Fuel research peat area

Summary of the data from the photoguide

Institute for Safety (the Netherlands)

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(Institute for Safety)

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Outline

Several fuel research in different vegetation types have been conducted since 2012. A fuel research in peat area took place in 2014. This research was conducted to gather more knowledge about the amount of fuel in different vegetation types on peat soil, to be able to predict the fire behaviour with that information. The main goal of the research is to collect data as input for the development of the Dutch wildfire spreadmodel.

The fieldwork took place in cooperation with the Stephen F. Austin State University Texas (SFA) and the University of Applied Sciences Van Hall Larenstein (Netherlands). The data is analysed by the SFA, the analysed data is shown in a photoguide. This document can be seen as a summary of the photoguide in combination with an explanation about the method.

The photoguide is a document with different data about each plot that's been conducted. The data per plot contains information about the biomass per (vegetation) layer (litter-herbs-shrubs-etc.), predicted fire behaviour and fuel model (Oswald, 2014). All the different fuel models connected to the investigated nature types are input for the wildfire spreadmodel. The predicted fire behaviour can be used for validation and mapping risk areas.

The data of the fuel models can also be used operational. For example due to the more detailed knowledge about the amount of fuel in an area, this knowledge can be used in consultation with managers and landowners during a wildfire.

Dutch Wildfire Spreadmodel

The Dutch wildfire spreadmodel is a derivative from a model from the United States. A spreadmodel was developed by the Rocky Mountain Research Centre, called Farsite, in the early nineties. The Dutch version of this model is further developed through the years from a standard model with a few functions, to a model that is able to calculate the spread of a fire to the application that is used nowadays. The original Farsite contains several extra functions, like the calculation of crowning and spotting and the ability to put in a control line. Control lines are lines where the activities of the fire crew can be simulated. The Dutch wildfire spreadmodel can calculate more fires at the same time. The effect of secondary fires can be calculated, for example due to spotting. It is also possible to draw a line in the model this can be seen as a line which the fire can't cross, this is a step towards the possibility to draw a control line.

The wildfire spreadmodel is constructed with different map layers. The topography map, so the user of the model can select the right area and the basic map NLtop10 where the fuel models are linked. For example the type dry heather is linked with the fuel model GR6 (grass) and mixed forest is linked with TU2 (timber shrub). It is possible to change the fuel model per location on the map. With the different fuel research a more detailed map can be made with all the fuel models. For example with heather, this can be divided in dry heather and moist heather. The input of a more detailed map in the spreadmodel should be reckoned with.

Research

The fieldwork took place in National Park Northumberland for ten weeks in the months May, June and July of 2014. This area was selected, as a comparison with the Dutch peat bog areas, due to the bigger area and the division of the vegetation types. During the fieldwork several different plots were conducted in peatbogs, peat heather, peat shrub and forest areas. These four types are from the Dutch Index Nature and Landscape. The data in the photoguide is shown per conducted plot.

Dutch Index Nature and Landscape

The OBN (Dutch knowledge network Development, Maintenance and Nature Quality) composed a list of the different Dutch nature types (www.natuurkennis.nl). The index of the OBN was taken into account for the classification of the vegetation types of the different fuel studies. The Dutch Index Nature and Landscape contains seventeen different nature types, see appendix C, which can contain different subtypes. The grouping of the index is mainly based on abiotic factors (hydrology and non-living resources). It is not needed to conduct research among fuel for all seventeen types. For example the types rivers and stagnant water. With the selection of the different types, most of all the moist and the flammability of the vegetation was taken into account.

Fieldwork

For each plot different data is collected. All the different layers are mapped, from litter to tree top. As a start a representable area (as well for the Dutch situation) is selected. Once the area is selected the lines of the plot, figure 1, are set. On each line there are five flags, figure 1; every blue dot, as a marking point. Along each line and at the flags several measurements are taken. As a start for fifty times the litter layer is measured, 31 times a line of 15,4 meters long is set out in a random direction. Along each line all the vegetation that crosses the line is noted, also the woody debris is counted per category*. 25 times a one meter square frame is set out, within each square the height of herbaceous species is measured and for each type the cover percentage is determined. After that a circle of three meters is used for twelve times, within the circle all shrubs and trees are counted and measured. Also the crown density is measured twelve times.

