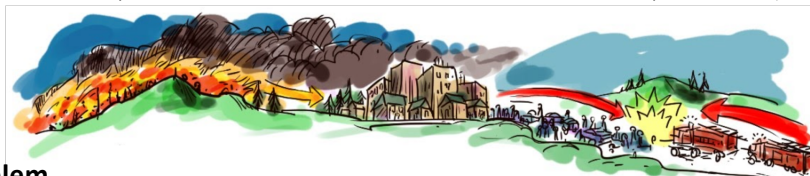


The Wicked Wildfire Problem and Solution Space for Detecting and Tracking the Fires that Matter

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Wicked Wildfire Problem

In the last decade, record-breaking fires, unprecedented losses, and escalating suppression costs have raised concern over the onset of a new era of megafires. This is a critical moment to redefine our nation's relationship with fire and build resilience in fire-prone social-environmental systems. Our biggest challenge is the wicked nature of the problem with many organizations working on different "solutions", all slightly different, but with similar challenges.

Many organizations misconstrue the nature of the problem; the problem is not fire, as fire has been characteristic of the North American west for millennia (Marlon et al., 2012); rather, the problem exists around megafires. Megafire is a sociopolitical term to describe "the fires that matter": Big fires matter for smoke, Proximal fires matter for infrastructure, and fast fires matter for lives.

There are three key ingredients for megafires:

- Climate** alone is expected to increase the likelihood of very large wildfires (Stavros et al., 2014).
- Fuels** are changing: A century of fire exclusion results in fuel abundance and flammable invasive species, both of which affect fire behavior. Additionally, the built environment encroaches on vegetated wildlands putting more homes in harm's way (Mietkiewicz et al., 2020).
- Ignitions** from people: humans are extending the fire season and starting over 90 percent of the fires that threaten homes (Balch et al., 2017).

Together these ingredients increase our chances of million-acre fires (Joseph et al., 2019), and increase fire risk leaving vulnerable communities exposed in fire-prone areas.

WKID Innovation

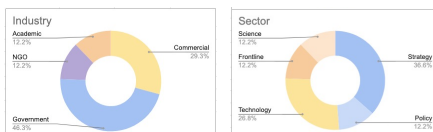
Innovation is the change in process, method, or product. Solving wicked problems, that are defined by their varied solutions and multiple organizations involved, requires systemic change. WKID Innovation (Stavros 2021) offers a framework for systemic change arguing that systems are composed of:

- Policy – the rules that govern us
- Economics – the markets for exchange
- Sociocultural Factors – the social constructs under which we adhere, and the
- Technology – tools that we use.

Each system can then be thought of in the context of the: hardware - infrastructure that supports it, software – means of communicating, people, processes, and the interactions of these components. As such, we must think about Problem and solution as it relates to these factors.

Detection and tracking the fires that matter

To co-produce recommendations for change to tactical fire management of the fires that matter, the Keck Institute for Space Studies (KISS) hosted a workshop with key change agents from across industries and sectors:



A "solution" to the Wicked Wildfire Problem will include:

Policy	Economics	Sociocultural	Technology
<ul style="list-style-type: none"> • Resolve conflicting policy: <ul style="list-style-type: none"> • Endangered Species Act • Clean Air Act • Suppression vs. Prescribed Burning • Enable sovereign stewardship through cultural fire • Expand Health & Safety: building codes and zoning • Incorporate Climate Policy: green, decentralized energy 	<ul style="list-style-type: none"> • Remove barriers to siloed funding: <ul style="list-style-type: none"> • Cross-agency collaboration • An organizing body with the single mission • Differentiate funds for pro-active vs. reactive measures • Disincentivize building in high risk areas • Incentivize equitable home hardening 	<ul style="list-style-type: none"> • Cultivate a User Community - Embed training for using technologies into NWCG ICS position trainings • Raise Public Awareness <ul style="list-style-type: none"> • Smokey the Bear in the Suburbs • No Drones - If you fly, someone could die • Redefine Fire Risk to include feedbacks between humans and the natural system • Collaborate to integrate Traditional Ecological Knowledge from Indigenous people 	<ul style="list-style-type: none"> • Coordinate data collection (drone, aircraft & satellite): <ul style="list-style-type: none"> • Data Standards and Compliance Certifications • Data Clearinghouse • Open data access • Provide sustainable, operational, viable product with the information of value on the fires that matter in the decision making context • Accessibility - fire management & public

