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ARE COMMUNITIES IN VICTORIA PROTECTED DURING THE RUNNING PHASE OF A BUSHFIRE?

ABSTRACT
This analysis provides support for the hypothesis that "Victorian communities are not protected by the fire agency model during the running phase of a bushfire in danger weather." The hypothesis is tested against two threats - Threat 1, the spreading perimeter and Threat 2, flame and ember attack on the house. It finds that a number of fire protection strategies are applied by fire agencies within the limits of their individual statutory jurisdictions. However, the analysis identified a number of strategies and works that are essential for protection of a community that are not done by any agency. It finds that several deficiencies in the government's current fire agency model prevent community protection against the running bushfire phase in danger weather.

INTRODUCTION

This note applies logic, experience and observation to test the hypothesis that a given community in Victoria is not protected when the bushfire runs out of control during danger weather. It analyses whether the fire agency model used by the government is capable of protection a community during a worst case bushfire attack.

The unreferenced observations are based on over 20 years of professional experience by the author in all aspects of bushfire management in the Victorian government and considerable ongoing experience in private property protection.

HYPOTHESIS

The hypothesis to be tested is this: ***Communities are not protected by the fire agency model during the running phase of a bushfire in danger weather***

Terms used in this note:
The bushfire **running phase** occurs when the moving flame and associated ember attack escapes control of fire agencies, and bushfire perimeter expands faster than control line can be built.

Danger weather is a collective summary term for VERY HIGH (when wind is strong (eg, > 30 kph), SEVERE, EXTREME AND CODE RED fire danger categories.
FDI is a quantitative measure of fire weather severity. Fire Dander Index is calculated from the McArthur Forest Fire Danger Meter (CSIRO). The following FDI ranges correspond with the fire danger codes respectively. Very High (25-50), Severe (50-75), Extreme (75-100), Catastrophic (100+)

A community is a group of houses or a neighbourhood or a town.

CFA is Country Fire Authority
DEPI is Department of Environment and Primary Industry

I propose this theory as self evident:

Most damage during a bushfire is inflicted on a community during the running phase of a bushfire

Thus, if hypothesis and theory are both true, this means that the Victorian community is helplessly exposed to a guaranteed damage toll.

I also propose the following defensive theory as also self evident:
Where suppression fails and the running flame escapes , to protect a property or a community from bushfire attack we must to stop the fearsome flame well away before it causes damage, and we must have appropriate pre-arranged mitigation strategies in place to enable successful defence against ember attack.

There are two elements in this theory that are relevant to the bushfire agencies. They must (1) stop the running bushfire at a designated location or (2) have pre-arranged mitigation strategies in place to protect communities downwind from damage from the flame and embers associated with the running bushfire phase.

The elements in this theory are well understood by the government because Acts of Parliament require fire agencies to provide both suppression resources and fire plans. Fire agencies have both weapons within their arsenal, the dominant one is the billion dollar cache of fire suppression resources (eg, refer CFA annual reports) and the low key one is the regional fire plan. On the night of 6 February, 2009, Premier Brumby declared Victoria was the best prepared ever to deal with the worst. When these preparations were put to the test the following day, now called Black Saturday, the tragic outcome was deaths and house losses, huge trauma and huge costs. The Royal Commission found that the fire agencies tried their best, but suffered from organisational and logistic impediments (Royal Commission Report, 2010, Victorian Government). It did not investigate the issue of design capability of Victoria's suppression forces. It observed that fire plans existed, but chose not to examine their performance. I can advise that each destroyed town and settlement had an approved fire plan, and that each fire plan was ineffective, as proven by outcomes. I can report Government has since increased its investment in and reliance on suppression and made no changes to fire plan policy. I therefore fear that the proven failure of the government model to protect the community from severe bushfire attack is destined to repeat again in the future.

METHOD

We now look systematically at two bushfire threats and how the fire authorities apply their strategies to deal with them. We compare the outcomes against the hypothesis.
We then look at an important administration issue – accountability for community protection and the design capability of community fire planning, and gauge the findings against the hypothesis.

BUSHFIRE THREATS AND STRATEGIES

The fire agency has to deal with two clear threats against a property or a community – (1) the spreading perimeter, which is the running flame phase and (2) the house or asset under attack from flame and / or embers. These threats are listed in the columns of the Table below.

