

ENVIRONMENTAL STUDIES

GROUP 13



AMAZON FOREST FIRE

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ABSTRACT

Amazon forest is a major contributor of oxygen supplier. Recently there has been an increase in forest fire all over the world including the Amazon forest itself. In this report we will start with the general idea about forest fire, its causes and its types. We have also describe how a rainforest could burn in forest fire as it sounds pretty much opposite saying fire in rain forest. We have also describe the trends of forest fires in entire world and in amazon forest for last few decades. We have also described how politics is playing a vital role in such fires. We have also described how president Bolsonaro could be criticized for playing politics in Amazon forest for his own profits. Finally we end this report by deriving fire potential index.

1.INTRODUCTION TO FOREST FIRE

Wood fire is the commonest danger in backwoods. It represents a danger to fauna and vegetation that upsets the biodiversity and the biology and atmosphere of a region, not exclusively to the woodland assets yet additionally to the entire system.

The forested areas are loaded up with dry senescent leaves and twinges all through the late spring, when there is no downpour for a considerable length of time, they could blast into flares started by the smallest flash. Woodland fire is an uncontrolled fire which wipes away enormous fields and land territories. Woodland fire, contingent upon the type of vegetation consumed, is otherwise called grass fire, peat fire and shrub fire.

Wood fire causes nature awkwardness and jeopardizes biodiversity by decreasing the bounty of fauna and verdure. Customary strategies for fire counteraction end up being insufficient and it is presently basic to raise open mindfulness on the issue, particularly among those individuals who live close or in backwoods.

- How backwoods fires spread?

- There are numerous elements that add to how a woods fire will spread and how exceptional the fire will be. They include:
- Climate - The climate largely affects how a fire will spread. Flames are substantially more prone to begin and spread during dry seasons when the grass and plants are dry. A solid breeze can assist a fire with spreading and move rapidly. The temperature and dampness will likewise affect how well the fire will spread.
- Fuel - Fires need fuel to consume. The sort of fuel will affect how rapidly the fire will spread just as how serious it will be. In the woods there can be a lot of fuel including trees, leaves, needles, bushes, and grasses developing underneath the trees.
- Geography - The geology is the shape and highlights of the land where the fire is consuming. Fire will in general move quicker though. Flames may spread rapidly up steep slants on the sides of mountains and slopes.

2.TRENDS OF FOREST FIRE IN THE WORLD

Both natural and human-caused activities are involved in global fire activity. Bands of fire includes Eurasia, North America, and Southeast Asia as farmers clear and maintain fields in April and May. Summer brings new activity in temperate forests in North America and Eurasia as there is lightning-triggered fires burning in remote areas. In the tropical forests of South America and equatorial Asia, fires caught up in August, September, and October as people make use of the dry season to clear rainforest and savanna, as well as stop trees and shrubs from encroaching on already cleared land. There are many trends according to different regions but many of them are most common.

- There are more fires.
- Those fires are larger.
- The same area keeps burning.
- Recent fires are burning more number of coniferous forests than other types of landscape

Wildfire has been an important process which is deliberately affecting the Earth's surface and atmosphere for over 350 million years and human societies have coexisted with fire since their emergence. Then too, many consider wildfire as an accelerating problem, with widely held perceptions both in the media and scientific papers of increasing fire occurrence, severity and resulting losses. However, important evidence which are currently available does not support these perceived overall trends. Instead, global area burned appears to have overall declined over past decades, and there is increasing evidence that there is less fire in the global landscape today than centuries ago.

One reason for this apparent contradiction can be that the global extent of fire is not necessarily correlated with impacts on human society. Another reason may be that our perception of fire is built up by some widely publicized regional trends and a lack of discrimination between reported fire activity parameters. An important distinction regarding the latter is that between area burned (i.e. total ha or km²) and fire occurrence (i.e. the number of fires for a given area and period). Area burned is perhaps the most commonly used parameter when fire trends are being examined and hence it is less compared to number of fires occurring in the same area.

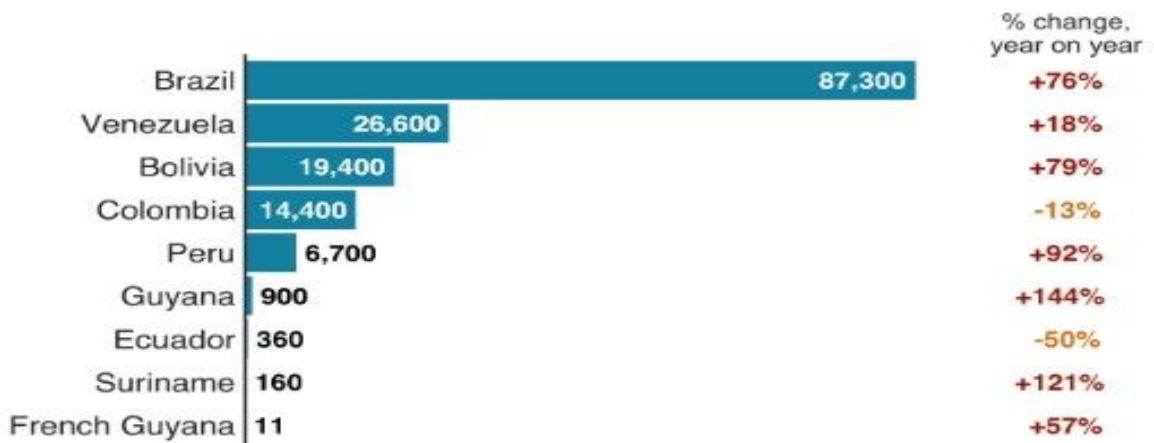


Figure 3. Area burned, number of fires and suppression costs (inflation adjusted to 2016 equivalent) for the USA with linear trend lines (1991–2015). Data: National Interagency Fire Center [48].

Regarding fire severity, limited data are available. For the USA (western-part), they indicate little change overall, and also that area burned at high severity has overall declined compared to pre-European settlement. Direct fatalities from fire and economic losses shows no clear trends over the past three decades. Trends in indirect impacts, such as health problems from smoke or disruption to social functioning, remain insufficiently quantified to be examined properly. Global predictions for increased fire under a warming climate highlight the already urgent need for a more sustainable coexistence with fire. Below graph shows Brazil is not the only country experiencing a large amount of forest fires.

Brazil is not the only country in the Amazon region experiencing a high number of fires

Total number of fires between 1 January - 29 August (2019)



3. CAUSES OF FOREST FIRE

We can classify causes into two classes named 1) Natural caused, 2) Human caused

1) Natural caused

Fires caused by natural events constitute the great majority of the total area burned. These causes are largely dependent on atmospheric temperature, pressure, humidity in the atmosphere as well as the soil, precipitation, percolation, wind speed and directions. Examples of fires that are caused by natural events are as follows:

a) One event can be lightning which sets trees on fire. But rain extinguishes the fire caused by lightning.

b) Fire caused by friction due to high wind velocity either trees or rolling stones which set fires on highly flammable (dry) leaves

2) Human caused

Fire is caused when a source of fire like naked flame, electric spark or any source of ignition comes into contact with inflammable material. When such fire is caused by a human caused event such as illegal deforestation by setting fires to the forest occurs then we say that this is human caused fire. Fires caused by man-made events constitute the greater percentage of forest fires in our forests. Some examples of human caused fire are as follows:

a) People set fires to obtain good grazing grass as well as to facilitate collection of minor/primary forest produce such as flowers of 'Madhuca indica' and leaves of *Diospyros melanoxylon*, and primary produces like wood, peat coal etc.

b) Shifting cultivation and zoom cultivation are also causes for human caused forest fires.

c) Villagers use fire to ward off wild animals.

d) Careless visitors to forests who discard cigarette butts can also set fire in the forest.

Most of the Amazon forest fires are caused by human activity, especially clearing lands for farming and deforestation.

Fire frequency has increased due to both climate and human intervention, the vast majority of amazonian fire sparked by humans and fire spread readily in areas of high flammability. This observation leads to this order

1. Amazon fire's part is primarily associated with human disturbance.
2. The highest proportion of sites exhibiting fire coincide with the driest period of the Amazon forest because the year 2019 was [el nino](#) year.
3. Highly seasonal setting will exhibit a higher incidence than a seasonal ones

4.WHAT IS DEFORESTATION AND HOW IT HAS BECAME A REASON FOR FOREST FIRE?

Deforestation is huge numbers cutting down trees in the forest. Deforestation has always been a threat to our climate. But this is still practiced by many humans. Deforestation is also causing environmental imbalance. Yet some egoistic people need to fill their pockets. So, they don't even think about it once. The government is trying counter measures to avert the harm to the environment.

