European Commission

JRC TECHNICAL REPORT

Weekly analysis of wildfires in the Amazon region: November 30 - December 6, 2020

2020

JRC123315

Joint Research Centre

Contact information
Name: Global Wildfire Information System
Address: https://gwis.jrc.ec.europa.eu
Email: jrc-effis@ec.europa.eu
Tel.: +39 0332 786138

EU Science Hub
https://ec.europa.eu/jrc

JRC123315

Luxembourg: Publications Office of the European Union, 2020

How to cite this report: San-Miguel-Ayanz, J[1]., Artes, T. [1], Oom, D. [1], Achard, F[1]., Vancutsem, Ch[1]., Eva, H[1]., Beuchle, R[1]., Campanharo, W.[2], Pfeiffer, H.[3], Branco, A. [3], Liberta, G.[1], De Rigo, D. [3], Grecchi, R. [3], Maianti, P.[3] , Boca, R. [3], Durrant, T. [4], Ferrari, D. [4], 2020. Weekly analysis of wildfires in the Amazon region: November 30 – December 6, 2020, Publications Office of the European Union, Luxembourg, JRC123315.

[1] European Commission, Joint Research Centre (JRC), Ispra, Italy
[2] Instituto Nacional de Pesquisas Espaciais (INPE), San Jose dos Campos, Brazil
[3] ARCADIA SIT, Milan, Italy
[4] Engineering Ingegneria Informatica S.p.A. Rome, Italy

Contents

Scope of this report and executive summary

This report describes the trends of wildfires in the Amazon in 2020 through the comparison with the fire activity in the region in previous fire seasons. It must be noted than 2019 was a critical year in terms of fire activity in many of the countries in the region. Seasonality and trends on fire activity in the countries can be found at the JRC Technical Report on the Amazon. The current report has been produced by the European Commission's Joint Research Centre (JRC) within its activities on the development of a Global Wildfire Information System (GWIS)[1]. Most of the Amazon region is in Brazil, specifically in the Brazilian Legal Amazon (BLA)[2], and in other neighbor countries. Paraguay has been included in this report due to the high fire activity observed this year, although it is not part of the Amazon region. Figure 1 shows the geographical extent of the countries analyzed in this report. **This report of December 2020 includes a monthly report section, which provides the monthly wildfire statistics of 2020 up to the 30th of November, data on burnt areas in protected areas in the countries, and monthly CO_2 fire emissions. Additionally, the report includes a section on forest degradation and deforestation in the Amazon in 2020**.

- In the Brazil Legal Amazon (BLA), within Brazil, a total of 33.06 Mha burnt since January 1 until December 6, 2020. This value is about 57% higher than that of 2019. **Last week 2,398 fires occurred, which is a higher value than those in 2019 and 2018 for the same week. During November 2020 the total burnt area is higher than previous years but with a considerable decreasing trend which points out to the end of the current fire season.**
- **46.76 Mha ha burnt in Brazil since January 1 until December 6, 2020**, with a total 0.78 Mha burnt in the last week. The value of the last week was above the value of the same week in 2019. So far, the total burnt area in Brazil is about **47% higher than that of 2019**. 3,535 fires occurred last week. The average fire size is similar to 2019 that was a critical year. **However, during November there is a decreasing trend showing an expected end of the fire season.**
- **In Bolivia**, the weekly burnt area and number of fires are stabilized to trends of previous years. However, **the total burnt area during 2020 is slightly higher than that of 2019 because of a significant increase of fires from mid-August to November.**
- In Colombia, the total burnt area in the country (3.37 Mha) remains approximately 24.41% above the values of 2019, due to the intensive fire activity from January to April 2020.
- **In Paraguay**, with 6.53 Mha burnt since January 1 until December 6, 2020, has reached values nearly two times the values in 2018 and 2019. **The fire activity remains higher than usual for November as compared with previous years.**
- A total of 2.79 Mha burnt in Peru since January 1 until December 6, 2020. This value is almost double than that of 2019, mainly because of the increase of the fire activity during July and August. The number of fires mapped in GWIS is nearly double of that in 2019.
- **In Venezuela,** 6.98 Mha burnt in the current year. The value of the total burnt area in Venezuela is approximately 15.62% higher than that in 2019 due to the intensive fire activity in the country between January and April. **The trend in the last week is lower to those of 2018 and 2019 when the fire season was already showing signs of a starting season.**
- This week, fire danger will remain extreme in the eastern part of Brazil and moderate to high in southern Bolivia and Paraguay.

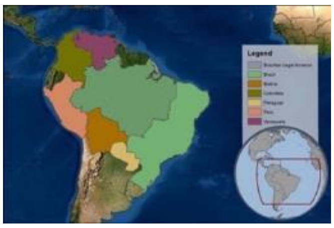


Figure 1. Areas analyzed in this report: Brazil Legal Amazon, Brazil, Bolivia, Colombia, Paraguay, Peru and Venezuela

[1] https://gwis.jrc.ec.europa.eu

[2] The Brazilian Legal Amazon is a geopolitical region in Brazil, established in the article 2 of the complementary law 124, of 2007, that includes 772 municipalities over 9 states. It comprises approximately five million square kilometres, which correspond to 59% of the Brazilian territory (IBGE, 2019)

1 Wildfires in the Brazilian Legal Amazon Region

Figure 2 shows the trends on the extent of burnt areas and the number of fires since January 1, 2020 produced by the Near-Real Time (NRT) fire analysis in GWIS. The last row shows the evolution of active hot spots (thermal anomalies) detected by the satellite sensor VIIRS. A total of 33.06 Mha burnt in the BLA since January 1 until December 6, 2020, with 0.54 Mha burnt in total the last week, similar for the same week in 2019. Until December 6, the total burnt area in 2020 in BLA is about 58% higher than that of 2019.

The number of fires recorded in GWIS in the last week was 2398, higher than the value in 2019 and 2018 in that week. The total number of fires in 2020 is above the figures in 2018 and 2019. On average, fires that occurred in the BLA in the last 3 weeks, were of a similar size in 2020 compared to 2019 and 2018. The number of thermal anomalies until December 6, 2020 (1,000,245) shows a typical trend in the region as compared to the trends in 2018 and 2019. A number of 13726 thermal anomalies was registered last week.

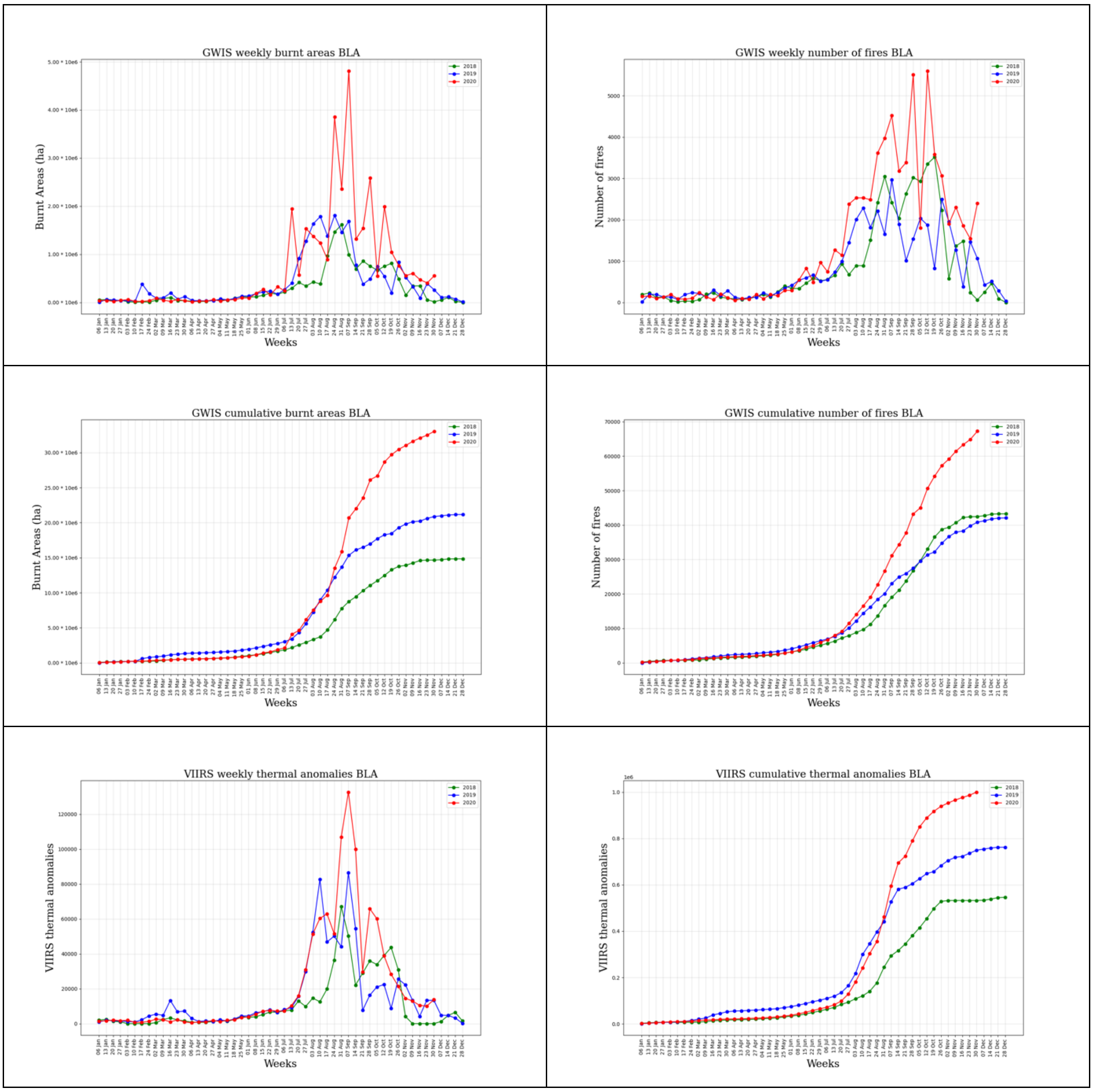


Figure 2. Trend of burnt areas and number of fires as compared to data in the last two years.

2 Wildfires in Brazil

Figure 3 shows the trends on the extent of burnt areas and the number of fires since January 1, 2020 produced by the Near-Real Time (NRT) fire analysis in GWIS. The last row shows the evolution of active hot spots (thermal anomalies) detected by the satellite sensor VIIRS. A total of 46.76 Mha ha burnt in Brazil since January 1 until December 6, 2020, with a total 0.78 Mha burnt in the last week. The value of the week was higher than of the values for the same week in 2019. Until December 6, the total burnt area in Brazil is about 48% higher than that of 2019.

The number of fires recorded in GWIS in the last week was 3535, higher the value than in 2019 and 2018 in that week. The number of fires in 2020 up to December 6 is higher than that of 2019, although the average fire size is similar to 2019 that was a critical year. The number of thermal anomalies until December 6, 2020 (1,423,194) shows a typical trend in the region with similar values as compared to the trends in 2019 and higher than 2018. 20,211 thermal anomalies were registered last week.

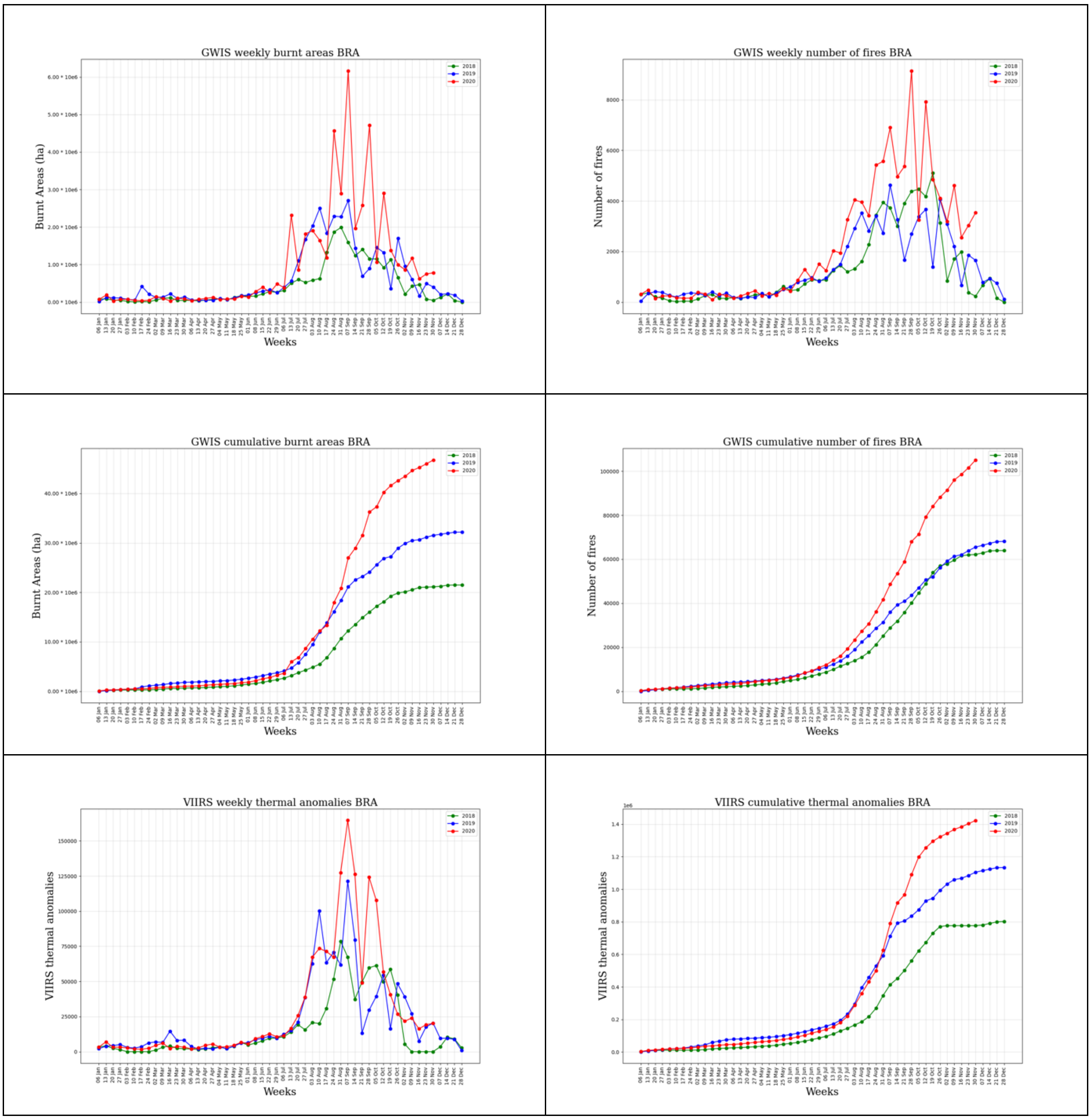


Figure 3. Trend of burnt areas, number of fires and thermal anomalies as compared to data in the last two years.

3 Wildfires in Bolivia

Figure 4 shows the trends on the extent of burnt areas and the number of fires since January 1, 2020 produced by the Near-Real Time (NRT) fire analysis in GWIS. The last row shows the evolution of active hot spots (thermal anomalies) detected by the satellite sensor VIIRS. A total of 8.97 Mha ha burnt in Bolivia since January 1 until December 6, 2020, with 50,824 ha burnt in the last week. The last week had similar burnt area but higher number of fires than the same week in 2019. However, the average fire size remains similar to previous years and much lower from the peaks of the average fire size reached during July of 2019 (see Figure 18).

The number of fires recorded in GWIS in the last week was 167, higher than the number of fires in the same week in 2018 and 2019.The number of thermal anomalies until December 6, 2020 (274,585) shows a typical trend in the region. 1,851 thermal anomalies were detected by VIIRS in the last week.

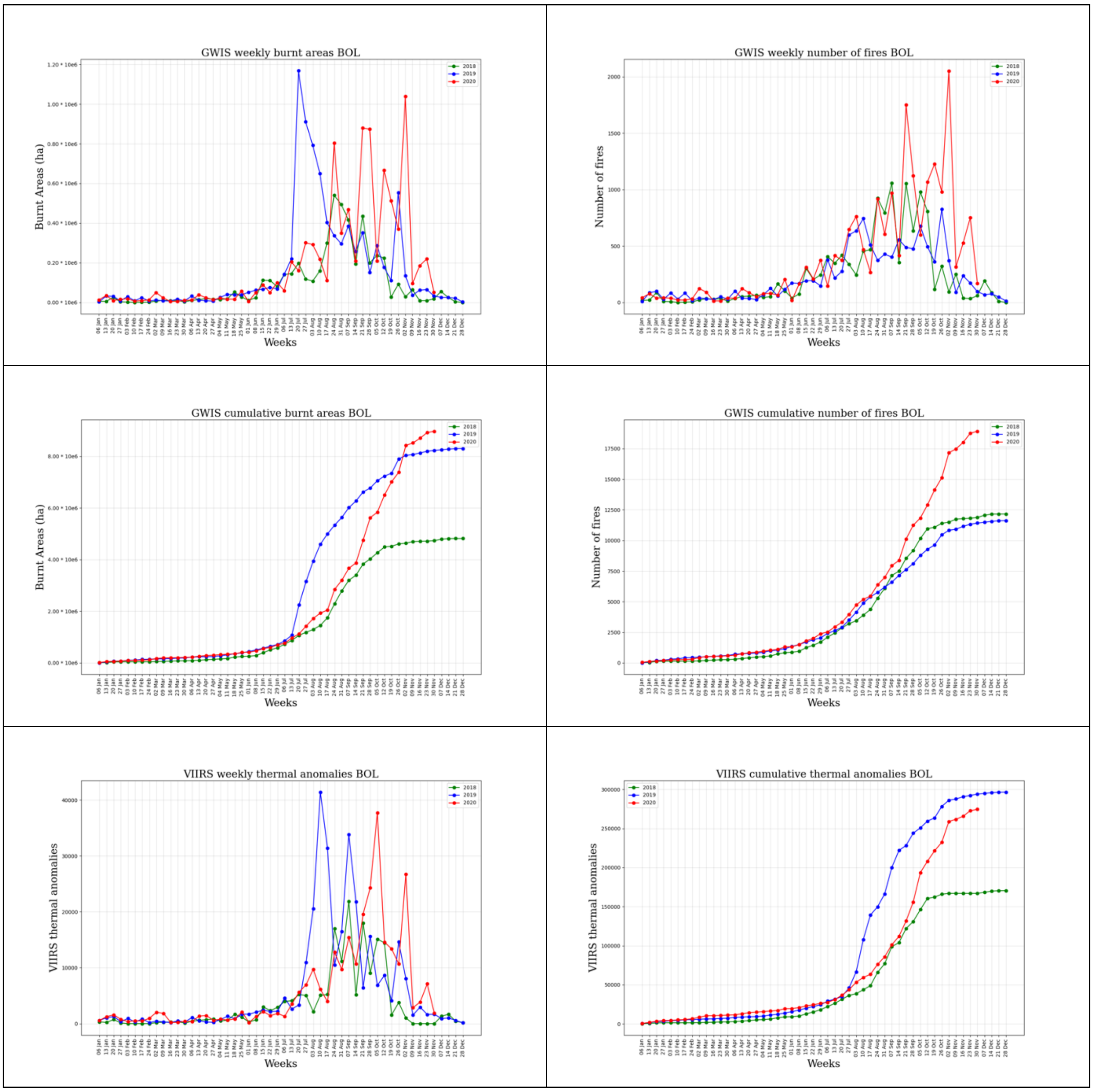


Figure 4. Trend of burnt areas, number of fires and thermal anomalies as compared to data in the last two years.

4 Wildfires in Colombia

Figure 5 shows the trends on the extent of burnt areas and the number of fires since January 1, 2020 produced by the Near-Real Time (NRT) fire analysis in GWIS. The last row shows the evolution of active hot spots (thermal anomalies) detected by the satellite sensor VIIRS. A total of 3.37 Mha burnt in Colombia since January 1 until December 6, 2020, with 24,945 ha burnt in the last week. The fire activity of last week is similar to those of previous years, the total burnt area in the country is approximately 24.41 % above the values of 2019, due to the intensive fire activity from January to April 2020.

The number of fires recorded in GWIS in the last week was 108, which shows a stable trend in the last weeks, as compared to 2018 and 2019, but increasing from the last week. The number of fires is approximately 26% higher than that of last year. The number of thermal anomalies until December 6, 2020 (117,218) shows a typical trend in the region as compared to the trends in 2018 and 2019, with values approximately 20% higher than those in 2019. 703 thermal anomalies were detected by VIIRS during the last week, which is similar to the values in the same week in 2019 and 2018.

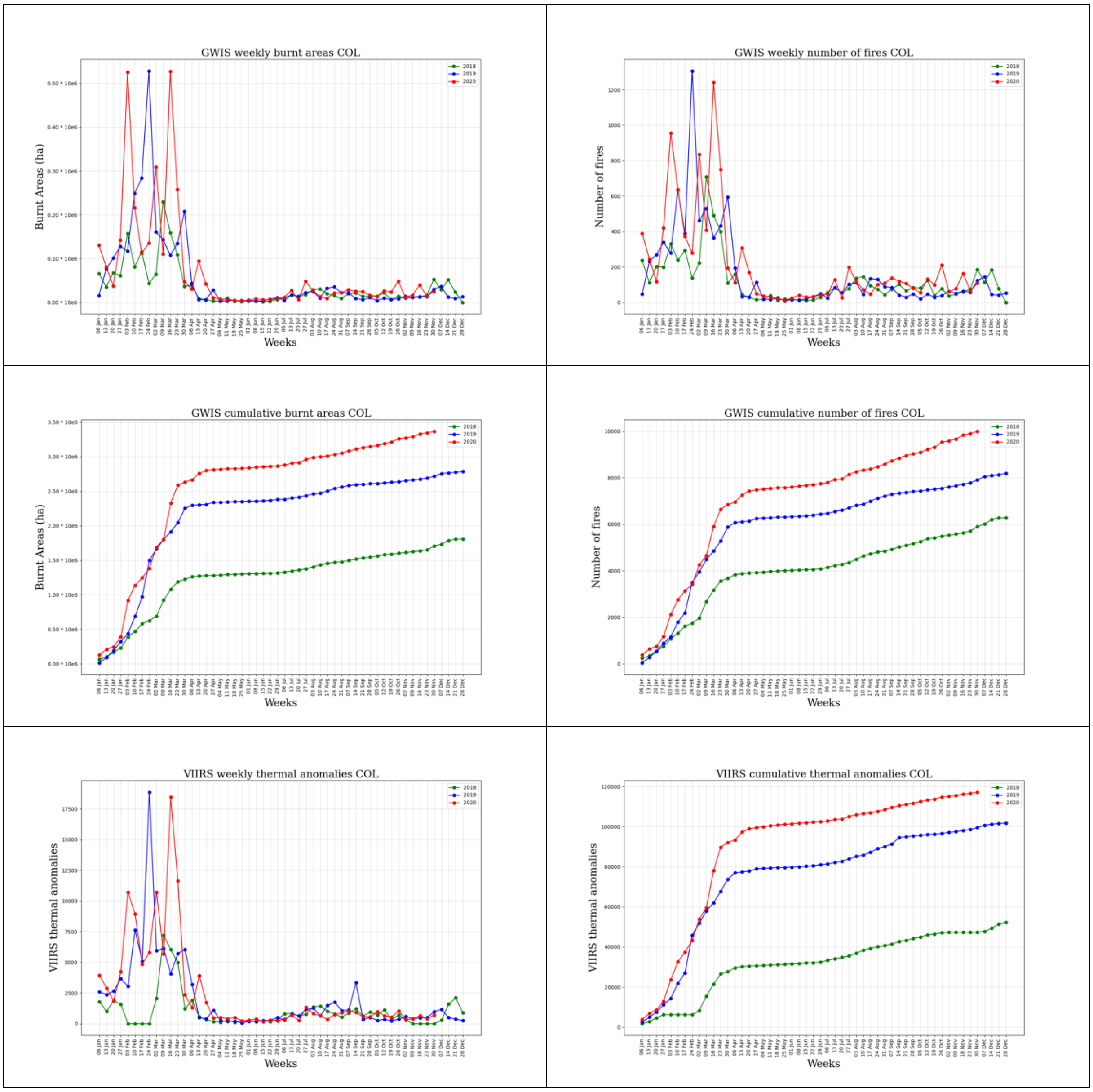


Figure 5. Trend of burnt areas, number of fires and thermal anomalies as compared to data in the last two years.

5 Wildfires in Paraguay

Figure 6 shows the trends on the extent of burnt areas and the number of fires since January 1, 2020 produced by the Near-Real Time (NRT) fire analysis in GWIS. The last row shows the evolution of active hot spots (thermal anomalies) detected by the satellite sensor VIIRS. A total of 6.53 Mha burnt in Paraguay since January 1 until December 6, 2020, which is nearly two times the values of previous years like 2018 and 2019. Approximately 31,538 ha burnt in the country the last week, similar with the value of the same week of 2019.

The number of fires recorded in GWIS in the last week was 122, which is higher than the value in 2019 and 2018. The average fire size has decreased during the last 3 weeks and is similar of the same weeks of 2018 and smaller than 2019. The number of thermal anomalies until December 6, 2020 (205,214) follows a typical trend in the region, but with higher values, nearly the double as compared to 2018 and 2019. 1,408 thermal anomalies detected by VIIRS last week.

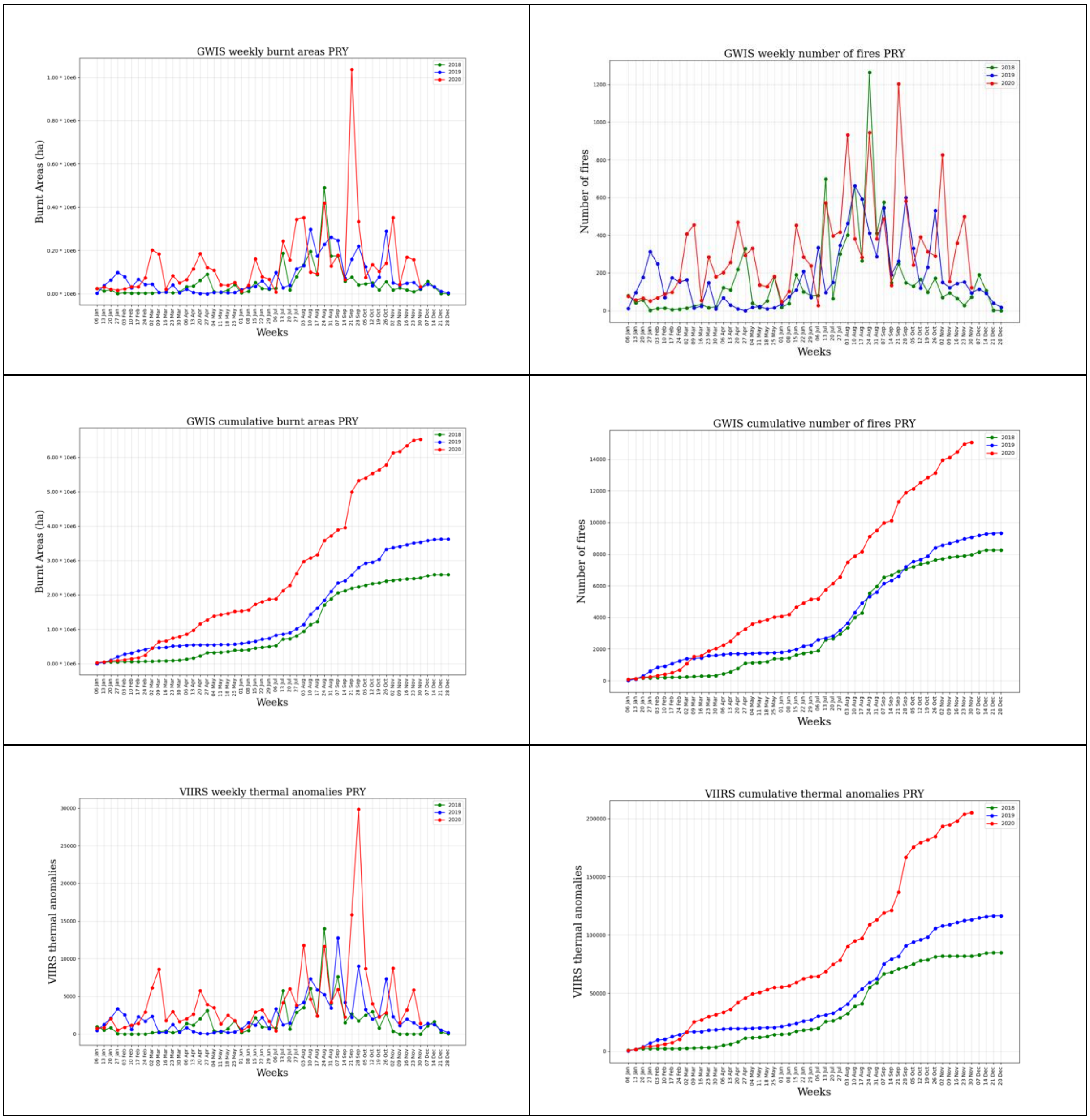


Figure 6. Trend of burnt areas, number of fires and thermal anomalies as compared to data in the last two years.

