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Executive summary

- A drought affects a wide cross boundary region of South America, roughly corresponding to central and northern Great Chaco (Paraguay, Bolivia, Argentina) and fringes of Pantanal (Brazil, Bolivia). Both 2019 and 2020 rainy seasons were markedly below average. Dry conditions are recorded further east as well, between Paraguay and Paraná rivers, whose levels are lower than usual. Hydrological drought is relevant in the lower basin.
- Impacts are different depending on location. Mainly livestock losses in the Great Chaco, transportations and power supply issues east of Paraguay river and downstream. Wider than usual fires affect both Great Chaco and Pantanal since the start of the dry period.
- The outlook at three months is not uniform, but only mildly wetter or drier than usual. However, at the tail of the rainy season, even positive anomalies are unlikely to compensate for accumulated deficits.

Risk of drought impact

The indicator RDri-Agri shows the risk of having impacts from a drought, by taking into account the exposure and socio-economic vulnerability of the area, with particular focus to the agricultural impacts.

Figure 1 shows the areas at risk during the first ten days of April: most of Paraguay, eastern Bolivia (Santa Cruz) and the cross-boundary region of Pantanal. Northern fringes of Argentina are affected as well. Despite the low population density west of Paraguay river and across Pantanal, the primary sector represents the main source of income and living for rural communities, cattle farming above all else. During the dry season, fires are commonly ignited to free land for agriculture in both Great Chaco and Pantanal. Such fires easily get out of control in

drier years and require challenging fire control operations. The Pantanal area is home to habitats of utmost importance for biodiversity and hosts several Ramsar sites¹.

East of Paraguay river the climate is wetter and land is more densely populated, with human settlements bonded to the major rivers of the area (i.e. Paraná basin). Paraguay relies on hydropower for all of its power supply and a significant fraction of its GDP².

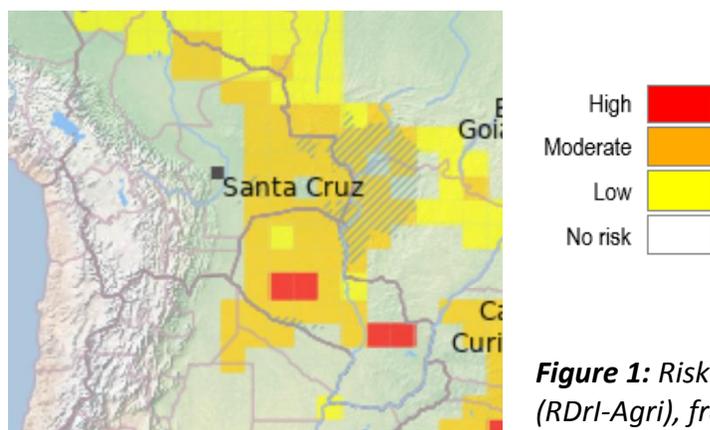


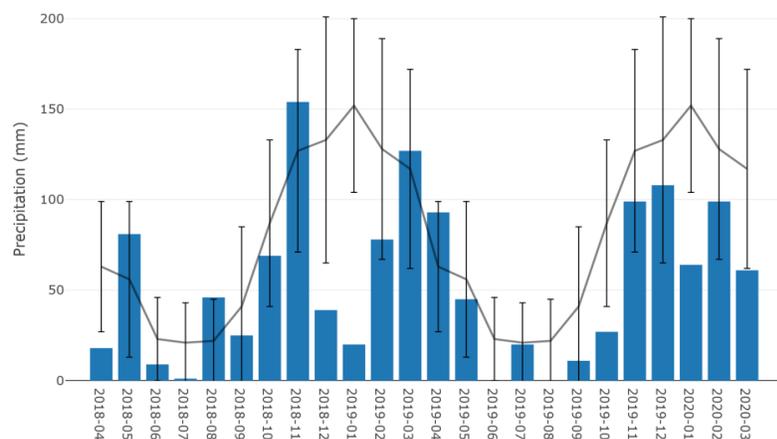
Figure 1: Risk of drought impact for agriculture (RDri-Agri), from 1st until 11th of April 2020.

