

# ANALYSIS OF HYDROMETEOROLOGICAL CONDITIONS IN THE MONTH OF DECEMBER 2021 IN THE STATE OF SÃO PAULO

Fundação de Apoio à Pesquisa Agrícola (FUNDAG); Centro Integrado de Informações Agrometeorológicas (CIIAGRO)  
(Partnership – CATI/ – APTA/IAC)

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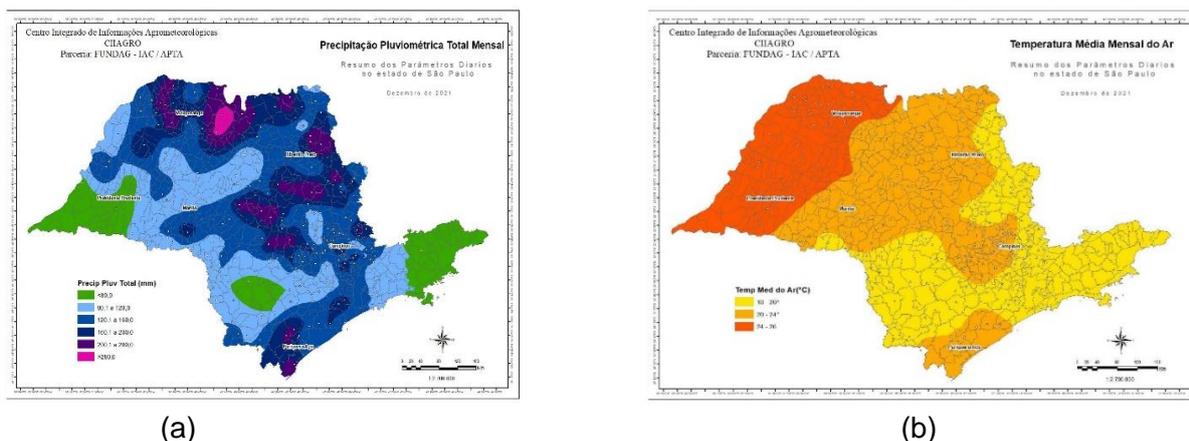
## 1. Introduction

The month of December presented two distinct characteristics in the medium and long term. Drought from the agricultural point of view was reduced with the momentary recovery of the water reserve in the soils. However, the water crisis to which the State has been subjected for a long time has been minimized, but not eliminated. The water restriction that has been highlighted by the previous bulletins still remains, and there is an urgent need for mitigation and adaptation mechanisms. This bulletin presents the characteristics of precipitation in the State of São Paulo in the month of December 2021, the characteristics of meteorological drought and possible current effects and future trends.

## 2. Climatology of the month of December 2021 in the State

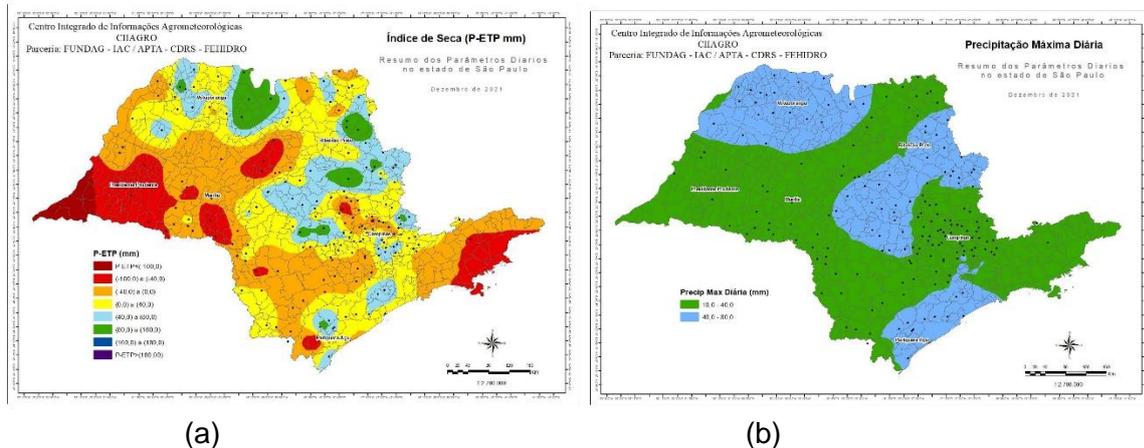
The water characteristics could be analysed with the existing database in the meteorological network of the Department of Agriculture and Supply, coordinated by CIAGRO, according to the agreement term signed between IAC and FUNDAG. This network is established with resources from the State Fund for Water Resources (FEHIDRO), with the collaboration of CATI and FUNDAG. Analyzes were performed considering meteorological elements such as rainfall and average temperature.

