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Potential oil spill risk from shipping and the implications for management in the Caribbean Sea

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ABSTRACT

The semi enclosed Caribbean Sea is ranked as having one of the most intense maritime traffic in the world. These maritime activities have led to significant oil pollution. Simultaneously, this sea supports many critical habitats functioning as a Large Marine Ecosystem (LME). While the impacts of oil pollution are recognised, a number of management challenges remain. This study applies spatial modelling to identify critical areas potentially at risk from oil spills in the form of a potential oil spill risk (POSR) model. The model indicates that approximately 83% of the sea could be potentially impacted by oil spills due to shipping. The results from this study collectively support a management framework for minimising ship generated oil pollution in the Caribbean Sea. Among the recommended components are a common policy, surveillance and monitoring controls, standards, monitoring programmes, data collection and greater rates of convention ratifications.

1. Introduction

Throughout history, maritime activities have been instrumental in promoting development and bridging civilisation, affording humanity a form of mobility whether for trade, transport or fishing among others. Into the twenty first century, these activities have evolved into a vibrant economic sector effectively linking economies worldwide and by way of maritime transport which accounts for over 90% of the global trade (IMO, 2012). Similarly regional and inter-regional shipping have also evolved especially in emerging economies growing at a significant rate. For example The Latin America and the Caribbean (LAC) region is classified as one of the fastest growing in terms of container trade (Sanchez and Ulloa, 2007). In some regions, shipping is critical to reliable supply of goods, for example in the Caribbean Small Island Developing State (SIDS), as much as 90–95% of all imported goods are transported through maritime shipping (Singh, 2008) and in the Eastern Caribbean region (OECS) as much as 96%.

Apart from the well-established economic benefits, shipping also brings tremendous environmental challenges such as pollution from ballast water, sewage, grey water, solid waste, noise, oil discharges and air emission (Singh and Mee, 2008; Singh, 2008; GESAMP, 2007). Ship related sources account for 51% of marine oil pollution in the marine environment with natural seepages commanding 49% (GESAMP, 2007). Studies have shown that oil pollution if not adequately managed, can have devastating effects, being harmful and potentially toxic to marine life. For example, the 1978 Amoco Cadiz incident resulted in the death of over 20,000 birds, millions of molluscs, sea urchins, benthic species, other shell and fin fisheries (Maritime Connectors, 2013). Oil with its inherent high concentration of polycyclic aromatic hydrocarbons (PAHs), when dispersed in an open sea environment either through accidental or operational activities, has the propensity to cause long term residual effects on marine biodiversity. Some of the noted observations include an increased susceptibility to diseases of certain species (Lafferty and Holt, 2003), reduced resilience (Loya, 2004) and abnormal reproductive cycles (Yanko et al., 2003). Further, the natural decomposition properties of oil makes it persist in the environment over a prolonged period, thereby having long term deleterious effects on critical ecosystems (Armentares et al., 2010; Pisanty et al., 2010) such as coral reefs (Norstrom et al., 2009), littoral forests (Peterson et al., 2003) sea grass (Kenworthy et al., 1993) and mangrove (Lewis, 1983).

Oil discharges occurring in semi or closed systems has the potential to magnify the concomitant environmental impacts aforementioned is a significant concern. One such area is the semi

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enclosed Caribbean Sea covering an area of 2,515,900 km^2, with one of the most intense maritime traffic in the world and where 37 countries and territories exercise jurisdiction (Singh, 2008). In tandem, this sea supports many critical habitats and shared resources which classified it as a LME (Singh, 2008; Sherman, 2014). Field monitoring data indicated the presence of oil throughout the Caribbean Sea with high levels of Dispersed/Dissolved Petroleum Hydrocarbons (DDPH) recorded at various locations (Fernandez et al., 2007; Persad and Rajkumar, 1995; Atwood et al., 1987; Harvey, 1987). Further, data available for the Caribbean, shows that between 1960 and 1995, 28 vessel spills occurred where in each instance, in excess of 240 barrels (>10,000 gallons) entered in the sea's environment (Singh, 2005). However, the most significant was the *SS Atlantic Empress* which occurred off the coast of Trinidad and Tobago and is regarded as the largest shipping related oil spill in known maritime history (Visser, 2012).

Although the impacts of oil pollution in the Caribbean Sea are recognised, a number of management challenges remain which include (a) lack of information on potential oil spill risk from shipping, (b) little emphasis on management interventions using scientific modelling from a spatial standpoint and (c) effective utilisation of this information in policy decisions. Mainstreaming marine spatial mapping and planning into decision making is growing in usage, supporting better decision making in integrated management regime. In an environment such as the Caribbean Sea in the context of being an LME, the development of spatial mapping for pollution risk identification and control will provide a decision making tool which could be used for management. In view of these gaps, this paper seeks to apply spatial modelling to identify critical areas potentially at risk from oil spills. It also aims at utilising this information to support a management framework for minimising ship generated oil pollution and to provide recommendations for improved management of the Caribbean Sea in this regard.

