A comparison of 2019 Pigeon Valley Forest fire with similar events in the past

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Abstract

As the most expensive fire in the history of New Zealand vegetation fires, the February 2019 Pigeon Valley wildfire has also been claimed by some to be the most destructive plantation fire in the past 60 years. This paper reviews data from other forest fires to show that the fire environment in the first five days of this fire does not warrant this characterisation.

The paper also reviews the use of fire weather information (both forecast and actual) in some of the key decisions made in containing the fire. The 5 February 2019 Pigeon Valley fire involved losses of more than 2,300 ha of forested lands located 30 km south-west of Nelson. It involved the deployment of resources from many parts of New Zealand, the construction of a firebreak external to the plantation, and the evacuation of people from communities to the south-east of the wild fire. The fire weather data for the days following the first 18 hour period of the fire is assessed. A conclusion is reached on the potential of the fire to spread beyond the plantation lands and into open lands on the south-eastern edge which questions whether these decisions were warranted.

The main conclusions reached in this paper include recommendations relating to the availability of forest fire behaviour specialists, comparisons with other similar forest fires, clarification to define when wildfire incidents become civil defence emergencies, the effectiveness of aircraft, and the need for an Independent Commission of Inquiry to be established by the Government to investigate the actions taken to manage the Pigeon Valley wildfire.

Figure 1: Area burnt by fire in Pigeon Valley near Wakefield on 5 January 2019

Introduction

At approximately 2pm on Tuesday 5 January 2019 a fire was reported in Pigeon Valley near Nelson. Given the elevated fire danger conditions at the time, this wildfire quickly spread from farmland into forested lands. The final area burnt by this wildfire involved more than 2,300 ha (Figure 1).

The first day of the Pigeon Valley fire involved weather conditions that were extreme, with a very high potential for 'spot fires'. A spot fire is a fire ignited outside the perimeter of the main fire by flying sparks or live embers. Observations made on the first day confirmed that spot fires did occur as the fire spread northwards towards Eves Valley. Containment was achieved at the northern edge of this fire after it exited the plantation forested lands and spread into lifestyle blocks. The fire danger condition on subsequent days was less than extreme, which resulted in a very low probability of further spot fires.

On day four of this fire, action was taken to evacuate a large number of people from homes on the eastern flank including 2,500 from the Wakefield community. The total cost in the suppression of fire has exceeded $17 million.

Wildfire behaviour

While the causes of wildfires vary and the outcomes are always unique, all of them can be characterised in terms of their physical properties, their fuel type, and the effect weather has on the fire. Wildfire behaviour and severity result from a combination of factors (such as available fuels, topography and weather).

The spread of vegetation fires varies based on the flammable material present, its vertical arrangement and moisture content, and weather conditions. Wildfires occur when all the necessary elements of a fire triangle come together in a susceptible area, i.e. an ignition source is brought into contact with a combustible material (such as vegetation) that is subjected to enough heat and has an adequate supply of oxygen from the ambient air.

Subject to fuels being dry enough and in sufficient quantity, with a high enough fuel hazard index to sustain a fire, the primary influences on how vegetation fires move through the landscape are humidity, topography, wind and temperature (Hines et al., 2010). The slope of the landscape is also important. Fires burn much faster uphill than down because the radiation and convection from a fire creates pre-heating of the unburned fuel ahead of the flame front. This is done more effectively upslope than down. A 10 degree increase in slope usually results in a doubling of the speed of the fire. Fire will spread up a 20 degree slope four times as fast as it will along flat ground.

Wind speed is the environmental variable that has the most significant effect on the spread of fires. With wind speeds below 10 km/hour, a fire will usually burn slowly without a definite spread direction. However, as winds increase in strength, the rate of fire spread increases. A change in wind direction, often from a cold front, can activate the side of a long and relatively narrow fire, turning it into a very broad flame front. In general, a wider fire will burn faster than a very narrow one.

The heat of a fire can create whirlwinds and turbulent air currents. Wind is also a major factor in transporting firebrands – pieces of burning fuel, like twigs, leaves or small embers – ahead of the main fire. This causes spotting, which is the ignition of new fires ahead of the fire front.

Humidity also plays a big part in fire behaviour as the lower the relative humidity (RH), the more vigorously fuels may burn. When the RH is 100%, the air is holding as much water vapour and it is most likely raining. In comparison, 0% humidity would indicate the complete absence of water vapour, but that does not occur in nature.

Preferred RH levels for managing prescribed burns should ideally sit from 30–55%. A prescribed burn is a planned fire; it is also sometimes called a ‘controlled burn’ or ‘prescribed fire’ and is used to meet management objectives. A prescription is a set of conditions that considers the safety of the public and fire staff, the weather, and the probability of meeting the burn objectives.

