

ADAPTIVE CAPACITY OF HUMAN COMMUNITIES TO
ENVIRONMENTAL DISTURBANCE

By

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Abstract

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This dissertation explores aspects of resident and community adaptive capacity to environmental disturbance in the context of wildfire and hurricane in Lee County, Florida. It is comprised of an introduction chapter and three articles written for publication in peer-reviewed journals.

The first study is based on focus groups with community leaders, land/emergency management and other professionals to examine how social elements of adaptive capacity for wildfire interact with structural conditions at the local level. Structuration theory helps to explain how different manifestations of community action might be needed for adaptation to wildfire risk given different structural conditions. Results suggest that preexisting structural conditions, especially land development patterns, influence adaptive capacity and identify a number of local social characteristics and processes that support adaptation.

The second study draws on interviews with residents in three communities to explore shared wildfire and hurricane risk perceptions. Participants perceived significantly lower wildfire risk, said they were less knowledgeable about how to mitigate and prepare for wildfires, and suggested they are doing less to deliberately adapt to wildfire risk in contrast to high hurricane risk perception, knowledge, and perceived adaptive capacity. The different perceptions of risk seem linked to several factors: direct experience with Hurricane Charley in 2004, different scales of impact, the local "hurricane culture," effectiveness of local ordinances and development patterns, perceived predictability of the event, and perceived ability to control the event. This study highlights the contention that while researchers tend to focus on a single environmental disturbance, residents and communities often face risk from multiple, potentially competing disturbances.

The final study examines generic adaptive capacity, or the elements of adaptive capacity that enable adaptation to multiple types of disturbance. Although wildfire risk has significantly less salience than hurricane risk for participants, results suggest that study communities have built generic elements of adaptive capacity: (1) interactional and organizational capacities; (2) professional knowledge and extra-local networks; and (3) local knowledge, resources and skills. While wildfire adaptation is not many participants' focus, wildfire adaptive capacity exists independently and is indirectly fostered by the process of implementing adaptive decisions and building adaptive capacity for hurricane.

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INTRODUCTION

The ability to adapt to dynamic social-environmental circumstances is central to societal, community and individual wellbeing and, at least incidentally, has long been the subject of sociological inquiry. While adaptation to environmental conditions has been part of the human experience throughout history (DeMenocal 2001; Brooks 2006), the scope of challenges presented by environmental disturbances are unprecedented, particularly as they are magnified by global climate change. An increasing awareness and concern about how climate change will impact societies has led to a proliferation of scholarly interest in social adaptation and the often more readily observable construct of adaptive capacity (Fankhauser, Smith, and Tol 1999; Adger 2003; Smith, Klein, and Saleemul 2003; Adger, Arnell, and Tompkins 2005; Engle and Lemos 2010; Engle 2011; Hamlet 2011). The imperative that human populations develop the capacity to adapt to future climatic conditions that are likely to be more extreme and beyond our range of experience—such as severe wildfire and hurricane events—is unarguable (US EPA 2006; Mills 2009), however, as Handmer (2003:67) notes, most communities could be better adapted to “...the *existing* natural hazards regime.” Supporting or improving communities’ capacity to deal effectively both with current and uncertain future threats and changing environmental conditions depends on our ability to identify, assess, and monitor those factors that facilitate and constrain proactive adaptation at the local level. The goal of this dissertation is to further unpack the notion of adaptive capacity by conducting case study research in three Florida communities to understand how adaptive capacity contributes to their ability to live with two threats—wildfires and hurricanes.

In this chapter I review the literature that lays the groundwork for my research, including multiple perspectives on adaptive capacity, with the aim of identifying where these literatures

converge and revealing gaps. In the first section, I briefly describe the origins of adaptive capacity in the biological sciences and the two dominant social science paradigms that incorporate adaptive capacity: resilience and vulnerability. In the next section I focus on three themes that emerge from the adaptive capacity literature and will inform the analysis of my case study data: determinants of adaptive capacity, the latent nature of adaptive capacity, and how adaptive capacity reflects and influences local context. In a third section I connect adaptive capacity to two social science concepts—community field and structuration theory—that form the theoretical basis of this dissertation. Finally, I conclude by providing a brief overview of each of the three research papers that comprise the subsequent dissertation chapters.

1. Adaptive capacity: biological origins, social science paradigms

Simply stated, adaptive capacity constitutes the underlying conditions and processes that enable adaptation. From the perspective of the natural sciences, adaptation “...broadly refers to the development of genetic or behavioral characteristics which enable organisms or systems to cope with environmental changes in order to survive and reproduce” (Smit and Wandel 2006:283). From the perspective of the social sciences, adaptive capacity does not just explain how people cope with change, but reflects an ability to learn, experiment, and foster innovative solutions in complex social-ecological circumstances (Folke, Colding, and Berkes 2003; Armitage 2005; Plummer and Armitage 2010). According to Plummer and Armitage (2010:6), adaptive capacity is:

...generally referred to as the capability of a social-ecological system to be robust to disturbance, and to adapt to actual or anticipated changes (whether exogenous or endogenous). From a social systems vantage point adaptive capacity is determined by the suite of resources (technical, financial, social, institutional, political) held, and the social processes and structures through which they are mediated (i.e. governance).

The meaning and utility of adaptive capacity has been widely debated (Klein, Nicholls, and Thomalla 2003; Davidson 2010). However, most social scientists link adaptive capacity to two related concepts: resilience and vulnerability. In the following subsections I describe the relative contributions of the resilience and vulnerability paradigms, and argue that focusing on adaptive capacity, a concept that is a component of both paradigms, and its linkages to adaptation has the potential to combine the strengths of both in future research (Engle 2011).

2.1 The resilience framework

The systems theory advanced by the resilience framework strongly reflects its origins in the field of ecology. In resilience studies, researchers seek to understand the dynamics of a social-ecological system (SES) as an inseparable whole (Folke 2006). There are two different conceptualizations of resilience in the ecology literature—one understands resilience as the ability of a system to return to some original state (the steady state perspective) while the second understands resilience as the ability of a system to not only bounce back but move on to one of several potential new states (multiple stability domains) (Holling and Gunderson 2002). This lack of agreement on what resilience means, and misunderstandings from this lack of agreement, has raised questions about its utility in the social sciences (Engle 2011).

The steady state perspective is based on an engineering concept of resilience that considers the ability of a system to return to a previous state or level of functioning after experiencing a shock (Holling 1996; Holling and Gunderson 2002). The weakness in this view is that it is not necessarily desirable for a system, particularly a social system, to return to a prior state as the status quo may be maladapted (Barnett and O’Neill 2010) or otherwise unviable in changing conditions. The steady state perspective was challenged by a number of ecological studies in the 1960s and 1970s that refocused the resilience debate on nonlinearity, variability,

and the existence of multiple stability domains. In short, rather than assuming ecological stability, the emerging resilience paradigm highlighted the different paths through which a system and its relationships might persist in the face of inevitably changing conditions (Holling 1973; Folke 2006). While social scientists have offered several alternative frameworks to understand the concept of resilience (c.f., Davidson 2010; Klein et al. 2003), the dominant meaning in the social science literature is tantamount to ecological resilience: "...the magnitude of disturbance that can be absorbed before a system changes to a radically different state as well as the capacity to self-organize and the capacity for adaptation to emerging circumstances" (Adger 2006:269).

Within this framework, adaptive capacity is the ability of an ecological or social system to influence resilience (Walker et al. 2004), where greater adaptive capacity enables a system to either transform or return to the original state, depending on what is tenable and desirable (Engle 2011). One valuable contribution of the emerging social science resilience framework is that it illuminates dynamic social-environmental processes and differences/interactions among nested scales. For example, resilience thinking provides the theoretical basis behind adaptive ecosystem management, a flexible, context-specific approach that is increasingly replacing the generalized, top-down, command-and-control management style that dominated much of 20th century environmental governance (Folke 2006; Armitage and Plummer 2010). Another strength of this emerging resilience framework is that it integrates economic, ecological, and institutional perspectives (Gunderson and Holling 2002). Indeed, there have been multiple calls for the development of such an integrated framework for the study of the future sustainability of social-ecological systems (Ostrom 2009; Armitage and Plummer 2010). Since it was derived from the

natural sciences, sociological systems theory seems promising to advance this effort because it offers a common vocabulary and analogous framing (Ritzer 2007).

However, serious shortcomings become apparent when trying to impose ecological notions of resilience on social systems as it overextends natural systems concepts at the expense of explaining social processes. In reality, social and natural sciences have developed separately and are based on different underlying assumptions and methods. Hence, these realms of knowledge are not easily integrated, and the resilience paradigm sometimes overstates similarities between the systems. The critical point of contention is that, unlike ecology, social theory must account for the fact that human actors can consciously influence their socio-environmental contexts, have the ability to learn, and have the capacity to anticipate outcomes (Armitage 2005).

In other words, human actors have *agency*, or the power to influence both natural and social structures through action and interaction. “While the structural complexity of both ecological and social systems can be conceived of in similar terms,” explains Davidson (2010:8), “The feedback processes associated with each are incomparable: social systems are unique in that the tendencies toward complexity, and the responses of individual organisms to those levels of complexity, are defined not solely by structural variables, but by agency.” Several characteristics of human agency distinguish social from ecological systems including: (1) the ability to defer consequences to other places and/or times; (2) unequal distribution of power; (3) humans can exercise imagination, and (4) anticipate; (5) societal well-being is enhanced by collective action (Davidson 2010). Other practical weaknesses of the resilience approach to integrating ecological and social concepts of adaptive capacity include the tendency of scholars to resist generalizing from one case to the next, (thereby making operationalization difficult) (for

exceptions c.f., Cutter et al. 2008; Magis 2010) and the different scales employed in ecological and social research because ecological and sociopolitical boundaries seldom align (Engle 2011).

1.2. The vulnerability framework

The vulnerability paradigm comes from the fields of political ecology and geography. It has primarily been used to frame studies on risk, hazards, disasters, and, more recently, global environmental change (Cutter 1996). Vulnerability typically refers to susceptibility to harm by social or environmental stressors (Adger 2006) and is a function of exposure, sensitivity and adaptive capacity (Smith, Klein, and Saleemul 2003). Engle (2011) depicts the role of adaptive capacity in the vulnerability framework as modulating between exposure and sensitivity to a disturbance (i.e., greater adaptive capacity results in lower vulnerability). In other words, where resilience looks at how systems respond to change, vulnerability looks at characteristics that might affect the extent to which a system is impacted by change.

Like resilience, the concept of vulnerability has evolved in the literature. One way to categorize vulnerability studies and their evolution through time is by their focus on either physical, social, or place vulnerability (Cutter 1996). Early vulnerability studies focused on physical vulnerability, and the attributes of risk or the probability of exposure to a specific hazard. Later vulnerability was recognized as "...a social construct not a biophysical condition" (Cutter 1996:533). In studies of social vulnerability, researchers recognized that vulnerability is not only a function of physical exposure, but also the social capacity to cope or sensitivity to a hazard. More recent research has emphasized 'place vulnerability,' which integrates the demographic and socioeconomic characteristics thought to shape individuals' or populations' ability to respond to risk (social vulnerability) and the biophysical characteristics of a specific

place that determine risk exposure and impact (physical vulnerability) (Cutter, Boruff, and Shirley 2003).

Recent vulnerability research seeks to develop metrics to measure or predict social vulnerability predominantly by employing secondary demographic and socioeconomic indicators (Cutter et al. 2008). The primary goal of these studies is to develop the ability to identify populations that are likely to experience adverse consequences to disturbance events. For example, Cutter's social vulnerability index (SoVI) creates a comparative metric of vulnerability based on indicators such as poverty, age, development density, and race at the county-level and smaller scales (Cutter et al. 2003; Boruff, Emrich, and Cutter 2005; Cutter and Finch 2008). Other researchers have developed similar quantitative vulnerability indicators at the municipal and national levels (Brooks, Adger, and Kelly 2005; Posey 2009). Contrasted to the resilience approach, the development of vulnerability indicators has statistically measured and yielded generalizable knowledge about social adaptation. Hence, a great deal of the existing scholarly knowledge about adaptive capacity has come from the analysis of vulnerability (Adger et al. 2007).

However, the credibility of these vulnerability measures has been questioned. Eriksen and Kelly (2007) call attention to the fact that the extent to which indicators of vulnerability can inform adaptation policy is limited by their tendency to be "static snapshots" of social characteristics. Quantitative indicators do not easily capture dynamic interactions and processes across multiple scales and within specific, operative contexts. Furthermore, vulnerability studies tend to overemphasize the constraining elements of social/physical structure while neglecting human agency and the important role of social processes. Consequently, the vulnerability approach is currently inadequate for understanding how populations might become better

adapted to deal with environmental disturbance. Assessments that negatively label individuals and populations as “vulnerable” are less productive than those that would seek to develop direct measurements of how they can reduce vulnerability by building adaptive capacity. Instead of highlighting psychologically demoralizing vulnerabilities, assessments of adaptive capacity and adaptation would have the ability to identify specific strengths that can be employed to build greater capacity and overcome barriers (Engle 2011). Jones et al. (2010:1) argue that “understanding adaptive capacity entails recognizing the importance of various intangible processes....Doing this requires moving away from simply looking at what a system *has* that enables it to adapt, to recognizing what a system *does* to enable it to adapt.”

1.3. *The adaptive capacity framework*

As discussed above, the analysis of adaptation is generally approached indirectly from either the vulnerability or resilience paradigms. While adaptation is not necessarily at the center of resilience or vulnerability studies, adaptive capacity is the fundamental attribute that unites these literatures (Engle 2011). For example, adaptive capacity is credited for both reducing vulnerability and increasing resilience. Although in comparison it is underdeveloped, a distinct literature on adaptation as an independent knowledge domain is also emerging (Janssen et al. 2006; Janssen 2007). Refocusing attention on adaptation has the potential to overcome the weaknesses and combine the strengths of the vulnerability and resilience paradigms. The resilience approach insufficiently accounts for human agency and resists the generalization required to develop assessments of adaptive capacity. Rather than simply emphasizing a problem (such as vulnerability), adaptation research focuses on finding solutions and the role local social processes play in developing the capacity to adapt. In other words, “vulnerability may reflect ‘stocks’ of adaptive capacity that are determined by a range of factors, whereas

adaptation transfers adaptive capacity into action” (Bohensky et al. 2010:26). Engle (2011) enumerates several compelling reasons why future assessments should combine the strengths of resilience (i.e., dynamic SES process and context-specificity) and vulnerability (i.e., operational profile) approaches, but focus instead on adaptive capacity: adaptive capacity is an attribute humans can shape, it is already integral to the dominant frameworks, and it is a universally positive attribute. Although in the above discussion resilience, vulnerability, and adaptive capacity are treated as largely independent, in reality there is a great deal of overlap and evidence of increasing unification and collaboration among researchers. Several interconnected key themes emerge from the literature linking all three concepts, and will guide analysis of data from my case study research.

1.3.1. Determinants of adaptive capacity

Most researchers focus on characterizing the elements or components of adaptive capacity—the result being that many of the same or at least similar underlying determinants have been identified by multiple studies (see Table 1). Commonly identified determinants of adaptive capacity include economic wealth and natural resources, knowledge, information and skills, technology, institutional support, social capital, infrastructure, and equity (Kelly and Adger 2000; Smit and Pilifosova 2001; Smith et al. 2003). The propensity to adapt is also determined to a great extent by a community’s capacity to take collective action (Ostrom 1990; Adger 2003; Adger et al. 2004). The ability of residents in a community to respond collectively to a problem is what Flint (2004) describes as ‘interactional capacity.’ Profile type ‘determinants,’ such as skills and access to resources, are easier to measure than the equally important but less tangible process components like interactional capacity, equity and social learning. A major challenge

for any study of adaptive capacity is that it is latent, often hidden until mobilized by a specific event.

