Peak District National Park

Wildfire Risk Assessment

2022

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FOREWORD

"The most desolate, wild, abandoned country in all England" is how Daniel Defoe described the moorlands of the Peak District in 1726. Yet in 1951 the importance of the Peak District moorlands to the nation was recognised by their inclusion in the newly designated Peak District National Park.

The moorlands of the Peak District are the product of interactions between people and nature over thousands of years. The resulting expanses of heather and bilberry moorland, "featherbed" cotton grass bogs, dramatic gritstone edges, springs, streams and more intimate valleys with woodland form a distinctive cultural landscape and are internationally recognised for their biodiversity importance. They are enjoyed by millions of people every year and play an important role contributing to the livelihoods of local people. They provide vital water supplies to the surrounding populations in some of England's major cities, their capacity to absorb water helps safeguard the same urban areas from flooding, and they store vast amounts of carbon in the underlying peat making a significant contribution to combating climate change.

Despite their wild and robust appearance these uplands are vulnerable. Uncontrolled moorland fires are a critical threat and one which is likely to increase with climate change and continuing visitor pressure. Such fires have the potential to destroy large areas of habitat, impact wildlife, burn peat that has accumulated over thousands of years, release carbon to the atmosphere, impact water quality and affect people's livelihoods. This is a risk affecting the large expanses of upland moorlands across the UK.

This report is a real game changer in how we think about and mitigate fire risk on upland moorlands by using data to strategically assess risk, fire behaviours and pathways. While such a strategic approach is commonly used to manage fire risk to major infrastructure and to manage flood risk, it has not been developed for moorland fire risk – until now.

For the first time in the UK we have brought together information from land managers, the fire and rescue service, fire specialists and conservationists to help address this threat, using the moorlands of the Derwent massif as a pilot. By identifying areas where fires are most likely to start, which areas are most vulnerable to wildfire, how fires are likely to behave and what capacity we have to fight them, it provides an opportunity to take a strategic approach to reducing wildfire risk across the moorlands as a whole. It makes an important contribution to our understanding of wildfires in the Peak District - what interventions we can make, and where, to reduce the likelihood and severity of wildfires; and where and how firefighting capacity can be deployed to best effect to tackle moorland fires when they do occur. It has the potential to be a very powerful tool to aid future fire risk planning and decision-making. The datasets and their interpretation in this report make an important start to develop such a tool. The next step is to test, refine, add to and improve the datasets used to gain the confidence and robustness needed for wide application of the model outputs.

It will never be possible to eliminate the risk of wildfires entirely, but this report provides an important baseline of information and analysis to allow stakeholders to work together, using a variety of measures, to tackle this issue of increasing concern. My thanks to the many moorland managers, fire specialists and conservationists who have come together to collaborate on this important work.

Were Defoe able to travel forward 300 years, he would doubtless be astonished at the affection with which these treasured moorland landscapes are regarded; and far from being abandoned, the considerable thought and effort that has gone into ensuring we hand them on to future generations in better condition than we inherited them.

Andrew McCloy *(Chair)* & Sarah Fowler *(Former Chief Executive) Peak District National Park Authority*

EXECUTIVE SUMMARY

The Natural Capital of the Peak District National Park (PDNP) is enjoyed by 13 million visitors annually. Managed by generations of custodians, its dramatic moorland scenery has been delivering ecosystem services for millennia. As well as harbouring a wealth of biodiversity, it forms part of the UK's largest carbon store. Helping to deliver the ambitions of the Nations' Nature Recovery and Net Zero strategies, the green economy will increasingly replace conventional land management practices. However, this outlook has a significant vulnerability.

Wildfire, to quote Professor Rob Marrs, President of The Heather Trust, **"is inevitable, it's not if, but when".** This report describes the approach that has been developed to assess the risk of wildfire in the PDNP, and ways in which resulting evidence can be used to develop a landscape-scale mitigation strategy. The approach has been piloted on an area of continuous moorland in multiple ownerships centred on the Derwent Valley (extending to approximately 38,000 acres).

The history and current state of the moorland landscape has been examined along with the potential environmental and financial consequences arising from wildfire. Crude calculations estimate that the Derwent area studied in this report could hold a biodiversity value of at least £2.5 billion, not to mention the value (environmental and financial) of the carbon stored within the peat landscape. With the effects of climate change, high levels of public access and evolution of management practices, it is easy to understand why the threat posed by wildfire is increasing. It is an expectation that the Fire and Rescue Service (FRS) will respond to any wildfire event, but this response is hindered by fire behaviour and lack of opportunities for successful suppression.

Having examined influencing factors, one can understand why stakeholders are fearful. In 2019 a 'call for action' was made by the National Park's Chief Executive, Sarah Fowler, for "***a strategic approach to the prevention and mitigation of moorland wildfires in the Peak District, including the provision of essential infrastructure to achieve this***."

The evolution of this project to date is described in detail in the full version, but it essentially began with a focus on providing a simple risk assessment approach, which could easily be applied across broad areas by the habitat managers who have extensive local knowledge (Tier One). This is combined with a wider map-based assessment (Tier Two) and finally the addition of expert technical modelling (Tier Three).

The evidence is alarming.

Climate change is driving increasingly frequent periods of fire supportive weather (warm & dry) of longer durations. Where these conditions might have been observed once a year at the turn of the century, this is now occurring 2-3 times per year and is projected to increase to six by the end of the Century (Zhang, et al., 2020).

The pressure of visitors, some of whom do not appreciate the danger posed by their actions, as well as those with malicious intent, places the fringes of the Derwent focus area, particularly around the honey pot areas of Woodhead, Langsett and the Derwent reservoir complex, at significant risk. Resources are required to reduce the risk of ignition, especially in key locations.

Fire behaviour modelling explores the interaction of different weather scenarios and fuel complexes arranged across the landscape, highlighting the greatest risk to fire behaviour - fuel arrangement. Simulations indicate the frightening potential of fire spreading across extensive areas of the landscape as high-intensity fast-moving fire types, moving from one polygon to the next. Indications of potential fire behaviour are alarming, reaching extremes both in the rate of spread and flame lengths far beyond the capacity of control of the FRS and other responders. The potential environmental, financial and social losses are enormous. Little can be done to control the topography of the area or the increasingly fire supportive weather, but fuel loading can be addressed. Action must be taken at critical locations to reduce fire behaviour to manageable intensities, providing opportunities to limit fire spread as part of strategic mitigation plan to protect the values prized by stakeholders.

Further research is required on the mitigation options which can be included in a plan. Ignition will never be eliminated entirely, but visitor management, education and monitoring can help reduce incidents. Tools available to habitat managers are varied and, alongside traditional vegetation management practices, blanket bog restoration will play its part to improve landscape resilience.

The nature of the current fuel complex means that there are unrealistic expectations of the FRS and local responders. In order to be successful in the future the FRS must continue to develop its response, working closely with stakeholders. A Fire Response Plan is required to improve operational firefighting capacity in the event of a fire and should be focused on making improvements to training systems, fire analysis capability, firefighting tactics, and preparedness.

Along with reviewing the initial approach before wider application, the next step is for a Landscape Wildfire Management Plan for the Derwent focus area to be

developed. It will identify the values stakeholders wish to protect and inform mitigation and fire response plans. Wildfire poses a more significant threat than it has done in the past and the valuable environmental and social-economic assets are becoming more vulnerable to the effects of fire, the only question now is, how dominant and damaging future wildfire events are allowed to become.

The approach is not without limitations. Tier One is subjective, due to assessors' sensitivities to risk but this is also invaluable in highlighting the local knowledge of habitat managers. The more objective Tier Two assessment could be improved with additional data sets (e.g. completed restoration works and accurate peat depth). Tier Three illustrates the value of the technical fire analysis, in particular the use of accepted methodologies for computer simulations and the ways in which this can be refined to account for different influencing factors. This will also be useful moving forwards to assess progress in mitigation.

The Project was intended to be applied to the remaining focus areas within the PDNP. However, wider interest and increased expectations (potential for national application) and limited timescales caused a shift in the focus of the team, who identified the need to provide additional information and evidence to ensure that stakeholders would have confidence in the report's conclusions. The project must now be refocussed to deliver to original expectations.

PROJECT DETAILS

A full version and a "taster" version of the report can also be downloaded from http://www.peakdistrictwildfire.co.uk.

ACKNOWLEDGEMENTS

With thanks to everyone who has contributed, including: Peak District National Park Authority, Natural England, Peak District Fire Operations Group, Moors for the Future, Individual land managers, rangers and keepers, United Utilities, Thomas Kier, Sir Philip Naylor-Leyland, Various Fire & Rescue Services, Thomas Smith, Prof. G. Rein, Gareth Clay, Moorland Association, Paul HedleyPeak District Farming in Protected Landscapes Scheme

PROJECT STEERING GROUP

Fitzwilliam Wentworth Estate
HERITAGE | LANDSCAPE | ECONOMY | COMMUNITY

IG INCENDIUM GROUP

PEAK DISTRICT NATIONAL PARK

NATURAL ENGLAND

NOTE FROM THE TEAM

Anthony Barber-Lomax (FRICS FAAV DipEstMan)
Resident agent, Fitzwilliam Wentworth Estate

Ruth Battye and I had little idea that the relatively simple approach to wildfire risk assessment (founded on the Upland Management Group template) we sketched out over a lockdown coffee in October 2020 would grow into something on which so much anticipation was to hang. The project was elevated by the foresight of Thomas Kier who financed the marriage of the immense fire behaviour knowledge of Steve Gibson and technical brilliance of Marc Castellnou & Mercedes Bachfischer. Whilst Ruth's extensive mapping knowledge and diligent recording became the glue, we were able to use our geographical knowledge and contacts to good effect gathering data and support.

My own motivation comes from the profound fear that exists amongst habitat managers (keepers and rangers) each spring when dry weather prevails. Fundamental shifts in vegetation management prescriptions on designated land mean that biomass accumulation represents an increasing threat. With countless unrecorded ignitions being extinguished by the quick action of habitat managers each year, there is a very real prospect of a disastrous fire affecting land in multiple ownerships.

Local protection measures may exist. Strategic landscape-scale strategies have not, and in the same way that we pay insurance premiums to protect property from significant events, we must invest in measures that protect our landscape from catastrophic wildfire.

We are immensely grateful for the engagement, support and encouragement the Project has generated. It was intended to address the whole of the Peak District moorland area and it remains our hope that this report will be the catalyst for more wide-spread engagement. Our apologies to those for whom assessment are outstanding. We have been pleased to receive the following supportive comments and observations from academics and FRS personnel who are experts in the field of wildfire.

Hopefully this report will provide the impetus for greater protection for all; biodiversity, carbon and people.

INTRODUCTION

The Natural Capital of the Peak District National Park (Figure 1) is enjoyed by 13 million visitors annually (Peak District National Park, 2021). Managed by generations of custodians, its dramatic moorland scenery has been delivering public goods for millennia. As well as harbouring a wealth of biodiversity, it forms part of the UK's largest carbon store. Helping to deliver the Nation's Nature Recovery and Net Zero strategies, the green economy will increasingly replace traditional management approaches. However, there is a significant vulnerability.

Wildfire, to quote Professor Rob Marrs, President of The Heather Trust, is inevitable, **"it's not if, but when".** Driven by changes in climate, vegetation management and human activity, this is already apparent. Unfortunately, occurrence is often attributed to arson.

This report describes a project developed to assess the risk of wildfire and ways in which resulting evidence can be used to develop a landscape-scale mitigation strategy. The approach has been piloted on 38,000 of acres of continuous moorland in multiple ownerships centred on the Derwent Valley.

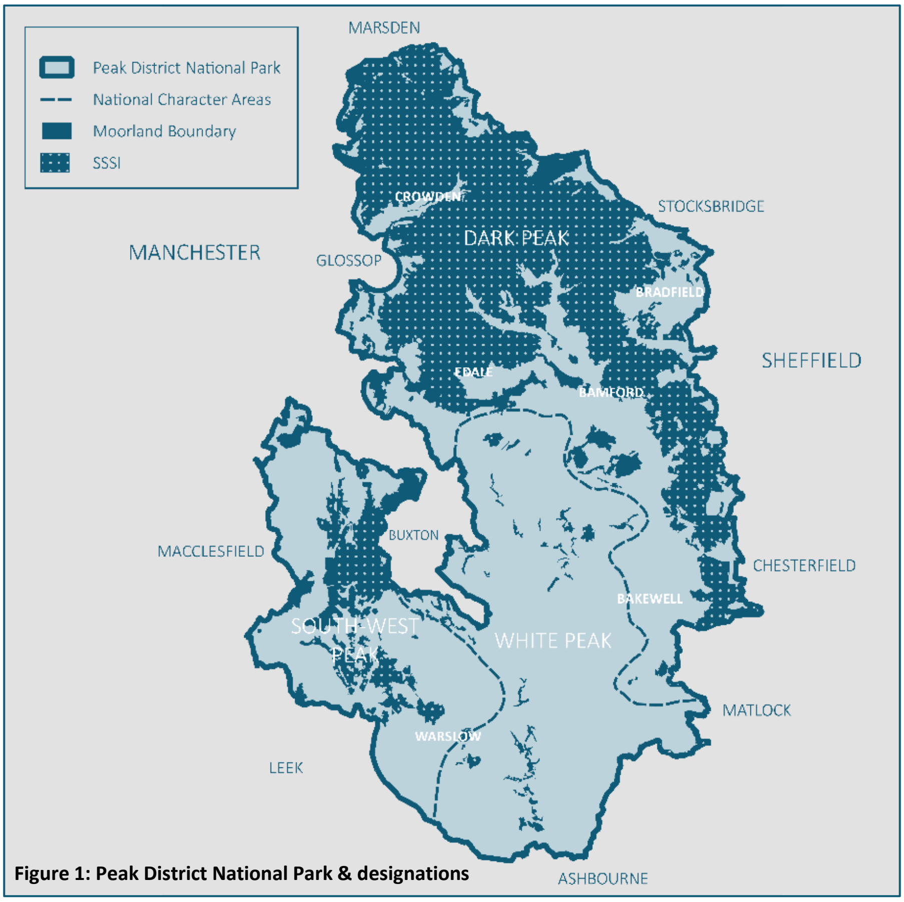


Figure 1: Peak District National Park & designations

THE LANDSCAPE

Protected Habitats

The Peak District Moorland Zone (PDMZ) extends to 131,000 acres, over 80% of which is subject to the highest form of statutory protection for its assemblage of habitat and ecology (SSSI, SPA & SAC). It includes BAP priority habitats of upland Heath (shallow peat), Upland Flushes and Blanket Bog (deep peat).

Ecosystem Services

The PDMZ provides a wide range of valuable ecosystem services including; **regulating** (climate, air and water quality control), **cultural** (recreational and educational) and **provisioning** (fuel, fresh water, fuel).

Historic Context

The PDMZ is the product of centuries of evolving agricultural, commercial, environmental, and social practices. Appreciating the historical context helps us to understand the current risk stakeholders' face and the barriers to reducing the risk.

The landscape has been shaped by human activity; firstly, with the clearing of indigenous scrub for farming and for industry. Then, in the 19th century, valleys were flooded to form reservoirs serving surrounding cities, today supplying approximately 450 million litres of drinking water to the surrounding population each day (Moors for the Future, 2021). Sporting interest also evolved and shepherds began to function hand in hand with moorland gamekeepers, focusing vegetation management (burning) to benefit fleece and beak.

