Quantifying and managing wildfire risks

Strategies for mitigation

December 2023

Wildfires make headline news for the damage caused to properties, health, and ecosystems. In just the last few months, unprecedented wildfire seasons have caused devastation from southern Europe to northern Canada.

WTW analysts and research leads are focused on helping clients to build resilience against wildfire in a rapidly changing climate.

In our recent webinar on 8 August 2023, we explored the causes of wildfires, how the risks are changing, and how advanced modeling tools, risk analytics and alternative risk transfer can help clients quantify and mitigate their risks at a site-specific level.

WTW Speakers

Katherine Latham
Senior Catastrophe Risk Analyst
Direct & Facultative

Aimee Colgate
Lead Associate, Physical Risks, Climate Practice
Risk & Analytics

Elizabeth Doocey
Data and Research Consultant
Alternative Risk Transfer

Scott St George
Head of Weather & Climate Risks Research
WTW Research Network

What constitutes wildfire?

Wildfire is defined as a large, uncontrolled fire that starts in a forest or grassland.
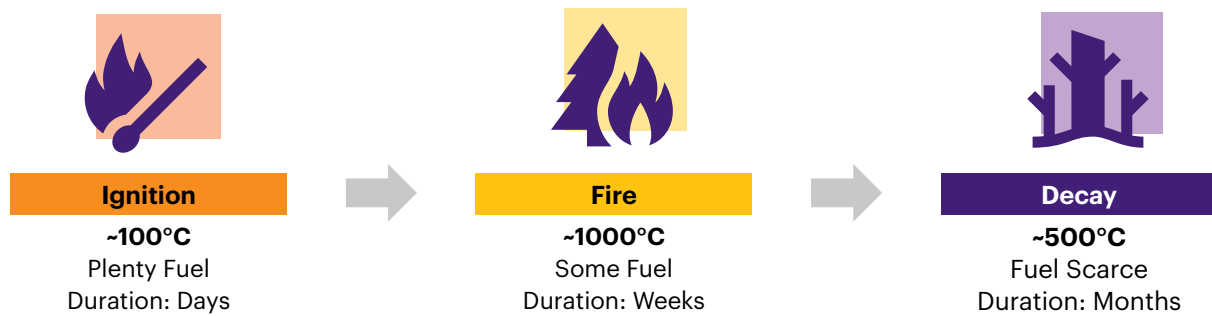
Wildfires, also known as bushfires, can be ignited by natural or human activity such as lightning or damaged electricity infrastructure.

Wildfires are a natural phenomenon and are essential for some forest and grassland ecosystems. Evidence from 2017 in the U.S. indicates that human activity is responsible for at least 80% of wildfire ignitions.[1] This indicates that more fires now occur where humans and the natural environment come together.

Wildfires require an ignition source and three components to form: heat, oxygen and fuel. Strong winds carry embers outside the fire boundaries to ignite vegetation and property, and fire also spreads faster on an upwards slope.

Wildfire season occurs during late summer/early autumn months where landscapes have experienced long dry spells and there is an abundance of dry vegetation to provide fuel. Climate change and seasonal conditions such as the amount of rainfall in the preceding winter also increase the likelihood of wildfires.

Figure 1: **Life cycle of a wildfire**

Ignition	Fire	Decay
~100°C	**~1000°C**	**~500°C**
Plenty Fuel	Some Fuel	Fuel Scarce
Duration: Days	Duration: Weeks	Duration: Months

Wildfire secondary perils

Large wildfires influence surrounding meteorological conditions with their strong updrafts of heated air. These conditions can create tornadoes within the fire zone, known as firenadoes. Extending hundreds of feet high and 25% hotter than the parent fire, a firenado amplifies the spread of the fire and increases the temperature in the fire zone.

