

Substantial terrestrial carbon emissions from global expansion of impervious surface area

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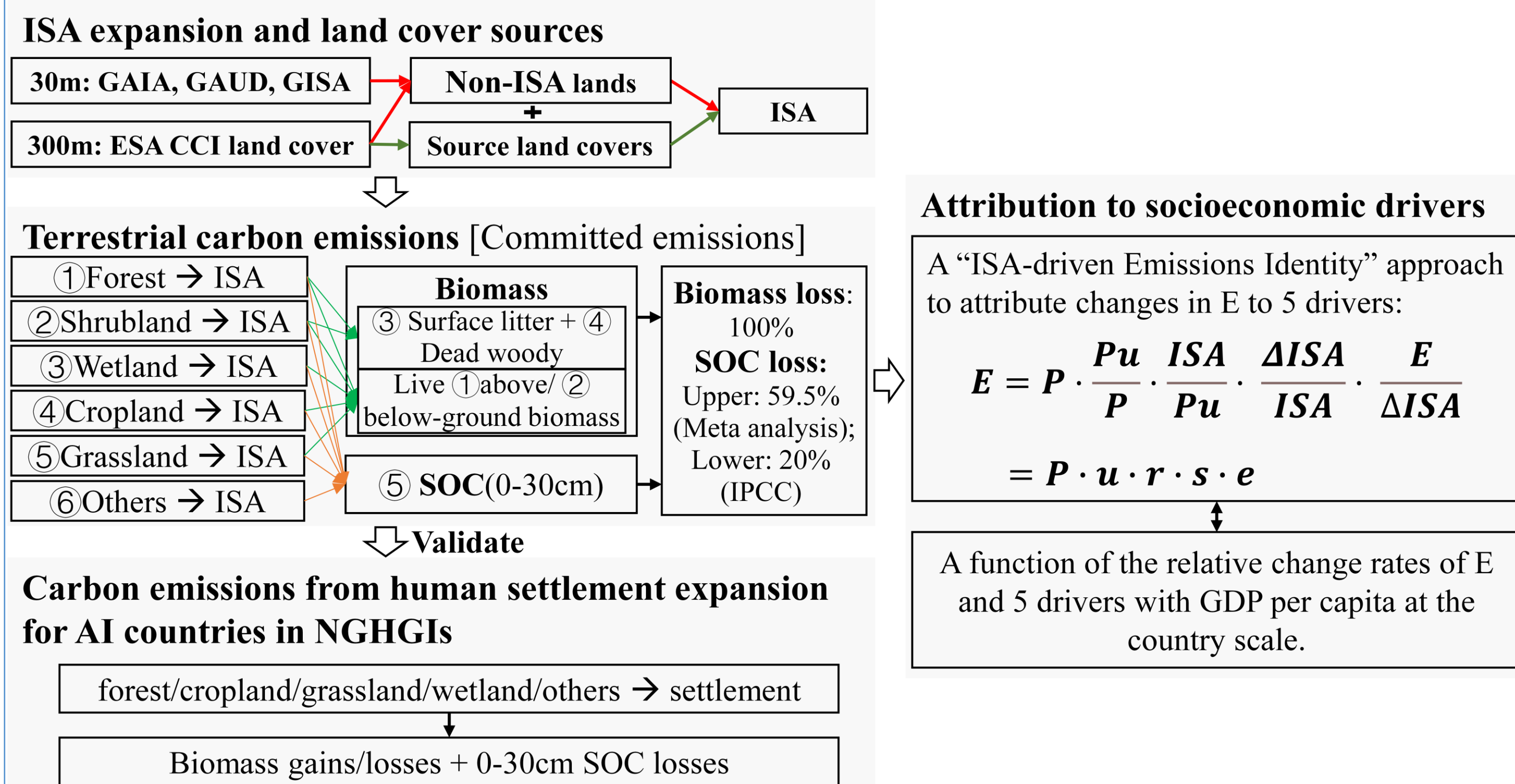
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Background

Global impervious surface area (ISA) has more than doubled over the last three decades, but the associated carbon losses resulting from the depletion of pre-existing land carbon stores are neglected by the Global Carbon Project and remain unknown.