6 Wildfires in Peru

Figure 7 shows the trends on the extent of burnt areas and the number of fires since January 1, 2020 produced by the Near-Real Time (NRT) fire analysis in GWIS. The last row shows the evolution of active hot spots (thermal anomalies) detected by the satellite sensor VIIRS. A total of 2.79 Mha burnt in Peru since January 1 until December 6, 2020. This value is almost the double than that of 2019. Approximately 2787 ha burnt in the last week, lower values than ones of 2018 and 2019 for the same week.

The number of fires recorded in GWIS in the last week was 16, the first low value after the fire season this year. The total number of fires since the beginning of the year, above 8,000, is about double of that of 2019. Compared with previous years, the fire season in 2020 is taking more weeks to end than in 2018 and 2019. The number of thermal anomalies until August 30, 2020 (82,130) shows a typical trend in the region, with values higher than in 2018 and 2019. 145 thermal anomalies registered last week, decreasing after the last week.

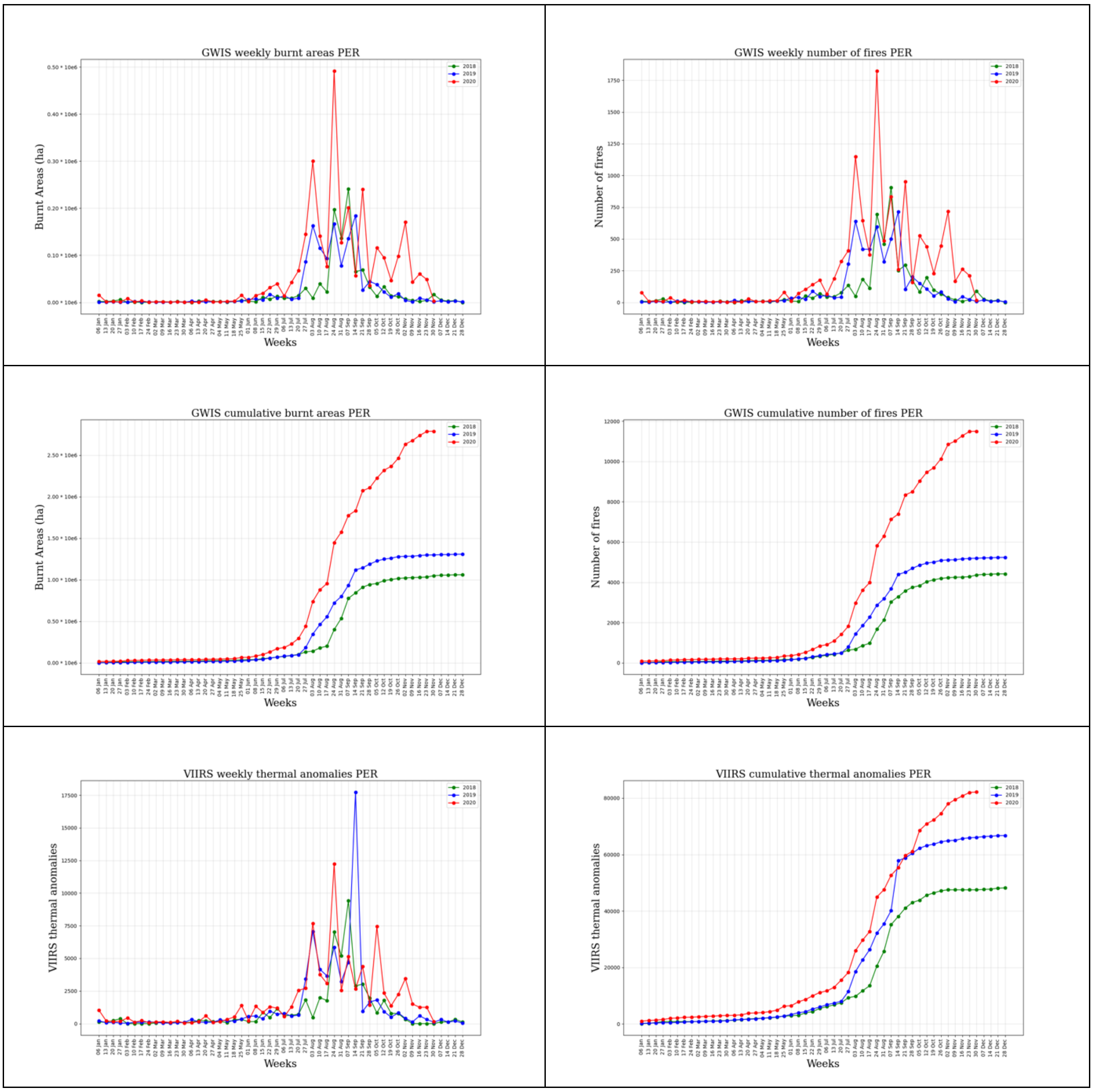


Figure 7. Trend of burnt areas, number of fires and thermal anomalies as compared to data in the last two years.

7 Wildfires in Venezuela

Figure 8 shows the trends on the extent of burnt areas and the number of fires since January 1, 2020 produced by the Near-Real Time (NRT) fire analysis in GWIS. The last row shows the evolution of active hot spots (thermal anomalies) detected by the satellite sensor VIIRS. A total of 6.98 Mha burnt in Venezuela since January 1 until December 6, 2020, with 24,609 ha burnt in the last week. The value of the total burnt area in the country is approximately 15.62 % higher than that in 2019 due to the intensive fire activity in the country between January and April. The trend in the last week is lower than that of 2018 and 2019. The fire season in Venezuela is expected to be starting during the following weeks.

The number of fires recorded in GWIS in the last week was 112, which shows a stable trend comparable to those of the previous two years, although the total number of fires remains approximately 18% higher than in 2019. The number of thermal anomalies until December 6, 2020 (278,016) shows a typical trend in the region as compared to the trends in 2018 and 2019, but with approximately 30% higher value than the previous years. 1508 thermal anomalies were recorded by VIIRS during the last week, a value that is like those recorded in that week the previous two years.

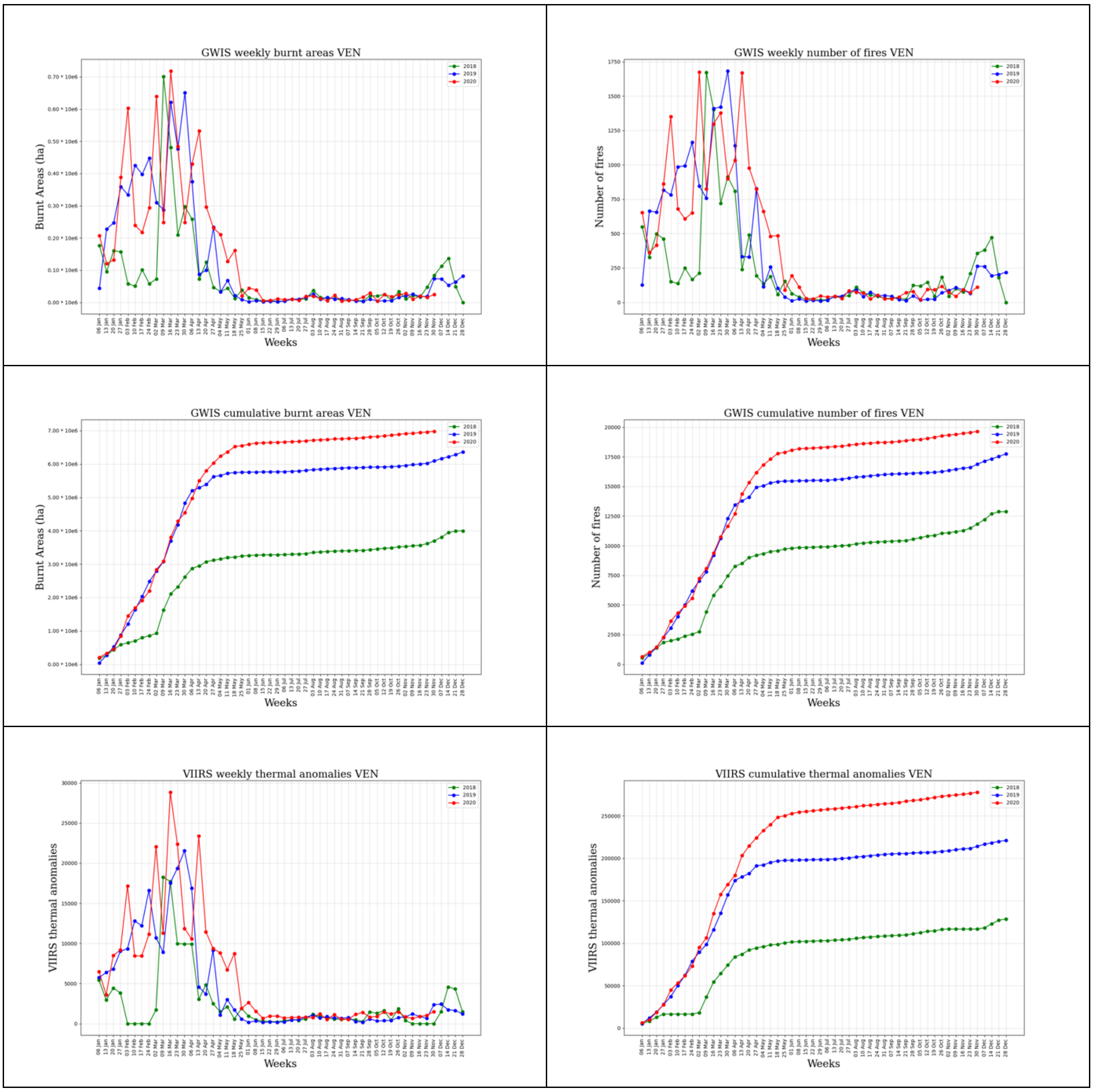


Figure 8. Trend of burnt areas, number of fires and thermal anomalies as compared to data in the last two years.

8 Fire danger and fire weather forecast in the Amazon region

This section provides information on the fire danger forecast in the Amazon region for the current week. High levels of fire danger facilitate fire ignitions and the propagation of ongoing fires. Figure 9 provides the average fire danger for the week of December 7 to December 13, 2020. This information is based on the daily fire danger forecast that is provided online in GWIS[3]. According to this forecast, it is expected that fire danger conditions will remain extreme in the eastern part of Brazil and moderate to high in southern Bolivia and Paraguay.

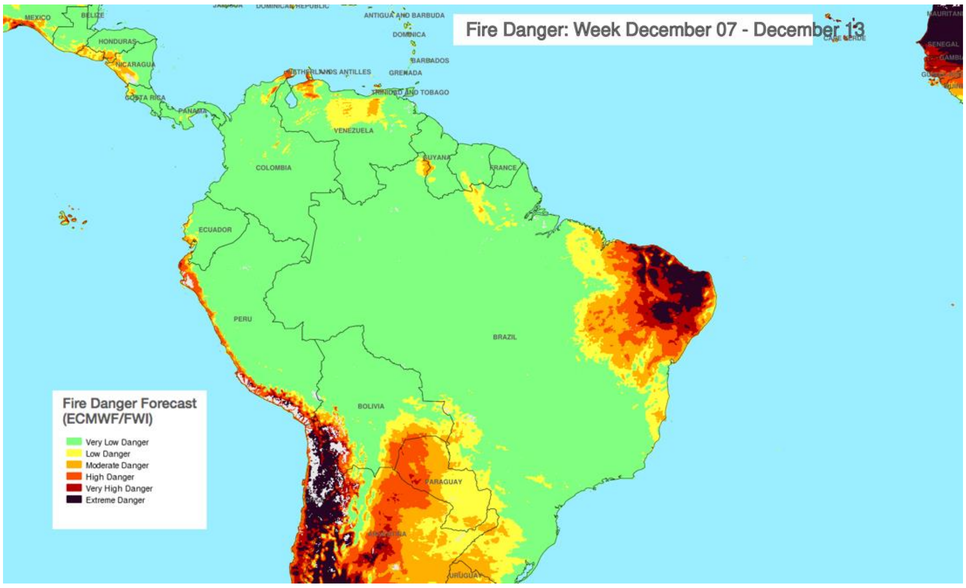


Figure 9. Average Fire danger forecast. Week, December 07 - December 13, 2020.

The weekly fire weather forecast of temperature and precipitation anomalies for this week is presented in Figure 10. Above average temperatures are forecasted for some areas of eastern Brazil and southern Bolivia. The models estimate an above average precipitation rates for this week mainly in eastern Brazil and Paraguay. Below average precipitation is foreseen mainly in central and southeastern Brazil.

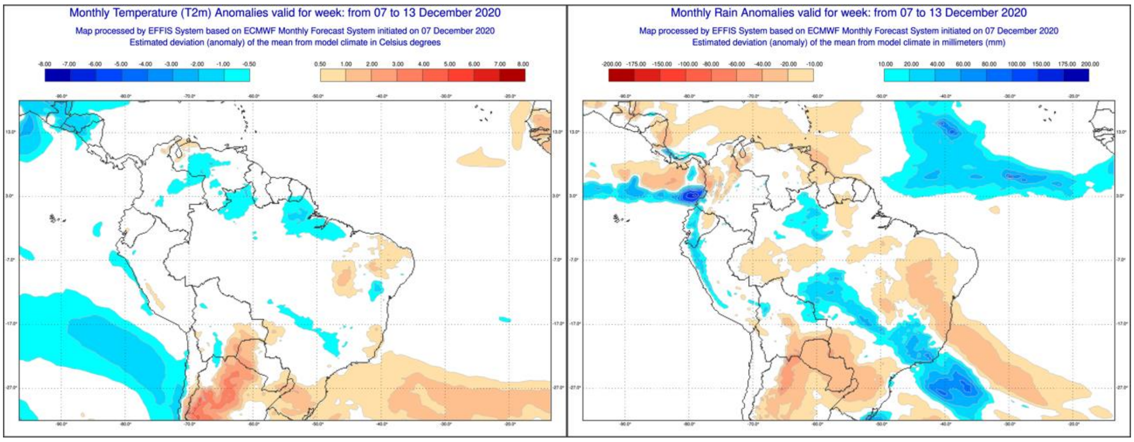


Figure 10. Fire weather anomalies of the current week, December 07 - December 13, 2020.

[3] https://gwis.jrc.ec.europa.eu/static/gwis_current_situation/public/index.html

9 Monthly analysis (up to December 1, 2020)

9.1 Brazilian Legal Amazon (BLA)

Figure 11 shows the spatial distribution of burnt areas for 2020 mapped by the Near-Real Time (NRT) process in GWIS in the Brazilian Legal Amazon region, within Brazil.

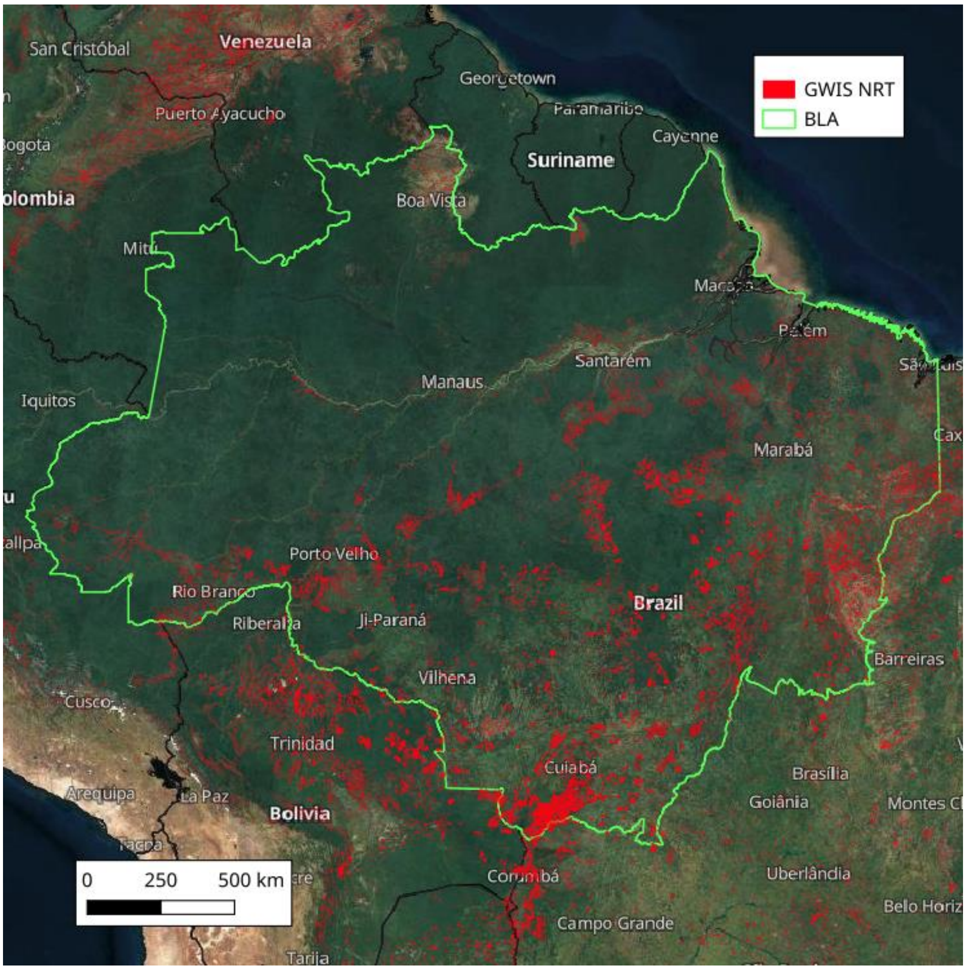
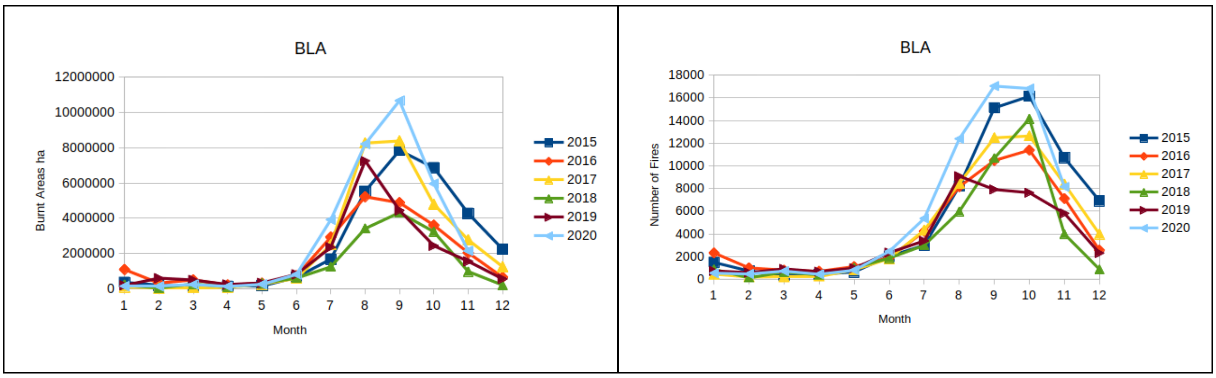


Figure 11. GWIS burnt areas for 2020 in Brazilian Legal Amazon (BLA). Burnt areas until December 1.

The 2020 fire season in the BLA was following similar trends of the last year until August as shown in Figure 12. The burnt area of November is similar (2.14Mha) to previous years for the same month. The numbers of fires are considerable high compared with 2018 (8134 in 2020 compared with 3978 in 2018 and 5804 in 2019). During December 2019 the fire season decreased and this year follows a similar trend, with an accumulated burnt area (30Mha) and similar average fire size than the same month for the previous. This year the fires are about the same size of last year but in more quantity and during a longer period of time. The 2020 fire season has a similar behavior of the one in 2018 but with an average fire size like the one of the last year 2019 (except for February).



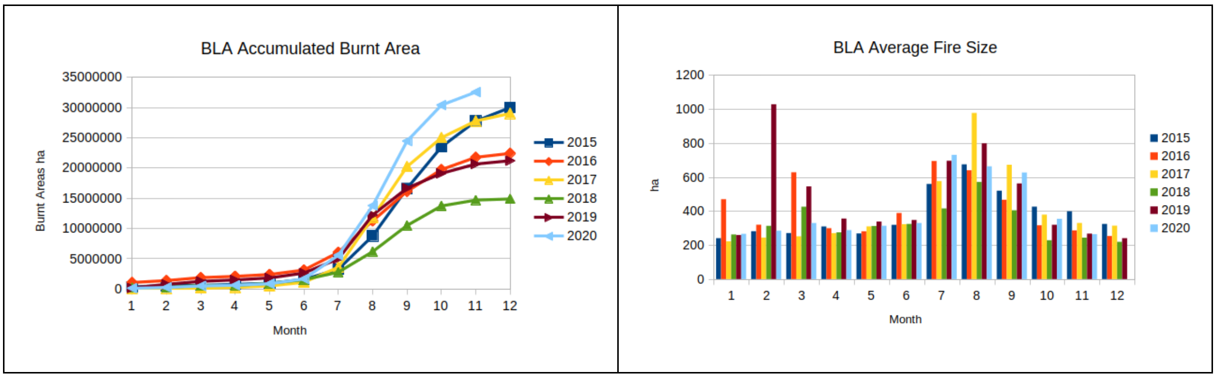


Figure 12. Trend of burnt areas and number of fires as compared to data in the last six years.

Figure 13 shows the monthly burnt land cover distribution for the year 2020, with an increase of burnt area in forest especially during the fire season months where the fires are bigger.

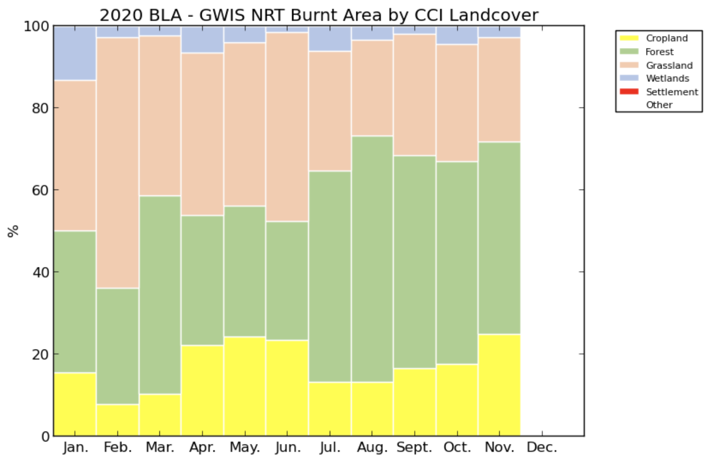


Figure 13. Monthly percentage of burnt land cover for the year 2020

Figure 14 shows the monthly percentage of burnt area in protected areas for the year 2020.

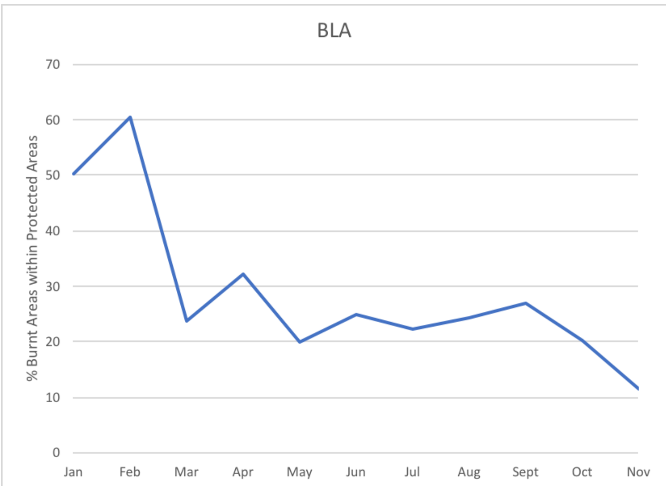


Figure 14. Monthly percentage of monthly burnt area within protected areas for the year 2020

In terms of the number of active fire spots retrieved directly by the VIIRS sensor, 2020 presents a number of active fire spots from May to October above the average for the period between 2012 and 2019 as shown in Figure 15. However, in November the active fire spots decreased to low numbers which could point out to a sudden decrease of fire activity at the end of the fire season. This type of data is often reported in the media, which point out to a higher number of fires this year as compared to past years.

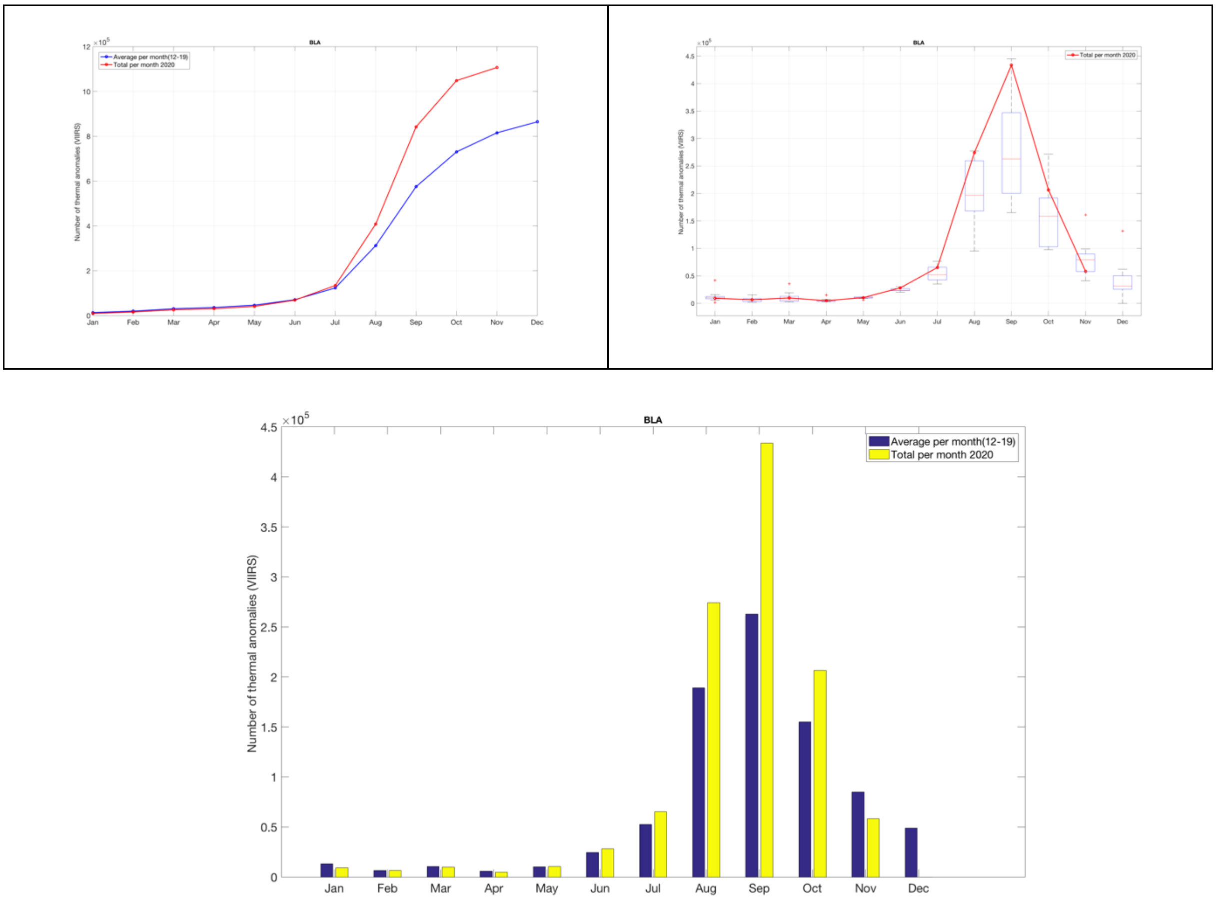


Figure 15. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 16 shows the monthly biomass burning CO_2 emissions from the Global Fire Assimilation System (GFAS). The 2020 fires have released lower amount of emissions than 2019 for August and 2017 between September and November.

