Technical Report

UNITED NATIONS UNIVERSITY
UNU-EHS

Interconnected Disaster Risks
2020/2021

Amazon Wildfires

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Table of Contents

1. Event

In 2020 the Amazon rainforest, one of the largest, most biodiverse ecosystems on Earth, was again ravaged by fires (Voiland, 2021). Although the Amazon rainforest experiences human-made fires on a yearly basis, coinciding drought conditions in 2020 turned them into the worst wildfires since measurements began, in 1998 (Woodwell Climate Research Center, 2020). In terms of area burned, the fires of 2020 were the largest since 2010 (INPE, 2021). Most of the over-2,500 individual fire events occurred in the Brazilian Amazon (88 per cent), followed by the Bolivian Amazon (8 per cent) and the Peruvian Amazon (4 per cent) (MAAP, 2020). Despite its geographical location (see Figure 1), the Amazon fires have larger-scale global impacts, interfering with climate and weather patterns, and the conservation of ecosystems for the provision of services associated with medicine, agriculture, and other key industries essential for the survival of humanity (Müller, 2020).

2. Impacts

Around 17 per cent of all primary forests have been destroyed in the Amazon region in the last 50 years (Müller, 2020). In 2020 alone, an estimated 20,000 km² of primary forest was lost (MAAP, 2021) as a result of wildfires and other deforestation practices. Wildfires and deforestation often go hand in hand, as fires are frequently used as tools to clear land for agriculture before turning into wildfires. The impacts of wildfires are thus not easily separable from those of deforestation (Voiland, 2021).

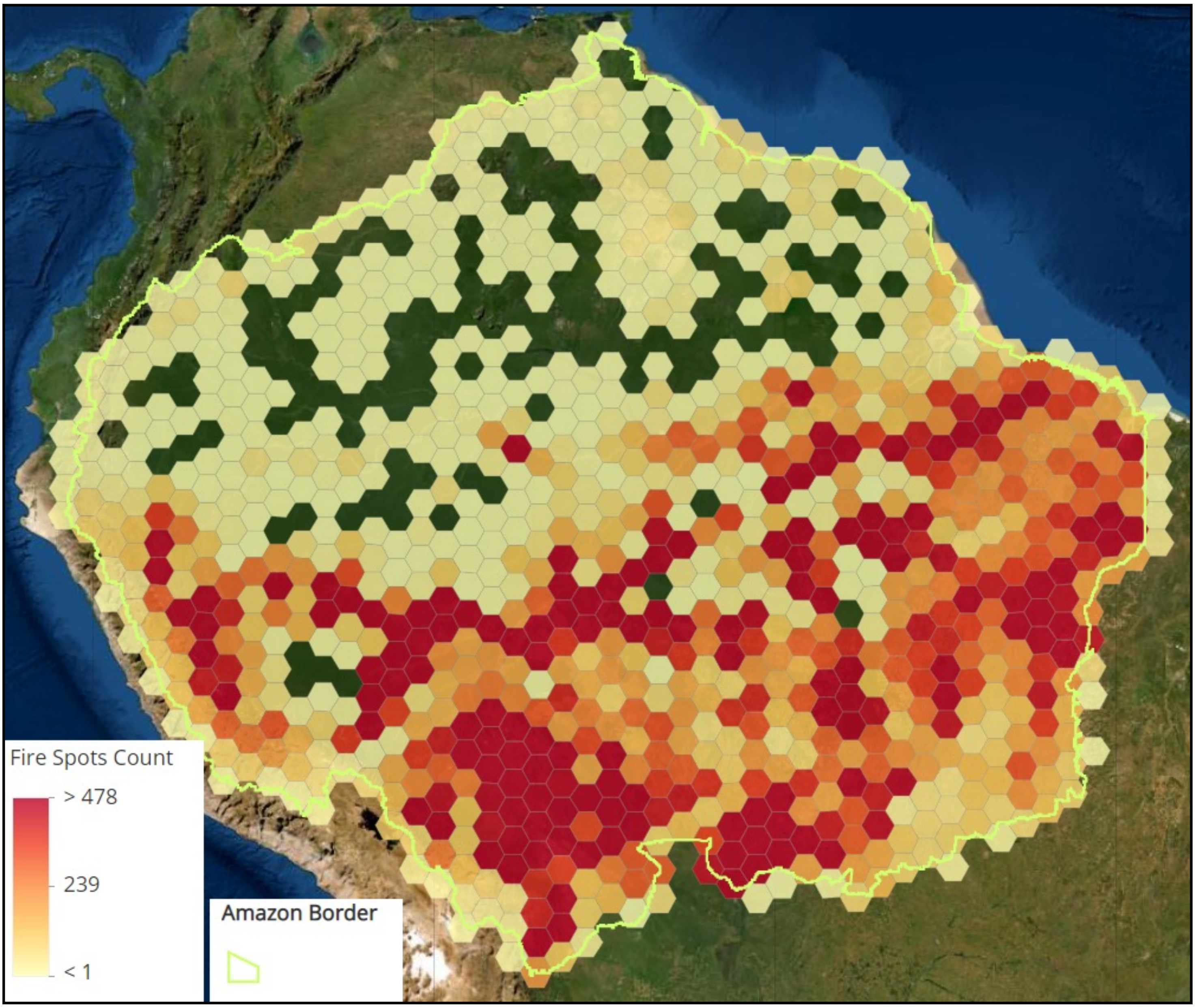


Figure 1: Wildfire density in the Amazon region in 2020 (adapted from Poirier, 2020).

The destruction of the Amazon has devastating impacts. With 40,000 species of plants, 16,000 tree species, 2.5 million species of insects, at least 4,000 species of fish and amphibians, 1,300 species of birds and at least 430 species of mammals, the Amazon represents one of the most important biodiversity hotspots in the world (Butler, 2020). Destroying this ecosystem results in serious long-term impacts as well as the emergence of new dangers and risks (for example, zoonotic diseases as described in the technical report on COVID-19). According to preliminary findings of the Science Panel for the Amazon, 10,000 species are at risk of extinction in the Amazon rainforest (Eisenhammer & Griffin, 2021) (to put this into perspective, the extinction of a single species of freshwater fish [one of 16 in the year 2020] is featured in the main report for its implications on the global picture of biodiversity crisis – see Chapter 2, Chinese Paddlefish Extinction). This happens as a direct result of habitat loss, and also as a result of fragmentation, pollution and an increase in vulnerability through 'edge effects', where areas of forest freshly exposed on the 'new edge' made by deforestation experience different environmental conditions they are often not adapted for, like changes in wind or temperature conditions (Müller, 2020). Due to the combination of these effects and the changing climate, Gomes and others (2019) expect a decline of 58 per cent in Amazon tree species by 2050. This pattern of biodiversity loss is contributing to a global biodiversity crisis (see main report, Chapter 3.3 Emerging risks) and is not confined to tree species, forest species or land species (see Technical Report, Chinese Paddlefish Extinction).

