USE OF SENTINEL-2 IMAGES IN COASTAL WATERS TO EVALUATE THE CONCENTRATION OF CHL-A AND CORRELATION IN THE OCCURRENCE OF THE SPECIES EMERITA BRASILIENSIS

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ABSTRACT: This work corresponds to an analysis of the scientific production on the species *Emerita* brasiliensis Schmitt, 1935 through biological indicators. *Emerita brasiliensis* is a decapod crustacean that belongs to the Hippidae family and is popularly known as armadillos. This species inhabits the intertidal benthic zone of beaches and, although it is abundantly distributed along the Brazilian coast, it has been suffering from anthropic impacts on its habitat. The object was chosen because of the need to understand the level of knowledge about the characteristics of this organism, which indicate it as a potential bioindicator, besides having great ecological importance in sandy beaches with considerable relevance in marine food chains. Thus, the objective of this work is to propose an analysis of the correlation of individuals of this species with the levels of chlorophyll-a in the water using remote sensing as a technique for data collection.
KEYWORDS: Remote Sensing; *Emerita brasiliensis*; Coastal Ecology; Chlorophyll-a.

INTRODUCTION

The sandy beaches are one of the most extensive landscapes in Brazil, being an environment that runs along the entire coast and among all the coastal environments present in the world, the beaches are the most frequented and occupied by man. As transitional ecosystems between the continents and the oceans, the beaches are of great ecological and economic importance, being the habitat of a dense benthic biodiversity.

Macrobenthos can be used by researchers as biological indicators of beach stability, helping coastal management and planning processes, and can be good biondicators. Among these organisms, the *Emerita brasiliensis* stands out, which are organisms of the genus *Emerita* belonging to the decapod group. They are distributed throughout Brazil, being found also in long stretches of the coast of South America and North America. The use of this organism as a bioindicator allows for an integrated evaluation of ecological effects

caused by various means of pollution. Thus, its use as a biological indicator is as efficient as instantaneous measurements of physical and chemical parameters that are usually measured in the field and used to assess water quality (CALLISTO et al., 2003).

Thus, the present work aims to articulate remote sensing techniques and coastal ecology by analyzing the correlation between the occurrence of *Emerita brasiliensis* and the chlorophyll-a concentration, proposing an environmental diagnosis of the studied areas aiming at a methodological evolution in studies about the benthic macrofauna since the available knowledge about the coastal biodiversity is still limited. The consequent lack of scientific dissemination and lack of faunal information surveys not only hinders the research of environmental scientists but also causes distancing between beach goers and the species that live there (AMARAL et al., 2002).

MATERIALS AND METHODS

The work consists of initially carrying out a bibliometric research on the theme. The Scopus database was used for the queries because of its relevance in terms of academic papers published. The keyword used was "*Emerita brasiliensis*". The VosViewer software was used to process the bibliometric data, generating visualization maps by similarity.

The study areas of the present work are concentrated in Grumari Beach and Sernambetiba Channel (Macumba Beach), located in the West Zone of the municipality of Rio de Janeiro.

Subsequently, Sentinel 2 images were used - throughout the year, since the species analyzed presents wide occurrence in all months of the year - to raise chlorophyll-a levels in the water. The images were obtained from the official site of the Copernicus program, linked to the European Space Agency (ESA). For the atmospheric correction, the Semi-Automatic Classification Plugin from the QGIS 3.26.2 software was used.

In the ArcGIS 10.8 software the images were cropped according to the study areas and later the NDCI (Normalized Difference Chlorophyll Index) calculation was done in the raster calculator. From the results obtained in this step it was possible to obtain the levels of chla-a in the water using Sentinel 2 images.

Subsequently, a field survey of water quality levels will be conducted in order to estimate chlorophyll-a levels in the study areas, in order to compare and validate the results obtained by satellite images. In the process will be colorimetric kits that assign instantaneous values for water quality levels.

Finally, *Emerita brasiliensis* individuals will be collected and counted to estimate the correlation between their occurrence and the chla-a gradient and, consequently, their interaction with the different trophic levels.

RESULTS AND DISCUSSION

Through bibliometric research it was possible to understand the development of research on the species *Emerita brasiliensis* over a 40-year period (1981 - 2021). Among the 40 articles available in the Scopus database, it is possible to see that the distribution of publications over the last 20 years (1981 - 2021) totaled an average of 2 publications per year, reaching its peak in the 2000s, with 17 publications. It is possible to see the need for the application of new methodologies in macrofauna studies. Traditionally, biology and ecology use methods that disregard the different gradients and microecosystems present on beaches. In the year 2010, Choi et al. (2011) conducted a research entitled "Crustacean habitat potential mapping in a tidal apartment using remote sensing and GIS". The work presented good results by articulating remote sensing and GIS techniques to model the physiographic characteristics that influence the abundance, frequency and distribution of crustaceans, generating maps of potential habitats.