Precipitation

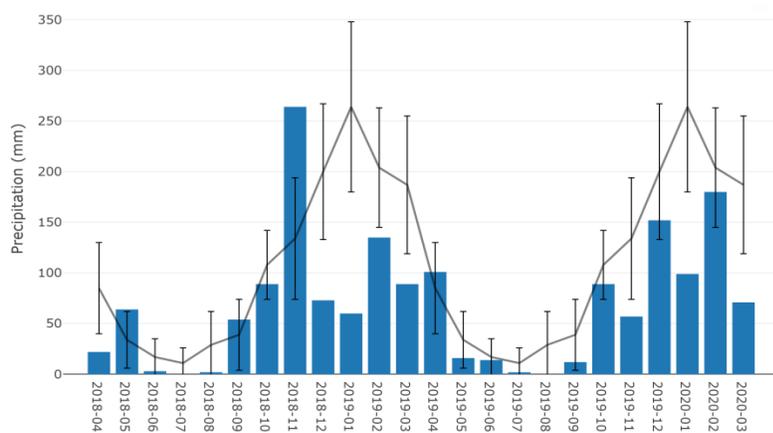
The precipitation patterns are similar across most of the area of interest, with a long wet season and a slightly shorter dry season, but different amounts of rainfall, varying from 700 to 1200 mm a year (figure 2, top and centre). Areas east of Paraguay river are wetter, up to 1500 mm, having a weaker seasonality (figure 2, bottom). Variability around the monthly averages is generally high, but nevertheless a remarkable number of months in the past two years have recorded even lower precipitation. A few months exceeded the normal upper boundary, but not nearly as many to compensate. In fact, overall cumulative deficits largely prevail, with 25% to 40% less rain over the last 24 months (e.g. Figure 3).

¹ <https://www.ramsar.org/>

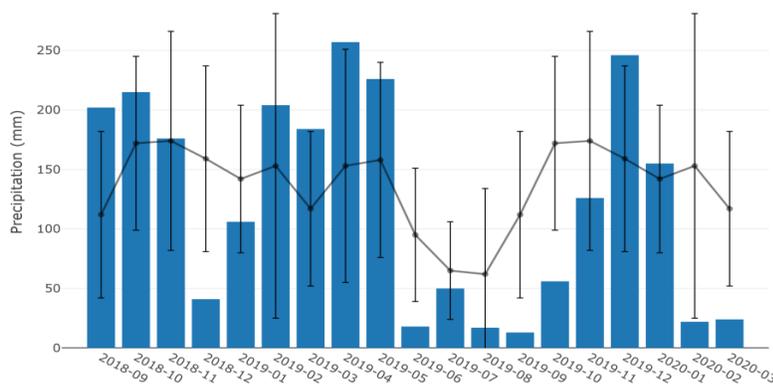
² <https://www.hydropower.org/country-profiles/paraguay>



Filadelfia (Paraguay, coordinates lat. -20.9, lon. -59.9)



Eastern Santa Cruz (Bolivia) and neighboring Pantanal area (Brazil), ca. lat. -16.4, lon. -59.1



San Estanislao (Paraguay, coordinates lat. -24.5, lon. -56.6)

Figure 2: Monthly total precipitation (blue bars), with the long-term monthly averages (1981-2010, solid line) and standard deviation.