Wildfire damages the soil, leaving burn scars that affect the absorbency of the soil.[2] Subsequent heavy autumn rainfall can't be absorbed into the soil and can cause widespread flooding. Scarred soil is also easily eroded, increasing the risk of landslides and mudslides during a flooding event.
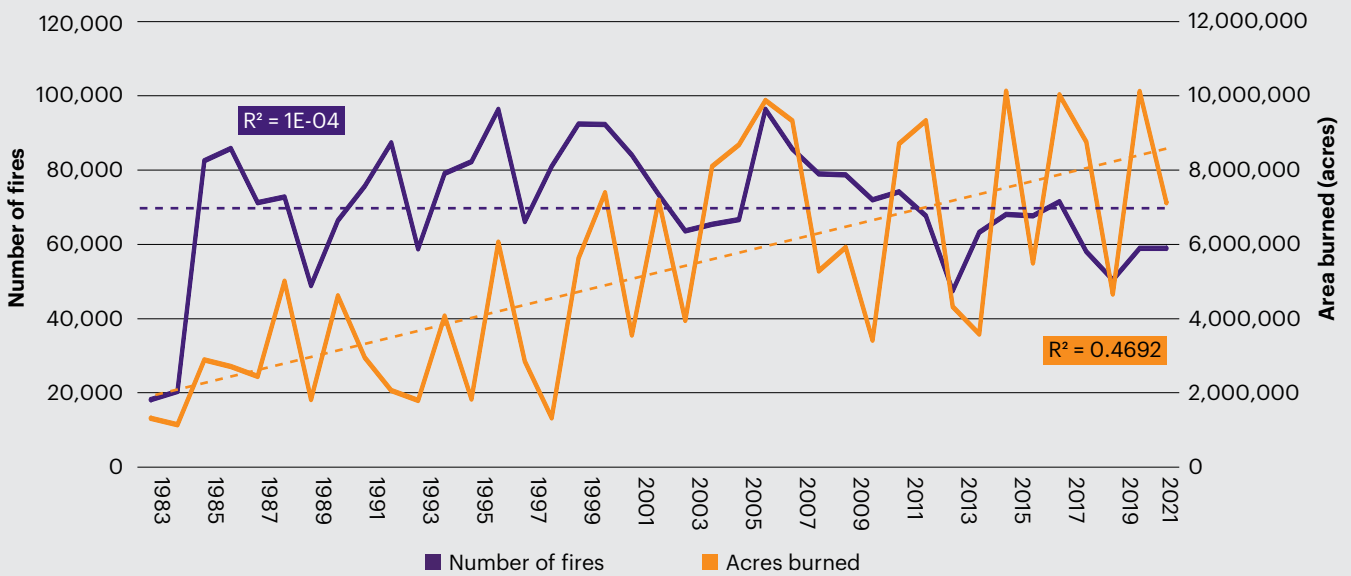
[1]https://www.pnas.org/doi/10.1073/pnas.1617394114
[2]https://www.wtwco.com/en-gb/insights/2023/03/on-co-occurring-and-cascading-hazards

Increasing risk of wildfire

The number of fires is not increasing but the severity and the extent of the area burned appears to be.

Figure 2: **Is the risk of wildfire increasing?**

$R^2 = 1E-04$

$R^2 = 0.4692$

Number of fires · Acres burned

Source: National Interagency Fire Center — https://www.nifc.gov/fire-information/statistics/wildfires
For illustrative purposes only.

Wildfire risk factors

Figure 3: **Factors driving insured wildfire risk**

Risk factor 1:
WUI exposure

- Expansion of the Wild Urban Interface (WUI)
- Wildland area reduced and encroached on by urban areas
- More structures within risk zones

Risk factor 2:
Fuel landscape

- Cyclical availability of fuel
- Historic fire suppression
- Forest density and spatial uniformity

Risk factor 3:
Ignition risk

- Population growth at the WUI
- Increased intersection of human activity in wildfire prone landscapes e.g. campfires, cigarettes, arsonists and electricity and transportation networks.

Risk factor 4:
Climate change

- Hotter drier summers
- Extended fire season
- Extreme weather conditions
- Tree mortality

Identifying wildfire risk

Mapping tools such as WTW Global Peril Diagnostic can identify risk locations in client portfolios, providing each location with a risk score. Global Peril Diagnostic also reports on live wildfire events and can alert users if their portfolio is likely to be exposed to an active wildfire.

