



**1. INTRODUCTION AND OBJECTIVES**

The increase in the accuracy of observations from satellite geodesy techniques (e.g. GNSS, SLR, VLBI, etc.), has allowed the detection of temporal deformations of the crust associated with different phenomena at the level of millimeters (BEVIS et al, 2003). The loading by water bodies is an example of the deflection of the crust around the affected region. The objective of the present research is to analyze the correlation between the vertical crustal deformation obtained from four GNSS stations around the reservoir of the ITAIPU Hydroelectric Power Plant, and the variations in the water level of the plant..

**2. METHODOLOGY**

First, weekly solutions of the Up component of GNSS stations belonging to the SIRGAS-CON network (SIRGAS, 2021) were acquired closer to the ITAIPU reservoir, namely: ITAI, PRCV, PRUR e SVIC (table 1). Daily data of the reservoir quota was also acquired through the ONS (Operador Nacional do Sistema Elétrico). Both data were collected for the period from January 2019 to July 2021. The GNSS series leaps by antenna switching were estimated and removed based on the trajectory model proposed by Bevis e Brown (2014). A cubic convolution interpolation process was carried out on the GNSS data. In order to obtain daily altitude data, a mobile mean was also made over a 30-day period to make the data resolutions consistent with each other. These processes were made using MATLAB software.

Station	Latitude (degrees)	Longitude (degrees)	Distance (km)
ITAI	-25.421	-54.588	1
PRCV	-24.963	-53.466	125
SVIC	-26.994	-54.488	176
PRUR	-23.806	-53.321	222

Figure 1: Distances between stations and the reservoir.

**3. RESULTS AND DISCUSSION**

The results obtained indicate a high inverse correlation between the vertical variations of the GNSS and the quotas, this situation can be observed in figures 1, 2, 3 e 4. When the water levels increase, the crust subsides due to the loading. The PRUR station ( $\rho=-0,73$ ) has a strong correlation, the ITAI ( $\rho=-0,59$ ), PRCV ( $\rho=-0,58$ ) stations have a good correlation, and the SVIC station ( $\rho=-0,43$ ) has a moderate correlation.

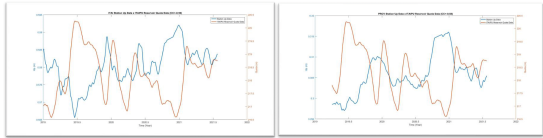


Figure 1: Station ITAI

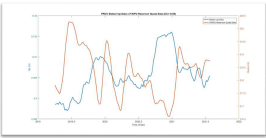


Figure 2: Station PRCV

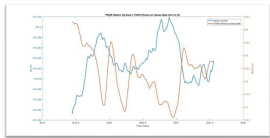


Figure 3: Station PRUR

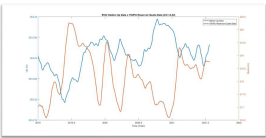


Figure 4: Station SVIC

In order to investigate whether the low correlation in 2020 was related to the strong drought that occurred in Paraná during this period, the daily data of the reservoir quota were correlated with rainfall data obtained by Foz do Iguaçu meteorological station of SIMEPAR (Sistema de Tecnologia e Monitoramento Ambiental do Paraná). Finally, a weak inverse correlation of approximately -0.33 was reached, indicating that the year 2020 has another influencing factor to be investigated in the future.

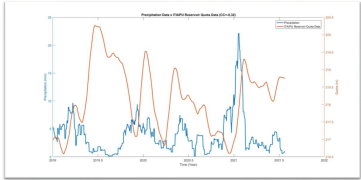


Figure 5: Precipitation Analysis

**4. CONCLUSIONS**

The stations obtained satisfactory inverse correlation values with the hypothesis of the present work. Regarding the graphs, it is evident that the least correlated period is in the first half of 2020 for all stations, and it is recommended that more detailed future studies be carried out in this period.

Furthermore, the hypothesis that the drought in the year 2020 is related to the weak correlation found in this period did not obtain satisfactory results ( $\rho=-0,33$ ).

ITAI station, due to the fact that it is very close to the reservoir (approximately 1 km), is susceptible to a greater hydrological signal from it compared to stations further away. The PRUR station, despite being further away, had the highest correlation in agreement with the hypothesis of this research, and it can also be used for more detailed future studies.

**References**

BEVIS, M. et al. *Geodetic measurement of the local elastic response to the changing mass of water in lago Laja, Chile*. Elsevier, 2003.

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