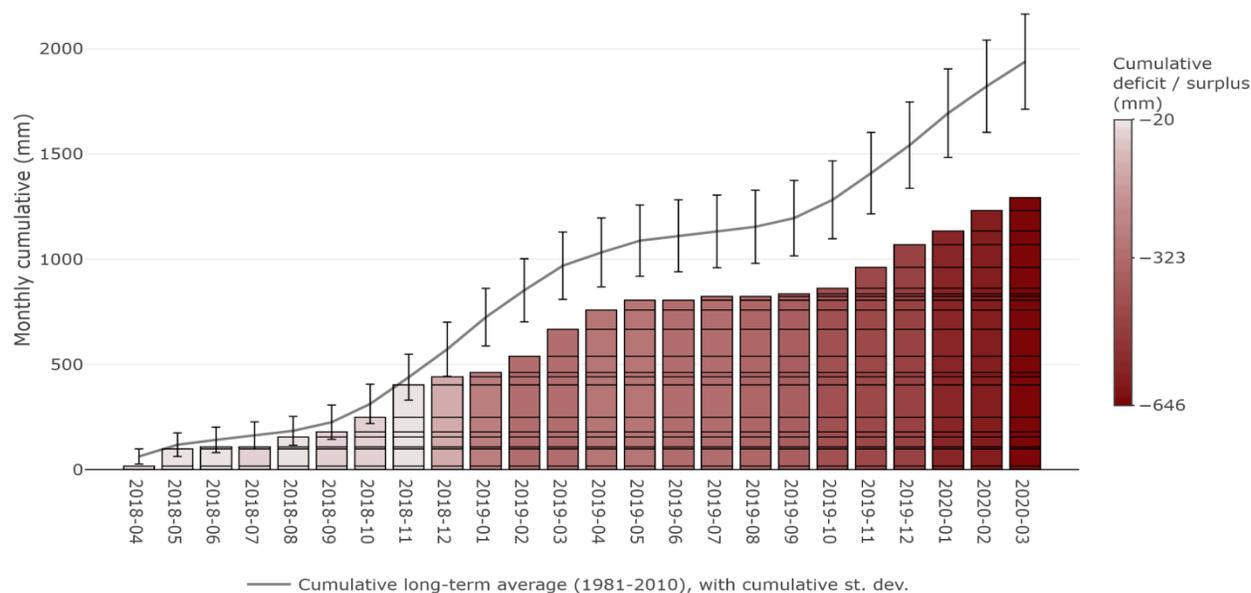


Figure 3: Cumulative precipitation over a period of 24 months near Filadelfia (Paraguay, coordinates lat. -20.9, lon. -59.9). The bar colors indicate the cumulative deficit (red gradient), compared to the accumulated monthly long-term average (solid line), for the same time span and location. The boxes overlapping the bars are the monthly totals stacked.

Standardized Precipitation Index (SPI)

The SPI indicator is used to monitor the occurrence of meteorological drought. The lower (i.e. more negative) the SPI, the more intense is the drought.

Figure 4 (left) shows the negative precipitation anomalies at the scale of 6 months (October 2019 to March 2020), encompassing the whole wet season. A large belt shows values from moderate to strong deficits, extending from Brazil to northern Paraguay through Bolivia and reaching Argentina's northernmost regions. By comparison, the SPI anomaly at the 12 months period is milder for western Paraguay, where precipitation balance was relatively closer to normal during the last year, while extreme values are observed over eastern Bolivia, Mato Grosso (Brazil) and further north.

Nevertheless, looking at the 24 months interval, the time series gives a picture of the magnitude of precipitation anomalies compared to the past, reaching historical lows in some locations (Figure 5).

