The Garden Route in flames:
Chapter IV - Assessing the fuel status of the region after the 2017 and 2018 wildfires

A book by Dr Neels de Ronde

The following article is the forth in the series of excerpts from a book written by Dr Neels de Ronde, The Garden Route in flames. Dr de Ronde lives in Sedgefield in the Southern Cape, South Africa and has done extensive research in the field of land management and wildfire prevention. Dr de Ronde gave permission to Fire and Rescue International to publish the book in the magazine in separate sections for the benefit of all forestry and wildfire managers, fire protection associations and land owners in order to gain insight and an understanding of the intricacies that form the basis of such extreme fires and how it can be prevented, highlighting effective fuel management and fire prevention measures.

Photograph 12: Picture taken of pine plantations, only hours after a wildfire spread through the area (somewhere in Mpumalanga, South Africa). Note damage categories: 1 = Crown fire with complete crown needle consumption, 2 = Complete crown scorch and 3 = Partly-scorched needle from the tree crowns, top crown still alive (courtesy Working on Fire).

4.1 Introduction to fuel dynamics
For optimum understanding of fuel dynamics, I will be using the list of fuel parameters used for the Input required for the BehavePlus 2-D fire simulation program (Andrews, 1986; Andres and Chase, 1986 and Burgan and Rothermel, 1984), which can be summarised as follows:

Description of fuel
1 hour fuel load (tons/ha)
10 hour fuel load (tons/ha)
100 hour fuel load (tons/ha)
Live herb fuel load (tons/ha)
Live woody fuel load (tons/ha)

1 hour (SAV)*
Live herb (SAV)*
Live woody (SAV)*
*SAV=Surface-to-volume ratio (square metre per cubic metre)

Fuel depth (m)
Fuel moisture extinction (percentage)
Dead fuel heat content (kilojoules per kilogram)
Live fuel heat content (kilojoules per kilogram)

The vegetation and/or fuel classification selected to be the optimum representative for a specific regions' individual fuel models, have to be developed and tested using a site-specific input for BehavePlus runs, to arrive at a representative fuel model set for a region. More about the fuel modelling development and testing processes later in this handbook.

There are two main fuel classes:
- Fine fuels (or 1 hour fuels, see above): Grass, small branches, pine needles and leaves with a diameter of up to 6mm. They dry very fast and need little heat to ignite. They are well aerated, they will burn rapidly but if they are compacted, they can burn very slowly.
- Coarse fuel (>1 hour fuels, see above): Thicker branches, logs and stumps. The fuels dry slowly and require more heat to ignite but once burning, will continue to burn (or glow) for extended periods of time.

4.2 Considering fire dynamics
Rate of spread of a fire
This is normally expressed in metres per minute or km/hr (in fast fire spread studies, such as fast-moving head fires in grasslands). Fast rates of spread can many times lead up to spotting, particularly if a fire is spreading uphill.

Flame length and flame height
In the absence of wind and slope, flame length and flame height are equal but wind and/or slope have the effect of tilting the flame towards the unburned fuel and thereby reducing flame height, while flame length remains unaffected. Flame height is another one of the four main fire parameters to be considered (Andrews, 1986) and is an important parameter for predicting the height of crown scorch in the canopy of trees.

Fire intensity parameters
The two most important ways to express fire intensity (kW/m or kJ/s/m) and heat per unit area (kJ/m2). Fire line intensity can be regarded as the heat released per second from a metre-wide section of the fuel extending from the front to the rear of the flaming zone (Byram, 1959) and is equal to the rate of spread of the fire front (Trollope, 1983; Trollope, et al., 2004)

Torching, scorching and spotting
Torching occurs when individual trees are ignited but there is insufficient wind to sustain a crown fire. A torching tree may give rise to burning embers being lifted straight up and then carried away by the prevailing wind to start spotting fires elsewhere.

Scorching: This is when tree needles or leaves in tree crowns die as a result of heat radiated from the flames of a surface fire. Scorch height is the height to which scorching (not fuel consumption) occurs in tree crowns, vertically measured from the soil or forest floor surface.

Spotting: This is one of the most dangerous characteristics of major wildfires in terms of fire suppression. In the case of long distance spotting, burning embers are carried several kilometres from the main fire front, to ignite new fires far ahead from the main burning fires.

4.3 Introducing the assessment procedures

This process consists of two phases, namely:

1. Assessing the present fuel/vegetation status after the two wildfires
2. Extrapolating the results from the above to predicted 'first burnable' status.