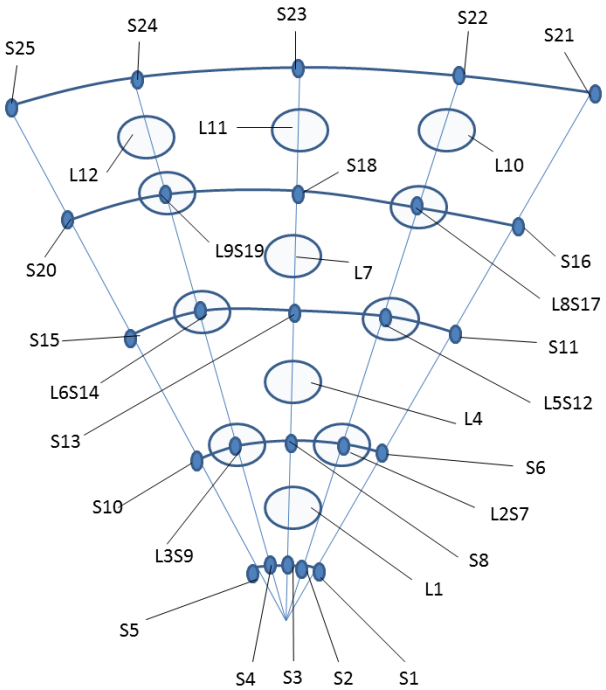


Figure 1; grit

**a distinction is made in 1,10,100 and 1000 hour fuels. Where 1 hours are twigs and 1000 hour fuels are dead tree trunks*

Photo guide’s

The fieldwork for the fuel research in different nature areas started in 2012. With reference to the Dutch Index Nature and Landscape, four different types were selected. Namely dry sandy areas, dune area, peat area and forest. The first research took place for the dry sandy soil areas in 2012. Following, the fieldwork in the dune area took place in 2013 and peat area in the summer of 2014. The fieldwork for different forest types will take place in 2015.

The Veluwe (dry sandy soil)

The focus of this research was the vegetation type dry heather. Besides heather, several plots were conducted in Scots pine, Douglas-fir, beech and oak stands on dry sandy soil. Of each type six different plots were conducted. Each plot is described in photoguide part 1; Veluwe. In the determination of the plots difference in the vegetation, undergrowth, density, age, etc. was taken into account to be able to map a great diversity. With the validation of the data the influence of the vegetation, density, age, undergrowth, etc. can hereby be validated. The vegetation type dry heather is yet validated and entered into the Dutch spreadmodel.

Dune area

In opposition with the first fuel research, five different vegetation types were researched, again the Dutch Index Nature and Landscape was taken into account. Hereby the location of each type in the dune area from the coastline to dune forest was included as well. Several plots were conducted in the open dune type, dune grassland, dune heather, dune valley and dune shrub. The type dune forest will be researched in 2015.