The main purpose of deforestation is to increase the land area. Additionally, this land area is to set up new industries. And, much of this is because of the population growth. The demand for goods also rises, as the population increases. So wealthy entrepreneurs set up those industries to maximize income.

Deforestation has many harmful effects. Some of them are soil erosion, landslides, floods, global warming, impact on the water cycle.

A major challenge to biodiversity: Biodiversity is also impacted by deforestation. Many species are already extinct, including Dodo, Sabre-toothed Cat, Tasmanian tiger, etc. In addition some species are on the brink of extinction. That's because they've lost their habitat or a place to live.

Deforestation is destruction or removal of an area of forests. This happens due to many reasons such as logging, mining, urbanization etc. This was found to be a critical reason in the destruction of the Amazon rainforest. Sometimes it may occur due to natural disasters also but man-made is much worse in this condition. Let us understand how logging works.

- **Logging**

Logging, or chopping down trees in a timberland to collect timber for wood, items or fuel, is an essential driver of deforestation. This influences the earth in different manners. Since trucks and huge hardware need to get into the woodland so as to get to trees and transport timber, lumberjacks should clear enormous regions for roadways. Likewise unique sorts of logging, for example, Selective logging - where just the most significant trees are felled, as one falling tree can cut down many encompassing trees and meager the timberland's defensive shade. The timberland shelter is imperative to the woods' biological system since it houses and secures plant, creature and creepy crawly populaces. It likewise ensures the backwoods floor, which hinders soil disintegration.

- **Mining**

This likewise brings about deforestation as burrowing for coal, precious stone or gold requires expulsion of enormous timberland evacuation. Additionally for digging as well as for transport and different exercises identified with it causes deforestation. Palm oil has been getting consideration of late for its potential as a biofuel and is utilized in many bundled nourishments and magnificence items. Be that as it may, palm oil is another reason for deforestation. Its rising costs make it increasingly important, and, accordingly, Indonesian and Malaysian ranchers decimate sections of land of trees to gather it. Therefore, a few nations are right now discussing a restriction on palm oil as a biofuel.

In the wake of arriving at a low record in 2012, deforestation in the Brazilian Amazon has been rising consistently, and has flooded since Jair Bolsonaro became president in January. Ongoing information shows deforestation from January to August was the most noteworthy in 10 years, expanding by 75% comparative with a similar period in 2018. That flames have likewise not been this broad for 10 years is unquestionably no fortuitous event.

With its immense store of carbon secured up trees and soils, the Amazon and its wellbeing – is vital for worldwide warming. There are worries that discharges from the ongoing flames could upset endeavors to arrive at the atmosphere targets set by the Paris Agreement.

Evapotranspiration can be thought of as the backwoods perspiring – as water vanishes from the leaves and the ground it cools the environment. Deforestation lessens woods spread thus diminishing evapotranspiration. Less evapotranspiration decreases the cooling limit of woodlands and makes nearby temperatures rise. While an unnatural weather change keeps on influencing all districts of the woodland, upset timberlands saw a lot more grounded nearby warming, with yearly temperatures ascending by 0.44°C more than neighboring flawless backwoods. This may not seem like a lot, yet it likens to around half of the warming found in the locale in the course of the most recent 60 years.

The impacts of deforestation were generally articulated during the dry season, when temperature contrasts of up to 1.5°C were seen among flawless and upset woods. This is on the grounds that water is just accessible from somewhere down in the dirt during the dryer months, out of reach to the shorter-established field vegetation that becomes once timberland has been felled.

One method of doing deforestation when transportation of products isn't accessible is by setting up fire in forest. This has been expanded in Amazon woodland after Jair Bolsonaro became president.

5.TYPES OF FOREST FIRE

•Surface Fire

A fire that is primarily along the surface and is spreading through the forest floor is known as Surface fire. This contains leaves that have fallen down and grass. Surface fires are the most tame fire and can be put out relatively easily, these fires only occur at the surface and are generally no taller than the average human. Surface fires create the least amount of destruction. Below is a picture of surface fire.



•Underground Fire

The fires of low intensity, consuming the organic matter beneath and the surface litter of the forest floor are sub-grouped as underground fire. This fire spreads very slowly and burns some meters below the surface so in most of the cases it becomes very hard to detect and control such types of fires. It is possible that it may continue for months and can destroy vegetation. The other terminology for this type of fire is Muck fires.



•Ground Fire

These fires happen in the subsurface organic fuels. There is no clear distinction between underground and ground fires. It is possible that sometimes underground may get converted into ground fire due to an increase in burning content. So we can say that it is similar to underground fire but in this it also burns the roots of trees. They are more damaging than surface fires, as they can destroy vegetation completely. Ground fires burn underneath the surface by smoldering combustion and are more often ignited by surface fires. Ground fires occur below materials such as leaves and peat, these fires are slow moving but when left unattended, can take out large areas. These fires are particularly dangerous as they can 'hibernate' below the surface during a warm winter and re-emerge once the weather gets warm again. Below is a picture depicting ground fire.



•Crown Fire

A crown fire is one in which as the name proposes the crown of trees and bushes consume, frequently continued by a surface fire. A crown fire is especially extremely hazardous as it can consume angrily. On slope inclines, if the fire begins downhill, it spreads up quickly as warmed air contiguous a slant will in general stream up the slant spreading blazes alongside it. On the off chance that the fire begins tough, there is less probability of it spreading downwards. Crown fires represent the most noteworthy hazard by a long shot because of their quick spreading conduct, they create on trees and at times can hop starting with one tree then onto the next making these the most aggressive form of fire. Below is a picture of crown fire.



•Firestorms

Among all the forest fires, this spread very quickly, which is an intense fire over a large area. As the fire burns, heat rises and air rushes in, causing the fire to grow. More air makes the fire spin violently like a storm. Flames fly out from the base and

burning ember spew out the top of the fiery twister, starting smaller fires around it. Temperatures inside these storms can reach around 2,000 degrees Fahrenheit.



6 . FIRES IN THE AMAZON FOREST

According to Mark Bush, a professor of paleoecology at the Florida Institute of Technology, the fires in Amazon rainforests do not show any historic trace of natural fires at all. So, the humans were the only cause of fires. Neither the flora of rainforests with thin bark and superficial root systems nor the animals can survive fires. Charcoal layers below the Amazon forest reveals that for thousands of years, the inhabitants of these forests used fires to clear the forest floors to use them for agriculture and that those fires made the rainforests more fire prone today. But those fires were different from the fires seen today which clears the entire area as those fires left the trees standing. “The signature of fire is a uniquely human signature in the Amazon. It comes right in with maize or manioc agriculture—you know exactly what’s going on; it’s people in that landscape,” he says. The fires would be less intense and frequent which could not spread in an uncontrolled manner. Researchers believed that these Amazonian dark earths or terra preta would be more lush than the surrounding areas but were found to have less green canopy and lower water content, specifically in drought years having less tree cover as well as smaller trees.

7. WHY STUDY OF AMAZON FOREST FIRE IS NECESSARY?

The Amazon forest covers approximately 6.7 million square kilometers, twice the size of India, which is shared by eight countries. Approximately 60% of the area

is located within Brazil, and thus the political situation in Brazil has a large impact on the region.

The Amazon rainforest contains the highest biodiversity than anywhere else on the planet. It is home to around 30% of the world known species and 390 billion trees of around 16,000 different species and the large numbers of indigenous people living predominantly within remote regions of the Amazon. These groups have the most to lose from land-use changes related to forest fires. Also, the Amazon river flows more than 6,600 km and contains the largest number of freshwater fish species in the world.

The Amazon rainforest is considered as the planet's lungs as it contributes about 20% of earth's oxygen. Hence fire could deliver a huge blow to the global fight against climate change because it will result in excess amount of CO₂ and pollutants into the atmosphere. Rainforest adds water to the atmosphere. When forest burns, there is less moisture released into the atmosphere, which can mean less rainfall. Researchers have linked the felling of forests to rises in malaria and dengue fever. Also lots of medicines are made from plants and trees.

According to Brazil's space agency, INPE, the number of fires between January 1 and August 20 of this year is up 85 percent from the same period last year. It will take decades to centuries for the forest to recover. It is clear that the region's hydrological and climatic status will change drastically if the situation continues to worsen.