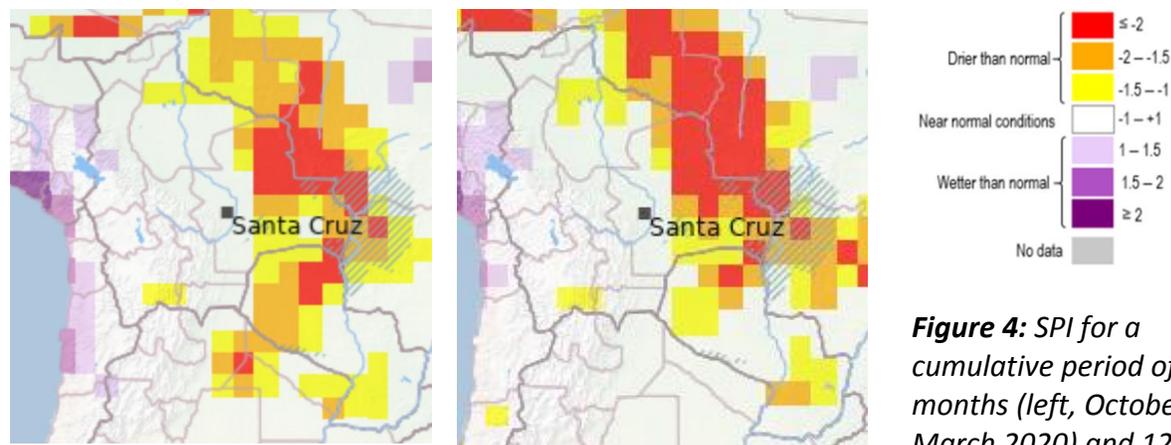


Figure 4: SPI for a cumulative period of 6 months (left, October to March 2020) and 12 months (right, April to March 2020).

In fact, the marked lack of rainfall for two wet seasons in a row determined the most extreme SPI value since the start of the GDO data records from northern Paraguay northwards. At such a temporal scale, a relevant cumulative deficit entails hydrological drought, thus affecting river levels and stressing wetlands areas. Concerning central and eastern Paraguay, and northern Argentina, the current two years negative anomaly is mild or negligible, given that precipitation deficits stacked up mainly during the last year (figure 4, left).

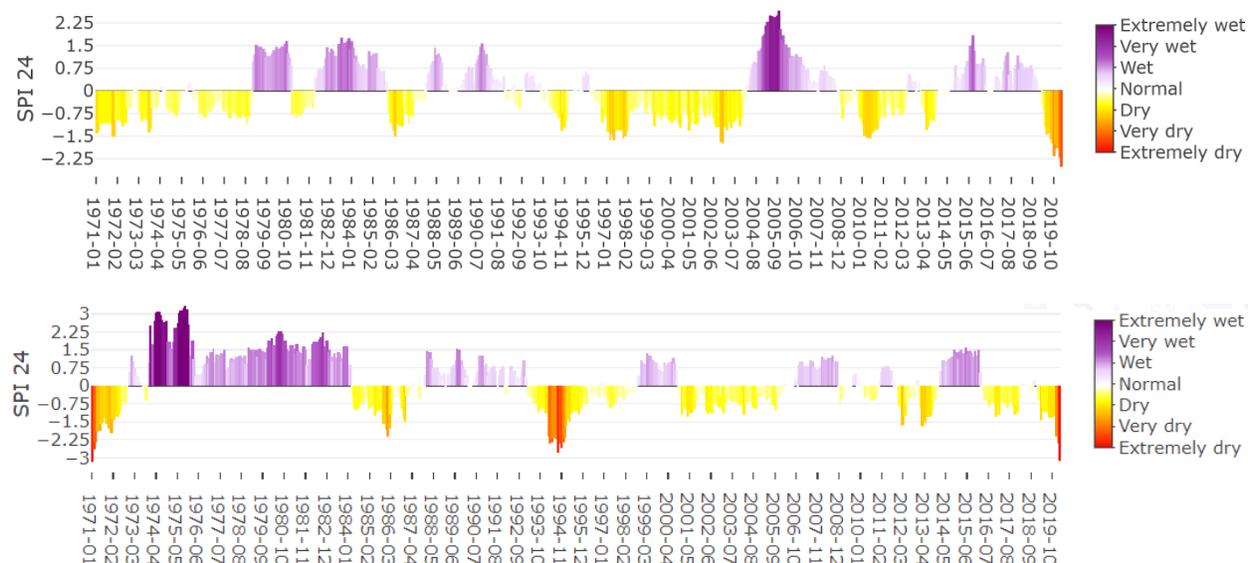


Figure 5: time series of SPI for 24 months cumulative interval in northern Paraguay (top, Robore, lat. -19.9, lon. -60.2) and brazilian Pantanal (bottom, Tiamã, lat. -16.7, lon. -57.8).

