CALIFORNIA ENERGY COMMISSION

Energy Research and Development Division

Comprehensive Open-Source Development of Next Generation Wildfire Models for Grid Resiliency

Long-term Risk Projections Workplan - Phase 2 (Task 10)

PYREGENCE™

Spatial Informatics Group

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Lumen ENERGY STRATEGY

Gavin Newsom, Governor

May 2022

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Introduction

California faces increasing risks of climate change-driven megafires and their catastrophic impacts over the coming century. To frame this risk and spur policies and actions to reduce it, the State funded the development of the 5th Climate Change Assessment (5th Assessment). The 5th Assessment will catalog research on potential impacts of climate change, including wildfire, and recommend adaptation measures to mitigate risk. Workgroup 4 of the Pyregence project will support the wildfire section of the 5th Assessment by modeling spatially explicit projections of wildfire risk based on a range of GHG emission, land use, future climate, and vegetation management scenarios. For each combination of scenarios, detailed map (and underlying tabular) data will be generated and made publicly available to catalyze secondary research that may inform electricity infrastructure resiliency planning and other research and data applications. All code and data will be open source and available via a web-based platform primarily to serve 5th Assessment contributors but also the wider community of investor-owned utilities (IOUs), planners, and researchers for a more resilient California. Specifically, key products developed through this effort will include:

- Specifications for a web-based platform to visualize wildfire risk under different GHG emissions, climate models, land-use pathways, and land management interventions scenarios.
- Meta data and data repository/archive for scenario map products, model inputs, and high-resolution wildfire risk modeled map surface outputs, including future projections under different combinations of scenarios of:
    - Vegetation
    - Biomass
    - Above and below ground carbon
    - Fire size
    - Number of fires
    - Fire presence
    - Fire severity
    - Smoke emissions
- A code repository for the Fire Risk Simulation Model (FRSM) – a coupled statistical and dynamical fire-climate-vegetation model that can be used to run long-term wildfire risk projections under different climate, land use, vegetation management and emissions scenarios.

This workplan outlines a path for collaborators and IOUs (stakeholders) to engage with 5th Assessment researchers with the goal of developing needed and applicable wildfire risk projection products.

Workplan Purpose

The purpose of this plan is to detail the program of work and schedule for activities relating to supporting the 5th Assessment collaborators and IOUs with wildfire risk projections. The primary outcomes of implementing the workplan are to:

- Establish working relationships with the IOUs and 5th assessment collaborators through direct interaction and engagement, leveraging existing collaborations from ongoing and related CEC-funded projects.
- Gain and document a refined understanding of stakeholders' wildfire risk modeling needs, including desired:
    - Future scenarios related to GHG emissions, land use, vegetation management, and climate models.
    - Wildfire risk projection output data and metrics.
    - Features to explore the drivers, likelihoods, and implications of extreme events.
    - Other useful data products and formats, data applications, and functions and features to be included in a web-based tool and can be used to visualize and download data products.
    - Other research and analysis needs associated with wildfire risk projections.

Workplan Tasks

The following section describes the tasks that Workgroup 4 has either already implemented or is planned to be implemented with this workplan.

Task 1. Scenario Development

This task involves the development and refinement of scenarios related to GHG emissions, climate models, vegetation management, and land use for stakeholders to consider and respond to.

Workgroup 4 began scenario design in early 2021. The year-long process to document and refine scenarios included presenting initial scenarios and posing questions to the project Technical Advisory Committee (TAC) and stakeholders through three memos and two dedicated meetings with the TAC. Workgroup 4 concurrently engaged with California's Wildfire & Forest Resilience Task Force and its predecessor, the Forest Management Task Force, to synergize with the Governor's initiatives to address wildfire threats.

For scenarios, we propose to model the following in consideration of feedback from stakeholders (See also Appendix A for additional description of scenarios and input desired from stakeholders):

- At least two GHG emissions scenarios through mid-century (2065, from among SSP2-4.5, SSP3-7.0, and SSP5-8.5), but with an expansive range of climate models (~ 4 or more climate models) that explore variability in precipitation extremes through mid-century. The project team prefers evaluating SSP2-4.5 and SSP5-8.5 through mid-century to capture the lower and upper range in likely emission scenarios. However, the project team is open to model whichever emission scenario is selected by stakeholders associated with the 5th Assessment.
- Two bookend emissions scenarios through the end of the century (from among SSP2-4.5, SSP3-7.0, SSP5-8.5), but with potentially fewer climate models.

For vegetation management, we vetted the following two scenarios with the project's TAC and other stakeholders (See also Appendix B):

- 'High Ambition' Vegetation Management Scenario - This scenario models forest treatments to meet a treatment goal of one million acres per year, identified in a 2018 Executive Order and emphasized in the 2021 California Wildfire and Forest Resilience Action Plan; the plan prioritizes reducing fuels (i.e., through vegetation management) in areas classified by Pyrologix[1] as "high" or "very high" wildfire hazard potential.
- 'Business-As-Usual' (BAU) Vegetation Management Scenario - This scenario represents an attempt to sustain the vegetation management/treatment approach/effort from the previous decade (2010-2019). As such, the total average annual treatment rate across the state is approximately 440,000 acres per year, or 55 percent less activity than the high ambition scenario.

Our greatest challenge in in the development of scenarios over the past year was collecting feedback, including:

- Minimal feedback on future global emissions and climate change scenarios in the State's and in various stakeholders' long-term planning processes. We believe that in 2021 stakeholders were

[1] Volger, K. C., C. J. Moran, and J. W. Gilbertson-Day. 2021. Contemporary Wildfire Hazard Across California. Prepared by Pyrologix, LLC. for the Pacific Southwest Region, USDA Forest Service.

still in the process of digesting modeling results from the IPCC Sixth Assessment Report. Some preferred scenarios appear to be emerging more recently as State agencies initiate staffing and planning for the 5th assessment. We received specific feedback from the CEC that would align scenario design across multiple climate resilience-related studies in progress. Our strategy as of February 2022 will be to propose a specific set of climate scenarios (from among CMIP6 SSP2-4.5, SSP3-7.0, and SSP5-8.5) and invite stakeholders to recommend alternatives that would be more useful for them.

- Lack of specific information about how to represent vegetation management plans or targets in our long-term models, including how to prioritize vulnerable communities. Our impression so far is that specific action plans and targets are still in the process of being developed by State and Federal agencies. The team does not wish to presume any specific wildfire threat mitigation and adaptation applications without more information from those responsible for implementing vegetation management strategies. Nevertheless, we do need to represent these applications in the model and have prepared modeling assumptions based on the general feedback we have received so far (Appendix B). As of February 2022, we have reiterated our tentative approach and assumptions, and we will request more specifics from stakeholders through the implementation of this workplan.
- Lack of feedback on representation of future wildfire threat extremes and their contributing factors (such as extreme/prolonged drought). We plan to incorporate extremes in precipitation as a major contributing factor to extreme wildfire threats in the future. Through the implementation of this workplan, we will welcome additional input from stakeholders about how to represent climate extremes or other types of contributing factors in the models or in model outputs.

