecological systems: building resilience for complexity and change*. Cambridge: Cambridge University Press.

Berkes, F., Folke, C., & Colding, J. (1998). *Linking social and ecological systems: management practices and social mechanisms for building resilience*. Cambridge, UK: Cambridge University Press.

Birkmann, J. (Ed.). (2006). *Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient Societies*. New York: United Nations University.

Bollin, Christina, & Hidajat, Ria. (2006). Community-based risk index conceptual framework. In J. Birkmann (Ed.), *Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient Societies* (pp. 257). New York: United Nations University.

Cinner, Joshua E., McClanahan, T. R., Daw, T. M., Graham, Nicholas A. J., Maina, J., Wilson, Shaun K., & Hughes, T. P. (2009). Linking social and ecological systems to sustain coral reef fisheries. *Current Biology, 19*(3), 206-212.

Coffman, M, & Noy, I. (2009). Hurricane Iniki: Measuring the long-term impact of a natural disaster using synthetic control. *Environment and Development Economics. In Press*.

CWRM. (2012). Hawai'i Drought Monitor.   Retrieved November 2012, from http://www.Hawaiidrought.com

Fazey, I, Fazey, JA, Fischer, J, Sherren, K, Warren, J, Noss, RF, & Dovers, SR. (2007). Adaptive capacity and learning to learn as leverage for social-ecological resilience. *Frontiers in Ecology and the Environment, 5*(7), 375-380.

Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: integrating resilience, adaptability and transformability. *Ecology and Society, 15*(4), 20. [online] URL: http://www.ecologyandsociety.org/vol15/iss24/art20/.

Gallopín, Gilberto C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change, 16*(3), 293-303.

Gunderson, Lance H. (2003). Ecological resilience - in theory and application. *Annual Review of Ecology and Systematics, 31*(1), 425-439. doi: 10.1146/annurev.ecolsys.31.1.425

HSCD. (2007). State of Hawaiʻi Multi-Hazard Mitigation Plan, 2007 Update: Prepared by Cheryl Anderson, Hazards, Climate, & Environment Program, University of Hawaiʻi Social Science Research Institute.

HTA. (2010). 2010 Annual Visitor Research Report. Hawaiʻi Tourism Authority.   Retrieved January, 2012, from http://hawaii.gov/dbedt/info/visitor-stats/visitor-research/2010-annual-visitor.pdf

Lédée, E.J.I., Sutton, S.G., Tobin, R.C., & De Freitas, D.M. (2012). Responses and adaptation strategies of commercial and charter fishers to zoning changes in the Great Barrier Reef Marine Park. *Marine Policy, 36*(1), 226-234. doi: 10.1016/j.marpol.2011.05.009

Marshall, N.A., & Marshall, P.A. (2007). Conceptualizing and operationalizing social resilience within commercial fisheries in northern Australia. *Ecology and Society, 12*(1), 1 [online] URL: http://www.ecologyandsociety.org/vol12/iss11/art11/.

McClanahan, T. R., Cinner, J. E., Maina, J., Graham, N. A. J., Daw, T. M., Stead, S. M., . . . Polunin, N.V.C. (2008). Conservation action in a changing climate. *Conservation Letters, 1*(2), 53-59. doi: 10.1111/j.1532-849X.2008.00008.x

NIDIS. (2012). National Integrated Drought Information System (NIDIS). Area Drought Information, State of Hawaiʻi. *Retrieved November 2012, from*

http://www.drought.gov/portal/server.pt/community/drought.gov/202/area_drought_inform
ation?mode=2&state=HI.

Olsson, P, Folke, C, Galaz, V, Hahn, T, & Schultz, L. (2007). Enhancing the fit through adaptive
co-management: creating and maintaining bridging functions for matching scales in the
Kristianstads Vattenrike Biosphere Reserve Sweden. *Ecology and Society, 12*(1), 28.
[online] http://www.ecologyandsociety.org/vol12/iss21/art28/main.html.

Robbins, Paul. (2007). Cultural ecology. In J. Duncan, N. Johnson & R. Schein (Eds.), *A
companion to cultural geography* (pp. 180-193). Boston: Blackwell Publishing.

Sutton, S.G., & Tobin, R.C. (2012). Social resilience and commercial fishers' responses to
management changes in the Great Barrier Reef Marine Park. *Ecology and Society, 17*, 1-
10.

TRIAMS. (2006). TRIAMS Working Paper--Risk Reduction Indicators. In P. V. Consortium (Ed.).
Geneva: TRIAMS (Tsunami Recovery Impact Assessment and: Monitoring System).

UNISDR. (2005). Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and
Communities to Disasters *Extract from the final report of the World Conference on
Disaster Reduction, Kobe, Hyogo, Japan. Retrieved May 2011, from*
http://www.unisdr.org/we/inform/publications/1037. Geneva, Switzerland:
UNISDR/A/CONF.206/6.

UNU-EHS. (2012). World Risk Report 2012. Berlin: United Nations University Institute for
Environment & Human Security, The Nature Conservancy, Alliance Development Works.

Walker, B., & Salt, D. (2006). *Resilience thinking: sustaining ecosystems and people in a
changing world*. Washington, DC: Island Press.

Wood, Nathan, Church, Alyssia, Frazier, Tim, & Yarnal, Brent. (2007, Rev. 2008). Variations in
community exposure and sensitivity to tsunami hazards in the State of Hawai`i: U.S. U.S.
Geological Survey Scientific Investigation Report 2007-5208 (pp. 38): USGS.

Yohe, Gary, & Tol, Richard S. J. (2002). Indicators for social and economic coping capacity--
moving toward a working definition of adaptive capacity. *Global Environmental Change,
12*(1), 25-40.

CHAPTER 5. RESILIENCE OF WHO AND WHAT, TO WHAT…ACCORDING TO WHOM?: FACILITATING PLACE-BASED ADAPTATION AND RESILIENCE THROUGH ANTICIPATORY SOCIAL LEARNING

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Abstract

Confronted by increasing intensity and frequency of disasters, the uncertainties of climate change and continuous demographic shifts, island coastal communities are at increasing risk. Engaging multiparty stakeholders in community-based disaster resilience planning encourages anticipatory social learning, creates sustainable place-based management schemes, facilitates intersectoral collaboration and builds trust. Through implementation of a three-phase research framework and process utilizing Fuzzy Cognitive Maps (FCM) or mental model representations, a community-based participatory research and learning (CBPRL) approach was used with a stakeholder group of North Shore, Oʻahu communities in order to promote anticipatory social learning, consensus-building and long-term resilience plan development and management. Community mental model representations include concepts or components of value that characterize community, including places, people, relationships, practices, and objects of social, economic, political, environmental or cultural systems, critical to understanding the dynamics of community and potential impacts of natural disasters and climate change. Recognizing the systems approach and the interconnectedness of community dynamics, these mental model concepts are connected by relationships, which qualify how concepts influence one another positively or negatively, and to what degree. These concepts and influences are quantified in mathematical adjacency matrices using dynamic modeling. The consensus or steady state mental model representation was compared with various model iterations, to examine the model dynamics when tsunami impacts

were added, followed by mitigation strategies proposed to address the impacts from tsunami.

These differences were illustrated as bar graphs to highlight change in values of community

concepts in order to uncover key gaps in preparedness and reveal targets for resilience priorities,

including building leadership capacity, increasing the number of shelters and volunteers,

increasing the number of evacuation routes coupled with improved protocols and public

awareness, and increasing the number of community members trained in disaster preparedness.

1.   Introduction

Located in the Pacific Ring of Fire, Hawaii's vulnerability to natural hazards and the impacts of

climate change is exacerbated by its geographical remoteness and large dependency on

imported food and energy (Kaly et al. 2002). Although native Hawaiians and long-term residents

have a history of utilizing place-based management which promotes resilience-building, the

increasing exogenous drivers of change, community members report that fragmentation and

globalization have weakened the social memory and legacy effects of past disasters. The

approach to disasters and environmental degradation has been reactive, with resources being

deployed in the aftermath, which is not efficient (Birkmann 2006). A comprehensive multi-sector

resilience approach is needed to bridge disaster relief and sustainable development (Folke 2002).

Analysis of key physical, social, economic and environmental factors is critical in order to reduce

vulnerability and enhance coastal resilience (Birkmann 2006). Critical gaps in hazard mitigation

plans include articulating the anticipated outcomes associated with various types and levels of

risk and vulnerability (HSCD 2007).

Building upon the classical refrain: "Resilience of What, to What?" (Carpenter et al. 2001) this

research explores the added inquiry: "Resilience of *Who* and *what*, to What…*According to*

Whom?" Locally-derived resilience modeling, based on local values, assets and concerns, plays

a critical role in resilience research and planning (Adger 2003, Abarquez and Murshed 2004,

TRIAMS 2006, USAID 2007). This paper addresses an major issue currently limiting community-

based environmental planning: the inability to standardize and represent diverse types of stakeholder knowledge (e.g. Western science, local and traditional ecological knowledge, diverse management strategies), beliefs and perceptions, in a form that maintains the integrity of complex human understanding and is useful for collaborative decision-making. Through community-based participatory methods that facilitated anticipatory adaptive social learning, mental model representations were constructed with stakeholders to identify and prioritize community values, capitals and assets, and the beneficial and detrimental influences upon them in order to guide development and testing of disaster resilience and adaptation strategies.

1.1   Mental models and fuzzy cognitive mapping

Mental models are fuzzy cognitive maps (FCM) (Abel et al. 1998, Jones et al. 2011) or interpretations of external reality that are used to filter, interpret and remember events, in order to inform anticipation, reason, explanations, learning, problem-solving and decision-making (Jones et al. 2011). Mental models are constantly evolving, based on the experiences, beliefs and expertise of individuals, groups and society, and as such are inaccurate representations that are difficult to elicit let alone quantify (*ibid*). Disasters and climate change affect all of society and governance, and thus resilience planning measures must be inclusive and collaborative. The development of collective or shared mental model representations is needed (Abel et al. 1998, Jones et al. 2011) to bring divergent efforts and perspectives to work jointly.

Mental models as "working models" (Craik 1943, Johnson-Laird 1983, Jones et al. 2011) inform reasoning, causal dynamics and learning (Jones et al 2011). Reasoning is enabled through the construction of mental model representations that can function like a computer simulation, allowing different possibilities to be examined apriori (*ibid*). Causal dynamics are illustrated in mental models based on the stakeholder's knowledge of the system. Learning is facilitated through the adaptation of models over time from development of new experiences, knowledge and skills under changing conditions and events.

1.2   Social learning

Social learning is a process of social change enabled by interactions and processes between stakeholders of a given social network (Reed et al. 2010). A change in individuals' understanding

is demonstrated, which also extends beyond the epistemological lens of individuals into wider

stakeholder or community groups. Engagement of stakeholders via social learning processes

encourages empowered inclusion in decision-making for adaptive socio-ecological systems

management amidst uncertainty and change (Holling 1978, Walters 1986, Walters and Holling

1990, Reed et al. 2010), and is particularly useful in the context of disaster resilience, risk under

uncertainty and adaptation to climate change (Folke et al. 2003, Pahl-Wostl 2007). Other

potentially desirable outcomes of social learning include improved social-ecological systems

understanding and management strategies, enhanced adaptive capacity and social trust,

behavior changes, and empowerment of stakeholders (Reed et al. 2010).

Social networks link individual learning to social learning by influencing people's opinions and

attitudes (Reed et al. 2010) and offering mechanisms through which stakeholders can challenge,

negotiate or propose new norms, policies or programs (Rist et al. 2007, Reed et al. 2010).

Research and planning must be cognizant of the role that diversity of backgrounds, differential

knowledge, value systems and power dynamics play (Keen et al. 2005, Pahl-Wostl 2007,

Wildemeersch 2007, Cundill 2010, Reed et al. 2010). Networks vary between stakeholders

across scales and time, and may be inflexible, such as governmental hierarchies, or flexible, such

that stakeholders may forge formal and informal relationships, build capacity and trust to form

agreements ranging from formal contracts and codes to informal voluntary pacts (Pahl-Wostl

2007). Such networks also affect the coping capacity to deal with the immediate impacts of

extreme perturbations, as well as longer-term adaptive capacity, by increasing knowledge and

skills through education and training (Tompkins and Adger 2004, Pahl-Wostl 2007). This research

engages a community-based network to increase social learning within several adjoining coastal

townships, hereafter referred to as North Shore community.

1.3   Adaptive capacity

Amidst constant fluxes, the ability of societies to be resilient (to absorb impacts of a phenomena

and still maintain system character and function) is largely dependent upon their coping capacity

(the ability to survive and manage in the short-term through accessing resources and networks)

and adaptive capacity (the ability to reorganize and renew utilizing knowledge and skills) in

response to change or disturbance such as disasters and climate change. Fazey et al 2007 state four requirements for societies or communities to adapt to change effectively: 1) the willingness to challenge and transform epistemological and cultural ways of thinking, knowledge and behaviors from the individual to societal level towards socio-ecological resilience; (2) a thorough understanding of how current practices and behaviors influence socio-ecological resilience and should be re-directed towards more sustainable goals which, in turn, supports (3) the willingness to engage in proactive, continuous assessment of the contribution made by current behaviors on sustainability in order to anticipate impacts and inform decision-making amidst uncertainty; and (4) the ability to change their behavior based upon these preceding requirements (Fazey et al. 2007).