Quantifying wildfire risk

Probabilistic catastrophe modeling using hazard and vulnerability information provides an estimate of the potential losses a portfolio could face. The modeling also gives an indication of the premium required to cover the risk. We use the loss values to assess the adequacy of a client's catastrophe limits, based on their risk appetite.
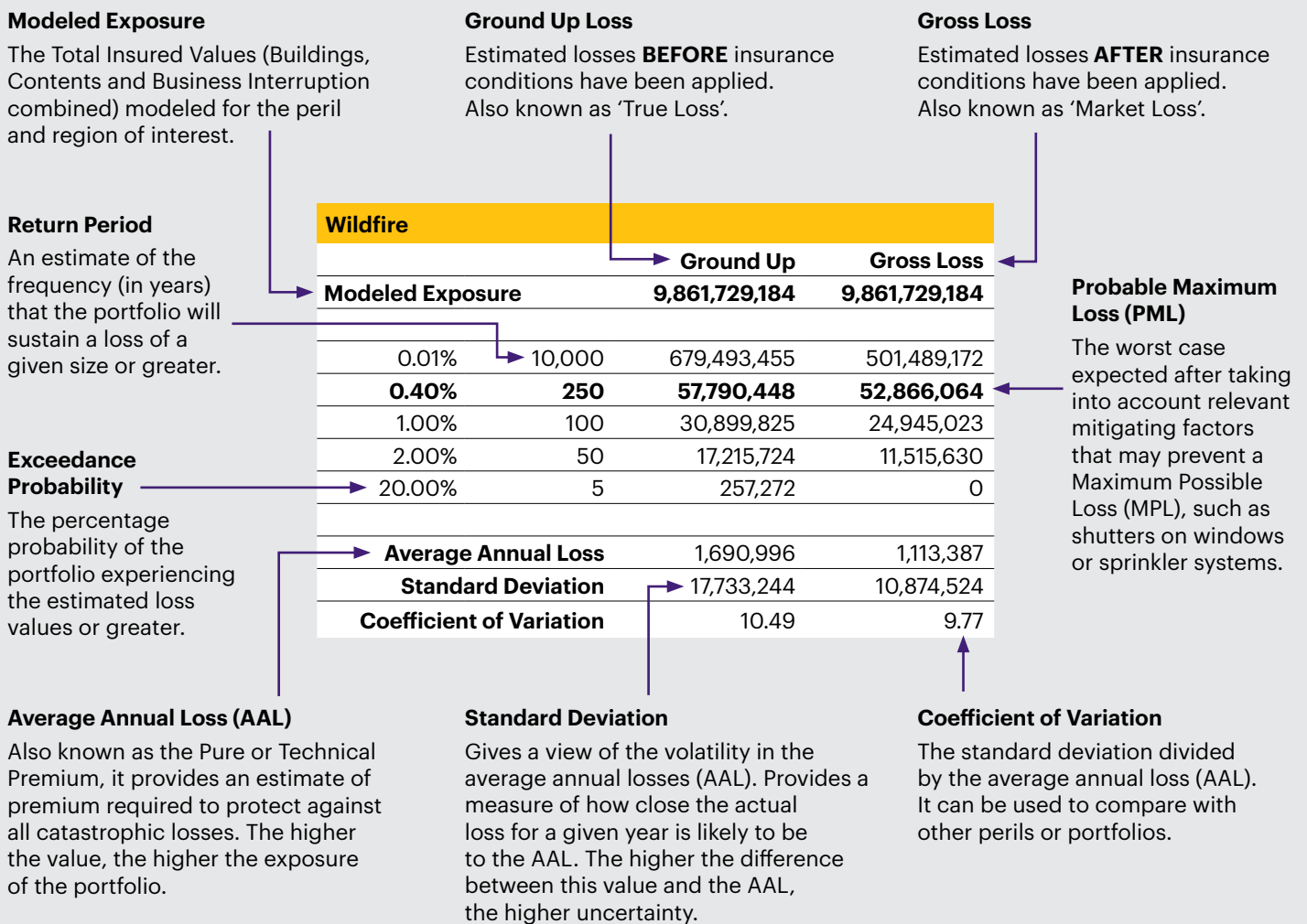
Data quality

When using catastrophe modeling, the data provided to insurance brokers and underwriters must be complete and accurate as the data will be used to calculate premiums.