In addition to the loss of forest cover and its direct impact on flora and fauna, wildfires also cause significant air pollution, in this case mainly through fine particulate matter, and are associated with respiratory admissions into hospitals (Liu and others, 2017). This impact is critical for people living where the fires take place. However, as the smoke and other pollutants can travel long distances, air pollution can also impact people in other areas. In 2020, 4.5 million people were affected by harmful levels of fine particulate matter associated with air pollution and at least 2,195 people were hospitalized due to respiratory illness associated with fire-related air pollution (HRW, 2020).

Besides these direct impacts manifesting after the fire season of each year, some impacts manifest only accumulatively from many fire seasons after a long period of time. The Amazon rainforest as a tropical forest biome is an important regulator of the global carbon cycle and climate change. It has historically represented an important carbon sink, absorbing carbon to photosynthesize and thrive (Mitchard, 2018). However, as a result of logging, burning and degradation the carbon stored in the forest is being released. Such human interventions turn the natural carbon sink actively into a source of carbon emission (Qin and others, 2021). With increased anthropogenic activity and disturbance, the Brazilian Amazon turned into a net carbon source of emissions between 2001 and 2019 due to deforestation and wildfires. Although the wider Amazon River basin continues to be a net carbon sink, this might change in the future if deforestation patterns and wildfires continue to their current extent, or even worsen (Mitchard, 2018).

Box 1: What types of fires can be found in the Amazon rainforest?

According to Barlow and others (2020) there are three types of fires in the wider Amazon region (see Figure 2, yellow boxes): first, deforestation fires – where fire is used as a tool to further clear deforested primary forest for agriculture; second, fires on already cleared land – with the goal to remove weeds and maintain pasture land; and third, unintentional fires in forests. These are mostly understory fires that may occur repeatedly, resulting in more intense fires.

The Amazon wildfires of 2020 were mostly intentionally lit deforestation and pasture-maintenance fires (Voiland, 2021). The understanding of what types of fire are prevalent, what exactly is burning and because of what drivers is crucial to manage wildfires and has important implications for policy responses (Barlow and others, 2020).

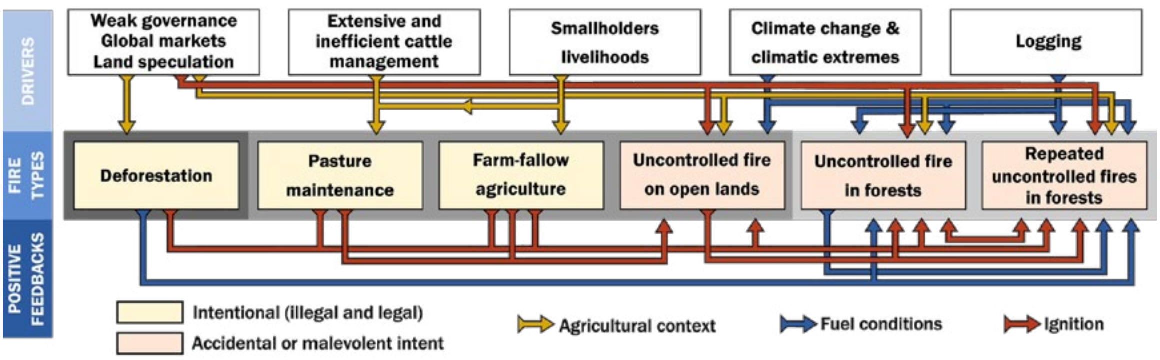


Figure 2: Types of Amazon fires, drivers and positive feedbacks. The three types of fires are in the yellow boxes (adapted from Barlow and others, 2020).

Some research indicates that this tipping point has already been reached (Gatti and others, 2021). Regardless of whether this tipping point has already been reached or will be reached in the future, deforestation and wildfires have already lowered the carbon-storage capacity of the rainforest and have been leading to the emission of greenhouse gases (GHG), worsening climate change on a global scale (Mitchard, 2018).