Table 1. Proposed determinants of adaptive capacity

Folke et al. (2003)	Smit et al. (2001, quoted in Swanson et al. 2007)	Yohe and Tol (2002:26)	Brooks et al. (2005:168)	IPCC (2001, as quoted in Albernini et al. (2006:124)	Paveglio et al. (2009)
<ul style="list-style-type: none"> • Learning to live with uncertainty, change (learn from crises, expect the unexpected, evoke disturbance) • Nurture diversity for reorganization and renewal (nurture ecological memory, sustain social memory, enhance socio-ecological memory) • Combine different types of knowledge for learning (combine experiential and experimental knowledge, integrate knowledge of structure and function, incorporate process knowledge into institutions, encourage complementarity of knowledge systems) • Create opportunities for self-organization (reorganize relationship between diversity and disturbance, deal with cross-scale dynamics, match scales of ecosystems and governance, account for external drivers) 	<ul style="list-style-type: none"> • Economic resources • Technology • Information and skills • Infrastructure • Institutions • Equity 	<ul style="list-style-type: none"> • Available resources and their distribution across the population • Structure of critical institutions and the allocation of decision-making authority • Stock of human capital • System's access to risk spreading • Way in which decision makers maintain and distribute information • Public's attribution of the source of stress • Significance of exposure in the local situation 	<ul style="list-style-type: none"> • Resources • Financial capital • Social capital (e.g., strong institutions, transparent decision-making systems, formal and informal networks that promote collective action) • Human resources (e.g., labor, skills, knowledge, and expertise) • Natural resources (e.g., land, water, raw materials, biodiversity) 	<ul style="list-style-type: none"> • Available technological options • Resources • The structure of critical institutions and decision making authorities • The stock of human capital • The stock of social capital including the definition of property rights • System's access to risk spreading processes • Information management and the credibility of information supplied by decision makers • Public perceptions of risks and exposure 	<ul style="list-style-type: none"> • Demographic and structural characteristics • Access to scientific and technical knowledge • Informal interactions and relationships among residents • Place-based knowledge and experience

Source: modified from Matthews and Sydneysmith (2010:226)

1.3.2. Latent adaptive capacity, proactive and reactive adaptation

The latent nature of adaptive capacity presents the greatest limitation on effectively evaluating the concept, its potential, and whether it even exists (Smit and Pilifosova 2001; Engle and Lemos 2010; Engle 2011). Latent adaptive capacity is inactive and does not perceivably lead to adaptation, hence is difficult to observe or predict in a practical sense. That is, adaptive capacity is little more than potential until mobilized by an exogenous catalyst, such as an extreme event (Adger and Vincent 2005; Adger et al. 2007; Lemos et al. 2007; Bohensky et al. 2010), or endogenous "...governance institutions that make it realizable" (Adger 2003:33). Adger et al. (2005) usefully identify two dimensions of adaptation that can be implemented in preparation for or in response to a stressor: building adaptive capacity and implementing adaptation decisions.

Adaptive capacity can be observed in relation to the type of adaptation occurring or that has occurred. In that light, some scholars have found it useful to distinguish between reactive and proactive (anticipatory) adaptation measures (Smith 1997; Fankhauser et al. 1999). Reactive adaptation measures are responses taken after a disturbance whereas proactive adaptation encompasses actions taken to prepare before an event. Since both environmental change and social adaptation are ongoing processes, it is often difficult to "...delineate before and after," pointed out Fankhauser et al. (1999:69). The distinguishing factor is intuitive, however: "anticipation requires foresight and planning, whereas reaction does not require but may involve foresight and planning" (69). Most studies to date have either characterized latent adaptive capacity or assessed reactive adaptation. A future direction should explore proactive adaptation in more depth—particularly the "motivational context," processes, and mechanisms through which adaptive capacity becomes engaged (Bohensky et al. 2010; Haddad 2005; Kelly and

Adger 2000). Exploring risk perceptions as a fundamental aspect of the motivational context of proactive adaptation for hurricanes and wildfires will be a focus of my case study research.

1.3.3. *Context*

Communities vary in their physical exposure to threats, and it is widely recognized that adaptation is place, culture, and issue specific. This means that strategies to facilitate and enhance adaptive capacity also must attend to context (Armitage and Plummer 2010:291) and recognize that capacities do not exist or are not developed uniformly across all communities (Adger et al. 2007). For example, Smit and Pilifosova (2001:19) observe that “what may work in one place or with one socioeconomic group may not work or may not be feasible elsewhere.” While all communities have some degree of adaptive capacity, some analysts have observed that it is generally not developed specifically to respond to environmental change (Handmer 2003) and might actually be hazard specific (Brooks 2003). Finally, temporal scale is often overlooked but important to consider. For example, adaptation (e.g., installation of air conditioners) at one time can “impose externalities” at others (Adger et al. 2005:80) and the temporal characteristics of disturbance events vary (e.g., in Florida hurricanes occur in a predictable season whereas wildfires can occur throughout the year), affecting potentially different timing of adaptation for different disturbances.

Another challenge for assessing adaptive capacity in specific contexts (e.g., at the community level of analysis) is that many elements of adaptive capacity exist at multiple scales—for example, geographic, institutional and governance scales. This means that some elements of adaptive capacity can be exogenous to the local community (Armitage 2005; Wesche and Armitage 2010), and building a community’s capacity may depend on its ability to access resources and establish ties outside the locality (Wilkinson 1991). The importance of

extra-locality linkages has been well-established by sociologists through various conceptualizations including the notion of ‘weak ties’ in social network theory (Granovetter 1973), ‘vertical linkages’ in community theory (Warren 1978), and ‘bridging social capital’ in the capitals framework (Emery and Flora 2006; Pretty 2003). Focusing on a specific scale is important to the “of what” question, but cross scale connections are also important to identify (Carpenter et al. 2001). In my case studies I will be looking at adaptive capacity for two different threats in two to three different communities, allowing for consideration of different contexts, and will pay particular attention to the scale at which different elements of adaptive capacity are found and accessed.

2. Theoretical frameworks: structuration and the community field

Although the literature on adaptive capacity spans from the individual to societies, many scholars recognize that the fundamental scale of adaption is at the local community level—even while community adaptation depends on conditions operating at multiple, often extra-local scales as discussed above (Adger 2001; Eriksen and Kelly 2007; Keskitalo 2010; Sydneysmith et al. 2010). Few studies have satisfactorily connected the dynamics of adaptive capacity to social theory (for an exception see Paveglio et al. 2009). In this section I briefly describe two theoretical frameworks, the interactional approach to community (Wilkinson 1991) and the theory of structuration (Giddens 1986), that help explain adaptive capacity at the community level with the potential to overcome this weakness in the literature.

3.1. The interactional approach to community

The local community is the primary connection between individuals and society (Wilkinson 1991; Luloff and Krannich 2002) as well as a fundamental locus of human interaction with the environment (Field and Burch 1988). This point is illustrated by the fact that

the effects of social-environmental disturbance events depend on specific levels of exposure, sensitivity, social processes and abilities at the local level where outcomes are actually manifest. That is, global changes and specific environmental disturbances are most tangible where they play out at the local level. In addition, social adaptation inevitably necessitates not only the actions of individuals but collective efforts aimed at improving the common interest; therefore this study takes the community as its unit of analysis.

Wilkinson (1991:7) defines community as a "...dynamic and changing field of interacting forces" that requires three criteria: a locality, a local society and, perhaps most importantly, a 'community field'. According to the interactional approach, community emerges through collective action and shared identity. Ultimately, the development of community hinges on the community field or what he defines simply as the "...capacity of local residents to work together for their own wellbeing" (81). Wilkinson distinguishes between social fields and the community field. Whereas a diversity of special interest groups (social fields) may be active in a locality as individuals and organizations interact to pursue common goals (e.g., economic development, environmental protection, etc.), such activity does not necessarily unify to promote the common good as the community field does. Collective action is at the center of interactional field theory because it has been shown to enhance general community wellbeing while developing capacity to respond to specific problems like environmental risk and hazards (Bridger and Luloff 1999).

By conceptualizing the basis of community as a set of interacting fields as opposed to subsystems with specific functions, community field theory presents a contrast to the systems approach from which 'adaptive capacity' and 'adaptation' emerged. Nonetheless, field theory

provides an alternative metaphor¹ with greater potential to move the development of these concepts forward in future research in part because of its focus on social processes (i.e., the perspective reveals what actors actually do to adapt). As Flint and Luloff (2005:405) explain:

Structural approaches drawn from social systems theory and human ecology help identify and define parameters that serve as the backdrop for community action. However, it is the study of actors in associational action at the community level of analysis that moves the study of risk and disaster to an understanding of variations in community response and recovery.

2.2. Structuration theory: Community agency and structure

Where community field theory provides a conceptual model for adaptive capacity that highlights community processes and agency, Giddens' (1986) theory of structuration helps reconcile the core tension in social science between agency and structure. Instead of focusing purely on agency or solely on structure, Giddens (1984: 14) conceives of the two as a duality, defining *agency* as "...the capability of the individual to 'make a difference' to a pre-existing state of affairs or course of events...that is, to exercise some sort of power" and *structure* as the rules and resources that enable or constrain that action. It is widely recognized that adaptive capacity is both enabled and constrained by structural variables (Agrawal 2008; Adger et al. 2009; Sydneysmith et al. 2010; Plummer and Armitage 2010; Engle 2011). Applying a structuration perspective will help connect the emerging construct of adaptive capacity to well-established and fundamental sociological knowledge. The conditions that constrain and enable agency have long been researched and debated in sociology. I propose for the purposes of this dissertation that community adaptation to hurricanes and wildfire can be understood as an expression of agency within a changing set of structural conditions.

¹ I do not argue that social theories are metaphors. However, the underlying notion employed by each theory—that communities can be conceived of as fields or systems—is metaphor.

3. Dissertation overview

This dissertation is comprised of three stand-alone manuscripts written for publication in peer-reviewed journals. Therefore, the format styles of the manuscripts may vary according to the style specified by the target journal. Each manuscript explores a different aspect of community adaptive capacity for environmental disturbance—specifically in the context of hurricane and/or wildfire.

Chapter two, “Land development patterns and adaptive capacity for wildfire: Three examples from Florida,” was co-authored by Matthew Carroll, Pamela Jakes, and Travis Paveglio. ‘Fire-adapted’ human communities have been widely promoted as essential for decreasing the costs of wildfire suppression while enhancing the ability of human populations to live with wildfire in their locality. In this paper we argue that achieving fire-adapted communities will be improved by understanding how social elements of adaptive capacity for wildfire interact with structural conditions at the local level. Insights from focus groups we conducted with local leaders, emergency/land managers, and other professionals are used to differentiate between the types and degrees of wildfire adaptation demonstrated at the local level in Lee County, Florida. We use structuration theory to explain how different manifestations of community action might be needed for adaptation to wildfire risk given different structural conditions. Results suggest that preexisting structural conditions, especially land development patterns, influence adaptive capacity and identify a number of local social characteristics and processes that support adaptation. My contribution to this chapter as primary author was the conceptualization of research questions, organizing and facilitating focus groups, focus group data analysis, and majority of writing. My co-authors contributed primarily by helping to develop a conceptual framework, co-facilitate focus groups, and editing and revising the

manuscript. This chapter has been accepted for publication in the *Journal of Forestry* and is reprinted with permission from the Society of American Foresters.

Chapter three, “Earth, wind, and fire: Wildfire risk perceptions in a hurricane-prone environment,” draws on interviews with residents in three Lee County communities to explore the social construction of wildfire risk relative to hurricane risk. Participants shared disparate perceptions of the risk associated with each disturbance. Residents view hurricanes as a "part of life" in southwest Florida, in contrast, they do not tend to perceive wildfire as a comparable threat—even in areas where wildfire is common and/or presents residents with greater exposure. Participants conveyed less wildfire risk awareness, knowledge, and deliberate action around wildfire issues in contrast to hurricane. The different perceptions of risk seem linked to several factors: direct experience, different scales of impact, the local "hurricane culture," effectiveness of local ordinances and development patterns, perceived predictability of the event, and perceived ability to control the event.

The effect of these factors on risk perceptions has implications for adaptive capacity in a place threatened by multiple environmental disturbances. First, the perception of risk is a necessary if insufficient factor motivating individuals and communities to build adaptive capacity and implement adaptive decisions. Therefore, on one hand, the attenuated wildfire risk collectively perceived along with participants’ behavioral accounts suggests that residents have low adaptive capacity for wildfire at the household and community scales. On the other hand, however, these results suggest that shared hurricane risk perceptions help promote high community adaptive capacity for hurricane. What is not clear based on this chapter is the extent to which the community adaptive capacity intentionally built to live with hurricane is generalizable to also living with wildfire—the issue addressed in chapter four.

Chapter four, “Human community adaptive capacity in a multi-hazard environment,” identifies social characteristics and processes of adaptive capacity that are generic across case study communities and disturbances. This chapter explores the extent to which having adaptive capacity for one type of disturbance indicates that communities also have adaptive capacity for other types of disturbance that they currently or might someday face. Although wildfire risk has significantly less salience than hurricane risk for participants, these results suggest that case study communities have built generic elements of adaptive capacity that are generalizable to address both disturbances: (1) interactional and organizational capacities; (2) professional knowledge and extra-local networks; and (3) local knowledge, resources and skills. I conclude offering examples of how the development of generic adaptive capacity can contribute to the development of ‘all-hazard’ communities.

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MANUSCRIPT 1

LAND DEVELOPMENT PATTERNS AND ADAPTIVE CAPACITY FOR WILDFIRE: THREE EXAMPLES FROM FLORIDA²

Introduction

Managing wildland fire in the wildland-urban interface (WUI) presents a number of dilemmas for policymakers and land managers. Among these dilemmas is how communities in the WUI can become better adapted to the risk and realities of living with wildfire. The creation of fire-adapted human communities has been identified as a national strategy to advance uniform wildfire management (Harbour et al. 2009). This strategy is supported by wildfire social science literature which promotes fire-adapted human communities as a policy alternative to increasing federal and state level fire protection of the WUI (Schoennagel et al. 2009). The potential benefits to communities becoming better adapted to wildfire go beyond the merits of efficient resource allocation and effective fire suppression tactics from extra-local entities. According to proponents, fire-adapted communities address the full range of wildland fire management actions—mitigation, preparedness, response, and recovery—through collaborative relationships among stakeholders and social learning that builds knowledge necessary to living in a fire-prone environment (Leschak 2010). Even as the notion of fire-adapted communities gains currency in wildfire programs, policy and literature, the social processes and dynamics that actually *lead to* fire-adapted human populations remain poorly understood.

In this paper we report the local structures and processes that have emerged in response to wildfire risk in three localities³ in Lee County, Florida according to focus group participants.

² This manuscript has been accepted for publication in the *Journal of Forestry*.

³ Wilkinson (1991) offers a commonly used definition of community; however, we refer to the following areas as 'localities' because they do not all fit the definition.

We conducted two focus groups with key community leaders and emergency/land management professionals in March 2011 in order to explore adaptive capacity for wildfire as it connects to how WUI populations become more fire-adapted. Plummer and Armitage (2010, 6) define adaptive capacity as “...the capability of a social-ecological system to be robust to disturbance, and to adapt to actual or anticipated changes...[and] is determined by the suite of resources (technical, financial, social, institutional, political) held, and the social processes and structures through which they are employed and mediated.” We adopt this definition but add that adaptive capacity also pertains to the ability to cope with risk that is unknown or unanticipated. We think this addition is useful because wildfire poses risks that are often unknown, at least to some stakeholders. Adaptation is a long-term response to disturbance that requires the capacity to learn from the event resulting in adjustments and corrections. Several studies have begun to document the specific attributes and processes that lead to community adaptive capacity for wildfire in multiple contexts (Paveglio et al. 2009; Paveglio et al. 2010; Jakes and Langer 2012).

In the following section we review the wildfire social science literature pertaining to the physical, ecological, and community perspectives for understanding wildfire adaptation. Next we describe how the use of structuration theory helps to better explain the range of possible local actions needed to respond to diverse physical and social conditions leading to wildfire risk and offer a definition of ‘fire-adapted communities’ informed by structuration theory. The design and composition of focus groups and analysis of data is described. We conclude by presenting findings from the data and engaging a discussion about the use of social theory to provide practical strategies that wildfire managers and community leaders can use to address local social conditions surrounding wildfire risk.

Literature and theory for understanding wildfire adaptation

Development patterns and vegetation management

Wildfire risk in the WUI is clearly a multifaceted and complex problem (Carroll et al. 2007). On the one hand, residential development and the resulting redistribution of populations in fire-prone ecosystems has commonly been characterized as a principal driver of wildfire risk (Gude et al. 2008; Hammer et al. 2008). Research has shown that development decisions at the household or parcel level (e.g., home siting, building materials, and landscape design) and level of infrastructure (road placement, water storage, and construction of community shelters) can significantly decrease wildfire risk in the WUI (Cohen 2008). Brzuszek et al. (2010) describe development patterns as setting the context for wildfire risk in Florida localities. Their analysis focuses on how physical and ecological planning, for example the utilization of greenbelts, road networks, and/or waterbodies in a subdivision, can mitigate wildfire risk.

On the other hand, development decisions that result in depopulation can also affect the distribution, intensity, and impacts of wildfires. For instance, rural depopulation has contributed to increased wildfire risk across the Mediterranean (Millington et al. 2007), particularly in Spain where the abandonment of agricultural landscapes has resulted in extensive buildup of scrub and woodlands (Romero-Calcerrada and Perry 2004).