Task 2. Frame Stakeholder and Collaborator Input

Under this task, Workgroup 4 will refine questions to focus stakeholder engagement in areas with limited input to date. For example, the following list of questions can help elicit stakeholder input:

- What temporal ranges and endpoints are most relevant for strategic planning and/or climate impact assessment?
    - Mid vs end of century vs beyond end of century?
- We plan on using more climate model runs through mid-century and fewer through end-of-century, with climate runs through mid-Century selected to explore the impacts of differences in timing and severity of droughts, while end of century climate runs would be selected to explore the impacts of global emissions scenarios. What climate scenarios do stakeholders assume in their planning models?
- We are modeling two vegetation management scenarios (Business as Usual and High Ambition). We are proposing that vegetation treatments are prioritized based on the colocation of Wildland Urban Interface, wildfire threat level (targeting high and very high threat level), and vulnerable communities. How can we refine this further? How should we identify vulnerable communities, and what is the best vegetation management strategy (avoid direct burn area vs. enable jobs vs. avoid smoke transport)?

Appendix A and Appendix B provides a more detailed (yet initial) set of focus areas and questions related to GHG emissions, land use, vegetation management and climate models, along with projection time frames and other considerations in need of clarification by collaborators and stakeholders.

For developing the specification for tool development, Workgroup 4 will develop an initial proposed list of desired functions and features that should be included in a wildfire projections tool as a starting point for engaging with stakeholders.

Task 3. Identify and Document Contacts Related to 5th Assessment Collaborators and IOU

This task will include working with our CEC Commission Agreement Manager (CAM) to connect with key 5th assessment collaborators (namely CA Office of Planning and Research). Similarly, Workgroup 4 will engage CEC and the project's Technical Advisory Group to identify individuals and departments within IOUs that are directly engaged with understanding wildfire impact and threats associated with climate change. An element of this task is to also coordinate/leverage stakeholder engagement with other State funded research programs to streamline interactions and reduce stakeholder burnout. For example, Workgroup 4 has already initiated coordination with other stakeholder engagement efforts led by the CEC funded 'Analytics Engine' project. Below is an initial list of organizations, initiatives, and individuals that we already initiated engagement with or otherwise plan to engage with through the implementation of this workplan.

Initial list of collaborator and stakeholders for engagement

Organization/Initiative	Contact
State Agencies (5th Assessment Collaborators)	
Office of Planning and Research - 5th Assessment Collaborators/Working Group	Neil Matouka
CEC C-DAWG	Susan Wilhelm, Alex Horangic, Michael Mastrandrea
IOUs	
San Diego Gas and Electric (SDG&E)	Brian D'Agostino, Fallon Condino, Max Beller, Mark Mezta, Phi Nguyen, Joaquin Sebastian Peral, Ashley Llacuna
Southern California Edison	Robert LeMoine, Dawn Anaiscourt, Stephen Torres, Alexander Pusch, Alexandria Chwierut, Erica Bowman
Pacific Gas and Electric (PG&E)	Bereket Habtezion, Scott Strenfel, Ashley Helmetag
PacifiCorp	Heidi Caswell
Bear Valley Electric Services, Inc.	Paul Marconi
Liberty Utilities (CalPeco)	Eliot Jones, Jordan Parrillo, and Rick Dalton
Other State Funded Research Projects	
Analytics Engine (Eagle Rock Analytics)	Owen Doherty, Mark Koenig, Kripa Jagannathan
Cal-Adapt (UC Berkeley)	Nancy Thomas, Owen Doherty
Climate Projections (UCSD-SCRIPPS, UCLA)	Julie Kalansky, Dan Cayan, Davis Pierce, Stafan Rahimi

For 5th assessment collaborators interactions to date, Workgroup 4 has participated in the inaugural meeting of CECs Climate Data and Analytics Working Group (C-DAWG) – a forum organized to facilitate technical discussions regarding issues surrounding climate change and California's energy system.

Task 4. Engage Collaborators and Stakeholders

Under this task, Workgroup 4 team members will either lead stakeholder engagement through direct meetings with focal IOUs or otherwise leverage and participate with others involved in stakeholder engagement (e.g., Analytics Engine, C-DAWG, 5th Assessment Working Group). At these meetings, we will focus our efforts on eliciting input from stakeholders identified in Task 3 on the focal questions identified in Task 2.

Task 5. Summarize Stakeholder Input

Key input received on both scenarios and desired functions and features for the wildfire risk tool will be documented and, if necessary, clarified with stakeholders if the input is unclear. The information collected on scenarios will be used to inform the parameterization of models associated with projecting wildfire risk outputs, and input received on tool features and functions will be integrated into a tool specification document.

Task 6. Follow-up engagement – Wildfire Risk Models

After wildfire risk model runs are completed (based stakeholder input on scenarios), additional stakeholder engagement meetings or a webinar will be scheduled to highlight methods used and results achieved. All input received at this meeting(s) will be noted.

Schedule

Task	2021	2022			2023		
		Quarter 2 (April to June)	Quarter 3 (July to Sept.)	Quarter 4 (Oct. to Dec.)	Quarter 1 (Jan. to March)	Quarter 2 (April to June)	Quarter 3 (July to Sept.)
Task 1. Initial Scenario Development/ Tool Features							
Task 2. Key Questions							
Task 3. Identify Collaborators							
Task 4. Engagement Meetings							
Task 5. Stakeholder Summary							
Task 6. Follow-up							

Appendices

Appendix A. Memo describing long-term climate and global emissions scenarios.

DATE: March 3, 2022

TO: Pyregence Technical Advisory Group

FROM: Leroy Westerling, Workgroup #4 Lead, Pyregence Project (and Workgroup #4 members)

RE: Long-Term Climate and Global Emissions Scenarios

The Pyregence Consortium, a collaborative group of forest and wildfire scientists and modelers, is in the process of developing the next generation of statistical and dynamical wildfire and landscape models. These models simulate potential future wildfire risks and vulnerabilities under **projected climates** and under different land use and vegetation management scenarios. Pyregence is undertaking this work through an EPIC grant (#EPC-18-026) administered by the California Energy Commission (CEC) Energy Program Investment Charge program (EPIC), with the goal of producing models for use in California's 5th Climate Change Assessment and other wildfire-related strategic planning efforts, especially related to investor owned utilities (IOU).

Desired Outcome from this Memo

We seek your input — even if just a sentence or two—via email (sromsos@sig-gis.com with a CC to lwesterling@ucmerced.edu). If you would prefer to talk over the phone, we will happily arrange 15- or 30-minute one-on-one calls to collect your thoughts. Your feedback will help us to select and design the most useful and relevant data and tools for the upcoming California 5th Climate Change Assessment.

