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Baseline

Spatial and temporal analysis of the risks posed by total petroleum hydrocarbon and trace element contaminants in coastal waters of Kuwait

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ABSTRACT

Nine trace elements including As, Cd, Cu, Fe, Hg, Ni, Pb, V and Zn, and total petroleum hydrocarbons were analysed from water samples collected from 23 stations since 1984 from Kuwaiti coastal waters. Here it was investigated whether concentrations of these determinants are at levels above Kuwaiti and internationally established assessment criteria (AC). The results indicate that Cu and Cd had the most Kuwaiti AC breaches over time. Comparing the data of the last sampled year to the least stringent international AC, then Cu and Cd showed breaches at all stations. The trends for trace metals are significantly downwards, especially for Cd and Hg. No determinant measured showed a significant upward trend, indicating that water pollution for these contaminants is not a worsening situation. However, further sampling should be carried out to confirm these findings, especially at shoreline locations, where routine monitoring ceased in 2011 to investigate any recent changes.

The State of Kuwait, located in the most northern regions of the Arabian (also known as the Persian) Gulf, has undergone major economic, social and industrial development over the past few decades (Al-Abdulghani et al., 2013; Al-Sarawi et al., 2015; Devlin et al., 2015a). The rapid expansion of Kuwait's urban and industrial sector has mainly occurred around its coasts (Al-Rifaie et al., 2007; Al-Abdulghani et al., 2013). Consequently, a variety of contaminants have been discharged directly into the marine environment, including total petroleum hydrocarbons (TPHs), metals, nutrients (from raw domestic sewage), and contaminated brine from desalination plants, which are essential for freshwater production in the region (Al-Ghadban and El-Sammak, 2005; Saeed et al., 2012; Al-Sarawi et al., 2015; Devlin et al., 2015b; Lyons et al., 2015a; Lyons et al., 2015b; Smith et al., 2015). These contaminant inputs pose a risk to Kuwait's marine habitats, which serve as a primary nursery ground for many ecologically and economically important species, like Green Tiger prawn (*Penaeus semisulcatus*), and the fish suboor (*Tenualosa ilisha*), orange-potted grouper (*Epinephelus coioides*) and tigertooth croaker (*Otolithes ruber*; Al-Husaini et al., 2007; Al-Mohanna et al., 2014). The Shatt Al-Arab mudflats close to Kuwait's northern border provide ideal habitats for numerous fish species and penaeid shrimp (Al-Zaidan et al., 2013; Al-Husaini et al., 2015). Kuwait Bay and Khor Al-Sabiyah are some of the most important marine ecosystems around the Kuwait coastline and are known to be affected by anthropogenic inputs of contaminants via the Shatt Al-Arab River, coastal construction and effluent discharges (Al-Sarawi et al., 2015).

TPHs reach the marine environment due to oil spills, fossil fuel combustion and road run-off. TPHs are acutely toxic and have mutagenic or carcinogenic properties (Ehrhardt, 1972, Klewowski et al., 1994; Hallier-Soulier et al., 1999). Metals have been shown to affect a range of invertebrate and vertebrate species inhibiting growth or being acutely toxic depending on its concentration (Leung et al., 2005; Oldham et al., 2014). Historically both TPHs and metal contamination have been perceived as a threat to the health of Kuwait's marine and coastal ecosystems. Sources of TPHs pollution in Kuwait include the 1991 Gulf War which resulted in an estimated 10 million barrels of oil being deliberately released into Kuwait's coastal waters following the sabotaged pipelines and tankers at the Al-Ahmadi terminal (Al-Abdali et al., 1996; Readman et al., 1996). Sub-sea seepage of natural oil at numerous locations around the Kuwaiti coastline is also an important natural source of oil contamination in the region (Al-Ghadban et al., 2002). Anthropogenic sources of metals include antifouling paints, such as those used on vessels and marine structures, industrial effluent from power generating and desalination plants, run-off from roads and leaching from waste materials (Jickells and Knap, 1984; Flood et al., 2005; Jones, 2011; Lyons et al., 2015a).