Unmanaged vegetation on public and private land can be a collective problem when it increases wildfire hazard for neighboring property owners (Shafran 2008; Schoennagel et al. 2009). For example the 1985 wildfire in Palm Coast, Florida destroyed 130 homes due to the combination of weather conditions and the unmanaged vegetation left on vacant lots by absentee property owners (Jakes et al. 2003). After a wildfire in 1998 burned another 70 homes in Palm Coast, a county ordinance was passed to enforce hazardous fuel reduction on private lots.

Community agency and structuration theory

One perspective in the wildfire social science literature can be described as focusing on ‘community agency,’ or the ability of a community to influence its own social and/or environmental outcomes through action and interaction. Community agency is critical to wildfire adaptation and is the realization of adaptive capacity at the local level. Instead of assuming that residents who fail to act in the face of ‘obvious’ risk either miscalculate that risk, are unknowledgeable, or unaware, scholars focusing on community agency illustrate how meanings for risk are collectively defined (Flint 2007). People often understand, respond to and manage wildfire according to common sociocultural heritages related to land use, resource dependency, and/or traditional knowledge (Blatner et al. 2003; Gordon et al. 2010; Carroll et al. 2010). Flint and Luloff (2005, 407) argue that how communities with comparable levels of vulnerability “respond to risks and disasters...” depends on their “...varying levels of interactional capacity, or ability to mobilize collective resources in the interest of community.” The interaction of actors within a locality can also be conceptualized as horizontal relationships and networks (Duane 1997).

Vertical information and resource networks, or the ties/relationships communities have to extra-local entities, can be an important component of adaptive capacity. Carroll et al. (2006) found that social conflict after wildfire events occurred when extra-local actors (i.e., Incident Command teams) did not meaningfully incorporate local knowledge, capacities and community agency into their wildfire management activities. The vertical networks communities develop and utilize with professional federal, state and other entities can help foster adaptive capacity by providing connections to extra-local resources—including programs, funding, technology, skills,

and information—that would otherwise be inaccessible or unavailable locally (e.g., Jakes et al. 2002).

Community agency perspectives highlight the plethora of capacities that enable agency, or the different forms of wildfire adaptation performed by locals. Yet these perspectives may highlight agency at the expense of sufficiently accounting for the potentially constraining elements of structure, which includes the social, physical, or ecological factors that can limit or enhance human agency. Sociologist Anthony Giddens' (1984) structuration theory offers a lens through which to potentially identify the diverse range of wildfire risk contexts that exist throughout the WUI while assessing the social processes and characteristics that lead to fire-adapted communities. Instead of focusing purely on agency or solely on structure, Giddens (1984: 14) conceives of the two as a duality, defining *agency* as "...the capability of the individual to 'make a difference' to a pre-existing state of affairs or course of events...that is, to exercise some sort of power" and *structure* as the rules and resources that enable or constrain that action. Therefore, we posit that a fire-adapted human community is one that can (1) express agency (i.e., take action) in a given set of structural circumstances and; (2) affect change in the structural factors (i.e., rules and resources) that enable and constrain action. A structuration approach has been useful in other wildfire social science research to understand wildfire as a source of both social cohesion and conflict (Carroll et al. 2005), the adoption of a shelter-in-place policy (Paveglio et al. 2010), and the long-term impacts of fire on non-tribal communities (Carroll et al. 2011). A structuration approach has not yet been explicitly applied to exploring the concept of adaptive capacity for wildfire.

Methods

This study is part of a larger research project looking at the adaptive capacity of communities to live with wildland fire. In April 2011, the research team conducted two focus groups to explore the adaptive capacity for wildfire in Lee County, Florida. The first focus group involved 11 participants and the second focus group involved nine participants. Participants were recruited purposively to represent a range of perspectives from professionals (e.g., local government/land management entities, state land management, fire departments, and private consultants), and community leaders (e.g., representatives of homeowner's associations) with a depth of experience with wildfire issues in Lee County.

Both focus groups completed four tasks. First, participants discussed and described the characteristics and conditions that promote the ability of Lee County residents to adapt to wildfire. This discussion did not refer to any specific locality but to the county generally, and was important for building a shared understanding of the social elements of adaptive capacity. Second, the participants of each focus group collectively identified four localities within Lee County that represent, in their judgment, different levels of adaptive capacity for wildfire (two they considered having "high" adaptive capacity and two "low" adaptive capacity). Although we focus our results section below on just three of the localities that represent the range of adaptation and development patterns identified by participants, a total of seven localities were discussed (one of the localities was identified by both groups). Third, for each of the localities identified in the previous task, participants completed a brief individual survey that asked them to evaluate the locality's adaptive capacity and described the primary factors that lead to their evaluations. Finally, participants discussed their adaptive capacity evaluations of specific

localities as a group (with an emphasis on the characteristics participants judged most important in their selection and why). Both focus groups lasted approximately four hours.

The sessions were digitally recorded (audio and video recordings), and videos were later analyzed using Atlas-Ti qualitative data analysis software. The lead author first created video segments or “quotations” of the focus group discussions. Once the focus group videos had been reviewed and parceled into segments, the lead author analyzed the data through several phases: (1) an initial phase wherein segments were coded with multiple labels that summarized and described each piece of data and suggested an analytic direction; (2) a process of progressive falsification, during which any anomalies or possible contradictions in codes were discussed among the research team and either incorporated into our explanation of results or recoded (Glaser and Strauss 1999); (3) a focused coding phase that used “the most significant or frequent initial codes to sort, synthesize, integrate, and organize large amounts of data” into relevant themes (Charmaz 2006, 46). Initial coding was conducted across the two focus groups and a second coding was conducted for data pertaining to each locality. The final step was to select the most representative quotation for each theme.

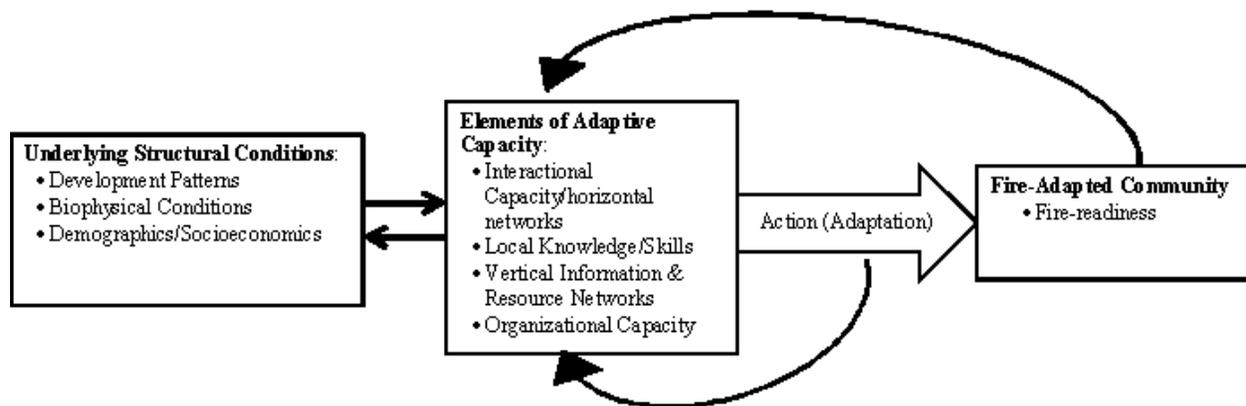
Results

Four elements emerged from the data as important to adaptive capacity: interactional capacity/horizontal networks, local knowledge and skills, vertical information and resource networks, and local organizational capacity. These elements were mobilized within a set of three structural conditions that enable or constrain residents’ collective ability to adapt to wildfire risk: biophysical⁴ conditions, demographic and socioeconomic characteristics, and land development

⁴ While the bulk of the findings we report here on biophysical conditions pertain specifically to hazardous vegetation, we refer to the broader category of ‘biophysical’ conditions because physical infrastructure was also important in many cases.

patterns (Figure 1). The importance of these individual conditions and elements, and their interactions, are illustrated by findings from three of the localities identified by the focus group participants: Lehigh Acres, Buckingham, and The Resort on Carefree Boulevard. Although we saw these interactions emerge in all seven localities, the following three localities represent the range of diversity in the area, including different development patterns. In the following sections we discuss the local context, including perceived wildfire risk, underlying structural conditions, and elements of adaptive capacity for each locality.

Figure 1. Relationship of structure, adaptive capacity, and fire-adapted communities



Lehigh Acres

Structural Conditions

Lehigh Acres is an unincorporated, pre-platted subdivision covering approximately 60,000 acres of west-central Lee County. The first wave of development in the area began in the 1950s when a business tycoon divided a former cattle ranch into 150,000 half-acre lots (Reyes 2010). With a down payment of as little as \$5 to \$10, individuals from across the country and

around the globe purchased their home sites, often sight unseen. Initial settlement and construction in Lehigh Acres was relatively slow, leaving thousands of lots undeveloped. The resulting highly fragmented interface was characterized by scattered houses surrounded by broad areas of highly flammable, largely unmanaged vegetation—including the highly flammable and exotic tree species, melaleuca (*Melaleuca quinquenervia*), which had been introduced throughout the region in the early 1900s in the belief that it would help dry the swamp. The housing boom of the early 2000s more than doubled the population of Lehigh Acres from 33,430 in 2000 to approximately 68,625 in 2009 (U.S. Census Bureau 2009a). However, much of the area has remained largely undeveloped and by 2009, the foreclosure crisis had driven the vacancy rate in Lehigh Acres' 29,936 housing units to 19 percent⁵ (U.S. Census Bureau 2009a).

Development patterns, low occupancy rates and unmanaged vegetation, were frequently identified by focus group participants as contributing to high wildfire risk in Lehigh Acres. “We have a ‘land scam’ community called Lehigh Acres,” one environmental management consultant explained,

...basically they chipped up some rock and poured some tar on it and put roads and a grid in with no infrastructure and all the trees remained. And now we have houses dotting into that [plant] community, which is probably our most problematic [human] community in terms of wildfire perspective.

Focus group participants described “large amounts of vegetated, pre-platted lots with little development [and] large amounts of out-of-town owners who do not manage lots” as endemic to Lehigh Acres from its inception. A significant turnover in population has also contributed to the wildfire risk. Other factors contributing to wildfire risk identified in the focus groups include the proliferation of vacant houses and persistence of unmanaged lots, and the amount and

⁵ In 2000, there were 14,486 total housing units in Lehigh Acres and a twelve percent vacancy rate.

distribution of a flammable timber overstory, a slash understory, and grass surface fuels. In focus group discussions of wildfire risk in other localities, Lehigh Acres was the (negative) standard against which these communities were compared.

Elements of Adaptive Capacity

Focus group participants chose Lehigh Acres as an example of a locality having low capacity to deal effectively with wildfire. Biophysical conditions resulting from the area's development pattern were identified as a significant constraint on adaptive capacity:

[Pre-platted communities] have tremendous WUI problems....100 square miles of developed land, and people just do what they want. There's nothing organizing them. While it's not perfect [in other Lee County localities], it's still light years ahead of what happened in these other areas where we had uncontrolled growth.

Our participants made it clear that physical and ecological characteristics constituted only a part of the wildfire story in Lehigh Acres. Focus group participants suggested that residents of Lehigh Acres lack local social organization and a shared identity that could contribute to adaptive capacity. Participants said these absences hinder the development of common goals and community norms around wildfire management in Lehigh Acres:

[In Lehigh Acres there is] fractured leadership without a common goal. They're part of the county, which means they're unincorporated, so there's really a lack of identity...It's also hard to cobble together suitable neighborhood groups. Basically your other neighbor may live in Germany...So it's hard to get together some groups that can actually organize.

The adaptive capacity in Lehigh Acres also is constrained by the lack of interactional capacity and horizontal networks. Focus group participants suggested that adaptive capacity could be improved if Lehigh Acres residents were able to "function as a community." They suggested that the lack in social interaction is due in part to the absence of local informal and formal social organizations. As one participant summarized:

There [are] two separate issues. One is the pre-platted community where they're plopping a house in the middle of some place where it doesn't have a PDP [preliminary development plan]...a homeowner's association, or even a city—some way of focusing in on it. With the preserves [required in gated communities] and the PDPs, you have at least somebody to go to try to work with. In Lehigh Acres it's not a city; it's part of the county. We used to say 'we don't have a fire problem; we have an ordinance problem out there.' So there's no one way...to go out and address one community's set of leaders. It's the county board of commissioners, which is very diverse.

Participants described how the housing crisis and depressed economy have resulted in a lack of financial resources to take action to adapt to living with wildfire. With homeowners leaving the area "...people, money, and motivation [for action]" that could contribute to adaptive capacity also left. Many of those who remain lack the resources to take action or organize:

They've paid just for the house and that's all the money they have. [They don't have the resources] to go ahead and take another \$4,000 to \$6,000 to remove some of the palmettos. There's some issues too: now they have to go talk to the two homeowners next to them. One lives in Ohio. They want nothing to do with it; they're upside[down] in it and they've lost money. And the other one lives in New York.

However, focus group participants realized that money alone is not the answer, and that local identity and social interaction can overcome this constraint: "...it's not always that poor communities don't do well. But the fact of the matter is if a community is poor, it's got to function as a community in order to adapt."

Despite these challenges, focus group participants identified one element of adaptive capacity that exists and is being developed in Lehigh Acres: vertical information and resource networks. A variety of land and emergency management professionals have worked with residents in the area. These local entities give technical assistance and training that provides residents the knowledge necessary to manage invasive vegetation and reduce hazardous fuels. For example, focus group participants talked at length about the Florida Division of Forestry's ongoing outreach and aggressive fuel mitigation projects—a result of partnerships with Lee

County. While the involvement by professionals and access to technical assistance and knowledge is a tremendous asset, they alone cannot overcome the constraining structural conditions operating in the locality nor translate into high adaptive capacity—that takes the community assuming responsibility for managing its wildfire risk. For all of these reasons focus group participants saw Lehigh Acres as having high wildfire risk but low adaptive capacity.

Buckingham

Structural Conditions

Buckingham is a 12,160 acre unincorporated area located between Lehigh Acres and the city of Fort Myers. Between 2000 and 2009 the population of Buckingham grew from 3,742, to 4,400 (U.S. Census Bureau 2009b). In contrast to other areas in Lee County, Buckingham has experienced relative stability in terms of population as participants described, “...people with lots of history in the area; families that go back generations.”

Characterized as a historically agricultural community, Buckingham residents have been highly motivated to “keep it rural” in spite of being surrounded by high growth areas. In 2007 residents of Buckingham passed an ordinance known as the Buckingham Community Plan, which legally designated the area a Rural Community Preserve. According to the ordinance, all residential lots within the Buckingham Rural Community Preserve must be at least one acre in size (Board of County Commissioners of Lee County 2010). Participants pointed out that such ordinances can have unintended consequences, producing wildland interface challenges, especially when the ordinance’s desired outcome is increased vegetation between properties:

Some of our communities have applied and been granted as what they refer to as Rural Land Reserves....what that means is that any development density increase is close to impossible. So the problem that you have there now: you can change a house, but you can’t clear a large chunk of land....when a new development comes in and [wants to be] a Firewise development, that’s not going to happen. They’re going to be one house in five acres; one house in ten acres. And you’re going to have big chunks of brush.

The wildfire risk due to vegetation in Buckingham is similar to that found in neighboring Lehigh Acres—timber overstory with grass, medium slash, and a dense understory. The locality also has received a high ranking on the wildfire susceptibility index (Florida Department of Agriculture and Consumer Services 2010). Yet rather than thousands of undeveloped “postage-sized” lots with heavy fuels, as in Lehigh Acres, Buckingham has fewer, larger developed lots with heavy fuels.

Elements of Adaptive Capacity

Focus group participants characterized Buckingham as having “high” adaptive capacity. During the focus group participants did not identify barriers to Buckingham’s adaptive capacity, but focused on elements contributing to adaptive capacity. One reason for Buckingham’s “high” adaptive capacity is the community plan and ordinances discussed above. Focus group members felt that these structural components not only define community goals and objectives for vegetation management, but also provide a focus for organization within the community.

The tendency of Buckingham residents to interact with their neighbors has produced an active culture and common identity as a rural southwestern Florida community. This interaction was seen by our participants as contributing to a relatively high level of adaptive capacity because they are more capable for acting collectively in preparation for disturbance. Adaptive capacity in Buckingham is also seen as driven by residents who share and apply local knowledge of the environment, wildfire, and prescribed fire (used for agricultural purposes):

[Buckingham] is an historic agricultural community and they have a high source of pride...they are more aware [of fire risk] because there is more pasture. [They use] prescribed fire for grazing pastures for cattle and horses...And I know they are more aware about wildfire because of adjacent Lehigh Acres—the wildfires out there. Then you have longer term families. Just longer term residents... There’s a community pride and a desire to keep it rural.

