Macroinvertebrate assemblages and functional traits in ashfall-impacted littoral zones of Lake Taal after the Taal volcano eruption in January 2020

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ABSTRACT

Natural disturbances such as volcanic eruptions can drastically alter the abiotic and biotic components of freshwater ecosystems. However, limited limnological post-eruption studies are being done in the tropics despite the geologically active nature of several states, such as the Philippines. The recent major unrest of the Taal Volcano last January 2020 offers a unique opportunity to assess the abiotic and biotic condition of tephra-impacted Lake Taal. Here, the study is the first post-eruption survey of macroinvertebrate communities and their functional trait diversity in the littoral zone of Lake Taal. Macroinvertebrates have been extensively used for biological monitoring and assessment. Their composition is also closely linked to pollution and habitat degradation. In contrast, functional traits can determine the effects of environmental perturbations and the distribution of resources across different spatial and temporal scales.

The study aimed to determine Lake Taal's post-eruption littoral macroinvertebrate communities in two areas that differ in ashfall loadings: high ashfall (HAS) and low ashfall (LAS) sites. Furthermore, the study examined and compared the macroinvertebrate taxa richness, diversity, community structure, and functional diversity between two locations and analyzed the relationship between littoral macroinvertebrate taxa, functional traits, and environmental variables. Field survey was done last October-November 2021 in 10 littoral sites (five HAS; five LAS). Macroinvertebrates were collected in the vegetation and sediment at two depths (1 m and 5 m). At the same time, water quality parameters were measured in-situ and ex-situ only in 5 m (i.e. subsurface and bottom). Sediments for particle size determination were also collected in the same depths.

Water quality parameters for tephra deposition, silica ($p < 0.001$), turbidity ($p < 0.001$), and color ($p < 0.001$) were markedly higher in HAS. While dissolved oxygen ($p = 0.039$) and pH ($p < 0.001$) were statistically higher in LAS. Macroinvertebrate abundance ($p = 0.035$) was also significantly higher in LAS. HAS is more taxonomically diverse ($p = 0.017$) than LAS. However, overall macroinvertebrate assemblage between HAS and LAS was not different due to the dominance of *Austrochiltonia* spp. and other tolerant taxa in both sites. Interestingly, the relationship between macroinvertebrate taxonomic structure to environmental variables (Model 2; $p = 0.032$) and functional traits (Model 4; $p = 0.015$) has shown significant differences in HAS and LAS. Macroinvertebrate associated traits with HAS, silica, and phosphate were piercer, terrestrial oviposition, hydrostatic vesicle, swimmer, and climber. While clinger, ovoviviparity, parasite, crawler, hermaphroditism, and hard-shell traits were linked to LAS and were associated with pH and dissolved oxygen. Among the 62 functional trait categories, 24 significantly correlated ($p < 0.05$) with nine environmental variables.

Despite these findings, the low diversity of macroinvertebrates, high levels of phosphate, and similar sediment composition may be due to the surrounding land use in the study areas, farming and fish cage operations on the northwest side of the lake, and the recent major eruption and continued activity of Taal Volcano. This study presents the need for continued monitoring of the littoral assemblages of macroinvertebrates, their functional diversity, and environmental variables to determine the post-eruption recovery of the lake's littoral zone. Moreover, the restoration of the watershed and shoreline of Lake Taal and regulation of fish cage operations in the lake should also be a prime agenda of every local government unit, relevant national government agencies, and the local community to promote

sustainable utilization of the lake's resources and ecosystem services. Lastly, there is an urgent need for further studies on our inland water's ecology and taxonomy to conserve, manage and sustainably use our freshwater systems.

Keywords: Post-eruption biodiversity, land use, tropical lake, littoral zone, functional diversity