The importance of a dedicated fire weather network – Part 1

Every year a vast majority of 30–46 million km^2 of the global land surface burn due to wildfire, approximately 4% of the global land surface. Recently in North America the area burnt by wildfires has increased sharply, while regions like Southeast Asia and South America have seen a rise in the number of land-clearing fires and other escaped wildfires in equatorial forests. In 1997, Malaysia, for example, spent $8.2 million to put out fires that resulted in major evacuations.

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The extraordinary costs of fire suppression activities are matched only by the damages to property and ecosystems these fires wreak – in South America, this loss is estimated at $1.6 billion annually. In the US, damages from major fires were found to account for as much as 95% of total costs from fire.

In emerging economies, the default mode of fighting wildfires is reactive – to tackle fires as they arise using whatever resources are available. This approach is both costly and dangerous.

Advances have been made through the use of basic weather data from meteorological stations. In years past, fire agencies used this data to develop fire danger rating systems that helped them predict, prevent and suppress fires. 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 errors in decision-making.

▼ **FTS Portable Automated Weather Station deployed in Whyte River.**

Image courtesy of Forest Technology Systems, Ltd.

As a senior executive at FTS, Mr. DeCiantis fulfills many strategic roles, including that of visionary, tactician, team leader and mentor to new associates. He has been with the company since 2014 and continues to steer the company towards new and gainful opportunities.

Fire Weather Data Adds Critical Insight to Fire Management

A wildfire moves at speeds of up to 14 miles an hour (23 kilometers an hour), consuming everything – trees, brush, homes, even humans – in its path. Modern 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. Should the focus be on ground operations, or is aerial support needed? Operations are constantly adapting to fire weather information: imminent rainfall may make fire suppression activities unnecessary; an expected change in the wind direction may inform a shift towards protection of a nearby town; windy conditions may make it too dangerous for a helicopter. By understanding the weather's effect on a fire's behaviour, decision-makers can make the most effective use of available resources while prioritizing the safety of their firefighters.

Fire danger rating systems: the key to fact-based decision-making

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 $750 million in firefighting expenditures. In China, implementation of a national fire danger rating system has reduced area burned by 90% since 1987.

Fire weather data reduces risks during prescribed burns

An excess buildup of fuel caused by ongoing fire suppression can lead to extreme fire conditions. Fire weather data and danger rating systems allow land managers to reduce fire risk by doing prescribed burns during times when the fire will achieve its objective but the probability of escape is low.

The importance of proactive resource allocation

It is not feasible to have 100% of staff ready to go at all times, nor is it feasible to have enough equipment and staff to deal with the most extreme fire season. Instead, fire danger ratings can help determine the level of preparedness and resource prioritization on any given day.

Image courtesy of Forest Technology Systems, Ltd.

▲ **FTS Fixed Site Weather Station with 10M mast deployed at the Mullion Site outside Canberra.**

Fire weather data helps post-fire analysis

Fire weather data allows fire investigators to trace a fire's path to its source, while fire danger ratings can help inform whether a fire was the result of natural or human causes – a low ignition risk, for example, could suggest arson.

Accurate Fire Weather Data = Accurate Fire Decisions

To be useful, fire weather data must be accurate. Likewise, fire danger ratings and fire behaviour prediction systems will produce significantly different results when weather inputs are changed.

Small weather changes have big consequences

In some situations, an underestimation of wind speed by 9 km/hr would result in an underestimation of the rate of fire spread by half. Even a 2 km/hr error in wind speed could produce a difference in the rate of spread that would cover the transition from surface fire to crown fire.

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-degree error in air temperature. Add in a 6 km/hr error in wind speed and the index will be 30% off.

Gaps in fire weather data invalidate historical analysis

Similarly, a gap in the weather data caused, for example, by equipment failure creates 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.

Image courtesy of Forest Technology Systems, Ltd.

▲ FTS Portable Automated Weather Station deployed in Whyte River.

Late fire weather data is useless data

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

Simply put, poor data leads to poor decision-making.

Inaccurate danger ratings rack up unnecessary expenses

A fire danger rating that has been mistakenly set too high will incur significant costs as a consequence. 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, this will quickly add up. Aerial resources are even more expensive: In South Africa, it costs $23,000 a month to keep a helicopter on standby. In Australia, a heli-tanker is $20,000 per day on standby. And in Italy and France, the average cost for water bombers on standby is $13,000 per hour. Public funds are too scarce to be wasted on being ready for fires that may never happen.

Inaccurate danger ratings lead to escaped fires

Fire danger ratings are used to determine crew readiness and resource availability. A delayed or insufficient initial attack will lead to more escaped fires. According to an Australian study, on a bad day, a fire crew delay of just one hour will reduce the probability of containment within 8 hours by 60%.

