UNIVERSITY OF CALIFORNIA
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Management plan for reducing the risk of wildfire to vulnerable populations in Ventura County

Group Project Work Plan

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June 2021

Ventura Regional Fire Safe Council

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Contents

Project description

As climate change increases the frequency and severity of wildfires across California, there is an urgent need for wildfire preparedness and response in Ventura County. Socially vulnerable communities disproportionately lack access to resources and services to prepare and recover from wildfires. As a result, they have a heightened risk for human suffering and property loss in the event of wildfire. In collaboration with the Ventura Fire Safe Council, this project will identify socially vulnerable communities at risk of wildfire and help to develop a Community Wildfire Protection Plan that equitably addresses community needs. This project will also contribute to the field of wildfire management by providing a model for local governments to address social vulnerability concerns. It will demonstrate effective methods for developing an accessible wildfire management plan that engages vulnerable communities to reduce local wildfire risk and increase community resilience with implications beyond Ventura County.

Objectives

The Kindling Equity project objectives are as follows:

1. Identify socioeconomically vulnerable populations at risk of wildfire in the wildland-urban interface (WUI) of Ventura County (VC)
2. Develop a written management plan for the reduction of wildfire risk to vulnerable communities for inclusion in the VC Community Wildfire Protection Plan (CWPP)
3. Produce a replicable set of recommendations on community engagement for similar counties across the state/country
4. Provide supplemental deliverables accessible by target communities outlining steps that can be taken to reduce wildfire risk

Significance

Communities across California must be prepared for the increasing threat of catastrophic wildfire. While the drivers of fire frequency are complex, the primary driver of increased fire frequency in Ventura County is climate change (Syphard & Keeley, 2020). As a result, Ventura County must prepare for increased fire frequency and severity.

All communities need tools to respond to wildfire, but social conditions, including poverty, poor vehicle access, and crowded households, may significantly affect a community's ability to prevent human suffering and financial loss from wildfire. Additionally, wealthier, whiter, and more educated communities are more likely to have the resources to rebuild postfire and more likely to mobilize and demand government appropriation of fire-mitigation strategies such as fuel treatments (Anderson et al., 2020). This highlights the importance of developing a targeted wildfire risk management plan for vulnerable communities in Ventura County.

The client for this project, Ventura Fire Safe Council, is a non-profit organization with over a decade of experience leading education and collaborative planning efforts to reduce local wildfire threat. They have received a grant to update the Community Wildfire Protection Plan

(CWPP), which will help prepare the community for wildfire. Understanding a community's social vulnerability is an important factor for emergency preparedness and relief as not all communities will require the same resources, and some communities are better equipped to request the help they need (Anderson et al., 2020; Cutter et al., 2003; Méndez et al., 2020). Therefore, this project will allow Ventura Fire Safe Council to accurately identify vulnerable communities within the county, and develop and implement a wildfire plan that equitably addresses community needs.

In addition to supporting Ventura County wildfire risk management, the results of this project will provide a model for other communities combating wildfire. Communities and fire safe councils in California and beyond can refer to the project's reproducible methods for identifying vulnerable populations and addressing social vulnerability concerns in a management plan as a template for updating their own CWPPs. This is especially useful and applicable due to the national increase of areas designated as wildland-urban interfaces (Radeloff et al., 2018). Upon completion, the project will demonstrate effective methods for developing wildfire management plans that are responsive and accessible to the community, and which also reduce local wildfire risk and increase community resilience with implications beyond Ventura County.

Background and literature review

i. Background.

The wildland-urban interface (WUI) describes areas where residences are interspersed with wild vegetation (Radeloff et al., 2018). Structures built in the WUI are particularly vulnerable to wildfire because of their proximity to flammable vegetation, and because an increase in human activity leads to heightened risk of human-caused wildfire ignition. Despite this threat, in the United States there has been a 41% increase in the number of homes located in the WUI and a 31% increase in land area classified as WUI from 1990-2010, making it the fastest growing land use type in the lower 48 states during this time period (Radeloff et al., 2018).

Nowhere is the heightened fire risk of the WUI more apparent than in California. Thirty-two percent of homes are located in the WUI and 82% of buildings destroyed by fires between 1985 and 2013 were located in the WUI, despite the majority of acreage burned being located in wildlands (Kramer et al., 2019). Although there has been significant structural loss due to fire throughout California, three of the twenty most destructive Californian fires were at least partially located in Ventura County: Matilija Fire (1932), Day Fire (2006), and the Thomas Fire (2017)(*Top 20 Largest California Wildfires*, 2021). An estimated 76% of the county's housing is located in communities identified as high burn risk by CALFIRE, which is home to 71% of the county's population (Ojai Valley Fire Safe Council, 2010). Therefore, there is significant fire risk to Ventura County WUI communities.

Ventura County's natural landscape contributes to this increasingly heightened fire risk. The county is characterized by forests and shrublands, also known as chaparral, scattered across rugged canyons. These landscapes are fire-adapted, and burned naturally as well as anthropogenically by the Chumash, who traditionally used fire to facilitate the growth of useful

plants (Timbrook et al.,1982). However, contemporary fire return intervals in these landscapes are less than 20 years, which is more frequent than before colonization, and fire size and severity have also increased (Potter, 2017; Safford & Van de Water, 2014). This is attributed primarily to increased human-caused ignitions, a function of population growth in the WUI, and climate change, which has extended the fire season in Southern California (Keeley et al., 1999; Syphard & Keeley, 2020).

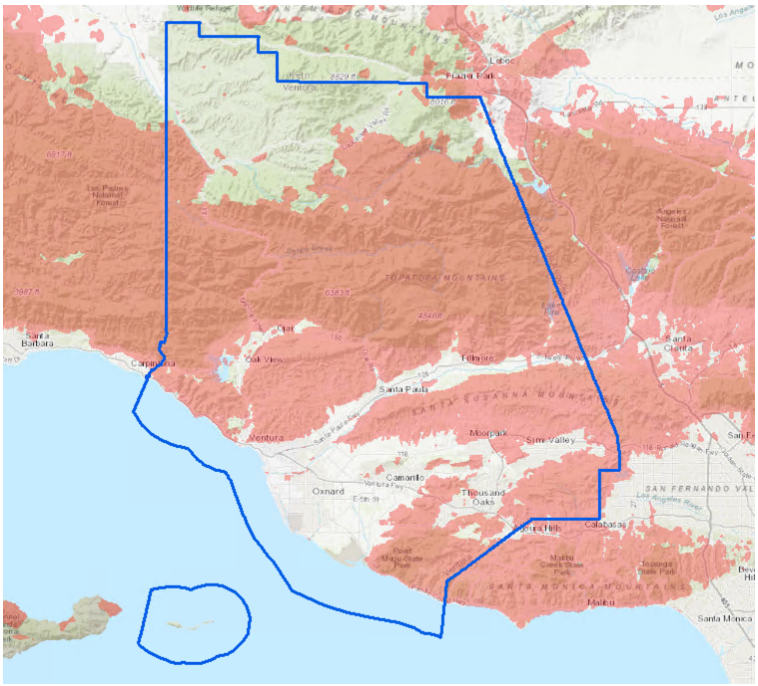

Figure 1. CALFIRE perimeter data of previous fires in Ventura County. Shown in rust color are aggregated fire perimeters since 1950. Ventura County is outlined in blue.

