

human dimensions

Land Development Patterns and Adaptive Capacity for Wildfire: Three Examples from Florida

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“Fire-adapted” human communities have been promoted as essential for decreasing the costs of wildfire suppression while enhancing the ability of human populations to live with wildfire. We argue that achievement of 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 conducted with local leaders and professionals are used to differentiate between the types/degrees of wildfire adaptation demonstrated in Lee County, Florida. We use structuration theory to explain how different manifestations of community action might be needed for adaptation to wildfire given different structural conditions. Results suggest that structural conditions (development patterns, biophysical conditions, and demographics/socioeconomics) influence adaptive capacity and identify local social characteristics and processes that support adaptation (interactional capacity/horizontal networks, local knowledge/skills, vertical information/resource networks, and organizational capacity). Assessing structural conditions and existing capacities of localities is a first step in fostering local adaptation.

Keywords: adaptation, wildfire risk, focus groups, preparedness

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 extralocal 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 article, we report the local structures and processes that have emerged in response to wildfire risk in three localities¹ in Lee County, Florida, according to focus group participants. We conducted two focus groups with key community leaders and emergency/land management professionals in March 2011 to explore adaptive capacity for wildfire as it connects to how WUI populations become more fire-adapted. Armitage and Plummer (2010, p. 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 so-

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cial 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, 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 are 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 have 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) describes development patterns

as setting the context for wildfire risk in Florida localities. Their analysis focused on how physical and ecological planning, for example, the use 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 as a result of 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,” which is 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 are 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 dependence, and/or traditional knowledge (Blatner et al. 2003, Carroll et al. 2010, Gordon et al. 2010). Flint and Luloff (2005, p. 407) argued 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 col-

Management and Policy Implications

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 found that development that promotes interaction among neighbors can help foster community wildfire adaptation. Overall, 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.

lective 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, the ties/relationships communities have to extralocal entities, can be important components of adaptive capacity. Carroll et al. (2006) found that social conflict after wildfire events occurred when extralocal 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 use with professional federal, state, and other entities can help foster adaptive capacity by providing connections to extralocal resources, including programs, funding, technology, skills, and information, that would otherwise not be accessible or available locally (e.g., Jakes et al. 2002).

Community agency perspectives highlight the plethora of capacities that enable agency (i.e., the different forms of wildfire adaptation performed by locals). However, 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 the diverse range of wildfire risk contexts that exist throughout the WUI can be potentially identified while the social processes and characteristics that lead to fire-adapted communities are assessed. Instead of focusing purely on agency or solely on structure, Giddens (1984, p. 14) conceives of the two as a duality, defining *agency* as “...the capability of the individual to ‘make a difference’ to a preexisting 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 express agency (i.e., take action) in a given set of structural circumstances and 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), to understand the adoption of a shelter-in-place policy (Paveglio et al. 2010), and to

understand the long-term impacts of fire on nontribal 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 9 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 led 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 4 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 three phases: an initial phase wherein segments were coded with multiple labels that summarized and described each piece of data and suggested an analytic direction; 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 1967); and 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, p. 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: biophysical² conditions, demographic and socioeconomic characteristics, and land development 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.

Lehigh Acres

Structural Conditions

Lehigh Acres is an unincorporated, preplatted subdivision covering approximately

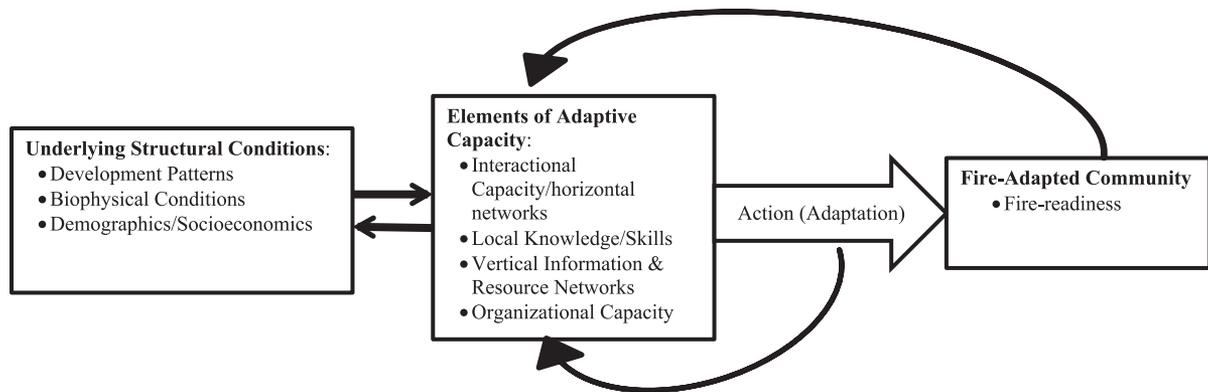


Figure 1. Relationship of structure, adaptive capacity, and fire-adapted communities.

