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Source attribution and mitigation strategies for air pollution in Delhi

Gregor Kiesewetter (1), Pallav Purohit (1), Wolfgang Schoepp (1), Jun Liu (1), Markus Amann (1), and Anil Bhanarkar (2)

(1) International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria (kiesewet@iiasa.ac.at), (2) National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur, 440020, India

Indian cities, and the megacity of Delhi in particular, have suffered from high air pollution for years. Recent observations show that ambient concentrations of fine particulate matter ($PM_{2.5}$) in Delhi strongly exceed the Indian national ambient air quality standards as well as the World Health Organization's interim target levels. At the same time, India is experiencing strong urbanization, and both Delhi's emissions as well as the exposed population are growing. Therefore the question arises how $PM_{2.5}$ concentrations will evolve in the future, and how they can be improved efficiently.

In the past, typical responses of the Delhi government to high pollution episodes have been restrictions on motorized road traffic, on power plant operations and on construction activities. However, to design sustainable and efficient pollution mitigation measures, the contribution of different source sectors and spatial scales needs to be quantified. Here we combine the established emission calculation scheme of the Greenhouse Gas - Air Pollution Interactions and Synergies (GAINS) model with regional chemistry-transport model simulations (0.5° resolution) as well as local particle dispersion (2×2 km resolution) to arrive at a source attribution of ambient $PM_{2.5}$ in Delhi. Calculated concentrations compare well to observations. We find that roughly 60% of total population-weighted $PM_{2.5}$ originates from sources outside the national capital territory of Delhi itself. Consequently, mitigation strategies need to involve neighboring states and address the typical sources there. We discuss the likely evolution of ambient concentrations under different scenarios which assume either current emission control legislation, or application of a Clean Air Scenario foreseeing additional regulations in non-industrial sectors which are often overlooked, such as phase-out of solid fuel cookstoves, and road paving. Only in the case where the Clean Air Scenario is applied both in Delhi as well as in surrounding states, a strong reduction in ambient concentrations is envisaged which would bring $PM_{2.5}$ levels close to the WHO interim targets.