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Historic and contemporary contamination in the marine environment of Kuwait: An overview

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ABSTRACT

The rapid expansion of industry, along with previous pollution events linked to conflicts in the region, have led to a variety of contaminants being inadvertently or deliberately discharged into Kuwait's marine environment. These include polycyclic aromatic hydrocarbons (PAHs) and trace metals, from the petrochemical industry, and contaminated brine from the region's desalination industries. The present paper has reviewed over 60 studies that have reported the levels of contaminants, including PAHs, metals and polychlorinated biphenyls (PCBs) present in seawater, sediment and representative marine organisms. Most of the reviewed literature confirmed that while Kuwait's marine environment has been subjected to a wide array of pollution events, the actual levels of contamination remains relatively low. However, sediment contamination hotspots associated with point sources of industrial contamination, such as originating from the Shuaiba industrial area, do exist at a number of locations around the coast.

1. Introduction

The State of Kuwait is situated at the north-western corner of the Arabian (Persian) Gulf, and is considered among the highest anthropogenically impacted regions in the world (Halpern et al., 2008; Sheppard et al., 2010). Its territorial waters are characterised by shallow seas, high summer water temperatures (>30 °C), intense Ultra Violet (UV) light exposure and elevated salinities (average 41‰) (Sheppard et al., 1993; Al-Rifaie et al., 2007). A main feature of its marine environment is Kuwait Bay (Fig. 1), a 750 km^2 semi-enclosed shallow body of water, around 35 km wide with a mean depth of 5 m (Al-Sarawi et al., 1988; Al-Abdulghani et al., 2013). The area provides vital habitats and nursery grounds for many fish, shrimp and other ecologically important organisms (e.g. elasmobranchs, marine mammals and sea birds). The waters around Kuwait contain some of the most northerly coral reef systems in the world and are internationally recognised for maintaining biodiversity, supporting fisheries and promoting recreational activities (Al-Ghadban et al., 2002; Al-Ghadban and El-Sammak, 2005; Al-Rifaie et al., 2007).

1.1. Sources of marine pollution in Kuwait

Like many of the other countries which comprise the Gulf Co-operative Council (GCC), Kuwait has undergone major economic, social and industrial development following the discovery and exploitation of its vast oil reserves (Al-Abdulghani et al., 2013). The rapid expansion of Kuwait's industrial sector has mainly occurred around its coastal margins. This has led to a variety of contaminants being discharged directly to the marine environment, including petroleum hydrocarbons, trace metals, nutrients (from domestic sewage), and contaminated brine from desalination plants, which are essential for the production of freshwater in the region (Readman et al., 1992; Al-Ghadban et al., 2002; Beg et al., 2003b; Al-Dousari, 2009). The impact of these activities are exacerbated by natural sources of marine pollution that include atmospheric deposition of particulates from dust storms, natural oil seeps and particulate matter transported from the Shatt Al-Arab River that is formed by the confluence of the Euphrates and the Tigris in southern Iraq (Al-Ghadban et al., 2002; Al-Ghadban and El-Sammak, 2005). Given the environmental extremes of the region many of Kuwait's marine species are likely to be functioning close to their physiological limits. Therefore, it is clear to see why concern has been raised by a number of studies as to the additional role chemical pollution events may play in further

