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Chemical fractionation of particulate-bound metal(loid)s to evaluate their bioavailability, sources and associated cancer risk in India

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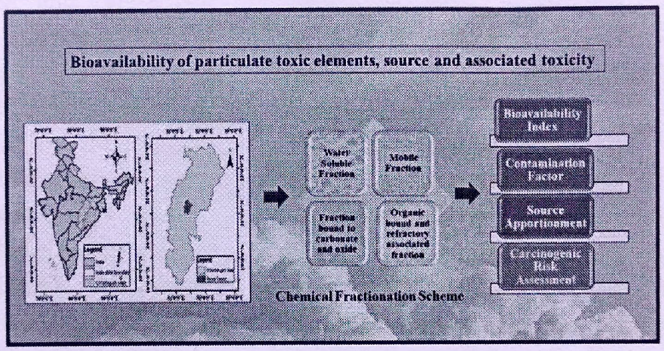
HIGHLIGHTS

- Chemical fractionation of 11 metal(loid)s in Indian ambient fine and coarse particulates
- $PM_{2.5}$ metal(loid)s bioavailable fractions are 2.4-fold higher than those for coarse mode.
- Mn has shown highest bioavailable fraction in both fine and coarse particulate mode.
- Source apportionment of fine and coarse particulate metal(loid)s bioavailable fractions
- Bioavailable index, contamination factors and Carcinogenic risks were estimated.

GRAPHICAL ABSTRACT



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ABSTRACT

Eleven potentially toxic metal(loid)s (Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, and Zn), proven source markers of mineral based coal-fired industrial emissions and vehicular exhausts, were analysed using the four steps sequential extraction method to evaluate metal(loid)s concentration, in total and fractions of bioavailable and non-bioavailable for fine ($PM_{2.5}$) and coarse ($PM_{10-2.5}$) particulate modes. A total of 26-day-wise samples with three replications (total number of samples = 78) were collected in January–December 2019 for each PM_{10} and $PM_{2.5}$ at an urban-residential site in India. In both the coarse and fine particulate modes, Pb and Cr have respectively shown the highest and lowest total concentrations of the measured metal(loid)s, indicating the presence of coal-fired power plants and heavy vehicular activities near to study area. In addition, Mn has shown highest bioavailable fraction for both coarse and fine particulate modes. More than 50 % of metal(loid)s concentration, in total to a bioavailable fraction (BAF) were observed in case of As, Cd, Cr, Co, Mn, Ni, and Pb of $PM_{2.5}$. Mn and Zn have shown similar behaviour in the case of coarse particulate mode. Source apportionment of metal(loid)s bioavailable fractions using positive matrix factorization (PMF 5.0) has found three significant sources: crustal and natural dust (30.04 and 39 %), road traffic (49.57 and 20 %), and industrial emission (20.39 and 41 %) for coarse and fine particulate mode, respectively. Cancer risk through the inhalation pathway was high in total concentration but lower in BAF concentration in both age groups (children and adults).

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BTEX in Ambient Air of India: a Scoping Review of their Concentrations, Sources, and impact

Aishwaryashri Tamrakar · Shamsh Pervez · Madhuri Verma · Dipanjali Majumdar · Yasmeen Fatima Pervez · Carla Candeias · Princy Dugga · Archi Mishra · Sushant Ranjan Verma · Manas Kanti Deb · Kamlesh Shrivas · Manmohan L. Satnami · Indrapal Karbhal

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Abstract Toxic gaseous organic air pollutants such as benzene, toluene, ethylbenzene, and xylene isomers (m, p, and o-x) (BTEX) are considered hazardous due to its adverse impacts on human health and on climate change. This review identifies the major research questions addressed so far and the research gap in research articles, published between 2001 and 2022, focusing on the ambient BTEX concentrations in different locations in India along with its sources, ozone formation potential (OFP), and associated health risks. The ambient levels of BTEX were also compared with those of other Asian countries. A comparison of ambient BTEX levels with different microenvironments in India is also presented. BTEX concentrations were found in the range of 30.95 to 317.18 μg m^{-3} and multi-fold higher in urban environments than those measured in the rural air. In most reported studies, the order of occurrence of BTEX compounds was toluene > benzene > xylene isomers > ethylbenzene and winter had higher concentrations than in other seasons, including summer. As far as BTEX levels in classified areas of urban environments are concerned, traffic locations have shown the highest BTEX concentrations, followed by residential, commercial, and industrial locations. OFP indicated that xylene isomers and toluene contributed to ozone formation. The major gaps in reported studies on BTEX measurement are (1) source apportionment; (2) impact on lower tropospheric chemistry, human health, and climate change; and (3) removal techniques from air.