Purpose of Long-Term Climate and Global Emissions Scenarios

We seek your advice on scenario selection to:

- Better understand what scenario characteristics, over what time horizons, and with what outputs are most relevant in your strategic planning, recognizing that climate and global emissions are interrelated. For example, how relevant to your work is the (a) global shared socioeconomic pathway (SSP) versus (b) global Representative Concentration Pathway (RCP) emissions scenario, versus (c) global warming level, regardless of how it is reached? How does your organization define an extreme wildfire event of interest?
- Align with recent/prior efforts to facilitate cross-study comparisons and understanding of our modeling results. We would like to align our work with climate scenarios you routinely reference or use as benchmarks, selecting SSPs for the current assessment that are comparable to RCPs used for prior assessments. For example, SSPs corresponding to RCP4.5 as a low GHG emissions scenario and SSPs corresponding to RCP8.5 as a high scenario would be consistent with Cal-Adapt, California Public Utility Commission (CPUC) decisions, and other prior modeling efforts we review.
- Align with your most current thinking on the most relevant climate and emission scenarios.
- Prioritize realistic temporal ranges or endpoints that would be most helpful to your strategic planning efforts. Through mid-century (say 2065) we can model a broader range of scenarios, but between mid-century and end of century we would like to limit to a smaller number of climate scenarios (e.g., two climate model runs) given our budget and scope of work limitations.

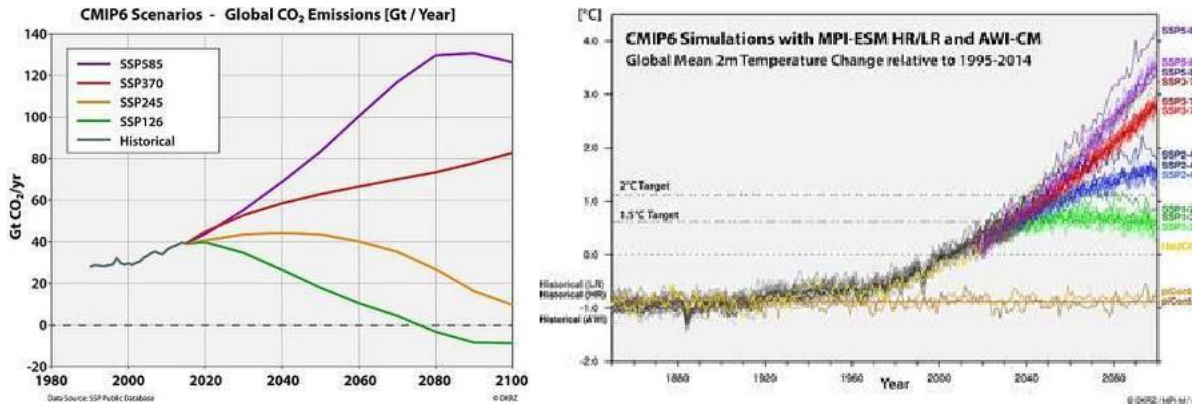
Overview of Scenario Options

Long-term GHG emissions scenarios provide useful context on the direction and severity of potential atmospheric and temperature changes by the end of the century. However, time horizons for policies to manage our exposure to (and ability to adapt to) climate change are shorter - extending through mid-century at most. Policy developments, such as forest treatment decisions for the next several decades, are better informed by exploring the effects of variability in drought and precipitation extremes more generally, coupled with nearer-term trends in temperature, expected population growth, and scenarios for development footprint and land management. The differences between the impacts of various global emissions trajectories on temperatures – and thus wildfire risks – through mid-century are potentially modest compared to the impacts of drought timing, severity, and duration coupled with the effects of investments in reducing our exposure to fire risks via fuels management and development footprints.

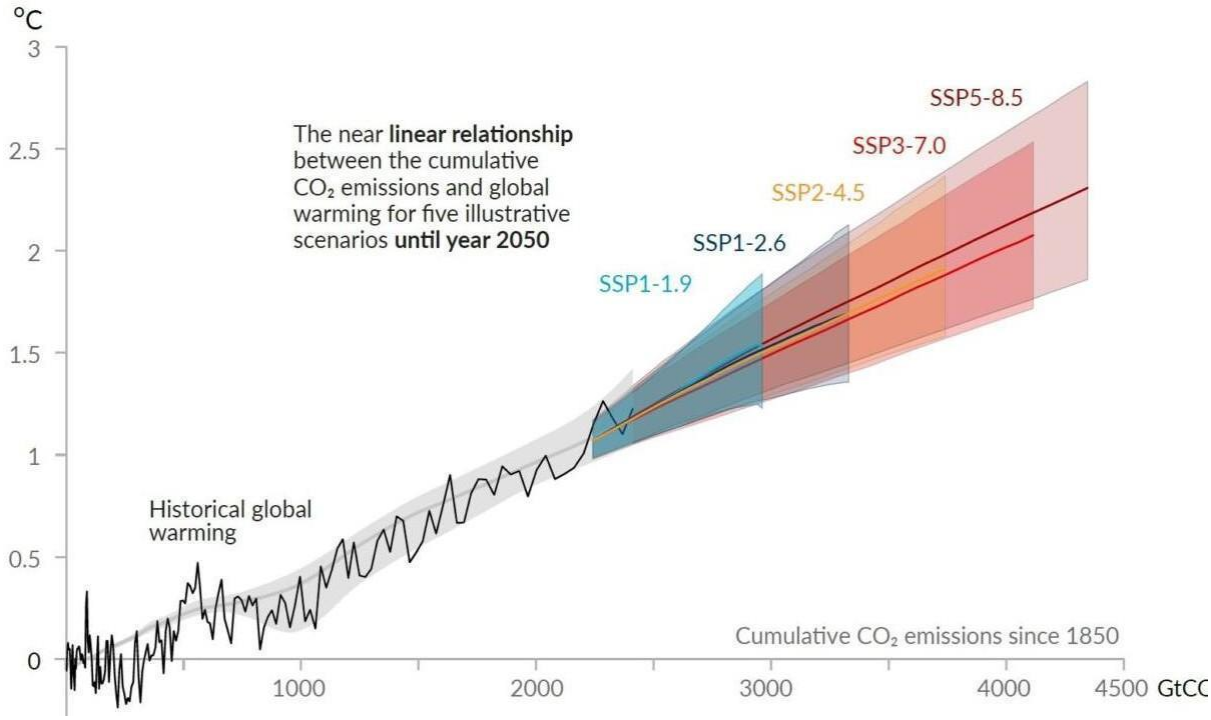
Over the longer term, uncertainties related to unanticipated changes in population and urban development (for example, people moving from urban to suburban or rural areas during a pandemic) and global emissions trajectories can dramatically impact end of century wildfire risks and our exposure to them. These uncertainties limit the usefulness of planning now for end-of-century fuels management. Part of our challenge in scenario design is to balance information from end-of-century projections, with mid-century concerns, and with the realities of even nearer-term issues that need to be addressed.

