## The Importance of a Dedicated

# WILDFIRE WEATHER NETWORK

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## Increase Wildfire Resiliency, Operational Safety and Reduce Weather Related Risk Exposures

**EXTREME ENVIRONMENTS**
**EXTREMELY RELIABLE**

FTS

# EXECUTIVE SUMMARY

Wildfire is impacting communities globally in unprecedented ways. Seemingly, new examples of increased impacts are demonstrated more often with each new wildfire season. With rising temperatures and associated dynamic weather events, we are experiencing the wrath of an upward trend of more frequent and higher intensity wildfire behavior causing catastrophic wildfire events. Some wildfires in our remote landscapes are beneficial to fire dependent ecosystems by supporting biodiversity and much needed carbon offsets. But within the context of population growth and communities built in the wildland urban interface, the risks and consequences are simply to great and we cannot let wildfire run its natural course. The risk and negative impacts to safety and overall costs from wildfires that spread into our communities are simply not acceptable. In the USA, this circumstance is highly reported and well documented, especially consecutive seasons of mega-fires in the West, fuelled by decades of vegetation accumulations that are left parched by cumulative drought and newer sources of ignition in our landscapes. Studies show that sparks from utility grid faults cause approximately 10% of wildfire ignitions in the United States.[1]

Most utility organizations in the Western USA, whether mandated by state law, as in California, or through acts of industry best practices and corporate good prudence are anxiously developing wildfire mitigation plans and associated calls to actions to address wildfire risk and consequence curves within their rights of way. Simultaneously, they are addressing customer engagement programs required to contend with widespread customer disdain for public safety power shutoffs (PSPS), a considerable pain point for many utilities, along with vegetation management which crosses over significantly with challenges facing local wildfire and land management agencies.

In this whitepaper, we will explore how to better understand wildfire risk in the context of overall risk both to and from utility assets and infrastructure, as well as the focus areas of wildfire mitigation planning deployed by utility organizations. We will take a deeper dive into the key weather data inputs from dedicated wildfire weather networks and examine scalable technologies that easily integrate into existing utility grid systems. These solution sets bring tremendous value to grid operations. With enhanced situational awareness using real-time information you are better able to make operational decisions based on observed conditions and circumstances. By investing upfront in a dedicated wildfire weather network, utility organizations can not only increase safety and operational efficiencies, that avoid damages and decrease emergency response costs, but can simultaneously optimize modern business practices. Thus, also improving overall grid resiliency to keep power flowing to their customers, including the front-line workers that need power to do their important jobs.

[1] Wildfire Prevention Summit, Western Fire Chiefs Association, May 2021

# INTRODUCTION

Climate change is causing extreme, dynamic weather events resulting in longer wildfire seasons, higher frequency of wildfires and greater wildfire intensities globally. Since 1970, wildfires have increased in frequency by 400% across the USA. [2] The 2020 wildfire season was record-breaking for many jurisdictions across the USA with more than 58,000 wildfires resulting in over 10 million acres burned across the country. Currently, 60% of Western USA has severe drought with soil moistures at their lowest in 120 years. Annual winter snowpack levels in the West have declined 25% since 1981. [3] The cost of natural disasters resulting from drought in the USA is $262B and wildfires alone costing $104B.[4]

This year's wildfire season is predicted to be another severe one. From January 1 to May 13, 2021 there were about 20,780 wildfires, compared with 14,890 in the same period in 2020. About 547,000 acres were burned, compared with 324,500 in 2020. In 2020 there were 58,950 wildfires compared with 50,477 in 2019, according to the National Interagency Fire Center. About 10.1 million acres were burned in 2020, compared with 4.7 million acres in 2019.[5] Wildfires in California have burned a record 4.3 million acres, damaging or destroying 10,500 structures and killing 33 people. Six of the top 20 largest California wildfires fires occurred in 2020, according to CalFire. Additionally, over the past 30 years, 4 out of 10 of the most destructive wildfires in California are related to wildfires caused by electric power lines; in 2017-2018 two of the ten deadliest wildfires in California history were sparked by electrical utilities that resulted in 107 deaths.[6]

Extreme weather events are trending up and resilient infrastructure is imperative to not only safety, but business operations continuity. Weather monitoring, observation technologies and predictive services can help utility organizations reduce risk exposure, enhance performance, and increased safety. Many advances have been made through the use of basic weather data from meteorological stations. In years past, wildland fire agencies used this data to develop fire danger rating systems that helped them predict, prevent and suppress wildfires. However, there is a mismatch between the specialized, comprehensive data needed for effective fire management today and what is available from rudimentary meteorology networks. This leads to inaccuracy that can cause dangerous and costly errors in decision-making.