Figure 1 presents the average values of the total accumulated precipitation and the average temperature in the State. The month showed high values in the total rainfall, only a few locations had less than 100 mm, and in about 70% of the state between 100- to 250 mm and a few regions above 300mm. Only part of CBH-ALPA, MP and PP the indices were not significant. In a large part of the state, average air temperatures were above 24°C, favoring the different crops.



**Figure 1** – Spatial variation of (a) rainfall and (b) average air temperature, both referring to the month of December 2021.

When analyzing the difference between precipitation and potential evapotranspiration (P-ETP) values and the estimated values of water deficit (Figure 2) there is a clear verification that a large part of the state has positive anomalies. However, there were daily with high values of precipitation that may had compromised soil management and caused erosion (Figure 2b) where some locations such as Votuporanga and General Salgado had a daily index above 100mm.



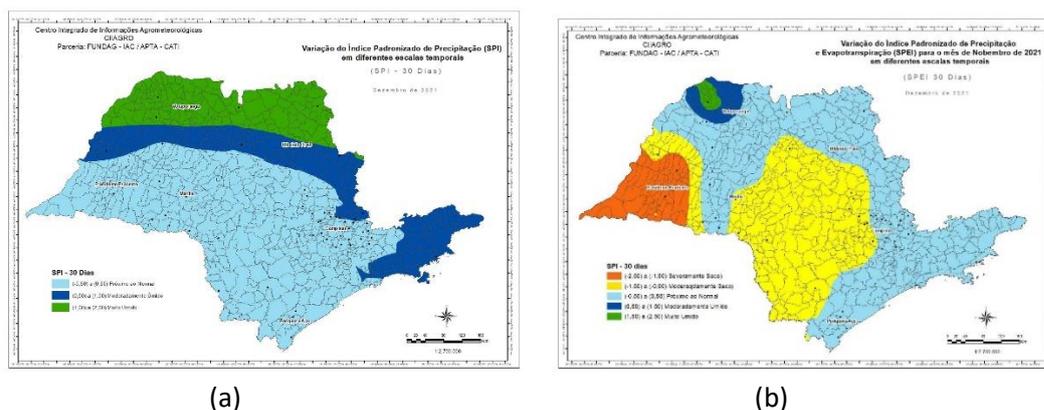
**Figure 2** – Spatial variation of a) P-ETP ratio, and b) maximum daily precipitation index in December 2021.

### 3. Indication of Hydrometeorological Conditions by the SPI and by the SPEI

#### 3.1. Monthly analysis

The Standardized Precipitation Index (SPI), as well as the Standardized Precipitation and Evapotranspiration Index (SPEI) are factors used worldwide to quantify meteorological drought, and recommended by the World Meteorological Organization (WMO). This index is mainly based on historical series of precipitation, and its coefficients are adjusted through the Gamma distribution.

The meteorological analysis of precipitation and its variability in a time scale of 30 days, that is, indicating the month of December, is presented in **Figure 3**. Values above the historical averages are predominant, indicating reasonable crop conditions in most of the territory of São Paulo, except for some specific areas of CBH-MP/APA\_PP and Adamantina, indicating no need for irrigation. The restriction or the occurrence of lower precipitation values in the regions described above are better highlighted with the SPEI on a monthly scale (**Figure 3b**).

