Atmospheric Input of Nutrients to the South-Western Continental Margin of India

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Introduction

The Northern Indian Ocean (NIO) is an important region in the global ocean in terms of the influence of monsoons, fluvial input as well as desert dust deposition. This region is one of the high biological productivity regions in the world ocean. In addition, anthropogenic perturbation seems to alter the climate thereby affecting changes in wind pattern, rainfall, and aridity over the South Asia (Crutzen, 1998; Smith, 2001; Ramanathan et al, 2001a; Lelieveld et al., 2001, Kaufman et al., 2002; Jickells et al., 2005, 2015; Kothawale and Rajeevan, 2017). In addition, regional air pollution during the winter is an escalating problem (Ramanathan et al., 2001b; Ramanathan and Feng, 2009). The occurrence of acid rain over the Northern and Central Indian Ocean is evidence for human impact on oceans (Kulshrestha, et al., 1999, 2001; Padmakumari et al., 2013; Vinoj et al., 2014). Nevertheless, atmospheric pollutants could be significant a source of nutrients, for instance, nitrate, iron and other essential trace elements. Air pollutants not only affect rainfall patterns in the major part of the globe (Rosenfeld, et al. 2002), but also alter bio-geo-chemical cycling of elements and carbon sequestration (Pabortsava et. al., 2017). The Northern Indian Ocean is influenced by the semi-annual reversal of monsoon wind patterns. During the winter, the major path of the north-east monsoon wind sweeps major part of South Asia, thereby transporting atmospheric dust of natural as well as anthropogenic origins. This study fulfils some of the objectives of the Surface Ocean – Lower Atmosphere programme (SOLAS; IGBP Report No. 50). Keeping in view the regional problems of the South Asia, this study has been undertaken to:

- determine nutrients characterization of the atmospheric dusts of local and regional origins,
- estimate atmospheric nutrient fluxes to the south-western continental margin of India;
- determine the episodic atmospheric input of nutrients compartment to the coastal ocean; and
- quantify relative magnitudes of nutrient fluxes from atmospheric and riverine compartments to the south-western continental margin of India, and their implications to primary productivity.

Area of investigation

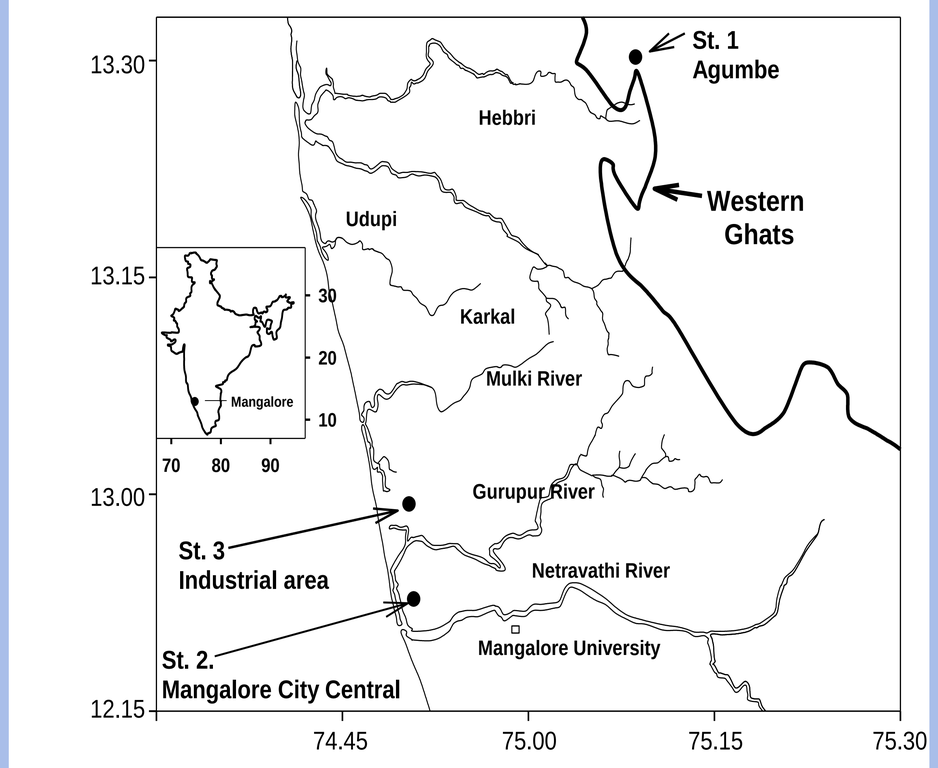

Figure 1. Map of the study area showing sample monitoring stations along the south-west coast of India.

Three monitoring stations have been selected:

Station-1 background area – Agumbe, the peak of Western Ghats. It is known as Cherrapunji in South India.

Station 2 - Urban area City Centre, Mangalore.

Station 3 - Baikampady industrial estate where most of industries located.

