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COMMENT

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Landscape management is urgently needed to address the rise of megafires in South America

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Climate change and unsustainable land-use practices are causing megafires in South America. Here we call for rigorous scientific coordination and global cooperation to claim back landscape planning, mitigate fire risk and foster resilience in the region.

A remarkable surge in the occurrence and severity of megafires has been observed around the world, particularly in South America[1]. Fire has played a crucial role in shaping ecosystems for hundreds of millions of years[2]. However, contemporary anthropogenic climate change has increased the probability of large and intense wildfires that have disastrous effects on ecosystems, communities, and economies[3]. Higher temperatures and prolonged droughts foster conditions conducive to the spread of fires and increase their intensity. Altered rainfall patterns resulting from climate change exacerbate drought conditions, intensifying the risk of fires. The increased likelihood and complexity of fire incidents currently complicate efforts to control them.

Once rare, megafires have become widespread, and their threatening potential is intensifying in the face of climate change. Forecasts project even worse conditions for the future with longer fire seasons and elevated risks of wildfire damage[4,5]. However, megafires are not solely attributed to anthropogenic climate change. Megafires often arise from the synergy of land-use practices that foster fire-friendly conditions and promote wildfire propagation[6]. Land-use alterations have significantly contributed to the expansion of megafires by modifying the landscape and rendering it more susceptible to fire outbreaks. Deforestation, for instance, eliminates natural firebreaks and induces edge effects, thereby increasing fire occurrences in humid forests within the tropics[7,8]. Agriculture, forestry, and urbanization, in turn, modify the landscape by creating vast dry and open areas that are highly susceptible to fire ignition[9,10]. Such land-use changes can influence the local climate, creating more conducive conditions for the ignition and spread of fires. As a result, some landscapes are more prone to megafires in South America.

The implementation of targeted measures and landscape strategies to prevent megafires is urgently needed[1]. However, there is currently a limited understanding of megafires as a different phenomenon than just large wildfires. Direct investments and global collaborations are crucial to avert catastrophic repercussions for vulnerable populations, particularly at the interface between urban areas and forested landscapes (Fig. 1).

South American forests on fire

In 2020, the Pantanal—the world's largest tropical wetland that includes Brazil, Bolivia, and Paraguay and that is particularly affected by drought[11,12], cattle ranging and deforestation[10,13]—experienced the worst fires in decades with over 30,000 fires burning an area larger than 40,000 square kilometers[14]. In 2019, the Amazon rainforest, also threatened by deforestation and degradation[15], was hit by a record number of fires that burned an area larger than 180,000 square kilometers in the Brazilian Amazon—the size of Greece[16]. Finally, the megafires that occurred in

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the South-central zone of Chile in 2017 and 2023—a region that has been severely transformed into vast exotic forestry plantations over the past 40 years—were larger than 520,000 hectares in 2017 and 450,000 hectares in 2023[9,17].

The case of Chile vividly illustrates that once a megafire engulfs the landscape, human intervention becomes futile. The megafires that occurred in the region in 2017 and 2023 were challenging to control and extinguish. The combination of extreme weather conditions—high temperatures, strong winds and low humidity—and highly flammable forests covering large areas contributed to an increase in the size and intensity of fires (Fig. 2). In both events, Chile allocated firefighting resources provided by both the government and private sources through a plan that reached the remarkable value of US$180 million. This investment was record-breaking for the country[1]. Other countries such as Argentina, Brazil, Japan, Israel, China, and the United States also provided financial aid to fight the fires. Despite these efforts, these megafires spread ultimately until the weather conditions changed. The fires had significant impacts on the region's ecosystems and communities. Only during the first few months of 2023, there have been already 7835 casualties and 2560 damaged houses[17]. Regrettably, no amount of financial support will ever suffice to shield against the deleterious effects of large fires that affect more than 10,000 hectares, let alone those that transcend the giga-size benchmark of 100,000 hectares[3].

Fig. 1 Forest urban fire risk interface in Vichuquén, Chile. Urban town surrounded by exotic forest plantations, demonstrating significant recovery of flammable species 5 years after the 2017 megafire. Photograph taken by @F. de la Barrera, April 2022.