Thus, the NDCI index used in the present study is broadly applicable to coastal waters, and can be used to detect algal blooms and qualitatively infer chl-a concentration ranges very similar to the application of NDVI in terrestrial vegetation studies. Based on absorption properties and spectral band structure, NDCI values in water bodies with moderate to high algal biomass are expected to vary in the range of -0.3 to near 1. In the case of algal blooms with surface scum in water bodies, NDCI values vary within a range of 0.5 to 1 (MISHRA, 2012). The surveys conducted in the study areas show results close to what Mishra (2012) suggests when he suggests using NDCI to estimate chla-a values.

Using the Sernambetiba Channel as an example, it is an environment with its surroundings highly urbanized. The use and coverage information (IPP, 2017) indicates part of the surrounding neighborhoods - especially Recreio dos Bandeirantes and Vargem Grande - with considerable areas classified as leisure areas, slums, and commercial and service areas. It was possible to notice the highlight for areas subject to flooding, woody grass cover, and tree and shrub cover.

It stands out for also being a eutrophicated environment. Its highest NDCI level reaches 0.58. For Mishra 158 (2012), this level points to the tendency of a severe algal bloom. In the field, Mishra (2012) indicates that such a level of NDCI represents a range in actual values of >50 chla-a (mg m- 3). The trophic state index (TSS)- with chlorophyll-a as a parameter-points these data as a supereutrophic or hypereutrophic environment.

In contrast, Grumari stands out as an environment with larger areas of shrub cover, rocky outcroppings, and small recreational and residential areas according to its use and cover classification (IPP, 2017). However, its NDCI presents classifications close to that of the Sernambetiba Canal. Its highest NDCI level reaches 0.53, also pointing in some points a tendency of severe algae blooms and being classified as an environment with supereutrophic or hypereutrophic areas.

We also made maps indicating the ratio of permanent private households with exclusive use of the residents' bathroom or toilet and sanitary sewer (V017) and permanent private households (V002) in the census sectors of the neighborhoods surrounding the Sernambetiba Canal - Recreio dos Bandeirantes and Vargem Grande. The best percentages presented are in the sectors near Macumba Beach, while the areas with the lowest percentages are in places with less urban infrastructure. Grumari presents a single census sector that is not in dialogue with the entire delimitation of the neighborhood due to its low occupation.

CONSIDERATIONS

The present work is in progress and the analyses and surveys are still being carried out. However, the methodology used for remote sensing presents good results because the normalized difference chlorophyll index can be used successfully to monitor the presence of chl-a in coastal and inland estuarine waters (MISHRA, 2012). Thus, it is expected that at the end of the project it will be possible to present results that contribute to the methodological advancement in studies about coastal ecology.

REFERENCES

AMARAL, A. C. Z. et al. Diagnóstico sobre praias arenosas. In: MINISTÉRIO DO MEIO AMBIENTE.. Avaliação e ações prioritárias para a conservação da biodiversidade das zonas costeira e marinha. Biodiversidade Brasileira: Avaliação e Identificação de Áreas Prioritárias para Conservação, Utilização Sustentável e Repartição de Benefícios da Biodiversidade Brasileira. Série Biodiversidade. 2002.

CALLISTO, M; GOULART, M.D. Bioindicadores de qualidade de água como ferramenta em estudos de impacto ambiental. Revista FAPAM, 2003.

MISHRA, Sachidananda; MISHRA, Deepak R. Normalized difference chlorophyll index: A novel model for remote estimation of chlorophyll-a concentration in turbid productive waters, Remote Sensing of Environment, Volume 117, 2012, Pages 394-406, ISSN 0034-4257.

CHOI, Jong-Kuk; OH, Hyun-Joo; Koo, Bon Joo; RYU, Joo-Hyung; LEE, Saro, 2011. Crustacean habitat potential mapping in a tidal flat using remote sensing and GIS, Ecological Modelling, Elsevier, vol. 222(8), pages 1522-1533.

EDGAR, Graham J. The use of the size estructure of benthic macrofaunal communities to estimate faunal biomass and secondary production. Journal of Experimental Marine Biology and Ecology, Volume 137, Issue 3, 1990, p. 195-214, ISSN 0022-0981.

IPP. Instituto Pereira Passos. Uso do Solo 2017. Dados vetoriais.

MISHRA, Sachidananda; MISHRA, Deepak R. Normalized difference chlorophyll index: a novel model for remote estimation of chlorophyll-a concentration in turbid productive waters. Remote Sensing of Environment, [S.L.], v. 117, p. 394-406, fev. 2012. Elsevier BV. http://dx.doi.org/10.1016/j. rse.2011.10.016.