For example, long term trajectories of emissions scenarios vary a great deal (see left graphic in Panel A below). They change the timing and end point of global temperature increases and they have a similar relationship with global mean temperature outcomes (Panels B and C). The range of temperatures across those scenarios is most striking at the end of the century. Over the next several decades, however, the impact is modest compared to the potential impact on wildfires of different scenarios for drought over the same time period. Regional and more local scenarios for variability in precipitation help us to explore impacts of drought variability coupled with temperature trends on wildfire through mid-century (Panel C).

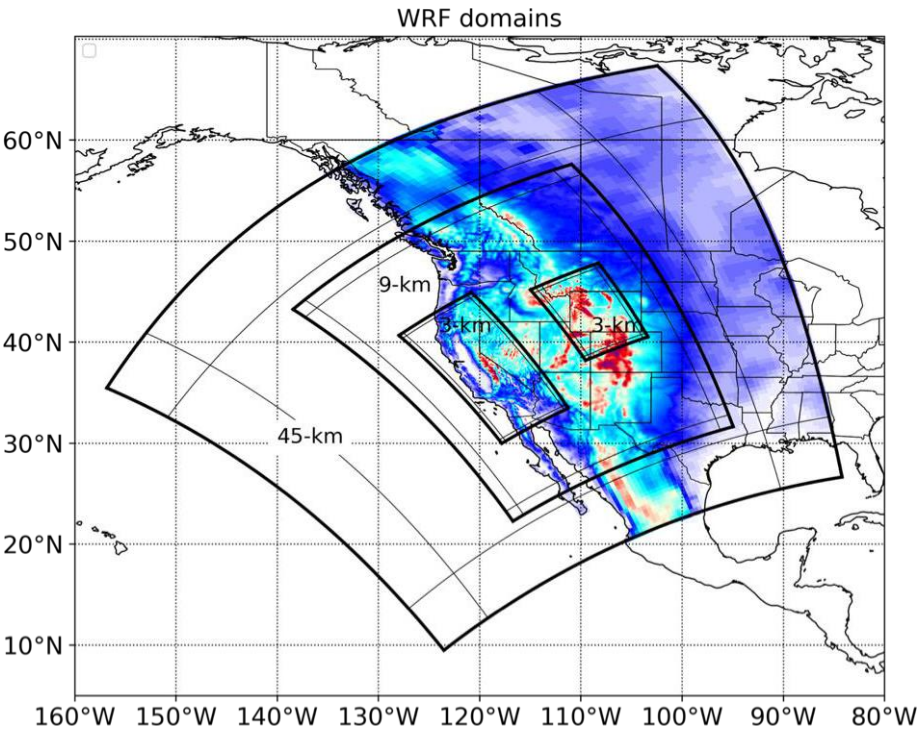
A: Coupled Model Intercomparison Project 6 (CMIP6) Emissions Scenarios through End of Century



B: Global Temperature Increase as a Function of Cumulative CO2 Emissions



C: Granularity of Climate Scenarios



Proposed Scenarios
We propose modeling:

- At least two GHG emissions scenarios through mid-century (from among SSP2-4.5, SSP3-7.0, and SSP5-8.5), but with an expansive range of climate models (~ 4 or more climate models) that explore variability in precipitation extremes through mid-century. The project team prefers evaluating SSP2-4.5 and SSP5-8.5 through mid-century in order to capture the lower and upper range in likely emission scenarios. However, the project team is open to model whichever emission scenario is selected by stakeholders associated with the 5th California Climate Change Assessment.
- Two bookend emissions scenarios through the end of the century (from among SSP2-4.5, SSP3-7.0, SSP5-8.5), but with potentially fewer climate models.

For vegetation management, we vetted the following two scenarios with the project's Technical Advisory
Committee and other stakeholders:

- High Ambition Vegetation Management Scenario - This scenario models forest treatments to meet a goal of one million acres treated per year, a goal identified in a 2018 Executive Order and emphasized in th; the plan prioritizes reducing fuels (i.e., through vegetation management) in areas classified by Pyrologix[2] as "high" or "very high" wildfire hazard potential.
- Business-As-Usual (BAU) Vegetation Management Scenario - This scenario represents an attempt to sustain the vegetation management/treatment approach/effort from the previous decade (2010-2019). As such, the total average annual treatment rate across the state is approximately 440,000 acres per year, or 55 percent less activity than the high ambition scenario.

Additional Considerations
Along with scenario selection, we are seeking your view(s) on:

- **Global warming level & impacts versus timing of impacts.** How important is it to (a) explore the range of global warming levels and corresponding impacts on California versus (b) projecting the timing of when such impacts could occur?
- **Mid-century versus end-of-century outlook.** The team is discussing how much effort to allocate for modeling the lattermost years of this century (2065–2100). In particular, we would suggest emphasizing the long-term trade-offs between low and high global emissions for the end of century scenarios. That is, by the end of the century the dominant effects driving any scenario analysis will be the cumulative effects of high versus low emissions trajectories on end of century temperatures. This is in contrast to mid-Century, where we believe differences in cumulative effects of different emissions trajectories are less important to planning than are the effects of variability in timing and intensity of precipitation extremes combined with overall

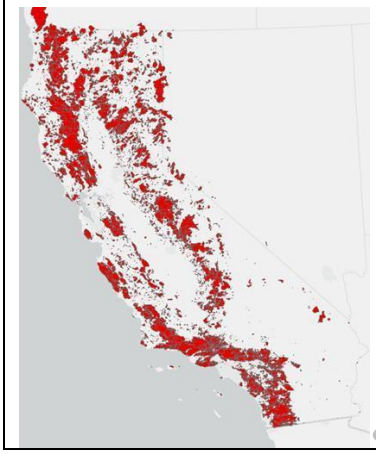
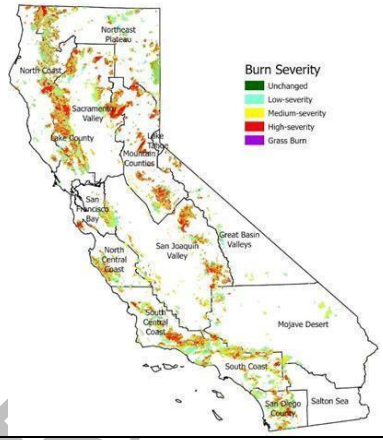
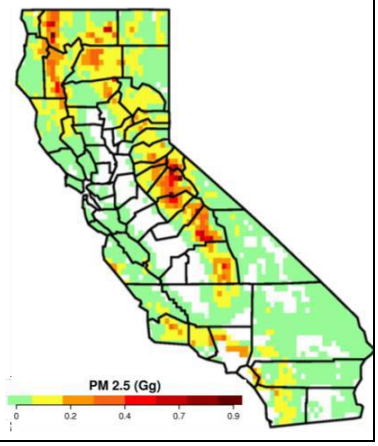
[2] Volger, K. C., C. J. Moran, and J. W. Gilbertson-Day. 2021. Contemporary Wildfire Hazard Across California. Prepared by Pyrologix, LLC. for the Pacific Southwest Region, USDA Forest Service.