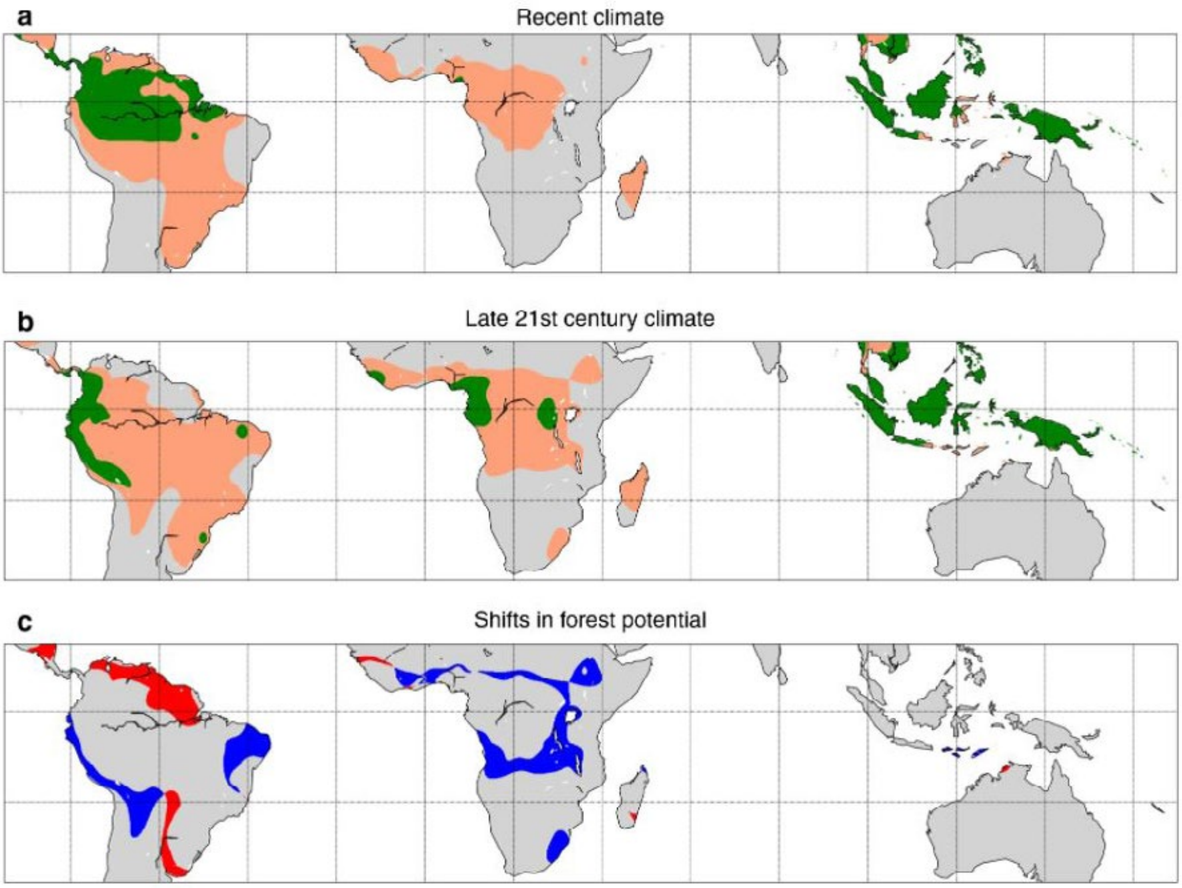
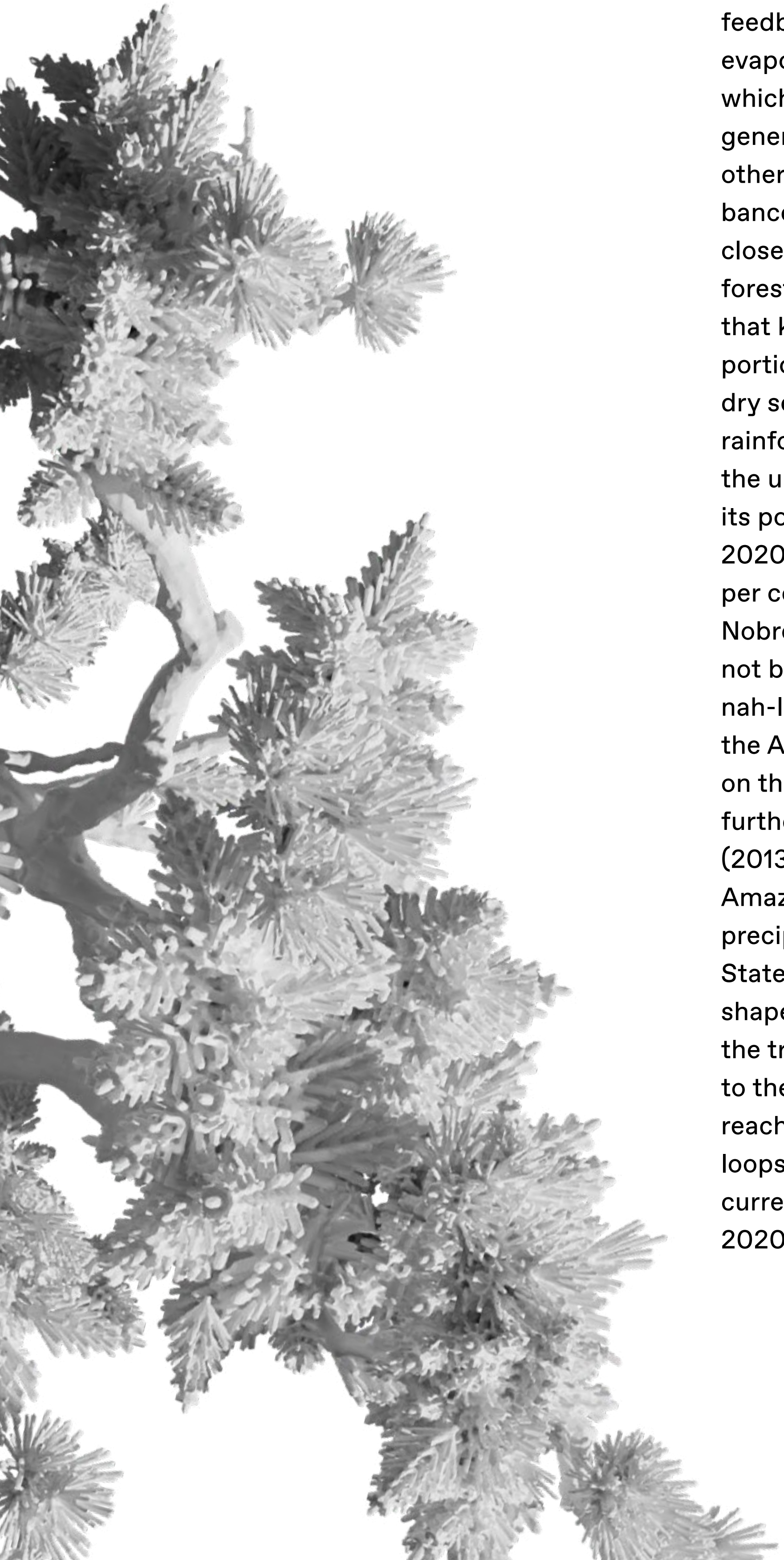


Figure 3: Change of potential forest cover due to changing climate in the 21st century. a Minimal (green) and maximal (beige) cover of tropical rainforest under the current climate (2003–2014). b Minimal (green) and maximal (beige) cover of tropical rainforest under the late-21st-century climates. c Red areas are currently stable rainforest areas that will most likely cross the tipping point under the late-21st-century climate, after which they cannot sustain forest ecosystems; blue areas are currently too dry for rainforest but will get rainfall in a range able to sustain forests under the late-21st-century climate (Staal, and others, 2020b).



Another potential long-term impact of deforestation and wildfires can be found in the ability of the tropical forests to shape their spatial extent by creating their own climatic conditions. Tropical forests are able to influence the water cycle through rainfall feedback loops, where dense vegetation increases evapotranspiration leading to an increase of rainfall, which then enables more vegetation to grow and generates more rainfall, creating a loop (Staal and others, 2020b). The numerous threats and disturbances discussed above mean the Amazon biome is close to reaching a tipping point, at which stage the forest will no longer be able to sustain the processes that keep it alive. This will result in the most affected portions suffering diminished rainfall and prolonged dry seasons (Lovejoy & Nobre, 2018). The Amazon rainforest might lose its stability and resilience in the upcoming decades, leading to drastic changes in its potential extent and structure (Staal and others, 2020b). This tipping point might occur when 20-25 per cent of forest area is deforested (Lovejoy & Nobre, 2018). Even parts of the Amazon that have not been deforested might shift into a drier, savannah-like ecosystem (WWF, 2021). These changes in the Amazon water cycle can have drastic impacts on the water availability in Brazil, and also in areas further away. For example, Medvigy and others (2013) estimate that the total deforestation of the Amazon would lead to a 10–20 per cent reduction in precipitation for the coastal northwest of the United States. The dependence on weather conditions shaped by the tropical forests can also be found in the tropical forests of Africa and Australasia. Similar to the Amazon, these biomes are highly at risk of reaching a tipping point where the rainfall feedback loops will not be able to sustain the forests in their current extent (see Figure 3) (Staal and others, 2020b).