[2] IDGA Wildfire Conference, Sacramento, CA, Dec 2020
[3] CBSN (2021)
[4] FEMA (2021)
[5] National Interagency Fire Center
[6] CalFIRE April 28, 2021

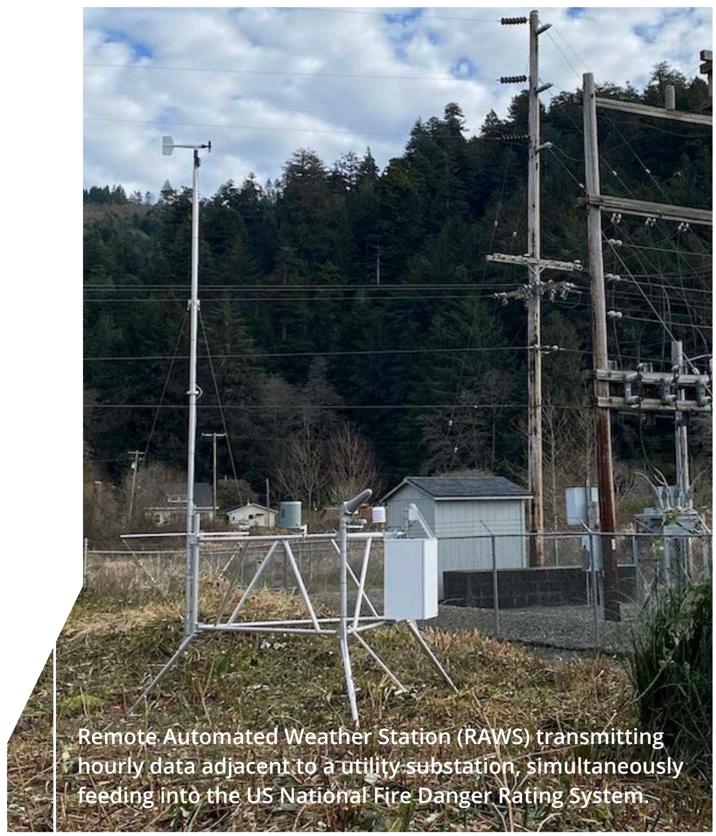
Not all meteorology stations meet the modern standards of wildland fire agencies because they are not typically located appropriately for fire weather purposes, do not collect observations for peak fire danger hours, and are not built to the national standard for weather sensor sets or to withstand harsh environmental conditions.

The 'All Hands, All Lands' cohesive strategy implemented by the USFS[7] in 2009 is helping to get the upper hand on wildfires. But are the electric utility rights of way in these fire adapted landscapes represented? Are they represented adequately from a wildfire weather data point of view? Are they protected adequately based on risk and consequence analysis to maintain uninterrupted grid operations? If not, how is that interruption quantified? How can fire management agencies and utility organizations improve their ability to predict, prevent and fight wildfires?

> ***"If the weather data is not accurate, then the indices will be off. For example, if the humidity is too high, then it will show a lower index than what is actually representative of the fuels. And when the firefighters go into attack, the fire behavior is going to be more extreme than what they were expecting. Same thing if the wind equipment is showing too light a wind, they're going to be in for surprises. And those are never pleasant."***
>
> **DON GREEN**
> Former Chief Fire Meteorologist,
> Yukon Government (Canada)

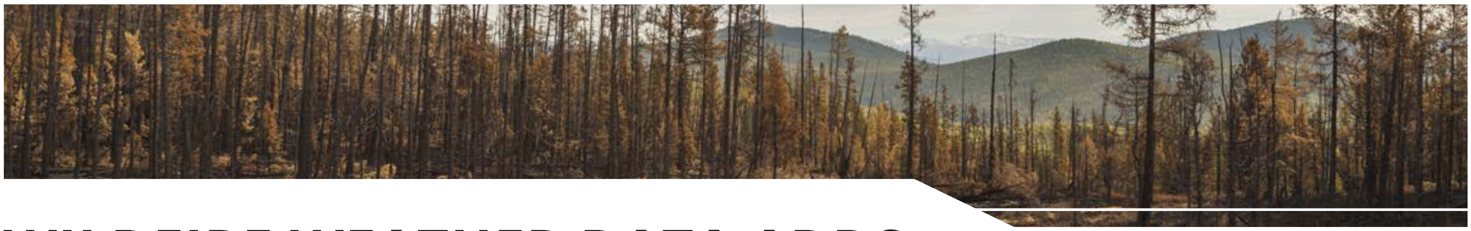
There are many technology solutions available, but a critical starting point to overcome these hurdles of uncertainty is the installation of dedicated fire weather networks that can collect critical weather data points from multiple sources in multiple locations. Knowing your workload is the first step. Next, you need to understand what you can realistically achieve in the context of your operational, organizational and budgetary limitations.

What is a dedicated fire weather network?
A dedicated fire weather network is a finely spaced grid of remote automated weather stations (RAWS) that are specifically designed for fire weather applications. These RAWS stations can be augmented with similar, smaller and/or portable options that have similar sensor sets but are positioned in fill-gap locations. We will examine those in more detail later in this whitepaper.



Remote Automated Weather Station (RAWS) transmitting hourly data adjacent to a utility substation, simultaneously feeding into the US National Fire Danger Rating System.

[7] US Forest Service (USDA) National Cohesive Wildland Fire Management Strategy, https://www.fs.fed.us/restoration/cohesivestrategy.shtml



# WILDFIRE WEATHER DATA ADDS CRITICAL INSIGHT TO WILDFIRE MITIGATION OPERATIONS

Fighting a wildfire without fire weather data is like walking into a burning building blindfolded. A severe wildfire can race across the landscape at upwards of 20km/hr and without accurate fire weather information there is no way of knowing how aggressive the fire behavior will be, where it will spread and what resources will be required to contain it. The Elephant Hill Fire in British Columbia, Canada spread approximately 10kms in a 24-hour period during the 2017 wildfire season[8]. The massive wildfire in the town of Fort McMurray burned from May 2016 until August 2017 when it was officially declared out. This fire devastated the community after burning 1.4 million acres, destroying 3,244 buildings and reaching a total cost of $9.9 billion USD[9].