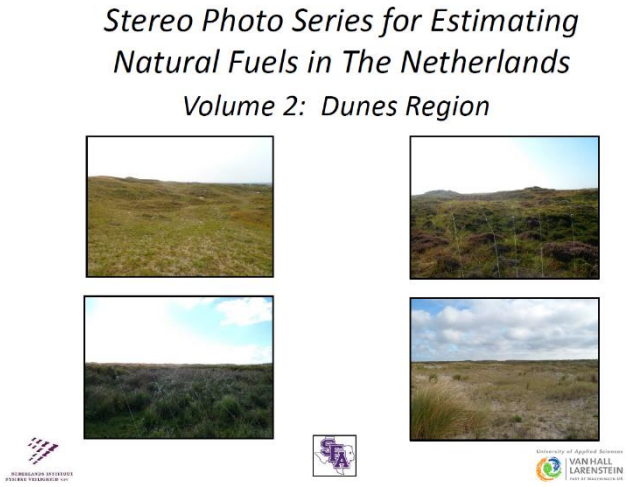
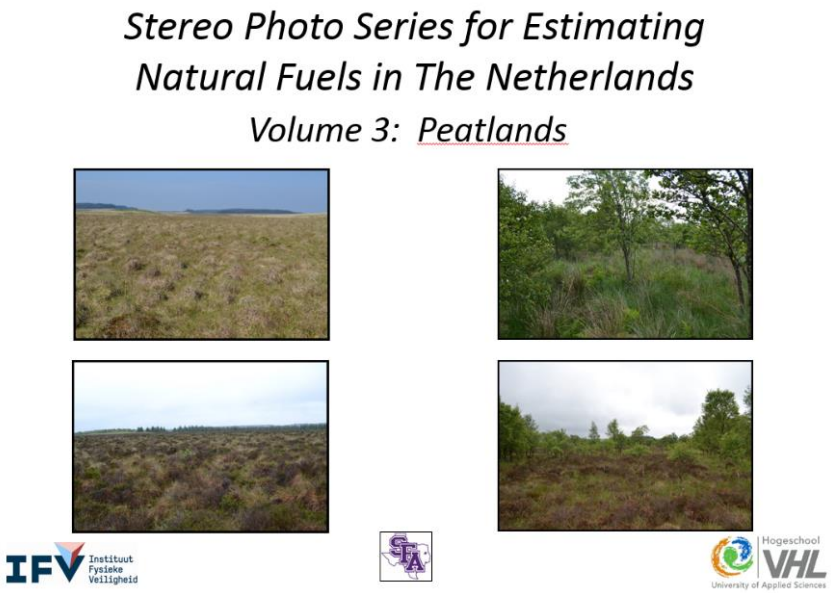


Photo guide Volume 3: Peat area

The data of the field research is presented in a photoguide after it has been analysed. The photoguide is a document with a collection of pictures related to the field data that is collected.

The description of each plot contains a picture and field data of the differences in amount of biomass and vegetation layers. In addition the amount of living and dead vegetation (fuel) can also be determined. With this information the fire behaviour can be predicted.

Through the analyses of the data the different vegetation types can be linked to fuel models. These models can be used in the spreadmodel by linking them to the map that is used in the model. With this information the spreadmodel can make a calculation of the predicted spread of a wildfire in time at a certain location.



Data photoguide peat

In total 23 plots divided over peat bog, heather, shrub and forest have been conducted during the fieldwork. In opposition with previous fuel research (Veluwe and dune), all the plots can be linked with standard fire behaviour models from Farsite. Some of the nature types of the dry sandy ground and dune regions can't be linked with standard models. Therefore custom fuel models need to be made in order to be able to put them in the wildfire spreadmodel.

The fuel types of peat can be linked with six different standard models (Scott, 2005). The description of the Farsite models can be found in appendix B. This chapter gives a description focussing on the collected field data (above ground) per type linked with the fire behaviour class.

descriptive class	rate of spread (meters/h)	flame height (meter)
Very low	0-40	0-0,33
Low	40-100	0,33-1,2
Moderate	100-400	1,2-2,4
High	400-1000	2,4-3,6
very high	1000-3000	3,6-7,6
extreme	>3000	>7,6

Table 1; fire behaviour classes (Scott, 2005)

Peat bog

Peatland bogs may burn very hot and move very quickly, but the fire severity itself will depend on how moist the organic layer is during the burn. The vegetation data for these bogs were best fit to existing fuel models.

From the analysis of the data is shown that there are two American fuel models that correspond well. GR3 is a fuel model for grassland with low biomass, whereby grass is the primary carrier of the fire. GR6/8 is a mix of two fuel models for humid grasslands with a moderate or high biomass. The primary carrier of fire is continuous grass less than 1 m tall. These sites varied in biomass levels across the site, and both GR 6 and GR 8 produced very small changes in predicted fire behaviour. Fires have the potential to spread very quickly, producing high energy levels and flame heights. Resulting in extreme fire behaviour (table 2).

Fuel model	Dominant species	Mean rate of spread	Mean flame height	Mean intensity	Fire behaviour class
GR3	Purple moor grass	3045 m/u	4,6 meter	7241 kW/m	Very high
GR6/8	Soft rush /purple moor grass/hare's tail	7500 m/u	10,9 meter	46597 kW/m	extreme

Table 2; peat bog

Peat heather

Many of the fuelbed characteristics found in the peatland heather sites were close to those associated with the US shrub models SH6, and SH8. Both SH6, and SH8 predict fast moving fires with relatively high flame heights. Both models are for humid shrub vegetation. The differences in these two models is the load, SH6 is a fuel model for humid shrub vegetation with a low load. The combination of heather and grass is the primary carrier of the fire. While SH8 is a model for humid shrub vegetation with a high load. This results in, as well higher rate of spread as flame height, table 3.