The 2017 Thomas Fire burned over 280,000 acres in Ventura and Santa Barbara Counties, significantly impacting the health and quality of life in those communities. The fire destroyed 1,063 structures and damaged 280 other structures (Saqui et al., 2017). In addition to these direct damages, many people in Ventura and Santa Barbara County were impacted by poor air quality, interruption in access to safe drinking water. During the fire, there were language barriers in distributing emergency response information, and predominantly Latinx and Indigenous farmworkers were exposed to heavy smoke as they worked. After the fire, disruptions to transportation and housing continued to affect working class people who commute to Santa Barbara for employment, because of lack of proximate, affordable housing (Méndez et al., 2020). Additionally, many immigrants were barred from receiving disaster aid due to their citizenship status (Méndez et al., 2020). While the damages were widely felt, Thomas Fire response and recovery were inequitable.

Ventura Regional Fire Safe Council is a local, non-profit organization dedicated to providing fire awareness and community education to reduce human-induced fires and wildfire risk, and increase community resilience to fire events. The organization is the recipient of a two-year

grant from the California State Fire Safe Council to prepare an updated Community Wildfire Protection Plan (CWPP) following guidelines set by the federal Healthy Forest Restoration Act of 2003. The primary purpose of the countywide CWPP will be to guide future actions of county and city fire departments, property owners, business-owners, homeowner associations, and other interested parties in their efforts to reduce the wildfire threat to the county and in individual communities. In light of the Thomas Fire, as well as research on social inequity in wildfire preparation and response (Anderson et al., 2020; Méndez et al., 2020), the Ventura Regional Fire Safe Council has partnered with the Bren School to specifically address how socially vulnerable populations will be included in the CWPP.

ii. Community wildfire protection plans.

Aside from regulations meant to protect federal buildings from wildfire, there are no federal laws dictating land-use planning or building practices to reduce wildfire risk. This leaves local governments and communities to decide how best to protect residential areas from wildfire, which is typically achieved through zoning policies, building codes, or other ordinances. The burden of compliance often falls on the residents to defend their home (Kramer et al., 2019). In 2003, the federal Healthy Forest Restoration Act was passed with bipartisan support. Among other goals, the act encourages communities to develop Community Wildfire Protection Plans (CWPP) to address this policy gap (Jakes et al., 2011).

In the first 10 years of the Healthy Forest Restoration Act, it is estimated that less than 10% of at-risk communities developed a CWPP (Jakes et al., 2012). Because of their slow adoption and localized nature, there is little information on the effectiveness of CWPPs. However, fire mitigation activities (i.e. defensible space) have been shown to reduce the chances of structural damage during a wildfire (Syphard et al., 2014), and pre-fire emergency planning has been shown to improve the overall outcome (Kolden & Henson, 2019). CWPPs encourage both of these behaviors, both at the individual and community level.

CWPP requirements are intentionally vague, allowing communities to create plans that reflect local ecological and social factors (Jakes et al., 2011). However, plans generally involve a collaboration of stakeholders and objectives to reduce structural ignitability, identify priority fuels treatment areas and forest restoration, and monitor progress (R. Ojerio et al., 2008). Though CWPP working groups are encouraged to focus planning efforts on “high risk” communities, risk is generally defined in the context of spatial and environmental factors. This is largely true of most federal wildfire planning efforts, which tend to focus on areas of high biophysical risk with less emphasis on social vulnerability (R. S. Ojerio, 2008).

There are some notable CWPPs that do include social vulnerability. Oregon’s Josephine, Jackson, and Walker Range counties developed CWPPs in collaboration with social services, which included funneling funds towards fuels mitigation for low-income homeowners (Jackson County, 2017; R. Ojerio et al., 2008; University of Oregon Community Service Center & Oregon Partnership for Disaster Resilience, 2017; *Walker Range Community Wildfire Protection Plan*, 2012). Additionally, the Forest Guild of New Mexico produced a methodology for evaluating

community capacity to respond to wildfire and has since encouraged communities to incorporate this factor in their CWPPs (R. Ojerio et al., 2008). Taos, NM was the first community to use the community capacity assessment to consider how it related to fire risk in its CWPP (Taos Pueblo CWPP Core Team & Lissoway, 2009).

It is not known how many other CWPPs include considerations of equity, community capacity, or social vulnerability as the practice is not yet widespread. We could not find any examples of CWPPs that specifically address the vulnerabilities of immigrants or non-English speakers. Similarly, we did not find any data on how including considerations of vulnerability in CWPPs might improve outcomes during a wildfire event, although literature on the shortcomings of wildfire preparedness and response clearly points to a need for more inclusivity (Méndez et al., 2020; R. S. Ojerio, 2008; Palaiologou et al., 2019). Again, the lack of literature on the effectiveness of more inclusive CWPPs is probably due to the fact that they are relatively new, each plan is unique to a community, and there is no centralized CWPP authority.

iii. Wildfire risk analysis.

Contrary to other regions, wildfire risk in Southern California is largely a function of human population. In coniferous forests of the western U.S., decades of fire suppression policy has demonstrably led to dangerous fuel loading, which is blamed for the increasing size and severity of wildfires. However, in Southern California chaparral and brushland, there is no evidence that fire suppression has led to increased fuel loading, fire size, or fire severity (Keeley et al., 1999). Rather, the increased destructivity of fires can be attributed to an increase in human-caused ignition as well as housing development in the WUI, leading to an increasing number of houses burned (Keeley et al., 1999). Increasingly, climate change will drive fire severity in Southern California (Syphard & Keeley, 2020).

There are many variables that determine the probability of a fire igniting and the subsequent severity of the wildfire including temperature, aspect and slope, humidity, wind speed, fuels loading, human activity, and the existence of fire mitigation infrastructure (Syphard et al., 2008). In Southern California, where most ignitions are human caused, the presence of roads, trails, and housing developments greatly increases the risk of ignition, while vegetation type, windspeed, and topography determine the size and severity of wildfire (Syphard et al., 2008). Unlike other vegetation types, chaparral and grasslands that are characteristic of Southern California can burn in consecutive years if ignited. Thus previous fires and prescribed burning do little to reduce the size of subsequent fires, though fuel reduction can still be an important way to create defensible space (Price et al., 2012). By considering the spatial overlap of relevant variables, future wildfire risk can be modeled and integrated into management plans.