Methods



Global ISA expansion and the associated carbon emissions over 1993–2018

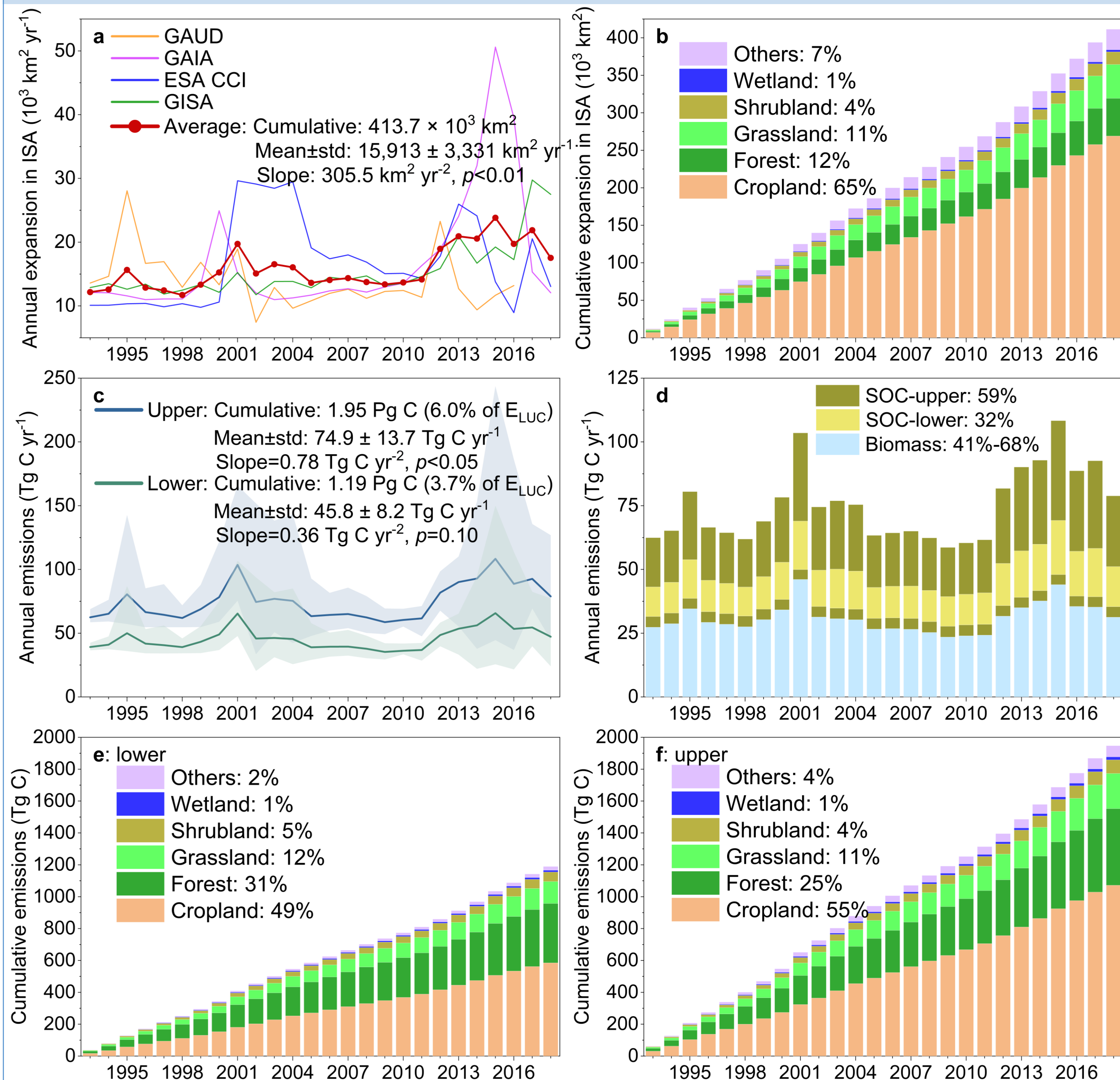


Fig. 1 Global ISA expansion and the associated carbon emissions over 1993–2018. a, Global annual increases in ISA. b, the land cover sources of the cumulative ISA expansions. c, Annual carbon losses of ISA expansion with upper and lower boundaries. d, Annual carbon losses from biomass and SOC, respectively. e and f represent cumulative carbon losses from different source land covers with the lower and upper boundary, respectively.