3. Drivers

In view of these impacts, urgent questions arise as to how such a thing could happen. This chapter will explain the factors that directly contributed to this disaster (drivers). In contrast to many of the wildfires that ravaged uncontrollably around the globe in 2020, 93 per cent of the wildfires in the Amazon rainforest were lit intentionally (Ramírez, 2019), mainly as part of a multi-step process that converts land from tropical rainforest into farm land and building land (Voiland, 2021). This process often occurs in two steps: in the first step, often in the first half of the year, trees are removed from the areas; in the second step, in the second half of the year, the land is fully cleared from any remaining plants through burnings (MAAP, 2021). In the Amazon region, the wildfires are so closely related to general deforestation practices that they can only be understood when also looking at drivers and impacts of general deforestation.

Land-use pressure

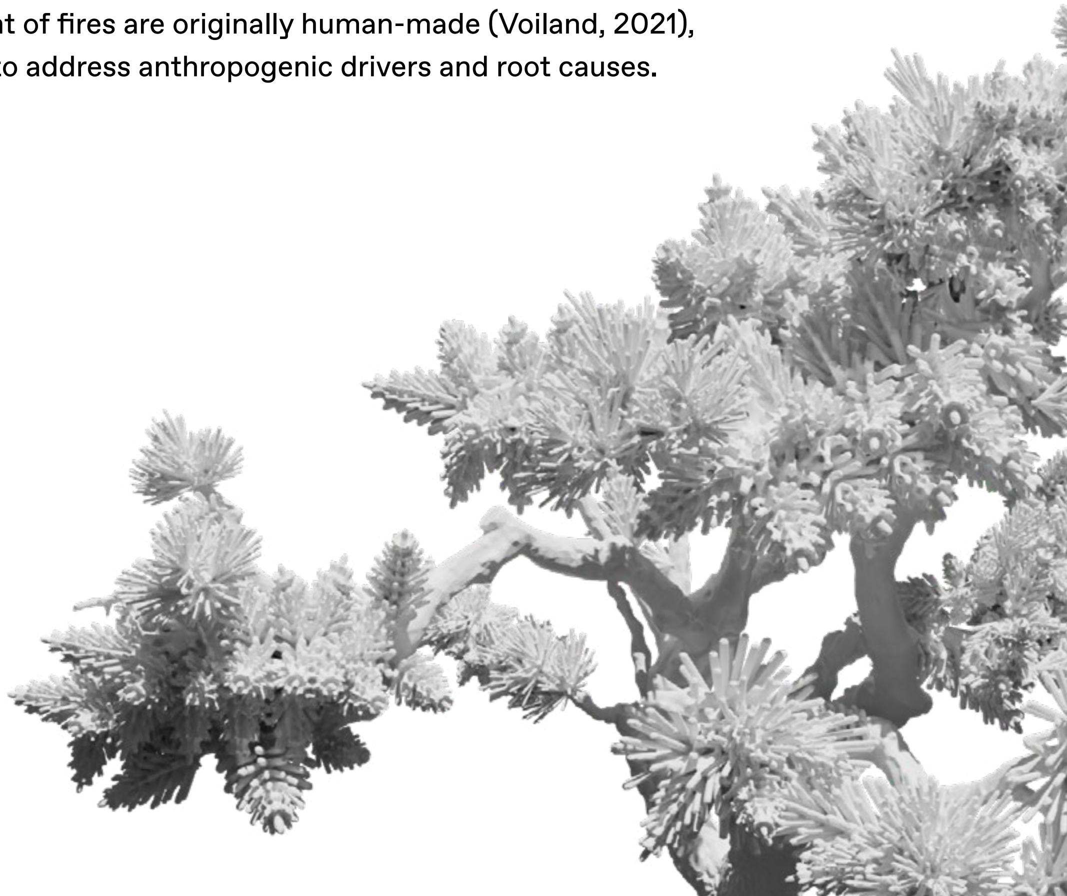
More than half of the Amazon region is experiencing pressure on land, i.e. pressure from clearing land for other more economically viable uses, such as agricultural production and exploitation of natural resources, promoting deforestation and wildfires (RAISG, 2020).
In the last decades, these land pressures have increased, leading to more incentives for deforestation (RAISG, 2020). As of 2020, road density is around 18.7 km/1,000 km^2; there are 177 hydroelectrical plants; 433 oil extraction sites covering a total area of 797,824 km^2; 84,767 areas with mining interest covering a total area of 188,374 km^2, plus an estimated 4,472km^2 where illegal mining is taking place. Despite this diversity of human activities putting pressure on the Amazon rainforest, 84 per cent of the forest cleared is for agricultural activities, including cattle ranching and soy production (RAISG, 2020).

Lack of commitment to environmental protection by national governments

Even though deforestation and wildfires have taken place in the Amazon for decades, recent policies have contributed to the increase in wildfires, particularly in Brazil and Bolivia (Ramírez, 2019). The lack of enforcement of environmental practices went so far that it is possible to publicly purchase freshly deforested land in the Amazon that should be in the hands of indigenous communities, but instead has been destroyed illegally and sold (Fellet & Pamment, 2021). The private sellers are most likely targeting indigenous land to sell off illegally due to the lack of strong enforcement of environmental protection by the Government. They often deforest land and then argue for the removal of the protection status of that area as it no longer serves its dedicated purpose. This often works as many of these organizations have allies in higher political positions who might admit their support but claim to have no knowledge of any illegal activities (Fellet & Pamment, 2021).

Drought

The drought of October 2020 worsened the Amazon wildfires. The southern Amazon saw only 1,100 mm rainfall that year (compared to the average annual 1,400 mm), which is the lowest recorded since 1981 (Woodwell Climate Research Center, 2020). The dry conditions are very likely related to the strong La Niña that developed in the last months of 2020 (Woodwell Climate Research Center, 2020). The strong impacts of La Niña were also found on the other side of the Pacific Ocean, although here it led to increased precipitation (see Technical Report, Central Viet Nam Floods). Drought is exacerbating wildfires and fire risk by reducing the moisture and effectively increasing the likelihood of ignition as well as the availability and flammability of fuel (Littell and others, 2016). It is important to keep in mind that even though drought and climate change are generally worsening wildfires, in the case of the Amazon wildfires 93 per cent of fires are originally human-made (Voiland, 2021), meaning potential solutions need to address anthropogenic drivers and root causes.