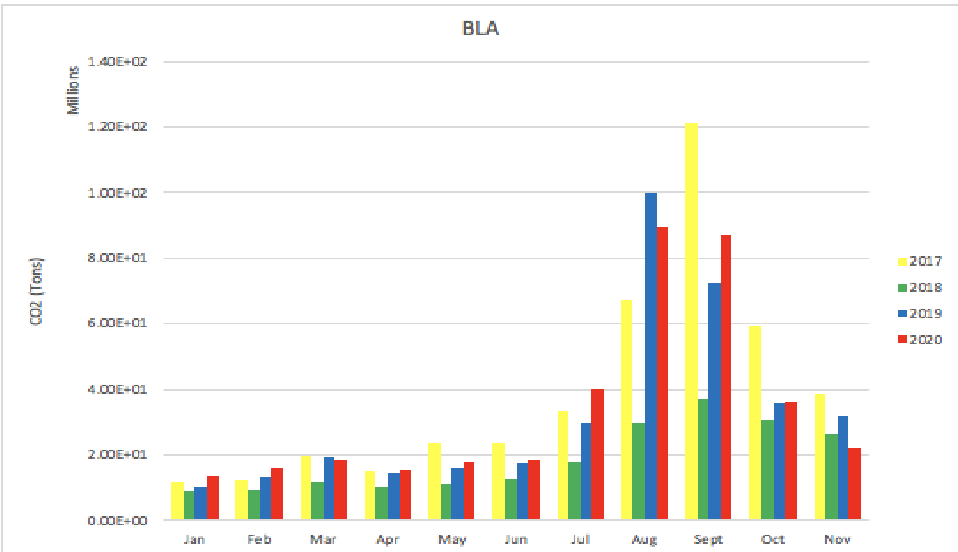


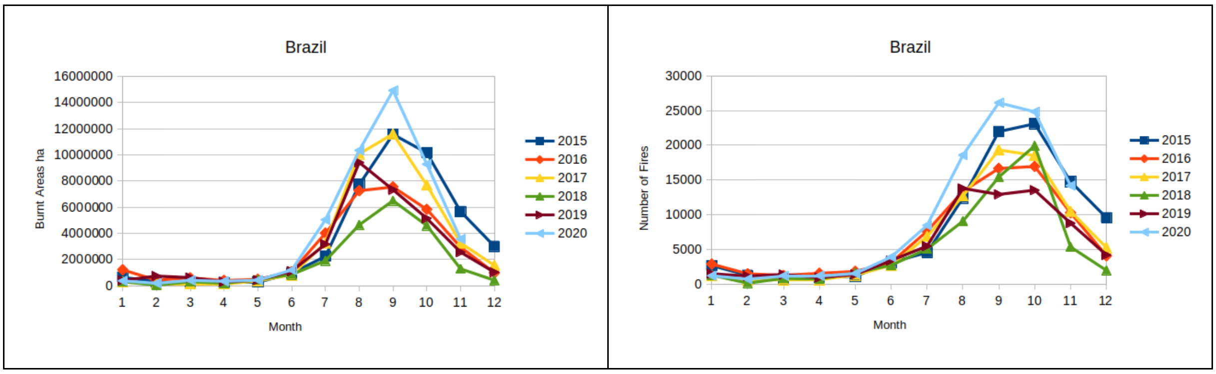
Figure 16. Trend of CO_2 emissions from biomass burning

9.2 Brazil

The spatial extent of the burnt areas mapped by the Near-Real Time (NRT) process in GWIS is presented in Figure 17. Although most of the burnt areas occurred in the center of the country (Cerrado Biome), the fire activity and the resulting burnt areas show a wide spread from north to south, including the humid Amazon forest.

Figure 17. GWIS burnt areas for 2020 in Brazil. Burnt areas until December 1.

The 2020 fire season in Brazil is showing similar behavior of 2017 as shown in Figure 18. This year the peak of the fire season is by now in September, like last year. The average fire size is less than in 2017 but the burnt area is higher. Therefore, this year has more burnt area despite of having smaller fires, in average, than of those of 2017. Last year 2019 had, in average, smaller fires during September than in August. During December 2020 the burnt area reached 3.56Mha with 14188 fires contributing to a total burnt area of 42Mha for 2020.



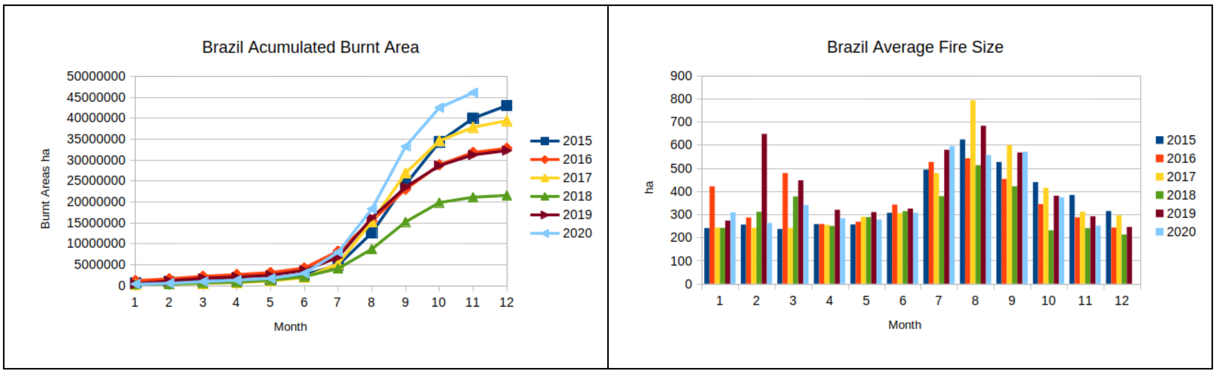


Figure 18. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 19 shows the monthly burnt land cover distribution for the year 2020, following a similar trend as in BLA where there is an increase of forest class during the fire season months when the fires are bigger.

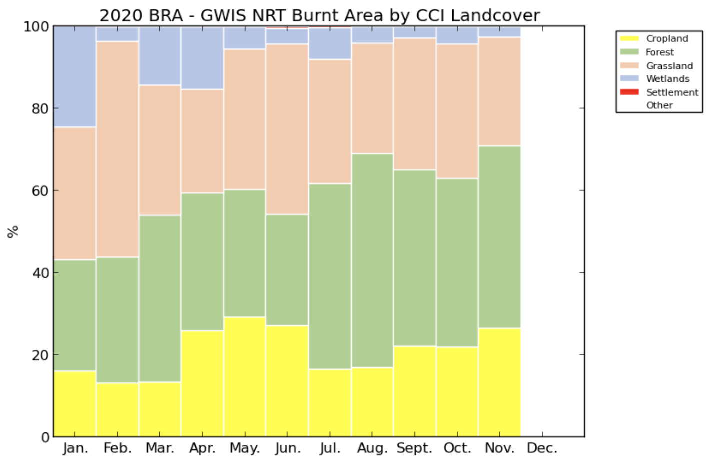


Figure 18. Monthly percentage of burnt land cover for the year 2020

Figure 19 shows the monthly percentage of burnt area protected areas for each month.

Figure 19. Monthly percentage of monthly burnt area within protected areas for the year 2020

In terms of active fire spots detected by VIIRS, 2020 presents a number of active fire spots in the period between March and October (especially August to October) above the average for the period between 2012 and 2019 as shown in Figure 20. As in BLA, the active fire spots show a sudden decrease which is below the average of previous years.

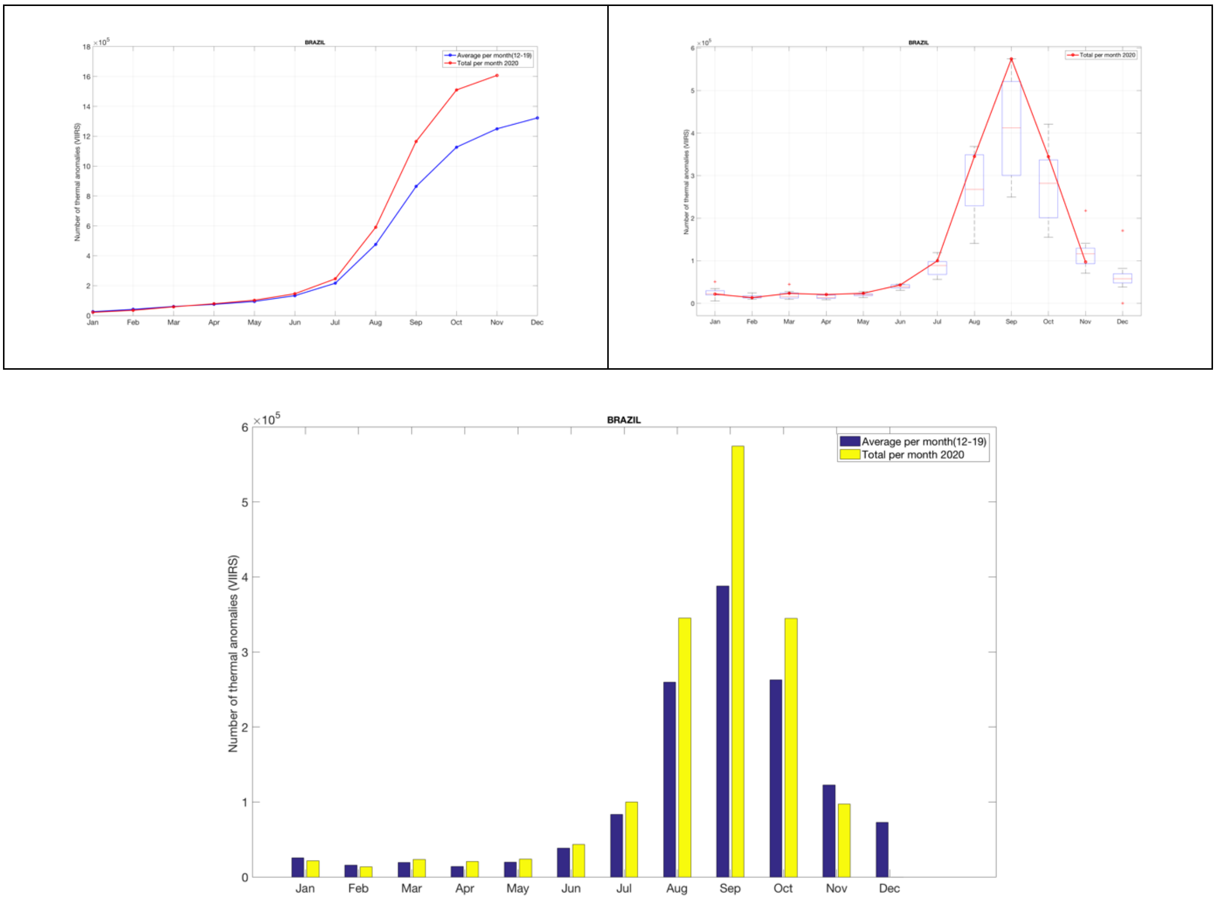


Figure 20. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 21 shows the monthly biomass burning CO_2 emissions from the Global Fire Assimilation System (GFAS). As in the BLA, the 2020 fires have released lower amount of emissions than 2019 for August and 2017 between September and November.

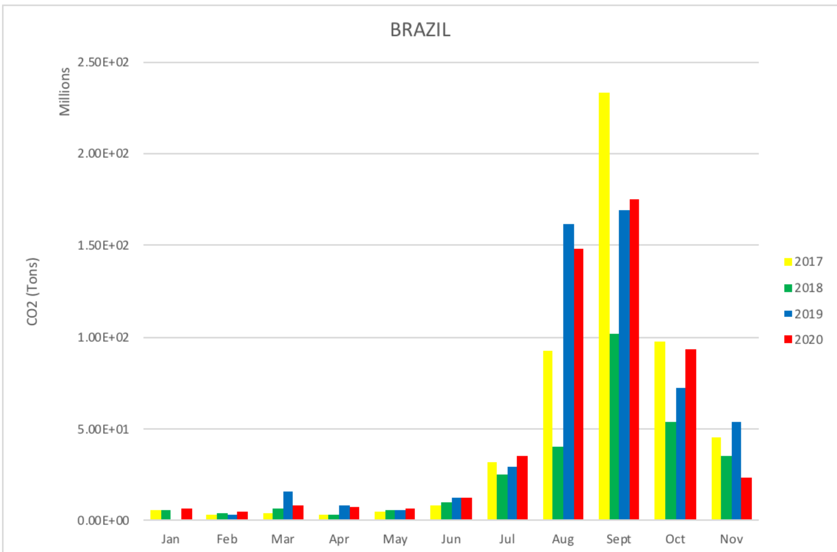


Figure 21. Trend of CO_2 emissions from biomass burning

9.3 Bolivia

The spatial distribution of burnt areas in Bolivia in 2020 mapped by the Near-Real Time (NRT) process in GWIS is shown in Figure 22.

In Bolivia the 2020 fire season is following a similar trend to the fire season of 2017 and 2018 as shown in Figure 21. Despite of this similar behavior, the number of fires is a record value since 2015. Although this season has much smaller fires than 2019, the high value of number of fires contributes to yearly burnt area that is above to the one of the critical season in 2019. Bolivia has 8.9 Mha of burnt area and 18,834 fires up to December. However, the current year is clearly better compared with the critical 2019 fire season that had clear peak in August and an anomalous average fire during July due to uncontrolled extreme wildfires, as can be seen in Figure 23.

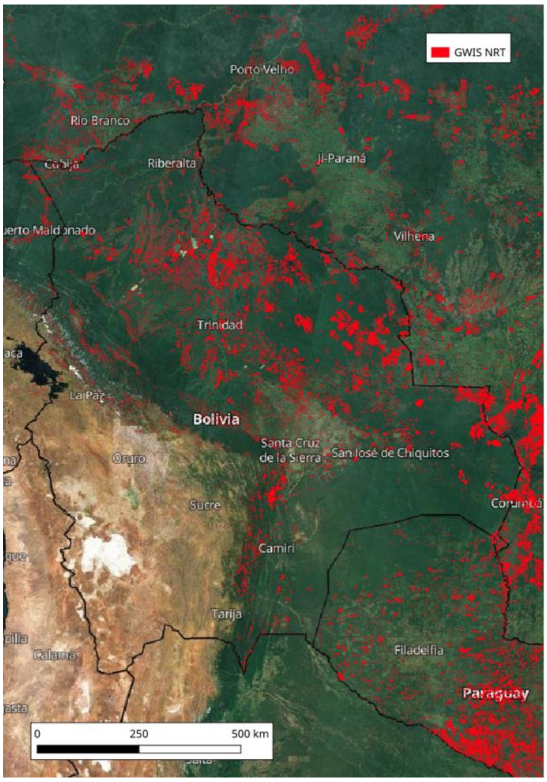
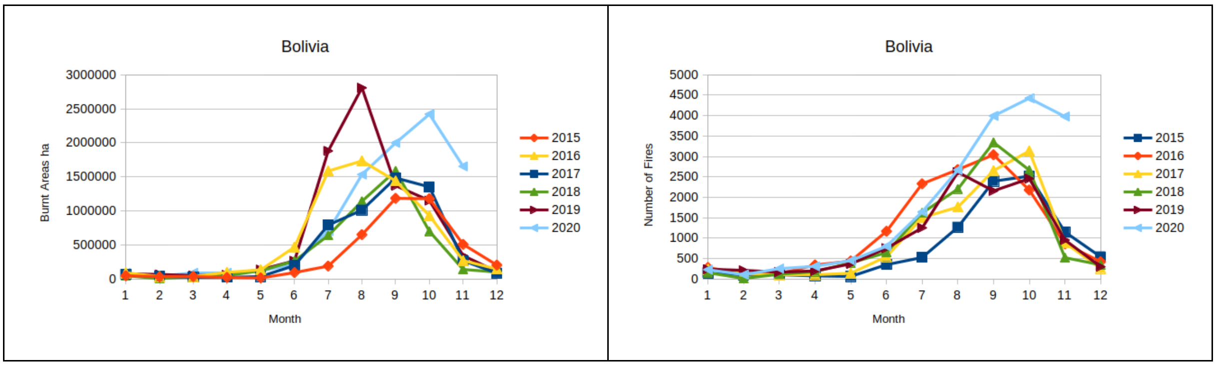


Figure 22. GWIS burnt areas for 2020 in Bolivia. Burnt areas until December 1.



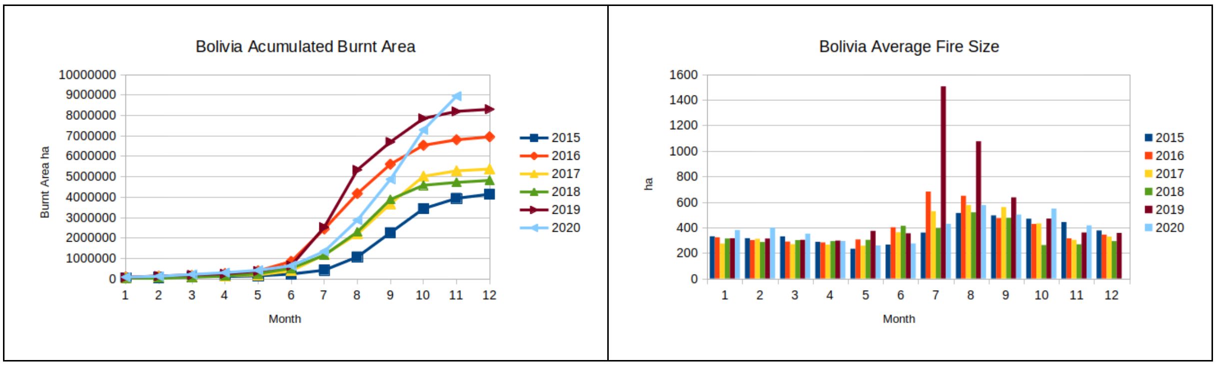


Figure 23. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 24 shows the monthly burnt land cover distribution for the year 2020, with forest as the most affected landcover by fire.

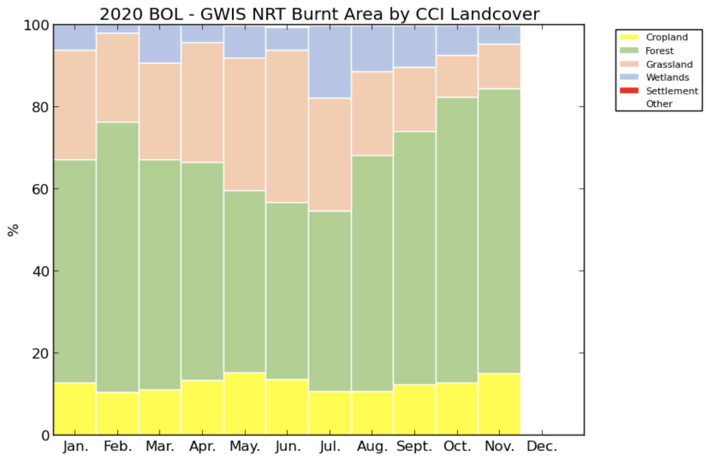


Figure 24. Monthly percentage of burnt land cover for the year 2020

Figure 25 shows the monthly percentage of burnt area in protected areas for the year 2020, with values above 30% in October.

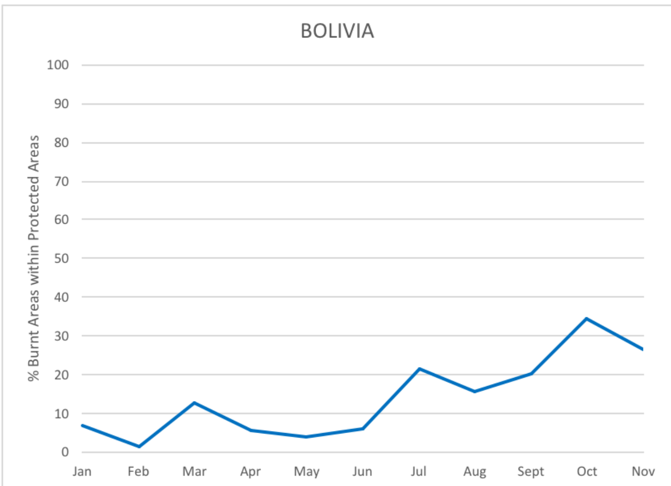


Figure 25. Monthly percentage of monthly burnt area within protected areas for the year 2020

In terms of active fire spots detected by VIIRS, 2020 presents a number of active fire spots in the period between September and November are above the average as shown in Figure 26.

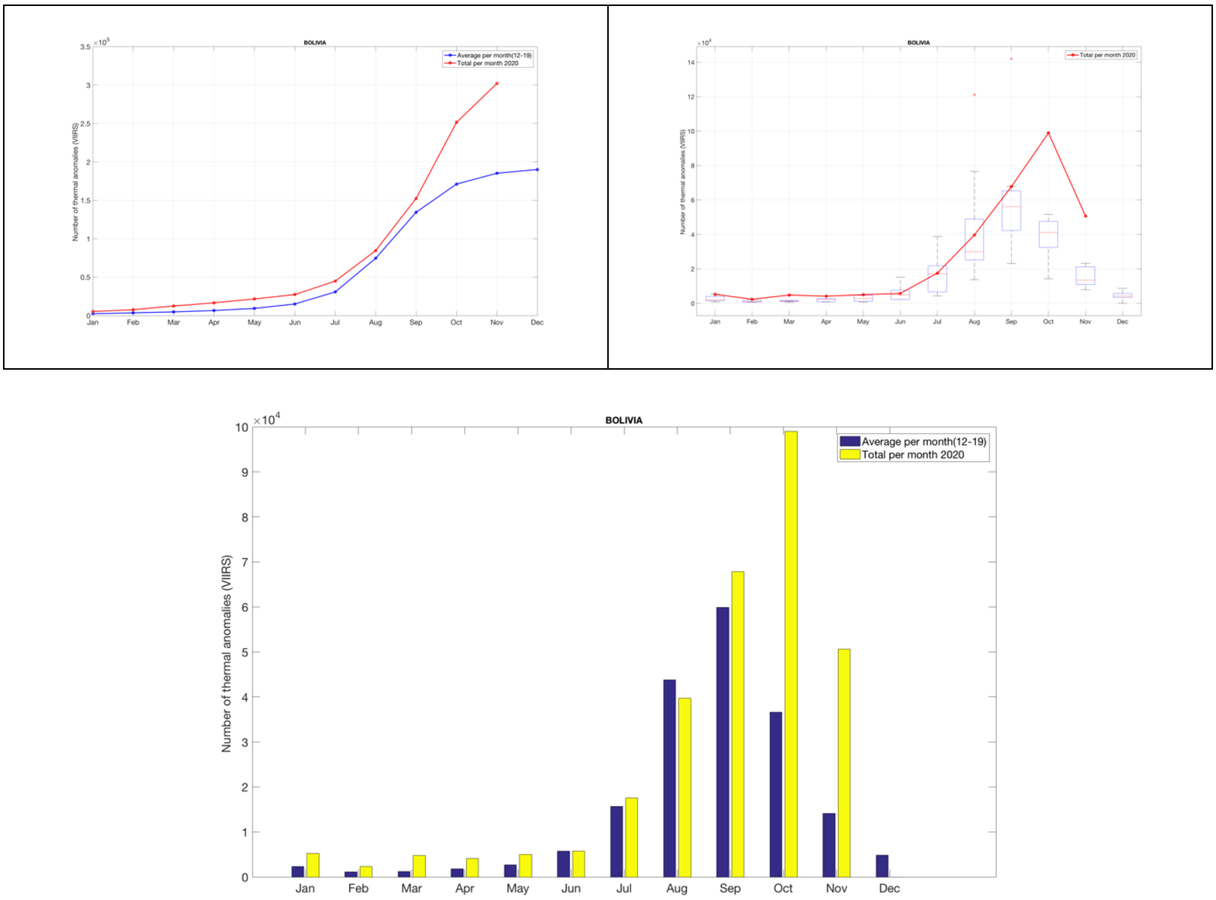


Figure 26. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 27 shows the monthly biomass burning CO_2 emissions from the Global Fire Assimilation System (GFAS). The 2020 fires have released higher amount of emissions than 2019 in October and November.

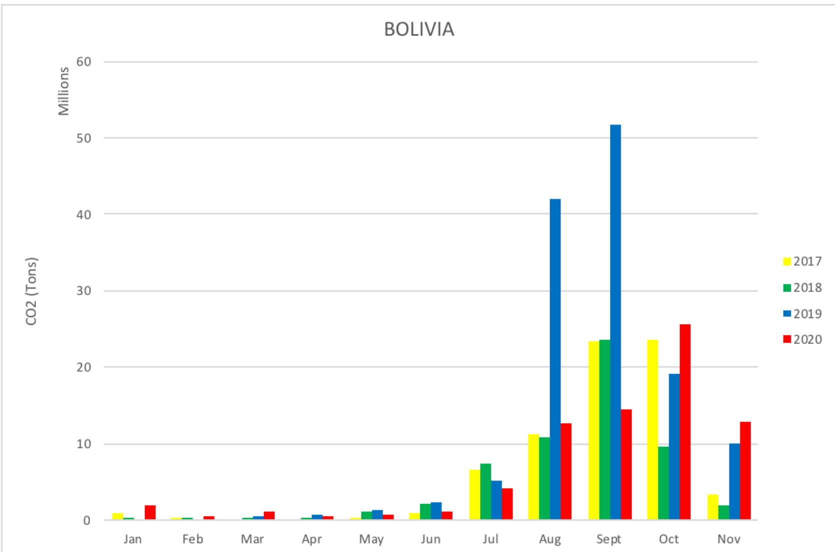


Figure 27. Trend of CO_2 emissions from biomass burning

9.4 Colombia

The spatial distribution of burnt areas in Colombia in 2020 mapped by the Near-Real Time (NRT) process in GWIS is shown in Figure 28.

