

INTEGRATED FRAMEWORK FOR COASTAL ZONE HEALTH INDEX AND VULNERABILITY ASSESSMENT

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INTRODUCTION

The coastal zone is the environment that connects terrestrial and marine environments. (Cabrera & Lee, 2022). It has been estimated that 23% of the world's population lives within 100 km of the coastal regions (Small & Nicholls, 2003). Coastal zones offer a variety of significant ecological, social, and economic benefits. It is a dynamic and diverse environment. It supports various human activities, such as fishing, tourism, and transportation, and is home to a wide range of plant and animal species.

However, there are several issues that coastal areas must contend with, such as pollution, climate change, and overdevelopment. The health and integrity of coastal ecosystems, as well as the communities and industries that depend on them, could be seriously harmed by these threats. It is crucial to routinely evaluate the health and well-being of these environments to address these issues and guarantee the long-term viability of coastal zones. The goal of this study is to identify any issues or problems that may be affecting the health and integrity of the coastal zone environment.

The outcomes of the coastal zone health and integrity assessment can be used to guide the creation of policies and management strategies that will protect and enhance the integrity of the coastal zone after all the data has been gathered and analyzed. This could involve actions like repairing damaged habitats, putting land use planning guidelines into practice, or creating protected areas.

Overall, assessing the health and integrity of the coastal zone is crucial for maintaining the many priceless resources and services that our coastal environments offer as well as for ensuring their long-term health and sustainability. It is also crucial that we continue to make investments in this process and create cutting-edge strategies that can aid us in better comprehending and addressing the difficulties that our coastal zones face.

Thus, this study focuses on the following: (1) developing a framework for assessing the coastal zone health index (CoZHI) using multicriteria decision analysis (MCDA), and (2) investigating the coastal zone integrity using the coastal zone vulnerability index (CVI) framework.

METHODOLOGY

Developing strategies for the wise use of our natural resources is a fundamental component balancing human development and environmental preservation. Local authorities need to have a strong strategy in place for environmental protection, which in turn informs leaders who are shaping policies for resource use. The focus of this paper is using a method that involves examining a range of criteria and indicators through the judgments of the policymakers who are tasked with forging paths

toward sustainability. This study outlines a methodical approach known as top-down multicriteria decision analysis, as depicted in Figure 1.

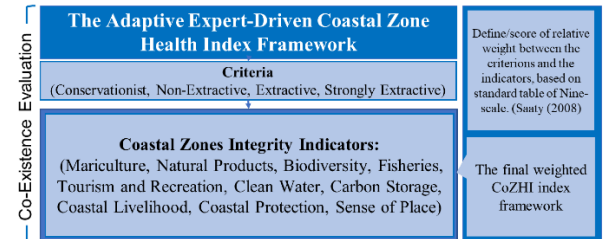


Figure 1. CoZHI framework adapted from Cabrera & Lee (2022).

In this study, a purposive sampling method was used to gather data. Participants in the survey included a diverse group of local government planners, administrators, managers, economists, city engineers, and scholars specializing in environmental studies. The questionnaire data collection was conducted online over the period from December 2021 to February 2022. There were 23 responses included in the analysis.

An index-based methodology was employed in the study for the CVI assessment. The data was collected for geomorphology, shoreline change rate, coastal elevation, significant wave height, sea level change rate, and sea surface temperature to build an initial database of the parameters. The parameters were assessed and ranked qualitatively based on how resistant a particular landform was to erosion. The parameter data values were classified in terms of coastal vulnerability based on value ranges according to the order in which it has the potential to cause *very low*, *low*, *moderate*, *high*, and *very high* damage. The factors were merged into a single index, then categorized based on the proportional risk to the coastal zone. Figure 2 shows a flow chart outlining the process for obtaining the CVI map.

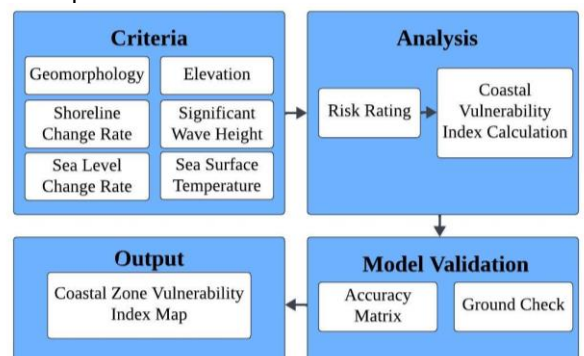


Figure 2. Coastal vulnerability index (CVI) assessment framework.

RESULTS AND DISCUSSION

This framework applied MCDA, where the judgment of the policymakers is quantified. The AHP approach under the MCDA ensures the consistency of the respondents' judgment to ensure that the decision is acceptable and reasonable (Saaty, 1980). Mati City and Davao City are the selected coastal cities in the Philippines as study areas. The AHP method was applied to determine weights and the results of each classification are described in the succeeding paragraphs.

