Board 52: Engagement in Practice: Role of Community Engagement in Disaster Recovery

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Abstract

This work-in-progress paper examines the role of community engagement in disaster recovery through the lens of the Household-Community Resiliency Nexus (HCRN) model which explains how household resiliency contributes to community resiliency in the aftermath of a natural disaster. HCRN consists of six capacity factors: tangible resources, investments, network support, household network, grit, and attitude toward change. Post-disaster survey responses of a community were utilized to validate the HCRN model. Our preliminary results indicate that the involvement of impacted households in local community meetings almost doubled post-disaster. Furthermore, there was a strong relationship between a household's community meeting attendance and their confidence in handling future difficulties. Additionally, a strong relationship was observed between households' confidence to recover and households' belief in the community's recovery. The findings of this research have implications for the development and implementation of community-based, sustainability-focused engineering projects and outreach efforts.

Introduction

Capacity and resiliency are stapling parameters in understanding the development of a community, despite their abundance of definitions in the literature. While capacity is defined in a multitude of ways, it can be thought of as a community's ability to counteract vulnerability and susceptibility brought about by adverse circumstances (Amadei, 2020). Resiliency, on the other hand, can be thought of as changes in capacity and the ability to adapt to shock quickly to where capacity is recovered efficiently. The Natural Resource Council (NRC) defines resilience as "the ability [of individuals, groups, communities] to prepare and plan for, absorb, recover from, or more successfully adapt to [actual or potential] adverse events" (Amadei, 2020; NRC, 2012). A visual depiction of resilience and its relationship to capacity is shown in Figure 1 below.

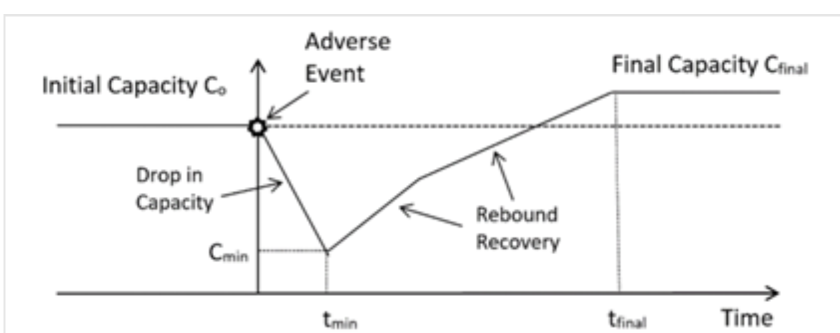

Figure 1. Resilience after a disaster or crisis or viewing resilience as variations in community capacity over time following a disaster or crisis (Amadei, 2020).

Engineers such as Amadei (2020) and Bouabid & Louis (2015) (henceforth referred to as the ABL model) have formed models to assess the capacity of communities to undertake engineering developments in their communities and have related these capacities to the improved resilience of the community. These models were created with the original purpose of ensuring infrastructure was not attempted to be constructed in a developing community that could not be finished being built or maintained by the community. However, these and other similar assessments of capacity and resiliency in engineering would benefit from an enhanced sociological perspective.

The current gap in the literature is that these models are lacking the possibility of change in community capacity during an engineering project or development, meaning that capacity is not stagnant throughout the course of a project but rather changes (Higgins et al., 2023), allowing resilience to increase throughout the project as opposed to solely at the projects' completion. Another current gap in the literature is that while larger-scale communities (e.g., neighborhoods, villages, towns, cities) are largely investigated in engineering literature, the households' building capacity has been neglected in the literature despite its importance for decentralized rural households. As such, the unit of analysis in this research is households rebuilding in the aftermath of a disaster. More specifically, our scope of research involves households rebuilding in the aftermath of disasters because households who have lost their homes in disasters cannot return to their communities feasibly immediately after the disaster become decentralized, even if they were previously living in a neighborhood or another close-proximity community.