Today, conservation agencies own or manage more than 50% of the PDMZ. Alongside numerous private landowners, the National Trust manages over 30% of the area and water companies are responsible for a further 25%.

Climate Change now represents a significant factor, affecting the composition of vegetation and increasing the risk of wildfire.

Improving Resilience

Resilience can be described as "the ability of an ecological system to cope with and adapt to environmental stress and change, whilst retaining the same basic structure and ways of functioning" (Natural England, 2019). Programmes of blanket bog restoration including raising the water table, re-vegetating bare peat and planting sphagnum moss help improve water quality, assist flood mitigation and capture carbon. It also increases resilience under the mantra "wetter is better".

Prescribed Cool Burning

Controlled or prescribed cool burning (as opposed to uncontrolled burning or wildfire) is a long-used management method to stimulate new growth. The Heather and Grass Burning Code (Defra, 2007) sets out the approach to ensure it avoids damaging habitat or causing wildfire. A cool burn ignites the fine surface vegetation, leaving the stick and moss layer intact. Once a wide-spread activity, since the introduction of voluntary agreements and subsequent statutory instrument (The Heather and Grass etc. Burning (England) Regulations, 2021) prohibiting burning over peat deeper than 40cm, it is estimated now that under 5% of the surface vegetation of the PDMZ is under a routine controlled cool burning regime. Consequently, approximately 425 acres might be subject to prescribed burning each year, just 0.3% of the PDMZ.

Prescribed Cutting

Another approach to vegetation management is cutting using machinery from a tractor mounted mower to remote-control automated machines. There are limitations to access with machinery where ground slopes steeply, is rocky or boggy. Cutting around controlled burn areas has been common for years however, it is not yet clear how much cutting is now undertaken. Cutting requires consent from Natural England on land designated as SSSI and indicators are that less vegetation over deep peat is under a prescribed cutting regime than would previously have been cool burnt.

Re-wilding

Gullies that were previously grazed are increasingly being fenced and planted with native trees. Forming part of the outlook for broad area Nature Recovery Networks, large areas of the landscape are currently being allowed to self-set or re-wild.

Uncontrolled Wildfire

Unlike controlled cool burning, wildfire can burn hot and can ignite underlying peat. In 2018, over 2,550 acres of moorland is recorded to have burnt by wildfire, equating to 2% of the PDMZ (6 times the area now subject to prescribed burning) and in 2019, over 1,700 acres is recorded to have been burnt by wildfire, equating to 1.3% of the PDMZ (4 times that now subject to prescribed burning)!

WHAT IS WILDFIRE ?

Wildfire is defined as "Any uncontrolled vegetation fire which requires a decision or action regarding suppression" (Scottish Govenment, 2013).

The consequences of wildfire events can vary from being insignificant to having a major impact on landscape and a wide range of ecosystem services.

Fire behaviour is influenced by (Figure 2):

Fuel

The type, quantity, moisture content and arrangement of vegetation affects the way it burns. Understanding how vegetation interacts with fire is important to appreciate potential **rate of spread (ROS)** , **flame length (FL) and fire line intensity (FLI)**.

The size and shape of available fuel is relevant, particularly in regard to their ease of ignition. Smaller fuels, referred to as 'fine fuels', are more receptive to fire, while larger or more coarse fuel types generally rely on their interaction with fire in finer fuels before they will ignite. ***Much of the moorland and grassland of the PDMZ contains high quantities of continuous fine fuels, which can burn readily and with high intensity and Rate of Spread (ROS)***.

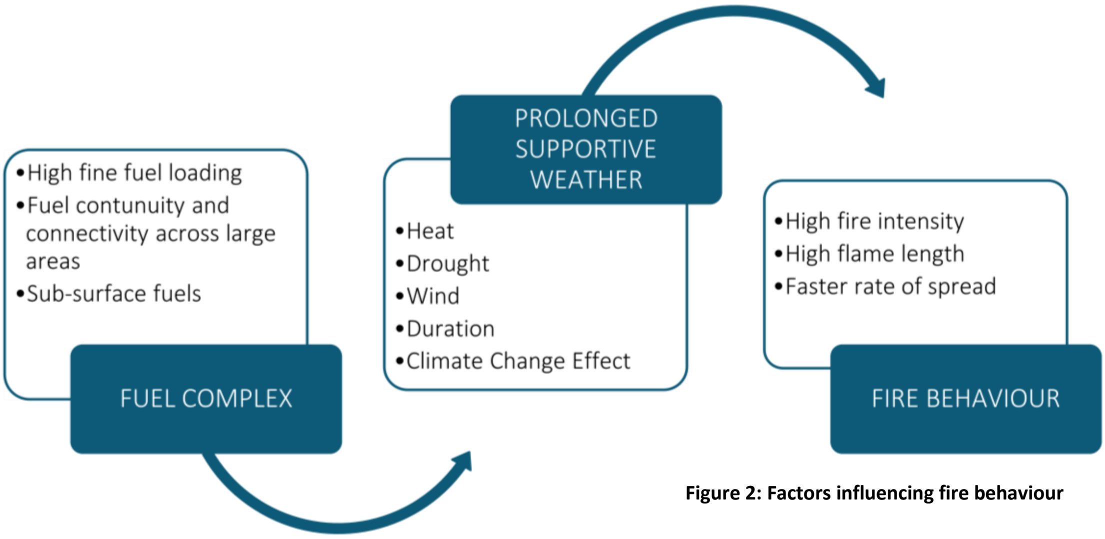


Figure 2: Factors influencing fire behaviour

Topography

In the Wildfire environment, topography plays an integral role in determining how fires behave. Topography is a static factor that will influence variables such as fuel types, fuel quantities, relative humidity, wind speed and direction and the potential size and shape of the fire.

Table 1. FRS capacity of control	Flame length		Rate of spread		Fireline intensity	
	Feet	*Metres*	*Chains/hr*	*Metres/hr*	*BTR/ft-s*	*BTR/m-s*
Low (Within control of FRS)	0-4	0-1.2	0-10	0-200	0-500	0-152
Medium (Potentially within control of FRS)	5-11	1.3-3.3	11-40	201-800	501-2000	153-609
High (Beyond control of FRS)	12<	3.4<	41-80	801<	2001<	610<

Table 1: FRS capacity based on fire behaviour taken from (Amraoui, et al., 2018)

Weather

Humidity, temperature, wind speed and direction also influence flammability, fire intensity and ROS. The flammability of surface vegetation and underlying peat is principally controlled by its moisture content as water absorbs heat, dilutes the flammable volatiles in vegetation and excludes oxygen from the combustion zone.

It is vital that there is an understanding of how prevailing weather conditions influence wildfire behaviour so high-risk periods of fire supportive weather are recognised in advance. However, it is a misconception to believe that wildfire is reliant on extreme weather conditions. A relatively short period of supportive weather can increase the risk of wildfire significantly and vegetation fires can occur at any time of the year.

Fire Response

Rather than on landowners, current policy places the burden on the Fire & Rescue Service (FRS) to suppress wildfire to prevent incidents developing into extreme events (Parliamentary Office of Science & Technology, 2019). FRSs face a number of challenges when attending wildfire incidents such as the absence of National Wildfire Training Standards and lack of aerial support (Figure 3).

Other issues are operational, such as the lack of available access or the length of time it takes to arrive at the scene. Successful intervention depends on a timely, well-resourced and hard-hitting initial response in the correct location. An effective response will result in less severe consequences. When a rapid intervention is not possible and fires are allowed to build in momentum and size, FRS response can be ineffective due to circumstances outside their control.

Despite investment by local FRSs in improving their suppression systems, the landscape and the fuels arranged upon it can provide little opportunity for these to be applied successfully. When the weather is fire supportive, a large continuous fuel complex has the potential to burn with such intensity and be so fast-moving that the result will be large or even catastrophic fire events.

Fire behaviour capacity of control

To simplify the understanding of what is controllable and what is likely to be beyond control, the Project relies on internationally accepted measurements (Amraoui, et al., 2018) to assess the likelihood of control success based on a fire's intensity (FLI), its flame length (FL) and its rate of spread (ROS) (Table 1). Estimations are based on intervention being made by well trained and well-resourced responders with adequate aerial support.

Currently, many FRSs in the UK lack appropriate analysis capability, wildfire training or specialist equipment and are often provided with no aerial support. The capacity of control measurements indicated in the table should be considered optimistic in the PDMZ.

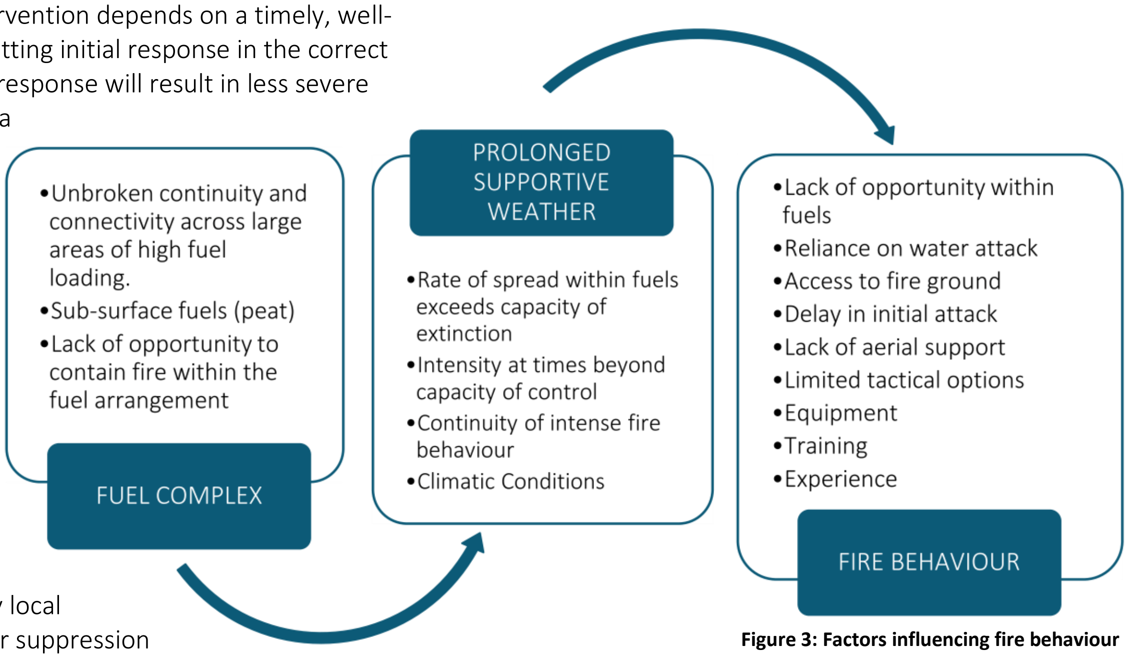


Figure 3: Factors influencing fire behaviour

WILDFIRE OCCURRENCE

Moors for the Future carried out a study in 2021 (Titterton, 2021) analysing wildfire data between 2007 and 2020 showing that the majority of fires occurred in the month of April, followed by March and May. The data shows those years, e.g. 2018, where extreme weather conditions have caused a spike in occurrence (Figure 4). This data does not account for many incidents which are extinguished by habitat managers and are unrecorded.

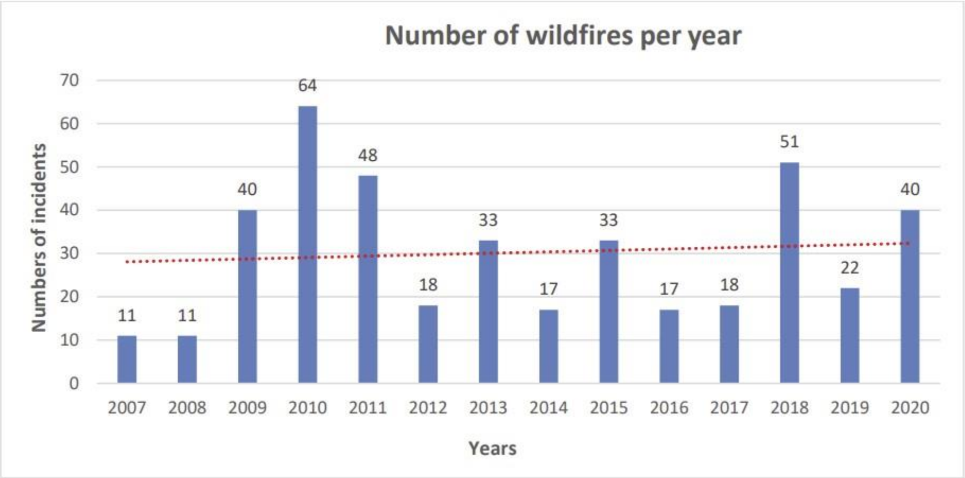


Figure 4: Wildfire incidents 2007-2020 (Data from (Titterton, 2021))

Causes of ignition

"Natural wildfires due to lightning strikes are rare in the UK and most wildfires are the result of human action, through either arson or accident." (Glaves, et al., 2020) "Risk and occurrence of wildfire in the UK is associated with hot, dry weather conditions, especially drought (or, particularly in spring, low temperatures and frozen conditions), with particular vegetation characteristics (especially plant functional type, height/structure, (high) fuel load and (low) moisture content) and human-related accidental ignitions associated with public access, recent or current wildfire and managed burning activity and arson" (Glaves, et al., 2020)

The Upland Management Group (Uplands Management Group, 2019) identifies the main factors influencing the risk of a fire starting as:

- People
- Access points
- Presence of "honeypot" areas
- Land management/land use type
- Adjacent land management/land use.
- History of wildfires in the area

Vegetation with high fuel load and low moisture content is most volatile and human-related accidental ignitions are associated with public access e.g. BBQ's, cigarettes, fireworks and lanterns. In 2019 Moors for the Future updated the ignition risk map for the Peak District (Dixon & Chandler, 2019) and found that the highest risk of accidental ignition was on the moorland fringes, particularly close to urban areas.

Climate is changing

Risk and occurrence of wildfire is commonly associated with drought conditions. Our usual maritime climate is influenced by moist Gulf Stream air. This is occasionally blocked by warm continental air characterised by prolonged dry periods.

These drought conditions can increase the occurrence and intensity of wildfire at any time of the year. Occurring on average once a year at the turn of the century, we now see these conditions occurring 2 or 3 times a year, and frequency might rise to 6 times a year by the end of the Century (Zhang, et al., 2020).

Historically, wildfire incidents have occurred most often in spring and summer, when the available vegetation is most vulnerable. Incidences of heather beetle attack prematurely desiccate vegetation, increasing vulnerability. In recent decades, and in particular since 2003, Europe has experienced an exceptional number of heat waves in summer months and an associated increase in more extreme wildfire events (Zhang, et al., 2020).

In the future, trends suggest the wildfire environment will become more dynamic, more powerful and severe.