Input of poor data into the model creates uncertain results so it's important to ensure that relevant info is provided for all locations in the client's portfolio, such as construction, occupancy, year built, floor area, etc.

Wildfire-specific data points such as the different vegetation, slope and fuel type, should be provided where available.

Figure 4: **A sample modeled loss calculation**

Modeled Exposure
The Total Insured Values (Buildings, Contents and Business Interruption combined) modeled for the peril and region of interest.

Ground Up Loss
Estimated losses **BEFORE** insurance conditions have been applied. Also known as 'True Loss'.

Gross Loss
Estimated losses **AFTER** insurance conditions have been applied. Also known as 'Market Loss'.

Return Period
An estimate of the frequency (in years) that the portfolio will sustain a loss of a given size or greater.

Wildfire		Ground Up	Gross Loss
Modeled Exposure		**9,861,729,184**	**9,861,729,184**
0.01%	10,000	679,493,455	501,489,172
0.40%	**250**	**57,790,448**	**52,866,064**
1.00%	100	30,899,825	24,945,023
2.00%	50	17,215,724	11,515,630
20.00%	5	257,272	0
Average Annual Loss		1,690,996	1,113,387
Standard Deviation		17,733,244	10,874,524
Coefficient of Variation		10.49	9.77

Probable Maximum Loss (PML)
The worst case expected after taking into account relevant mitigating factors that may prevent a Maximum Possible Loss (MPL), such as shutters on windows or sprinkler systems.

Exceedance Probability
The percentage probability of the portfolio experiencing the estimated loss values or greater.

Average Annual Loss (AAL)
Also known as the Pure or Technical Premium, it provides an estimate of premium required to protect against all catastrophic losses. The higher the value, the higher the exposure of the portfolio.

Standard Deviation
Gives a view of the volatility in the average annual losses (AAL). Provides a measure of how close the actual loss for a given year is likely to be to the AAL. The higher the difference between this value and the AAL, the higher uncertainty.

Coefficient of Variation
The standard deviation divided by the average annual loss (AAL). It can be used to compare with other perils or portfolios.

Strategic risk consulting

Our risk consultancy services include in-depth risk analysis, hazard and catastrophe modeling and vulnerability assessments to help clients understand and quantify their wildfire hazards.

Armed with this information, they can see their mitigation, risk management and risk transfer options more clearly.

Natural hazard and catastrophe modeling

WTW's Climate Diagnostics tool helps us to assess the change in physical hazards across different climate scenarios. We can use the output of Climate Diagnostic to assess the future risk of heat stress and drought and how this could increase the risk of wildfire. Climate Diagnostic also has a fire hazard element showing how the risk to life or property from existing or potential wildfires due to weather and fuel conditions can change over different climate scenarios.

These features enable us to predict changes in risk level across large global portfolios. We can create deterministic and probabilistic loss estimates for property damage and business interruption.

Data sources:

- **Risk Management Solutions** — used for the USA and Canada. We are working with third parties in Europe and the UK to extend our modeling portfolio.
- **Wildfire hazard review data** — WTW Global Peril Diagnostic, Munich Re, HD Wildfire and other global modeling sources.
- **Historical fire footprint data** — to determine the extent to which a study area has been impacted. This can help us produce a probable maximum loss for property damage and business interruption.
- **Geoprocessing and geospatial tools** — expertise within the team helps us to assess the potential extent and land cover of wildfires.

Mapping of secondary perils

The Strategic Risk Consulting team can produce a bespoke assessment of the secondary landslide risk that may occur after an event using wildfire footprint data from a specific region, taking into account the topography and soil type. The accuracy of the assessment depends on the data available.

Client case study: USA

A client with operations across the U.S., Canada and Mexico wanted to quantify its natural catastrophe risks, especially wildfire, to better inform the company's risk financing strategy and decide whether its current insurance capacity, retention levels and sub-limits were appropriate to cover these risks.