SPI outlook

The outlook of precipitation for the period April to June is positive for central Paraguay, moderately negative for eastern Bolivia and north of Pantanal (Brazil), neutral or uncertain elsewhere (figure 6). The trimester accounts for only 15% of annual precipitation though, so it is unlikely to replenish stressed water resources, whose recovery may be 5 or 6 months ahead, at the onset of the next wet season.

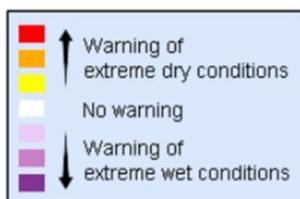
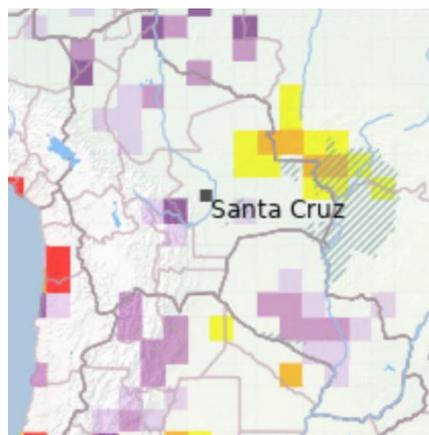
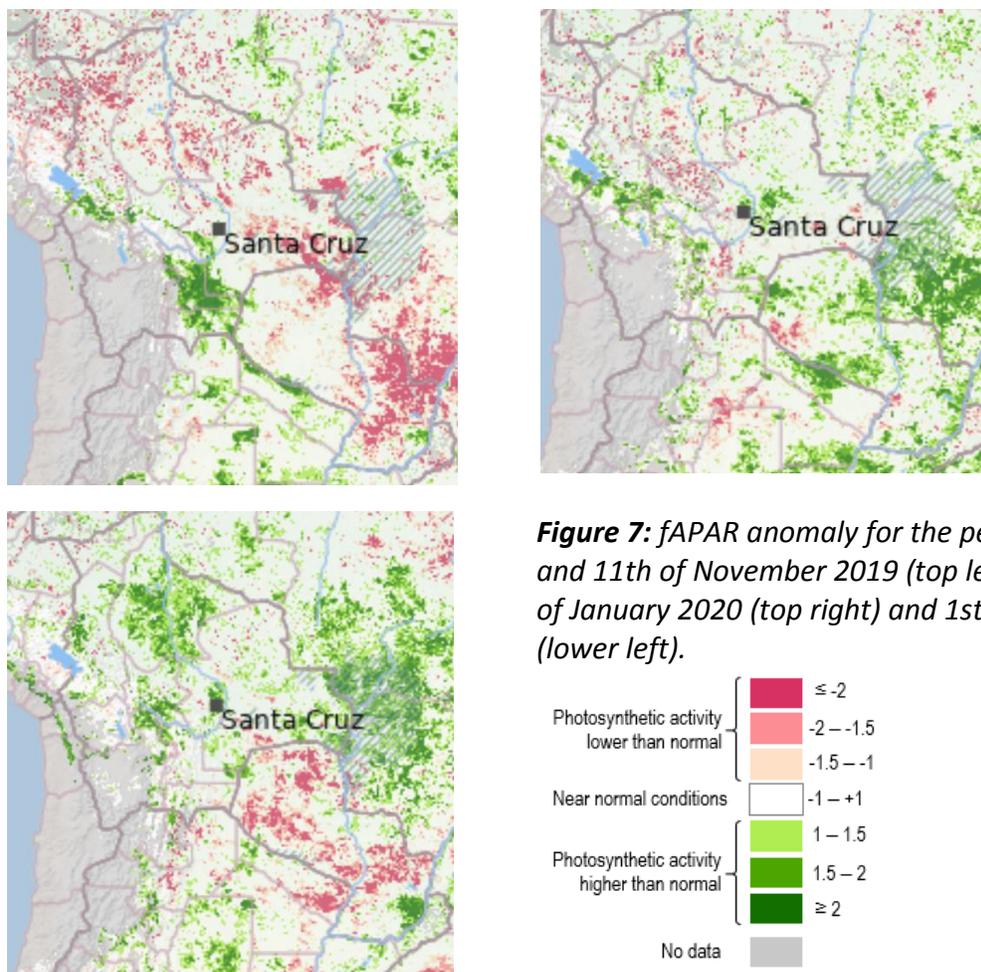