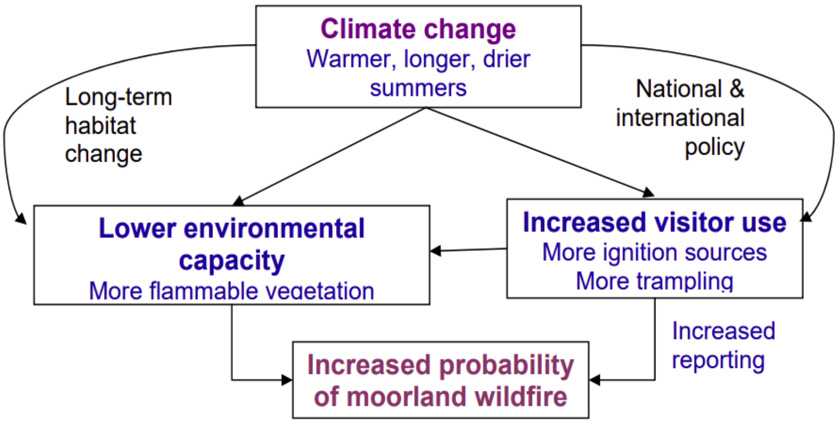
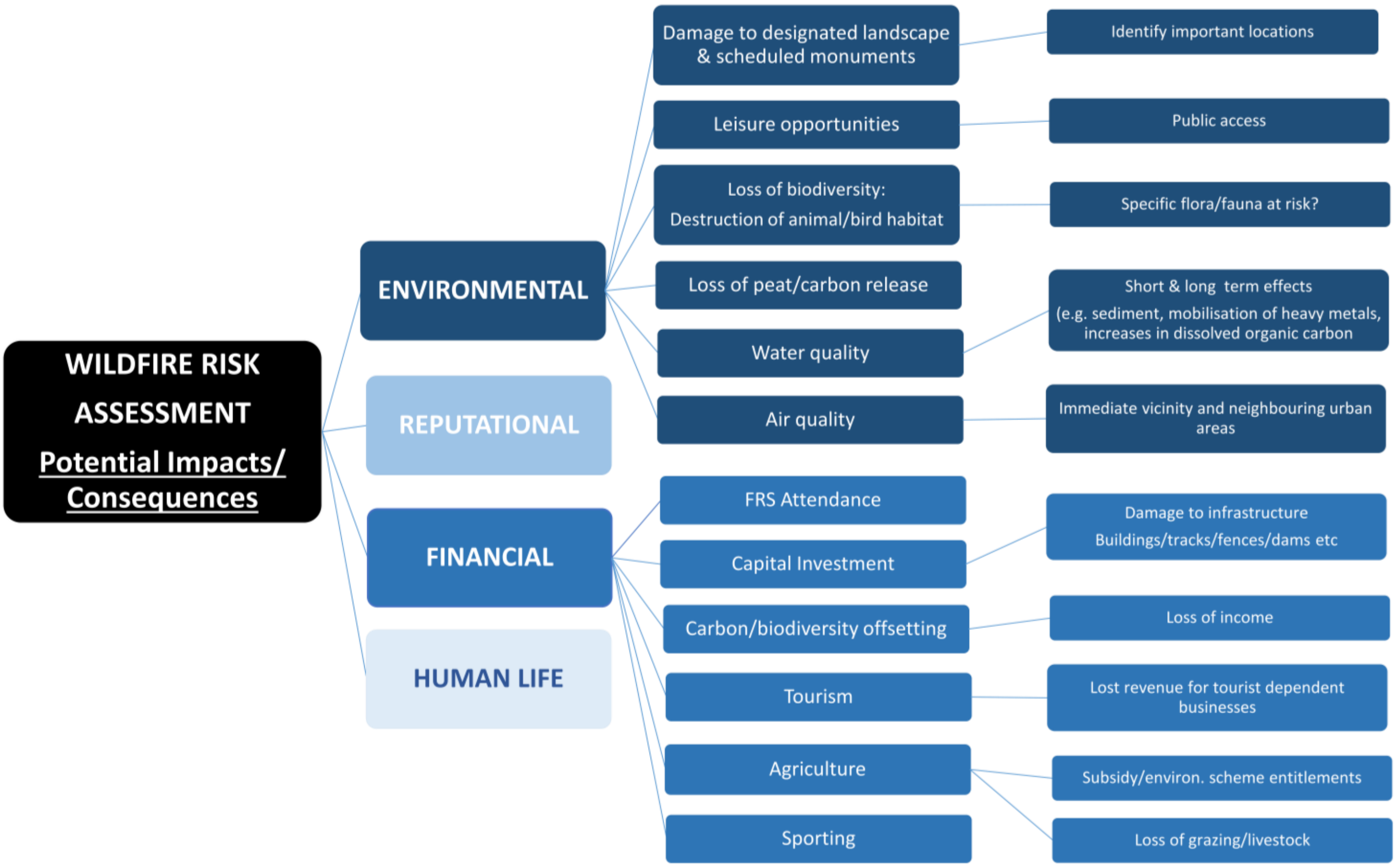


Figure 5: Climate change and moorland wildfire risk (McMorrow & Lindley, 2006)

COST OF WILDFIRE

Figure 6. Potential impacts/consequences of wildfire in the PDNP



Wildfire Dominance
Wildfire is already a significant cause of habitat, carbon and ecology loss in the PDMZ.

Carbon Emissions
When wildfire ignites underlying peat, it emits carbon that has been stored for decades, hundreds, even thousands of years, and can leave bare ground exposed to further erosion. Major events include the Stalybridge or Saddleworth Moor fire of 2018 (2,400 acres) which resulted in the release of 26,281 tonnes of CO_2 (equivalent) (Moors For the Future, 2022).
Alone, the Marsden moor wildfire was calculated to have released 12,500 tonnes of carbon, 2% from the surface vegetation and 98% from the underlying peat. A family car will emit around 24 tonnes of CO2 during its life cycle.

The Cost of Recovery
Losses & recovery costs associated with the Stalybridge wildfire have been assessed as £3,650/acre (Table 2). This excludes the cost of the Army's attendance. It equates to £430M across the PDMZ.

Legal Issues
Significant values are at stake in the PDMZ. Crude calculations suggest that at £60/T, the value of carbon stored might be £2.5bn and at £11,000/unit, surface biodiversity might have a value of £7.5bn. Failure to act, plan and implement could leave stakeholders exposed to claims of neglect say, if wildfire on one property impacts a neighbour's realm or where investment in restoration is devastated. Capital receipts and income from carbon & biodiversity offsetting, as well as Government funded environmental schemes, may have to be repaid.

Stalybridge Wildfire 2018

Loss/costs	£	Data source
Carbon Sequestration Capacity	3,600,000	Environment Agency Estimate (Moors for the Future, 2022)
CO_2	1,680,000	Environment Agency Estimate (Moors for the Future, 2022)
Leisure visits	205,000	Environment Agency Estimate (Moors for the Future, 2022)
FRS	1,200,000	(Manchester FRS, 2021)
Restoration	1,500,000	Peat Action Plan estimates 2.8M for Winterhill & Stalybridge fire
Landowner costs	576,000	(United Utilities, 2021)
TOTAL:	8,761,000	

Table 2: Estimated costs of Stalybridge wildfire 2018

THE PROJECT

With increasingly frequent fire supportive weather conditions, biomass accumulation and rising ignition incidents, the threat of wildfire has become a great concern to stakeholders.

Project Evolution.

In 2019, the Peak District National Park Authority called upon stakeholders to assess wildfire risks to the moorland landscape and identify mitigation options. With initial funding from the landowning sector, a project came together incorporating the steer of the National Pak Authority (PDNPA), Natural England (NE) and the Peak District Fire Operations Group (FOG), combining the knowledge of practitioners with the expertise of wildfire specialists.

From its local focus, the Project attracted external interest from a broad range of agencies and practitioners, some of whom identified its potential for wider geographical application. As a result, the Project evolved beyond its original focus to become a more considerable piece of work and secured additional funding through the Farming in Protected Landscapes (FIPL) scheme.

Stakeholder Collaboration

An important part of the Project has been to promote collaboration between as many stakeholders as possible. As well as early online workshops with habitat managers and other interested parties including utility companies, various agencies and FRS, in November 2021 technical experts, Steve Gibson and Marc Castellnou, visited the Peak District for a series of site visits and to meet with the Steering Team & FOG.

A THREE TIER APPROACH

The Project identified **8 Focus Areas** (Figure 7) within the PDMZ encompassing 114,000 acres, and initially concentrated on the **Derwent Focus Area** extending to 38,860 acres, half of which comprises the National Trust's Derwent Estate.

An approach was developed consisting of three tiers of assessment.

Tier 1 – Individual Moorland Assessment (Matrix)

Subjective assessment of 1km OS grid squares by habitat managers looking at ignition, combustion & control factors to produce heat maps for the whole landscape.

Tier 2 – Wider Landscape Assessment.

Objective collation and assessment of wide-area map data.

Tier 3- Fire Behaviour Analysis

Expert computer modelling of weather scenarios and vegetation classification to predict fire behaviour and fire response capabilities, identifying key opportunities for mitigation.

Figure 7: PDNP Moorlands, allocated into Focus Areas

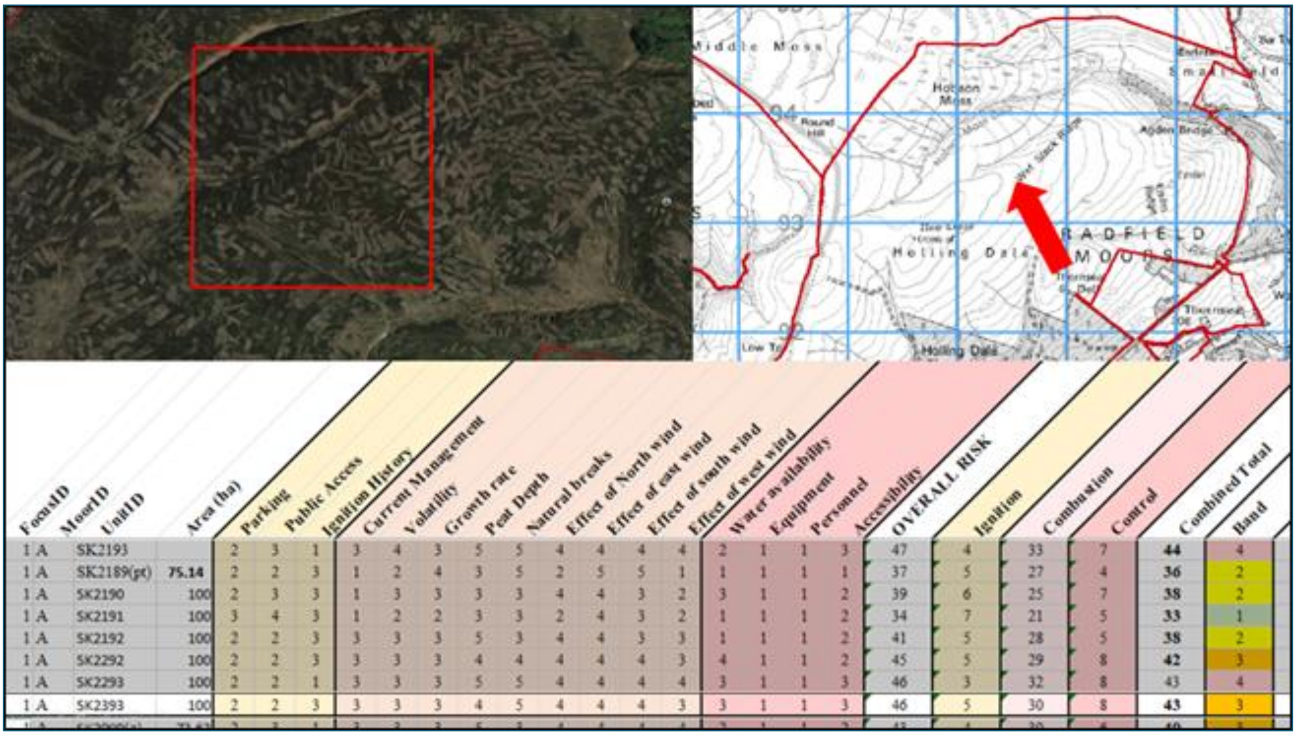


Figure 8: Example scoring grid and matrix completed by individual land managers

Based on the Upland Management Group Template

The Uplands Management Group (UMG) has an advisory role to DEFRA through the Uplands Stakeholder Forum and has produced a useful template for preparation of individual moorland wildfire risk assessment and mitigations strategies (Uplands Management Group, 2019). A moor is subdivided into coherent study parcels and a matrix used to judge the severity of factors influencing the likelihood, characteristics and consequences of a wildfire event.

Factors are identified according to attributes important at a local level. Advocated by DEFRA and NE, this is the current recognised approach to wildfire risk assessment which can be adapted to any landscape.

There are limitations to this approach which did not easily translate to a wider landscape assessment and the matrix approach in this Project is a simplified version.

For the Study Area, 16 influencing factors or hazards were identified and grouped into three categories; ignition, combustion and control. A set of parameters was developed for each factor to a enable a score of 1-5 (Table 3) to be applied by habitat managers to 1km OS grid squares across their landholdings (Figure 8).

Being gathered from practitioners, this ground-based data means the Project is collaborative and individuals' intimate understanding of the ground conditions, its fire history and control opportunities have been recorded. However, it could be said that this judgement is subjective, nuanced by the assessor's sensitivity to risk.

nd presented as a heat map; darker colours indicating greater risk.

Scoring Criteria – Public Access		
1	Not at all	
2	Below average	i.e. no direct PROW, CROW only, perhaps close to highway
3	Average	e.g. PROW regularly used.
4	Above average	e.g. popular bridleway e.g. Dukes Road
5	Honeypot location	e.g. Focal points (people linger) e.g. slippery stones popular particularly good weather conditions

Table 3: Scoring criteria for public access matrix factor

The Matrix data is a valuable layer of information gathered for strategic assessment. Whilst presented here as heat maps combining factors, individual scores can also be interrogated, for example to see areas subject to the heaviest visitor pressure or least accessibility. Consideration could be given to the addition/removal of some factors to improve this tier of data going forwards.