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. With a down payment of as little as \$5–\$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 (US Census Bureau 2009a). However, much of the area has remained largely undeveloped and by 2009, the foreclosure crisis had driven the vacancy rate in the 29,936 housing units of Lehigh Acres to 19%³ (US 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, preplatted 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 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:

[Preplatted 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 of 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 preplatted 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 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. Although the involvement by professionals with access to technical assistance and knowledge is a tremendous asset, this 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 (US 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" despite being surrounded by high-growth areas. In 2007, residents of Buckingham passed an ordinance known as the Bucking-

ham 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 1 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 desired outcome of the ordinance 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 understorey. The locality also has received a high ranking on the wildfire susceptibility index (Florida Department of Agriculture and Consumer Services 2010). However, 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 residents are more capable of acting collec-

tively 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 15-year-old gated community located in the city of North Fort Myers. Carefree has about 130 full-time residents and 450–600 seasonal residents who are predominantly retired white women. The gated community consists of 278 manufactured home/recreational vehicle (RV) lots covering roughly 50 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 those in 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 2010). 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 and 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 the 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 preexisting 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, policymakers, and scientists (Harbour et al. 2009, Schoennagel et al. 2009, Leschak 2010). Whereas 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 si-

multaneously 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, preexisting 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 in 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 preexisting 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 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, whereas others have exacerbated challenges. Whereas residents in one locality, such as Buckingham, may already be in a position to take action and adapt to wildfire risk, others, such as those in Lehigh Acres, may face considerable structural constraints. Although 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. Because 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. However, 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 although 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.

Endnotes

1. 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 field theory definition of community.
2. Although 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.
3. In 2000, there were 14,486 total housing units in Lehigh Acres and a 12% vacancy rate.

Literature Cited

ARMITAGE, D., AND R. PLUMMER. 2010. *Adaptive capacity and environmental governance*, 1st ed. Springer-Verlag, New York. 307 p.

BLATNER, K.A., S.R. MENDEZ, M.S. CARROLL, A.J. FINDLEY, G.B. WALKER, AND S.E. DANIELS. 2003. Smoke on the hill: A comparative study of wildfire and two communities. *West. J. Appl. For.* 18(1):60–70.

BOARD OF COUNTY COMMISSIONERS OF LEE COUNTY. 2010. *Lee County Ordinance No. 10-15: Buckingham community plan*. Available online at www.lee-county.com/gov/BoardofCountyCommissioners/ordinances/Ordinances/10-15.pdf; last accessed Aug. 1, 2011.

BRZUSZEK, R., J. WALKER, T. SCHAUWECKER, C. CAMPANY, M. FOSTER, AND S. GRADO. 2010. Planning strategies for community wildfire defense design in Florida. *J. For.* 108(5):250–257.

CARROLL, M.S., K.A. BLATNER, P.J. COHN, AND T. MORGAN. 2007. Managing fire danger in the forests of the US Inland Northwest: A classic wicked problem in public land policy. *J. For.* 105(5):239–244.

CARROLL, M.S., P.J. COHN, T.B. PAVEGLIO, D.R. DRADER, AND P.J. JAKES. 2010. Fire burners to firefighters: The Nez Perce and fire. *J. For.* 108(2):71–76.

CARROLL, M.S., P. COHN, D. SEESHOLTZ, AND L. HIGGINS. 2005. Fire as a galvanizing and fragmenting influence on communities: The case of the Rodeo-Chediski fire. *Soc. Nat. Resourc.* 18(4):301–320.

CARROLL, M.S., L.L. HIGGINS, P.J. COHN, AND J. BURCHFIELD. 2006. Community wildfire events as a source of social conflict. *Rural Sociol.* 71(2):261–280.

CARROLL, M.S., T. PAVEGLIO, P.J. JAKES, AND L.L. HIGGINS. 2011. Nontribal community recovery from wildfire five years later: The case of the Rodeo-Chediski fire. *Soc. Nat. Resourc.* 24(7):672–687.

CHARMAZ, K. 2006. *Constructing grounded theory: A practical guide through qualitative analysis*, 1st ed. Sage Publications Ltd., Thousand Oaks, CA. 208 p.

COHEN, J. 2008. The wildland-urban interface fire problem: A consequence of the fire exclusion paradigm. *For. Hist. Today* 21.

DUANE, T.P. 1997. Community participation in ecosystem management. *Ecology Law Q.* 24: 771.

FLINT, C.G. 2007. Changing forest disturbance regimes and risk perceptions in Homer, Alaska. *Risk Anal.* 27(6):1597–1608.

FLINT, C.G., AND A.E. LULOFF. 2005. Natural resource-based communities, risk, and disaster: An intersection of theories. *Soc. Nat. Resourc.* 18(5):399–412.

FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES. 2010. *Caloosahatchee Forestry Center mitigation action plan*. Available online at www.lee-county.com/gov/dept/dcd/Planning/.../CPA201117A1.pdf; last accessed Mar. 7, 2013.