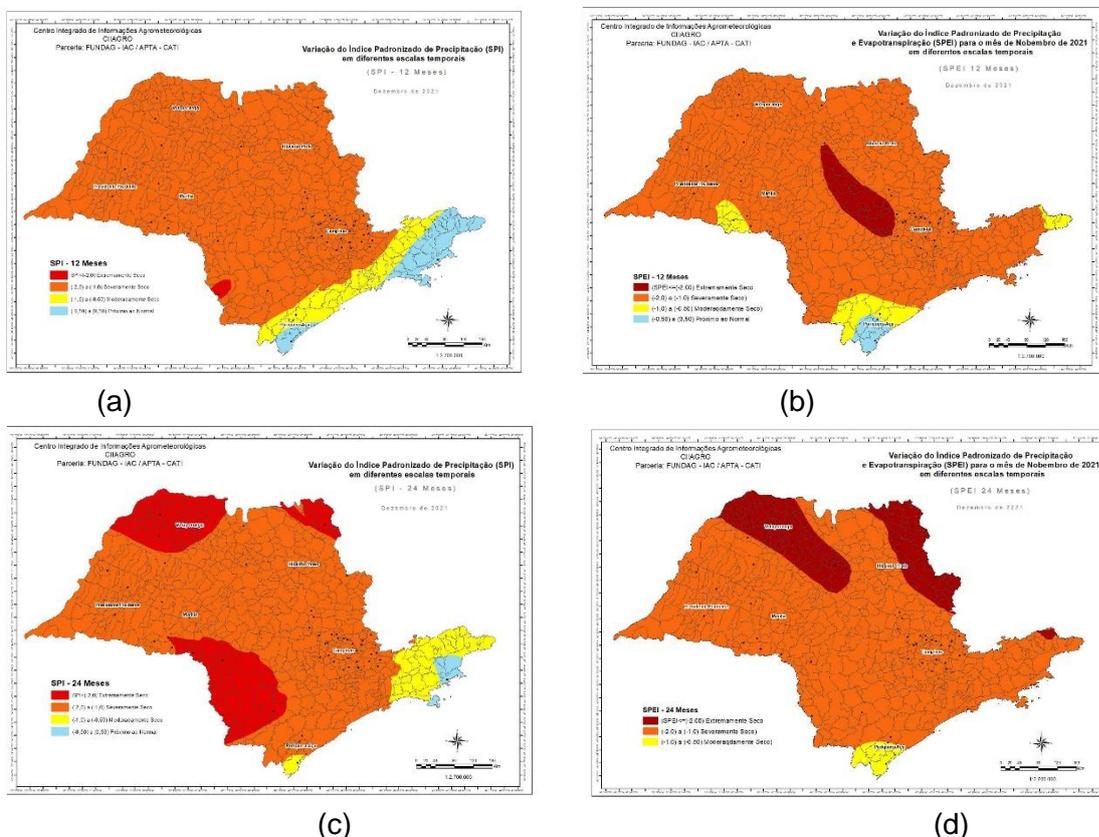


**Figure 3** – Spatial variation of (a) SPI, and (b) SPEI, both referring to the month of December 2021 on a monthly scale.

### 3.2. Annual and biennial scale

The months from November to December are characterized as wet months, where only a high volume of precipitation can indicate humid climatic conditions, but that do not necessarily reflect the current state of soil water storage, and the conditions in the reservoirs and even the need for human, animal and irrigation supplies. Crop water need, without even considering the need for energy generation. The Standardized Precipitation Index (SPI) and the Standardized Precipitation and Evapotranspiration Index (SPEI) can, in a certain way, be used for hydrological considerations when used on longer time scales, such as 12 and 24 months, being of great importance for the evaluation of the climate risk of the present time and, later, of the vulnerability to climate change, thus serving as planning elements. The characteristics of water stress by SPEI follow similar patterns to the SPI (**Figure 4**). The SPEI also incorporates evapotranspiration, which in a way accounts for the water that actually becomes available to the system, as it considers precipitation, minus what is removed from the system by evapotranspiration. The current analysis indicates a reasonable recovery of water conditions, corroborating the analysis of figures 1 and 2.