Future wildfire risk can be modeled and incorporated into management plans by analyzing the spatial overlap of relevant variables. There are numerous existing GIS layers that quantify the risk of wildfire, most developed by government branches. In 2015 the United States Forest Service's Fire Modeling Institute updated its Wildland Fire Potential map (originally created in 2012), which was created to depict the potential for wildfire that would be difficult to suppress. It

is based on past fire occurrence, 2008 fuels data from LANDFIRE, and 2012 estimates of wildfire likelihood and intensity from a model called Large Fire Simulator, developed by the fire modeling institute. Areas with high values of wildland fire potential represent fuels with a higher probability of burning in high-intensity fire (Dillon et al., 2015). Similarly, CALFIRE produces a fire threat layer which is based on expected fire frequency combined with potential fire behavior, resulting in four “threat classes.” The U.S. Forest Service has also developed a tool to explore nationwide wildfire susceptibility at the community level, called “Wildfire Risk to Communities,” which uses wildfire likelihood and intensity combined with location-based exposure and susceptibility to wildfire to determine risk. This tool, which can be found online (wildfirerisk.org) now also includes the wildland fire potential produced by Dillon et al. Open-access data and spatial tools are increasing the accessibility and range of wildfire risk assessments.

At a finer resolution, wildfire risk can be modeled as a function of direct proximity to wildlands, where houses are potentially exposed to heat and flame, and ember cast zones, which are a function of ember size and wind speed (Roberts et al., 2021). Embers can start small fires downwind of large fires, and are a leading cause of structural damage in wildfire events (Roberts et al., 2021). For example, the City of Montecito used geospatial modeling of ember zones to inform their CWPP (Kolden & Henson, 2019). New technical approaches to modeling wildfire risk can help inform revisions to CWPPs.

iv. Social vulnerability analysis.

Although most analyses of wildfire risk focus on biophysical risk, social vulnerability will determine how people are affected by wildfire (Wigtil et al., 2016). Factors such as age, physical mobility, class, wealth, gender, race, language, and literacy have an impact on an individual or community’s ability to plan for, cope with, or recover from an environmental disaster (Cutter et al., 2003). While social scientists agree that social vulnerability is caused by lack of access to resources, including political power or representation, social networks, infrastructure and social supports, and the physical condition of individuals, there is less consensus on which metrics should be included in a quantitative analysis of social vulnerability (Cutter et al., 2003). Therefore, it is imperative to increase understanding of how to incorporate these factors into wildfire planning.

A Social Vulnerability Index (SoVI) was created by Cutter et al., 2003 to specifically examine place-based vulnerability across the entire U.S. to natural disasters beyond just biophysical risk. This method starts with many variables from the U.S. Census, then, using principal components analysis, selects factors that explain the most variance. This country-wide analysis produced 11 factors that determine social vulnerability: personal wealth, age, density of the built environment, single-sector economic dependence, housing stock and tenancy, race--African American, ethnicity--Hispanic, ethnicity---Native American, race--Asian, occupation, and infrastructure dependence. Some variables had a negative correlation with social vulnerability (median age, and housing stock and tenancy), while all others were positively correlated. The resulting variables were placed in an additive model to produce the composite SoVI per county, which can be used to rank relative vulnerability. However, this particular index may have drawbacks

when specifically analyzing vulnerability to wildfire. For example, the SoVI assigns much more vulnerability to populations with younger median ages, but history has shown that older Americans are much more vulnerable to wildfire (Palaiologou et al., 2019).

The method itself has been proven statistically robust and has been used to create SoVi indices using different variables and at different spatial scales. In several instances this method has been specifically applied to wildfire risk. One analysis used data from the U.S. Census and the American Community Survey to quantify where social vulnerability and wildfire risk overlap at the Census tract level throughout the entire U.S. (Wigtil et al., 2016). Another analysis used SoVI methodology to examine structural exposure to wildfire and social vulnerability in three study areas: North-central Washington, Northern New Mexico, and Central California (Palaiologou et al., 2019).

This is not the only method that has been used to examine social vulnerability and wildfire. The CDC has also developed a social vulnerability index (called the SVI), which considers 15 variables as indicators of socioeconomic vulnerability. Individual census tracts are ranked relative to other census tracts in the United States based on indicator variables, then their rank for each variable is aggregated into a total vulnerability score. Recognizing that certain census tracts might have a high vulnerability score by one metric that is masked by a lower average in other categories, the CDC also “flags" any census tract that is in the 90th percentile for any individual vulnerability metric (Flanagan et al., 2011). This index is broadly used to identify areas that need support during a public health crisis or natural disaster.

Other notable vulnerability indices used to examine how communities interface with wildfire include the SOVUL and the community capacity index. A study looking at social vulnerability and wildfire in the American South used 5 variables selected through a review of disaster vulnerability literature to create a unique index called the SOVUL, for social vulnerability (Poudyal et al., 2012). As previously mentioned, the Forest Guild of New Mexico developed a community capacity index based on variables grouped into four categories: social capital, human capital, financial capital, and political capital. This community capacity index has since been included in various CWPPs (R. Ojerio et al., 2008).

v. Qualitative approaches.

Data-driven analyses of social vulnerability are useful at the coarse scale, but they do little to elucidate the lived experiences of vulnerable populations at a finer scale. Qualitative analyses are often better at capturing the nuances of local experiences and can also highlight populations who may not be adequately represented in census data. Fortunately there are also numerous examples of qualitative research on social vulnerability and natural disasters.

Surveys have been conducted after natural disasters to assess the damages and needs of those impacted by the natural disaster including after Hurricane Katrina and Florence, and earthquakes across China and India. The types of questions asked include demographic information, if people felt the need to evacuate the area, their ability to evacuate, and their

current needs resulting from the disaster. Although few studies have specifically focused on social vulnerability, some have given recommendations for how to best identify and include vulnerable populations in survey research. One main recommendation was to recruit a diverse team to disperse the survey that has a close connection to or are from the community in question. After Hurricane Florence specifically, researchers found that vulnerable communities were less likely to ask for assistance in meeting their immediate food and shelter needs simply because they were not aware of the assistance being offered or did not have access to the survey (Crowley, 2020).

There are also prior examples of qualitative research in Santa Barbara and Ventura counties in response to wildfire. Semi-structured interviews revealed vulnerability among informal employees (who were often Latinx) and the elderly in Montecito after a major mudslide (Goto et al., 2021). Similarly, another set of semi-structured interviews as well as participant observation during and after the Thomas fire revealed that Latinx, Indigenous, and undocumented immigrants were particularly vulnerable during the fire, which intensified existing structural inequalities (Méndez et al., 2020). These studies are particularly useful because they amplify voices and experiences in a way that data-driven approaches cannot.