Figure 6: Extreme SPI forecast, 3 months cumulative period (April to June 2020).

fAPAR anomaly

The fraction of Absorbed Photosynthetically Active Radiation (fAPAR) represents the fraction of the solar energy absorbed by leaves. fAPAR anomalies, specifically the negative deviations from the long term average over the same period, are a good indicator of drought impacts on vegetation.

Coming from neutral or positive conditions in the previous couple months (figure 7, top right), at the beginning of April the anomaly is leaning towards lower photosynthetic activity over Paraguay, while strongly positive over Pantanal areas and neutral in eastern Bolivia (figure 7, lower left).



Compared to October and November 2019, when negative anomalies were much more widespread in the neighboring regions (figure 7, lower left), in mid March only Paraguay fell back to those values, after the recovery period. Figure 8 displays the prolonged photosynthetic deficit from September to December 2019, followed by a recovery and then a new regression in mid March.

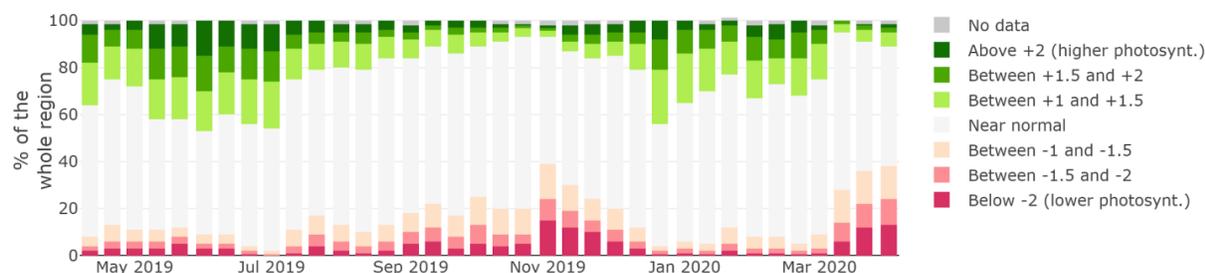


Figure 8: fAPAR anomaly, evolution over time in Paraguay.

Soil moisture anomaly

The aim of this indicator is to provide an assessment of the top soil water content, which is a direct measure of drought conditions, specifically the difficulty for plants to extract water from the soil.

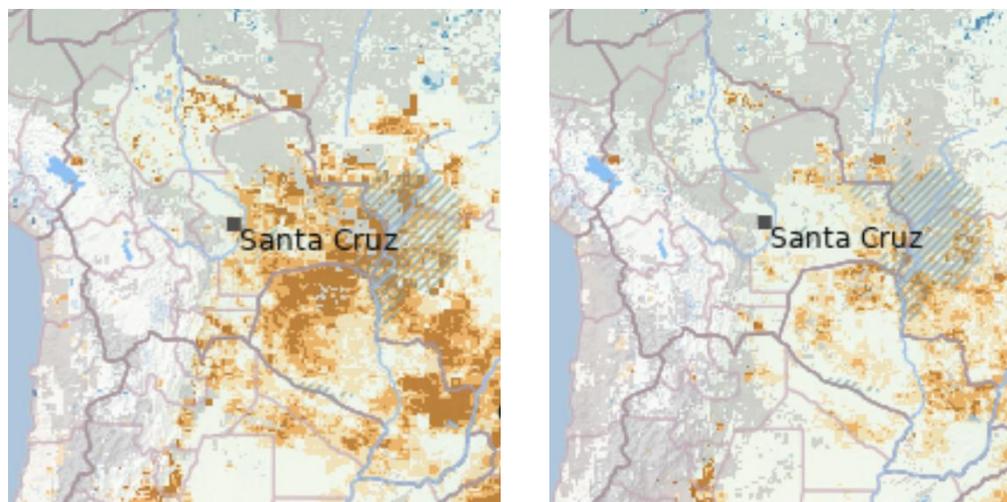
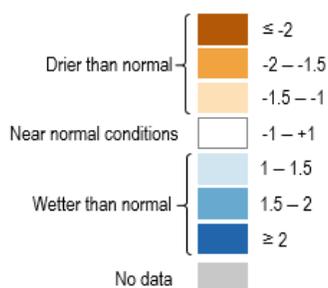