However, on a biennial time scale, drought conditions are maintained for almost the entire state when considering the periods of one and two years combined with evapotranspiration (SPEI), attributing a high overload in the use of water resources, in particular the use of irrigation. Such maps demonstrate the current stage in which São Paulo reservoirs are still found.



**Figure 4**– Spatial variation of (a) SPI, and (b) SPEI, on an annual scale, and of (c) SPI, and (d) SPEI, on a biennial scale, all referring to the month of December 2021.

### 4. Conclusions

In December 2021, there was high rainfall throughout the State, as shown in **figure 1**. This analysis can be verified by the graphs of the water balance on a ten-day basis (**Figure 5**), for some locations. It is observed that **after a** long period of drought (**except for Ribeirão Preto**), there is a significant improvement in soil moisture conditions, indicated by the absence of water deficit favoring summer crops

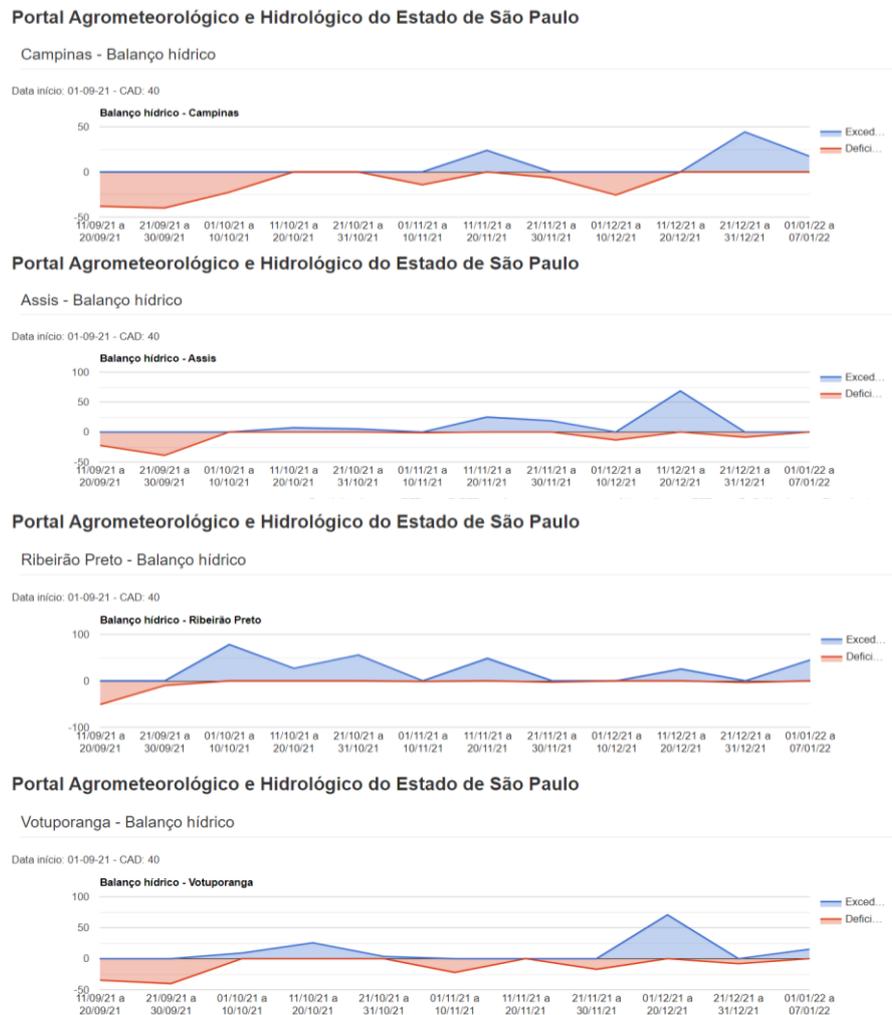


Figure 5-Estimation of soil water deficit, from September to December 2021, considering a maximum available water depth in the soil of 40mm up to the average depth of rooting system roots.