Modern wildland fire agencies use fire weather data to make decisions about how many people to send to a fire, where to send them, and how quickly they must arrive. They need accurate data to determine if the focus should be on ground operations, or if aerial support is needed. Operations is constantly adapting to fire weather information. For example, imminent rainfall may make fire suppression activities unnecessary, an expected change in the wind direction may inform a shift towards enhanced protection or evacuation of a nearby town, or windy conditions may make it too dangerous for aerial firefighting operations. Decisions may also need to be made with regards to Public Safety Power Shutoffs (PSPS) to mitigate wildfire ignitions and protect adjacent communities from aggressive, deleterious wildfires. By understanding the weather's effect on wildfire behavior, decision-makers can make the most effective use of available resources while prioritizing the safety of operational line workers and the firefighters that are protecting people, property, assets and infrastructure.

> ***"We have mutual aid agreements with other provinces and countries. But it's a bit of a guessing game because it costs a lot of money to bring those resources in. By using the RAWS network and our fire danger indices, we can look into our crystal ball and predict that in two weeks we're going to be okay, so we can export crews to other provinces and recover those funds back."***
>
> **JOHN FLANAGAN**
>
> Superintendent (retired) Wildfire Management
> British Columbia, Canada

[8] https://wildfiretoday.com/2017/07/31/elephant-hill-fire-in-british-columbia-grows-to-194000-acres

[9] Bob Weber, BNN Canada (2017)

## FIRE DANGER RATING SYSTEMS: THE KEY TO FACT-BASED DECISION-MAKING

Perhaps even more important than the ability to predict fire behavior during a fire event is the ability to identify dangerous conditions before a fire starts. By knowing when and where conditions are optimal for wildfire, operations personnel can take the appropriate measures to reduce new wildfire ignition risk and increase wildfire preparedness measures or calls to action.

A reliable fire danger rating system is acknowledged worldwide as the keystone of effective wildfire management. A fire danger rating system removes reliance on experience and intuition, and instead allows decisions to be based on consistent, science-based criteria. An early study of Canada's fire danger rating system found that over an eleven-year period the system saved more than USD$750 million in firefighting expenditures.[10]

Preventative measures are the first step towards reducing wildfire. Fire danger ratings can be used to ramp up public education campaigns, limit open fire burning, and restrict industrial activities in the forest. In British Columbia, Canada, Provincial Government regulations restrict or place conditions on certain high-risk activities depending on the fire danger level. For instance, when the danger has been 'high' for three days, activities that might throw sparks or start a fire—like tree harvesting, railroad grinding, arc-welding, grass-mowing, or use of explosives for road clearing—are prohibited in the afternoon, and require at all times a person nearby to patrol for and extinguish any fire.[11] This approach takes the guesswork out of restrictions, avoiding legal battles and creating common ground with private landowners who want to protect their land resources while maximizing their operations.

*"The indices are calculated at noon to give a projection of what's going to be the conditions later on in the afternoon during the time when the fire will spread the most. Some airport stations don't report until seven o'clock in the evening, so they're useless to us. If it rains halfway through the day, there's no record of it until the evening. Well, you can't base anything on that kind of information."*

**DON GREEN**

Former Chief Fire Meteorologist,
Yukon Government (Canada)

## THE IMPORTANCE OF PROACTIVE RESOURCE ALLOCATION

When it comes to wildfire response, timing is everything. A quick initial attack can make the difference between a new wildfire that is extinguished before it has the chance to spread, and an inferno that burns for weeks or months, claiming lives and destroying property. Wildfire operations staff can pre-position firefighting resources into areas with the highest danger. It is not feasible to have 100% of staff ready for dispatch all the time, nor is it feasible to have enough equipment and staff to deal with the most extreme wildfire season. Instead, fire danger ratings can determine the level of preparedness and resources on any given day and during times of extreme risk, resource-sharing agreements can be drawn upon with other jurisdictions and stakeholders. For example, USA and Canada have such agreements in place.

[10] Taylor & Alexander, Canadian Forest Service (2006)
[11] Province of British Columbia, Queen's Printer (2012)

# HOW FIRE WEATHER DATA IMPACTS FIRE DANGER RATINGS

Fire weather observations consist of temperature, precipitation, relative humidity, wind speed, wind direction and sometimes solar radiation and fuel moisture. Fire danger is determined by three elements: topography, fuels, and weather. Of these three, weather is the largest factor in day-to-day changes in fire danger.[12] Fire danger rating[13] systems use these daily and hourly weather inputs to create multiple "indices" that assess the potential over a large area for fire to ignite, spread, and require suppressive action. Predicting fire behavior, on the other hand, also assesses this potential but produces more concrete outputs that are site-specific and pertain to existing fires.[14]

There are a number of fire danger rating systems in use across the globe. Most use a collection of indices that include a summary index indicating the potential intensity of a fire (in Canada - Fire Weather Index, in the US - Burning Index), and related sub-indices. These indices describe both the potential for ignition based on fine fuel moisture and wind speeds, and the potential for prolonged burning based on the build-up of dry fuel. Forecasted weather data can be used to estimate future fire danger.