4. Root causes

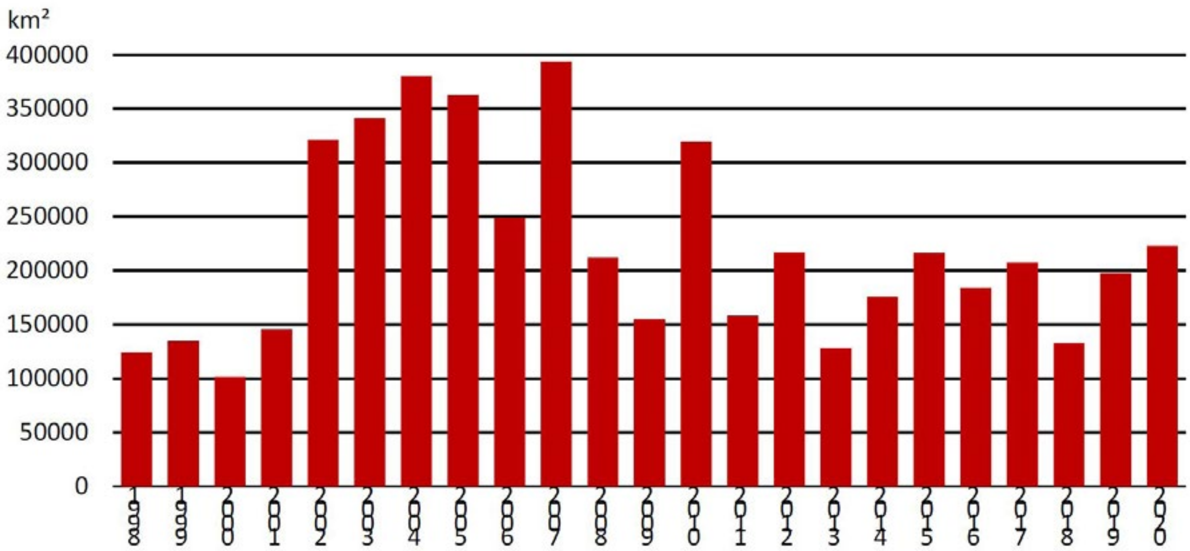
Environmental costs and benefits undervalued in decision-making

The wildfires have been partly getting worse in the last few years due to anti-nature-conservation messaging provided by some national governments in the Amazon region towards land speculators and illegal loggers. For example, the Brazilian Government under the presidency of Jair Bolsonaro has officially declared a zero-tolerance policy for illegal logging and wildfires, even displaying the establishment of a military-led control operation to combat illegal activities (Müller, 2020). However, there was a substantial drop in Government spending on the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) in 2020, and the Brazilian President personally declared his support for landholders setting wildfires (Angelo, 2020; Müller, 2020). Despite the articulated goal of deforestation to improve economic wellbeing, deforestation in the Amazon has not increased the quality of life and has not led to better development in the region (Moutinho and others, 2016). The current prioritization of profits leads to an undervaluation of many environmental costs and benefits (see main report, Chapter 3.2 Deep dive into the root causes of 10 disastrous events – Full environmental cost undervalued in decision-making). A paradigm shift would be needed, which realizes that socio-economic development can only be achieved by preserving the forest’s capacity to generate and provide ecosystem services (Moutinho and others, 2016).

Global demand pressures due to wood, fodder and food consumption

Box 2: Historical context and future occurrence of the Amazon wildfires

Most of the Amazon rainforest is part of Brazil. At the same time most of the wildfires in 2020 (88 per cent) also took place in Brazil (MAAP, 2020). The historical development of wildfire is displayed in Figure 4. One can clearly see the increase of burned forest land in 2019, which has been attributed to the election results and the Bolsonaro regime (Müller, 2020). At the same time one can clearly see that wildfires have been an impactful problem long before the inauguration of Jair Bolsonaro, hinting towards more systemic root causes of the wildfires. Any solution needs to understand these root causes and address the recurring nature of wildfires.



Given their seasonal recurrence, wildfires will continue to be a hazard in the future. The increase of deforestation under the Bolsonaro regime will most likely continue. In combination with the increasing meat demand (Phillips and Standaert, 2021) and the change in weather conditions due to climate change, wildfires may become more frequent, longer and more severe (Wedeux and Schulmeister-Oldenhove, 2021). Furthermore, the expansion of roads through the Amazon rainforest (RAISG, 2020) will make large undisturbed areas of the Amazon accessible to economic expansion, increasing potential forest losses (Moutinho and others, 2016).

The land pressure in the Amazon region can be traced back to the high profitability of agricultural exploitation in contrast to forest protection. Livestock for consumption as well as fodder are the main uses of deforested land. Their demand, therefore, is the root cause of the recently deforested and burned rainforest (RAISG, 2020; Heal and others, 2020; Ermgassen and others, 2020).

With an estimated annual value of over US$5.4 billion, the Brazilian beef export industry is the biggest in the world (Ermgassen and others, 2020). Brazil's industry alone is linked to one-fifth of all commodity-driven deforestation in the tropics globally (Ermgassen and others, 2020). Considering tropical deforestation globally, the European Union was the largest importer of goods associated with deforestation and associated emissions between 2005 and 2013. In 2014, China became the biggest importer of goods driving deforestation. As of 2017, China remains the main importer (24 per cent of all trade), including soy, palm oil and beef, and also wood, cocoa and coffee, followed by the European Union (16 per cent), India (9 per cent), the United States (7 per cent) and Japan (5 per cent) (Wedeux & Schulmeister-Oldenhove, 2021).