There are four recognised strategies to deal professionally with these threats - prevention, mitigation, presuppression and suppression, represented as four rows in the Table below. I have observed that the four strategies are only effective when they are physically enacted on the ground – enacted by appropriate scale, timing and location. In property or community

protection, the four strategies are most effectively deployed as an iterative four step process as follows. Apply each row in turn like an extra layer of protection. The first row is the best option - to prevent the fire outbreak. If a fire attack occurs, go to the next row, which is to mitigate the dangers with passive defence barriers. If barrier is breached, the next row is to prepare for active defence. The row of last resort is to launch a full scale active defence or counter attack.

Text book application of this process is akin to protecting a city against an enemy by progressive layers of defence. Consider this old world example. Diplomacy is the first layer, where the aim is to prevent an attack. If this fails, the moat is the next layer, aimed at stopping the enemy at a distance. If this is breached, the next line of defence is tall vertical walls. If the enemy mount the wall, rock throwers and hot oil pourers get to work. If they breach these defences, the enemy then deals with fully armed and trained soldiers.

How fire agencies deal with these threats in practice

In Victoria, the two bushfire agencies are CFA - responsible for prevention and suppression on private property and DEPI is responsible for prevention and suppression on public land. I have indicated how each agency deals with some of the elements in the Table to some extent (CFA on left, DEPI on right). I also add the observation that both agencies appear to use suppression as the first resort option, rather than the final option.

Threats / **Strategies**	**1 Spreading perimeter**	**2 House under attack**	
		Flame attack	***Ember attack***
Prevention Its role is to …	Reduce fire occurrences CFA DEPI	Prevent moving flame from entering residential area O O	Reduce ember source upwind O *DEPI*
Mitigation Its role is to …	Restrict spread and location of moving flame by passive defence measures O *DEPI*	Eliminate danger by managing flame height and separation gap. Fire resistant materials / BMO* O O	Reduce ember ignition points Fire resistant materials / BMO* O O
Pre suppression Its role is to …	Prepare for active response with water attack. Prepare and equip fire fighters for control line construction CFA DEPI	Prepare and equip residents to extinguish spot fires on and near house *CFA* O	Prepare and equip residents to extinguish spot fires on and near house *CFA* O
Suppression Its role is to …	Extinguish flame along fire edge. Build control line. Secure control line. CFA DEPI	Extinguish spot fires on and near house *CFA* *DEPI*	Extinguish spot fires on and near house *CFA* *DEPI*

* BMO refers to new homes only (= 2% of total house population in any given year). Bushfire Management Overlay provisions require fire resistant materials and design standards on new houses. The Royal Commission found no evidence that either treatment was effective in preventing house loss.

CFA means implemented by targeted statewide CFA program
DEPI means implemented by targeted statewide DEPI program

CFA means implemented ad hoc or locally or to small extent by CFA
DEPI means implemented ad hoc or locally or to small extent by DEPI

O means not or negligibly implemented by respective fire agency (CFA on left, DEPI on right)

In regard to treating the threats (columns), we can see that both agencies apply some effort to all strategies in the **"spreading perimeter" threat** column, but the minimal effort in the **"house under attack"** columns, ie, flame attack and ember attack. Yet, as explained to the Royal Commission, study after study has identified these threats as the primary cause of house loss.

The next sections examine to what extent the four strategies deliver community protection on a worst case weather day.

Threat 1 Spreading bushfire perimeter
Can fire agencies protect a community against Threat 1 using the four strategies?

For bushfire outbreaks on private property, the local CFA trucks arrive quickly from many stations on danger weather days. Thus suppression strategy is applied, and by default, the pre-suppression strategy. We are fortunate because these selfless volunteers stop most outbreaks, but in recent years, despite their best efforts, some fires have escaped. When this happens, any number of extra trucks cannot catch them. This can be proven by doing the maths:
If a grassfire runs through a flat paddock at 10 kph (which happens when wind is only 30 kph like the recent Epping fire), its perimeter grows at least 20 km per hour. If a large fire truck can drive up to the fire edge, and let's say it can theoretically squirt out 1 km in an hour before it runs out of water. So each hour, they will need 20+ new trucks at work on the edge just to keep pace with bushfire perimeter growth (see INSET A).