Under special conditions a wider range of RH, as low as 20% and as high as 60%, can produce successful burns. When RH falls below 30% prescribed burning becomes dangerous. Fires are more intense under these conditions, and fire behaviour is unpredictable and spotting is much more likely. On the other hand, when RH is 60% or higher, a fire may leave unburned islands or may not burn hot enough to accomplish the desired result.

Spotting ignition is one of the three significant mechanisms of wildfire spread. It can be considered as a discontinuous fire spread mechanism (Koo et al., 2010), which is synonymous with solid mass transport (Albini, 1979; Alexander, 2009). The transport of burning fire embers outside the fire perimeter is a cause of serious concern to firefighters because it affects fire behaviour and the difficulty of control, and poses a serious safety threat for them and civilians.

Research undertaken in Portugal involved the monitoring and documenting of selected wildfires, noting the appearance or absence of spot fires during the prevailing conditions at the time. This work showed that, on a database of 166 field observations, no spotting ignitions were recorded at RH values higher than 46%. Massive spotting that triggered extreme fire behaviour was, however, documented for RH values lower than 17%.

Research undertaken by John Weir, Superintendent of the Oklahoma State University Research Range, showed from 99 prescribed burns that for RH below 40%, the probability of spot fires rises rapidly. The data also showed that below the 40% threshold, spot fire probability rose with each 5% drop in RH (Figure 2). At 25% RH, there appears to be another threshold; below this point there was a 100% probability of a spot fire occurring. But in the 25–29% RH range, spot fire probability dropped from 100% to almost a 50–50 chance. In the 30–35% range, only one out of three burns was likely to produce a spot fire.

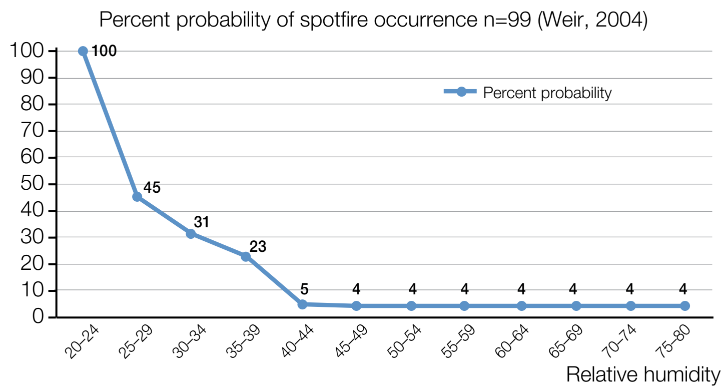

Figure 2: Relative humidity and probability of spot fires

Crossover

A formal definition of crossover is listed by the Canadian Forest Fire Centre as 'the point at which the numerical value of the ambient RH is less than, or equal to, the numerical value of the ambient air temperature.' This may be used as a rule of thumb indicator of extreme burning conditions, an indicator primarily used by fire suppression staff. However, some researchers have been cautious about the crossover rule of thumb, saying that it has some value but may be overused and misinterpreted (M.E. Alexander, Forest Fire Research Officer, Canadian Forest Service, personal communication).

One of the problems, according to Alexander, is the tendency of fire managers to prepare for severe fire behaviour only when crossover conditions occur. However, severe vegetation fires can occur in the absence of crossover. Obviously, fires may exhibit extreme behaviour because of other factors including wind speed, temperature, RH, steepness of the slope, and the dryness of medium and heavy fuels. In the interactive training course 'Wildland Fire – Safety on the Fireline', Alexander has stated:

> *Crossover can be a useful reminder that the potential for blowup or extreme fire behaviour exists. However, do not rely on crossover as your only indicator of such situations. Forecasters must be mindful that there is more to extreme fire behaviour potential than just crossover or wind speeds greater than 30 km/h. Crown fire behaviour can occur in the absence of crossover conditions and with only moderate wind speeds (about 15 km/h) if other criteria are met, such as dry medium or heavy fuels or steep slopes.*

Predicting fire behaviour

Fire intensity is one of the major determinants associated with the difficulty of controlling or containing a free-burning vegetation fire. From a fire behaviour standpoint, the other factors include the rate of perimeter increase or growth (a function of the rates of spread at the head, flanks and back of the fire), spotting characteristics (partly related to fire intensity), and the development of volatile and dangerous fire behaviour such as fire whirls.

A further reference about the Pigeon Valley wildfire environment and fire behaviour is a 1994 report prepared by Marty Alexander, a Canadian forest fire scientist who helped re-establish our New Zealand forest fire research programme in 1993 and revised the Fire Danger Class Criteria for this country's forest and rural areas. This report refers to the Canadian Forest Fire Behaviour Prediction (FBP) System (Forestry Canada Fire Danger Group, 1992). This allows for the quantitative prediction of fire behaviour (including fire intensity) using, among other inputs, the Initial Spread Index (ISI) and Build Up Index or BUI (which represents the increasing amount of fuel available for combustion as a dry spell lengthens) components of the Fire Weather Index (FWI) System. Overviews of the FBP System can be found elsewhere (Alexander & Maffey, 1992–93; Hirsch, 1993). Fire spread rates are based on the Fine Fuel Moisture Code (FFMC), wind speed, BUI, slope steepness and fuel type.