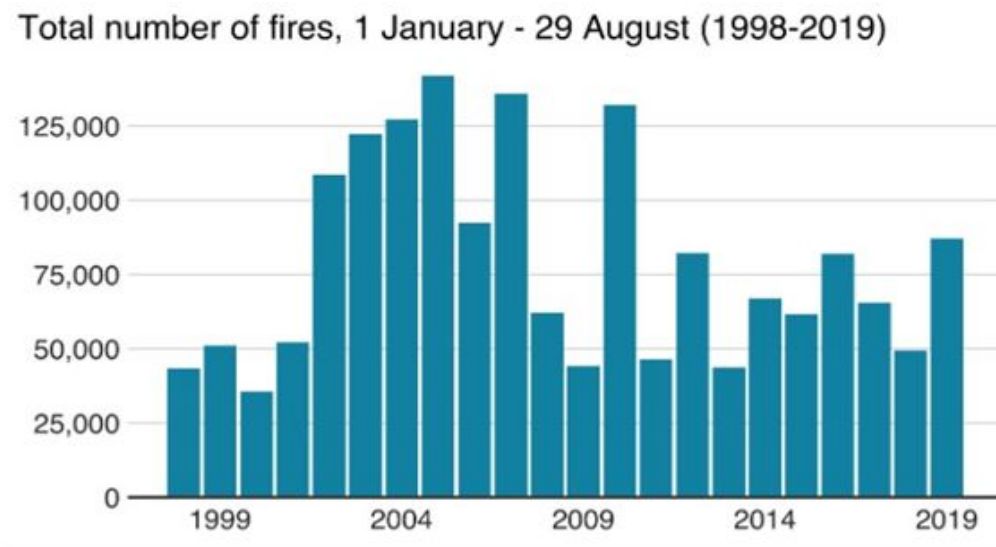
8. HOW WIDESPREAD ARE FIRES IN AMAZON FOREST?

INPE (research unit of the Brazilian Ministry of Science) has reported more than 80,000 fires across all of Brazilian-subcontinent. Moreover, there is a 77% year-to-year increase for the same tracking period, with more than 40,000 in the Brazil's Legal Amazon (BLA). Similar year-to-year increases in fires were subsequently reported in Bolivia, Paraguay and Peru, with the 2019 fire counts within each nation of over 19,000, 11,000 and 6,700, respectively, as of August, 2019. It is estimated that over 906 thousand hectares (9,060 km²) of forest within the Amazon biome has been lost to fires in 2019. In addition to the impact on global climate, the fires created environmental concerns from the excess CO₂ and CO within the fires emissions, potential impacts on the biodiversity of the Amazon, and threats to indigenous tribes that live within the forest.

The number of fires burning across the Amazon in 2019 is higher than at any point since 2010, which was a particularly bad year of drought, says Ruth DE Fries,

an expert on sustainable development at Columbia University. About 7,000 square miles of the forest were in flames, an area just smaller than the size of New Jersey.

However, we cannot say that 2019 is the worst year in recent history. Brazil experienced more fire activity in the mid 2000s - with 2005 seeing more than 142,000 fires in the first eight months of the year.

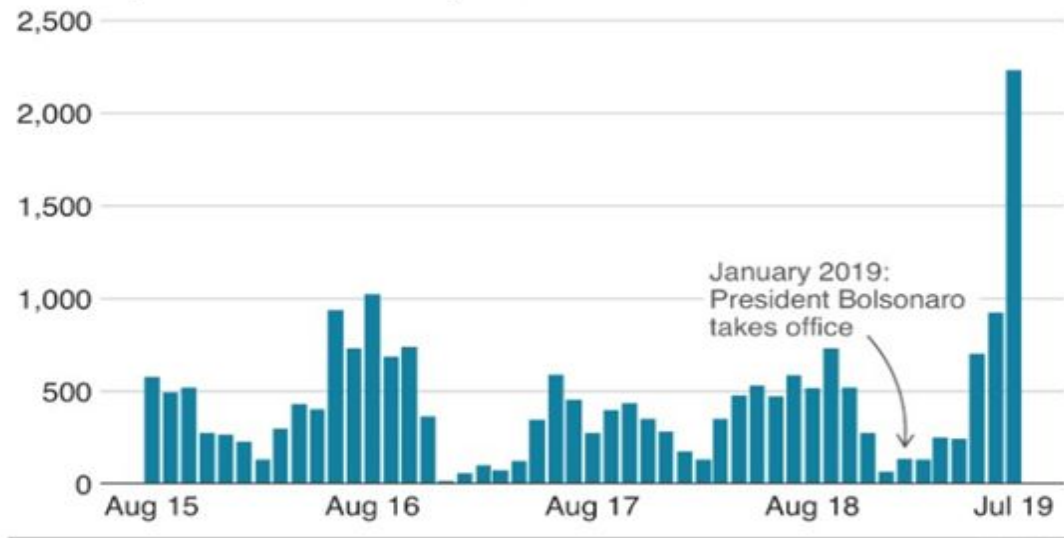


The official figures indicate that more than 87,000 forest fires were recorded in Brazil in the first eight months of the year. That is the highest number since 2010. That compares with 49,000 in the same period in mid - 2018.

The recent increase in the number of fires in the Amazon is directly connected to intentional deforestation and not the result of an extremely dry season, according to the AERI (Amazon Environmental Research Institute). Monthly data shows that the scale of the areas cleared has been creeping up since January, but with a spike in July this year - which is almost 278% higher than in July 2018

Destruction in the Amazon

Monthly deforestation in sq km



9.HOW CAN THERE BE FIRE IN RAIN FOREST?

Despite the name 'rain-forest' the Amazon rain-forest does have a dry season. However, this dry season still has a lot of water, just markedly less than the wet season, which sees daily monsoons occur. Amazon rain-forests in Brazil, Bolivia, Paraguay, and Peru are considered to be the lungs of the world that convert maximum carbon dioxide into oxygen. Still, these lungs have been damaged by the recent forest fire. These fires can be for many reasons like due to agriculture, climate change, country development, etc.

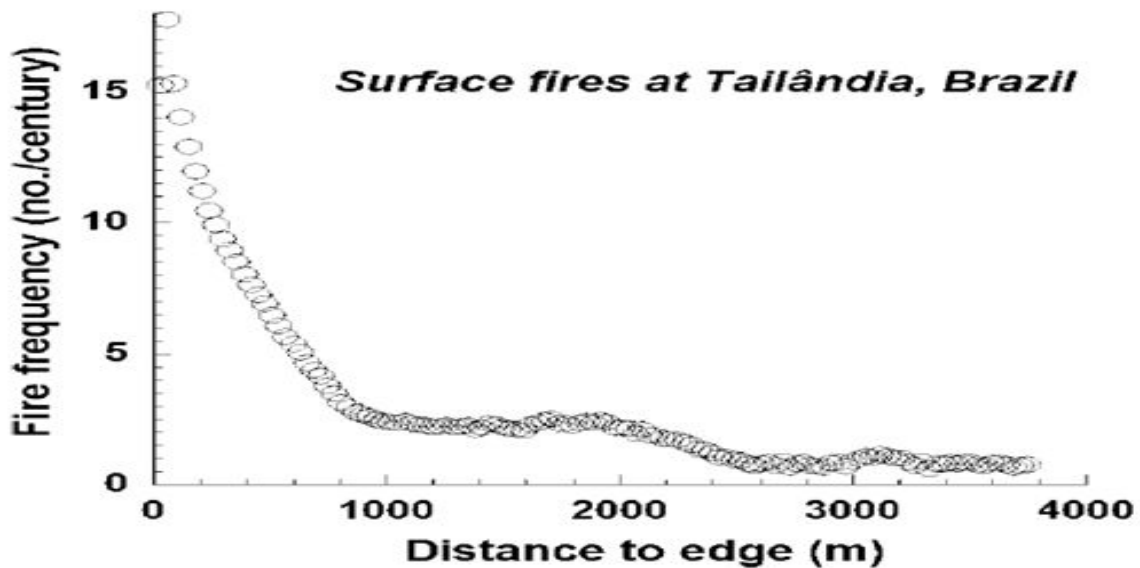
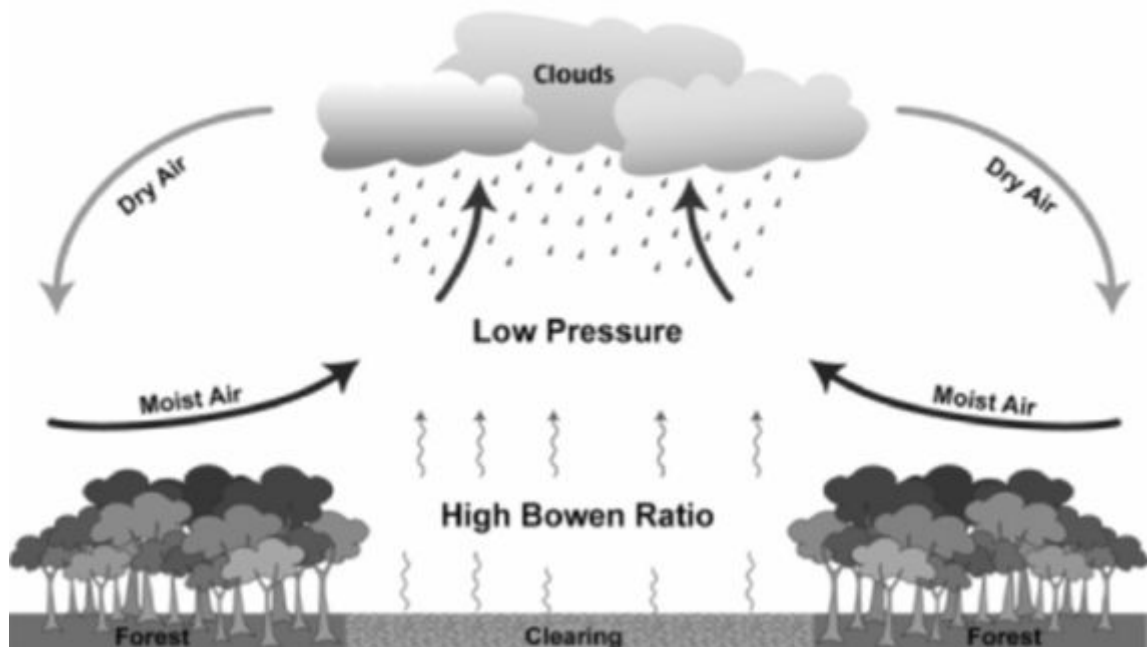


