

The Use of Aquatic Macrophytes in the Bioremediation of the Casqueiro and Cubatão Rivers, Cubatão, SP

*¹Manoella Almeida Candido, ²Ronaldo José Torres, ³Sidney Fernandes

*¹Graduate Student, Department of Engineering, Federal University of Pernambuco, UFPE, Brazil.

²Professor, Department of Marine Sciences, Federal University of São Paulo, UNIFESP, Brazil.

³Professor, Department of Life Science, Paulista University Sao Paulo, UNIP, Brazil.

Abstract

The study was carried out in the municipality of Cubatão, Baixada Santista, São Paulo, in the Casqueiro and Cubatão rivers. Three aquatic macrophyte species were used: water hyacinth (*Eichhornia crassipes*), lettuce (*Pistia stratiotes*) and Salvinia (*Salvinia auriculata*). The use of plants is to observe their ability to bioabsorb toxic chemicals present in the water, serving as bioaccumulation of toxins that cause damage to the species present in the hydric body and people who use. Some way these water bodies, since it is observed the use of these rivers as a source of obtaining food resources and recreation. The search for environmental recovery of these rivers is one of the tasks of this work, rivers that over the years were being destroyed by the addition of domestic and industrial effluents. It is known that many aquatic macrophytes have the power to bioabsorb toxic substances, whether with this study, to observe how much they can absorb and what would be the best species to use in the treatment of water, or if equivalence occurs in the power of bioremediation of a degraded environment. These species are being used due to the ease of finding the same in the water bodies of the Baixada Santista, are being sampled from Lagoa da Saudade, Morro da Nova Cintra, Santos, in this location there is an abundance of these species, facilitating the Sampling. The plants were stored in plastic boxes with water from the rivers under study. Therefore this project helped to understand how much the environment itself can recover without intervention in fact of man who in the use of these 3 (three) species of plants we can in future recover both rivers and back bring aquatic life Diversified that inhabited it, we know that it is an intense work o but that with the help of the correct macrophyte for both rivers we can see good results before the rivers Casqueiro and Cubatão.

Keywords: Aquatic macrophytes, Casqueiro River, Cubatão River

Introduction

The study aimed to use aquatic macrophytes in the bioremediation process of the Casqueiro and Cubatão Rivers, located in the municipality of Cubatão, which belongs to the Baixada Santista Metropolitan Region, seeking to recover the rivers through aquatic macrophytes as biological models. The anthropic alteration observed over the years, mainly in the 70's and 80's, where the industrial expansion took place in Cubatão, directly affected the local water bodies and the surrounding environment. The city of Cubatão has an area of 142,879 km² and an estimated population of 132,521 inhabitants according to the IBGE in 2021. The region's climate is humid subtropical (Cfa) with an annual average between 18-25°C. Among the species found in the vicinity of the rivers, it is possible to observe: green turtles, broad-snouted caimans, guarás, imperial herons, irerê, shin-huggers, socós, herons, blue herons, spoonbills, cormorants, curlews, batuíra, gulls, osprey, skimmer, tern, peregrine falcon, harpy eagle, black hawk, crab hawk, grebe, maguari, raccoon and capybara. Among the local flora, there are juçara palm hearts, shrub palms, ferns, nettles, tilandsia, heliconia and manacá-da-serra. Search for the recovery of rivers, making them usable for both the local population and the species that need it for drinking water or to nest in it. The suppression of

aquatic ecosystems in the region and predatory exploitation are concerns, leading us to carry out this project.

Methods

During the study, an attempt was made to carry out the most comprehensive sampling in a coverage as uniform as possible, with materials that present a representation of the degree of pollution to which the rivers are. Seasonal studies will be carried out in order to observe the environmental influence on the distribution of pollutants. The area covered by this study was the municipality of Cubatão, located in the metropolitan region of Baixada Santista, State of São Paulo and composed of 9 (nine) municipalities. According to Ross (2003), the region has a subtropical climate. An attempt was made to cover the geographic area as far as possible and as uniformly as possible.