Participants indicated that interaction between residents can take many forms and that this interaction, more than its content, was the basis for the ability to work collectively. As one participant said, “the neighbors don’t necessarily like each other, but they interact with each other.”

Focus group participants felt that Buckingham residents have the financial resources necessary to adapt to wildfire. As our participants explained, “...they typically have the means to at least fund some level of protection on their own homes whether it be they buy their own equipment and do it [themselves, or] hire a contractor.” In Buckingham there is evidence of two elements of adaptive capacity (interactional capacity and local knowledge and skills) interacting with structural conditions (residents with financial resources, fuels management promoted by local planning and zoning ordinances, and agricultural practices applicable to wildfire management) to enable wildfire adaptation.

The Resort on Carefree Boulevard

Structural Conditions

The Resort on Carefree Boulevard (or “Carefree”) is a fifteen-year-old gated community located in the city of North Fort Myers. Carefree has about 130 fulltime residents and 450 to 600 seasonal residents who are predominantly retired white women. The gated community consists of 278 manufactured home/recreational vehicle (RV) lots covering roughly fifty acres (New Concept Realty, Inc 2011). Carefree’s retired population, housing, and open areas represent a third common development pattern in Lee County.

Wildfire risk in Carefree was largely described by participants as an unintended consequence of Florida’s environmental conservation mandates. “Lee County developed later than southeast Florida,” one participant explained, “so there were more environmental

protections in place...every gated community has preserve areas where the historic model of development in Florida did not have those.” Many lots in Carefree are adjacent to the same combustible surface fuels as Lehigh Acres and Buckingham because of the environmental preserve area, but few structures are interspersed in heavy vegetation (Florida Department of Agriculture and Consumer Services 2011). There is only one entrance/exit into the gated community, which focus group participants flagged as a concern and driver of vegetation mitigation.

Elements of Adaptive Capacity

Focus group participants rated the Carefree locality as having “high” adaptive capacity for wildfire. The discussion of adaptive capacity in Carefree concentrated on elements that facilitated, rather than limited, adaptive capacity. This was similar to the discussion of adaptive capacity in Buckingham. Participants told the story of how two residents became aware of the need to conduct a controlled burn in the area to reduce fuels and then actually organized the activity over the course of several years, gaining widespread community “buy-in” throughout the process. One Carefree leader summarized how the environmental grounds committee for the homeowner’s association, which initially began with gardening and landscaping goals, evolved to accomplish the controlled burn:

There is a core group [of residents] highly interested in doing the right thing environmentally. The rest of the population was educable; though originally alarmed! ...I’d say it took five to six years. We had to slowly work up to it. The leaders sought help wherever they could get it. That’s how we ended up [working with land management professionals]....The community was a growing community and members were learning lots of new things about their new home and so this [controlled burn] became part of the new things they were learning.

Focus group participants highlighted Carefree’s internally motivated residents, leaders, and active management of their preserve area as the primary factors that influenced their high adaptive capacity rating.

Members of Carefree’s environmental grounds committee realized they needed to implement fuels management activities in their nature preserve to achieve their environmental goals and to meet Florida land management mandates for gated communities. They sought the necessary information and technical support by partnering with local land management agencies such as the Florida Division of Forestry. Although residents are relatively new to Florida and initially did not have knowledge of or experience with the local ecosystem and wildfire risk, leaders in the locality were motivated to become educated about “environmentally friendly” land management practices in their new surroundings and spread what they learned throughout Carefree until they had widespread support to carry out the burn with assistance from the Florida Division of Forestry.

In addition to the environmental grounds committee, focus group members pointed to Carefree’s well-organized homeowner’s association that is able to “provide lasting leadership and continuity” on multiple fronts, adding to their high capacity to adapt to wildfire risk. A formal homeowner’s association has helped residents overcome the potential obstacle of having a population that may be frequently absent or visiting only seasonally. The interaction of pre-existing structural conditions (e.g., related to the gated community development pattern) with elements of adaptive capacity (organizational and interactional capacities coupled with access to vertical networks) enables sustained wildfire adaptation from the view of focus group participants.

Discussion and conclusions

The goal of fire-adapted human communities has been widely promoted among land managers, policy makers, and scientists (Harbour et al. 2009; Schoennagel et al. 2009; Leschak 2010). While existing literature gives insight into what a fire-adapted community might look like in terms of physical and ecological characteristics (Cohen 2008; Brzuszek et al. 2010), there is still a great deal to learn about the social characteristics and processes that actually lead to wildfire adaptation at the community level (Paveglio et al 2009). This study both illustrates structuration theory and expands understanding of the linkages and interactions of local structural conditions with adaptive capacity for wildfire. Structuration theory offers a useful framework to understand influences on adaptive capacity because it can be understood as the expression of agency interacting with the structural conditions residents are both influenced by and simultaneously shape. Figure 1 depicts our results regarding the reciprocal relationships among structure, the potential elements of adaptive capacity, and the development of fire-adapted human communities. As the arrows in Figure 1 suggest, social adaptation is an ongoing process wherein action at the locality level has the potential to influence not only outcomes for wildfire readiness, but also the structural conditions and adaptive capacities that enable future adaptive action.

Specifically, we found that structure and agency may interact to produce some telling outcomes for community adaptive capacity. For example, development patterns not only include structural conditions with physical and ecological relevance (Brzuszek et al. 2010), but also social conditions that can predispose the local social interaction and organization central to community adaptive capacity. That is, pre-existing structural conditions can differentially facilitate and/or constrain the mobilization of adaptive capacities for wildfire. Focus group

participants indicated that in Lehigh Acres, for instance, the preexisting structural conditions have constrained the formation of local social organization and a shared identity that have been important to fostering adaptive capacity for wildfire in other places. The interaction of adaptive capacity with preexisting structural conditions like land development patterns at the local level points to the importance of assessing aspects of both community structure and agency. Just as wildfire risk is not driven solely by physical and ecological factors, this study supports the contention that human adaptation to wildfire is not determined by community structure or agency alone, but by the evolving interaction of the two.

At a practical level these results suggest that “one size does not fit all” in terms of what it takes to help communities become more fire-adapted. Different pre-existing structural conditions—such as development patterns—may require different types of community action and different approaches for outreach intended to help those communities. What a community needs in order to adapt to wildfire risk in one context is not necessarily what another community might need. Some communities have greater existing structural advantages than others such as lower risk (or easily treatable) vegetative conditions, physical infrastructure that enhances wildfire defensibility, and economic and educational resources (e.g., the existence of a cooperative extension office). Our findings indicate that land development patterns have been particularly important to the development of adaptive capacity in Lee County. Some developments have attenuated barriers, fostering social interaction and organization, while others have exacerbated challenges. Where residents in one locality, such as Buckingham, may already be in a position to take action and adapt to wildfire risk, others, as in Lehigh Acres, may face considerable structural constraints. While neighboring localities, these two areas need different types of assistance to facilitate additional wildfire adaptation.

Communities may already have types and levels of social and organizational capacities (e.g., local leadership, a tradition of working together, relevant local knowledge, and experience) that can help them adapt. As localities are situated in different structural conditions, they may also draw from different capacities to promote similar levels of adaptation. For example, being relatively new to Florida, residents in Carefree did not initially have the depth of experience and knowledge about wildfire that contributed to what participants perceived as Buckingham's high level of adaptive capacity. Yet participants described Carefree residents as demonstrating comparably high adaptive capacity by drawing on their ability to engage formal organizational capacity and vertical resource and information networks with county and state land management professionals.

This study also suggests that while managers and other professionals can offer different means to assist community adaptation to wildfire, outside help is not necessarily a sufficient substitute for social interaction and organization at the local level among community members. In the case of Lehigh Acres a state agency partnered with the county to perform vegetation reduction projects. Participants indicated that these projects are necessary, in part, because residents within the locality have been unable to organize and initiate these types of collective action to reduce wildfire risk themselves. This example suggests that external intervention can serve as a partial substitute for community level action, but it is significant to note that despite this intervention, participants did not rate Lehigh Acres particularly high in terms of adaptive capacity for dealing with wildfire risk.

Implications for managers and community leaders

The ability of resource managers, community leaders, and residents themselves to assess existing elements of adaptive capacity along with the elements that could be strengthened in a

locality is a first step to promoting fire-adapted communities. These results suggest the existence of four key elements of adaptive capacity that professionals might look for when dealing with communities at risk from wildfire: vertical information and resource networks, interactional capacity/horizontal networks, local knowledge and skills, and local organizational capacity. Although we do not propose that this list is exhaustive, we suggest these elements as a starting point that resource managers and community leaders might use to identify how adaptive a particular community is and to consider what it may need to improve its adaptive capacity. For example, a community may have strong relationships with and access to information from professionals outside the locality (vertical networks) but lack the capacity to organize within the locality to reduce collective wildfire risk, which is related to interactional capacity and organizational capacity. In this case, efforts intended to bolster adaptive capacity could focus on developing opportunities and processes for interaction among residents within the locality (such as the organization of community meetings and/or community groups).

This research also demonstrates that conditions existing in the locality have the potential to enable or constrain any future actions relating to reducing wildfire risk. Some of these conditions may include land development patterns, biophysical conditions (e.g., invasive species), and demographics/socioeconomics (e.g., high foreclosure rates). Ideally resource managers, community leaders, and residents themselves will be able to promote the structural conditions that underlie, enable, and sustain local action toward the development of adaptive capacity for wildfire. For example, this study finds that development that promotes interaction among neighbors can help foster community wildfire-adaptation. Over all this study points to the importance of considering the elements of adaptive capacity that communities both have and need as well as the local context within which wildfire adaptation will ultimately unfold.

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MANUSCRIPT 2

EARTH, WIND, AND FIRE: WILDFIRE RISK PERCEPTIONS IN A HURRICANE-PRONE ENVIRONMENT

1. Introduction

In the United States the number of acres burned, resources threatened, and wildfire suppression costs have been steadily increasing. In 2012 alone 67,774 wildfires burned more than 9 million acres on private, state, and federal lands with suppression costs totaling more than \$1.9 billion (National Interagency Fire Center 2013). The majority of wildfires in the U.S. burn in the fourteen contiguous western states plus Georgia and Florida (Hammer, Stewart, and Radeloff 2008). Policy makers have responded in part by attempting to engage property owners and communities in wildfire mitigation and preparedness. Property owners are encouraged to maintain defensible space and the 2009 Quadrennial Fire Review (QFR) promotes fire-adapted human communities as a core strategy in addressing the complex challenges of wildland fire management. Fire-adapted communities take a variety of actions to manage their wildfire risk including maintaining defensible space, enacting regulations, adopting “leave-early-or-stay-and-defend” policies, and developing collaborative fire prevention and response approaches with federal agencies (Harbour et al. 2009).

Understanding public perceptions of wildfire risk is an important aspect of promoting a range of fire-adapted actions at multiple scales. Researchers have explored relationships between wildfire risk perceptions and adaptive behavior at individual (Martin, Martin, and Kent 2009; McCaffrey 2004; McGee, McFarlane, and Varghese 2009) and community levels (Gordon et al. 2010; Gordon, Luloff, and Stedman 2012). Yet, people do not face wildfire risk in a vacuum. Wildfire is just one of several potential disturbances that could have extraordinary

impacts on individuals and communities in fire-prone areas. While policies and programs are typically disturbance-specific, risk perceptions and adaptive behaviors often develop relative to other issues in people's lives (Eriksen and Gill 2010), including potentially competing environmental disturbance threats.

Studies that explore the relationship between natural hazard risk perception and adaptive behaviors also tend to focus on a single hazard (McGee et al. 2009; Paton et al. 2008; Peacock, Brody, and Highfield 2005). An exception is Perry and Lindell (2008) who quantitatively examine risk perceptions and mitigation behavior for wildfires, earthquakes, and volcanic activity. Yet, while they simultaneously analyze multiple threats, Perry and Lindell evaluate each threat separately. Contextualizing hazards risk perceptions by considering the multi-hazard environment remains a gap in the literature. An important next step to understanding collective wildfire risk perceptions and adaptive behavior is to consider how these are embedded in a broader biophysical risk context that includes risk from multiple environmental disturbances.

In this paper we describe disturbance risk perceptions of residents in three Florida communities that face significant wildfire and hurricane risk. Our original objective was to explore the applicability of elements of wildfire adaptive capacity (defined below) found in other U.S. regions to Florida communities (Paveglio et al. 2009, 2012). However, when interviewing residents we found that their perceptions of disturbance risk was based almost exclusively on hurricane risk—although emergency managers identified wildfire as a significant threat to the area, there was little awareness among residents. This preliminary finding led us to expand our research. In the following analysis we explain factors contributing to social construction of disparate wildfire and hurricane risk perceptions among residents and discuss implications for adaptive capacity.

2. Literature review

Understanding risk perception provides insight into why people act—individually and collectively—to reduce their risk. It is also important to advancing understanding of adaptive capacity, which we posit is the ability to take action that reduces wildfire risk within evolving structural circumstances (Newman et al. 2013). Recently there have been calls for studies that go beyond characterizing adaptive capacity to unpacking the ‘motivational context’ that mobilizes capacity into action (Bohensky et al. 2010; Haddad 2005; Kelly and Adger 2000). These calls have been prompted by the observation that capacity to adapt does not necessarily lead to implementation of adaptive decisions (Adger, Arnell, & Tompkins, 2005; Rudberg et al., 2012). Although it is but one factor, risk perception is fundamental to the motivational context underlying wildfire adaptation.

Adaptive capacity is often built at the community level through interactions among residents who have developed collective perceptions and values through the course of shared experience (Jakes and Langer 2012). Actions communities and residents themselves take before, during, and after an environmental disturbance depends largely on shared risk perceptions (Tilly 1973; Flint, McFarlane, and Müller 2009). Focusing on social constructions of risk allows researchers to examine how social actors frame environmental disturbance events and “...the processes that are involved in the social production of knowledge about risk” (Tierney 1999:522). Flint (2007:1598) defines community risk perceptions as “...collective expressions of anxiety, fear, or concern due to a commonly understood threat of loss or harm to community residents, property, and/or values.” Informal social interactions among residents in a community facilitate development of shared risk perceptions, information sharing, and affect homeowners’ wildfire mitigation decisions (Brenkert-Smith 2010). Gordon et al. (2012) found that social and

cultural characteristics can influence shared wildfire risk perceptions. In their risk-related framework, Flint and Luloff (2007:423) suggest "...action is influenced by: (1) a community's biophysical and socioeconomic risk context; (2) a shared community perception or social construction of risk; and (3) local interactional capacity to work together on community issues and problems."

Of course, wildfire risk perception and awareness do not necessarily translate into action (Daniel 2008; Steelman 2008; McCaffrey 2004). Nonetheless, risk perception is a necessary factor motivating wildfire adaptation (McCaffrey et al. 2011). Wildfire risk perceptions have been found to be influenced by factors such as values (Bright and Burtz 2006), awareness of related environmental risk factors like climate change (Schulte and Miller 2010), media coverage (Jacobson, Monroe, and Marynowski 2001), and previous wildfire experience (McGee, McFarlane, and Varghese 2009). Much of the literature attempts to explain the 'action-awareness gap.' For example, direct experience with wildfire does not necessarily increase risk perception or mitigation (Martin, Martin, and Kent 2009). McCaffrey (2004:511) summarizes qualitative characteristics of wildfire that may help explain low risk perceptions: "Years of successful fire suppression contribute to a feeling of control; the extent of most wildfires is reasonably limited; and there is generally enough warning to be able to evacuate, thereby avoiding fatalities." Winter and Fried (2000) alternatively found Michigan homeowners unlikely to engage in mitigation because they perceived wildfires as random and uncontrollable.

While little work has contextualized wildfire risk perception by considering it relative to other environmental disturbance threats people face, research does substantiate the contention that wildfire risk is often simply not salient compared to other daily concerns (McCaffrey 2004). Eriksen and Gill (2010) examine the gap between wildfire risk awareness and action in the

context of landowners’ routine decisions and concerns. They find that even when landowners are aware of wildfire risk, they often prioritize other social, economic, or environmental issues. In this study, we contribute to the literature by examining residents’ collective perceptions of wildfire risk relative to hurricane risk in three Florida communities.