Figure 1. Dramatically elevated frequency of surface fires near forest edges in eastern Amazonia (adapted from Cochrane and Laurance [46]). Fire frequency (number per century) was estimated based on 12–14 y of satellite observations.

This graph shows how fires are near to the forest edge, that's why we can predict that humans did this. Today's agricultural fields and pasturelands have encroached into forest areas. Fires are used to maintain crops and clear new lands. The Amazon tropical rainforest has high air and soil humidity, buffered temperatures, little light and wind in the forest understory. These microclimatic conditions are ideal for decomposers such as bacteria, fungi, and termites, which rapidly break down leaf litter and fine wood debris and thereby limit potential fuels on the forest floor. so fires have been rare in amazon. Using the "slash and burn method," humans cut the tree, many times the absence of transport and roads timber can not be sold, so burning is the easiest way to clear the land. so they burn it.

Amazon forest most of the fires are started by humans, but this is not always that case in tropical amazon experienced lightning strikes and dry environment during El Nino years.

The Vegetation Breeze



Air over the woods will in general be cooled by evaporative cooling. Where such cooling is greatly diminished above clearing (this builds the Bowen proportion which is the reasonable to inert warmth) accordingly, the air over clearances warms up and rises, lessening nearby pneumatic force and bringing soggy air from encompassing backwoods into the clearing. As the rising air cools, the dampness it conveys consolidates into convective mists that may create precipitation over the clearing. The air is then reused—as cool, dry air—back over the woodland. In the Amazon, vegetation-breeze impacts have been seen in clearings as little as two or three hundred hectares, however these impacts seem to top when clearances are approximately 100–150 km in distance across. The vegetation breeze is basically an enormous scope edge impact; satellite perceptions in Rondonia, Brazil, recommend that the drying up impacts of significant clearings can stretch out up to 20 km into abutting woodlands.

In outline, timberland fire is caused because of both atmosphere and human intercession, most by far of amazonian fire is started by people and fire spreads promptly in regions of high combustibility

10.HOW DID FIRE START?

Fires in the Amazon occur every year, but natural ones are extremely rare. It's the rainforest, after all. But who or what is responsible? They're for, which isn't unique to the Amazon. We see managed burns throughout the world, and, often, where we see deforestation, we see fire. What fluctuates is how many fires. 2019 has more fire activity than we've seen in a year since 2010 up until this point in the dry season.

Deforestation and land management fires are set every year during the dry season from August through October. Farmers wait for the dry season and they start burning and clearing the areas so that their cattle can graze. The vast majority of the fires started by humans in service of mining, logging, and agriculture. After clearing an area of forest, fires are ignited by farmers using slash-and-burn techniques to help put nutrients in the soil for crops.

And like many natural resources, the Amazon is caught in a tug of war between economic growth and environmental protections. And in that war, politics almost always comes into play. About 60% of the Amazon lies within Brazil. That means environmental laws have fluctuated as the Brazilian economy, pressures from the international community, and administrations have changed.

The Brazilian government 2004, then under President Lula, launched a national action plan to deal with deforestation. In 2004 to about 2014, it was a massive success and was a real reduction in the rates of deforestation. 2015 and 2016, Brazil had a very deep recession. So, in 2015, we started to see deforestation rates rise again, and they continued to rise through 2016 and 2017. 2018, the situation kind of died down a bit, but then came the electoral campaign. Fires in the Amazon are nothing new, but this year has raised alarms.

Some have pointed to the weather, but these fires look different than what we would see if climate were the main factor. Fires that are in the locations we expect to see fires for deforestation, and they're early in the dry season, which tends to be more motivated by economic pressures rather than climate conditions.

On August 5th, a Brazilian newspaper reported an organized day of burning called "Fire Day" scheduled for August 10th. IBAMA is the Brazilian environmental protection agency that is tasked with stopping deforestation fires in the Amazon. A federal prosecutor reported that IBAMA was ordered to stop these fires, but the state police refused its support. This is the region of new progress where much of that coordinated fire activity was scheduled for August 10th. This is an area that does show an increase in fire activity on that day and then continuing afterwards across the southern Amazon that actually is the start of increased regional fire activity. In

other words, the majority of the fires were likely started by the same kinds of people who were behind Fire Day. According to Alberto Setzer, a senior scientist at Brazil's National Institute for Space Research (INPE) "About 99% of Amazon fires start from human actions, "either on purpose or by accident"

11.EFFECT OF FOREST FIRE ON BIODIVERSITY

Amazon has in excess of 40,000 plant species, in excess of 3,000 freshwater fish species and in excess of 370 sorts of reptiles. Amazon contains a huge decent variety in any living species. As per WORLD WIDE LIFE one of every ten realized species on Earth dwells in Amazon. Additionally, there are specific sorts of woods that have visited fires thus living species have embraced this nature however in Amazon woodland this isn't the situation. So for this situation any living species there needs to endure a ton in their pattern of living. This leads a portion of the animal groups to be wiped out. For e.g: Jaguars in Amazon are in peril because of such flames. One of the significant reasons is food lack due to fires. Giant Otters are additionally in peril because of this.

For the most part, low portability creatures have been influenced more by fire. It isn't the situation that oceanic life won't get upset as fire happens on lands as it were. The tree ashes with water make their way to oceans and will alter the oxygen level and furthermore prompts an expansion in temperature which will hurt explicit oceanic species. This additionally upsets the evolved way of life.

Timberland fires have a huge impact on biological diversity. At the worldwide scale, there is a high measure of carbon outflow which prompts an Earth-wide temperature boost and change in biodiversity. At the territorial and neighborhood level, they lead to a change in biomass stocks. Smoke from flames can altogether lessen photosynthetic action and can be negative to the soundness of people and creatures. One of the most significant biological impacts of consuming is the expanded likelihood of further consuming in resulting years, opening up the timberland to drying by daylight, and working up the fuel load with an expansion in fire-inclined species. Because of rehashed consumes it is unfavorable on the grounds that it is a key factor in the impoverishment of biodiversity in rainforest biological systems. Additionally, deforestation must be controlled.

12.PREVENTION OF FOREST FIRE :

In forests, mostly fire occurs due to humans, but sometimes it is natural also. Forest fires are due to contact of dry leaves, dry wood, etc. with some inflammable substance or due to friction between air and trees or due to campfires, etc. To prevent forest fire, we should take care that there should not be piling of dry leaves, vegetation, wood, etc.

Here are some measures to be taken before burning anything or making campfire any fire in a forest.

- 1) Should follow all local rules and regulations. Local government has laws governing the burning of stuff, including the time of day, time of year, and what to burn.
- 2) While burning anything in the forest, it is essential to check the weather. We should not consume any stuff during high winds. Wind can act as both an accelerant and can spread the fire. Besides, check your state's most current fire danger rating system, which will explain any areas' susceptibility to fires and any required precautions that may be necessary. The Wildland Fire Assessment System provides a frequently updated map which shows the current fire danger rating for each state.
- 3) Decide locations for burning very carefully so that it can be easily controlled. Take care that all campfires occur in surrounded fire pits and limit the size of all fires. No matter whatever you are burning, it is crucial to do it in a controlled area. Fires can quickly get out of control, so it is necessary to have it in an area that will provide some containment so it can be extinguished if needed.
- 4) Do not burn anything unusual or combustible.
- 5) Make sure that anything that you put into a campfire does not react violently with fire.

Vegetation should be burned periodically to maintain high species diversity, and frequent burning of surface fuels limits fuel accumulation. Wildland fire use is the most cheapest and ecologically appropriate policy for many forests. Wildfire models are used to predict and compare the benefits of different fuel treatments on future wildfire spread, but their accuracy is low.