warming. What outlook years are most important to you (e.g., 2045 for meeting clean energy goals)?[3]

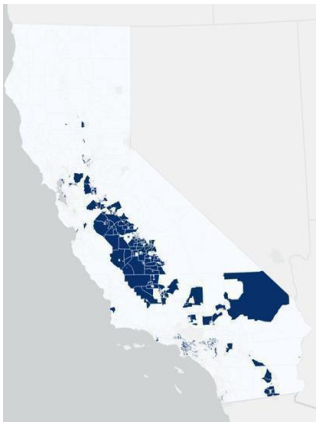
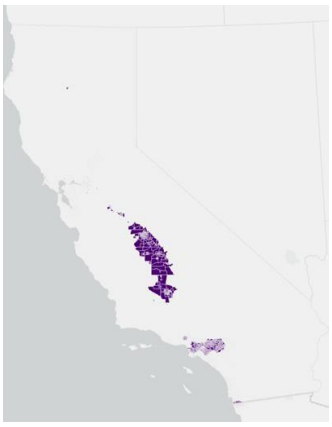
- **Extreme events.** Other than climate changes in general, how important is it to capture extreme events in your long-term models? Specifically, what types of extreme events or combinations of events are you interested in? Over what time horizons are needed and meaningful for decision making? Extreme events here could refer to the impacts of the timing and intensity of major droughts interacting with the warming trend. They could also refer to how one defines an extreme wildfire event: A season with a number of wildfires over a threshold? A season with a number of very large fires over a threshold? A season with total area burned over a threshold? A season with an area burned at high severity over a particular threshold? A season with large fires burning simultaneously in pre-specified locations? A single fire event of a certain size or severity occurring in a particular location? Historically uncharacteristically large and severe (i.e., high biomass burned or high energy release) in highly populated wildland-urban interfaces, or in critical watersheds, or in endangered species habitat, or …?
- **Streamlined scenarios after 2064.** The team may streamline the vegetation management and urban development scenarios after 2064. For example, maintain a low sprawl trajectory (concentrated around existing communities) for urban development footprint after 2064. For vegetation management - should we assume a vegetation treatment "maintenance mode" in terms of extent, timing, and space - where fuels are maintained at a level conducive to reduced fire risk? What would be most useful to you: BAU vs. high ambition treatment rates? Low vs. high sprawl urban development?
- **Trade-offs in work effort**. Extreme events significantly influence vegetation conditions and the extent and distribution of fires. Examples of such linkages include the severe 2012-2016 drought resulting in widespread tree mortality or a combination of extreme heat and drought resulting in the 2020 and 2021 fire seasons. Generally, climate model outputs do not capture the frequency or magnitude of extreme events that we have recently experienced. We could consider the feasibility of using resampled climate data in lieu of an additional SSP scenario because that approach would allow us to investigate ecosystem response and area burned in response to increasingly frequent extreme events. Regardless of how the supporting climate data are derived, what should the minimum set of scenarios through the end-of-century look like? How much additional detail should we incorporate through mid-century with fully coupled fire and vegetation models? Is there a preference to generate outputs that better reflect variability in extreme events or is there a preference to stick to selected emissions scenarios and the range of precipitation variability available in the existing climate model runs?
- **Spatial prioritization of vegetation management efforts.** We previously proposed prioritizing reducing wildfire risk through vegetation management at the wildland-urban interface (WUI) and in areas designated with high wildfire threat. Under this prioritization scheme, WUI areas with high fire threat classification would be prioritized for fuels reduction treatment first. As those acres are completed, areas beyond the WUI that are classified as high fire threat would be addressed next and so on until all high fire threats are treated then move into vegetation maintenance mode. The graphics below show California's historical large wildfire burn

[3] Per CPUC's Adaptation Rulemaking, Decision 20-08-046, Findings of Fact item #33 "*The appropriate intervals for the intermediate time frame for vulnerability assessments is 10-20 years and for long-term horizons it is the next 30-50 years. The key time frame for the vulnerability assessment is the next 20-30 years.*"

perimeters over 10 acres (Panel D), our estimates of historical burn severities (Panel E), and projections (from 2014) of mid-century PM2.5 emissions (Panel F) for reference on where most vegetation management would be generally modeled. For California's Fourth Climate Assessment, only "large" fires over 1,000 acres in size were simulated. For the 5th assessment, we could conceivably use a lower size threshold for large fires since we are mapping our own burn severity products and using perimeter rasters from CAL FIRE, which span a broader fire size range. In either case, we are excluding most observed fires, since most fires are very small and quickly controlled, and have a modest impact.

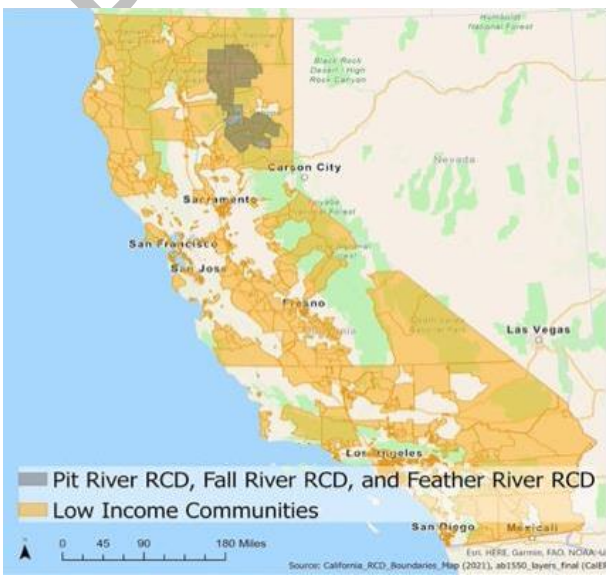
D: CAL FIRE Historical Large Wildfire Burn Perimeters	E: Historical Burn Severity	F: 2014 Projection of Mid-Century PM2.5 Emissions
		

We have also been asked to include socioeconomic factors under our "high ambition" vegetation management scenario of treating one million acres per year. The graphics below show the current distribution of 1) disadvantaged communities from CalEnviroScreen (v4) (Panel G), 2) the top 25th percentile of communities in terms of poverty burden (Panel H), and 3) the top 25th percentile of communities in terms of PM2.5 burden (2.5; Panel I) according to CalEnviroScreen 4.0 (October 2021).