3. Methods

3.1 Selection of study sites

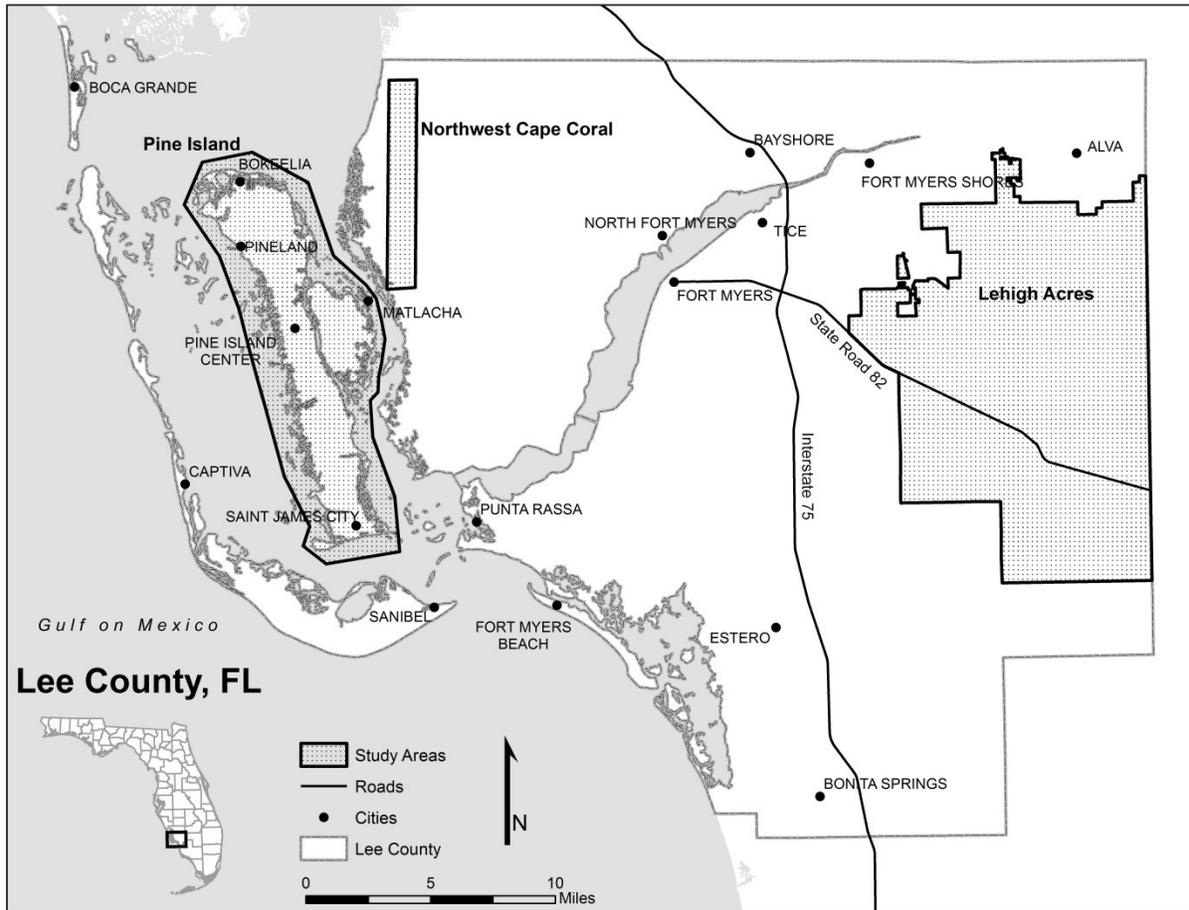
Local land and emergency managers suggested two case study sites in Lee County, Florida (Pine Island and Northwest Cape Coral) that faced significant exposure to wildfire and hurricane. A third site was included because it frequently experiences wildfire (see Table 1), has a reputation throughout Lee County as a high fire risk community, and is located inland (as opposed to the coastal setting of the other two communities) (see Figure 1). Northwest Cape Coral (NCC) is a pre-platted subdivision and an incorporated section of the city of Cape Coral. Pine Island (PI) is a rural and agricultural area with four unincorporated population centers: Matlacha, PI Center, Bokeelia, and St. James City. Lehigh Acres (LA) is an unincorporated pre-platted subdivision.

Table 1. Number of wildfires responded to by study site fire departments, 2008-2012

Year	Cape Coral	Pine Island	Lehigh Acres
2008	12	39	160
2009	10	36	195
2010	10	21	159
2011	6	48	189
2012	11	29	202

Sources: Bennett (2013), Roach (2013), and Mackowski (2013)

Figure 1: Map of Lee County, Florida study sites



3.2 Data collection and analysis

An inductive grounded theory approach to social science research was used to gather and analyze data (Glaser and Strauss 1999). Grounded theory allows researchers to make “...generalizable theoretical statements that transcend specific times and places and [to perform] contextual analyses of actions and events” (Charmaz 2006:46). A total of 77 in-depth, semi-structured interviews were conducted with 94 participants in March, May, and June of 2012: 36 interviews (42 participants) in PI, 30 interviews (39 participants) in NCC, and 11 interviews (13 participants) in LA.

There are more participants than interviews because in some cases two or more members of the household were interviewed together. The first two to three participants in PI and NCC were identified through organizations' websites (civic groups, homeowner's associations, etc.). The first participants in LA were identified with assistance from emergency managers. Most subsequent participants were identified through snowball sampling and recruited to represent citizen types with whom we had not yet spoken. In the case of NCC, additional participants volunteered through an announcement published in the NCC Neighborhood Association newsletter. Participants were asked open-ended questions that covered three topic areas: (1) community characteristics, relationships, and concerns; (2) wildfire risk perceptions, experiences, and preparedness; and (3) hurricane risk perceptions, experiences, and preparedness. Ninety-two participants were interviewed in person and two interviews were conducted by phone. Interviews lasted between 60-90 minutes, were audio recorded, and transcribed.

AtlasTi qualitative data analysis software was used to code and analyze the data through a systematic process that included several phases: (1) descriptive initial codes were assigned to segments of the data until all subsequent observations fit into established codes; (2) initial codes were organized into categories and subcategories, (3) remaining data were used to validate existing codes, and to refine analytical categories and subcategories; (4) a conceptual analysis was conducted to answer specific research questions and to "...identify patterns and relations in the data to see how various aspects of the findings [could] be integrated" (Charmaz 2006; Friese 2012:235). Finally, quotations were selected that represent the results.

4. Results

4.1 Emergency managers' perceptions of risk

According to Lee County Emergency Management, wildfires and hurricanes are significant events in Lee County with the potential to adversely impact the population (Florida Division of Public Safety 2007). Lee County is the 7th fastest growing county in Florida, experiencing a 40 percent growth rate since the 2000 census (Lee County Public Safety 2011). The area is projected to grow another 25 percent by 2060, with much of the development expected in the wildland-urban interface (WUI) (1000 Friends of Florida 2006). According to the Lee County Wildfire Protection Plan (CWPP) (2011:2), “Lee County was selected as one of 10 counties to receive assistance in developing a CWPP because of its high wildfire vulnerability relative to other counties in Florida...[and] the Florida Division of Forestry ranked Lee County as the most vulnerable county to wildfire in the State of Florida.”

Table 1 provides a count of wildfires to which each community's fire department responded from 2008 to 2012. In that period, NCC, PI, and LA had an average of 10, 35, and 181 wildfires a year, respectively (Bennett 2013; Mackowski 2013; Roach 2013). Lee County has experienced ten to fourteen hurricane strikes since 1900 (NOAA 2013). Since 1960 five major hurricanes—defined by the National Hurricane Center as a hurricane that is classified as a category 3 or higher (NOAA/National Weather Service 2013)—have threatened the area. One environmental manager who helped select study sites conveyed a common view among professionals:

There are [hurricane] workshops, a lot of outreach, education, media attention. It's a good comparison because there's the same amount of damage potential, but less preparedness and attention given to wildfire. Even though fires are a lot more frequent than hurricanes—the last big hurricane could be decades in the past. People don't realize how vulnerable they are to wildfire.

Other land management professionals saw wildfire frequency as helping to build adaptive capacity for the event and described how they work with residents to reduce wildfire risk, for example, by doing home assessments with property owners:

Wildfire prevention is a shared responsibility with residents. We encourage them to understand the role fire plays in Southwest Florida and show them what they can do to reduce the risk around their homes and businesses. Complacency about wildfire is not as much of an issue among residents as it can be with hurricanes because wildfires occur frequently throughout the year. [Wildfire mitigation specialist]

3.2 Residents' perceptions of risk

Residents in all three study sites perceive greater hurricane risk than wildfire risk, said they are more knowledgeable about how to mitigate/prepare for a hurricane event, and indicated they are more likely to deliberately take action to reduce hurricane risk. The perception of hurricane risk was generally based on experience from two hurricanes—Hurricane Donna in 1960 and Hurricane Charley in 2004. Even residents who perceived low hurricane risk communicated knowledge of how to mitigate risk and prepare for hurricanes and typically engaged some adaptive action (“I’ll be honest, at our house we make sure we have water and canned goods but I didn’t put any shutters up—we live so far inland” [LA resident]).

In contrast, participants who did not perceive wildfire risk typically said they are not as knowledgeable about how to mitigate and prepare for wildfire events nor did they take deliberate action to reduce wildfire risk. Furthermore, their degree of exposure to wildfires seems to make little difference in many participants’ wildfire risk perceptions. Even residents who have been directly threatened by wildfires did not tend to express concern:

I’ve never prepared for a fire; I wouldn’t know [how]...I’ve lived here [my whole life] and we’ve never really worried [about] fires....We used to have to stand outside with a hose...until the fire department came. That happened a couple times where a fire...burned the woods all the way around the house. [LA resident]

3.3 *Factors influencing risk perception*

Analysis suggests that different risk perceptions for each disturbance are primarily linked to six interconnected factors: direct experience, different scales of impact, local "hurricane culture," effectiveness of local ordinances and development patterns, perceived predictability of the event, and perceived ability to control the event. These factors emerged as important to the social construction of risk in all three communities. We explain each finding in more detail below.

3.3.1 *Direct experience*

Many participants noted prior to Hurricane Charley residents had generally low hurricane risk perception and preparedness at the household and community levels. Most participants who experienced Charley in 2004 described it as a catalyzing event—with residents recognizing the importance of preparedness activities:

Prior to Charley...we'd have... 'block parties.' We would literally put people's furniture up on blocks...and then we'd gather at the local bars and have a few adult beverages. That went on for...a 40 year span where there were no storms of any consequence. Then Charley hit us. People...no longer just go 'we'll see you down at [the bar].' You are prepared. [PI resident]

Direct Charley experience prompted even long-time residents to “take hurricanes more seriously.” Participants described specific household-level adaptations they made after Charley, which commonly included updating or acquiring storm shutters and buying a generator: “After Charley we went ahead and had shutters put on the house and we bought a generator” [PI resident]. Participants conveyed how experience with Charley has affected greater hurricane risk perceptions and prompted implementation of hurricane adaptation measures among residents.

3.3.2 *Scales of impact*

Hurricanes and wildfires can present residents in the same locality with different levels of

exposure and impact. Participants indicated that the spatial extent of hurricane impacts are unparalleled by wildfire. They believe hurricanes affect everyone in their community and broader region to some extent, whereas wildfires are comparatively small in scale, impacting only isolated and sparsely populated areas. The scale of a hurricane can influence how wildfire risk is perceived and prioritized:

A hurricane is much more massive and extensive....Our forest fires here maybe [destroy] two or three homes...rather than a hundred homes....Therefore one has to look at what their priorities are. Which would be the biggest disaster? [NCC resident]

Many participants described how property damage caused by hurricanes diminishes residents' wildfire risk perception and suggested wildfire damage would be easier to recover from ("If [my house] burns down...I've got insurance. I'll have it fixed and more than likely [after a fire] you don't have 300 people needing to rebuild at one time [like you do] when a hurricane comes through" [PI resident]).

Participants also contrasted the time it takes to recover from a hurricane to a wildfire. Many pointed out that the large spatial extent and population affected by a hurricane often results in a significantly longer recovery period "[Emergency managers come] in with their [hurricane] disaster group and say, 'You're gonna be doing this for anywhere from two to five years'...Wildfires usually are more contained" [PI resident]).

The different temporal, damage, and spatial scales of wildfire impact has been experienced as a non-event by most residents when contrasted to the scale of hurricanes.

3.3.3. Local "hurricane culture" and ubiquity of information

Most participants talked about hurricane risk as an expected part of life in Florida. Preparing for hurricane season was therefore described in terms of a "way of life" or cultural practice:

It's never once occurred to me to prepare for a wildfire.... [Hurricanes] just seem to be part of the life here that by the first of July you have all your supplies and you're ready to go...I never think about wildfires, *ever* unless one happens...and we live in the woods. [PI resident]

Participants described a ubiquity of hurricane information and messaging from hurricane evacuation route signs to merchants' hurricane supply advertising to local media coverage: "I think people probably [have high hurricane adaptive capacity] because all the news media talks about hurricanes, hurricanes, hurricanes" [LA resident]. As one PI resident summarized, residents perceive themselves as more prepared for hurricanes because "they get a lot more information about hurricanes—told about it a lot more." Another participant observed:

Hurricanes...come every year and...they have seminars, there's flyers in the newspaper that have a list of what you need for preparation...So it's just beat into you...every time the hurricane season comes around that you need to be prepared. They talk about the shelters and you can see the evacuation signs....So [hurricane] is front and center all the time as to where fire is such a hit and miss thing. [NCC resident]

The Hurricane Charley experience resulted in a cultural memory related to the event, so that Charley's impacts on risk perceptions and residents' actions have not been limited to those directly affected. Several participants who moved to Lee County years after Charley described a process of social learning through which hurricane risk and mitigation measures continue to be informally communicated. Social interaction within the community has affected many residents' behavior:

[Hurricanes are] very much [an issue] because Charley came through in 2004...we weren't here...but we knew our neighbors because we'd visited...and they said it was really terrible. Even the builder of our home—he and his family were without water for a week—and that's one of the reasons we put a generator in. [NCC resident]

Participants commonly perceive and respond to hurricane risk more than wildfire risk partly due to a hurricane culture with pervasive hurricane information and messaging.

3.3.4. Effectiveness of local ordinances and development patterns

Local ordinances and development around reservoirs and canals were often cited as reducing wildfire risk and affecting risk perceptions in NCC and PI. These structural factors have an important role in the perception and reality of wildfire risk. NCC, for instance, has enacted a citywide lot mowing ordinance intended to control vegetation, remove invasive plant species, and limit vermin populations. This ordinance has reduced wildfire risk for many residents. As one local firefighter and NCC resident explained:

We used to have [wildfire] problems...before they put an ordinance in place that required mandatory lot mowing. Whether you built on your lot or not you're still responsible for maintaining its grass...and people pay a small fee to make sure those lawns are cut. Prior to that we'd have wildfires here; it could go from block to block.

Not surprisingly the city ordinance has influenced not only NCC residents' perceptions of wildfire risk, but also their perception of the action required to reduce wildfire risk. As an unincorporated area, residents of PI referred to county ordinances, which are seen as a mechanism to enforce vegetation management: "Lee County has ordinances on keeping your lots and your land clean and people are pretty good about letting somebody know if they think their neighbor's yard isn't kept up the way it should be" [PI resident].

In addition to local ordinances, many participants in NCC and PI pointed to certain development pattern characteristics they perceive as reducing wildfire risk. In some areas of NCC and PI many people live along canals or reservoirs. Participants perceived the significance of these water features for reducing wildfire as twofold: as fire breaks ("There's a lot of wildfires in Florida lately, but...NCC...is like Venice, there's...400 miles of canals and so I don't think of fires spreading very easily" [NCC resident]) and water sources:

Even though there may not be city water, the problem isn't that acute because you have canals and you have lakes, so all you got to do is dump a hose in there and [firefighters] can pump forever more. [NCC resident]

In this multi-disturbance environment, living on water presents greater hurricane risk whereas the same structural elements are seen as attenuating wildfire risk. As one PI resident explained, "I'm much more concerned about hurricanes living right here on the water than I am about fire."

3.3.5. *Perceived predictability of event*

Another factor affecting perceptions of wildfire and hurricane risk, according to participants, is the ability to observe a hurricane building and receive advisory well before the storm makes landfall. Hurricanes also have a predictable, discrete season. Wildfire is perceived as a random event that can occur throughout the year for which residents get no warning:

I don't even put them in the same category...maybe it's because wildfires are so damn random and they can be started by a strike of lightning or somebody welding or throwing a cigarette out that I don't think about (A) that being a natural disaster and (B) being anything you could've prepared for. [PI resident]

The hurricane warning affects the amount of time, when, and frequency residents have to take adaptive action. It is partly this warning that sets hurricanes apart from wildfires:

You can...pick up stuff, board the windows...prepare in the time the hurricane is coming. So consequently you don't have to be prepared on a...regular basis...when [wildfire] happens, it's happening right now and there's no preparation. [NCC resident]

There are many actions Lee County residents can take over the course of several days once they know the likelihood of being exposed to a specific storm (e.g., by putting up storm shutters, buying extra supplies, and deciding if and where to evacuate). Many hurricane actions residents take can be initiated once they know a hurricane is coming. A longer, yet discrete, window of opportunity means residents are more likely to engage in some level of hurricane risk-reducing action.