Wildfire models are reported as "the most effective treatment for reducing a fire's rate of spread, fireline intensity, flame length, and heat per unit of area," according to Jan van Wagtendonk, a biologist at the Yellowstone Field Station.

To prevent forest fires, some flame-resistant plants or stuff should be kept at regular intervals so that if there is fire it will be in a particular block and can be extinguished quickly.

- How the government of Brazil stopped the forest fire?

According to the president, Jair Bolsonaro non-governmental organizations had started a forest fire in the Amazon forest, but this is all without evidence. He also added that his team is investigating the fire. Also, he said that they did not have enough funds to control the fire, so they need support. After a few weeks of fire due to the pressure of his superiors, Bolsonaro deployed the military to help battle the fire on August 24, and He sent 44,000 troops to six states. According to Paulo Barroso, it was a complex operation, and more than 10,400 firefighters are spread thin across 55 lakh square kilometers in Amazon.

13.DID CLIMATE CHANGE CAUSE THESE FIRES?

Many factors that have worsened this year's Amazon fires include climate change, deforestation and Government policies. So Climate change is not a cause but still a strong factor for spreading Amazon fires. Climate change can help forest fire spread by increasing temperature and increasing chances of drought. These factors create a condition called "Tinderbox" which means once ignited a fire can quickly spread over large areas of the field. So forest fires can't be directly linked with climate change but because of the hot and dry atmosphere, Amazon's humidity cannot stifle these fires. Also, hotter air sucks away moisture from trees and soils, and decreased rainfall makes parched forests (dry forests) which are more prone to burning. So, in this way climate change and Amazon fire are interconnected but climate change is not the cause for these fires, fires were set up by humans either deliberately or by accident.

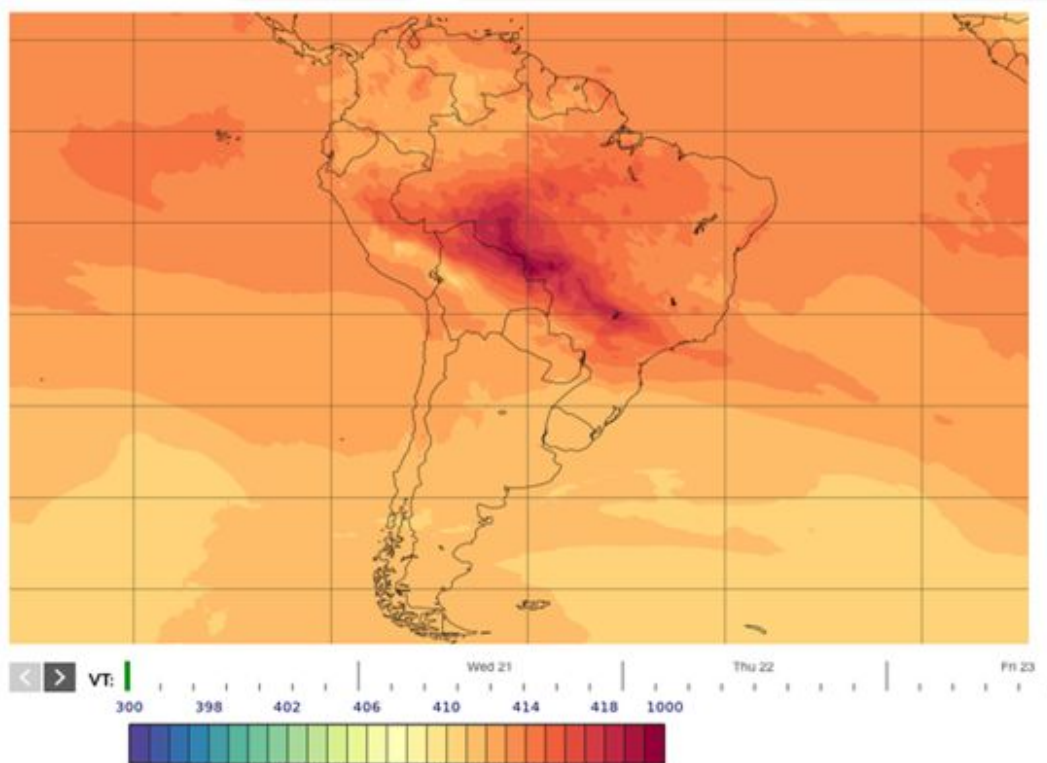
- HOW DOES FIRE AFFECT CLIMATE CHANGE?

The Amazon is the largest rainforest in the world. Amazon plays a crucial role in keeping the carbon-dioxide levels of our planet in control. Plants and trees take in carbon-dioxide from the atmosphere and release back oxygen into the atmosphere by the process of photosynthesis. The Amazon which covers 2.1 million square miles is referred to as the "Lungs of the Planet". It also produces about 6% to 20% of the oxygen in our planet's atmosphere. When trees burn, they release carbon-dioxide

into the atmosphere which they have captured for years and thus, contributes to climate change. Amazon's ability of pulling in carbon to that of releasing is diminishing rapidly because of changing weather patterns, deforestation, increasing tree mortality and various other factors. These fires will further reduce its function as a carbon sink and could push it toward a tipping point, after which the region would enter into a self-sustained cycle of forest "dieback" as it converts from rainforest into Savannah. If the tipping point is triggered, the dieback will take 30 to 50 years and in this time around 200 billion tonnes of carbon-dioxide will be released back into the atmosphere and thus causing global warming at a tremendous rate. Also all these fires could cause a decline in Amazon tree species richness and thus harming biodiversity. Amazon is very important for us, for our future and for our ability to avoid for time-being the worst of climate change. Thus, climate change could intensify the Amazon fires, turning it from a carbon sink to a carbon source, which in turn will increase global warming and intensify climate change.

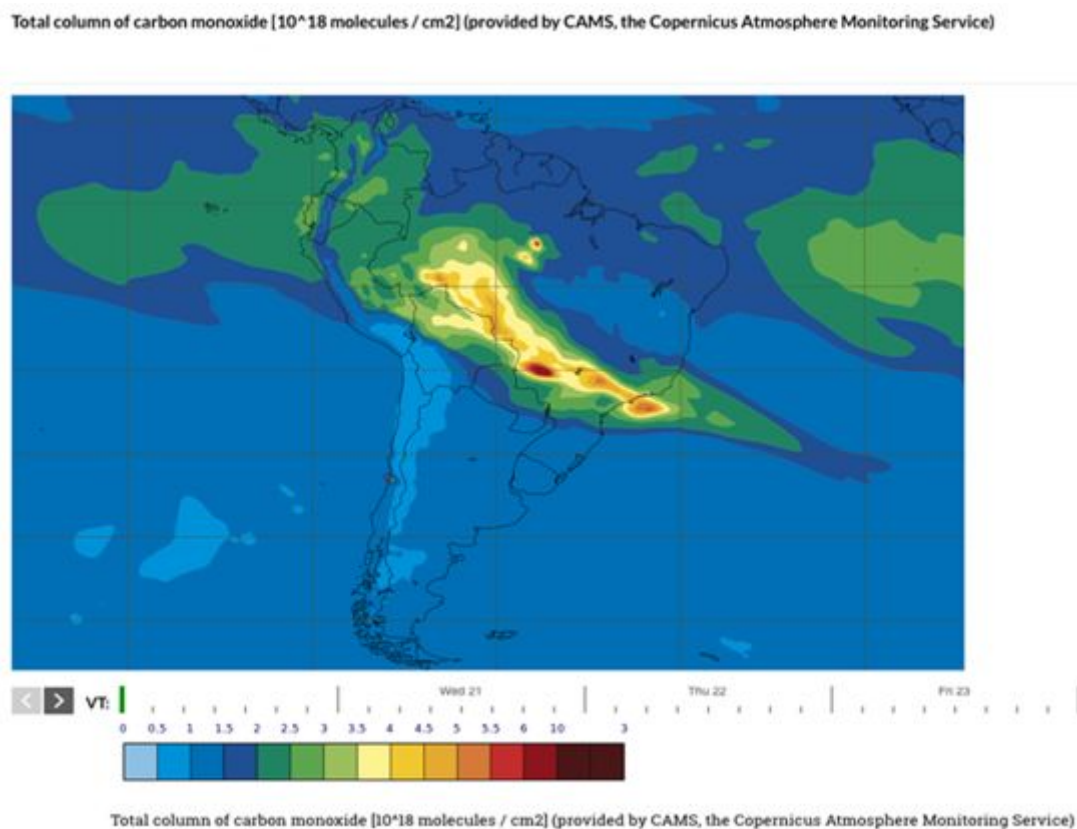
Below given image shows the change in CO₂ levels due to Amazon forest fires.