Fuel model	Dominant species	Mean rate of spread	Mean flame height	Mean intensity	Fire behaviour class
SH8	Hare's tail/heather	2200 m/u	6,2 meter	8417 kW/m	Very high
SH6	Hare's tail	1800 m/u	5,0 meter	8417 kW/m	Very high

Table 3;peat heather

Peat shrub and forest

These two types are different successional conditions, the peatland shrub is a younger site compared to peatland forest. Over time, and without any disturbance, one should expect a peatland shrub to become a peatland forest. The tree species contribute very little to the estimated fire behaviour, so these sites have been modelled as grass types GR5 and GR6. GR5 is a model for humid grass lands with low biomass.
This dynamic fuel model responds greatly once live fuel moistures drop below 90% within the 20-32 km/hr wind speeds, with rapid increases in rates of spread, fireline intensities and flame heights. This applies to GR6 as well. The differences between these models is the primary carrier of the fire. As well by GR5 as GR6 grasses lower then 0,5 meter are the primary carrier. However by GR6 these grasses have a higher biomass. The plots that can be linked with GR6 have a higher moist content in the Spaghnum layer, this results in a lower rate of spread and flame height then expected (appendix B, description fuel models).

Fuel model	Dominant species (undergrowth)	Mean rate of spread	Mean flame height	Mean intensity	Fire behaviour class
GR5	Soft rush	2500 m/u	3,9 meter	5359 kW/m	Very high
GR6	Soft rush	2200 m/u	3,3 meter	4770 kW/m	high

Table 4; peat shrub

Fuel model	Dominant species (undergrowth)	Mean rate of spread	Mean flame height	Mean intensity	Fire behaviour class
GR6	Soft rush /hare's tail/ purple moor grass	2200 m/u	3,3 meter	4770 kW/m	high

Table 5; peat forest

Recommendations

There are several things that can contribute to an improvement of the wildfire spreadmodel. It's determined that a fuel research in several forest types will take place in 2015. In addition to the four fuel research it is recommended to conduct fuel research in nature types that are not or barely analysed for fuel, for example different types of grassland.

Further analysing of the data from the photoguides is strongly recommended in order to further improve the wildfire spreadmodel. Besides analysing the data it is also needed to validate it before it can be used in the wildfire spreadmodel. This can be done in the Netherlands as well in other North West European countries of which the climate and the vegetation can be compared with the Netherlands.

In order to be able to connect the fuel models to the right area it is recommended to use more detailed maps then the NLtop10, which is used at the moment, the wildfire spreadmodel. A possibility for the future is remote sensing. With these images an up-to-date map can be created. Before this method can be used a research for the use of remote sensing and the link with the right data is needed.

The wildfire spreadmodel is used and developed for the Netherlands at this moment. The development of the model is done with the possibility of the use of the model in North West Europe in mind. To be able to do this it is recommended to contain European contacts (as yet is made during the field research) but also to invest in potential users (in the Netherlands and abroad).

References

B. Oswald, Brouwer, N.L., 2014, *stereofoto-serie for estimating natural fuels in the Netherlands*, Institute for Safety and Stephen F. Austin State University, Texas

J.H.Scott, R.E.Burgan, 2005, *standard fire behaviour fuel models: A comprehensive set for use with Rothermel's surface fire spread model*, U.S. department of agriculture, Forest Service, Rocky mountain research station