INSET A
In theory, let's say the equivalent of 3mm heavy rain per sq m delivered very quickly will extinguish a grass flame flank with a depth of 1m. This is 3 litres / sq m of fire depth. If the tanker holds 3,000 litres, it can squirt 1km of edge.

In practice, a hose operator might deliver 50 litres per minute to a fire edge. This means a 3000 litre tanker runs out in 60 minutes. Usually there are two or three hose operators, which means the tanker could run out in 20 minutes.

When glitches arise, logistical reality slows the perimeter control line rate, eg, the refill time is too long, the flame is too hot or obstacles slow them down like fences, steep slopes, gullies and trees. If the edge is not accessible because of terrain or obstacles or it is just too hot to approach safely, they cannot catch it with water trucks. The tanker is their main weapon. A helicopter can only dump water on 100m of edge at a time. The result is that the fire perimeter continues to run with the wind towards a property or a community.

The 2012/13 fire season showed that the moving flame can escape fire agency control on moderate danger weather days and causes damage. Eg, the one day flash fires like the Carngham fire occurred when the peak FDI was in the 30's and the Epping and Dereel fires had a peak FDI of 55. By comparison, the long running campaign fires at Harrietville,

Aberfeldie and the Grampians had very few days above FDI 25. However, they became so large that, as the wind direction followed its regular anti-clockwise cycle, unprotected communities downwind were successively at the mercy of the strength of the wind, and fire fighters had to be diverted from the fire perimeter to help defend them. The campaign fires were eventually contained, but only with the help of mild weather and rain. The inevitable conclusion is that fire suppression and presuppression strategies have a maximum design capacity that is sometimes exceeded on danger weather days.

For bushfire outbreaks on public land, the suppression strategy is applied, and by default, the presuppression strategy. DEPI troops are often an hour or more from a bushfire ignition. When the first attack troops arrive on a danger weather day, it has long escaped their control capability. They know that they will not stop its spread while the weather is unhelpful. They then call in reinforcements, aiming to contain the perimeter overnight when the weather becomes milder.

Of the two remaining strategies, prevention can be ruled out because ignition has already occurred and mitigation strategies will now be examined. I have observed that to stop flame spread of an intense running flame, mitigation strategies have to be carefully designed to reduce flame height upwind of a fuel free barrier, and ensure the barrier is wide enough to prevent flame rollover across it. It also requires a pre-arranged strategy to deal with ember throw down-wind. I can report that such mitigation strategies are rarely if ever seen on fire plans of both agencies.

In conclusion, it is clear that when the running bushfire phase escapes fire agency control on days of danger weather it runs freely with the wind because there is no mitigation strategy in place to stop its spread. This finding supports the hypothesis that the community is not protected from Threat 1, the running flame, when it escapes fire agency control.

Threat 2 House under attack

Can fire agencies protect a community against Threat 2 using the four strategies?

Of the four strategies, pre suppression and suppression strategies can only be performed in safety if the property or community has been protected by prevention and mitigation strategies.

Firstly, consider the property or community that has been bushfire-protected. Residents and fire fighters can be confident that the flame attack has been excluded from the house environment, which means the remaining threat is ember attack. If the residents have been empowered with presuppression and suppression knowledge and skill, they can defend their own property from ember attack, and assist on neighbouring properties. Fire brigade crews can also assist this task in safety as well. For example, a tanker and crew could comfortably extinguish ember attack on a small group of houses (eg, 2 or 3) during the height of ember attack. But if fire takes hold in vacant house, a team of five tankers would not be able to save it.

Current policy and procedural issues may prevent application of pre-suppression and suppression strategies:

- Current government policy is to evacuate residents from towns threatened by bushfire attack.
- Allocation of fire fighters to house protection means diverting them from the fire perimeter.

Secondly, consider the property or community that remains bushfire-exposed. It can expect a double barrelled attack of running flame and embers. Such an environment is not safe for application of presuppression or suppression strategies by either residents or fire fighters.

What fuel management works are done by agencies on the ground that can be classified as prevention or mitigation strategies?