Total column of carbon dioxide [ppmv] (provided by CAMS, the Copernicus Atmosphere Monitoring Service)

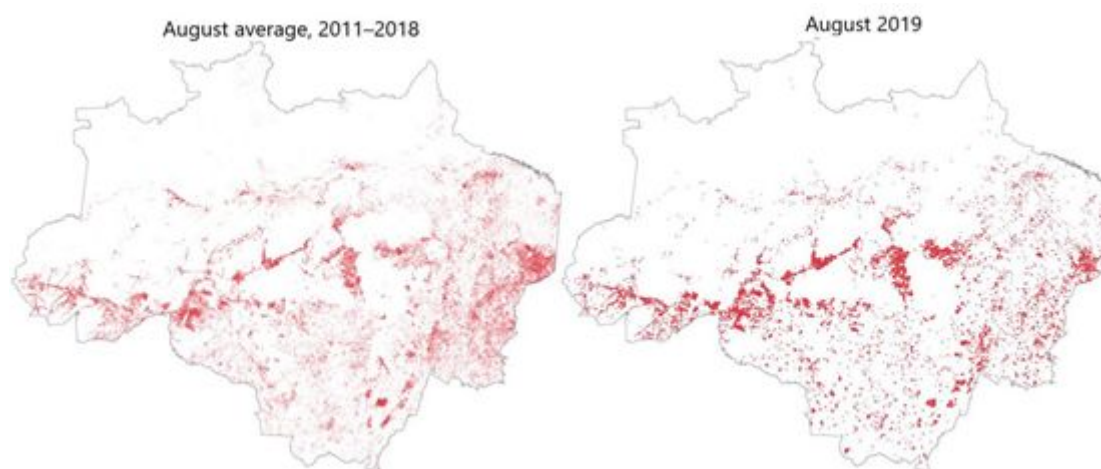


Total column of carbon dioxide [ppmv] (provided by CAMS, the Copernicus Atmosphere Monitoring Service)

Below given image shows the change in CO levels due to Amazon forest fires.



Below image shows the comparison between the average number of fires in August, 2011-2018 and August 2019.



Thus, we can say that even though climate change is not a cause for these fires, it was certainly a strong factor for spreading it and in turn these fires have deteriorated the climate itself.

14.HOW DID POLITICS INFLUENCE AMAZON FIRE?

For over a century, Brazilian governments have vision in nation's inside, building up the Amazon. From the populist president who made one of the early mechanical drives into Amazonian backwoods during the 1930s, During this military government the arrangement that was executed named as Operation Amazon to incorporate the region into Brazil through structure streets and building up the nation. Amazonian fire which have been blasting for a considerable length of time appear to be an intense image of mankind's detachment to natural issue, including atmosphere change. But environmental change isn't the essential driver of the wildfires. The two most terrifying numbers for understanding the flames are this: There are 80% more flames in 2019 when contrasted with 2018 summer, as indicated by the Brazilian Government.

For what reason are these figures so significant? On January 1, 2019, Jair Bolsonaro, was confirmed as president, and has a comparative arrangement that suggests deforestation of Amazon. He is a supporter of agribusiness and unequivocally against a few organizations planning to defend the Amazon rainforest and against grounds saved for indigenous tribes. Further more, Bolsonaro stops subsidizing Brazilian natural Office, and utilizes this store on the nation's inside.

All prompts enormous scope consuming of woods in August 2019 grabbed the eye of the world. The aftereffect of this is judgment of Brazilian President Jair Bolsonaro by different offices and remote forces, Notably by Emmanuel Macron, The French President. Bolsonaro proposed nongovernmental associations were setting the backwoods on fire to dishonor his government. Bolsonaro at first dismissed the consideration from the media and outside forces, guaranteeing that the reports of flames were sensationalist. Bolsonaro plans to create atomic and hydroelectric force in the Amazon Basin, just as extending mining tasks for Nickel, which could end up being dubious to a few.

15.ARE RECENT FIRES FAULT OF PRESIDENT JAIR BOLSONARO

It was discovered that the Brazilian President and their ecological clergyman Ricardo Salles haven't attempted to stop the fire however have energized it for their benefit. Consequence of this was by the New York Times it was accounted for that 39,194 flames occurred. In this way in 2018 the quantity of flames expanded by 77%. In the beginning time there was probability to have control on exercises on Amazon however because of legislative issues of Brazil it kept on doing as such and now it can't be recuperated. Deforestation was seen as an agreed objective of Bolsonaro. That can be accomplished by chopping down trees or, all the more proficiently, by just consuming enormous territories that Brazil's farming industry needs to misuse. This brought about removal of indigenous clans living there. Their uprooting from those terrains has frequently been practiced with viciousness against natural activists and indigenous pioneers. Bolsonaro and Salles see deforestation as such a squeezing need, that they transparently disdain any individual who tries to block it. They got so avaricious in these exercises that one day Bolsonaro terminated a top researcher after he cautioned the nation that deforestation was occurring at an exceptional and perilous rate. At the point when a columnist got some information about the harm being done to the earth by his mechanical strategies, the president scornfully told the correspondent he ought to poop less: "One day truly, one day no." Worst of all, deforestation is devouring the Amazon at a terribly fast pace. As the New York Times put it "The obliteration of the Amazon in Brazil has expanded quickly since the country's new far-right president dominated and his administration downsized endeavors to battle illicit logging, farming and mining." The administration office answerable for observing deforestation archived the loss of "1,330 sq miles of backwoods spread in the primary portion of 2019, a 39% expansion over a similar period a year ago". Recognizing the guilty party – Bolsonaro and Salles – is essential however not adequate to deflect the ecological debacle. The Amazon has a place with Brazil, yet the need to spare the planet has a place with the entirety of humankind, and we all must bear this weight all in all.

16.THE FIRE POTENTIAL INDEX

The Fire Potential Index (FPI) is a modis-NDVI & moisture-based vegetation flammability indicator. It is a function of current living vegetation greenness as an

inverse proportion of maximum greenness. It is also a function of current 100-h dead fuel moisture as a proportion of the moisture of extinction. Thus the FPI is high when the living vegetation is mostly or completely dried and the 100-h dead fuel moisture is low. The FPI is low when the living vegetation is near fully green and the 100-h moisture is high. For example, near extinction moisture. In any case, if the 100-h moisture is equal to or greater than the extinction moisture, the FPI will be zero. Wind is not included in the calculation because of its spatial variability and transitory nature.

The FPI is calculated 16-days time for the southern Amazon where the most forest fires were reported . at a resolution of 1 square kilometer. Although these maps provide a relative measure of fuel flammability across northern Bolivia and south Amazon , on a scale of 0 to 100, they do not indicate the chance that a large fire will occur. The same can be said for the National Fire Danger Rating Indexes as they too lack the capability required to deal with the probabilistic nature of fire danger across a large spatial area. The Large Fire Probability and Predictive Service Area maps accomplish that.

1) Data-collection

- Source of data: GEE (Google Earth Engine)
- How to: As there are multiple Tiff images we require for these calculations, the best way to get this data is to make a set of satellite images i.e. a set of TIFF images. So [here](#) is the link for the GEE script to get the tiff images.

2) Calculations

- In the calculation we require two types of images 1) MODIS-NDVI and 2) TRMM
- 1) MODIS-NDVI: From this we can get the greenness(NDVI score) of a specific geographical point. From this we can get the LR (Live Ratio) because the dead creatures are the source of fuel hence called dead fuel. For the calculation of the dead fuel we need to take the inverse of LR because the lesser the live ratio the more dead fuel will be there for fire hence $(100 - LR(\%))$.
- 2) TRMM: TRMM gives us the precipitation, 100h moisture (related to the rainfall) which is the most important factor that can cause the forest fire hence the factor which is considered in FPI. From the TRMM score we can get the MR (Moisture Ratio). The lesser the moisture the more prone to the forest fire. So we need the inverse of MR. Here we can define the moisture factor by $(1 - MR)$.

- From the images. We can determine the two factors named LR (Live Ratio) from MODIS-NDVI images and MR (Moisture Ratio) from TRMM images. From the LR and MR we can get FPI by the equation below:

$$FPI = (1 - LR) \times (1 - MR) \times 100 \text{ (in \%)} \quad (\text{eq. 1})$$

- Here LR, MR values are from 0 to 1. These are the values calculated for each pixel.
- So we can get the pixel wise FPI by the eq. 1.

3) Calculations in python and their results:

- File: FPI/calculations.py
- Required packages: mentioned in requirements.txt. To install the packages type:

pip install -r requirements.txt or

pip3 install -r requirements.txt

(optional)For rasterio installation click [here](#).