Keywords BTEX · Ozone formation potential (OFP) · Volatile organic compound (VOCs)

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Article

Atmospheric Abundance of $PM_{2.5}$ Carbonaceous Matter and Their Potential Sources at Three High-Altitude Glacier Sites over the Indian Himalayan Range

Sushant Ranjan Verma, Shamsh Pervez,* Papiya Mandal, Judith C. Chow, John G. Watson, Syed Muzaffarali Andrabi, Madhuri Verma, Princy Dugga, Noor Afshan Khan, Yasmeen Fatima Pervez, Archi Mishra, Manas Kanti Deb, Indrapal Karbhal, Suresh Tiwari, Kallol K. Ghosh, Kamlesh Shrivas, and Manmohan Lal Satnami

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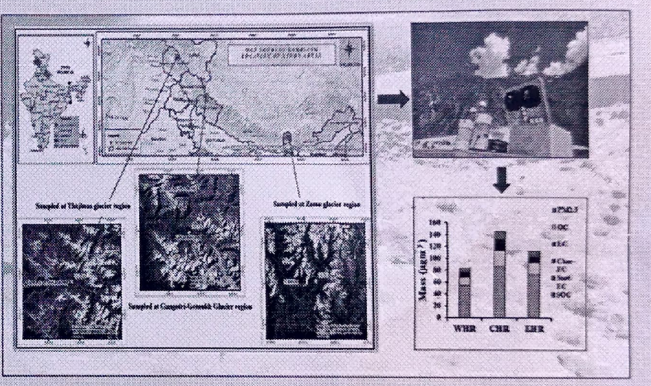
ABSTRACT: This study inspects the concentrations of fine particulate matter ($PM_{2.5}$) mass and carbonaceous species, including organic carbon (OC) and elemental carbon (EC), as well as their thermal fractions in the Indian Himalayan glacier region at the western Himalayan region (WHR; Thajiwas glacier, 2799 m asl), central Himalayan region (CHR; Gomukh glacier, 3415 m asl), and eastern Himalayan region (EHR; Zemu glacier, 2700 m asl) sites, throughout the summer and winter periods of 2019−2020. Ambient $PM_{2.5}$ samples were collected on quartz fiber filters using a low-volume sampler, followed by carbon (OC and EC) quantification using the IMPROVE_A thermal/optical reflectance methodology. Different seasonal variations in $PM_{2.5}$ and carbonaceous species levels were found at all three sites investigated. Averaged $PM_{2.5}$ mass ranged 55−87 $\mu g\ m^{-3}$ with a mean of 55.45 ± 16.30 $\mu g\ m^{-3}$ at WHR, 86.80 ± 35.73 $\mu g\ m^{-3}$ at CHR, and 72.61 ± 24.45 $\mu g\ m^{-3}$ at EHR. Among the eight carbon fractions, high-temperature OC4 (evolved at 580 °C in the helium atmosphere) was the most prevalent carbon fraction, followed by low-temperature OC2 (280 °C) and EC1 (580 °C at 2% oxygen and 98% helium). Char-EC representing incomplete combustion contributed to 56, 67, and 53% of total EC, whereas soot-EC contributed to 38, 26, and 43% of total EC in WHR, CHR, and EHR, respectively. The measured OC/EC ratios imply the presence of secondary organic carbon, whereas char-EC/soot-EC ratios suggested that biomass burning could be the predominant source of carbon at CHR, whereas coal combustion and vehicular emission might be dominant sources at WHR and EHR sites.



KEYWORDS: *$PM_{2.5}$, Himalayan glacier aerosol, carbonaceous matters, char-EC and soot-EC, secondary organic aerosol, biomass burning*

1. INTRODUCTION

Carbonaceous aerosols, including organic and elemental carbon, are important components of suspended particulate matter (PM), especially in the respirable fraction with aerodynamic diameters less than 2.5 μm($PM_{2.5}$).[1] These carbonaceous aerosols work as climate forcing[2] agents and contribute to glacier retreat via interactions with solar radiation in the atmosphere.[3,4] The Himalayan glacier contains the most extensive glacial area outside the polar regions and is also known as the "Third pole".[5] Severe glacier retreat in the Himalayan region has the potential to disrupt water availability to billions of residents living in the Indo-Gangetic plain.[5−11] Because of lower population density and minimal industrial activities, the Himalayan region is considered to be one of the most pristine region, alongside the Arctic and Antarctic.

However, the emergence of atmospheric brown clouds (ABCs) over south Asia raised environmental concerns.[12−14] Numerous studies have suggested that long-range transport of pollutants from the Indo-Gangetic plain to the Himalayan region during premonsoon is the vital factor.[15,16] In addition, local sources from low lands of the Himalayan region also contribute to air pollution.[17] Most of studies were conducted in the foothills[18−20] rather than high altitudes of the Himalayan region.[21−23] This study measures ambient $PM_{2.5}$ and carbonaceous matter (OC and EC) over three subregions of Himalayan glacier locations to evaluate associated spatiotem-