Alexander then assumed that since the ISI represents only a few days of weather history after rain via the FFMC, the BUI is therefore presumed to have at least some effect on the rate of fire spread as well (Van Wagner, 1973, 1989). Using the Alexander findings and applying this to the Pigeon Valley fire, the ISI and BUI on each of the seven days commencing 5 February 2019 provide the following results (Table 1) of fire spread in forested lands.

Table 1: Estimated forward rate of spread

Date	BUI	ISI	Estimated forward rate of spread
5 February	125	11.6	400 m/hr
6 February	126	2.9	10 m/hr
7 February	129	4.7	70 m/hr
8 February	131	4.9	75 m/hr
9 February	133	4.2	70 m/hr
10 February	135	5.4	90 m/hr
11 February	138	5.9	100 m/hr

The hourly ISI and the daily BUI of the fire danger conditions shown in Figure 3 outline the overall hourly fire intensity for the Pigeon Valley wildfire and how it compares with the Onamalutu, Port Hills, Mount

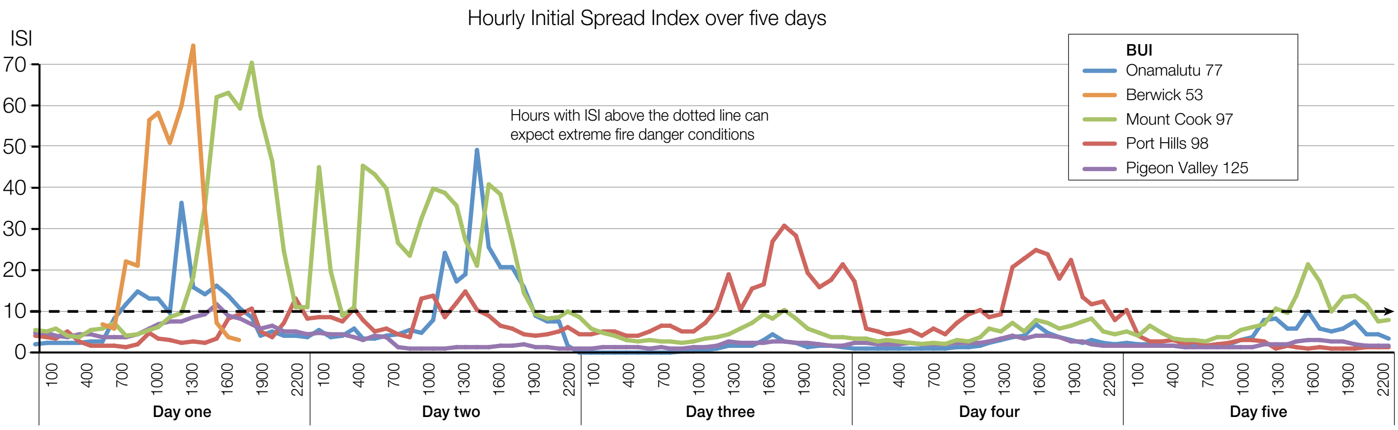

Figure 3: Fire danger from time of ignition

Cook and Berwick forest fires. This shows the points of difference over a five-day period for each wildfire. The figure shows the Pigeon Valley fire danger conditions following the first day were low to moderate when compared with the other four forest fires.

Figure 4 also shows the fire danger conditions associated with the time of ignition for a number of New Zealand forest fires for the past 80 years. These fires are also compared with the 1983 Ash Wednesday fires in Australia and the 1988 Yellowstone fire in the US.