When specifically targeting input from Indigenous people regarding disaster preparedness, it is crucial that the community feels involved in the process and that the data collected will actually benefit their community, rather than being simply extractive. Some key ways to build a relationship with indigenous people include increasing awareness and education, building connections with tribal leaders, and maintaining dialogue with the community after the survey has been completed (Pan Health Organization, World Health Organization, 2015)

Qualitative methods, such as semi structured interviews, focus groups, participant observation, and the photovoice method, can also be used to facilitate community resilience. Of particular relevance to our objectives, a toolkit for developing community resilience towards disasters in Los Angeles revolves around 2-way learning, wherein researcher knowledge and community knowledge is shared omnidirectionally (Wells et al., 2013). In Australia, researchers co-created conceptual maps to resilience with refugees via co-learning, which involved informing, engaging, and partnering with refugees through 26 interviews (Shefali Juneja Lakhina, 2018). Photovoice is another method that can facilitate community empowerment, knowledge, and connections. In this method community members are encouraged to capture images that help them reflect on, document, and communicate issues of concern (Budig et al., 2018). Although these methods have been used to examine community experiences with wildfire (Méndez et al., 2020; Ribeiro & Silva, 2020) we are not aware of any examples of using participatory research methods to evaluate CWPPs.

Although analysis of existing CWPPs does not generally include qualitative research, the principles underpinning the methods discussed above, engagement and community empowerment, also underpin the methods used to include vulnerable groups in CWPPs. The Forest Guild, which created the Community Capacity Index, also created a series of

recommendations for including vulnerable populations in the CWPP. They recommend facilitating broad community engagement through multiple avenues, and open and transparent planning processes to ensure that needs of vulnerable groups are addressed in the CWPP (R. Ojerio et al., 2008). As such, a survey would be beneficial while developing the CWPP because it can identify how communities traditionally excluded from disaster preparedness and resilience programs can be included in the future. Gaining insight on how a community can best prepare based on their needs can ensure that the actions taken will increase their preparedness and resilience in the future.

vi. Our study area.

Ventura County covers 1,845 square miles of the coast of southern California and inland coastal range. It is bordered by Santa Barbara County to the west, the Pacific Ocean to the south, Los Angeles County to the east, and Kern County to the north. The northern portion of the county lies in Los Padres National Forest, where the population is sparse, leaving the southern part of the county more densely populated. In 2019 the estimated population was 847,263. 6.1% of families live in poverty and 4.3% of households do not have access to a car. 15.1% of the population is over 65, 10.9% of the population has a disability, and 9.5% face language barriers. Language barrier is the only metric for which Ventura County exceeds the national average (U.S. Department of Commerce, 2020). There are sixteen high risk communities designated by CALFIRE in Ventura County, all concentrated in the south. After the 2010 Census it was estimated that 71% of the county's population (535,049 people) live in communities at risk (Ojai Valley Fire Safe Council, 2010).

There are exceptionally diverse vegetation communities in Ventura County, including but not limited to subalpine forests, yellow pine forests, oak woodlands, coastal sage scrub, and chaparral (Timbrook et al., 1982). The climate throughout the county is classified as Mediterranean Dry-Summer Climate, characterized by relatively cool wet winters and hot dry summers (Timbrook et al.,1982). This climate is particularly conducive to fires, and CALFIRE perimeter data shows that a high percentage of the county has been subject to burns since 1950 (Figure 1).

Data Management Plan

i. Data sources.

A variety of GIS and socioeconomic data will be used for this analysis and will be drawn from sources at the federal, state, and local levels. Available data include:

- Census Data and American Community Survey Data: provides recent demographic data that can be intersected with spatial data
- Voting data as provided by Secretary of State
- CDC's Social Vulnerability Data (2016): identifies communities that most likely need support before, during, or after a hazardous event
- National Interagency Fire Center: provides information on interagency wildfire incident data and documentation

- CalFire: provides numerous GIS data resources on California's wildfires, including fire threats, vegetation layers, and fire hazard severity zones
- USFS: Numerous GIS layers of wildfire probability, hazard, exposure, flame length, etc.
- LANDFIRE: Provides fire risk and vegetation layers as well as ecological/fire models
- As needed, GIS data accessed through the Ventura Regional Fire Safe Council and the Ventura County Fire Department.

ii. Data standards.

Anticipated formats for data management and dissemination include:

- ArcMap files and associated geodatabases (.mxd, .gdb)
- Shapefiles and their associated spatial data (.shp, .shx, .dbf, etc.)
- Comma separated values files (.csv)
- Raster grid files (.tif)
- Excel files (.xls)

The Data Managers are responsible for ensuring that data standards are properly organized, applied, and formatted.

iii. Metadata.

For GIS analyses, metadata will be housed within the shapefile/feature class itself. In most cases, metadata is already provided by the source of download. For our own analyses, (i.e. feature classes we produce), we will provide metadata within ArcCatalog description conventions.

For all other technical analyses, we will keep a Google Doc outlining the data, workflow, and general procedure of the analysis. Furthermore, any coding scripts will be heavily annotated. Taking these steps will ensure transparency and reproducibility.

iv. & v. Data sharing and access & Intellectual property and re-use.

Most data used in this project will be publicly available, therefore data sharing and access will not be a pressing concern. In cases where data has been exclusively given to us, we will keep data confidential as needed by the client.

For any analysis on our end, we intend to share our results with our client first, and then receive approval to share with others. The purpose of this project is to share findings to the greater Ventura County area; therefore, hosting and working with private data should not be a concern.

GIS data will ideally be read in ArcMap; however, open source GIS data file formats will also be supported. We intend to make full use of the ArcGIS Online platform and ArcGIS StoryMaps which are publicly accessible. Our R scripts will be uploaded to the project GitHub.

vi. Data archiving and preservation.

Data from the project will be uploaded on our project website and GitHub group that will exist long after the project timeline is complete.

As mentioned in the metadata section, procedures and workflows will be documented to ensure reproducibility for future projects. Files that were used for analysis will be shared at the discretion of the client. Files will also be uploaded into a repository that will be implemented with the help from the UCSB Library.

Technical approach to solving the problem

To meet the project objectives identified above (p. 2), we will implement a mixed methods approach. Our approach utilizes spatial analysis of existing social vulnerability indices and ecological wildfire datasets to identify where socially-vulnerable groups coincide with biophysical fire threat. We will supplement the existing quantitative data with qualitative data gathered in collaboration with Ventura County residents, the client, and community-based organizations through a survey and guided community conversations.

Using survey data in conjunction with publicly available data (from the Census, CALFIRE, etc.) will better inform our approach of understanding at-risk communities. Oftentimes, Census data can be too large-scale and inaccurately portray the population that lives within a boundary. Census data lacks information such as community-based preferences and opinions that can be extremely helpful in analyzing hazard risks. Thus, surveying can be a way to mitigate these inaccuracies and patch up any holes in the data. In this project, using surveys and data-driven information will supplement each other and further bolster our findings.