The present status, during say 2020, can be best assessed from photographs taken from the representative fuel/vegetation status of the region, which can best be subdivided in the Garden Route region under the following sub-headings:
A. Burned over by the 2017 and 2018 wildfires:
a. Old fynbos
b. Pine plantations
c. Coastal sand dunes, mostly covered by fynbos with dominantly infested Acacia.
B. Not burned over by the 2017 and 2018 wildfires:
a. Old fynbos (mountains and foothills)
b. Mature pine plantations
c. Younger pine plantations, with prominent forest floor vegetation cover
d. Coastal sand dunes, mostly covered by fynbos infested with Acaci.
e. Sand dunes, covered by mature, natural (coastal) fynbos.

4.4 The fuel model base to be developed

The fuel/vegetation assessment phase only has to be applied at this stage (2020) to the regional areas NOT burned over by the 2017 and 2018 wildfires, thus not in the three categories provided above under (A), namely old fynbos, pine plantations and coastal sand dune vegetation. To avoid the regional plan-users/developers having to go through a comprehensive learning curve of fuel model development and testing at this point in time, as well as to avoid the use of the BehavePlus fire behaviour

Fuel model parameter	Old (senescent) fynbos S. Asp (tons/ha)	Mature pine spp (mostly P. rad.)	Younger pine spp. 11 – 15yrs	Coastal fynbos infested with Ac.	Coastal fynbos un-infested
1hr fuel load	10.4	6.0	6.0	13.0	12.0
10h fuel load	13.2	1.0	3.5	15.0	2.4
100h fuel load	13.2	0.2	0.7	20.0	1.2
Live herb f.l.	0.5	0	0.4	1.7	0.1
Live woody f.l.	8.8	0	0	5.0	3.7
1h SAV	6200	6700	6700	4200	5000
Live herb SAV	5000	4900	4900	3000	4000
Live woody SAV	4000	4900	4900	3000	4000
Fuel depth (m)	1.5	0	0.4	1.5	0.9
Moist (%)	20	20	25	20	19
Dead fuel heat c.	20485	20485	17989	20485	19500
Live fuel heat c.	20485	20485	17989	20485	19500
Crown canopy closure (%)	50	30	50	50	40

Table 1: Summary of representative fuel models developed for the Garden Route region (using the C de Ronde fuel model database to provide closest developed fuel models for the region).

Fire behaviour parameters	Senescent (Old) Fynbos	Mature P. rad. natural regeneration	Young pine 11–15 yrs old	Coastal fynbos Infested with Acacia	Old coastal fynbos uninfested
Rate of fire spread (m/min)	18.6 (4)	5.5 (1)	8.0 (2)	12.1 (3)	23.1 (5)
Heat per unit area (kj/m2)	34808 (4)	9659 (1)	10252 (2)	56401 (5)	34460 (3)
Fireline intensity (kW/m)	10810 (3)	858 (1)	1365 (2)	11396 (4)	13241 (5)
Flame length (m)	5.6 (3)	1.8 (1)	2.1 (2)	5.7 (4)	6.1 (5)
Spotting distance (km)	1.2 (5)	0.4 (1)	0.5 (2)	1.0 (3)	1.1 (4)
Ranking totals	19	5	10	19	22
Fire hazard class	Extremely high	Medium	High	Extremely high	Extremely high

Table 2: BehavePlus outputs from five runs conducted to arrive at regional ranking for each of the five representative regional fuel models for the Garden Route (rankings provided in brackets).

simulation programme at this stage for this purpose, I will develop and use the basic fuel models for the Garden Route region, arrived at from my developed and completed South African fuel model database eg de Ronde, 2004 and de Ronde and Goldammer, 2016.

For the above purpose, I will thus only use five fuel models to represent the main fuel categories provided under section B above, by using my personal fuel model database for South Africa (de Ronde et al., 2004; de Ronde and Goldammer, 2016) as basis and to provide the necessary adjustments to create new models for this purpose. The above basic (five) fuel models (see Ba – Be above) will then be run under typical fire hazard conditions experienced in the Garden Route region when the two wildfires occurred, with the BehavePlus BP6 fire behaviour prediction simulation programme. See Appendix (a) for the results.

