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Magnitude of shoreline retreat in the Itaipu Reservoir (Brazil-Paraguay border region) from 1984 to 2016

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The Itaipu reservoir had been established in 1984 on the Parana River, along the Brazil-Paraguay border region. The reservoir has a total length of 181 km, mean width of 7 km, the capacity exceeds 29,109 m³ while the coastline covers 2,919 km. In the reservoir area, Serra Geral Basalt Group, a Cretaceous age continental flood basalt flow outcrops exist, that formed a plateau (220-725 m a.s.l.). The predominant chemical weathering in basalt resulted deep soil layers with abundant clay content (> 80%).

The objective of the present work was to estimate the rate of retreat around reservoir margins at 5 erosion stations in the Brazilian margin from the formation of the reservoir (1984) to 2016, by cartographic methods (1984-1992), direct field measurements based on erosion pins (1993-1995) and Google Earth imagery (2002-2016).

Cartographic methods were used to compare shoreline positions of the reservoir in 1984 and 1993 delimited in an orthophotograph (scale 1:10,000) elaborated by Itaipu Binacional. The initial margin line of the reservoir on the base map was adopted as the average reservoir operation level (200 m a.s.l.) reached in 1984. The shoreline for the year 1993 was defined by adding the level of the reservoir with the height of the bank measured in the field.

Steep cut banks with slump blocks are present along most of the shoreline. Retreat of coast is controlled by wave activity in lower portion of bank and by cohesive and tensile strength of the soil in the upper portion of bank.

Five erosion stations had been under monitoring, 3 of them are located in headlands (stations 1, 4 and 5) and the others (points 2 and 3) were installed in embayment zones of the lake. The mean bank heights measured in the field is 1.6 m, varying from 1.11 m (station 5) to 2.50 m (station 4). The total retreat of the margin line quantified by the 3 techniques between 1984 and 2016 was 42.9 m (station 1), 38.9 m (station 2), 28.6 m (station 3), 92.9 m (station 4) and 42.5 m (station 5). The erosion rate in the first 8 years after the reservoir was created, shows that 54 to 75% of the total retreat of the margin was recorded in this period. It is worth mentioning that the banks of the lake were reforested along the entire edge of the reservoir in a strip 210 m wide. Reforestation was necessary to protect the banks since much of the banks of the newly formed lake.

Erosion rates ranged from 0.89 to 1.33 m/y at most stations monitored. These values could have been higher if the soils did not have the low erodibility of the basalt residual soils (Oxisols and Ultisols) and the low height of the banks. The exception was station 4 that presents the highest erosion rate (2.9 m/y) conditioned by the highest height of the margin and its position in the headlands where the impacts of the waves have a greater erosive potential.