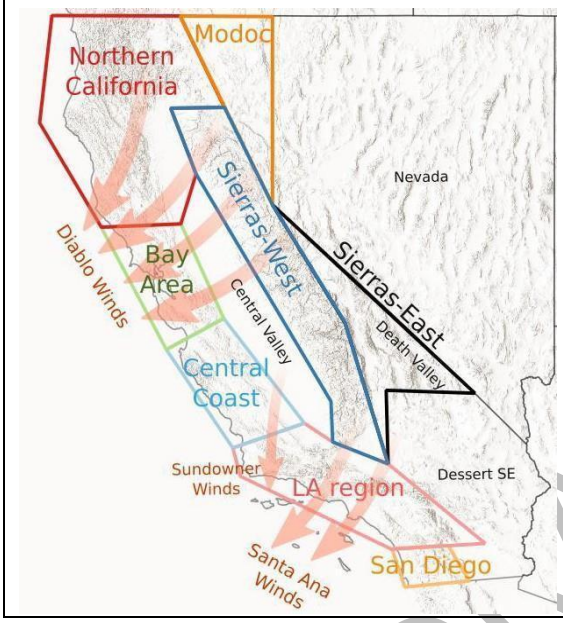
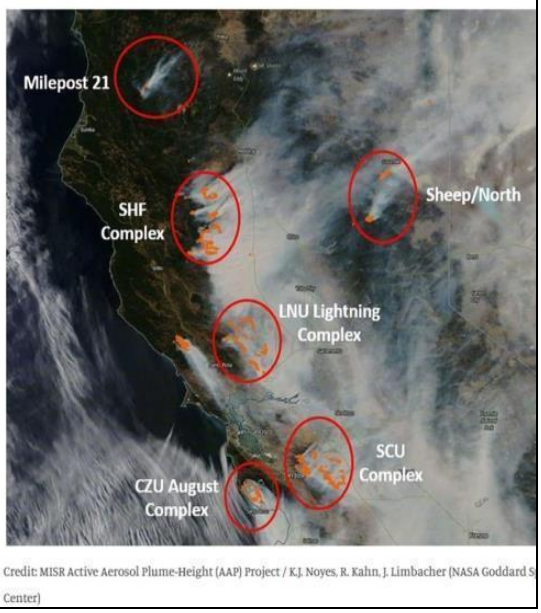
G: Distribution of Disadvantaged Communities per CalEnviroScreen	H: Distribution of High Poverty Burden Communities per Housing and Community Development	I: Distribution of High PM2.5 Burden Communities
		

The areas historically burned do not have high spatial alignment with the disadvantaged communities shown in panels G to I (predominant in California's central valley). However, additional prioritization within the WUI Interface, high wildfire threat areas, and low-income communities (Panel J) may be beneficial to the extent some of the most likely or highest severity burn areas are responsible for transporting air pollutants to already burdened communities and could provide economic benefit to low-income communities within the high-fire threat context (Panel J).

J: Low-Income Communities within California



The graphic below shows two frequent extreme wind patterns in California (Panel K) and an example of 2020 historical smoke transport patterns (Panel L). Diablo and Santa Ana's extreme wind types help to illustrate the spread from distant sources of pollutants to disadvantaged communities, although we may also want to consider less extreme winds such as those in 2020.

K: Extreme Wind Patterns - Diablo and Santa Ana Wind Events	L: Sample of 2020 Smoke Transport
	

Credit: MISR Active Aerosol Plume-Height (AAP) Project / K.J. Noyes, R. Kahn, J. Limbacher (NASA Goddard S Center)

Do you have thoughts on how we could refine our prioritization/allocation of vegetation management efforts to better relieve disadvantaged communities or otherwise better mitigate wildfire related risks to communities?

Thank you for sharing your thoughts and for providing valuable guidance to the Pyregence team. Please call or email Shane Romsos (at 530-721-7508 or sromsos@sig-gis.com) to set up a meeting to further discuss scenario options.

Appendix B. Memo on proposed vegetation management scenarios for long-term wildfire risk projection models

DATE: July 21, 2021

TO: Pyregence Technical Advisory Committee (TAC) and Stakeholders

FROM: Leroy Westerling, Workgroup #4 Lead, Pyregence Project

RE: Proposed Vegetation Management Scenarios for Long-term Wildfire Risk Projection Models

The Pyregence Project Consortium, a collaborative group of forest and fire scientists and modelers, is in the process of developing the next generation of statistical and dynamical wildfire and landscape models to simulate potential future wildfire risks and vulnerabilities under projected climates and a range of vegetation management scenarios. The Consortium is undertaking this work through an EPIC grant (EPC-18-026) from the California Energy Commission and is tasked with producing these models for use in California's 5th Climate Change Assessment and other wildfire-related strategic planning efforts.

This memo is a follow-up to a previous request for information from March 2021 regarding the development of future vegetation management scenarios that are to be integrated into the long-term wildfire risk modeling framework. Below, we have characterized aspects of two scenarios ('*high ambition*' vs '*business-as-usual*') and seek your acceptance and/or feedback in their refinement.

If you would like to provide feedback on the scenarios described below, we request it by close of business on August 6, 2021**.** Please submit your feedback and/or clarifying questions related to the scenarios to Charles Maxwell (cmaxwell@sig-gis.com), Leroy Westerling (lwesterling@ucmerced.edu), and/or Shane Romsos (sromsos@sig-gis.com).

We developed two vegetation management scenarios to assess the potential effectiveness of a '*high ambition*' forest health treatment regime (one million acres treated per year), consistent with 2021 California policy, versus management regime associated with '*business-as-usual*' forest health treatments (approximately 440,000 acres treated per year) consistent with 2010-2019 reported treatments within the State. This memo includes definitions, assumptions, and results as applied under both scenarios to different forest management zones in California.

Definitions

Wildland Urban Interface (WUI), Interface - housing is adjacent to wildland vegetation, mechanical and manual treatments are possible. WUI Interface zones are found throughout the state and are adjacent to state and federal managed lands.

WUI Intermix - housing and wildland vegetation intermix, with mechanical and manual treatments possible. WUI Intermix zones are found throughout the state and are adjacent to state and federal managed lands.

Mechanical treatments – are available on slopes less than 30%, and for the sake of modeling any area under the slope requirement considered accessible. This is inclusive of activities like mastication, tractor

logging, chipping, crushing, and piling. Trees up to 24" dbh in size are removed using mechanical treatments.

Manual treatments – are available on all slopes, prioritized on slopes greater than 30 percent, generally inclusive of hand piling, lop and scattering. Trees up to 11" dbh are removed.

Ecological harvest methods – are available on slopes less than 30 percent, with no accessibility constraints. Limited to specific state and federal management areas. Trees up to 30" dbh are eligible for harvest.

State responsibility area (SRA) – are areas where California is responsible for fire suppression, inclusive of state-managed, non-industrial private, local, and federal lands.

