

Thesis title:

Aerosol Emission Inventory for Residential Sector of India based on Fuel Use Survey and On-field Emission Measurement

Abstract:

The previous emission estimate for cooking activity based on secondary data and lab-based emission measurements has been questioned for its representativeness. The present work addresses these drawbacks by integrating extensive country-wide survey data on fuel types, stove technologies, and cooking processes into a multivariate regression modeling framework to estimate district-level fuel users. Further, a bottom-up methodology was used to estimate fuel consumption for 7 types of fuel used at the district level. To improve the emission factors, a newly developed Versatile Source Sampling System (VS3) has been used for on-field emission measurement from the traditional cookstoves. District-level emission estimates (Gg yr^{-1}) of $\text{PM}_{2.5}$, OC, EC, CO, and CO_2 for the base year 2022 were calculated by integrating activity data (in kg) with emission factors (g/kg) and were spatially distributed on a $0.01^\circ \times 0.01^\circ$ grid using population data.

The study found significant persistence of solid biomass fuel (SBF) use for cooking activity, with 62% of the rural population still relying on SBF dominated fuel mix. The national total fuel consumption for the base year 2022 was 306 Mtyr^{-1} , of which 88% comprised SBF (276 Mtyr^{-1}) and 7% (21.7 Mtyr^{-1}) was LPG. The on-field emissions measurement showed the difference in emission factor while using single fuel versus mixed fuel. The emission factor for fuelwood with dung cake was comparable to that of fuelwood, but comparatively lower than dung cake when used individually. However, for fuelwood with crop residue and dung cake with crop residue, the emission factors were reduced by approximately 30% compared to their respective single-fuel counterparts. The OC/ $\text{PM}_{2.5}$ ratio, indicative of incomplete combustion, is higher for crop residue and mixed fuels under field conditions, particularly at higher burn rates, reflecting inefficient combustion. In contrast, EC/ $\text{PM}_{2.5}$ ratios remain low and variable for dung cake and crop residue, indicating limited elemental carbon formation. The present study estimates the annual emission of $\text{PM}_{2.5}$, OC, and EC at the national level as 3620 (1439-5803) Ggyr^{-1} , 1557 (582-2532) Ggyr^{-1} , and 357 (125-589) Ggyr^{-1} , respectively.

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