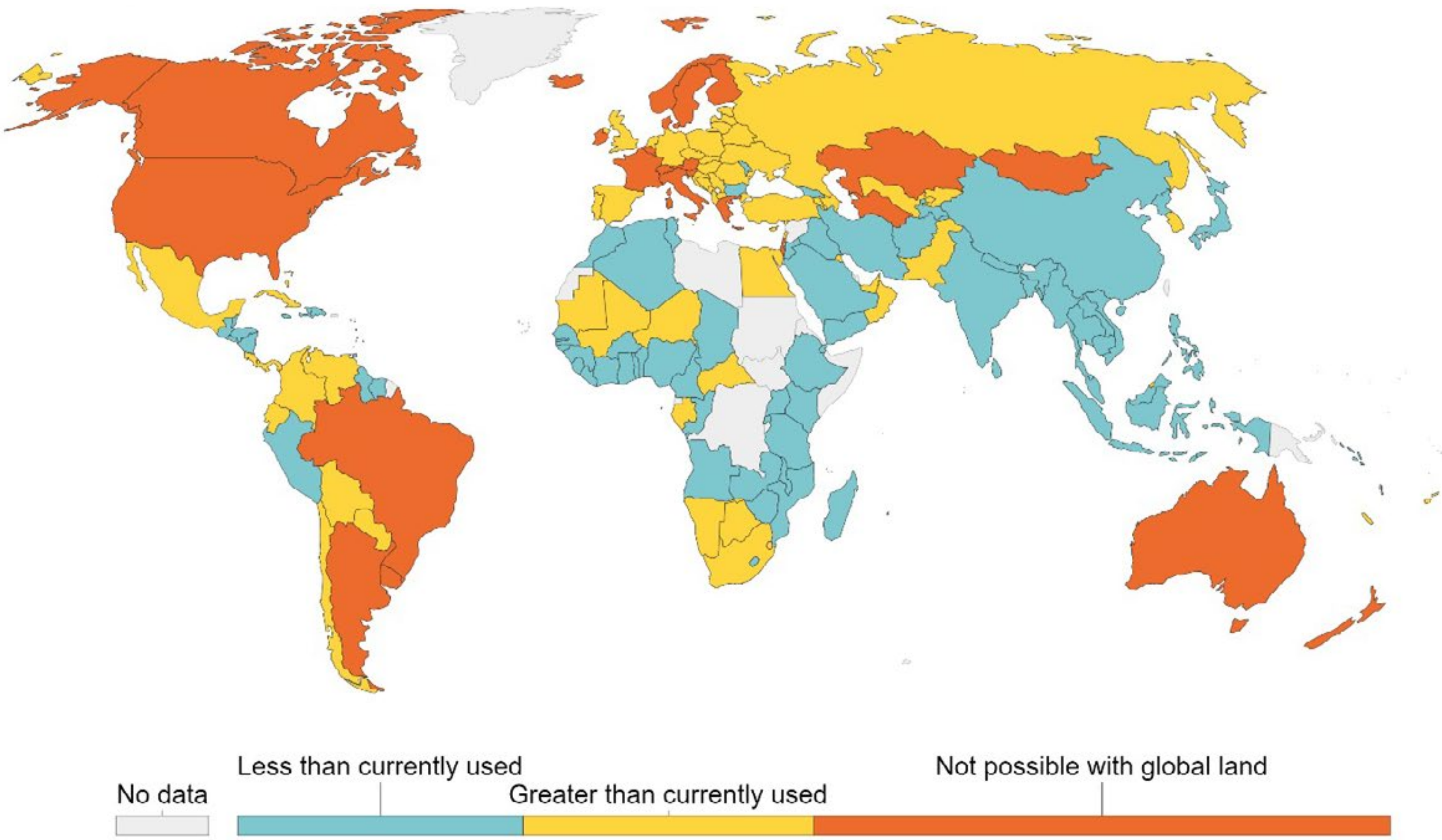


Figure 5: Share of global habitable land needed for agriculture if everyone had the diet of one specific country (data from 2011, Ritchie, 2017, adapted from Alexander and others, 2016).

The cause of deforestation is not only high consumption of meat and the associated cattle ranching in freshly deforested areas, but also the expansion of soy production. Here it is important to keep in mind that of all globally produced soy, only 19.2 per cent is used for direct human consumption – mostly in the form of soybean oil – compared with 77 per cent fed to animals, mostly poultry and pigs, and 3.8 per cent for industrial use (FAO cited in Our World in Data, 2021). Deforestation driven by the expansion of soy production can, therefore, also be traced back to the increased global meat demand. The increased meat demand in turn is associated with higher incomes and increased urbanization. Therefore, higher meat consumption can be mostly found in industrialized and newly industrialized countries (OECD & FAO, 2020). Considering that the current demand of many countries is already exceeding the potential agricultural area of their own countries, pressure on land through the expansion of agriculture is manifesting elsewhere (Alexander and others, 2016; Willett and others, 2019). Figure 5 illustrates how much global habitable land would be needed for agriculture if everyone had the average diet of one specific country. If the world would, for example, adopt the average United States diet we would need to convert all habitable land to agriculture and still be 38 per cent short of covering the demand (Ritchie, 2017).

Human-induced GHG emissions are the root cause of increasingly dry and warm conditions in the Amazon (Staal and others, 2020a). The dry season length in the south-east Amazon has increased by around 0.6 days per year since the 1970s (Brando and others, 2020a). This has accumulated to a nearly one-month prolonged dry season per year now. This climate change-related lengthening of the dry season is contributing to longer, hotter and drier fire seasons (Barlow and others, 2020). The subsequent loss of forest cover decreases the amount of water evaporating into the atmosphere, while smoke also reduces rainfall and cloud cover by trapping moisture and preventing raindrops from forming. These factors exacerbate drought stress, creating a cycle that intensifies over time (Laurance & Williamson, 2001). Brando and others (2020b) estimate that projected climate change will double the area burned by wildfires. The positive feedback loop between wildfires/deforestation and drought/climate change might continuously worsen wildfires as well as climate change as an increase in either of them will also increase the severity of the other (Staal and others, 2020a).

5. Solutions

To end deforestation and wildfires in the Amazon region, root causes need to be addressed by political action on both the national scale by federal and local authorities as well as the international scale by distant but interconnected actors (Ramírez, 2019). A straightforward solution would be to reduce global meat demand through the implementation of more sustainable diets (Aleksandrowicz and others, 2016). In cases where this is not possible, or where there is a lack of political commitment for dietary changes, international agreements could be implemented with the goal of channelling the meat demand into more sustainable agricultural practices that do not lead to wildfires and deforestation (Gibbs and others, 2015). Direct payments for forest protection though civil society or NGOs are another viable solution (Zanon, 2020). All of these solutions can be very effective, however the interconnected root cause of 'insufficient national/international cooperation' must be addressed to make them viable (see main report, Chapter 3.2 Deep dive into the root causes of 10 disastrous events). Another highly effective change would be a paradigm shift away from the false juxtaposition of profit/economic development and environmental protection towards an understanding of the protection of the Amazon and its ecosystem services as critical for achieving prosperity in a sustainable way (Moutinho and others, 2016).

Box 3: What role do indigenous territories and protected natural areas play in the Amazon wildfires?

Indigenous territories cover 2,376,149 km^2, or 27.5 per cent of the Amazon region; protected natural areas cover 2,123,140 km^2, or 24.6 per cent of the region. Due to overlaps a total of 47.2 per cent of the Amazon region is covered by indigenous territories and/or protected natural areas, as of December 2019 (RAISG, 2020 – see Figure 6).