Our qualitative research methods aim to fill the gaps in current data to better understand the unique circumstances, assets, needs, and barriers to fire resilience in Ventura County. This analysis will be intersectional and seek to understand how race, class, ethnicity, gender, age, ability, housing type, citizenship status, and culture impact people's ability to prepare for, respond to, cope with, and recover from wildfire. These methods, including focus-group style community conversations, will help us identify which groups are most vulnerable to wildfire, how they are vulnerable, and possible areas of intervention to increase wildfire resilience. Our analysis, and the depth of local knowledge provided through qualitative methods will together provide the basis for our CWPP recommendations for risk reduction and needs assessment.

i. Survey methodology.

1. Build and implement structured survey and semi-structured survey
    a. Preliminarily determine areas where risk and vulnerability coincide using CDC vulnerability index and wildfire risk layers created by the USFS and CALFIRE.
    b. In RStudio, utilize Declare Design analysis tools to declare population parameters, determine appropriate sample size and design an evaluation

approach in a way that minimizes biases, including response bias, and seeks results that are representative of the target population.

c. Determine ideal conditions for a qualitative survey distribution methodology to identify key populations.
d. Write and distribute a county-wide survey, being sure to include sufficient representation of geographic areas that we have identified through a preliminary GIS analysis as high fire risk with higher likelihood of social vulnerability.
e. We aim to distribute a broad-reaching, county-wide survey, to gather results that are representative of the population. To ensure we receive sufficient participation from vulnerable populations we will survey at community centers like grocery stores and churches and will work with community organizations that are closely connected with residents representative of different vulnerable groups (VC Social Services, CAUSE, VC disability commission, VC housing agency, Chumash Band leadership, Mixteco/Indigena Community Organizing Project, Meals on Wheels, etc.).
f. After survey distribution and in partnership with the client and community-based organizations, utilize photovoice input method wherein residents submit pictures of features and amenities in their landscape around their homes that they either value or consider unsafe. Collect photos and use as examples during community conversations and in supplemental educational materials.

2. Input responses into tidy formatted datasets for use in analysis.
3. Use findings from surveys in our analysis of social vulnerability, and to provide a basis for focus-group style community conversations with VC residents who represent a diversity of different socially or geographically vulnerable groups (e.g. Mixteco-speaking, housing-insecure, Chumash, seniors, etc.) for further feedback at the community or neighborhood scale, and to make recommendations for the CWPP that are relevant to the needs of the community.
    a. Analysis may utilize R text sentiment analysis where appropriate.

ii. Social vulnerability.

1. Download census data and social vulnerability layers calculated by CDC.
2. Use survey findings to add qualitative data to the pre-calculated social vulnerability to assess mechanisms for wildfire vulnerability.
    a. Answer questions, such as: Are there vulnerable communities in VC that are missing from the initial analysis? Do the indices represent the aspects of vulnerability that we want to address?
3. If existing indices do not adequately address our questions and concerns, or do so only in part, develop an index based on Cutter *et al.*'s SoVI (2003).
    a. Compile vulnerability factors based on 2020 Census: personal wealth, age, gender, built environment density (perhaps WUI category), housing stock/tenancy/type, race, ethnicity, occupation, newly-arrived residents

(asylum-seeking, refugee migrants), physical ability and infrastructure dependence.

   b. Scale vulnerability factors between -1 and 1 such that higher positive values indicate higher levels of impact on vulnerability and negative values indicate lower vulnerability based on the proportion of a certain risk factor in a given analysis unit. For example, a population with a high percentage of highschool graduates would have a low or negative value, while a population with a high percentage of refugee migrants would have a high value. Where the effect of the variable is ambiguous, use the absolute value.
   c. Calculate *additive* vulnerability index with equal weighting of factors unless there is a defensible method to assigning weights; this methodology does mean that all risk factors impact the vulnerability index equally which may not be the case in the true effects on vulnerability.

4. Using vulnerability index and intersectional analysis, calculate spatial distribution of vulnerability at the census tract level or a finer scale (if possible).
   a. Create a shapefile that can be utilized in further analysis.

We recognize that social vulnerability and resilience are difficult to quantify, as they are connected to complex relationships between identity, economic circumstances and location. With that in mind, we will conduct these analyses while also considering the broader context, and ground truthing findings through our qualitative methods.

iii. Wildfire risk.

This set of analyses will help us identify which socially vulnerable census tracts are at the highest risk from wildfires. Here we define risk as the likelihood that a wildfire will occur based on biophysical characteristics. Specific definitions of risk will depend on which pre-calculated raster we use (USFS vs CalFIRE). Additionally, we will analyze the locations of risk-mitigation efforts and fire fighting infrastructure to inform our recommendations.

1. Download pre-calculated wildfire risk raster-layers from the USFS and CalFire
2. Determine the fire risk of socially vulnerable census tracts relative to other tracts in Ventura County by overlaying tracts with high SoVi scores (methodology described in the previous section) and wildfire risk raster-layers, then calculate mean, median, and additive risk per census tract using the raster-calculator tool in ArcGIS or calc() function in R Studio.
3. Spatially locate past wildfire risk mitigation efforts (i.e. fuels reduction efforts, fire breaks, staging areas) and key fire fighting infrastructure (i.e. known water sources, fire departments) and bind them to the census tract data layer created in the previous step.
4. Use regression analysis to determine how SoVi scores predict the presence of mitigation efforts and key infrastructure, while controlling for wildfire risk and population. If this reveals significant disparities, recommend key areas to perform mitigation efforts and/or identify/facilitate fire fighting infrastructure.

5. Use linear regression to assess additional wildfire risk at a finer scale, utilizing factors such as: fuels loading from vegetation layers, fuels reduction effort, fire breaks, staging areas, known water sources, distance from fire departments, and evacuation capacity to identify localized hazard levels. This aspect of our approach will evolve as we explore the datasets available.

iv. Preliminary analysis.

Social vulnerability varies across Ventura County. The most socially vulnerable census tracts also threatened by fire based on the CDC vulnerability index are along highway 126, encompassing the cities of Saticoy, Santa Paula, Fillmore, Barsdale, and Piru (Figure 2). Since the CDC index may not accurately depict the social vulnerability in relation to fire hazard response and resilience, the distribution of social vulnerability to fire is likely to be similar to, but not exactly the same as this distribution. As such, we will not constrain our analyses to the census tracts shown in Figure 2, but will pay particular attention to the 126 corridor.

Initial analysis of census data in these tracts reveals a relatively high percentage of non-white residents and non-fluent English speakers. Although this is a preliminary analysis, it demonstrates the characteristics of vulnerability that we will likely be addressing in our management recommendations. See Table 1 for risk factors.