4.5 Calculating the basic fire hazard classes for the region, with fire risk adjustments omitted at regional level

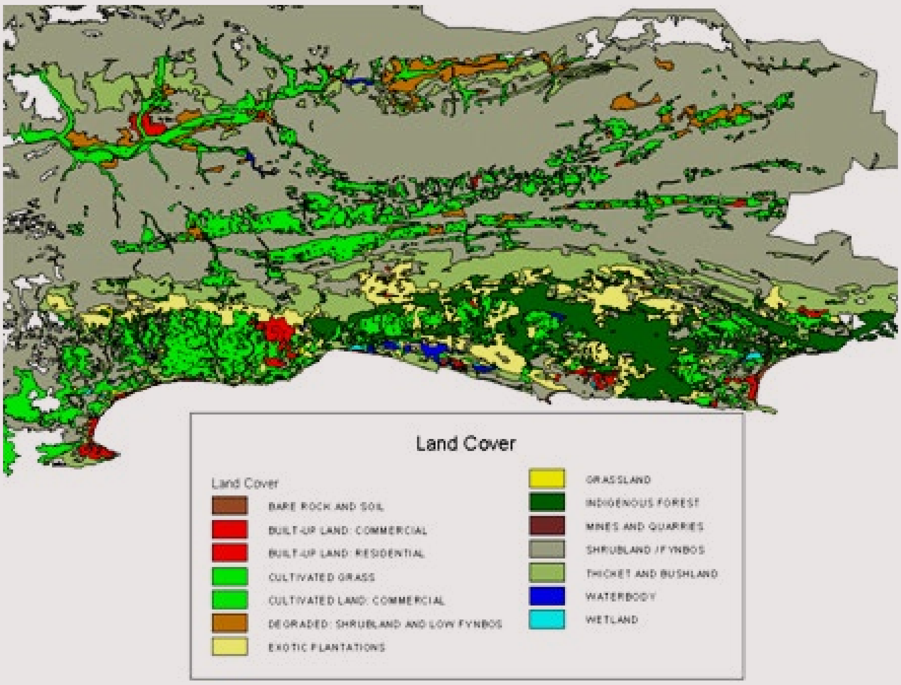
The outcome for the BehavePlus runs for the above five fuel models will be used as a basis for these calculations, when the Output for the following five parameters will be used to arrive at fire hazard classes (Trollope, et al., 2004; Calvin et al., 2004):

Flame height (m)	FL
Rate of fire spread (m/min)	ROS
Fireline intensity (kW/m)	FLI
Heat per unit area (kJ/m2)	HEAT
Max spotting distance (km)	SPOT

The BehavePlus output results can be summarised as follows (Table 1):

Contrary to popular believe, mature pine stands are not nearly as hazardous as the fynbos classes in general and sometimes offer counter fire opportunities where this is not possible in other vegetation bases where the fire burns through (see Table 2 and also see Photograph 13 below).

The fire hazard rating classification arrived at (Table 2) will have to be mapped for the region, as adjustments for fire risks cannot be performed at this



Map 2: Land cover map of the Southern Cape region (unknown source of origin).

"Where's the command post?": Placement and positioning of incident commanders during structural fireground operations

By Colin Deiner, chief director, disaster management and fire brigade services, Western Cape Government

A lesson learned

At approximately 23h00 on Thursday, 20 February 2003, sparks from a pyrotechnic display ignited the ceiling of the Station Club in West Warwick, Rhode Island in the US. The fire spread rapidly throughout the building and within minutes flames engulfed the entire structure. A police officer who was working a security detail at the Station Club that night made the first emergency notification at 23h07. The intensity of the blaze, combined with the number of victims who needed to be treated and evacuated from the scene, required a huge response. Approximately 575 fire, police and emergency medical personnel from over 35 agencies responded to the incident.

Early on in the response, the chief of the West Warwick Fire Department arrived on. He assumed overall (incident command IC) and established an incident command post (ICP) near the front entrance of the building, converting the trunk of his vehicle into a makeshift worktable. The IC chose to establish the command post at this location because the proximity to the incident allowed him to observe both fire suppression and rescue operations.

The incident command post's location, however, presented certain problems at the site. The IC's proximity to the scene allowed responders to bypass the normal chain of command and to communicate directly with him. This created confusion because many responders were unaware of the decisions and orders coming from the IC. Here was some concern that the location of the command post unnecessarily placed the leadership in harm's way because of the potential for the wall to collapse on the ICP.

The incident after-action report recommended that ICPs should be located close enough to allow the IC to observe operations but far enough away to provide safety and shelter from the noise and

Photograph 13: Picture taken of the Knysna fire in progress in Kruisfontein plantation. Note how the backfire spreading down slope presents an opportunity to control this fire line by means of a counter fire, down slope of this fire line (Picture taken by unknown photographer).

(regional) level for the Garden Route region.

I did not perform a fuel model spread survey for the region because this survey still has to be conducted by the future fire management staff. However, a basic regional fire hazard map for say the year 2020, will have to be used to assess and check regional buffer zone specifications (see photographs 9 and 10) and then to adjust these buffers accordingly.

Remember that the Garden Route regional buffer zones will have to be mapped first, before thefive5-year (detailed) fire prevention plan is considered and drawn up. The regional fire prevention plan will likewise have to be drawn up before detailed year plans are developed and produced for the region.