Given the escalating frequency and severity of megafires in South America, it is clear that traditional fire suppression methods are no longer sufficient to protect ecosystems and communities from their devastating effects[1]. Paradoxically, despite the increasing global and regional allocation of resources toward fire suppression, funding aimed at addressing the root causes of megafires remains stagnant or grossly insufficient.

Focus on landscape planning

Regrettably, regulations at the regional scale have failed to recognize the significance of landscape planning as a viable pathway to mitigate the occurrence of megafires. It is imperative to prioritize scientific research and coordinate efforts to understand and address the underlying factors that contribute to these devastating events. Only through proactive landscape planning and investment in preventive measures can we effectively tackle the rising threat of megafires in South America. Adopting sustainable land-use practices, such as agroforestry and silvopastoral systems, cultural burning and green firebreaks can play a critical role in reducing fire risk.

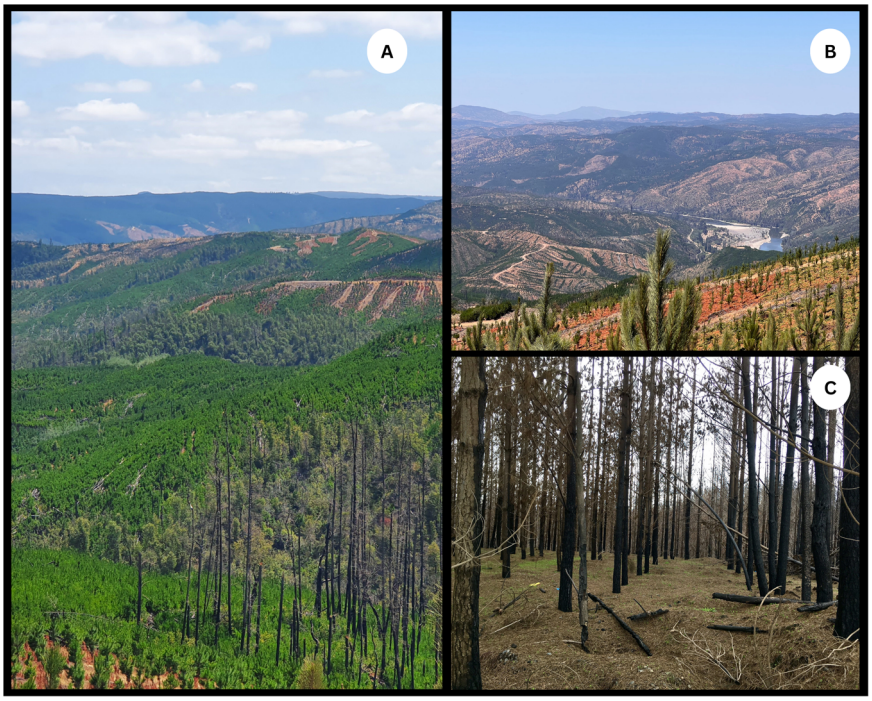

Fig. 2 Landscapes dominated by forestry plantations affected by fire in Constitución (2017) and affected forest stands in Florida, Chile. Photographs **A** and **C** show plantation landscapes in Constitución 5 years after the 2017 megafire. Photograph **B** depicts forest stands in Florida, Chile. Photo credit: @F.de la Barrera, February 2022.

These practices maintain natural firebreaks and limit the presence of dry, open areas susceptible to ignition. Furthermore, fire prevention programs promoting safe practices are vital to minimize fire risks. Restoring native forests is of paramount importance as they also provide ecosystem services. Natural nonflammable green barriers enhance landscape resilience against megafires and extreme weather conditions and can help recover landscape heterogeneity and multifunctionality. Effective monitoring of landscape evolution that exacerbates fire risk should encompass both natural and anthropogenic changes following megafire events. Unmanaged forestry plantations or other land uses are more susceptible to flammability than expert-managed ones[18].

