Wildfire Research Update

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SCION
FORESTS ▪ PRODUCTS ▪ INNOVATION

Debris pile temperature sensor

In logging operations, the process of creating logs from trees results in the generation of debris – sawdust, broken branches and logs, needles and cut-off ends of logs "slovens". This debris builds up on the landing and is swept into a debris pile. Over time the debris pile decomposes into soil but occasionally decomposition results in the debris pile spontaneously igniting.

Key findings

- The external temperature of a forest debris pile, as measured by a thermal camera, has no relation to the internal temperature of the pile.
- Spontaneous combustion of debris piles often occur in remote places so a thermometer which can be read remotely is an advantage.
- The forest environment is unforgiving with strong winds, rain, snow and curious animals and makes it difficult to maintain delicate instruments to reliably measure, record and transmit temperature data to the internet.
- After much field testing and refinement in design we have a prototype device which can provide near real time temperatures from inside remote debris piles.
- Trends in debris pile temperature can be monitored by the forest manager long term and when the piles cool monitoring can be discontinued.

Background

In 2014, Northland kaumātua Kevin Prime identified that the average fire-kit (of tools) used by land managers had not been updated. He suggested that if it were to be updated it should include tools for both burn offs and fire suppression. This got us thinking about technology to detect fire and transmit alerts or warnings. A fire sensor and communications system was developed by Scion and inFact Ltd, a design company in Christchurch. The technology was successfully tested at research burns and demonstrated in Northland. Subsequently Wenita Forestry in Otago had a problem with forest debris piles spontaneously combusting. There was no way, from outside the pile, to identify which piles were heating up dangerously. Scion, working with inFact, and funded through the MBIE Extreme Wildfire research programme, modified the fire sensor system to measure the temperature inside the debris piles and transmit the temperature to the internet by satellite.

Wenita staff deployed and monitored the probes in their forests to assess the risk of spontaneous combustion in 11 debris piles. The probes found six very hot piles with the hottest internal pile temperature in excess of 90°C with a high risk of spontaneous combustion.

Setting up communications system for temperature probe.

John Kerr, forester at Wenita, says the probes are a practical solution that perfectly suited Wenita's needs.

"The probes have been extremely useful and they're easy to use.

"Most slash piles don't cause any problems, but the odd one does and monitoring them the old way, by driving out to inspect them, used to be very time-consuming. These probes mean the suspicious piles can be monitored anytime from almost anywhere, which is brilliant."

Satellite communications proved difficult with the only available geostationary satellite being low in the sky in Otago; it was obscured from view in some forests. The latest version of the system uses the more robust cellular network.

Problem

Logging debris piles can catch fire by spontaneous combustion.

Solution

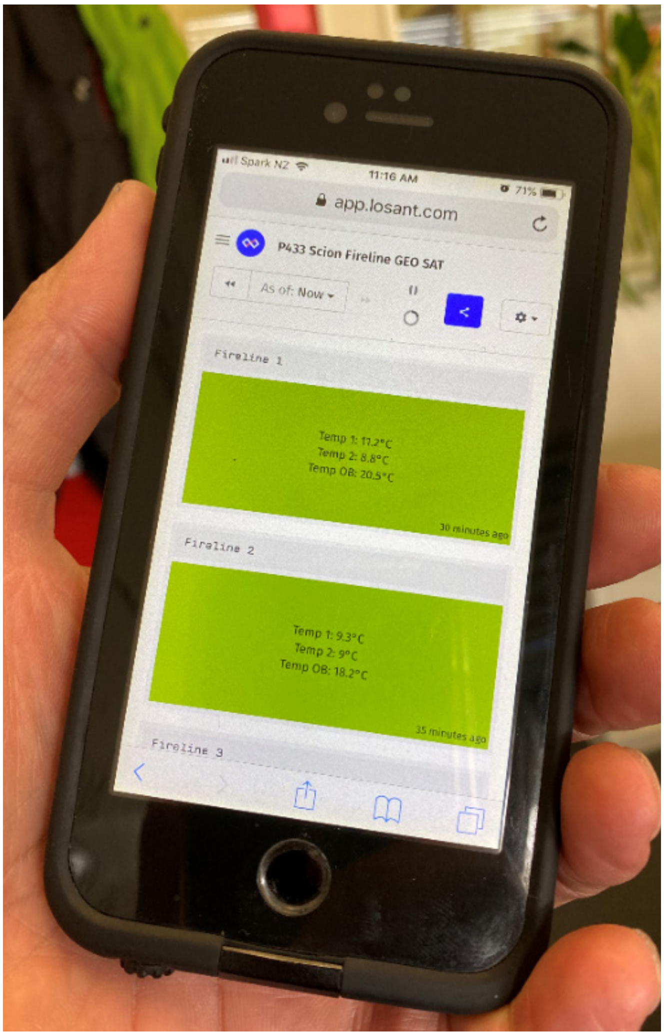
Monitor the internal temperature of the debris piles and watch long term trends in temperature.

