THE MOTHER RANGE: INVESTIGATING THE POWER DYNAMICS OF CLIMATE CHANGE

ADAPTATION IN AN ARIZONA FIRE-PRONE CONTESTED LANDSCAPE

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ABSTRACT

THE MOTHER RANGE: INVESTIGATING THE POWER DYNAMICS OF CLIMATE CHANGE

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Interviews with diverse actors regarding wildfire, values, and individual perspectives were conducted to add to the emergent body of literature utilizing a political ecology case study approach in the context of more developed countries. The Bighorn Fire as a case study provided several unique dynamics, such as community awareness of the fire, controlled management of the fire away from structures, ecological variability, the likelihood of near-future climate stress for the Tucson area, and history of socially prominent wildfires. Semi-structured interviews best aligned with the iterative nature of data analysis required by a political ecology approach. This methodology, combined with guidance from case study literature, informed the organization of interview data and the general structure of the research process. Analysis of interview data utilizing research questions informed by political ecology yielded rich insights into barriers to future governance efforts on and around Mt. Lemmon as well as novel findings of charismatic 'indicators' of climate change impacts for actors with different values and power. Future case studies examining communities, wildfire, and climate change impacts would benefit from similar critical engagements with local geography to understand how power influences both discourse and resulting action in relation to adaptive governance.

ACKNOWLEDGEMENTS

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CHAPTER ONE

INTRODUCTION

I. Overview

This research sought to investigate the socio-ecological contexts of the Bighorn Fire

prior to, during, and post-ignition to build upon contemporary studies utilizing a political

ecology approach. Areas containing a mix of human-built and vegetated environments are

often called the wildland-urban interface (WUI) (Moritz & Stephens, 2007; Stewart et al., 2007).

This definition of the WUI will serve as a foundation for further, situation-specific nuance that

incorporates political, ecological, cultural, and economic factors. The term WUI is necessarily

vague in this context, as to invoke imagery of average environmental conditions without

applying specific connotations. Paveglio et al. (2015) expressed these elements in their

definition of WUI communities by using archetypal continuums for types of development and

community lifestyles, with increments based on levels of land fragmentation, community

cohesion, or trust in governmental bodies. By incorporating this level of complexity, the WUI

not only encompasses both social and ecological components but acknowledges these

elements as inextricably linked. This research understands community as a process rather than

a static collection of a population. Approaching community in this way allows for more nuance

in analysis and acknowledges the continuing evolution inherent to communities. WUI

communities also face variability in the degree of fire adaptivity of their landscape. Fire-

adapted landscapes denote the historical presence of fire and its importance for ecosystem function.

Framing the WUI this way necessitates understanding the area as a social-ecological system (SES). A common definition of an SES is "a complex adaptive system, in which people rely on ecosystem services and are key drivers of ecosystems" (Hansen, 2014). Moritz et al. (2005) state, "How physical and biological processes, in conjunction with both evolutionary and historical influences, result in the "coalescence" of complex and functioning natural communities is a key open question in ecology." In consideration of these two perspectives, this research will define the WUI as an SES that incorporates evolutionary and historical influences on physical and biological processes in the boundary area between built and vegetated environments (Moritz et al., 2005; Paveglio & Edgeley, 2017; Stewart et al., 2007). This definition is utilized to mitigate the contextual limitations of a traditional spatial definition of the WUI, which does not account for the far-reaching impacts of and reliance on forests.

A targeted and circumscribed application of political ecology and adaptation to understanding the WUI as an SES may provide significant advancements in wildfire and associated climate change risk mitigation (Nightingale, 2017; Turner, 2014). However, such efforts are not without their potential pitfalls. The Intergovernmental Panel on Climate Change (IPCC) has defined adaptive capacity as the ability of humans, organisms, social systems, and institutions to adjust to climate change impacts (IPCC, 2014). More critical explorations of the term stress that more nuance is required for interpretations and invocations of adaptive capacity (Petersen et al., 2018). The authors highlight the importance of varying spatial scales and considerations for actions beyond those delineated by vulnerability assessments (Petersen

et al., 2018). Overall, contemporary adaptive efforts would benefit from a more critical

examination of adaptive capacity within power dynamic contexts—denoting a gap this research

seeks to contribute to filling (Petersen et al., 2018).
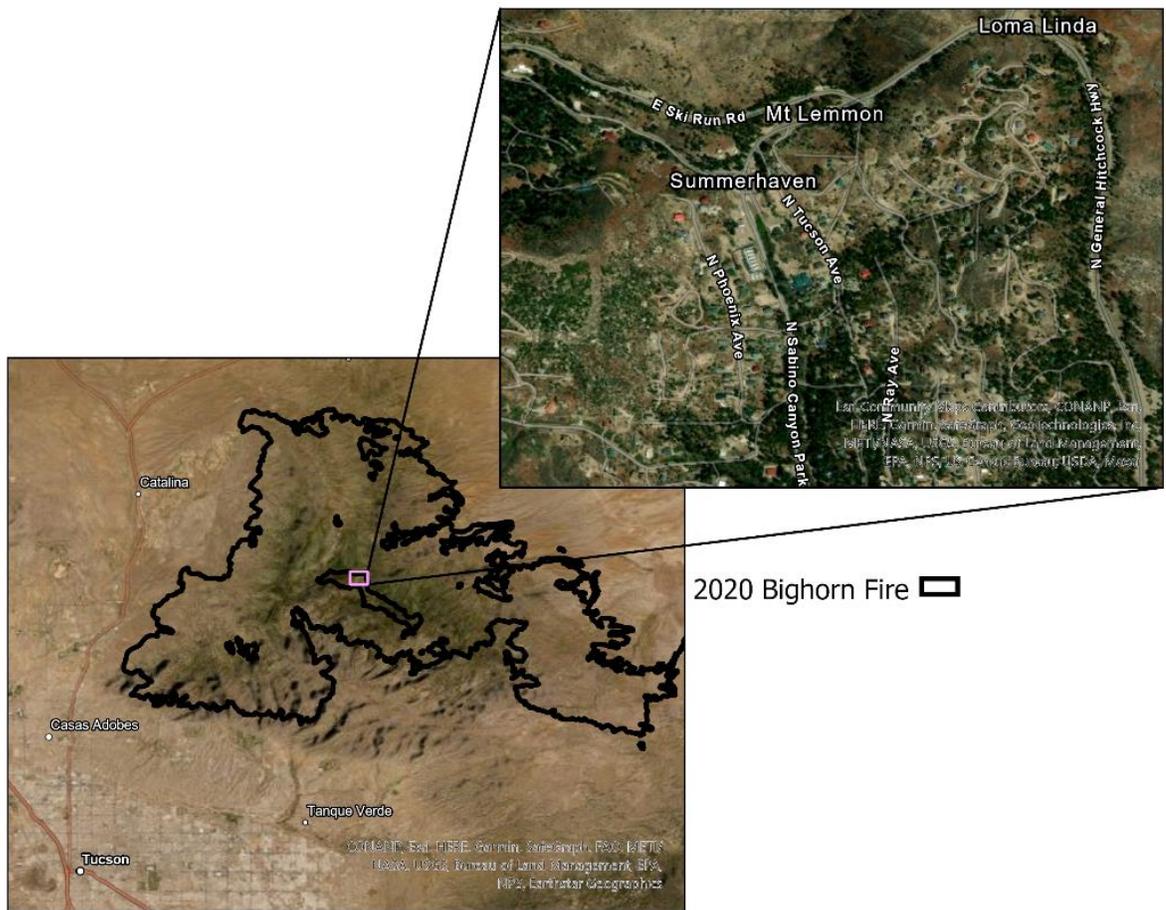

Figure 1. A map of the Bighorn Fire in relation to Tucson and Mt. Lemmon.

II. Climate change, management, and the Bighorn Fire

On June 5th, 2020, at 10:22 PM in the Catalina Mountains near Tucson, Arizona, a lightning strike ignited a fire on Bighorn Mountain (InciWeb, 2020). It wouldn't be until 48 days later, on July 23rd, 2020, that the aptly named Bighorn Fire would be declared 100% contained (InciWeb, 2020). Prior to its containment, the Bighorn Fire burned approximately 119,978 acres necessitating the response of over 900 personnel, including 20 hand crews, 64 engines, 18 water tenders, six bulldozers, and seven helicopters (Gabbert, 2020; Tucson, 2020). The fire threatened around 850 homes and resulted in costs estimated from $37 to over $40 million (Holcombe & Sutton, 2020; Steinberg, 2020; Tucson, 2020).

However, these estimates do not account for more nebulous but crucial long-term costs associated with a large fire near a human population center (Dale, 2010). Two overlooked or otherwise unattributed costs may include rehabilitation of watershed areas and loss of tax or tourist revenue (Dale, 2010). Arguably the most important of the omitted long-term costs is the loss of human life or wellbeing—especially as it pertains to individuals requiring extra assistance, such as children, the elderly, non-English speaking actors, or those with medical conditions (Simon & Dooling, 2013). In other words, groups that can be thought of as disadvantaged compared to the average population for varying lengths of time or actors who are experiencing vulnerability at different spatiotemporal scales.

Simon & Dooling (2013) identify four actions that can act as a catalyst for new material vulnerabilities in the WUI: ignorance, exploitation, mobilization, and resistance. Each of the four categories is intrinsically political and value-driven—highlighting the importance of critically analyzing both the values of actors as well as the reasoning for their inclusion or exclusion. Potential actors in a WUI setting include residents, tourists, activists, scientists, commercial

interests such as timber, state and federal staff, and non-human actors such as fauna. Each group may have different values resulting in agendas that, depending on the context, weave in and out of agreement. These values stem from cultural, economic, and personal roots (Anton & Lawrence, 2016). Power asymmetries arise from the ability of wealthy individuals or interests to disproportionately influence systems through policy, budgeting, and discourse in relation to those with less wealth (Simon & Dooling, 2013).

Actors with disproportionate power have an incentive to maintain the system that justifies their power (Simon & Dooling, 2013). Due to this inclination, inequalities are present in the representation of values in management decisions (Simon & Dooling, 2013). This materializes in management that has been ideologically striving for domination of the environment. The United States Forest Service provides a well-document example of this dynamic in the form of a past emphasis on total fire suppression as a policy, which served to significantly increase fire risk in managed forests by increasing stand density well past historical averages (Stephens et al., 2005). In managing for social values, wildfire became something to eliminate from the landscape despite its long-standing existence there (Stephens et al., 2005). Though this policy ended in the 1970s, the increases in forest density and accompanying strain on land management efforts remain problems contemporarily (Forest History Society, 2011; Stephens et al., 2005).

In contrast to this interpretation of land management, the term governance represents a flexible process of interactions between social and ecological systems with the goal of meeting objectives (Arts et al., 2013). This distinction is made to eschew the narrative of environmental control pervasive in contemporary management paradigms (Arts et al., 2013;

Stephens et al., 2005). Additionally, the flexibility central to governance encourages the

integration of local knowledge and the facilitation of communication between actors of

differing values and scales (Steelman, 2016). This flexibility may also be conceptualized as

adaptive capacity—the ability a system has to respond to an event to create a values-based

outcome (Devisscher et al., 2016).

Petersen et al. (2018) argue for a more nuanced interpretation of adaptive capacity.

They improve upon an existing framework for adaptive capacity by: explicitly incorporating

ecosystem traits that affect the sensitivity of the natural system, acknowledging that some

useful actions may only be weakly related to system sensitivity, emphasizing a need for greater

social adaptive capacity overlapping different spatial scales, and by stressing the pivotal step

wherein, relevant actors convene to make decisions regarding the system. This is an important

reframing of adaptive capacity for several reasons; the first reason is that it stresses the

adaptive capacity at the ecosystem level because managing for this scale is likely more cost-

effective than species-specific interventions. This reframing also stresses awareness of all

possible adaptation actions—not just actions that stem from vulnerability assessments, which

lends itself to a critical examination of the decision-making process as a whole (Petersen et al.,

2018). Incorporation of awareness regarding the adaptive social capacity at different scales will

help inform my political ecology approach, which asks who are the winners and losers of a

given decision (Petersen et al., 2018; Simon & Dooling, 2013).

The importance of adaptive capacity should not be understated due to future

uncertainties arising from climate change-induced temperature increases and droughts

(Abatzoglou & Williams, 2016; Westerling et al., 2006). In the past 30 years, wildfires have

become more severe, frequent, and widely dispersed (Abatzoglou & Williams, 2016). Humans have a more immediate impact on fire regimes by changing fuel loads and connectivity (Swetnam et al., 2016). Fuel connectivity is influenced by the level of thinning in tree stands, prescribed burning, or land-use changes such as road or structure construction (Swetnam et al., 2016). The pervasiveness of human activity throughout the landscape and its impact presents a daunting challenge. Managers are presently faced with a difficult task in mitigating wildfire risk in a rapidly expanding WUI with sparse funding, limiting policies, and the large scale of land for which they are responsible (Charnley et al., 2015).

Despite comprising a relatively small portion of national forest, WUI accounted for 67 percent of the 2.6 million acres treated for hazardous fuel by the United States Forest Service in 2013 (Charnley et al., 2015). A trend that is not likely to abate anytime soon, as recent estimates place the U.S. WUI at nearly 50 million homes (or 770,000 km^2 in 2018)—increasing by one million every three years (Burke et al., 2021; Radeloff et al., 2018). With treatment in WUI environments facing costs as high as four times more than non-WUI forest land treatment, it is important to strategically approach governance for community values in WUI communities (Charnley et al., 2015; Simon & Dooling, 2013).

The 2020 U.S. fire season was indicative of the future of wildfire with current management practices and acute climate change impacts (Signals, 2020). There were approximately 6,500 more fires and 5.6 million more acres burned in 2020 compared to 2019 (Jergler, 2020). Estimates for insured property losses in the U.S. to wildfire in 2020 range from $7 billion to $13 billion (Smith, 2020). Fires have also been increasing in size, with one 2020 California fire achieving the designation of gigafire—a one million acre fire (Jergler, 2020).

These concerns do not solely apply to instances of human-caused ignitions, as even lightning strikes are predicted to increase by up to 50% by 2100 (Signals, 2020). This is due to the higher capacity for water vapor in warmer air temperatures—providing fuel for the strong updrafts that create lightning (Signals, 2020). An example of this relationship arises, again, from California in the summer of 2020. A Northern California state fire official detailed a 'historic lightning siege' taking place in mid-August of 2020. Extreme heatwaves lead to around 11,000 bolts over 72 hours—igniting 367 wildfires, ultimately resulting in 350,000 acres burned over five days (Signals, 2020).

Arizona has not fared much better, with 700,000 acres burned and three of the ten largest fires in state history occurring in 2020 (Steinberg, 2020). The Arizona Department of Forestry and Fire Management reported a 117% increase in fire suppression costs between the 2015 and 2018 fiscal years, which has, ironically, diverted funds from preventative endeavors such as stand thinning (Steinberg, 2020). This all culminates in a distressing vision of the future—especially for the non-fire adapted Southwestern U.S. (Alford et al., 2005). This is, perhaps, best depicted in a statement from Bighorn Fire Public Information Officer Cindy Wolfe: "The Tucson area fire has been competing for resources with more than a dozen other wildfires in Arizona and New Mexico." (Alaimo & Brean, 2020).

III. Research Statement and Questions

I utilized a political ecology approach to investigate the dynamics of power within the socio-ecological contexts of the Bighorn Fire prior to, during, and post-fire. Interviews with

diverse actors regarding wildfire, values, and individual perspectives were conducted to add to the emergent body of literature utilizing a political ecology case study approach in the context of more developed countries (McCarthy, 2005). This research approaches WUI governance as inherently political with the goal of identifying potential opportunities for addressing vulnerabilities and increasing cohesion between involved parties. I selected the Bighorn Fire for my case study for several reasons including: community awareness of the fire, controlled management of the fire away from the town of Summerhaven, variability across five ecozones from lower Sonora to mixed conifer, the potential for future climate stress for the Tucson area, and history of fires on the Coronado National Forest, such as the destructive 2003 Aspen Fire (*Explore Mt. Lemmon's Life Zones Near Tucson*, 2016). Below are the research questions that informed this research:

1. What power asymmetries exist between actors affected by wildfire in the Tucson area?
2. What is the relationship between power asymmetries and management outcomes after the Bighorn Fire?
3. To what extent will actor dynamics related to the Bighorn Fire influence future efforts to manage socio-ecological systems for fire in the Tucson area?

IV. Research Scope

Critical perspectives offered by a political ecology approach provide rich nuance to social-ecological studies. However, one potential drawback of this approach is the unrestrained exploration of topics, which can result in a seemingly endless process of analysis. To mitigate this potential drawback, this research was conducted with iterative documentation and reflection throughout the data collection and analysis process. These efforts ensured that interview data was consistently being reflected upon and related to my broader research questions. Accompanying this process was an awareness of the relatively short timeframe of a master's thesis, which necessarily served to limit which actors I sought to interview for this research. Specifically, this meant I emphasized diverse residents impacted by the Bighorn Fire, NGOs related to the Catalinas, and relevant management agencies from varying political and spatial scales.

V. Organization of this Thesis

This thesis has been organized into six chapters, introduction, theory and literature review, methodology, a case study, a standalone manuscript, and conclusion. This organization is somewhat atypical due to the standalone manuscript chapter. Traditionally theses have results and discussion chapters where my case study and manuscript chapters reside. To mitigate any potential loss of analytic richness, the case study chapter contains both a results and discussion section addressing the first two of my three research questions. The manuscript chapter was added due to my plans to continue my academic career by pursuing a Ph.D. with

the School of Forestry at NAU and the resulting desire for published work. This chapter will

necessarily contain condensed reiterations of methodology and literature review sections to

create a document able to exist outside of this thesis. However, this chapter will also contain

novel results and discussions generated from interview data. Finally, my conclusion chapter

provides a summary of key takeaways from this research as well as specific recommendations

for managers, academics, and residents.

CHAPTER TWO

THEORY & LITERATURE REVIEW

Introduction

This thesis utilizes a political ecology approach to understand land management discourses of varying spatial-temporal scales with diverse actors. In this chapter, I detail my theoretical approach and contrast it against other approaches to researching wildfire as a social-ecological system. After establishing my theoretical foundation, important concepts such as social-ecological systems, resilience, adaptation, place, and space are critically engaged as they relate to wildfire and this research, specifically. Following these sections, the diverse impacts and interpretations of climate change are addressed—allowing for a final discussion of the social dynamics of contemporary efforts to adapt to climate change and wildfire impacts in the Wildland-Urban Interface (WUI).

I. Political Ecology

Rather than denoting a single theoretical framework, political ecology is perhaps best described as a community of practice concerned with normative goals of social and environmental justice (Robbins, 2012, pg. 10). Broadly, political ecology interrogates social-ecological interactions with an understanding of Marx's political economy (Robbins, 2012, pg.

21). Political economy, in this invocation, refers to the inextricable link between politics and economics as they relate to the environment (Robbins, 2012, pg. 54). Such an understanding is critical to uncovering what Blaikie & Brookfield (1986) referred to as 'chains of explanation.' Contemporary applications of political ecology frequently utilize a chains of explanation framework when analyzing human-environmental conflicts to uncover not only why there is conflict but also what exactly is being contested (Watts & Peet, 2004). Despite often appearing obvious, the root cause of social-ecological conflict is often more nuanced than what can be gleaned at first glance—thus the emphasis on what is truly in contestation. To this end, political ecology entails recognition of social-ecological interactions as inherently political (Robbins, 2012, pg. 21). This distinction is made in direct contrast to the apolitical claims and narratives prevalent in environmental management and related knowledge production.

Underlying this approach is an understanding of soft social constructivism. Foundationally, social constructivism of any kind necessitates assessing the degree to which human social institutions have influenced the framing of what is 'real'—allowing for further investigation into assumptions resulting from such a framing (Robbins, 2012, pg. 127). Hard social constructivism understands reality to be a highly subjective term wherein many perspectives can be true at once depending on the context in which one creates said perspective. Soft social constructivism, in contrast, maintains that there is an empirical reality that is understood and influenced differently by various actors (Robbins, 2012, pg. 128). Actors, for the purposes of this research, is applied as a general term used to refer to any human or non-human thing within a social-ecological system (Robbins, 2012, pg. 79).

II. Political Ecology and Wildfire

Political ecology is primarily applied to analyze normative social and environmental justice narratives with more nuance to the social component—it is an approach that asks who the winners and losers of any given decision are (Turner, 2014). Davies et al. (2018) illustrate how this concept translates to wildfire and vulnerable groups in the WUI. In their findings, Davies et al. (2018) state that white Americans are both underrepresented in the highest risk and overrepresented in the lowest fire risk census tracts. Additionally, the least-adaptable actors were concluded to have a higher-than-average vulnerability to fire even in moderate fire risk tracts. While no individual may seek to marginalize these groups outright, the systemic outcome is not dissimilar. Vulnerability, in this sense, has many spatiotemporal scales that are often outside the conventional definition, which assumes an action or potential action occurs at a singular time or due to an identifiable actor. This definition of vulnerability is then perpetuated within a system that relies on economic growth as a panacea; because there is little political incentive to divert management attention or resources to vulnerable actors and environments within such a system.

Simon & Dooling (2013) highlight the importance of a spatially grounded historical analysis in understanding power asymmetries that can lead to material or political vulnerability. As they state, "People are made vulnerable […] [by] political and economic power imbalances, inadequate representation, and the marginalizing tendencies of powerful interest groups [that] play significant roles in how the material conditions of vulnerability are translated, manipulated, and exploited in the political realm." Within such a system, vast concentrations of

wealth maintain slow, rigid, and detached bureaucracies that are ineffective in addressing

crises of their own design. Wealth can then appropriate public failure to justify its continued

existence as the best solution for the very crises that sustain it. Such a process can be iterative

as it allows a pretense for funds to be diverted from vulnerable groups in the form of social

services to address the expanding crisis through accumulation (Simon & Dooling, 2013).

Striving for meaningful approaches to WUI fire risk mitigation cannot be done

apolitically for these reasons. Mockrin et al. (2020) echo this sentiment in their conclusion,

which encourages municipalities to exert their control over the urban portion of the WUI to

encourage community cohesion, risk awareness, and mitigation. In arguing for a community-

based approach, the authors seek to circumvent what Steelman (2016) identifies as

nationalized wildfire suppression that effectively subsidizes WUI development. This attempted

circumvention is important due to the propensity of wealthier—and often risk-aware—

individuals to expand WUI environments for aesthetic and economic purposes (Goemans &

Ballamingie, 2013).

In conceptualizing WUI environments on a scale of development and social-ecological

fragmentation, Paveglio et al. (2015), stress the importance of community interventions in fuel

loads and contemporary management practices to promote fire-adapted communities

regardless of their state of development. Such a process would encourage the incremental

ownership of obligations of safety to the community by the individuals that comprise it (e.g.,

creating a defensible space around a home). In one encouraging case study, ranchers were

found to be instrumental in mitigating localized disturbances (York & Schoon, 2011). However,

it was also found that locals were ineffective in mitigating disturbances caused by private

interests in aggregate, such as climate change (York & Schoon, 2011). It is essential, then, that

options such as those put forth by Paveglio et al. are explored in greater depth so that an

incremental process of solutions in aggregate can be formed in response to increasing WUI fire

risk and future uncertainty due to climate change.

III. Apolitical Wildfire Narratives in the Western U.S.

Romanticized ideals attributed to landscapes are a long-standing narrative in the U.S. as

a whole, but in the West in particular. Such romanticism arises, in part, in association with the

concentration of federal land in the West compared to the East (Cronon, 1995; Stephens et al.,

2005). Denevan (1992) provides a useful starting point in deconstructing hegemonic notions

related to the environment in the U.S.—as is evident from the title *The Pristine Myth.* In his

discussion of a socially constructed narrative pertaining to the quality of historic environments

in the U.S., Denevan (1992) touched on an important narrative that still holds relevance to this

day. Narratives of human-nature dichotomies remain prevalent with an emphasis on the value

of nature in relation to minimized perceived human impact. Perception is used to qualify this

statement because—as Denevan (1992) illustrated, human-environmental interactions have a

long, relational, history.

