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Contribution of post-harvest agricultural paddy residue fires in the N.W. Indo-Gangetic Plain to ambient carcinogenic benzenoids, toxic isocyanic acid and carbon monoxide

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In the North West Indo-Gangetic Plain (N.W.IGP), large scale post-harvest paddy residue fires occur every year during the months of October–November. This anthropogenic perturbation causes contamination of the atmospheric environment with adverse impacts on regional air quality posing health risks for the population exposed to high concentrations of carcinogens such as benzene and toxic VOCs such as isocyanic acid. These gases and carbon monoxide are known to be emitted from biomass fires along with acetonitrile. Yet no long-term in-situ measurements quantifying the impact of this activity have been carried out in the N.W. IGP. Using high quality continuous online in-situ measurements of these gases at a strategic downwind site over a three year period from 2012 to 2014, we demonstrate the strong impact of this anthropogenic emission activity on ambient concentrations of these gases. In contrast to the pre-paddy harvest period, excellent correlation of benzenoids, isocyanic acid and CO with acetonitrile (a biomass burning chemical tracer); ($r \geq 0.82$) and distinct VOC/acetonitrile emission ratios were observed for the post-paddy harvest period which was also characterized by high ambient concentrations of these species. The average concentrations of acetonitrile (1.62 ± 0.18 ppb), benzene (2.51 ± 0.28 ppb), toluene (3.72 ± 0.41 ppb), C8-aromatics (2.88 ± 0.30 ppb), C9-aromatics (1.55 ± 0.19 ppb) and CO (552 ± 113 ppb) in the post-paddy harvest periods were about 1.5 times higher than the annual average concentrations. For isocyanic acid, a compound with both primary and secondary sources, the concentration in the post-paddy harvest period was 0.97 ± 0.17 ppb. The annual average concentrations of benzene, a class A carcinogen, exceeded the annual exposure limit of 1.6 ppb at NTP mandated by the National Ambient Air Quality Standard of India (NAAQS). We show that mitigating the post-harvest paddy residue fires can lower the annual average concentration of benzene and ensure compliance with the NAAQS. Calculations of excessive lifetime cancer risk due to benzene amount to 25 and 10 per million inhabitants for children and adults, respectively, exceeding the USEPA threshold of 1 per million inhabitants. Annual exposure to isocyanic acid was close to 1 ppb, the concentration considered to be sufficient to enhance risks for cardiovascular diseases and cataracts. This study makes a case for urgent mitigation of post-harvest paddy residue fires as the unknown synergistic effect of multi-pollutant exposure due to emissions from this anthropogenic source may be posing grave health risks to the population of the N.W. IGP.

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