DRYAD
CONNECTING THE NATURAL WORLD

WHAT LIES BENEATH:
The hidden truth about wildfire

Introduction

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Recklessly ignoring wildfire risk puts us all in danger

For how much longer can we afford to put ourselves and our children in danger by ignoring the risk of wildfires?

Sadly, once again, the world's powerbrokers have jeopardised our efforts to tackle climate change by failing to appropriately tackle the issue. To say COP27's attitude to wildfire risk was a disappointment is a significant understatement. It was reckless.

Wildfires are responsible for up to 20% of global CO_2 emissions. Unless the increasingly severe wildfires we experience every year – and which wreak havoc on our health and our economies – are given sufficient attention and investment, global temperatures will rise by more than 1.5C.

Terrifying prospect

It's worth reminding ourselves exactly what a temperature increase of 1.5C would mean for all of us. We would experience droughts that last for months, and vital food supplies would run short as rice, maize and soybean production decrease significantly. In addition, sea levels would rise 48 centimetres and displace 46 million people. It's a terrifying prospect.

Worryingly, COP27 proved world leaders are not serious about avoiding this disastrous scenario. Despite contributing 6.5 billion tonnes of CO_2 to total global emissions annually, the issue of wildfires was largely ignored at the conference. It's especially concerning because the problem is worsening. Eight of the worst wildfire seasons on record have occurred in the last decade, and wildfires are becoming more widespread, burning nearly twice as much tree cover today as they did 20 years ago.

Where are we going wrong?

If the 1.5C target slips and we reach two degrees of warming, data from the UN Environment Programme show that burned areas will increase by 62%. If we reach three degrees that figure rises to 97%.

Why is wildfire risk largely being ignored? One reason is that it is often miscalculated or underestimated. Wildfires are consistently discounted from countries' CO_2 emissions reporting as they're written off as carbon neutral 'natural phenomena'.

But this is a mistake. With 80% of wildfires caused by humans, added to the fact that carbon neutrality is reliant on forest regrowth – which can take over 100 years – this means that omitting wildfire emissions from global CO_2 inventories is inaccurate, and worse, it's cynical. Sadly it leads to inaction when it comes to tackling a significant emitter.

How to extinguish fires easily

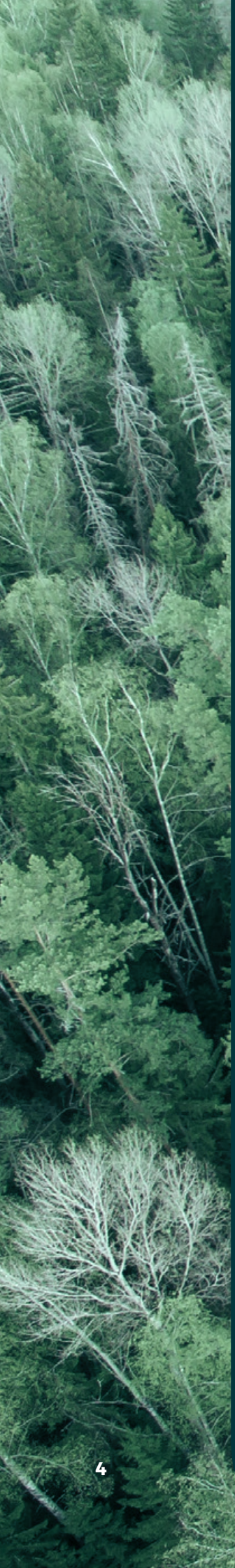
Increased investment in tackling wildfires is now mission critical.

Currently, government wildfire funds are focused on firefighting rather than detection or prevention. Yes, it is essential to support emergency service workers and firefighters responding on the frontline – but the deployment of new, affordable wildfire detection technology is key to enabling emergency responders to effectively defend forests.

The ability to detect fires earlier, while they are still easy to extinguish, drastically reduces CO_2 emissions, by stopping them spreading out of control.

Wide-scale implementation of early detection technologies would cut emissions by hundreds of millions of tonnes and save precious forests. Dryad calculates that deploying 120 million of its sensors worldwide by 2030 could save up to 3.9 million hectares of forest from burning and prevent 1.7 billion tons of CO_2 emissions.

We need to wake up to the issue of fire risk and take the precautions that will significantly aid us in the battle against climate change. And we need to do it now, before it's too late.



Summary

While the immediate and devastating impact of wildfires is easily seen, the true cost of wildfire is often hidden. In addition to the massive environmental damages, the economic costs are staggering and the long-term effects on public health are rarely considered.