The social learning process incorporated these four requirements for the community case study work. The participatory mental modeling process promotes learning to learn, by enabling adaptive expertise development of community stakeholders through varied methods of identifying, discussing and problem-solving using mental model representations, iterative reflection upon them, and encouraging and learning acceptance of diverse opinions and beliefs of their cohort (Fazey et al. 2007). This adaptive learning dynamic fosters new knowledge, proactive thinking, and empowers stakeholders with the ability to change through informed decision-making, social learning and building of trust amongst community (*ibid*).

1.4   Anticipatory learning, adaptive cycles and learning loops

Forward-looking or anticipatory learning plays a key role in resilience-building, through facilitation of iterative learning processes and adaptive decision-making, as opposed to reactive adaptation (Tschakert and Dietrich 2010). Anticipatory learning addresses adaptation as a dynamic, learned process towards resilience, where stakeholders continually communicate (Osbahr 2007), evaluate risks and mitigation options (Leary et al 2008), learn from mistakes (Adger 2003) and innovation (Armitage 2005) amidst uncertainty, emerging events, past, present and future conditions (Nelson et al. 2007) and new information (McGray et al. 2007), to make trade-offs for adaptation strategies and decision-making based on community values and consensus-building (Tschakert and Dietrich 2010).

The linkages between anticipatory learning, adaptation and resilience can be derived from Holling's (1986, 2004) illustration of adaptive cycles, which identify specific types of learning that may contribute to adaptation and resilience: "incremental front-loop learning, spasmodic or profound back-loop learning, and transformational learning" (Holling 1986, 2004, Tschakert and Dietrich 2010). Socio-ecological system dynamics include two forms of learning. The first consists of small and fast cycles of learning which "revolt," such as immediate mitigation strategies for persistent common stressors like floods. These in turn impact the second type which consists of larger and slower cycles that elicit long-term social memory, legacy effects and knowledge for renewal and reorganization towards longer-term resilience and adaptation (*ibid*). Anticipatory learning within community-based participatory research and planning (otherwise known as anticipatory action learning or action research) offers a "process of foresight" that iteratively reveals, through single, double and triple-loop learning, system dynamics and impacts upon which to act, reflect and problem-solve through experimentation and facilitated action learning (*ibid*).

The role of mental model representations in facilitating anticipatory social learning can be understood through feedback loops or multi-level loop learning (Reed et al. 2010, Biggs et al. 2011, Jones et al. 2011) which operate at varying individual and group scales as well as time scales. Single-loop learning, the most common type, refers to the type of learning based on norms and beliefs that filters out the majority of incoming information, particularly that which doesn't resonate with previously-held beliefs (Biggs et al. 2011). For single-loop learning to occur through mental modeling, an individual or group refines the pre-existing mental model or cognitive map by changing practices and actions (Argyris 2005, Biggs et al. 2011). Double-loop learning indicates active questioning of the mental model representation, which may lead to more fundamental changes in and refinement of the model (Argyris 2005, Biggs et al. 2011). Double-loop learning is often the minimum target of research and planning frameworks (Biggs et al. 2011).

Triple-loop learning goes further to probe questioning of the mental model representation's underlying norms, assumptions, values and beliefs, which can result in a significant changes in the mental model representation and ultimately changes in attitudes, beliefs and behaviors (Altman and Illes 1998, Peschl 2007, Biggs et al. 2011). While difficult to achieve, triple-loop learning enables longer-term targets of adaptation and resilience to be realized (Biggs et al. 2011), as these often require paradigm shifts in thinking and action. Social learning occurs at various time scales, which contribute to varying scales of what will be referred to as *domains of influence* upon different sectors of society, from micro or short to medium time scales (contributing to individual and stakeholder group processes), to meso or medium to long time scales (contributing to social network processes and outcomes) and macro or long time scales (contributing to institutional and governance-level shifts in cultural values and norms) (Biggs et al. 2011).

To navigate change, society must gain awareness of the problem, improve knowledge about it, diversify their ideas by reflecting and communicating together, in order to develop a shared vision that can be acted upon (Tschakert and Dietrich 2010). Anticipatory learning includes learning, information exchange, reflection, innovation and anticipation. Facilitation of this is limited by current learning tools, methods and lack of awareness and knowledge of locally-relevant stressors like climate and hazard impacts (*ibid*). The focus on anticipation in the learning process elicits deliberation on potential futures "by giving meaning to images, trends and memory that can be qualitatively envisioned, tested and revisited" (Inayatullah 2006, Tschakert and Dietrich 2010). This research uses community mental models representations that engage first, second and third-person research such that "learning and transformation are most likely to be achieved" (Bradbury and Reason 2001, Tschakert and Dietrich 2010). As illustrated in Figure 5.3. *Conceptual framework and process,* the research addresses the three micro, meso and macro scales of social learning, with the goal of achieving double- and triple-loop learning as measured through shorter, midterm and long-term resilience planning utilizing mental modeling to construct measurable targets and benchmarks.

Achieving a shared vision built by collective deliberation towards consensus is critical to community planning. Often planning processes fail to do this adequately, particularly in communities with diverse groups of people with varying and sometimes conflicting values, beliefs, behaviors, power dynamics, institutional barriers and diverse sources and types of knowledge (Biggs et al). Mental modeling is a process that can improve upon such communication and collaboration barriers, through "(1) contributing to clear and open communication between stakeholders; (2) aiding in overcoming obstacles to incorporating multiple sources of knowledge; (3) enabling shared ownership of a conservation plan; and (4) improving social assessments" (Biggs et al. 2011).
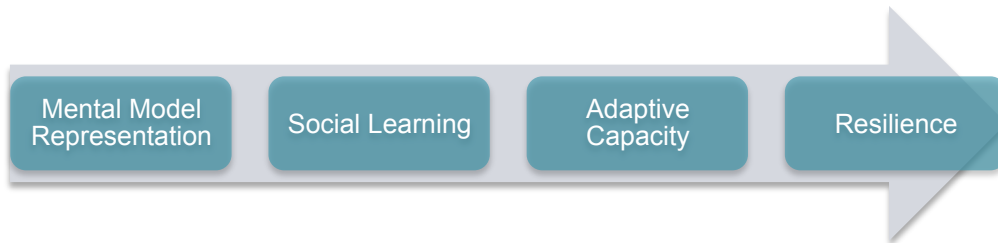
Figure 5.1. Mental modeling as mechanism for community resilience.

Development of stakeholder-driven consensus mental model representations for the purposes of long-term community resilience planning, with revised iterations over time, should promote cultural schema which are developed (Quinn 2005, Jones et al. 2011) as this group will share experiences that generate cultural meaning, influence individual mental models and shift thinking. As illustrated in Figure 5.1, this shared cultural mental model representation, or collective cultural model, will reflect the group's understanding of community and thus promote a more unified community resilience plan, particularly because this procedure elicits anticipatory social learning, flexible knowledge structures and decision-making processes amenable to unanticipated hazard events (Langan-Fox et al. 2000, Jones et al. 2011).

<u>1.6   Research questions, operational assumptions and procedures</u>

This research explores how FCM guides community-based disaster resilience and climate change adaptation planning with multiparty stakeholders. The operational assumptions and procedures that will be examined include the following:

1. FCM using mental modeling *informs characterization and understanding of the community socio-ecological system* through:

    i.   Identification and prioritization of values, assets, capital of the community socio-ecological system

    ii. Identification of relationships & interconnected dynamics of the system

2. FCM using mental modeling *informs decision-making* for the community socio-ecological system through:

    i.   Identification of threats to the system;

    ii.   Identification of opportunities for mitigation & adaptation strategies of these threats;

    iii. Testing of these mitigation and adaptation strategies for efficacy within the model and success at achieving intended outcomes; and,

    iv.   Identification of best strategies for inclusion in plan.

3. FCM through mental modeling *guides anticipatory social learning* through:

    i.   Enabling consolidation of small stakeholder group mental model representations into a larger community group mental model representation to elicit diverse knowledge acquisition and representation for discussion and consensus-building into a shared community model;

    ii.   Empowering diverse multiparty group stakeholders to communicate, deliberate, and build consensus on a model that is used as the planning framework;

    iii. Development of baseline "business as usual" models highlights pre-existing system dynamics including vulnerabilities, weaknesses or gaps in resilience as well as current coping and adaptive capacity, in order to inform decision-making on targets for mitigation & adaptation strategies; and,

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iv.   Running various hazard scenarios will further highlight impacts to the system to inform

hazard-specific vulnerabilities and areas to target for mitigation & adaptation strategies.

To explore these research questions through the research operational assumptions and outlined procedures, small stakeholder group and community group mental modeling was employed in one case study site that is prone to multiple natural hazards.

2.   Materials and methods

2.1   Approach

An interdisciplinary social science, multi-sector approach was employed, engaging in a community-based participatory research and learning (CBPRL) process involving stakeholders and community residents from one case study site. The CBPRL approach is increasingly used to ensure more sustainable community programs (Chambers and Conway 1992, Chambers 1994, ACOSA 2005) and is an ideal approach to disaster resilience (FEMA 2011). The purposeful mélange of community members is aimed at exploring various stakeholder expertise or typology groups or "communities of practice" (Wenger 1998, Pahl-Wostl 2007) in order to develop mental models representations through collaborative governance. Collaborative governance recognizes the central role that all stakeholders from varying institutions and backgrounds contribute to more effective, accepted natural resource management, place-based planning and resilience strategies (Pahl-Wostl 2007).

The role of mental model representations in climate change adaptation and resilience-building is relatively unexplored (Jones et al. 2011),. Mental modeling through the use of software such as MediatedModeling (trademarked by van den Belt, 2004) that promotes influence diagrams to be visually constructed using icons facilitates simplistic illustration of individual to group representations of complex systems and issues, increasing transparency, improving comprehensions and communication (van den Belt 2004, Voinov and Bousquet 2010).

Software that facilitates the integration and analysis of stakeholder knowledge in modeling is currently lacking. To address this, a joint approach was used to: 1) construct visual representation of community stakeholder mental models through a computer-based software tool called *Mental Modeler* (Gray et al. 2011b, Gray et al. 2012) and, 2) interpret these mental model

representations into adjacency matrices to quantify model dynamics and construct scenarios. This dual approach enables exploration of the reasoning, causal dynamics and learning features of mental model representations, allowing community planners and researchers to easily collect and standardize individual and collective community knowledge through simple modeling tasks (Ozesmi and Ozesmi 2004, Gray et al. 2011b).

Through a multi-step process, mental modeling allows groups of stakeholders to come together and easily develop semi-quantitative models of socio-environmental issues which: (1) define the important components relevant to a community (reasoning); (2) define the strength of relationships between these components (causal dynamics); (3) run "what if" scenarios on these models to determine how the community might react under a range of possible conditions (reasoning and causal dynamics); and, revise the model given results of these scenarios, community discussion and improved insight for decision-making (learning). Iterative modeling supports the CBPRL that involves additional decision-support designed to facilitate community planning.

2.2   Materials and instruments

A FCM is a fuzzy cognitive map with elements of a "mental landscape" of components or concepts connected in causal relationships (weighted between -1 and 1) that can be used to compute the "strength of impact" of the system's elements. If the relationship between components is positive, this indicates that an increase in the transmitting component (from which the relationship originates) indicates an increase in the receiving component (where the relationship terminates), and is the reverse for negative relationships (Gray et al. 2012). FCM has been called simplified mathematical modeling of belief systems (Wei et al. 2008) and has been used to represent both individual (Axelrod 1976) and group (Özesmi and Özesmi 2004, Gray et al. 2011a) knowledge systems. FCM was accomplished using Excel to conduct data analysis because it requires no prior training. FCM is also utilized to run "what if" model scenarios allowing users to evaluate system dynamics (Ozesmi and Ozesmi 2004, Gray et al. 2011b). These "mental model" representations are then subject to a range of quantitative measures (Ozesmi and Ozesmi 2004) that can be used to draw conclusions about a community's

knowledge, attitudes, decisions, and behaviors. Participatory modeling has grown in popularity in recent years with the acknowledgement that stakeholder knowledge is an essential component to informed decision-making (Gray et al. 2011b).

2.3   Research design

2.3.1   Community case study

The project was carried out in one coastal community in Hawai'i that is vulnerable to coastal hazards, extreme weather events and the potential impacts of climate change: North Shore of the island of O'ahu, which includes the towns from Mokuleia to Sunset Beach and is classified as the City & County of Honolulu Evacuation Zone 1 (HSCD 2007, 2010). Site selection was based on the following criteria: (1) geographic isolation and physical vulnerability to climate change and natural hazards (Fletcher III et al. 2002, DBEDT 2011); (2) potential for community participation and engagement (particularly underserved populations), cross-scale intersectoral collaboration; (3) degree of involvement of community members in agriculture, resource management, disaster preparedness, or similar fields; (4) potential for community-based resource and information network development; (5) potential for project adaptation and sharing of resources with communities and stakeholders elsewhere in Hawai'i and the Pacific; and, (6) desire of community members, leaders and stakeholders to engage in a coastal resilience research and planning process.