**FIRE DANGER RATING SYSTEM APPLICATIONS**

- Pre-positioning resources
- Wildfire detection planning
- Dispatching and alerting
- Fire suppression tactics
- Fire behavior analysis
- Incident action plans
- Crew situation analysis
- Prescribed fire planning
- Fire/fuel modelling
- Fire aviation management
- Wildfire research
- Electric grid decision making
- Industry activity closures
- Public campfire bans

[12] National Wildfire Coordinating Group Fire Danger Working Team (2002)

[13] For definitions of fire danger, fire danger index, fire danger rating, and fire behavior, see USA & Canada info: https://www.usgs.gov/ecosystems/lcsp/fire-danger-forecast https://cwfis.cfs.nrcan.gc.ca/maps/fw

[14] Ibid

Precipitation, temperature, wind speed, and relative humidity all affect the daily wetting and drying of the various layers of fine and dense wildland and forest fuels (such as organic duff, needles, branches and fallen logs). This cycle is cumulative, with each day's moisture serving as an input to the next day's calculations—making a continuous fire weather record a critical factor in attaining accurate fire danger rating results. In the case of the USA, fuel temperature and moisture sensors are deployed to capture real-time, site specific conditions of the fuels available for consumption by wildfire in any given region on any given day throughout the USA.

Fire behavior prediction systems work on similar principles but rather than producing indices that are simple numeric scales, they produce detailed outputs such as rate of spread, head fire intensity, fuel consumption, and fire type (e.g., ground or crown fire). They incorporate site specific information about vegetation, slope, elevation, and latitude, as well as wind direction.

# ACCURATE FIRE WEATHER DATA = ACCURATE OPERATIONAL DECISION-MAKING

To be useful fire weather data must be accurate. As discussed above, a fire's behavior is affected by even small changes in the weather. Likewise, fire danger ratings and fire behavior prediction systems will produce significantly different results when weather inputs are changed.

## SMALL WEATHER CHANGES HAVE BIG CONSEQUENCES

A single day's error in weather measurement can result in danger indices that are off- base. In some situations, an underestimation of wind speed by 5 mph would result in an under-estimation of wildfire spread rates by half. Even a 1 mph error in wind speed could produce a difference in the rate of spread that would cover the transition from surface fire to crown fire[15]—a dangerous situation that requires significantly more suppression resources. In the same way, just 5 mm of rainfall can bring double the fine fuel moisture content and dramatically lower the risk of spread.

***"We used to have a lot of logging activity fires because businesses want equipment operating 24/7. There were always folks out in the woods wanting to operate on a particular day and we're having to tell them "no" because we believe there's a fire threat. And they're standing there saying "but it's raining." Now we feed the RAWS data into a National Fire Danger Rating System and based on historical fire load and threat, we can take out that intuitive piece and make it based on science that everyone can agree upon."***

**DAVID GRANT**
Smoke & Fuels Specialist
Department of Natural Resources (DNR)
Washington State (USA)

[15] Lawson & Armitage (2008)

The Fire Weather Index can be thrown off by 20% - a significant difference in terms of expected fire weather—by a single day's error of 10% in relative humidity, or a 2°C error in air temperature. Add in a 3.5 mph error in windspeed and the index will be off by 30%.[16]

## IMPROPER WEATHER STATION LOCATION COMPOUNDS ERRORS

When a weather station is too far away for it to be representative of an area, such problems are compounded because the error will be repeated daily. The tracking of the drying and the wetting of fuels is done by entering each day's fire weather indices into the next day's calculations. Estimations of fuel moisture—particularly important in the early and late season—can become entirely incorrect.

## GAPS IN FIRE WEATHER DATA INVALIDATE HISTORICAL ANALYSIS

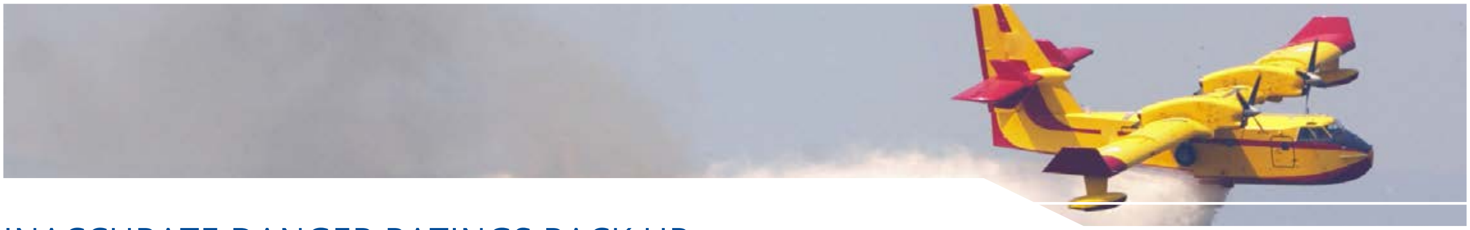
Similarly, a gap in the weather data caused by equipment failure or a staff absence for example can create inconsistencies. Since fuel moisture content is established over the course of years, a fire danger rating cannot be properly calculated without a continuous record of fire weather data.[17]

## LATE FIRE WEATHER DATA IS USELESS DATA

Fire danger rating systems are intended to predict the worst-case scenario, which for wildfire preparedness and planning is the afternoon when the temperature peaks. Weather observations must be taken at noon and reported quickly so that ratings reflect today's fire danger, not tomorrow's fire danger. Hourly data is even more useful, particularly during wildfire suppression when sudden shifts in weather can jeopardize a crew's safety. Simply put, poor data leads to poor decision-making.