In contrast, wildfire adaptation is perceived as requiring continuous activity and awareness (“People have to be more in tune for wildfire because there's no advanced warning. Nowadays with a hurricane you get a week” [LA resident]).

Participants argued that because wildfire events are less predictable, residents are less likely to exert the energy necessary to be in a constant state of readiness: “Hurricane has a season. You know when your risk is so people are more apt to get prepared. Fires happen all the time so you have to be prepared all the time” [PI resident]. As residents typically do not receive the same amount of warning for wildfires, participants communicated a fatalistic attitude about wildfire adaptation. The unpredictability of wildfires supports a widespread notion that communities can only react once a wildfire occurs as opposed to being proactive.

Ongoing [hurricane] predictions...put you in a state of readiness. With fire you don't have that. You think, ‘well, it is going to be lightening and how do you prepare for that? We will cope with it if it happens.’ With the hurricane it is, ‘we will cope with it even before it happens.’ [PI resident]

Participants tend to experience wildfires as smaller, random events contrasted to hurricanes that occur within a predictable season and with plenty of forewarning. The predictability of each disturbance affects the nature of action (e.g., continuous or discrete) required for communities and households to be adaptive.

3.3.6 Perceived ability to control the event

Another common theme is the notion that wildfires, once ignited, can be controlled by humans, primarily emergency managers, while hurricanes cannot. Participants in all three localities expressed tremendous respect for their local firefighters and emergency managers and believed in these professionals' ability to contain and control wildfires. Some participants felt the ability of professionals to control wildfire let communities “off the hook”—precluding a need

for communities or households to also take action. According to participants, the inability of professionals to “contain and control” a hurricane focuses more responsibility for preparedness on communities and residents themselves.

Obviously you’re not going to stop Mother Nature, so a hurricane’s going to do what it’s going to do....Where with a fire...[firefighters] can control it....A hurricane’s out of everybody’s control...But...these guys are really, really good here in the State of Florida at containing fires. [NCC resident]

Participants have seen firefighters effectively respond to and, in most cases, control wildfires before private assets are negatively impacted. In contrast, residents perceive they cannot realistically depend on professionals to offer assistance and a similar level of protection during a hurricane. Different notions constructed around humans’ ability to control each disturbance type affect the level of personal responsibility and action residents engage in to reduce risk. That is, participants widely perceive wildfire adaptation as the responsibility of professionals whereas most participants said it is up to individuals to prepare for and mitigate hurricane risk themselves.

5. Discussion

Research has shown that wildfire risk perceptions and mitigation behaviors are often developed relative to other issues and priorities in residents’ everyday lives (Eriksen and Gill 2010). Communities’ biophysical risk context often includes multiple, potentially competing (in terms of salience and priority) environmental disturbance types and this study shows that residents may perceive and act to reduce risk for one disturbance in relation to their perceptions and concern for another. Florida residents involved in this study share high hurricane and low wildfire risk perceptions. In spite of the Florida Forest Service’s ranking of Lee County as the county most vulnerable to wildfire in Florida (Lee County Public Safety 2011), low wildfire risk

perceptions were conveyed even by residents who have had recent and/or multiple wildfire threats to their properties.

Community context can affect collective wildfire risk perceptions (Gordon et al. 2012). In spite of different incidence of wildfire events across study sites (e.g., in 2012 LA had more than seven times as many wildfires as PI and approximately 18 times more than NCC—see table 1) and varied proximity of the three localities from the coast (i.e., PI is off the coast, NW NCC borders the coast, and LA is approximately 30 miles inland), participants in all three localities shared surprisingly similar perceptions of wildfire and hurricane risk. This suggests a shared construction of risk prevails throughout Lee County, unifying perceptions across communities that actually have different biophysical and socioeconomic contexts as well as different degrees of exposure to each disturbance.

The cultural salience of hurricanes in this context helps explain why it is so much more a focus of local attention than is the case for wildfire. The cultural narrative around hurricanes so dominates local formal, informal, and commercial messages about environmental risk in Florida that even residents who personally have had more experience coping with wildfire perceive greater hurricane risk. The cultural dominance of hurricane risk was amplified by a major hurricane event, namely Hurricane Charley, the impacts of which were experienced in some way by all residents in the region. This research offers evidence of how effective preparedness marketing can be when combined with media hype and personal experience. Officials and community leaders interested in increasing wildfire adaptive capacity might be able to learn from the “hurricane culture” phenomenon. One question begged by this research is could images and testimonials related to human and community impacts of wildfire be a stand-in for personal experience? Perhaps the “hurricane awareness” system can incorporate messaging about

wildfire preparedness. Would people be more likely to engage in the wildfire issue if it were linked to more salient information about hurricane preparedness?

Community biophysical characteristics and regulatory frameworks can have different implications for hurricane and wildfire risk perceptions and realities. In NCC and PI, canals, reservoirs, and vegetation management ordinances were perceived as attenuating wildfire risk while living along canals was perceived as amplifying hurricane risk. Residents also considered the scales of each event when evaluating their risk and prioritizing implementation of adaptive measures. Wildfires may occur more frequently, but when a hurricane impacts the area, potential numbers of people affected, damage, and recovery time has been much greater in residents' experience. In cases where temporal aspects of competing disturbance events vary (e.g., wildfire risk can be continuous throughout the year in Florida whereas hurricane events have an advisory period and occur within a discrete season), residents faced with multiple disturbances may focus on the event that, like hurricane, is easier to predict due to seasonality and/or technology, and has the greatest potential to precipitate a large scale disaster.

Participants prioritized hurricane risk mitigation because it is perceived as a greater threat and, due to its discrete season and predictability; it is also easier for communities and residents to engage in some degree of action once a hurricane is detected. Mitigation in advance of wildfire requires more energy or constant preparedness on the part of communities and individuals because fires can ignite throughout the year. Since hurricanes hit within days or hours of residents taking action, they immediately perceive the benefits of the actions they have taken to reduce hurricane risk. With wildfire, property owners are asked to take potentially expensive and time-consuming wildfire mitigation actions that they are less likely to perceive as beneficial (Collins 2005; Daniel 2007; Martin, Bender, and Raish 2007). Furthermore, wildfires are

perceived as randomly occurring, less threatening, and more controllable by professionals, in contrast to a hurricane. Our finding that residents perceive wildfire as both random and controllable builds on research suggesting that residents' behavior is influenced by the perception of wildfire as either a controllable event (McCaffrey 2004) or as essentially random and uncontrollable (Winter and Fried 2000).

Disparate perceptions of wildfire and hurricane risk in this study have important implications for adaptive capacity because “the ways risks are perceived within communities influence the range of actions undertaken to reduce them” (Flint and Luloff 2005:408). The evidence here may suggest a negative relationship between hurricane and wildfire risk perception because participants are so focused on hurricanes. At the same time, we cannot assume that collective hurricane risk awareness and an emphasis on hurricane adaptation indicates that participants necessarily lack adaptive capacity for wildfire. A next step beyond this paper would be to directly analyze the extent to which adaptive capacity built for a specific disturbance might generalize to adapting to other stressors. Where communities demonstrate strong adaptive capacity for one type of disturbance and less for others, natural resource and emergency managers can help communities identify and leverage the adaptive capacity they have already built to cope with other relevant hazards. Managers' risk mitigation strategies could be strengthened by assessing residents' perceptions of the risk they face from multiple relevant disturbances along with technical risk assessments. The ways residents construct and perceive wildfire risk do not always align with managers' assessments (Slovic 1987; Martin, Raish, and Kent 2008). Here participants' low wildfire risk perceptions diverged with many county and state-level land and emergency managers.

6. Conclusions

Communities often face risk from multiple environmental disturbances. Therefore understanding risk perception and adaptation has to be considered in the context of the multiple hazards communities face. Residents involved in this study live in an environment prone to wildfire and hurricane, yet they experience, perceive, and construct these events quite differently. Residents also perceive the risks and construct wildfire differently than emergency management professionals whose professional assessments indicate significant wildfire risk. Participants' collective perception of wildfire risk and deliberate behaviors to reduce it are low in light of the greater cultural and biophysical salience of hurricanes in Florida. While potential impacts presented by a single hurricane event may be greater and farther reaching than risks our participants have faced from a single wildfire, Lee County has been identified as one of the most vulnerable counties to wildfire in Florida and multiple wildfire events threaten property, livelihoods, and potentially human lives every year. As population continues to grow in the WUI, the imperative for residents and communities to be more fire-adapted and hurricane-adapted will be amplified (Lee County Public Safety and Florida Division of Forestry 2011).

Understanding residents' collective perceptions of wildfire risk relative to hurricane helps contextualize wildfire risk perceptions and is part of the motivational context underlying adaptive behavior. First, perception of risk is a necessary if insufficient factor motivating individuals and communities to build adaptive capacity and implement adaptive decisions. Therefore, attenuated wildfire risk collectively perceived, along with participants' behavioral accounts suggests that residents have developed less adaptive capacity for wildfire at household and community scales. On the other hand, these results suggest that shared hurricane risk perceptions help promote high community adaptive capacity for hurricane. The extent to which

community adaptive capacity built to address hurricane risk is also applicable to wildfire risk should be further explored in future research. Natural resource managers and communities may be able to mobilize significant aspects of the adaptive capacity intentionally built for one hazard to develop an approach applicable to concurrently adapting to multiple sources of risk.

Professional and community leader efforts might benefit from linking messages and activities to reduce wildfire risk to the disturbance with greater cultural salience. In this case, perhaps residents' wildfire risk perception and actions would be enhanced if more explicitly linked to the culturally salient issue of hurricane adaptation.

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MANUSCRIPT 3

HURRICANES AND WILDFIRES: GENERIC CHARACTERISTICS OF COMMUNITY ADAPTIVE CAPACITY

1. Introduction

Human communities have been adapting to environmental conditions throughout history (Brooks, 2006). However, triggered by global climate change, the impacts of individual disturbance events are expected to become more extreme (IPCC, 2007). Large wildfires are projected to occur more frequently and ‘it is *likely* that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation’ (IPCC, 2007, p. 46). Even while individual disturbance events are projected to become more extreme, the reality is that communities often must cope with multiple, interacting environmental disturbances. While climate change is creating new threats and exacerbating old ones, many communities are already vulnerable and could be better adapted to the environmental disturbances they currently face (Handmer, 2003). Understanding interconnected notions of human vulnerability, resilience, and adaptive capacity to existing and potentially unprecedented environmental conditions and disturbances at multiple scales is an important step to support human coping to the environmental disturbance regime and a focus of the natural hazard and global climate change literatures.

Vulnerability, defined as susceptibility to harm, is determined by a community’s exposure to hazardous biophysical conditions and the social factors that enable or constrain coping with that exposure (i.e., sensitivity) (Adger, 2006; Cutter, 1996; Cutter, Boruff, & Shirley, 2003). Where the vulnerability perspective tends to focus on the characteristics that predict or exacerbate harm, community resilience is defined as ‘...the existence, development,

and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise' (Magis, 2010, p. 402). Adaptive capacity—simply stated, the ability or propensity to adapt—is a central analytical concept in both resilience and vulnerability frameworks. In the vulnerability framework, adaptive capacity modulates a community's exposure and sensitivity (Engle, 2011). A community with greater adaptive capacity is theorized to have lower vulnerability. Within the resilience framework, adaptive capacity is the ability of an ecological or social system to influence resilience (Walker, Holling, Carpenter, & Kinzig, 2004), where greater adaptive capacity enables a system to either transform or return to the original state, depending on what is tenable and desirable (Engle, 2011).

Adaptive capacity can be conceptualized as the underlying characteristics, resources, and processes that enable adaptation to actual, anticipated, or unanticipated stressors. According to Plummer and Armitage (2010, p. 6), '...adaptive capacity is determined by the suite of resources (technical, financial, social, institutional, political) held, and the social processes and structures through which they are mediated.' In this paper, we focus on the adaptive capacity of human communities as the fundamental scale at which individuals interact with society (Wilkinson, 1991; Luloff & Krannich, 2002) and the environment (Field & Burch, 1988). The social aspects of adaptive capacity have been strongly associated with the ability to engage in collective action (Adger, 2003, 2004), which is also the basis of interactional field theory.

Interactional theory posits that a geographically bound local society and locality-oriented collective action are the foundations of community (Wilkinson, 1991). From this perspective, social interaction over time is the structure of community and occurs primarily through different loosely bound, constantly evolving and interacting fields. Wilkinson (1991) distinguishes

between what he calls social fields and the community field. Social fields are comprised of individual actors and associations (i.e., formal organizations and informal groups) interacting over time in pursuit of identifiable interests (e.g., economic development, environmental planning, etc.) (Flint, Luloff, & Theodori, 2010). In contrast, the community field is ‘the mechanism that actually connects these multiple and different spheres of action’ (Bridger, Luloff, & Krannich, 2002, p. 19). Or as Wilkinson (1991, p. 84) says, the community field:

...pursues not any single interest, as most other fields may be said to do, but the general community interest instead. The actions in this field serve to coordinate other action fields, organizing them more or less (through unbounded, dynamic, and emergent process) into a whole.

The ability of communities to respond collectively to local issues is known in the natural resource literature as interactional capacity (Flint & Luloff, 2005, 2007).

The most commonly cited characteristics believed to promote adaptive capacity in the global climate change literature are economic resources, technology, information and skills, infrastructure, institutions, and equity (Smit et al., 2001; Tol & Yohe, 2007; Yohe & Tol, 2002). Rudberg, Wallgren, and Swarling (2012) refer to the aggregation of these factors as a system’s generic (as opposed to hazard- or context-specific) adaptive capacity. Adaptive capacity is generic to the extent that it promotes adaptation to a range of environmental hazards. What constitutes a pro-adaptive versus maladaptive action can depend on the particular characteristics of a hazard (e.g., spatial extent, temporally recurrent versus continuous, etc.); therefore, the adaptations enacted to deal with one type of hazard may not be adaptive for another (Adger et al., 2004). The notion that the adaptation context is important is a common theme throughout the natural hazards and climate change literatures (Bohensky, Stone-Jovicich, Larson, & Marshall, 2010). Carpenter et al. (2001) call for researchers to define ‘of what’ and ‘to what’ resilience refers and Brooks et al. (2005) differentiate between generic and hazard-specific vulnerability.

Researchers have sought to distinguish between generic and specific adaptive capacities, primarily attempting to identify indicators that can be used at the national level of analysis (Field et al., 2012; Yohe & Tol, 2002).

In this paper we focus on the analytical concept of adaptive capacity because it is a property that humans can influence to reduce their vulnerability and enhance their resilience (Engle, 2011); however, researchers have observed that having the capacity to adapt does not necessarily predict adaptation (Rudberg et al., 2012). Adaptive capacity is often merely potential until mobilized by an exogenous catalyst, such as an extreme event (Adger & Vincent, 2005; Adger et al., 2007; Bohensky et al., 2010; Lemos, Boyd, Tompkins, Osbahr, & Liverman, 2007), or endogenous ‘...governance institutions that make it realizable’ (Adger, 2003, p. 33). The potential latency of adaptive capacity presents a challenge for effectively evaluating its existence in a particular setting (Engle & Lemos, 2010; Smit & Pilifosova, 2001). In light of these challenges, some researchers have found it useful to distinguish between two dimensions of adaptation: building adaptive capacity and implementing adaptive decisions, ‘i.e., transforming that capacity into action’ (Adger, Arnell, & Tompkins, 2005, p.78; Rudberg et al., 2012).

Many scholars have examined aspects of adaptive capacity in the context of climate change (Abramovitz et al., 2002; Hamlet, 2011; Saavedra & Budd, 2009; Smit & Pilifosova, 2001) or specific disturbance events such as wildfire (Paveglio, Carroll, Jakes, & Prato, 2012), bark beetle outbreak (Parkins & MacKendrick, 2007), and flood (Eakin et al. 2010). Most human communities, however, live in environments that are prone to multiple, often interacting types of environmental disturbance. The fact that communities are often faced with multiple types of disturbance means their wellbeing may ultimately depend on the ability to proactively

adapt to multiple environmental stressors, yet few studies have considered adaptive capacity in the context of multiple environmental hazards.

In this study, our original objective was to explore the generalizability of wildfire adaptive capacity identified in other regions of the U.S. to Florida communities (Paveglio et al., 2012; Paveglio, Jakes, Carroll, & Williams, 2009). However, the preliminary finding that residents had little wildfire risk awareness in contrast to their hurricane risk perception (despite emergency managers assuring us that wildfire is a significant threat in the area) led us to instead adopt a multi-hazard approach to understanding community adaptive capacity. Drawing from case studies examining community adaptive capacity for wildfire and hurricane in Lee County, Florida, this paper contributes to the literature by providing insight into the extent to which adaptive capacity at the community level can be mobilized as a generic capacity to address multiple environmental disturbances.