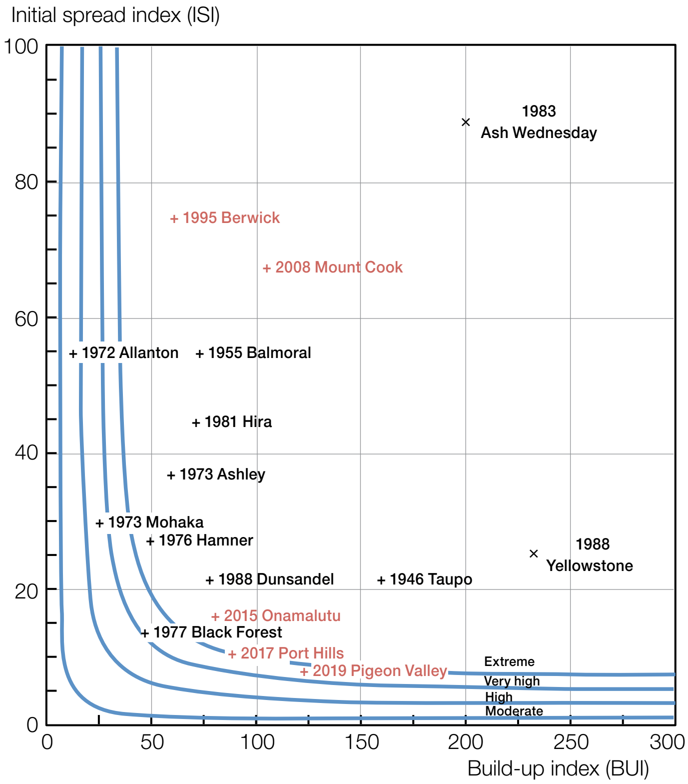

Figure 4: The fire danger conditions associated with time of ignition for the Berwick, Mount Cook, Onamalutu, Port Hills and Pigeon Valley fires compared with other New Zealand and overseas forest fires (adapted from Pearce & Alexander, 1994, amended by Dudfield, 2019)

New Zealand plantation wildfires – case studies

From a number of plantation wildfires over the past 30 years, a fire environment comparison between five wildfires that burnt areas of plantation greater than 100 ha makes for an interesting appraisal (see Figure 4). The forest fires were:

a) Berwick Forest fire – 26 February 1995
b) Mount Cook Forest fire – 16 January 2008
c) Onamalutu Forest fire – 4 February 2015
d) Port Hills fire – 13 February 2017
e) Pigeon Valley Forest fire – 5 February 2019

(a) Berwick Forest fire – 26 February 1995

The Berwick Forest is located 36 km south-west of Dunedin, not far from Waipori Falls. The 26 February 1995 Berwick Forest fire burnt a total area of 255 ha, including 181 ha of radiata pine and 74 ha of scrub and recent cut-over. This fire exhibited extreme and uncontrollable fire behaviour, with frontal spread being halted only when the fire reached pastoral lands.

The fire danger conditions, from an RH perspective, were as bad as (or worse) than those encountered in many other New Zealand and overseas wildfires. Spread rates of the major fire runs were 850 to 2,780 m/hour and fire intensities ranged between 12,750 to 41,650 kW/m. Changes in wind direction, fuel types and terrain significantly altered the fire behaviour, making suppression difficult and dangerous.

Extreme burning conditions prevailed from 1100–1830 hours on the first day. Within six hours a theoretical free burning fire on flat ground in continuous plantation of mature and mix-rotation conifer would be expected to spread more than 17 km, have a perimeter length exceeding 30 km, and burn an area greater than 4,500 ha. The Berwick Forest fire burnt a much smaller forest area (255 ha), and this is entirely due to the head fire running out of continuous forest fuels when it reached pastoral lands.

On the first day for a period of 10 hours from 0900–1800 hours the fire environment experienced crossover effects where the RH values were lower than the temperature values. For the two-hour period from 1300–1500 hours, the RH was less than 10%. With the lack of water vapour in the atmosphere this provided for a very dry environment that produced extreme fire behaviour involving spot fires. From 1100–1600 hours, wind speeds varied between 24–33 km/hour. These conditions are the most extreme of any recorded for a plantation wildfire in New Zealand.

b) Mount Cook Forest fire – 16 January 2008

On the afternoon of Wednesday 16 January 2008 a fire was ignited on farmland on the eastern side of Lake Pukaki in South Canterbury. This fire escaped initial attempts at containment and went on to burn an area of 756 ha of mainly forested lands. The fire burnt actively for the first two days, during which periods of extreme fire behaviour were witnessed. This was due to hot, dry windy conditions and heavy fuel loadings. The change in weather conditions on the third day produced lower fire intensity, and with lower fuel loadings this allowed the fire to be contained.

On the first day, for a period of seven hours from 1400–2000 hours, the fire environment experienced crossover effects where the RH values were lower than the temperature values. For the six-hour period from 1500–2000 hours, the RH was less than 20%, providing for a dry environment. From 1600–2300 hours wind strengths varied between 34–43 km/hour. During the second day there was also a second period of a crossover of temperature and RH effects for four hours, with RH less than 20% for three of those hours.

c) Onamalutu Forest fire – 4 February 2015

The 4 February 2015 Onamalutu Forest fire burnt close to 600 ha, the biggest fire to impact the Marlborough region since the Boxing Day fires of 2000. It devastated forest and pastoral lands between the Onamalutu and Okaramio Valleys. On the first day, the fire environment experienced RH values greater than 40%. Wind strengths from 900–2100 hours varied between 23–38 km/hour.