Comparisons with Annex I countries

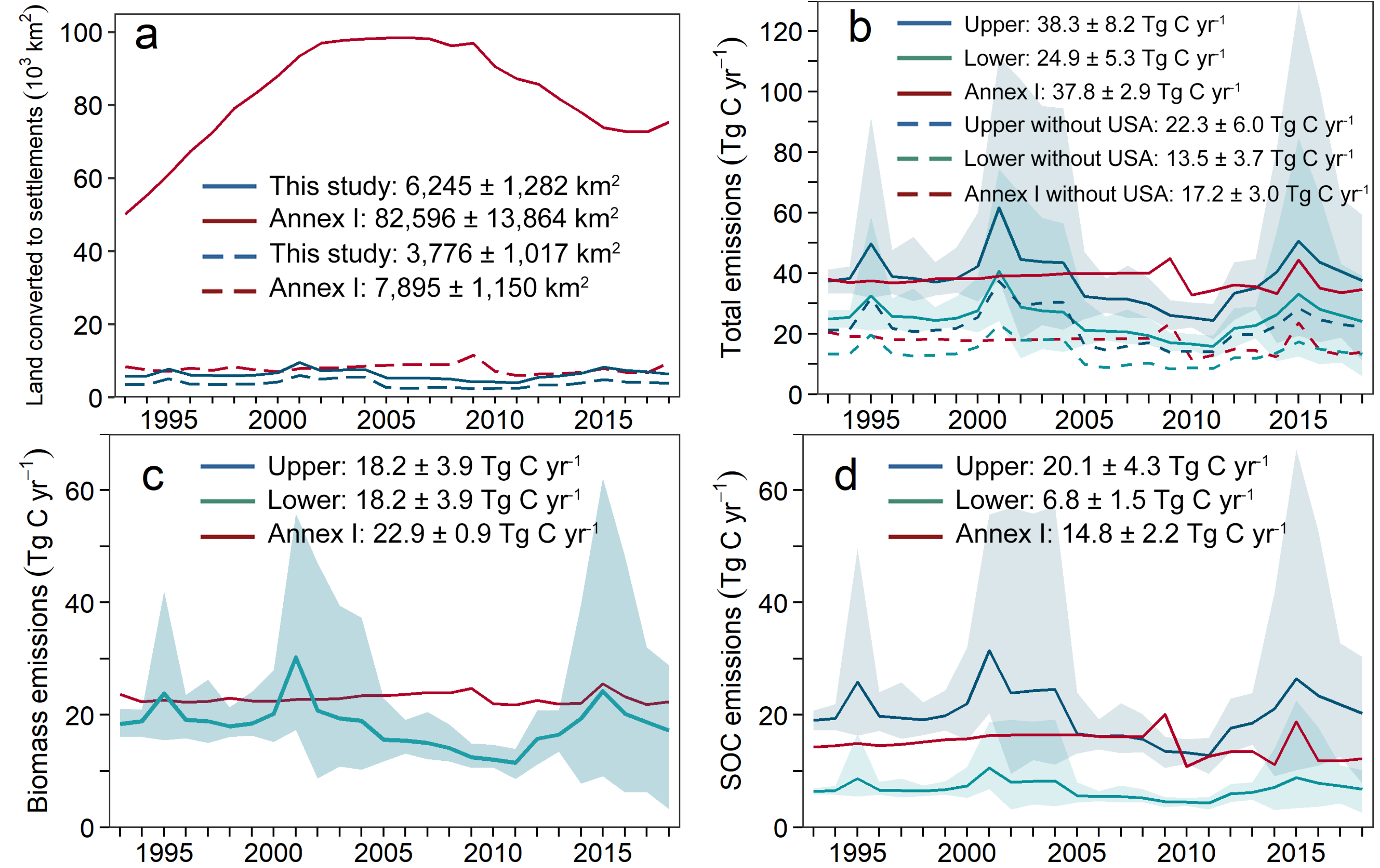


Fig. 2 Comparisons of ISA expansion and associated carbon emissions with those reported by AI countries in NGHGs. a, Land area converted to settlements/ISA. b, Total carbon emissions due to settlement/ISA expansions. c, ISA-driven biomass carbon emissions. d, ISA-driven SOC carbon emissions.

