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# Macrophytes with Phytoremediation Potential

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## Abstract

Macrophytes can remove and degrade pollutants in soil and water which basically refers to phytoremediation. The objective of this study was to identify locally growing macrophyte species in Cagayan de Oro (CDO) city and determine abundance. Quadrat method was used and a plant expert was consulted. Eighteen plant species were identified and the 5 most abundant were: *Brachiaria mutica*, *Ipomoeae triloba*, *Ipomoeae aquatica*, *Commelina diffusa* and *Panicum maximum*. Various literatures have reported scientific evidences on the capacity of the species to absorb and accumulate metals and pollutants present in soil or water. In conclusion, CDO has a number of macrophytes with phytoremediation potential for wastewater treatment.

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## Introduction

Sixty-eight percent of the global population is projected to live in urban areas by 2050 (United Nations, 2018). As the number of people increases, waste production including volume of wastewater also increases. Untreated wastewater contains high concentration of pollutants coming from ordinary household processes (i.e. bathing, laundry, dishwashing, etc.) as well as from commercial and industrial establishments which are simply discharged to canals eventually ending up in water bodies. This remains a common practice especially in developing countries due to lacking infrastructure for wastewater treatment.

Phytoremediation consists of four different plant-based technologies that include rhizofiltration, which uses plants to clean various aquatic environments; phytostabilization, where plants stabilize rather than clean contaminated soil; phytovolatilization, where plants extract metals from soil and release them to the atmosphere; and phytoextraction, where plants absorb metals from soil and translocate them to the shoots where they accumulate (Setia *et al.*, 2008; Chatterjee *et al.*, 2013;).

Macrophytes are aquatic plants growing in or near water and they have significant capacity to uptake nutrients and other substances from their growth medium thus lowering pollution concentration of a target water body (Dhote and Dixit, 2009). They may be emergent (i.e. with upright portions above the water surface), submerged or floating (USEPA). Emergent and floating macrophytes primarily take up nutrients and other contaminants through their roots (Gabrielson *et al.*, 1984). Specific mechanisms for pollutant removal and degradation by macrophytes depend primarily on the type of pollutant (nutrient, heavy metals, organic pollutants) and the location of the contaminant within the surface water body (Xing *et al.*, 2013; McAndrew *et al.*, 2016).

Wastewater treatment facilities are too costly so they are not easily available in most countries (USEPA). Absence of such facilities in highly urbanized areas like CDO (the major city in Northern Mindanao, Philippines) can seriously damage aquatic ecosystem and poses great threat to human health. Low-cost technologies such as constructed wetland and the use of the phytoremediation technique should be adapted particularly in tropical regions. The main objective of this study was to identify species of locally growing macrophytes along canals in the downtown area of CDO and determine which species are abundant.

## Materials and methods

The first step was to locate main canals with considerable number of existing plants based on visual observation. Only the downtown area was used since it is where most wastewater pass. The Quadrat method was used in determining the abundance of species. Both sides of the canal were sampled. On each side, there were 5 sampling points with 2 meter distance between points. Sampling was done using a wooden frame (1 meter x 1 meter) with 100 sub-plots (with equal size) formed by strings. In each sampling point, the wooden frame was placed and all the plants found within were identified and counted. A plant expert was consulted for plant identification.

Abundance refers to the number of plant species in a community. Abundance and frequency are important in determining the community structure. Abundance of any individual species is expressed as a percentage of the total number of species present in a community and therefore it is a relative measure.

Abundance is computed as the total number of individual species divided by the number of quadrats in which they occur. The result was multiplied by 100.

## Results and discussion

Nine canals were used as sampling sites located in the following areas: Kulambog, JR Borja extension, Gusa Galaxy road, Bitan-ag creek, Kauswagan, Sapang Creek and Iponan. These sites were found to have a number of plants growing along their vicinities. A total of 18 macrophyte species were identified (Table 1) and the top 5 species in terms of abundance were: *B. mutica*, *I. triloba*, *I. aquatica*, *C. diffusa* and *P.*

*maximum*. *P. maximum* is a densely clump-forming, perennial grass with erect or ascending culms. It often has shortly-creeping rhizomes at the base and can also produce new roots at the lower nodes of the culms. It was found to be very effective in removing heavy metals and radionuclides from contaminated water (Dushenkov *et al.*, 1997; Roongtanakiat *et al.,* 2010). *P. maximum* accumulated more Nickel and Lead and its phytoextraction potential according to the level of soil contamination can be a phytotechnology for polluted soils remediating (Coulibaly *et al.,* 2020). Accumulation of heavy metals in *P. maximum* ranges in the following: 13-45% Lead, 13-65% Chromium and 11-52% Cadmium of the soil concentration level (Olatunji *et al.*, 2014). Using *P. maximum*, bioaccumulation factors of trace metals were 8.93 (Lead), 8.47 (Nickel) and 3.37 (Cadmium) where Nickel was more accumulated in shoot biomass, while Lead and Cadmium were concentrated in root biomass (Coulibaly *et al.,* 2021).