State-managed lands - are lands owned and managed by California, also included fully within SRA.

Vegetation Management/Treatment Scenarios

High Ambition Vegetation Treatment Scenario

This scenario models forest treatments to meet the one million acres treated per year goal found in the 2021 California Wildfire and Forest Resilience Action Plan and prioritizes reducing fuels (i.e., through treatments) in areas classified as 'high' and 'extremely high' fire hazard risk zones (Figure 1). The high rate of treatment in this scenario allows some, but not all, of the management areas to be completely treated within a 15-year timespan. Areas that are only able to be treated manually will not be fully treated within a 15-year time frame (except that state-owned lands will be completely treated). Federal lands eligible for mechanical treatments would be treated within that timeframe, while areas requiring manual treatment would not. At a treatment rate of 111,000 acres per year for WUI Interface lands in State Responsibility Areas, all acres would be treated within 18 years. For accessible WUI Intermix lands, mechanical treatments would allow all eligible areas to be treated within 20 years. However, for WUI Intermix lands that are only eligible for manual treatment, only 28 percent of the extremely high hazard areas would be treated in 15 years. Treatable areas exclude areas that are inaccessible due to special jurisdictional/administration designation (e.g., wilderness, national monuments, etc.) and natural features (e.g., high slope). Table 1 provides a summary of all forested acres and annual treatment acres by management zone under this scenario.

Assumptions

The major assumptions to prioritize treatments include:

1. Treatment of the WUI Interface takes precedence over WUI Intermix at a 60%/40% split.
2. This Interface to Intermix precedence would result in a 70%/30% split between mechanical treatment over manual treatment[4].
3. Timber harvesting on private lands will count towards the acreage target of treatments on private lands.

[4] This assumption would mean that of the total acres allotted to WUI treatments, there would be 300,000 * 40% * 70% = 84,000 of mechanical treatments in the WUI Intermix (where slopes are less than 30%).

4. Prescribed fires can occur on any slope class and harvestable areas occur only where mechanical treatment is possible (areas with slopes less than 30%).
5. For State and federally-managed lands, harvesting will be based on ecological harvest methods which would leave a high residual of remaining basal area and standing snags.
6. For Private lands, harvesting will be consistent with current practices.
7. Any areas with a protected status—such as roadless areas, PACs, wilderness, national monuments, etc. (totaling 40 percent of acres considered)—would not be treated by mechanical or manual means.
8. High fire suppression effort would be emphasized everywhere except in roadless and wilderness areas where fire would serve as a restoration action.
9. Corporations would be responsible for reducing the fire risk on their lands; corporately-held lands would harvest at business-as-usual rates of a 36-year return interval.
10. For family-owned forests, the continuation of present harvest rates would indicate a 200+ year return interval.
11. For transmission infrastructure, investor-owned utilities would perform significant additional vegetation control around their respective transmission infrastructure up to 175 ft from transmission lines (totaling a 350 ft buffer, centered on transmission poles), following Liberty CalPeco and the California Tahoe Conservatory's Powerline Resilience Corridor Strategy.

Treatment Schedule

The vegetation treatments would follow CalFire's fire hazard ranking order where areas mapped as 'extremely high' hazard would be treated first, descending through 'high,' 'moderate,' and eventually any 'low'-risk areas if time and resources permit.

Retreatment would occur on a 15-year rotation for WUI areas (both Interface and Intermix) and State managed areas.

After 15 years, for federally managed lands, prescribed fire would supplant mechanical and manual treatments at a rate of 50% to maintain the "treated" status, such that annual treatments would be 335,000 acres of prescribed fire, 190,000 acres of mechanical treatments, and 72,500 acres of manual treatments.

Results

Using the described schema:

- At a rate of 111,000 acres treated per year for the WUI Interface zone, all areas in State Responsibility Areas would be treated within 18 years, regardless of fire risk level.
- At a rate of 51,800 acres treated per year for the WUI Intermix areas that allowed for mechanical treatment, all eligible areas would be treated within 20 years.
- At a rate of 22,200 acres treated per year for the WUI Intermix areas only eligible for manual treatment, only 28% of the extremely high hazard area would be treated after 15 years, leaving a potential shortfall of over 840,000 acres.

At the proposed rate of treatment of 50,000 acres per year, all State Park lands, excluding protected areas, could be treated within 15 years, potentially allowing for treatment of 500,000 acres of lands under local or tribal management in the same timeframe.

For federally managed lands, while all of the eligible mechanically treatable areas could be treated within 15 years at a rate of 380,000 acres per year, lands receiving manual treatment at a rate of 145,000 acres per year for 15 years would leave close to four million acres untreated. Because most of the funding is coming from the State of California, it is assumed that treatments on federal land would follow SRA risk prioritization. Using this approach, the rate of treatment would be sufficient to treat all the lands in the elevated hazard risk areas and could feasibly be distributed differently depending on annual priorities.

For corporate and family-owned forest lands treated at a rate of 115,000 acres per year (95,000 acres corporate, 20,000 acres family), a substantial deficit of nearly four million acres would remain after 15 years.

Based on a treatment rate of 10,000 acres per year around transmission lines, it would take almost 30 years for all the areas in the elevated fire risk classes to be treated, or 16 years for the high and very high-risk areas to be treated. Increasing the treatment rate to 30,000 acres per year allows for a retreatment interval of 10 years.

Business-As-Usual (Low Ambition) Treatment Scenario

This scenario represents an attempt to perpetuate the vegetation management/treatment approach from the previous decade (2010-2019). As such, the total average annual treatment rate across the state is approximately 440,000 acres per year, or 55% less activity than the high ambition scenario. Treatment levels are based on completed activities reported by departments and agencies and averaged across the decade. Rather than specifically targeting areas of the landscape, treatments are opportunistic and scattered across the landscape. High fire suppression efforts will be applied across the entire landscape. All the assumptions from the high ambition scenario apply to this scenario as well. Table 1 provides a summary of all forested acres and annual treatment acres by management zone under this scenario and is compared to the high ambition scenario.

