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Water Quality Deterioration and its Linkage with Water Hyacinth Expansion in Lake Tana, Ethiopia

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Abstract

Lake Tana is located in northwest Ethiopian highlands where intensive and traditional agricultural practice is dominant. The lake receives point and non-point sources pollutants from the surrounding cities and agricultural fields and its Trophic Status Index is shifting from mesotrophic to eutrophic condition. This condition of the lake favours the expansion of invasive aquatic species like water hyacinth which is one of the world's worst invasive weeds. The aim of this study was to evaluate the linkage between lake water quality, lake level and water hyacinth expansion on Lake Tana. To see the relation between water quality and the expansion of water hyacinth, water quality data such as total phosphorus (TP), total nitrogen (TN), chlorophyll-a (Chl-a), Secchi Disc Depth (SDD), salinity, pH and temperature were collected on the lake at 143 and 27 sampling sites in the entire lake and along the shore of the lake for the period of 2016-2020. In addition, lake depth and lake level data were collected from secondary sources. The area covered by water hyacinth was determined using monthly Sentinel-2 images, which were collected from November 2015 to December 2019 through the application of Google Earth Engine Platform. The maximum areas covered by water hyacinth were in the range of 278.3 - 2504.5 ha. The mean monthly lake-level fluctuation was observed in the range of 1.5 to 3.98 m in this study. The values of TP, TN, Chl-a and SDD were found in the range of 0.07-2.39 mg. L^{-1}, 0.32-5.88 mg. L^{-1}, 0.28-104.15 µg. L^{-1} and 0.09-1.25 m, respectively. Average estimated amount of 40.27 – 1374.83 t. yr^{-1} TP, and 184.1 – 3382.42 t. yr^{-1} TN might be delivered into the lake by rivers. Except TP, the value of all parameters was decreasing but statistically insignificant. The major source of TP and TN was found to be the internal and external loading, respectively. The value of TP, TN in water hyacinth covered areas was higher than other parts of the lake but Chl-a and SDD were low. The results of multi-criteria analysis indicated that from 21,568.7 ha - 30,728.4 ha of the lake is susceptible to invasion by the water hyacinth. According to the result of this study, the north and north-eastern parts of the lake are highly susceptible for invasion. Control on wastewater and nutrient discharge to rivers and Lake Tana should be part of the larger plan to control the water hyacinth in the lake. Improved watershed management, on-

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farm nutrient management, buffer zone delineation and protection need to be part of the effort in reducing nutrient loading. Re-evaluation of Chara-Chara weir operation needs special attention from hydrology and water quality point of view.

Keywords: Lake Tana, Water hyacinth, Water quality, Sentinel-2, Phosphates, Nitrates