Examining the Use of Risk Analytics in Climate Adaptation and Vulnerability Assessments (GC13L-0775)

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Introduction

The impact of extreme climate hazards, such as heat waves, floods, and droughts, on society is far reaching. As our climate continues to change, adaptation strategies become even more critical for ensuring a resilient future. Climate Adaptation and Vulnerability Assessments (CAVAs) provide a way for entities, from local communities to large businesses, to assess climate-hazard risks on their activities. When these risk assessments are built on a strong foundation of science using high fidelity data, they provide an opportunity for an entity to make climate-informed decisions so as to reduce exposure, enhance resilience and mitigate impacts for a more climate-resilient future.

Many advanced risk analytics are produced by the private sector, and unavailable to communities and entities due to financial barriers. The Cal-Adapt: Analytics Engine (AE), led by Eagle Rock Analytics (ERA), is an open-source, cloud-based platform co-produced with utilities and state agencies to build solutions. AE provides high fidelity open-access climate data, methods, tools, and guidance materials for users as they produce their state-mandated CAVAs.

Here we present recent work done to meet the growing demand for climate change information and decision support to examine the climate risks to watersheds, renewable energy, and more. This work emerges from engagement with entities from utilities, universities, county and local governments, regional government consortiums and trans-national consortiums.

Regional Impacts on Global Warming Levels

Eagle Rock Analytics is pioneering the use of a Global Warming Levels (GWL) for regional vulnerability assessments. Adopting the latest scientific methods from international climate assessments, the GWL framework allows vulnerability assessments to use the latest climate simulations while avoiding the "hot model problem". Through extensive co-production efforts, ERA has developed novel approaches to integrate GWLs into regional vulnerability assessments. Yielding a clearer view of regional climate impacts, in sync with globally recognized climate change mitigation milestones.

	Global Warming Level	Best estimate year
Historical baseline	0.8 °C	2002
Near Term Planning	1.5 °C	2031 (SSP 3-7.0)
Mid-Century Planning	2.0 °C	2047 (SSP 3-7.0)
Long Term Planning	3.0 °C	2075 (SSP 3-7.0)

Table 1: The IPCC best estimate year (year the GWL will be passed) and planning scenario corresponding to each GWL.

Region Specific CAVAs

Snowpack is important in Nevada County, CA, which spans the Sierra Nevada. We find that snow drought will be an increasing hazard for the county. Snow drought is defined as a year where the daily peak SWE (snow water equivalent) is less than the baseline (1.0 GWL) mean daily winter SWE (Figure 1).

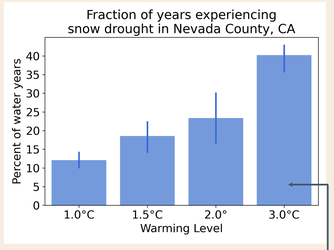

Figure 1: Fraction (%) of the time to anticipate snow drought in Nevada County, CA under different GWLs.

While snowpack is important in the mountains, rain is critical along the coast in Ventura, CA. Our analysis, using the Standardized Precipitation Index (SPI) to characterize drought, finds a greater risk of severe droughts in the future (Figure 2).

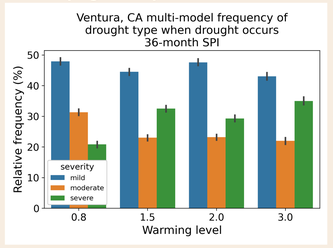

Figure 2: Relative frequency (%) of drought severity for Ventura, CA using the Standard Precipitation Index (SPI).

Figure 3: Map showing the two locations representing vastly different climates and hazards

Fit to Purpose CAVA Analysis

The Association of Monterey Bay Area Governments (AMBAG) seeks to ensure their network of electric vehicle (EV) charging stations is more resilient to climate change impacts. Power Safety Public Shutoffs (PSPS), a method for reducing the risk of a wildfire by temporarily stopping power, can lead to grid reliability issues. ERA developed a new PSPS metric based on the weather factors that trigger PSPS events, finding an increase in PSPS event conditions in the future for the region (Figure 4).

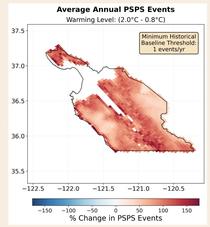

Figure 4: Fractional change (%) in the number of PSPS Events in Central CA.

Extreme heat reduces the efficiency of transmission lines. As the temperature rises, demand increases, leading to more energy running through the wires, creating a cascading effect. As part of a CAVA, ERA analyzed changes in daily maximum temperature for the Sacramento Municipal Utility District (SMUD) and found that transmission lines will be increasingly stressed in the future (Figure 5).

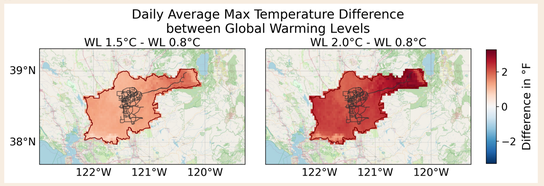

Figure 5: Change in the average daily maximum temperature for the Sacramento Municipal Utility District (SMUD) with transmission lines overlaid.