The North Shore of O'ahu is at risk to multiple coastal hazards and becomes isolated as access roads quickly become flooded or inundated (HSCD 2010), making local disaster preparedness critical. Based on a community survey, residents prioritized (in order of importance) the hazards of tsunami, hurricane, earthquake, flood, sea level rise, severe weather and wildfires. Regarding perceptions of self- and family-preparedness, less than 59% feel prepared, and only 20,7% feel that the North Shore community is prepared for natural disasters, in support of the 92.3% that feel the North Shore could benefit from development of a community disaster plan (Figure 5.2).
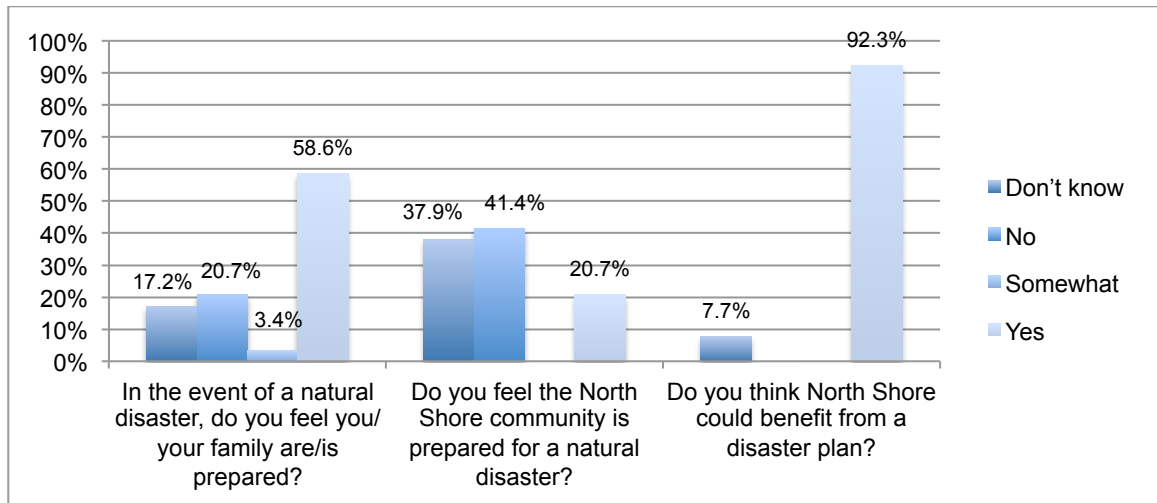
Figure 5.2. Perceptions of disaster preparedness.

2.3.2   Research framework and process

Development of a common, agreed-upon action-oriented framework amongst community

stakeholders is one indicator that social learning has occurred (Biggs et al. 2011). Following the

Conceptual research framework and process (Figure 5.3), mental model representation was

utilized in various iterations including small stakeholder group modeling and community group

modeling. This approach supports the conclusions that cognition is language and image-based

(Kearney and Kaplan 1997, Ozesmi and Ozesmi 2004) and considers the arrangement and

distribution of components (Ozesmi and Ozesmi 2004). Three project phases comprised the

anticipatory social learning processes used to transform loosely organized diverse stakeholders

into a self-organized group within an at-risk community. The following section identifies the three

phases of the project, the activities implemented in each phase, and the methods and tools

employed. These phases are iterative and include feedback, aimed at promoting single-, double-

and triple-loop learning across the micro, meso and macro social learning scales (over the short,

midterm and long-term timeframes) and across domains of influence.

2.4   Data collection and processing

A series of guided workshops using direct elicitation, participatory procedures were conducted

utilizing semi-structured and open-ended questions, through the following steps as outlined in

Figure 5.3.
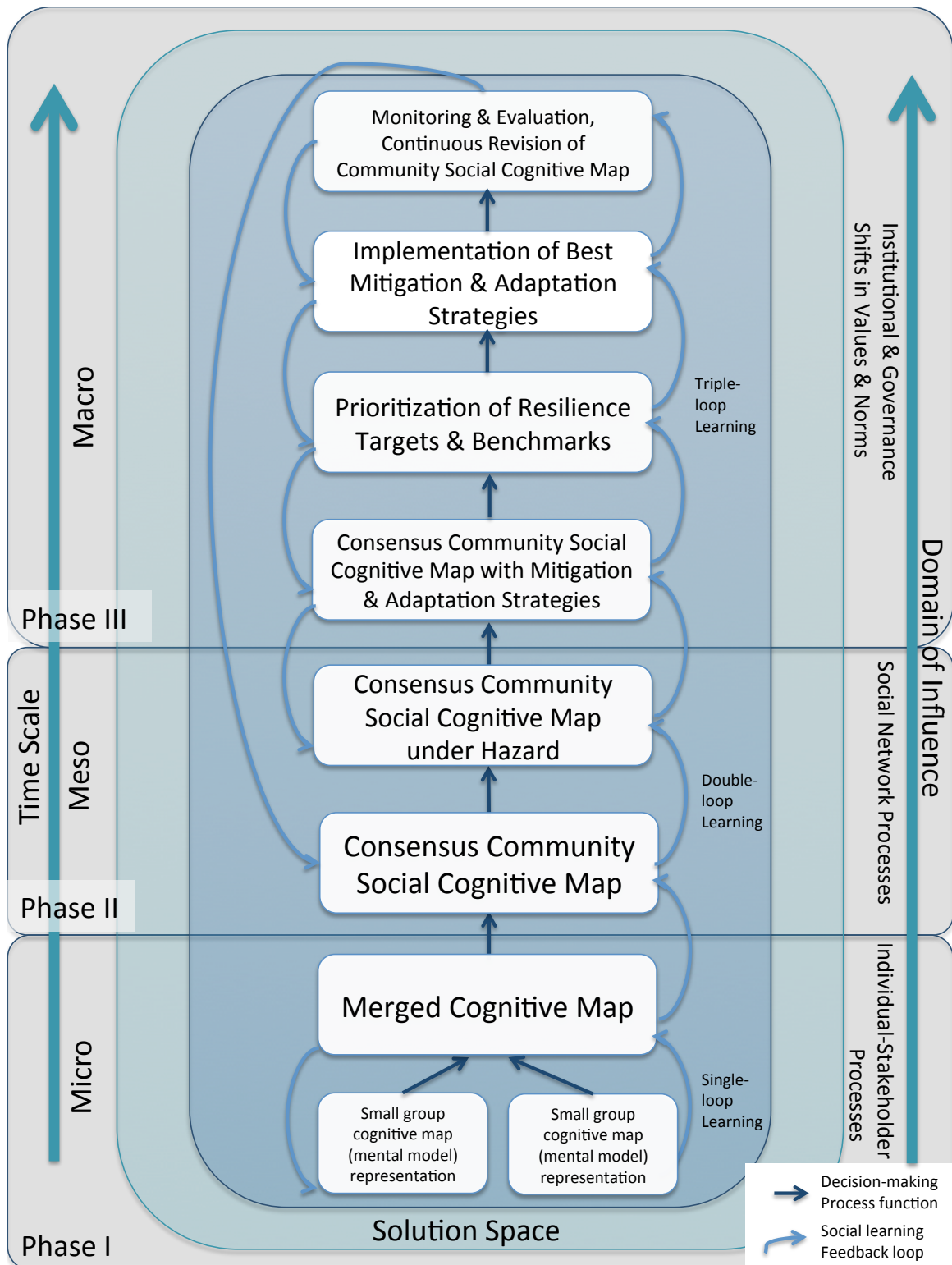
Figure 5.3. Conceptual research framework and process.

2.4.1   Phase I—Co-planning and development of research processes and solution space

Occurring in the micro (short to medium-term) time scale of social learning, the first phase

focused on consensus-building with the stakeholders around the project design, protocols,

processes, methods and tools, timeline and the community resilience planning objectives, in

order to ensure social and cultural appropriateness of the research and promote joint ownership

of the processes and outcomes (Pahl-Wostl and Hare 2004). This was coordinated through

collaboration with a multiparty community disaster planning committee, comprised of community

leadership and governmental, non-governmental, faith-based and other representatives from

diverse backgrounds and expertise (hereafter referred to as *committee*) through which agreed-

upon communication and collaboration platforms were established.

The first workshop consisted of dividing the committee into two small stakeholder groups tasked

with developing model representations of the North Shore community. Specifically, the workshop

followed the following procedures: 1) identifying what system is being modeled (in this case,

community); 2) listing key components or stocks (i.e. social, economic, environmental and cultural

assets, capitals or values) of the community system; 3) prioritizing the most important ones to

include that best characterize the community system; 4) interpreting the relevance of components

to one another into an influence or network map in a diagrammatic representation of the

community system; and, 5) connecting the components to one another to infer relationships

(Ozesmi and Ozesmi 2004, Jones et al. 2011). Components were selected by each group and

related to one another through node connections indicating directionality (uni- or bi-directional),

strength of influence (high, medium or low), and influence type (positive or negative).

Each small group representation was refined by individual assessment and group negotiation as

to why certain components should or should not be included, dependent upon stakeholder

knowledge based on individual norms and beliefs. Based on the small group discussion and

debate, individuals were presented with new ideas from different realms of expertise that

challenged their current behaviors and practices, specifically their current goals and tasks of the

disaster committee. This initial phase contributed to a revisiting of the larger committee's working

group tasks, resulting in eliciting single-loop learning feedbacks (Argyris 2005, Biggs et al. 2011).

These shifts in practices informed Phase II wherein the small group representations were methodically merged into one consensus community mental model representation, as discussed in Section 2.6.

2.4.2   Phase II: Community model reassessment, refinement and consensus-building

Taking place in the meso (medium to long-term) time scale of social learning, the second phase adapted the merged consensus representation during an interactive workshop using reassessment and re-evaluation, engaging the committee in double-loop learning (Argyris 2005, Biggs et al. 2011). Components were defined with qualitative and quantitative descriptions, and relationships were negotiated and refined. Then, the committee was tasked with adding a negative driver or exogenous force that influences the model. Since tsunami was one of the top hazards of concern, this was chosen for the first hazard scenarios. The committee added relationships from the new component of Tsunami to indicate how the hazard impacts other components of the community. Following the workshop, the component tsunami and its influences was added to the model, and the scenario output was calculated (see Section 2.6) to show how different components fare under tsunami, in order to inform mitigation and adaptation planning for Phase III.

2.4.3   Phase III: Developing resilience benchmarks for anticipatory planning

The final phase occurred in the macro (long-term) time scale of social learning, for sustained iterative management. This phase aimed to examine efficacy of community model mitigation and adaptation strategies in order to guide implementation, evaluation and adaptation of them for the disaster plan development. The scenario analysis generated from the representation run under the tsunami scenario identified in Phase II (Appendix F) informed the group decision-making around specific mitigation and adaptation strategies.

The committee was asked to further define components, by indicating which components were *desirable* in that they will increase resilience of the community system, and which components are *undesirable* in that they decrease its resilience. The mitigation strategy deliberation was informed by the scenario output of which *undesirable* components (e.g. number of visitors) decrease resilience, and which *desirable* components (e.g. close knitness of community) increase

resilience. Desirable components then become the benchmarks or targets to increase, and

undesirable components become targets for reduction, and these benchmarks will constitute the

measurable evaluation and outcomes tools for the community resilience plan.

By illustrating the scenario results, the committee was then asked to discuss the model output,

focusing on the potential underlying root causes of the negative impacts. Discussion was

facilitated around what human causal aspects (such as behaviors, attitudes, norms and values)

could be contributing to these relationships and impacts, promoting triple-loop learning (Altman

and Illes 1998, Peschl 2007, Biggs et al. 2011). The mitigation and adaptation strategies

proposed then were focused largely on implementing measures that address these underlying

dynamics.

2.5   Data analysis

The *Mental Modeler* software was utilized primarily for displaying and real-time editing of

representations. The standardization, structural metrics analysis, reduction and merging of small

group mental model concepts into the consensus model, and the generation of scenario analyses

under tsunami and mitigation strategies, were done using FCM functions in Microsoft Excel 2010.

Adjustment and agreement of the model across both stakeholder groups was achieved through

real-time editing of the representation during a workshop, and the adjacency matrix model

concepts and values were adjusted ex-post.

2.5.1   Sample size

Four iterations of mental model representations occurred. First, the two simultaneous FCMs were

created by small stakeholder groups, followed by a merged community model constructed ex-

post, and a final consensus community model agreed upon by stakeholders. For each iteration,

concepts were listed side by side, and common concepts were eliminated in order to identify new

concepts between each model. To test whether sufficient sampling was achieved, an

accumulation curve was constructed (Ozesmi and Ozesmi 2004) which highlights the decreasing

and leveling off of new concepts or variables with each additional group model (Figure 5.4),

indicating adequate population and sectoral representation.