> ***"When you have to start managing wildfire with minimal resources, you better make sure you're sending those resources to the right fire. Nothing worse than going to the wrong fire, when you've got another one that shows up and gets away when the one you are on does nothing and the data says so."***
>
> **DAVE MAREK**
> Fire Behavior Specialist & Air Attack Officer (retired)
> Wildfire Management
> British Columbia, Canada

[16] Turner & Lawson (1978)
[17] National Wildfire Coordinating Group Fire Danger Working Team (2002)



## INACCURATE DANGER RATINGS RACK UP UNNECESSARY EXPENSES

Rattlesnake Fire 8000 Acres
Photo Credit: PJ Stevko - Sequoia Kings Canyon NP 2020

A fire danger rating that has been mistakenly set too high will incur significant costs as a consequence. The average cost of a large fire in the US is $3.3M*.[18] In the US, higher fire danger ratings trigger a lengthening of staff hours, resulting in overtime pay of 50%. Given the average crew cost of $3,000 per day[19], this will quickly add up. Aerial resources are even more expensive; in the US, operating and support costs per fixed-wing aircraft run $7.1M per year.[20] And in Europe, the cost for water scooper aircraft availability on standby daily is in the tens of thousands while operating them can cost approximately $13,000 per hour.[21] Public funds are too scarce to be wasted on being ready for fires that will never happen. It is also particularly costly to bring in external firefighting resources from other jurisdictions to support the wildfire suppression efforts. Importing wildland firefighting personnel from other states and in more recent wildfire seasons, from other countries, has a tremendous logistics cost on top of the daily rates that are incurred for these services. These costs can be offset by reduced damages from wildfire in hiring resources at other times, but only if fire danger can be accurately predicted using fire weather indices.

## ERRONEOUS DANGER RATINGS HAVE PUBLIC CONSEQUENCES

An overestimated fire danger rating can also incur private costs when restrictions are placed on industrial operations and agricultural activities. Tourist revenue can be lost, and public frustration can result from campfire bans and other precautionary steps. Nevertheless, the worst consequences arise when fire danger ratings are underestimated.

[18] RAND Homeland Security and Defense Center, Report (2012)
[19] Donovan (2007)
[20] RAND Homeland Security and Defense Center, Report (2012)
[21] Study on Currently Available Aerial Forest Fire Fighting Assets, Final Report, Valdani Vicaria & Associates, European Union (2018)

* Note: all costs in USD.

## UNDERESTIMATED FIRE DANGER LEADS TO UNNECESSARY WILDFIRE RISK

When danger ratings are too low, Fire Managers will be allowing high-risk activities when they shouldn't be. In British Columbia, a 20% error in the fire weather index will mean the difference between a ban on all high-risk activity, and the restriction in the afternoons.

Even worse, incorrect danger ratings may lead to prescribed burning at times that are not safe. Today's cautious attitude towards prescribed burning is in large part due to high-profile incidents where the fire escaped, and serious damages resulted. This has a wider reaching impact on the accumulations of vegetation (fuels) on our landscapes, especially in fire dependent ecosystems that require regular prescribed burning to mitigate the fuel loads. Therefore, accurate fire weather data is crucial for the safety of these operations.

## INACCURATE FIRE DANGER RATINGS LEAD TO ESCAPED WILDFIRES

Fire danger ratings are used to determine crew readiness and resource availability. A delayed or insufficient initial attack will lead to more escaped fires causing considerable extra suppression costs and overall damage. According to an Australian study, a fire crew delay of just one hour will reduce the probability of containment within 8 hours by 60%.[22] The damages from an escaped fire can be enormous. In the US, just 1% of fires account for 94% of suppression expenditure.[23]

[22] Bushfire Cooperative Research Centre & Australian Fire and Emergency Service Authorities Council (2009)

[23] Ingalsbee (2010)

## POOR PREDICTION OF FIRE BEHAVIOR ENDANGERS LIVES AND PROPERTY

Once a fire gets going, an accurate prediction of its behavior is needed to safely and effectively allocate firefighting resources and defend lives and property. Weather conditions dictate whether it is safe for aerial resources to come in, where ground crews should be set up, and whether nearby communities need to evacuate or not. Proper resource allocation is a large factor in cost. A study of large fires in the US found that geospatial technologies (which are often informed by fire weather data) reduce cost inefficiency by 44%, suggesting there is significant scope for improvement in even sophisticated operations like those found in the US.[24]

*"We used to have remote data loggers that we'd pay local guides and outfitters to go out and read the data and phone it in. It wasn't timely. And you never knew for sure that the readings were correct. Because there were tales of people saying, "It's pouring rain, I don't want to go out there." They'd just guess. So, for not a huge investment, the automated stations give us an hourly report-back with no intervention required. And we know the equipment is calibrated, and the readings are accurate."*

**ERIC MEYER**

Fire Weather Specialist (retired)
Wildfire Management
British Columbia, Canada

*"I need to know: did a rain shower actually come through there or did that area get missed? Are the winds really as bad as they say they are 30 kilometers away? I have to make decisions based on the weather at the fire site, and the more RAWS data I have coming in the better."*