2. Shipping in the Caribbean Sea

2.1. Shipping trends

The Caribbean Sea (Fig. 1) is ranked as one of the principal transit zones in the world, harbouring in excess of 90,000 port calls per year (Singh, 2008; Girvan, 2002). There is a huge inter and intra-regional and international shipping in this sea, moving various products from ports and refineries. Colombia, Mexico, Trinidad and Tobago and Venezuela are the major crude oil producing countries in the Caribbean Sea with a total production of 6,436,500 barrels per day in 2012 (OPEC, 2012).

There are 214 ports found within or bordering the Caribbean Sea (Fig. 2) in addition to a number of refineries found in various countries (Singh, 2005). The refineries throughout the Caribbean supply refined products to countries within the region, the Gulf of Mexico and beyond. Refined products are shipped into or through the Caribbean Sea via the Panama Canal to other destinations. Not only are other products such as crude oil and its refined products shipped from Africa, the Middle East, Argentina and Alaska into the Caribbean but also oil and its derivatives are shipped from Venezuela, Trinidad and Columbia to the USA and other parts of the region (Dillion, 1995; Singh, 2005). Large storage terminals in Saint Lucia, Aruba, Curacao, US Virgin Islands (USVI) and St. Eustatius are used as trans-shipment ports for crude oil, thereby contributing to the traffic intensity of the Sea.

The Panama Canal also plays a significant role in promoting the increase of traffic in the Caribbean Sea. Petroleum shipments represented approximately 28% of total canal traffic in 2013, of which about 60% of that sum went from the Caribbean Sea/Atlantic to Pacific Ocean (MEEM, 2013). The expansion of the Panama Canal scheduled to be completed in 2014 is projected to witness an increase in transit volumes of liquefied natural gas (LNG), petroleum and other related products, thereby increasing the marine traffic and potential oil pollution in the Sea. Further, the Nicaragua Grand Canal, similar to the Panama Canal when it becomes operational is predicted to add greater pressures to the Caribbean Sea.

Apart from commercial shipping, the Caribbean Sea plays a significant role in cruise ship tourism with over 70 cruise ships from approximately 24 cruise companies operating in the Caribbean Sea (Singh, 2005, 2008). Overall, the region is regarded as the most visited destination in the world, commanding over 45% of the world's cruise market (Ocean Conservancy, 2002). In 2012, it was estimated that over 1929.24 million USD were contributed by the cruise industry through tourist expenditure in the Caribbean countries (BREA, 2012). This large market coupled with the number of cruise ships has the potential to contribute to accidental oil spills thereby compounding the oil pollution issue which emanates from other types of shipping activity. Collectively, the shipping network

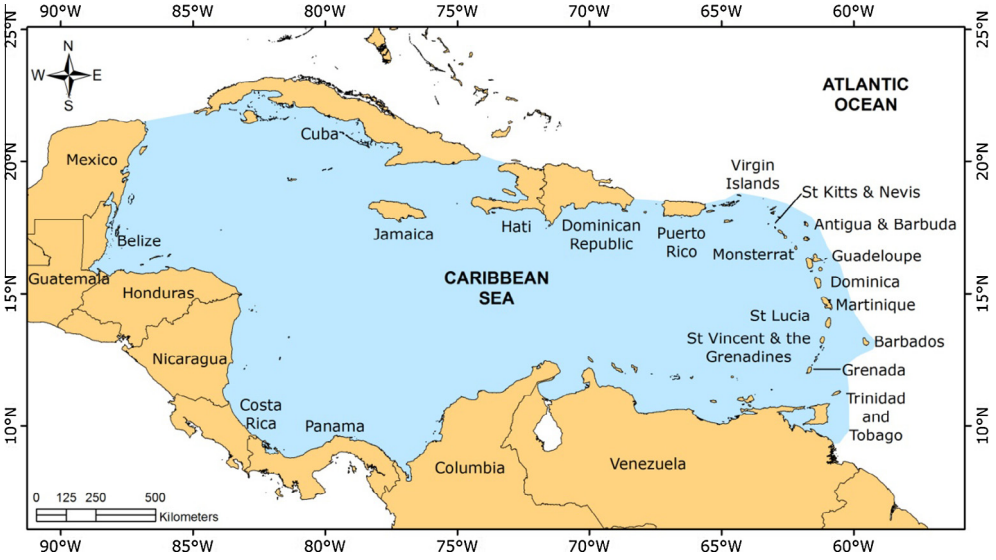

Fig. 1. The study area which includes the Caribbean Sea and the countries with jurisdiction over the sea. Adopted from Singh (2008).

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