QUANTIFYING THE CUMULATIVE EFFECTS OF CLIMATE CHANGE, UPSTREAM DEVELOPMENT, AND LARGE DAMS ON HYDROLOGY AND SEDIMENT FLUX IN THE MADEIRA RIVER, THE AMAZON'S LARGEST TRIBUTARY

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The Madeira River contributes up to half the sediment load to the Amazon, which has extensive global social and ecological importance. Until recently, basin-wide sediment dynamics and river geomorphology have not been well quantified due to data scarcity. As the Madeira region continues to develop, understanding these dynamics is paramount. In the last decade, two mega, hydroelectric "run-of-the-river" (ROR) dams were installed along the Madeira River. ROR reservoirs are expected to quickly fill up with sediments and stabilize to a dynamic equilibrium. However, this depositional expectation may not hold along large, tropical rivers with high and historically sparse sediment load estimations. Here the uncertainty of present and future Madeira Hydroelectric Complex (MHC) sedimentation is rigorously reassessed using the dam companies' monitoring data, data collected on an independent field campaign, and a sediment transport model. First, the recent field data are synthesized with relevant data from the literature. The synthesized data and model structure uncertainties are then tracked through a model sensitivity analysis to identify the model´s parameter uncertainties. Modeling of sedimentation is done for both present and future climatic conditions. Results show that there is considerable variability and uncertainty in estimated annual sediment load (250-715Mt/yr) and gradations. The initial bed material input data, riverbed roughness coefficient, and critical shear stress are expected to be the main sources of uncertainty of reservoir sedimentation estimations to-date and into the future. Pre-dam estimations of reservoir sedimentation predicted the need for sediment management after 20-30 years. Due to an extreme flood event (300-year return period), observations have shown sediment has already exceeded the intake elevation, requiring early sediment management and operational guideline changes. This highlights the importance of reducing uncertainty of sediment transport predictions by improving discharge and sediment load forecasts through continued sediment monitoring and consideration of basin-wide development and climate change projections.