Material Studied

Three species of aquatic macrophytes were used: water hyacinth (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes*) and salvinia (*Salvinia auriculata*). During the sampling, materials from the most diverse points along the rivers were sampled, in a coverage as uniform as possible and to the materials an equivalent representation with regard to habitats. The following masses were obtained: 102.8 mg of

water lettuce; 100.2 mg salvinia; 100.9 mg of water hyacinth from the Casqueiro river and 101.8 mg of water lettuce; 100.4 mg of salvinia; 101.3 mg of water hyacinth from the Cubatão river.

Material Sampling

Manual sampling was carried out along the course of the rivers in order to assess the degree of anthropization and water contamination.



Fig 1: Cubatão river sampling site.



Fig 2: Casqueiro river sampling site.

Preservation and Preparation of Material for Observation

The preservation of the materials was provided immediately after sampling, still in the field, in plastic bottles, stored in styrofoam boxes. Immediate fixation prevents the rate of decomposition from compromising the results. After 30 days of storage of the plants in polypropylene boxes with water from the Casqueiro and Cubatão rivers, the plants are placed for drying in an oven at 50°C for 48 h. Once the material was dry, it was macerated using a mortar and pestle, 200 mg of the powdered macerate was separated in a plastic tube, eppendorf type. Triton® and Gallium (standard) were added in 5 mL tubes. Twelve tubes were separated due to replication, the samples were placed in the tubes and weighed, 2 mL of 1% Triton X-100, 10 µL of Gallium and 10 µL of silicone were added.



Fig 5: Preparation for drying the material.



Fig 6: Maceration of macrophytes for analysis.

Material Analysis

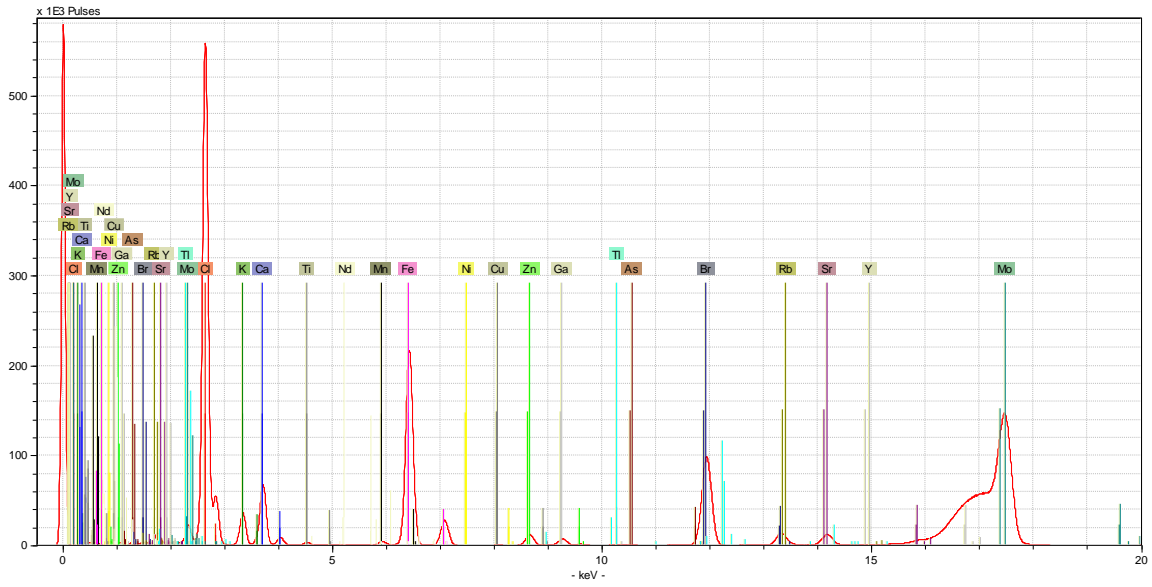
The material was analyzed using the equipment called TXRF- Total X-Ray Reflection Fluorescence, belonging to the Department of Marine Sciences-UNIFESP, Baixada Santista campus.