**DAVE MAREK**

Fire Behavior Specialist & Air Attack Officer (retired)
Wildfire Management
British Columbia, Canada

[24] Hesseln, Amacher & Deskins (2010)

# HOW TO ACHIEVE FIRE WEATHER DATA ACCURACY

To meet the modern standards of fire management agencies, weather data must be accurate, timely, representative of actual field conditions, and durable enough to ensure a continuous historical weather record. These can be achieved by working towards a dense network of Remote Automated Weather Stations (RAWS) that are correctly located, finely calibrated, and robust. In the US, the national standard for RAWS includes a fuel temperature and fuel moisture sensor on each station. Data from these sensors are collected hourly and transmitted along with all weather data parameters being measured to support the US National Fire Danger Rating System.[25]

## STATION LOCATION IS CRITICAL

A weather station's location needs to reflect the conditions it is trying to assess. A meteorological station at an airport, for example, will accurately gauge flying conditions in the valley bottom and the approach of broad weather fronts. A fire weather station, on the other hand, needs to gauge what weather conditions are like in the places where wildfires start—within the forest cover, close to the ground, on a level or sunny slope, and embedded in the local terrain. Wind speeds in a forest opening are typically 40% less than those at an airport station.[26] Terrain and elevation can substantially alter temperature, relative humidity, and wind speed and direction. Existing meteorological networks rarely cover the areas where fire danger information is required, particularly in jurisdictions with large wilderness areas. In British Columbia, the meteorological network has approximately 370 stations in the province, with 90 mostly located in urban areas, while another 280 RAWS are used to collect fire weather data throughout the province, particularly in wildfire-prone ecosystems.

## GREATER DATA DENSITY EQUALS GREATER FORECASTING ACCURACY

The data accuracy of a fire weather network increases with its density. One modelling study set in Spain found that switching from a grid spacing of 100 km to 50 km in just the most critical fifth of an area would reduce annual burned area by 20%.[27] The initial RAWS network in the US had a spacing of 120 km, but an 80 km distance is now considered the minimum necessary for a meaningful network. This reflects a shift in use from only coarse fire danger ratings to support of decisions that affect firefighter safety in specific locations.[28] A study of the US RAWS network found that, in spite of a median distance of only 29 km between stations, only 5% of stations were redundant, indicating that such a dense network is useful for representative fire weather data.[29]

[25] NWCG Standards for Fire Weather Stations (PMS426-3)
[26] Lawson & Armitage (2008)
[27] Khabarov, Moltchanova & Obersteiner (2008)
[28] Fire Environment Working Team (2007)
[29] Horel & Dong (2010)

The more varied the terrain is, the more stations are needed for accuracy. Complex terrain also requires greater judgement and analysis to determine station placement. Portable RAWS stations can be particularly useful in confirming the accuracy of the nearest weather station during a major wildfire event or during a prescribed burn.

**LOCATING A FIRE WEATHER NETWORK**

1. Identify priority regions using fire incident records, bio-geoclimatic information and existing weather stations.
2. Equip field staff with training and cross-reference with local wildfire agencies to make site-specific weather observations in the landscape and to identify areas not represented by existing weather stations.
3. Install permanent/fixed RAWS to collect a wide range of weather data over many years.
4. Install portable and/or compact weather stations to fill data gaps.

## AUTOMATION INCREASES RELIABILITY AND EFFICIENCY

According to the World Meteorological Organization, "the benefits of Automated Weather Stations include their cost effectiveness, high frequency data, better ability to detect extremes, deployment in hostile locations, faster access to data, consistency and objectiveness in measurement, and ability to perform automatic quality monitoring.[30]

Timeliness is essential for wildfire weather, and as discussed in the previous section, rudimentary weather stations don't always report at the right time of day or with the required level of accuracy for calculating fire danger indices. Fire suppression operations particularly value having access to hourly data because it could impact decisions that save lives.

Automated fire weather stations are purpose-built to transmit data without any intervention. Manual weather stations are difficult and expensive to staff in remote areas where few people live. They also require staff time on the receiving end to receive and process the information. Automated wildfire weather stations reduce human error by cutting out these processes, providing fire managers and utility operations personnel with peace of mind that observations are correct. Automation also frees up staff time to focus on other tasks, reducing overall budget expenditures.

[30] Heino (2010)

> *"With the national weather service automated stations, it takes us a lot of human interaction to get their observations, edit them and place them into the National Fire Danger Rating System. Our RAWS stations beam that information directly to the national computer so we can make up to the hour adjustments."*
>
> **DAVID GRANT**
> Smoke & Fuels Specialist
> Department of Natural Resources (DNR)
> Washington State (USA)

## LOW VOLUME VS. HIGH VOLUME PRECIPITATION

Fire weather operators have unique needs. Where standard meteorological stations are more focused on accurately capturing high-volume rainfall events, a fire weather station needs to be finely tuned to gauge minute quantities of precipitation. The faint drizzle in the morning or the overnight dewfall—these small quantities of moisture can have a significant impact on the day's fire behavior. They are also easy to miss because of their rapid evaporation from a typical rain gauge. The best fire weather stations are designed to prevent this from happening.