Socioeconomic drivers for ISA-driven carbon emissions

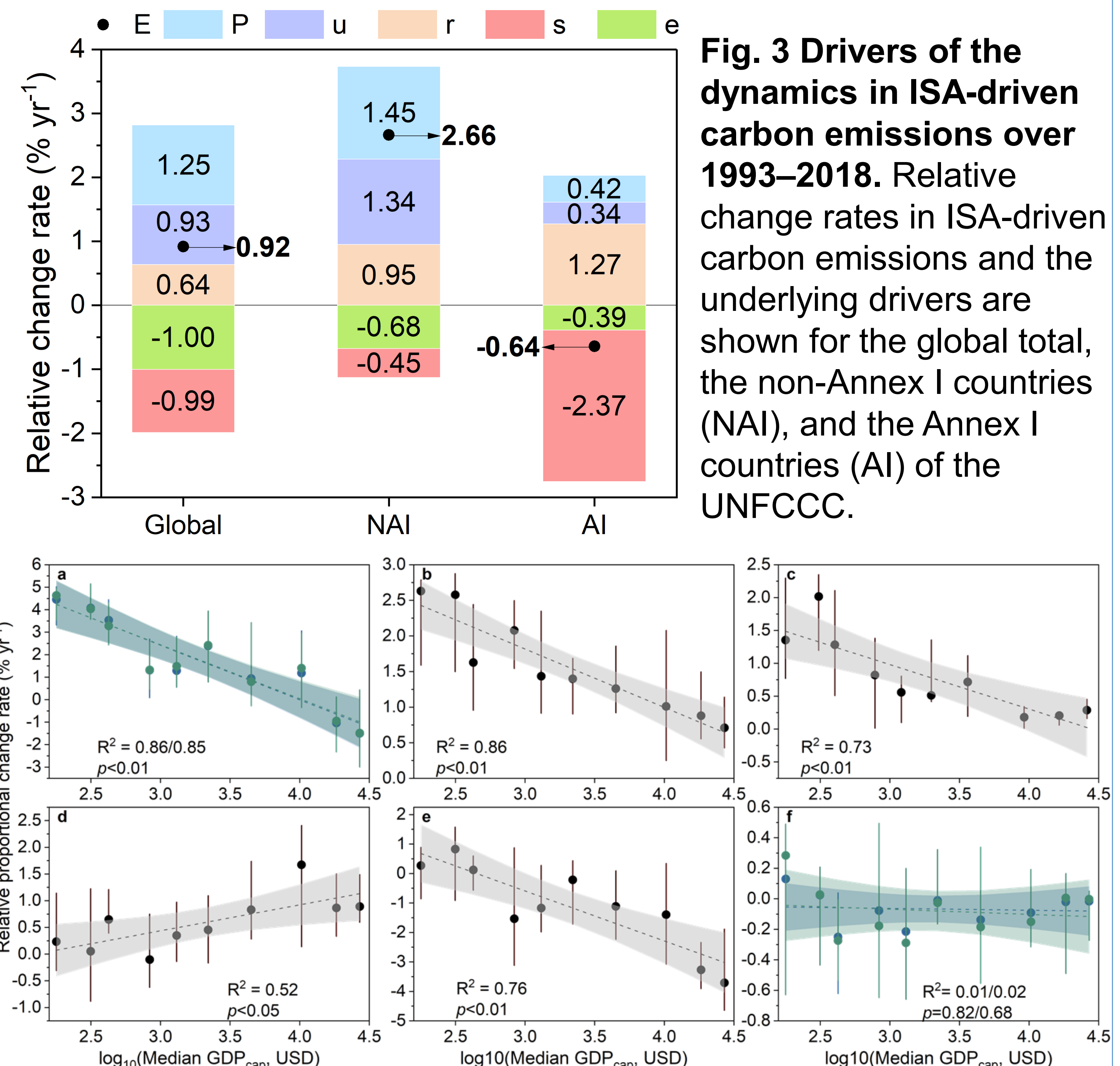


Fig. 3 Drivers of the dynamics in ISA-driven carbon emissions over 1993–2018. Relative change rates in ISA-driven carbon emissions and the underlying drivers are shown for the global total, the non-Annex I countries (NAI), and the Annex I countries (AI) of the UNFCCC.

Fig. 4 Relationships between relative proportional change rates in ISA-driven carbon emissions and the underlying drivers over 1993–2018 and per capita GDP. a, The relative change rate in carbon emissions (E). b–f, The relative change rates in P, u, r, s, and e, respectively.