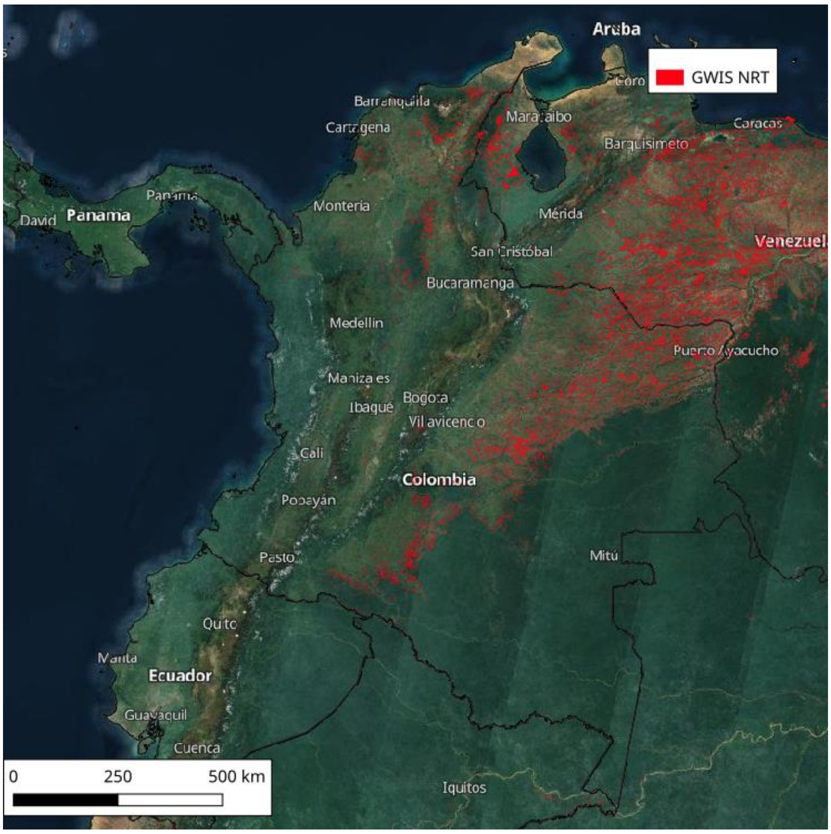
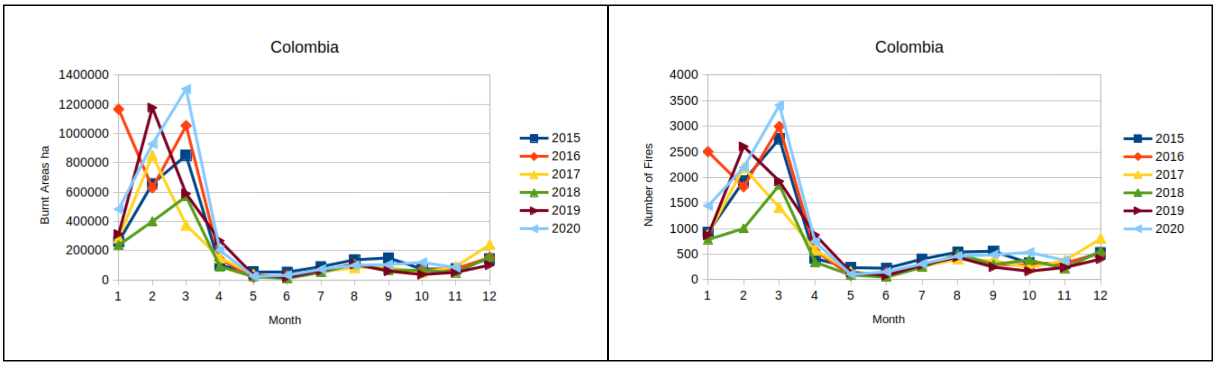


Figure 28. GWIS burnt areas for 2020 in Colombia. Burnt areas until December 1.

The current fire season has been more severe than the last years, except of 2016. About 3.45 Mha of burnt areas have been mapped in the country until end of December. Figure 29 shows how the number of fires is considerable higher in March of 2020. The same happens with the burnt area and the average monthly fire size. This fact points out to a considerable increase of fire activity, having more uncontrolled fires. The fires are mainly located on the center and south-west of the country, a region designated as “Llanos”, a complex savanna ecosystem which undergoes periodic, human-induced and natural biomass burning during the dry season, usually between November and April.



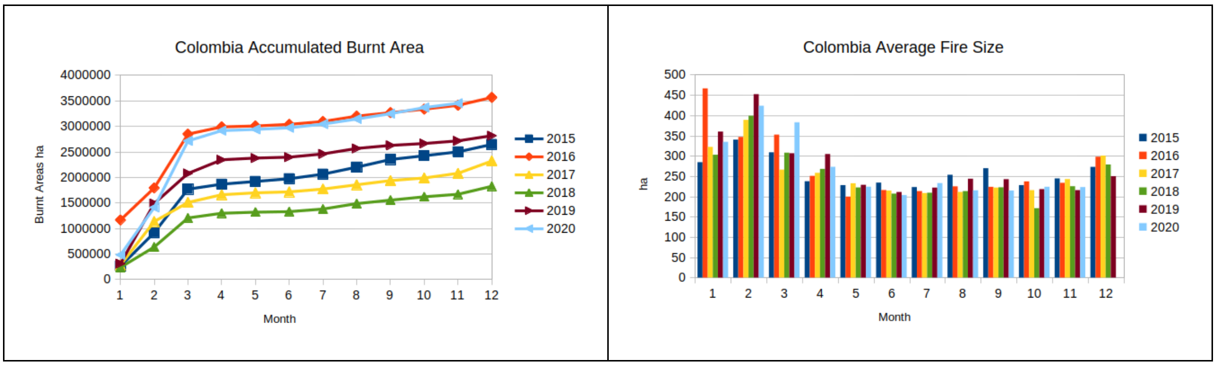


Figure 29. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 30 shows the monthly burnt land cover distribution for the year 2020, with forest but mostly grassland as the most affected landcover classes by fire during the fire season from January to April.

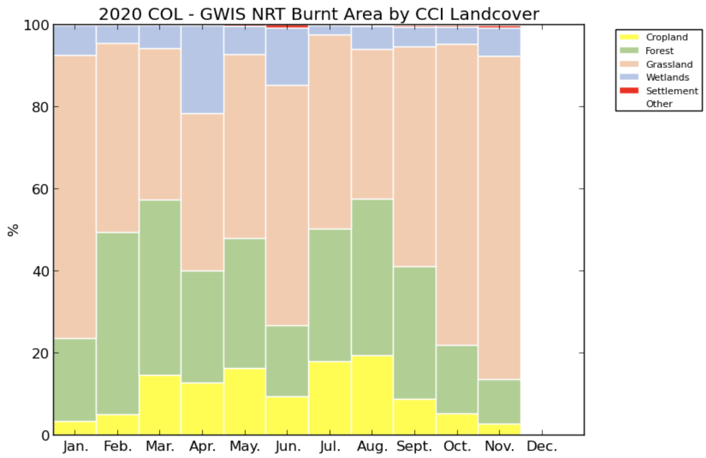


Figure 30. Monthly percentage of burnt land cover for the year 2020

Figure 31 shows the monthly percentage of burnt area in protected areas for the year 2020, with values above 10% in May.

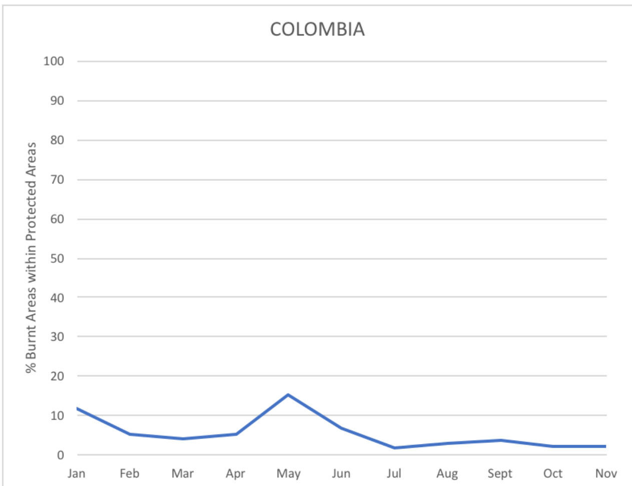


Figure 31. Monthly percentage of monthly burnt area within protected areas for the year 2020

In terms of active fire spots detected by VIIRS, 2020 presents a number of active fire spots mainly in the period between January and May above the average for the period between 2012 and 2019 as shown in Figure 32.

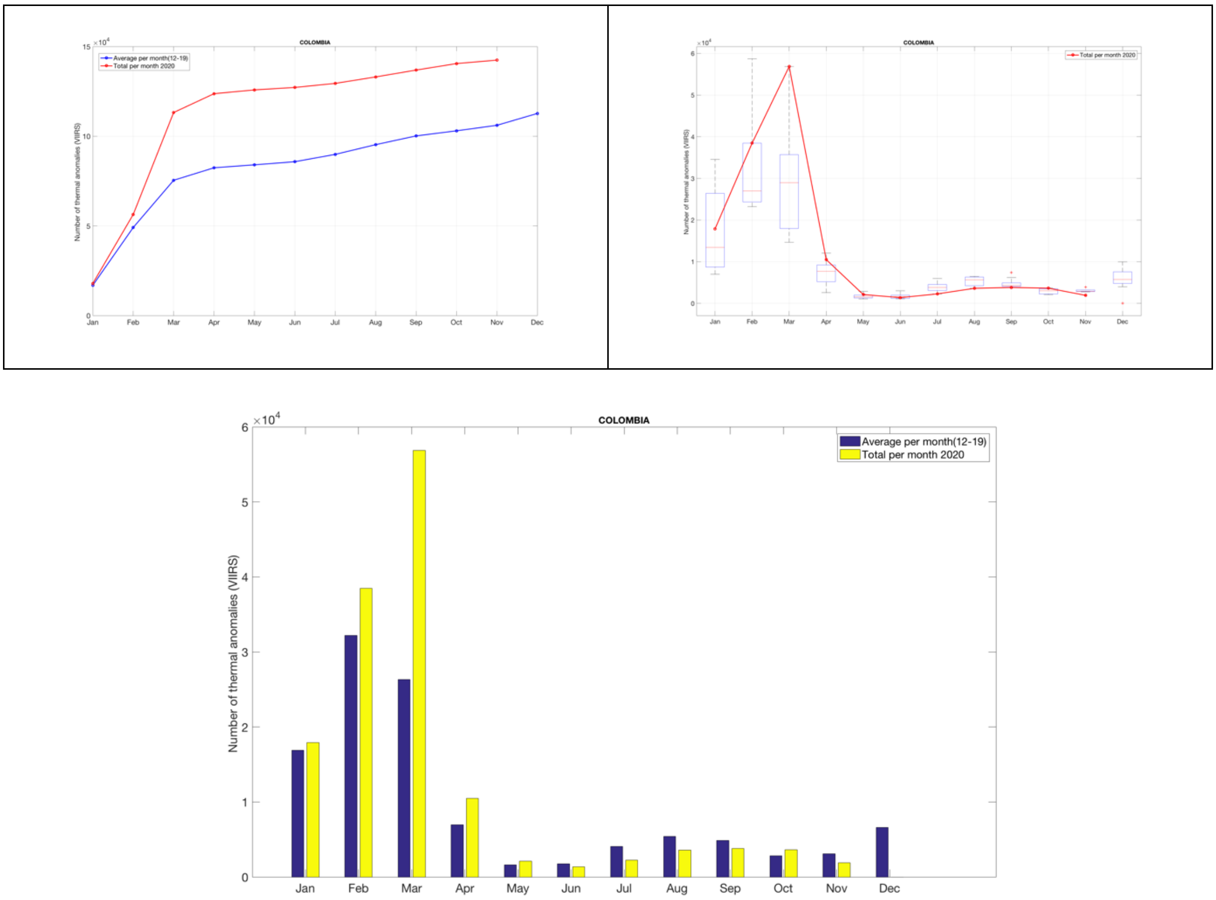


Figure 32. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 33 shows the monthly biomass burning CO_2 emissions from the Global Fire Assimilation System (GFAS). The 2020 fires have released higher amount of emissions than 2019 especially during the fire season months with higher fire activity.

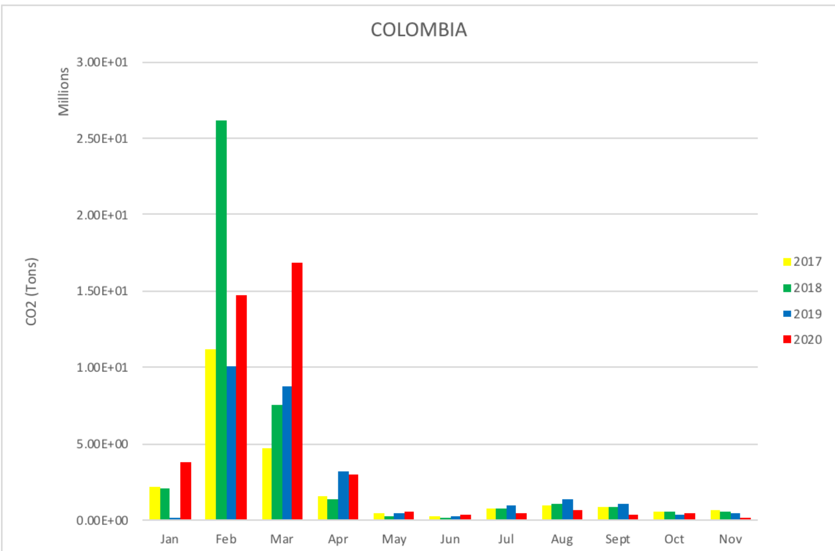


Figure 33. Trend of CO_2 emissions from biomass burning

9.5 Paraguay

In 2020, the spatial extent of the burnt areas in the country mapped by the Near-Real Time (NRT) process in GWIS is presented in Figure 34.

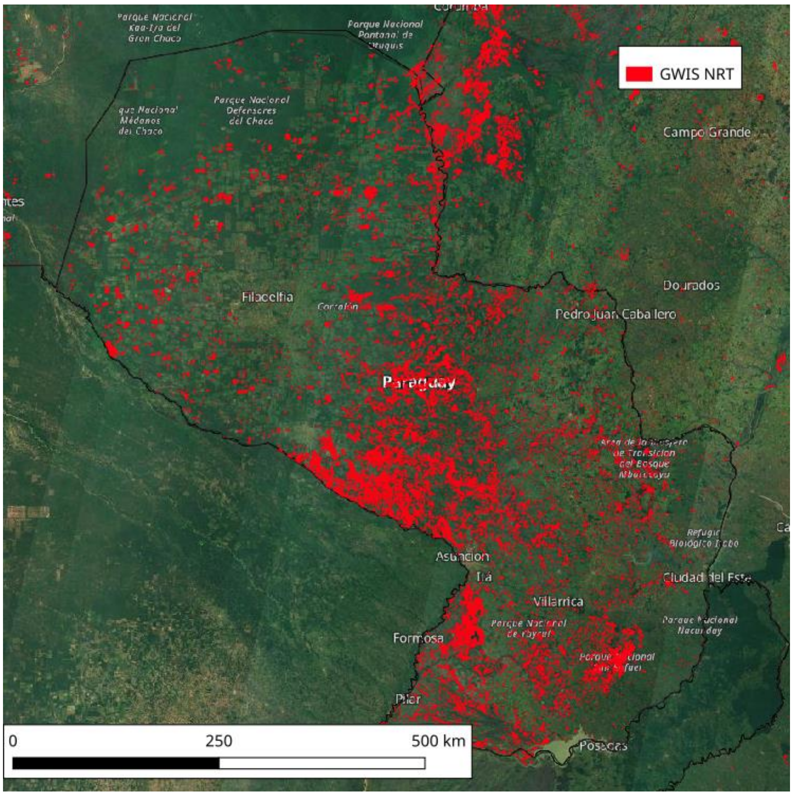
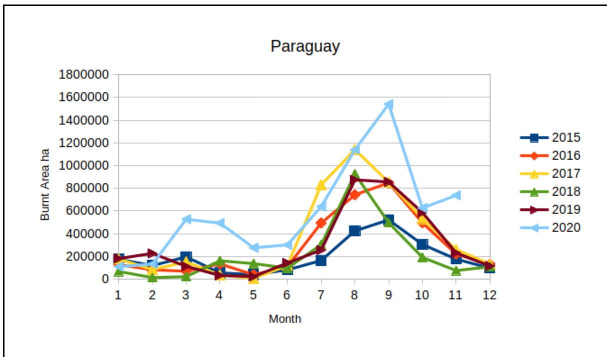
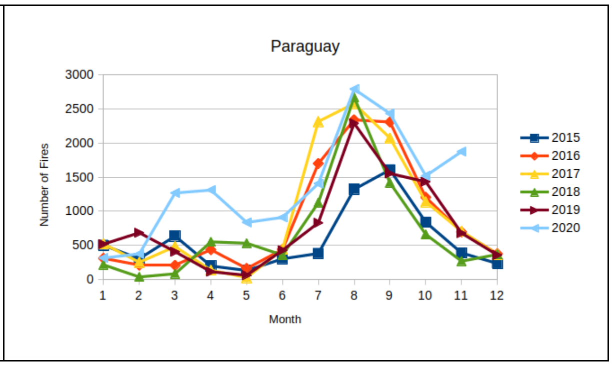


Figure 34. GWIS burnt areas for 2020 in Paraguay. Burnt areas until December 1.

The 2020 fire season in Paraguay is showing an atypical behavior compared with the two previous years. March and April had a peak with is not present in 2018 and 2019 (Figure 35). In addition, in September 2020 there was an increase of number of fire and average fire size producing an anomalous burnt area. This fact already happened last year but in September 2020 the fires were even larger than the same month in 2019. In September we had a record of average fire size regarding to all the months since 2015. The current burnt area is 6.52 Mha and 15,032 fires. The anomalous peak of burnt area for September 2020 is 1.54 Mha, 80.11% higher than 2019 (which was already critical compared with 1.14 Mha of August of 2018). During November there is an anomalous increase in burnt area and number of fires.





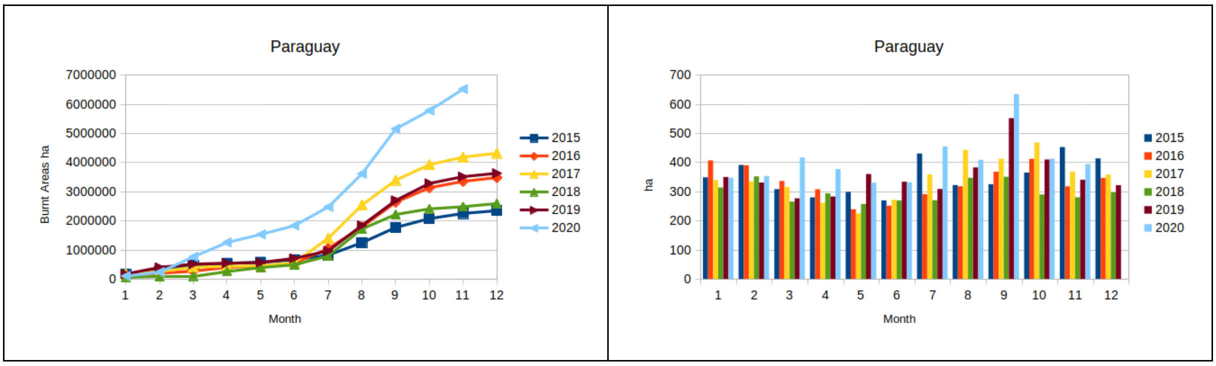


Figure 35. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 36 shows the monthly burnt land cover distribution for the year 2020, with forest as the most affected landcover class by fire, except January when grasslands is as dominant as forest.

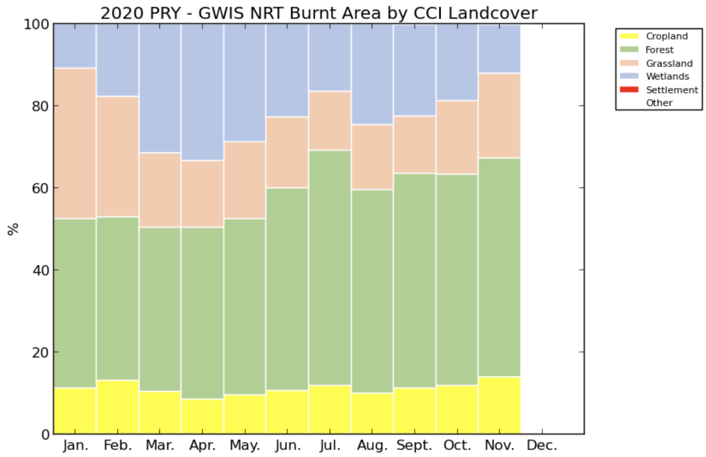


Figure 36. Monthly percentage of burnt land cover for the year 2020

Figure 37 shows the monthly percentage of burnt area in protected areas for the year 2020, with values above 20% in July.

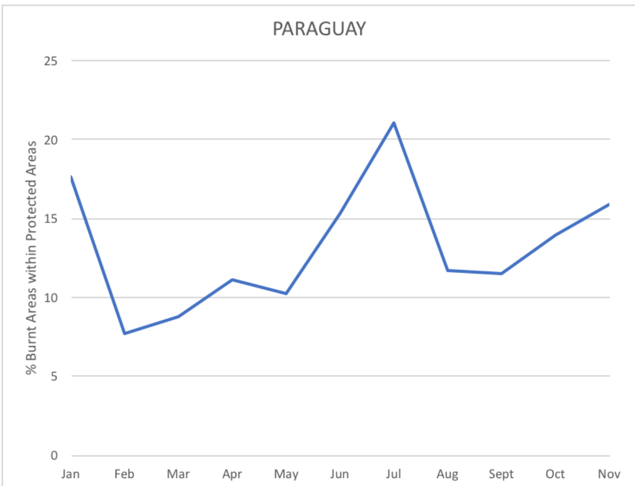


Figure 37. Monthly percentage of the monthly burnt area within protected areas for the year 2020

In terms of active fire spots detected by VIIRS, 2020 presents the same atypical trend of the burned area and number of fires shown in Figure 38, with a number of active fire spots in the period between March and November above the average for the period between 2012 and 2019, as shown in Figure 34.

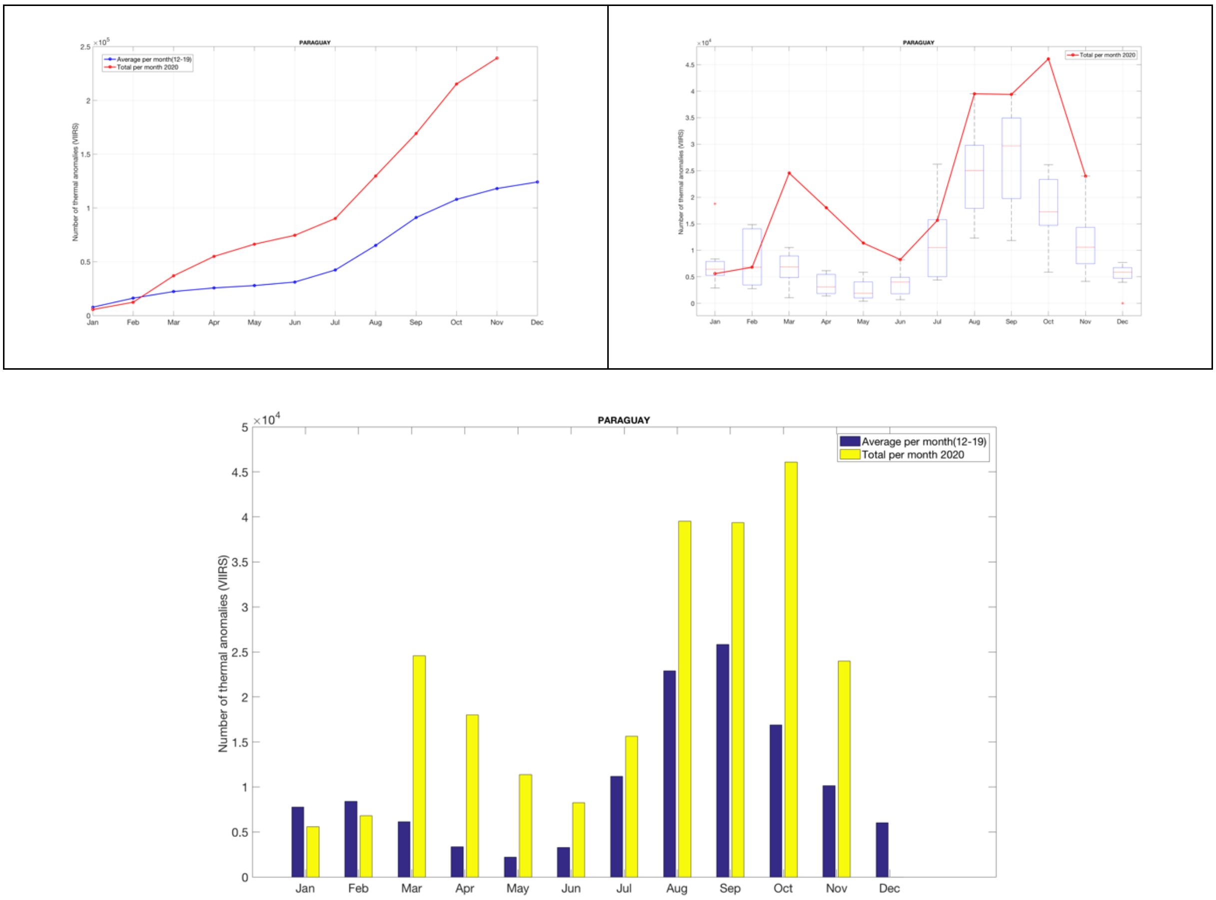


Figure 38. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 39 shows the monthly biomass burning CO_2 emissions from the Global Fire Assimilation System (GFAS). The 2020 fires have released higher amount of emissions than 2019 especially during the first months of the year and in October.

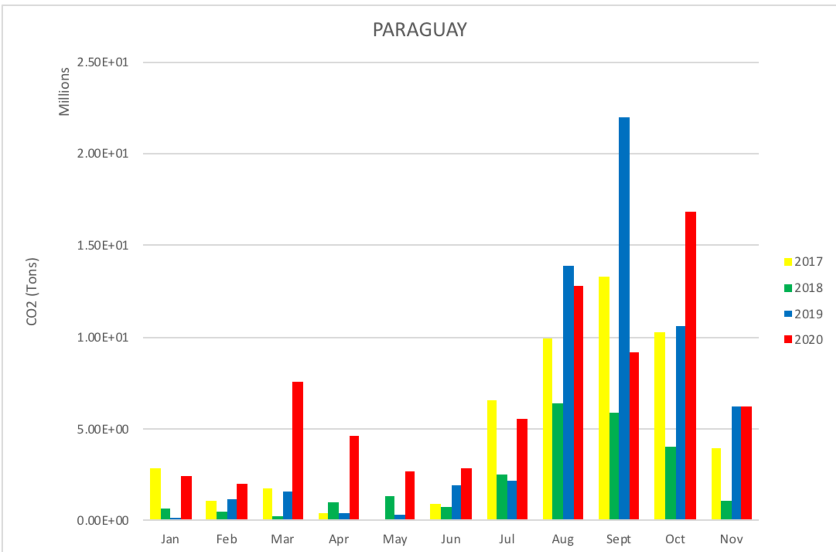


Figure 39. Trend of CO_2 emissions from biomass burning

9.6 Peru

The spatial extent of the burnt areas in the country in 2020 mapped by the Near-Real Time (NRT) process in GWIS is presented in Figure 40.