Furthering this deconstruction of environmental narratives, Cronon (1996) offers a

critical analysis of the concept of wilderness and associated narratives. Similar to language

utilized by *The Pristine Myth,* Cronon's *The Trouble with Wilderness* details a wilderness

imaginary. This particular social construction of the landscape, again, prerequisites that true

nature is most pure in its extrication from human influence (Cronon, 1996). This is perhaps best summarized in a quote from the aforementioned article, "To the extent that we celebrate wilderness as the measure with which we judge civilization, we reproduce the dualism that sets humanity and nature at opposite poles. We thereby leave ourselves little hope of discovering what an ethical, sustainable, honorable human place in nature might actually look like." (Cronon, 1996). Polarizing dualities of human and environment provide little way forward given the prevalence of humans and their impacts coupled with our inextricable link to environments however tenuous or convoluted as they may now be. If our conceptions of the environment are socially constructed, invocations of terms such as conservation, preservation, restoration, and indeed management itself benefit from questions such as "of what?" and "for who?".

Introducing further complexity, Peluso & Vandergeest (2010) detail how designations of landscapes, terminology used relating to the landscape, and how humans interact with the environment all feed into an intrinsically political process—providing further cause for taking seriously the role of power in management and environmental discourses. The three articles I have briefly touched on here all provide a unique element to a more nuanced understanding of environmental management and associated narratives. It is important to consider environments as in flux, with histories which influence the current particular moment in a specific location. Generalized notions of a world in which nature can only exist external of humans provides no pragmatic way forward in addressing social-ecological conflict.

Political ecology concepts of enclosure also critique social constructions relating to nature, although with a slightly different angle than what has thus far been presented. Enclosure in the sense can be thought of as "the imposition of a political geography over an

ecological geography" (Robbins, 2012, pg. 181). Essentially, how we demarcate the landscape and how we regulate our interactions with it have profound consequences for both human and environment. Central to the concept of enclosure is the theme of control over the environment (Robbins, 2012, pg. 181). The importance of enclosure is that it is a common practice for U.S. land management. The political nature of such a process, as Peluso & Vandergeest (2010) demonstrate, creates a context in which those with disproportionate power can dictate management towards goals which reproduce their power rather than the wellbeing of human and non-human actors. Concepts of enclosure can lead to management that is ideologically striving for domination of the environment. A well-documented example of this dynamic is past Forest Service policy of total fire suppression which served to significantly increase fire risk in managed forests by increasing stand density well past historical averages (Stephens et al., 2005). In seeking to preserve ideological notions of what a forest should be as well as economic interests by way of timber production, The Forest Service has been enveloped in control narratives since its inception.

In *Madagascar Aflame,* Kull (2002) examines the history of fire usage in Madagascar, incorporating political and economic pressures showing how they influenced how perspectives of fire changed over time (Kull, 2002). The articles discussion of the more contemporary framing of state narratives of fire exclusion and how farmers utilized it regardless was used to demonstrate fire usage as a form of protest (Kull, 2002). Central to this understanding is a political ecology thesis wherein conservation is invoked for the purpose of control (Robbins, 2012, pg. 178). In his analysis, Kull (2002) stresses perspectives surrounding fire shifted to fit political and economic interests. An important consideration in light of the vulnerabilities that

can be produced or reproduced through the process of enclosure—such as forced relocation, as

one example. It is important to consider these factors as they pertain to wildfire in the West,

because vulnerabilities and marginalization is similarly reproduced by enclosure practices and

dominant environmental narratives. Environmental and social degradation can introduce or

compound vulnerabilities for associated actors. To this end, Ajibade & McBean (2014) provide a

definition of vulnerability that accounts for some of the nuance addressed above, stating:

"Vulnerability is an inherent inability of individuals or communities to cope with external

pressure due to a chain of causes and multiple processes occurring at the local, national, and

global scale." As with ecological management, so too should the vulnerability or even potential

for vulnerability be considered at differing spatial and temporal scales.

IV. Wildfire and Social-Ecological Systems

     A social-ecological system (SES) is one that represents both the built environment and

the ecosphere in complex and dynamic self-producing systems (Moffatt & Kohler, 2008).

Contemporarily, SES's are the basis of present understandings pertaining to the relationship

between the built environment and ecosystem (Moffatt & Kohler, 2008). Mcginnis & Ostrom

(2014) argue that recognition of the conscious agency of individuals and its potential for

significant impact is fundamental to the SES framework. Mcginnis & Ostrom (2014) also detail

important questions to ask when framing an area as an SES. These questions can broadly

address the types of interactions within the system that are most relevant to the research, the

types of actors that are involved, and which governance systems influence the actions of identified actors (Mcginnis & Ostrom, 2014).

Contextualizing wildfire in the WUI as an SES acknowledges the reciprocal relationship between actors and their environments (Hansen, 2014). This change in perspective attributes value to the environment that is external to its material value—allowing for a conception of space outside of its productivity. Andersson et al., 2017, exemplify the implications these values have for management under the increasing complexity resulting from climate change. In their discussion of nature-based solutions (NBS), the authors argue for mitigation efforts that integrate existing environmental disturbance controls such as wetlands acting as flood mitigation in coastal cities. Utilization of NBS approaches and perspectives allows for solutions that do not require constructing new environments to protect people—at least not out of concrete.

Another critical aspect of visualizing wildfire as an SES entails seeking locals' perspectives with close relationships to the land, such as indigenous peoples, ranchers, or farmers. Hamilton, Salerno, & Fischer, 2019, utilized fuzzy cognitive maps to understand individual and aggregated perceptions of key SES links. The authors found that an individual was likely to be ineffective in perceiving these key elements. However, aggregated data from the individual cognitive maps were able to identify critical elements. Indeed, community, collaboration, and cohesion all become accentuated under this framework as they can be integrated into current practices and add adaptive capacity to them (Steelman, 2016). Action resulting from community members may be a different story. Prior & Eriksen (2013) concluded that, while communication was elemental to informing the collective consciousness about risks,

what drove individuals to action was dependent on their unique values. The obstacle, then,

becomes bridging various, seemingly disparate or tenuously linked, values of actors in the WUI

to promote meaningful fire mitigation actions.

V. Resilience

Literature pertaining to wildfire in the West often invokes the term resilience. However,

definitions of this term vary. The most common definition of resilience is some iteration of

"[The] capacity of a system to tolerate disturbance without shifting to a qualitatively different

state that is controlled by a different set of processes" (Hansen, 2014). Political ecologists offer

a critique of this invocation of the term, stating it is too ecological to consider the social

nuances in an SES and is a malleable term, which makes it vulnerable to being appropriated by

powerful interests (Ingalls & Stedman, 2016; Turner, 2014). Turner (2014) also concludes that

an intentional and well-documented attempt to engage both frameworks may provide

significant advancements in our understanding of human-nature dialectics.

Higuera et al. (2019) provide a potential starting point for this effort by asserting a new

overarching objective for resilience to signify—namely a coalescence of diverse objectives and

acceptance of multiple valid definitions of resilience. The authors conceptualize resilience as a

"boundary concept" or foundation for groups of different backgrounds and ultimate goals to

build upon (Higuera et al., 2019b). In this reframing, resilience shifts from a method striving for

dominance over the environment (traditional management) to a process of seeking and

interpreting the values held by different actors. Imperfection is not only acknowledged in this definition, but it is leveraged to bridge concerns of seemingly tenuous relationships (Higuera et al., 2019). The authors conclude by stating, "although we have demonstrated how this framework could be applied to hypothetical systems, future work should explore the governance processes that are used for translating these concepts into practice"—an endeavor political ecology is uniquely situated to address (Higuera et al., 2019a; Turner, 2014).

Critics of resilience frameworks may not approve of a perspective that embraces the malleability of the term. Even Higuera et al. (2019) do not explicitly ask for whom a change is acceptable in their value-based model. Incorporation of a political-ecological perspective becomes essential for this reason. In concerning itself primarily with the question of power asymmetries and how they influence systemic decisions, political ecology offers a critical lens to evaluate the values and associated management implications (Turner, 2014). Critical assessment of resilience as applied to an SES is encouraged in order to explore what actionable interventions can be made to meaningfully include historically marginalized or vulnerable actors in both the creation and interpretation of normative values (Higuera et al., 2019a; Turner, 2014).

Resilience, as Cretney (2014) stresses, has widespread usage—creating the potential for miscommunications, either accidental or otherwise. Taking it a step further, Cretney (2014) is largely concerned with the appropriation of the term to serve different political and economic interests. This expands on simply questioning resilience of what and for whom to include the nuances of power and how those with a disproportionate amount influence normative definitions of terms (Cretney, 2014). Arguably vital to their critique is the concept that resilient

ideologies, nations, cities, and individuals are well situated to shift with the demands of a

globalized market-driven economy (Cretney, 2014). This is actualized, in theory, by decreased

state responsibility and a narrative of constant, inevitable crises (Cretney, 2014). To this end,

the importance of power in resilience frameworks is paramount. Despite being uniquely

situated to collaborate with political ecology, resilience frameworks allow for troubling

potentialities by failing to meaningfully incorporate considerations of power in its analysis

(Ingalls & Stedman, 2016). One such drawback is that failure to address power in resilience

approaches allows for preexisting powerful entities (e.g., the state) to appropriate the term—

invoking it in management documents without enacting any significant changes to the way in

which management is done (Ingalls & Stedman, 2016). Secondly, and perhaps most relevant to

this research, failure to consider power in management and associated analyses fulfills the role

of knowledge production in power/knowledge institutions, serving to reproduce existing power

(Ingalls & Stedman, 2016).

VI. Adaptation

Adaptation is a term often invoked in contemporary wildfire, climate change, and land

management literature. However, varied definitions and contexts of invocation adds complexity

to the process of translating the term into action. For instance, while Devisscher et al. (2016)

define adaptive capacity as the ability, a system has to respond to an event—so as to create a

desired outcome. Petersen et al. (2018) argue for a more nuanced interpretation of adaptive

capacity. They improve upon an existing framework for adaptive capacity by: explicitly incorporating ecosystem traits that affect the sensitivity of the natural system; acknowledging that some useful actions may only be weakly related to system sensitivity; emphasizing a need for greater social adaptive capacity overlapping different spatial scales; and by stressing the pivotal step wherein, relevant actors convene to make decisions regarding the system. This is an important reframing of adaptive capacity for several reasons; the first reason is that it stresses the adaptive capacity at the ecosystem level because managing for this scale is likely more cost-effective than species-specific interventions. This reframing also stresses awareness of all possible adaptation actions—not just actions that stem from vulnerability assessments, which lends itself to a critical examination of the decision-making process as a whole (Petersen et al., 2018).

Failure to critically incorporate considerations of power allows for the appropriation of adaptive governance similar to the critiques of resilience presented earlier (Van Assche et al., 2017). However, Van Assche et al. (2017) cover much more than this in their Foucauldian analysis of natural resource management (NRM) and accompanying power-knowledge dynamics. Through their analysis, the authors outline the important relationship between knowledge and power (e.g., who has the knowledge, who produces the knowledge, and what interests does the generated knowledge ultimately serve?) (Van Assche et al., 2017). Adaptation discourses in NRM are becoming increasingly common; the question that arises from this article is what application of adaptation will look like given the notable spatial and temporal scales of NRM as well as the variable values and power differentials. As a key term in contemporary land management literature and in light of the critiques offered, the authors

argue that "If NRM wants to be adaptive governance, it thus needs to rest on a detailed analysis of interplays between power/knowledge in the narrow sense, and of how power in its other forms influences discourse." Similar to resilience, adaptive governance is already a widely used term, and it holds some promise in helping shift management narratives. As demonstrated by Van Assche et al. (2017), adaptive governance, again much like resilience, would benefit from taking the role of power and knowledge in the management process seriously.

A similar argument is made about the term adaptation by Nightingale (2017), who states, "[P]ower [is] constitutive of adaptation rather than an externality that requires post-implementation management." Nightingale (2017) conceptualizes adaptation programs as realigning power-knowledge paradigms through struggles over authority. In opposition to reducing this process to the term adaptive capacity as a term alone, the author argues that the unpredictability and complexity of management outcomes must be taken into account. In light of these arguments, Nightingale (2017) states that adaptation efforts must refocus emphasis on politics, power, and institutional designs. This delineation is made in contrast to purely technical implementation and evaluation of adaptation initiatives (Nightingale, 2017).

Adaptation is often invoked in contemporary climate change narratives in calls for shifts in management paradigms and associated actions. However, attempts to enact this shift should take existing critiques of adaptation into consideration when implementing programs under the term. Adger & Barnett (2009) identify four concerns regarding climate change adaptation: increasing threats to unique ecosystems, distribution of impacts, the aggregate scale of impacts, and risks of large-scale disruptions. The importance of these factors is informed by the authors' concerns regarding dominant narratives that adaptation will be easy to implement

(Adger & Barnett, 2009). To address these concerns, the authors argue that metrics informing adaptation and measurements of its success should only be understood within the specific social context in which adaptation is occurring (Adger & Barnett, 2009). Equally important, the values and power of actors involved in adaption influence associated discourses and implementations (Adger et al., 2005). The authors reflect on these influences to scales of adaptations stating, "Understanding adaptation, therefore, requires consideration not only of different scales of human action, but also of the social construction of appropriates scales by institutions to further their own aims" (Adger et al., 2005). Consideration for social dynamics of the implementation of adaptation at different scales entails considering the potential spatial and temporal externalities that could result from adaptation actions (Adger et al., 2005).

Further nuance in adaptation discourses can be found through an awareness that adaptation efforts are dependent on the ethics, knowledge, and perceptions of risk and culture (Adger et al., 2009). Reflections on adaptation in this vein found that an adaptable society must have an awareness of diverse community values, specific and variable vulnerability to impacts, and the ability to accept some amount of loss through changes (Adger et al., 2009). Other authors argue for an emphasis on vulnerability over adaptation for transformative goals seeking to address climate change impacts (Ribot, 2011). Importantly, even articles that critique adaptation to this degree acknowledge its value as a preexisting term and its compatibility with risk-focused efforts to address vulnerability (Ribot, 2011). For these reasons, the author argues that future engagements of the term are necessary with the caveat that the above considerations must be applied to the contexts wherein adaption is being attempted (Ribot, 2011). Incorporating these considerations into adaptation methods, Biesbroek et al. (2013)

argue that future research should, "[I]nvestigate the influence of barriers on the course and outcome of the adaptation process; examine more closely the relationship between barriers and opportunities and between barriers and interventions; extend the analysis of barriers beyond [local scales]; intensify the analysis of barriers in the most vulnerable low-income countries; and conduct empirical studies on different types of intervention strategies that could be used to deal with barriers." These future directions for research provide useful, practical applications of the nuance argued for by the above authors.

VII. Place

WUI residents' awareness and ownership of environment is a theme pervasive in the existing literature regarding the WUI as an SES (Anton & Lawrence, 2016; Ryan & Hamin, 2008). These concepts are often addressed using terms such as sense of community, community cohesion, individual values, risk awareness, and place (Anton & Lawrence, 2016; Bihari & Ryan, 2012; Devisscher et al., 2016; Faas et al., 2017). Anton & Lawrence (2016) explore these factors within the WUI by using them as measures for an umbrella term—place attachment. To measure these concepts, the authors compared the response of WUI residents to fire risk against their homeownership status, income, education level, and residency length (Anton & Lawrence, 2016). They found that place attachment, as they defined it, had a positive relationship with greater mitigation effort from individuals—but only in rural areas (Anton & Lawrence, 2016). One possible reason for the dampening of the impact place attachment has in

less rural areas arises from a conflict of values (Paraskevopoulou et al., 2019). Residents in the

WUI may not undertake mitigation actions such as vegetation removal around the home for:

aesthetic reasons (Paraskevopoulou et al., 2019), lack of risk awareness (Labossière & Mcgee

2017), as well as values influenced by gender, politics, ecological concerns, and economics

(Hansen & Naughton, 2013; Kooistra & Hall, 2014). However, these justifications are more likely

to be found in high-amenity communities specifically (Paraskevopoulou et al., 2019).

Attachment to place in forested landscapes has been a point of interest for WUI-related

research (Williams & Vaske, 2003). This interest stems from the potential for incorporating local

values and knowledge into existing land management practices. Williams & Vaske (2003) note

two distinct components of place attachment: identity and dependence. Place identity denotes

an emotional attachment and conceptualizes place as containers of emotions and relationships

(Williams & Vaske, 2003). In contrast, place dependence refers to a functional attachment, with

some common examples being reliance on localized natural resources or, in a similar vein,

economic dependence on tourism (Williams & Vaske, 2003). The authors make this distinction

to explain variability in both the causes and effects of placement and associated actions. For

example, place identity has been noted to be linked with increases in environmentally

responsible behavior (Vaske & Kobrin, 2001; Williams & Vaske, 2003). Place dependence, on

the other hand, was more positively linked to development and extractive prioritizations

(Bricker & Kerstetter, 2002; Williams & Vaske, 2003).

It is worth reiterating that although place identity and dependence are two distinct

components, both are just that—two components of the overall concept of place attachment

(Williams & Vaske, 2003). As a whole, place attachment in forested landscapes has been noted

to be linked to higher sensitivity to resource impacts and a perceived lack of substitutes (Williams & Vaske, 2003; Young et al., 1990). This fact presents a challenge to future efforts to manage forested landscapes due to predicted climate change impacts (Abatzoglou & Williams, 2016; Williams & Vaske, 2003). Albrecht et al. (2007) highlight the mental toll of environmental change disrupting place attachments. The authors correlate environmental and human distress with increasing correlation resulting from a sense of powerlessness or control over environmental change (Albrecht et al., 2007). Residents living in or near forested landscapes face a potential future of compounding distress; first from awareness of contemporary and predicted environmental change, and second from the resulting irrevocable sense of loss when such changes are actualized (Albrecht et al., 2007; Williams & Vaske, 2003).

VIII. The Production of Space

Originating from Henri Lefebvre (1991)'s seminal work *The Production of Space*, the titular concept refers to space as something which is constantly produced and reproduced by social interactions. There is an important distinction between place as addressed above and space as invoked here—relationality (Massey, 2004; Nicholls, 2009). Space in this conception encompasses the materiality of place as well as the sum of activities that occur within a place (Lefebvre, 1991; Massey, 2004). Crucially, traditionally natural areas may initially seem outside the scope of this conception of space due to the emphasis placed on social construction; however, the subjectivity of the term 'natural' and the dialectic between social and environmental systems highlights the fact that space, in its conception, weaves together human

thought and ecological materiality (Denevan, 1992; Massey, 2004). Social space, then, results

from the collection of interactions, interpretation of interactions, and layers of self-reflection

localized to a specific physical space (Lefebvre, 1991). Building on the relational

conceptualization of space, the materiality of a location and the social interactions

encompassed within that location produce and reproduce one another (Lefebvre, 1991). The

material realities constrain social interactions, yet spaces are changed and reproduced by the

thoughts and actions of social actors (Lefebvre, 1991).

Critical geographers continue to engage with the production of space to understand

complex social-ecological dialectics and to identify potential interventions in spatial production

to address inequity (Nicholls, 2009). In this conceptualization, the relationality of space and

spatial production are key factors in the organization of social movements (Nicholls, 2009).

Additionally, space is not a nebulous concept detached from the realities of place; instead,

place forms an important component to spatial production through several mechanisms. The

author elaborates on this concept by stressing the strategic value of place resulting from its

ability to inform diverse actor attachments allowing for the potential to galvanize diverse actor

values around collective efforts to mitigate impacts to a shared landscape (Nicholls, 2009). It is

this potential that allows place to often facilitate the creation of various social capitals (Nicholls,

2009). Despite its localize connotations, place can be invoked to refer to variable points of

contact—allowing social movements the opportunity to continually form and shift lines of

communication with diverse actors (Nicholls, 2009). Combined with broader place attachment

and adaptation literature, the implementation of place and the associated production of space

conceptualizations may yield profound insights for future efforts seeking to mitigate climate change impacts.

IX. Climate Change

Presently, the vast majority of climate scientists – up to 97 percent based on a recent study – contend that climate change, with accompanying elements such as increasing global average temperatures, presents an existential threat to life on Earth (Reusswig, 2013). Consequently, the discourse on climate change has quickly developed from acknowledging its presence to a determination of its causes, and currently, settling on effective ways of reverting it and adopting more sustainable approaches to living on Earth (Rosso Grossman, 2018). The overwhelming consensus on climate change among climate scientists is that human activities are the main culprits for climate change being experienced globally (Abatzoglou & Williams, 2016). the main focal points continue to be the impacts of climate change that are increasingly being felt across the globe and stem from the gradual public acceptance of climate change phenomena around the globe.

Contemporary framings of climate change posit it as a phenomenon that is isolated from daily life—leading to a perception that the responsibility of and capability to address its impacts lies beyond the scope of individual conceptions of spatial and temporal scales. However, there remains significant skepticism pertaining to the ability of individualistic approaches to respond to climate change impacts and cynicism regarding proponents of this

approach (Kent, 2009). The fact that British Petroleum developed the 'carbon footprint' model

serves as perhaps one of the most often cited examples inspiring cynicism of individualistic

proponents and proposed actions (Solnit, 2021). As more studies have been conducted to

understand the nature of climate change, it has become evident that its diverse consequences

cannot be separated based on strictly social or ecological concerns (Kakaki, 2013; Lineman et

al., 2015). For instance, some health risks are linked to extreme weather, such as smoke from

wildfires, which can be exacerbated by increases in temperature and drought conditions

resulting from climate change (Reid et al., 2016).

Based on studies, it is now well understood that heatwaves have become more

prevalent and hotter, and there is a growing acceptance that such heatwaves have resulted in a

rise in mortality rates. For instance, in the summer of 2010, a heatwave engulfed Moscow,

accompanied by a considerable increase in air pollution, and a spread of infectious diseases,

which contributed to more than 11,000 additional deaths (Sternberg & Edwards, 2017).

Furthermore, temperature-related increases in morbidity are linked to cardiovascular,

respiratory, and kidney complications. In the United States, such complications resulting from

heatwaves are now known to cause over 1,300 deaths annually (Sternberg & Edwards, 2017;

The United States Environmental Protection Agency, 2021). One of the other health impacts of

extreme weather events, as highlighted by Orru et al. (2017), is related to the release of

particulate particles comprising nitrogen oxides, sulfur dioxide, and other harmful compounds

released from forest fires.

In addition to the health impacts associated with extreme weather events such as

wildfire, an extensive body of research has continued to broaden the understanding of the

effects of climate change on physical health. These include a rise in vector-borne diseases and

an increase in the number of people with acute and chronic respiratory conditions, including

asthma and allergies (Hayes et al., 2018). Climate change introduces new mental health

challenges, especially for those who have experienced extreme weather events (Berry et al.,

2009). Noted potential mental health challenges include anxiety, depression, complicated grief,

survivor guilt, vicarious trauma, and major depressive disorder (Berry et al., 2009; Cunsolo

Willox et al., 2013). With such variable impacts, climate change has been regarded as one of the

greatest health threats of the 21st century (Berry et al., 2009).

Existing literature on climate change provides a limited discussion of diverse actor

perspectives of climate change impacts, mitigation efforts, and the values informing said

perspectives (Siders, 2019). Despite acknowledging the effects of climate change, there is

limited consensus regarding what should be done in response (Lobell, 2014). This lack of

consensus is partly due to the uncertainty of the course that climate change will take in the

years to come and whether current management efforts will be able to adequately respond to

future climate change effects (Horne et al., 2021).

Increases in global average temperatures and extended droughts resulting from climate

change have been shown to have a significant impact on wildfire behavior, with a predicted

future variability from historic fire behavior ranging anywhere from 33 to 62 percent

(Abatzoglou et al., 2019). In light of this predicted departure from historical averages, Fulé

(2008) poses an important question: should management efforts continue to aim to restore

forests to historical averages? Fulé (2008) concludes that while management efforts will benefit

from considering other metrics of success, historical conditions are likely to provide useful

insights for future efforts to respond to climate change, vegetation shifts, and wildfires. Key

knowledge gaps remain pertaining to understanding the future impacts of wildfire and climate

change on forested environments (Nolan et al., 2021). The authors highlight four gaps in

particular: fire frequency impacts on resprouting, heatwave and drought impacts on seed

quality and availability, climate change impacts on vegetation growth rates, and the capability

of species to adapt to these impacts (Nolan et al., 2021).