Our solution: We carried out a desktop hazard analysis using WTW's Global Peril Diagnostic tool to identify the wildfire risk faced across the client's portfolio. We found that 7% of the total insured value was exposed to medium or high wildfire risk. Based on this analysis, we then used catastrophe modeler Risk Management Solutions (RMS) to calculate the maximum losses from wildfire at varying levels of probability and frequency. Using WTW's actuarial tool Igloo, we were able to compare the modeled results with the client's current risk finance structure, to see how it would cover wildfire losses in a range of probability and frequency scenarios.

Results: We found that all probable losses would be retained by the client even in wildfire events with a relatively low level of probability, up to a 1 in 200-year return period. Wildfire events with a very low probability, up to a 1 in 1,000-year return period, would see some losses transfer to the captive and the insurance program. However, even in these scenarios, the client's current insurance structure overall would be adequate.

We assured the client that it was very unlikely that any wildfire event would breach the limits of the current insurance structure. We also recommended mitigation strategies for the high risk properties to reduce the risk of fires spreading.

Parametric wildfire insurance

WTW's Alternative Risk Transfer team can help clients design unique parametric solutions for specific wildfire risks.

Parametric insurance is designed to pay out when the burned area or total loss from a wildfire reaches a pre-agreed threshold.

The burned area can be measured using imagery from satellites that frequently image the Earth to distinguish between burned and healthy vegetation. Different satellites take images at different times — daily with 500-m resolution or weekly with 20-m resolution. The images are used to create high resolution maps of an area which inform the objective index in a parametric solution.

Parametric solutions can be applied worldwide as the satellites take images of the entire globe. WTW has parametric wildfire contracts placed in South America, Australia and Africa, with further interest in North America and Europe.

Figure 5: **Wildfire impact in California**
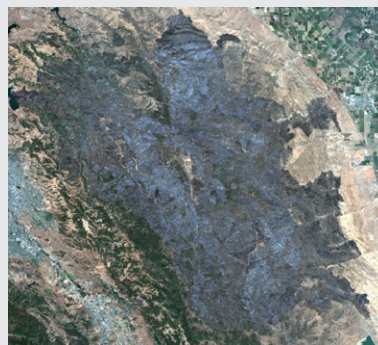
Burned area
True colour
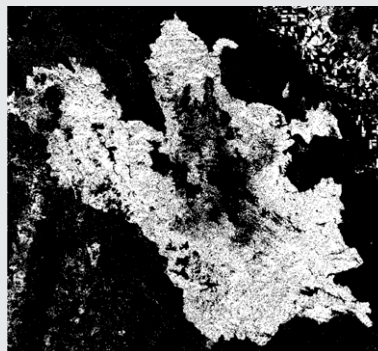
Severity classification
dNBR

Source: https://www.onda-dias.eu/cms/data/catalogue/sentinel-2/

Client case study: Chile

An agribusiness company had traditional fire insurance for 1.6 million acres of commercial pine and eucalyptus plantations, with an insured value of up to $1.6 billion. But major fire losses in 2017 meant their existing insurance had become unviable.

Our solution: Our parametric team developed an innovative Burned Area Index solution that would pay out only for specific fire damage detected by satellite imagery.

The Alternative Risk Transfer team carefully combined data sources to make this possible and give insurers confidence in the solution. This included mapping satellite imagery to geolocation information for each of the client's forests and calculating detailed valuations.

Results: We were able to secure competitively priced cover, with quotes from two insurers. Because our satellite based method is accurate in pinpointing damage and values and imagery is available soon after an event, pay-outs are generally much quicker than with traditional cover. It also allows salvage to occur much more rapidly than is possible with traditional loss adjustment processes. The cover has been renewed since 2018, with incremental improvements to the policy in each iteration. In 2023 a full limit loss was recorded and the policy responded appropriately.

Client case study: Australia

Our client owns AUS $63 million of timber forest in areas of Victoria where there is a high risk of wildfires. In 2021, traditional markets pulled out of covering wildfire in Australia due to heavy losses suffered locally and overseas.

Our solution: We developed a parametric solution that would pay out based on evidence from high resolution satellite imagery.