This new lens incorporates sociological models such as Yosso's (2005) Community Cultural Wealth model, the Rickaby et al. (2020) Sustainability Performance model, the findings of Azsen & Kurani (2013), the Schwartz Value Survey (1992), and the DeFrain & Stinnett (2008) Family Strengths Inventory (FSI). These models are theory-driven and widely recognized, standing at the intercept of social sciences and engineering to respond to people and institutions involved in disaster recovery. Therefore, drawing from them will allow for a capacity assessment model which has greater synergy and a more holistic capability of evaluating the social behavior behind the development of engineering project capacity and resiliency. This new capacity assessment model is named Household-Community Resiliency Nexus (HCRN) and explains how household resiliency contributes to community resiliency in the aftermath of a natural disaster. HCRN consists of six capacity factors: 1) Tangible Resources, such as materials and labor; 2) Investments, or the allocation of resources to increase capacity; 3) Network Support, or the support and pressure regarding the project from social networks external to the household; 4) Household Network, or the organization of the household that allows its members to work effectively as a unit; 5) Grit, or the household's ability to progress their work through engagement and taking ownership of it; and 6) Change, or the household's desire to progress their work and strive for outcomes past the tasks of this individual project. Our research aims to validate these six capacity factors using a case study and will serve as a benchmark for the total resilience needed to rebuild in the aftermath of a disaster.

To refine and validate our capacity model a case study is warranted. Literature about households rebuilding in the aftermath of disaster does show an observed building of capacity in the household (Andrew et al., 2013; Di et al., 2020; Mills et al., 2011; Talbot et al., 2020). The tragedy of the 2021 Marshall Fire in Colorado was an opportunity for us to collect perishable data regarding the capacities of households in each of the six capacity factors of resiliency.

The recent increase of natural disasters years, the natural wildland-urban interface (WUI) fires, have had increasing frequency due to climate change, and thus will likely continue growing in frequency as climate change worsens (Radeloff et al., 2018; Schoennagel et al., 2017). The impacted households will need to have the capacity and resiliency to rebuild their homes and livelihoods in the aftermath of these types of disasters. The results of this research will allow engineers to better quantify capacity and resilience and will allow households, community leaders, and policymakers to invest more appropriately in increasing the capacity of households for disasters.

Methods

Survey Design and Administration: Our research team utilized quantitative data which was already collected through the "Marshall Fire Unified Research Survey" - a survey created by a partnership of research teams through CONVERGE and the Natural Hazards Center to reduce the burden of surveys on people affected by the fire (Dickinson, et al., 2022). The community survey was designed as a three-wave longitudinal study that was distributed to the impacted communities in the aftermath of the Marshall fire, in Colorado. The first survey went out in May of 2022, the second survey in December of 2022, and a final survey is planned to go out in the summer of 2023. In this community survey, respondents were asked to answer a plethora of questions which included demographics, level of damage to their homes after wildfires, and HCRN capacity factors inferred from the dataset. In total, 3,462 people responded to this survey, and 429 columns of data were collected. The results utilized in this paper are from the first wave and as a result, respondents' perceptions of their capacity factors are five months away from the disaster. Most of the questions relating to capacity factors had five response options, ranging from 1-5 with 1 being the lowest in the category and 5 being the highest in each category.

Statistical Analysis: Due to the presence of categorical data, most of the questions' responses had more than two response categories (i.e., non-binary categorical variables). Most of the statistical methods utilized in this research involved Chi-Square Tests of Independence, which compare the expected distribution of two variables with the observed one. These tests assist us in realizing whether there is a relationship between these two variables that is statistically significant. Research conclusions were based on using these Chi-Square tests in combination with looking at the correlation between those two variables, which is an indicator of the relationship between either of the variables. For the workability of the dataset, a lot of these variables were coerced into a binary variable to have adequate data in each response category. Due to the categorical nature of the data, several methods such as linear regression were not applicable. Logistic regression and stepwise logistic regression were considered, but due to the existence of non-mandatory responses for every question, many null values were present. After selecting relevant variables and removing the null values, a dataset was left which was not large enough to create a model which was both meaningful and robust enough to conclude.

Results

Statistical analyses were performed on survey responses of impacted households in the following three areas: 1) attendance in community meetings pre- and post-fire, 2) the relationship between community meeting attendance and one's confidence in handling future difficulties, and 3) the relationship between one's confidence in their recovery and their confidence in the community's recovery post-fire. Each of these areas was initially examined purely using exploratory analysis and later was further backed up using Chi-square independence tests. Each Chi-square test of independence yielded a p-value of < .05 or smaller, implying a strong relationship between the variables for all three tests.

The involvement of impacted households in local community meetings almost doubled post-fire (Table 1). Before the fire, 34.7% of respondents claimed to have attended a meeting in the community. After the fire, this percentage rose to 64.7%.