X. Climate Change Perspectives and Actions

Research investigating climate change perspectives utilizing a social-ecological

understanding stresses the importance of place and proximity to climate change impacts

(Sloggy et al., 2021; Zanocco et al., 2018). Attachment to place and close proximity to climate

change impacts on a place were found to have the potential for creating an experience with

enough salience to inspire action (Sloggy et al., 2021). However, this potential requires further

study, especially with unknowns stemming from varying spatial and temporal contexts of

impacts and perceptions of them (Zanocco et al., 2018). While there is a consensus in the

literature that extreme weather events may serve as a catalyst for changes in community

perspectives, there remains uncertainty regarding the extent to which these events can be

leveraged for action (Zanocco et al., 2018). Future research would benefit from investigating

the spatial and temporal scales different actors use to conceptualize climate change impacts

and how these factors inform local discourses and actions (Sloggy et al., 2021; Zanocco et al., 2018).

Abiotic events such as wildfires have often been explored as potential catalysts for changes in land management discourses and actions (Birkland, 2016; Mockrin et al., 2018; Wilson et al., 2018). Climate change impacts on extreme weather events have served to increase interest in the potential for changing disaster narratives from reactionary to proactive (Birkland, 2016; Ojewola et al., 2021). Specific to wildfire, Mockrin et al. (2018) found that community experience of wildfire impacts were at once crucial for changes to wildfire and climate change discourses and insufficient for encouraging lasting changes when overemphasized. Elements such as actor values, power, and the spatial manifestations of these dynamics must be critically considered alongside impactful events for significant and lasting interventions to occur (Mockrin et al., 2018; Wilson et al., 2018).

More general to natural disasters, Birkland (2016) found that social interpretations of disaster and its relationship with management discourse and activities create a dynamic where salient disasters cause federal management agencies to assume a defensive role post-disaster. Through this finding, Birkland (2016) cautions that salient extreme weather or other natural disasters are more likely to reinforce existing federal responses that are usually reactionary and concerned with restoring spaces to pre-disaster conditions. This reactionary emphasis promotes a positive feedback loop, wherein management efforts must constantly respond to disaster impacts without enacting changes that may reduce the impacts of future events (Birkland, 2016). Essentially, this process encourages conceptual and physical reproductions of space agnostic of natural disasters (Birkland, 2016; Lefebvre, 1991). The resulting decrease in

saliency serves as a step in this positive feedback loop, reinforcing reactionary management

practices (Birkland, 2016).

Translating community awareness of climate change impacts into actions has been a

topic of interest for contemporary studies incorporating social aspects into climate change

research. Ballantyne (2018) found visualization to be instrumental in the saliency of climate

change impacts. The author elaborates on elements of visualization that increase salience,

stating, "participants emphasized visual representations they felt made complex aspects of

climate change visible, clarified connections, provided an overview, or made climate change

tangible" (Ballantyne, 2018). The elements that allow visualization to resonate with community

members are interesting to consider in relation to the literature exploring climate change

action-awareness gaps. For example, Budolfson (2021) calls for increased awareness and

translation of climate change impacts encountered by diverse actors in their daily lives.

Combining the salience of visualization with efforts to understand community perceptions of

climate change impacts may facilitate clearer communication among diverse actors—especially

between actors operating at different scales (Ballantyne, 2018; Budolfson, 2021).

Rodrigo-Alsina (2019) found actor response to climate change impacts to be a product

of previous encounters with impacts and awareness of climate change influences on said

impacts. Building on this notion, Sailesh & John (2018) investigate how awareness does or does

not result in actions. Efforts to translate awareness of climate change impacts into actions have

utilized varied approaches such as raising awareness, creating fear, moralizing, and strategic

provisioning of information (Sailesh & John, 2018). These efforts have primarily been employed

by powerful actors to garner community support for management initiatives (Sailesh & John,

2018; Svarstad et al., 2018). This framing poses a challenge for efforts to more meaningfully engage diverse actors in actions responding to climate change impacts. Considerations of power and its propensity for coercive or controlling approaches are important for future efforts to bridge the action-awareness gap (Sailesh & John, 2018; Tenbrunsel, 1999). Efforts to critically analyze impediments to community action would also benefit from exploring actor perceptions of climate change impacts to ways of living and livelihoods connected to a specific landscape (Pickson & He, 2021). However, historical processes utilized by powerful actors, as detailed above, necessitate caution to ensure that insights gained from such an analysis would not serve narratives of coercion or control (Pickson & He, 2021; Tenbrunsel, 1999).

Recent literature examining the relationship between place attachment and climate change suggests that attachments to place can inspire action or impede adaptation depending on local context and adaptive measures being considered (Devine-Wright & Quinn, 2020; P. Singh et al., 2020). The differing emotional attachments of actors to a shared place may serve as a point of cohesion, providing an opportunity to galvanize support for a given action or actions (Bihari & Ryan, 2012; Devine-Wright & Quinn, 2020; Prior & Eriksen, 2013). However, similar attachments to place may cause some actors to be resistant to climate change adaption efforts if they threaten the values informing attachments (Singh et al., 2020). An example of a proposed climate change adaptation that would likely meet resistance informed by place attachment is the concept of adaptive release or similar concepts such as climate change-induced relocation (DeSilvey et al., 2021; Singh et al., 2020). Future efforts to adapt to climate change will likely need to navigate the complex relationship between place attachment and future uncertainty regarding climate change impacts (DeSilvey et al., 2021).

Gemenne & Blocher (2017) explore migration in the context of climate change adaptation and highlight its potential for either adaptive or maladaptive outcomes depending on the contexts of implementation. Elements influencing the success of migration as an adaptive measure include considering the environmental, cultural, and economic impacts migration would have at both departure and destination locations (Gemenne & Blocher, 2017). Proactive as opposed to reactive implementation of adaptive migration was also found to inform the success of outcomes, with proactive implementation more likely to yield positive outcomes (Gemenne & Blocher, 2017). This preference is largely informed by perceptions of future uncertainty resulting from climate change (Gemenne & Blocher, 2017; George & Athira, 2020). Tarek et al. (2021) provide a contemporary example of climate change uncertainty in their findings that regional temperatures and rain patterns provide notable uncertainties for efforts to model future stream flows. Climate change uncertainties such as this are important to consider for efforts to enact a concerted and collective response to predicted or actualized impacts (George & Athira, 2020). Uncertainty can fragment community expectations and actions, presenting another and distinctly social complexity to climate change adaptation efforts (George & Athira, 2020).

XI. Climate Change Indicators

Contemporary land management discourses often rely on various indicators to inform management plan creation and to gauge said programs' success. Conceptualizations and

applications of indicators vary depending on the associated discipline. For instance, Biesbroek et al. (2013) argue for the creation of indicators that allow for systematic identification of barriers to adaptation. In contrast, research with a more ecological focus use indicators to refer to biotic changes that can inform measurements of climate change impacts (Singh & Kushwaha, 2016; Zeppilli et al., 2015). Examples of ecological indicators from the literature include meiofauna, deciduousness in tropical trees, and lightning activity (Reeve & Toumi, 1999; Singh & Kushwaha, 2016; Zeppilli et al., 2015).

Literature investigating the social dynamics of adaptive governance cautions against reliance on indicators to conceptualize vulnerability without a broader context of what makes them indicators and what can be done about impacts (Adger et al., 2009; Ribot, 2011). Adger et al. (2005) delineate two key indicators of successful adaptation actions, robustness to uncertainty or the ability to change with emergent circumstances. Incorporating a social-ecological perspective to climate change indicators, Nguyen et al. (2016) argue that climate change vulnerability assessments would benefit from indicator-based vulnerability assessments. This type of assessment may enable consistent methodology for comparison between sites, or metrics may be developed that are site-specific to aid in more localized efforts aimed at mitigating climate change vulnerability (Nguyen et al., 2016)—supporting this claim, Horne et al. (2021) call for more research of risk-related decision making in climate change adaptation efforts due to concerns regarding uncertainty. Research seeking to address these elements must also maintain an awareness of the equally likely potential for maladaptation informed by climate change uncertainty (Horne et al., 2021).

Publications arguing for more critical implementations of climate change adaptation methods reiterate the importance of understanding personals experiences, perceptions, and expectations as ways to bridge action-awareness gaps (Horne et al., 2021). Similarly, Adger et al. (2009) find that diversity of actor values points to a need to identify implicit or hidden values and interests for meaningful adaptation to occur. Topics of locality, place, and cultural icons are denoted as useful starting points for investigations of these implicit or hidden values (Adger et al., 2009). To this end, Engle et al. (2014) argue for the development of a strong indicator and monitoring program to inform climate change response. Three points of emphasis for such a program include: conducting pilot indicator studies that result in a toolkit of cases and examples to inform future studies; evaluating differentiated perceptions of indicators; and the utilization of social-ecological climate change indicators for comparative analyses of adaptation efforts (Engle et al., 2014).

XII. Social Factors of Management in the WUI

Incorporation of the knowledge and values of locals within the WUI may help inform future mitigation efforts (Devisscher et al., 2016; Higuera et al., 2019a). However, there remain broader, systemic concerns related to who makes those decisions or controls the narrative surrounding them (Simon & Dooling, 2013). Understandings are still limited regarding effective coordination or even communication between actors (Faas et al., 2017). Bihari & Ryan (2012) refer to the connections between actors and place as social capital—which is created by individuals actively developing trust and social norms. In their findings, Bihari & Ryan (2012)

state encouragement of community engagement and interactions may lead to more fire-adapted WUI communities, depending on local contexts. However, this is likely to require bridging multiple social, cultural, and even operational gaps in wildfire suppression and mitigation in the WUI (Faas et al., 2017). A fire-adapted community (FAC), in this instance, refers to collaborative engagement between residents, land management professionals, politicians, emergency managers, and fire professionals (Paveglio & Edgeley, 2020). The overarching goals of a FAC include planning for, responding to, and recovering from evolving wildfire risks both in and around the WUI (Paveglio & Edgeley, 2020).

Barnes-Mauthe et al. (2015) refer to social capital as a resource that can be mobilized for either meaningful action or economic gain. Because of this, the authors argue social capital assessed on an individual level, while keeping the larger network in mind, can provide insights into socioeconomic outcomes and agency (Barnes-Mauthe et al., 2015). In their conclusion, Barnes-Mauthe et al. (2015) argue that future research involving social capital should explore the explicit role of social capital (e.g., hegemonic appropriation of terms) and the different values of actors of differing ethnicities. This is primarily due to their findings which indicated the importance of 'ties,' which serve to bridge actors with different backgrounds or at different scales (Barnes-Mauthe et al., 2015). Tie strength is measured by levels of kinship, trust, reciprocity, and frequency of contact in this instance (Barnes-Mauthe et al., 2015). Increasing tie strength affords involved parties increased social capital; through this medium, action can be appropriated (Barnes-Mauthe et al., 2015).

Regarding conflicts over environmental governance, Tenbrunsel (1999) highlights the importance of trust between actors. Interestingly, the author found uncertainty to inspire more

self-interested behavior in actors, with an associated devaluation of opposing information

(Tenbrunsel, 1999). The implications of this fact considering contemporary climate change

uncertainty narratives in land management discourses should not be understated—especially

for vulnerability-focused approaches to adaptive governance. Approaches to the resolution of

environmental conflicts can be sorted into three pathways, interest-based, which seeks to

address the underlying concerns or values of involved parties; rights-based, which relies on an

external standard such as the rule of law; and power-based, which relies on the use of force

and coercion to meet to objectives of actors with majority power (Tenbrunsel, 1999). It is

important to highlight the impact of power on each of these approaches, "Asymmetries of

power… perpetuate cycles of distrust independent of conflict resolution method" (Tenbrunsel,

1999). Efforts to mitigate the impact of power asymmetries in environmental conflicts would

benefit from identifying key actors, shifting discourses from control to creativity and consensus,

and developing shared frameworks to understand complex social-ecological interactions

(Tenbrunsel, 1999).

Trust has also been explored in conflict literature specific to wildfire management

agencies (Rasch & McCaffrey, 2019; Sharp et al., 2013). Rasch & McCaffrey (2019) make a

distinction between two forms of community-agency trust, calculative and relational.

Calculative trust is informed by community perceptions of the ability of relevant agencies to

respond to local wildfire risks (Rasch & McCaffrey, 2019). Relational trust is influenced by the

degree of alignment between communities and agencies (Sharp et al., 2013). It is worth noting

that conceptualizations along this line necessarily rely on erroneous assumptions of value

homogeneity within communities. While this framing is utilized to investigate community-

agency trust, a more nuanced understanding of the variability in community values is required

to fully understand trust within local contexts (T. Paveglio & Edgeley, 2017).

XIII. Community Dynamics and Wildfire Risk

Investigations of community decision-making related to wildfire risks employed

heterogenous understandings of actor values, power, and spatial-temporal scales (McCool et

al., 2006; Paveglio et al., 2017; T. Paveglio & Edgeley, 2017). Regarding the social impacts of

wildfire risk, McCool et al. (2006) found the impacts of a major wildfire to be highly disruptive

to place attachment. The authors emphasize the importance of ensuring some degree of

generalizability when investigating wildfire impacts on communities at varying spatial and

temporal scales (McCool et al., 2006). The authors promote generalizability by framing their

understanding of impacts associated with fire decisions in terms of community consequences,

responses, and adaptations (McCool et al., 2006).

Critical to this framing, McCool et al. (2006) posit several lingering questions for future

research seeking to utilize a similar framework: what criteria are and should be used to

measure fire decisions; how can a comparative analysis of the cost of preparation versus losses

incurred from fire be conducted; how do the spatial and temporal scales of investigations

influence data collection and analysis; and how can fire decisions and consequences be

measured and integrated at multiple scales? These questions are pressing and only made more

so from incorporation with critical geography perspectives such as the production of space

(Lefebvre, 1991).

Research seeking to explore the questions presented by McCool et al. (2006) would

benefit from understanding the variance found both between and within communities (

Paveglio et al., 2017). Implementation of this understanding could emphasize commonalities

that may help inform future efforts to understand community dynamics with more nuance

(Paveglio et al., 2017). To this end, Paveglio et al. (2017b) draw on the concept of Gesellschaft

as introduced by Tonnies & Hollis, 2001, which "…refers to the influence of non-local

institutions in which 'ration' will, regional and global economies, and bureaucratic governance

at larger scales (e.g., federal government) lead individuals to at least partially disassociate

themselves from local and kinship networks to act in their own self- interests as defined by

these later institutions." This concept is not dissimilar from governmentality concepts found in

political ecology texts (Robbins, 2012, pg. 74).

Providing further common ground between crucial wildfire and geography literature,

Paveglio et al. (2017) argue for the importance of geography, both in relation to place

attachment and in its material impacts on community dynamics. The authors present an

important finding that social capital understandings related to community dynamics and

wildfire risk often assume existing cohesion in communities will facilitate actions (Paveglio et

al., 2017). In contrast to this assumption, the authors continue to explain that closely bonded

sub-groups may actually present barriers to future efforts of collective action (Paveglio et al.,

2017). While such a finding may seemingly encourage notions that every population is unique

and thus argue against generalizability, the authors argue that similarities persist between and

among diverse communities (Paveglio et al., 2017). Consistent application of methodological

approaches, flexible definitions of community, and systematic documentation of research

utilizing similar approaches provides a way to progress more nuanced research of community

dynamics as they relate to complex social-ecological systems (Paveglio et al., 2017).

Community diversity in the WUI can be conceptualized at various spatial and temporal

scales (Paveglio & Edgeley, 2017). Rather than the expansion of WUI communities being the

primary driver of changes to WUI community dynamics, the authors argue for a more dialectical

(e.g., relational) understanding of social and ecological factors informing WUI community

composition (Paveglio & Edgeley, 2017). As an example, the authors highlight that the social

makeup of WUI communities changes over time and can prove to be just as important as WUI

expansion due to the reciprocal effects between humans and landscapes (Paveglio & Edgeley,

2017). Paveglio et al. (2015) identify 21 characteristics for understanding community evolution

at the local level. From this list, Paveglio & Edgeley (2017) provide some specific examples, such

as the presence of community organizations; localized ability to reduce fire risk; average

residency time; and the means of communication (e.g., formalized or informal). Focusing efforts

to understand WUI community heterogeneity on these aspects will likely allow for further

nuance in discussions pertaining to community dynamics and wildfire risks.

Studies aiming better to understand wildfire mitigation through heterogenous

understandings of communities revealed barriers to adaptive actions in the form of narrow

framings of wildfire impacts in terms of risk-benefits analysis alone and irregular spatial

patterns of landownership (Paveglio et al., 2019; Steelman, 2007). Generalizations of

community wildfire adaptation to the degree of risk-benefits analysis mix with challenges

detailed above to create limitations to community perceptions of what mitigative actions are

feasible (Steelman, 2007). Underlying this particular limitation is the inter-jurisdictional nature

of wildfire risks and responses, which can either serve to encourage or discourage solution

conceptualization and implementation depending on the support of relevant actors across

scales (Steelman, 2007). Regarding the support of diverse actors for fire mitigation efforts,

Paveglio et al. (2019) pose two questions to consider, how do the social dynamics affect the

scale at which management of wildfire occurs; and how do emergent communities or social

fragmentation affect collective fire management? The authors conclude that "irregular spatial

patterns across landownerships could influence larger wildfire management efforts by dictating

the consistent or variable proliferation of specific mitigation activities, planning efforts, and

support for resource management across the landscape" (Paveglio et al., 2019). Social and

spatial stratification within WUI communities presents a complex but necessary consideration

for future efforts to implement adaptive measures to wildfire risk.

Finally, reflections on contemporary efforts to address wildfire risk in WUI communities

have explored what is politically possible (Wilson et al., 2018). Emphasis on fuel reduction and

restoration of forested landscape to 'historical' or 'natural' conditions were found to strain if

not surpass political and economic feasibility (Wilson et al., 2018). In light of this finding, the

authors argue that the social or political realities of WUI communities may be better suited for

adaptation efforts by utilizing a social-ecological understanding as a foundation (Wilson et al.,

2018). In practical terms, research seeking to explore possible community adaptations to

wildfire risk would benefit from prioritizing wildfire treatments on broader criteria (e.g., risk

reduction, cultural values, and overall landscape health) (Wilson et al., 2018). These broader

criteria should be examined within the specific contexts of the values held by people residing in

or relying on the landscape so that understandings of how these efforts translate between

localities can be formed (Wilson et al., 2018). Aligning with critiques of adaptation efforts such as the vulnerability first concept presented by Ribot (2011), Wilson et al. (2018) stress that uncovering individual factors for mitigations is important, but studies attempting to do so often engage an implicit assumption that community values are homogenous. Future research would benefit from exploring heterogenous actor values and how that influences what is politically possible in terms of regional wildfire risk mitigation (Wilson et al., 2018).

Conclusion

This literature review covered a breadth of topics relevant to this thesis. I began by detailing the specifics of my political ecology approach while differentiating it from apolitical analyses. Following this foundation, I explored essential terms and concepts present in land management, wildfire, and climate change discourses. Examples of these important concepts include words such as resilience and adaptation. These terms were singled out due to their prevalence in contemporary discourses and their potential for appropriation by powerful actors. It is crucial to utilize language and terms that are accessible to as large a population as possible to make research relevant beyond localized contexts. For this reason, I continue to use adaptation as a term, so long as its potential shortcomings are explicitly stated. Requiring this degree of nuance allows for the usage of terms with variable definitions without confusion. Specific emphasis was given to climate change due to its importance to wildfire behavior in the Western U.S. and due to abundant public concern regarding its future impacts. Similar to adaptation, climate change literature was analyzed critically to ensure that claims made about

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it in this study were justified and to aid in identifying potential knowledge gaps that this

research may assist in filling.

CHAPTER THREE

METHODS

Introduction

I chose a qualitative approach to align with my theory informed by political ecology for this study. This decision was made over other potential methodologies, such as a strictly quantitative approach, to ensure that I could critically examine the nuances of community response to wildfire. This decision was made because interviewing—semi-structured interviewing in particular—as a methodology allows for engagement with individuals or groups wherein a dialog is co-created between the interviewer and interviewee (Seidman, 2006). Semi-structured interviews best aligned with instruction from my political ecology approach and case study literature. This alignment is due to the context-specific nature of investigating phenomena and the often nebulous factors that interrelate with the phenomena (Carspecken, 1996). A grounded theory methodology was applied to bridge the data collection and analysis stages of this research. Grounded theory necessitates an iterative approach to creating an understanding of interview data in a process that takes place during and after the interviewing period (Charmaz, 2006). This methodology, combined with case study literature, informed the organization of interview data and the general structure of the research process. Case studies are well suited for a qualitative interview approach—especially one utilizing a political ecology approach (Andrade, 2009; Robbins, 2012). Literature pertaining to both topics stresses the

importance of the 'chains of explanation'; however, their application varies slightly (Rocheleau, 2008; Yin, 2009). Case study literature invokes this concept for organizing and reflecting on interview data, whereas political ecology invocations often serve to interrogate the political economy underlying understandings gleaned from interview data (Andrade, 2009; Rocheleau, 2008). Both applications of the term concern themselves with maintaining claims based on interview data as well as ensuring that steps leading to such claims can be retraced (Rocheleau, 2008; Yin, 2009).

I. *Case Studies*

To best address my research aim of understanding how power asymmetries affect the adaptive capacity to wildfire across diverse groups of actors impacted by the same fire, I planned a case study approach. As the first step of this process, I conducted a literature review to understand better the potential knowledge gap or areas of research identified as needing more exploration (Yin, 2009). In conducting this literature review of wildfire literature with theoretical underpinnings taken from political ecology, a question repeatedly arose—what impact does the power and values of a given group have on vegetation management and wildfire mitigation, especially considering mounting future uncertainty resulting from climate change? As Yin (2009) details, case studies are best suited for research that focuses on contemporary events and does not require control of behavioral events. After reflecting on the questions that resulted from the literature review and considering the parameters from Yin

(2009), a case study approach was confirmed as the best methodological fit for investigating community and organizational power dynamics as they relate to wildfire in the Western U.S.

I initiated a search to identify an appropriate wildfire that would satisfy the needs of a case study approach. Case study selection included the following criteria: the proximity of the fire to structures; presence of unique geographic and ecological influences; social prominence of the fire; potential climate vulnerability of the study area; and a history of fire in the area. These criteria ensured that there would be substantial potential interview participants that had previous experience with fire in the study area and that the area would be likely to experience future wildfires. Finally, the recency of the fire also influenced wildfire selection, resulting in a timeframe of fires that had occurred the year before the start of data collection (2020). This timeframe was selected so questions regarding both short and long-term adaptation strategies are relevant and the information is still easy for respondents to recall—as opposed to a longer span of time between fire and data collection (Paveglio & Edgeley, 2017). Using these criteria, I began a review of wildfires occurring within the determined timeframe. I first restricted my search to the state of Arizona to align with research parameters. Next, I conducted a search of wildfires occurring in Arizona in 2020.

I chose the Bighorn Fire for my case study for several reasons including, community awareness of the fire, controlled management of the fire away from the town of Summerhaven, variability across five ecozones from lower Sonora to mixed conifer, the potential for future climate stress for the Tucson area, and history of fires in the Coronado National Forest, such as the destructive 2003 Aspen Fire (*Explore Mt. Lemmon's Life Zones Near Tucson*, 2016). Criteria informing a search for an appropriate wildfire, as detailed above, were

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delineated for their likelihood to produce the conditions necessary to apply my research questions examining the role of power in wildfire adaptation under climate change stress.

Upon selecting a fire for my case study, I then began drafting research questions and an accompanying interview protocol. This process was primarily informed by a political ecology approach that seeks, in part, to investigate the role of power in the management of social-ecological systems with a normative goal of equity (Robbins, 2012). With this understanding, draft research questions were created and presented to my committee for feedback. Hafiz et al. (2008) provide helpful examples, with a table of case examples and potential research questions that could be developed from them. Applying this structure, I then crafted research questions specific to my study area and case fire with explicit attention given to uncovering the roles of power at differing spatial and temporal scales.

Composition of emergent themes into results, as advised by Yin (2009), took place concurrently with the collection of interview data and carried on into the analysis stage. This process entailed a debrief or summary exercise after each interview in which interviews were discussed and documented with another investigator involved in the collection and analysis of this data—a process sometimes referred to as 'memoing' (Flick, 2002). Emergent themes in this document were also co-written by said colleague and myself. It was important to summarize what was heard after each interview to help internalize the information to improve future interviews as well as to provide an evolving document that provides a "chain of evidence" for later analysis (Yin, 2009). This iterative approach to interviewing and information gathering is critical to the formation of grounded theory, which is detailed in section II below (Charmaz, 2006). Once interviews were complete, this document summarizing important quotes, themes,

or areas of discussion aided in the formation of descriptive codes, a process which I will address

further in section V of this chapter.