2.5.2 Coding mental model representations into adjacency matrices

Using graph theory to translate cognitive maps into adjacency matrices (Harary et al. 1965, Ozesmi and Ozesmi 2004), the directional relationships were interpreted by type (uni-, bi- or multi-directional) and amount of influence (positive or negative and low, medium or high values calculated as 0.25, 0.5 and 1.0 values, respectively) (Gray et al. 2012). Drawing upon the mental model representations of the two small stakeholder groups, the standardized concepts and relationships were translated into adjacency matrices.

2.5.3 Standardization of concepts and structural metrics

Both small group FCM concepts were listed in separate spreadsheets, and structural metrics were calculated to determine centrality (based on the number of relationships of a concept which is an indication of the most important concepts), as well as whether they were transmitter variables with principally forcing functions, receiver variables with principally receiving functions, or ordinary variables with both receiving and forcing relationships (Gray et al. 2012). Concepts with high congruence and centrality were normalized (standardized) and selected as the concepts for the merged community cognitive map.

2.5.4 Social cognitive map

In order to create a representation for a community-wide cognitive map, the two small group FCMs were merged into one by constructing a third adjacency matrix consisting of the standardized variables, creating one social cognitive map (Kosko 1987, 1992a, b, Laszlo 1996, Ozesmi and Ozesmi 2004). Relationships from the small group FCMs were consolidated by averaging all relationship values of common concepts into the new social cognitive map matrix. Conflicting relationships (e.g. a positive value in one small group model and a negative value in the other) will decrease the strength of the causal relationship, whereas agreement will reinforce it (Kosko 1992b). Conflicting values could be a result of different logical structure of variables (Zhang and Chen 1988, Ozesmi and Ozesmi 2004), so thorough understanding of whether variables are neutral, negative or positive is critical to ensure that translation of the relationship values reflects this appropriately. Finally, the summed values were divided by the sample size to get an average value for each relationships, and the resulting values form a consensus social

cognitive map or community mental model representation (Ozesmi and Ozesmi 2004). The

social cognitive map was used to build consensus in a second workshop, where variables were

modified and defined in detail to ensure group understanding around the interpretation of each

variable and the relationships between them.

2.5.5   Steady state

Using the average values in the adjacency matrix, the steady state was calculated so that the

community consensus model could be run to determine how it fared under tsunami, and later how

it fares under mitigation options. The auto-associative neural network method (Reimann 1998,

Ozesmi and Ozesmi 2004) that focused primarily on the outcome or inferences that can be

gleaned was used (Kosko 1987, Ozesmi and Ozesmi 2004). In this method, a vector of the initial

states of the variables in multiplied with the adjacency matrix. Subsequent lines carry or "activate"

the input from one variable to another (Ozesmi and Ozesmi 2004), the product of which is the

connection strength, and the sum of all of these individual products results in the total unit input.

These values are "clamped" or bounded at each simulation step through a logistic, linear function

$(1/(1 + e{-1}°øx)$ which transforms the results into a 0 to 1 interval (Ozesmi and Ozesmi 2004. This

vector is repeatedly multiplied by the adjacency matrix until the values converge to a stable point

(*ibid*). This steady state represents how the community consensus model would fare under

"normal" conditions, such that it can be compared with the tsunami or other hazard states, as well

as mitigation and adaptation solutions.

2.5.6   Tsunami scenario simulation

Following the consensus-building process, a tsunami scenario was run on the revised mental

model representation to simulate perceived impacts of tsunami on the community consensus

model, and output results were shared again with the committee in a following interactive

workshop (Appendix F). Using the steady state value output, the concept tsunami was clamped at

a high level (value of 1.0), and the scenario state is the result of the difference between the new

state under tsunami and the steady state, as illustrated in Appendix F.

2.5.7   Mitigation and adaptation option simulations

The results of the tsunami scenario state guided decision-making wherein mitigation strategies were proposed, added to the model, and scenarios were run to test the efficacy of the mitigation strategies to achieving the desired effects. The mitigation or adaptation strategies were individually, and later collectively, clamped at high levels. The individual and collective mitigation and adaptation simulation state scenario output are the result of the difference between the combined tsunami and mitigation states and the steady state, compared with the tsunami scenario state (Tables 5.2 to 5.7). This difference is seen in the relative difference or change in the values for both tsunami state and mitigation state for each given variable (Appendix F).

3.   Results

3.1   Sample size and accumulation curve

Although a total of 47 concepts were developed in the small groups, much congruence existed across the two representations. Stabilization of new concepts occurred as the number of model iterations increased, illustrating adequate sampling and representation of diverse stakeholder groups in the modeling process after four iterations.
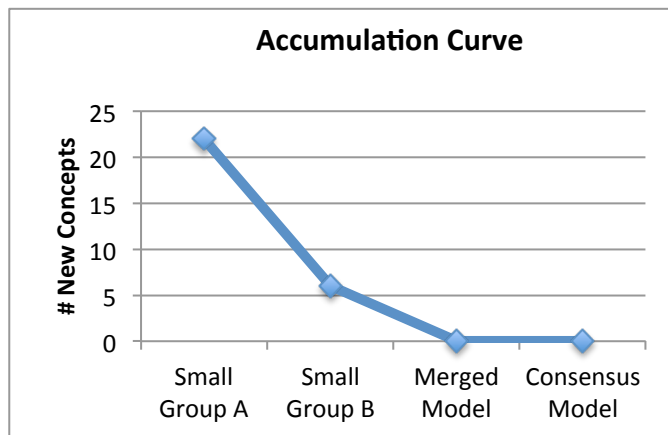
Figure 5.4. Accumulation curve.

3.2   Cognitive Map Inferences

3.2.1   Structural metrics

Based loosely in network analysis, the structural metrics of the community consensus model under tsunami can be generated using FCM modeling (Table 5.1). The number of concepts (n=20) indicates how many components of importance are in the model. The number of

connections (n=57) indicates the degree of interaction between concepts in the model (Ozesmi and Ozesmi 2004). The connections to variables ratio of 2.85 shows the degree of connectedness between the model concepts and how they influence system function (ibid). The concepts with highest centrality, or those with the most connections to other concepts, included tsunami, evacuation capacity, number of responders and emergency response, number of visitors, functionality of healthcare facilities, disaster knowledge, awareness and planning, and close knitness of community. These concepts are important to focus on in the planning process as they are seen as the most important causal and influenced variables in the community system.

Structural Metric	Value
Number of Concepts	20
Number of Connections	57
Connections/Variables	2.85
Number of Transmitter	4
Number of Receivers	5
Number of Ordinary	11
Complexity (Transmitters to Receivers)	1.25
Density (# connections/ 400 total possible connections)	0.1425

Table 5.1. Structural metrics of community consensus model under tsunami.

The majority (n=11) of variables were ordinary, as they both influenced other variables and were influenced. Four transmitter variables were noted in the model, including tsunami, schools and daycare, livestock and mountains and streams, such that these concepts are seen as influencing other variables but not being influenced. Five receiver variables, those which are influenced by other concepts but do not influence others, included evacuation capacity, communications and logistics demand, demand for infrastructure, utilities and potable water, disaster knowledge, awareness and planning, and shelter capacity. Complexity of the model (1.25) is seen by the ratio of total concepts to transmitter concepts, and generally reflects how well the model is developed by experts (Gray et al. 2012). The density score (0.1425) illustrates the relative number of relationships per concept and thus the potential number of policy, programmatic or other options for influencing change in the system (Ozesmi and Ozesmi 2004, Gray et al. 2012).

3.2.2   Tsunami influences on community consensus model

Appendix E: *Community Consensus Model under Tsunami* illustrates the mental model

representation in *Mental Modeler (Gray et al. 2011b)* which illustrates the concepts and their

relationship complexity (over 50 relationship nodes), for which the initial scenario results are

displayed in. As seen in Appendix F, tsunami had negative and positive influences on various

concepts.

The dynamics of the influences of tsunami on the community mental model concepts are as

follows: evacuation capacity (high negative), number of responders (medium positive),

communications demand (high positive), demand for infrastructure, utilities and potable water

(high positive), demand for security (high positive), number of visitors (high negative), businesses

(high negative), functionality of healthcare facilities (high negative), disaster knowledge,

awareness and planning (medium positive), shelter capacity (high negative), close knitness of

community (medium positive), number of residents (medium negative), churches & community

center services for special populations (medium negative), farmers and food supplies (high

negative), and usable low lying terrain that is populated or has businesses (high negative). These

influences help guide social learning and decision-making around which desirable relationships to

increase, and which undesirable relationships to decrease, through development of potential

mitigation and adaptation strategies. Such community-driven priorities and relationships facilitate

discussion for planners and researchers around disaster planning objectives and linkages.

3.3   Mitigation and adaptation option simulations for disaster planning decision-making

A final round of data collection in the form of a third community-based committee workshop,

consisted of categorizing the preferences of the committee's consensus model concepts as

desirable (i.e. concepts desired to increase), undesirable (i.e. concepts desired to decrease) or

neutral. Desirable concepts that the committee wants to increase include the following:

evacuation capacity; number of responders/emergency response; disaster knowledge,

awareness & planning; shelter capacity; close knitness of community; number of residents and

families; livestock; farmers & food supplies; businesses; and, functionality healthcare facilities.

Undesirable concepts that the committee ideally wants to see decrease include: demand for

infrastructure, utilities & potable water; demand for security/safety (protection); and, number of

visitors. The remaining concepts were seen as neutral and desired to be maintained at the

current status or level, including: shoreline (i.e. beaches, ocean and coastal zone geography);

communications and logistics demand; schools and daycare; churches and community center

services for special populations; mountains & streams; and, usable low lying areas (which include

homes, businesses, farms, etc.). These measures serve as the committee's resilience targets,

such that establishment of baseline and iterative measurements of these targets can serve as

benchmarks utilized to measure the potential for specific mitigation strategies to measurably

contribute to their disaster preparedness and resilience. This also allows the committee to

understand more tacitly the impacts of tsunami (and other hazards modeled) on their consensus

model, and what this means inherently for their disaster planning efforts.

Following the discussion of conceptual preferences, the group was asked to propose mitigation

and adaptation strategies. The top 4 strategies were chosen for modeling, and the results of the

influences of each strategy on the consensus model are summarized in Table 5.2, where

desirable, undesirable and neutral concepts are separated so as to indicate whether the

proposed strategy aligns with the committee's preferences.

| | Mitigation/Adaptation Strategy | Consensus Model Concepts and Direct Preferences | | | | | | | | | |
| | | Desirable (want to increase) | | | | | | Neutral (want to maintain) | Undesirable (want to decrease) | | |
		evacuation capacity	# responders/ emergency response	functionality healthcare facilities	disaster knowledge, awareness & planning	shelter capacity	close knitness of community	churches & community center services for special populations	communications & logistics demand	demand for infrastructure, utilities & potable water	demand for security/ safety
1.0	Build leadership capacity in community	1	0.5	**0**	1	**0**	0.5	0	-0.5	0	-1
2.0	# Shelters and Shelter volunteers increased	0.5	**0**	**0**	0.25	1	0.25	**0.25**	**0.25**	**0.25**	**0.25**
3.0	Increase # evacuation routes, protocols and public awareness	1	**0**	**0**	0.5	0.25	0.5	0	**0.25**	**0.25**	**0.25**
4.0	Increase # of people trained in disaster preparedness	0.5	0.5	0.25	1	0.5	0.5	0	-0.5	-0.5	-0.5

Table 5.2. Mitigation and adaptation strategies influence on consensus model concepts.

The majority of the prioritized strategies proposed were only related to less than half of the consensus model, and are effectively achieving the committee's desired state, except for the relationships anticipated by strategies 2.0 and 3.0 that will increase demand for communications and logistics, infrastructure, utilities and potable water, and security and safety (as noted in bold in Table 5.2).

Another tsunami scenario was conducted to investigate the difference in tsunami impacts without and with each of the strategies). Tables 5.3 through 5.7 show the difference in values and the desired impacts achievement status of the consensus model under tsunami for each mitigation strategy as well as a cumulative strategy integrating all four strategies. Appendix G illustrates the bar graph scenario output with change in values or impacts of tsunami changing under different mitigation strategy simulations, as a measure of the relative change (increase, decrease or no change) in values of concepts between different states. When comparing tsunami state with the strategy states, the scale change in value illustrates the increase or reduction of influence tsunami will have on different concepts of the model, due to implementation of the mitigation strategy and its anticipated benefits.