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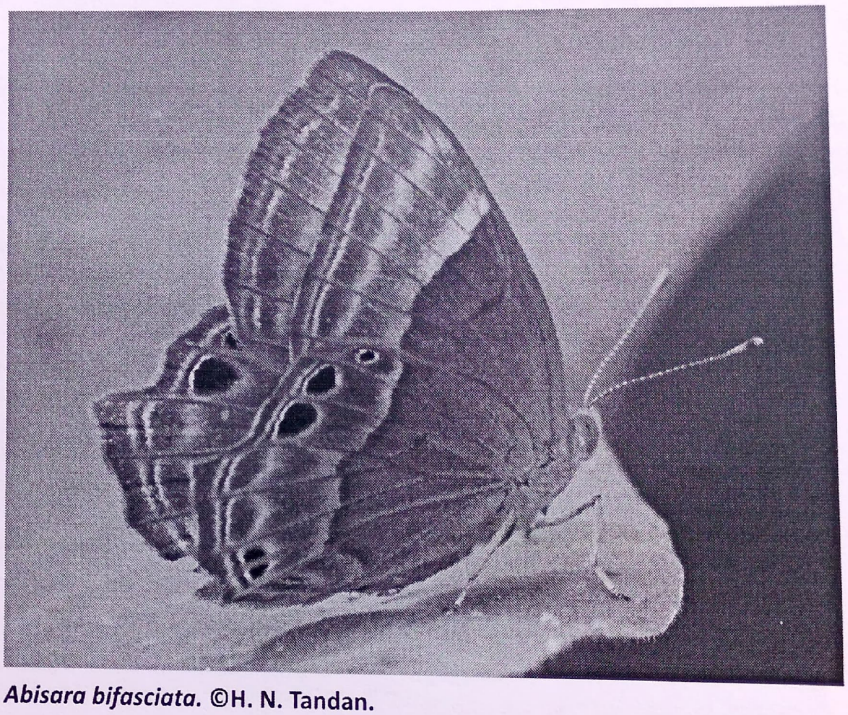
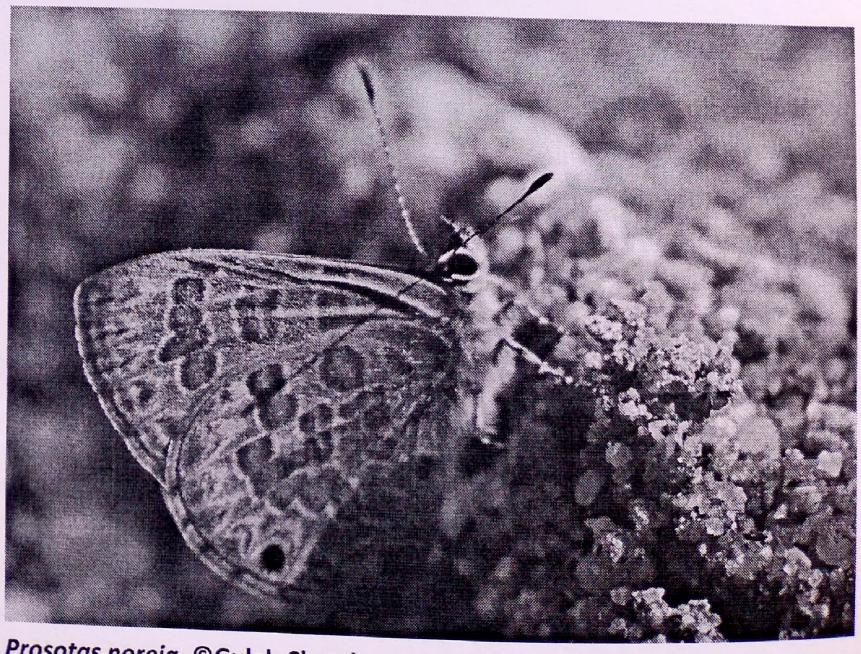
Butterflies of Rhishijharan Waterfall, Gariaband, with three additions to the state fauna of Chhattisgarh, India

Recent studies on butterflies from Chhattisgarh list 170 species, last updated with addition of Black Spotted Pierrot (Chand et al. 2022). The major contribution has been made by Sisodia (2019) who added 19 new records and listed 159 species from Chhattisgarh based on Chandra et al. (2014) and Dubey et al. (2015). Further addition to tally 170, has been made by Sisodia & Khirsagar (2020), Tandan et al. (2020, 2021a & b,) and Nihlani et al. (2021). Here we report three butterfly species for the first time from Chhattisgarh.



Abisara bifasciata. ©H. N. Tandan.

Our survey area was restricted to the Rishijharan Waterfall (19.7798 & 82.5837), which is located in the Deobhog block of Gariaband District in the vicinity of Udanti-Sitanadi Tiger Reserve in Chhattisgarh, India. Rishijharan Waterfall is a small seasonal waterfall where the water flows in full force during the rainy season only, whereas a trickle of water continues throughout the year



Prosotas noreia. ©Gulab Chand.

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at Chhattisgarh; hence the presence of *A. bifasciata* in Chhattisgarh has been confirmed with this report and there are already records from Surguja, Raipur, Dhamtari, Gariaband, Bastar, and Kondagaon districts of Chhattisgarh on IFB.

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