2. Methods

2.1 Selection and description of study sites

Pine Island and Northwest Cape Coral were selected as study sites in Lee County, Florida. Local land and emergency managers suggested these areas as potential study sites based on two criteria: significant exposure to wildfire and hurricane risk and their representation of different land development patterns (Newman, Carroll, Jakes, & Paveglio, 2013). Pine Island is the largest island in southwest Florida yet high density development has been prohibited along its mangrove coastline. Most Pine Islanders live in one of four unincorporated population centers: Matlacha, Pine Island Center, Bokeelia, or St. James City. While tourism and seasonal residents help sustain the local economy, characterized as a remnant of ‘Old Florida,’ much of the island is rural and some residents have agriculture- and fishing-based livelihoods. A mix of

multigenerational fishing and farming families, retirees from around the U.S. and abroad, Hispanic farm workers, young families, and others, Pine Island is socioeconomically and demographically diverse.

Across the Pine Island Bridge a few miles from Matlacha, Northwest Cape Coral, described as ‘New Venice,’ is an incorporated pre-platted subdivision with hundreds of miles of canals—many with Gulf access. Land speculators began developing Cape Coral in the 1960s, with building initially concentrated in the south and expanding northward where houses are still spread out and many neighborhoods are several miles from grocery stores and other businesses. In contrast to other more developed areas in the city of Cape Coral, residents consider Northwest Cape Coral rural or suburban. Attracted by the natural amenities and recreational opportunities offered by canals and Gulf access, many Northwest Cape Coral residents are retirees from other states or professionals nearing retirement.

2.2 Data collection and analysis

Data were gathered and analyzed following inductive grounded theory research methods (Glaser & Strauss, 1999). A total of 66 in-depth, semi-structured interviews were conducted in March, May, and June of 2012. Thirty-six Pine Island interviews were conducted with 42 participants and 30 Northwest Cape Coral interviews were conducted with 39 participants. Some interviews included multiple members of a household, which is why there are more participants than interviews. Most interviews were conducted with residents who are not emergency management experts (two interviews—one each in locality—were with local firefighters), but have firsthand experience living in a hurricane- and wildfire- prone environment. The first two to three participants in each locality were identified through the websites of local organizations. Participants were subsequently selected through referral sampling until theoretical saturation was

reached (i.e., no new information emerged from interviews). Additional Cape Coral residents volunteered to participate after reading an announcement published in the Northwest Cape Coral Neighborhood Association newsletter. Participants were asked a series of open-ended questions that addressed (1) community characteristics, relationships, and concerns, (2) wildfire risk perceptions, experiences, and individual/community preparedness, and (3) hurricane risk perceptions, experiences, and individual/community preparedness. All interviews lasted between 60-90 minutes, were audio recorded, and later transcribed. Sixty-four interviews were conducted in person and two were conducted by phone.

Data was coded and analyzed using AtlasTi qualitative data analysis software. The analysis followed a systematic process informed by Friese (2012) and Charmaz (2006). First descriptive codes were assigned to segments of data until subsequent observations fit into existing codes (in other words, descriptive codes were developed until no new codes were forthcoming). These initial codes were organized into categories and subcategories. Remaining and new data were used to create additional codes where necessary and to validate existing codes and refine analytical categories and subcategories. Salient themes were identified throughout the analysis and quotations that represent the results were selected.

3. Results

From January 2008 to December 2012, Cape Coral Fire, Rescue, and Emergency Management Services responded to an average of 10 wildfires a year in Cape Coral (Mackowski, 2013). In the same five-year period, Pine Island Fire Department reports responding to an average of 35 wildfires a year (Roach, 2013). Tropical storms and hurricanes are not uncommon in Southwest Florida; however, only two hurricanes were seen by participants as significantly impacting Lee County in recent history: Hurricane Donna in 1960 and Hurricane Charley in

2004. Some participants experienced Hurricane Donna or other hurricanes prior to moving to Florida, but most of the discussion relevant to hurricane adaptation and adaptive capacity centered on the period directly before and since Hurricane Charley. While the interviewer was equally interested in in-depth descriptions of experiences, capacities, and adaptations for wildfire and hurricane, most participants focused on hurricane risk and explained that wildfire is not a comparable threat to their community.

Most participants said their community has high adaptive capacity (defined by the interviewer as residents' individual or collective ability to deal with a hazard) for hurricane, and perceived less adaptive capacity for wildfire. Participants described many measures they've implemented at the household (e.g., acquiring storm shutters and generators, stockpiling fuel, water, and food supplies, and trimming vegetation), community (e.g., establishing evacuation routes, developing evacuation plans and bus shuttles, and resident identification tags) and broader scales (e.g., the state-level legislative action of adopting building codes with stricter hurricane standards) to become more adaptive to hurricane. Some participants indicated that the degree of community adaptive capacity for wildfire was sufficient to cope with the current risk; while others suggested that the lack of collective action and awareness around wildfire issues should be more of a community concern ('I would say on the island as a group, for fire, no. There is much more preparation and community awareness about hurricanes...which is an interesting point. I hadn't thought about that before, but fire is probably a greater danger' [Pine Island resident]).

Although our results demonstrate that wildfire risk has significantly less salience than hurricane risk for participants, the themes that emerged from the data nonetheless suggest that case study communities have built generic elements of adaptive capacity that are generalizable to

address both hazards: (1) interactional and organizational capacities, (2) professional knowledge and extra-local networks, and (3) local knowledge, resources and skills. We explain each of these interconnected elements below in the dominant context of hurricane and then share our results supporting how these social characteristics are generalizable to wildfire (see Table 1).

3.1 Adaptive capacity for hurricanes

3.1.1 Interactional and organizational capacities

Local relationships, community networks, and locally-based organizations provide mechanisms, processes, and opportunities through which residents can address collective challenges, institutionalize learning, and continually build adaptive capacity from the ‘bottom-up.’ Interactional and organizational capacities were interconnected themes that emerged as foundations of adaptive capacity at the community level. The ability to work collectively to prepare, respond, and recover from hurricane events in particular was a key theme throughout the interviews. Pine Islanders emphasized an island-wide ‘sense of community’ and mutual support that they mobilize to address shared concerns and help residents (‘It’s a very strong community as far as if a Pine Islander needs help, no matter race or creed or financial socioeconomic status, the whole island comes together to help you’ [Pine Island resident]). The interviews suggest that Pine Islanders’ interactional capacity has contributed to what they perceive as high adaptive capacity for hurricane. Northwest Cape Coral residents described collective action taken with neighbors in their immediate area to adapt to hurricane:

You’ll see sometimes neighbors helping each other out like trim trees...it’s like, ‘oh the tree branch is gonna snap and go through the window [in a hurricane].’... You will see maybe a group of neighbors that are going around to different houses and putting up people’s [hurricane] shutters. [Cape Coral resident]

Some Cape Coral residents perceived an absence of ‘community’ or engagement in collective

action in their neighborhood or city. These participants also underscored the importance of interactional capacity by lamenting its absence in their experience (‘This area is very transient: there’s very, very, very few people that stay and it’s very, very difficult to make friends. You meet somebody and next year the house is foreclosed or they don’t like it here and they’re gone’ [Cape Coral resident]).

Participants’ accounts provided examples of the importance of interactional capacity for implementing adaptive actions at all stages—preparedness, response, and recovery—of community hurricane management. In some cases, preexisting interactional capacity facilitated recovery after Hurricane Charley (‘Pine Island’s always been a very community-minded place...but I think it really came to a pinnacle during Hurricane Charley because so many people had so many needs’ [Pine Island resident]). For example, residents organized to help each other repair damaged property and clean up debris. In other examples, Hurricane Charley was a catalyst for residents to develop additional interactional capacity that contributes to their current preparedness. Like this Cape Coral resident said, ‘We all lived through Charley together and we started bonding in the neighborhood... [now] we have a lot of neighbor parties and get-togethers.’ Pine Island residents indicated that interactional capacity is a long-established asset in their community; however they too suggested that Hurricane Charley was a catalyst for building adaptive capacity and implementing additional adaptive measures. Pine Island participants described how their organizational capacity was built as local churches and many nonreligious organizations cooperated to facilitate Hurricane Charley recovery efforts. For example, residents quickly formed a local organization, the Pine Island Long-Term Recovery Organization (now called the Beacon of Hope), to assist residents with tasks like filing FEMA and insurance claims. In the process of coping with Hurricane Charley, local organizations strengthened their networks

and established the Beacon of Hope to support long-term hurricane recovery and address other critical issues (e.g., the economic crisis) confronting the island.

The core group of people that started in these different churches doing stuff that actually got the Pine Island Long Term Recovery formed...It's now called the Beacon of Hope and...they just have a giant umbrella of stuff that they do for people in this community. Huge impact on this community that we probably would never have had if it weren't for Charley.

With activities ranging from offering GED (General Education Development) and ESL (English as a second language) classes to annually going 'door-to-door' to update a hurricane contact information database for all seasonal and year-round residents, the Beacon of Hope is one of several local organizations participants said are instrumental in building adaptive capacity for hurricane.

When Charley came through, there was a lot of damage on Pine Island because it came right through over the top of us. The pastors...formed a non-profit...called The Beacon of Hope...There is a civic association in St. James City, there is a civic association in Matlacha, there is a civic association in Bokeelia....The Matlacha Hookers is another group that is very active. The Elks, Kiwanis—and the community is really geared to helping other people—the VFW, American Legion. There is organization after organization—they are all active.

Pine Island participants emphasized the importance of helping more vulnerable populations in their hurricane adaptation measures. For example, several organizations partner with Lee Tran (Lee County's public transit system) to coordinate community evacuation plans that provide transportation for elderly, farm worker, low-income, and other populations who might not otherwise have a way to leave the island in the event of a hurricane.

Northwest Cape Coral interviews highlighted organizational capacity talking about their active Northwest Cape Coral Neighborhood Association, which residents created to promote their collective interest as the area develops. The neighborhood association helps identify community needs and organizes a range of collective actions, including an annual neighborhood

clean-up, the development of bike lanes, and advocating for land use and zoning to enhance quality of life. Neighborhood association meetings are an important venue where information about hurricane risk mitigation and other collective issues are discussed ('We have this neighborhood association and...they'll have people come in and give seminars on all different types of things and hurricane awareness is one' [Cape Coral resident]). Local organizations facilitate collective action, can help build adaptive capacity, and institutionalize learning and the adaptive measures already initiated by a community.

3.1.2 Professional knowledge and extra-local networks

Hurricane impacts can be far-reaching. Many participants who experienced Hurricane Charley sustained property damage and some lost their homes. Coping with emotional and psychological stress was a major part of hurricane recovery for numerous participants. Due in part to the extensive reach of hurricanes, the importance of having access to extra-local resource networks emerged as a key theme. Pine Island and Northwest Cape Coral residents observed that hurricane adaptation for them sometimes requires resources beyond what is typically available within a community. Hurricane Charley overwhelmed local resources and illuminated the need to work with extra-local professionals and organizations to access a variety of resources and programs ('Almost everybody is affected—that is when you need to have the Red Cross come in, and the Salvation Army, and the power company from Georgia that came down' [Pine Island resident]). Following Hurricane Charley, organizations like the Federal Emergency Management Agency (FEMA) offered physical support ('There was so much roof damage that there was a run on blue tarps...they called them 'FEMA roofs' for the longest time because...that was the biggest damage; if your windows didn't break, then your roof blew off on your older homes' [Cape Coral resident]). FEMA also supported residents' emotional recovery

(‘Project Hope was a FEMA-funded organization...they hired locals to go around and find out how people were doing emotionally after the storm’ [Pine Island resident]).

According to Pine Islanders, Hurricane Charley catalyzed the development of extra-local networks that continue to promote and help sustain adaptive measures for hurricane and other shared issues:

The relationships we developed with Health and Human Services, Red Cross, Salvation Army, our other organizations on the island, other grant organizations is tremendous...but we developed those relationships first through [Hurricane Charley]. [Pine Island resident]

Residents of case study communities learned how to use their local relationships, organizations, and networks to access, organize, and distribute extra-local resources. The local organizational and interactional capacities developed help these communities more effectively leverage and utilize extra-local resources to support adaptation and adaptive capacity.

I think the most important thing and we’ve...learned...is to realize you are going to be overwhelmed by people trying to help you and to be able to categorize that help....Where do shelter supplies go? I’ve got 25 people that just showed up and they wanta do something. Who organizes them so they don’t feel left out and utilized the best way? Who’s the gate keeper of managing resources? Really the most important thing is to have those identified ahead of time....Because we have that relationship with our churches, they stepped up, but all communities need somebody to do that. [Pine Island resident]

The availability of professional knowledge and information resources was also cited as supporting community hurricane adaptation and building capacity. Participants noted the wealth of hurricane mitigation and preparedness information that is made available every year before and during hurricane season through television media, published guides, and seminars (‘Starting in May there’ll be hurricane preparedness seminars everywhere...Home Depot, Lowe’s, insurance companies, all the banks will hold them, investment companies, the churches will hold them, FEMA will come in, Red Cross will come in, all kinds of different groups—CERT

[Community Emergency Response Teams] will come in' [Cape Coral resident]). Residents said that the ubiquity of hurricane information helps communities build their knowledge of how to mitigate hurricane risk and to implement hurricane mitigation and preparedness decisions; even though many participants also said they tire of hearing about hurricane risk.

3.1.3 *Local knowledge, resources, and skills*

In addition to drawing from extra-local knowledge and resource networks, Pine Island and Northwest Cape Coral residents said they have knowledge, resources, and skills that contribute to community adaptive capacity for hurricane. Many residents have developed knowledge of how to adapt to their hurricane-prone environment through years of firsthand experience preparing for and evaluating hurricane threats. Most participants said they annually engage in hurricane mitigation activities, such as stocking up on supplies and making evacuation plans, however, living through hurricanes that made landfall in Florida or elsewhere were the most significant learning opportunities. Participants talked not only about their direct hurricane experiences, but also about how that experience is passed on and becomes shared knowledge through social interaction. Residents said that living with hurricanes is a part of life in the area and something people are likely to talk about. Many people who moved to the area in the years since Charley said they have gained valuable knowledge by interacting with other community members ('So many people moved down just prior to those major hurricane events...that there are a lot of people down here have their [Hurricane] Charley story so... just in conversation with neighbors, you're aware its hurricane season' [Cape Coral resident]).

Participants talked about how they have combined their unique sets of skills and resources with neighbors' to approach problems ('It's amazing the diversity of people that are here—there are professionals and yet there are also guys that work with their hands that have

retired and come down here, so...in this area, it's almost a melting pot of different careers and abilities' [Cape Coral resident]). For example, the role of local resources and skills was illustrated by Pine Islanders who told the story of a multigenerational family who owns a construction business and has experienced many hurricanes staging equipment around the island prior to Hurricane Charley's arrival:

For Charley they had strategically placed bulldozers at major intersections before the storm, but they were truly our first responders. When my wife and I came back on the island, it was real quick after the storm had subsided some, we followed our fire truck up to the north end of the island just so we could see our home and...the ---- family was already up there clearing the streets, so we had no problems getting there at all. So from that standpoint, we're very prepared. [Pine Island resident]

Pine Island and Northwest Cape Coral residents expressed pride in the hurricane-related knowledge and skills that enable self-sufficiency. Both localities have areas that are sparsely populated. Residents in these areas especially articulated a necessity to be self-sufficient:

I couldn't get to my house [after Hurricane Charley]; all the trees had fell down, so once I got here, I was able to get a chainsaw and go out and clean up, do different things. If I lived in town, I wouldn't have that worry; it would be like, you know, you have your neighbor next door. [Cape Coral resident]

Local knowledge, resources, and skills, such as owning and having the ability to run a chainsaw, were factors Pine Island and Northwest Cape Coral residents said builds adaptive capacity for hurricane.

According to participants, Northwest Cape Coral and Pine Island have high adaptive capacity for hurricane, demonstrating preparedness at the household and community scales by implementing multiple adaptive measures like installing hurricane shutters and developing community evacuation plans. Interactional and organizational capacities, professional knowledge and extra-local networks, and local knowledge, resources and skills were the three primary themes that emerged from the interviews that support high community hurricane

adaptive capacity and readiness. Residents suggested that their high level of adaptive capacity and hurricane readiness has been motivated by shared experiences—especially Hurricane Charley in 2004. While the majority of participants said that they are not deliberately building adaptive capacity for wildfire, the following evidence suggests that to a significant extent the same characteristics and processes that support hurricane adaptive capacity are also being utilized to live with wildfire.