On the second day, the fire environment became elevated. For a nine-hour period between 800–1600 hours the fire experienced RH values between 28–40%. With these hourly RH levels, and the wind strength during this period between 6–43 km/hour, this would have seen spotting fires during this time. On day three, the fire environment was greatly reduced as the relative RH levels only went below 40% for a three-hour period in the late afternoon with light winds. On day four, the RH did not go below 43%.

d) Port Hills fire – 13 February 2017

On Monday 13 February 2017, two fires broke out in the Port Hills area of Canterbury at (a) Early Valley Road at 1745 hours and (b) Marleys Hill at 1900 hours. The two Port Hills fires merged into one wildfire and covered an area of 1,661 ha, with a perimeter of 61 km, and resulted in the loss of nine dwellings, with a further five suffering fire damage. The fire area also included 595 ha of forested lands.

The decision made on Monday night to manage both the Early Valley Road and Marleys Hill fires as one incident, under one Incident Management Team (IMT), was an appropriate one which proved insightful as both fires spread and eventually merged as one.

During the evening on the first day of the Port Hills fires the fire environment hourly temperatures were between 15–23°C, RH was between 27–56% and wind speed between 12–36 km/hour. On the second day, the fire environment remained in extreme conditions with a crossover of RH and temperatures from 1400–1500 hours. Also, for the 16-hour period from 800–100 hours the following day, RH was less than 40%. Within that period the RH went below 30% for four hours. Wind strengths over this three-day period involved nine hours of wind greater than 30 km/hour. Given these conditions, spot fires would have become a concern for the IMT on the first three days of this fire.

e) Pigeon Valley Forest fire – 5 February 2019

At approximately 1400 hours on Tuesday 5 January 2019, a wildfire was reported in Pigeon Valley near Wakefield, about 30 km south-west of Nelson. Given the elevated fire danger conditions at the time, this wildfire quickly spread from farmland into forested lands, covering more than 1,600 ha by the end of the first day. This also included the destruction of one dwelling. The second day saw this wildfire continue to slowly spread, covering a further 400 ha. By day three the wildfire was finally contained to an area involving 2,300 ha.

Most of the area burnt was planted forest. This forest is owned by a number of corporate and smaller private forest owners. The area involved a range of different aged forest plantings from recently cut-over logging slash, newly planted trees with scrub understory, to intermediate and mature forest stands. A heavy commitment of aircraft resources, firefighters and overhead personnel was deployed to this fire. The final cost involved in the management of the Pigeon Valley wildfire is estimated to be at least $17 million. This would be the highest cost incurred for any single wildfire in New Zealand history.

For the afternoon on the first day of the Pigeon Valley fire hourly weather information taken from the Dovedale remote automatic weather stations (RAWS) showed the fire environment hourly temperatures ranged between 10–24°C, RH was between 34–70%, and wind speed between 10–24 km/hour. On the second to the seventh day, the fire environment for RH was no lower than 40% (Figure 5) and temperatures no higher than 25°C. Figure 6 provides an overview of wind speed for each of the five forest fires for the first three days.