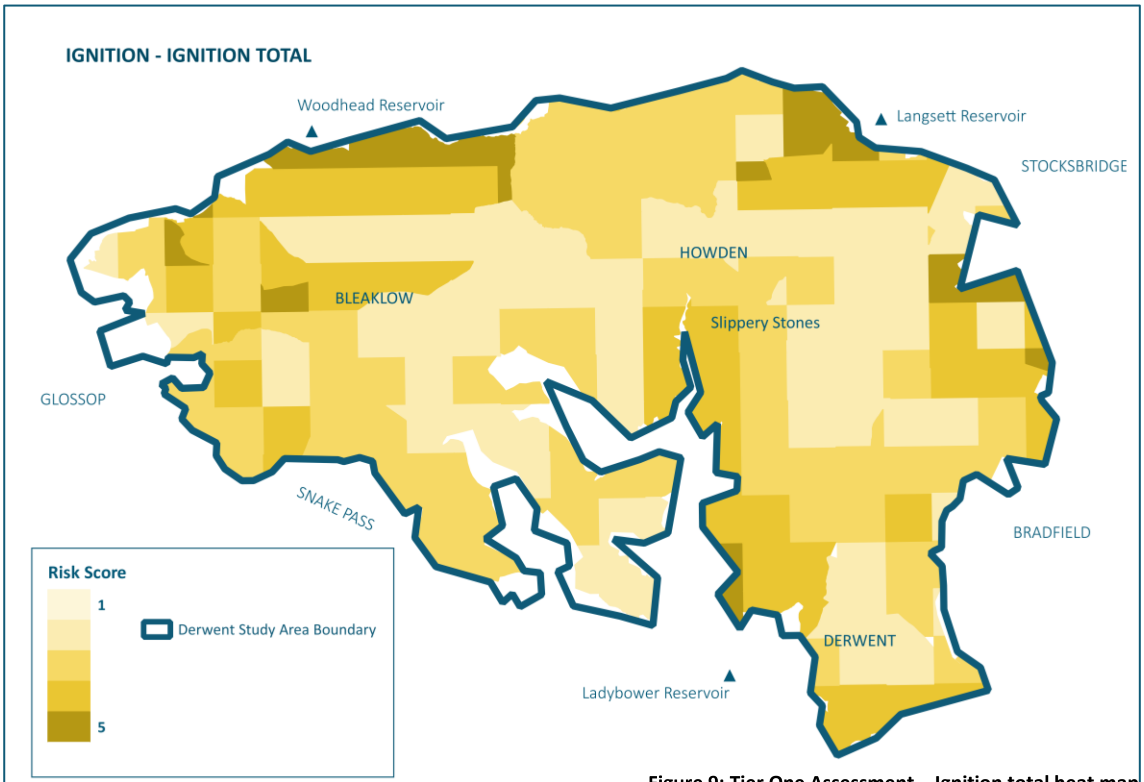


Figure 9: Tier One Assessment – Ignition total heat map

Assessments for the whole of the Derwent area were collated and GIS software used to produce heat maps.

When combined, the three matrix factors grouped to **Ignition** indicate that areas on the moorland fringe, particularly close urban settlements and good access routes, are considered to have the highest risk of ignition (Figure 9).

The **Combustion** heat map shows a fairly consistent level of risk across the whole landscape, with slightly lower perceived risk in the east and southwest of the focus area (Figure 10). Collated, the four matrix factors grouped to **control**, illustrate highest risk in the deeper reaches of the study area, away from access points and ready water sources (Figure 11).

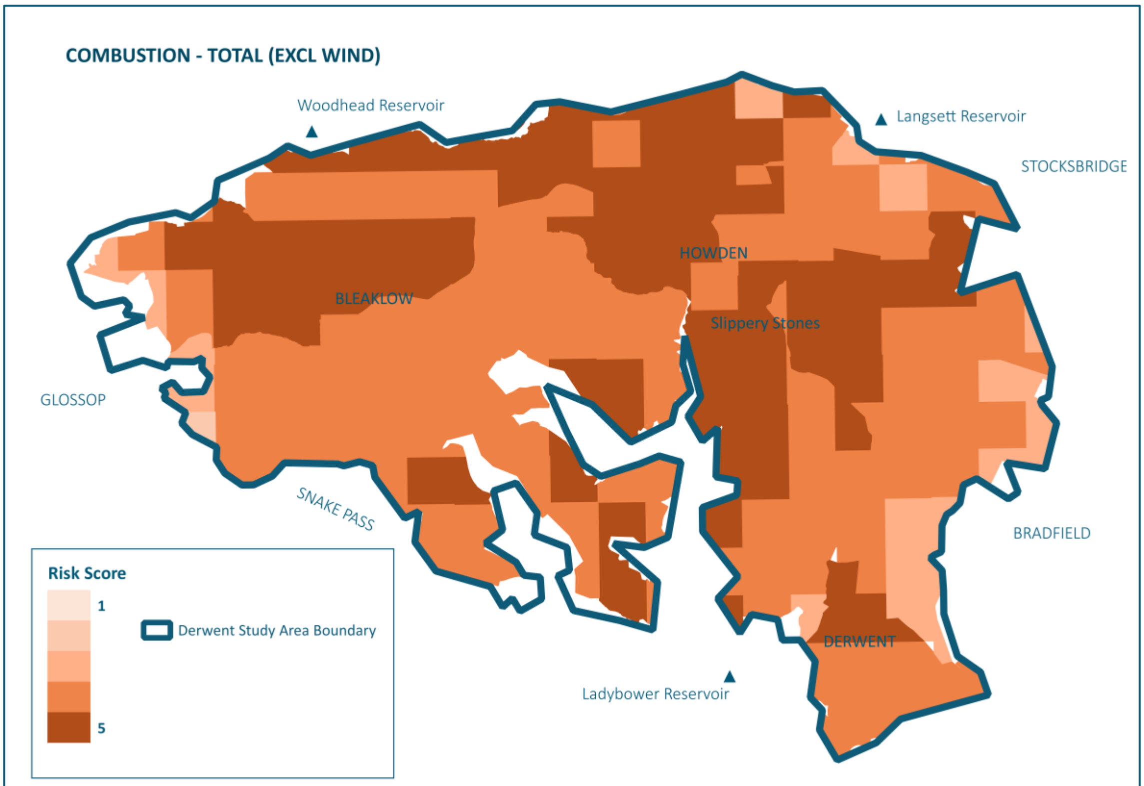
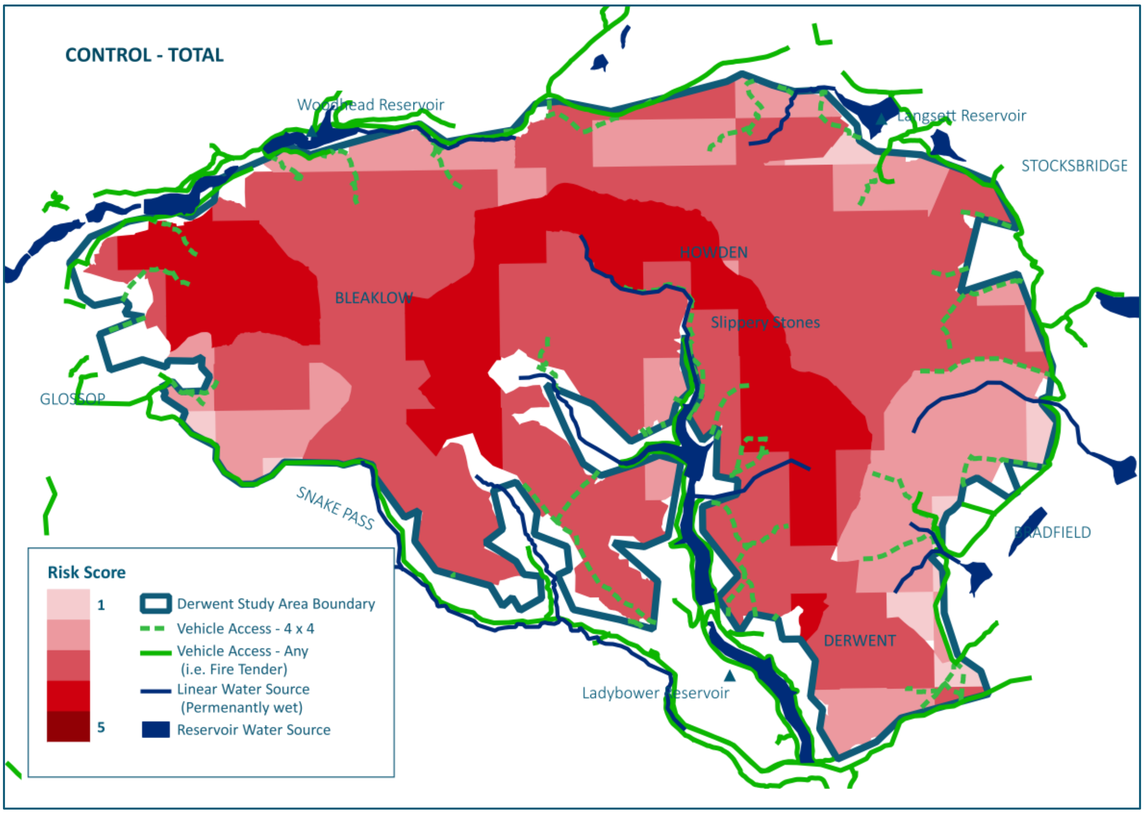


Figure 10: Tier One Assessment – Combustion total heat map

Figure 11: Tier One Assessment – Control total heat map



TIER 2- WIDE AREA MAP DATA ANALYSIS

For the Second Tier, freely available map data has been objectively assessed to identify vulnerability zones grouped to ignition, combustion and control.

Data assessed includes ignition history, peat depth, vegetation status, water resources, natural & man-made breaks and access routes.

Combining the ignition, combustion and control assessments, an overall vulnerability zone is identified, shaded red (Figure 14).

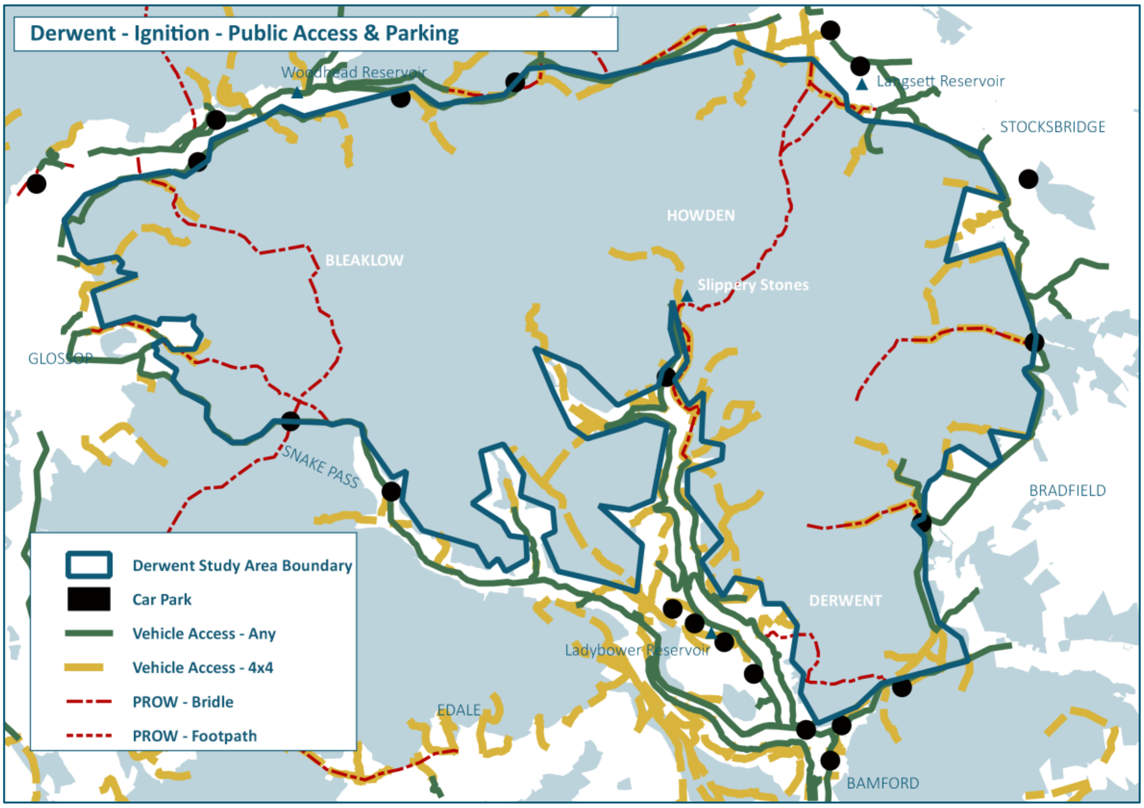


Figure 12: Tier Two Assessment – Public access & parking locations

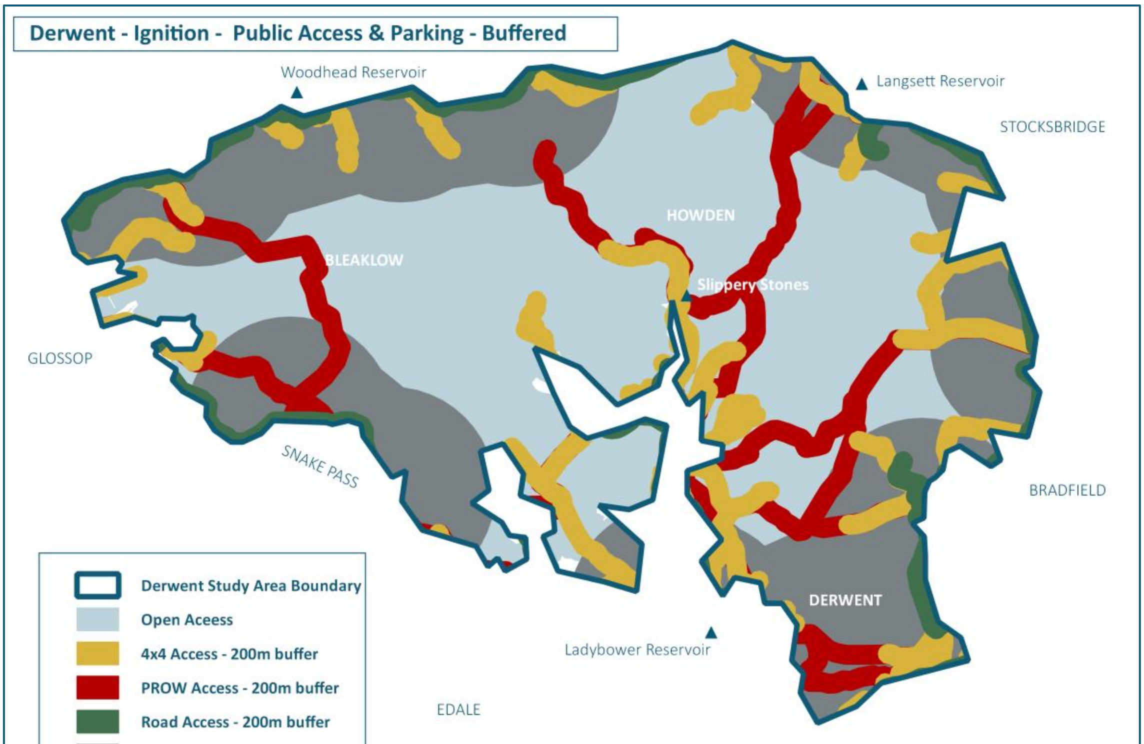


Figure 13: Tier Two Assessment – Public access & parking locations with buffers

The Tier 1 matrix and Tier 2 datasets correlate well, illustrating that the more readily accessible fringes of the Derwent Study Area are susceptible to ignition and that the opportunities for control are weakest in the less accessible interior areas.

Whilst more objective than Tier 1, the Tier 2 approach does not take into consideration habitat manager knowledge. For example, the control assessment includes water sources based on distances shown on a map, but this does not take account of the fact that some of these may be inaccessible. Ground knowledge, whilst it might be considered subjective, is an important contribution to the whole assessment.

Consideration could be given to expanding the Tier 2 assessment with additional data sets such as completed restoration works.

