Resilient Energy Systems
Mission Campaign

DYNAMIC MONITORING TO ANALYZE GRID VULNERABILITY TO FIRE

This project will investigate autonomously digesting multi-spectral satellite imagery and applying machine learning algorithms to identify wildfire risk across a landscape. Grid simulation methods will be integrated into the analysis to determine the impact of component damage. As an outcome, we will offer data-driven response strategies that increase the grid's resilience to fire risk.

THE CHALLENGE

Wildfires, including naturally, accidentally, and maliciously ignited wildfires, impact critical electric grid infrastructure across the western United States, which can lead to large-scale blackouts. Megafires have been increasing over the last several decades in response to a century of fire suppression and changing climate. An increased severity and duration of drought along with high wind events have led to dangerous fire behavior conditions once a spark is ignited. This makes the landscape primed for pyro-terrorism.

We will propose to develop a framework that will digest daily satellite imagery and identify hazardous fuel conditions with machine learning techniques. This will lead to the creation of wildfire hazard maps that pinpoint areas that would be difficult to suppress if a fire were to occur. The satellite imagery will also highlight portions of the grid that are most at risk. We plan to use a suite of applications, tools, and models to aid in understanding wildfire threat and improving wildfire mitigation strategies.

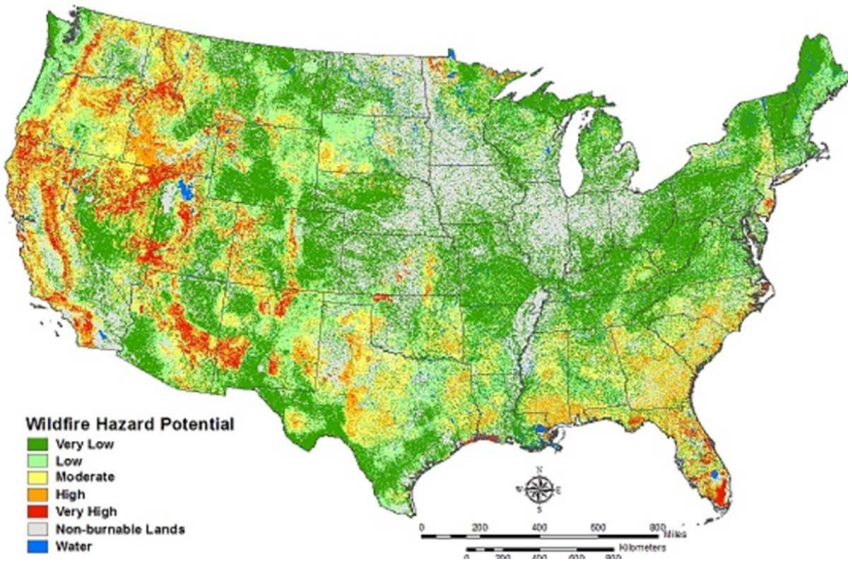
APPROACH

The approach to this research will be to acquire satellite imagery on a monthly basis, refine existing machine learning algorithms to identify wildfire risk from satellite imagery, create a webmap that identifies wildfire hazards, and use software applications to run random ignitions in landscape surrounding critical infrastructure to model fire spread. We also plan to present our project and its breakthroughs at the Utility Management Conference.

EXPECTED RESULTS

The final product from this research project will help plan for and mitigate a disaster from fire by:

1. Developing fire hazard maps given current vegetation conditions;
2. Simulating fire behavior to determine vulnerable infrastructure;
3. Identifying grid response strategies and resilient designs that reduce vulnerability, leveraging past work on cascading failures.

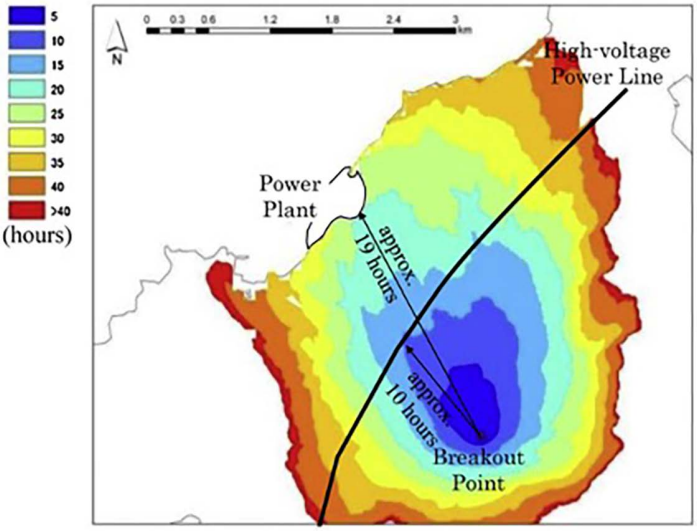


An example of wildfire hazard potential mapped nationally by the U.S. Forest Service.

EXPECTED IMPACT OF THIS RESEARCH

The impact of this project is to provide response strategies for a utility company when faced with fire threats that are caused by environmental factors or maliciously ignited. The successful completion of this project will enable utility managers to make informed decisions in their planning to make the grid more resilient to fire risk and to mitigate potential impacts to customers. This project will find locations most at risk of wildfire and pinpoint vulnerable infrastructure systems within that area.

Resulting analyses could be used during a wildfire disaster to simulate the arrival time of flames from the ignition source. This will allow utilities to plan for upcoming service disruptions and choose the best mitigation option with the least amount of impact on the grid. In an ideal world, every utility company would have a tool like this to guide them through the best mitigation options during a fire. Lastly, this research will also pinpoint locations that are vulnerable to intentional threats, which will reinforce national security interests.



(b) Fire Arrival Time

An example of mapped arrival times to a structure of interest (Okano 2015).

RESILIENT ENERGY SYSTEMS

Sandia's investment in this project is part of the Resilient Energy Systems portfolio of projects, coordinated R&D that addresses the resiliency of the nation's energy systems and other critical infrastructures to threats.

This project connects to the *Science of Vulnerability* thrust by identifying wildfire (intentionally started or accidental) as a physical threat to critical infrastructure and exploring resiliency options.

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Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. SAND2020-13355 O