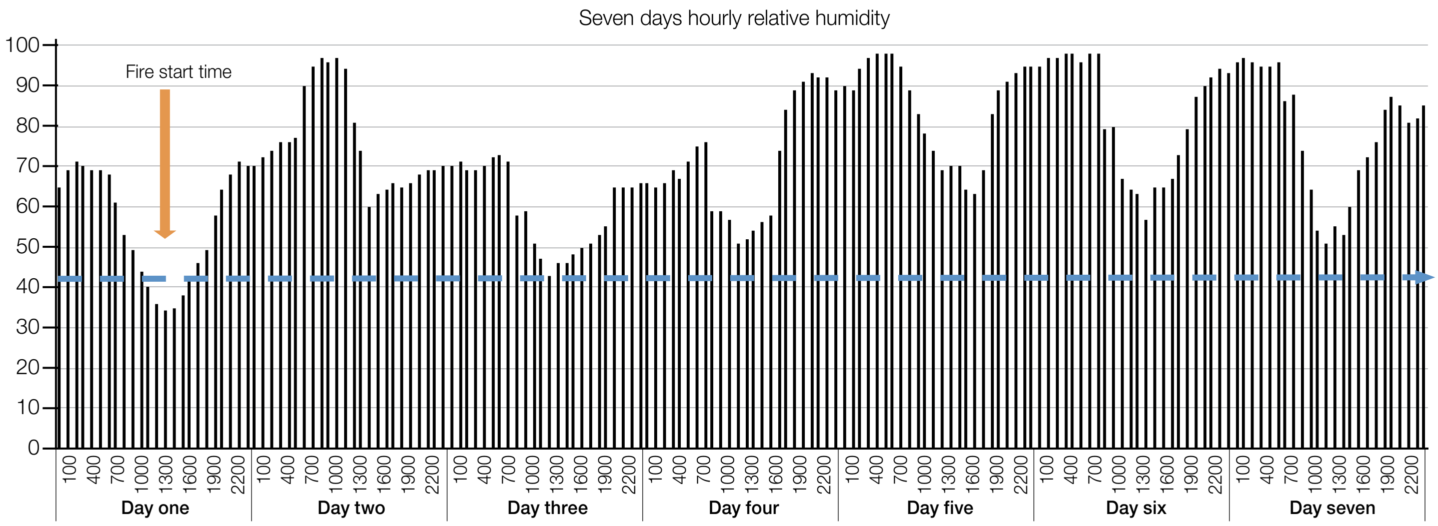

Figure 5: Relative humidity – Pigeon Valley fire, 5 February 2019

Table 2: Relative humidity values and wind speed – Pigeon Valley fire, 5 February 2019

6 Feb	RH 60%	7 Feb	RH 43%	8 Feb	RH 50%	9 Feb	RH 58%	10 Feb	RH 57%	11 Feb	RH 48%
	18.7 kph		16.9 kph		18.7 kph		19.1 kph		21.2 kph		19.4 kph

At the Nelson airport RAWS, 22 km from the Pigeon Valley fire site, it recorded a comparable fire environment to the Dovedale RAWS, with hourly temperatures that ranged between 18–30°C, RH was between 34–68%, and wind speed between 11–26 km/hour. On the third day of this fire, the fire environment for RH was no lower than 45% and temperatures no higher than 24°C. This produced a benign fire environment for the second day of this fire. At no time during the first two days was there a crossover period of RH and temperatures at the Nelson Airport or Dovedale weather stations.

From the second to the seventh day of the Pigeon Valley wildfire, the probability of spot fires was less than 4%, given the lowest daily RH values and wind speed shown in Table 2.

Given the points made above, the transportation of live embers beyond the fire ground boundary was highly unlikely over this six-day period.

Examination

An analysis of the weather forecasts provided to the Pigeon Valley fire IMT has shown a strong correlation with the actual weather that followed. When you compare this actual weather with the Berwick, Mount Cook, Onamalutu and Port Hills fires there are a number of interesting observations.

The hourly RH figures (along with the time of ignition) are outlined in Figure 7, which shows the number of hours when the RH was less than 40%. These are the hours where the risk from spot fires was extreme. The figure shows that the Pigeon Valley fire had the least number of hours at risk from spot fires on the first day when compared with the Berwick, Mount Cook, Onamalutu and Port Hills fires.

For the hourly recorded weather, Table 3 outlines the number of hours during the first two days for each of the five forest wildfires. This compares the number