Description of Chemical Elements

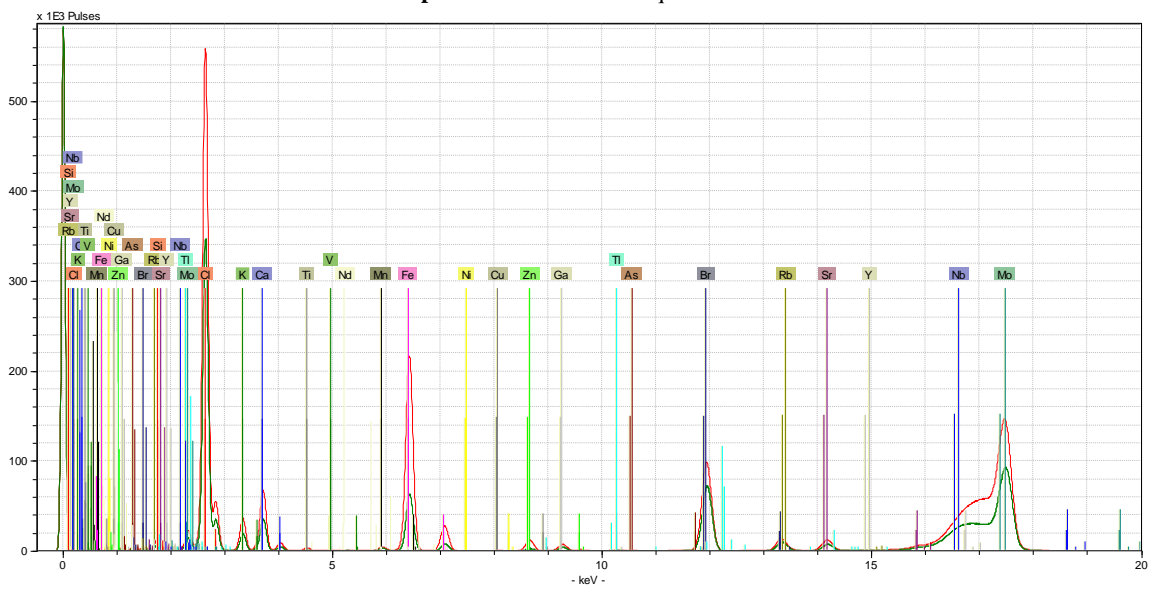
The description of each chemical element in the examined materials was based on specialized literature and with the aid of X-ray fluorescence equipment, helping to identify the contaminating element or not in aquatic macrophytes.