3.2 Adaptive capacity for wildfire

While most participants said they are not as prepared for wildfire at the household and community levels, a few participants identified measures implemented to adapt to hurricane that might also be helpful during a wildfire event.

All of our focus is on hurricane. We're not probably going to have a fire that sweeps the whole Island area, but we indeed could have a hurricane that sweeps the whole area. We have all these emergency things in place for [hurricanes] which would certainly do very nicely if you had a fire as well. We have evacuations and emergency routes....We get little tags so that if we get evacuated we can get identified that it is okay to come back on.
[Pine Island resident]

Interview participants focused on their experiences adapting to hurricane risk and generally perceived greater adaptive capacity for hurricane in contrast to wildfire. However, our analysis suggests that many of the capacities leveraged to adapt to hurricane have also been applicable to coping with wildfire risk.

3.2.1 Interactional and organizational capacities

Interactional and organizational capacities, in some cases developed specifically to adapt to hurricane risk, enables collective action for other community stressors, including wildfire. Pine Island participants whose property and nursery business was recently damaged by a wildfire illustrated the generalizability of community interactional capacity ('I found particularly after

going through several disasters—the last being our forest fire—the community actually came together and helped us out: mentally, financially, they’re offering physically’). In Cape Coral, participants talked about how their neighborhood association holds wildfire seminars and described working with neighbors to reduce vegetation they thought would be hazardous in the event of a wildfire:

There’s some vacant lots...[that] have lots of vegetation growing here...so [the neighbors and I] rented a bobcat. We pulled all the old [Brazilian] pepper [*Schinus terebinthifolius*] trees out...and now basically what we did on our own was eliminate the source of combustion...and everybody does that. I mean, you have to because the city’s big and we’re under-funded and you can’t expect them to do everything. You just, you know, take care of it. [Cape Coral resident]

Pine Island residents reiterated that their high level of organizational capacity is generalizable to multiple stressors (‘It is amazing that you have so many organizations in such a small area... they will pull together definitely after any kind of disaster and work together’ [Pine Island resident]). As reiterated through examples given below in the local knowledge, resources, and skills for wildfire subsection, participants provided examples of interactional and organizational capacities supporting adaptive capacity and adaptive actions to wildfire, such as vegetation management to mitigate risk and coming together to help fight fires when they occur and to offer support in recovery when community residents need.

3.2.2 Professional knowledge and extra-local networks

Although they did not perceive high individual or collective wildfire preparedness on the part of residents, Northwest Cape Coral and Pine Islanders expressed confidence in the ability of their local firefighting professionals to suppress and control wildfires. The performance of local firefighters and the ability to call in extra-local professionals from neighboring fire departments or the Florida Forest Service for backup were the primary factors residents perceived as

contributing to sufficient adaptive capacity for wildfire.

I think we're very prepared. I mean with the wildfires that we have had there's been terrific response not only from our fire department but from neighboring fire departments. For instance several months ago a fire started...and fire departments came from all over to battle the fire and I think it ended up being like 12 acres or 22 acres that burned—terrific response. [Pine Island resident]

In contrast to the professional and extra-local support communities received for hurricane, which was largely seen as enabling or complementing community action, participants often pointed to their excellent local fire fighters as evidence that community-level adaptation to wildfire driven by residents themselves is unnecessary. A step towards building greater community adaptive capacity for wildfire might be reframing professionals' capacities and support as merely one aspect of a community's overall adaptive capacity rather than as the end.

Some Pine Island and Cape Coral residents participate in Community Emergency Response Teams (CERT). CERT is a FEMA program conducted by local emergency managers to train and involve community residents in hazard preparedness and disaster response. CERT members gain technical skills, knowledge, and training while developing networks with professionals, hence the program is useful for building adaptive capacity and implementing adaptive actions not only for hurricane, but for a variety of hazards, including wildfire:

I became a CERT member for the City of Cape Coral and through that training they show you what the perimeter should be around one of your structures [for wildfire]...they did fire, they did hurricane, they did tornado, windstorm. They went through all the natural disasters and how you should prepare for them. [Cape Coral resident]

On Pine Island, the CERT was an adaptive measure directly implemented for hurricane, yet is also trained and available for wildfire ('We have a CERT group, it was formed under Hurricane Charley... and we haven't had to use them yet for brush fires. What we would do is use them for traffic control or to help with evacuations if we needed to' [Pine Island resident, firefighter]).

CERT is an example of a program that builds local community wildfire adaptive capacity by developing local skills and knowledge and facilitating local residents' ability to engage with extra-local knowledge and resource networks.

3.2.3 Local knowledge, resources, and skills

Local knowledge, resources, and skills were recognized by many participants as contributing to adaptive capacity to wildfire as well as hurricanes. Pine Island and Northwest Cape Coral have several wildfires every year; therefore, many residents have had direct experience. As with hurricane, the knowledge gained from direct wildfire experience contributes to adaptive capacity:

I just think we have a community here where people really care, we still have a lot of the old-timers that live here and they've lived here long enough to experience a lot of things whether its brush fire, storms or whatever. Pine Island takes care of itself. [Pine Island resident]

The agricultural land on Pine Island is some of the most susceptible to wildfire. Many Pine Islanders perceived farmers' ability to use agricultural equipment as contributing to wildfire adaptive capacity. One local famer described these skills and resources:

You would think that [wildfire] would be one of our greatest concerns but it is not. Any time we see smoke on the horizon every farmer runs to see what is happening. We bring our equipment in. We have the kinds of equipment that can move stuff out of the way. We even have equipment that sprays water and so on. [Pine Island resident]

As with hurricane, case study communities draw on local knowledge, resources, and skills to build adaptive capacity and implement adaptive actions for wildfire.

Participants' perceptions of preparedness are based on their experiences living with wildfire and hurricane. As we have presented above, wildfire does not have the same salience as hurricane for residents in our case study communities and participants said they are not individually or collectively engaging in the same level of preparedness for wildfire as they are

for hurricane. Therefore, on one hand, Pine Island and Northwest Cape Coral can be portrayed as less adapted to wildfire at the household and community scales. On the other hand, we find examples that the same characteristics and processes that help build adaptive capacity for hurricane (interactional and organizational capacities, professional knowledge and extra-local networks, and local knowledge, resources, and skills) also underlie adaptive capacity for wildfire, indicating that adaptive capacity for wildfire may be greater than it initially seems.

In these two empirical cases, of the three themes that emerged, interactional and organizational capacities seem most generic for both hazards. That is, having social mechanisms and processes in place to enable collective action promotes adaptation in a generalizable sense. Community-level networks, relationships, and organizations initially developed to collectively cope with one stressor (e.g., hurricane) can be mobilized to address other community stressors (e.g., wildfires and economic crises). The ability to access and implement professional knowledge and extra-local networks was also equally important for community wildfire and hurricane adaptation. However, in some cases, the types of professional knowledge or extra-local networks necessary to enable adaptation for each hazard do not directly correspond. For instance, the greater scale of hurricane impacts can necessitate accessing federal and/or national-level resources (e.g., FEMA and the Red Cross). In contrast, neighboring fire departments and state-level assistance is typically sufficient support for wildfire. CERT is an example of a program that connects local community members to professional knowledge and extra-local networks to help residents build generic adaptive capacity by supporting community hurricane and wildfire adaptation. As with extra-local networks and professional knowledge, local knowledge, resources, and skills can be both generic and hazard-specific. For example, knowledge of and ability to install hurricane shutters does not directly influence wildfire

adaptation but the ability to use a chainsaw to manage vegetation can promote adaptive capacity for both hazards (see Table 1).

Table 1. Examples of generic adaptive capacity for wildfire and hurricane

Element of generic adaptive capacity	Hurricane example	Wildfire example
Interactional and organizational capacity	<ul style="list-style-type: none"> • Residents help each other maintain vegetation/put up shutters • Pine Island organizations help residents file FEMA claims, provide public evacuation transportation, and maintain a resident contact information database • The NW Cape Coral Neighborhood Association organizes hurricane seminars 	<ul style="list-style-type: none"> • Residents work together to reduce hazardous vegetation between lots/along canals • Local farmers use equipment to help neighbors contain wildfires • Community raises money to help residents recover from wildfire property damage
Professional knowledge and extra-local networks	<ul style="list-style-type: none"> • FEMA and the Red Cross provide financial and emotional assistance 	<ul style="list-style-type: none"> • Local fire departments train local CERTs • Local fire departments have mutual aid with neighboring departments and state fire crews
Local knowledge, resources and skills	<ul style="list-style-type: none"> • Residents learn from, communicate, and apply their direct hurricane experience into local knowledge • Residents use construction equipment and chainsaws to clear vegetation 	<ul style="list-style-type: none"> • Residents learn from, communicate, and apply their direct wildfire experience into local knowledge • Residents use farm equipment and chainsaws to clear vegetation and contain fires

4 Discussion

In this study we have adopted a multi-hazard approach to understanding community adaptive capacity in the case of two Florida localities that are confronted by wildfire and

hurricane risk. The residents we interviewed widely considered their communities ‘hurricane-adapted.’ In contrast, wildfire is not perceived as a significant risk and participants reported having less community adaptive capacity for wildfire. Despite different levels of risk perception and deliberate development and implementation of adaptive capacity for each hazard, we find examples of adaptive capacity and adaptive actions have been implemented for wildfire. Based on examples from our case studies and parallels identified in the wildfire social science literature, we anticipate that the same elements of adaptive capacity communities have developed primarily to cope with hurricane risk will also enhance adaptive capacity for wildfire.

In Pine Island and Northwest Cape Coral, residents develop local knowledge as they experience hurricane events and routinely prepare for and mitigate the annual threats associated with hurricane season. Common experiences and social interaction in preparing for, responding to, and recovering from hurricane events fosters shared perceptions of hurricane risk and promotes adaptive capacity. Social interaction among residents—informal and facilitated by local organizations—along with the relationships developed with extra-local entities, such as government agencies, helps to enhance and institutionalize community hurricane adaptation. While hurricane adaptation is supported by professional knowledge and extra-local networks, community members also have valuable knowledge, resources, and skills that contribute to community adaptive capacity.

Social theory suggests that locality-oriented collective action (Wilkinson, 1991) and social networks within and extending beyond the community (Warren, 1978) are the basis of community resilience and well-being. Wildfire social science research provides examples of how social interaction among neighbors can affect property owners’ implementation of wildfire adaptation measures such as maintaining property and utilizing fire-resistant building materials.

Individuals with strong community ties are more likely to receive wildfire information from neighbors and engage in mitigation (Brenkert-Smith, 2010; 2011; Kyle, Theodori, Absher, & Jun, 2010). By strengthening social networks among residents and with extra-local government agencies and providing opportunities to generate and develop wildfire mitigation knowledge, community wildfire mitigation programs (e.g., Firewise Communities) have been shown to enhance community resilience (McGee, 2011). Residents' previous experience with wildfire can also influence wildfire mitigation actions (McGee, McFarlane, & Varghese, 2009).

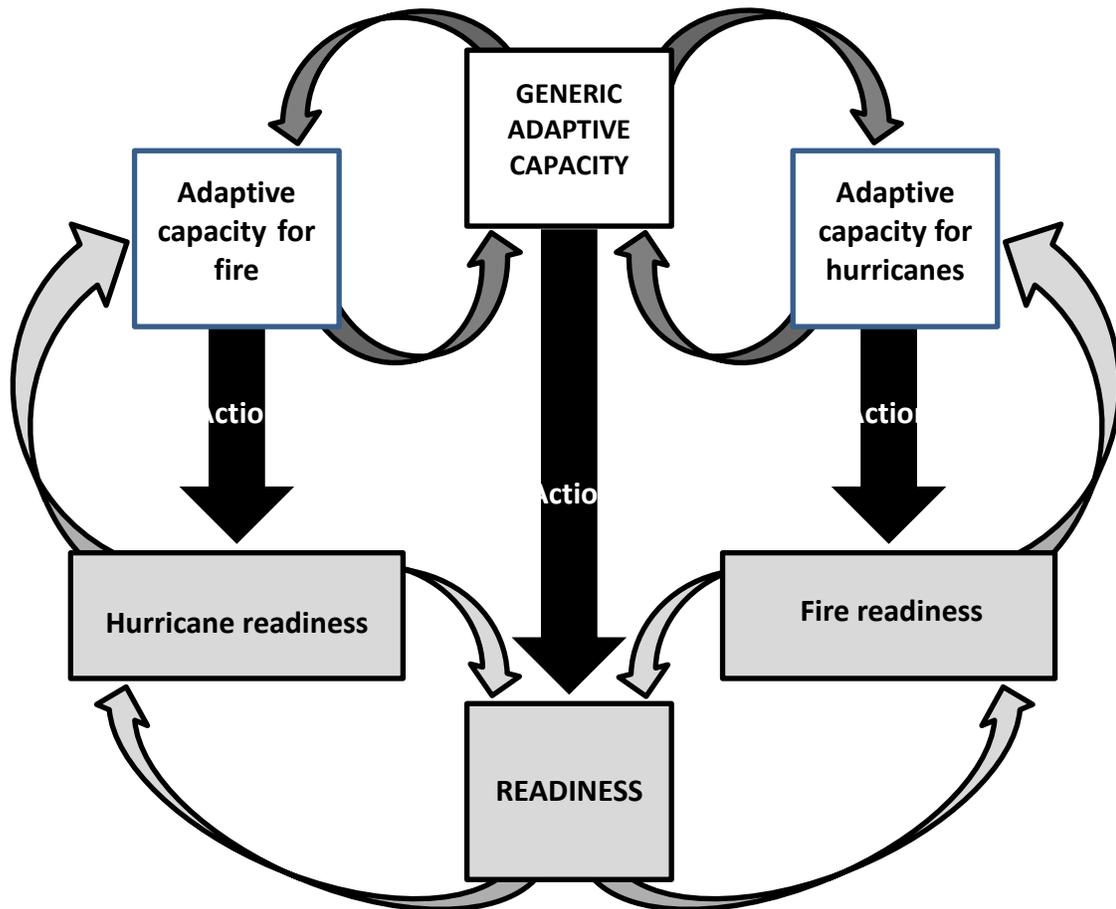
Paveglio et al. (2009) provide a model for community wildfire adaptive capacity based on the wildfire social science literature that includes four interacting conceptual elements: demographic or structural characteristics, access to scientific/technical knowledge networks, place-based knowledge/experience, and informal interactions and relationships among community residents. Paveglio et al. (2010) apply this framework to explore the characteristics that promote 'fire-adapted' human communities in the case of developing community alternatives to wildfire evacuation. Similar to the findings of the current study, Jakes and Langer (2012) identify networks and relationships among locals, local knowledge and experience, and expert knowledge and institutional capacity as characteristics supporting adaptive capacity to wildfire in a New Zealand community. That these themes have emerged across multiple case studies in the context of different environmental disturbances indicates that they are generic characteristics of community adaptive capacity and therefore can promote adaptation to a range of stressors. Figure 1 illustrates the relationship between generic adaptive capacity, hazard-specific adaptive capacity, and readiness at the community level.

5 Conclusions

Human communities face risk from multiple, often interacting types of environmental disturbance. Even while many communities could be better adapted to the disturbances they already face, global climate change is expected to exacerbate existing environmental stressors, putting even more pressure on communities to adapt (IPCC, 2007). Interviews with residents in two Florida communities help elucidate what it means to have generic adaptive capacity, or the ability to adapt to a range of environmental stressors as opposed to adaptive capacity for a specific hazard. We identify three social characteristics that seem to support adaptive capacity and the implementation of adaptive measures to cope with hurricane and wildfire risk: interactional and organizational capacities; professional knowledge and extra-local networks; and local knowledge, resources and skills. That these themes have emerged across multiple case studies in the context of different environmental disturbances indicates that they are fundamental elements of generic community adaptive capacity.

Our results suggest that while wildfire adaptation is not the focus of residents in our case study communities, community adaptive capacity for wildfire exists in part because it is indirectly fostered by the process of implementing adaptive decisions and building adaptive capacity for hurricane. Although some adaptive actions for hurricane are context-specific (e.g., installing hurricane shutters), the process of adapting to a hurricane-prone environment has helped residents and communities build the generic adaptive capacity necessary to implementing adaptive measures for multiple environmental disturbances. Reframing these communities as possessing generic adaptive capacity that enhances their resilience to multiple hazards, rather than merely seeing them as adapted to the most salient natural disturbance (e.g., hurricane) is an important step towards fully implementing an ‘all-hazards’ adaptation approach.

Figure 1: Relationship between generic adaptive capacity, hazard-specific adaptive capacity, and readiness



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