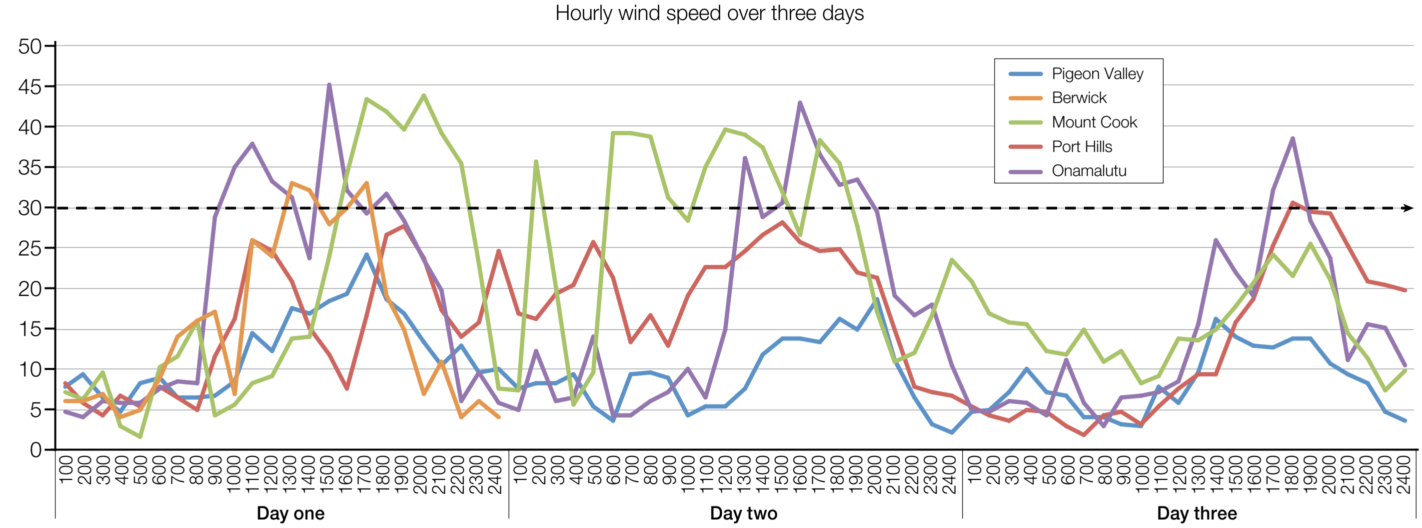

Figure 6: Wind speeds

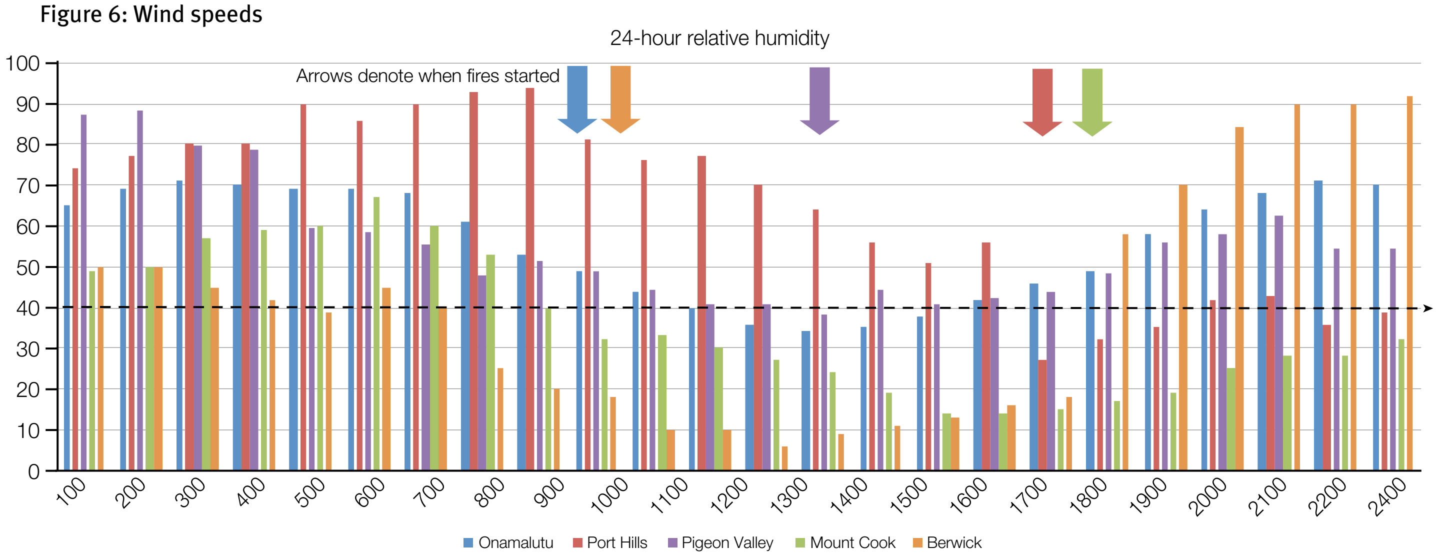

Figure 7: 24-hour relative humidity

Table 3: Hourly recorded weather

	No. of hours with RH less than 40% over first two days (No. hrs < 20%)	No. of hours with wind greater than 30 km/hr over first two days	No. of hours in crossover #	Area burnt	Total cost	Cost per hectare
Pigeon Valley fire **5 Feb 19** (Dovedale RAWS)	4 hrs (0 hrs)	0 hrs	0	2,300 ha	$17,000,000	$7,400
Port Hills fire **13 Feb 17** (Motukarara RAWS)	21 hrs (0 hrs)	6 hrs	0	1,661 ha*	$7,900,000	$5,800
Onamalutu Forest fire **4 Feb 15** (Onamalutu RAWS)	10 hrs (0 hrs)	10 hrs	0	600 ha	$1,294,000	$2,157
Mt Cook Station fire **16 Jan 08** (Tekapo RAWS)	29 hrs (8 hrs)	19 hrs	11	756 ha	$749,000	$991
Berwick fire **26 Feb 95** (Dunedin Airport RAWS)	18 hrs (10 hrs)	12 hrs	10+	255 ha	$250,000	$980

* Denotes 594 ha of forest burnt + Denotes first day only
# Crossover is the point at which the numerical value of the ambient relative humidity is less than, or equal to, the numerical value of the ambient air temperature

of hours between each wildfire where the RH and wind speed were at levels that would have provided a fire environment conducive to elevated fire behaviour conditions and the potential for spotting fires.

Also provided is the fire suppression cost per hectare for each of these wildfires. This shows a clear disproportional cost per hectare for the three fires in the past four years when compared with the Mount Cook and Berwick forest fires. Further work, at some future point, is required to identify why the cost per hectare is so much greater for the suppression of forest wildfires in 2019 compared to those in 1995 and 2008.