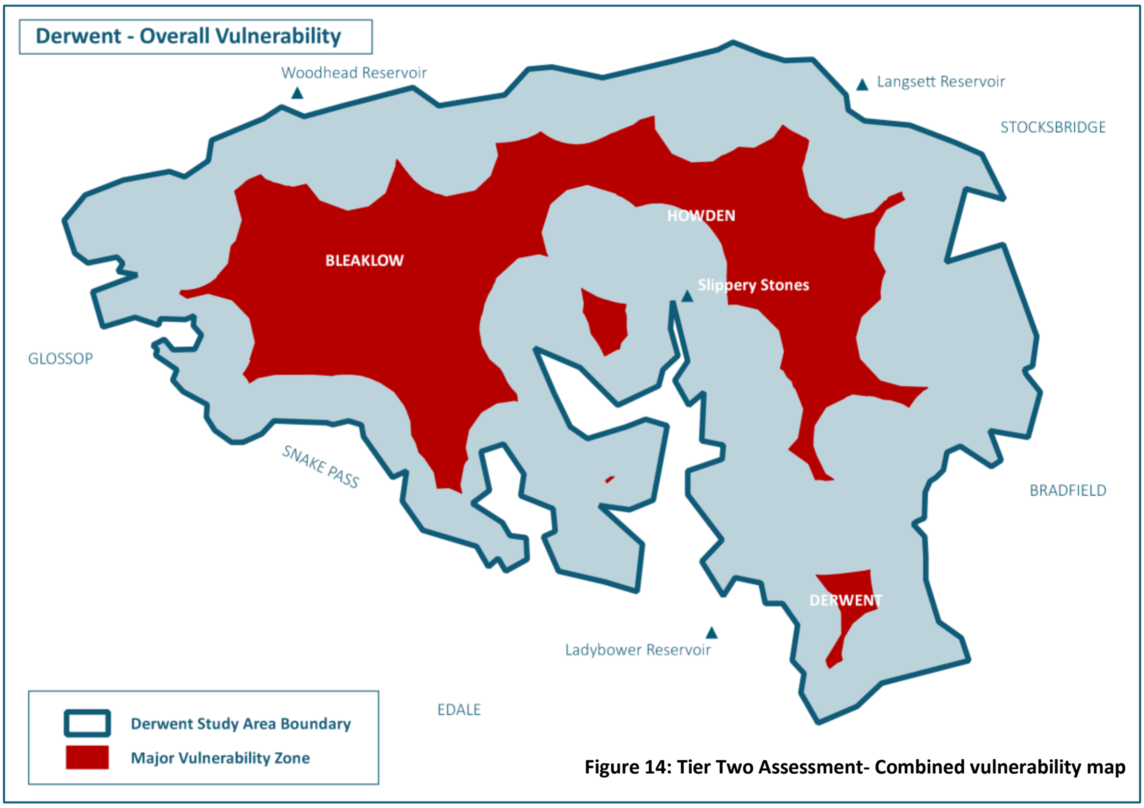
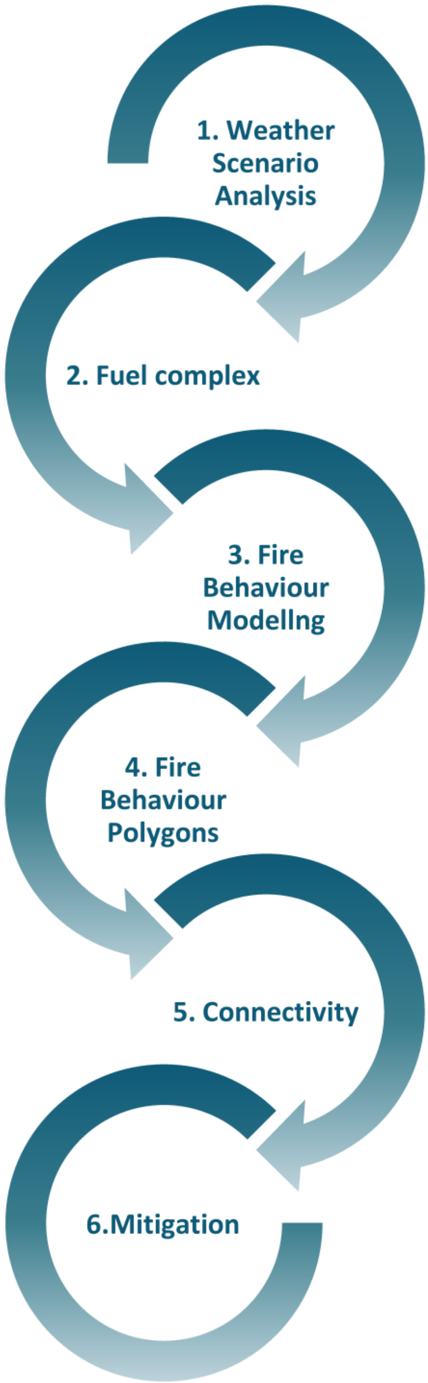


Figure 14: Tier Two Assessment- Combined vulnerability map

TIER 3 – FIRE BEHAVIOUR ANALYSIS

A combination of global fire monitoring systems, satellite data, remote ground information and historic data bases were employed to analyse and forecast potential fire behaviour within present fuels. The purpose of this modelling is to establish an understanding of how the fuel, topography and supportive weather conditions interact to influence fire behaviour. Fire behaviour and FRS capacity can then be evaluated to identify areas where action must be taken to allow successful intervention.

Figure 15: Overview of Tier Three methodology



Weather Scenario Analysis

Utilising the Global Forecasting System and climate data from Terra Climate (Abatzolgou, et al., 2018), trends have been evaluated to identify historic weather patterns supporting extreme fire behaviour. The data suggests two weather scenarios result in the vast majority of large-scale wildfire events in the PDMZ (A & B, Table 4). Two further common weather scenarios were identified to add to the dataset. Major wildfire events of 2007, 2011 and 2018 occurred under Scenario 'B' weather conditions; a stable high-pressure system over the UK supporting a very warm and dry environment. Wind blows from the East and travels over the continent adding to the dryness and warmth of the air as it passes over the warm land mass.

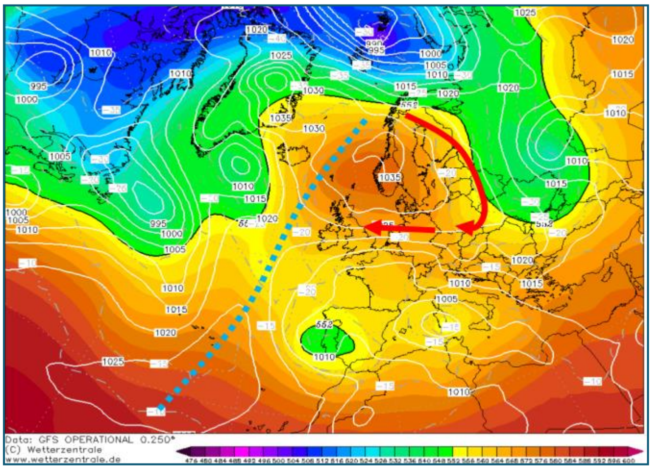


Figure 16: Weather classification "B"

Table 4 – Weather Scenarios	Wind Direction	Temp (°C)	Relative Humidity (%)	Wind Speed (km/h)
A – Average	East	21	31	9
B – Extreme	East	27	19	30
C	West	21	40	6
D	South	21	50	6

Fuel Complex

The fuel complex (vegetation and its arrangement) is modelled on broad area national datasets which have been refined using Sentinel satellite imagery and local datasets to ground truth. This refinement is applied across the whole study area to allow for more reliable modelling (Figure 17).

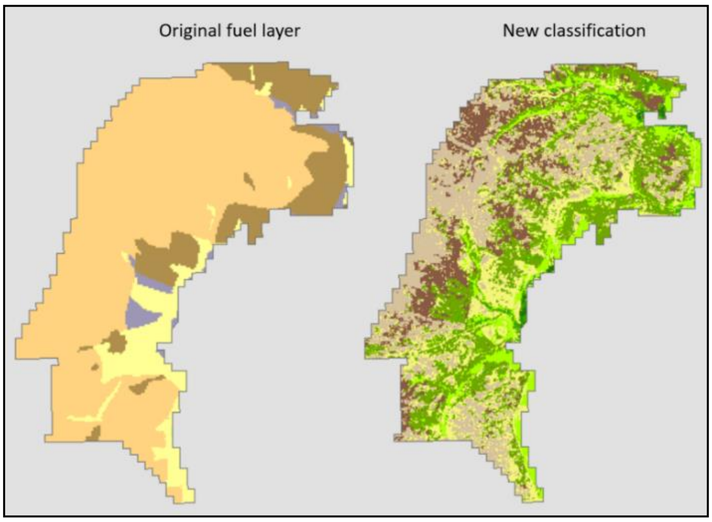


Figure 17: Vegetation refinement at Bradfield Moor, showing the original and refined fuel classifications.

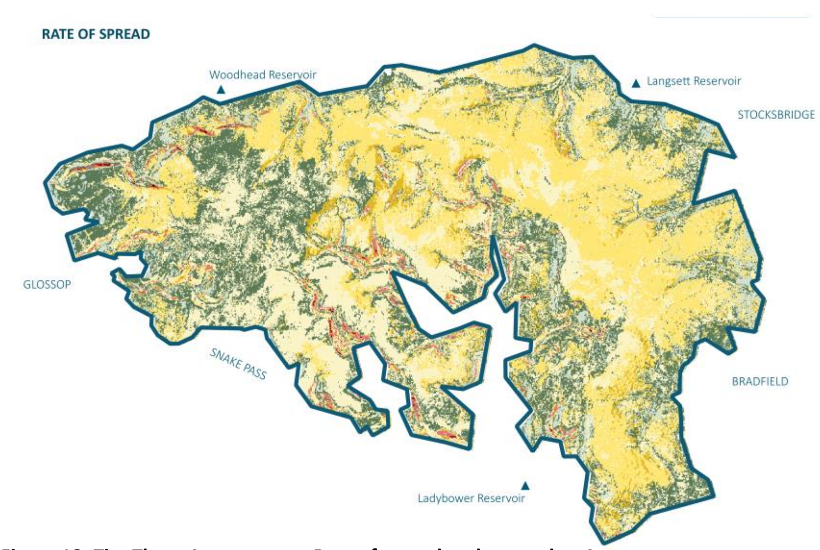
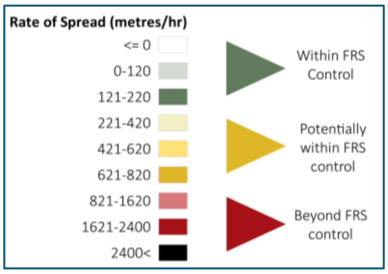


Figure 18: Tier Three Assessment – Rate of spread under weather A

Behaviour Modelling

Combining the weather scenarios with the fuel complex and other datasets (e.g. topography), fire simulation software (FARSITE & Windninja) identifies the likely fire intensities, rates of spread and flame length.

Figures 18 & 19 demonstrate rate of spread under weather scenarios A and B



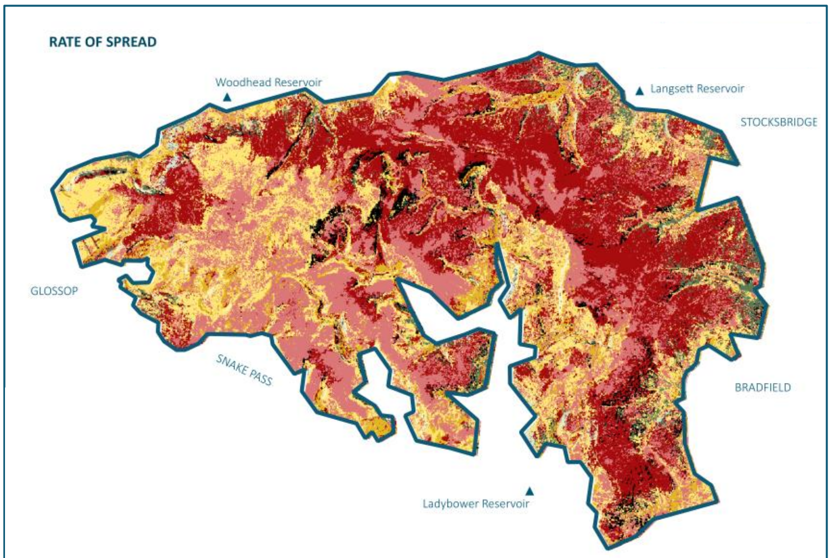


Figure 19: Tier Three Assessment – Rate of spread under weather B

Fire Behaviour Polygons & Connectivity

An algorithm is used to create polygons of homogenous fire behaviour. The boundaries of each polygon are essentially where the fire behaviour is likely to alter owing to changes within the wildfire environment (watershed, aspect, slope and fuel type). Two sizes of polygons (400ha & 150ha) have been mapped. The strength of fire connection between the polygons gives an indication of how a fire will move across the landscape (Figure 20). This analysis has been carried out for all four weather scenarios identifying potential fire highways (Figure 21) where a fire could travel uninterrupted across the landscape and the level of FRS control opportunity.

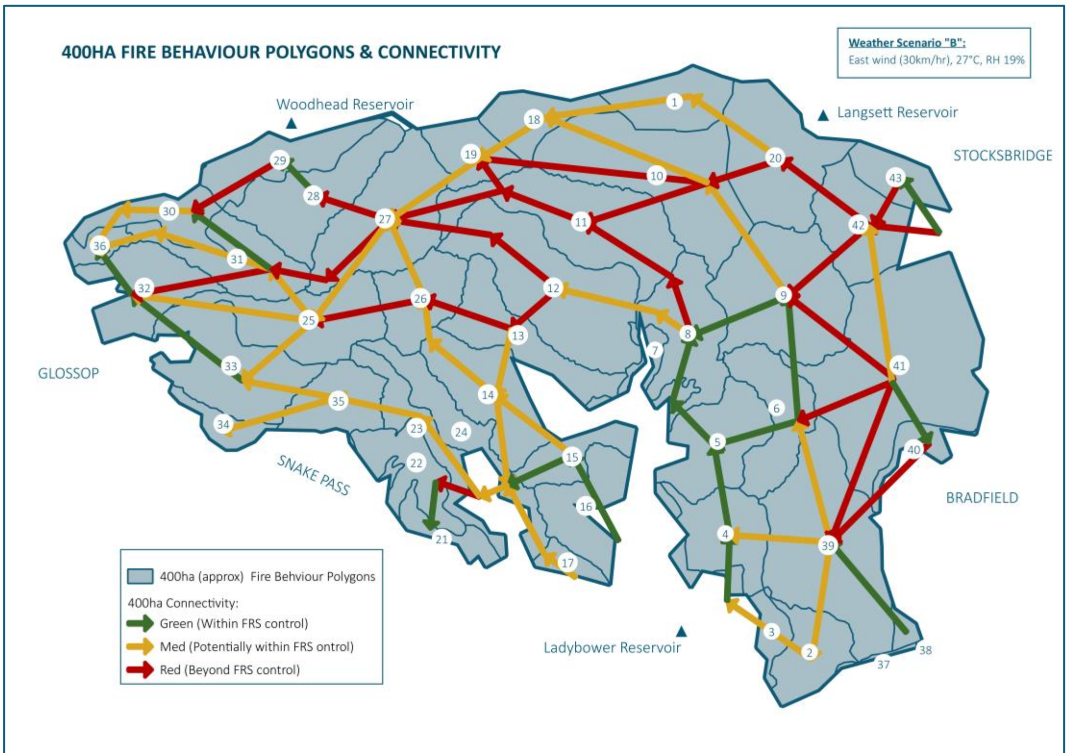


Figure 20: 400ha fire behaviour polygons and connectivity (East wind)