II. *Grounded Theory*

Grounded theory, despite the name, is not a theory; rather, it is an approach concerned

with the iterative generation of theory from data that has been systematically collected and

analyzed (Bryman, 2015; Glaser & Strauss, 2017). There are several different applications of

grounded theory, and this research utilized constructivist grounded theory specifically. Charmaz

(2006) details the constructivist approach, stating: "[it] places priority on the phenomena of

study and sees both data and analysis as created from shared experiences and relationships

with participants." This understanding aligns well with the "chain of evidence" concept central

to a political ecology approach (Rocheleau, 2008). Furthermore, grounded theory stresses that

the co-productive nature of generating interview data is essential for accurate and transparent

analysis throughout the research process. Charmaz (1990) interprets reality as fundamentally

shaped by social interactions, and constructivist grounded theory incorporates this

understanding into the research process (Charmaz, 2006).

Constructivist grounded theory was chosen for this research due to its emphasis on the

engagement of the researcher in both data collection and analysis within case study

approaches (Charmaz, 2006). Grounded theory provided a much-needed guide for both

interpreting and incorporating what was being heard in interviews for future interviews and

analysis. This interpretation and incorporation relies heavily on the concept of emergent

themes (Charmaz, 2006). Emergent themes are generated through reflecting on and making

notes of interviews, both on their own and in relation to one another, while the interviewing

process is still ongoing (Charmaz, 2006). This concept is similar to other terms such as initial or

in vivo coding—however, this paper will simply refer to the byproducts of such a process as

emergent themes to avoid any misconceptions regarding coding methodology (Flick, 2002). The

term code refers to a unit of categorization for relevant sections across interviews (Saldaña,

2016). Themes emerge from the thoughtful reflection of codes—especially in relation to one

another(Saldaña, 2016). With both emergent theme and phenomenon emphases, grounded

theory is uniquely situated to address my research questions regarding power and its influence

on fire mitigation and suppression (Flick, 2002). Emphasizing the iterative process of creating

emergent themes helps ensure that conclusions reached are based on what was heard in

interviews, and that said conclusions can be retraced to their origin in the data (Flick, 2002; Yin,

2009).

Creation of emergent themes entailed a debrief after each interview. This debrief—or

memoing—was either conducted with a colleague when present or in a document where key

points of discussion were noted. Over time, summaries began to share commonalities,

important topics, or lines of discussion and were noted in the memo. New descriptive codes

and any associated potential themes were added to a section of the memo as interviews

progressed, ensuring that past data was being built upon and that new concepts were

identified so they may be addressed in upcoming interviews. Upon completion of the interview

process, the resulting memo informed the creation of the first descriptive codes for the analysis stage of this research, as is advised by Charmaz (2006).

III. *Qualitative Interview*

To best investigate the role of power in a phenomenon—wildfire in this instance—a qualitative interview approach to data collection was selected. Generally, this process entails the creation of dialogical data between researcher and interviewee (Bryman, 2015). An interviewing methodology that best suits the iterative nature of case study research as outlined by Yin (2009), my political ecology approach, and the creation of emergent themes necessitated by grounded theory is the semi-structured interview (Charmaz, 2006; Rocheleau, 2008). Semi-structured interviews require an interview protocol to be created; however, as opposed to structured interviews, the interview protocol serves primarily as a starting point for the creation of interview questions (Bryman, 2015; Charmaz, 2006). Once interviewing began and emergent themes were noted, I would compare the interview notes with the interview protocol to ensure that meaningful questions were being answered and that meaningful data that did not result directly from a question was noted to be incorporated into future interviews. It is for this reason that the semi-structured interviewing approach is best suited for this study, as it allows for revision of the interview protocol as well as deviation from the existing protocol to accommodate these changes (Bryman, 2015).

Once my interview methodology was selected, I conducted semi-structured interviews with actors involved with the Bighorn Fire. Forty-three interviews were conducted with 53 total participants with an average interview length of 65 minutes. Interview length varied from 30 to 170 minutes. Interviews were conducted both in-person and over the phone or video call. Each interview was recorded and transcribed verbatim following the three-week interview period— except for one respondent who declined to be recorded, in which case comprehensive notes were taken during the interview. A semi-structured interview approach was used to allow for a collaborative effort between interviewer and interviewee to explore power dynamics their implications as they related to the Bighorn Fire (Carspecken, 1996). My research questions were broken down into smaller thematic questions for the interview protocol (Carspecken, 1996). These were adjusted slightly to accommodate the background of the interviewee. Questions were formed in such a way that they were broad and approachable to minimize any perception of threat to the participant, which can diminish the quality of data collected in the interview (Raymond Gorden, 1992). Additionally, care was taken to ensure that the interview questions used language that was sensitive to interviewees' experiences with fire, which can often be traumatic experiences(To et al., 2021). During the interviews, probing questions were used to guide discussions stemming from interview protocol questions (Raymond Gorden, 1992). Development of the interview protocol entailed stratifying aspects of my three initial research questions into several overarching questions associated with different sections of the interview. These questions primarily focused on the networks of communication, actions, and governance trends in the study area. These themes were explored through participants'

experience of the wildfire over time to understand how the fire impacted or could be expected to impact these factors.

In addition to its suitability for a grounded theory case study, I have chosen the semi-structured interview approach due to its versatility both in application to various research topics and in interviewing individuals with different backgrounds (Galletta & Cross, 2013). Exploring nebulous topics as they arise in the interview will provide the nuance necessitated by my political ecology approach—especially regarding the role of power (Galletta & Cross, 2013). I chose an interview approach over a more quantitative approach for the same reason. I decided that semi-structured interviews would be the best methodology for my interviewing approach, as it allowed me to maintain my goal of creating a dialog surrounding individual perceptions (Galletta & Cross, 2013).

Each interview began with an explanation of the research purpose and the opportunity for the interviewee to ask any questions about the project or process; following this, the interview either started on a topic of particular interest to the interviewee or continued organically from the initial discussion of the research. This approach allowed the interviewee to construct a narrative containing what they feel are the most important points (Seidman, 2006). Using the semi-structured interview approach, I then asked broad, probing questions to explore relevant details further as they arose (Galletta & Cross, 2013; Seidman, 2006). Relevant detail is often produced and identified reflexively in a semi-structured interview (Galletta & Cross, 2013). Utilizing the memo document, I was able to contextualize the interview experience so that dialogical data was created and explored based on a shared sense of importance between myself and the interviewee (Galletta & Cross, 2013). Maintaining awareness of this approach

served an additional purpose of reaffirming the interviewee throughout the experience by

ensuring equal investment by both parties (Galletta & Cross, 2013). I have provided a final draft

of my interview protocol in the appendix. Each question was created with the goal of providing

a broad starting point for an exploration of key elements as they relate to my research

questions as is advised by Galletta & Cross (2013).

IV. *Selecting Participants*

Theoretical sampling was used for the initial recruitment of potential interviewees,

which entailed creating a list of organizations that were involved in mitigation, suppression, or

recovery efforts. Additionally, news media related to the Bighorn Fire was reviewed to aid in

identifying interviewees. Public residential documents, NGO, and government websites were

searched for residents and professionals that either had a role in the management of the fire or

a stake in its potential impacts. After this initial list of potential respondents was created from

these sources, further respondents were needed to comprehensively address the varying scales

and impacts involved in the Bighorn Fire. For this reason, an additional sampling approach

referred to as "snowball sampling" (also known as "chain referral") was used (Biernacki &

Waldorf, 1981; Lindlof & Taylor, 2010). Using this approach, a researcher finds additional willing

and relevant interview participants through referrals from initial points of contact (Biernacki &

Waldorf, 1981). Additionally, any individuals or groups mentioned in initial interviews provided

leads to additional respondents (Lindlof & Taylor, 2010).

Tentative participants were contacted a minimum of two times over the span of two weeks before being marked as uninterested in the interview roster. Upon making contact with an individual, I informed them of the goals of my study and verbally expressed Institutional Review Board (IRB) guidelines for identity protection to interested respondents. I preferred oral consent to interviews over other options such as written consent to minimize the amount of identifying information associated with each interview. For this reason, I filed an Appendix D: waiver of consent form as part of our IRB application—allowing for oral consent to participation and recording to be sufficient. To further protect the identity of participants, recordings were systematically named following the chronology of their occurrence (e.g., BHF_001). As a final step of protection, respondents' backgrounds were explained with generalized language and representative quotes chosen with careful attention paid to ensure the omittance of any information that could allude to a participants' identity. For instances where participants requested written consent for their own documentation, they were presented with a pre-approved written consent form following IRB guidance. The IRB number for this study is 1755548.

V. *Data Analysis*

Analysis of interview data entailed a methodology referred to as coding—a process of categorizing interview data (Bryman, 2015; R Gorden, 1998). Creation of these categories is necessarily iterative and was conducted concomitantly with debrief and reflection practices

that occurred after each interview (Saldaña, 2016). Not only does this process maintain and build upon the chain of evidence instrumental to the case study approach—but it also lends itself to a grounded theory approach (Charmaz, 2006; Saldaña, 2016; Yin, 2009). Both methodologies call for an iterative reflection and revision process throughout the interview process, allowing for themes identified in previous interviews to be incorporated into future interviews (Charmaz, 2006; Yin, 2009). Coupled with the semi-structured interview approach, this meant that new or emergent themes were incorporated into future interviews for further exploration (Bryman, 2015; Charmaz, 2006). Themes that persisted across multiple interviews were noted in the interview memo document. Exploration of these persistent themes in the following interviews would then serve to either stress or temper their importance relative to other themes (Bryman, 2015; Denzin & Lincoln, 2005). Upon completion of the interview stage, themes identified in this document became the first, rudimentary, iteration of descriptive codes (Bryman, 2015; Charmaz, 2006).

Following the interviewing stage, I applied these descriptive codes to an interview while allowing for the creation of new codes where relevant—a process commonly referred to as progressive falsification (Ellis et al., 1992). Analysis of this first interview entailed categorizing interview data into descriptive codes while also developing new codes to fit important data that did not fit preexisting categories (Ellis et al., 1992). Upon completion of this first analysis, codes and categorized sections of the interview were compared against that of a colleague who conducted the same process on the same interview. This was done to create intercoder reliability, ensuring that my chain of evidence was founded on correct analysis of interview data

as corroborated by a more experienced researcher that was present for a majority of the interviews (Bryman, 2015; Saldaña, 2016).

After this initial analysis, I continued to progress through transcripts of each interview in the qualitative analysis software *NVivo* using progressive falsification, applying existing codes where relevant, and creating new ones as needed (Ellis et al., 1992; Flick, 2002). As descriptive codes were progressively developed, parent codes that would contain a collection of related codes began to develop as well. These parent codes stressed actor networks, social-ecological impacts related to fire, adaptation strategies, community dynamics, climate change, and climate indicators. Serving two primary objectives, these parent codes both increased the organizational quality of data as it was being categorized and aided in the conceptualization of further thematic codes to be developed at the end of the descriptive coding cycle (Flick, 2002; Saldaña, 2016). Thematic codes were developed through analytic induction and thematic analysis following the chain of evidence created by documenting emergent themes as they were discovered (Boyatzis Richard, 1998; Flick, 2002). These emergent themes guided the results presented in the following chapters, alongside representative quotes selected for each theme (Boyatzis Richard, 1998).

Conclusion

In alignment with the nuance required by my political ecology approach, I utilized a semi-structured qualitative interview methodology. Guidance from case study and grounded

theory methodologies accompanied my interview approach, ensuring that the data collected

was useful and well documented (Andrade, 2009; Flick, 2002). My case study area was chosen

with criteria that would allow for discussions relevant to my research questions and exploration

of adaptation strategies in response to expected future climate impacts as they relate to

wildfire. Respondents were identified from residential or organizational websites, appearance

in news media related to the fire, and through a process referred to as 'snowball sampling'

(Biernacki & Waldorf, 1981). Snowball sampling entails finding new potential interviewees by

asking participants if they can recommend any other relevant participants (Biernacki & Waldorf,

1981; Lindlof & Taylor, 2010). Important concepts from interviews were noted and reflected

upon under advisement from my case study and grounded theory approach—a process

referred to as 'memoing' (Charmaz, 2006). Maintaining this document created a chain of

evidence for results drawn from interview data (Flick, 2002; Hafiz et al., 2008). Initial descriptive

codes were developed from reflection on interview notes in the memo document. These

descriptive codes are drawn directly from what is heard across interviews, providing

categorization for related sections from different interviews (Saldaña, 2016). Later reflection on

how these descriptive codes relate to each other informed the creation of emergent themes

(Charmaz, 2006).

CHAPTER FOUR

CASE STUDY

Introduction

This chapter will address my first two research questions:

1) what power asymmetries exist between actors affected by wildfire in the Tucson area?

2) what is the relationship between power asymmetries and management outcomes of the

Bighorn Fire?

The aim of these questions is to understand how power asymmetries affect response to

wildfire across diverse groups of actors impacted by the same fire. I begin by detailing the

results from my interview data generated through discussions prompted by my semi-structured

interview protocol as they relate to these two research questions. My discussion of these

results within historical and theoretical contexts will allow me to uncover a chain of

explanations for my two research questions (Rocheleau, 2008). This case study engages with

critical historical materialism, which seeks to understand how historical events and processes

inform contemporary organizations of places and social interpretations of places. Using this

understanding, this research applies further analysis utilizing concepts such as the production

of space (Lefebvre, 1991). Investigations utilizing these two approaches uncovered four points

in time that denoted a change in community composition on Mt. Lemmon. Further examination

of these different iterations of the community highlighted diverse values informing

management preferences among residents and professionals. Interrogation of these different

community compositions, values, and associated conflicts revealed both a shared love for the

Catalina Mountains as a landscape and contestation over how the mountains should be

reproduced as a space. Engaging spatial reproduction with critical considerations of power

yielded novel insights into environmental conflicts on and around Mt. Lemmon. Specifically,

the federal nature of the USFS, coupled with its majority land ownership has informed how the

Catalina Mountains are conceptualized within the community in terms of what actions are

possible.

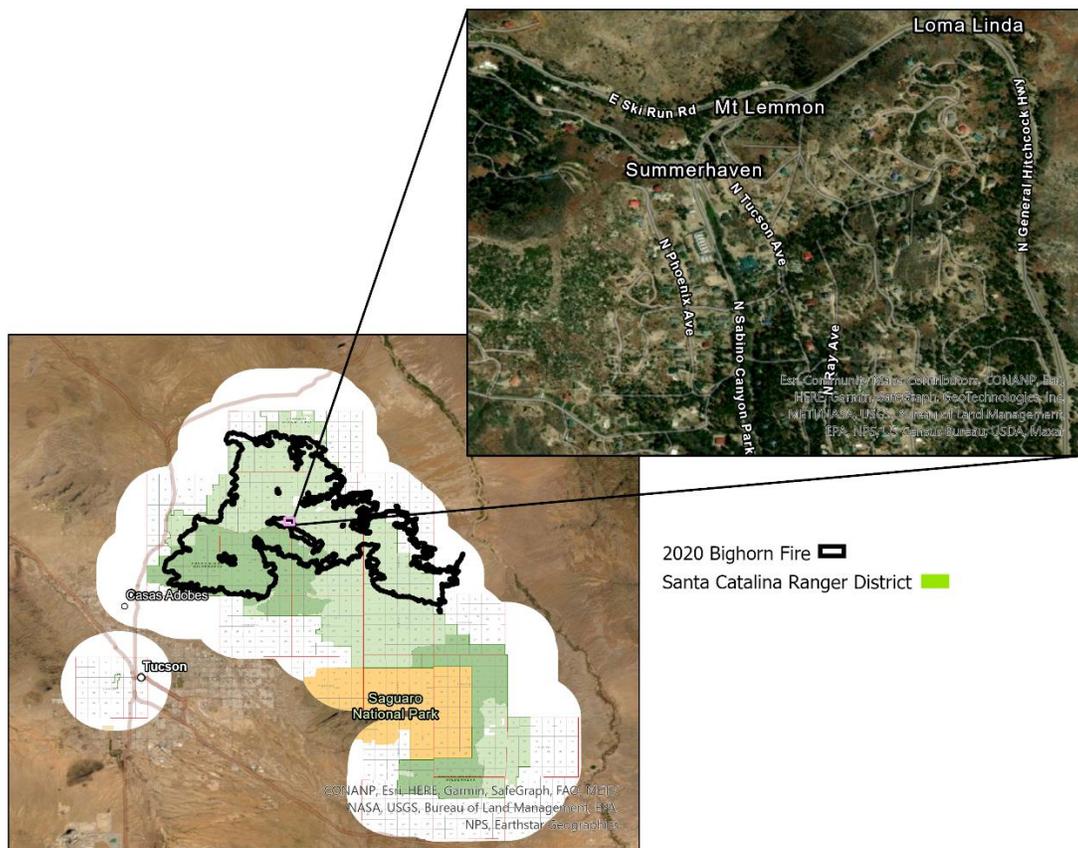## The Santa Catalina Ranger District in Reference to The Bighorn Fire

Figure 2. The Santa Catalina Ranger District in relation to the Bighorn Fire.

I. Results

I.I Historical contexts of community evolution and wildfire

Conversations with community members regarding their experiences with wildfire and relationships with the United States Forest Service (USFS) expanded beyond discussions of responses to the Bighorn Fire. Narratives tended to gravitate towards the successes and failures of past mitigation efforts as well as uncertainty pertaining to future efforts. Community perspectives of past fire mitigation and suppression activities were largely dependent on the interviewees' connection to place.

Residents on Mt. Lemmon identified four points in time or events that marked an evolution of the community. The first point in time was the attempted buyout of and subsequent land swap between Summerhaven and the USFS. This event is the earliest important event found in the dataset regarding what informed the relationship between Summerhaven and the USFS. The second event is the 2003 Aspen Fire, the impacts of which served to alter community dynamics on Mt. Lemmon significantly. Residents identified loss of housing, businesses, and subsequent reduction of Mt. Lemmon community members resulting from the Aspen Fire as the main reasons for the significance of this impact. The third time period denotes post-Aspen Fire recovery and is best characterized by community development of a collective action initiative known as 'Firewise.' The Bighorn Fire serves as the fourth and final event identified by residents to influence community evolution and relationships with the

USFS. Each of the four points identified represents a moment of evolution for the Mt. Lemmon community informed by changing populations, perspectives, histories, and values.

"People have a lot of different histories up here, and it's really, really interesting to see all the different histories and the remembrances."

-Resident

The first event creating a unique community composition on Mt. Lemmon identified by residents was the attempted buyout and eventual land exchange that took place in the 1970s. This event was identified as influential in community relationships with the USFS both initially and into the present day. This event entailed an initial attempt to buy out all of Mt. Lemmon, which was interpreted by the community as a message that they were a burden to the USFS. This sentiment was echoed by interviewees with varying lengths of residency on Mt. Lemmon— suggesting that residents that experienced this interaction have instilled historical distrust of the USFS into newer residents. Conversations pertaining to the land swap centered on the power differential between the community and the USFS and the perception of diverging values.

"I think, you look at it, Summerhaven is the bane of the Forest Service existence down here, right? They put a town in the middle of a mountain range, where if there's nothing here, you could just fire, do whatever you want to do, and do your natural thing. Because at one point, years ago, the Forest Service tried to buy all the property back."

-Resident

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Importantly, though the USFS did not end up buying all the private holdings on Mt. Lemmon, some lots were purchased. Residents noted that some of the purchased lots now effectively blocked access to other, remaining, private lots. This impediment required potential buyers or developers to purchase additional lots for access due to the topography of the area. Additionally, the mosaic nature of lot ownership created by this USFS land swap presents a contemporary challenge to collective action in the form of Firewise. Firewise is a national initiative that emphasizes community management of vegetation near structures to reduce the potential for fire spread. USFS lots present a challenge to this endeavor as they fall under federal management and its associated organizational limitations. Residents are unable to conduct Firewise activities on USFS land, and federal budgets are already strained by fire suppression efforts. Coupled with a small and aging full-time population, Firewise efforts on Mt. Lemmon face an uphill battle to succeed in the future.

The 2003 Aspen Fire marks the second key event identified by participants on Mt. Lemmon. Impacts of this fire strained the relationship between the USFS and the community and served as a pivotal moment for the Mt. Lemmon community. Due to the significance of impact from the Aspen Fire, residents that experienced it firsthand now use it as a benchmark and compare any new fires against it. This significance also delineates a pivotal moment in the overall dynamic of the Mt. Lemmon community resulting from changing populations and shifts in perspectives for remaining community members.

"You didn't hear people complaining about [the Bighorn Fire], the way that there was the really, really angry stuff after the Aspen Fire."

Significant loss of structures on Mt. Lemmon had diverse impacts on the community dynamics following the Aspen Fire. Loss of housing for community members and livelihoods on the mountain informed residential frustration, though the USFS was not the sole receptor of this frustration as interviewees also identified discontent with state and county entities. Following the Aspen Fire, many decided not to or were unable to rebuild, citing concerns of future fires, strict rules for rebuilding, and loss of place attachment. Loss of these community members restricted the ability of the community to negotiate with powerful actors such as the USFS as well as its ability to conduct independent mitigation efforts. These limitations would prove especially challenging as the remaining residents of Mt. Lemmon began to rebuild and reconceptualize the future of their community.

> *"Before the Aspen Fire, there were more people who lived up here. There are people who live up here now, but there's not that many of them. And there used to be people who would rent places up here, and they were the workers. After the Aspen Fire, all the workers' rentals got wiped out, so you couldn't get... It's hard to get people up here. That's why none of the businesses, or very few of the businesses, come back."*

-Resident

The third event encompasses post-Aspen Fire recovery and is best characterized by community development of a collective action initiative known as Firewise. Residents in this iteration of the community favor this form of collective action due to earlier perceptions of the community as an inconvenience for the USFS and the following devastation experienced by the

Aspen Fire. However, residents cite an aging population and lack of external support as some of the barriers to the successful implementation of Firewise. These two barriers result from impacts of the first two key events and compound over time. The aging of the population stems, in part, from the loss of community members following the Aspen Fire. Community perceptions of lack of external support were informed by the initial attempt at a buyout and later reinforced by the challenge USFS lots pose to Firewise efforts within the community.

> *"I am constantly trying to figure out ways to get people inspired with Firewise. I can tell you that we've had fires right here in town. One structure burned down, it wasn't Firewise, the other one, saved. That's the difference. I've seen it burn hard all the way around the house and not burn the house. They get somebody else that's... but it's not all everybody's fault. You get some elderly people out there, they just can't do it. They're old, and they got some disabilities, and they can't do that. The county and the state doesn't have anything requiring them, and they don't even have funds for somebody to come help them."*

-Resident

The fourth and most recent event is the Bighorn Fire. Due to intensive efforts to protect structures on Mt. Lemmon during the Bighorn Fire, none were lost. Such success at defending structures, especially given the impact of the Aspen Fire previously and the social significance of the Bighorn Fire, informed a more positive impression for those newer to the community in this iteration. Importantly, residents in this iteration faced mounting uncertainty stemming from climate change impacts on wildfire behavior and continued perception of divergence of values

between the community and the USFS. While residents of Mt. Lemmon reflected positively on the response to the Bighorn in comparison to the Aspen, many retained worry for the future of the community and Mt. Lemmon. Past challenges, conflicts, and understandings drawn from them remain influential in community discourses—especially pertaining to the future of wildfire and the community.

