The AIR Bushfire Model for Australia

In February 2009, amid triple-digit temperatures and drought conditions, fires broke out just north of Melbourne, Australia. Propelled by high winds, as many as 400 fires raced across the region. These “Black Saturday” fires destroyed more than 2,000 homes, and if they were to recur today they would cause insured losses of nearly AUD 2 billion. It is essential for companies operating in Australia to have the tools necessary to assess and manage this risk.

AIR

Bushfires are a natural part of Australia's ecology. But today, fires that once raged across unbroken grassland and forest burn instead through highly developed commercial and residential areas, causing insured losses that rival those from cyclones or earthquakes. This peril matters to insurers because most properties in Australia are covered against bushfire and the risk is growing as more people build and live where bushfires are likely to burn.

The AIR Bushfire Model for Australia provides the most current and comprehensive view of Australia bushfire risk on the market today.

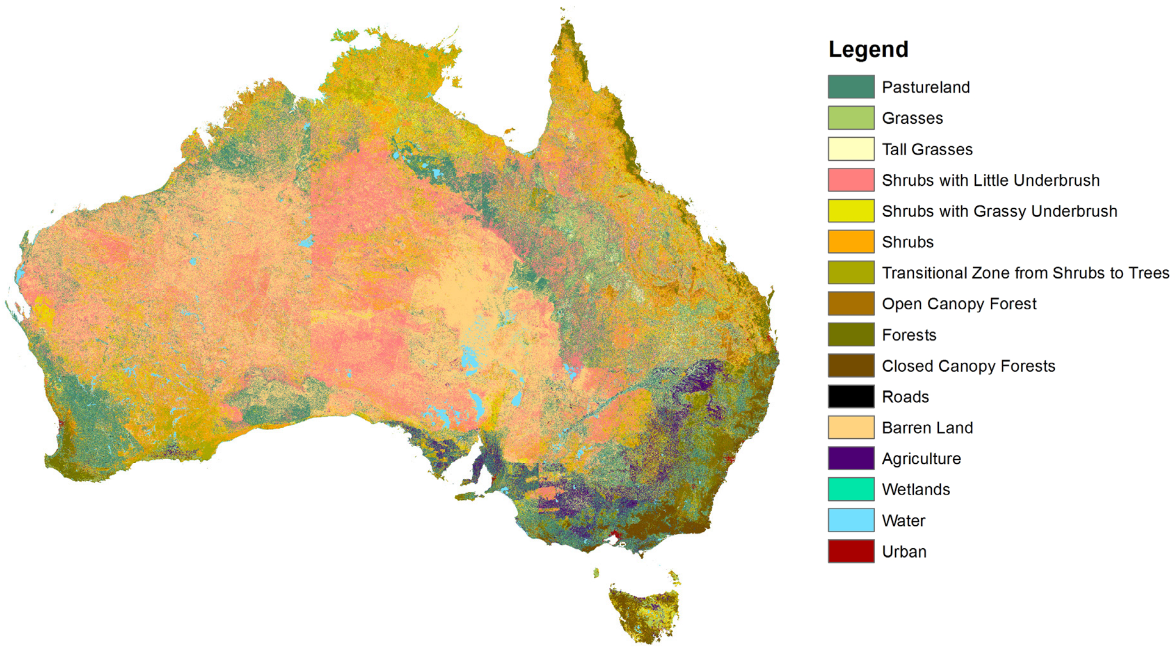
Detailed Data on Fuels, Weather, Seasonality and Fire History Generate a Robust Event Catalog

Australia's vast and varied geography means that different regions of the country have different climates—and thus different bushfire seasons. In the south, the season peaks between March and May, but in Queensland and the Northern Territory peak activity occurs later in the year. Thousands of fires start every year in Australia. Most are small, quickly burn out (or are put out), or occur in the sparsely populated Australian Outback. The AIR model filters the thousands of annual ignitions to generate a catalog of simulated loss-causing bushfires that appropriately reflects historical frequency and seasonality by region.

Other modeled factors that contribute to the development and spread of loss-causing bushfire events include:

- **Available fuels.** The condition of a location's vegetation determines the readiness and rapidity with which a spark will "catch," the vegetation burn, and the fire spread.
- **Weather.** Precipitation, aridity, and the speed and direction of winds all affect a fire's possible development.
- **Topography.** As the fire spreads, the local topography can cause updrafts and downdrafts, which influence the fire's direction, intensity, and rate of spread.

The AIR Bushfire Model for Australia utilizes a state-of-the-science spatial layer that accurately differentiates between 16 fuel classes consistently across the continent of Australia on a high-resolution 90-meter grid. The classifications in AIR's fuel map layer are analogous to those in the Anderson fuel models. With remote sensing data obtained from Landsat collected in 2015 (at the height of the Australian summer when foliage is thickest for wildland areas and during the winter when bare trees allow for more accurate imaging of urban areas), AIR researchers were able to create a fuels map that clearly delineates the wildland-urban interface and determines an exposure's distance to brush. In addition, because roads serve as highly effective fire breaks, AIR's fuel map layer incorporates a road network derived from the Australian government.



The fuel map layer for the AIR Bushfire Model for Australia.

A Fire Propagation Algorithm That Produces Realistic Bushfire Footprints

AIR's bushfire model probabilistically selects an ignition location and "target" fire size (from a distribution fitted to historical fire data). Then a fire propagation algorithm developed at AIR generates the extent and shape of the fire's final perimeter. The simulated fire is spread radially, advancing its perimeter by calculating the effects of several enabling factors: available fuels, topography, and possible barriers to continued spread such as roads, rivers, or deserts (places where there are no fuels to propagate the fire). The model adjusts the rate and direction of the perimeter extension by means of a simulated wind profile, and terminates the spread when available fuels are exhausted—or when the "target" fire size is attained.