We then supported insurers, helping them understand the advantages of the technology. We prepared detailed valuation, risk and location data, communicating our proposals clearly and effectively so that we were able to generate market interest and secure enough capacity for the client without excessive deductibles.

Results: Three insurers quoted for the business. We were able to get all of the capacity the client needed at a competitive price, with reasonable deductibles. Analysis has shown the new policy pays out similarly to the traditional policy for historical losses. It also offers flexible cover for a wide range of costs, including salvage, debris removal, site preparation, weed control and post-fire planting and infrastructure costs.

.

WTW Research Network
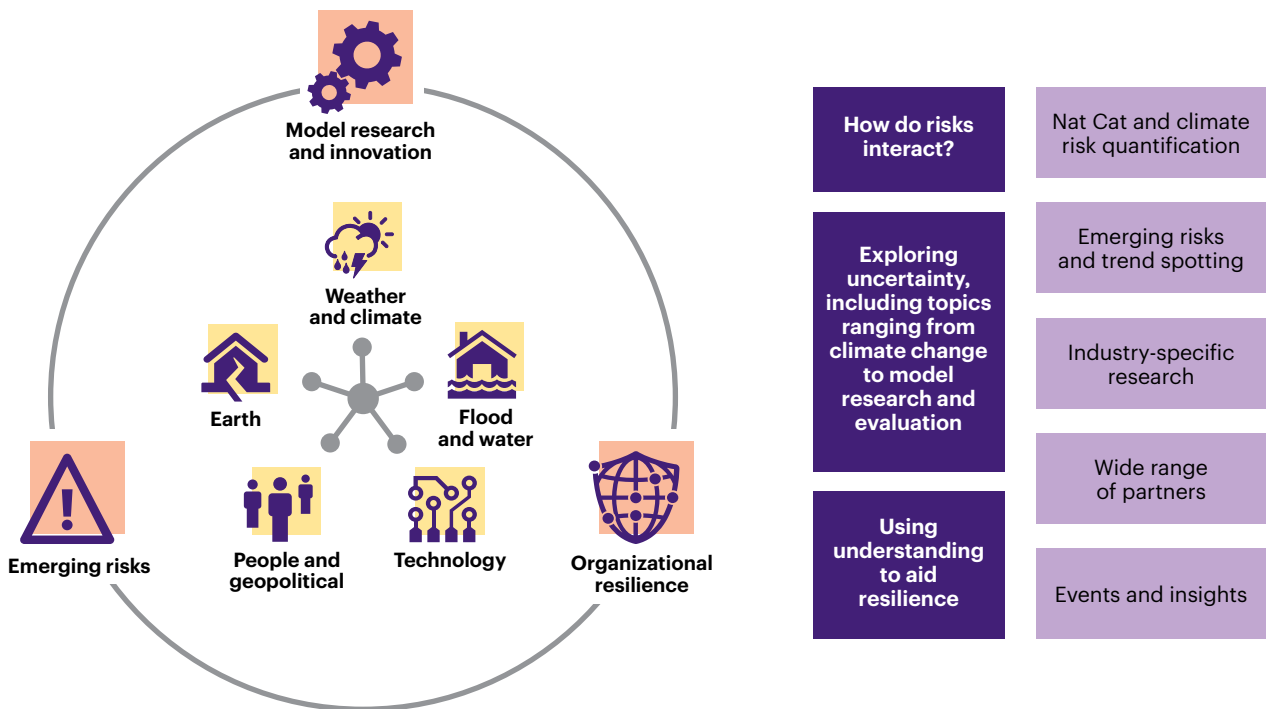## Science for resilience

The WTW Research Network (WRN) represents a 17-year investment in research and ongoing horizon scanning to help organizations protect their assets. The network includes dedicated research hubs and more than 60 partners in science, academia, think tanks and the private sector.

Together, we bring best practice research and evidence into risk models, advice, thought leadership, focused roundtables, and knowledge sharing events, to reduce uncertainty and help with natural catastrophe risk management and resilience.

The Weather and Climate Risk research hub covers all aspects of climate risk from natural hazards such as wildfires to transition risk research for a low carbon economy and liability risk associated with loss and damage arising from climate change.