Results and Discussion

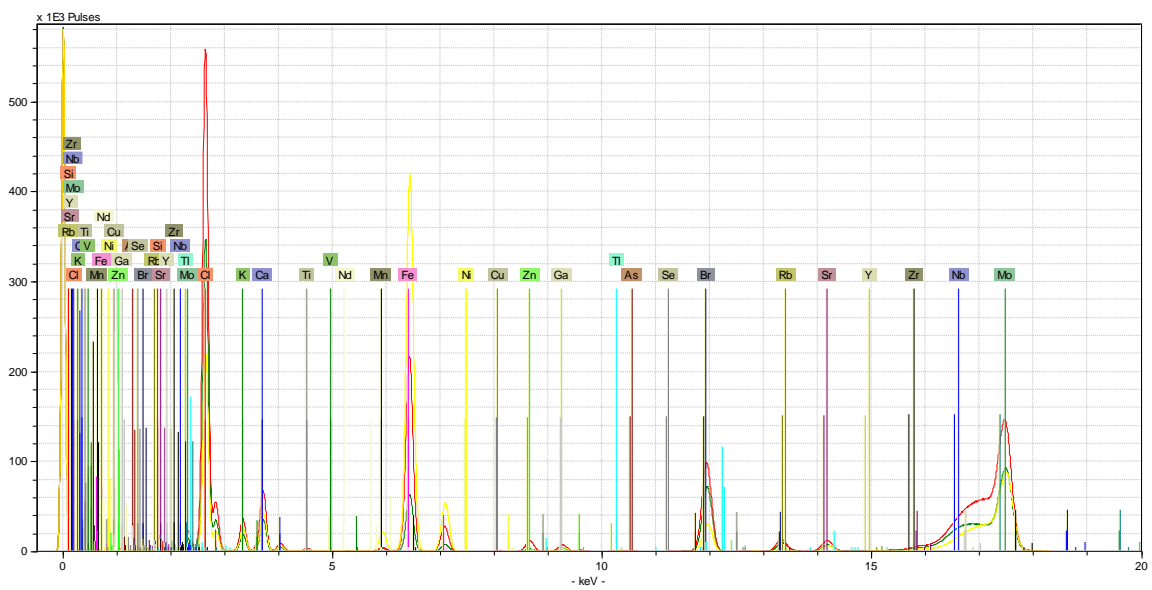
Through a first analysis of the dry material, the concentrations described in graphs 1-6 were obtained. The concentration of elements and/or chemical substances in aquatic macrophytes will serve as indicators of pollutants and probably new contributions to science, since so far, no study on the subject has been carried out in the municipality. Through this information, it will be possible to have subsidies for long-term ecological studies in the sense of local preservation.



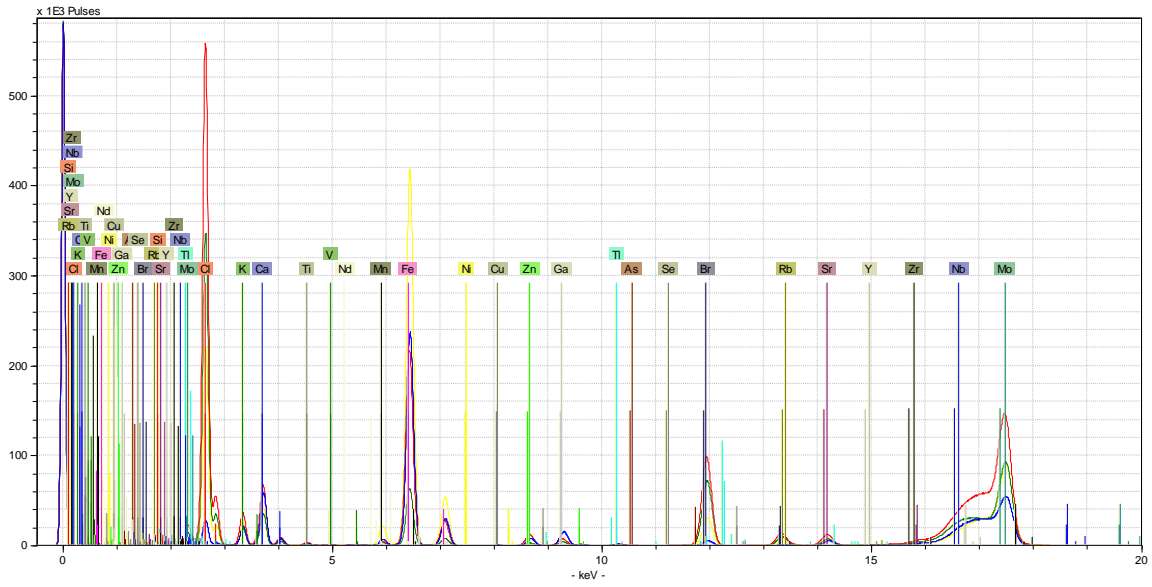
Graph 1: Water lettuce-Casqueiro river.