This whitepaper will examine the wider, largely unseen, impacts of wildfire and explore why traditional fire detection methods are currently failing to reduce the risks.

We'll also look at:

- The extent to which wildfires cause widespread environmental damage
- The number of deaths caused by wildfires
- The devastating impact of wildfires on billions of animals
- The direct and indirect economic cost of wildfires

Finally, we'll take a look at new technological advances in wildfire detection and explain how they can:

1. Save billions of dollars in economic losses
2. Reduce carbon emissions by billions of tonnes per year
3. Stop millions of hectares from being burnt
4. Stop billions of animals from being killed or displaced
5. Potentially save thousands of lives

Not all wildfires are bad

Wildfires have always occurred and are part of the cycle of life on earth. Naturally occurring wildfires can be caused by lightning and, in a healthy forest environment, their impact is often limited to ground vegetation, and thus most of the grown trees are left intact.

Wildfires are even beneficial for some tree species because they trigger the release of seeds.

Moderate wildfires that clear ground vegetation can prevent devastating megafires by reducing the fuel load and thus preventing future fires from spreading and developing into crown-fires (fires that have ascended from the ground into the forest canopy and are spreading through it) or megafires, which kill most trees and have significant adverse effects on the ecosystem.

Indigenous communities in the past have used a method described as ‘prescribed burning’ to intentionally initiate modest wildfires as a means of clearing out ground vegetation to prevent a dangerous build-up of potential fuel. This approach to wildfire management was stopped when Europeans migrated to the US and Australia – this has led to a dangerous build-up of combustible fuel in many forests and, consequently, prescribed burning is now being re-introduced to pre-empt megafires by reducing fuel load.

How do wildfires start and what impact does climate change have on wildfire incidents?

Naturally occurring wildfires can only be caused by lightning, and such fires represent around 20% of fire starts in most regions.

However, around 80% of wildfires are human-induced, with the vast majority caused by arson, reckless behaviour, accidents or technical faults.

Due to the visible effects of climate change, we are experiencing more droughts that are affecting forested regions and therefore increasing the risk of devastating and fast-spreading megafires. With climate change accelerating, it is expected that the frequency and damage caused by megafires will increase substantially in the coming decades.

of wildfires are human-induced

Why is wildfire risk underestimated?

People do not understand the true nature of wildfires.

As a result, they are unaware of the impact they can have on human health and the immense damage they inflict on the global environment as well as the massive financial costs they impose on our economies.

While there may be a perception that wildfires only pose a risk to people, wildlife and property in remote, rural areas, this is a misconception – wildfires pollute the air we all breathe, sometimes thousands of miles from the fire, and contribute substantially to global warming. Wildfires harm us all and we only have ourselves to blame.

How wildfires endanger the planet and biodiversity

Wildfires have a devastating impact on the climate, indeed a much bigger impact than many would think possible.

It is estimated that wildfires account for between 6-8 billion tons of CO_2 emissions, which equates to an astonishing 20 percent of total global greenhouse emissions.[1] To put this in context, this is equal to the environmental damage wrought by global transport, which also accounts for around 20 percent of global CO_2 emissions.[2]

But, alarmingly, wildfires' contribution to climate change is set to increase even more – it is predicted that wildfires could be the source of 30 percent of greenhouse gas emissions by the end of the century. [3]

In addition, wildfires damage biodiversity – billions of animals have been killed or have had their habitat destroyed by wildfires. A report commissioned by the World Wide Fund for Nature (WWF) said that nearly 3 billion animals were killed or displaced by devastating wildfires in Australia in 2020. The total included 2.46 billion reptiles, 180 million birds, 143 million mammals and 51 million frogs.[4]

Wildfires contribute to 20% of total global greenhouse emissions

1 https://www.bbc.co.uk/news/science-environment-46212844
2 https://ourworldindata.org/co2-emissions-from-transport
3 https://www.bbc.co.uk/news/science-environment-46212844
4 https://www.worldwildlife.org/stories/3-billion-animals-harmed-by-australia-s-fires

How wildfires endanger our health

Forest fires can also have a devastating impact on mortality and morbidity.

According to the World Health Organization (WHO), “wildfires and volcanic activities” affected 6.2 million people between 1998-2017 with 2,400 attributable deaths worldwide from suffocation, injuries, and burns.

Alarmingly, the WHO says that, since that period, the “size and frequency of wildfires are growing due to climate change”. It concludes: “Hotter and drier conditions are drying out ecosystems and increasing the risk of wildfires.”

