TRENDS
DEFORESTATION

Megafires Push Cities and Businesses to Shift Their Strategies

AUDE VALADE • Researcher, CIRAD

Beset by agriculture, extractive activities, and numerous economic, technological and political factors, the world's forests are subject to accelerating deforestation and degradation. In recent years, another enemy triggered by climate change has put forests in considerable peril: megafires. While record losses of tree cover have been reported over the past few years, firefighting solutions reveal a lack of preventive and anticipatory measures in the long term. In an attempt to preserve the lungs of the planet, different techniques are progressively emerging that draw on the knowledge of indigenous populations and scientific expertise.

DATA OVERVIEW

Tropical rainforest degradation is causing emissions to rise

The LULUCF (land use, land-use change and forestry) sector as a whole was responsible for net emissions of about 11.6 gigatonnes of CO_2 equivalent ($GtCO_2e$) in 2018, or about 22% of global greenhouse gas emissions.[1] Changes in land use and management account for 47% of these emissions (5.4 $GtCO_2e$ annually in 2018, 6.1 $GtCO_2e$ in 2019).[2] This category includes deforestation and degradation of forests (the biggest emitters), conversion of grassland to crops and farmland to forests, peatland drainage and fires, timber harvesting and soil respiration due to agricultural practices.

In 2020, the planet lost 25.8 million hectares (Mha) of forest cover, 12.2 Mha of which were in the tropics (forests and plantations), and 4.2 Mha in primary rainforests (**fig. 1**), a 12% increase compared to 2019 and equivalent to 2.64 $GtCO_2$ of emissions.[3] Brazil and the Democratic Republic of the Congo are the two countries that lost the most forest area in 2020. Since 1990, the world's primary rainforests have reportedly lost 17% of their surface area due to human and natural factors.[4]

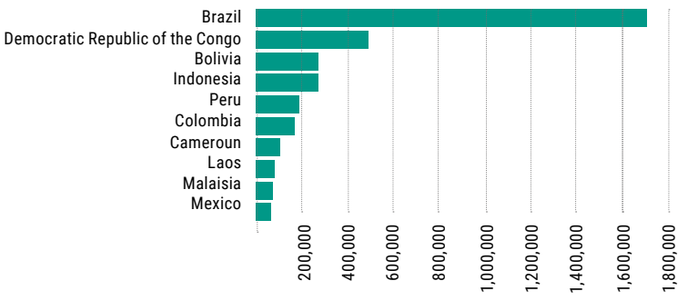
In addition to this loss of forest area, several scientific studies published in 2020 and 2021[4, 5, 6, 7] point to a second crucial mechanism: forest degradation, a term that covers occasional disturbances due to timber extraction, small fires and storms. In January 2020, of the 1,071 Mha of remaining tropical rainforests, an estimated 10% were degraded. Forest degradation is reportedly responsible for about 73% of biomass loss and 44% of carbon emissions related to land use, compared to 27% and 56% respectively for deforestation.[6, 7] In addition to considerable CO_2 emissions, these degraded zones are more likely to go on to be deforested. According to researchers, 7.5 years after such disturbances, almost 50% of degraded forests have been deforested.[4]

The drop in energy demand related to the Covid-19 pandemic drastically reduced CO_2 emissions from the main emission sectors in 2020. For the land-use sector, on the contrary, the restricted surveillance activities resulting from lockdowns, coupled with people's return from urban centres, brought the fear of an increase in illegal deforestation. Nevertheless, although deforestation continued its upward trend, no sign of an increase linked to Covid is observable in the latest data from Global Forest Watch.[3] This paradox can be explained by the offset between, on the one hand, a shortage in supply and decreasing global demand, and on the other hand, economic

FIGURE 1

LEFT: PRIMARY FOREST LOSS BY COUNTRY IN 2020 (HECTARES)
RIGHT: GLOBAL TROPICAL PRIMARY FOREST LOSS FROM 2002 TO 2020 (HECTARES)

Source: Weisse and Goldman, 2021



support policies and the resilience of the drivers of illegal deforestation.