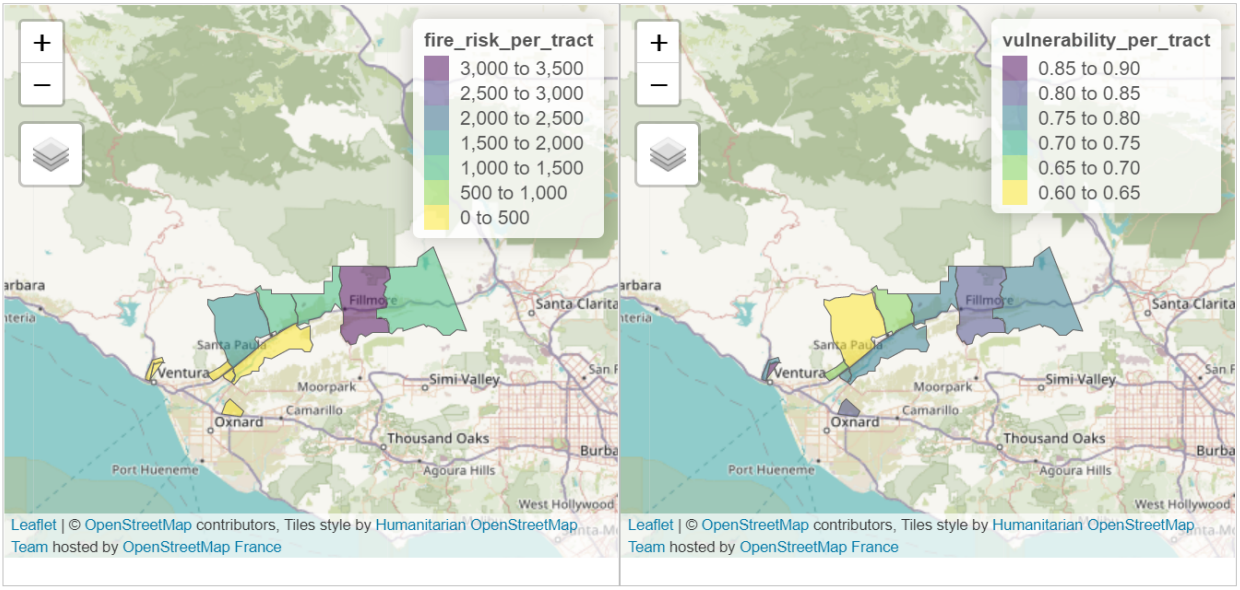

Figure 2. Mean fire risk and social vulnerability by census tract. Census tracts that are in the top quartile of CDC social vulnerability and the top quartile of wildfire hazard potential (mean value per tract) are shown. Fire risk (left) is assessed by USFS wildfire hazard potential which is a continuous dataset, with higher values representing higher wildfire hazard potential. Social vulnerability is based on the CDC social vulnerability index.

Table 1. Risk factors in top quartile of CDC social vulnerability and fire potential by census tracts.

Census Tract	Fire Risk	CDC Vulnerability	Poor English Rate (%)	Unemployment Rate (%)	Minority Rate (%)	Over 65 Rate (%)	Disability Rate (%)
Census Tract 2	1479.9371	0.7728	19.2	7.6	89.4	12.5	14.4
Census Tract 3.02	3018.7972	0.8280	13.7	6.4	76.2	13.0	17.0
Census Tract 3.04	1436.8859	0.7635	15.5	2.8	78.4	10.7	11.5
Census Tract 4	1352.0260	0.6825	17.0	5.4	76.9	14.0	10.8
Census Tract 5	425.7571	0.7823	15.7	6.2	64.2	22.3	13.2
Census Tract 8	1662.5065	0.6426	13.6	8.1	72.7	16.2	13.0
Census Tract 12.01	188.1554	0.6869	3.1	3.6	55.4	15.3	13.0
Census Tract 13.02	122.2510	0.7607	18.6	8.7	67.8	27.6	22.3
Census Tract 22	413.4791	0.8681	10.3	8.4	71.6	9.8	11.5
Census Tract 23	157.6234	0.7842	25.0	7.3	79.0	5.4	9.3
Census Tract 50.02	129.3943	0.8192	31.6	3.7	92.8	5.2	9.3

Deliverables

i. Client deliverables.

The following are the project deliverables created for the Central Ventura County Fire Safe Council:

1. Spatial identification of vulnerable populations exposed to high wildfire risk within Ventura County
2. A reproducible and scalable model analyzing social vulnerability
3. Key recommendations on how to address specific needs of socially vulnerable populations for an equitable Ventura Community Wildfire protection Plan (CWPP)
4. Develop an accessible and inclusive educational tool to support community outreach in VC, with applications in other communities (e.g. Shiny App)

ii. Academic deliverables.

The following are the project deliverables to fulfill the MESM degree:

1. Work plan (Expected Completion by June 2021)
2. Website (Expected Completion by October 2021; *Not a MESM requirement*)
3. Faculty Review Presentation (Expected Completion by February 2022)
4. Final Report (Expected Completion by March 2022)
5. Executive Summary (Expected Completion by April 2022)
6. Final Presentation (Expected Completion by April 2022)
7. Data and metadata (Expected Completion by February 2022)

Milestones

Spring 2021

May 7	Submit draft work plan to faculty advisor
May 21	Submit revised work plan to faculty advisor, client and external advisors
May 24	Host work plan review meeting with faculty advisor, client and external advisors
June 7	Draft community wildfire survey language; prepare survey protocol for UCSB ORAHs; complete Bren Building Committee paperwork
June 11	· Submit final work plan to faculty advisors, client, external advisors, and Group Project (GP) Coordinator; · Submit Self/Peer Evaluation to faculty advisors and GP Coordinator

Summer 2021

June 19	Submit survey and protocol to UCSB for human subjects review
June 30	Develop project website content; Develop community outreach/stakeholder strategy and timeline for survey
July	Develop community outreach/stakeholder strategy and timeline for community focus groups Research & develop a draft structure for a community advisory council for VC wildfire management
August	Administer community vulnerability survey
August/September	Analyze survey results, summarize; plan community conversations around results

Fall 2021

October	Complete community focus groups Complete additional stakeholder outreach (interviews, focus groups) as needed

October	Compile complete list of data sources and identify gaps; tidy up data, walk through with team; complete preliminary analyses of wildfire risk and social vulnerability including infrastructure considerations; Develop social vulnerability definition and index (if needed)
November	Complete analysis of surveys and community conversations, summarize findings Incorporate new community data into social vulnerability and wildfire risk analyses Develop shapefile(s) for vulnerability, finalize spatial model for intersection of wildfire risk and social vulnerability
TBD (By November 24)	Host fall review meeting with faculty advisor, client and external advisors
December 10	· Submit outline of Final Report to faculty advisor; · Submit Self/Peer Evaluation to faculty advisors & GP Coordinator

Winter 2022

January	Develop CWPP contributions, wildfire management recommendations
February 4 & 11	Master's project faculty reviews
February 18	Draft of Final Report due to faculty advisor
March	Develop and finalize Shiny app educational tools by end of the month
March 18	· Final Report (.pdf version) due to faculty advisors and GP Coordinator; · Submit Self/Peer Evaluation to faculty advisors and GP Coordinator

Spring 2022

First week of April	Complete draft final presentation and submit to faculty advisor
April 15	Submit final executive summary to faculty advisor and GP coordinator
April 22	Master's Project Final Presentations

May	Develop strategy for dispersing educational tools; develop recommendations for wildfire managers
May	Project presentation for Ventura Fire Safe Council Board of Directors, Ventura County Community Presentation

Management Plan

The Management Plan herein outlines Kindling Equity's management structure and general plan for the form and function of the group. This is a living document and may change as the project evolves and the group encounters challenges and must respond to them.

i. Group structure and management.