www.natuurkennis.nl

Appendix A; description plots

Peat bog

Name	Description	Species (in order)	Scientific name	fuel model
PB1	Slightly grazed by sheep, open field, mixture of Sphagnum and Hare's tail	Sphagnum, hare's tail, bog-rosemary	Sphagnum spp., Eriophorum vaginatum and Andromeda polifolia	GR3
PB2	Mixture of grasses (lower then PB1), Sphagnum en Bog-rosemary, slighlty grazed by sheep	Purple moor-grass, deer grass, Sphagnum and bog- rosemary	Molinia caerulea, Eriophorum vaginatum, Sphagnum spp. and Andromeda polifolia	GR3
PB3	Relative wet area with soft rush	Soft rush and Sphagnum	Juncus effusus and Sphagnum spp.	GR6/8
PB4	Soft rush mixed with waivy hair grass and fern	Soft rush, waivy hair grass and fern	Juncus effusus and Deschampsia flexuosa	GR6/8
PB5	Tufts of purple moor grass, hare's tail, Sphagnum, between 30 and 60 cm high	Purple moor-grass, hare's tail en Sphagnum	Molinia caerulea, Eriophorum vaginatum and Sphagnum spp.	GR6/8
PB6	Low tufts of purple moor grass and Sphagnum	Purple moor-grass, Sphagnum and soft rush	Molinia caerulea, Sphagnum spp. and Juncus effusus	GR6/8
PB7	Tufts of moss and Sphagnum with different grass species with young heather	Purple moor-grass, common bent, hare's tail, cross-leaved heather, Sphagnum, cranberry and heather	Molinia caerulea, Agrostis capillaris, Eriophorum vaginatum, Erica tetralix, Sphagnum spp. Vaccinium oxycoccos and Calluna vulgaris	GR6/8
PB8	Tufts of Sphagnum with grasses, about 50 cm with cranberry on top	Common bent, Sphagnum, cranberry and hare's tail	Agrostis capillaris, Sphagnum spp. Vaccinium oxycoccos and Eriophorum vaginatum	GR6/8

Peat heather

Name	Description	Species (in order)	Scientific name	fuel model
PH1	Mixture of heather (older then PB2) and hare's tail	Heather, Sphagnum, cross-leaved heather and hare's tail	Calluna vulgaris, Sphagnum spp., Erica tetralix and Eriophorum vaginatum	SH8
PH2	Mixture of heather, deer grass and tufts of Sphagnum with hare's tail	Heather, hare's tail, deer grass and Sphagnum	Calluna vulgaris, Eriophorum vaginatum, Trichophorum cespitosum and Sphagnum spp.	SH8
PH3	More tufts and higher tufts then PH2. mix of heather and hare's tail	Heather and hare's tail with bilberry	Calluna vulgaris, Eriophorum vaginatum and Vaccinium myrtillus	SH8
PH4	Relative older heather met hare's tail and cross-leaved heather	Heather, hare's tail, deer grass and cross-leaved heather	Calluna vulgaris, Eriophorum vaginatum, Trichophorum cespitosum and Erica tetralix	SH8
PH5	Relative young heather with bilberry and hare's tail	Heather, bilberry, hare's tail and Sphagnum	Calluna vulgaris, Vaccinium myrtillus, Eriophorum vaginatum and Sphagnum spp.	SH6
PH6	Tufts of hare's tail with heather and bilberry in between	Hare's tail, heather and bilberry	Eriophorum vaginatum, Calluna vulgaris and Vaccinium myrtillus	SH8
PH7	Heather with several tufts of hare's tail and Sphagnum	Heather and hare's tail	Calluna vulgaris and Eriophorum vaginatum	SH8

Peat shrub

Name	Description	Species (in order)	Scientific name	fuel model
PS1	Open shrub	Soft rush, sweet vernal grass, hairy birch and goat willow	Juncus effusus, Anthoxanthum odoratum, Betula pubescens and Salix caprea	GR5
PS2	Mixed shrub with different shrub species	Soft rush, mountain ash, black alder, hairy birch	Juncus effusus, Sorbus aucuparia, Alnus glutinosa and Betula pubescens	GR6
PS3	open mixed shrub	Soft rush, rosebay willowherb, hairy birch and black alder	Juncus effusus, Chamerion angustifolium and Alnus glutinosa	GR6
PS4	Open mixed shrub, older shrub then PS3 with relative high undergrowth	Soft rush, rosebay willowherb, black alder, hairy birch and goat willow	Juncus effusus, Chamerion angustifolium, Betula pubescens and Salix caprea	GR6