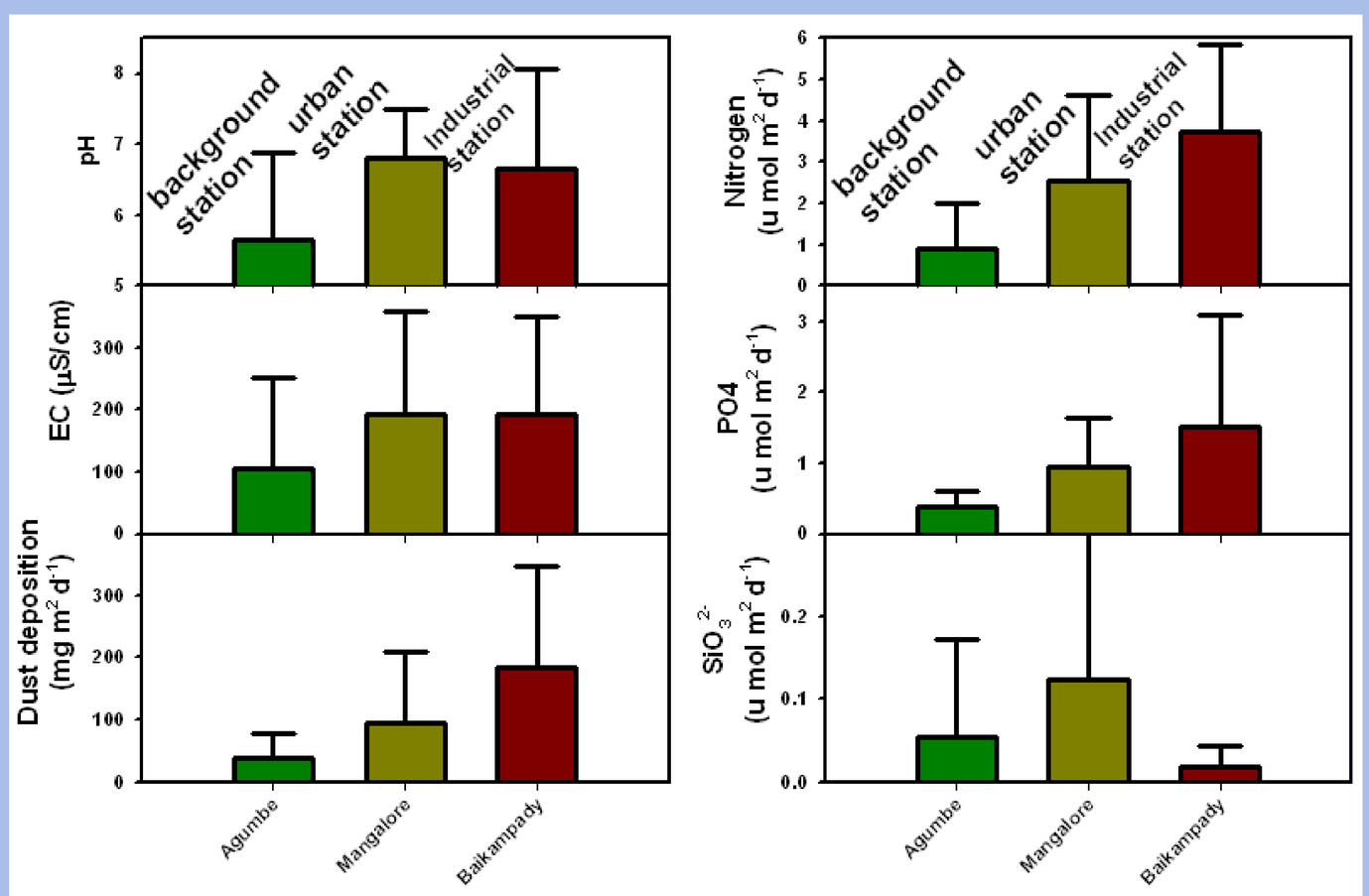

Fig. 2. Distribution of pH and EC, and deposition of dust, and associated nutrients around Mangalore, south-west coast of India.

Methodology

Using bulk precipitation collector, samples of dust collected (on the terrace of tall buildings) once in a fortnight during the winter season. Samples were washed with de-ionized water and filtered immediately after collection. The filtrate has been measured for physico-chemical parameters and nutrient concentration. A part of the filtrate has been acidified with the ultrapure nitric acid to measure trace elements. The residue collected on membrane filters has been preserved for further geochemical analysis.

Results and discussion

The pH at the pristine location was lower than that at urban and industrial stations, implying that the local dust neutralize acidic components in the atmosphere of the latter two stations. Whereas the electric conductivity (EC) was about 2-fold higher for the latter stations. Dust accumulation rates at urban and industrial sites higher by 2.5 to 5.0 times than the pristine location. Corroborating this, phosphate and nitrate fluxes steadily increase from pristine to industrial region. The atmospheric fluxes estimated for the background/pristine station considerably lower the anthropocentric regions of the coastal locations. This study indicates the importance of atmospheric input of nutrients in enhancing primary productivity in the south-western continental margin of India, particularly during the winter season. Sampling is continued to determine the seasonal importance of atmospheric input. Besides this, sample are processed trace elemental measurements to determine the input of biogeochemically important elements to the ocean.

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