Table 3 also provides a detailed weather environment comparison between the five forest wildfires. This shows that the Pigeon Valley fire involved only four hours over the first day when the RH was between 20–40%, and nil hours with wind speed greater than 30 km/hour. This is a lot less time in the extreme danger zone when compared with the Mount Cook Forest or Berwick forest fires, which had 29 hours and 18 hours, respectively, of RH less than 40%, and RH values less than 20%, 8 hours and 10 hours, respectively.

Wind speed was also greater than 30 km/hour for the Mount Cook fire (19 hours) and the Berwick fire (12 hours). Given these points of difference, the Pigeon Valley fire environment following the first day was moderate when compared with the extreme conditions of the Port Hills, Onamalutu, Mount Cook and Berwick fires over the first two days.

When also comparing the Mount Cook, Berwick and Port Hills wildfires with the Pigeon Valley wildfire, for the period during which there was elevated fire danger, the risk of spotting fires for Mount Cook, Berwick and Port Hills (second day) was extreme. For Pigeon Valley, following the first day, the probability for spot fires from the second to the seventh day was less than 4%. Also for the Wakefield community on the south-eastern area of the fire, to be impacted by this wildfire, it had to breach the containment lines within the forest, burn downhill 1.5 km through the remaining forested lands, travel 500 m through pastoral grasslands, bridge a small river bed, and travel a further 1 km before then presenting a threat to the community.

Had the IMT had a strategy to preposition adequate resources on the eastern flank of this fire to respond quickly, should a ground fire exit the forest lands onto pastoral lands, this would have been adequate to cover the risk of a less than a 4% probability of spot fires. This proposition is supported, as time has shown that the fire did not spread from the forested lands onto pastoral lands on the south-eastern flank of this fire. Given this probability, and the landscape, the IMT had no need for the construction of firebreaks external to the forested land and the evacuation of people from their homes on the south-eastern flank of this wildfire.

Social impacts

From overseas experience, evacuation from homes during a wildfire is inherently stressful because of the disruption to daily life and the uncertainty about what will happen (Cohn et al., 2006). Indeed, evacuees have cited a lack of current information about fire activity and fire impacts as one of the greatest challenges of evacuation (Kent et al., 2003, Sutton et al., 2008). Although individuals vary in their responses, evacuations often elicit strong negative emotions that can have a lasting impact (e.g. post-traumatic stress, anxiety, health problems, lack of trust) on both the individual and the community (Hodgson, 2007). Evacuations should be undertaken only when clear evidence confirms that homes will have a high risk of being impacted by the wildfire.

The 5 February 2019 Pigeon Valley fire impacted the lives of those who owned lifestyle properties on the northern edge of the affected lands on the first day. Also more than 2,500 residents evacuated from Wakefield and other surrounding villages along the eastern side of the forested lands were also affected, along with forest owners who lost forest, and particularly the forest contractors who lost their livelihoods during the civil defence emergency.

Fortunately, in the week that followed the first day the fire environment did not meet the same extreme levels present on the first day. This situation did not appear to have influenced the actions taken by the IMTs when the evacuation of families from their homes was undertaken in communities along the south-eastern area external to the forested lands (e.g. Wakefield). A further point of concern was the need to construct the extended length of firebreaks external to the forested lands, and the damage to them that has resulted in the need to spend tens of thousands of dollars to reinstate the affected lands.

Conclusions and recommendations

Lessons learnt from extended wildfire incidents are critically important. A review of all aspects of the institutional, operational and financial implications of the management of any wildfire incident can enable these lessons to be identified. The comparison of the Pigeon Valley fire with similar forest fires (e.g. Berwick (1995), Mount Cook (2008), Onamalutu (2015) and Port Hills (2017)) can provide important lessons for the future management of forest fires.

In summary:

- In comparison to the Port Hills, Onamalutu, Mount Cook and Berwick fires the Pigeon Valley fire did not have an elevated fire environment that produced the same extreme levels of high risk of spotting fires after the first day
- Analysis of the Pigeon Valley fire weather data that was available to the IMT at the time shows the risks that resulted in ordering the evacuations and the major works to create firebreaks was low. It is unclear what additional or different information the IMT leaders were considering when they made their decisions
- There was a lack of clarity within the IMT process about when a wildfire incident becomes a civil defence emergency
- There is a lack of forest fire behaviour specialists available to support fact-based decision-making for interpretation of risks in wildfire incidents in New Zealand, which urgently requires attention
- There has been a distinct change in the strategy and operational management of wildfires over the last five years, with the heavy deployment of aerial resources without adequate support from ground resources. This has had a major implication for the effectiveness and cost of fire management compared with the management and cost of past wildfires of a similar nature
- It is recommended that an Independent Commission of Inquiry be undertaken for the Pigeon Valley wildfire to review the strategic, technical and administrative performance and the lessons learned, including from previous forest wildfires, and along the lines of past Independent Inquiries (e.g. Mount White (1973) and Canterbury (1989)).

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