> *"The Bighorn didn't change our view as the Aspen did. So you learn that it's just a different fire. Different kind of fire. And we all know fire is beneficial, but again, back to the Aspen, in my opinion, we tried to get the Forest Service to help and do things. And again, there's just too many excuses, too much red tape."*
>
> -Resident

> *"Well, [The Bighorn Fire] didn't burn any cabins down last year. So, I think most of the landowners up there are pretty happy this time, where you sacrifice most of the mountain to keep that $6 or $7 billion in assets up there from burning down. Between all the comm sites, the observatories, and communications installations, and all the residents up there, it's been estimated at like $6 or $7 billion. $45 million's a drop in the bucket when you're trying to stop a fire from compromising a lot of those super high dollar places."*
>
> -Professional

I.II Values Influencing Management

Conversations regarding management priorities related to wildfire in the Coronado National Forest elicited strong responses from community members. In comparing sections of conversation relevant to this topic across interviews, several factors were identified as influential to how participants interpreted management actions and impacts to the social-ecological system of the Coronado National Forest. Influential factors can be generalized into the geography of residence, aesthetics, ecological concern, and economic priorities. Geography of residence separated community perspectives of management into two primary groups—those living on Mt. Lemmon and those living in Tucson. Generally, conversations with Mt. Lemmon residents were primarily concerned with careless visitors due to fears that they may cause ignitions. These concerns were often raised in relation to the high visitation rates of both Tucson residents and tourists, as well as the fact that the devastating Aspen Fire was a human-caused ignition. One poignant example of how residents identified this relationship came from an interviewee's reflection that Mt. Lemmon is featured on the front page of the Visit Tucson website. Further amplifying this tension, residents living on the mountain develop place-attachment, which results in the sense of responsibility for the biota present in the Catalina Mountains and the mountain range itself (Williams & Vaske, 2003). Residents that developed these strong attachments professed increasing concern as conversations flowed from localized to larger spatial scales and from shorter to longer temporal scales.

"Our biggest fears are, you know, the flatlanders coming up. If they would limit them coming up earlier. […] That's our biggest fear right now is the visitors coming up there. Luckily, we're not getting the dry lightning. The Bighorn was a dry lightning strike. Of

course, the Aspen fire was manmade, people smoking. And, you know, we've lived

through that."

<div align="right">-Resident</div>

"We, not only are we blessed to have this opportunity at but we are stewards of the

mountain because you can't own a mountain. It doesn't belong to any one person; it

belongs to everybody. And so, you know, my, my feeling is, we're there to keep it clean

because people are pretty messy. Keep it safe because people build fires, and they don't

put them out properly. But to ensure that everybody has a wonderful time when they

come up, and if we weren't there, it would be overrun with tourists. And our forest

service just doesn't have the budget to monitor and care for the volume of people we get

on the mountain. In 2019 we had 1.6 million vehicles drive up that mountain road."

<div align="right">-Resident</div>

"So you kind of have to say, "You're inviting a million and a half visitors up, but you don't

want to open the bathrooms, and you want to charge them $5 or 8 or whatever it is now

for them to stop and use the bathroom? And you don't expect there to be litter and fires

and all the other things? And, okay, you have an area that gets a million, million and a

half visitors, and you have one federal enforcement officer?"

<div align="right">-Resident</div>

In contrast, some participants residing in Tucson who value Mt. Lemmon for ecological,

aesthetic, and/or recreational purposes identified residents living on Mt. Lemmon as an

impediment to management. While residents both on and off the mountain may share these values, perspectives on managerial success to meet them and barriers to that success were informed by whether they lived on the mountain. Tucson residents perceived wildfire mitigation and response efforts on Mt. Lemmon as largely serving to protect structural values. Interviewees from this group stress that this prioritization has come at the expense of the overall character of the area. This sentiment was expressed in discussions regarding invasive species, conversion of flora and fauna composition, and the future of wildfire response in the area. Notable concerns regarding the predicted impacts of climate change in the Tucson area proved to be important in this group's conceptualization of current management and potential future actions. To this end, Tucson residents expressed frustration with prioritizing recreation and existing infrastructure over ecological factors such as forest health, drought resilience, and fire severity.

> *"But that's really the story. I mean, how do you have a town at the top of a forest, in the middle of a national forest mountain, and actually having a healthy bioecology. You can't. You always have to put that out. And so that's always the priority. But they let basically 70% of the mountain burn, but they saved those. Only one or two cabins burned. They worked so hard to save those, and there was... It was really interesting because we could just see at the very end it was becoming so embarrassing to them, this fire. They would just have to protect those picnic areas at all costs.*
>
> *And I thought, what about the forests? What about the real resource? Who gives a shit about a picnic bench?"*

Interviewees from both residential backgrounds expressed high valuation of the aesthetics and ecology of the mountain. Participants from both backgrounds emphasized the importance of tree presence on the mountain in particular. However, reasons for this emphasis ranged from aesthetics and economics to attachment to place or even specific biota. No single participant expressed values informed strictly by one perspective over another. Conversations regarding expectations for the future of Mt. Lemmon helped participants express their values and associated preferred actions to be undertaken in the area. Clarity lent by this framing stems from community expectations of climate-induced changes in the area, such as type conversion, loss of tourism and recreation, and cultural impacts associated with a change to an important shared landscape.

> Interviewer: "How many fires is it going to take for people to not want to go up there anymore?"

> Interviewee: "That's a great question. Yeah, who wants to go visit a tomb? People want to go to beautiful areas."

-NGO member

"That's kind of where I was at, where it's like, when this fire came through, it's like, I felt pretty sure that most of the houses were going to survive, if not all of them. But whatever's left will burn. And it's like, well what's the point, you know? The difference between being up here in the summer it's hot because you're in an exposed area versus

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covered in trees, and it's nice and cool. Who wants to be in an area where it just looks

like that, it's open, and it's hot?"

-Resident

Ecological concerns ranged from the impacts of fire retardant, type conversion, the spreading of fire to the non-fire-adapted desert via invasives in the Catalina Foothills, and the future of wildfire under climate change. Concerns pertaining to the ecology of Mt. Lemmon were evident across interviewee backgrounds. However, specific manifestations of and prioritizations informed by ecological concerns depended on the background of the participant. As an example, invasive grass species were a unifying concern due to their facilitation of increased fire spread and severity, whereas the impacts of fire retardants were primarily a concern of Tucson residents and not those residing on Mt. Lemmon. These concerns present another instance wherein the spatial and temporal scales at which impacts and solutions are discussed combine with participants' backgrounds to inform community values and associated managerial preference. Similarly, conversations with residents about their ecological concerns stressed the interconnectivity between the social and ecological. This was highlighted in reflections on the vulnerability of WUI communities to climate change and wildfire. This vulnerability was attributed to fire behavior exacerbated by climate change and the reliance of the Mt. Lemmon community on the economic influx provided by recreation and tourism industries.

"I would theorize that [fire retardant is] going to affect a shift in the microorganisms

present in the soil if there's a sudden explosion of phosphorus and knowing that

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Buffelgrass converts soil over time to microorganisms that are kind of catering to its

phosphorous needs. I could see that kind of species really thriving in these areas. So you

almost wonder if in trying to stop the fire via these fire retardants, you've created a

situation where you've now sown the seed proverbially for the next fire."

-NGO member

"But I think [this] scenario, I mean, it's replaying itself in every community in the West.

People live in an area surrounded by forest because they love it and the forest burns;

what do you do? You live amongst the ashes, or you pick up and move. If you have the

resources to move, then you do. So then, who's there? I look at towns in California that

burned up, and the people who are still living came here and people with no resources to

go anywhere. So again, climate change is significantly impacting vulnerable

communities."

-Resident

Economic concerns were identified by residents as a significant influence on

contemporary management in the area. Interviewees from multiple groups identified the

importance of 'Radio Ridge,' an area in The Catalina Mountains that hosts expensive and

important infrastructure from communication towers to research telescopes. The importance

of this ridge and the wildfire risk mitigation it necessitates was identified by participants from

residential and professional backgrounds. A commonality shared by these perspectives is that

Radio Ridge is a high priority for USFS planning relating to wildfire in The Catalina Mountains.

Residents on Mt. Lemmon identified another example of economic values influencing

management in the form of tourism and recreation. Mt. Lemmon residents point to high annual

visitation rates, abundant recreational opportunities on the mountain, and use of the mountain

in tourism marketing campaigns as evidence of economic influences on management in the

area. Residents often expressed a perception of inequality relating to these values citing their

responsibility to act as hosts to these visitors, economic benefits from tourism that are not

reinvested into the community, and limitations of the community to leverage these economic

benefits for their objectives.

> *"Yeah, [The Forest Service] does a lot of work around structures that are important to*
> *them, you know? Like radio towers. Where people have like millions upon millions of*
> *dollars."*

-Resident

> *"Radio ridge. You look at the U of A equipment up there. You have some... I don't know*
> *what the dollar amount is, but some very expensive stuff up there. That if some of those*
> *things go down, Pima County has no telephones, like their cell phone service. We're*
> *down, it's gone. So that radio ridge is critical infrastructure. So then, do you move the*
> *critical infrastructure? Well, guess what? For a lot of that stuff, you need a high point,*
> *right?"*

-Resident

I.III Structural and financial limitations to relationships with the United States Forest Service

Financial and agency structure limitations were identified across interviews as critical mediating factors in relationships with land management agencies. Limiting financial factors were diverse in reasonings and impacts. The funding an agency received and the prioritizations stipulated by said funding informed how agencies approached land management both in conceptualization and realized action. This limitation was identified by both residential and professional participants. Limitations on funding restricted staffing numbers and actions that could be taken by an agency. With small employee numbers, agencies were restricted in their ability to create and maintain community relationships and complete objectives. This limitation hints at broader, systemic factors influencing the ability of the USFS to mitigate fire risk. One example of these broader factors is the multiple-use management objectives of the USFS (United States Congress, 1996).

> *"Our deputies and our fire department, if they pull up on [an illegal campfire], they're not allowed to fine these people. The only people who are allowed to fine them is Forest Service law enforcement. And there's one or two of them for the whole Coronado District."*

> -Resident

> *"At one point, I asked the [agency] rangeland resource manager if they would ever contemplate reassessing livestock stocking rates. And the gentleman said, "[name], we don't get paid to manage the land. We get paid to generate revenue for the school trust." Which he was 100% honest.*

"[A]s you probably know in talking with especially federal agencies, they are absolutely

overworked and absolutely unable to get out on the ground to get stuff done. So, lack of

funding, not a whole lot of staff."

-NGO employee

Organizational limitations of agencies such as rigidity, staffing issues, and prioritization

of values informed both agency to community and interagency relationships. Residents

generally classified these issues as externalities—namely, congressional funding and oversight

regarding the USFS. Generally, these concerns were raised with sympathy for the local USFS

personnel and frustrations with the broader political and land management context,

particularly among NGO employees and other professionals. Interestingly, the source of USFS

power in the area (federal mandates and majority land ownership) also serves to hinder USFS's

ability to mobilize that power into realized actions. Associated federal policies, budget

limitations, and resulting reduced staff all lead to challenges to local management for diverse

community values. Interviewees reflecting on this aspect of the USFS expressed concern

regarding future efforts to mitigate wildfire risks due to expectations of increased fire spread

and severity in the future resulting from climate change.

"I don't think it's necessarily a bad thing for the Forest Service to be cautious in making

moves, but I do think that caution can turn to a real impediment as a result of changes in

political administration that create radical shifts in overall policy."

-NGO member

"Now, the fires are starting in March. So, when do you do the project work? Everybody's out fighting fires until December in California, or whatnot. It's just, when do we even do anything then? I don't know. You kind of wonder because it almost seems like it needs to be a different tactic, right? Other than suppression, doing something else, which is kind of what we're all talking about. But how do you even do that? Do you create a whole new federal system? Because you are going to have these guys that are basically being used up constantly by doing suppression, and then the amount of money that it would cost to go in and do the cleaning projects and all that."

-Resident

Underlying these conflict points was the importance of interactions between individuals of different groups with the USFS, which could either serve to build or reduce trust. Employees from NGOs identified building relationships with USFS employees to be pivotal to their ability to collaborate on projects that align with both organizations' goals. Employee turnover in the Coronado National Forest was noted to have a significant impact on the ability of other groups to form relationships and build trust. Interviewees identified the organizational structure of employee promotions and associated relocation in the USFS as a detriment to the formation and maintenance of important relationships. Elaborating on this point, interviewees highlighted the potential misalignment between the aspirations of a USFS District Ranger and the prominence of desert ecology in the Santa Catalina Ranger District. With relationships already strained by the aforementioned limitations, and the resulting increased importance of relationships with individuals, this aspect of the USFS structure provides another barrier to building rapport with the community.

"I think it's kind of the redheaded stepchild, the sky Islands. You get in the Forest Service. Who wants to come down into the desert, you know what I mean? And then everything's so spread out. I mean, we're lucky if you'll get some really good folks in, but you know, I get it. You want to promote and make more money and go to where you want to go, Montana, something like that. What Idaho? And so they'll come through, and they're here for two or three years. And, obviously, there's like these projects that are always in the works, but then these people keep trying to come in and have to like, "we're here in this project." Okay. And then you take it to this point and then, promote somewhere else, and someone else comes in."

-Resident

This barrier to USFS and community relationships was identified by participants often in relation to the USFS Santa Catalina district manager position. The Santa Catalina District encompasses approximately 265,000 acres in the Catalina Mountains, including critical areas such as the foothills that lead into Tucson and the entire area surrounding the town of Summerhaven. This specific geography funnels significant power and associated burdens of expectations to the Santa Catalina District Ranger position. This concentration of power and associated responsibility onto an individual position has led to large variation in the relationship between the USFS and other groups. Perhaps the best example of the nature of this relationship is the often-noted high turnover rate for the District Ranger position, which served as a point of frustration for residents and professionals alike. This frustration stemmed from the variability of management values held by community members for the area and USFS dominance in landownership without the financial and political means to manage for such a

diverse set of values. This barrier reinforces notions of systemic limitations to USFS as barriers to creating meaningful and lasting relationships with the community.

"I always joked when a new [District Ranger] came in because they always want a tour and stuff, and I'm like, 'You're going to stick around, right? So I don't have to explain this to the next person?' So, it's kind of a little bit of a joke, but it's just how it works. That's how the Forest Service... I think that's how they move up and move on. But, right now, it's a really good relationship."

-Professional

"I think as an agency [the USFS is] very organized. Their structure is very rigid, but it all comes down to relationships, I feel like. And that's a lot of what I think [agency] has done for decades, is worked hard to build those relationships. Even though there's a revolving door of employees, it's good for them to know that we have their back."

-NGO employee

"Yes. I think one of the frustrations is that whenever you're dealing with a large governmental entity, you see a change in staff. And so you, you know, I think the frustration is we develop a relationship of trust and integrity with someone, and then they're promoted, and someone else steps in, and you have to start all over again. But luckily, we've gotten a lot of things improved or approved. You know, and we still have the same staff. So that's a really good thing for us right now."

-Resident

"So typically, district rangers, you get them primed and prepped, and historically

situated, and you go, 'They're going to help us.' Boom, they're gone."

<div align="right">

-Resident

</div>

II. Discussion

The aim of this research is to understand how power asymmetries affect response to

wildfire across diverse groups of actors impacted by the same fire. A political ecological

framework necessitates further consideration of interview data presented in the results section

for such hidden themes to be understood. This section presents a discussion of results within

historical and theoretical contexts so that chains of explanations for my research questions may

be established (Rocheleau, 2008).

II.I Power Relations on Mt. Lemmon are (Re)produced Spatially and Temporally

Acknowledgment of USFS power in the area and the resultant need to compromise was

a frustration that served as a point of agreement between Mt. Lemmon residents. This

cohesion persisted despite changes in population and differing ideologies present in the

community. Residents of Mt. Lemmon share one important commonality as evident from

interview data—a love for the landscape. Following this commonality are deeply held concerns

and care for how the landscape is managed. Coupled with the fact that the USFS controls the

vast majority of the landscape on and around Mt. Lemmon, residents expressed further

cohesion in response to what can be explained as significant social and spatial power

differentials. In this way, place is conceptually transformed into space. The material reality of

Mt. Lemmon both informs and is informed by social interactions (Lefebvre, 1991). Perhaps the

best example of this dynamic is the fact that the USFS controls the majority of the land,

including the entirety of that which surrounds the town of Summerhaven. Social conceptions of

land management and the federal institutions created to meet said conceptions create the

source of USFS power on Mt. Lemmon. However, the same conceptions and processes that

allow for such power also serve to limit the ability of the USFS to exert the full extent of that

power on Mt. Lemmon in the form of policy prioritizations or organizational limitations. This

power differential and associated limitations were noted to support community cohesion and

even inspire action, as is evident from community enthusiasm regarding Firewise initiatives.

While community cohesion and power have been explored within neoliberal management

discourses, the interaction between community cohesion and power dynamics remains

understudied (MacLeavy, 2008). Given the noted importance of this dynamic in this study, I

argue that this framing is crucial for understanding how actors of differing social and spatial

power produce and reproduce a shared space (Lefebvre, 1991). Specifically for Mt. Lemmon,

this dynamic emboldens residents through their shared concern for the landscape and an

implicit awareness of the power and priorities of the USFS.

Throughout the evolution of the community on Mt. Lemmon, key events interwove with

dynamic relationships with the USFS. The history of the relationship between the USFS and the

community on Mt. Lemmon indicates a power asymmetry—stemming from USFS control over

The Coronado National Forest, which surrounds the town of Summerhaven. The earliest

example of the nature of this relationship is the 1970s land swap conflict, wherein the USFS

initially tried to purchase all private holdings on the mountain. For residents that experienced

this conflict firsthand, this experience informed their later interactions with the USFS, often in

the form of distrust. Residents understood the land swap as a sign that USFS and community

objectives were not the same. As this understanding was passed on to more recent residents

and mixed with later interactions with the USFS, the original source of the discontent may have

been diluted. However, understandings informed by the power imbalance and diverging

objectives noted in this interaction have only served to increase over time. Trust has been

identified as essential to social-ecologic conflict (Tenbrunsel, 1999). Lack of trust can have

discursive impacts on future conflicts, potentially compounding distrust (Tenbrunsel, 1999); for

example, tensions between residents and USFS around the Mt Lemmon land swap evolved into

questions regarding the validity of fire suppression strategies decades later. Actor-oriented

power perspectives aid in understanding the causes and impacts of this distrust at different

points in time (Svarstad et al., 2018).

Three factors are central to actor-oriented power perspectives, 1) intentionality: actors

exercise power to achieve particular objectives, 2) relationality: actions occur between two or

more actors, 3) causality: the ability of an action to produce an intended result (Svarstad et al.,

2018). The application of these factors to this case study allows for a nuanced discussion of

actors, their power, and how their interactions create and recreate the space of Mt. Lemmon

(Lefebvre, 1991; Svarstad et al., 2018). One clear example of actor-oriented power perspectives

was a shift in perceptions between fires; conflict emerged after the Aspen Fire as residents and local organizations raised concerns about a lack of proactivity around fire management, raising questions among some residents about the ability of the USFS to adequately manage fire in the area during the Bighorn Fire nearly two decades later. A consequence of this was a rapid spread of misinformation around fire management strategies. This theoretical lens aligns with calls from literature for the application of political ecology to environmental conflicts in more developed countries with an emphasis on power (McCarthy, 2005; Svarstad et al., 2018). It also highlights the role that actor-oriented power can have in the spread of information, misinformation, and dis-information during climate-driven hazard events. Characterization of these power dynamics in socially unique locales can play a critical role in managing information channels during processes condensed across time and space.

Communities on and off the mountain, as well as smaller agencies, all identify that the USFS holds the majority of power in the Catalina Mountains. This power results from being a federal agency and ownership of the majority of the land in the Catalina Mountains. The majority land ownership by the USFS in the area reproduces its power over time both on the landscape and in societal hegemonies of land management. USFS power reproduces the landscape through management activities, restrictions, and collaborations with other groups. Importantly, due to the significance of this power imbalance as well as the aforementioned organizational and financial limitations to the USFS in the area, collaborators must endeavor to contribute to the overarching goals of the USFS. With said limitations already restricting USFS efforts, any attempts at collaboration necessities some degree of alignment with USFS priorities for the area. Tenuous in its current form, this approach to collaboration is cause for concern

regarding future efforts due to expected increases in fire spread and severity under current climate predictions. Underlying this concern is a contestation of values between USFS and community values, which seems increasingly likely to diverge as fire conditions worsen. This discussion raises a more general question about communities that exist with the permission of an agency, namely, how much control a community can have over its identity and actions within such a context. In this way, the community on Mt. Lemmon can be considered to be part of the USFS reproduction of space, at least to some extent.

Use of a political ecology approach necessitates an important question—which and whose values are the Catalina Mountains being managed for? Mt. Lemmon residents conceptualize their community as a commodity to external forces like the USFS. Much of this discussion boiled down to "respect" over biocentric values versus anthropogenic worth. Residents connected with Mt Lemmon's landscape through emotional value, place attachment, and sense of place; the USFS did not demonstrate the same reverence for that landscape; as a result, trust was also strained. However, the USFS's mandate is to balance multiple uses with sustained yield on public land, leaving little opportunity for their values to mirror those of residents'. Put differently, the history of USFS control over the majority of the landscape serves as a notable catalyst for the social interactions and reflections that produce and reproduce space (Lefebvre, 1991; Robbins, 2012). The influence of this historical materialism was evident in the fact that wildfire and land management discussions predominantly focused on USFS actions and relationships. Mt. Lemmon residents' awareness of the power differential between themselves and the USFS served to galvanize the community, especially regarding the local wildfire risks.

The longstanding USFS claim on the landscape informed not only what actions can be

conducted but also conceptions of what the space of Mt. Lemmon is or should be; over time,

this influence on landscape discourses confines what is believed to be possible to actions that

do not disrupt existing power dynamics. This process reflects how historical power differentials,

their spatial materiality, and reflections on the two over time serve to produce space on Mt.

Lemmon. Future wildfire mitigation research may benefit from critical analysis of the historical

materialism informing the present moment of a given place. Using this understanding,

researchers can uncover the influence of power on the landscape and associated discourses.

Critical reflection on these dynamics may provide insights outside of existing discourses or

paradigms, as was seen in the community adoption of Firewise activities in response to USFS

spatial dominance in this study.

II.II A desire for collaboration without the means

A desire for increased collaboration was a sentiment expressed across interviews.

However, further exploration of the values of different actors uncovered a misalignment, which

proved to be a barrier to increased collaboration. Residential values were informed by the

extent of place attachment (and type, e.g., identity or dependency), risk perceptions,

ecological, aesthetic, and economic priorities (Williams & Vaske, 2003). While diverse in their

reasons, the community of Mt. Lemmon finds common ground for their actions through a

shared love of landscape and awareness of differing power and values between themselves and

the USFS. In contrast, the values of the USFS as an organization are restricted by federal policies

and budgets. The most important examples of these restrictions are limited staffing, high

turnover rates for important positions, and the federal nature of the USFS. These barriers to

cohesion between the Mt. Lemmon community and the USFS are important to consider within

the contexts of vulnerability and adaptation. The Mt. Lemmon Fire District is currently at its tax

income limit for the community, meaning it has reached its tax revenue maximum; in

conjunction, there is a predicted exacerbation of wildfire behavior and an associated increase in

strain on the USFS. These facts inform a concern for the future ability to mitigate, suppress, or

adapt to climate change and wildfire impacts. This understanding, while somewhat contingent

on context, is important for understanding the broader environmental changes and

accompanying decision making (McCool et al., 2006). Increasing insights into contemporary

management decisions responding to wildfire and climate change allowed for a critical

reflection on the costs and benefits of different actions at multiple spatial and temporal scales

(McCool et al., 2006). Exploring the values and power of the USFS and Mt. Lemmon residents

uncovered significant barriers to future collaboration that provide cause for concern in light of

predicted future climate and wildfire changes. Future studies conducting interviews with

diverse groups pertaining to land management may benefit from further exploring how the

values and power of different groups inform collaboration and, as a result, conceptualization of

what is feasible in terms of action.

Interviews with Tucson residents revealed variation between residential values based on

the primary location of participants. Tucson residents generally expressed a perspective of

current wildfire mitigation efforts on Mt. Lemmon as prioritizing the protection of structures in

suppression and the restoration of recreation areas in recovery efforts. However, participants from both residential backgrounds expressed place attachment informed by aesthetic values such as the abundance of trees. Interestingly, the aspects that make Mt. Lemmon such a desirable location for tourism, recreation, and ecological conservation also prove to limit agencies' investments in mitigating fire risk. The best example of this dynamic is the sky island characteristic of Mt. Lemmon. Providing cooler temperatures for Tucson residents and visitors to escape to, the rapid shift in elevation, temperature, and associated biota also creates long drives and difficult terrain for timber harvesting enterprises—making efforts to engage the private sector in fuel reduction tenuous at best. Emphasis on the economic benefits of Mt. Lemmon without similar investment in actions that protect ecology and community values allude to a limited social capital of Mt. Lemmon residents as well as scalar and temporal variations in community vulnerability (Bihari & Ryan, 2012; Simon & Dooling, 2013).