## STANDARDIZED WEATHER DATA: SIMPLE, RELIABLE, LOW MAINTENANCE

To maintain data accuracy, stations should be built and maintained to rigorous fire weather network standards. The US fire weather network standards specify everything from sensor accuracy and station placement to calibration and maintenance schedules.[31] These requirements are tailored to the unique demands of fire weather applications while upholding standards set by the World Meteorological Organization. Purpose-built remote fire weather stations are designed to make scheduled maintenance simple enough for a non-technical staff person to do. This reduces costs and makes it more affordable to keep up a regular maintenance schedule. A remote automated fire weather station must be virtually indestructible in order to maintain the continuous weather records so necessary for fire danger applications. Lightning strikes, fire, freezing temperatures, bear attacks, and vandalism are just some of the harsh conditions they must withstand.

[31] National Wildfire Coordinating Group (2009)

# REMOTE AUTOMATED WEATHER STATION (RAWS) VS. COMPACT OR PORTABLE WEATHER STATIONS FOR UTILITY WILDFIRE MITIGATION

Many typical weather stations deployed by power utility companies to have situational awareness and mitigate wildfire risk as part of standard operating practices, measure the temperature, relative humidity, wind speed and wind direction. From the two sensors on each station dew point and wet bulb temperature can also calculated. This data is often reported every 10 minutes using a weather/meteorology supplier and then used internally to inform the utility organization about this aspect of the weather impacts on grid operations.

A Remote Automated Weather Station (RAWS) by contrast measures the following variables: temperature, relative humidity, wind speed and direction, solar radiation, precipitation, fuel moisture and fuel temperature. These sensors meet the accuracy specifications, collection requirements, calibration requirements and measurement intervals specified by the National Wildfire Coordinating Group (NWCG). Additional variables that can be calculated from RAWS data can include those from above, but also importantly include a 10-hour fine, dead fuel measurement which is a critical measurement in assessing wildfire risk potential and wildfire behavior.

The data reported by a RAWS is also collected hourly using the GOES Wildland Fire Management Information system and is used to inform decisions made by interagency wildland fire management professionals. This includes wildfire behavior assessments and the National Fire Danger Rating System (NFDRS) wildfire hazard levels. National preparedness levels for responding to wildfire emergencies are only set using data from verified and calibrated RAWS, and those national preparedness levels dictate what resources are going to be available from State and Federal agencies to prepare for and respond to wildfires in any given region across the USA.

The data from a micro-station is used locally within a power utility organization to make decisions specific to internal demands and requirements for grid operations and safety. The data from a RAWS can be used locally as well but is also used at a national level to support the larger scope of national and state wildfire emergency planning efforts. If there is no RAWS weather data coverage of power utility company's assets, then there is no preparedness and response resources available from wildland fire agencies such as state organizations i.e., CalFire or a federal organization like the Department of Interior and its sub-agencies (USFS, BLM, BIA, US Parks, US Fish & Wildlife), etc. The addition of a nationally accepted 'standard' (RAWS) can help provide a power utility wildfire mitigation plan (WMP) a highly accurate, standardized reference station as a benchmark for good prudence and best practices with power utility regulatory organizations like the local state public utility commission.  In addition, they also provide an opportunity for weather data information sharing and better coordination with local wildfire agencies working on multi-jurisdictional boundaries where wildfires are encroaching on utility rights of way or into other state/federal territories.

Siting locations for fixed RAWS should follow the recommendations in PMS426-3. This could mean locating the RAWS close to the existing stations already in place but could also be sited in other locations that might not be easily accessible to micro-stations. If the best sites for the RAWS were in pre-existing micro-station locations a power utility company operations supervisor could consider moving the micro-station to another location and increasing coverage.

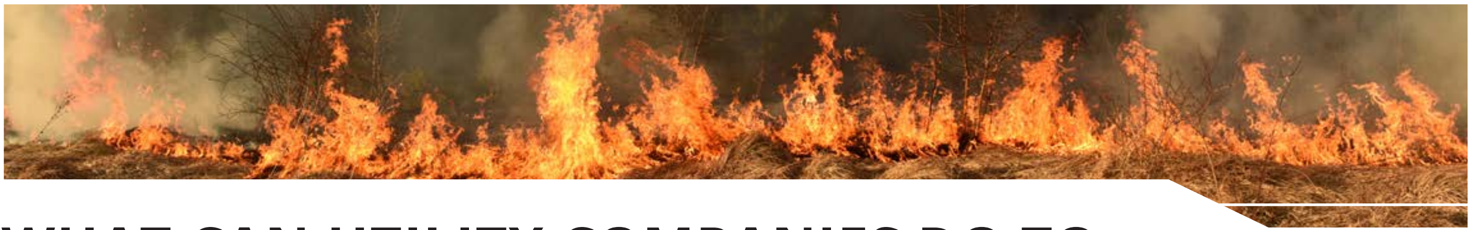
***"Some of the costs involved in firefighting are extremely expensive—especially the aircraft expenses. From that perspective, the amount to spend on weather is very small. So, it's not something that is even debated. It's known that you need to put the weather stations out there to be able to get the fire indices, and we need to maintain them to get accurate indices. It's pretty well accepted that it's saving money and saving property and saving lives."***

**DON GREEN**
Former Chief Meteorologist,
Yukon Government (Canada)

Compact Automated Weather Stations (CAWS) and Portable (Quick Deploy) Weather Stations augment the RAWS or utility micro-station networks with similar sensor sets to the RAWS but with on-site requirements and portability in mind. In the case of Quick Deploy stations and Compact stations that attach to existing utility infrastructures (distribution poles, transmission towers, communications towers) they provide great granularity to existing weather network systems.

