



Spatial and Temporal Trends of Ship Based Oil Spill and Maritime Pollution Incidents in Sri Lankan Waters: Hotspot Identification and Maritime Hazard Assessment (1999–2025)

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Sri Lanka is strategically located adjacent to one of the world's busiest East-West international shipping routes, making its surrounding waters highly vulnerable to ship-based pollution incidents and marine environmental emergencies. Despite substantial vessel traffic in Sri Lankan waters, systematic analyses of maritime incidents patterns remain limited. This study presents a comprehensive assessment of ship related pollution and other maritime incidents reported to the Marine Environment Protection Authority (MEPA) between 1999 to 2025 around Sri Lankan waters. Spatial analyses were conducted using ArcMap, while descriptive statistical analyses were performed using Microsoft Excel. Kernel Density Estimation (KDE) was applied to identify spatial clustering patterns and hotspot areas of maritime incidents. A total of 55 ship-related incidents were analyzed and categorized into nine major incident types. The frequency of maritime incidents in Sri Lanka remained low from 1999 to 2020 but increased sharply thereafter, reaching a peak of 11 incidents in 2025. This upward trend is likely associated with the post-pandemic recovery of global maritime trade, increased vessel traffic, and port congestion, collectively elevating navigational risks in Sri Lankan waters. Oil spills were the most frequently reported incident type (44%), whereas collisions were the least reported (2%). Spatial analysis revealed that approximately 89% of incidents were concentrated along the western and southern maritime corridors of Sri Lanka, with KDE identifying Colombo Harbor as the primary hotspot. Nearly 90% of recorded incidents occurred within 30 nautical miles of the coastline, and a binomial test confirmed a statistically significant concentration in nearshore waters ($p < 0.05$). Monsoon seasonal analysis revealed that 62% of incidents occurred during the southwest monsoon season, highlighting the notable influence of seasonal conditions on maritime risk. The study underscores the need to strengthen maritime risk governance through enhanced oil spill preparedness, improved vessel traffic management, stricter enforcement, and seasonally responsive emergency planning to mitigate increasing environmental risks and protect coastal marine ecosystems.

Keywords: *Maritime, Maritime pollution, Oil spills risk assessment, Ship incidents, Sri Lankan waters*