Consensus Model Concept	Tsunami State	Mitigation Strategy 1 State	Relative Change	% Change	Desired Change	Desired Change Achieved (Y =1, N=0)
Demand for Infrastructure, Utilities & Potable water	0.062	-0.122	-0.185	-18.477	Decrease	0
Communications & Logistics Demand	0.081	-0.069	-0.150	-14.979	Decrease	1
# Visitors	-0.109	0.000	0.109	10.881	Decrease	0
Demand for Security/Safety	0.082	-0.109	-0.190	-19.046	Decrease	1
Close Knitness of Community	0.075	0.098	0.022	2.244	Increase	1
Disaster Knowledge, Awareness & Planning	0.052	0.128	0.076	7.579	Increase	1
# Responders/Emergency Response	0.062	-0.002	-0.063	-6.337	Increase	1
Evacuation Capacity	-0.064	0.063	0.126	12.638	Increase	1
Livestock	0.000	-0.074	-0.074	-7.407	Increase	0
Shelter Capacity	-0.069	0.000	0.069	6.879	Increase	1
Functionality of Healthcare Facilities	-0.072	-0.080	-0.008	-0.843	Increase	0
# Residents (& Families)	-0.080	-0.015	0.065	6.476	Increase	0
Farmers & Food Supplies	-0.118	-0.118	0.000	0.000	Increase	0
Businesses	-0.146	1.000	1.146	114.619	Increase	1
Shoreline (Beaches & Ocean)	0.013	-0.096	-0.110	-10.966	Neutral	0
Schools (& Daycare)	0.000	-0.143	-0.143	-14.337	Neutral	1
Mountains & Streams	0.000	0.131	0.131	13.114	Neutral	1
Services for Special Populations	-0.043	0.188	0.232	23.170	Neutral	1
Usable Low Lying Areas (Residential/Businesses/Farm)	-0.109	0.000	0.109	10.860	Neutral	1

Table 5.3. Community variable change under tsunami state and strategy 1 state.

Consensus Model Concept	Tsunami State	Mitigation Strategy 2 State	Relative Change	% Change	Desired Change	Desired Change Achieved (Y =1, N=0)
Communications & Logistics Demand	0.081	-0.588	-0.669	-66.873	Decrease	1
Demand for Infrastructure, Utilities & Potable water	0.062	-0.610	-0.672	-67.202	Decrease	1
Demand for Security/Safety	0.082	-0.554	-0.636	-63.609	Decrease	1
# Visitors	-0.109	0.225	0.334	33.363	Decrease	0
Evacuation Capacity	-0.064	0.572	0.636	63.561	Increase	1
# Responders/Emergency Response	0.062	-0.477	-0.538	-53.831	Increase	0
Businesses	-0.146	0.175	0.322	32.153	Increase	1
Functionality of Healthcare Facilities	-0.072	0.511	0.583	58.277	Increase	1
Disaster Knowledge, Awareness & Planning	0.052	-0.730	-0.782	-78.226	Increase	0
Shelter Capacity	-0.069	0.303	0.372	37.195	Increase	1
Close Knitness of Community	0.075	-0.149	-0.224	-22.443	Increase	0
# Residents (& Families)	-0.080	0.065	0.145	14.461	Increase	1
Livestock	0.000	0.000	0.000	0.000	Increase	0
Farmers & Food Supplies	-0.118	0.318	0.435	43.527	Increase	1
Shoreline (Beaches & Ocean)	0.013	0.097	0.083	8.313	Neutral	0
Schools (& Daycare)	0.000	0.000	0.000	0.000	Neutral	1
Services for Special Populations	-0.043	-0.161	-0.117	-11.741	Neutral	0
Mountains & Streams	0.000	0.000	0.000	0.000	Neutral	1
Usable Low Lying Areas (Residential/Businesses/Farm)	-0.109	0.354	0.462	46.212	Neutral	0

Table 5.4. Community variable change under tsunami state and strategy 2 state.

Consensus Model Concept	Tsunami State	Mitigation Strategy 3 State	Relative Change	% Change	Desired Change	Desired Change Achieved (Y =1, N=0)
Communications & Logistics Demand	0.081	0.115	0.034	3.392	Decrease	0
Demand for Infrastructure, Utilities & Potable water	0.062	0.096	0.034	3.412	Decrease	0
Demand for Security/Safety	0.082	0.120	0.038	3.766	Decrease	0
# Visitors	-0.109	-0.096	0.013	1.311	Decrease	0
Evacuation Capacity	-0.064	0.116	0.180	17.961	Increase	1
# Responders/Emergency Response	0.062	0.068	0.006	0.619	Increase	1
Businesses	-0.146	-0.144	0.002	0.192	Increase	1
Functionality of Healthcare Facilities	-0.072	-0.073	-0.001	-0.141	Increase	0
Disaster Knowledge, Awareness & Planning	0.052	0.099	0.048	4.758	Increase	1
Shelter Capacity	-0.069	-0.022	0.047	4.664	Increase	1
Close Knitness of Community	0.075	0.189	0.114	11.353	Increase	1
# Residents (& Families)	-0.080	-0.079	0.001	0.119	Increase	1
Livestock	0.000	0.000	0.000	0.000	Increase	0
Farmers & Food Supplies	-0.118	-0.118	0.000	0.000	Increase	0
Shoreline (Beaches & Ocean)	0.013	0.012	-0.001	-0.106	Neutral	0
Schools (& Daycare)	0.000	0.000	0.000	0.000	Neutral	1
Services for Special Populations	-0.043	-0.014	0.029	2.921	Neutral	0
Mountains & Streams	0.000	0.000	0.000	0.000	Neutral	1
Usable Low Lying Areas (Residential/Businesses/Farm)	-0.109	-0.109	0.000	0.000	Neutral	1

Table 5.5. Community variable change under tsunami state and strategy 3 state.

Consensus Model Concept	Tsunami State	Mitigation Strategy 4 State	Relative Change	% Change	Desired Change	Desired Change Achieved (Y =1, N=0)
Communications & Logistics Demand	0.081	-0.001	-0.082	-8.211	Decrease	1
Demand for Infrastructure, Utilities & Potable water	0.062	-0.021	-0.083	-8.289	Decrease	1
Demand for Security/Safety	0.082	-0.010	-0.092	-9.156	Decrease	1
# Visitors	-0.109	-0.096	0.013	1.262	Decrease	0
Evacuation Capacity	-0.064	0.001	0.065	6.512	Increase	1
# Responders/Emergency Response	0.062	0.135	0.073	7.309	Increase	1
Businesses	-0.146	-0.143	0.003	0.283	Increase	1
Functionality of Healthcare Facilities	-0.072	-0.030	0.042	4.197	Increase	1
Disaster Knowledge, Awareness & Planning	0.052	0.132	0.081	8.053	Increase	1
Shelter Capacity	-0.069	0.023	0.092	9.210	Increase	1
Close Knitness of Community	0.075	0.188	0.113	11.311	Increase	1
# Residents (& Families)	-0.080	-0.070	0.010	1.030	Increase	1
Livestock	0.000	0.000	0.000	0.000	Increase	0
Farmers & Food Supplies	-0.118	-0.118	0.000	0.000	Increase	0
Shoreline (Beaches & Ocean)	0.013	0.012	-0.002	-0.156	Neutral	0
Schools (& Daycare)	0.000	0.000	0.000	0.000	Neutral	1
Services for Special Populations	-0.043	-0.015	0.028	2.812	Neutral	0
Mountains & Streams	0.000	0.000	0.000	0.000	Neutral	1
Usable Low Lying Areas (Residential/Businesses/Farm)	-0.109	-0.109	0.000	0.000	Neutral	1

Table 5.6. Community variable change under tsunami state and mitigation strategy 4 state.

Consensus Model Concept	Tsunami State	Cumulative Mitigation State	Relative Change	% Change	Desired Change	Desired Changes Achieved (Y =1, N=0)
Communications & Logistics Demand	0.081	0.003	-0.078	-7.849	Decrease	1
Demand for Infrastructure, Utilities & Potable water	0.062	0.065	0.003	0.313	Decrease	0
Demand for Security/Safety	0.082	-0.122	-0.203	-20.336	Decrease	1
# Visitors	-0.109	-0.074	0.035	3.451	Decrease	0
Evacuation Capacity	-0.064	0.552	0.616	61.587	Increase	1
# Responders/Emergency Response	0.062	0.192	0.130	12.999	Increase	1
Businesses	-0.146	-0.138	0.008	0.775	Increase	1
Functionality of Healthcare Facilities	-0.072	-0.034	0.038	3.789	Increase	1
Disaster Knowledge, Awareness & Planning	0.052	0.169	0.117	11.678	Increase	1
Shelter Capacity	-0.069	0.327	0.395	39.541	Increase	1
Close Knitness of Community	0.075	0.380	0.305	30.476	Increase	1
# Residents (& Families)	-0.080	-0.071	0.009	0.927	Increase	1
Livestock	0.000	0.000	0.000	0.000	Increase	0
Farmers & Food Supplies	-0.118	-0.118	0.000	0.000	Increase	0
Shoreline (Beaches & Ocean)	0.013	0.009	-0.004	-0.427	Neutral	1
Schools (& Daycare)	0.000	0.000	0.000	0.000	Neutral	0
Services for Special Populations	-0.043	0.090	0.133	13.349	Neutral	0
Mountains & Streams	0.000	0.000	0.000	0.000	Neutral	1
Usable Low Lying Areas (Residential/Businesses/Farm)	-0.109	-0.109	0.000	0.000	Neutral	1

Table 5.7. Community variable change under tsunami state and cumulative strategies state.

Table 5.8 highlights which mitigation and adaptation strategies were most effective at achieving

the desired impacts, both direct and indirect. The most effective mitigation strategy that achieved

100% of the desired changes and 78% of the total desired changes (the highest percentile in both

categories of all strategies) was Strategy 4.0.

	Mitigation/Adaptation Strategy	% Direct Desired Impacts Achieved	% Total Desired Impacts Achieved
1.0	Build leadership capacity in community	100%	67%
2.0	# Shelters and Shelter volunteers increased	50%	44%
3.0	Increase # evacuation routes, protocols and public awareness	57%	56%
4.0	Increase # of people trained in disaster preparedness	100%	78%
5.0	Cumulative Strategies	80%	56%

Table 5.8. Percent desired changes across all strategies.

The subsequent best strategies include Strategy 1.0, leadership capacity building in the community, Strategy 2.0, increasing the number of shelters and volunteers trained, and Strategy 3.0, increased evacuation routes, protocols and associated public awareness. Strategy 5.0, a collective of all four strategies, unexpectedly did not exhibit the highest percent of desired change as compared with the individual strategies. All strategies had a greater success rate of achieving direct versus total desired impacts, due to explicit influences established between the strategies and specific concepts.

4.   Discussion

Use of FCMs facilitated explicit representation of stakeholder group cognitive maps, which served as the basis for identifying perceived risks, assets, values and dynamics of the social, economic, environmental and political aspects of North Shore. Community stakeholders were guided through multiple iterations of FCMs, designed to facilitate single, double and triple-loop learning. Deliberation over anticipated impacts of tsunami and proposed mitigation and adaptation solutions was informed through FCM scenario output. Facilitation of this process requires great care in promoting creative and sensitive discussions within the solution space, while continuously guiding the community committee through the structured project phases. The framework and process provide a template that is best used when adapted and modified over time, and may be amenable for decision-making and planning in other communities, diverse multiparty groups or organizations.

The findings support implementation of the more "effective" strategies, however the indirect effects were not anticipated. Not all strategies are intended to impact the entire consensus model, but are targeted at certain concepts, and may even have unintended negative outcomes. For example, Strategy 3.0 was primarily linked to increasing evacuation capacity, functionality of healthcare facilities, close knitness of community and shelter capacity, however this strategy was also viewed as necessitating an increase in the demand for communications and logistics, infrastructure and safety and security, which is an undesirable outcome. The results of each strategy must be deliberated with stakeholders to recognize these indirect effects.

Pros and cons to engaging in individual, small group or larger group modeling exist. The method presented here combined the FCMs of small stakeholder groups into a larger group representation, and allowed for concepts to be freely chosen by participants and not prescriptively given. This approach facilitates social learning, time efficiency, accommodation and pooling of diverse knowledge sets, as well as allowing for real-time modification of the model through discussions and consensus-building (Gray et al. 2012). Constraints of this approach include the need for diverse expertise in the group setting, the inability to weight individually-prioritized concepts or relationships, and the issues inherent with varying power dynamics in the group that require expert facilitation (*ibid*).

General limitations exist with mental model representations and processes, which are dependent upon the value, quality and diversity of information put into the model. Construction of mental models in small groups is time consuming, and building consensus of complex socio-ecological systems like communities is a daunting task. Evaluation of the social learning processes through surveys and FCM outcomes over time validates whether social learning and improved resilience occurred. Issues with having different stakeholders participate during each iteration of modeling also exist, such that continued revision of the model may delay the consensus-building and simulation production.

5.   Conclusions

Because social cognitive maps represent perspectives of specific stakeholders that are not constant as they move away or become disengaged and new members join, the maps must be

continually re-visited and new participants must be engaged in the process (Carley 1997, Ozesmi and Ozesmi 2004). Community mental models are dynamic and must be modified as the community undergoes change, learns from past experiences and confronts new challenges (Ozesmi and Ozesmi 2004). Utilizing FCM for decision-making enables more efficient prioritization of funding, human resources and mitigation and adaptation strategies (Biggs et al. 2011). Potential next steps for this research include leveraging the decision-making power facilitated through FCM-generated findings of mental modeling scenario outputs, in order to inform a framework for prioritization of mitigation and adaptation strategies for policy and programmatic recommendation. This could be done through the use of Alternative Hierarchy Processes or Cost-Benefit Analyses, in order to consult diverse stakeholder groups and constructively weigh and deliberate which solutions are ideal, given manpower, time and funding resource constraints.