The WRN team regularly publish white papers[3] and insights on the results of their research on important topics and recent hazard events, such as the Natural Catastrophe Review that explored Canada's 2023 wildfire season[4], and an annual review[5] showcasing research projects across all hubs.

Figure 6: **Supporting solutions to real world challenges with science-based research**

Model research and innovation

Weather and climate

Earth

Flood and water

Emerging risks

People and geopolitical

Technology

Organizational resilience

How do risks interact?

Exploring uncertainty, including topics ranging from climate change to model research and evaluation

Using understanding to aid resilience

Nat Cat and climate risk quantification

Emerging risks and trend spotting

Industry-specific research

Wide range of partners

Events and insights

[3]http://www.wtwco.com/en-gb/insights/research-programs-and-collaborations/wtw-research-network#wnss-white-papers
[4]https://www.wtwco.com/en-gb/insights/2023/07/natural-catastrophe-review-january-june-2023
[5]https://www.wtwco.com/en-gb/insights/2023/05/weather-and-climate-risks

Notable points from the Jan-June 2023 Natural Catastrophe Review:

1. Canada's 2023 wildfire season is officially its worst on record. The total burned area has surpassed 16 million hectares, breaking the previous record for the largest area burned in a single year. This shows that future wildfires will not necessarily resemble previous fires.

2. There are enormous changes year to year. For example, 2022 was below average year for wildfires compared to 2023. With the same climate conditions, this shows that the peril is more volatile and suggests a trend to increasing unpredictability.

3. Climate change is a synchronizing factor pushing perils like wildfire to become more correlated over vast areas, such as the boreal forests of Canada. This increased correlation must be factored into future risk.

Figure 7: **Canadian wildfire area burned**
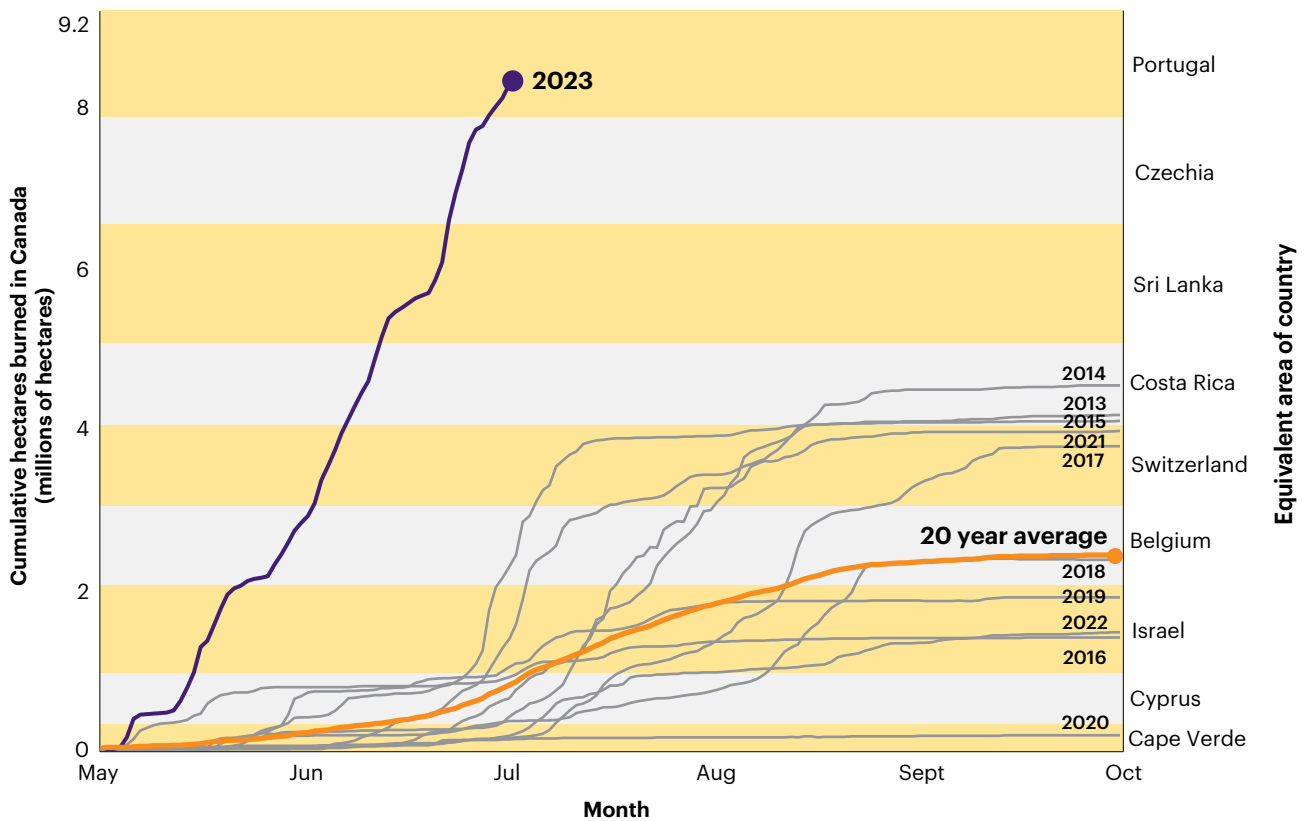
Source: Data — https://cwfis.cfs.nrcan.gc.ca/home Last updated: July 2, 2023.