While the causes of these dynamics are undoubtedly variable in their sources and reasons, it is worth revisiting the USFS land-swap to understand how these dynamics are produced on Mt. Lemmon. Lots purchased by the USFS in and around the town of Summerhaven proved to be a barrier to increasing social capital within the community and trust between the community and the USFS. Purchased lots not only restricted the effectiveness of Firewise efforts on the mountain but also informed community distrust by exemplifying the existing power asymmetry and divergence in values. This understanding is still prevalent in the community and was reinforced at different stages of community evolution— providing another hurdle to future collaborative efforts to address wildfire, and climate change impacts locally (Bihari & Ryan, 2012; Tenbrunsel, 1999). Investigation of where community and

agency contentions originated detailed a story of Mt. Lemmon as a socially produced space,

wherein the values of different groups and their capability to act on those values are both

informed by the realities of place and reproduce space based on realized actions and reflections

on the implication of those actions (Massey, 2004). In light of this conceptualization, it is

important to consider cautions put forth by Barnes-Mauthe et al. (2015), which stress that

social capital can be mobilized for either meaningful interventions in management processes or

to reinforce existing prioritizations.

Critical analysis of social capital, trust, and power dynamics illuminates why previous

efforts to collaborate in the Catalina Mountains have had limited success or the groups are now

inactive. The majority of collaborative projects were required to meet USFS terms and

guidelines to be able to conduct any meaningful actions, meaning that any substantiative

actions to be taken on the mountain must first seek approval from the USFS. While USFS

restrictions often proved to hinder collaborative project objectives, the increased burden of

responsibility collaborative efforts placed on the limited USFS staff and finances all but ensured

that collaborative efforts could not meaningfully succeed. These barriers to collaboration locally

are informed by the historical materialism of the Catalina Mountains and the accompanying

space as it has currently been produced (Lefebvre, 1991; Neumann, 2009). What is meant by

this is that the federal nature of the USFS, coupled with its majority land ownership, has

informed how the Catalina Mountains are conceptualized within the community in terms of

what actions are possible. This finding is important to consider in relation to the challenges to

adaptive governance that have been identified in the relevant literature. In emphasizing the

differing values and power of actors relevant to this study, this research seeks to contribute to critical adaptive governance literature efforts. Future efforts to add to this emergent body of literature would benefit from a similar analysis of perceptions, values, social norms, and power differentials to uncover barriers to equitable adaptive governance (Adger et al., 2009; Nightingale, 2017).

It is worth noting that the power of the resources on Mt. Lemmon, such as the landscape, built environment, and other amenities that attract tourists, seem to be overlooked by actors locally. If the historical materiality of USFS land ownership and associated dominance of management discourses serve as a barrier to collaborative efforts and adaptive governance, then the power of these resources may provide a means of overcoming said barrier. The power in these resources is the economic and political importance of the landscape informed by community place attachment and tourism emphases from city and state levels. It is here that the production of space becomes useful once again. If USFS's influence on the production of the space in the Catalina Mountains is partially resultant of its disproportionate land ownership, then efforts to critically engage adaptive governance would benefit from efforts to counter-produce the space by leveraging the power of the resources and existing community cohesion (Lefebvre, 1991; Nightingale, 2017).

II.III Mitigating Fire Risk on Mt. Lemmon Faces Increasing Complexity

Barriers such as the misalignment of values between actors, distrust stemming from power differentials and associated limitations, and uncertainty regarding the extent of future climate change impacts on local ecology will be important to consider in the collective effort to mitigate and respond to fire risks on Mt. Lemmon. These barriers influence spatial reproduction through influences on discourse, sometimes resulting in an explicit delineation of what actions are possible and through the material reality of a place as it is influenced by associated social processes (Massey, 2004). In more practical terms, the processes that grant the USFS capability to own the majority of the land in the Catalina Mountains also restrict local actions and conceptualizations of solutions through policy, agency structure, finances, and discourse. Existing literature stresses the importance of trust and community cohesion in environmental conflicts and wildfire risk mitigation (Paveglio et al., 2017; Tenbrunsel, 1999). This section contributes a critical perspective of how these elements influence spatial production (Lefebvre, 1991).

Participants identified financial and organizational limitations of the USFS as barriers to trust and relationship building. This has resulted in frustrations for residents, who have the desire to conduct work on the landscape due to their attachments to it but do not feel enabled by the USFS to act. One important reason for this feeling is due to the necessity for mitigation actions to occur across the private lots of the communities on Mt. Lemmon and USFS lands. A significant collaborative effort would be required to attempt this effort meaningfully and would encounter equally significant challenges such as a conflict of values between the community and USFS and the accompanying social-spatial power imbalance. None of this is to say that collaboration between the community and the USFS is not present nor unlikely in the future.

Instead, what should be highlighted is the importance of this dynamic and how it informs the ability to conceptualize and act on possible solutions within the community. This finding aligns with broader wildfire literature that highlights the mounting infeasibility of restoring U.S. forests to historical conditions and reliance on thinning alone to mitigate fire risks (Fulé, 2008; Wilson et al., 2018). These two concepts are prevalent in management as well as relevant academic discourses and were prevalent in interviews for this study. As the viability of existing management approaches and goals becomes increasingly suspect due to current financial allocations and a growing body of research finding vegetation management alone to be insufficient for addressing fire risk, approaches will likely benefit from a more heterogenous engagement of community values (Paveglio & Edgeley, 2017; Ribot, 2011).

The current socio-spatial iteration of Mt. Lemmon as a space and its continuance is not inevitable. Rather, in conceiving space as a sum of the material reality and human interpretations of that reality, community members from diverse backgrounds can engage with and influence how space is produced—especially when acting towards a shared goal (Massey, 2004; Nicholls, 2009; Paveglio et al., 2017). Barriers to the reconceptualizing space can result from strictly demarcating the social from the ecological and limited consideration of the variable spatial and temporal scales that contemporary management entails. Interviews with community members uncovered a relatively short-term temporal scale and nebulous conceptions of relevant spatial scales for decision making. The impact of this dynamic is evident from the prevailing community prioritization of funding despite being unsustainable for addressing existing wildfire risks (McWethy et al., 2019; Wilson et al., 2018). While increases in funding may aid mitigation efforts, reliance on funding alone does little to address the

overarching misalignment of values and resulting management practices. Inquiring about

actors' values and preferred management actions for the future was essential to understanding

barriers to collaboration.

Related to sentiments of the inevitability of static power dynamics, some residents

reflected a belief that solutions may be impossible due to climate change. While the challenges

posed by climate change are serious, this discourse is again restricted by the current spatial

moment (Horne et al., 2021). Community actions and imaginations are informed by the limited

financial and organizational structures in which they originate; maintaining awareness of this

fact will allow for conceptualizations of solutions beyond existing paradigms. Specific to Mt.

Lemmon, residents were noted to often collect micro-scale observations by the fact of

residence and attachment to place that provide insights into environmental changes. This

knowledge is currently undervalued by powerful actors due to assumptions of superior

knowledge generation processes. Future efforts to mitigate climate change and wildfire impacts

would likely benefit from engaging with residential knowledge and taking their associated

diverse values seriously (T. Paveglio & Edgeley, 2017; Ribot, 2011; Steelman, 2007).

Conclusion

This case study sought to answer two research questions, what power asymmetries

existed between actors affected by wildfire in the Tucson area; and what is the relationship

between power asymmetries and management outcomes related to the Bighorn Fire? Analysis

of interview data utilizing my two research questions informed by political ecology yielded rich

insights into barriers to future governance efforts on and around Mt. Lemmon. Power dynamics

in the Catalina Mountains had diverse impacts on the production of Mt. Lemmon as a space.

The power differential between the community and the USFS manifests in similar spatial

asymmetry. Implicit assumptions regarding the inevitability of this power to reproduce space in

accordance with associated values proved to be a barrier to collaboration between groups.

However, community awareness of this power imbalance and its spatial manifestation served

as a point of cohesion for residents. Historical environmental conflicts such as the land swap

and Aspen Fire informed community perceptions of diverging values between the USFS and

their community. Compounding with the impacts of the observed power differentials, this

perception of diverging values both inspired collective action and was a source of trepidation

for community members. By engaging in dialogue with community members regarding their

values, current management practices, and expectations or desires for future actions, this study

uncovered important barriers to future governance efforts in the area. Primary barriers to

current and future management include: the misalignment between diverse community values

and current land management efforts; historical patterns of power asymmetries and their

spatial manifestations that inform community distrust; and the resulting limitations to

innovative solutions resulting from these two elements. This research adds to an emerging

body of literature concerned with power, community heterogeneity, and adaptation as it

relates to wildfire. A novel contribution of this study is the engagement of wildfire adaptation

and spatial production narrative in unison to better understand barriers to future efforts to

mitigate wildfire risk. Future case studies would benefit from similar critical engagements with

local geography to understand how power influences both discourse and resulting action in

relation to adaptive governance.

CHAPTER FIVE

(MANUSCRIPT) CHARISMATIC INDICATORS OF CLIMATE CHANGE

Abstract The increase in global frequency and scale of impactful and destructive wildfires has been linked to human-induced climate change, necessitating a greater understanding of how different populations measure and interpret local impacts. Identifying which ecological shifts on local landscapes may act as socially-interpreted "indicators" of climate change and why that change is salient to different groups can produce critical insights regarding factors that may motivate local adaptation and mitigation. Conversations around climate change are common in this area, as Tucson is situated at the intersection of drought, fire, and vegetation shifts, among other climate-driven changes. We conducted 43 semi-structured interviews with residents, professionals, and locals during the summer of 2021, gathering information regarding experiences with fire and other climate-affected processes, changes they had observed in their local environment, and mitigative or adaptive actions they were interested in pursuing. We found that specific biota became the focus of certain groups' interpretations of fire and climate change impacts – for example, some tracked climate change impacts based on saguaro health, spring presence, or extent of invasive buffelgrass. We characterize these as "charismatic indicators" that can be used to frame conversations about and motivate actions to address climate change among different groups (e.g., recreation groups, land managers, and residents, each focused on different indicators). These indicators were informed by the values of the designating group, each entrenched in a unique history and process of interactions with the

landscape and power dynamics between other groups, among other drivers. We conclude with guidance for identifying varying uses of charismatic indicators of climate change in future studies and suggest how to utilize this understanding in ongoing efforts to understand and address future uncertainty related to wildfire and climate change.

I. Introduction

This study aims to address my third and final research question regarding the extent to which actor dynamics related to the Bighorn Fire influenced future efforts to manage socio-ecological systems for fire in the Tucson area. The increase in global frequency and scale of devastating and destructive wildfires has been linked to human-caused climate change, necessitating a better understanding of how different populations measure and interpret local impacts. Identifying which ecological shifts on local landscapes may act as socially-interpreted "climate change indicators" and why that change is significant to different groups can provide crucial insights into factors that may motivate local adaptation and mitigation. Because Tucson is situated at the intersection of drought, fire, and vegetation shifts, among other climate-driven changes, discussions about climate change are common in this area.

During the summer of 2021, we conducted 43 semi-structured interviews with residents, professionals, and locals to gather information on their experiences with fire and

other climate-affected processes, changes they had seen in their own environment, and mitigation or adaptive measures they were interested in taking. Several groups tracked climate change impacts based on saguaro health, spring presence, or the extent of invasive buffelgrass, according to our findings. These indicators were influenced by the values of the designating group, each with its own history and process of interactions with the landscape as well as power dynamics between other groups, among other drivers.

The goal of this study was to understand how community and professional perspectives, values, and power influenced management outcomes after the Bighorn Fire. We discovered shared landscapes and the biota within them to be important points of emphasis for future efforts at collaboratively engaging in adaptive governance measures through conversations with diverse actors and critical analysis of interview data. This research builds on existing literature investigating the diversity of community values, power dynamics, and climate change adaptation Better understanding of these elements will allow for increased community cohesion and resulting collaboration in response to climate change impacts.

II. Literature Review

II.I Climate Change

Presently, the vast majority of climate scientists – up to 97 percent based on a recent study – contend that climate change, with accompanying elements such as increasing global average temperatures, presents an existential threat to life on Earth (Reusswig, 2013). Consequently, the discourse on climate change has quickly developed from acknowledging its presence to a determination of its causes and currently, settling on effective ways to mitigate impacts (Rosso Grossman, 2018). Some health risks are linked to extreme weather, such as smoke from wildfires, which can be exacerbated by increases in temperature and drought conditions resulting from climate change (Reid et al., 2016). For instance, in the summer of 2010, a heatwave engulfed Moscow, accompanied by a considerable increase in air pollution, and a spread of infectious diseases, which contributed to more than 11,000 additional deaths (Sternberg & Edwards, 2017). Furthermore, temperature-related increases in morbidity are linked to cardiovascular, respiratory, and kidney complications. In the United States, such complications resulting from heatwaves are now known to cause over 1,300 deaths annually (Sternberg & Edwards, 2017; The United States Environmental Protection Agency, 2021).

In addition to the health impacts associated with extreme weather events such as wildfire, an extensive body of research has continued to broaden the understanding of the effects of climate change on physical health. Climate change introduces new mental health challenges, especially for those who have experienced extreme weather events (Berry et al., 2009). With such variable impacts, climate change has been regarded as one of the greatest health threats of the 21st century (Berry et al., 2009). Existing literature on climate change provides a limited discussion of diverse actor perspectives of climate change impacts, mitigation efforts, and the values informing said perspectives (Siders, 2019).

This lack of consensus is partly due to the uncertainty of the course that climate change

will take in the years to come and whether current management efforts will be able to

adequately respond to future climate change effects (Horne et al., 2021). Increases in global

average temperatures and extended droughts resulting from climate change have been shown

to have a significant impact on wildfire behavior, with a predicted future variability from

historic fire behavior ranging anywhere from 33 to 62 percent (Abatzoglou et al., 2019). Key

knowledge gaps remain pertaining to understanding the future impacts of wildfire and climate

change on forested environments (Nolan et al., 2021). In applying this uncertainty to forest

management, Fulé (2008) concludes that while management efforts will benefit from

considering other metrics of success, historical conditions are likely to provide useful insights

for future efforts to respond to climate change, vegetation shifts, and wildfires.

II.II Climate Change Perspectives and Actions

Research investigating climate change perspectives utilizing a social-ecological

understanding stresses the importance of place and proximity to climate change impacts

(Sloggy et al., 2021; Zanocco et al., 2018). Attachment to place and close proximity to climate

change impacts on a place were found to have the potential for creating an experience with

enough salience to inspire action (Sloggy et al., 2021). However, this potential requires further

study, especially with unknowns stemming from varying spatial and temporal contexts of

impacts and perceptions of them (Zanocco et al., 2018). While there is a consensus in the

literature that extreme weather events may serve as a catalyst for changes in community

perspectives, there remains uncertainty regarding the extent to which these events can be

leveraged for action (Zanocco et al., 2018). Future research would benefit from investigating

the spatial and temporal scales different actors use to conceptualize climate change impacts

and how these factors inform local discourses and actions (Sloggy et al., 2021; Zanocco et al.,

2018).

Extreme weather events such as wildfires have often been explored as potential

catalysts for changes in land management discourses and actions (Birkland, 2016; Mockrin et

al., 2018; Wilson et al., 2018). Climate change impacts on extreme weather events have served

to increase interest in the potential for changing natural disaster narratives from reactionary to

proactive (Birkland, 2016; Ojewola et al., 2021). Specific to wildfire, Mockrin et al. (2018) found

that community experiences of wildfire impacts were at once crucial for changes to wildfire and

climate change discourses and insufficient for encouraging lasting changes when

overemphasized. Elements such as actor values, power, and the spatial manifestations of these

dynamics must be critically considered alongside impactful events for significant and lasting

interventions to occur (Mockrin et al., 2018; Wilson et al., 2018).

More general to natural disasters, Birkland (2016) found that social interpretations of

disasters and their relationship with management discourse and activities create a dynamic

where salient disasters cause federal management agencies to assume a defensive role post-

disaster. Through this finding, Birkland (2016) cautions that salient extreme weather or other

natural disasters are more likely to reinforce existing federal responses that are usually

reactionary and concerned with restoring spaces to pre-disaster conditions. This reactionary

emphasis promotes a positive feedback loop, wherein management efforts must constantly respond to disaster impacts without enacting changes that may reduce the impacts of future events (Birkland, 2016). Essentially, this process encourages conceptual and physical reproductions of space agnostic of natural disasters (Birkland, 2016; Lefebvre, 1991). The resulting decrease in saliency serves as a step in this positive feedback loop, reinforcing reactionary management practices (Birkland, 2016).

Translating community awareness of climate change impacts into actions has been a topic of interest for contemporary studies incorporating social aspects into climate change research. Ballantyne (2018) found visualization to be instrumental in the saliency of climate change impacts. The author elaborates on elements of visualization that increase salience, stating, "participants emphasized visual representations they felt made complex aspects of climate change visible, clarified connections, provided an overview, or made climate change tangible" (Ballantyne, 2018). The elements that allow visualization to resonate with community members are interesting to consider in relation to the literature exploring climate change action-awareness gaps. For example, Budolfson (2021) calls for increased awareness and translation of climate change impacts encountered by diverse actors in their daily lives. Combining the salience of visualization with efforts to understand community perceptions of climate change impacts may facilitate clearer communication among diverse actors—especially between actors operating at different scales (Ballantyne, 2018; Budolfson, 2021).

Rodrigo-Alsina (2019) found actor response to climate change impacts to be a product of previous encounters with impacts and awareness of climate change influences on said impacts. Building on this notion, Sailesh & John (2018) investigate how awareness does or does

not result in actions. Efforts to translate awareness of climate change impacts into actions have

utilized varied approaches such as raising awareness, creating fear, moralizing, and strategic

provisioning of information (Sailesh & John, 2018). These efforts have primarily been employed

by powerful actors to garner community support for management initiatives (Sailesh & John,

2018; Svarstad et al., 2018). This framing poses a challenge for efforts to more meaningfully

engage diverse actors in actions responding to climate change impacts. Considerations of

power and its propensity for coercive or controlling approaches are important for future efforts

to bridge the action-awareness gap (Sailesh & John, 2018; Tenbrunsel, 1999). Efforts to critically

analyze impediments to community action would also benefit from exploring actor perceptions

of climate change impacts on ways of living and livelihoods connected to a specific landscape

(Pickson & He, 2021). However, historical processes utilized by powerful actors, as detailed

above, necessitate caution to ensure that insights gained from such an analysis would not serve

narratives of coercion or control (Pickson & He, 2021; Tenbrunsel, 1999).

Recent literature examining the relationship between place attachment and climate

change suggests that attachments to place can inspire action or impede adaptation depending

on the local context and adaptive measures being considered (Devine-Wright & Quinn, 2020;

Singh et al., 2020). The differing emotional attachments of actors to a shared place may serve

as a point of cohesion, providing an opportunity to galvanize support for a given action or

actions (Bihari & Ryan, 2012; Devine-Wright & Quinn, 2020; Prior & Eriksen, 2013). However,

similar attachments to place may cause some actors to be resistant to climate change adaption

efforts if they threaten the values informing attachments (Singh et al., 2020). An example of a

proposed climate change adaptation that would likely meet resistance informed by place

attachment is the concept of adaptive release or similar concepts such as climate change-induced relocation (DeSilvey et al., 2021; Singh et al., 2020). Future efforts to adapt to climate change will likely need to navigate the complex relationship between place attachment and future uncertainty regarding climate change impacts (DeSilvey et al., 2021).

Gemenne & Blocher (2017) explore migration in the context of climate change adaptation and highlight its potential for either adaptive or maladaptive outcomes depending on the contexts of implementation. Elements influencing the success of migration as an adaptive measure include considering the environmental, cultural, and economic impacts migration would have at both departure and destination locations (Gemenne & Blocher, 2017). Proactive as opposed to reactive implementation of adaptive migration was also found to inform the success of outcomes, with proactive implementation more likely to yield positive outcomes (Gemenne & Blocher, 2017). This preference is largely informed by perceptions of future uncertainty resulting from climate change (Gemenne & Blocher, 2017; George & Athira, 2020). Tarek et al. (2021) provide a contemporary example of climate change uncertainty in their findings that regional temperatures and rain patterns provide notable uncertainties for efforts to model future stream flows. Climate change uncertainties such as this are important to consider for efforts to enact a concerted and collective response to predicted or actualized impacts (George & Athira, 2020). Uncertainty can fragment community expectations and actions, presenting another and distinctly social complexity to climate change adaptation efforts (George & Athira, 2020).

II.III Adaptation

Petersen et al. (2018) argue for a more nuanced interpretation of adaptive capacity by: explicitly incorporating ecosystem traits that affect the sensitivity of the natural system; acknowledging that some useful actions may only be weakly related to system sensitivity; emphasizing a need for greater social adaptive capacity overlapping different spatial scales; and by stressing the pivotal step wherein, relevant actors convene to make decisions regarding the system. This reframing also stresses awareness of all possible adaptation actions—not just actions that stem from vulnerability assessments, which lends itself to a critical examination of the decision-making process as a whole (Petersen et al., 2018). Failure to critically incorporate considerations of power allows for the appropriation of adaptive governance (Van Assche et al., 2017). As a key term in contemporary land management literature and in light of the critiques offered, the authors argue that "If NRM wants to be adaptive governance, it thus needs to rest on a detailed analysis of interplays between power/knowledge in the narrow sense, and of how power in its other forms influences discourse." (Van Assche et al., 2017).

A similar argument is made about the term adaptation by Nightingale (2017), who states, "[P]ower [is] constitutive of adaptation rather than an externality that requires post-implementation management." Nightingale (2017) conceptualizes adaptation programs as realigning power-knowledge paradigms through struggles over authority. In opposition to reducing this process to the term adaptive capacity as a term alone, the author argues that the unpredictability and complexity of management outcomes must be taken into account. Adaptation is often invoked in contemporary climate change narratives in calls for shifts in management paradigms and associated actions. However, attempts to enact this shift should

take existing critiques of adaptation into consideration when implementing programs under the term. The importance of these factors is informed by the concerns regarding dominant narratives that adaptation will be easy to implement (Adger & Barnett, 2009). To address these concerns, the authors argue that metrics informing adaptation and measurements of its success should only be understood within the specific social context in which adaptation is occurring (Adger & Barnett, 2009).

Equally important, the values and power of actors involved in adaption influence associated discourses and implementations (Adger et al., 2005). The authors reflect on these influences on scales of adaptations stating, "Understanding adaptation, therefore, requires consideration not only of different scales of human action but also of the social construction of appropriate scales by institutions to further their own aims" (Adger et al., 2005). Consideration of social dynamics of the implementation of adaptation at different scales entails considering the potential spatial and temporal externalities that could result from adaptation actions (Adger et al., 2005). Other authors argue for an emphasis on vulnerability over adaptation for transformative goals seeking to address climate change impacts (Ribot, 2011). Importantly, even articles that critique adaptation to this degree acknowledge its value as a preexisting term and its compatibility with risk-focused efforts to address vulnerability (Ribot, 2011).

II.IV Place Attachment

Individual attachments to place are often explored using concepts such as a sense of community, community cohesion, individual values, risk awareness, and the specifics of place (Anton & Lawrence, 2016; Bihari & Ryan, 2012; Devisscher et al., 2016; Faas et al., 2017). To measure these concepts, one study compared the response of WUI residents to fire risk against their homeownership status, income, education level, and residency length (Anton & Lawrence, 2016). They found that place attachment, as they defined it, had a positive relationship with greater mitigation effort from individuals—but only in rural areas (Anton & Lawrence, 2016). Residents in the WUI may not undertake mitigation actions such as vegetation removal around the home for: aesthetic reasons (Paraskevopoulou et al., 2019), lack of risk awareness (Labossière & Mcgee 2017), as well as values influenced by gender, politics, ecological concerns, and economics (Hansen & Naughton, 2013; Kooistra & Hall, 2014). Place attachment in forested landscapes has been noted to be linked to higher sensitivity to resource impacts and a perceived lack of substitutes (Williams & Vaske, 2003; Young et al., 1990). Residents living in or near forested landscapes face a potential future of compounding distress, first from awareness of contemporary and predicted environmental change, and second from the resulting irrevocable sense of loss when such changes are actualized (Albrecht et al., 2007; Williams & Vaske, 2003).