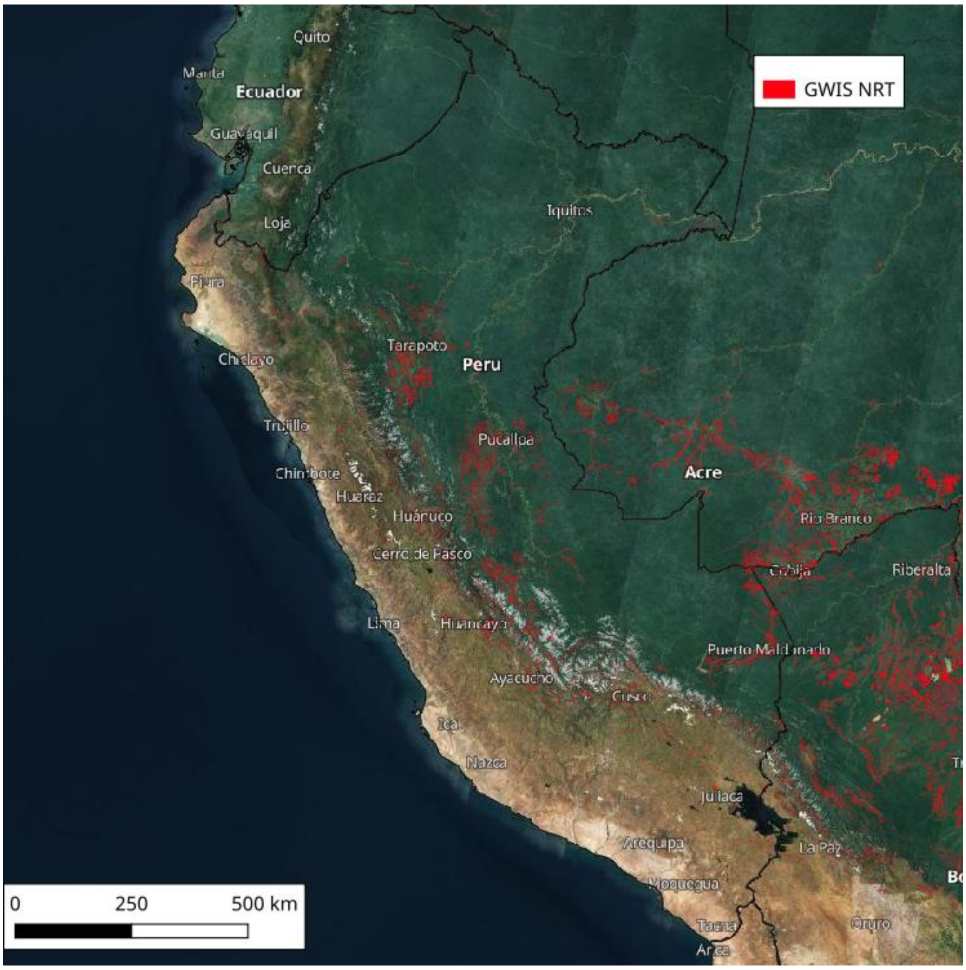
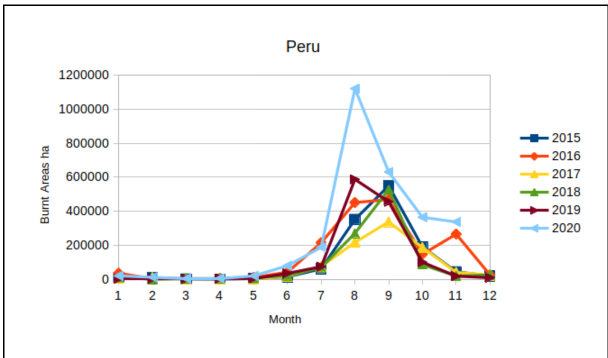
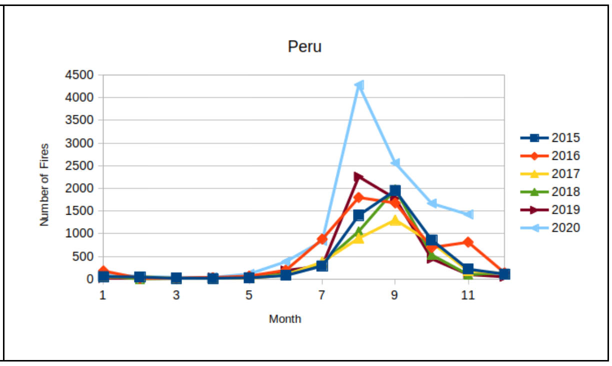


Figure 40. GWIS burnt areas for 2020 in Peru. Burnt areas until December 1.

Despite the 2020 fire season may look much worse than previous years, it is worth to mention that the average fire size remains quite constant during the years and also considerably low, see Figure 41. Therefore, the data for Peru is much more sensitive to uncertainty in the data when monitoring small fires for large areas for long time periods. Despite this last fact, it is clear that there is an increase of fire activity in 2020 compared to other years. The fact that the fire size remains constant during the year could point out to a very low amount of uncontrolled burnt area and a strong relation of fire activity with human activity in forested areas.





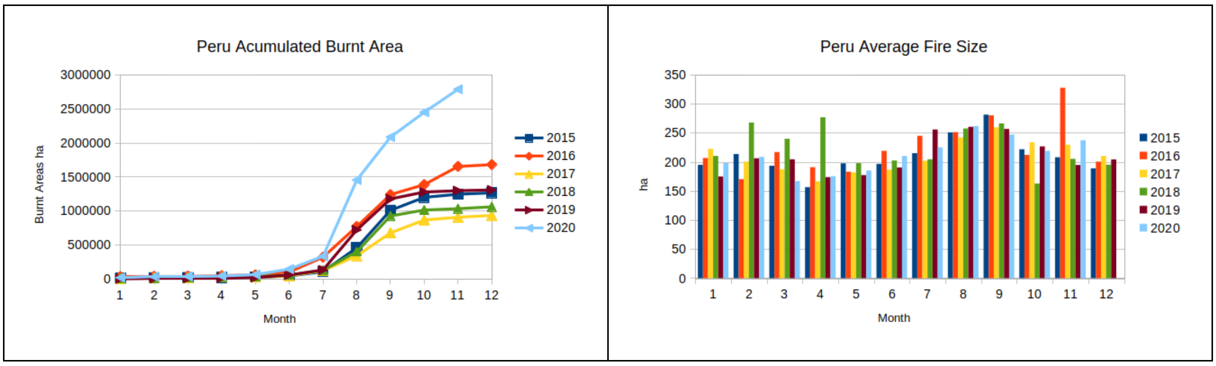


Figure 41. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 42 shows the monthly burnt land cover distribution for the year 2020, with forest as the most affected landcover class by fire, especially during the fire season months.

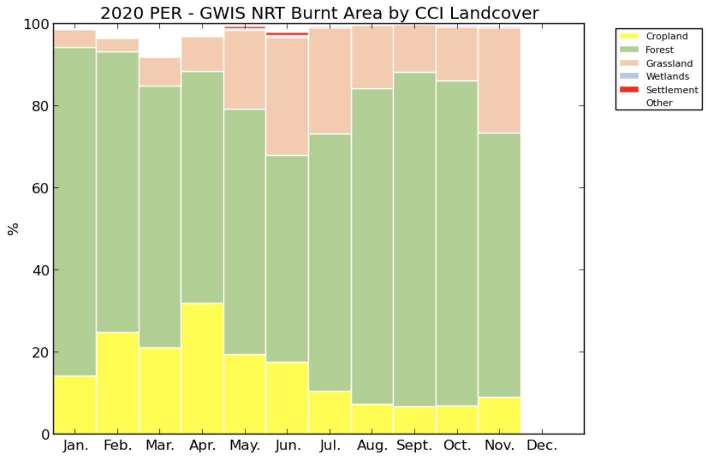


Figure 42. Monthly percentage of burnt land cover for the year 2020

Figure 43 shows the monthly percentage of burnt area in protected areas for the year 2020, with values above 10% in June.

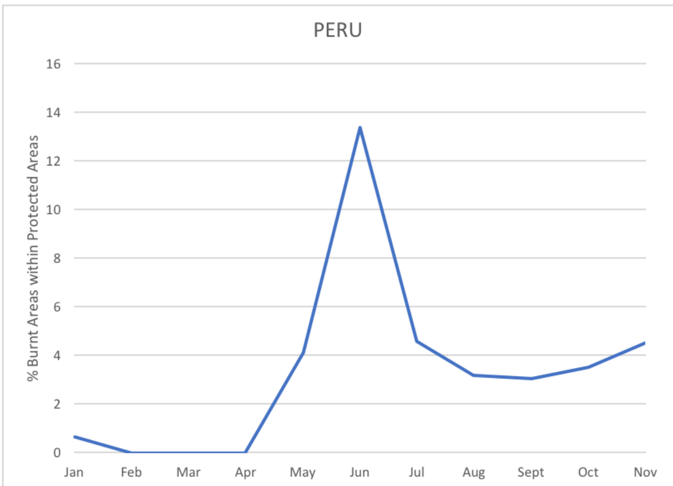


Figure 43. Monthly percentage of monthly burnt area within protected areas for the year 2020

In terms of active fire spots detected by VIIRS, 2020 presents the same trend of the burned area and number of fires shown in Figure 27, with a number of active fire spots in ten of the eleven months of the year above the average for the period between 2012 and 2019, especially in August, as shown in Figure 44.

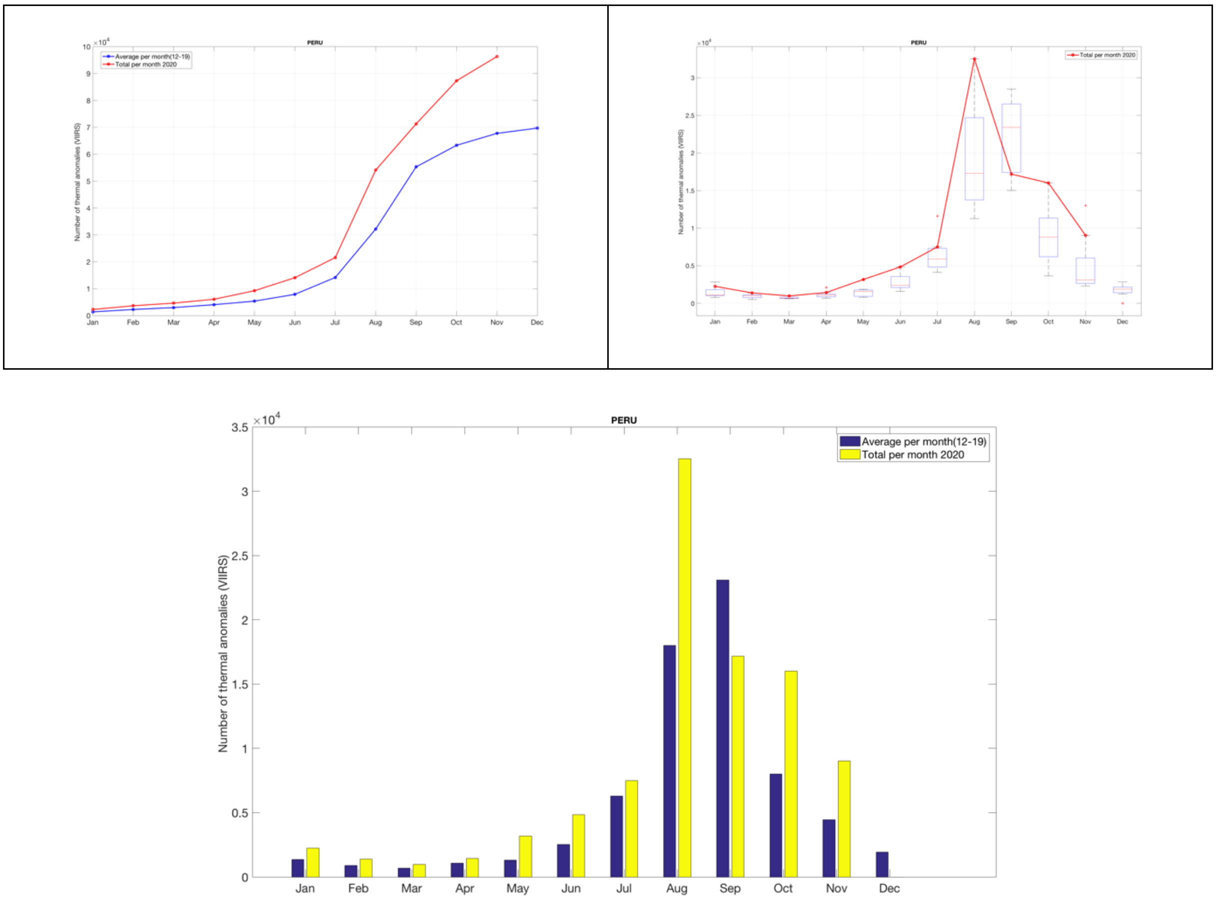


Figure 44. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 45 shows the monthly biomass burning CO_2 emissions from the Global Fire Assimilation System (GFAS). The 2020 fires have released higher amount of emissions than 2019 in July and August and then again in November.

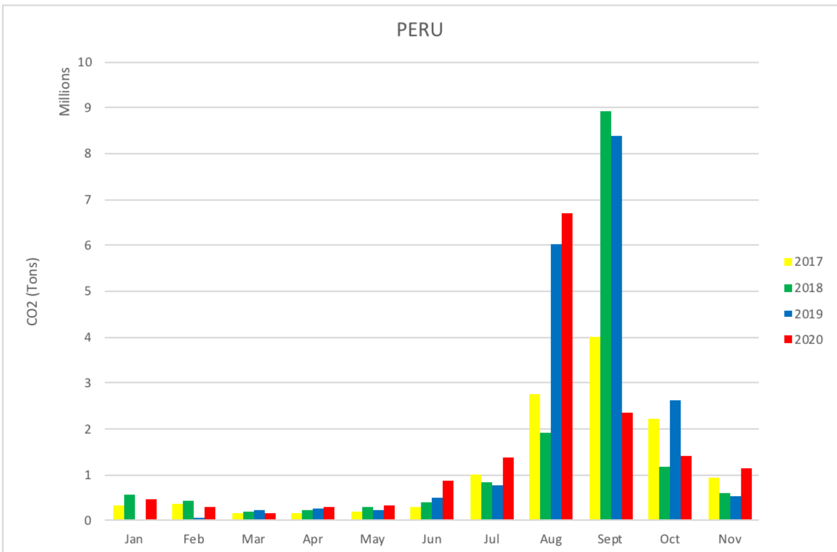


Figure 45. Trend of CO_2 emissions from biomass burning

9.7 Venezuela

In 2020, wildfires in Venezuela spread over the central and northern areas of the country, with very large fires on the west of the country, such as those on the west side of Maracaibo lake. (Figure 46). This region is part of the designated “Llanos”, a complex savanna ecosystem where it undergoes periodic, human-induced and natural biomass burning during the dry season, usually between November and April.

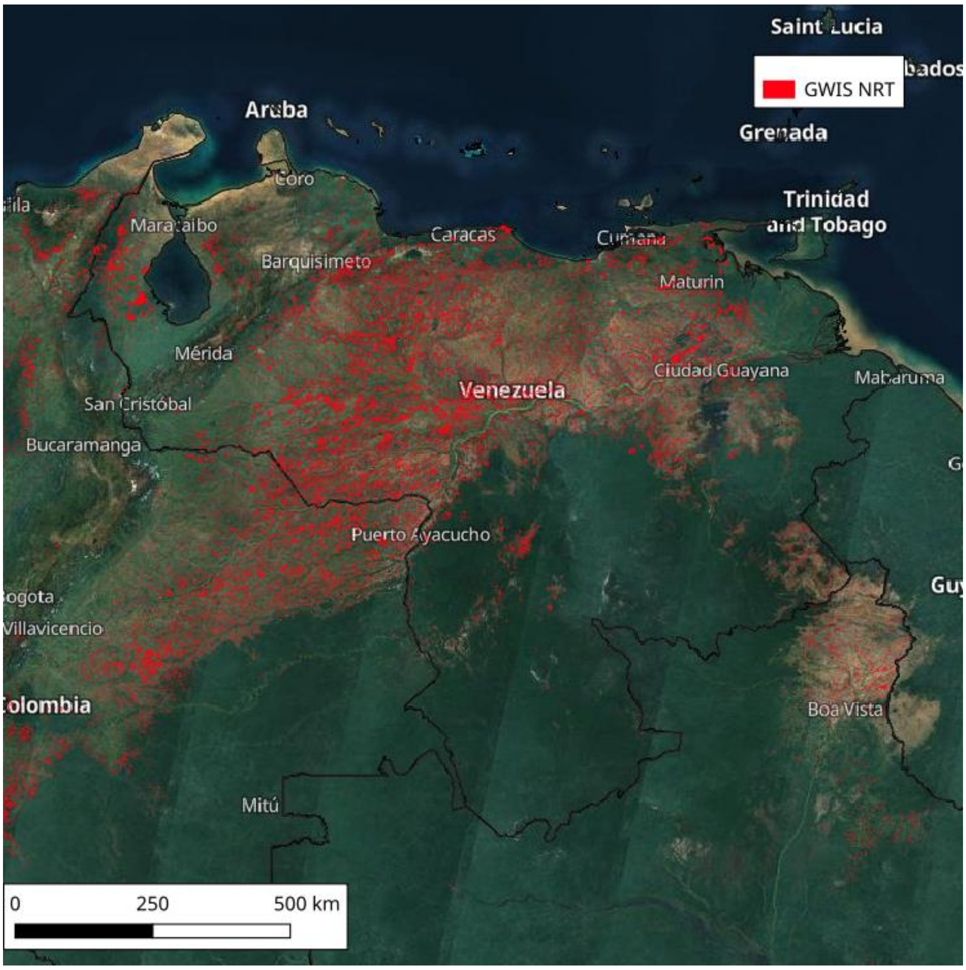
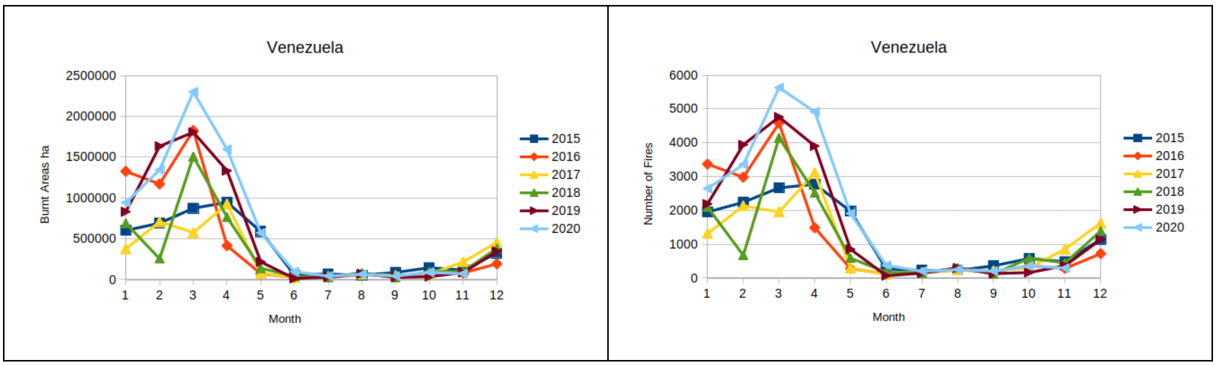


Figure 46. GWIS burnt areas for 2020 in Venezuela. Burnt areas until December 1.

The current fire season for 2020 is above the last two years in all terms, see Figure 47. The total burnt area is slightly above the previous year, 2019, and considerable higher than that of the 2018 fire season. Besides, the number of fires also increased. Looking at the average fire size, the largest fires occurred in March, instead of February, as in 2018 and 2019. The average fire size was like previous years until February, afterwards the monthly average fire size in 2020 is above the 2018 and 2019. During March, there was an increase of burnt areas, number of fires, and size of the fires. Until December, almost 7.61 Mha of burnt areas have been mapped by GWIS in the region, which are higher values than in 2019 and almost double than the value of 2018.



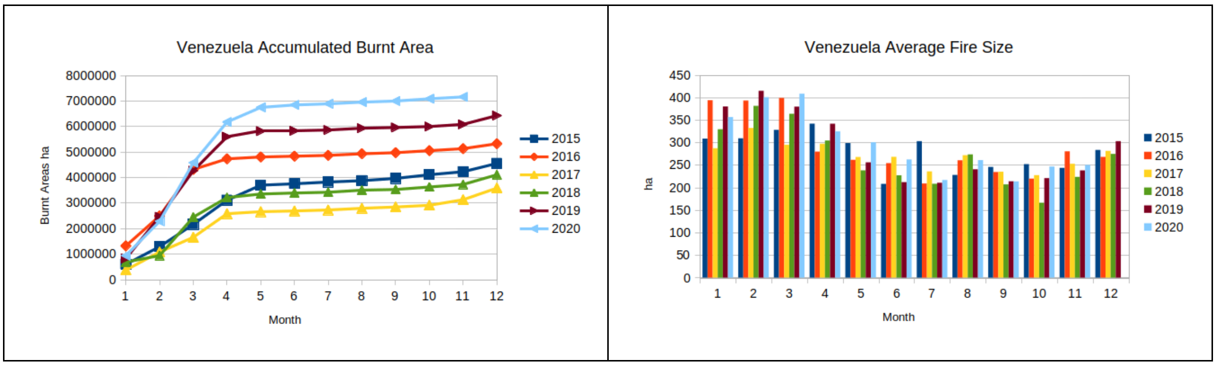


Figure 47. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 48 shows the monthly burnt land cover distribution for the year 2020, with grassland as the most affected landcover class by fire, especially during the fire season months.

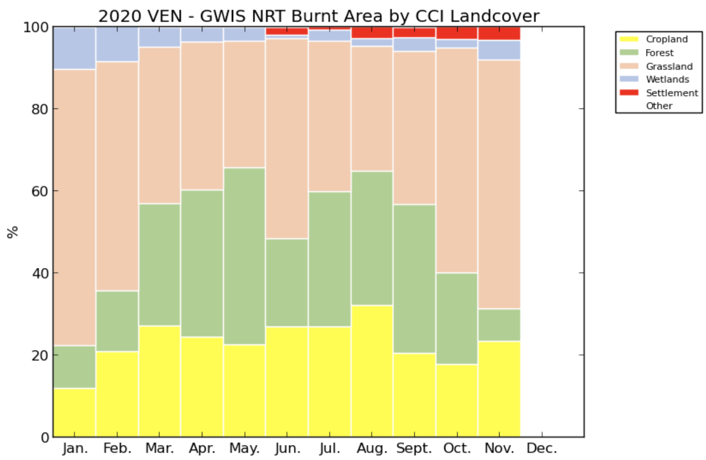


Figure 48. Monthly percentage of burnt land cover for the year 2020

Figure 49 shows the monthly percentage of burnt area in protected areas for the year 2020, with values above 70% in September.

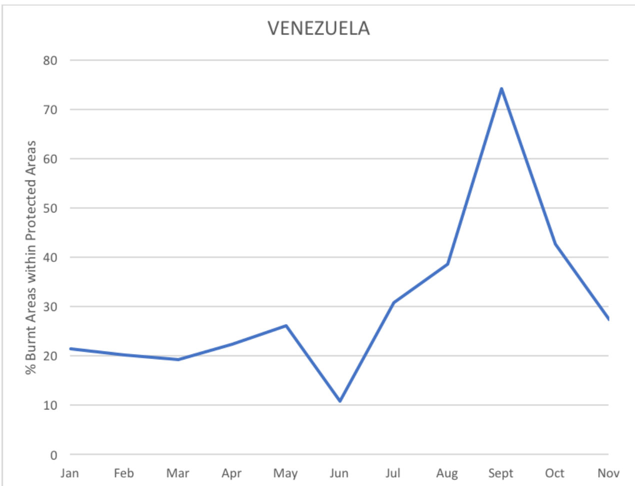


Figure 49. Monthly percentage of monthly burnt area within protected areas for the year 2020

In terms of active fire spots detected by VIIRS, 2020 presents the same trend of the burned area and number of fires shown in Figure 30, with a number of active fire spots in the first six months of the year above the average for the period between 2012 and 2019, especially in March, as shown in Figure 50.

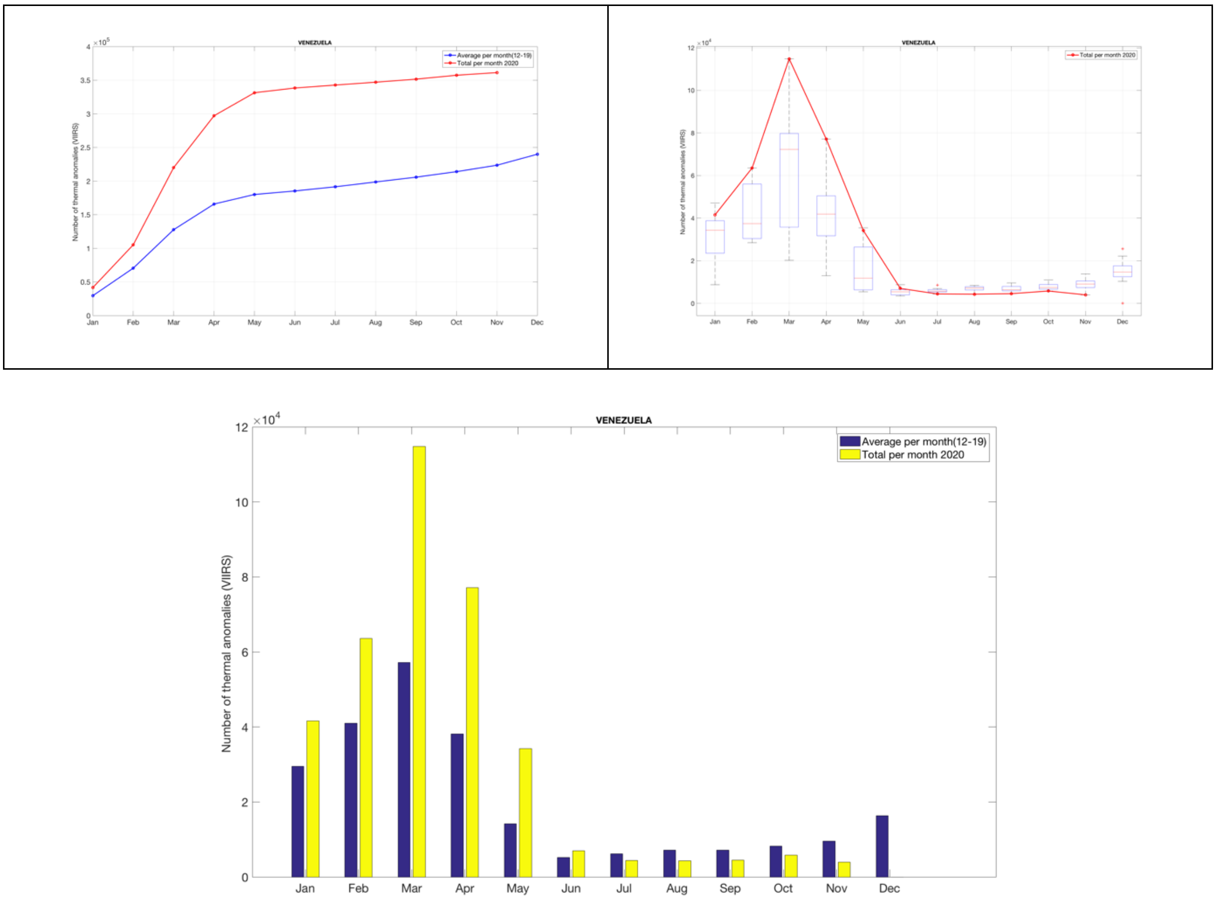


Figure 50. Trend of burnt areas and number of fires as compared to data in the last two years.

Figure 51 shows the monthly biomass burning CO_2 emissions from the Global Fire Assimilation System (GFAS). The 2020 fires have released higher amount of emissions than 2019 during the fire season months.

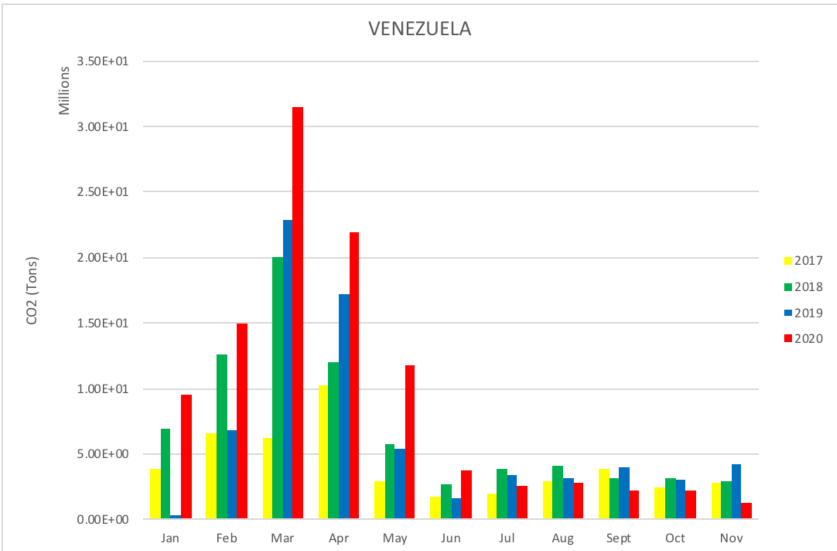


Figure 51. Trend of CO_2 emissions from biomass burning

9.8 Fire danger and fire weather forecast in the Amazon region

The monthly fire weather forecast of temperature and precipitation anomalies for December is presented in Figure 52. **An average temperature anomaly is forecasted for southern Brazil, extending to Bolivia too.** Additionally, negative trends on temperature are only mainly in Paraguay. The models estimate a decrease on precipitation rates for this month in southern Paraguay.