- This involves image processing. So using the PIL(or rasterio) package we can read images and get the corresponding numpy array. But we are processing multiple images so we have explicitly defined a function which is used to read a folder and give a list of numpy arrays of all the images.
- Equations to calculate pixel wise LR & MR are given below:

$$LR = RG \times LR_{max} \div 100 \text{ (LR: Live Ratio)}$$

$$RG = \frac{NDVI_0 - NDVI_{min}}{NDVI_{max} - NDVI_{min}} \text{ (RG: Relative Greenness)}$$

$$LR_{max} = 30 + 30 (NDVI_{max} - NDVI_{Overall_{min}})/(NDVI_{Overall_{max}} - NDVI_{Overall_{min}})$$

(NDVI: NDVI score)

$$MR = \frac{H_{100} - H_{100min}}{H_{100max} - H_{100min}} \text{ (MR: Moisture Ratio } \equiv \text{ Relative Moisture)}$$

- Equations for calculating pixel wise FPI are given in eq. 2, LR is given in eq. 3, MR is given in eq. 6.
- Equation for calculating pixel wise FPI is implemented as a function of addresses to the folder containing NDVI images and TRMM images named FPI_calc.
- Equation for calculating pixel wise LR(MR) is implemented as a function of address to the folder containing NDVI images(TRMM images)named LR_data(MR_data) in the calculations file.
- Other support functions are also created which are as below.

- We can save our computed list of arrays in images format with the scale and bias by `arr_to_imgs` function.
- Another important function is to create a GIF out of a given set of images for a better representation. This function is `make_gif` which will take certain parameters and create a gif out of it.
- In `FPI.gif` we can clearly see that in August-September days there are more fire hotspots than any other days.
- We can clearly see that the areas where the forest fire happened are amongst these fire hotspots.
- These fire hotspots are increased in the areas where illegal deforestation happens in the areas of northern Bolivia ,south Amazonia state in Brazil and the actual south Amazon rainforest.
- In the beginning of October (or late September), we can clearly see that the fire hotspots are reduced. Because the rainfall starts at the same time. Hence the MR is increased by a very large value because of having rainforest. It implies that $1 - MR$ is close to zero hence the FPI vanishes to nearly 0. The other reason can be given as by increasing rain, the dead fuel values decreases as greenery increases hence LR increases and $1 - LR$ decreases hence the FPI is lowered further.
- We took the average FPI across the region and it came out to be 44.2% or 0.442 which is very close to the actual vulnerability index of the region (around 0.401). And it is in the region of all the vulnerability indices which are varying from 0.400 to 0.460. So the answers are precisely defining the actual event that is the Amazon forest fire.

4) Conclusion:

The Amazon forest fire occurred in August,24 2019 and the good thing is that this is not the worst case where the highest forest fires were reported. The worst year is around 2007-08. There after the forest fire reports we controlled till 2016-17. But now they are increasing rapidly which is why it's been a terrific concern all across the world. This time more serious. And the causes for such alarming forest fires are nothing but man made illegal deforestation(Huge impact upon LR-Live Ratio) and global warming which causes irregularity in annual rainfall thus it has a huge impact upon the MR-Moisture Ratio. So these are the major factors for forest fires and we should always remember,