Figure 9: Soil moisture anomaly for the period between 1st and 31st of March 2020 (left) and 11th of March to 11th of April (right).



The anomaly for March (figure 9, left) indicates a large and consistent pattern of dryness, with a stark improvement in the second half of March and the beginning of April (figure 9, right). Despite improvement, a positive trend can't be confirmed over a time interval of only ten days and requires a few more weeks to do so. Looking at the sequence of *dekadal* intervals over the last year in two main administrative areas currently affected (figure 10), a constant soil moisture deficit persisted all year long and primarily over certain locations, despite a pause in late 2019 and early 2020.

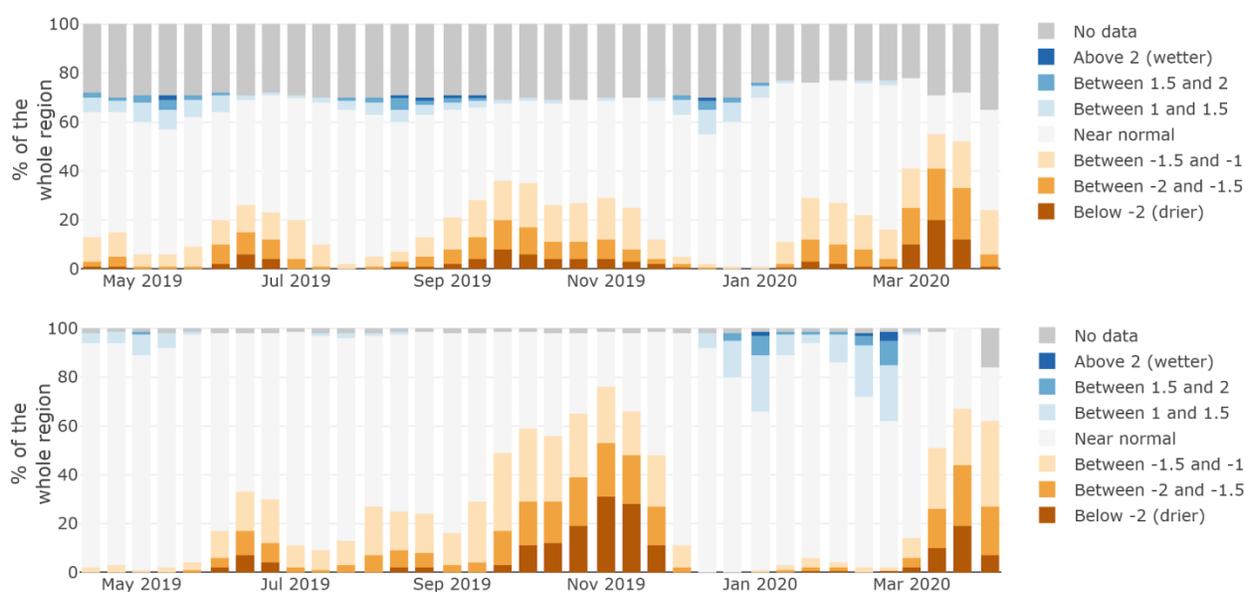


Figure 10: Soil moisture anomaly, evolution over time in Santa Cruz (Bolivia, top), Mato Grosso do Sul (Brazil, bottom).