Peat forest

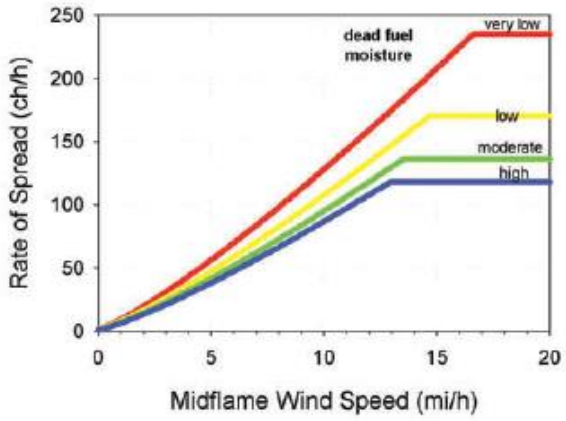
Name	Description	Species (in order)	Scientific name	fuel model
PF1	Dense downy birch forest with mainly Sphagnum as undergrowth, thin birch stems	downy birch and Sphagnum	Betula pubescens and Sphagnum spp.	GR6
PF2	Mixture of youg Downy birch with heather	Heather, Downy birch, purple moor grass and hare's tail	Calluna vulgaris, Betula pubescens, Molinia caerulea and Eriophorum vaginatum	GR6
PF3	Dense young Downy birch forest	Downy birch, Sphagnum, hare's tail and heather	Betula pubescens, Sphagnum spp., Eriophorum vaginatum and Calluna vulgaris	GR6
PF4	Relative older Downy birch forest with purple moor grass	Downy birch, purple moor grass and Sphagnum	Betula pubescens, Molinia caerulea and Sphagnum spp.	GR6

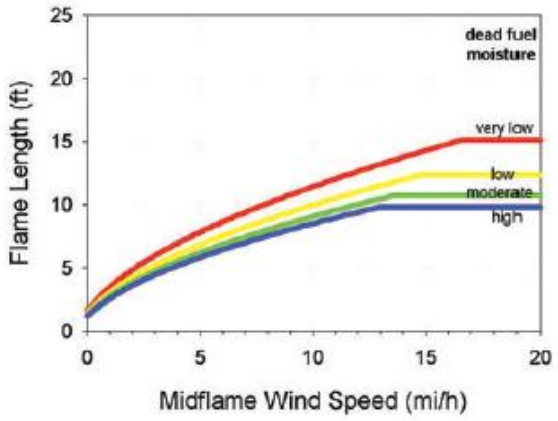
Appendix B; description fuel models (USA)

note: the units of the graphs are in miles en feet

GR3: low load, very coarse, humid climate grass (dynamic)

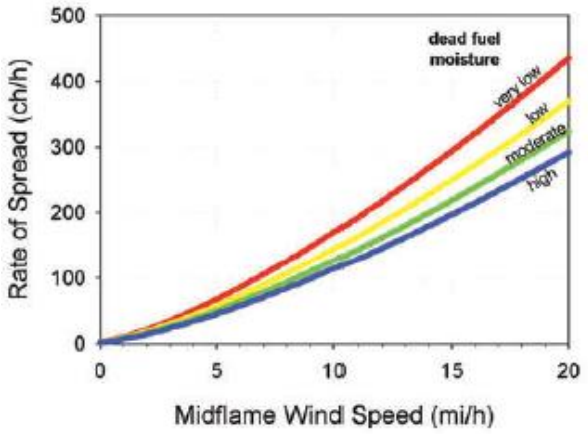
The primary carrier of fire in GR3 is continuous, coarse, humid-climate grass. Grass and herb fuel load is relatively light; fuelbed depth is about 2 feet. Shrubs are not present in significant quantity to affect fire behavior.