Responses to deforestation are still too weak to deal with the intensifying drivers. According to Forest Trends, 60% of tropical deforestation is related to commercial agriculture, and 69% of this farmland conversion is illegal.[8] The drivers behind deforestation and forest degradation however vary depending on the region, and evolve over time in response to global markets, investment trends, and national and local policies.

A report published in 2020 by WWF looks at the evolution of deforestation drivers and the responses made through an analysis of 24 fronts of tropical deforestation.[9] Nine types of drivers are analyzed in the report, broken down into direct drivers (agriculture, extractive activities, infrastructure, others) and indirect drivers (demographic, economic, political, technological and environmental), along with two types of responses: area-based and sector-specific.

Soy, palm oil and cattle rearing are the most common culprits of illegal deforestation (although other crops like rubber, coffee and corn also account for large areas[8]). In South America, agricultural activities are the main cause of deforestation, and the trend is worsening, with animal rearing overtaking crops, both at industrial and smallholder scales. Infrastructure expansion is an indirect and less widespread driver, although it is also worsening on most fronts. Africa is subject to drivers that are different from the ones in South America because industrial agriculture is secondary compared to smallholder farming. These two drivers are worsening on most deforestation fronts, with the exception of West Africa, where industrial agriculture is decreasing. However, extractive activities are driving deforestation on every front, led by the extraction of firewood and by coal mining, but also timber extraction, mostly at a smaller scale. At the scale of the African continent, these drivers have on the whole remained at relatively stable levels for several years, but are worsening in Zambia and Central Africa. In Asia and Oceania, large-scale cultivation and industrial tree plantations dominate the direct drivers while infrastructure development is a secondary driver.

Action carried out at different scales also varies depending on the region. The development of protected areas is the most common widescale action in all areas, accompanied by the development of REDD+ projects. The Brazilian Amazon and Indonesia stand apart for having established moratoriums on deforestation, while sectoral "zero-deforestation" projects stand out in Indonesia and Cambodia. However, this kind of action is not enough, as underlined in the report on the progress of the New York Declaration on Forests.[10] An analysis of the nationally determined contributions (NDCs) that followed the Paris Agreement reveals that only five countries have included commitments to combat deforestation in their NDCs (Indonesia, Colombia, Papua New Guinea, Guyana and the Republic of the Congo). Consequently, only 11% of the global economic potential for reducing deforestation is met by state commitments. On the other hand, numerous commitments have been made concerning afforestation and reforestation.[a]

The weaknesses revealed in the WWF report on commitments to "zero deforestation" and traceability of supply chains are in line with the conclusions of the 2021 report by Forest500, which analyzes the commitments of the main international companies in raw material sectors posing a risk of deforestation.[11] Only 25%, 28% and 31% of companies exploiting raw materials to produce leather, beef and soy respectively have established commitments. Palm oil is an exception, with 71% of the companies concerned having made commitments to combat deforestation (**see Agriculture trend**).

To tackle the difficulty of evaluating the trends and drivers behind the deforestation and degradation of forests in Africa, a joint initiative involving the FAO and CAFI (Central African Forest Initiative) should open up new perspectives. The CAFI/FAO DDD project aims to make an in-depth study of changes in forest cover and its drivers in six countries in the Congo

a Afforestation consists in planting trees on land that was not previously planted, while reforestation involves planting new trees on a previously planted area.

basin, while developing a methodology that could be used on a global scale. The uniqueness of the study lies in the wide range of partners involved, with six ministries from CAFI partner countries working with 14 research centres and NGOs to pool their data and improve methods.