Reported impacts

Due to the low population density and remote locations, impacts are likely underreported. This issue may concern especially natural ecosystems³. The Pantanal is the largest wetland on the planet and an area of global importance for biodiversity⁴, which depends on seasonal flooding cycles. Despite the strong natural resilience of large ecosystems, an intense drought coupled with human pressure (e.g. fires) may threaten habitats and ecological niches locally.

Due to the abnormal dryness, fire hazard is very high⁵ and the seasonal fires affecting the Great Chaco and Pantanal started earlier⁶ and are wider than usual, threatening both ecosystems and human settlements^{7,8,9}. In Paraguay, the livestock sector is severely affected in the whole region

³ e.g. <https://edo.jrc.ec.europa.eu/gdo/php/index.php?id=2025&lon=-57.8&lat=-16.7&refDate=2020-03>

⁴ <https://rsis Ramsar.org/> ; e.g. <https://rsis Ramsar.org/ris/2363>

⁵ <https://gwis.jrc.ec.europa.eu/>

⁶ <https://www.poconet.com.br/noticias/ler/marco-registra-recorde-no-numero-de-queimadas-na-regiao-do-pantanal/18400>

⁷ <https://www.campograndenews.com.br/meio-ambiente/com-40-menos-chuva-estiagem-chega-antes-e-pantanal-tem-400-focos-de-fogo>

⁸ <https://www.midiamax.com.br/cotidiano/2020/incendio-na-regiao-norte-do-pantanal-comeca-amenizar-e-ficar-sob-controle-afirma-bombeiros>

west and north of the Paraguay river, as a combination of reduced production due to drought and low market prices^{10,11,12}. Water supply is at stake locally¹³. In eastern Paraguay, river levels are below usual¹⁴, with the notable case of Paraná and affluents^{15,16}. This is due in part to management on the Brazilian territory^{17,18}, but still in relation to dry conditions upstream. Freight transportation is also affected over the Paraná waterway. As a consequence of conditions upstream, hydrological drought spread far downstream, hitting hydropower production as far as Uruguay and Argentina^{19,20,21}.

⁹ <https://www.canalrural.com.br/noticias/tempo/estiagem-precoce-aumenta-queimadas-no-centro-oeste/>

¹⁰ <https://www.ultimahora.com/atipica-sequia-amenaza-al-ganado-el-norte-y-chaco-n2879587.html>

¹¹ <https://www.abc.com.py/nacionales/2020/04/24/sequia-obliga-a-masivo-traslado-de-ganado-en-el-chaco/>

¹² <https://www.abc.com.py/edicion-impres/interior/2020/04/21/preocupacion-en-alto-chaco/>

¹³ <https://www.lanacion.com.py/pais/2020/04/24/nativos-del-chaco-están-sin-asistencia-en-medio-de-una-sequia/>

¹⁴ <https://www.meteorologia.gov.py/>

¹⁵ <https://www.abc.com.py/este/2020/04/12/rio-parana-esta-tan-bajo-que-en-tramos-se-puede-cruzar-a-pie/>

¹⁶ <https://www.elcomercio.com/actualidad/sequia-rios-argentina-iguazu-exportaciones.html>

¹⁷ <https://www.meteored.com.ar/noticias/actualidad/brasil-levanta-compuertas-y-regresa-agua-a-las-cataratas-del-iguazu.html>

¹⁸ <https://www.lanacion.com.py/politica/2020/04/17/piden-a-itamaraty-reducir-embalses-brasilenos-ante-bajante-del-rio-parana/>

¹⁹ <https://misionesonline.net/2020/04/20/uruguay-paralizada-por-la-sequia-no-genera-energia-y-la-provee-el-sin-con-ayuda-de-arauco-pindo-y-soenergy/>

²⁰ <https://viapais.com.ar/posadas/1712882-paralizan-la-mayor-hidroelectrica-de-misiones-por-la-sequia/>

²¹ <https://santafe.telefe.com/noticias/la-provincia-intensifica-los-controles-por-la-bajante-en-el-rio-parana/>

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