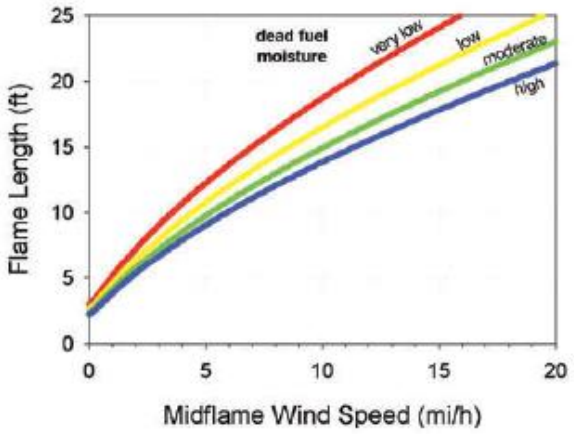




GR5: Low load, humid climate grass

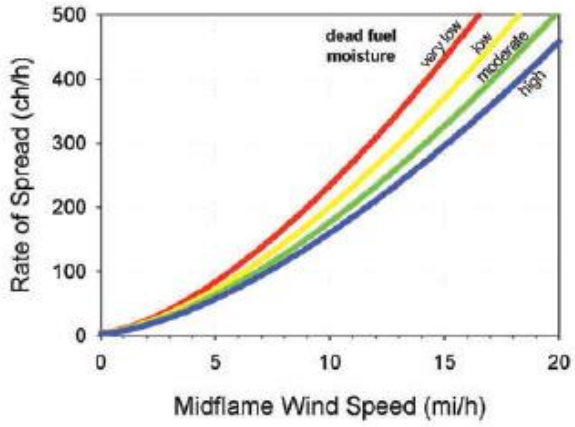
The primary carrier of fire in GR5 is humid-climate grass. Load is greater than GR3 but depth is lower, about 1 to 2 feet.

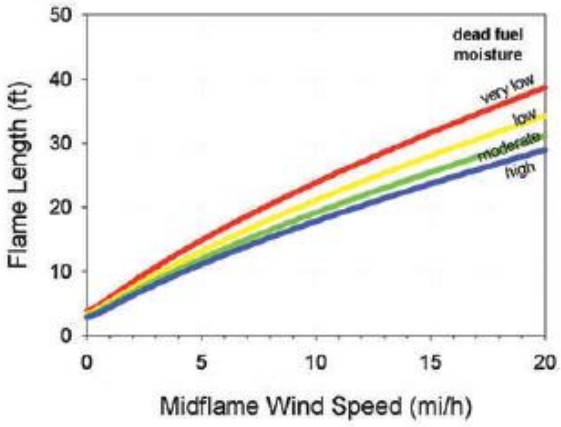




GR6: moderate load, humid climate grass (dynamic)

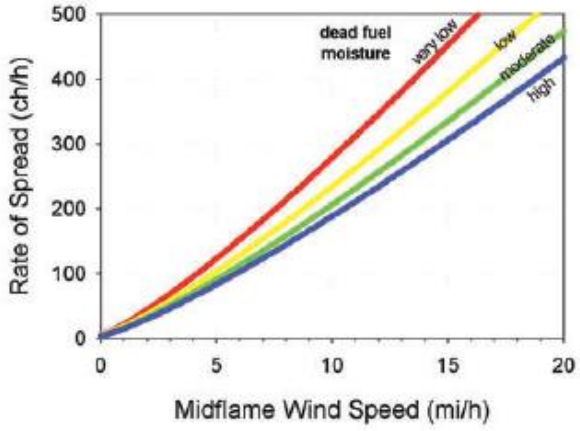
The primary carrier of fire in GR6 is continuous humid-climate grass.
Load is greater than GR5 but depth is about the same. Grass is less coarse than GR5.

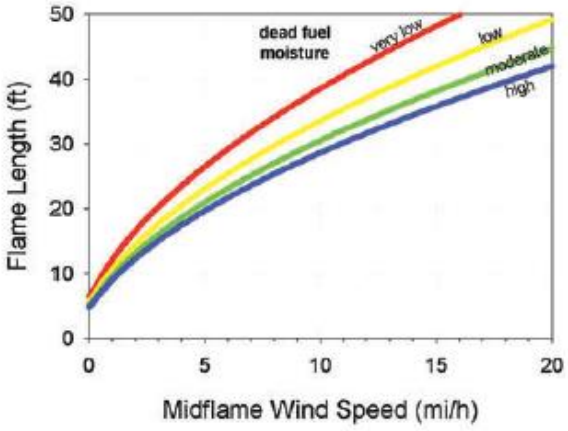




GR8: high load very coarse, humid climate grass (dynamic)