Summary of main points

- Wildfires are large, uncontrolled fires that start in a forest or grassland usually after long dry spells. Factors such as climate change are increasing the likelihood of wildfires.

- They can cause secondary perils such as firenadoes or flooding as the ground loses its absorbency after large fires.

- Strategic Risk Consultancy provides in-depth risk analysis, catastrophe and hazard modeling and vulnerability assessments to help clients understand and quantify their wildfire hazards.

- Catastrophe modeling can quantify the potential losses in a wide range of scenarios and indicate the premium required to cover the risk.

- WTW Global Peril Diagnostic can identify risk locations in client portfolios and provide live alerts if any locations within a portfolio are likely to be exposed to an active wildfire.

- Our Climate Diagnostics tool helps us to assess the change in physical hazards in different climate scenarios, including the future risk of heat stress and drought.

- We can provide parametric insurance solutions that pay out when the burned area or total loss from a wildfire reaches a pre-agreed threshold, based on satellite imagery of the burned area.

- WTW Research Network links brings best practice research and evidence in wildfire into risk models, advice and thought leadership, with the aim of improving risk management and resilience.

Contacts

For further information please contact:

Asia

Paul Ward
Head of Property and Casualty
+65 6958 2800
paul.ward@wtwco.com

Australia and New Zealand

Trent Williams
Head of Broking, Australasia
+61 423 598 493
trent.williams@wtwco.com

Europe

Victor De Jager
Head of Property for Europe
+31 (0)6 2111 6250
victor.de.jager@wtwco.com

GB

Katie Latham
Senior Catastrophe Risk Analyst
Direct & Facultative
katherine.latham@wtwco.com

Aimee Colgate
Lead Associate, Physical Risks, Climate Practice
Risk & Analytics
aimee.colgate@wtwco.com

Elizabeth Doocey
Data and Research Consultant
Alternative Risk Transfer
elizabeth.doocey@wtwco.com

Daniel Bannister
Weather & Climate Risks Research Lead
WTW Research Network
daniel.bannister@wtwco.com

North America

Scott St. George
Head of Weather & Climate Risks Research
WTW Research Network
scott.stgeorge@wtwco.com

Christian Ryan
North American Industry Leader
christian.ryan@wtwco.com

South America

Roman Mesuraca
Regional Head of P&C & Broking — LatAm
+54 11 4324 1195
roman.mesuraca@wtwco.com

About WTW
At WTW (NASDAQ: WTW), we provide data-driven, insight-led solutions in the areas of people, risk and capital. Leveraging the global view and local expertise of our colleagues serving 140 countries and markets, we help you sharpen your strategy, enhance organizational resilience, motivate your workforce and maximize performance. Working shoulder to shoulder with you, we uncover opportunities for sustainable success — and provide perspective that moves you. Learn more at wtwco.com.

wtwco.com/social-media

wtwco.com