Figure 3 shows the societal views of each city based on the four criteria. These criteria were defined and documented in detail in Cabrera & Lee (2022).

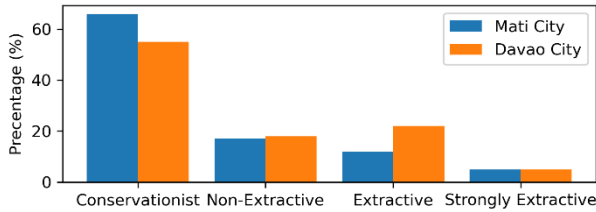


Figure 3. The societal development views of the two cities.

The criteria ratio (CR) values for Mati and Davao are 8.7% and 4.3%, respectively which are reasonably acceptable judgments. Davao City is a conservationist (55%) yet extractive (22%), and a little empathizes in non-extractive (18%), and strongly extractive (5%). Mati City, on the other hand, scores higher on the environmentalist criterion, indicating that the environment is vital to the city. Moreover, non-extractive characteristics are highly valued in Mati City. It follows that, despite the city's development goals, environmental concerns are a bigger factor in their success. Mati City is the home of the Mt. Hamiguitan UNESCO Heritage. On the contrary, Davao City is an urbanized city.

The indicator weights in each city serve as the foundation of the CoZHI framework. The complete definition of each indicator is shown in the study of Cabrera & Lee (2023). Figure 4 shows the relative weights of each indicator. Furthermore, the framework is depicted in Equations 1 and 2.

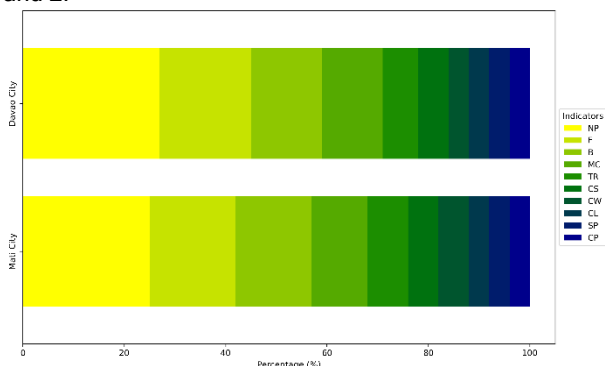


Figure 4. Relative weights of indicators for the two coastal cities.

$$\text{CoZHI}_{\text{Mati}} = \text{NP} \times 0.25 + \text{F} \times 0.17 + \text{B} \times 0.15 + \text{MC} \times 0.11 + \text{TR} \times 0.08 + \text{CS} \times 0.06 + \text{CW} \times 0.06 + \text{CL} \times 0.04 + \text{SP} \times 0.04 + \text{CP} \times 0.04 \quad (1)$$

$$\text{CoZHI}_{\text{Davao}} = \text{NP} \times 0.27 + \text{F} \times 0.18 + \text{B} \times 0.14 + \text{MC} \times 0.12 + \text{TR} \times 0.07 + \text{CS} \times 0.06 + \text{CW} \times 0.04 + \text{CL} \times 0.04 + \text{SP} \times 0.04 + \text{CP} \times 0.04 \quad (2)$$

In relation to the coastal vulnerability assessment, Davao City and Mati City are Moderate to High and Moderate classifications with model accuracy of 80.07% and 88.24%, respectively, as shown in Figure 5. In Davao City, ten towns with 193,853 people are at least highly vulnerable, while five towns with 97,995 people are highly vulnerable in Mati City.

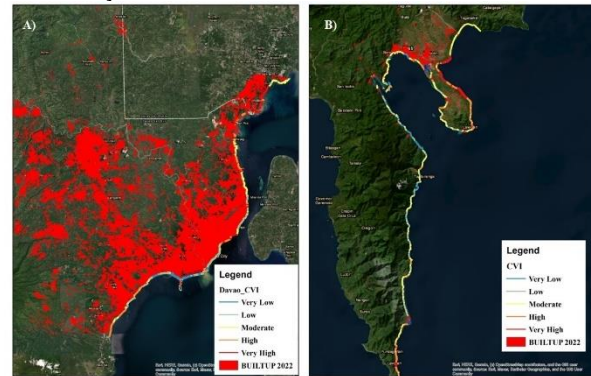


Figure 5. CVI risk exposure map. A) Davao City CVI map. B) Mati City CVI map.

CONCLUSIONS

The development strategy in the two cities is focused on sustainable development, which allows people to coexist with the natural environment. When creating the sustainable coastal zone assessment plan, the MCDA-AHP technique aims to take individual perceptions into account. Additionally, the coastal zone environment's sensitivity to external forces is evaluated using the CVI method. The analysis finds a strong correlation between each city's development strategy and the characteristics of the city in which it is now located.

The study demonstrates the adaptability and flexibility of the indices in the framework. This study demonstrates distinctive characteristics of the coastal environment and the perspectives of policymakers, which each city should implement the coastal zone management plan in a particular way.

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