**Table 1.** Relative abundance of macrophytes found within the sampling sites.

| Sl.No | Common Name | Scientific Narne | Total Number of | Relative Abundance |
|---|---|---|---|---|
| 1 | Para Grass | *Brachiaria mutica* | 584 | 26.4 |
| 2 | Little Bell | *Ipomoea triloba* | 312 | 14.1 |
| 3 | Water Spinach | *Ipomoea aquatica* | 450 | 20.3 |
| 4 | Climbing Dayflower | *Commelina diffusa* | 232 | 10.5 |
| 5 | Guinea Grass | *Panicum maximum* | 149 | 6.7 |
| 6 | False Daisy | *Eclipta prostata* | 12 | 0.5 |
| 7 | Fuzzy Flat Sedge | *Cyperus pilosus* | 21 | 0.9 |
| 8 | Sessile Joyweed | *Altenathera sessilis* | 10 | 0.5 |
| 9 | Annual Sedge | *Cyprus compressus* | 5 | 0.2 |
| 10 | Napier Grass | *Pennisetum urpureum* | 9 | 0.4 |
| 11 | Rice Flat Sedge | *Cyperus iria* | 58 | 0.1 |
| 12 | Linear-leaf Water Primrose | *Ludwigia hyssopifolia* | 8 | 0.4 |
| 13 | Bullet Grass | *Panicum repens* | 16 | 0.7 |
| 14 | Natal Grass | *Melinis repens* | 22 | 1.0 |
| 15 | Nut Grass | *Cyperus rotundus* | 57 | 2.6 |
| 16 | Whorled Pennywort | *Hydrocotyle verticillata* | 27 | 1.2 |
| 17 | Bahama Grass | *Cynodon dactylon* | 123 | 5.6 |
| 18 | Gaping Swamp Weeds | *Hydrophila ringens* | 8 | 0. 4 |

*I. aquatica* or water spinach is a semi-aquatic, tropical plant grown as a vegetable for its tender shoots. It grows in water or on moist soil. Its stems are 2–3 meters or longer and they are hollow and can float. Phytoremediation using *I. aquatica* can improve the quality of Palm Oil Mill Effluent which contains high amount of chemical oxygen demand, Nitrate and Phosphate (Hanafiah *et al.,* 2020). The same study also stated that *I. aquatica* accumulates higher Aluminium and Iron contents with translocation factor greater than 1 implying that this can accumulate and extract heavy metals from industrial wastewater. The Chromium and Manganese removal efficiencies of *I. aquatica* increased with increasing Chromium or Manganese concentrations in the medium with the potential to effectively remove the metals within a relatively short period of time, thereby raising the prospect of the plant's use in phytoremediation of wastewater (Haokip and Gupta, 2020). The highest accumulation of Lead and Chromium in *I. aqautica* was recorded at 0.1587 and 0.2167 milligram per liter respectively (Suherman *et al.*, 2021) and the plant has been also recommended for the phytoremediation of Cadmium-contaminated soil (Borines *et al.*, 2019).

*B. mutica* is an evergreen, perennial grass spreading freely from a vigorous, stoloniferous rootstock to form a colony of culms 100 – 200 centimeter tall. The stout culms have a trailing habit, they often root at the lower nodes. It thrives in swampy and wet places such as marshes, rice fields, ditches and riversides. It is a salt-tolerant grass species that showed considerable Cadmium-accumulating potential with an accumulation of more than 150 milligram per kilogram of shoot dry matter at a higher level of Cadmium-contamination (25 milligram per liter) (Ullah *et al.,* 2019). *B. mutica* showed 92, 95 and 95% Lead removal from the 10, 20 and 30 milligram per liter Lead solutions and it is recommended that it can be efficiently used in low-cost phytoremediation process for removal of Lead metal (Kumar *et al*., 2020).

*I. triloba* plant species are suggested to be possible indigenous phytoaccumulators for landfill (Messou *et al.,* 2013) while *C. diffusa* is a good candidate as phytoextractor of Copper contaminated soils in low and high concentration (Garcia *et al*., 2019). The capacities of these plants to absorb heavy metals and other pollutants in soil and water are extremely useful in the preservation and conservation of our environment. The lack of actions in providing simple remedies to address the increasing accumulation of pollutants in water bodies will surely end up causing devastating effects which might become uncontrollable in the long run. Just like solid wastes coming from the households which are handled by the local government on a daily basis in terms of collection and disposal, wastewater treatment must also be included in their agenda. Authorities must come up with clear methodologies and multi-disciplinary approaches of program implementation in handling wastewater disposal and treatment. Urban planners and decision makers should take note that in aiming for progress and development, strategies must be designed in a holistic manner to ensure that all aspects that are linked with human health and environmental protection are covered to attain sustainable development.

## Conclusion

Macrophytes with phytoremediation potential are abundant in CDO. Appropriate technologies must be created and applied in specific localities considering adaptability measures in order to realize the maximum use of the plants in remediating pollutants most critically in water. Especially in urban areas where population is increasing in a faster rate, implementing such measures in treating wastewater will have a huge impact in the preservation and conservation of the water ecosystem.

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