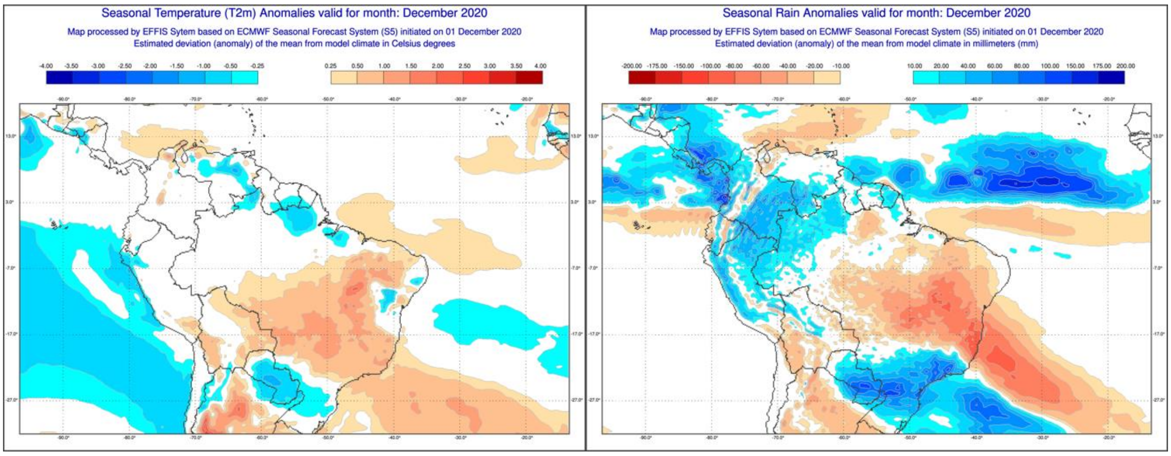


Figure 52. Fire weather anomalies of the current month, December 2020.

Figure 53 shows that the temperature in eastern Brazil will be moderated above normal and with an anomalous negative trend in precipitation rate.

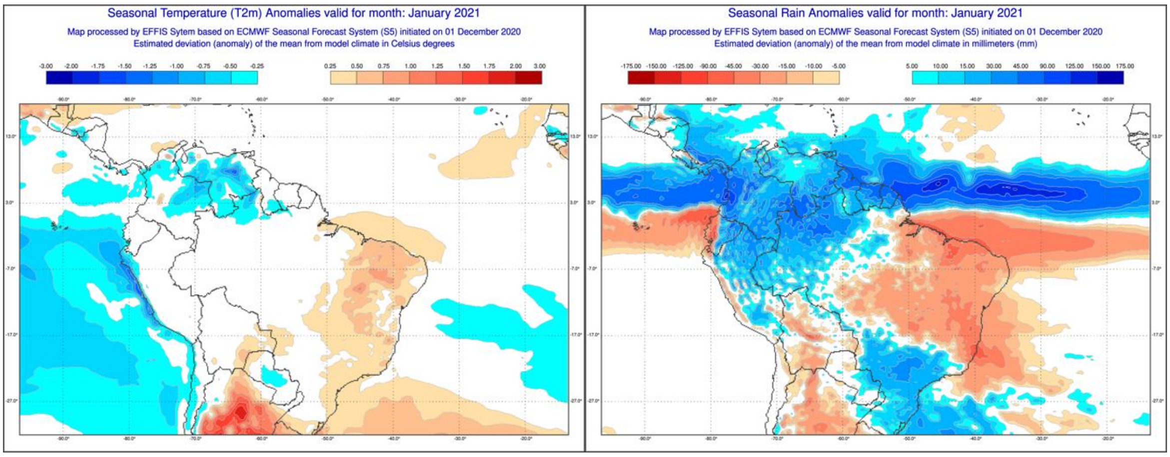


Figure 53. Fire weather anomalies of the next month, January 2021.

10 Deforestation and forest degradation in the Pan-Amazon and the BLA

10.1 Introduction

The largest and most well-preserved tropical rainforest on Earth, the Amazon rainforest, housed within the important Amazon River System, and containing one in ten of global species, is shared by eight South American countries[4]. The Amazon region shows renewed fire intensity in 2020 and continuous overall deforestation numbers. At stake are some of the most important issues affecting human life on Earth today: climate change and the conservation of natural systems essential to our survival as a species.

A study from 2017 by Armenteras et al. [5] shows a high variability of forest loss rates among South American countries and forest types.

Since the 1970ies the Brazilian Amazon has lost considerable parts of its old-growth forests, mostly due to conversion into cattle pasture, cash crop field (mostly soy) and, to a lesser extent, into mining areas and water dams. In the so-called Brazilian Arc of Deforestation on the Eastern and Southern border of the Amazon forest, the area with South America's highest deforestation rates in the last 40 years, by 2014 the forest area had decreased, since 1975, by more than 24%[6]. The deforestation rates in the Brazilian Amazon have shown increases and decreases in the last decades, always connected to the political circumstances in the country[7],[8].

In recent years, more attention has been given to a collateral effect of deforestation: the increase of forest edges in tropical humid forests due to the fragmentation of forest areas. These forest edges, which can reach up to 100 m into the forest, lead to increased tree mortality rates induced by microclimatic changes in the forest (e.g. changes in sun air humidity, soil humidity etc. due to the sudden exposition of plants and soil to sun and wind)[9]. The biomass collapse at the forest edges contribute significantly to the carbon emissions caused by deforestation.

Since many decades, intensive, and mostly illegal, selective logging activities have degraded the remaining forests specifically at the Southern and Eastern border of the Brazilian Amazon. The logging activities have started recently also on the Northern border and in the South-West of the Amazon forest[10]. Since ca. 20 years forest fires have become a major concern with respect to the degradation of the Amazon forest. With the recurrence of extreme draughts in the region more and more forest fires occurred, either escaping into the forest from burning agricultural areas or of criminal origin, ignited e.g. by illegal loggers[11].

10.2 Geographic concepts of the Amazon forest

Scientists, politicians, farmers and inhabitants all have different views on what the 'Amazon forest' includes. There are different concepts in this context, which are briefly presented here:

BLA

The BLA is a socio-economic rather than a geographic entity. It has been created in the late 1940 (with the current borders updated in 1988) in order to "concentrate the efforts for the further development of the region"12. The BLA encompasses nine Brazilian Federal States that are part of the Brazilian Amazon Basin; the Legal Amazon consists in 59% of the Brazilian National Territory.

The Brazilian Amazon Biome

The Brazilian Biomes were created in 2003 by the Brazilian Institute of Geography and Statistics (IBGE) 13 and the Brazilian Ministry of Environment in order to "define "bio-geographic provinces" of Brazil. Six biomes have been designed for the country, the Amazon Biome being by far the largest (almost 50% of the Brazilian National Territory).

[4] Müller (2020) - PE 648.792
[5] Armenteras et al (2017)
[6] Velasco-Gomez et al (2015)
[7] Boucher et al. (2013)
[8] Pereira et al. (2019)
[9] Silva Junior et al. (2020)
[10] Conde et al. (2019)
[11] Silva Junior et al. (2019)
[12] O Eco (2014)
[13] IBGE 2003

The Brazilian State of Amazonas

Brazil is divided into 26 federal States (plus one federal district with the capital Brasilia), with the State of Amazonas being the largest one (1,559,000 km^2)

Amazon basin

The Amazon basin is defined by the Pan-Amazon catchment areas of all rivers that drain into the Amazon River. This concept leaves out the area of the Guyana Shield (i.e. most of the Venezuelan Amazon, Guyana, Suriname and French Guiana).

Geographic Boundaries of the Amazon, by Eva & Huber 2005

Upon request from the Amazon Corporation Treaty Organization (ACTO), in a workshop at JRC in 2005, Hugh Eva and Otto Huber, together with 20 renowned international experts on Amazon biology, ecology, geology, soil science, forests, hydrology and anthropology, defined an Amazon geographic boundary, which today is widely used by scientists working on the Pan-Amazon region.

Figure 54: Different Brazilian Amazon boundaries: Legal Amazon, Amazon Biome and State of Amazonas

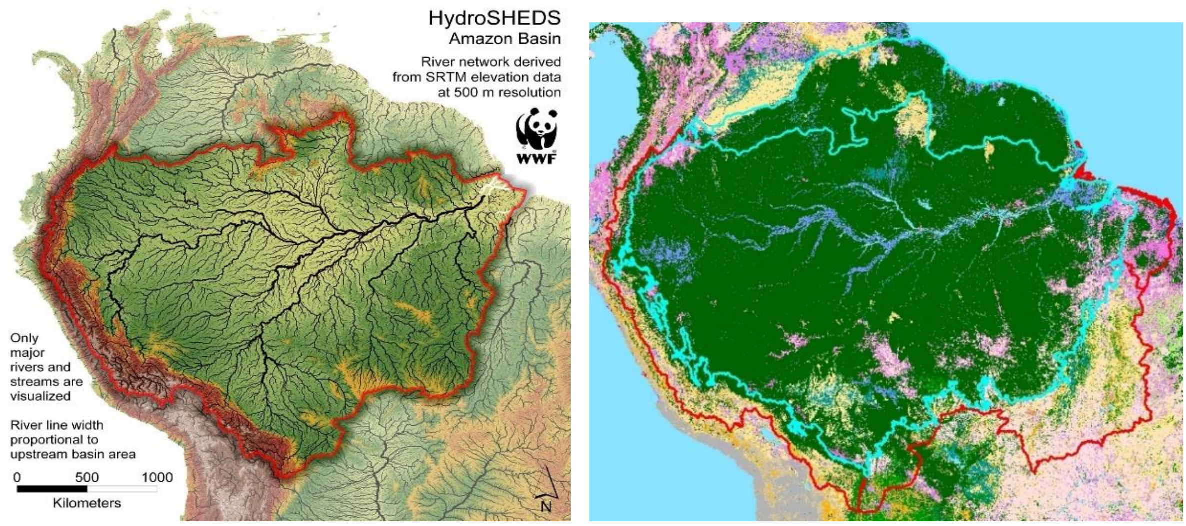


Figure 55: Different Pan-Amazon boundaries: Amazon Watershed Boundary by WWF[14] (left) and Amazon Geographic Boundary proposed by Eva & Huber et al. (2005)[15] (right)

14 WWF

15 Eva & Huber et al. (2005)

10.3 Deforestation and Forest Degradation in the BLA

Deforestation implies the long-term or permanent loss of forest cover and implies transformation into another land use (FAO 2001)[16]. In the Brazilian Amazon, deforested areas are mainly converted into pastures and crop fields (e.g. soy fields)[17]. Most of the deforestation in this region is illegal, violating the Brazilian Forest Code, which states that 80% of the native, old growth forest within a land parcel has to be left standing by the owner[18].

A degraded forest is the result of a process of degradation, which negatively affects the structural and functional characteristics of that forest. Forest degradation occurs as a result of human activities (Vásquez-Grandón et al., 2018)[19] This definition implies that a degraded forest remains a forest, even if the changes in the forest structure are severe. The main causes of forest degradation are forest fires and high-impact (i.e. non-sustainable) selective logging, both of which happen due to human intervention. The degraded forests at the edges of deforestation areas spatially links these two types of forest cover change, but these forest edges are, according to the definition, part of the degraded forests.

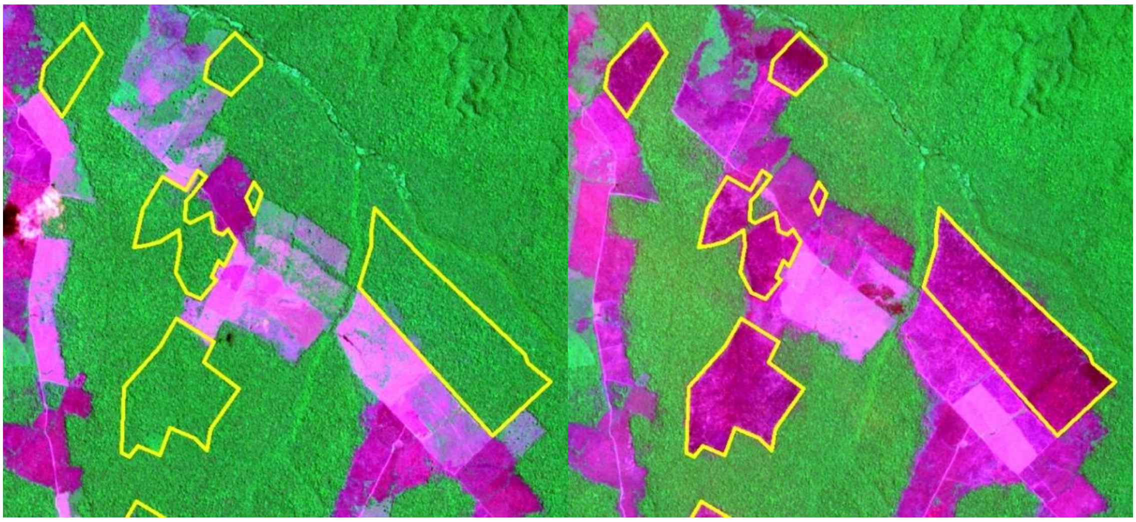
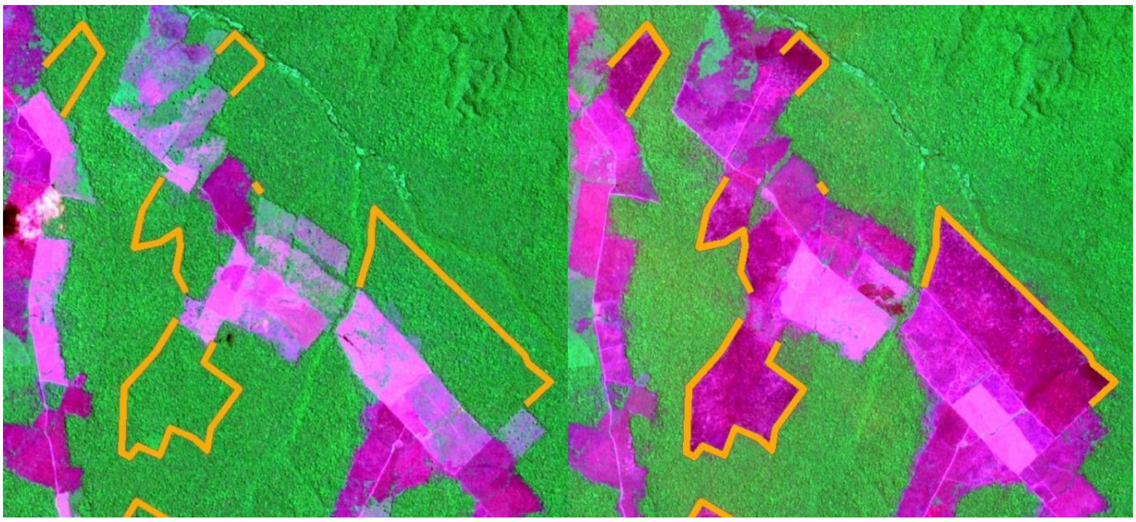


Figure 56: Sentinel-2 images before (2019) and after (2020) deforestation – near the town of Apui in the South of Amazonas State. The deforested areas in this region become cattle pasture.



[16] FAO 2001
[17] Barona et al. (2010)
[18] Azevedo et al. (2017)
[19] Vásquez-Grandón et al., (2018)

Figure 57: Sentinel-2 images before (2019) and after (2020) the creation of new forest edges, consisting in degraded forest areas (ca. 100 m wide) at deforestation borders. Image width: ca. 7 km.

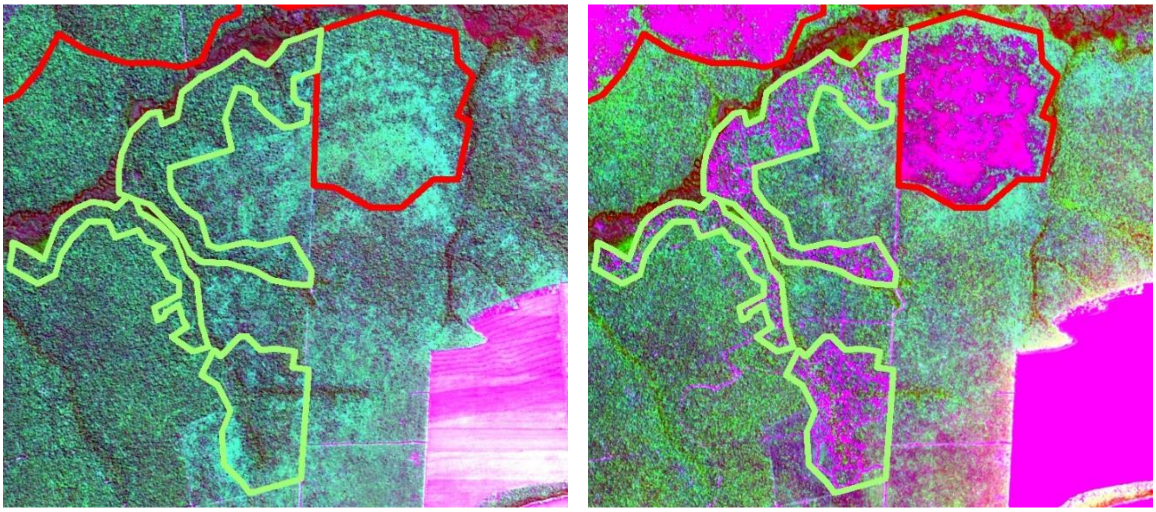


Figure 58: Sentinel-2 images before (left, 2019) and after (right, 2020) selective logging activities (light green) and forest fire occurrence (red). Image width: ca. 7 km.

10.4 Monitoring deforestation and forest degradation in the humid tropics

The JRC has carried out a study to accurately characterize the changes in tropical humid forests to support conservation policies and to better quantify their contribution to global carbon fluxes. This study was supported by the Directorate-General for Climate Action (DG-CLIMA) through the Roadless-For pilot project (Making efficient use of EU climate finance: Using roads as an early performance indicator for REDD+ projects) and since 2019 through Lot 2 ('TroFoMo' - Tropical moist Forest Monitoring) of the ForMonPol (Forest Monitoring for Policies) project.

The resulting pan tropical dataset covering the period 1990-2019 is available for visualization (https://forobs.jrc.ec.europa.eu/TMF/) with a Technical Report describing the approach (Vantcutsem et al 2020[20]) and results to be published soon in a scientific journal (Vancutsem et al, in revision for Science Advances)[21],

The JRC dataset on Tropical Humid Forest was created from the analysis of imagery from the US-American Landsat satellites that are available over the Amazon basin since 1984. The sensors on-board the Landsat satellite have a 30 m spatial resolution and a temporal revisit cycle of 16 days.

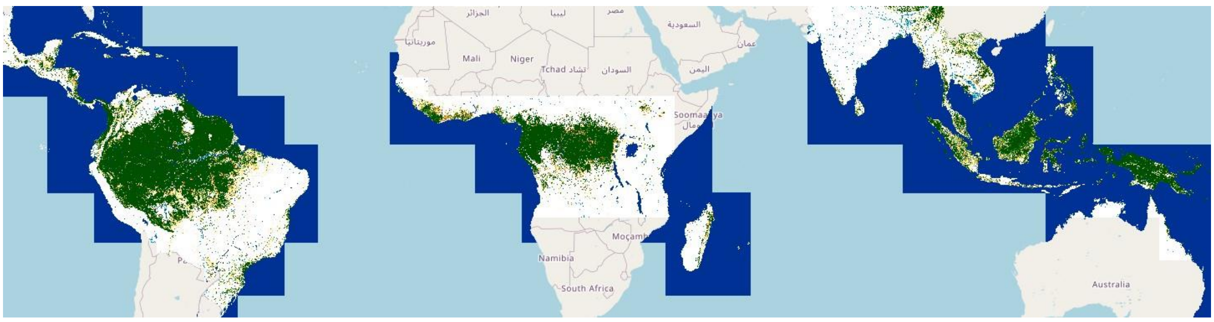


Figure 59: Pan-tropical coverage of the JRC dataset

The JRC dataset provides information on changes in the tropical humid forest cover since 1985, it tells us in which year(s) forest pixels had been deforested or degraded, or when non-forest pixels have started to

[20] https://ec.europa.eu/jrc/en/publication/long-term-monitoring-tropical-moist-forest-extent-1990-2019
[21] https://www.biorxiv.org/content/10.1101/2020.09.17.295774v1

regrow. The data differentiates between short-term forest disturbances and long-term ones (severe degradation or deforestation).

The dataset allows to understand if a forest had been degraded (e.g. by selective logging or fires) before deforestation or where and when a forest has regrown after deforestation. The complex temporal dynamics of tropical forest cover change can be traced from this dataset at regional, national or local scale.

10.5 Deforestation and forest degradation trends for the Amazon region 2001-2020

We report here the trends in national deforestation rates for the six largest countries in the Pan-Amazon region (Brazil, Colombia, Venezuela, Peru, Bolivia and Ecuador) from 2001 to 2020 (year 2020 has been processed until early October 2020). These figures report the forest cover changes of the moist forest in these countries, thus do not include the changes in seasonal dry forests of Venezuela, Colombia, Peru and Ecuador, of the Brazilian Caatinga and Cerrado biomes and of the Bolivian Chaco.

The JRC dataset is then compared (in following section) to the Brazilian estimates of forest cover change in the Brazilian Legal Amazon that are provided by INPE.

In the charts representing the trends of annual rates of deforestation and forest degradation, the share between deforestation and forest degradation for the three most recent years (2017-2019) is guessed from the average proportion measured during previous years. The final decision on the attribution to degraded forests or deforestation for these recent years can only been taken after a forest regrowth has been observed or not in successive three years. In consequence, the area of degraded forest for year 2018 can only be consolidated in 2021.

The satellite imagery has been processed until the 9th October 2020, thus the extent mapped for deforested areas and degraded forests is not final yet for the year 2020. However, the figures for the year show a reliable trend, given that the remaining time to the year's end is less than three months with lower activities during the months of November and December. The Y scale of the charts (for annual forest area changes) are adapted to each country.

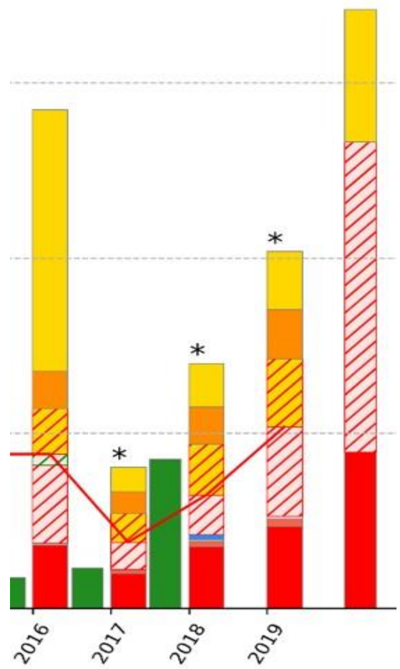


Figure 60: subset of JRC forest cover change mapping for Venezuela for the past five years.

For recent years (2017-2020), the JRC process maps all deforested and forest degradation areas as "disturbed forest". At this moment in time, the JRC automatic classification process cannot know if the forest disturbance is temporary (in case of forest degradation) or permanent (deforestation). However, the areas of deforestation and degradation by country are estimated for the recent years based on the average proportions of disturbance types (within total disturbances) over the period 2005-2014.

Before the year 2017, in case that a given pixel remains permanently disturbed for 2.5 years (i.e. no forest regrowth is recorded during this time), it falls into the "deforestation" class. If for a "disturbed forest pixel" a significant, permanent regrowth is recorded within 2.5 years' time, it falls into the forest degradation class.

The statistics for 2020 are simplified (only three disturbance classes) and preliminary (status 9th October), however the trend of an increase of forest cover change during this year is confirmed. A rerun of the JRC process is foreseen at the beginning of 2021 to compute the complete statistics for the year 2020.

10.5.1 Brazil

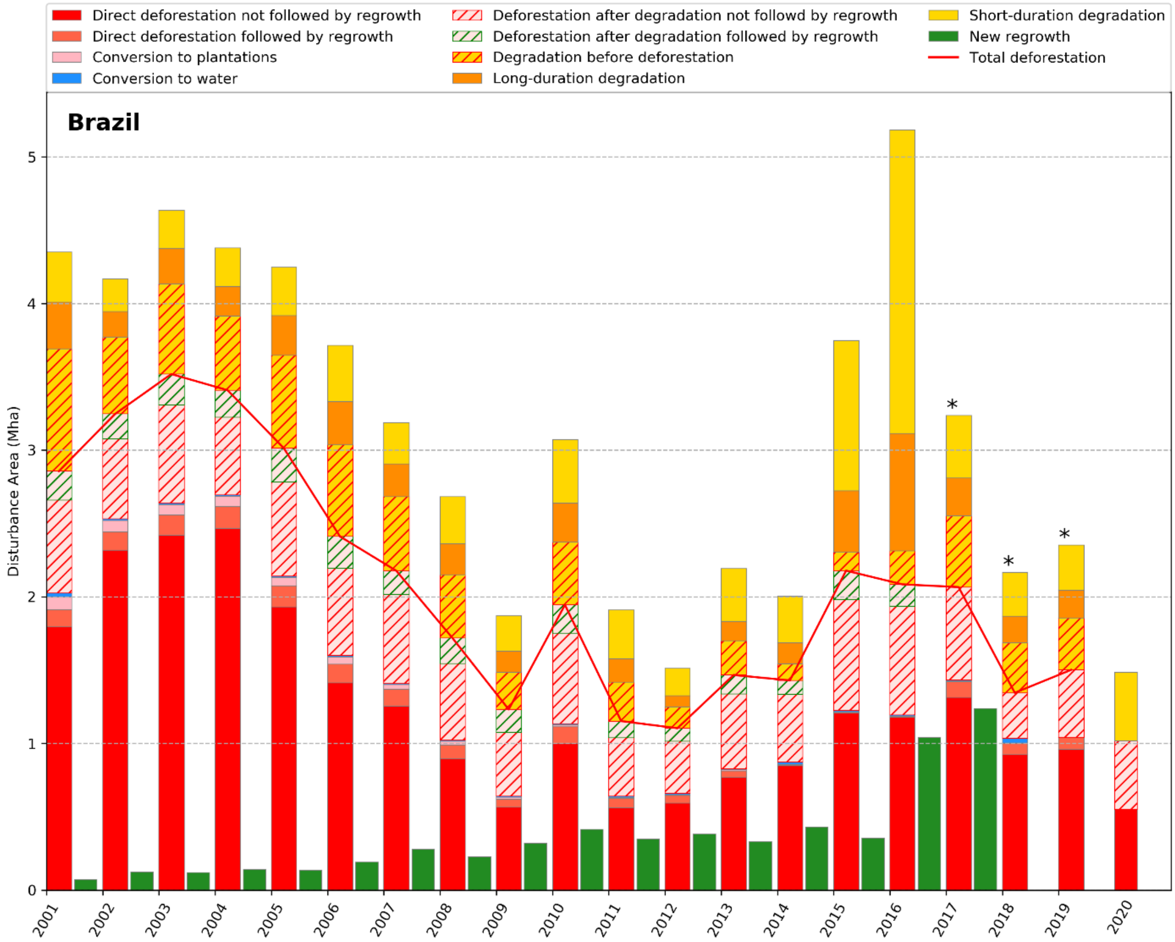


Figure 61: The Brazilian statistics include all humid forests of the country, located mainly in the Amazon and Mata Atlantica biomes. For the year 2020, JRC data report a notable decrease of deforestation and forest degradation over the whole country. This tendency will probably still be valid, even if to a smaller extent, once the full year's data (thus until 31st December) has been taken into account.