Objective

Develop a debris pile temperature monitoring system that can send near-real time temperature readings from locations that have cellular coverage.

Probe and electronics enclosure with solar panel.

Temperature probe inserted into debris.



Losant dashboard page displaying real time temperature.

Methods

The system consists of a two-metre-long temperature probe that measures the temperature inside the debris pile. The probe is attached by a cable to a weatherproof box which houses a data logger, cellular modem, battery and solar panel. The temperature sensor is encapsulated in a fiberglass tube to protect it from the moisture and prevent it being damaged by material in the debris pile.

The probe is gently pushed into the debris pile by hand and manoeuvred to avoid solid blocking debris like heavy branches, logs and slovens.

Data from the sensor is transmitted from the forest to a hosted webpage by the LTE Cat-1 cellular network. The webpage can be viewed from any device connected to the internet such as a phone or computer. The device has a small onboard battery which is kept charged by a solar panel.

Results

Data is being recorded at 10 minute intervals from the temperature probe and monitored in real time by the Losant dashboard on a cell phone or internet connection.

Losant is an Internet of Things (IoT) cloud platform which takes data from IoT devices. It provides data collection, storage, visualisation, and analytics features to help users understand their data. Losant is classified as an application enablement platform and allows developers to quickly build applications for custom purposes.

Figure 1 shows two weeks of data from a temperature probe two metres inside a debris pile (orange line). The blue line is ambient temperature inside the plastic terminal weatherproof housing. The terminal housing is exposed to full sunshine so exhibits great diurnal fluctuations in temperature.