This research explored a place-based interpretation of resilience for community members, stakeholders and the local environment and infrastructure, to the impacts of tsunami, according to multiparty community-based committee. Using a structured framework to facilitating place-based adaptation and resilience through anticipatory social learning, the research guided stakeholders through single-, double- and triple-loop learning cycles to improve resilience at the micro, meso and macro levels with iterative, sustained community planning utilizing and readdressing the identified resilience targets and benchmarks over time

155
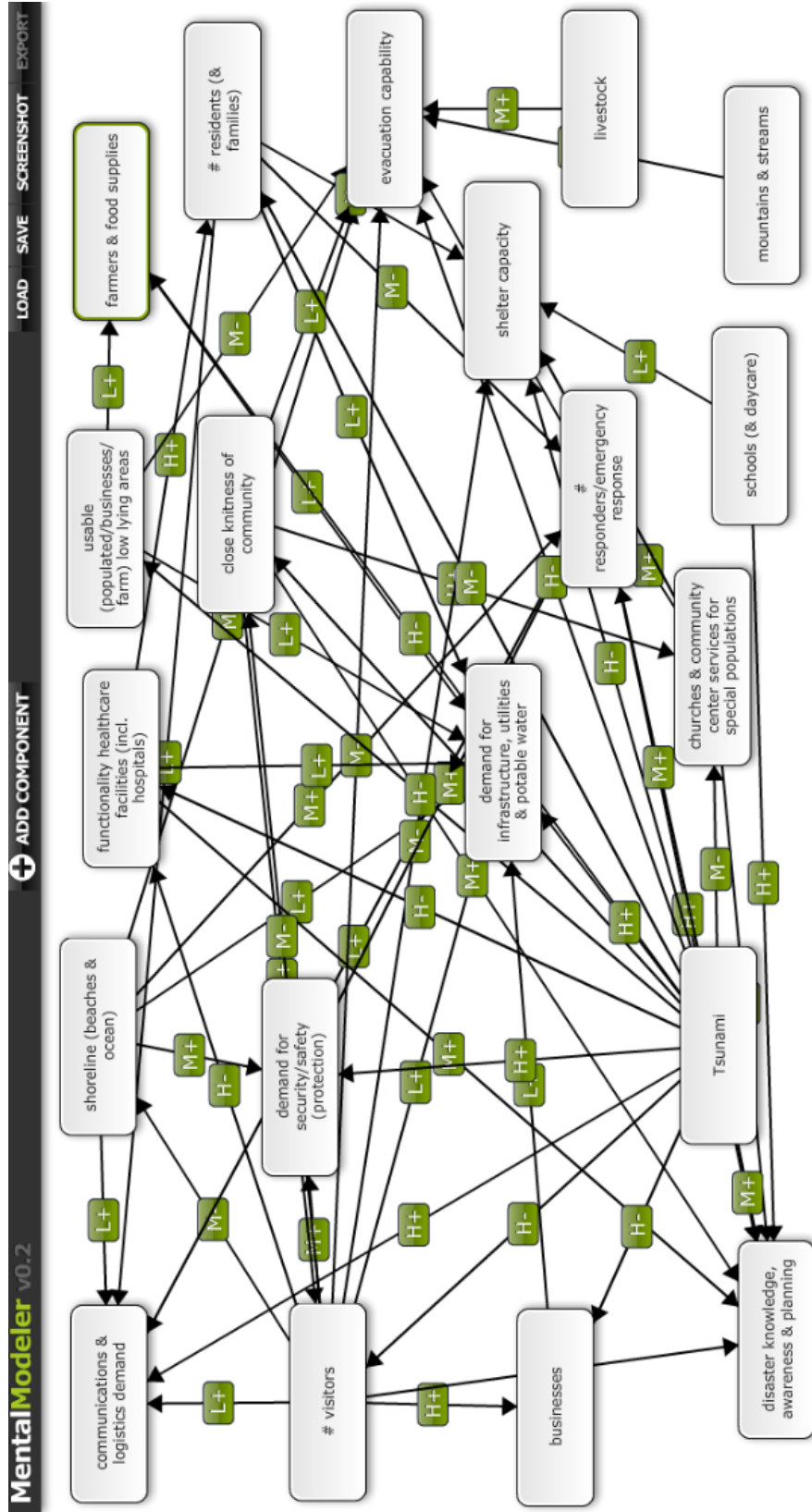
APPENDIX F: COMMUNITY CONSENSUS MODEL—TSUNAMI SCENARIO OUTPUT

Influence of Tsunami on Concept

Relative Change in Value

156
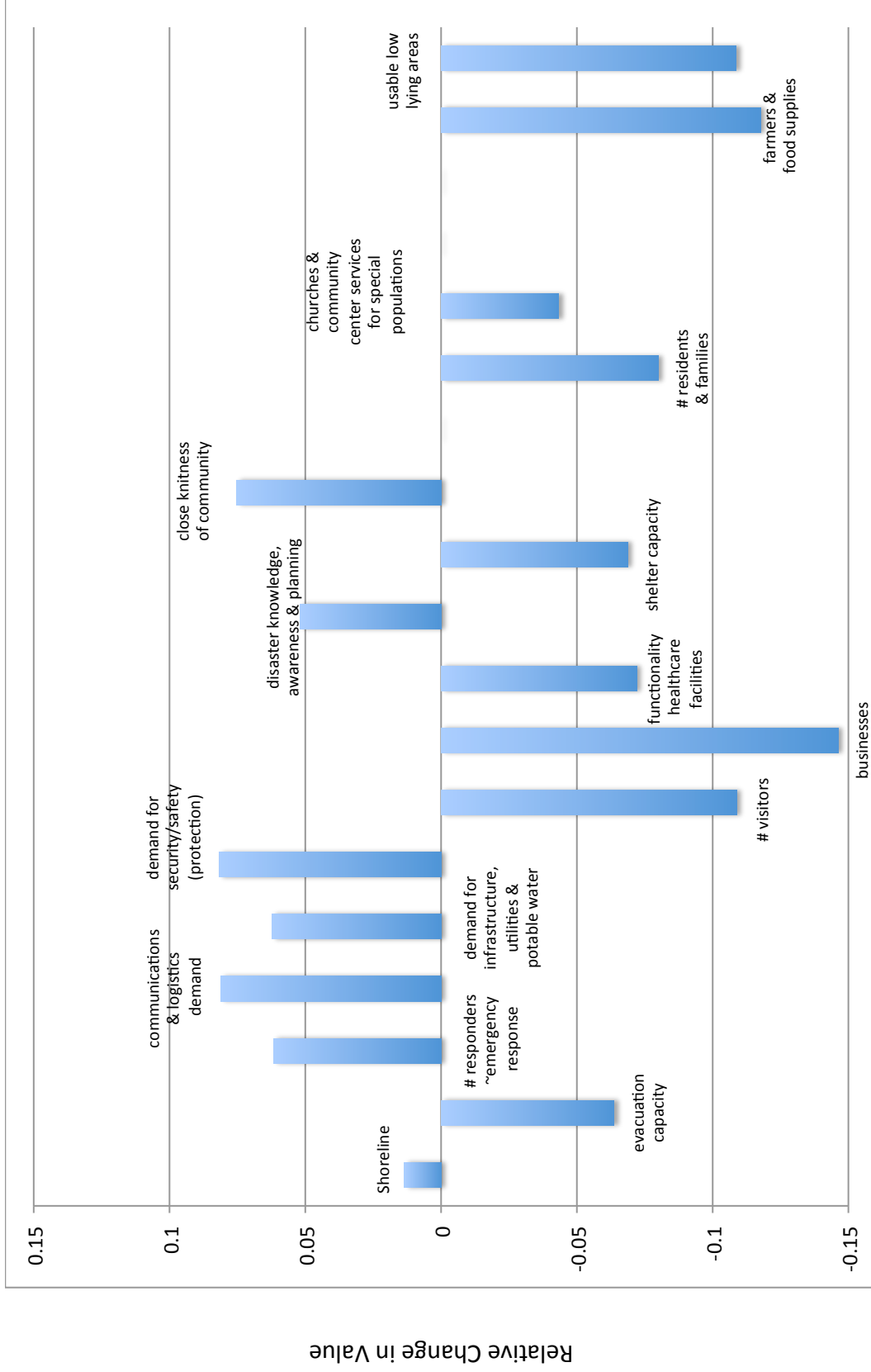
Appendix G. Community Consensus Model—
Tsunami & Mitigation Strategies Scenario Output for all Desired Impacts

Relative Change in Value

0.6 0.5 0.4 0.3 0.2 0.1 0 -0.1 -0.2

evacuation capacity

responders/
emergency response

communications
& logistics demand

demand for
infrastructure,
utilities & potable water

demand for
security & safety

functionality of
healthcare
facilities

disaster knowledge,
awareness and planning

shelter capacity

close knitness
of community

services for
special populations

Legend:
- Tsunami State
- Strategy 1 State
- Strategy 2 State
- Strategy 3 State
- Strategy 4 State
- Cumulative Strategies State

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REFERENCES

Abarquez, I. and Z. Murshed. 2004. Community-Based Disaster Risk Management: Field Practitioner's Handbook. ADPC, The Asian Disaster Preparedness Center, UNESCAP.

Abel, N., H. Ross, and P. Walker. 1998. Mental models in rangeland research, communication and management. Rangeland Journal:77-91.

ACOSA. 2005. Journal of Community Practice: Organizing, Planning, Development, and Change. Sponsored by the Association for Community Organization and Social -Administration (ACOSA).

Adger, W. N. 2003. Social capital, collective action, and adaptation to climate change. Economic Geography **79**:387-404.

Altman, Y. and P. Illes. 1998. Learning, leadership, teams: corporate learning and organisational change. J Manage Dev **17**:44-55.

Argyris, C. 2005. Double-loop learning in organizations: a theory of action perspective. Pages 261–279 *in* K. G. Smith and M. A. Hitt, editors. Great minds in management: the process of theory development. Oxford University Press, Oxford, UK.

Armitage, D. 2005. Adaptive capacity and community-based natural resource management. Environmental Management **35**:703-715.

Axelrod, R. 1976. Structure of Decision: The Cognitive Maps of Political Elites. Princeton University Press, Princeton, NJ.

Biggs, D., N. Abel, A. T. Knight, A. Leitch, A. Langston, and N. C. Ban. 2011. The implementation crisis in conservation planning: could "mental models" help? Conservation Letters **4**:169-183.

Birkmann, J., editor. 2006. Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient Societies. United Nations University, New York.

Bradbury, H. and P. Reason. 2001. Conclusion: broadening the bandwidth of validity: issues and choice points for improving quality in action research.*in* P. Reason and H.Bradbury, editors. Handbook of action research: participative inquiry and practice. Sage Publications, London, UK; Thousand Oaks, California, USA; and New Delhi, India.

Carley, K. 1997. Extracting team mental models through textual analysis. J. Org. Behav **18**:533-558.

Carpenter, S., B. Walker, J. M. Anderies, and N. Abel. 2001. From metaphor to measurement: Resilience of what to what? Ecosystems:765-781.

Chambers, R. 1994. The Origins and Practice of Participatory Rural Appraisal. World Development **22**:953-969.

Chambers, R. and G. Conway. 1992. Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discussion paper 296. Institute of Development Studies, University of Sussex, Brighton, UK.

Craik, K. J. W. 1943. The nature of explanation. Cambridge University Press, Cambridge, UK.

Cundill, G. 2010. Monitoring social learning processes in adaptive comanagement: three case studies from South Africa. Ecology and Society **15**.

DBEDT. 2011. Hawaiʻi Statewide Geographic Information System Program.

Fazey, I., J. A. Fazey, J. Fischer, K. Sherren, J. Warren, R. F. Noss, and S. R. Dovers. 2007. Adaptive Capacity and Learning to Learn as Leverage for Social-Ecological Resilience. Frontiers in Ecology and the Environment **5**:375-380.

FEMA. 2011. Federal Emergency Management Agency. Are You Ready? Basic Preparedness.

Fletcher III, C., E. Grossman, B. Richmond, and A. Gibbs. 2002. Atlas of Natural Hazards in the Hawaiian Coastal Zone. U.S. Geological Survey Geologic Investigations Series I-2761. Prepared in cooperation with University of Hawaii, State of Hawaiʻi Office of Planning, and National Oceanic and Atmospheric Administration.

Folke, C., J. Colding, and F. Berkes. 2003. Synthesis: building resilience and adaptive capacity in social-ecological systems. Pages 352-387 *in* F. Berkes, J. Colding, and C. Folke, editors. Navigating social-ecological systems: building resilience for complexity and change. Cambridge University Press, Cambridge, UK.

Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C.S Holling, B. Walker. 2002. Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. Ambio **31**:437-440.

Gray, S., A. Chan, D. Clark, and R. C. Jordan. 2011a. Integrating stakeholder knowledge in social-ecological system decision-making: Benefits and limitations to knowledge diversity. Ecological Modelling *In press*.

Gray, S., A. Chan, D. Clark, and R. C. Jordan. 2011b. Integrating stakeholder knowledge in social-ecological system decision-making: Benefits and limitations to knowledge diversity. Ecological Modelling, In press.

Gray, S., E. Zanre, and S. Gray. 2012. Fuzzy Cognitive Maps as representations of mental models and group beliefs.*in* E. I. Papageorgiou, editor. Fuzzy Cognitive Maps for Applied Sciences and Engineering – From fundamentals to extensions and learning algorithms.

Harary, F., R. Z. Norman, and D. Cartwright. 1965. Structural Models: An Introduction to the Theory of Directed Graphs. John Wiley & Sons, New York.

Holling, C. S. 1978. Adaptive environmental assessment and management. John Wiley and Sons, London, UK.

Holling, C. S. 1986. Resilience of ecosystems; local surprise and global change. Pages 292-317 *in* W. C. Clark and R. E. Munn, editors. Sustainable Development of the Biosphere. Cambridge University Press, Cambridge.

Holling, C. S. 2004. From complex regions to complex worlds. Ecology and Society **9**.

HSCD. 2007. State of Hawaiʻi Multi−Hazard Mitigation Plan, 2007 Update. Prepared by Cheryl Anderson, Hazards, Climate, & Environment Program, University of Hawaiʻi Social Science Research Institute.

HSCD. 2010. State of Hawaiʻi Multi−Hazard Mitigation Plan, 2010 Update. Hawaii State Civil Defense.

Inayatullah, S. 2006. Anticipatory action learning: theory and practice. Futures **31**:656-666.

Johnson-Laird, P. N. 1983. Mental Models. Cambridge University Press, Cambridge, UK.

Jones, N., H. Ross, T. Lynam, P. Perez, and A. Leitch. 2011. Mental Models: An Interdisciplinary Synthesis of Theory and Methods. Ecology and Society **16**.

Kaly, U. L., C. R. Pratt, and R. Howorth. 2002. Towards Managing Environmental Vulnerability in Small Island Developing States (SIDS). SOPAC Miscellaneous Report 461:16; 11 appendix, 13 tables.

Kearney, A. R. and S. Kaplan. 1997. Toward a methodology for the measurement of knowledge structures of ordinary people: the conceptual content cognitive map (3CM). Environment and Behavior **29**.

Keen, M., T. Bruck, and R. Dyball. 2005. Social learning: a new approach to environmental management. Pages 3-21 *in* M. Keen, V. Brown, and R. Dyball, editors. Social learning in environmental management: towards a sustainable future. Earthscan, London, UK.

Kosko, B. 1987. Adaptive inference in fuzzy knowledge networks. Pages 261-268 *in* First IEEE International Conference on Neural Networks (ICNN-86), San Diego, CA.

Kosko, B. 1992a. Fuzzy associative memory systems. Pages 135-162 *in* A. Kandel, editor. Fuzzy Expert Systems. CRC Press, Boca Raton.

Kosko, B. 1992b. Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence. Prentice-Hall, Englewood Cliffs, NJ.

Langan-Fox, J., S. Code, and K. Langfield-Smith. 2000. Team mental models: techniques, methods and analytic approaches. Human Factors **42**:242-271.

Laszlo, E., Artigiani, R., Combs, A., Csanyi, V. 1996. Changing visions, human cognitive maps: Past, Present, and Future. Praeger, Westport, Connecticut.

McGray, H., A. Hammill, R. Bradley, E. L. Schipper, and J.-E. Parry. 2007. Weathering the storm: options for framing adaptation and development. Washington, D.C., USA.

Nelson, D. R., W. N. Adger, and K. Brown. 2007. Adaptation to environmental change: contributions of a resilience framework. Annual Review of Environment and Resources **32**:395-419.

Osbahr, H. 2007. Building resilience: adaptation mechanisms and mainstreaming for the poor. Fighting climate change: human solidarity in a divided world. New York, New York, USA.

Özesmi, S. L. and U. Özesmi. 2004. Ecological Modeling based on People's Knowledge: A multi-step fuzzy Logic Cognitive Modeling Approach. Ecological Modelling **176**:43-64.

Ozesmi, U. and S. L. Ozesmi. 2004. A participatory approach to ecosystem conservation: fuzzy cognitive maps and stakeholder group analysis in Uluabat Lake, Turkey. Environmental Management **31**:518-531.

Pahl-Wostl, C. and M. Hare. 2004. Processes of social learning in integrated resources management. Journal of Applied and Community Psychology **14**:193-206.

Pahl-Wostl, C., M. Craps, A. Dewulf, E. Mostert, D. Tabara, and T. Taillieu. 2007. Social learning with water resources management. Ecology and Society **12**.

Peschl, M. F. 2007. Triple-loop learning as foundation for profound change, individual cultivation, and radical innovation: construction processes beyond scientific and rational knowledge. Constructivist Foundations **2**:136-144.

Quinn, N. 2005. How to reconstruct schemas people share. Pages 33-81 *in* N. Quinn, editor. Finding culture in talk: a collection of methods. Palgrave Miller, New York, New York, USA.

Reed, M. S., A. C. Evely, G. Cundill, I. Fazey, J. Glass, A. Laing, J. Newig, B. Parrish, C. Prell, C. Raymond, and L. C. Stringer. 2010. What is Social Learning? Ecology and Society http://www.ecologyandsociety.org/volXX/issYY/artZZ/.

Reimann, S. 1998. On the design of artificial auto-associative neural networks. Neural Networks **11**:611-621.

Rist, S., M. Chidambaranathan, C. Escobar, U. Wiesmann, and A. Zimmermann. 2007. Moving from sustainable management to sustainable governance of natural resources: the role of social learning process in rural India, Bolivia and Mali. Journal of Rural Studies:23-37.

Tompkins, E. L. and W. N. Adger. 2004. Does adaptive management of natural resources enhance resilience to climate change? Ecology and Society **9**.

TRIAMS. 2006. TRIAMS Working Paper--Risk Reduction Indicators. TRIAMS (Tsunami Recovery Impact Assessment and: Monitoring System), Geneva.

Tschakert, P. and K. A. Dietrich. 2010. Anticipatory learning for climate change adaptation and resilience. Ecology and Society **15**.

USAID. 2007. How Resilient is Your Coastal Community? A Guide for Evaluating Coastal

    Resilience to Tsunamis and Other Coastal Hazards. U.S. Indian Ocean Tsunami Warning

    System Program, Bangkok, Thailand.

van den Belt, M. 2004. Mediated Modelling: a System Dynamics Approach to Environmental

    Consensus Building. Island Press, Washington, D.C.

Voinov, A. and F. Bousquet. 2010. Modelling with stakeholders. Environmental Modeling &

    Software **25**:1268-1281.

Walters, C. 1986. Adaptive management of renewable resources. Macmillan, New York, New

    York, USA.

Walters, C. and C. S. Holling. 1990. Large scale management experiments and learning by doing.

    Ecology:2060-2068.

Wei, Z., L. Lui, and Z. Yanchun. 2008. Using fuzzy cognitive time meaps for modeling and

    evaluating trust dynamics in the virtual enterprises. Expert Systems with Applications

    35:1583-1592.

Wenger, E. 1998. Communities of practice; learning, meaning, and identity. Cambridge University

    Press, Cambridge, UK.

Wildemeersch, D. 2007. Social learning revisited: lessons learned from north and south. Pages

    99-116 *in* A. Wals, editor. Social learning: towards a sustainable world. . Wageningen

    Academic Publishers, Wageningen, The Netherlands.

Zhang, W. and S. Chen. 1988. A logical architecture for cognitive maps. Pages 231-238 *in* IEEE

    International Conference on Neural Networks, San Diego, CA.

CHAPTER 6. CONCLUSIONS: DIRECTIONS FOR DISASTER RESILIENCE

1.   In Review: common theoretical themes and critical gaps addressed

The work completed for this dissertation is based on the recognition that human-induced and

natural degradation of coastal and surrounding ecosystems, coupled with underlying

vulnerabilities, contributes directly and indirectly to increased vulnerability to natural hazards and

impacts from climate change. Climate change and natural hazards are complex, in both the

causes and effects they ensue on social-ecological systems. It was posited, therefore, that

mitigating and adapting to these effects necessitates that resource managers, emergency

managers and communities employ pro-active and integrative adaptive frameworks, methods and

approaches to understand and address underlying vulnerabilities.

Chapter 1 gave an introduction to the research by reviewing the issues of climate change and

hazards in Hawaiʻi, identifying critical gaps in the field, and providing an overview of the research

goals, objectives and anticipated outcomes. The identified critical theoretical and practical gaps in

the field of disaster resilience (Chapter 1 Table 1) include: 1) Framing the issue; 2) Meaningful

measurement; 3) Dynamic integration; 4) Institutional limitations; 5) Recognizing place-based

knowledge; and, 6) Moving beyond "do no harm." To address these gaps, the dissertation

presented three unique papers exploring different facets of disaster resilience, proposing novel

frameworks, identifying key literature and definitions, and applying diverse interpretations and

measurements of resilience at the household, stakeholder and community-levels (Chapters 4, 5

and 3, respectively) illustrated in Chapter 1 Figure 1. Chapter 2 provided an overview of the

methods including the research design, approach, integrated dimensions and tools, and data

management protocols.

The goal of the dissertation research was to examine issues of climate change, hazards, and

resilience-building in three unique papers addressing critical gaps. Chapter 3 proposed a rights

and justice-based community disaster resilience framework with theoretical underpinnings.

Chapter 4 implemented an adapted household conceptual risk framework in Hanalei, Kauaʻi, and

Chapter 5 implemented a stakeholder action-oriented anticipatory social learning conceptual

research framework in North Shore, Oʻahu, two communities that are at-risk to multiple hazards, geographically isolated, and in need of developing localized disaster resilience plans. Chapters 3 and 4 addressed Critical Gap 1 by reviewing current definitions and constructing frameworks with defined components in order to clarify terminology and communication, and Chapter 5 employed place-based cognitive maps that model stakeholder resilience as defined and interpreted by participants. Critical gap 2 is addressed in Chapter 5 through developing community mental models that are meaningful and relevant to stakeholder participants, and the conceptual resilience frameworks of Chapters 3 and 4 offer indices to better standardize definitions and components as well as to illustrate and measurably link the various components, which in turn syncs with Critical gap 3. Critical gap 4 is discussed in detail in Chapter 3 through highlighting institutional and policy failures and proposing recommendations through use of a resilience framework that is built upon the foundation of rights and justice. Chapter 5 also addresses this gap through addressing institutional limitations through collaborative multi-party planning and decision-making. In support of the dissertation focus on community-based socio-ecological resilience research & planning, Chapter 3 offers a literature review and formulates recommendations to address the gap, and Chapters 4 and 5 integrate place-based knowledge into the community-based participatory research and learning (CBPRL) approach, engaging local stakeholders and integrating place-based knowledge with Western Science. Finally, Critical gap 6 is addressed in Chapter 3 through proposing the need for ethically-founded resilience practices and research approaches to encourage rights and justice for all, while Chapters 4 and 5 offer adaptable and replicable research processes that improve household, stakeholder and ultimately community resilience.

All three papers were framed within the Research Scope integrating three schools of thought (Chapter 1 Figure 1.3): 1) socio-ecological systems including considerations for socio-ecological dynamics, panarchy and the systems approach; 2) socio-cultural resilience theories including place-based knowledge, integration with Western Science, social learning and issues of rights, justice and equity; and, 3) disaster and climate change resilience including the interrelated fields of disaster risk reduction, response, relief, adaptation and development. In addition, the papers

were based on the dissertation Research Approach (Chapter 2 Figure 1) employing socio-ecological systems thinking to address multi-hazard and climate change impacts, by engaging multiple disciplines and sectors and integrating western science with place-based knowledge for implementation of community-based participatory research and learning processes. The papers explored three integrated dimensions of the application of disaster resilience frameworks, methods and strategies, including social science methods integrating qualitative and quantitative measures, utilizing mental models for anticipatory social learning to inform decision-making, and leveraging diverse community, governmental and non-governmental partnerships for cross-scale resilience.

2. Lessons learned

2.1   Applicability, adaptability of conceptual models, frameworks and place-based methods

Resilience is fast becoming a replacement for the over-coined term "sustainability." Because the field of disaster resilience is still rather novel, current challenges center around formulating and agreeing upon common definitions and resultantly measurements of resilience. Despite the increasing support for integrated approaches to resilience, the understanding of how to implement frameworks and strategies at the international, national, sub-national, regional and particularly local levels is poor.