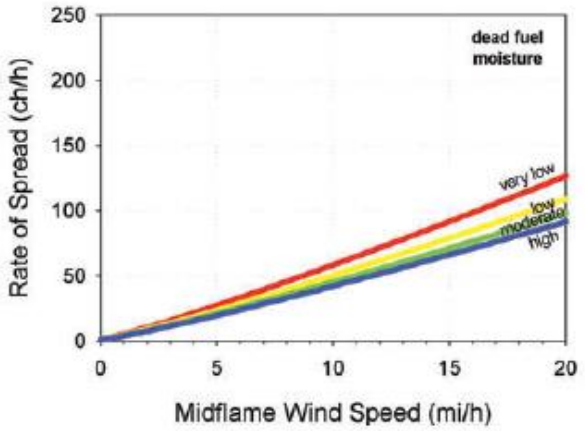
The primary carrier of fire in GR8 is continuous, very coarse, humid climate grass. Load and depth are greater than GR6. Spread rate and flame length can be extreme if grass is fully cured.

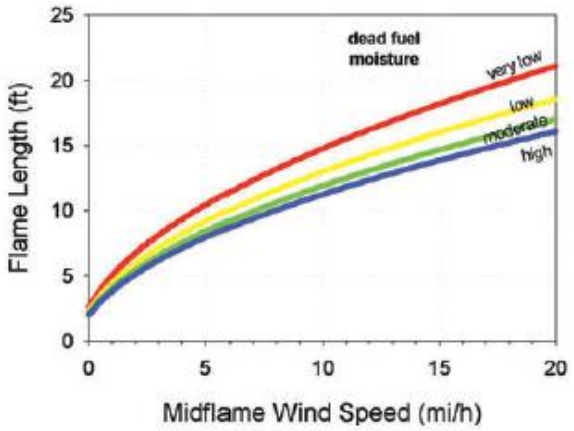




SH6: low load, humid climate shrub

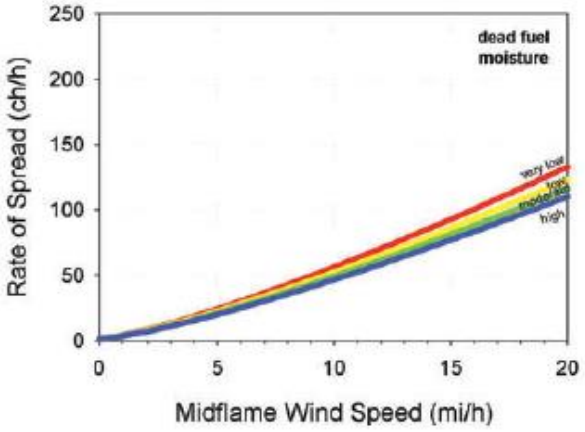
The primary carrier of fire in SH6 is woody shrubs and shrub litter. Dense shrubs, little or no herbaceous fuel, fuelbed depth about 2 feet. Spread rate is high; flame length high.

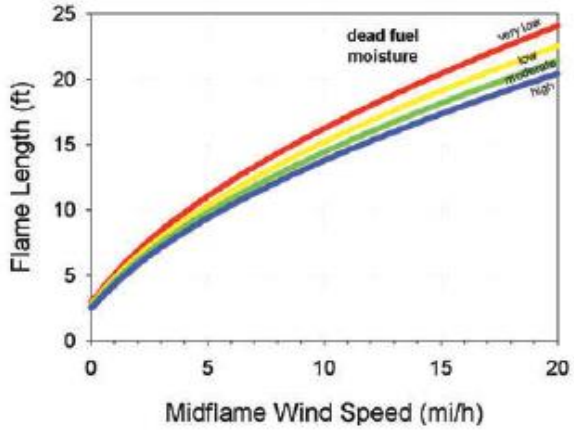




SH8: high load, humid climate shrub

The primary carrier of fire in SH8 is woody shrubs and shrub litter. Dense shrubs, little or no herbaceous fuel, fuelbed depth about 3 feet. Spread rate is high; flame length high.





Appendix C; Dutch Index nature and landscape

N	Description
N00	nature in development
N01	large scale dynamic nature
N02	rivers
N03	streams and springs
N04	stagnant water
N05	swamps
N06	peat and humid heather
N07	dry heather
N08	open dune
N09	salt marshes
N10	humid grasslands
N11	dry grasslands
N12	grasslands rich in species and cultivated fields
N13	bird grasslands
N14	humid forest
N15	dry forest
N16	forest with a production function
N17	forest with a cultural history