THE OBSERVATORY'S LENS

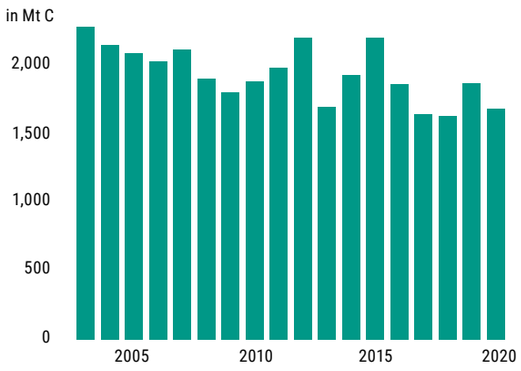
The start of an era of megafires reveals inconsistencies and shortfalls in the way forest fires are managed

In addition to disturbances due to human activity (agriculture, extractive activities, etc.), climate irregularities also affect the state of forests, further worsening their situation and undermining their potential for absorbing carbon dioxide. Droughts, storms, fires, insects, and diseases are having adverse effects on the world's forests. Of these climate-induced disturbances, the best known and monitored are forest fires, mostly thanks to satellite data that reveal their complexity and highlight paradoxical situations. Firstly, from a geographic point of view: while the Arctic and the United States saw record areas of land burn in 2020, Canada and tropical Africa had minimal fire outbreaks. Secondly from a temporal aspect: 1.7 gigatonnes of carbon (GtC) were released into the atmosphere by forest fires in 2020, which is less than the 1.9 GtC released in 2019, continuing a global downward trend of carbon dioxide emissions from forest fires since the 2000s (**fig. 2**).[12]

FIGURE 2

ANNUAL CARBON EMISSIONS FROM FOREST FIRES FROM 2003 TO 2020

Source: Copernicus, 2020



These apparent paradoxes can be explained by interactions between the control mechanisms of fire regimes: the quantity of combustible material, humidity, ignition (fire outbreak), and suppression (fire extinction). Climate change extends fire seasons, causing drier vegetation and higher temperatures, but the quantities of combustible matter, risks of ignition, and the intensity of suppression practices follow less uniform trends. In most cases, they are triggered by humans, whichever be the region (**see Keys to Understanding**).

KEYS TO UNDERSTANDING

IDENTIFYING RESPONSIBILITIES FOR FIRE OUTBREAKS

While forest fires are becoming more probable and more intense in response to drier, hotter climatic conditions, they are usually caused by human acts and negligence. In southern Europe, 98% of fires are of human origin, and in the United States, 84% of fires are triggered by human activity. In California, the main electricity operator, PG&E, was taken to court for having triggered the Camp Fire in November 2018. The gigantic fire, which killed 85 people and burned the city of Paradise to the ground, was caused when a pylon fell onto electricity lines, causing sparks that set fire to the surrounding vegetation. PG&E's shortfalls in maintaining its power lines and pruning nearby vegetation saw the long-established company brought before the courts, where it was judged guilty of involuntary homicide and ordered to pay tens of millions of dollars in compensation to the victims. PG&E went on to declare bankruptcy, qualified by Wall Street as the "*First climate-change bankruptcy, probably not the last*". Since then, following new accusations of responsibility for the 2020 Zogg Fire and the 2021 Dixie Fire, PG&E, which recovered from bankruptcy in 2020, has announced plans to bury 10,000 miles of power lines, a project due to last over a decade at a cost around 20 billion dollars.

Sources: Balch et al. (2017) ; New York Times (18/06/2020) ; Wall Street Journal (18/01/2019)

An analysis of fire regime mechanisms points to a change in the regimes that differs by region: in tropical rainforests and the boreal forests of the Urals, a decrease in available biomass is naturally accompanied by a drop in humidity, two factors that offset each other to limit the increase in expected burned area in response to climate change.[13] In the Mediterranean, on the other hand, an increase in available biomass and ignitions leads to a higher risk.

These fire regime changes coincide with the emergence of a new type of fire that is more complex and harder to control. To describe this shift, a new name has been coined for these extreme fire events: "megafires". Megafires are characterized by their intensity, swift spread and unpredictable behaviour. Their exact definition varies depending on the region: over 100,00 acres (40,500 ha) burned according to the US Interagency Fire Center, over 500 ha in general in Europe.[14] The size and intensity of these fires even creates a microclimate that feeds them, generating clouds called procumulus and lightning capable of setting off new fires.