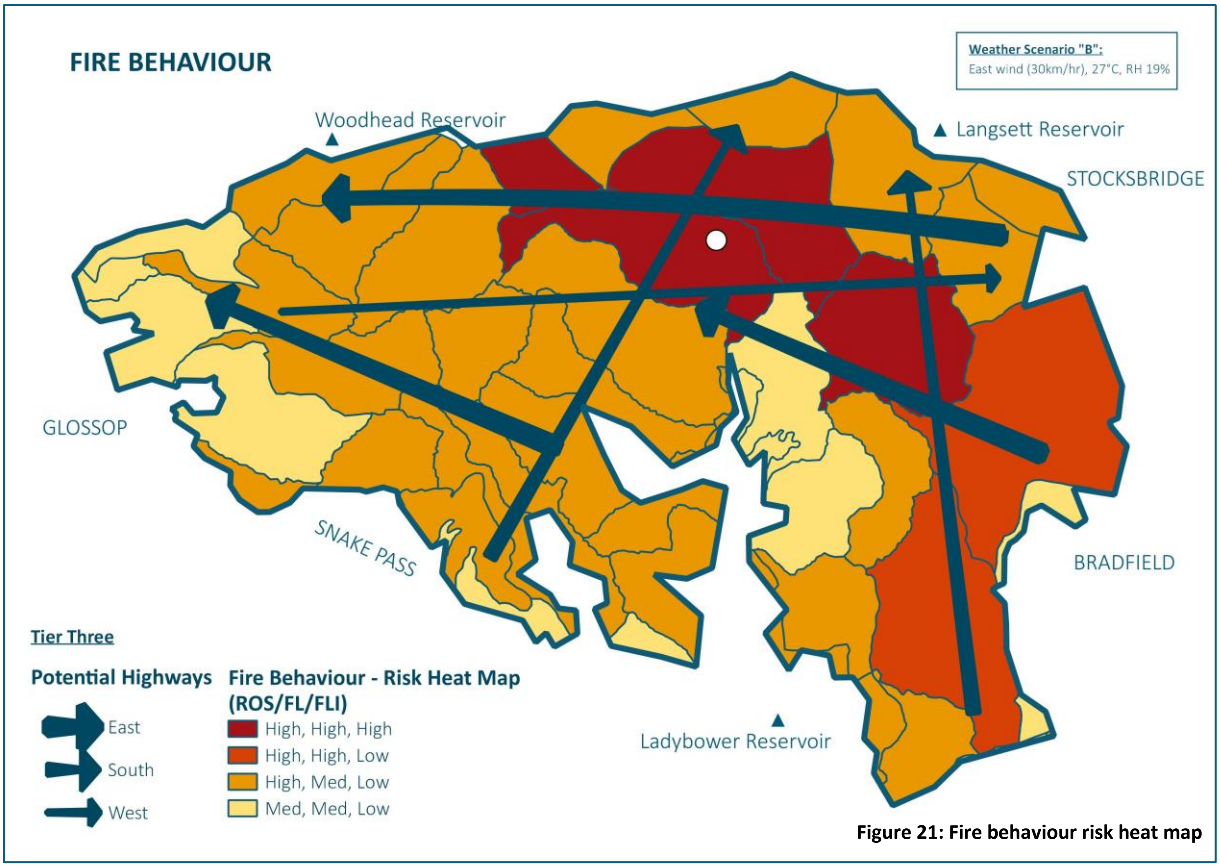


Figure 21: Fire behaviour risk heat map

Fire Behaviour Heat Maps

Using the fire behaviour polygons, heat maps have been produced incorporating rate of spread, flame length and fire intensity (Figure 21).

The four hub polygons identified dark red are regarded as having the most intense fire behaviour. To illustrate fire characteristics, the white dot has a FL of 25 feet (7.6m), ROS of 119 chains per hour (2,393m/hour) and a FLI of 6,600 BUT ft-s (7.5kW/cm^2). Average household gas boiler heat output = 25kW.

Looking at the data in this way helps us to see that the ROS in particular across the whole landscape would prove problematic and the areas shaded dark red are of the greatest concern.

The next step is to use this data to explore the ways in which fire behaviour can be interrupted in the highest risk areas to limit the effect of fire (i.e., potential size, intensity etc).

Identifying Mitigation Opportunities

The creation of fire maps and their analysis can provide a clear picture of the potential fire behaviour within a given fuel complex, where it may be controllable and where it is likely to be beyond control.

It can also indicate Strategic Management Areas (SMAs) where mitigating action can be taken to manage the fuel arrangement and have the greatest impact on reducing the scale of future fire events. These are areas where the fuel complex can be addressed so that the FRS can initiate effective operational activity. They should be pre-established points from which fire responders can have an opportunity to contain a fire, where perhaps currently there are none.

Understanding the changes in fire behaviour at a wildfire will also assist fire commanders to make the correct tactical decisions. Timing is crucial and taking full advantage of windows of opportunity where the fire is within the threshold of control of available resources is hugely important.

Comments

The amount, arrangement & combustibility of biomass across the case study area has a direct bearing on fire behaviour and the resultant fire intensity, flame length and rate of spread. The heavy and continuous fuel loads across broad expanses of the landscape have the potential to support high intensity, extreme wildfire events in multiple weather scenarios.

As evidenced by historic fire events, as well as the data produced in this report, during fire supportive weather conditions there is the potential in the current fuel complex for fire behaviour to overwhelm firefighting systems. Whilst these weather scenarios may be relatively infrequent, there is data to demonstrate that as a result of climate change they are occurring more often. This situation is compounded by the limited potential of responders being able to launch a speedy intervention, and a lack of initial aerial support.

COMBINING THE THREE TIERS TO FORM A MITIGATION STRATEGY

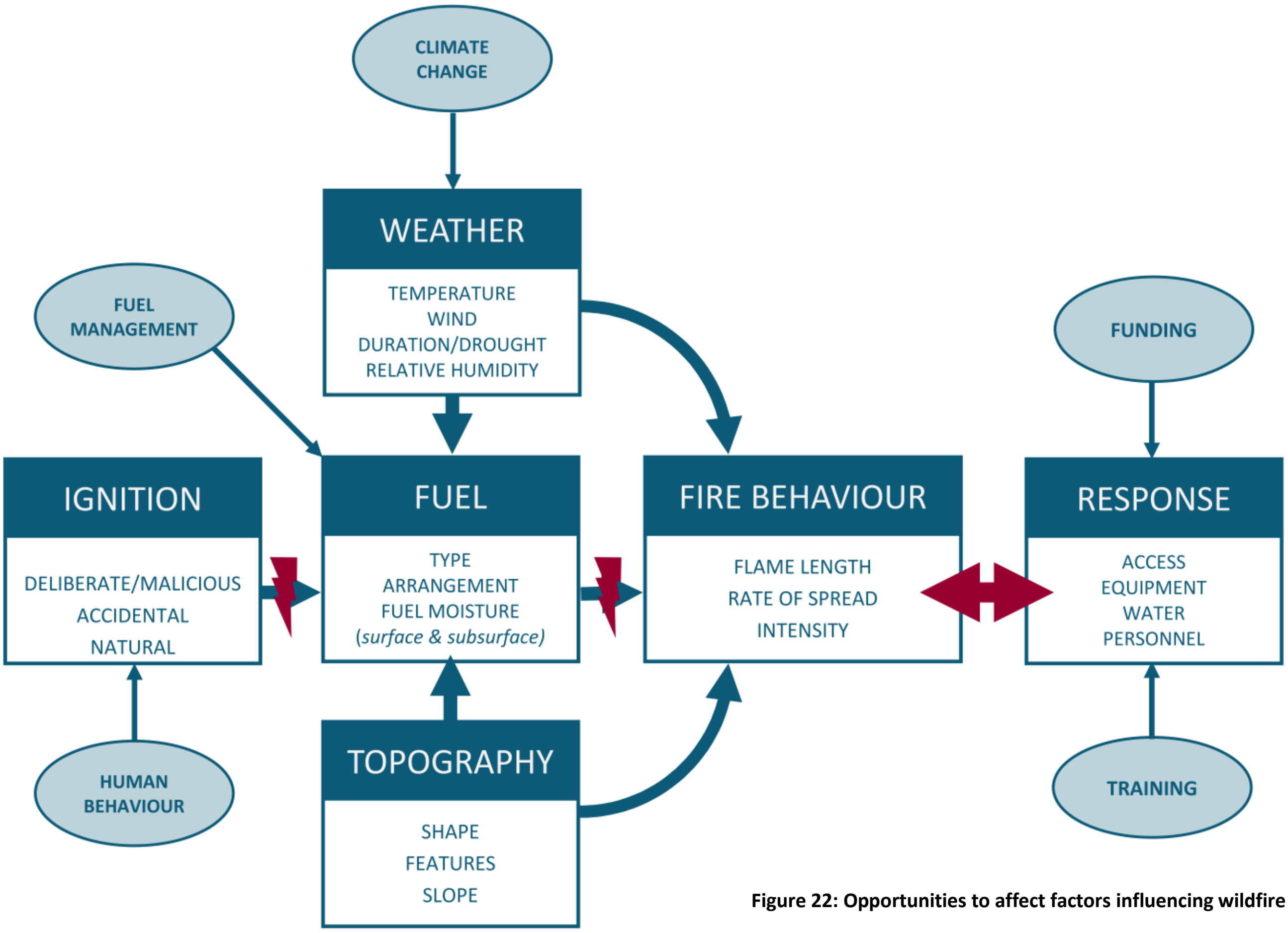


Figure 22: Opportunities to affect factors influencing wildfire

This Project presents compelling evidence.

The FRS require support from government agencies, the land sector and other stakeholders to create landscapes that are resilient, enabling effective action to be taken to minimise fire spread. This can be achieved if mitigation measures are implemented at strategic locations.

The subject of wildfire is complicated and there are limited opportunities for stakeholders to have an impact (Figure 22).

This Report does not advocate any particular response measures but, provides an evidence base to identify locations where strategic management can reduce vulnerability. There's a wide range of tools available and it is for stakeholders to work together to formulate a mitigation plan which will protect the wider landscape.

Combining the three Tiers of data identifies four points for action, each of equal importance:

1. Reduce Ignition
2. Manage fire behaviour
3. Improve Control
4. Improve stakeholder collaboration

1. REDUCE IGNITION

Preventing ignition is the most effective way of reducing the consequences of wildfire.

- Identify locations requiring mitigation
- Combining the tiers (Figure 23) shows that the areas at highest risk of ignition, which could develop into extreme wildfire events, are located closest to the 'honeypot' locations, with good public access and parking, which already have a history of ignition incidents. This is fairly consistent around the boundary of the whole Focus Area, coinciding with major road access, but is of particular concern close to the Langsett, Woodhead and Derwent series of reservoirs.
- Improve reporting – Create a robust data set to inform focussed campaigning
- Expand visitor management/education – Manage/ educate the public to increase awareness of the consequences of their actions and reduce ignitions.
- Improve monitoring – To ensure early response
- Managing fuel at high-risk ignition points – To reduce fire spread potential
- Opportunities to mitigate malicious ignitions are limited, but publicising fines / successful prosecutions may act as deterrent.

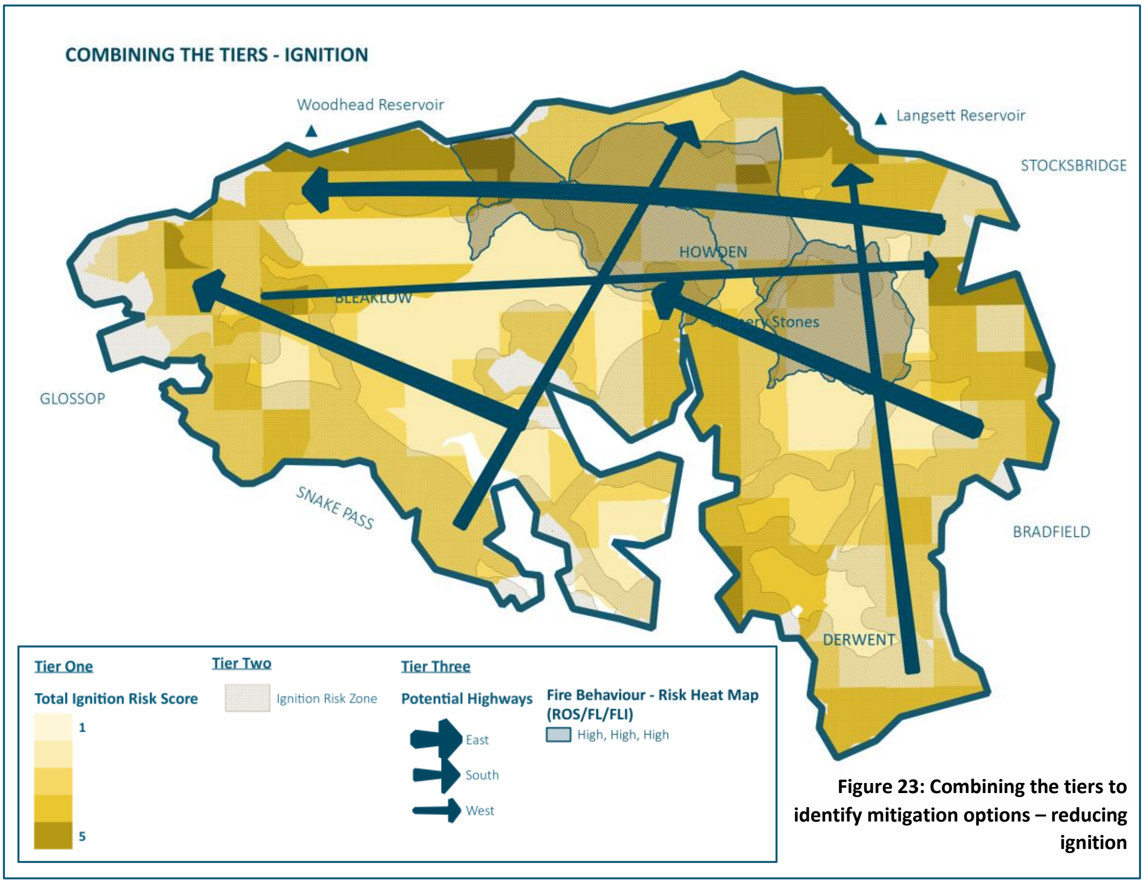


Figure 23: Combining the tiers to identify mitigation options – reducing ignition

2. MANAGE FIRE BEHAVIOUR

Identify locations in need of mitigation

Wildfire behaviour is driven by fuel, topography and prevailing weather conditions. Stakeholders have the power to manage the fuel complex. Tier Three assessment has identified the areas where fire behaviour needs to be mitigated to reduce the potential for fire highways to develop and provide opportunities for suppression via management of the fuel complex.

Climate Change Adaption

Past government policy has had little regard to wildfire. Natural England's Evidence Review of July 2020 suggested that knowledge of some aspects is lacking and within the 2021 Heather & Grass Burning Regs, the Government declared their intent to develop Local Control Plans. More recently, the UK's 3rd Climate Change Risk Assessment identifies wildfire as one of the key threats to terrestrial species and habitats, stating "Defra hopes to reduce the threat by restoring peatland, supporting training and using management plans to mitigate and adapt".