GIFS

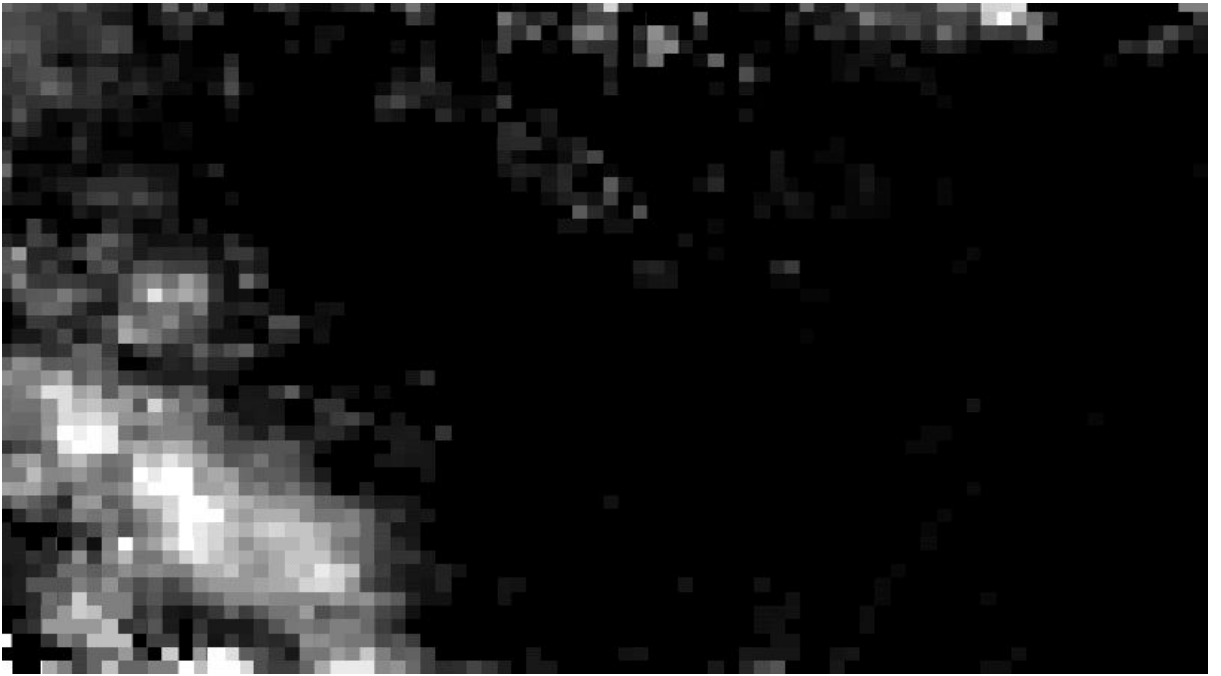
FPI



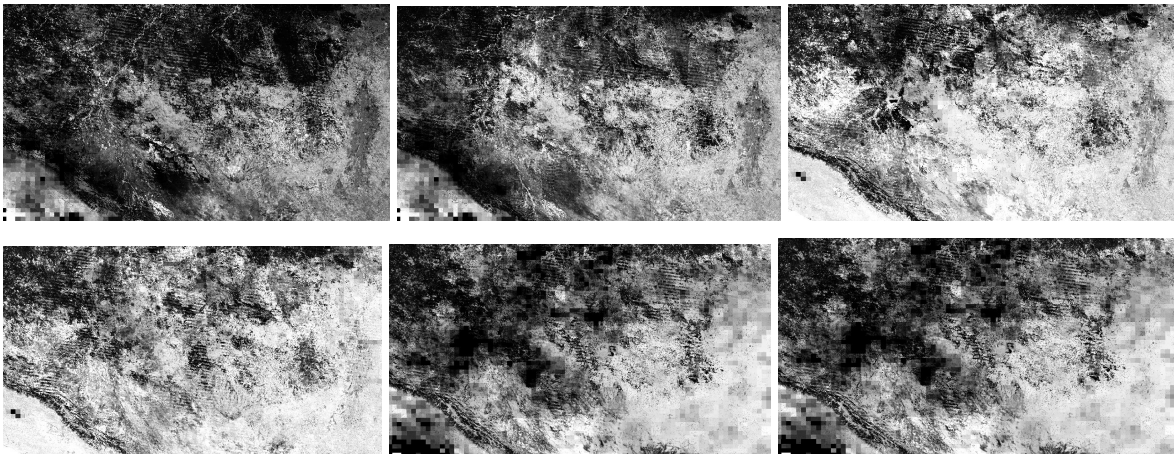
LR

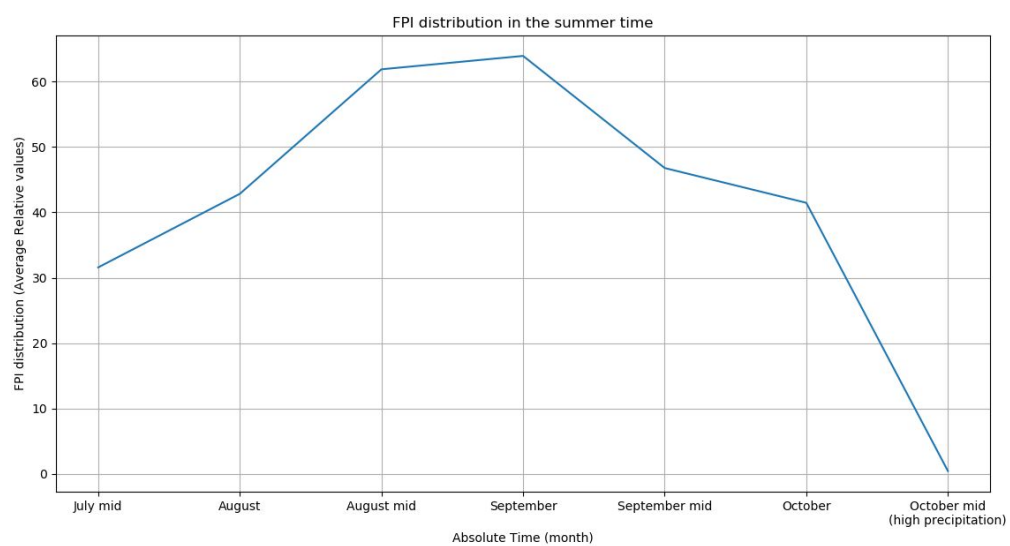


MR

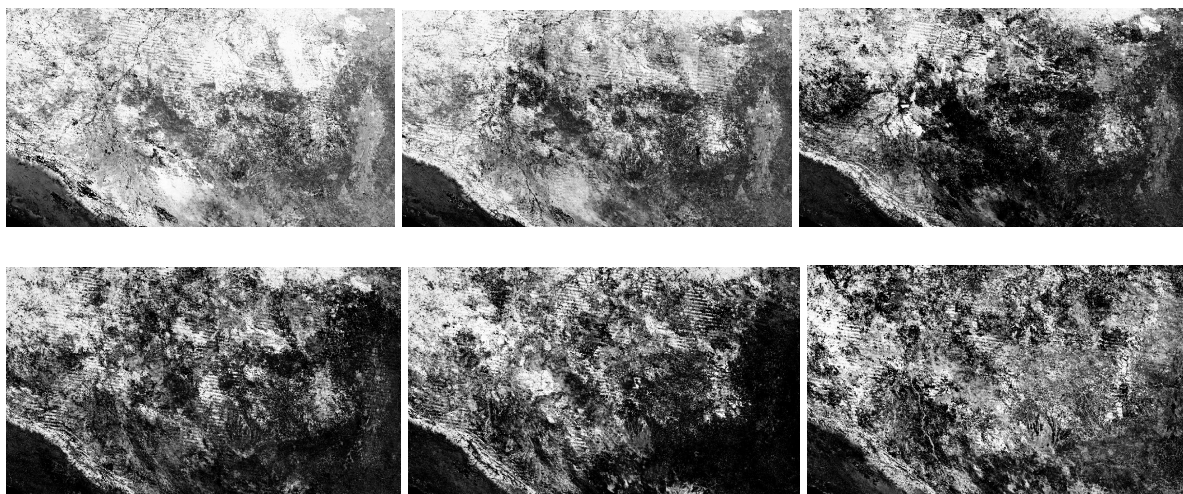


FPI IMAGES

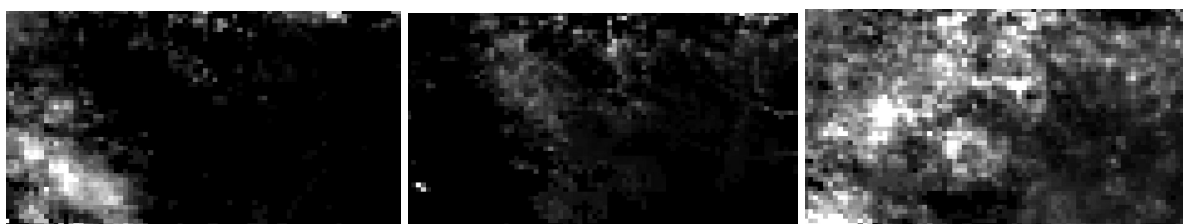




LR IMAGES



MR IMAGES



BIBLIOGRAPHY

1. Introduction to forest fire

<https://www.slideshare.net/sachinsinghshekhawat/forest-fire-a-natural-disaster>

2. Trends of forest fire in the world

https://www.researchgate.net/publication/303504221_Global_trends_in_wildfire_and_its_impacts_Perceptions_versus_realities_in_a_changing_world

<https://climate.nasa.gov/blog/2830/six-trends-to-know-about-fire-season-in-the-western-us/>

<https://earthobservatory.nasa.gov/images/145421/building-a-long-term-record-of-fire>

3. Causes of forest fire

http://agritech.tnau.ac.in/agriculture/agri_majorareas_disastermgt_forestfire.html

4. What is deforestation and how it has become a reason for forest fire?

<https://science.howstuffworks.com/environmental/green-science/deforestation.htm>

<https://www.toppr.com/guides/essays/essay-on-deforestation/>

5. Types of forest fires

http://agritech.tnau.ac.in/agriculture/agri_majorareas_disastermgt_forestfire.html

<https://vikaspedia.in/energy/environment/know-your-environment/forest-fires>

6. Fires in Amazon forest

<https://www.nationalgeographic.com/environment/2019/09/ancient-humans-burned-amazon-fires-today-entirely-different/>

<https://www.firstpost.com/tech/science/rainforests-in-2020-trends-and-happenings-that-could-decide-the-fate-of-rainforests-this-decade-7867431.html>

<https://news.mongabay.com/2018/01/rainforests-the-year-in-review-2017/>

7. Why study of Amazon forest fire is necessary

<https://towardsdatascience.com/an-analysis-of-amazonian-forest-fires-8facca63ba69>

8. How widespread are the fires in the Amazon?

<https://www.bbc.com/news/world-latin-america-49433767>

<https://www.nationalgeographic.com/environment/2019/08/amazon-fires-cause-deforestation-graphic-map/>

9. How can there be fire in rainforest

https://www.researchgate.net/publication/23995876_Synergisms_among_Fire_Land_Use_and_Climate_Change_in_the_Amazon

<https://towardsdatascience.com/an-analysis-of-amazonian-forest-fires-8facca63ba69>

10. How did the fires start?

<https://www.youtube.com/watch?v=zQsymdiuXMg>

11. Effect of forest fire on biodiversity

<https://www.worldwildlife.org/places/amazon>

<https://www.greengeeks.com/blog/2019/08/29/how-the-amazon-rainforest-fire-impacts-animals/>

<http://www.fao.org/3/y3582e/y3582e08.htm>

12. Prevention of forest fire

What has brazil government done about amazon forest fire

<https://cultureofsafety.thesilverlining.com/wilderness/forest-fire-prevention/>

www.bbc.com

www.theverge.com

www.wikipedia.in

13. Did climate change cause these fires, and how will they affect climate change?

<https://www.carbonbrief.org/media-reaction-amazon-fires-and-climate-change>

<https://www.businessinsider.in/science/environment/the-amazon-rainforest-is-burning-heres-why-there-are-so-many-fires-and-what-it-all-means-for-the-planet-/articleshow/70818992.cms>

<https://www.washingtonpost.com/weather/2019/08/21/amazonian-rainforest-is-ablaze-turning-day-into-night-brazils-capital-city/>

<https://www.climatechangenews.com/2017/10/05/amazon-forest-fires-pushing-climate-change-beyond-human-control/>

Images :

<https://www.citylab.com/environment/2019/08/amazon-rainforest-fire-map-burning-bolsonaro-deforestation-map/596605/>

14. How did politics influence amazon fire

<https://www.theatlantic.com/science/archive/2019/08/amazon-fires-are-political/596776/>

<https://www.weforum.org/agenda/2018/12/politics-are-failing-to-protect-the-amazon-its-time-to-use-finance/>

<https://towardsdatascience.com/an-analysis-of-amazonian-forest-fires-8facca63ba69>

15. Are the fires the fault of President Jair Bolsonaro?

<https://www.theguardian.com/commentisfree/2019/aug/26/fires-are-devouring-the-amazon-and-jair-bolsonaro-is-to-blame>

16. vulnerability index

<https://www.mdpi.com/1999-4907/9/4/190/pdf>

<https://www.sciencedirect.com/science/article/abs/pii/S0303243413001025>

CONTRIBUTION

NAME	TOPICS DONE
Palak,Hemang,Raj,Utsav	<ul style="list-style-type: none">● Introduction to forest fire● What is Deforestation and how it has become a reason for forest fire?● Types of forest fire● Effect of forest fire on biodiversity● Are recent Amazon fires the fault of President Jair Bolsonaro?
Parth,Hiren,Mihir,Soham	<ul style="list-style-type: none">● Prevention of forest fire and what did Brazil government do about the Amazon fire?● How did Politics influence forest fire?● Why is the study of Amazon forest fire necessary?● Fires in Amazon forest
Dikshen,Dhruv,Kiran,Keval	<ul style="list-style-type: none">● How can there be fire in the rainforest?● Trends of forest fire in the world● How widespread are fires in amazon?● Did climate change cause these fires and how fires affect climate change?
Naman,Akshar,Harsh,Daksh,Himanshu	<ul style="list-style-type: none">● How did fire start?● Causes of forest fire● Vulnerability index in forest region