Surface areas of burned land establish new records every year, and 2020 and 2021 were no exception. For California, 2020 was the worst fire season on record, with over 4% of its land area burned, which is almost 1.8 million hectares.[15] The "August complex" that began with 38 different fires following

lightning strikes is the biggest fire ever observed in California. The complex alone burned nearly 418,000 hectares of vegetation.[16] In 2021, the Dixie Fire with 275,000 hectares burned ranks second in the modern history of large fires in California.[17] In 2021, records were also beaten in Siberia. The Sakha Republic in particular saw its tundras burn from early June right through to the start of September. In total, the fires of 2021 in Russia emitted 806 $MtCO_2$ over this period.[18]

To combat these devastating fires, different solutions are gradually emerging, yet with some significant shortfalls.

Firefighting budgets favour short-term suppression rather than long-term prevention

In September 2021, the flames of three fires raged dangerously close to the Sequoia National Park in California, and to its trees, some of which are the biggest, oldest trees on the planet. In addition to combatting the flames with water and flame retardants, and the controlled burning of grass at the foot of trees, firefighters employed an innovative technique: the bases of some trees were enveloped in fireproof aluminium blankets. The protection of giant sequoias using these exceptional means illustrates the increased investments in emergency firefighting. Yet investments in preventing fires have not grown to the same extent. Governor G. Newsom has in fact been criticized for cutting prevention budgets while expenditure on emergency action has surged, exceeding one billion dollars for the first time in 2021.[19]

In the highly urbanized Mediterranean region, a 2019 WWF report describes forest fire action centred on suppression rather than prevention.[20] Out of total forest fire expenditure of about 2 billion euros a year for Spain (1.3 billion euros), France, Greece, Portugal and Turkey, on average 80% is spent on emergency action and 20% on prevention. The report points out the difficulties caused by national borders in combating fires in Europe, complicating cross-border assistance between countries (loan of equipment and/or personnel). The WWF analysis highlights the larger scale of suppression policies at the cost of prevention action based on land use and urbanization, faced with specific risks in the region generated by dry vegetation, the disappearance of orchards and crops, and the proximity between scrubland and urban areas.

The same observations had already been established by the European Commission in 2018, which recognized the imbalance between prevention and suppression and suggested developing an integrated forest fire management system.[21] The European Union set up the Resc'EU system in 2019, which works alongside the EU civil protection system to finance and make available to Member States a European resource fund including a fleet of water bomber airplanes and helicopters. Resc'EU is operating with a fund of 1.9 million euros for 2021-2024.[22] Prevention action is a lot less developed but does include the setting-up of a European network of knowledge-sharing on civil protection. The objective is to put experts in contact with associations working in the field in order to communicate their knowledge and provide support to all stakeholders throughout the disaster management process. This network is still in its early days, but has already organized expert exchange programmes, full-scale exercises, and expert training.[23]

Lastly, civil society and private companies can sometimes make up for gaps in public action to manage forest fires. In Russia and Indonesia, when national services impacted by budget cuts cannot deal with fires, associations organize funding and logistical campaigns to set up voluntary fire brigades, such as in Siberia in 2021, in camps supported by Greenpeace and Sinet-Spark.[24] In 2019, peatland fires in Indonesia in the Pulang Pisau district witnessed the mobilization of international volunteers to work alongside local communities, local authorities, and 29,000 agents from official firefighting services, soldiers and the police.[25] While equipment for volunteers and water are lacking, one of the tasks for reinforcement teams is to raise the awareness of local people about the danger of slash-and-burn cultivation during the dry season.

In September 2021, Google announced that it was integrating a new layer in its Maps application, on which users can see fires taking place thanks to data exchanges with the National Interagency Fire Centre. The fires it shows are the main fires that involve evacuations, for which the application provides information. For the United States, and soon Australia, these data also include updates on control of the fire, the surface area burned, and roads closed.

Although increasing numbers of initiatives are taking place, they are not enough to provide an effective solution for more intense and frequent megafires. To attempt to curb fires and contain them, forest restoration techniques calling on the knowledge of indigenous people and scientific knowledge are gradually being tested in different countries prone to fires.

