https://doi.org/10.1038/s41477-024-01647-6

Scorched Earth

The destructive consequences of catastrophic wildfires, which are capable of destroying homes and livelihoods, frequently hit the front pages of newspapers worldwide. But scientific attention is increasingly turning towards understanding changes in wildfire regimes.

Forest fire in British Columbia, Canada, during the 2023 fire season.

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Just one week into 2024 was enough time for climate scientists to take stock of the year gone by and officially confirm 2023 as the hottest year on record. Air temperatures rose 1.48 °C above pre-industrial levels, ocean surface temperatures hit record heights and some of the worst wildfires for centuries burned across parts of North America[1]. For many, the devastation caused by these fires is emblematic of the effects of human-induced climate change. It seems fitting, therefore, that changing fire regimes across a diversity of ecosystems – from fire-sensitive forests to fire-adapted savannahs – and their impacts on biodiversity and people were hot topics of conversation at the recent British Ecological Society conference in Belfast.

Fire regimes in temperate forests are historically linked to seasonal variations in temperature and rainfall. However, the window of the fire season has widened, and fires are now larger and more intense. Furthermore, fires are increasing in ecosystems, such as tropical forests, that are maladapted to frequent and extreme disturbance. Research presented by Jos Barlow, at the University of Lancaster, reported unprecedented fires across the Amazonian rainforest driven by interactions among logging, forest fragmentation and extreme drought[2]. The effect of these fires can be far-reaching: a single megafire in the 2015–2016 El Niño event killed over 2.5 billion trees in the Amazonian forest and released 495 teragrams of carbon into the atmosphere[3].

Despite the prevailing narrative that fire only ever leads to destruction, fire is a regenerative force for many ecosystems; a key driver of biodiversity, ecosystem productivity and resilience. Many fire-adapted ecosystems are suffering from a reduction in fire frequency and seasonality that leads to a misalignment of fire events with reproductive and regenerative processes. Perhaps surprisingly, the total global burned area has declined by 25% over the past two decades[4], as a result of agricultural expansion and intensification. This decrease has primarily occurred in fire-adapted tropical grasslands and savannahs that account for the majority of fires on Earth. The consequences of this reduction and loss for the fire-dependent savannahs of the Cerrado, Brazil were highlighted by Alessandra Fidelis, Universidade Estadual Paulista. Fire exclusion in this ecosystem led to encroachment of woody species at the expense of a highly biodiverse herbaceous flora and resulted in 80% reductions in plant diversity, which affected ecosystem structure and functioning[5,6].

Plants possess many adaptive traits that enable their persistence and regeneration after fire: for example, the thick bark of giant redwoods, the varied belowground bud bank structures of herbaceous species in Brazilian grasslands and the fire-released dormancy mechanisms in shrubs of Western Australia. As catastrophic fire events increase in frequency, they provides researchers with the opportunity to uncover some of the more remarkable ways in which plants respond to potentially devastating threats. A recent paper from Andrew Richardson and colleagues at the Northern Arizona University reported that post-fire recovery of redwoods is aided by tapping into reserves of decades-old carbon to rebuild canopies, as new leaves form from dormant buds that are over 500 years old[7]. However, although these fascinating insights into plant resilience may inspire some hope, there is little time for complacency.

As climate targets for curbing carbon emissions seem increasingly unattainable, feedbacks between anthropogenic-induced climate change and fire have substantive implications for the global carbon cycle[8]. Governments across the world are moving to develop effective fire-management policies and practices, but one of the clearest sentiments from the British Ecological Society meeting was that these responses should be nuanced and region-specific – accounting for environmental, ecological and social differences. Research from Caroline Lehmann, at the Royal Botanic Garden Edinburgh, and collaborators in Madagascar highlighted the importance of considering complexity in fire–vegetation–landscape interactions when developing such policies. For many years, the accepted dogma has been that the biodiversity of Madagascar is under threat from anomalous and anthropogenic fire. Yet Lehmann's studies challenge this simplistic view by finding no uniform link between fire and tropical forest loss[9]. Untested assumptions can lead to inappropriate and even harmful policies in these regions.

A prime example of such inappropriate policies are the historical bans implemented by European colonizers on cultural burning and the use of fire to support livelihoods: practices of Indigenous peoples to manage ecosystems and landscapes in various regions, including North America and Australia.

It is increasingly recognized that fire provides key services in varied ecosystems and can reduce the risk of megafires by keeping vegetation open. Integration of cultural burning into sustainable fire management policies — combined with spatially resolved predictive fire models and improved monitoring — may go some way towards mitigating the risks to people and ecosystems of changing fire regimes in the Anthropocene[10].

Published online: 22 February 2024

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