Atmospheric Environment 45 (2011) 7705–7713

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Key issues in controlling air pollutants in Dhaka, Bangladesh

Bilkis A. Begum [a], Swapan K. Biswas [b], Philip K. Hopke [c,*]

[a] Chemistry Division, Atomic Energy Centre, Dhaka, Bangladesh
[b] Clean Air and Sustainable Environment Project, DoE, Dhaka, Bangladesh
[c] Center for Air Resources Engineering and Science, Clarkson University, Potsdam, NY, USA

ARTICLE INFO

Article history:
Received 28 June 2010
Received in revised form
7 September 2010
Accepted 13 October 2010

Keywords:
Positive Matrix Factorization
BC
Traffic
Compressed natural gas
Aerosol or particulate matter (PM)
Gent-stacked filter unit

ABSTRACT

Particulate matter (PM) sampling for both coarse and fine fractions was conducted in a semi-residential site (AECD) in Dhaka from February 2005 to December 2006. The samples were analyzed for mass, black carbon (BC), and elemental compositions. The resulting data set were analyzed for sources by Positive Matrix Factorization (EPA-PMF). From previous studies, it is found that, the air quality became worse in the dry winter period compared to the rainy season because of higher particulate matter concentration in the ambient air. . Therefore, seasonal source contributions were determined from seasonally segregated data using EPA-PMF modeling so that further policy interventions can be undertaken to improve air quality.

From the source apportionment results, it is observed that vehicular emissions and emission from brick kiln are the major contributors to air pollution in Dhaka especially in the dry seasons, while contribution from emissions from metal smelters increases during rainy seasons. The Government of Bangladesh is considering different interventions to reduce the emissions from those sources by adopting conversion of diesel/petrol vehicles to CNG, increasing traffic speed in the city and by introducing green technologies for brick production. However, in order to reduce the transboundary effect it is necessary to take action regionally.

1. Introduction

The visible impact of air pollution is haze, a layer of gaseous pollutants and particles from biomass burning, traffic, and industrial emission. This cloud of pollution at times has a brownish color and this brown cloud phenomenon is a common feature of industrial and rural regions around the world. At times, the South Asian brown haze (Ramanathan, 2008) covers most of the Arabian Sea, Bay of Bengal and the South Asian region. It occurs yearly and generally extends from November to April. Black carbon and other species in the haze reduce the average radiative heating of the ocean by as much as 10% and enhance the atmospheric solar radiative heating 50–100% (Pandve and Patil, 2008). Domestic wood and dung fires and smoke from the burning of forests and fields for agriculture are major contributors to the haze. In addition, vehicle exhaust, power plants and factory emissions also add to the haze. Gustafsson et al. (2009) have shown that biofuels combustion represents 50–90% of the black carbon emissions. INDOEX (Ramanathan et al., 2001) has revealed that this haze is transported far beyond the source region, particularly during December–April. This Asian Brown Cloud may be rapidly melting Himalayan glaciers (Kehrwald et al., 2008) and could lead to an environmental disaster that could affect billions of people.

During the last few decades, positive industrialization and urbanization trends have contributed to the significant population increase and economic development in many cities of the world. This rapid growth has led to the increased demand for transport, facilities, and supplies that have not always been met. In many cities, the economic expansion has occurred without appropriate development planning. The case of the Dhaka is similar to other mega cities in developing countries. Emissions from transport and brick industries have been previously identified as major contributing sources (Begum et al., 2004, 2005) that make the ambient air of Dhaka injurious to human health.

It has also found in multiple studies and Department of Environment monitoring results (Begum et al., 2010a) that during the rainy season, the particulate matter (PM) concentration in Dhaka air meets the daily Bangladesh National Ambient Air Quality Standard (BNAAQS). However, during the wintertime, the PM increases substantially and the resulting air quality cannot meet the

* Corresponding author.
E-mail address: hopkepk@clarkson.edu (P.K. Hopke).

1352-2310/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.atmosenv.2010.10.022

BNAAQS. As a result, the annual average remain always remains non-compliant with the standards.

The high level during wintertime is attributable to low wet deposition from low rainfall during this period. A large number of brick kilns around the city operate only in wintertime. In addition, transboundary air pollution may have some impact on local air pollution during this period because of prevailing regional meteorological conditions. Therefore, in this paper, almost two years (February 2005 to December 2006) of PM air pollution data were analyzed to explore seasonal pollution source patterns and compared with the previous results (Begum et al., 2010b). Efforts are also made in suggesting the key issues that need to be address in order to control air pollutants in Dhaka, Bangladesh from both local contributions and regional events.