Restoring forests to reduce their vulnerability

While the droughts and heatwaves observed in different regions round the world due to climate change create the conditions for these ecological and human disasters, the ecosystem management implemented in recent decades often makes things worse. Fires are in fact part of the natural cycle of forests: they regulate the quantity of biomass and thus reduce the risk of larger, uncontrollable fires. For some trees, fires are even essential to their reproduction. For example, only heat from fire can cause the cones on Jack pines to explode and release their seeds, while the heat or chemical composition of fire causes the seeds to sprout on coffeeberry and redberry shrubs. The ponderosa pine has a thick bark that enables it to resist frequent fires of low intensity.[26] Progress in knowledge of the causes of fire and the impacts of systematic suppression are leading to more long-term strategies that fit in with the natural rhythm of forests, based on the ancestral practices of indigenous people, on the development of the timber industry, or on the financing of integrated research.

In many regions, attention is turning back to traditional indigenous practices (**see Forestry trend**). Traditional crop farming often involves controlled slash and burn to clear undergrowth, promote certain species, and increase soil fertility. In California, the Karuk and Yurok tribes are working with forestry services:[27] the frequent slash and burn employed by these tribes

encourages the growth of hazelnut trees that the locals use to weave baskets, fostering both ecosystem functioning and the socio-economic balance of indigenous people.

In Australia, indigenous populations traditionally avoided major fires by creating cool-burning, knee-high blazes in the bush during periods when it was not dry.[28] As a result of selecting which plots to burn, for how long, and how often, a patchwork of trees and grassland was created that was resistant to bushfires and attracted marsupials that could be hunted. The abandonment of these once illegal practices has resulted in overgrown, thick vegetation that is more likely to propagate fire. Recently, partnerships between indigenous peoples and firefighters have applied these ancient practices, first on indigenous peoples' territories and then gradually in the rest of the country. The limitations of the system include the difficulty of obtaining the right conditions of humidity, temperature and wind to get the benefits of controlled burning.[28]

In the southwest of the United States in 2010, faced with sizeable risks, a widescale initiative to restore the ecosystem was set up, covering four national forests and grouping thirty stakeholders from the forest lumber industry, including local authorities, companies and associations: the Four Forest Restoration Initiative (4FRI). The project concerns 970,000 hectares of ponderosa pine forests and involves different types of action, two of which aim to reduce the quantity of biomass that could act as a fuel for fire – the creation of clearings and controlled fires. The overall objective of the programme is to structure and operate forests in line with the natural dynamic of fires by which the ecosystem self-regulates. After ten years, the results of the programme are mixed. While the restoration of habitats and catchment areas is judged significant, objectives to reduce biomass have not been reached.[29] Of the annual 12,000 hectares of preventive clearings planned, only about one-third have been created due to difficulties in developing a timber processing industry that is ill-equipped to handle small-scale timber. In Arizona, for example, the timber yards that secured contracts have not reached their timber targets due to insufficient investment in the necessary machines.[29] Some voices are calling to implement controlled burning rather than mechanical timber harvesting to deal with dense forests.

In Canada, the approach is to develop scientific knowledge on new fire regimes. A strategic research programme on forest fires was recently launched, called Blueprint Canada.[30] The programme's objectives are to improve understanding of delays in scientific knowledge, establish research priorities, and develop scientific and technological tools to make Canadian forests more resilient to fire. Blueprint Canada is run by the Canadian Forest Service, which coordinates exchanges between government partners and indigenous groups, academics and associations.

KEY TAKEAWAYS

As forest degradation and deforestation worsen, a new type of forest fire is emerging: megafires. The budgets and means allocated to fight these fires remain concentrated on suppression, and often overlook the vital aspect of prevention. Private companies and associations sometimes supplement the means implemented by public authorities, through numerous initiatives, such as funding campaigns and logistical assistance. At the same time, and with a view of limiting forests' vulnerability to fire, governments, scientists and indigenous communities are working closely together to find more successful, controlled ways to restore forests.

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