Improve resilience

Extensive restoration works have already been carried out across the PDMZ and this investment needs protecting from future wildfire events as well as concerted effort to expand works to improve localised resilience. The Peak District is not flat. Being dependent on suitable topography, it would be useful to assess the landscapes' capacity to accommodate successful re-wetting/blanket bog restoration as part of strategic mitigation planning. Whilst permanent saturation can provide protection for underlying peat under usual weather conditions, incidents suggests that it has limited impact during extended periods of fire supportive weather. Long-term vegetation development also requires study. Anecdotal evidence suggests some areas in which sphagnum is established become colonised with dwarf shrub species which ultimately dominate, their closed canopy representing the outcome set out to be avoided.

Whilst habitat extensification & diversity may ultimately bring some resilience, the establishing years are a considerable risk as increasing biomass will elevate connections between fire behaviour polygons. Scrub and young plantations are more vulnerable to fire than mature close-canopy woodland. Proposals should be risk assessed and vegetation management plans prepared to build in protective/defensive measures.

Fuel mitigation

Stakeholders must agree the strategic action to be taken within the fuels, ensuring the right methods are applied in appropriate locations.

Methods may include:

- Targeted vegetation management to reduce biomass and break fire highways.
- Establishing green (grass) breaks and hard grazing of specific areas.
- Woodland establishment and management.

NE's Evidence Review of 2020 suggests that there is little UK research into the effectiveness of managing fuel and

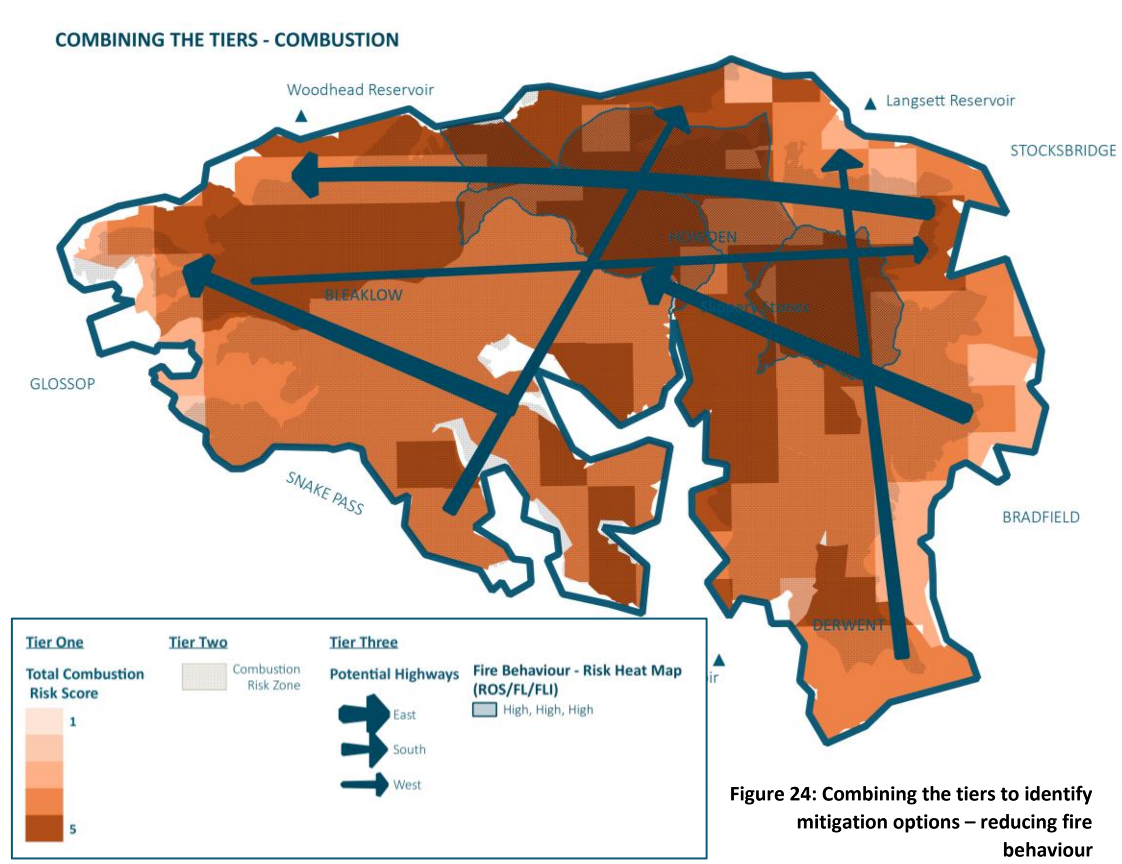


Figure 24: Combining the tiers to identify mitigation options – reducing fire behaviour

a need for greater evidence to support the effectiveness of reducing occurrence and spread of wildfire.

The efficacy of various types of fire break should be assessed. Depending on the nature of adjacent fuels, tracks with tightly manged (cut/burnt/green/grazed) vegetation on either side can act as fire breaks.

Careful consideration should be given to the positioning of fire breaks, taking advantage of areas where fire intensities can be expected to be lower, for example on reverse slopes where fires will be burning downhill.

Whilst building knowledge will assist future planning, it must not delay immediate response to protect the landscape.

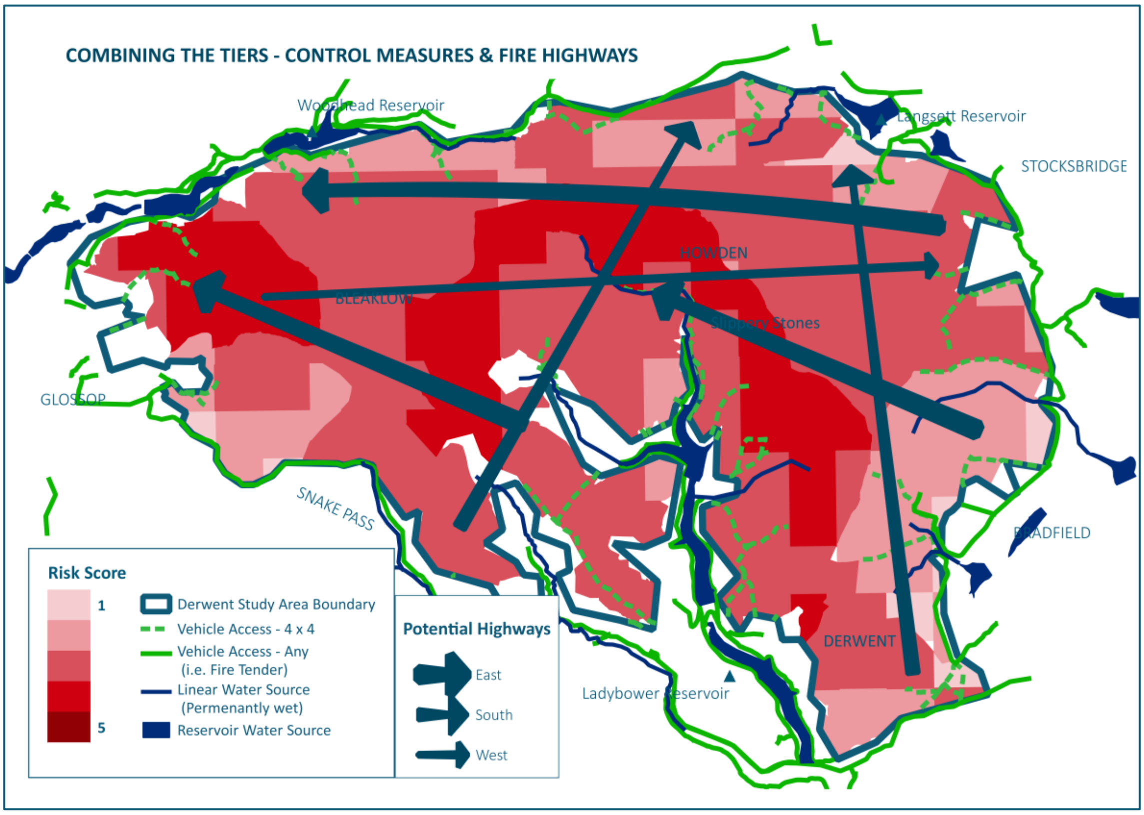


Figure 25: Combining the tiers to identify mitigation options – improving response

3. IMPROVE CONTROL

Access limitations and accumulating biomass mean large parts of the Study Area are at risk of wildfire which will overwhelm the FRS, whatever the background weather situation. Opportunities must be provided in the landscape and resources improved to allow successful intervention.

Identify the locations where improvements are required

Tiers 1 and 2 identify areas where resources are lacking i.e. access and water availability and Tier 3 assessment provides evidence on the areas where fire will overwhelm the FRS. Combining this data (Figure 25) shows the areas where fuel mitigation is required.

Improve infrastructure

Improving control opportunities relies on effective infrastructure such as firefighting equipment, personnel, accessibility, water availability and early aerial attack.

Training & Planning

Training should include not only for FRS directly fighting fires, but also training for wildfire analysis and development of an effective fire response plan (improvements to current firefighting systems, less reliance on water attack, earlier deployment of aerial assets, use of fire as a suppression tool, utilisation of preprepared strategic anchor points, etc).

4. STAKEHOLDER COLLABORATION

Leadership

Whatever their outlook, habitat managers have a desire and a responsibility to protect not only their own landholdings but those of their neighbours and the PDMZ as a whole.

Collaboration, utilising the evidence collected in this Report to produce a Landscape Wildfire Management Plan is one of the ultimate goals. Leadership is required to achieve this and the expectation is that agencies and those with statutory protection responsibilities will work together with landowners.

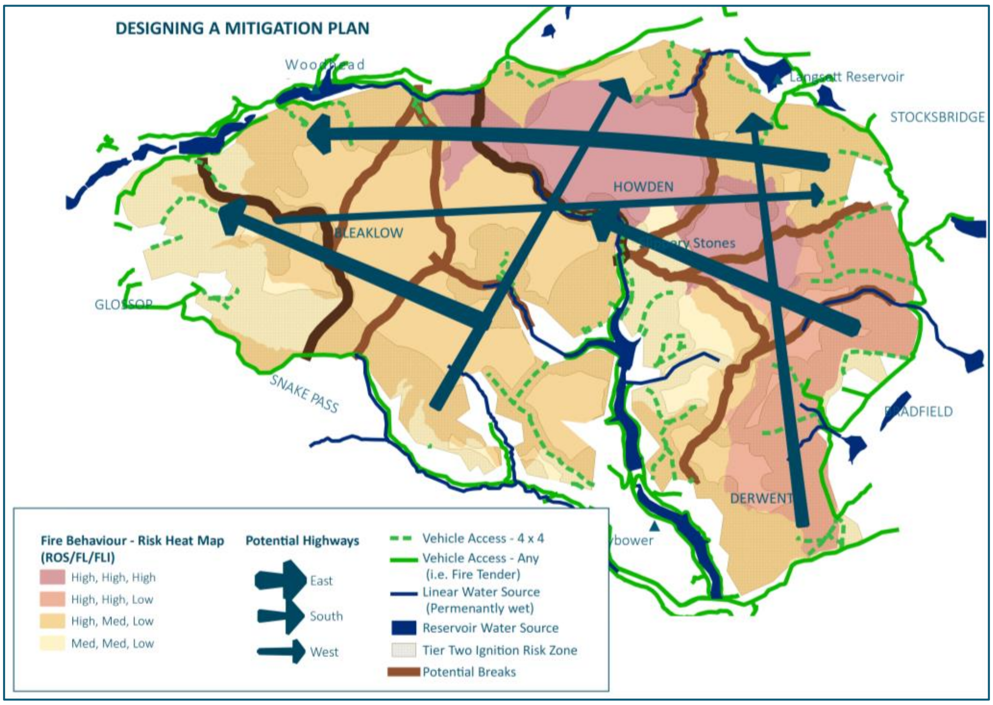
This study is a point-in-time presentation of the risks and mitigation options. It is important to appreciate that there will always be wildfire and the landscape, and its fuel loads are constantly evolving. The assessment of risk and mitigation responses need occasionally to be re-appraised. Responsibility for this should rest with an appointed body with clear terms of reference, roles, responsibilities and reporting routines. This might be the Fire Operations Group, or a DEFRA/Natural England led body with appropriate knowledge and training (practical and theoretical).

Landscape Wildfire Management Plan (LWMP)

There are three aspects to a LWMP that stakeholders need to consider:

- **Identify the values in the landscape to be protected**
  What assets or values are to be protected (peat, habitat, investment, heritage, leisure etc) and what size of future fire is tolerable?
- **Improve visitor management/education**
- **Agree and implement a mitigation plan**
  A fuel mitigation plan is designed to limit the scope and scale of fire by reducing fuel availability at strategically important hubs with treatments sympathetic to existing ecosystems. Weakening the network of fire connectivity creates defensive spaces where responders have opportunities to bring fire under control.
- **Develop a fire response plan**
  A response plan is designed to improve operational firefighting capacity and is focused on making improvements to training systems, fire analysis capability, firefighting tactics, and preparedness. Importantly, responders should fully understand the fuel mitigation plan and assist in its development.

Figure 26: An example of how the three Tiers of data could be used to inform a mitigation plan *(please note, this is intended as an example only and is not an indication of any proposals)*



CONCLUSIONS

Next Steps:

- Stakeholders must collaborate to go through the findings of this Report and begin to develop a Landscape Wildfire Management Plan for the Derwent Focus Area.
- Consider any modifications to the Project approach and extend assessment across the remaining seven focus areas in the PDMZ.

Comments on the pilot approach

- The three Tiers of analysis can be combined in a variety of ways to inform a LWMP.
- There are benefits & limitations associated with each of the Tiers.
- Whilst Tier 3 assessments are perhaps more scientific, the benefits of including local knowledge within Tier 1 assessments makes an important contribution, and both Tiers 1 and 2 provide useful details on ignition and control risks. Tiers 1 and 2 can scrutinised further and adjusted where necessary.
- Tier 3 illustrates the value of the technical fire analysis, in particular the use of accepted methodologies for computer simulations and the ways in which this can be refined to account for different influencing factors. This will also be useful moving forwards to assess progress in mitigation and to model/risk assess future habitat management options.

Key Findings

- The highest probability with regards to ignition of wildfires are shown to be on the fringes of the study area, particularly those subject to higher visitor pressures.
- Historically more intensive vegetation management in these fringe locations (lighter fuel load & habitat manager presence) provides valuable protection.
- The risk of malicious ignitions outside these areas should not be overlooked.
- Consideration must be given to reducing the risk of ignitions via education and increased monitoring during fire-supportive weather conditions.

- Fuel types and their arrangement have been extensively analysed, historic weather information has been collated and topographic shape data has been included in detailed computer modelling, this has provided evidence regarding the potential fire behaviour across the Study Area. (Flame Length, Rate of Spread and Fireline intensity).

