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Effect of aerosols on ecosystem productivity: a double-edged sword in climate change

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Rapid climate change exerts a burden on terrestrial primary productivities, which perturb the carbon budget. Being an atmospheric pollutant, a high load of aerosols dampens/overweigh the diffuse radiation; likewise, optimal aerosol load upsurges diffuse radiation and enhance plant photosynthesis (Net Primary Productivity; NPP). This cascading effect is inevitable for understanding the enviro-climate feedbacks, backing which, the present study is framed for multiple ecosystems of India using MODIS products with Carnegie-Ames Stanford Approach (CASA) model. The sensitivity of NPP to aerosol loading was analysed on a decadal scale, isolated for 2001 – 2020. The analysis revealed that, for the Indian scenario, when the overall AOD was greater than 42% above the threshold, i.e., relatively more than 0.81, it cribs NPP. Contrastingly, NPP was influenced when the AOD was at 14% (0.32). The analysis highlighted that the maximum NPP for the forest ecosystems was observed when AOD was 0.38, and the growth persisted with higher AOD until 0.51. In contrast, the agroecosystem's NPP growth was restricted at 0.59, and maximum growth was observed with 0.49. Even though agroecosystems indicated the maximum NPP growth with higher AOD, the fertilisation effects were comparatively lower than the forest ecosystem due to the consistent, intense AOD load over the croplands (especially over the Indo Gangetic Pain belt). This indicated that the vegetational adaptiveness in the agrosystems to the effect of aerosol was weaker than the forest-based ecosystems. Presumably, anthropogenic interventions in cropland management (biomass burning) may also have steered the sensitivity responses of NPP. Based on the analysis, the presented study elucidates the need for considering the intricating aerosol effects on ecosystem productivity in projecting the Indian terrestrial carbon cycle under changing climate.

Keywords: Aerosol; CASA; India; Net primary productivity; Radiative forcing; Terrestrial carbon cycle