In the US, just 1% of fires account for 94% of suppression expenditure. The damages from an escaped fire can be enormous. In India, a single fire in a Sandalwood Forest in 1997 generated $43 million in damages.

Poor prediction of fire behaviour endangers lives and property

Once a fire gets going, an accurate prediction of its behaviour 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 settlements need to be evacuated 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.

Reducing the impact of wildfires with a dedicated fire weather is not only critical in saving lives and reducing damage to property, but it also reduces unnecessary wildfire expenses. Having critical fire weather data insight into fire management arms decision-makers with accurate information to prioritize resources and reduce risk to their firefighters. But, how do you achieve fire weather data accuracy? Find out next issue.

For more information, go to www.ftsinc.com

The importance of a dedicated fire weather network – Part 2

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.

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Station location is critical

A weather station's location needs to reflect the conditions it's 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 . 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, for instance, the meteorological network has approximately 90 stations in the province, mostly located in urban areas, while another 260 RAWS are used to collect fire weather data throughout the province, particularly in fire-prone ecosystems.

More density equals more 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% . 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

▼ **FTS Portable Automated Weather Station deployed on a prescribed burn.**

▶ **FTS Remote Automated Weather Station with 10m mast deployed at the Mullion Site outside Canberra.**

Image courtesy of Forest Technology Systems, Ltd.

locations . 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.

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 or challenging the accuracy of the nearest weather station during a major fire event or during a prescribed burn.

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."

Timeliness is essential for fire weather, and as discussed in the previous section, rudimentary weather stations don't always report at the right time of day for calculating fire danger indices. Fire suppression operations particularly value having access to hourly data, because it could 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 fire weather stations reduce human error by cutting out these processes, providing fire managers with peace of mind that observations are correct. Automation also frees up staff time to focus on other tasks, reducing budget expenditures.

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 behaviour. 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.

Tailored to fire weather standards

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 . These requirements are tailored to the unique demands of fire weather applications while upholding standards set by the World Meteorological Organization.

Maintenance simplicity reduces costs

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.

Durable stations prevent interruptions

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, humidity, insects, and vandalism are just some of the harsh conditions they must withstand.

Image courtesy of Forest Technology Systems, Ltd.

▲ **FTS Portable Automated Weather Station training in Australia.**

The value of a dedicated fire weather network

A dedicated fire weather network will result in more accurate, timely, and complete fire weather data. Better data means better decision-making, which in turn leads to lower expenditure on fighting fires and less damage to property, lives, and ecosystems. The cost of a dedicated fire weather network is very small in comparison with the cost of errors in fire suppression. Using very conservative estimates, an agency would need to reduce the area burned by only 2.5% in order to justify the cost (see box). If reductions are 20% as in the study previously mentioned , then the costs will be vastly outweighed by the benefits.

Conclusion

A dedicated fire weather network helps fire management agencies improve their ability to predict, prevent and fight wildfires. This article has shown how costly and dangerous errors can be made when fire weather data is incorrect or missing. A dedicated network of remote automated fire weather stations ensures fire weather data is timely, accurate, and representative of actual field conditions. This investment will be paid back many-fold in the form of more effective and efficient firefighting, reduced damages to property and ecosystems, and saved lives.

For more information, go to www.ftsinc.com

A Cost-Benefit Analysis

Based on data collected between 1985 and 2012, the United States sees an average of 76,669 fires per year, impacting 4.96 million acres (20,075 km^2). This is roughly 22% of the total land area of the United States.

Using the US average as a reference (which is lower than the global average) an area the size of Malaysia (330,000 km2) could expect to have fires impacting 726 km^2 annually. Assuming* a cost of $100/hectare for fire suppression and $100/hectare for damages, this would result in approximately $14.5 million dollars in suppression and damage costs annually. The approximate cost of a fire weather network for an area this size, spaced at 80-km apart and amortized over ten years and including maintenance costs, would be covered by a 2.5% reduction in annual fire costs.

Estimates of cost per hectare vary enormously. In the US, the 20-yr average cost of suppression alone is $600/haxxxi. Case studies in the US have shown suppression costs ranging from 53% to more typically only 5% of total costs incurred by fires. In 1997, fires in Malaysia, Indonesia, and Khazakstan incurred damage costs of $609,000/ha, $2,418/ha, and $717/ha respectively. In the Malaysian case, fire suppression only accounted for three percent of the total costs—the bulk were incurred from lost productivity due to evacuations, and lost tourism revenue. Other examples include Sri Lanka, where average damages from 1990-2000 were $60/ha, and Mongolia, where average damages from 1996-1997 were $13,000/ha.