Meanwhile, the WHO states that young children, pregnant women and older adults are the most susceptible to “health impacts” from smoke and ash.[5]

Smoke and ash from wildfires can “greatly impact those with pre-existing respiratory diseases or heart disease”, the WHO says. In addition to fatalities, wildfires can also cause burns, decreased lung function, pulmonary inflammation, bronchitis, the exacerbation of asthma, and the exacerbation of cardiovascular diseases, such as heart failure, the WHO states.

Wildfires can also lead to the contamination of our water supplies. After vegetation has been destroyed by fire, soil becomes hydrophobic – meaning it is unable to absorb water. Consequently, debris and sediment is transported into larger bodies of water, resulting in the pollution of local supplies. Indeed, stormwater runoff has been highlighted as one of the most noticeable impacts of forest fires.

Post-fire flash floods become a threat and can result in heavy metals from ash and soil infiltrating waterways. Filtering these water sources can be costly as well as time consuming.[6]

5 https://www.who.int/health-topics/wildfires#tab=tab_2

6 https://untamedscience.com/blog/the-environmental-impact-of-forest-fires/

The massive financial cost of wildfires

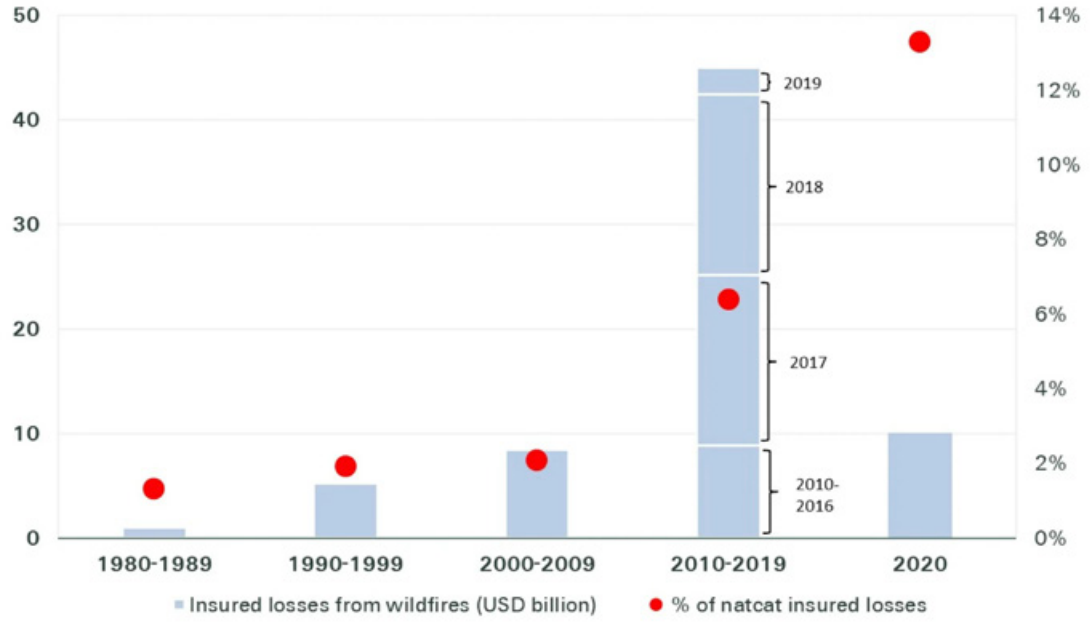
Wildfires cost the global economy hundreds of billions of dollars per year.

For example, a study by University College London showed that California's 2018 wildfires alone cost the US economy $148.5 billion, of which $45.9 billion was lost outside the state.

In the case of the California fires, the losses incurred by the state itself ($102.6 billion) amounted to roughly 0.5% of the US annual GDP. Capital losses and health costs within California totalled $59.9 billion, while indirect losses through economic disruption to 80 industry sectors within the state came to $42.7 billion. Power transmission was affected, as well as road and rail freight transport, pipelines and other infrastructure-dependent sectors.

The University College London study concluded that a "majority of economic impacts were felt by industries and locations far from the fires and that nearly a third of the total losses were outside California".

Meanwhile, insurance giant Swiss Re has highlighted how the cost of global insured claims due to wildfire events have soared to around $10 billion per year.[7] By way of comparison, global insured claims for the entire period 2000 to 2009 totalled less than $10 billion, and rose to $45 billion for the entire period 2010 to 2019. Swiss Re forecasts that the proportion of its total insured losses that arise from natural catastrophes will increase from just over 6% in 2020 to more than 13% by 2030.