10.5.2 Bolivia

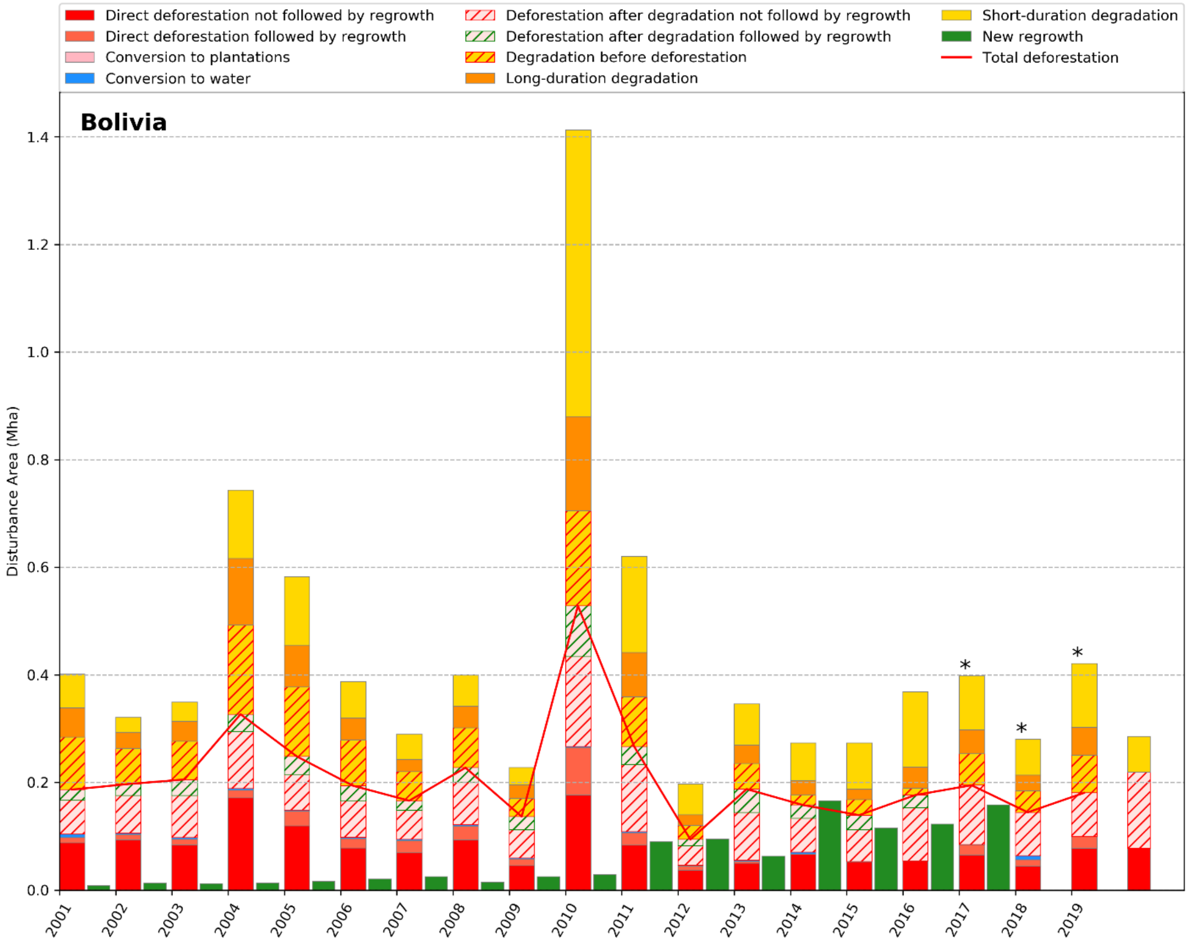


Figure 62: Bolivia shows an increasing trend regarding deforestation, status 9th of October 2020. The deforested area is larger than in the year before, i.e. ca. 2200 km2 in comparison with approximately 1800 km2 for the whole year 2019. The very high forest degradation values of 2019 have decreased, probably because the fires did not devastate the forests to the same extent as the year before.

10.5.3 Peru

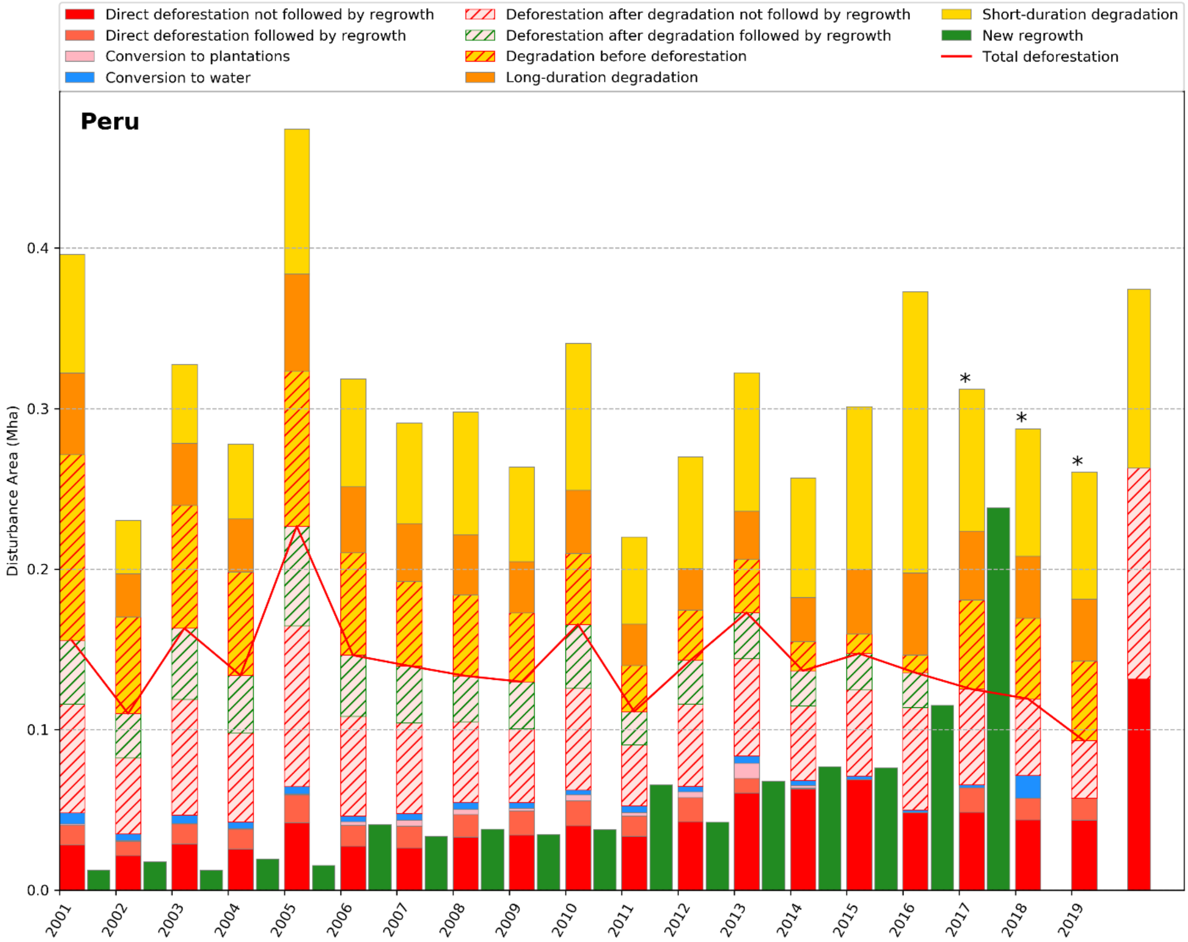


Figure 63: Peru shows a sharp increase in deforestation in 2020 (status 9th of October), the area deforested area is largest since 2001, i.e. ca. 2600 km2 in comparison with approximately 900 km2 for the whole year 2019 or 2200 km2 in 2005 (largest deforestation area in the past 20 years). The forest degradation areas appear roughly on the same scale as in past years.

10.5.4 Venezuela

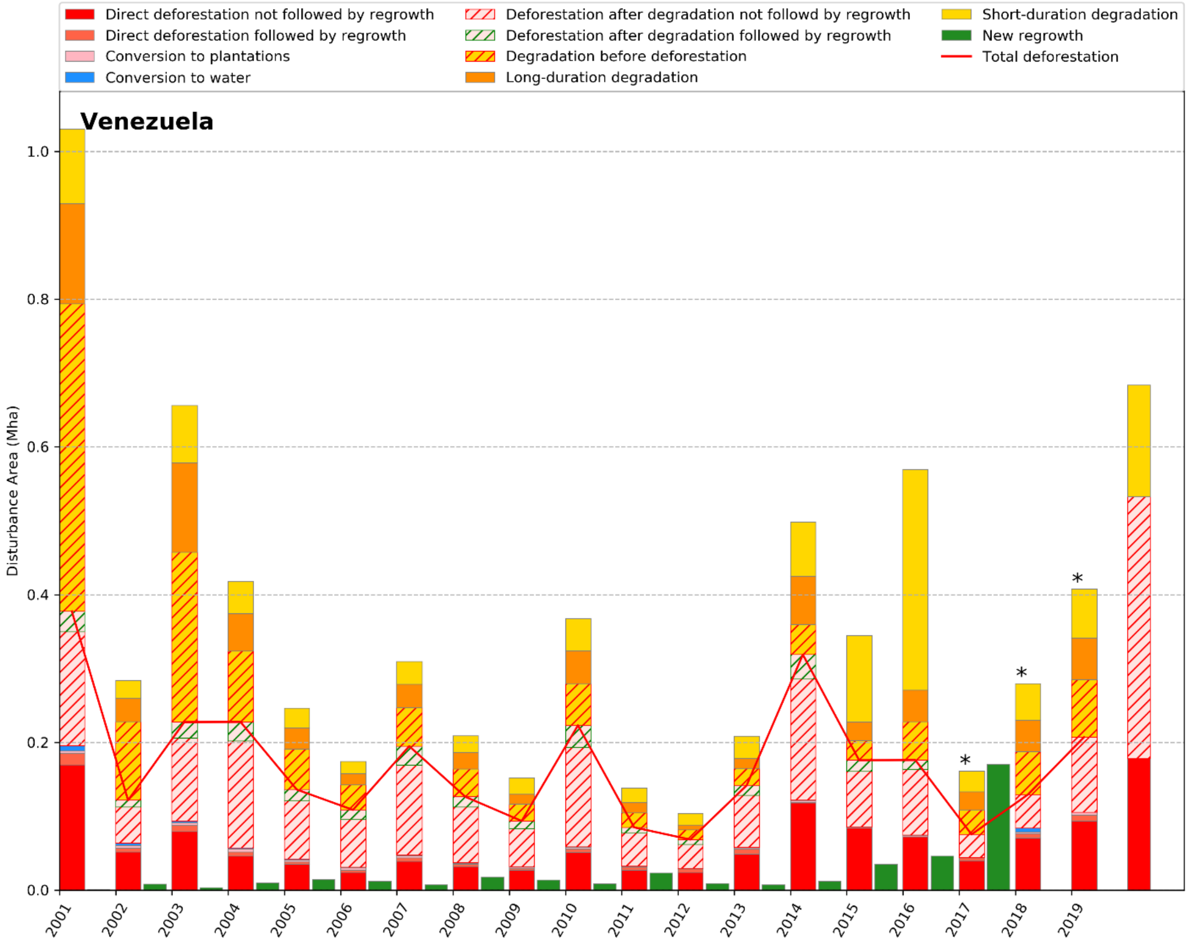


Figure 64: Venezuela shows a sharp increase in deforestation in 2020 (status 9th of October), beating the overall figure of the year 2000 deforestation (ca. 3800 km^2) with an estimated area of 5400 km^2. The estimated area of forest degradation is small in comparison (1400 km^2).

10.5.5 Colombia

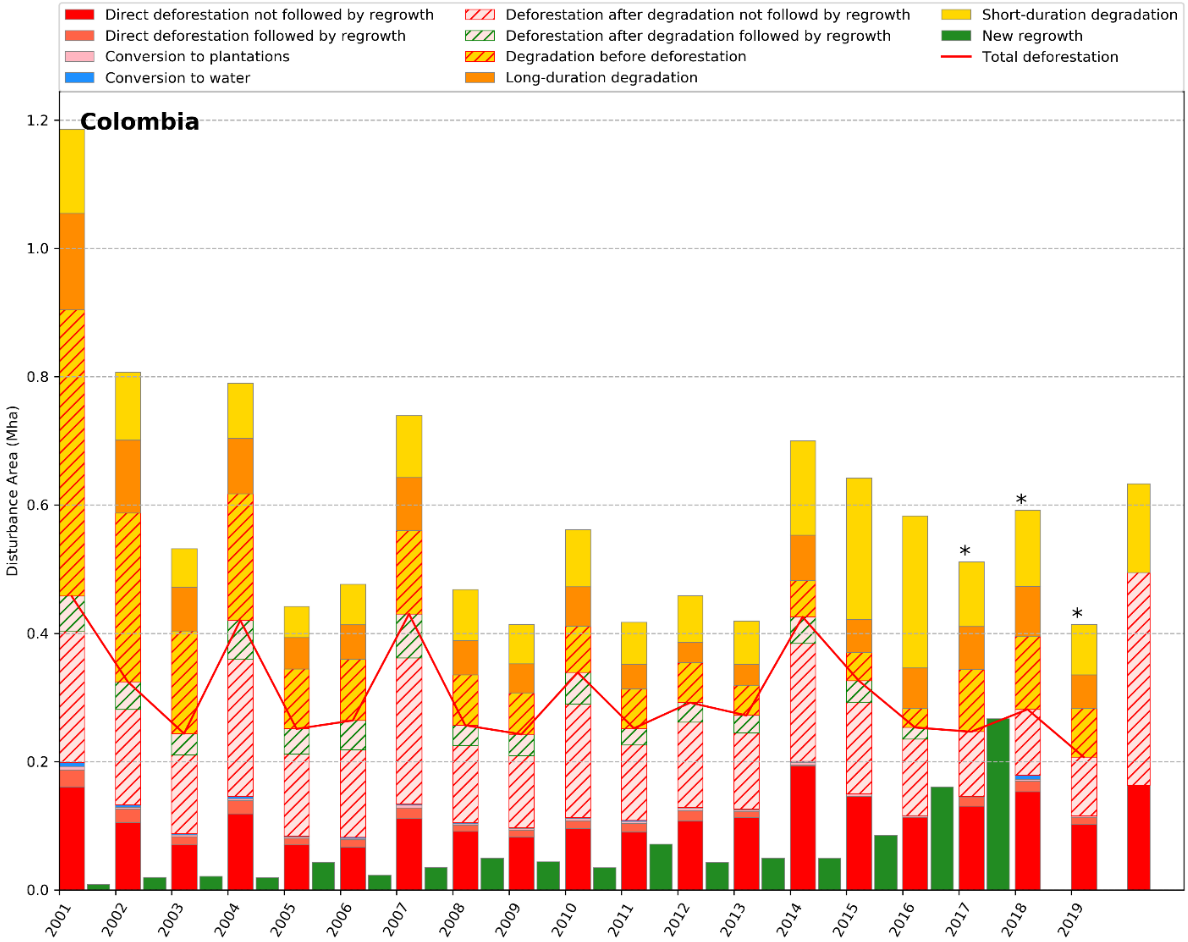


Figure 65: In Colombia the statistics for 2020 show an increase of negative forest cover change (i.e. deforestation and forest degradation) with respect to 2019, but, at least on the date of the 9th October, seem to be on average in comparison with the past 6 years. However, the deforestation figures (red and red hatched bar) are very high, compared to previous years.

10.5.6 Ecuador

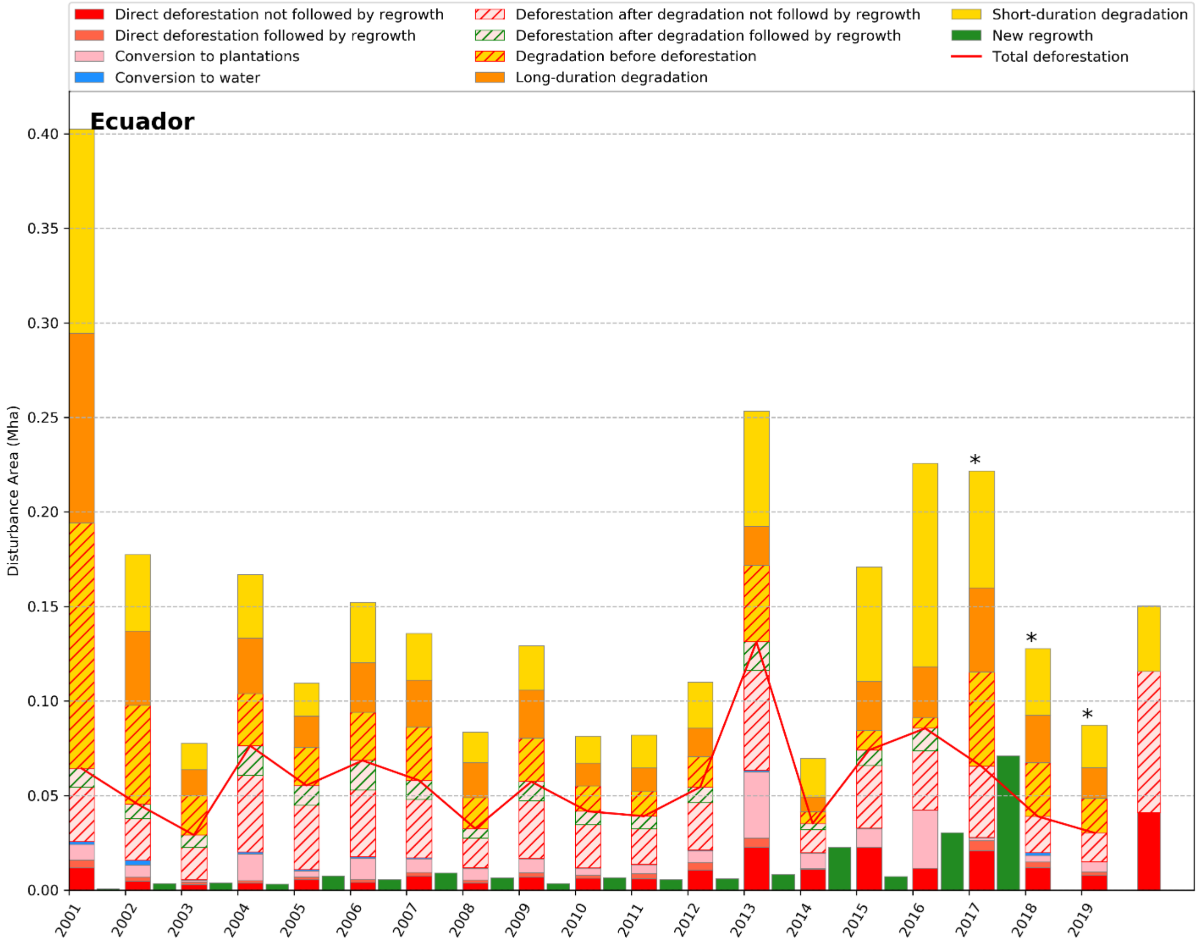


Figure 66: Ecuadorian humid forests show increased deforestation and forest degradation activities in 2020 with respect to the two previous years; however, the statistics in this context might be slightly lower at the end of 2020, compared to the years 2015 – 2017.

10.6 Trends in deforestation and forest degradation in the BLA

We illustrate here below some typical examples of patterns of deforestation and forest degradation in the Brazilian Amazon, as they appear in the JRC dataset - like the fishbone-type of deforestation pattern in a new deforestation frontier in the South of Amazonas State (near the town of Apui), a typical forest fire area in the Xingu National Park and typical signs of selective logging near the town of Claudia (Mato Grosso State).

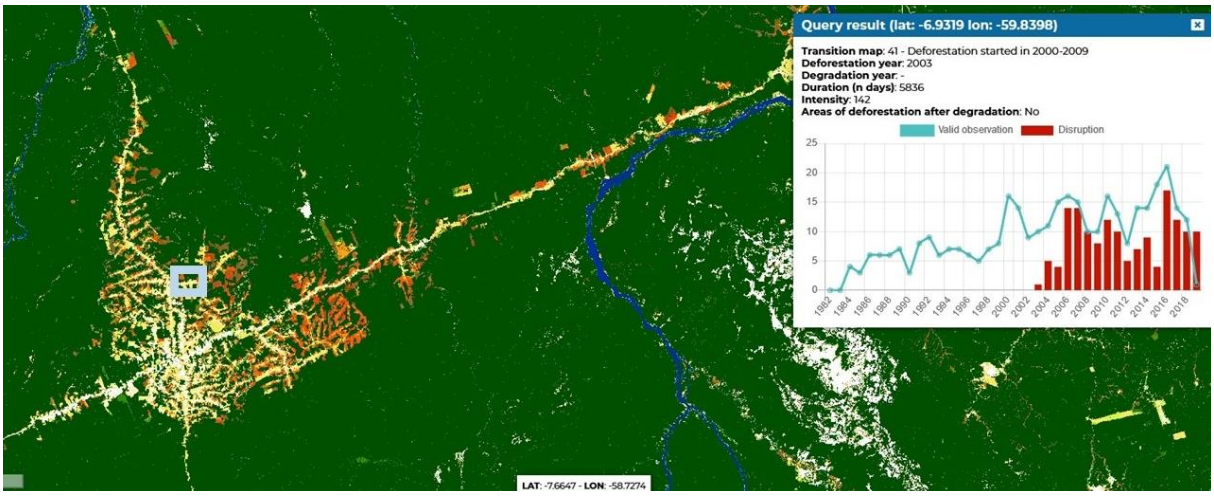


Figure 67: Deforestation near the city of Apui in Southern Amazonas State (at the crossing of two main roads). Remaining (undisturbed) forest appears in dark green, deforested areas appear in light yellow to dark red (from old to recent deforestation) in the eastern side of the town of Apui and along the BR 230 road. The white areas in the southeast of the map are natural savanna areas. The inset panel shows the temporal history of observations over a plot (light blue rectangle) that was a forest area until 2003, Image width: ca. 450 km.

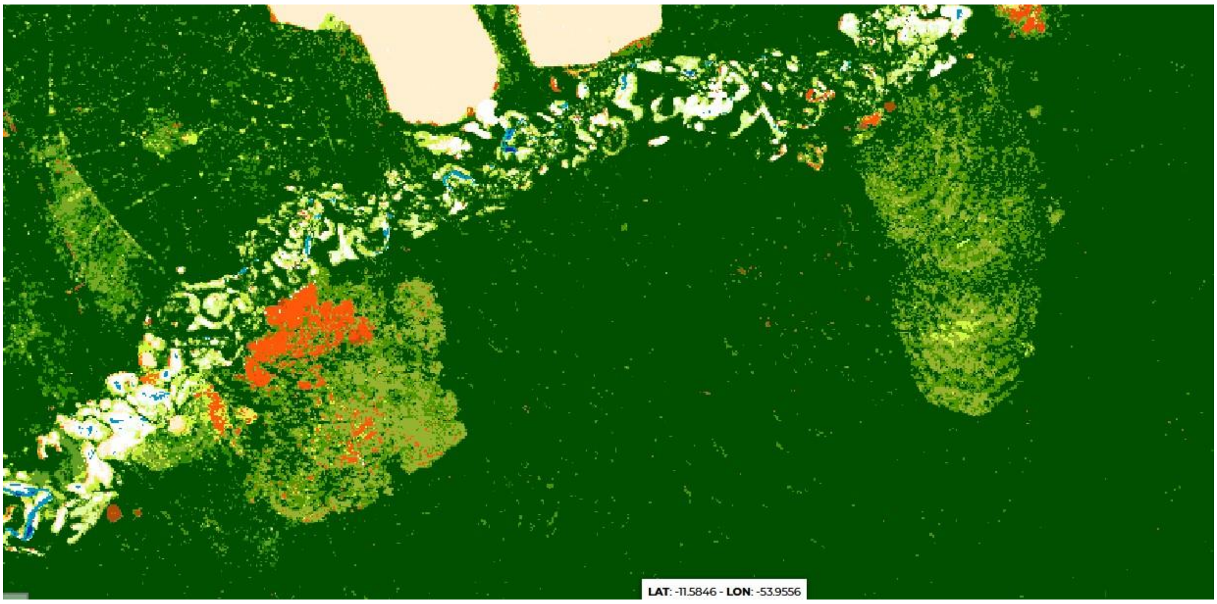


Figure 68: Typical forest fire pattern in the Southern Brazilian Amazon near Sinop (Mato Grosso State). The ring structure represent day fires (heavier disturbances) and night fires (or understory fires) with lighter or disturbances mapped. The large areas of light orange in the North represent consolidated agricultural fields (soy bean), the broad band of non-forest mixed with forest from northeast to southwest represents a tributary to the Xingu River. The fire in the East occurred in 2010, according to the JRC dataset, the one in the West in 2015. The areas of the 2015 fire appearing in red represent forest that had already burned in 1999. The consequence of the re-burning of these areas is the total destruction rather than 'only' a degradation of the forest. Image width: ca. 20 km.

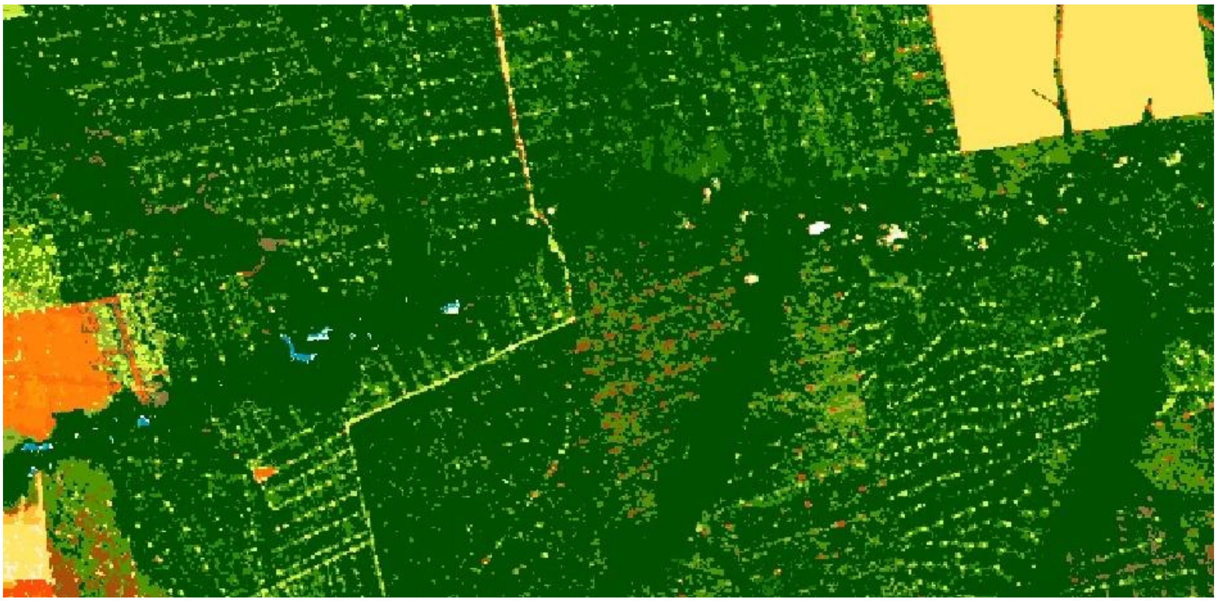


Figure 69: Typical selective logging pattern in the Southern Brazilian Amazon near Sinop, Mato Grosso State. The geometric pattern represent the regular distribution of logging roads and logging decks. The different logging activities in this area occurred over a period of 20 years (1998 – 2018), for each disturbance pixel (in light greens) the exact year of selective logging is indicated in the data. Image width: ca. 15 km.