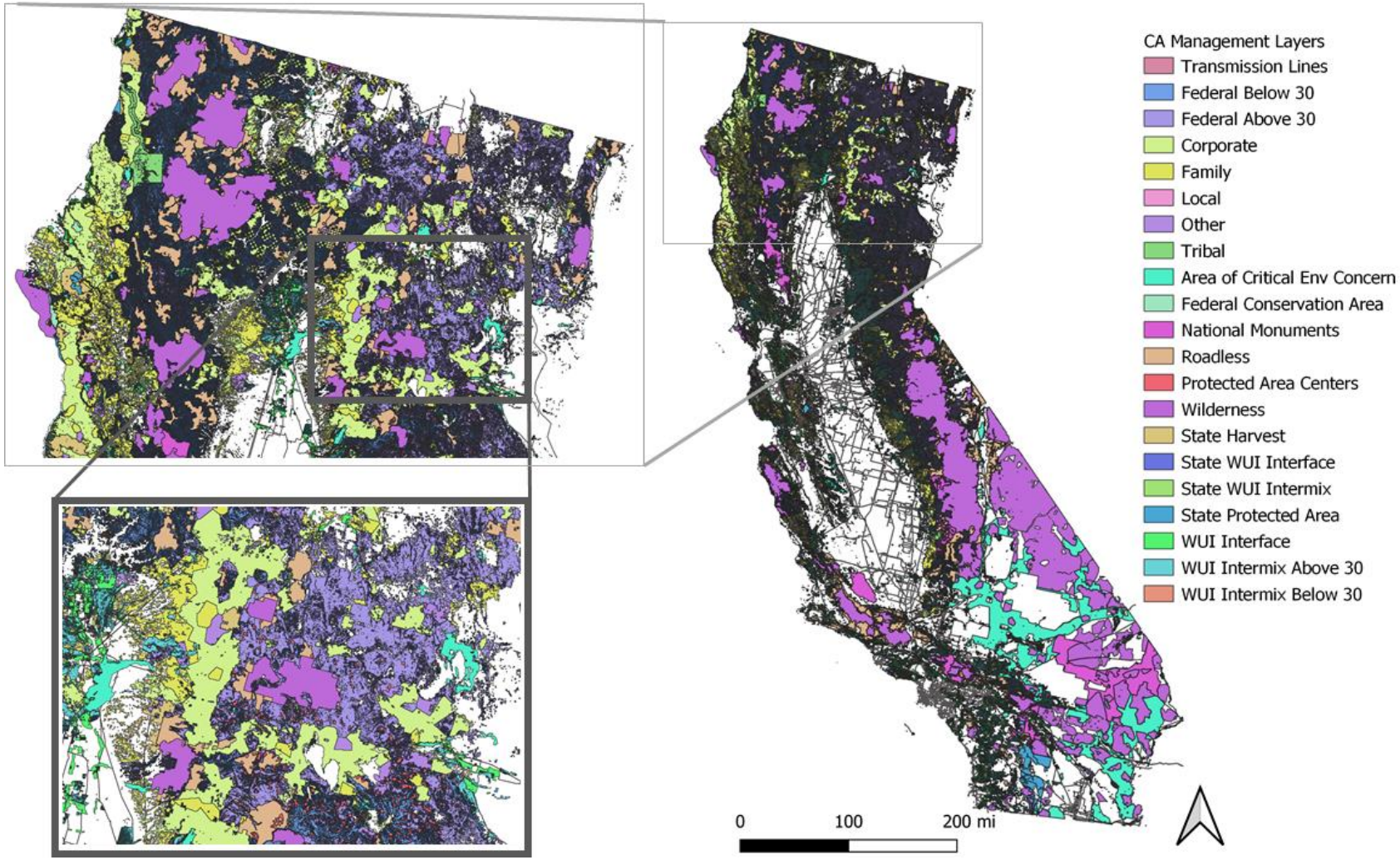
Figure 1. Map of Pyrologix's Wildfire Hazard Potential Rating binned into quartiles. This map is inclusive of all acres delineated in Table 1.

Table 1. *Summary of management zone by fire hazard severity class (Figure 1), and targets for acres of vegetation treatment achieved under both scenarios. Note that the "State Prescribed Fire" zone is inclusive of State Harvest Eligible, State WUI Interface and State WUI Intermix.*

		CalFire Fire Risk Severity Classes			Scenario assumed percent allocation for WUI zones		Scenarios - Acres Treated per Year	
Management Zone	**Total**	**Moderate**	**High**	**Very High**	**Allocation**	**Sub-allocation**	**High Ambition**	**BAU**
WILD/URBAN AREAS								
WUI Interface	1,949,231	152,102	85,962	128,551	60%		111,000	57,000
WUI Intermix Slope Above 30%	3,416,728	749,110	758,526	1,173,885	40%	30%	22,000	11,400
WUI Intermix Slope Below 30%	1,042,384	103,391	249,976	453,450		70%	51,800	26,000
STATE MANAGED								
State Harvest Eligible	778,196	40,631	399,658	241,427			2,000	2,000
State WUI Interface	13,119	293	220	37	25%		13,119	6,250
State WUI Intermix	85,415	2,047	4,627	1,149	75%		36,881	18,750
State Prescribed Fire Assumes that Rx can be applied on any of the other State owned zones	876,729	42,971	404,504	242,613			50,000	20,000
OTHER OWNERSHIPS								
Corporate	3,466,899	137,679	1,051,836	2,138,617			95,000	95,000
Family	4,068,454	541,333	1,709,092	1,646,432			20,000	20,000
Local	210,431	29,385	100,223	65,506				
Other	383,006	21,858	118,188	223,570				
Tribal	227,151	6,637	19,002	41,866				
FEDERAL MANAGED								
Fed Below 30	5,548,680	162,291	304,133	1,074,333	70%		380,000	87,070
Fed Harvest Eligible	5,548,680						40,000	29,000

		CalFire Fire Risk Severity Classes			Scenario assumed percent allocation for WUI zones		Scenarios - Acres Treated per Year	
Management Zone	**Total**	**Moderate**	**High**	**Very High**	**Allocation**	**Sub-allocation**	**High Ambition**	**BAU**
Assumes harvest can only occur on slopes below 30%								
Fed Prescribed Fire Assumes that Rx fires can be applied on any slope	5,548,680	162,291	304,133	1,074,333			75,000	24,100
Fed Above 30	5,710,213	36,762	188,122	894,358	30%		145,000	37,316
UTILITIES								
Transmission Lines	939,983	139,330	83,095	73,700			30,000	10,000
PROTECTED AREAS								
State Protected Area	587,204	55,549	174,640	197,700			NA	NA
Areas of Critical Environmental Concern	2,139,361	61,820	60,968	52,915			NA	NA
Fed Conservation Areas	131,404	520	2,269	296			NA	NA
National Monuments	1,866,727	44,063	43,287	96,318			NA	NA
Protected Area Centers	422,107	0	1	719			NA	NA
Roadless	4,414,251	516	536	3,685			NA	NA
Wilderness	6,947,567	12,229	23,468	98,870			NA	NA
Total Acres	39,512,152	7,939,884	10,633,345	12,532,681			1,072,000	443,486

Figure 2. *Map of derived management areas in California inclusive of all landscape types except for urban areas, agricultural lands, and deserts in private ownership. Zoomed areas indicate the variability of forested landscapes throughout the state in terms of jurisdictional management, accessibility, and ecosystem type.*



Sources:

CalFIRE Fire Hazard Severity Zones Maps <https://osfm.fire.ca.gov/divisions/wildfire-planning-engineering/wildland-hazards-building-codes/fire-hazard-severity-zones-maps/>

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