Global insured losses from wildfires since 1980 by decade (USD billion), at 2020 prices

Source: Swiss Re

7 https://www.swissre.com/risk-knowledge/mitigating-climate-risk/yet-more-wildfires.html

What can we do to reduce the number of wildfires?

As already discussed, proven methods for lessening the risk of megafires include reducing the fuel load through prescribed burning, and even allowing goats to graze in forest areas.

By reducing the fuel load, these methods reduce the risk of future wildfires. However, most experts agree that these methods alone are not enough to prevent megafires and that, in addition, we need to employ, and improve, fire detection and suppression to reduce or even eliminate human-induced wildfires.

Fires need to be detected faster

When it comes to detecting wildfires, time is of the essence.

The earlier the fire department is notified of a fire start, the higher the chances that the fire can be extinguished before it spreads out of control. If the fire is small, often a single fire truck is sufficient to extinguish the fire.

Depending on weather conditions and the state of vegetation, a small fire can grow into the size of a football pitch in as little as 30 minutes, which means it is difficult or sometimes even impossible to contain without significant firefighting resources.

Why traditional methods of early wildfire detection are flawed

Commonly used approaches to wildfire detection are flawed.

By the time firefighters arrive at the scene, the fires have often grown to a large area and have sometimes completely spread out of control. The resulting megafires can rage for days or weeks and, in some instances, are hard to contain – for example, in 2018, 3,000 firefighters were battling to extinguish fires in New South Wales, Australia.[8]

One of the main problems is that the most common way of detecting fires remains old-fashioned human surveillance – but this approach has several flaws. For example, for a person to spot the smoke plume of a wildfire from, say, 20 kilometres away, the fire will already have to be substantial in size and, consequently, will have spread to such an extent that it will be difficult to easily bring under control.

8 https://www.bbc.co.uk/news/world-australia-50887982

Why using cameras and satellites to detect wildfires is inadequate

Automated systems that involve cameras using optical systems suffer from the same disadvantages. Cameras can't see what's happening under the tree canopy and rely on optical detection of smoke plumes rising above the tree canopy. Optical systems also don't work at night and are inactive for several hours each day. Infrared cameras, on the other hand, do work at night, but typically offer lower resolution than optical cameras – they are also very expensive and thus not ideally suited for detection of wildfires.

Meanwhile, another approach to detecting wildfires involves using satellites, but some of these are tens of thousands of kilometres above the earth's surface – these satellites offer a rather low resolution of 25 hectares (500 metres x 500 metres) per pixel.

Low orbiting satellites (LEO) are closer to earth – operating at an altitude of around 600 kilometres – but they are not geostationary, so the earth rotates beneath them and, as a result, they are only intermittently focussed on specific locations and several hours pass before they are focussed again on the same location. In order to get a point where 'revisiting' a particular location takes less than 30 minutes, hundreds of satellites are required to create a so-called 'constellation'. However, even with a costly constellation in place, these satellites cannot see under the tree canopy and may only have a resolution of one hectare (100 metres x100 metres) per pixel.

Consequently, while cameras and satellites are a great resource for tracking and forecasting the development of wildfires, they are not particularly effective when it comes to the early detection of wildfires that are starting underneath the tree canopy, which are mostly invisible to optical systems.

Why is early wildfire detection challenging?

Developing a system for the effective early detection of wildfire is not easy.

For such technology to be effective, it needs to be able to detect fires during the early stages of development, ideally during the smouldering phase, underneath the tree canopy, before it has evolved into an open fire.

However, developing this type of technology poses a number of major challenges, including:

1. **How is such technology powered?**

   Powering systems that detect fires underneath the tree canopy is challenging because there is no mains supply and batteries have a limited lifetime and need maintenance, which can be difficult in very remote areas. Solar power can work, but the technology needs to be designed in such a way that it can operate on the limited amount of daylight that penetrates particularly dense forest canopies.

2. **Is it possible to develop a functioning network?**

   Mobile networks are, at best, patchy and, at worst, non-existent in remote forests and satellite communication is difficult with the tree canopy overhead, so an alternative network needs to be developed.

3. **How can such early fire detection systems be made affordable?**

   Some products designed to quickly detect wildfires beneath the forest canopy can be prohibitively expensive and therefore an unattractive option for many potential customers.

Which technology will detect wildfires more rapidly?

