Estimation of Ship Carbon Emission at Coastal Area based on AIS Data

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Abstract

Air pollution from maritime shipping has become a critical environmental concern, as industry generates substantial greenhouse gas and pollutant emissions that significantly impact coastal communities and port cities, despite its essential role in global commerce. Ports like Kuantan in Peninsular Malaysia face increasing concerns about air quality degradation and climate impact as maritime traffic in Southeast Asia grow rapidly. The lack of accurate, high-resolution data that accurately reflects vessel operations and fuel use patterns at the local settings has been a significant barrier to resolving these issues. This investigation uses data from the Automatic Identification System (AIS), which facilitates the monitoring of vessels' operational status, routes, and activities. An engine load-factor approach is used to estimate CO_2, NO_X, SO_X, and PM emissions, with three operational modes considered: berth at the port, at anchor at the offshore area, and when moving within port areas. The analysis of 5,240 validated AIS records from 25 vessels operating in Kuantan's coastal waters within latitude 3.014-3.847 and longitude 103.43-103.76, revealed an insight into emission patterns. Results indicate that maneuvering generates the highest emissions, with bulk carriers contributing approximately 2.83 million tons of CO_2 and 416.47 tons of NO_x due to intensive main engine use in near coastal area. Berthing emissions, particularly from auxiliary engines in bulk and general cargo ships, while anchoring resulted in the lowest emissions across all pollutants. Tugboats, despite their small size, exhibited high NO_x emissions during maneuvering due to frequent high-load operations. The CO_2 emissions across all modes ranged from 1.27 tons to over 26 million tons. This integrated AIS-based methodology provides more accurate emission estimates than traditional approaches, offering valuable data for policymakers developing targeted emission reduction strategies and sustainable port management practices across Southeast Asia's expanding maritime sector.

Keywords: Ship emission; AIS data, port sustainability, carbon footprint.