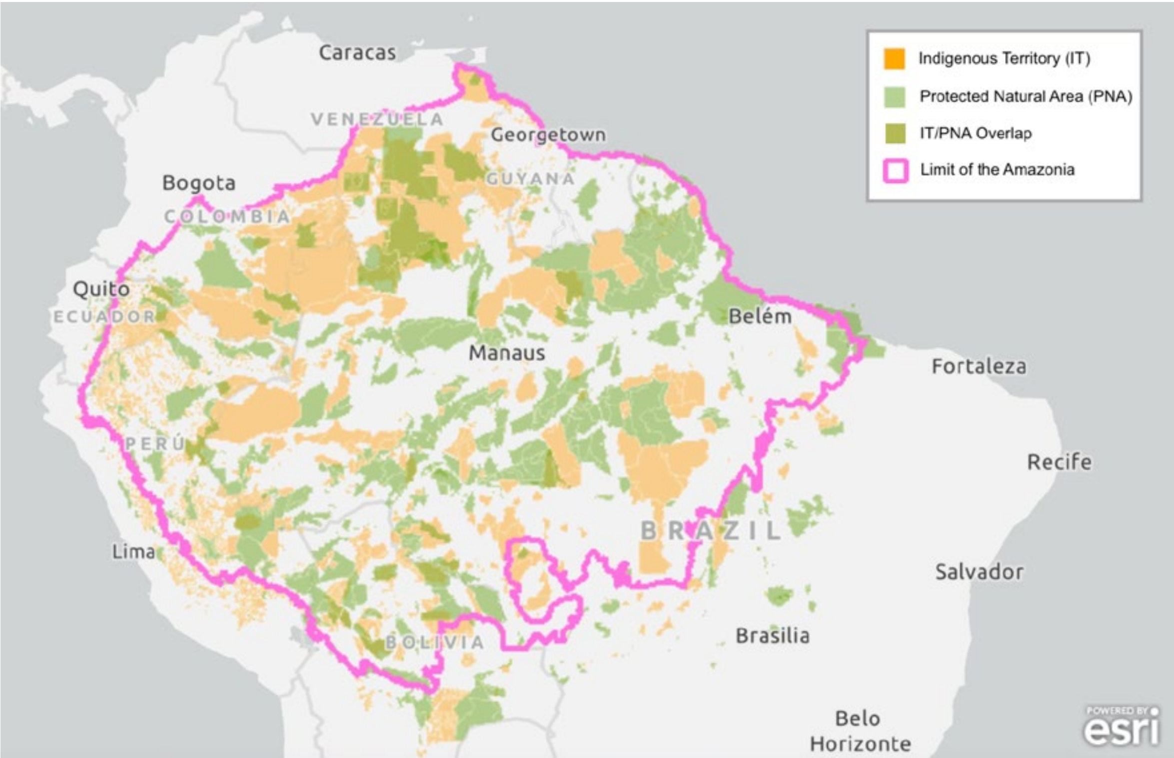


Figure 6: Indigenous territories and protected natural areas (Data from RAISG, 2020)

Twenty-five per cent of wildfires in the Amazon region occur in indigenous territories and/or protected natural areas (see Figure 7). Indigenous communities are dependent on primary forest land. Designated indigenous territories are intended to safeguard indigenous livelihoods for social, cultural and equity reasons as well as to avoid the communities' dependence on markets for subsistence (Walker and others, 2020). The destruction of forest in indigenous territories and/or protected natural areas is not only always illegal, but also has especially strong impacts on indigenous livelihoods and the destruction of particularly biodiverse and carbon-rich areas (RAISG, 2020).

Box 3: What role do indigenous territories and protected natural areas play in the Amazon wildfires?

Protected natural areas and indigenous territories are important conservation areas to promote environmental protection. In some indigenous territories the locals have taken action against illegal deforestation; the support of indigenous communities is directly linked to a decrease in deforestation and degradation of native forests (RAISG, 2020). The expansion of indigenous territories and protection of their land rights could be one solution to deforestation and wildfire practices (Moutinho and others, 2016). The designation of public forests and nature-protected areas outside of indigenous territories is also effective in limiting the availability of land for uncontrolled expansion and agricultural land-use change (Stabile and others, 2020; Moutinho and others, 2016).

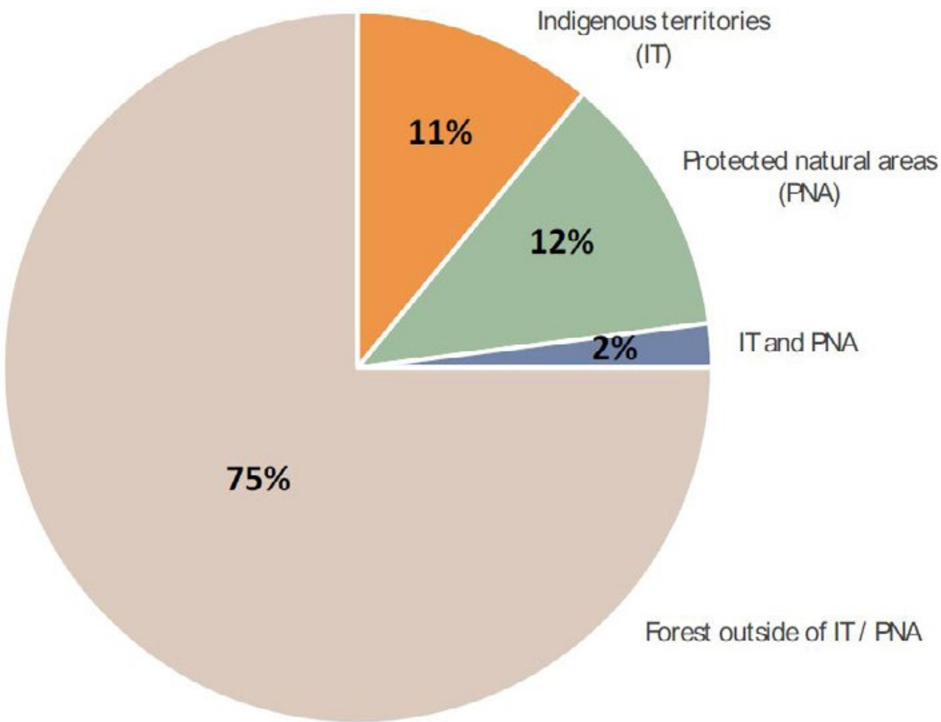


Figure 7: Proportion of indigenous territories and protected natural areas of the wider Amazon regions affected by wildfires 2001–2019 (Data from RAISG, 2020).

Reduce global demand for meat

Shifts in dietary patterns can provide benefits for the environment and health. A healthy diet that could promote 10 billion people living on Earth would need to include more than a doubling of fruit, vegetables, legumes and nuts consumption, while reducing the consumption of, for example, added sugars and red meat by more than 50 per cent (Willett and others, 2019). Even though the complete removal of animal-source foods is not realistic in many cultures and may have health and food-security implications, a shift of typical Western diets to more sustainable dietary patterns will have an overall positive effect on our health, GHG emission, water and land-use (Aleksandrowicz and others, 2016).

Changing dietary behaviour is difficult. The microenvironments we live in, such as worksites, friend circles, schools or restaurants, affect our consumption behaviours through social pressures and individuals might not have the motivation or capacity to change their diets (Rose, 2018). One way to help people shift to a more sustainable diet is a change of these microenvironments. Bianchi and others (2018) found that especially the reduction of portion sizes in meat servings, the provision of meat alternatives and a change of the sensory properties of meat products and its alternative are promising changes that promote lower demand for meat. Another option could be the implementation of carbon taxes and other environmental taxes to discourage meat consumption (Aleksandrowicz and others, 2016; Rose, 2018).