Recommended next steps

The workshop converged on a set of recommendations as a coordinated voice across industries and sectors to inform policy and support at state and national levels. This workshop reached consensus despite each organization's self-interests and embodied co-production, a practice of working together across agencies and organizations to identify public services of value.

We recommend follow-on workshops to continue deep dive studies to scope the megafire problem more holistically thinking about the pre-/post- resilience planning.

It is worth noting that we focused on pre/post fire to contextualize the fires that matter for tactical fire management, which centers the problem around current authority systems. We recommend that future workshops include collaborations with broader, more diverse communities and perspectives that build on millennia of traditional ecological knowledge from the Tribal Nations to find fire resilient solutions in the context of our modern world.

Acknowledgements

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Problem Definition	Solution	Action
Organization Need for single vision unified interagency leadership Siloed efforts that are not coordinated	A single Interagency Body for operations on pre-, during, and post-fire management that has the authority to set a vision and driving objectives, coordinate roles/responsibilities, and deliverables as well as manage dependencies across agencies. A single plan for the nation (e.g., cancer cure map)	Establish an Federal Organizing body with longevity that has authority to coordinate across agencies (Fire Service, NASA, NOAA, SDA, NIST, NGA, USGS, NSF, USDA, DOI, DOD, DHS, others) Assign responsibilities and develop mechanisms for cross-sector collaboration between NGOs, Federal, State, Philanthropists, and Industry
Data and Observations Need for sustained access to free, open-access, unclassified data in a stable format that is bandwidth friendly, low latency (< 5 min), and reliable (many false alarms and poor geolocation accuracy) Need for data from different sources to be universally program accessible to display on different operating platforms Need for data standards: format, quality, and metadata	An interconnected system of systems linking ground sensors (cameras, people - e.g., social media), drone, airborne, and space-based data Technology development for integrated communications networks in low reception areas Technology development of missions designed for fire: multi-spectral (not just 4 um to drive down False Positives), precise geolocation (i.e., high accuracy), high spatial resolution, high temporal resolution, and longevity of the mission	Conduct a thorough mission architecture study leveraging a constellation of nascent systems, new systems to fill gaps, and commercial sector Assign a single point lead agency
Research and Development Need for appropriate intel Need for intel that matches the human experience Need for context to detect 100% of fires that matter in real time	Co-production with decision makers to define the Information products and establish benchmarks for thresholds of utility of the intel created Testbed for agile solution development and implementation Dynamic pre-fire assessments that identify high fire risk as defined by fire hazard potential as well as social exposure and vulnerability An end-to-end modeling framework for a human-earth system for fire to improve predictability of a fire that will matter	Establish a Community of Practice to facilitate federal to local level communication, cooperation, and intelligence and guide data search, discovery, and access, intel definition, software development, trainings, and table-top exercises Enable cross-disciplinary, cross-program sponsored research to address wildfires in a holistic way, from preparedness and mitigation, to response, monitoring, and rehabilitation.
Financing and Business Current funding mechanisms do not support innovation by private industry Need to support localized, custom solutions for building community resilience and preparedness Poorly defined operating costs compared to benefits Need for public awareness of efforts underway and funded	A clear communication of relevant requests for information, contracts, etc in the broader context of strategy and easy to find despite the sponsor A single data clearinghouse with APIs on all data Estimates of the true, holistic economic costs of fires to inform business as usual vs. cost of what is required Media engagement and public relations	Remove barriers to siloed funding motivated by different agency motivations Assign a single point lead agency Shift incentives, taxes, and regulations accordingly Include a communications specialist in the Federal Organizing body