Dryad has accepted the challenge of creating effective wildfire detection technology and developed an affordable system for detecting wildfires within the first 60 minutes of a fire starting. In contrast, technologies – such as satellites and cameras – take hours or days to detect fires, which means they have already spread considerably and are difficult to extinguish.

Dryad's technology 'smells' changes in the atmosphere via solar-powered gas sensors placed directly into the forest, rather than 'looking' for smoke plumes rising above the tree canopy using cameras or satellites. Dryad's technology can detect fires during the smouldering phase, even if they are beneath the tree canopy or dense vegetation.

Enabling the sensors to communicate, Dryad's IoT mesh network can be deployed deep in the forest where no regular telecommunications network infrastructure can reach. This mesh network can also be used to create a generic communication infrastructure for forests, which in the future will – in addition to detecting fires – be able to also assist with health and growth monitoring, weather monitoring, emergency communications and illegal logging detection.

How Dryad's fire detection technology reduces emissions and saves on costs

Dryad spent more than two years developing its recently launched end-to-end Silvanet® ultra-early wildfire detection and forest monitoring system.

The Silvanet system incorporates low-cost sensors and a unique solar-powered LoRa® based mesh networking infrastructure – which is compatible with LoRaWAN, the dominant standard for IoT sensor systems – and a cloud analytics platform, a market first.

The patent-pending Silvanet mesh network extends the reach of LoRaWAN networks – with a proprietary multi-hop – deep into the forest, which enables the wildfire sensors to be placed even in the most remote locations.

Other solutions using LoRaWAN – and which lack Silvanet's mesh technology – can only be deployed within close proximity (around 2-3 kilometres) from the location of the LoRaWAN gateway.

Some solutions that rely on connectivity via 4G/LTE mobile networks face the challenge of mobile operators not typically providing sufficient coverage in most forested areas due to the fact that the radio signals cannot penetrate dense forests. Thus the deployment options in areas with 4G/LTE network coverage are limited.

What are the benefits of Dryad's technology?

The potential benefits of the widespread use of Dryad's technology include:

- **Saving billions of dollars in economic losses**

  The global financial cost of wildfires is predicted to reach up to $200 billion a year if one or more countries have bad fire seasons, according to Chuck Watson, a disaster modeler for Enki Research. Current numbers for 2022 put the financial bill for wildfire damage in North America alone at $3.7 billion. The 2018 wildfires in California cost the US economy $148.5 billion

- **Stopping millions of hectares being burnt**

  Dryad aims to prevent 3.9 million hectares of forest from burning by 2030

- **Reducing carbon emissions by billions of tons**

  Dryad aims to prevent 1.7 billion tons of CO_2 emissions by 2030

- **Stopping the killing or displacement of billions of animals**

  A total of 3 billion animals were killed or displaced by wildfires in Australia in 2020

- **Potentially saving thousands of lives**

  "Wildfires and volcanic activities" affected 6.2 million people between 1998-2017 with 2,400 attributable deaths worldwide from suffocation, injuries, and burns

FLASHBACK

How early wildfire detection would have reduced the impact of previous major fires

Mosquito Fire

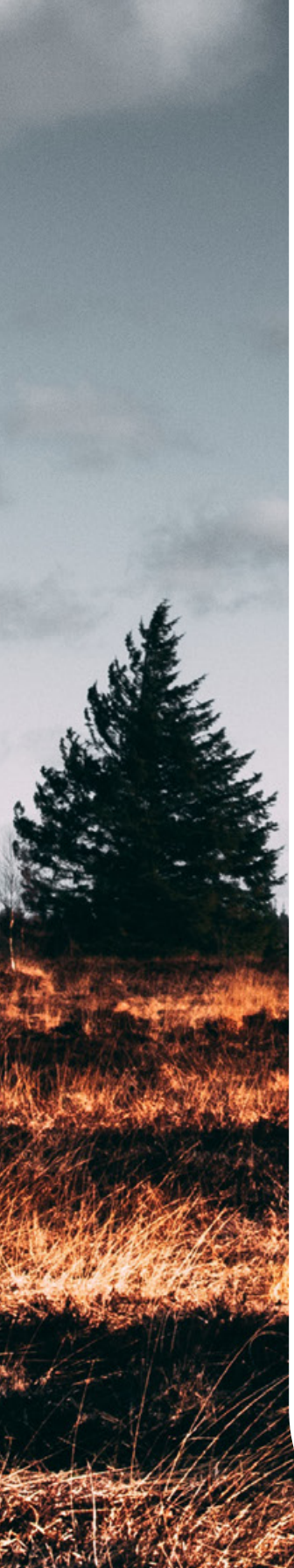
California, USA, 2022

If early wildfire detection technology had been in place in California's **Tahoe National Forest** and **El Dorado National Forest** prior to the *Mosquito Fire* in September 2022, the fire could have been detected up to six hours earlier. In such a scenario, **76,700 acres** of forest could have been saved from being burnt, **13 buildings** could have been saved from destruction, while damage to a further **78 buildings** could have been prevented. Furthermore **11,000 people** would not have needed to be evacuated from their homes, and hazardous quality air would not have reached neighbouring regions in Northern California and Nevada.