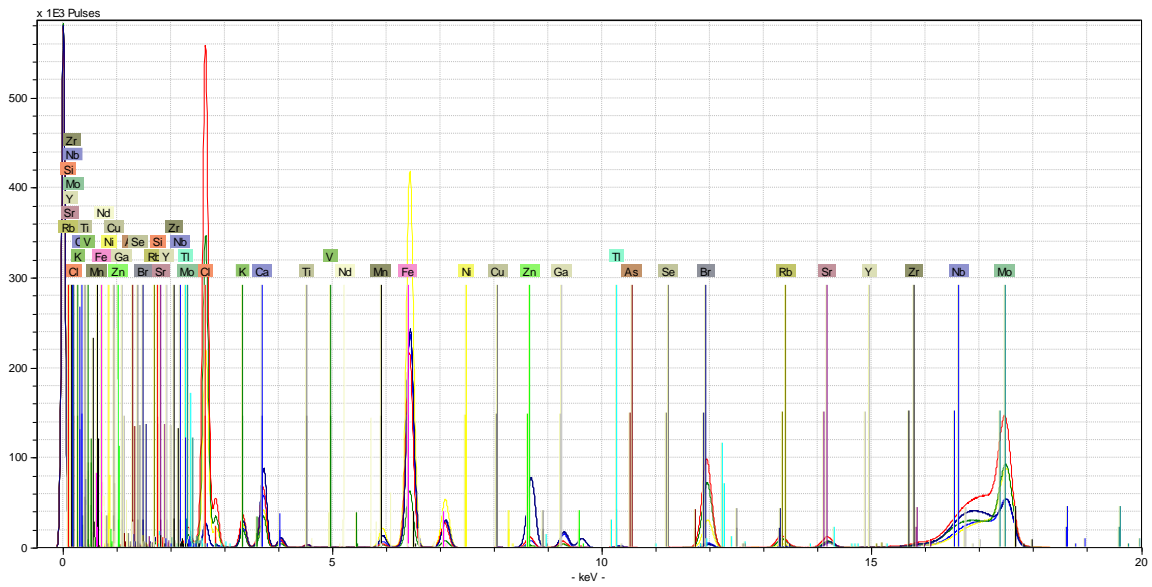
Graph 2: Salvinia-Casqueiro river.



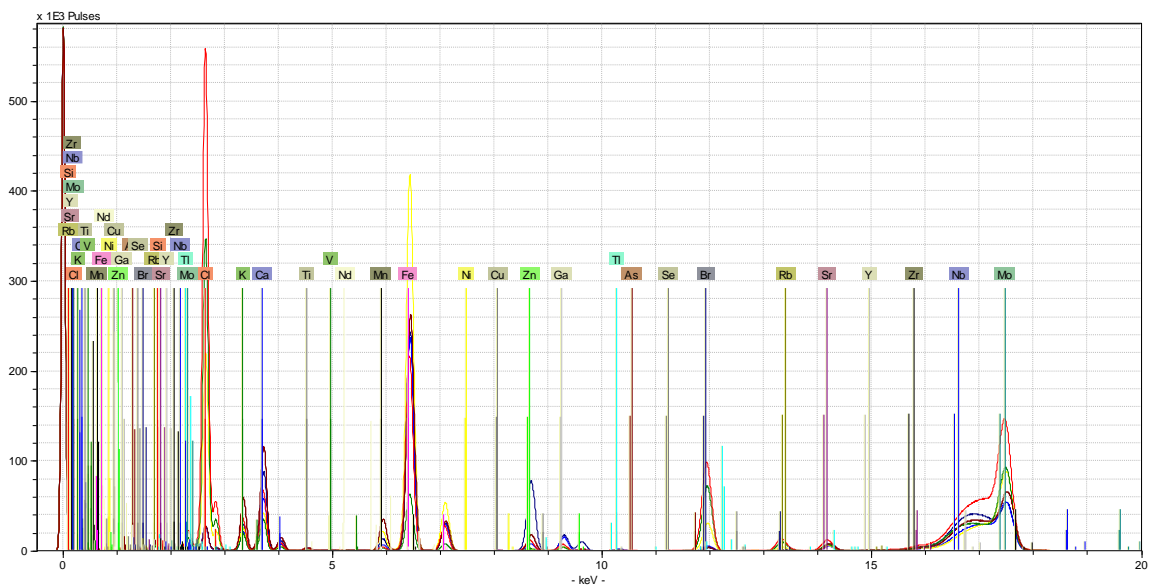
Graph 3: Aguapé-Casqueiro river.