Table 1: Pre- vs Post- Marshall Fire Participation in Community Meetings

Pre-fire Participation in Community *Meetings*	Frequency (Percentage)
Yes	275 (34.7%)
No	518 (65.5%)
Post-fire Participation in Community *Meetings*	Frequency (Percentage)
Yes	513 (64.7%)
No	280 (35.3%)
Total (number of valid responses)	793

Yates Chi-square test of independence corrected for continuity yielded a value of 141.61 with 1 degree of freedom and a p-value of <.001***.
* p-value <0.05; ** p-value <0.01; *** p-value < 0.001

The relationship between one's confidence in handling future difficulties and post-fire community meeting attendance was inspected through a Chi-square test of independence and exploratory analysis. Of those who attended a community meeting, 61.7% of respondents claimed to be confident in their ability to handle future difficulties, whereas only 51.2% of people who did not attend a meeting claimed to have confidence (Table 2).

Table 2: Community *Meeting Attendance vs one's confidence in handling future conflict (Percentages are column-wise).*

Community Meeting Attendance	No Meeting Attendance	Meeting Attendance
No Confidence	103 (48.8%)	156 (38.3%)
Confidence	108 (51.2%)	251 (61.7%)

A Chi-square test of independence yielded a value of 5.85 with a p-value of .015* which indicates that there is a relationship between these two variables.
* p-value <0.05; ** p-value <0.01; *** p-value < 0.001

Table 3 depicts a comparison of two variables: one describing the respondent's confidence in their ability to recover within the next year (self-recovery of household) and that individual's confidence in the community's ability to recover within the next year (community recovery). In other words, if someone were to say that they were confident that the community was going to recover (288 respondents) 96.5% of them stated that they had confidence in their ability to recover as well. The results depicted in Table 3 suggest that people who were confident in their community very likely were also confident in themselves, further backing up the idea of community engagement and involvement being important on a personal and household level.

Table 3: Confidence in oneself vs confidence in the community's recovery (percentages are column-wise)

	No confidence in community	Confidence in community
No confidence in self	164 (32.5%)	10 (3.5%)
Confidence in self	340 (67.5%)	278 (96.5%)

Yates Chi-squared test of independence corrected for continuity on these variables returned a value of 88.64 with a p-value < .0001***.
* p-value <0.05; ** p-value <0.01; *** p-value < 0.001

Implications of Our Findings

The totality of our findings reveals that community meeting attendance rose considerably after the fire. Those who attended community meetings had moderately stronger confidence in handling future difficulties compared to their fellow community. This, also combined with the presence of a strong relationship between a household's confidence and that household's belief in community recovery, further emphasizes the crucial role of community involvement in disaster recovery.

As it relates to engineering education instructional practices, educators could adopt specific project-based practices that examine real-world contexts of community engagement in engineering applications. When carefully designed, those experiences can foster students' attention to incorporate HCRN's six capacity factors in design. An example of such efforts could be motivating engineering teams to invite and engage local communities in different decision-making stages of their capstone design projects. These efforts will ingrain asset-based, capacity-enhancing practices in community engagement toward community resiliency.

Summary and Conclusions

The recent increase in natural disasters due to climate change will likely continue growing in frequency as climate change worsens (Radeloff et al., 2018; Schoennagel et al., 2017) which will result in a high number of households misplacement. This new social phenomenon demands the evolvement of engineering instructional practices to leverage the existing skills and knowledge of students to incorporate community resiliency. Our study sought to pinpoint the required knowledge in engineering students through the lens of the newly developed household-community resilience nexus (HCRN). The six proposed capacity factors of HCRN were quantified using the Marshall Fire community survey distributed to affected households post-disaster in Colorado. The survey sought to explore households' change in resilience capacity post-fire. This study represents preliminary research to understand how to holistically strengthen affected households' capacity post-disasters. The future phase of this work-in-progress research involves statistical analysis of waves 2 and 3 to better capture elements of the household-community resiliency nexus in the aftermath of natural disasters. HCRN will serve as a benchmark for total resilience needed to rebuild in the aftermath of a disaster. The results of this effort can assist engineering educators in the design of capstone design modules that involve resilience designs that incorporate HCRN. Hence, these refined, holistic lenses can be used to invest appropriately in increasing household capacity for disaster in a world where disasters are becoming ever-more present.

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