2. Material and methods

2.1. Receptor site and aerosol sampling technique

A size-fractionating aerosol sampler, the Gent stacked filter unit (SFU) (Hopke et al., 1997) was used to collect particle samples in a semi-residential area of Dhaka that is situated inside the Atomic Energy Centre, Dhaka (AECD) campus. The location of Dhaka and the sampling station (23.73N, 90.38E) is shown in Fig. 1. There is relatively low local traffic, but the site is located approximately 1 km from a heavily trafficked road. Other high traffic roads lie to the north and northwest of the site. Private cars, buses, minibuses, and motor cycles operate on these heavily trafficked roads. The traffic density is about 165,000 per day. Private cars are the main

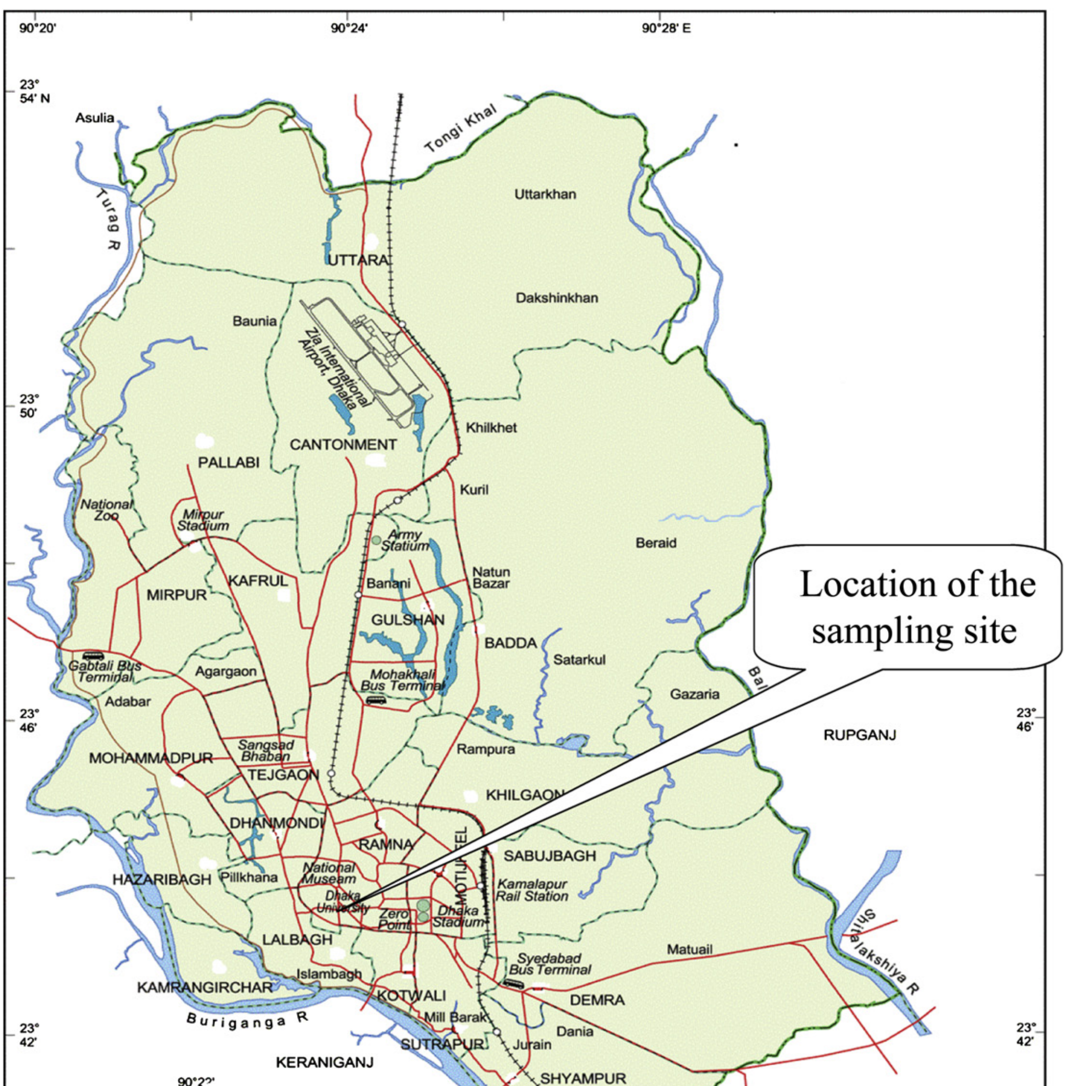

Fig. 1. Map of Dhaka, Bangladesh showing the location of the sampling site.