10.7 JRC estimates and INPE deforestation statistics for the BLA

Monitoring of Legal Amazon Deforestation and Forest Degradation in Brazil: the DETER and PRODES Projects from INPE

The institution in Brazil with the mandate to officially producing the statistics on deforestation in the Legal Amazon is the Brazilian Space Research Institute (INPE). The institution has a long history of tropical forest monitoring with remote sensing imagery, since 1988 INPE is producing annual deforestation statistics for the Brazilian Legal Amazon, which are, at least since the year 2000 (start of the PRODES Digital Project[22]) a reliable source of open and precise data on forest loss in the Brazilian Amazon. PRODES data is widely used in the scientific community and INPE researchers are globally recognized high-level scientists in the field.

INPE maps (through the PRODES programme) deforested areas over the whole Brazilian Legal Amazon on Landsat imagery with 30 m spatial resolution, excluding from analysis only areas within the BLA, which are defined as non-humid forest (with savanna-type vegetation), and non-forest.

Based on PRODES data, INPE communicates in December the Legal Amazon deforestation statistics for the so-called 'reference year' (August of the precedent year – July of the current year), using a complex approach which takes into account the cloud coverage in different areas, daily deforestation rates for a given time period, the length of the dry season, etc. (INPE 2019). INPE-PRODES does not map forest degradation, but analyses remote sensing imagery for deforestation areas. In consequence, forest degradation is neither included in the yearly INPE communication on BLA deforestation statistics, nor in the Brazilian communication on FREL in the REDD+ context.

The yearly INPE statistic for the BLA are communicated via:

http://terrabrasilis.dpi.inpe.br/homologation/dashboard/deforestation/biomes/legal_amazon/rates

[22] INPE 2019

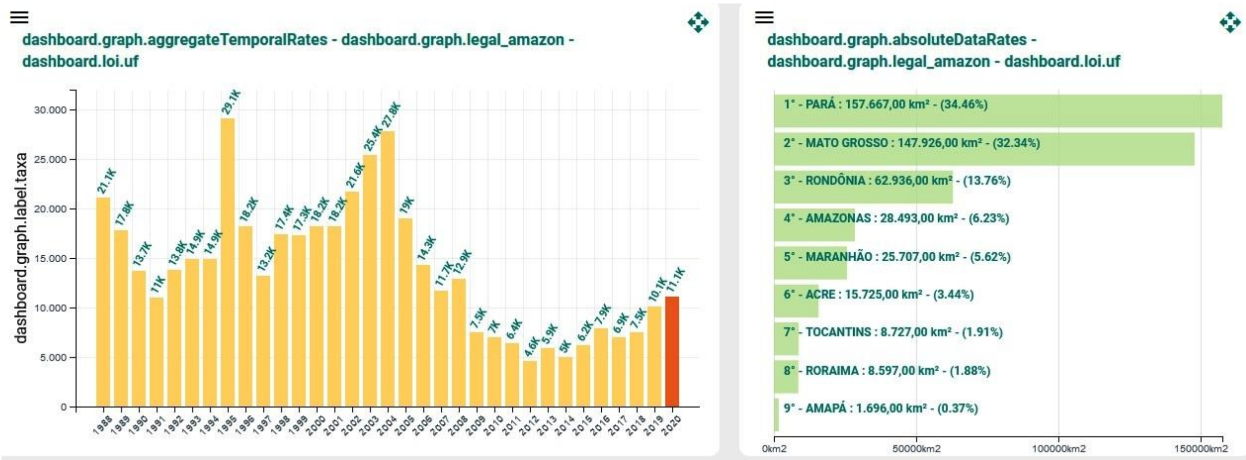


Figure 70: Yearly official deforestation statistics for the BLA provided by INPE-PRODES (left side of figure). In addition, information on deforestation areas for each State is provided (right side of figure). The official PRODES deforestation statistics for the BLA 2020 were communicated by INPE on the 1st December 2020.

In addition to the PRODES project, INPE has a near-real time alert system for deforestation in place, called DETER[23],[24], which uses daily CBERS-4 WFI satellite imagery with coarse spatial resolution (64 m) to map deforestation and forest degradation (selective logging, forest fires and mining). DETER data is sent on a daily basis to the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), which is responsible for the law enforcement related to illegal deforestation and selective logging in the Brazilian Amazon. PRODES and DETER are independent projects, as their purpose, their type of satellite data used, their minimum mapping units (MMUs) and forest change area calculation approaches are very different.

DETER produces daily and monthly (aggregated) deforestation and forest degradation statistics[25] for the Legal Amazon and, since May 2018, corresponding monthly deforestation figures also for the Cerrado biome.

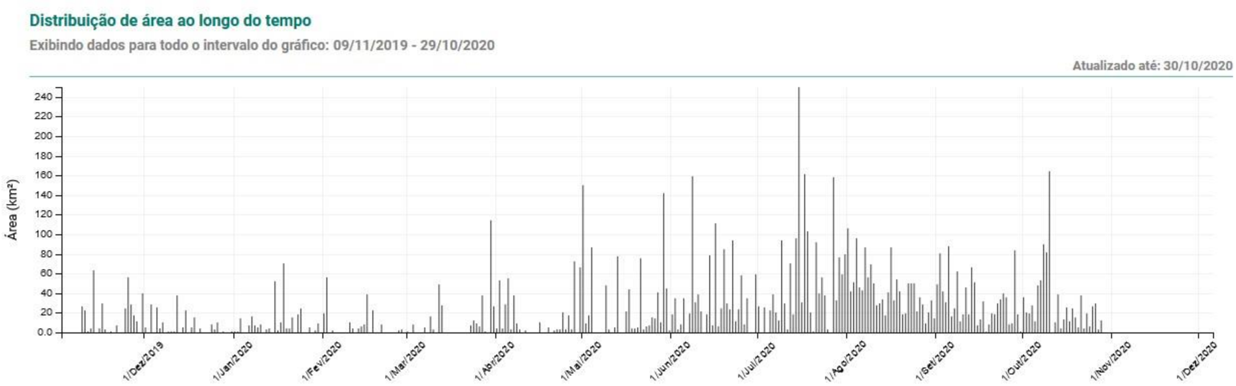


Figure 71: Daily near-real-time deforestation alerts provided by DETER

[23] INPE 2019
[24] http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/deter/deter
[25] http://terrabrasilis.dpi.inpe.br/app/dashboard/alerts/legal/amazon/aggregated/

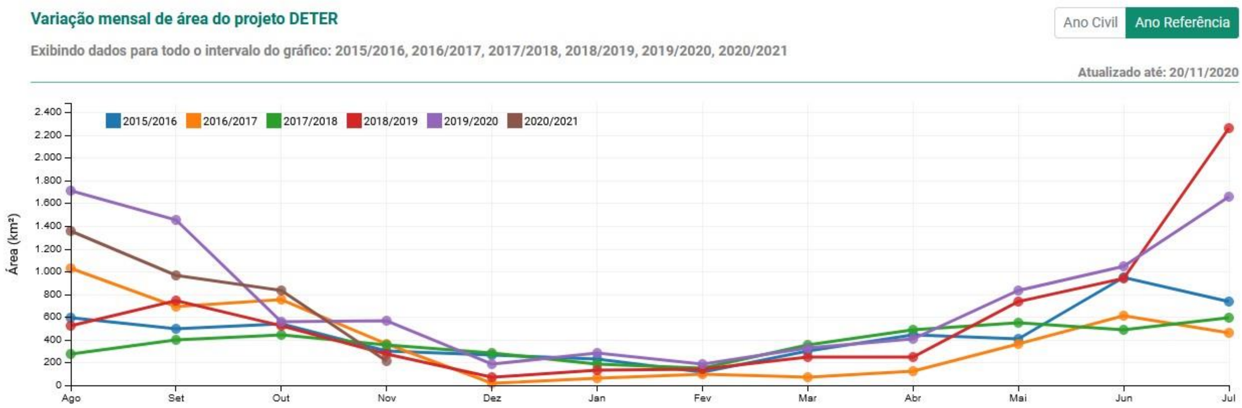


Figure 72: Monthly aggregated near-real-time deforestation alerts provided by DETER

INPE-DETER monthly data gives an indication about the trends of deforestation for a given month or year, e.g. in comparison of the year(s) before; however, the accuracy of the DETER data, using optical satellite imagery, depends very much on the cloud coverage for the analysed time period.

The comparison between 12 months DETER accumulated monthly near-real-time alerts and official PRODES deforestation statistics for 2015/16-2018/19 shows differences which are significant but consistent. The yearly aggregated DETER results (Aug-Jul period) for deforestation areas, compared to official PRODES statistics range from 60.7% (2017/18) to 68.1% (2015/16), with an average of 65.8%.

In the graph that compares INPE-DETER and INPE-PRODES yearly deforestation statistics (Figure 73), the result for PRODES 2019/20 (which was published on 1st December 2020) shows that the DETER deforestation statistics for the reference year 2020 (Aug 2019 – Jul 2020) were considerably closer to the PRODES official deforestation area for the same period (83.1%), compared to previous years.

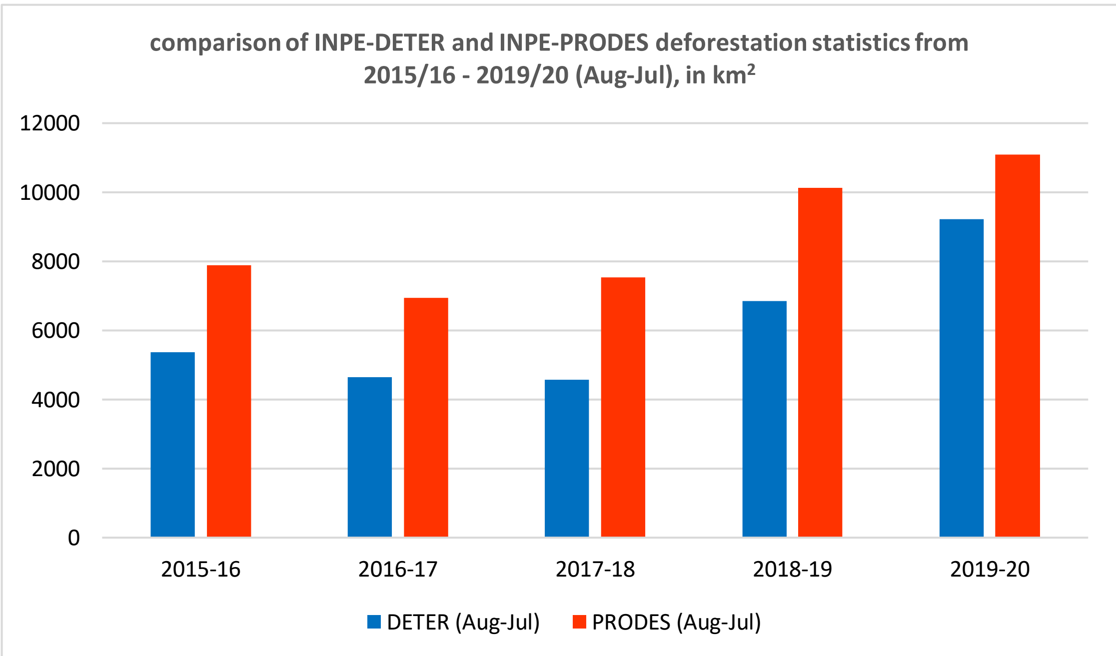


Figure 73: INPE-DETER yearly aggregation (blue) of deforestation near-real-time alerts 2015/16 – 2019/20 for the BLA in comparison with INPE-PRODES official deforestation statistics (red) for the same period. The INPE-DETER results for 2020, in relation to PRODES figures, have shown an underestimation of 16.9%. This is a significantly better estimate compared to the years before with an average of 34.2% underestimation by INPE-DETER.

10.8 Forest cover changes in the BLA 2020

According to the JRC dataset the total new areas of deforestation and forest degradation in the Brazilian Legal Amazon from the 1st of January to the 9th October 2020 (day of the analysis) amounted to c. 10,800 km^2, with 7,100 km^2 of deforestation, including deforestation of intact forest and previously degraded forest and 3,700 km^2 of forest degradation from forest fires and selective logging. Compared to the previous year, deforested areas seem to be decreasing; however, this would have to be confirmed once the deforestation activities in the last three months of 2020 will be assessed. An update of the JRC dataset up to 31st December 2020, is expected to be produced at the beginning of 2021.

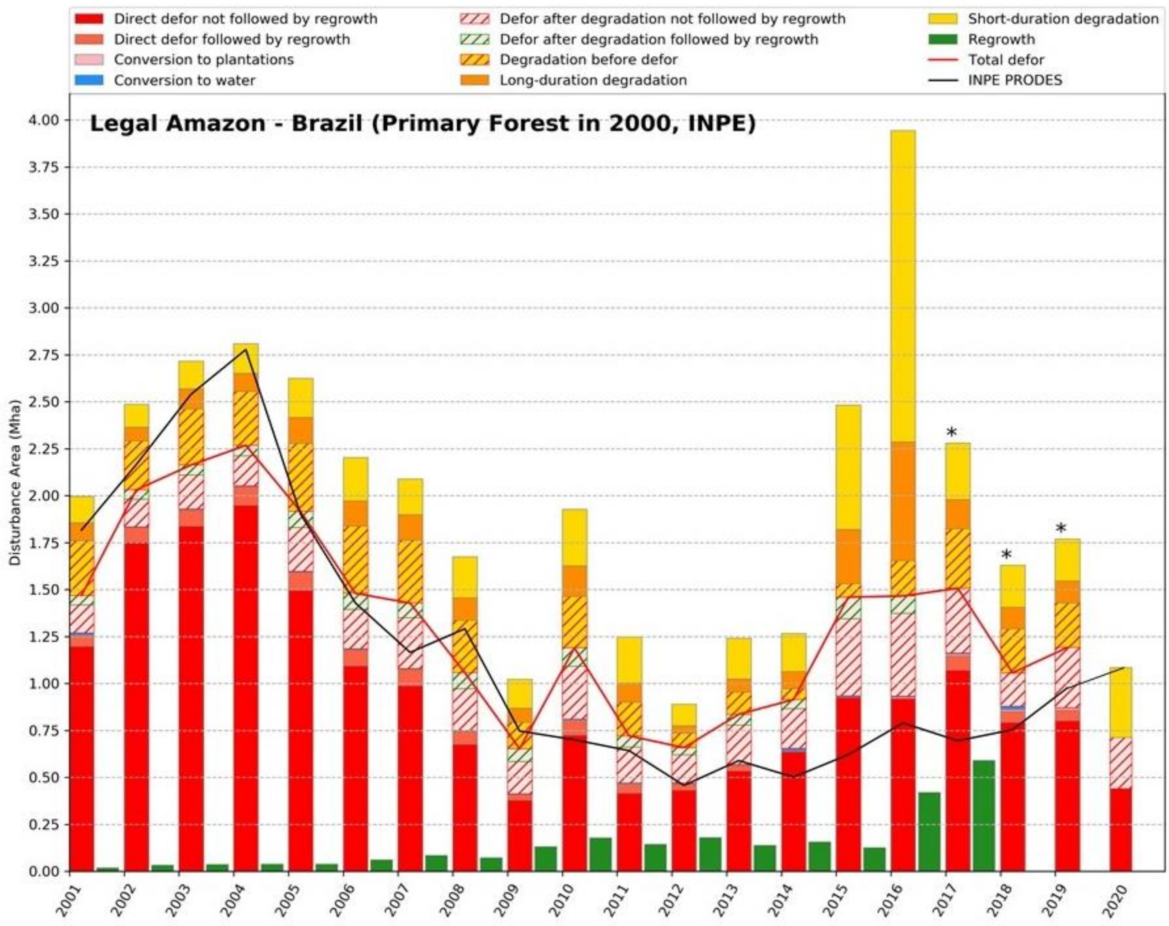


Figure 74: Trend in annual deforestation and forest degradation in the BLA from 2001 – 2020 (from JRC dataset). Deforestation appear in red bars (direct deforestation) and red hatched bars (deforestation after degradation) and forest degradation appear in yellow/orange bars The INPE PRODES deforestation statistics appear as black line. The JRC data for year 2020 is incomplete (analysis only until 9 October 2020), in addition the proportion between deforestation and forest degradation has been guessed on the basis of the average proportion for the period 2005-2014. PRODES deforestation statistics for 2020 are showing an increase, while JRC data reports a decrease of BLA deforestation for year 2020 until the 9th October. This opposite trend is explained by the fact that PRODES reports 'annual' deforestation between August and July, while JRC reports annual deforestation by calendar year (January – December).

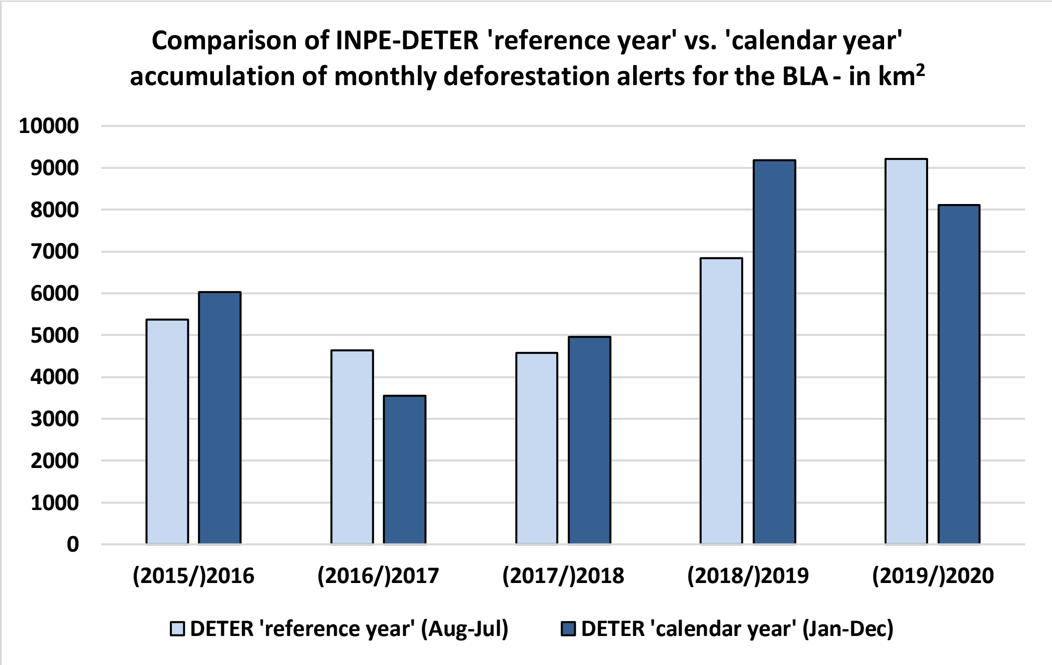


Figure 75: Difference between 'reference year' and 'calendar year' accumulation of INPE-DETER monthly deforestation alerts. For year 2020 ('calendar year'), the month of December is missing.

The comparison of different accumulation periods, i.e. for an INPE 'reference year" (e.g. August 2015 – July 2016) and 'calendar year' (January 2016 – December 2016) shows how the deforestation trend for a given year can vary with the observation period. While the yearly accumulated deforestation alerts show an area increase for the 2019/2020 'reference year', the deforestation area decreases when looking at the 2020 'calendar year'. The reason is the exclusion of the large areas of deforestation alerts in the months of August and September 2019, which are counted for the statistics of the following year (2020) in the 'reference year' accumulation, but are counted for year 2019 in the 'calendar year' statistics. The INPE-PRODES official deforestation statistics apply the 'reference year', while JRC data produces statistics for 'calendar years' hence the difference between the PRODES and JRC deforestation trends for the year 2020 (Figure 21).

10.9 Forest degradation by forest fires, selective logging and edge effects

The distinction between the main causes of disturbances that lead to the degradation of forests through sudden changes in the canopy (selective logging and forest fires) cannot be made based on automatic image analysis alone. The studies in this context e.g. carried out by Tyukavina et al. (2017)[26], Beuchle et al. (2019)[27] and Matricardi et al. (2020)[28] all used semi-automatic satellite data analysis approaches (incl. image interpretation) for the mapping and distinction of the two mentioned main causes for forest degradation.

Forest fires 2020

The degraded forest area for year 2000 (yellow bar in previous figure) could still reach the figure of year 2019 as last three months of 2020 have still to be incorporated (present estimates are: c. 5,600 km^2 and 3,700 km^2 for years 2019 and 2020 respectively). This assumption is backed by the increasing trend, according to the GWIS statistics (in previous chapter), of 2020 active fires and burned areas in the Legal Amazon (increase of 45% and 55%, respectively, for 2020 in comparison with 2019), specifically after the 9th October. This increase in October and November 2020 for burned areas and active fires, occurring late in the Amazon fire season, can lead to the conclusion that also areas of burned forests will show an increase with respect to the year 2019 during this period. In consequence, the gap between 2020 degraded areas by forest fires in the BLA (status 9th October) and those of 2019 could become significantly smaller in the last three months of 2020.

[26] Tyukavina et al. (2017)
[27] Beuchle et al. (2019)
[28] Matricardi et al. (2020)

Selective logging 2020

A substantial part of the activities leading to the degradation of an intact old-growth forest is unsustainable selective logging. In some parts of the BLA the areas of selective logging are far larger in comparison to deforested areas or forests affected by fire. In a study from Beuchle et al. (2019)[29] on the Northern part of Mato Grosso State (over 400000 km^2 analysed from year 1996 - 2018) provided detailed data on selective logging and forest fire areas, which was intersected with JRC data on degraded forests for the years 2001-2011. The results of the analysis show that approximately 75% of forest degradation in this region is caused by selective logging, while only 25% of the JRC forest degradation areas were burned. This balance, however, might have changed in recent years due to a relative increase of burned forest areas in relation to selectively logged forests. In addition, the distribution of selective logging and forest fires could be different for other areas within the BLA.

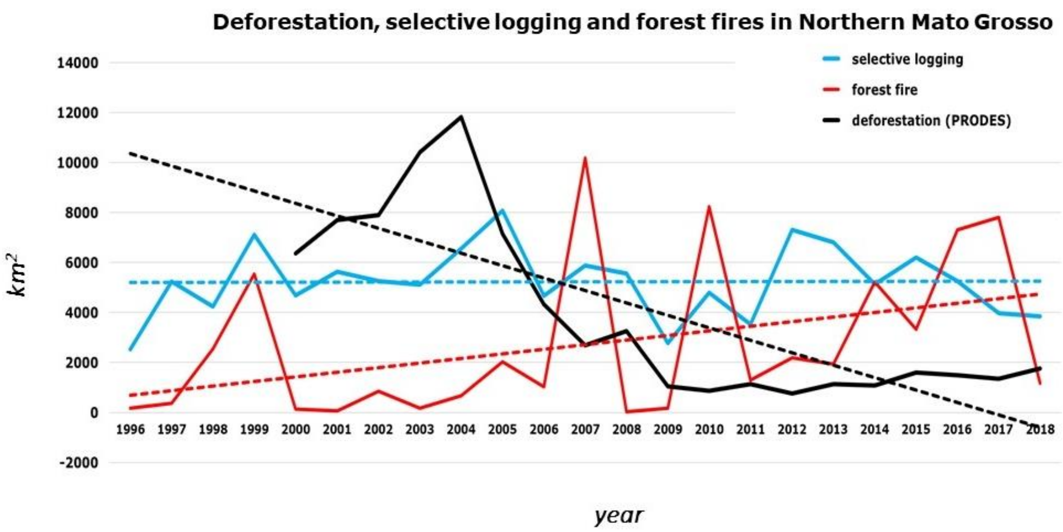


Figure 76: Distribution of deforestation, selective logging and forest fire in Northern Mato Grosso from 1996 – 2018, according to Beuchle et al. (2019). The trend lines are displayed dashed of the same colour.

Edge effects

The edge effects on 'hard forest borders' (between forest and deforested areas) have been described in the section on deforestation. Edge effects, according to a recent publication in Science Advances[30], can increase carbon emissions to up to 37% to those caused by deforestation. The authors used satellite imagery, airborne laser scanning (LiDAR) data and field data for their study, because the effects on a forest being exposed to an abruptly changed microclimate (leading to increased tree mortality, biomass loss, degradation of ecosystem services, changes of flora and fauna composition within the forest edge zone) are not measurable through satellite images alone. The forest edge effects happen slowly over time and, thus do not appear as sudden changes in the forest canopy like the changes caused by deforestation, selective logging or forest fires. In consequence, the forest degradation caused by edge effects do not appear in neither of the forest cover change statistics of INPE-DETER, INPE-PRODES or JRC.

Relation between deforestation and forest fires

In the 21st century, areas affected by forest fires and areas of recent deforestation are not strongly correlated any more in the BLA. A study from 2018[31] states that the decoupling between fire-related and deforestation-related carbon emissions has been driven by recurrent extreme 21st century droughts. Whereas in the 1990ies and before forest fires were driven by the deforestation process, the lack of rainfall in the region and raising air temperatures paved the way for forest fires being more independent from the activities of loggers. Currently, carbon emissions related to forest fires increasingly dominate the overall

[29] Beuchle et al. (2019)
[30] Silva Junior et al. (2020)
[31] Aragão et al. (2018)

figures for the Amazon region, specifically during extreme drought years[32]. However, a more detailed analysis of the burned areas distribution over consolidated pastureland (or crop fields), in recently deforested areas or in the forest is still to be carried out.

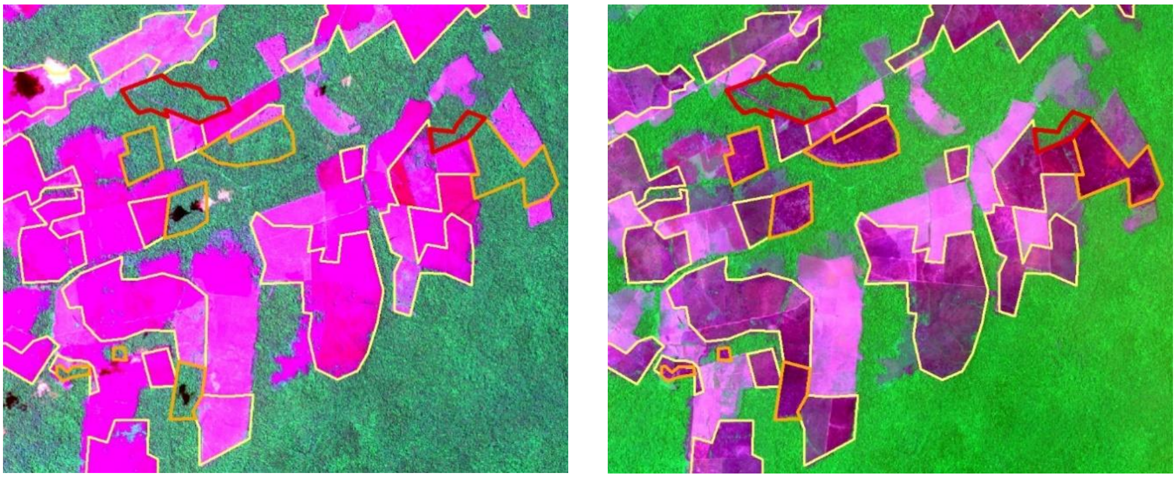


Figure 77: Distribution of 2020 pasture maintenance fires (light yellow), fires after deforestation (orange) and forest fires (red) over Sentinel-2 imagery from 2019 (31st July) and 2020 (9th October) near the town of Apui in the South of Amazonas State. Image width: ca. 10 km

32 Aragão et al. (2018)

The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

Publications Office
of the European Union