In 2020, 30% of the Pantanal was burned to cinders by wildfires

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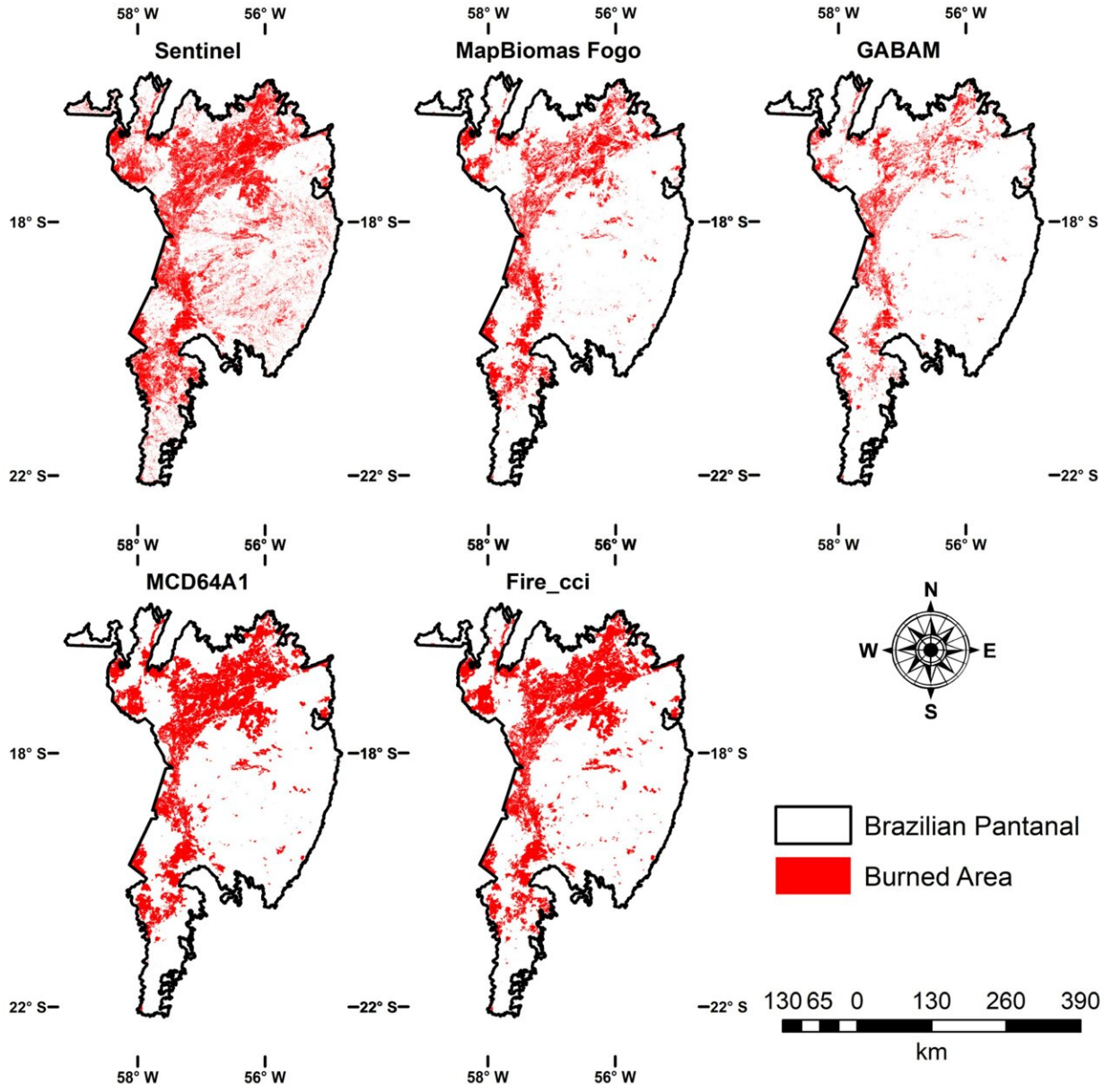

Spatial distribution of the burned area mapped in the Brazilian Pantanal biome during the 2020 fire crisis using MSI sensor images onboard the Sentinel-2 satellites and the four burned area products analyzed in this study. Credit: *Fire* (2023). DOI: 10.3390/fire6070277

In 2020, the Pantanal, the largest tropical freshwater wetland in the world and a biodiversity hotspot, was swept by high-intensity fires that destroyed native vegetation in an area totaling 44,998 square kilometers, or about 30% of the Brazilian portion of the biome, which spans some 150,000 km^2. The estimate is presented in an article published in *Fire*.

The area destroyed by that year's disastrous fires was far larger than had been thought, according to the article. Previous estimates ranged from 14,307 km^2 to 36,017 km^2. Led by scientists at the National Space Research Institute (INPE) in Brazil, the study included construction of a model based on satellite images from the European Space Agency's SENTINEL-2 satellite, which was shown to estimate regional-scale burned areas with significantly greater precision and accuracy than other satellite-based models for the Pantanal.