DEPI manages large areas of public land and its fire plans include fuel reduction burn areas. Their Acts do not require them to protect a town, but they do what they can under a good neighbour policy. INSET B shows that burn areas are not necessarily effective on danger weather days. There is one exception. If they have been burnt in the past 2 or 3 years, the fuel load is so low that flame height will be low and ember production will be low. For, example, Marysville township protection relied to a large extent on the approved DEPI fire plan and its fuel reduction areas, but only one small section had been recently burnt, and DEPI advised the Royal Commission how well it reduced fire intensity. But the bushfire that rampaged in the rest of their planned fuel reduction areas on Black Saturday was tall flame and major ember generation, and it was much too close to the town.

INSET B
DEPI applies mitigation works, but uses a calculated Byram's Fire Intensity (BFI) as the indicator. [It can be shown that BFI is an inappropriate indicator, but this is beyond the scope of this note.]. It believes suppression in forest is theoretically successful when calculated BFI is less than 3000 kW / m. It calculates Byram's Intensity using Fire Danger Index (FDI).
Its P2 zones remain less than BFI 3000 when FDI is less than 25, and the P1 zones remain less than BFI 3000 when FDI is less than 50. P1 zones are the highest level of protection burning that DEPI provide. In other words, the design capacity of P2 zones is FDI 25 (moderate fire weather), and of P1 zones is FDI 50 (eg, a Total Fire Ban, FDI exceeds 50). Therefore, suppression by definition will fail in all DEPI protection zones in danger weather. The issue of design capacity is further discussed later.
A further observation is that when fires run into treated DEPI protection zones, they will keep spreading because the fuel bed remains continuous. The fire behaviour benefit of these zones is that they reduce flame height and ember production.

CFA by contrast, does not manage land directly. The CFA Act does not require it to protect a town. Its duty is to provide prevention and suppression services (quantity or quality or purpose is not specified). It requires the local shire to prepare a municipal fire plan, with advice from local CFA. Preparing a plan carries no obligation or assurance to protect a town. Identifying a building at risk and reducing the risk is a fraction of what is required to protect a town. These plans typically have a few fire breaks that are mown by the shire using the shire's budget. Their location should ideally be of strategic value to town protection or to fire fighters, and sometimes this may occur. The CFA knows that mown grass does not stop the spreading flame, it simply reduces flame height. They also know that embers ignite spot fires downwind and new flames become runaways. If the troops can access the downwind side of the strategic break, they can stop these spot fires. But this requires specific pre-planning, which I have not yet seen on fire plans.

Fire agencies also know that non-fire agency infrastructure will stop the run of the flame, such as broad roadways and edges of residential areas. We can therefore ask - How did the 2 m tall grass flames cross the 50m wide Hume Highway in the recent Epping fire? They did not, of course. Embers ignited downwind and were not stopped by coordinated or pre planned mitigation works and suppression.

A bushfire-protected town has effective infrastructure to stop the running flame out of town and deal with mass ember attacks inside the town, and the community will be protected from Threat 2. A bushfire-exposed town may be unsafe for people to stay and defend unless they undertake their own protection. It may also be an unsafe workplace for fire fighters. If the

bushfire running phase is acknowledged as the most destructive period, damage is inevitable. This finding supports the hypothesis that the community is not protected from Threat 2, flame and ember attack against houses.

ACCOUNTABILITY FOR COMMUNITY PROTECTION AND DESIGN CAPABILITY OF PLANNING

The accountability issue can be illustrated by the Marysville example. Marysville is a town surrounded by state forest, which is managed by DEPI. DEPI fire plans include fuel reduction burns and fire break maintenance on DEPI land, but DEPI is not responsible for protection of Marysville township. CFA Act delegates the responsibility of preparing a fire plan for the municipality to the Shire, but the municipal fire plan is prepared with heavy reliance and under prescribed direction from CFA. Because the community falls within the fire plan area, the Shire seems to be responsible for **preparing a fire plan** for a given community, ie Marysville.

In theory, the municipal fire plan integrates the fire plans of other agencies into a single reference document. In practice, each agency has different roles. They each act in accordance with their respective Acts. In practice, each accepts what the other plans and does. But there is a gap that is not the fault of any agency. The missing ingredient is oversight direction and accountability. It becomes apparent when I ask the following four diagnostic questions:

- What are the worst types of bushfire attack that will assault the town?
- How well is the town protected?
- What houses are at risk?
- How can we prevent these houses from loss?