The Kindling Equity (KE) team will function in a collaborative, supportive, transparent and communicative manner. Throughout the project, all group members will be empowered to grow their qualitative and quantitative research, communication, data analysis, and project management skills. The group will approach decision-making through consensus, while also encouraging members to take initiative and lead distinct areas of the project. The specific student roles are as follows:

- Co-Project Manager: Brianna (Bri) Baker
- Co-Project Manager: Elena Ortiz

Co-Project managers will facilitate overall progress on the project and ensure that the team appropriately meets the objectives of the project within the designed scope and timeline. In addition, they are responsible for: delegating tasks to team members as needed; tracking progress of project deliverables; and providing tools, support and feedback to team members to ensure the project is progressing successfully and conflict is addressed. They will lead communications with the client, faculty advisors, and external advisors, manage the Kindling Equity email account, and coordinate internal and external meetings. Additionally, the co-project managers will meet every 1-2 weeks.

In particular, Brianna will take the lead on editing project deliverables, website development, and client communications. Elena will lead Spanish-language needs of the project and faculty and advisor communications. The Co-Project Managers will further divide management of project goals and deliverables as they evolve.

- Co-Data Manager: Yvonne Dinh
- Co-Data Manager: Iris Foxfoot

The co-Data Managers are responsible for leading the accurate collection, organization, and

analysis of the project's data. This includes: leading development of the data management plan; meeting with UCSB Librarian; identifying and organizing high-quality quantitative and qualitative data sources; managing the team's citation organization system; providing tools to accurately organize metadata; delegating data analysis tasks to other group members; and ensuring the team is relying on data-analysis best-practices.

In particular, Yvonne will manage the project's Geographical Information Systems data and analysis, with special attention to social science data, and will develop file naming conventions. Iris will manage the project's natural science data, explore relevant statistical analysis methods, and organize and manage meta-data.

- Communication and Financial Manager: Alison Sells

Alison will lead financial and external communications aspects of the project. Financial management responsibilities will include: tracking the project budget using Bren internal systems and providing a budget spreadsheet the whole team can access; updating the team on budget status; tracking gifts or grants made to the project; maintaining contact with the Bren Financial Team; and signing-off on project purchases and reimbursements, with advanced notice of at least one-business day. Communications responsibilities include: leading the project's external communications strategy (such as website content creation); delegating external communications tasks to team members; and managing team branded content and style guides as needed.

The Client, Faculty Advisor, PhD. Advisor, and External Advisors will also support the project.

- Client - Ventura Fire Safe Council (VFSC): Kate Furlong will serve as the main point of contact between the student team and the client, with additional support from Elaine Himelfarb. Both are available to support with questions related to the project scope, timeline, and objectives by email and phone throughout the project. They can also help provide relevant data to the project. Both will attend project review meetings, and may attend/host additional meetings or site visits as needed and when it is safe to do so. They will provide feedback on draft and final deliverables.
- Faculty Advisor - Dr. Sarah Anderson: Dr. Anderson will serve as the primary faculty advisor for the team. She will meet with the team weekly; participate in spring and fall review meetings; review and provide feedback on the work plan, faculty review presentation, final report, executive summary, and final presentation; and assign grades to students for ESM 401A, B, C, and D. Dr. Anderson will be continually kept informed on all progress and challenges related to the project throughout the process.
- External Advisor (Faculty) - Max Moritz: Dr. Moritz will serve as the secondary faculty advisor, providing expertise in California wildfire dynamics, planning and management. He will also attend spring and fall review meetings.
- External Advisor (non-affiliate) - Celine Moomey: Ms. Moomey is the Pre-Fire Specialist with the Ventura County Fire Department, and will provide expertise about local wildfire management and risk reduction strategies, and community engagement.

- PhD Advisor - Louis Graup: Louis will advise the team on wildfire impacts; environmental modeling and spatial data; and strategies for completing successful, long-term, graduate-level projects.

ii. Meeting structure.

The Co-Project Managers will schedule all meetings, coordinate meeting rooms, and notify the participants of the meetings.

The scheduling of weekly meetings will take place at the beginning of each quarter to give the faculty advisor and PhD student mentors plenty of notice.

Meeting times and locations for Spring 2021:

- Advisor Meetings: Mondays 4:10 - 5:10 pm PST, zoom
- Core Team Meetings: Wednesdays, 1:15 - 2:15 pm PST, zoom

The role of taking and distributing meeting minutes along with facilitating the meetings will rotate on a weekly basis; with the notetaker from the previous week becoming the facilitator for the next week's meetings. The current facilitation order is: Bri, Elena, Alison, Yvonne, Iris. This is subject to change.

The meeting agenda will be set and distributed 1-2 days before the meeting, and after the meeting the notetaker will distribute the action items discussed to everyone before the end of that business day.

The meetings will follow the agenda set by the students with accommodations made based on topics that arise during the meeting, subject to timing. The facilitator will be cognizant of the time and help keep the group on task while encouraging all group members to share thoughts and voice concerns. Weekly meetings with the Faculty Advisor and PhD Advisor will last for approximately one hour to be respectful of everyone's time.

iii. Guidelines for interacting with faculty advisors, clients, and external advisors.

The group members who are primarily responsible for contacting faculty advisors, clients, and external advisors will be the Co-Project Managers. They are responsible for scheduling peer review and progress report meetings with advisors and clients at least two weeks in advance, via email. They will schedule recurring meetings with the Faculty Advisor, at least two weeks before the quarter starts, again via email. All email correspondence will use the GP alias, and aim to be conducted during typical business hours.

Before any meeting, the assigned facilitator will send out a meeting agenda (two weeks in advance for major milestone meetings, and at least one day in advance for recurring meetings). Within 24 hours after all meetings, the assigned notetaker will email out a short summary and a

list of next steps (also highlighted at the top of the meeting notes). After major milestone meetings, group members (as assigned on a rotating basis) will send out thank you notes to external advisors and clients. Notes will be sent out within a week of the meeting, and this will be coordinated by the Project Managers.