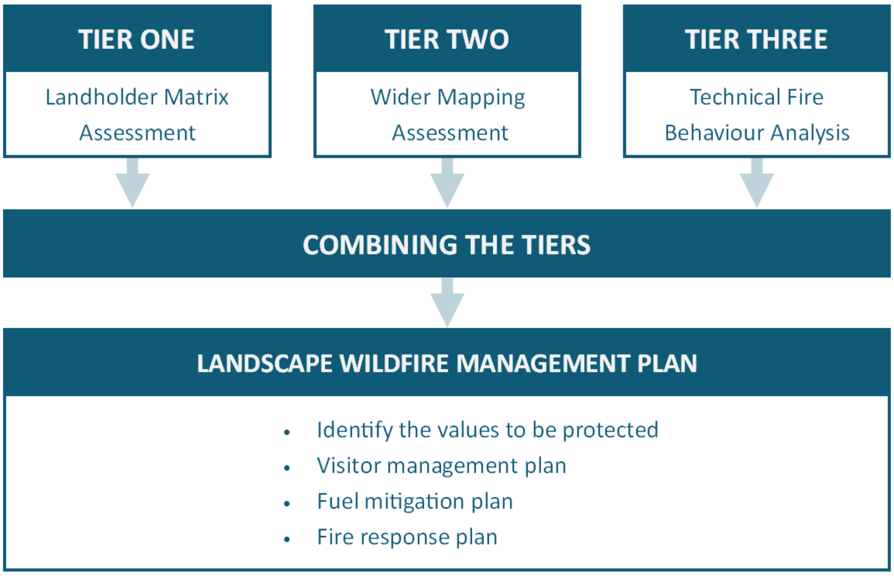


Figure 27: Summarising the approach

- The landscape has been broken into **fire behaviour polygons** identifying different strengths of **connectivity**, patterns of spread and potential fire pathways under different weather conditions.
- The identification of **Hub polygons** highlights the location and level of adaptation required within the fuels.
- The modelling shows that heavy and continuous fuel loading across broad expanses of the landscape will support high-intensity fires that could cause catastrophic damage to environmental, economic and social values.
- The extreme fire behaviour that may prevail in the current fuel complex has the capacity to overwhelm local firefighting systems, a situation compounded by restricted access and a lack of aerial support.
- The Project illustrates that little adaptation action has been taken to keep pace with the worsening reality of fire risk, and the gap is widening.
- The PDMZ benefits from having active habitat managers that are skilled and equipped to monitor ignitions and carry out mitigation actions.
- Efforts must primarily be concentrated on limiting the potential scale of wildfires and reducing their impact.
- As well as historic accumulations of sequestered carbon, the significant investment made in restoring peatlands needs to be protected from the impact of wildfire and be subject to robust risk assessment, identifying suitable protection measures.
- Similarly, future land management plans, including rewilding, should be subject to wildfire risk assessment to ensure that they do not present an unacceptable fire hazard.
- Stakeholders should consider the reputational damage should they not respond with a robust mitigation strategy.

FINAL SUMMARY

Precarious Situation

It is easy to see why stakeholders are fearful. Shifts in vegetation management prescriptions affecting protected landscapes mean that biomass accumulation represents an increasing threat. Climate change is driving increasingly frequent periods of fire supportive weather and some visitors do not appreciate the danger posed by their actions. Ignitions are occurring with increasing frequency, many extinguished by the quick action of resident habitat managers. There is a very real prospect of a disastrous fire affecting land in multiple ownerships and the nature of the current fuel complex means unrealistic expectations are placed on responders. Aerial support should probably be engaged earlier than has historically been the case.

Motivations

As custodians of an immense wealth of habitat, ecology and carbon, stakeholders have a duty to protect the natural capital of the PDMZ and will incur reputational damage should they not respond with a robust mitigation strategy. Amongst other public goods, wildfire threatens climate change mitigation, public health and fire operative safety. In other parts of Europe, land abandonment has elevated the impacts of wildfire. As the front-line service, we must respect the knowledge and protect the presence of habitat managers.

Leadership

There is limited understanding of wildfire amongst some Government agencies which could frustrate successful mitigation. However, a statement of leadership has been made through the 2021 Peat Action Plan and it is now up to stakeholders to work together to formulate responses to the evidence presented by the Project. With its multi-stakeholder representation, the Fire Operations Group (FOG) might lead from here?

Management Planning

Ignitions cannot be eliminated but, improving education and monitoring can help. The effect of topography and supportive fire weather cannot be significantly altered either but, fuel loading can be addressed. A Landscape Wildfire Management Plan for the Derwent Focus Area can be used by stakeholders to adapt the fuel complex, mitigate wildfire risk, and build fire resilience.

Mitigation

Mitigation options are varied. Along with traditional vegetation management practices, the use of blanket bog restoration is part of the solution to improve resilience. For a Fire Response Plan to be successful, an appropriate Fuel Mitigation Plan must be implemented along with improvements to infrastructure (greater accessibility, water provision, & training). In the same way that insurance premiums are paid to protect assets, investment (finance) and sacrifices (protected landscape) must be made in measures that protect the wider landscape from catastrophic wildfire.

Role of training beyond fighting fire

In order to form a group that has the capacity to provide meaningful advice and support to the future development of any strategic plan, it is essential that adequate training is provided. This should include the development of individuals, primarily from the FRS, who better understand the dynamics of wildfire behaviour who could assist in the formulation of both strategic and operational planning.

Phenomenal Opportunity

The opportunity that exists is phenomenal. A ***UK wildfire centre of excellence*** could be formed to: collect & process data, share information, undertake risk assessment/monitoring, engage in mitigation planning/implementation, provide public education and operator training, to form a strategic taskforce and provide tactical guidance. Further research is required on the efficacy of different mitigation options.

Refocussing

The Project was intended to be applied to the remaining focus areas within the PDMZ. However, wider interest, increased expectations (potential for national application) and limited timescales meant the Project drove towards providing additional information and evidence to ensure that stakeholders would have confidence in the report's conclusions. The Project must now be refocussed to deliver to original expectations.

Proactive Response

The Project requires a proactive response from all stakeholders (habitat protection agencies, land sector representatives & FRS) who must now respond with courage, open minds and determination to engage in collaborative strategic mitigation planning, followed by concerted implementation. As well as capital assets, there are people to protect; visitors, habitat managers and the FRS.

INDEPENDENT OBSERVATIONS

Professor Guillermo Rein,

Professor of Fire Science, Imperial College London, UK

This report is a novel and advanced assessment of the wildfire risk in a key area of the Peak District National Park (PDNP). It is extensive, detailed and modern. I applaud the work of the authors in putting forward a strategic response to wildfire threats in PDNP moorlands based on evidence and scientific analysis while paying attention to stakeholder engagement. The authors are responding to current concerns about the increasing number of wildfire incidents recorded in the Peak District National Park, and the expectation that the fire weather will further deteriorate and facilitate even more wildfire in the near future. The environmental, cultural and economic damage that wildfire can inflict to moorlands is large and costly and must be addressed. This report will inform ongoing efforts to improve the wildfire mitigation, preparedness and land management of PDNP. When I read this report, the first thing that called my attention was the integration of simple and complex techniques for a comprehensive assessment. It is not often that the tiers of traditional risk assessment, mapping and modelling are combined in this way, from simple to complex. This combination of tiers has the power of reducing overall the disadvantages and augmenting the advantages. It is conducted by a well-balanced team of authors with all the expertise required and plenty of national and international experience. I was pleased to see them working together with the honourable aim of protecting the precious Peak District National Park.

Thomas E L Smith, PhD FRGS

Associate Professor in Environmental Geography
Department of Geography & Environment
London School of Economics & Political Science

This report provides a comprehensive regional wildfire risk assessment and mitigation strategy. The assessment is undoubtedly the most detailed undertaken for a UK landscape. Given recent warnings about increased wildland fire risk associated with climate change in the UK's 2021 Independent Assessment of UK Climate Risk (CCRA3), the report is both timely and important.
One of the major strengths of the report is the interdisciplinary approach to understanding the wildfire risk and mitigation situation. By covering environmental, social and economic considerations, the report makes a careful approach to the many trade-offs that are required for landscape wildfire management.

The report provides a detailed assessment of UK wildland fire weather and the climatic scenarios that might lead to potential future wildfires on the Peak District landscape. An exhaustive approach to assessing archival meteorological data and projections of climate change from the UK Climate Impacts Programme leads to an authoritative assessment of future patterns of wildfire on the Peak District Landscape. By careful consideration of the landscape terrain, prevailing wildfire weather conditions, and expert knowledge of wildfire behaviour, the report establishes a complete wildfire risk assessment, with scenarios of wildfire spread across the National Park landscape. Wildfire risk on this landscape include ecosystem services and crucial peatland carbon stores, both of which are considered in-depth by the report.

The report provides a well-informed and full mitigation strategy to wildfire risk in the Peak District National Park landscape. Applying expert fire and rescue service knowledge, the report discusses the various mitigation options available to land managers. This includes landscape management for fire risk via fuel reduction treatments, including grazing, cutting and prescribed burns; as well as appropriate fire-fighting techniques in the event of a wildfire event. Compartmentalising the landscape into regions of wildfire pathways and locations where opportunities for fire prevention and preparation might be deployed should be seen as a significant contribution to the understanding of wildfire preparedness in the Peak District National Park.

As the report stresses, a significant wildfire event in the Peak District National Park is not a matter of if, but when. This state-of-the-art report provides an assessment that can address this imminent risk of devastating wildland fire losses in the region, and implementation of the mitigation strategies that are crucial to avoiding a national disaster.

Paul Hedley

Chief Fire Officer/NFCC Director
Northumberland Fire & Rescue Service

I very much welcome the proactive and collaborative approach by Peak District National Park (PDNP) to deliver this strategic assessment report which provides a comprehensive review of PDNP wildfire risk and threat. The report provides a systematic assessment of the PDNP wildfire risk environment, the scale of the challenge, but also offers practical and sensible mitigations. I was especially pleased that those fire and rescue services (FRS) who cover the PDNP have been involved in the development of the report through the Peak District Fire Operations Group, and have contributed, along with many other partners, to the recommendations to improve wildfire prevention, pre-planning and response.
Wildfire is an incident type which can have significant, and potentially devastating, impact on the environment,

wildlife, local economy, infrastructure, and local communities - it therefore requires a cross-sector, co-ordinated response to mitigate the impact and consequences of a wildfire incident. Across the UK, FRS are facing a growing challenge to adapt to the increasing scale, scope and severity of wildfires and the recommendations within the report are as equally applicable to many FRS the length and breadth of the UK as they are to those who have responded to several significant incidents within PDNP in recent years.

Many of the current aims and areas of focus of the National Fire Chiefs Council (NFCC) Wildfire Forum and NFCC Wildfire Tactical Advisor group are reflected within the report. Of note are the recommendations relating to effective fuel management and fuel continuity breaks in areas of high wildfire risk, the development of localised multi-agency tactical fire plans and enhanced collaboration with wildfire stakeholders, and the development of a more mature and sophisticated fire behaviour analysis and prediction capability.

The report has the potential to act a catalyst for a fundamental change in the approach of how to mitigate wildfire risk and threat across the Peak District National Park.

ABOUT THE TEAM

Anthony Barber-Lomax (FRICS FAAV DipEstMan)

Anthony was brought up in East Anglia and studied Rural Estate Management at the Royal Agricultural University. He started his career in Lancashire where he qualified as a chartered surveyor and became a Fellow of the Central Association of Agricultural Valuers. He then worked in Northumberland for 11yrs, managing a wide range of agricultural, residential and sporting estates alongside a variety of professional work. In 2004 he joined Fitzwilliam Wentworth Estate in South Yorkshire as Resident Agent. Wentworth is a diverse rural estate in an urban fringe location with considerable heritage assets and an upland moorland element. Anthony is a trustee of various charities, a member of the Peak District Sustainable Moorland Management Group (SMMG) and a Yorkshire committee member of the Country Landowners & Business Association. It is through his membership of the SMMG that Anthony became involved with the National Park's initiative to formulate a strategic approach to the control of moorland wildfires and the provision of essential infrastructure.

Ruth Battye (BscHons PgDipSurv)

Ruth Battye completed a degree in agriculture at Nottingham University in 2005 and began working in the livestock office of Dovecote Park, supplying beef to Waitrose supermarkets. In 2007 she joined the Fitzwilliam Wentworth Estate, as Assistant Estate Administrator. As well as general estate management, Ruth is particularly responsible for IT processes and data management, including digital mapping. It is this technical expertise that she brings to this Wildfire project. Other current projects include administering a cluster group of Estate tenant farmers and further developing a recent Estate wide Natural Capital Assessment. With a family farm on the edge of Peak District and years of engagement with Young Farmers Clubs, Ruth is passionate about the countryside. Ruth has played a pivotal role in the project including administration, data processing, mapping and publishing.

Steve Gibson

Steve Gibson is a specialist in wildfire operations having gained extensive international wildfire experience in Africa, Europe and the US working with fire services and forest and land agencies. He served in Northumberland Fire and Rescue Service, and wrote extensively on the subject completing the Scottish Operational Wildfire Guidance document in 2013, and assisting in developing new National Wildfire Operational Guidance and documents for the UK FRS. He established wildfire training systems for NFRS, which has since been used to train FRS personnel in the UK, Ireland and Denmark. In 2007 he was instrumental in setting up the England and Wales Wildfire Forum and was until 2020 a member of the National Fire Chief Councils, Wildfire Group. He was, until his retirement, a National Wildfire Advisor and as such attended the Saddleworth Moor and Winter Hill fires in 2018. Since retiring from the FRS, he has carried out a number of high-profile wildfire projects in the UK and Europe.

Marc Castellnou

Marc is a forest ecologist from University of Lleida (Spain, 1997) as well as a fire officer since 1999 in the Catalan Fire and Rescue Service. He serves in the Catalan Fire Service as a Strategic Wildfire Analyst and Incident Commander as well as being Chief of the GRAF (Specialist Wildfire Unit Catalonian FRS) type one crews. He is also a Wildfire Expert for the European Civil Protection and Humanitarian Aid Operations (DG ECHO), Marc is a leading wildfire expert who has gained extensive experience in wildland fire fighting across the globe. He has been a Senior expert for the European Forest institute from 2014, FMI (international monetary fund) for crisis management in 2009-2010, Awarded with Fire Safety award 2015 for the IAWF in Boise, USA, awarded the Montero Burgos prize for forest issues communication through media, Madrid 2017, an associated professor at University of Lleida, Master Fuego since 2015, Atmospheric physics and wildfire PhD at Waweningen University, Netherlands, took part in the EU missions to the crisis in Chile, Bolivia and Portugal, member of the CTI at the Asamblea da Republica Portugal during 2017 wildfires, provided advice to CALFIRE assessment wildfire analyst team during the wildfires in California 2020 and 2021.

Steve and Marc have worked together on many wildfire projects over the last 15 years and have jointly been involved in studies in the UK, and across Europe, Africa and the USA.

Mercedes Bachfischer

Mercedes was raised in Argentina, where she studied Environmental Management at the National University of Patagonia San Juan Bosco. Upon graduation, she dedicated the next ten years to developing her professional career in wildfire, working at a provincial Fire Service. There her main roles were information management (statistics, GIS, remote sensing), wildfire season assessment, and cartographic and meteorologic support during fire incidents. She also worked as an instructor for the Wildfire Management National Service and technical support to other institutions such as the Civil Protection, in relation to other types of emergencies (floods, mountain rescue, risk assessment). Nowadays, she lives in Catalonia, Spain, working as a data analyst and researcher at The Emergency Program, a global wildland fire training program. Without leaving the world of emergencies, she has become part of international wildfire strategic support teams, such as FAST (Fire Analysis Support Team) for the European Civil Protection.

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