Advanced Analytics: Coinciding Compounding and Cascading Events

Consecutive storm events increase the impacts of heavy precipitation. This compound-event analysis examines the frequency of back-to-back large precipitation events within the same week in Nevada County, CA. The Event Finder notebook available on the Cal-Adapt platform was used to identify the 1-in-X events in all available downscaled LOCA2 and WRF simulations. These results demonstrate an overall increase in the frequency of these events during the 21st century (Figure 6).

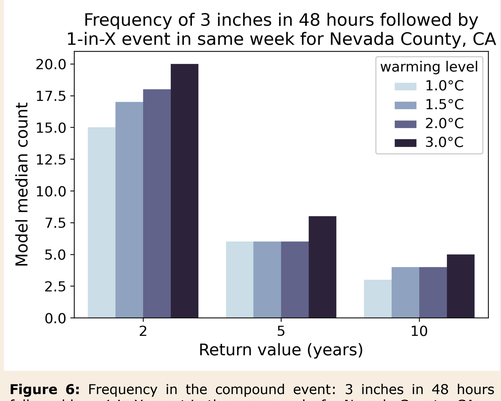

Figure 6: Frequency in the compound event: 3 inches in 48 hours followed by a 1 in X event in the same week; for Nevada County, CA

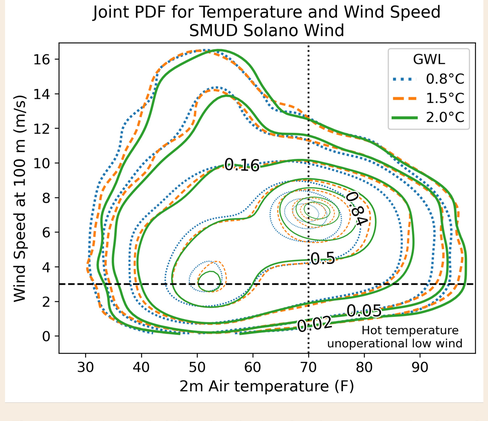

Figure 7: Joint probability distribution for the compound event of high temperatures and low winds for the Sacramento Municipal Utility Districts (SMUD) wind generating assets.

Wind-generated energy is a critical part in achieving California's renewable energy goals, but experiences short-term variability due to weather. As part of a CAVA for the Sacramento Municipal Utility District (SMUD), ERA performed a compound event analysis across SMUD's wind-generating assets. Hot and calm weather conditions are a risk to operations: wind turbines cannot operate when wind speeds are below 3 m/s and energy demand is high when hot. Knowing the probability of coincident occurrences of hot temperatures and low wind speeds is critical for assessing reliability under a future climate. The joint probability distribution (Figure 7) shows an increase in the probability of these unoperational days (hot temperatures and low winds).

Cal-Adapt Enterprise

Cal-Adapt supports vulnerability assessments within California's energy sector and beyond by bringing together regionally downscaled climate data, powerful tools for analysis, and in-depth guidance on best practices for utilizing climate data for adaptation planning and vulnerability assessment.

Data Explorer: Open and Intuitive Climate Data

Cal-Adapt.org offers intuitive tools for visualizing climate data and understanding the major risks from a rapidly warming climate. Paired with an approachable web-based data download tool, the Cal-Adapt: Data Explore provides a public gateway into climate vulnerability assessment for anyone in California.

Major updates coming to the Cal-Adapt: Data Explorer in 2026

Analytics Engine: Flexible Tools for Powerful Insights

The Cal-Adapt: Analytics Engine brings together python tools, a cloud-compute environment and high-resolution climate & weather data to empower in-depth climate data analysis. Open access tools and workflows, developed with utility partners and state agencies have created the capacity for integration of the latest climate simulations and scientific best practices into utilities state-mandated CAVAs.

Interested in learning more? Check out additional Cal-Adapt Posters and Talks:

- Building Climate-Informed Hourly Profiles for a Resilient Future via the Co-Produced Cal-Adapt: Analytics Engine (*GC13L-0775 - This Afternoon*)
- Co-producing State-level Climate Services — An Operational Framework from the Cal-Adapt: Analytics Engine (*SY33C-0660 - Wed Afternoon*)
- Building the Cal-Adapt: Analytics Engine, a Cloud-Native Open Source Climate Platform for California (*IN23A-07*)

Eagle Rock Analytics, Inc.

Eagle Rock Analytics (ERA) is an environmental research and data analysis firm based in Sacramento, CA. ERA specializes in developing data, tools, and analyses that support user-defined applications for climate science. ERA's mission is to work alongside data users to create more actionable science that can translate complex environmental data into practical solutions. In doing so, ERA aims to help data users develop context-specific and climate-informed analyses.

ERA leads the scientific and technical development and management of Cal-Adapt, California's state-funded climate hazard data portal. Cal-Adapt offers innovative tools and visualizations that support the state's adaptation and resilience efforts. These initiatives include the Data Explorer platform—a fast, interactive web-based interface—and the Analytics Engine, a cloud-based data platform with tailored analytical workflows co-produced alongside energy sector utilities and state agencies.

In addition to Cal-Adapt, ERA provides climate services for a wide range of sectors to develop tailored hazard analyses that fit their specific needs. Interested in learning more about ERA's Climate Services? Scan the QR code and reach out to see how we can help you!