Channel global demand in more sustainable practices through multilateral agreements

In 2006 a soy moratorium was signed by all major agribusinesses in the Amazon region. This voluntary zero-deforestation agreement forbids the purchase of soy grown on land deforested after July 2006 (Gibbs and others, 2015). From time to time, big food companies have been accused of breaking this contract by being supplied by farmers who have been sanctioned multiple times after destroying rainforest areas (Wasley and others, 2021). Food giants, accused of breaking the moratorium indirectly by partnering with recently sanctioned farmers, have exported millions of tons of soy in recent years from Brazil to China, Saudi Arabia, Russia, Spain, Portugal, the Netherlands and the UK, where it is used as poultry, pig and cattle fodder (Wasley and others, 2021). The soy moratorium and other agreements like the beef moratorium need to be enforced more rigorously to be effective. They also need to be extended to neighbouring ecosystems to prevent simple redirection of land-use pressure into the destruction of other ecosystems, for example the Cerrado biome south of the Amazon (Gibbs and others, 2015).

Direct interference with deforestation, forest protection payments and reforestation

To prevent wildfires from occurring, direct interventions on-site that stop and prosecute illegal activities can be made. International players can support organizations, directly interfering when deforestation is taking place, financially or through the provision of other goods. Actions that circumvent the national government and instead assist at the regional/state level have been successful in reducing deforestation and wildfire (Müller, 2020). Müller (2020) argues that, at least during the current administration, support to civil society and non-governmental organizations might be the most useful for reducing the destruction of the Amazon. At the same time direct payments to protect forests can help in creating the financial security rural producers need to prevent them from harvesting forest resources. One example of an initiative promoting these types of payments is Conserv, which is led by the Brazil-based Amazon Environmental Research Institute (IPAM) and aims to preserve 20,000 to 30,000 hectares of vegetation at a cost of $4.5 million (Zanon, 2020). Furthermore, reforestation and the creation of secondary forest is proven to ease pressure on primary forest by creating an alternative source of timber, and can help to rebuild the carbon stock in the Amazon River basin (Heinrich and others, 2021).

Inclusion of environmental protection in economic activities

(addressing the root cause 'full environmental costs undervalued in decision-making')

According to Moutinho and others (2016), the Brazilian Government could achieve zero deforestation through, among other solutions, the implementation of social and environmental safeguards for infrastructure plans, more positive incentives for the production of sustainable commodities, a new policy to guarantee the social and environmental sustainability of rural settlements, and the full implementation of the national legislation protecting forests (the Forest Code). There needs to be a paradigm shift away from the false dichotomy of environmental protection versus economic development, towards an understanding that acknowledges the importance of ecosystems and their services as essential bases to allow sustainable economic development. This move would need to address the factors behind the root cause 'full environmental costs undervalued in decision-making' to be viable (see main report, Chapter 3.2 Deep dive into the root causes of 10 disastrous events): as long as stakeholders are not convinced of the seriousness of the impacts of environmental degradation they are unlikely to adhere to protective legislation in an effective way. Between 2004 and 2017 annual deforestation fell in the Brazilian states where the Amazon basin is situated by >70 per cent, while soybean production increased by >130 per cent and beef production by 72 per cent, suggesting that there is an opportunity to increase agricultural production without new deforestation by optimising already cleared land and innovating agricultural techniques (INPE 2018 and IGBE 2019, cited in Stabile and others, 2020).

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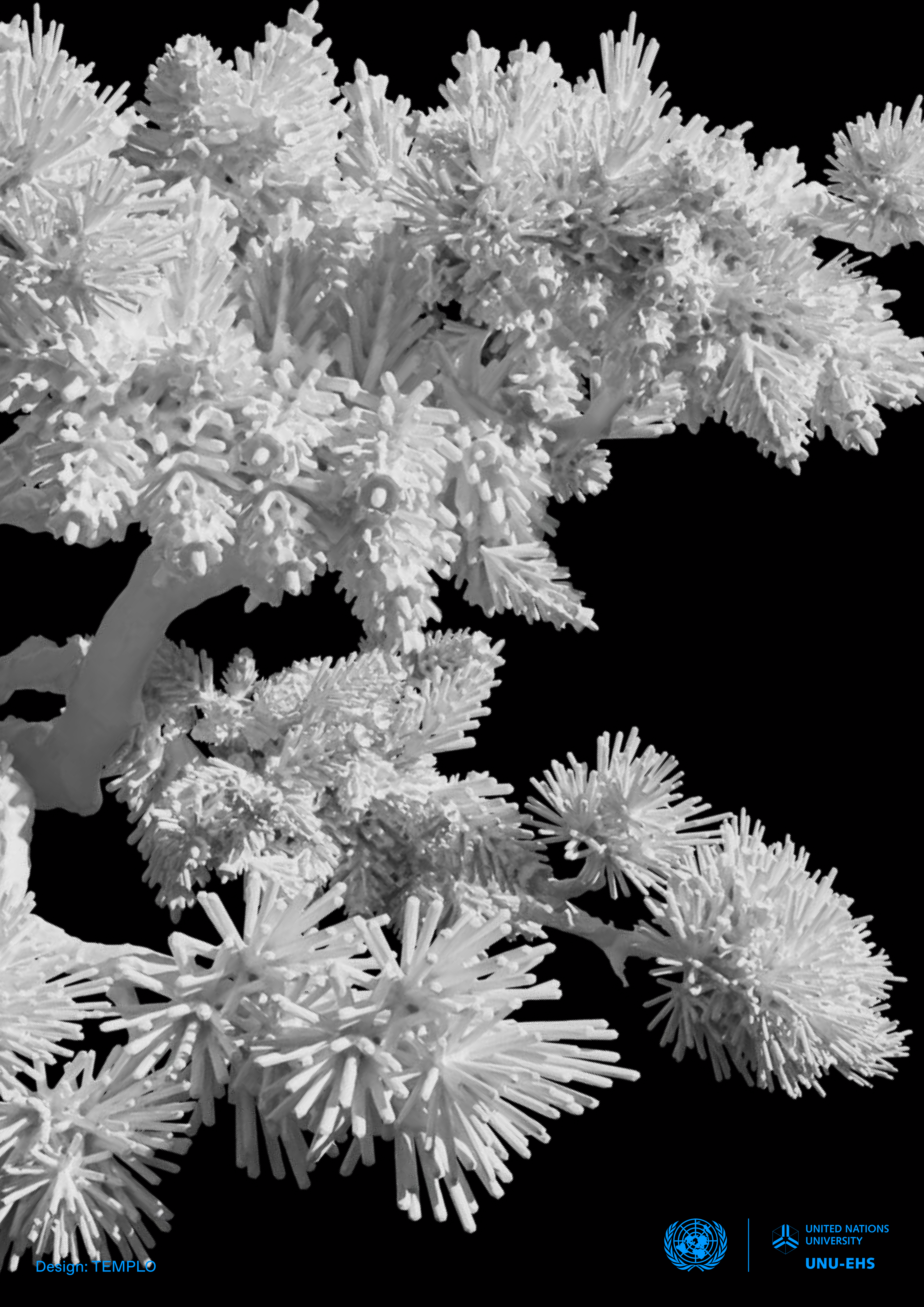

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