The approach used in the study achieved 96% accuracy, and the results "will help to improve estimates of trace gases and aerosols associated with biomass burning," the authors note, adding that "global biomass burning inventories are widely known for having biases at a regional scale."

The findings highlight the need for approaches that better assess the influence of fire on ecosystems and biodiversity in regions critically sensitive to climate change, such as the Pantanal. Their importance is all the greater in light of the strength of this year's El Niño, which could make the northern portion of the Pantanal and adjacent areas in the

Upper Paraguay Basin drier and more susceptible to fire.

"The results of the study don't show one model or product to be better than another. Every method has its own strengths and limitations. Estimates tend to vary significantly as a result. However, the images furnished by the MSI [Multispectral Instrument] on board SENTINEL-2 have two positive points: spatial resolution is 20 meters, providing much better detail of burned areas; and temporal resolution, very important to this type of study, is 5 days, compared with a revisit frequency of up to 16 days for the Landsats," said forest engineer Andeise Cerqueira Dutra, an author of the article and a Ph.D. candidate at INPE's Earth Observation and Geoinformatics Division (DIOTG), with Yosio Edemir Shimabukuro as thesis advisor.

Shimabukoro is the penultimate author of the article. The last author is Guilherme Augusto Verola Mataveli, also a researcher at DIOTG-INPE.

For Mataveli, it is important to refine this type of analysis and obtain regional-scale estimates in order not only to estimate burned areas more accurately but also to calculate greenhouse gas emissions, which directly affect climate change.

"The 2020 Pantanal fire crisis was caused by an extreme drought. Severe drought will tend to be increasingly frequent there and in other parts of Brazil. Knowing more about the impact of these extreme weather events on the biome and its biodiversity will be more and more important to decisions regarding fire management and fire mitigation programs," said Mataveli.

"Finding ways to improve these products and generate more accurate data is very important for society. An example is the pilot project launched this year in the Pantanal, also using remote sensing data to identify areas affected by fire and estimate the accumulation of

combustible matter. Managers of environmental agencies and firefighters can use these findings to manage fire in an integrated manner, defining priority areas and actions to combat or control fires," Dutra said.

Consequences

The Pantanal is normally under water in the rainy season, which extends roughly between October and May, and is modulated by the South American Monsoon System (SAMS). The dry season usually begins in June or July. Fires in the region tend to peak in September. However, the pattern changed in 2019, which saw the onset of a prolonged drought that worsened in 2020, when annual precipitation in the Brazilian portion of the Pantanal was the lowest since the 1980s and 26% lower than the 1982–2020 average.

As a result, the water surface area shrank 34% compared with the average, the aggregate burned area was 200% more than the long-term average, and 35% burned for the first time on record.

The cost of restoration was estimated at USD 123 million. Researchers estimated that the 2020 wildfires killed some 16 million small animals (under 2 kg) and 944,000 larger animals.

The Jaguar (Panthera onca), the largest feline species in the Americas, was especially hard hit. The fires destroyed 45% of the estimated population of P. onca, or some 450 individuals (87% in Brazil), burning 79% of its home range area and 54% of protected areas within that range. Until then, the Pantanal was home to the second-largest population of jaguars in the world.

Another consequence was a rise in the number of people hospitalized for treatment of respiratory problems in the states of Mato Grosso and Mato

Grosso do Sul, as shown by a study (in Portuguese) conducted by Oswaldo Cruz Foundation (Fiocruz), an arm of Brazil's Health Ministry.

Methodology

The researchers used satellite images from SENTINEL-2 to estimate burned areas in the Brazilian part of the Pantanal in 2020 and compared these with estimates based on MODIS (the Moderate Resolution Imaging Spectroradiometer sensors aboard NASA's Terra and Aqua satellites) and Landsat imaging. The former (MCD64A1 and Fire_cci) gave estimates of 35,837 km^2 and 36,017 km^2 respectively, while the latter (MapBiomas Fogo and GABAM) gave estimates of 23,372 km^2 and 14,307 km^2.

The spatial distribution patterns in these maps were visually similar, but the estimates based on SENTINEL-2 imaging detected a larger number of smaller fires, especially in the eastern Pantanal. "The model we developed is available to anyone interested, as is the data collected in the validation exercise. We believe they can help researchers engaged in future projects," Mataveli said.

"Drought is set to be increasingly frequent, and fire episodes therefore will tend to be more frequent as well, so we expect more collaborative research and a growing supply of data," Dutra said. "We also expect more field data to be accessible, especially for scientists who work with remote sensing to produce more accurate output."

Between January 1 and August 23, 2023, 381 fires were detected in the Pantanal, according to data from INPE (in Portuguese). In the same period of 2020, there were 8,127, the highest number since 1998 for the biome. Forest fires have intensified this year in the context of heat waves in Europe and North America, leaving many deaths and ruined neighborhoods in their wake.

More information: Yosio Edemir Shimabukuro et al, Assessment of Burned Areas during the Pantanal Fire Crisis in 2020 Using Sentinel-2 Images, *Fire* (2023). DOI: 10.3390/fire6070277

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