GIDDENS, A. 1984. *The constitution of society: Outline of the theory of structuration*. University of California Press, Berkeley, CA. 417 p.

GLASER, B., AND A. STRAUSS. 1967. *The discovery of grounded theory: Strategies for qualitative research*. Aldine de Gruyter, Hawthorne, NY. 271 p.

GORDON, J.S., D. MATARRITA-CASCANTE, R.C. STEDMAN, AND A.E. LULOFF. 2010. Wildfire perception and community change. *Rural Sociol.* 75(3):455–477.

GUDE, P., R. RASKER, AND J. VAN DEN NOORT. 2008. Potential for future development on fire-prone lands. *J. For.* 106(4):198–205.

HAMMER, R.B., S.I. STEWART, AND V.C. RADELOFF. 2008. Demographic trends, the wildland-urban interface, and wildfire management. Available online at scholarsarchive.library.oregonstate.edu/jsui/handle/1957/9260; last accessed July 5, 2011.

HARBOUR, T., T. MURPHY, L. CARLILE, T. NICHOLS, B. MCMANUS, AND D. SMITH. 2009. Quadrennial fire review 2009. Available online at www.iafc.org/files/wild_QFR2009Report.pdf; last accessed Mar. 7, 2013.

JAKES, P.J., S. AGRAWAL, AND M. MONROE. 2003. *The Palm Coast community: Steps to improve community preparedness for wildfire*. Available online at www.treesearch.fs.fed.us/pubs/11803; last accessed July 11, 2012.

JAKES, P.J., AND E.R. (LISA) LANGER. 2012. The adaptive capacity of New Zealand communities to wildfire. *Int. J. Wildl. Fire*. Available online at dx.doi.org/10.1071/WF11086; last accessed July 5, 2012.

JAKES, P.J., K. NELSON, E. LANG, M. MONROE, S. AGRAWAL, L. KRUGER, AND V. STURTEVANT. 2002. *A model for improving community preparedness for wildfire*. USDA For. Serv., Gen. Tech. Rep. NC-GTR-231, North Central Research Station, St. Paul, MN. 9 p.

LESCHAK, P. 2010. Strong partnerships and the right tools: The pre-wildfire strategy of fire adapted communities. *Disaster Safety Rev.* 2 p.

MILLINGTON, J.D.A., G.L.W. PERRY, AND R. ROMERO-CALCERRADA. 2007. Regression techniques for examining land use/cover change: A case study of a Mediterranean landscape. *Ecosystems* 10(4):562–578.

NEW CONCEPT REALTY, INC. 2011. *The Resort on Carefree Boulevard*. Available online at www.resortoncb.com/; last accessed July 5, 2012.

- PAVEGLIO, T.B., M.S. CARROLL, AND P.J. JAKES. 2010. Alternatives to evacuation during wildland fire: Exploring adaptive capacity in one Idaho community. *Environ. Hazards* 9(4): 379–394.
- PAVEGLIO, T.B., P.J. JAKES, M.S. CARROLL, AND D.R. WILLIAMS. 2009. Understanding social complexity within the wildland urban interface: A new species of human habitation? *Environ. Manage.* 43(6):1085–1095.
- ROMERO-CALCERRADA, R., AND G.L.W. PERRY. 2004. The role of land abandonment in landscape dynamics in the SPA 'Encinares Del Rio Alberche y Cofio, Central Spain, 1984–1999. *Landscape Urban Plann.* 66(4):217–232.
- SCHOENNAGEL, T., C.R. NELSON, D.M. THEOBALD, G.C. CARNWATH, AND T.B. CHAPMAN. 2009. Implementation of national fire plan treatments near the wildland-urban interface in the Western United States. *Proc. Natl. Acad. Sci. USA* 106(26):10706–10711.
- SHAFRAN, A.P. 2008. Risk externalities and the problem of wildfire risk. *J. Urban Econ.* 64(2): 488–495.
- US CENSUS BUREAU. 2009a. *2005–2009 American Community Survey: Lehigh Acres CDP, Florida*. Available online at factfinder.census.gov/servlet/ADPTTable?_bm=y&-geo_id=16000US1239925&-qr_name=ACS_2009_5YR_G00_DP5YR2&-ds_name=ACS_2009_5YR_G00_&-_lang=en&-_sse=on; last accessed July 5, 2012.
- US CENSUS BUREAU. 2009b. *2005–2009 American Community Survey: Buckingham CDP*. Available online at factfinder.census.gov/servlet/ACSSAFFacts?_event=Search&geo_id=&-geoContext=&-street=&-county=Buckingham&-cityTown=Buckingham&-state=04000US12&-zip=&-lang=en&-sse=on&pctxt=fph&pgsl=010; last accessed July 5, 2012.
- WILKINSON, K. 1991. *The community in rural America*. Greenwood Publishing Group, Westport, CT. 166 p.