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Characterisation of atmospheric deposited particles during a dust storm in urban areas of Eastern Australia

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HIGHLIGHTS

- The dust storm contributed a large fraction of fine particles to pollutant build-up.
- The dust storm increased TSS, Al, Fe and Mn loads in build-up on ground surfaces.
- Dust storm did not significantly increase TOC, Ni, Cu, Pb and Cd loads in build-up.
- Cr and Zn in dust storm deposition were contributed by local anthropogenic sources.

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ABSTRACT

The characteristics of dust particles deposited during the 2009 dust storm in the Gold Coast and Brisbane regions of Australia are discussed in this paper. The study outcomes provide important knowledge in relation to the potential impacts of dust storm related pollution on ecosystem health in the context that the frequency of dust storms is predicted to increase due to anthropogenic desert surface modifications and climate change impacts. The investigated dust storm contributed a large fraction of fine particles to the environment with an increased amount of total suspended solids, compared to dry deposition under ambient conditions. Although the dust storm passed over forested areas, the organic carbon content in the dust was relatively low. The primary metals present in the dust storm deposition were aluminium, iron and manganese, which are common soil minerals in Australia. The dust storm deposition did not contain significant loads of nickel, cadmium, copper and lead, which are commonly present in the urban environment. Furthermore, the comparison between the ambient and dust storm chromium and zinc loads suggested that these metals were contributed to the dust storm by local anthropogenic sources. The potential ecosystem health impacts of the 2009 dust storm include, increased fine solids deposition on ground surfaces resulting in an enhanced capacity to adsorb toxic pollutants as well as increased aluminium, iron and manganese loads. In contrast, the ecosystem health impacts related to organic carbon and other metals from dust storm atmospheric deposition are not considered to be significant.

1. Introduction

The frequency of extreme dust storm events is expected to increase in the future as a result of anthropogenic activities on desert surfaces and climate change impacts (Goudie, 2009). Therefore, an in-depth knowledge of the characteristics of particulates deposited on ground surfaces due to dust storm activity is essential to understand the potential adverse human and ecosystem health impacts that can arise. In this context, the characterisation of particles carried by the dust storm of 23 September 2009 in Australia is important since it is considered as one of the country's worst dust storm events covering an estimated total distance of 3450 km and transported an estimated 1.6 million tonnes of dust (Jayaratne et al., 2011).

The human health impacts of dust storm particulates depend primarily on the mass concentration and the chemical composition of respirable particles, specifically PM_{10} and $PM_{2.5}$. However, the ecosystem health impacts depend mainly on the characteristics of particles deposited on ground surfaces. A detailed characterisation of respirable airborne particles from the 2009 dust storm has been reported by Jayaratne et al. (2011) and Radhi et al. (2010). The study by

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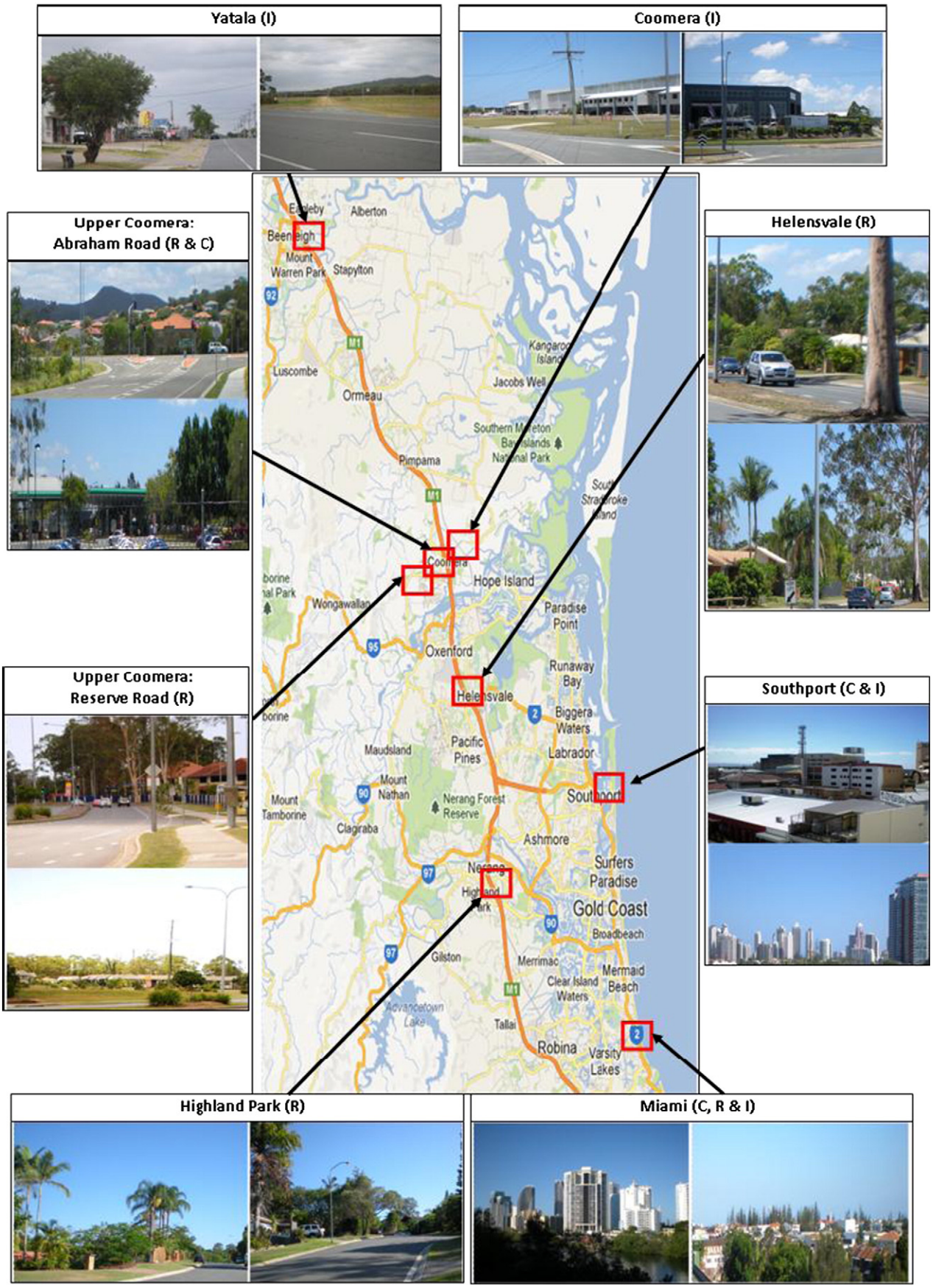

Fig. 1. Location map (R—residential); (I—industrial); (C—commercial). (map of Gold Coast adapted from Google Maps).