Camp Fire

California, USA, 2018

Northern California's **Butte County** could also have benefitted from early wildfire detection technology ahead of the devastating *Camp Fire* of November 2018, which tragically resulted in at least 85 casualties, according to official figures. In addition to saving lives, such technology could have also prevented **153,000 acres** being engulfed in fire, stopped more than **18,800 structures** being destroyed, and prevented **52,000 people** from having to be evacuated from their homes. Early detection technology could also have drastically reduced the costs associated with the fire – the total losses amounted to **$16.5 billion**, of which $12.5 billion was incurred by insurers. Meanwhile, suppressing the fire was also extremely costly, with a bill of **$150 million** racked up.



Gonfaron Fire

France, 2022

If early wildfire detection technology had been in place in the **Plaine des Maures** national park and the **Massif des Maures** mountain range in France ahead of the *Gonfaron Fire* in August 2021, the fire could have been detected up to six hours earlier. In such a scenario, **6,832 acres of forest** would have been saved from being burnt, **130 buildings** would not have been destroyed and damage to a further 400 would have been prevented. Meanwhile, two fatalities and the evacuation of **7,500 people** could have been avoided.

Black Summer Bushfires

Australia, 2019-2020

The *Black Summer Bushfires* were the worst **New South Wales** had ever recorded. Early wildfire detection technology could potentially have prevented **26 fatalities**, the destruction of nearly **2,500 homes**, and the burning of **5.5 million hectares** of land. In addition, the destruction of a further **284 facilities** and **5,469 outbuildings**, as well as damage to a further **1,013 homes** could have been avoided. Meanwhile, billions could have been saved in costs – the cost to insurers was put at **A$1.88 billion**, but research by the World Wide Fund for Nature (WWF) and the Australian Research Council said the cost of restoring the environment would run to **$73 billion a year for 30 years**.

Conclusion

The impact of wildfire is greatly underestimated. In addition to the environmental hazards and massive financial cost, an increasing number of people suffer from associated health issues such as decreased lung function, pulmonary inflammation, bronchitis, the exacerbation of asthma, and the exacerbation of cardiovascular diseases, such as heart failure.

Wildfires account for an astonishing 20 percent of total global greenhouse emissions and cause the death or displacement of billions of animals.

Wildfires have also caused thousands of deaths and billions of dollars' worth of damage to national economies.

This is the hidden cost of wildfire, and the fact these costs are hidden means wildfire risk is dangerously underestimated.

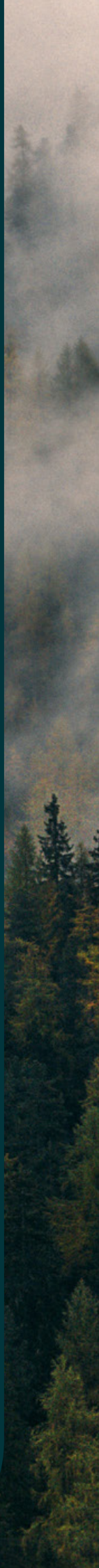
Wildfires often go undetected until it's far too late – this is due to outdated methods of detection such as human surveillance and the use of cameras or satellites that are incapable of identifying fires when they start because they are beneath the forest canopy.

But new technology developed by Dryad now has the ability to detect wildfires within 60 minutes of ignition, increasing the chance of extinguishing fires before they spread out of control.

This gives us all a big opportunity to reduce carbon emissions by billions of tonnes per year, prevent billions of dollars of economic damage, stop millions of hectares being burnt, stop millions of animals being killed or displaced, and potentially save thousands of lives.

If you represent a forest owner or reseller, or a local government or municipality, and you want to explore ways in which Dryad could potentially work with you to substantially decrease the risk of wildfire, talk to us.

The sooner we take this opportunity, the sooner we can reduce the widespread and increasingly damaging effects of wildfires.



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