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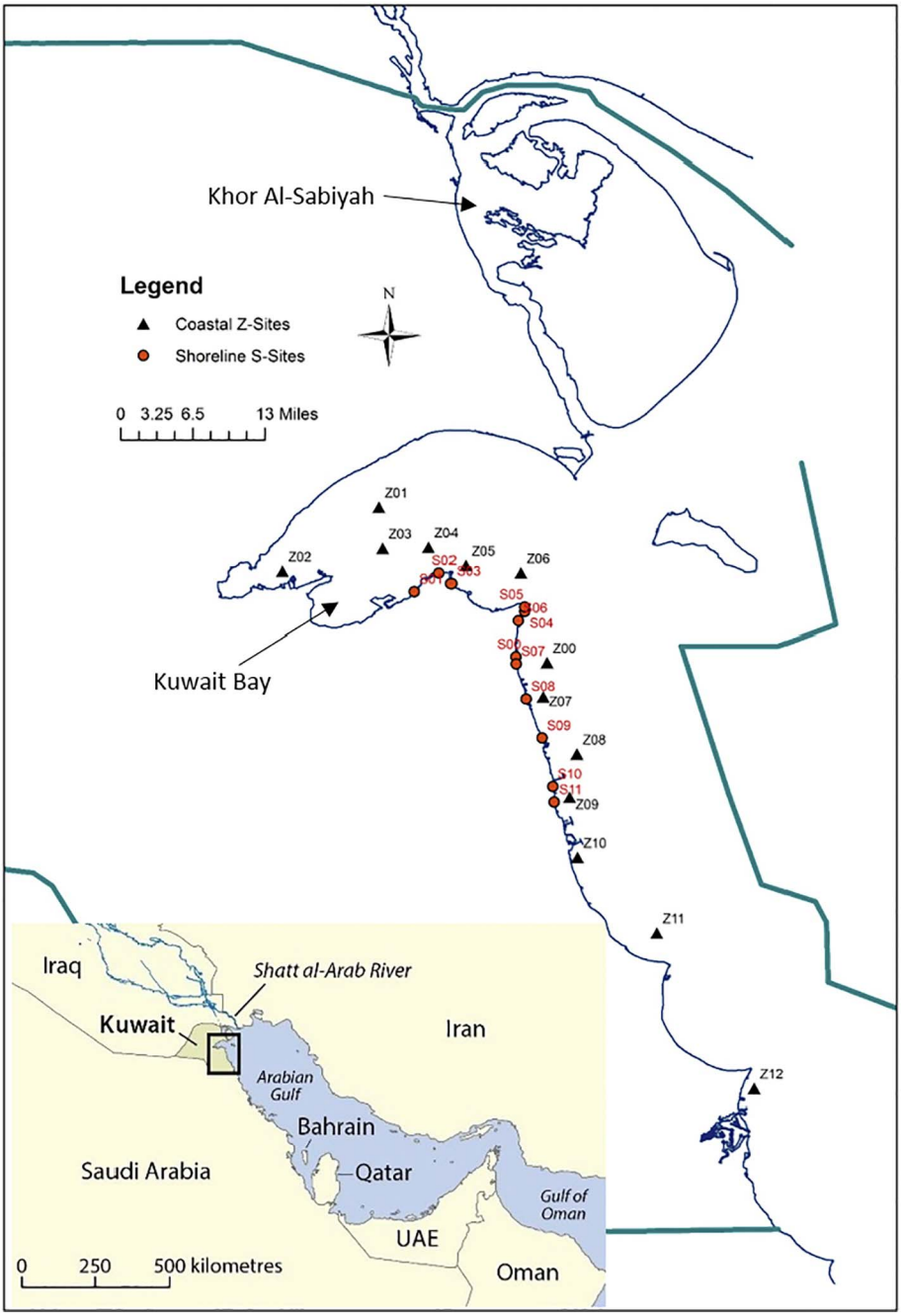

Fig. 1. EPA Kuwait shoreline and coastal water monitoring stations.

Table 1
Coordinates (decimal degrees) of EPA Kuwait shoreline and coastal water monitoring stations.

Station ID	Station name	Longitude	Latitude	Station ID	Station name	Longitude	Latitude
S00	Al-Beda'a	48.08867	29.28293	Z00	Al-Beda'a	48.12936	29.27562
S01	Al-Salam	47.95742	29.36662	Z01	Medayrah (Jal Az-Zour)	47.9111	29.47746
S02	Al-Amiri	47.98947	29.39103	Z02	Al Doha	47.78502	29.39364
S03	Benaid Al-Gar	48.00507	29.37707	Z03	Ras Ushayrij	47.91603	29.42369
S04	Al-Sha'ab	48.1001	29.34097	Z04	Al-Shuwaikh	47.97593	29.42497
S05	Ras Al-Ardh	48.1001	29.34653	Z05	Ras Ajuzah	48.02331	29.40115
S06	Salmiya	48.09198	29.32888	Z06	Ras Al-Ard	48.0951	29.39142
S08	Abo-Al-Hasaniya	48.10212	29.22782	Z07	Al-Messila	48.12424	29.23103
S09	Al-Fintas	48.12278	29.17687	Z08	Al-Fintas	48.16832	29.15608
S11	Al-Fahaheel	48.13872	29.0929	Z09	Al-Fahaheel	48.15883	29.0994
				Z10	Mina Abdulla	48.16908	29.0205
				Z11	Ras Al-Julayah	48.27267	28.92167
				Z12	Mina Az-Zur	48.4	28.71867