Fire suppression policies can inadvertently lead to fuel accumulation and intensifying fires upon ignition Smaller fire suppression, if not managed effectively, can also contribute to fuel buildup and exacerbate the challenge of controlling larger fires. Ill-planned forest plantations, such as those in Chile, played a prominent role in the devastating megafires of 2017 and 2023[9]. Monoculture plantations are vulnerable to pests and diseases that weaken trees and escalate fire potential. The use of highly flammable species like eucalyptus or similar further aggravates fire risk. Furthermore, poor choice of plantation locations in fire-prone areas increases the risk of fire spreading to native forests. A lack of natural firebreaks or green barriers hinders fire control efforts and enhances fire expansion. Addressing these issues is crucial for mitigating fire risks effectively[1].

Develop effective fire prevention

Integrated fire management strategies into multifunctional landscapes encompass a multifaceted approach, integrating monitoring and early detection systems, as well as participatory and collaborative processes. This holistic approach aims to comprehend the ecological, cultural, and socioeconomic significance of fire while simultaneously reducing fire risk. The safety, well-being, and quality of life of communities can be promoted by incorporating techniques such as green barriers and prescribed burning into the sustainable management and planning of territories. A comprehensive strategy is imperative to counter the widespread proliferation of megafires in regional landscapes and needs to target the root causes facilitating their occurrence. This endeavor demands addressing legislative deficiencies, ensuring compliance with nature conservation agreements, and demonstrating an unwavering commitment to effective landscape management.

Address policy and legislation barriers

Numerous barriers exist within policies and legislation that hinders the implementation of a comprehensive approach to combat megafires in South America supported by scientific knowledge. Many countries in South America may lack the financial resources and funding to invest in science that aims to understand the root causes of megafires and can guide key fire prevention and management actions. National strategies to prevent megafires tend to remain the same as those oriented to prevent frequent wildfires. There is a limited understanding of the high risk of experiencing more frequent and devastating megafires. Weak regulatory frameworks can also complicate the enforcement of fire prevention and management policies, especially in economic sectors that can generate landscape modifications over several tens of thousands of hectares.

Conflicting policies of land planning also impede the implementation of comprehensive approaches to fire prevention and management. For example, reactive fire management by fire suppression is an approach that primarily responds to fires as they occur, while forest management might advocate for a proactive approach, such as prescribed burning that can be used to reduce fuel loads, restore natural fire regimes, and promote ecosystem health. Another example is when wilderness areas are managed with an emphasis on natural processes and minimal human intervention and conflicting policies may arise when considering whether to suppress fires there or let them burn as part of the natural ecosystem dynamics. Policies focusing on human safety during wildfires might also lead to decisions that prioritize protecting human communities and infrastructure over the preservation of entire forest ecosystems. This conflict can arise when fire management actions, such as constructing firebreaks or using heavy machinery, impact the natural integrity of the forest. Such weak regulatory frameworks can lead to a lack of compliance and coordination to address the underlying factors contributing to the expansion of megafires. A lack of political will can prevent the implementation of long-term strategies for fire prevention and management at national and international levels. Short-term dominance and political changes in South America may shift political priorities and disrupt efforts to address megafires. Limited public participation is a barrier to fire prevention programs and can lead to a lack of awareness of megafires.

Without cohesive regional agreements driving concerted efforts to implement and enforce fire prevention measures, it will be inevitable that we coexist with megafires and their increasingly adverse consequences. Fire risks cast a shadow not only on inhabitants of affected regions but also on the world because, during megafires, an even higher substantial amount of greenhouse gases can be emitted. To effectively address the growing threat of megafires in South America, it is imperative to prioritize a comprehensive approach and foster international collaborative actions that promote careful regional coordination among scientists, decision-makers, and local practitioners. Additionally, there is an urgent need to establish local agreements expeditiously between fire departments, land managers, and local communities, enabling the implementation of traditional cultural and evidence-based actions within these landscapes.

Only through these concerted efforts can we truly optimize resource allocation, reduce the quantity of flammable fuels and risk of fire and enhance decision-making capabilities before, during, and after fire events. By doing so, we can safeguard ecosystems, livelihoods, and the environment, thereby mitigating the escalating risks posed by the increasing number of anticipated megafires in the region.

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D.A. and F.B. conceived, researched and wrote the paper.

Competing interests

The authors declare no competing interests.

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