II.V Community Dynamics and Wildfire Risk

Investigations of community decision-making related to wildfire risks employed heterogeneous understandings of actor values, power, and spatial-temporal scales (McCool et

al., 2006; Paveglio et al., 2017; Paveglio & Edgeley, 2017). The authors emphasize the importance of ensuring some degree of generalizability when investigating wildfire impacts on communities at varying spatial and temporal scales (McCool et al., 2006). The authors promote generalizability by framing their understanding of impacts associated with fire decisions in terms of community consequences, responses, and adaptations (McCool et al., 2006). McCool et al. (2006) posit several lingering questions for future research seeking to utilize a similar framework: what criteria are and should be used to measure fire decisions; how can a comparative analysis of the cost of preparation versus losses incurred from fire be conducted; how do the spatial and temporal scales of investigations influence data collection and analysis; and how can fire decisions and consequences be measured and integrated at multiple scales? Implementation of this understanding could emphasize commonalities that may help inform future efforts to understand community dynamics with more nuance. Paveglio et al. (2017) argue for the importance of geography, both in relation to place attachment and in its material impacts on community dynamics.

Paveglio et al. (2017) present an important finding that social capital understandings related to community dynamics and wildfire risk often assume existing cohesion in communities will facilitate actions. Rather than the expansion of WUI communities being the primary driver of changes to WUI community dynamics, the authors argue for a more dialectical (e.g., relational) understanding of social and ecological factors informing WUI community composition (Paveglio et al., 2017). Paveglio & Edgeley (2017) provide some specific examples of these factors, such as the presence of community organizations; localized ability to reduce fire risk; average residency time; and the means of communication (e.g., formalized or

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informal). Focusing efforts to understand WUI community heterogeneity on these aspects will likely allow for further nuance in discussions pertaining to community dynamics and wildfire risks.

Studies aiming better to understand wildfire mitigation through heterogeneous understandings of communities revealed barriers to adaptive actions in the form of narrow framings of wildfire impacts in terms of risk-benefits analysis alone and irregular spatial patterns of landownership composition (Paveglio et al., 2017). Generalizations of community wildfire adaptation to the degree of risk-benefits analysis mix with challenges detailed above to create limitations to community perceptions of what mitigative actions are feasible (Paveglio et al., 2017). Social and spatial stratification within WUI communities presents a complex but necessary consideration for future efforts to implement adaptive measures to wildfire risk.

Finally, reflections on contemporary efforts to address wildfire risk in WUI communities have explored what is politically possible (Wilson et al., 2018). In light of this finding, the authors argue that the social or political realities of WUI communities may be better suited for adaptation efforts by utilizing a social-ecological understanding as a foundation (Wilson et al., 2018). In practical terms, research seeking to explore possible community adaptations to wildfire risk would benefit from prioritizing wildfire treatments on broader criteria (e.g., risk reduction, cultural values, and overall landscape health) (Wilson et al., 2018). These broader criteria should be examined within the specific contexts of the values held by people residing in or relying on the landscape so that understandings of how these efforts translate between localities can be formed (Wilson et al., 2018). Future research would benefit from exploring

heterogeneous actor values and how that influences what is politically possible in terms of

regional wildfire risk mitigation (Wilson et al., 2018).

II.VI Climate Change Indicators

Contemporary land management discourses often rely on various indicators to inform

management plan creation and to gauge said programs' success. Conceptualizations and

applications of indicators vary depending on the associated discipline. For instance, Biesbroek

et al. (2013) argue for the creation of indicators that allow for the systematic identification of

barriers to adaptation. In contrast, research with a more ecological focus use indicators to refer

to biotic changes that can inform measurements of climate change impacts (Singh & Kushwaha,

2016; Zeppilli et al., 2015). Examples of ecological indicators from the literature include

meiofauna, deciduousness in tropical trees, and lightning activity (Reeve & Toumi, 1999; Singh

& Kushwaha, 2016; Zeppilli et al., 2015).

Literature investigating the social dynamics of adaptive governance cautions against

reliance on indicators to conceptualize vulnerability without a broader context of what makes

them indicators and what can be done about impacts (Adger et al., 2009; Ribot, 2011). Adger et

al. (2005) delineate two key indicators of successful adaptation actions, robustness to

uncertainty or the ability to change with emergent circumstances. Incorporating a social-

ecological perspective on climate change indicators, Nguyen et al. (2016) argue that climate

change vulnerability assessments would benefit from indicator-based vulnerability

assessments. This type of assessment may enable consistent methodology for comparison

between sites, or metrics may be developed that are site-specific to aid in more localized

efforts aimed at mitigating climate change vulnerability (Nguyen et al., 2016)—supporting this

claim, Horne et al. (2021) call for more research of risk-related decision making in climate

change adaptation efforts due to concerns regarding uncertainty. Research seeking to address

these elements must also maintain an awareness of the equally likely potential for

maladaptation informed by climate change uncertainty (Horne et al., 2021).

Publications arguing for more critical implementations of climate change adaptation

methods reiterate the importance of understanding personals experiences, perceptions, and

expectations as ways to bridge action-awareness gaps (Horne et al., 2021). Similarly, Adger et

al. (2009) find that the diversity of actor values points to a need to identify implicit or hidden

values and interests for meaningful adaptation to occur. Topics of locality, place, and cultural

icons are denoted as useful starting points for investigations of these implicit or hidden values

(Adger et al., 2009). To this end, Engle et al. (2014) argue for the development of a strong

indicator and monitoring program to inform climate change response. Three points of emphasis

for such a program include: conducting pilot indicator studies that result in a toolkit of cases

and examples to inform future studies; evaluating differentiated perceptions of indicators; and

the utilization of social-ecological climate change indicators for comparative analyses of

adaptation efforts (Engle et al., 2014).

Literature investigating indicators in the context of adaptive capacity found them to be

useful for understanding local contexts and communication across diverse groups or scales

(Adger et al., 2004; Wall & Marzall, 2006). Adger et al. (2004) characterize indicators as

increasingly vital to policy discourses and implementation. Through this framing, the authors

offer a critique of indicator-based assessments with the hope of incorporating more nuance into their implementation (Adger et al., 2004). Development of indicator-based approaches to better account for vulnerability and allow for generalizability beyond local contexts requires critical examination of the social, economic, political, geographic, and environmental contexts (Adger et al., 2004). Additionally, Wall & Marzall (2006) state that while indicators cannot be exactly replicated across local contexts, frameworks of identifying and utilizing climate change indicators for different groups are likely to prove useful for future studies investigating community heterogeneity in relation to climate change impacts. Importantly, further development of indicator frameworks will allow for an increased understanding of community values and how they influence preferred adaptive measures (Wall & Marzall, 2006). Applying indicator frameworks to specific local contexts is likely to allow for increased relevance to communication efforts regarding climate change impacts and responses (Wall & Marzall, 2006). Future development of indicator frameworks would benefit from critically engaging with local social-ecological contexts and investigations of salient indicators for different groups (Adger et al., 2004; Wall & Marzall, 2006). Investigations of the drivers of indicator salience and resulting adaptation preferences for different groups will aid in the development of indicator frameworks and reveal insights into community values and vulnerabilities (Adger et al., 2004; Wall & Marzall, 2006).

III. Methodology

III.I Site selection and description

I began the process of site selection by conducting a search of wildfires that had

impacted human populations in the state of Arizona during 2020. This timeframe was chosen to

ensure that participants could recall specific actions taken and decisions made during the fire

event while allowing for enough time to have passed to allow for recovery and reflection post-

fire. Additional search criteria included: the proximity of the fire to structures, the presence of

unique geographic and ecological influences, social prominence of the fire, the potential

climate vulnerability of the study area, and a history of fire in the area. These criteria ensured

that there would be a substantial group of potential interview participants that had previous

experience with fire in the study area and that the area would be likely to experience future

wildfires. Search parameters as outlined above follow existing criteria utilized in other wildfire

impact research (T. Paveglio & Edgeley, 2017). Criteria of potential wildfires were collected

from a variety of agency sources (Incident Information System fire reports, United States Forest

Service reports) and existing media coverage of wildfire events. I continued to narrow my

search with considerations for actor diversity for both residential and professional groups

involved with or affected by the fire event.

I chose the Bighorn Fire for my case study for several reasons, including community

awareness of the fire, controlled management of the fire away from the town of

Summerhaven, variability across five ecozones from lower Sonora to mixed conifer, the

potential for future climate stress for the Tucson area, and history of fires in the Coronado

National Forest, such as the destructive 2003 Aspen Fire (*Explore Mt. Lemmon's Life Zones Near*

Tucson, 2016). Criteria informing a search for an appropriate wildfire, as detailed above, were

delineated for their likelihood to produce the conditions necessary to apply my research

questions examining the role of power in wildfire adaptation under climate change stress.

Tucson, the second-hottest city in the U.S., is at the forefront of climate change impacts

(Lakhani, 2020). Ecological variability found in Tucson and the surrounding Catalina Mountains

allows for an intersection of diverse impacts to be recognized by community members and

professionals. The Catalina Mountains, located on the North-eastern outskirts of Tucson,

contain unique ecologies due to the rapid change in elevation from the desert ecology of

Tucson up to the tops of the mountains. In fact, the ecological change is significant enough to

designate these mountain tops as 'sky islands' (*Explore Mt. Lemmon's Life Zones Near Tucson*,

2016). This geography, combined with the existence of the Catalina Highway, allows residents

and visitors to quickly travel through an abundance of ecosystems. From the base of Mt.

Lemmon to the top, the drive takes about an hour and takes you through five ecozones (*Explore*

Mt. Lemmon's Life Zones Near Tucson, 2016). With abundant recreation options present on Mt.

Lemmon, residents and visitors alike enjoy spending time on the mountain. These factors

indicated variable ecology, diverse actors, strong place attachments, and the sensitivity of

Tucson to climate change impacts.

On June 5th, 2020, at 10:22 PM in the Catalina Mountains near Tucson, Arizona, a

lightning strike ignited a fire on Bighorn Mountain (InciWeb, 2020). It wouldn't be until 48 days

later, on July 23rd, 2020, that the aptly named Bighorn Fire would be declared 100% contained

(InciWeb, 2020). Prior to its containment, the Bighorn Fire burned approximately 119,978 acres

necessitating the response of over 900 personnel, including 20 hand crews, 64 engines, 18

water tenders, six bulldozers, and seven helicopters (Gabbert, 2020; Tucson, 2020). The fire

threatened around 850 homes and resulted in costs estimated from $37 to over $40 million

(Holcombe & Sutton, 2020; Steinberg, 2020; Tucson, 2020). Vegetation recovery efforts were

limited by minimal summer monsoon rains following the suppression of the Bighorn Fire.

III.II Data Collection

The authors traveled to the Catalina Foothills in the summer of 2021 to conduct semi-

structured interviews. They obtained approval for their research from a University Institutional

Review Board prior to reaching out to potential participants. The authors spent 14 days

interviewing actors involved in or affected by the Bighorn Fire, with additional phone or video

interviews conducted outside of this two-week period. In total, the authors conducted 43

interviews with 53 total participants and an average interview length of 65 minutes.

We used theoretical sampling for the initial recruitment of potential interviewees, which

entailed creating a list of organizations that were involved in mitigation, suppression, or

recovery efforts. Additionally, news media related to the Bighorn Fire was reviewed to aid in

identifying interviewees. Public residential documents, NGO, and government websites were

searched for residents and professionals that either had a role in the management of the fire or

a stake in its potential impacts. After this initial list of potential respondents was created from

these sources, further respondents were needed to comprehensively address the varying scales

and impacts involved in the Bighorn Fire. For this reason, an additional sampling approach

referred to as "snowball sampling" (also known as "chain referral") was used (Biernacki &

Waldorf, 1981; Lindlof & Taylor, 2010). Using this approach, a researcher finds additional willing and relevant interview participants through referrals from initial points of contact (Biernacki & Waldorf, 1981). Additionally, any individuals or groups mentioned in initial interviews provided leads to additional respondents (Lindlof & Taylor, 2010).

Tentative participants were contacted a minimum of two times over the span of two weeks before being marked as uninterested in the interview roster. Upon making contact with an individual, I informed them of the goals of my study and verbally expressed Institutional Review Board (IRB) guidelines for identity protection to interested respondents. I preferred oral consent to interviews over other options such as written consent to minimize the amount of identifying information associated with each interview. For this reason, I filed an Appendix D: waiver of consent form as part of our IRB application—allowing for oral consent to participation and recording to be sufficient. To further protect the identity of participants, recordings were systematically named following the chronology of their occurrence (e.g., BHF_001). As a final step of protection, respondents' backgrounds were explained with generalized language and representative quotes chosen with careful attention paid to ensure the omittance of any information that could allude to a participants' identity. For instances where participants requested written consent for their own documentation, they were presented with a pre-approved written consent form following IRB guidance. The IRB number for this study is 1755548.

A qualitative interview approach to data collection was selected to best investigate the impacts of power differentials on wildfire and climate change responses. Generally, this process entails the creation of dialogical data between researcher and interviewee (Bryman, 2015).

Semi-structured interviewing was chosen as the methodology that best suits the iterative

nature of case study research as outlined by Yin (2009), my political ecology approach, and the

creation of emergent themes necessitated by grounded theory (Charmaz, 2006; Rocheleau,

2008). Semi-structured interviews require an interview protocol to be created; however, as

opposed to structured interviews, the interview protocol serves primarily as a starting point for

the creation of interview questions (Bryman, 2015; Charmaz, 2006). Once interviewing began

and emergent themes were noted, I would compare the interview notes with the interview

protocol to ensure that meaningful questions were being answered and that meaningful data

that did not result directly from a question was noted to be incorporated into future interviews.

It is for this reason that the semi-structured interviewing approach is best suited for this study,

as it allows for revision of the interview protocol as well as deviation from the existing protocol

to accommodate these changes (Bryman, 2015).

III.III Data Analysis

Data analysis was informed by constructivist grounded theory and, as such, was

conducted in three distinct phases. A constructivist approach to grounded theory utilizes an

event-based prioritization and conceptualizes data and its analysis as relational (Charmaz,

2006). This understanding aligns well with the "chain of evidence" or "web of relations"

concepts central to a political ecology approach (Rocheleau, 2008). Furthermore, grounded

theory stresses that the co-productive nature of generating interview data is essential for

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accurate and transparent analysis throughout the research process. Charmaz (1990) interprets

reality as fundamentally shaped by social interactions, and constructivist grounded theory

incorporates this understanding into the research process (Charmaz, 2006).

This approach heavily on the concept of emergent themes (Charmaz, 2006). Emergent

themes are generated through reflecting on and making notes of interviews, both on their own

and in relation to one another, while the interviewing process is still ongoing (Charmaz, 2006).

This concept is similar to other terms such as initial or *in vivo* coding—however, this paper will

simply refer to the byproducts of such a process as emergent themes to avoid any

misconceptions regarding coding methodology (Flick, 2002). The term code refers to a unit of

categorization for relevant sections across interviews (Saldaña, 2016). Themes emerge from the

thoughtful reflection of codes—especially in relation to one another(Saldaña, 2016). With both

emergent themes and event-based emphases, grounded theory is uniquely situated to address

my research question regarding interactions between power dynamics, wildfire impacts, and

future efforts to mitigate climate change (Flick, 2002). Emphasizing the iterative process of

creating emergent themes helps ensure that conclusions reached are based on what was heard

in interviews, and that said conclusions can be retraced to their origin in the data (Flick, 2002;

Yin, 2009).

Creation of emergent themes entailed a debrief after each interview. This debrief—or

memoing—was either conducted with a colleague when present or in a document where key

points of discussion were noted. Over time, summaries began to share commonalities,

important topics, or lines of discussion and were noted in the memo. New descriptive codes

and any associated potential themes were added to a section of the memo as interviews

progressed, ensuring that past data was being built upon and that new concepts were identified so they may be addressed in upcoming interviews. Upon completion of the interview process, the resulting memo informed the creation of the first descriptive codes for the analysis stage of this research, as is advised by Charmaz (2006).

Analysis of interview data entailed a methodology referred to as coding—a process of categorizing interview data (Bryman, 2015; Gorden, 1998). Creation of these categories is necessarily iterative and was conducted concomitantly with debrief and reflection practices that occurred after each interview (Saldaña, 2016). Not only does this process maintain and build upon the chain of evidence instrumental to the case study approach—but it also lends itself to a grounded theory approach (Charmaz, 2006; Saldaña, 2016; Yin, 2009). Both methodologies call for an iterative reflection and revision process throughout the interview process, allowing for themes identified in previous interviews to be incorporated into future interviews (Charmaz, 2006; Yin, 2009). Coupled with the semi-structured interview approach, this meant that new or emergent themes were incorporated into future interviews for further exploration (Bryman, 2015; Charmaz, 2006). Themes that persisted across multiple interviews were noted in the interview memo document. Exploration of these persistent themes in the following interviews would then serve to either stress or temper their importance relative to other themes (Bryman, 2015; Denzin & Lincoln, 2005). Upon completion of the interview stage, themes identified in this document became the first, rudimentary, iteration of descriptive codes (Bryman, 2015; Charmaz, 2006).

Following the interviewing stage, I applied these descriptive codes to an interview while allowing for the creation of new codes where relevant—a process commonly referred to

as progressive falsification (Ellis et al., 1992). Analysis of this first interview entailed categorizing interview data into descriptive codes while also developing new codes to fit important data that did not fit preexisting categories (Ellis et al., 1992). Upon completion of this first analysis, codes and categorized sections of the interview were compared against that of a colleague who conducted the same process on the same interview. This was done to create intercoder reliability, ensuring that my chain of evidence was founded on correct analysis of interview data as corroborated by a more experienced researcher that was present for a majority of the interviews (Bryman, 2015; Saldaña, 2016).

After this initial analysis, I continued to progress through transcripts of each interview in the qualitative analysis software NVivo using progressive falsification, applying existing codes where relevant, and creating new ones as needed (Ellis et al., 1992; Flick, 2002). As descriptive codes were progressively developed, parent codes that would contain a collection of related codes began to develop as well. These parent codes stressed actor networks, social-ecological impacts related to fire, adaptation strategies, community dynamics, climate change, and climate indicators. Serving two primary objectives, these parent codes both increased the organizational quality of data as it was being categorized and aided in the conceptualization of further thematic codes to be developed at the end of the descriptive coding cycle (Flick, 2002; Saldaña, 2016). Thematic codes were developed through analytic induction and thematic analysis following the chain of evidence created by documenting emergent themes as they were discovered (Boyatzis Richard, 1998; Flick, 2002). These emergent themes guided the results presented in the following below, alongside representative quotes selected for each theme (Boyatzis Richard, 1998).

IV. Results

IV.I Characteristics of Tucson's climate informed actor perspectives

Participants expressed concerns regarding drought, wildfire, vegetation shifts, and how these impacts interact. Concerns pertaining to drought were often raised in conjunction with specific conversations about water rationing for communities on Mt. Lemmon or water levels in the Colorado River. Water restrictions on Mt. Lemmon were informed by a below-average monsoon season in the summer of 2020. Participants presented complex reflections on the drivers and impacts of existing drought conditions. As an example, despite preexisting drought conditions and awareness of its impacts, residents were nonetheless grateful for the lack of the historically intense monsoon rains following the Bighorn Fire; this gratitude was informed by the steep topography in the Catalina mountains, their proximity to Tucson communities, and awareness of the potential impacts from post-fire flooding. Participants' awareness of climate changes and associated impacts was reinforced by the desert ecology of their environment.

> *"Southern Arizona, we're really kind of at the tip of the spear for climate change from a hotter drought point of view... This is really climate change. And yeah, we really are in the process of ecosystem conversion. It's starting to happen in edges. It's not widespread*

across everywhere, but a lot of people don't want to talk about this because it's

alarmist."

The Catalina Mountains provide abundant recreation opportunities with the additional benefit of having generally cooler temperatures than Tucson. There are many trails easily accessible from the Catalina Highway, allowing Tucson residents and visitors alike to explore the various ecosystems and escape the summer heat. With the close proximity of differing ecologies and incentives to explore them, participants have already noted ecological changes they attributed to climate change. One participant reflected on their colleagues' personal experience with said impacts:

"And his comment was basically that he sees people on... hikes now, he sees people up at 5,000 feet, and they say, "Isn't it beautiful up here?" And he wants to say, "You have no idea what it used to look like up here. You think it's beautiful. You have no idea what we've already lost.""

IV.II The Catalinas served as a climatic benchmark and were integral to local identity

As host to diverse ecologies and sensitivity to future climate changes, the Catalinas serve as an indicator landscape for the U.S. Southwest. The aesthetic prominence of the

Catalinas and its abundance of recreation opportunities also informs its designation as an indicator landscape for the community of Tucson. The spatial and temporal scales used in landscape discourses informed varied and complex understandings of social-ecological interactions as well as changes in those interactions. Understanding landscapes as nested scales of values and interactions in this way allowed for discussion of experienced and predicted climate change impacts between diverse groups.

> *"[T]hese mountains are what a lot of people would call the mother range in Tucson. There's so many people that love these mountains because they're the big, giant mountains right near Tucson, which is kind of their curse, which is why they've been so beaten and abused."*
>
> -NGO Member

Personal attachments to the mountain environment were evident in participants' concerns regarding current wildfire, climate, and vegetation impacts. Conversations with residents pertaining to these topics would often elicit a general sense of concern for the future. Participants displayed an awareness of contemporary challenges to management and their likelihood to become compounded under future climate change impacts. Residents' attachments to the Catalinas make it an indicator landscape within a local context; their consideration of the broader influences and implications of climate change impacts and adaptation suggests that understanding landscapes this way may be useful for efforts to communicate abstract concepts or concepts that are spatially or temporally distant.

"Well, [the Catalinas] have been there for forever. It's the escape from heat. That's part of the sky. So, people go up there to get out of the heat they're creating. If people want things back the way they were, it's not happening. Like that mountain is forever changed. It's changed. Like those big old groves aren't coming back. I mean, it might be back in 60 years, but that's assuming that the oak that's up there doesn't choke out new growth, like the catclaw."

-Resident

"[T]hat mountain range is the most prominent thing in the entire viewscape. And most people that I know that are somewhat outdoors oriented chose to live in Tucson because of that mountain range specifically. It wasn't the job. Sometimes it's the overall climate which is changing and is unlivable for a chunk of the year now. But Mount Lemmon is why a lot of people live in Tucson. So, to seeing that resource burn, and you can watch it burn from the city, there was widespread trauma… when I see an area burning, I'm thinking about all my personal memories of that place. That hike with that person. That animal encounter. I see those memories, those things actually burning, which is what makes everything so personal. And it's one thing to look at on a computer, television news or whatever, but to be in town or at home, or from your office and then watching it burn, yeah really, pretty heavy."

-NGO member

IV.III Actor values and interpretations associated with climate change impacts were diverse

Following the Bighorn Fire, many residents of Tucson expressed concern over social and ecological impacts such as hiking trail closures, loss of revenue from tourists, and compounding vegetation impacts. Emblematic of this sentiment, Tucson residents framed wildfire recovery in terms of when "our Catalinas" will return. Upon further analysis of participants' attachment to the Catalinas, we found that specific biota in the Catalinas became focal points for certain groups' interpretations of wildfire and climate change impacts. Different groups focused on their own specific biota, such as invasive species, mountain springs or streams, saguaros, and wild turkeys.

> *"Most of the damage on Saguaros that you're seeing out in the Tucson's and it's everything from limb drop to those sort of downward pointing limbs to senescence of the outer skin, essentially. I definitely think its drought. Specifically, if you look at hundreds of Saguaros out there, and then you look at 10 Saguaros on the top of a mountain, you'll notice that they're incredibly branched, candelabra branched, and they're all tiny and sort of strange. They just look very, very different."*

> -NGO Member

These indicators were informed by the values of the designating group, each entrenched in a unique history of processes of interactions with the landscape. Power dynamics between groups influenced these processes of interactions, eventually influencing discourses of which indicators matter or delineating what responses to observed changes to charismatic indicators are feasible. This was perhaps best exemplified by community concerns regarding invasive

grasses, which were reinforced by a strong valuation of native biota and awareness of the risks

posed by these species. Conversations in this vein explored the correlation between invasive

grasses and increased fire spread and severity. Concerns raised in this regard were

compounded by the uncertainty of future climate change impacts on the distribution of

invasive grasses in the Catalinas. Participants specified fire spread to the non-fire adapted

Catalina Foothills and accompanying damage to desert biota like the saguaro as top priorities

for future vegetation management, wildfire mitigation, and overall climate adaptation.