Compact stations have a fully customizable sensor set, including all RAWS sensors and come with the option of a portable tripod or pole mount options to attach to existing infrastructure. The weather data is transmitted over cellular or GOES satellite with one-minute to hourly frequency. The Quick Deploy (QD) stations provides on-demand, real-time radio transmitted weather data to incident responders on the ground. Weather data can also be transmitted over GOES satellite into the LRGS and onto WFMI and comes equipped with the same sensor set as a RAWS and data collection control for referencing quality reporting. Additional sensors can be added. The QD is completely portable in a carrying case and can be easily assembled on site by one person in 15 minutes without tools.

By adding RAWS stations to an existing micro-station network power utility companies would be enhancing the granularity of their own wildfire risk to their grid operations data. RAWS stations would also improve decision making and provide a highly referenceable (ground-truth) data set to validate existing micro-stations.  In any given area of responsibility, a power utility operation will likely have many opportunities to site both RAWS and micro-stations in unique and valuable locations to obtain highly accurate, quick weather data, increase field awareness and make critical decisions to maintain safety and efficient grid operations as it relates to wildfire risk awareness, mitigation efforts including operational calls to action.



# WHAT CAN UTILITY COMPANIES DO TO MITIGATE WILDFIRE?

Some of the key wildfire mitigation steps being taken by power utility companies as part of their wildfire mitigation plans are targeted at fuel management, predictive services and situational awareness to improve capabilities and capacities in wildfire prevention and suppression.

## ENHANCED SYSTEM PROTECTION

Centralized aggregation of data from power system assets provides visibility into the state of the power system so that operators can quickly adjust protection and control to match wildfire risk conditions. This allows utilities to rapidly disable reclosing or, in extreme cases, shut off power in response to an increased wildfire hazard in accordance with established procedures. Precise, granular weather data from a dedicated network provides greater awareness of the potential impacts of extreme weather events (wind, snow, ice, wildfires) and provides enhanced decision making about risk exposure levels in utility areas of interest that have major impacts on grid operations.

## SYSTEM HARDENING

System hardening often focuses on pole or line loading, the prevention of equipment flashover and equipment resilience during wildfire exposure. Examples of system hardening include: the replacement of wooden poles with metal or composite poles, insulating overhead conductors, increasing conductor spacing and selectively burying circuits. Hardening power systems also includes applications of fire-retardant chemicals and other equipment through updated designs and material selections that allows the power system to withstand wildfire contact, higher wind speeds, and other environmental factors. Decisions around which of these programs can and should be prioritized are based on historical wildfires, that intersect with archived and/or real-time fire weather analysis.

## PREVENTATIVE MAINTENANCE

Constant inspection and repair of aging power system infrastructure minimizes the risk of ignition in high wildfire risk areas. Inspections of distribution poles, transmission structures, pole-mounted equipment and substations are conducted on a regular schedule to identify potential risks. A proactive vegetation management program is also critical in high wildfire risk areas. Such programs typically include the trimming and removal of trees and other fuel sources. Automated weather stations and camera technologies exist to determine which areas the driest vegetation intersects with vegetation encroachments on the rights of way and helps to more readily discover the most vulnerable areas to prioritize calls to action in preventing new wildfire ignitions.

## STRATEGIC OPERATIONAL PRACTICES

A critical component of wildfire mitigation is the ability to assess and forecast the wildfire risk based on weather conditions and other environmental factors. These variables are dynamic, and accurate forecasting requires processing a large amount of data from multiple sources. The National Weather Service and other organizations provide information on wildfire risk for different areas. However, many utilities in high fire risk areas deploy their own weather stations and other sensors to collect information on wind speed, temperature, humidity, fuel temp/moisture, lightning and other factors to determine the wildfire risk and make decisions regarding the operation of the power system.

## CONCLUSION

A dedicated wildfire weather network will result in more accurate, timely, and complete wildfire weather data that is more representative of actual field conditions. This enhancement to situational awareness can help utility organizations and wildfire management agencies alike improve their ability to predict, prevent and suppress wildfires with efficacy. The relatively low cost of a scalable, dedicated wildfire weather network is small in comparison to the cost of errors associated with untimely or the absence of critical decision making to address wildfire risk concerns and implementation of operational wildfire mitigation calls to action. Better data means better decision-making, which in turn leads to reduced expenditure on preventing, suppressing wildfires that results in less damage to assets, infrastructure, property, ecosystems and most importantly, improving safety and security in people's lives.

## ABOUT THE AUTHOR:

For over 20 years Shawn Bethel worked for the Province of British Columbia as both a Wildfire Protection Officer and Manager of International Development based out of Victoria, Canada. Shawn understands the importance of reliable data via enabling technologies to understand the workload and the associated organizational response required to mitigate risks, overcome challenges, pursue continuous improvement and maintain long-term successful operations. Shawn joined the FTS team in 2019 and is using his wildfire background and industry knowledge to lead the FTS business development activities, as part of the AEM group of companies.

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