Mass fish mortality events: a (novel?) threat to hydropower in tropical systems

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ABSTRACT: Fish mortality events at hydropower plants are a known phenomenon and can be associated with various mechanisms including water quality and flow alterations downstream of the dam and fish interaction with structures such as turbines and/or spillways. In the Neotropical region, a recent study demonstrated that mass mortality events are likely more common at hydropower plants than hitherto thought, posing questions about the extent of knowledge to understand the mechanisms leading to such events and the ability to provide informed management decisions to mitigate the problem and avoid future problems by modifying infrastructure design.

To shed light in this scenario, this study builds up on a unique case from Sinop Dam located at the Teles Pires River, Central-West region in Brazil. Sinop Dam started operation in the Teles Pires River in February 2019 with reservoir filling. During that process, the spillways were opened to ensure downstream flows and fish kills started to occur immediately downstream, with several mortality events registered in almost a daily basis for several months, and with other sporadic events occurring over a 18 month period (February 2019 to August 2020). Given the magnitude of the fish kills, an expert panel was assembled to investigate the mortality events: both their causes and potential mitigation solutions. This study aimed to identify the main factors likely associated with mortality, quantify the biomass as well as the diversity of fish groups and species affected.

In total, tonnes of fish died downstream of Sinop Dam during the study period affecting 87 species. The period with the highest mortality affected 43% of the total biomass of dead fish collected and over 65 species, whereas the lowest mortality involved 6% of the total dead biomass and 27 species. Statistical modelling using the General Linear Mixed-Effects Models (GLMM) approach showed that most of the mortality events were linked to a rapid increase in spillway discharge, promoting gas supersaturation above lethal thresholds for fish. Also, at specific conditions the interaction of fish with the turbines were deemed to be the cause of mortality, likely because of fish entrainment into the draft tubes during operation with the downstream stop log.

These results contributed to the identification of management solutions to mitigate fish mortality at Sinop Dam, particularly with recommendations to spillway operation and design modifications. Following spillway operation modifications, no further mass mortality events have been recorded. However, such operational measures are constraining, and design modifications are being studied. As a result, an ambitious ecological and technical research program on supersaturation effects on neotropical fish and spillway design is currently underway.