> *"In talking to people, we would say, with climate change, that... Buffelgrass at this point*
>
> *is limited by elevation. Now, it's getting up to six with the climate change. The*
>
> *cheatgrass is the higher elevation. With climate change, we've got Buffelgrass coming*
>
> *up and cheatgrass going down, and they're going to meet in the middle, and the whole*
>
> *thing's going to go on fire."*

-Resident

IV.IV Community perspectives were informed by specific biota within a shared landscape

Residents' valuation of preexisting landscape dynamics (e.g., cooler temperatures and

aesthetics of the forested environment in the Catalinas) informed adaptation preferences that

seek to maintain the existing landscape and ecological conditions. This prioritization was

manifest in a general consensus among residents for adaptation methods that resisted

significant social-ecological change. An example of this can be found in residents' proposal to create a firebreak around the town of Summerhaven, which would theoretically provide a buffer for future wildfires. Residents' emphasis of this particular adaptation strategy reveals a high valuation of the existing landscape dynamics.

"Okay, put a buffer around the community, and those are known to work. And trying to communicate a lot of times with the Forest Service or the federal or the park systems or whatever, we feel it's a waste of time. Because the first thing they do is go, "Well, we can probably do that, but we don't have any money. So it can't happen. So, it's very frustrating"

-Resident

In this instance, residents seek to balance ecological values associated with the forested landscape with social values of mitigating fire risk to structures. As a further example, one participant reflected that the landscape was recovering from the impacts of the Bighorn Fire because the wild turkeys had returned to the streets of Summerhaven. Discrepancies between management actions and community values associated with specific biota informed skepticism regarding the viability of existing management approaches in light of expected climate change impacts.

"Everywhere, right? Now, the fires are starting in March. So, when do you do the project work? Everybody's out fighting fires until December in California, or whatnot. It's just when we do we even do work then? You kind of wonder because it almost seems like it needs to be a different tactic, right? Other than suppression, doing something which is

kind of what we're all talking about. But how do you even do that? Do you create a

whole new federal system? Because you are going to have these guys that are basically

being used up constantly by doing suppression, and then the amount of money that it

would cost to go in and do the cleaning projects and all that."

-Resident

Implicit to this discourse is the responsibility of the USFS to protect the Catalinas. At many junctures in the development of social interactions and environmental changes in the Catalinas, notions of USFS dominance and associated responsibilities were a recurring theme among participants. This theme was accompanied by increasing concern for the viability of current management approaches due to climate change. It is crucial to note that perceptions of existing power dynamics and expectations of responsibility create a positive feedback loop in this context. Conceptualizing actions as limited to the scope of the USFS capabilities restricted which actions were viewed as feasible and served to reinforce community perceptions of the USFS as the dominating actor locally.

V. Discussion

The aim of this study was to investigate community and professional perspectives, values, power, and how these social elements influenced management outcomes following the Bighorn Fire. Through conversations with diverse actors and critical analysis of interview data

with the above considerations, we found shared landscapes and the biota within them to be

important points of emphasis for future efforts to collaboratively engage in adaptive

governance measures. A prominent theme across interviews was the notion that people will

not care about wildfire and climate change impacts if they do not affect them directly. This case

study investigated a population that is very much being directly affected by climate change

impacts. Insights gained from this study provide focal points for future efforts to communicate

climate change impacts and increase collaborative responses. The climatic sensitivity of Tucson

and the variance of ecology found in the Catalinas make this case study particularly relevant to

modern climate change adaptation discourses in the U.S. Southwest. Diverse community

attachments to the Catalinas informed awareness of localized wildfire and climate change

impacts, suggesting that shared landscapes can act as an indicator for communities to interpret

climate change within the context of their lives. Additionally, this relationship can serve to

internalize more distance spatial and temporal scales of climate change impacts, with

conceptions of localized impacts being scaled up through shared concerns for a landscape. This

finding aligns with existing literature that highlights the need for further development of

understanding and communicating climate change impacts at the local level (Adger et al., 2004)

V.I Specific attachment to the mountain and associated ecology makes climate change impacts

salient

Approaching landscapes with an emphasis on the salience of community perceptions of impacts serves as a novel contribution to research efforts concerned with climate change adaptation in social-ecological systems. Contemporary small-scale climate change impacts were found to be salient to individuals depending on their place attachments and resulting biotic indicators. Incorporating an understanding of a shared landscape and associated biota into future climate change or wildfire research allows for increased inter-scalar communication both spatially and politically. While the Catalinas and their associated indicators are specific to this case study, searching for biotic and landscape indicators in social-ecologic systems experiencing climate change impacts will allow for a clearer and more meaningful analysis of community values and accompanying preferred adaptation methods.

The salience of climate change impacts was informed by different biota for different actors. Analysis of participants' attachments to the Catalinas and associated biotic indicators revealed that preferred adaptation strategies were informed by connections to place and resulting observed changes to indicators. As was found in this study, participants utilized specific biotic and landscape indicators to internalize climate change impacts and future uncertainty. Biotic indicators helped to frame conversations about and motivate actions to address climate change impacts between diverse groups. This finding builds on existing literature that has researched social-ecological indicators of adaptive capacity (Adger et al., 2004; Wall & Marzall, 2006). Further development of indicator frameworks in adaptive governance efforts would benefit from investigations of landscape and socially identified biotic indicators to understand diverse community values as informed by attachments to place.

Socially defined indicators are important for addressing gaps between awareness and action regarding localized climate change impacts (Sloggy et al., 2021; Zanocco et al., 2018). Identification of socially defined biotic indicators may help increase community cohesion by providing a framework for understanding differing values and perspectives within a community (Ballantyne, 2018; Budolfson, 2021). While socially defined indicators detailed in this study are specific to the local context, future studies can investigate social indicators through conversations with diverse actors regarding their values, observed environmental changes, and questions about biota associated with these two elements. Within this study, socially defined indicators were informed by the values of the designating group, each entrenched in a unique history and process of interactions with the landscape and power dynamics between other groups, among other drivers. There is a need for more research into how indicators may inform risk perceptions and vice versa.

V.II Preferences for adaptation strategies change under differing spatial and temporal scales, based on the power of the group, and are related to salient or 'charismatic' indicators of change

We characterize the socially defined biotic indicators found in this study as 'charismatic indicators' that can be used to frame conversations about and motivate actions to address climate change among diverse groups. Participant awareness of impacts on their respective charismatic indicator motivated action across interviews. However, efforts to leverage this

finding will entail a combination of actions and concepts that can promote and direct desires for collaboration. This caution certainly holds true for collaborative efforts on and around Mt. Lemmon. While participants from various backgrounds were largely able to identify charismatic indicators specific to their priorities, awareness of other groups' indicators and the reason for their designation are often underdeveloped. Providing further complexity, climate change itself is variable in impacts and spatial-temporal scales of those impacts. It is in this regard that indicator landscapes provide further help. Within this study, the Catalina Mountains were found to be a shared landscape between diverse groups due to being host to the charismatic indicators for specific groups. Leveraging a shared landscape to unify diverse populations with varying needs, values, and priorities may help counteract the social stratification that can accompany environmental conflict (Paveglio & Edgeley, 2017; Tenbrunsel, 1999; Wall & Marzall, 2006).

Communities may be able to identify their own indicators by reflecting on present biota and its importance in relation to different groups. Critical examination of how these indicators inform the internalization of climate change or extreme weather impacts will likely yield valuable insights into implicit values that inform the actions of different groups. Efforts to build upon the framework of charismatic indicators outlined here should explore ideas such as cataloging indicators and the drivers of their salience across the U.S. This documentation would allow for more nuanced discussions of landscape values and accompanying preferred adaptation methods between diverse groups. Indicators have already been invoked and explored within the contexts of adaptive capacity and climate change impacts, further exploration of socially defined indicators incorporates much-needed social-ecological

relationality—acknowledging that no impact is strictly confined to either social or ecological conditions. Another important contribution of this approach is a fundamental awareness of communities as diverse in composition and values. This awareness cannot be isolated from a charismatic indicators approach and thus counters observed tendencies to presume communities as a homogenous group with shared values in adaptation literature (Adger et al., 2004; Paveglio & Edgeley, 2017). Studying the temporal relationships with charismatic indicators served as a catalyst for understanding how relationships with climate change evolved and is expected to evolve over time. Incorporating varying temporal scales into charismatic indicator investigations will likely increase the tangibility of climate change impacts locally and provides a rich area for future research. Further research into the relationship between the preferred adaptation strategies and related indicators of different groups may provide new insights into the broader decision-making processes of different groups.

The sentiment that conceptualizing meaningful solutions to climate change is difficult was identified across interviews. This was evident in participants' interest in inventing our way out of environmental crises with rapid technological or managerial improvements. Underlying this interest was a sense that contemporary strategies and approaches will likely be unable to address expected near-future climate change impacts. Participants expressed a desire to move beyond familiar management and adaptation strategies while being unsure how or even if such change is possible. This study provides a novel focal point in the form of charismatic indicators to aid conceptualizations of novel solutions that meet the needs of diverse groups within a community. Utilizing nuance gleaned from the examination of different groups' indicators may help communities' adaptation conversations to progress beyond preexisting adaptation

strategies. Combining nuanced understandings of community values with novel adaptation

strategies that help protect diverse values may provide a path forward beyond commonly held

beliefs that increases in funding would resolve any manner of complex social-ecological

impacts.

VI. Conclusion

This study aimed to address my third and final research question regarding the extent to

which actor dynamics related to the Bighorn Fire influenced future efforts to manage socio-

ecological systems for fire in the Tucson area. Identifying which ecological shifts on local

landscapes are noticed by which groups and the biota that internalized those shifts acted as

socially-defined or "charismatic indicators." This research builds on existing literature

investigating the diversity of community values, power dynamics, and climate change

adaptation. Small-scale climate change impacts are already being noticed in climatically

vulnerable sites, with uncertainty regarding future, larger, impacts fueling interest in climate

change adaptation efforts (Abatzoglou & Williams, 2016; Bowman et al., 2011; Sloggy et al.,

2021). Understanding values informing preferred adaptation actions is an important step in

critically approaching adaptation with an emphasis on equity (Adger et al., 2005; Ribot, 2011).

The results of this research indicate that diverse groups internalize complex changes to local

social-ecological systems through specific biota. They also demonstrate how a shared landscape

either galvanized the community to respond to observed changes or served to demotivate depending on the power of actors involved and the alignment of values within the community.

Understandings gained from analysis of the Catalinas as an indicator landscape revealed that strong attachments to place informed localized awareness of climate change impacts as well as the ability of an important landscape to scale-up ones thinking in both spatial and temporal scales. Results from this research offer several practical lessons for incorporating diverse community values into adaptive governance efforts. Investigating community values, observed climate change impacts, attachments informing values, and actions resulting from values allowed for the discovery of the charismatic indicators for different groups. Framing this investigation around environmental conflicts, such as wildfire, on a shared landscape ensured participants would have strong perspectives and a willingness to share them. Future research pertaining to extreme weather events, climate change, adaptation, and entailing social diversity will likely benefit from the investigation of charismatic indicators within relevant local contexts. Investigation of such indicators may provide insights into the values, perspectives, and power of different groups.

Planning for future wildfire events within our study area would likely benefit from acknowledging the values informing charismatic indicators for different groups within the community. Doing so may aid in creating community cohesion, even across spatially dispersed communities. Increases in cohesion are likely to result in innovative conversations and adaptive actions that better align with community values. Understanding how different groups internalize localized impacts and how this process sometimes results in consideration for larger scales is important for future efforts to mitigate climate change and associated wildfire impacts.

CHAPTER SIX

CONCLUSION

I employed a semi-structured qualitative interview technique in order to meet the nuance required by my political ecology approach. The data collected was useful and well-documented, thanks to guidance from case study and grounded theory approaches. My case study area was chosen based on criteria that would allow for discussions relevant to my research questions and the exploration of adaptation strategies in response to predicted future climate impacts as they relate to wildfires.

Qualitative methodology provided rich depth and diversity of perspectives that can be lost in the pursuit of statistics for analyses. Measures to increase the validity of claims made in this thesis included inter-coder verification, documentation of the entire research process as informed by a grounded theory approach, and iterative reflection on interview themes to ensure they are true to the interview data. These steps maintained a chain of evidence for claims made in this thesis and ensured that the development of claims was true to what was heard in interviews. As a result of this strong linkage between the interview data and claims made in this paper, there are some limitations to the generalizability of claims. Findings specific to the local context of this study may not be true in another location; however, the relationality of broader concepts explored in this thesis provides a helpful way to translate findings to different contexts. Explorations of diverse actor perspectives, values, and power within a social-ecological system impacted by wildfire provided insights into the influence of power in land management narratives and actions. Analysis of diverse community values reveals how place

attachments can be informed by specific biota—making environmental changes more personally meaningful and their causes salient.

Chapter four addressed two of my three research questions, what power asymmetries existed between actors affected by wildfire in the Tucson area, and what is the relationship between power asymmetries and management outcomes related to the Bighorn Fire? Many insights into barriers to future governance efforts on and around Mt. Lemmon were discovered through the analysis of interview data based on my two research questions informed by political ecology. Power dynamics in the Catalina Mountains influenced Mt. Lemmon's development as a place in many ways. The power gap between the community and the USFS causes a similar spatial imbalance. Power differentials between communities and agencies influenced physical place through management and broader conceptions of space through influences on discourse. Utilization of a semi-structured interview approach allowed for the iterative development of emergent themes. Awareness of these themes and continued reflection on them allowed for more nuanced conversations about participants' perceptions, values, and associated actions. Discussions pertaining to the relationship between Mt. Lemmon and the USFS highlighted a history of social and ecological conflicts informing contemporary sentiments of distrust for some. Groups that experienced this distrust were perceptive of the power disparity between themselves and the USFS, providing further grounds for distrust— combining investigations of local contexts informing values and preferred action with broader theoretical literature from political ecology critiquing power in management narratives allowed for a critical analysis of current management practices and discourses in the Catalina Mountains. Following critiques of adaptation and adaptive governance presented in the

literature review of this thesis, this research offers a general framework for incorporating

considerations of power into land management narratives and research.

Important understandings for this approach are spatial and temporal relationality,

community heterogeneity, and power as an implicit element of management. In addition to

space being the sum of the physical reality attributed to place, space, as invoked in this

research, encompasses human interactions with place as well as reflections on those

interactions. In this way, space is rooted both in the material and conceptual. Spaces in this

conception influence each other creating changes to the environment and perceptions of it

over time. In the context of this study, critical engagement of space and power revealed the

reasons for current disagreements in management discourses as well as potential starting

points to mitigate them. Future research investigating environmental conflicts, wildfire, and

climate change adaptation would benefit from similar engagements with space and power

considerations.

My third and final research question was to see how actor dynamics related to the

Bighorn Fire influenced future efforts to manage socio-ecological fire systems in the Tucson

area. This question was addressed in chapter 5 of this thesis. Identifying which ecological shifts

on local landscapes are noticed by which groups and the biota that internalized those shifts

acted as socially-defined or "charismatic indicators." This chapter sought to build on existing

research pertaining to the diversity of community values, power dynamics, and climate change

adaptation. A critical approach to adaptation with an emphasis on equity begins by

understanding the values that guide preferred adaptation actions (Adger et al., 2005; Ribot,

2011). The findings of this research show that diverse groups internalize complex changes to

local social-ecological systems through specific biota. They also show how depending on the power of actors involved and the alignment of values within the community, a shared landscape either galvanized or demotivated the community in response to observed changes.

Strong connections to place informed localized awareness of climate change impacts, as well as the ability of an important environment to scale up one's thinking at both spatial and temporal scales, according to an analysis of the Catalinas as an indicator landscape. Several practical lessons can be learned from this study's findings for incorporating diverse community values into adaptive governance efforts. Investigating community values, observed climate change impacts, attachments that inform values, and actions arising from values led to the discovery of charismatic indicators for various groups. The framing of this investigation was centered around environmental conflicts, such as wildfires, on a shared landscape, ensuring participants would have strong perspectives and be willing to share them. Future research on extreme weather events, climate change, adaptation, and social diversity will likely benefit from the study of charismatic indicators in relevant local contexts. Such indicators may provide insight into the values, perspectives, and power of various groups.

Understanding the values that drive charismatic indicators for various groups in the community would likely help with planning for future wildfires in our study area. This can help to build community cohesion even among geographically dispersed communities. Incorporating this understating with findings from chapter 4 of this thesis, charismatic indicators may provide communities the opportunity to build awareness about different values present within the community and allow for the development of actions that better align with these values. Efforts in this vein would allow for consideration of those with less power or increased vulnerability to

social-ecological shifts. Such a process will be necessary for equitable attempts to enact wildfire mitigation or even climate change adaptation measures.

This thesis explored adaptation discourses in academic, land management, and community contexts. Explorations of the term in the literature review chapter highlighted the variable definitions that can be associated with the umbrella term of adaptation. Critiques of adaptation approaches stressed the need for further considerations of power, vulnerability, and social diversity to ensure adaptation measures address impacts at the appropriate spatial and temporal scales. This research sought to contribute to filling this gap in the literature by exploring community perspectives on drivers of wildfire behavior and its impacts. Through discussions of previous wildfires and expectations for its future in the area, this research uncovered how power influenced land management narratives and activities. Over time, this influence manifests in the physical characteristics of a place as well as community perspectives of a place. This thesis explored unifying diverse values through a shared appreciation of a landscape to mitigate this observed mechanism associated with power in local land management contexts. Findings of charismatic indicators were offered as a novel contribution to efforts to communicate between communities with diverse attachments to place and accompanying values. Future utilization of the framework for identifying charismatic indicators may aid efforts to increase equitable representation in conversations about adaptation. Doing so will likely increase community cohesion and the overall ability to respond to abiotic surprises such as wildfires. Efforts in this vein are likely to become even more pressing as climate change impacts continue to exacerbate historically average conditions in local contexts.

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APPENDICES

Appendix 1

Research Aim: To understand how power asymmetries affect adaptive capacity to wildfire

across diverse groups of actors impacted by the same fire.

1. What power asymmetries exist between actors affected by wildfire in the

   Tucson area?

2. What is the relationship between power asymmetries and management

   outcomes of the Bighorn Fire?

3. To what extent will actor dynamics related to the Bighorn Fire influence

   future efforts to manage socio-ecological systems for fire in the Tucson area?

An iteration of the interview protocol

Introduction for residents

- How long have you lived here?

  o Do you live here full time?

- What is the fire risk like in this area at the moment?

Introduction for professionals

- Describe your position and associated responsibilities.

  o How long have you held this position?

  o Where did you work before?

- How does the fire risk here compare to other areas?

RQ1. Before the Bighorn Fire

- What projects/efforts have you been involved in to address fire risk in this area?

    - Were others involved in those efforts? → inside/outside your

        organization/community?

- Who usually comes to the table when there are conversations about fire risk and

    management in this area?

    - Are these conversations typically formal or informal?

    - What do different people/groups contribute to the conversation?

    - Has there been any change in who is involved in these conversations since the

        Bighorn Fire?

    - Who do you work well with?

    - Who is more challenging to work with in this area?

        - Why is that the case?

- Is there agreement about how to manage fire in the Tucson area?

    - Why is that the case?

- What impact do invasive species have on fire risk in this area?

    - To what extent is this an issue?

    - What management efforts have been taken to address invasives?

RQ2. During the Bighorn Fire

- Tell us about your experience with the Bighorn Fire.

- When/how did you first hear about the fire?

- What were your predominant concerns during the fire?

- Who did you work with/interact with during the fire?

- Who/what influenced your decision-making during the fire?

- Describe the response that you saw to the Bighorn Fire

  - Who responded?

  - Did they work together? Successfully or unsuccessfully?

  - Was the response to the fire adequate?

  - How did this compare to what was represented in the media?

- Was the Tucson area prepared for a fire like this?

  - Are some groups better prepared than others?

    - Why is that the case?

RQ3. Fire futures in the Tucson area

- What are the core lessons learned from the Bighorn Fire?

  - For you versus for others?

- Will you modify your plans during future fires in the area?

  - What are others doing to better prepare?

    - Is that a direct response to the Bighorn Fire?

- Are people thinking long-term about fire risk in this area?

  - Are land management agencies, local governments, residents thinking long-term about fire risk in this area?

  - What are the current or planned recovery efforts?

- What resources do you need to improve fire adaptation in this area?

  - Is this a local issue or is it the product of something larger?

- Who is most/least prepared for future fires moving forward?

  - Was that because of the Bighorn fire, or something else?

  - Has the fire created more unity or division?

- Who else needs to be part of the fire conversation in the Tucson area?

Close out questions

- Is there anything else we haven't talked about yet that you'd like to discuss?

- Who else should we talk to about the Bighorn Fire?

  - Who agrees with you?

  - Who has different opinions to you?

  - Inside versus outside your organization/community?

Socially Prominent Fires in Comparison to The Bighorn Fire
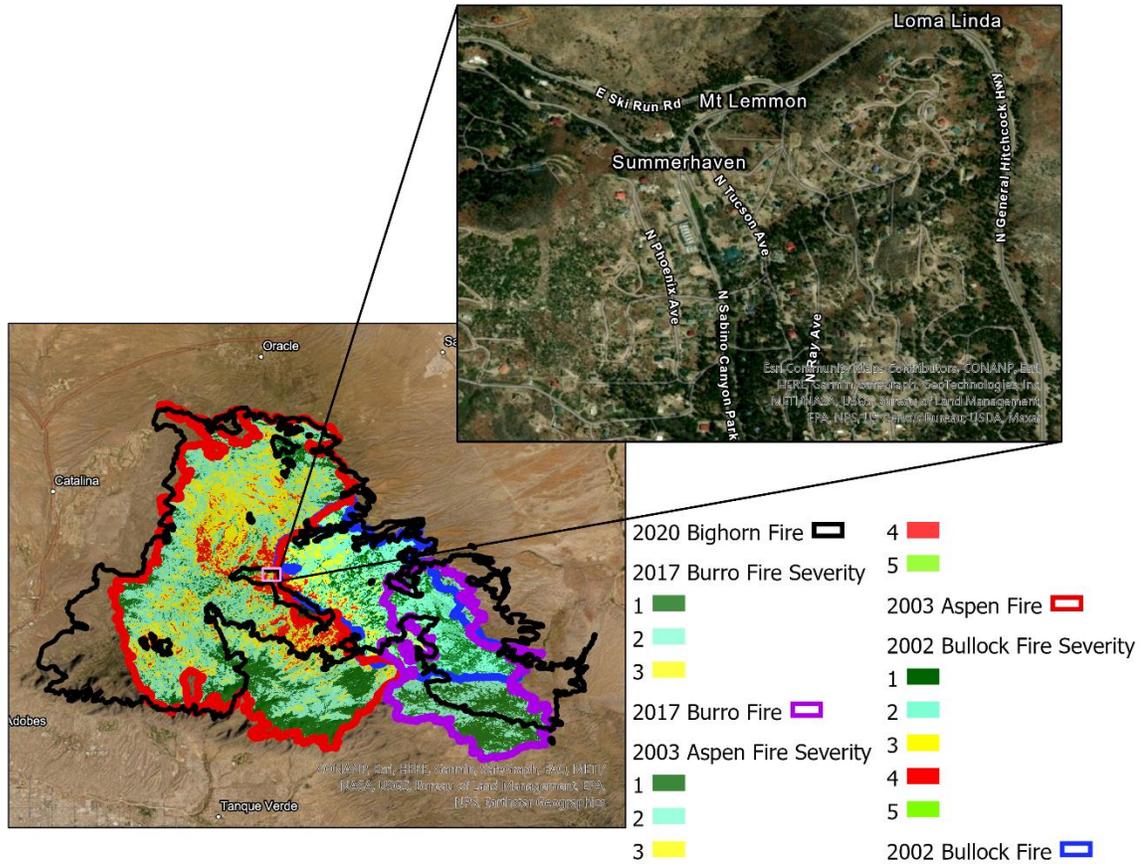
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