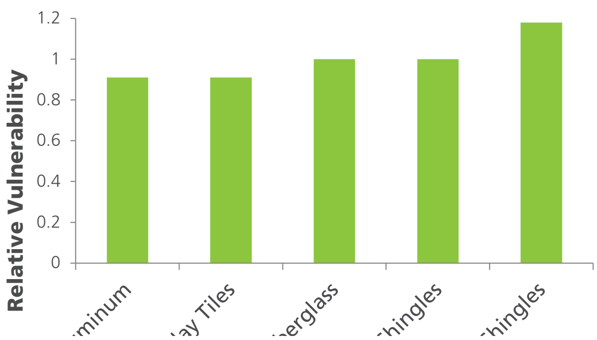
The Model Explicitly Captures Bushfire Clustering

Australian bushfires—much more so than Californian wildfires, for example—tend to occur in clusters of multiple nearby fires. The 2009 Black Saturday outbreak was such an event; several hundred individual fires were involved. The AIR model's 10,000-year catalog includes approximately 360,000 multi-fire events, each of which consists of as few as two to as many as 100 or more individual fires that are closely associated both temporally and spatially.

Individual Risk Characteristics Can Exacerbate or Mitigate Damage

The flammability of a structure's exterior surfaces, particularly the roofing and wall-siding materials—where firebrands (or wind-borne embers) often land—is a critical factor in determining a structure's vulnerability to fire. Using engineering research, claims data, and findings from post-disaster surveys in Australia and elsewhere, AIR engineers have developed separate damage functions for 44 construction types and 48 occupancy types common across Australia.

A simulated multi-fire cluster similar to the Black Saturday fires near Melbourne.



Relative vulnerability of different roofing materials.

Comprehensive Approach to Model Validation

The loss estimates produced by the AIR Bushfire Model for Australia have been validated using post-disaster damage survey information, engineering research, and industry loss data. But to ensure the most robust and scientifically rigorous model possible, validation is not limited to final model results. Each component is independently validated against multiple sources and data from historical events. Modeled damage ratios were validated against actual observations from published reports.

Leveraging AIR'S Detailed Industry Exposure Database for Australia

AIR has developed a high-resolution industry exposure database (IED) for Australia that is based on the latest information on risk counts, building characteristics, and construction costs from a wide variety of local sources. The benefits and uses of AIR's IED are numerous. It provides a foundation for all modeled industry loss estimates. Risk transfer solutions, such as industry loss warranties that pay out based on industry losses, rely on the IED. Using Touchstone®, companies can also leverage the IED for Australia to disaggregate the exposure data in their own portfolios to a highly detailed level for improved loss estimates.

The IED is also used to estimate damage functions for exposures with one or more primary building features missing—for example, when the building occupancy is known, but the construction material and/or building height is missing. The model uses regional building inventory data to estimate the damage functions for risks with unknown features as a weighted average of damage functions for buildings with known features and weights calculated from the regional demographics of the building stock, leveraged from the IED. Each CRESTA in Australia has damage functions that account for regional differences in the building stock.

Model at a Glance

Supported Geographic Resolution	CRESTA and user-provided latitude and longitude
Stochastic Catalogs	The 10,000-year and 100,000-year catalogs include simulated wildfires comprising both individual fires and fire clusters; the model also includes two historical events
Supported Lines of Business	Residential, Commercial, Agricultural, Auto
Supported Construction and Occupancy Classes	Damage functions for 44 construction types and 48 occupancy classes that estimate losses to buildings, contents, and time element coverages; users can input individual risk characteristics such as roofing and siding type; more than 60 categories of industrial facilities are supported explicitly
Model Validation	The AIR Australia Bushfire Model has been validated using post-disaster damage survey information, engineering research, and industry loss data
Industry Exposure Database	Provides a foundation for all modeled industry loss estimates; can be leveraged to disaggregate exposure data to a highly detailed level for improved loss estimates

Model Highlights

— Features both a 10,000-year and a 100,000-year catalog of stochastically generated bushfire events
— Incorporates empirical data and mathematical descriptions of fire seasonality, ignition locations, available fuels, wind speed and direction, and topography to simulate the development and spread of bushfires
— Explicitly accounts for firebrands, which are the mechanism by which a propagating fire front crosses non-burnable barriers such as major roads, highways, and rivers
— Probabilistically simulates the presence of man-made firebreaks that take into account practical fire suppression techniques, procedures, and experience
— Explicitly accounts for bushfire clustering
— Leverages a detailed, continent-wide industry exposures database
— Supports damage estimation to residential, commercial, and agricultural buildings, as well as automobiles

ABOUT AIR WORLDWIDE

AIR Worldwide (AIR) provides risk modeling solutions that make individuals, businesses, and society more resilient to extreme events. In 1987, AIR Worldwide founded the catastrophe modeling industry and today models the risk from natural catastrophes, terrorism, pandemics, casualty catastrophes, and cyber attacks, globally. Insurance, reinsurance, financial, corporate, and government clients rely on AIR's advanced science, software, and consulting services for catastrophe risk management, insurance-linked securities, site-specific engineering analyses, and agricultural risk management. AIR Worldwide, a Verisk (Nasdaq:VRSK) business, is headquartered in Boston with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.