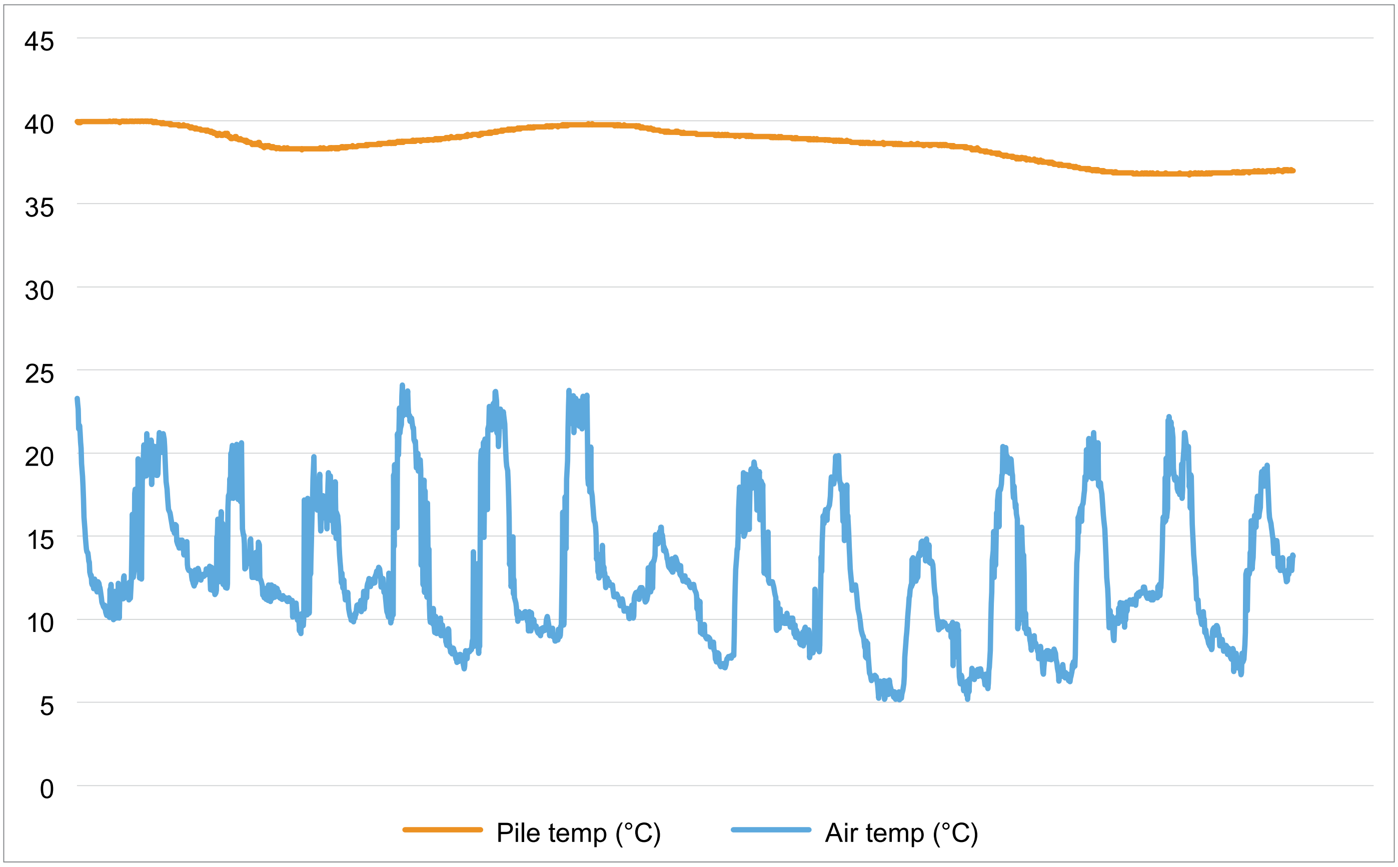


Figure 1: *Two weeks of temperature records from a temperature sensor buried in forest debris pile (orange line) and a temperature sensor inside the terminal enclosure (blue line).*

Discussion

There are considerable advantages to a forest company having real time data on the temperature inside a debris pile. Rises in temperature that could result in spontaneous combustion can be monitored remotely without the need to travel to the debris pile. Temperature deep inside the debris pile can be monitored and tracked over time to identify rising temperatures so giving early warning of piles that may spontaneously combust in the future.

Compost decomposes hotter and more rapidly in the presence of moisture. There is a belief that debris piles are more at risk of heating after rainfall. Combining internal pile temperature profiles over time with ambient weather conditions (air temperature, humidity and rainfall) may provide evidence of the effect of rain increasing moisture and raising decomposition temperature. A humidity sensor buried with the temperature sensors may provide valuable information on the changes of humidity inside the pile.

The sensor system could be used to monitor the temperature of debris piles constructed by different methods to provide guidance to forest managers on the best pile architecture to promote decomposition without the risk of combustion.

Next steps

- We plan to collect weather data along with the internal debris pile temperature to gain a better understanding of how weather conditions influence pile temperature.
- Working to make the probe and communications system more robust to stand up to the rigours of forest weather and curious animals.

Acknowledgements

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Further information

Clifford, V. R., Bayne, K. M., Melnik, K., Yao, R. T., Baillie, B. R., Parker, R. J., & Pearce, H. G. (2020). Factors contributing to spontaneous combustion of slash at skid sites. (Report No. 182). Scion Rotorua, NZ: Fire and Emergency New Zealand.

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