In some cases members of the team with specific roles may reach out to advisors and the client regarding matters under their purview. For example, Data Managers may reach out to the client regarding specific data matters, or the Communication Manager may reach out to clients regarding deliverable content and framing. This correspondence will also take place during business hours and using the GP email alias or by phone.

Virtual meetings, in-person meetings, and field site visits with External Advisors or the Client will require business casual attire, unless an activity necessitates specific clothing (for example, OSHA compliant shoes for a field visit). Casual wear is acceptable for meetings with the Faculty Advisor.

The Client and Advisors will be notified of progress both at the intervals required by the group project handbook, and, in the absence of Bren requirements, at least biquarterly. Progress updates will take the form of short and organized reports via email, or a pre-scheduled meeting.

iv. Systems to ensure that critical tasks are completed on time.

The Co-Project Managers will be responsible for ensuring that all critical project tasks are completed on time; however individual group members are expected to keep track of their assigned tasks. The team will rely on a combination of virtual tools and group meetings to successfully track progress and meet deadlines.

Tools include, but are not limited to: tracking project milestones and deadlines on a shared Google Calendar; visualizing the project timeline and breaking down project milestones into smaller tasks using a shared Gantt chart in Google Sheets; a shared project checklist that assigns group members to particular tasks; group Slack workspace to delegate tasks and update members on progress between meetings; emails after team meetings with assigned action items.

During Wednesday group meetings the Co-Project Managers will highlight any upcoming deadlines, check-in on group progress towards completing deliverables, delegate tasks, or address challenges that arise.

Group members/Kindling Equity Team should notify each other and/or Faculty Advisor at least a day in advance (more for larger deliverables) if interim or final products will be submitted late with an alternative deadline. The project managers will also explore updates to task delegation to ensure all members are being supported and set up for success. If secondary deadlines are not met, the project-managers or Faculty Advisor will set an updated deadline and revisit team responsibilities if relevant as outlined in *Section vii. Conflict Resolution*.

v. Procedures for documenting, cataloging, and archiving information.

Information (documents as well as data) shared by the group will primarily be housed in a shared Google Drive folder, where all members have access. Folders within the shared drive will hold specific documents pertaining to the folder name. For example, */Spring Deliverables 2021* will hold documents related to all deliverables required in the Spring 2021 quarter.

Notes will be taken during every meeting and will be uploaded to the shared Google Drive following each meeting.

A shared Google Calendar will be used to remind and notify group members of upcoming meetings, workshops, and deadlines. Additionally, a project Gantt chart will be made to further remind members of important deadlines and to ensure all tasks are completed.

General team messaging and communication will occur over Slack, where a separate slack workspace exists. This will be the primary communication application between student team members.

Data plays a large role in the success of this project, therefore an efficient and proper data management system must be utilized. Relevant data for this project will likely come in the form of GIS data (ie .shp, .prj, .dbf), which is not conducive for storage in the Google Drive environment. In this case, a separate, physical hard drive OR in a folder on the Bren Server that can be accessed virtually and remotely by all members will be used to store GIS data and other large datasets.

The following data naming conventions will be used when applicable (subject to change):

- Snake case (eg. this_is_snake_case)
- ISO 8601 date formatting (eg. 20210408)
- A prefix of “KE” for “Kindling Equity” (eg. KE_workplan_draft)
- No files that begin with a date

The above conventions are more appropriate for data files and not within the shared Google Drive folder, which mostly holds Google documents where strict naming conventions are not as important.

vi. Overall expectations of group members and faculty advisors.

Students. The students expect timely constructive feedback and regular meetings with the faculty advisor. The project is of their construction with input from the advisor to be treated as guidance and expertise. The students expect that all members of the group will contribute equally and to their full capacity.

Faculty advisor. The faculty advisor intends to be actively involved. She prefers to be kept up to

date through both email and regular meetings. Regarding conflict: the advisor views small issues as easy to solve, and the team should bring any that arise to her to brainstorm and solve together. Dr. Anderson is eager to provide feedback on written documents if a specific deadline is provided. All meetings should be scheduled based on her Google calendar, and attendance can be expected at planned meetings unless otherwise noted.

vii. Conflict resolution process.

As a group, Kindling Equity recognizes that situations will arise that create conflict either for an individual, between group members, or for the group as a unit. We also understand that conflict resolution is highly situationally dependent. Here, we outline our planned responses for a few likely scenarios and types of conflicts along with general conflict resolution guidelines.

General Guidelines. We want to foster a supportive and caring group dynamic that encourages members to address and solve conflict as a group. We will address an issue early, whether it feels insignificant or insurmountable. Together, we will collectively problem solve and make a plan. If we feel that we are out of our depth, we will request the aid of the Faculty Advisor.

Should group problem solving be inappropriate for a given conflict, the order of operations is as follows:

a) Parties involved discuss with the individual one-on-one. Make note that you have had this discussion in your personal notes including the issue and the discussion outcome (applies to intra-group conflict).
b) Talk to a Co-Project Manager. They will act as a mediator and help to hold all parties accountable. They will also notify the Faculty Advisor that there is a conflict but it will be handled by the group. The Co-Project Manager(s) and parties in question will meet and the parties involved will make a plan of action.
c) Meet with the Faculty Advisor. The parties involved will meet with the Faculty Advisor and Co-Project Manager(s) to discuss the conflict and rethink the plan of action.
d) If resolution is still not reached, it may be necessary to schedule a facilitated group meeting with the Assistant Dean or campus ombuds.

Individual struggles. Should an individual group member be struggling, we expect that they will let the group know. This can be a personal struggle or a work related struggle - anything that they find is impacting their ability to complete group work. The team will work with them to alleviate the problem through peer review and re-allocation of responsibilities.

Group disagreements. We recognize that we will not always agree on what is best for our project. To keep our project moving, we will default to majority rule, though will aim to reach group consensus and gain the support of the entire team regarding major project decisions. Dissenting opinions will always be noted in meeting minutes.

Lack of contribution. Initially, lack of contribution will be handled by the Co-Project Manager(s);

however, if the problem persists, the Co-Project Manager(s) will meet individually with the faculty advisor and/or the Group Project Coordinator to discuss the problem and possible solutions.

Budget and Budget Justification

This project has a budget of $1,300 provided by the Bren School with an additional $200 allocated for printing costs. The $ 200 printing budget will be divided equally among members. The expected expenses for this project are listed below. If any unexpected needs arise, the finance manager will make sure to follow proper procedures and/ or reach out to the financial team when necessary.

Expense Details	Amount
Opening Balance	
Translator/ Interpreter	$ 500.00
Transportation/Parking	$ 200.00
meeting refreshments	$ 150.00
Total	**$ 850.00**

Starting Balance	$ 1,300.00
Estimated Expenses	$ 850.00
Remaining Balance	$ 450.00

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