ABSTRACT

Climate change is one of the most critical challenges facing humanity today, and one of its most alarming consequences is the rise in sea levels. This phenomenon poses significant risks to coastal areas worldwide, threatening ecosystems, infrastructure, and human livelihoods. Miami Beach, a renowned coastal city in Florida, USA, is particularly vulnerable due to its low-lying topography, high population density, and economic dependence on tourism and real estate. The increasing frequency of coastal erosion, flooding, and saltwater intrusion underscores the urgency of assessing and mitigating these risks. This research focuses on evaluating the coastal vulnerability of Miami Beach using the Coastal Vulnerability Index (CVI) and project future sea level changes using machine learning techniques. By integrating geomorphological data, shoreline change rates, land use and land cover (LULC), and slope analysis, this study provides a comprehensive assessment of the city's susceptibility to sea level rise. The use of Geographic Information System (GIS) technology and machine learning techniques enhances the accuracy and reliability of the predictions and vulnerability assessments. The findings indicate a significant increase in sea levels for Miami Beach, with projections showing a rise of approximately 2.46 meters by 2070. The CVI analysis reveals high vulnerability in several areas, highlighting the urgent need for mitigation and adaptation strategies. The integration of machine learning for sea level prediction and GIS for spatial analysis proves to be an effective approach in assessing coastal vulnerability. This study contributes to the existing body of knowledge by providing a detailed and methodologically robust assessment of coastal vulnerability for Miami Beach. It underscores the importance of using advanced technological tools to inform policy-making and urban planning in coastal regions threatened by climate change.