Fire plans provide no answers to these questions. In fact, nobody is accountable for answers to these questions. This means, in effect nobody was (or is) responsible for protecting Marysville homes against bushfire attack under the current fire agency model. Therefore, until statutory changes are made to acknowledge and fill the gap, proper community protection cannot be delivered. In the meantime, how can a community protected itself against a worst case bushfire attack? (1) A proactive Shire or a proactive community group can insist upon or can implement infrastructure required to achieve the design capability to deal with a worst case bushfire attack. (2) A property owner or a neighbourhood can adopt appropriate self defence infrastructure and strategies.

"***Preparing a fire plan***" was deliberately highlighted above to set up this question - Is preparing a fire plan synonymous with protecting a community? The format of a fire plan is prescribed by fire authorities and its stated purpose is to "reduce the risk of fire" (eg, Hepburn Shire Fire Plan 2011-2014). Reducing the risk of fire (assume bushfire) is not consistent with and it too weak as an aim to protect a community from severe bushfire attack, including Threats 1 and 2. Whilst it does not preclude full protection, it does not require it. The key point of difference lies in the design capability. To protect a community requires infrastructure to deal with worst case fire danger, eg, FDI 100+, whereas a municipal fire plan's capability can be shown to peak in moderate weather, eg, FDI 25 at best. Similar issues arise with DEPI fire plans. Marysville was primarily protected by a DEPI fire plan which had a peak design capacity of FDI 25 or so, if the works had been done. A Black Saturday is typically FDI 100+. Thus, even though a fire plan existed, the community was bushfire-exposed.

CONCLUSION

The foregoing analysis provides support for the hypothesis that "Communities are not protected by the fire agency model during the running phase of a bushfire in danger weather." The hypothesis is tested against two threats - Threat 1, the spreading perimeter and Threat 2, flame and ember attack on the house. It finds that whilst a number of fire protection strategies are available to fire agencies to deal with these threats and they each apply strategies within the limits of their individual statutory jurisdictions, there are a number of strategies and works that are essential for protection of a community that are not done by any agency. This is a deficiency in the government's current fire agency model.

The analysis suggests that communities are not protected by prevention or mitigation strategies. Instead, fire agencies rely heavily on application of the suppression and presuppression strategies to provide community protection, but the analysis proves by simple mathematics why they fail on danger weather days. In other words, the design capability of fire suppression resources is lower than required for danger weather. It is inevitable, therefore, that each time the running bushfire phase hits an unprotected settlement or a town on a danger bushfire weather day, the community will be exposed to unchecked running flame and ember attack. Destruction is likely to follow. Recent examples include Marysville and Kinglake in 2009, Carngham and Seaton in 2013 and Blue Mountains in October 2013. [The NSW fire damage occurred on the first day when FDI at Penrith was 36. The fire agencies flooded the area over the next few days, but the weather was mild. The damage could not be undone, so far over $180M insurance payouts and a few hundred disrupted families. This year, the RFS was found negligent for suppression inadequacies in the Canberra fires of 2003. The Blue Mountains damage has the appearance of mitigation failure.]

The analysis also highlights a more significant void. There is nobody with assigned responsibility to protect a community against Threats 1 and 2 in a severe bushfire attack. The default outcome is that nobody is accountable for implementing the four diagnostic questions that test the protection level of a community.

Finally, the analysis indicates that fire plans have a low design capability, perhaps reflecting their low key stated aim – eg, to reduce the risk or impact of bushfire. It suggests that to protect a community from a worst case bushfire attack requires a much higher design capability. Thus if a community relies on protection from a government sponsored fire plan, it will not be protected in danger weather.

It is noted that the current fire agency model does not prevent a municipality with a strong protective vision or a committed group within a municipality from demanding its community is properly bushfire-protected, or initiating private self defence options.

The current equation is this:
Running bushfire phase + bushfire-exposed community ➔ major damage toll

It suggests that the Victorian community is helplessly exposed to a guaranteed damage toll. Because both the running flame phase and the community can be treated with bushfire protection strategies, the preferred equation is this:
Neutralised running phase + bushfire-protected community ➔ zero damage toll

Hopefully, this paper arms a community with evidence to ask the government to review its fire agency model and protect communities against damage toll during danger fire weather. In the meantime, they can arm themselves for self defence.