Several aspects of resilience are difficult to measure in a quantitatively, making validation and facilitation qualitative locally-based valuation systems for such indices critical. This is particularly true for repeated measurements that support evaluation strategies to determine research and project efficacy in achieving resilience. Conceptual frameworks and models are useful whether they are of a theoretical or practical nature, or both. Caution must be paid when applying a single framework to understanding, measuring and addressing the complex issue of disaster resilience to diverse communities. While a common measurement platform is tempting in its simplicity, pitfalls exist for one-fits-all model, such that it must be adaptable and flexible to diverse and non-static communities, conditions, constraints, and climate. Adaptable, locally-appropriate methods must be engaged in to understand vulnerability and resilience of populations, through methods such as small group talk story, individual interviews, town meetings, and interactive workshops.

To address this, Chapters 3 and 4 propose and adapt theoretically-grounded conceptual frameworks that recognize the interdependency of socio-ecological systems as well as the interdependency of the contributing fields to disaster resilience, and facilitate quantitative and qualitative measures for components of the frameworks which must be adapted and validated by community stakeholders to accord with their values, experiences and knowledge of what makes them resilient. Chapter 3 proposes the development of a new framework to address current gaps, and offers a rights-based approach to both conceptualizing and operationalizing and measuring resilience. As examined in Chapter 4, framework components may need to be modified or focused on depending upon the co-developed goals, objectives and scope of work. Chapter 5 proposes a conceptual research and process framework to guide anticipatory social learning utilizing qualitative processes of mental modeling that are translated into quantitative values and re-validated through discussions and consensus-building. As such, the methods and tools utilized must be adaptable for the local contexts and characteristics, recognizing the "Resilience of What *and Who,* To What, *According to Whom?*" discussed in Chapter 5.

All three frameworks promote a community-based lens to interpret and validate resilience at a localized scale, from the household, stakeholder and community-levels. They enable decision-making through generation and deliberation of results and facilitate identification of underlying strengths or weaknesses that may be targeted as benchmarks for disaster planning. Different frameworks, methods and tools are needed that address diverse scales (spatial and time—short vs. long-term) and levels (household, stakeholder group, community, regional) of resilience. The multiple scales highlight the dynamic nature of resilience and the interdependency and feedback of resilience components as well as the interconnectedness of households, stakeholders and communities within social and environmental systems, extending across local to global scales and varying across the time continuum. As such, each conceptual framework or model in Chapters 3-5 was developed as a platform from which the community-based disaster resilience planning processes could be adapted for use in different communities for different purposes, goals and resource and time constraints.

<u>2.2   Challenges and recommendations</u>

General limitations exist with conceptual frameworks and models, which are dependent upon the value, quality and diversity of information put into the model. Potential bias is recognized as community case study sites are selected, in part, due to self-selection and their willingness to collaborate in the proposed research. Communities that self-select may be more organized and thus have higher social network connectivity, potentially making them less vulnerable to disasters than communities without clear leadership or representation. Each of the case study communities in Chapters 4 and 5 have very diverse ethnic, socio-economic and cultural demographics, and as such are somewhat fractured, such that individuals identified as local leaders or organizers may not be representative of the entire community's interests and demographics.

Defining "community" and capturing representative input from diverse stakeholders in both case study sites for Chapters 4 and 5 was challenging, as certain populations historically do not participate in community activities or research initiatives. Because resilience-building and adaptation are long-term processes, and due to the fact that community-based resilience frameworks and models ultimately represent perspectives and experience of community and the specific stakeholders involved, inherent challenges exist with inconsistency of participation over time. Sustained participation in community-based participatory research and learning faces the realities of turnover and disengagement, such that models and measurements must be continually recorded and revisited as new participants are engaged in the process.

Access barriers to key populations existed, including residents not at home or not available during the time of the household surveys or interviews, inaccessible homes, as well as limitations of time, resources, and various barriers including cultural, gender and language. In island settings, additional considerations may be needed to access and address the needs of visitor populations that are unaware of hazards, are unprepared and may create a significant burden upon residents in a disaster. Responder bias may have occurred with the household surveys in Chapter 4, due to certain typologies that were home at the time of the survey, as well as self-selection, which result in certain populations with different characteristics.

These challenges were mitigated as best as possible through efforts to engage underrepresented stakeholder groups or sectors through diverse methods, including focus groups, informal talk-story in community settings, key informant interviews, surveys, among others.

3. Outcomes, deliverables and significance

<u>3.1   Societal benefits</u>

A critical component of this dissertation was to understand current community dynamics and resilience characteristics in order to inform decision-making. Societal benefits include: 1) facilitating community-developed multi-sector resilience frameworks, networks, processes and evaluation strategies that contribute to long-term disaster risk reduction; 2) promoting opportunities for participation of underrepresented, vulnerable and special population groups in the research and planning process; 3) creating solidarity-building within the advisory boards that house the community resilience planning processes; 4) enhancing access to tools, resources and coordination of networks; 5) developing locally-relevant processes and protocols to guide the resilience planning; 6) enhancing community awareness of risks to storm hazards and climate change impacts through participatory workshops and deliverables; 7) enhancing capacity to prepare for, respond to and recover from hazards and adapt to climate change; 8) enabling informed decision-making and consensus-building for planning efforts to reduce these risks and build long-term resilience.

The dissertation resulted in more informed and educated communities and stakeholders, with heightened ability to prepare for, respond to, and recover from hazards and to adapt to short and long-term impacts of climate change. The research supported the creation and facilitation of community advisory boards in two sites that leveraged and shared information and resources with organizations, formal and informal groups, institutions, academia, and governmental agencies in Hawaiʻi and the Pacific Region. The research led to enhanced public awareness and programmatic and policy integration, through outcomes of dissemination and discussion of the relevant results with policymakers and the public through open forums, contributing to hazard mitigation planning efforts, presenting at conferences and workshops, and developing publications.

The research also increased institutional capacity and training of existing partners and trainers through participatory learning processes and addressing gaps in knowledge, training and preparedness by leveraging stakeholder educational opportunities.

The dissertation contributed to community-building processes, institutions and programs, which ultimately lead to improved adaptive capacity and resilience to hazards and related impacts from climate change. This will provide the means for communities to continually self-assess vulnerabilities in order to maintain long-term resilience planning efforts. Community organization, training and capacity-building will provide decision-making opportunities to minimize exposure, improving the critical emergency response and shortening the post-disaster recovery period. The research also enhanced scientific literacy through collaborative research processes. The case studies promoted interdisciplinary multi-sector communication and collaboration around common goals of reducing risk and vulnerability of key populations, sectors and ecosystems to hazards, with new focus on improving intergenerational equity, rights and justice.

3.2   Policy and programmatic implications

3.2.1   Integrated planning

County and State hazard mitigation plans, development plans and resource management plans currently make sufficient concessions at the community-level for reducing risk to natural hazards and climate change. Mental modeling-generated data and processes generated improved understanding of community structure and vulnerabilities, ultimately resulting in informed decision-making to improve community preparedness and reduce risk. Particular attention to "differential vulnerability", variables deeply rooted in the internal dynamics of society, and promotes the understanding of the needs of the disadvantaged segments of society (Cannon, 2008). Finally, the findings from the case studies will ultimately result in comprehensive community mitigation and adaptation strategies to address hazards and climate change, which may be integrated with County and State hazard mitigation plans.

3.2.2   Institutional and scientific significance

The dissertation identified the gaps between linking science, practice and policy, and the need to better inform resilience programs and policies with scientific research methods and findings, and

encourage sharing of best practices and intersectoral collaboration. Dissemination of the dissertation results will continue to occur through open-forum public presentations and meetings; development and distribution of public awareness and preparedness printed materials; educational and planning workshops; preparedness and recovery trainings; policy briefings; planning meetings; and, presentation of scientific contributions at meetings conferences. This will facilitate sharing of best practices and lessons learned, in order to facilitate broader discussions around improving community-based disaster resilience research protocols and practices, policy formulation and programs.

The dissertation produced adaptable and replicable frameworks, process templates and methods useful for disaster resilience planning for individuals, households and communities. These frameworks may be implemented in diverse stakeholder groups or communities in a variety of geographic and cultural locales to facilitate social learning, informed decision-making, improved understanding of local socio-ecological systems, enhanced multi-sector collaboration and place-based processes for building resilience to hazards and climate change.

Through identifying and defining critical gaps in the field, the dissertation utilized theoretical and applied case study approaches and methods to explore and address gaps, contributing to advancing the fields of disaster resilience, climate change adaptation and risk reduction by identifying challenges to developing and operationalizing conceptual frameworks and models, proposing suggestions for how to adapt them to local conditions and purposes, and formulating recommendations for trouble-shooting and mitigating for such issues.

4.   Personal reflections: conclusions and next steps

Due to the multiplicative nature of disasters, climate change and human and environmental security, the frameworks, methods and strategies developed to deal with these areas should measure and reduce the root vulnerabilities of people and places at risk. Additional considerations for integration of human rights, equity and justice are needed to promote ethical resilience frameworks and projects. The adapted and proposed frameworks and methods facilitate improved theoretical and practical understanding of the connections between natural hazards, disasters and climate change, and better link the historically disconnected fields of

disaster risk reduction, relief and development. The *Rights-based Resilience Conceptual Model* in Chapter 3 must next be empirically tested in at-risk communities to validate its use in measuring and evaluating resilience within components and across all components.

The *Conceptual framework of community-based household disaster risk* in Chapter 4 was used to focus on social vulnerability and resilience aspects, and may be more powerful when used in conjunction with the other components that increase risk, including the hazard, exposure and vulnerability of the community. This may be done through coupling the household-level social vulnerability and resilience data with secondary data sources for hazard probability and severity, exposure data utilizing GIS hazard maps or census data, and physical, environmental and economic vulnerability data, though difficulties with acquiring household-level data are an issue. Chapter 4 offers a process for how this framework may be supplemented, adapted and focused in on to examine specific resilience characteristics of a community or population. Next steps for the planning efforts in Hanalei, Kaua'i includes finalization of the community disaster resilience plan, guided in large part by the results outlined in Chapter 4. The disaster resilience plan will then be incorporated into an overarching place-based integrated natural resource management plan, of which addresses the larger socio-ecological systems approach by combining coral reef management, urban development and watershed management plans. This integrated natural resource management plan will be the first of its kind in the State and will offer guidelines for piloting elsewhere in the State, the Pacific Islands and internationally.

The *Conceptual research framework and process* of Chapter 5 will be utilized to guide the disaster resilience planning process of North Shore, O'ahu, and like is also a process that can be easily replicated elsewhere to guide decision-making under uncertainty. Pre- and post-intervention surveys may be utilized to evaluate achievement of single, double and triple-loop learning amongst stakeholder participants. Iterative modeling of the community cognitive map provides means to continually re-assess and re-address the mitigation and adaptation strategies, and capacity-building of stakeholders to utilize this process and methods will promote sustainability of this project over time. Potential integration of participatory GIS may facilitate locally-validated hazard maps that facilitate decision-making around what populations, places,

resources and structures to prioritize for mitigation and adaptation measures. These maps could supplement the planning process as well as offer visual guidance for the disaster plan document and public awareness materials.

The proposed conceptual frameworks and models were developed to be adaptable to varying locations, conditions and project goals, employing mixed methods and engaging community and multi-party stakeholders as collaborators in the research and learning process. Leveraging local partnership resources and knowledge facilitates sustained resilience processes and planning in communities over time, through supporting integrated resource management, hazard mitigation, vulnerability reduction and food and water security. Critical to community-based disaster resilience research and planning is capacity building of stakeholders to enable their sustained participation and employment of place-based approaches and methods to evaluate and increase their resilience to hazards and climate change, in hopes of fostering more informed, forward-thinking, resilient socio-ecological development for the welfare of present and future generations. In conclusion, in practice of the reflexive qualitative method, as a researcher and practitioner this research process continues to teach me a great deal.

Resilience is, to a great extent, not something that can easily be described or measured quantitatively; the frameworks, methods and tools utilized in the dissertation acknowledge that there is no panacea, and adaptive, place-based approaches must be used. I found that a critical component (and potentially determinant) of community resilience and successful collaborative partnerships between sectors and disciplines, is social learning and relationships: relationships people have to one another, to the place they live in, and to the governmental and other groups that influence their social, political, cultural and environmental systems, capacity and opportunities. As such, resilience research and planning must facilitate relationship-building, foster social networks, encourage cross-pollination of ideas whilst always bringing focus back to community as the convener, and should encourage ingenuity and creativity.

I will take these lessons learned to guide the continued development of long-term disaster resilience and climate change adaptation plans, processes and most importantly, networks and capacity in at-risk communities in Hawaiʻi, the Pacific and internationally. I hope to contribute to

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the field of disaster resilience by addressing critical lacunas, through pushing the agenda for transparency, accountability and evaluation for better integration of public health, human rights, justice and equity into international to bottom-up socio-ecological frameworks and processes. Facing a booming global population and increasing incidence and severity of disasters amidst times of economic, social and climate change uncertainty, there has never been a greater need for linking research and development to more effectively reduce vulnerabilities and inequities, increase environmental stewardship and improve equity, justice, and intergenerational hope.