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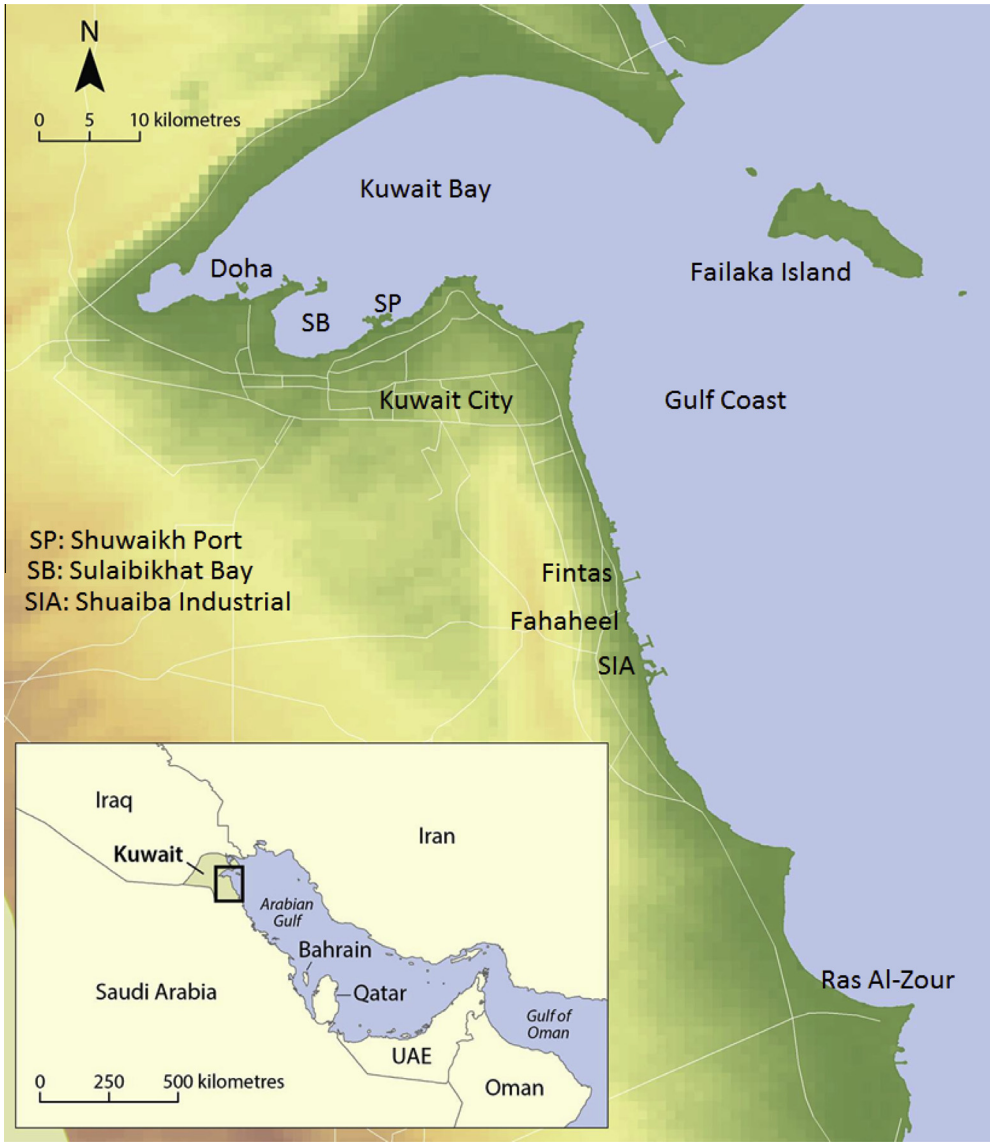

Fig. 1. Map of Kuwait's marine environment.

stressing Kuwait's marine ecosystem (Al-Ghadban et al., 2002; Sheppard et al., 2010; Al-Abdulghani et al., 2013).

The Arabian Gulf is considered to contain the largest reserve of oil in the world (Literathy et al., 2002). Kuwait, along with other GCC states, has expanded its industrial infrastructure to meet the demands of oil extraction, refining and transport, leading to hot spots of marine degradation and contamination in areas associated with industrial activity (Al-Ghadban et al., 2002). Historically, events such as the 1991 Gulf War have intensified problems associated with rapid industrialisation. During this period it is estimated that 9–10.8 million barrels of oil, originating from sabotaged tankers and pipelines at the Al-Ahmadi terminal, were deliberately released into the coastal waters of Kuwait (Al-Abdali et al., 1996; Readman et al., 1996). As a result of the war, the environment was exposed to an array of contaminants, which included pyrolytic petroleum hydrocarbons from burning oil wells, hazardous wastes from war damaged industries (such as PCBs and metals), along with spent or discarded munitions (Fowler et al., 1993; Readman et al., 1996; Massoud et al., 1998). In addition, areas of natural oil seepages have been identified and are thought to be important point sources of contamination at various locations around the coast (Zarba et al., 1985; Massoud et al., 1996; Massoud et al., 1998; Al-Ghadban et al., 2002).

A large proportion of Kuwait's population is situated along its coastal margin. This has led to the accumulation of high levels of bacterial contamination (e.g. faecal coliforms and faecal streptococci) associated with discharges of domestic sewage. It is known that the organic content of the sewage dumped into Kuwaiti waters is also relatively high and often septic due to low flows, long retention times, high ambient temperatures and concomitant anaerobicity (Ghannoum et al., 1991; Al-Ghadban et al., 2002). Trace metal pollution has been detected close to known discharges of domestic sewage and their accumulation has been attributed to the closed, shallow nature of the receiving beaches and outlets discharging within a few meters of the shoreline (Al-Ghadban et al., 2002; Bu-Olayan and Thomas, 2014). In recent years environmental disasters, such as the Mishref pumping station plant breakdown, have also contributed to the degradation of Kuwait's marine environment (Saeed et al., 2012; Lyons et al., this issue-b). The Mishref pumping station malfunctioned in August 2009, resulting in the discharge of around 150,000 m^3 per day of untreated sewage directly into the sea over a 24 month period.

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