Graph 4: Water lettuce-Cubatão river.



Graph 5: Salvínia-Cubatão river.



Graph 6: Aguapé-Cubatão river.

It is observed that anthropic action as well as the different seasonality have not influenced the distribution of aquatic macrophytes in the sampling environments because they are plants with easy proliferation, remaining in all sampling periods, having high sensitivity to heat, but with the ability to bioaccumulate toxins present in the rivers that were sampled. Among the observations made, it was found that during the 30 days that the three species were in the polypropylene boxes they bioaccumulated many substances such as chlorine (Cl), iron (Fe) and zinc (Zn) in high concentrations, as shown in the graphs of the two rivers with the three species of macrophytes, but nothing that could harm the fauna, flora and the population that lives around the rivers, I believe that during the project we will have a different result due to the industries around the rivers and the action anthropic activity that occurs in both rivers. In addition to serving as bioaccumulators of heavy metals as shown in the graphics, they also served as a shelter for small animals such as spiders and snails, which were found several times. It is believed that by the end of the project we will have rich information about the importance of aquatic macrophytes for the environment, helping the recovery of rivers, ponds, lakes where human action may have occurred. The lack of security in certain places where the sampling of macrophyte species and sampling of the waters of the two rivers were carried out prevented us from having some data obtained such as pH, temperature and salinity due to the possibility of theft of the analysis measuring equipment physicochemicals.

Conclusion

The present study shows that the plants in question lend themselves in the activity of bioabsorbing heavy metals from the environment, helping in the recovery of a polluted water body. The three species studied proved to be bioaccumulators of toxins found in the Casqueiro and Cubatão rivers, similar data were not obtained, because we observed that each aquatic plant has the power to withstand a certain amount of toxins, which is important to identify which macrophyte can be used in that particular river. The study was important since the graphs show the absorption of heavy metals found in rivers by plants, helping the recovery of rivers, enabling the survival of the species that nest there, as well as promoting the return of organisms that previously inhabited there, and perhaps, the presence of new species. Use for recreation may also be feasible. Thus, it was a study that aimed at environmental recovery that, due to lack of knowledge and neglect, are being degraded over the years.

References

1. Garcia VSG *et al.* Avaliação da toxicidade em sedimento do Rio Cubatão-SP. *O Mundo da Saúde*. 2014; 38(1):56-65.
2. Joly AB. *Introdução à taxonomia vegetal*. São Paulo: Editora Nacional, 1993, 777.
3. Machado LL. *Cádmio, chumbo e mercúrio em medicamentos fitoterápicos*. Dissertação de Mestrado. Brasília: Universidade de Brasília, 2001, 160.
4. Nascimento CAO *et al.* *Parque Ecológico Perequê: plano de manejo*. CEPEMA-USP, 2015, 158.
5. Oliveira EC. *Introdução à biologia vegetal*. São Paulo: Editora da Universidade de São Paulo, 2003, 266.
6. Raven PH, Evert RF, Eichhorn SE. *Biologia Vegetal*. Editora Guanabara Koogan, Rio de Janeiro, 2001, 906. (6ª edição).
7. Sidinei Magela Thomaz, Luis Mauricio Bini. *Ecologia e*

Manejo de macrófitas aquáticas. Maringá- PR: Editora da universidade Estadual de Maringá, 2003, 341.

8. IBGE, 2021. <https://cidades.ibge.gov.br/brasil/sp/cubatao/panorama>.