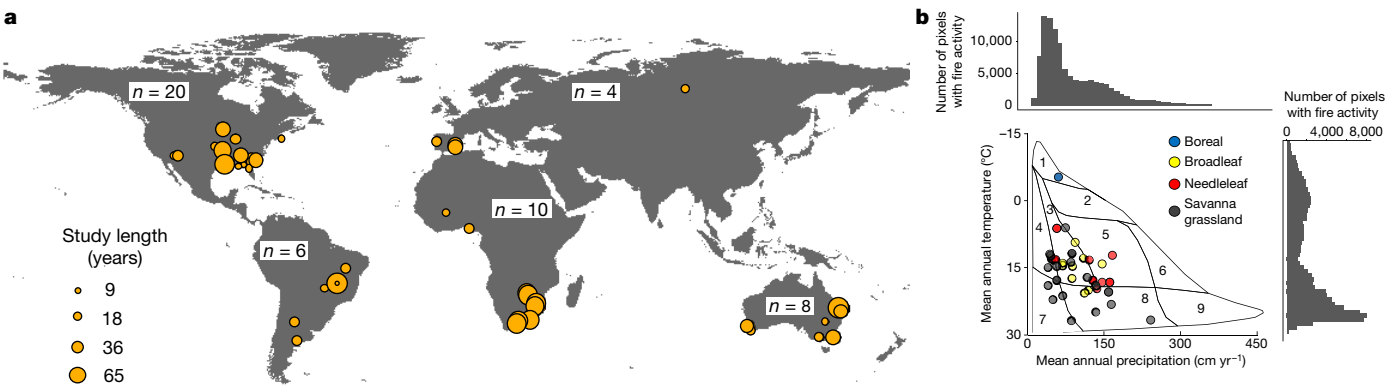

Figure 1 | Distribution of study sites. a, Geographical distribution of sites ($n = 48$), with dot size representing study duration. **b**, Climatic distribution of sites. Bottom left, vegetation types are indicated by different colours plotted over a modified diagram of Whittaker's biomes[30] (1, tundra; 2, boreal forest; 3, woodland/shrubland; 4, temperate grassland/desert; 5, temperate forest; 6, temperate rainforest; 7, subtropical desert; 8, tropical forest and savanna; 9, tropical rainforest). Dots are slightly transparent to allow overlap to be visualized. The histograms above and to the right illustrate the frequency distribution of global fire activity for a given climatic condition. Fire activity was determined using gridded maps of mean fire occurrence taken from the global fire emissions database 4 with small fires (GFED4s)[7].

a broad range of mean annual temperature (−5–27 °C) and precipitation (410–2,410 mm yr^{-1}) (Fig. 1b and Supplementary Fig. 2). To evaluate whether fire effects depended on plant communities, we categorized sites on the basis of the dominant plant functional type into savanna grasslands, broadleaf forests and needleleaf forests. Statistical significance was evaluated using mixed-effects models of the logarithmic response ratio (natural logarithm of the quotient between elemental concentration in elevated and protected plots), weighted by site replication and variance[19] (Supplementary Fig. 3).

We found that elevated fire frequencies substantially decreased total soil C and nitrogen (N) concentrations globally, with the largest effects observed in broadleaf forests and savanna grasslands. Averaged across all sites, vegetation types, and treatment lengths, higher fire frequencies reduced the concentrations of total soil C and N concentrations by 12.1% (confidence interval ±10.2%; $P = 0.02$) and 10.4% (±10.0%; $P = 0.04$), respectively, compared with plots protected from fire (Fig. 2a, b and Supplementary Table 1; 30-year mean treatment length). Within vegetation types, fires had strong depletion effects on soils in both broadleaf forests (27% less C and 25% less N in elevated versus protected plots; $P < 0.001$ and $P = 0.02$, respectively) and savanna grasslands (21% less C and N in elevated versus protected plots; $P < 0.001$ for each; Fig. 2a, b and Supplementary Table 1). By contrast, soil C and N in needleleaf forests increased by 26% and 21%, respectively, in elevated compared with protected plots ($P < 0.001$ for each; Fig. 2a, b and Supplementary Table 1). The different responses that we observed in needleleaf forests were unlikely to be caused by climatic variables or study design, given that, in our dataset, there were no differences between sites in temperate needleleaf forests and those in savanna

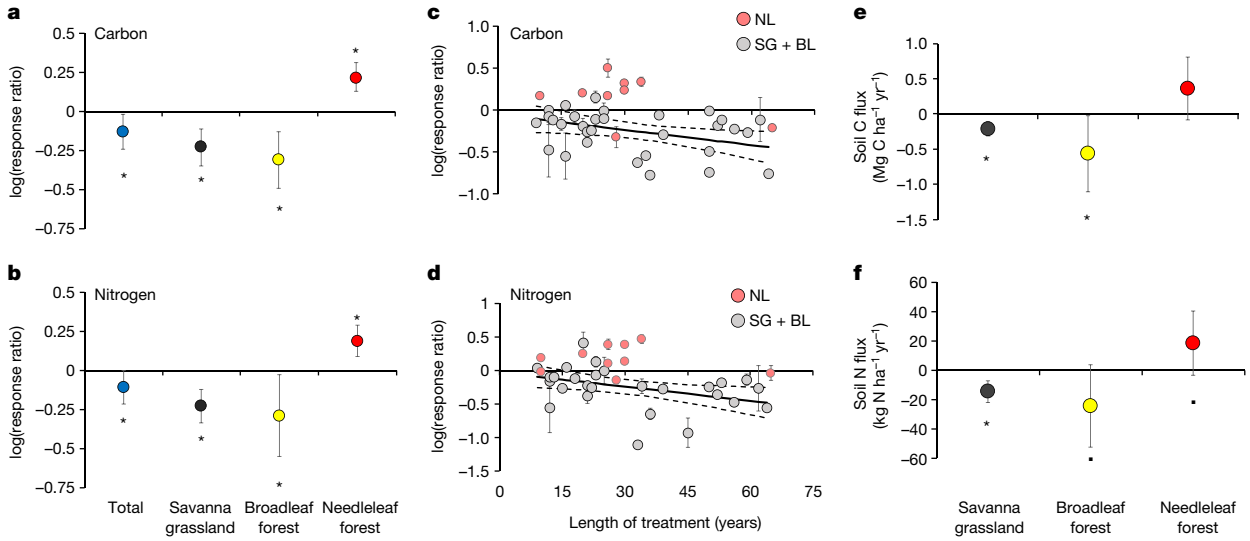

Figure 2 | Effects of fire on soil carbon and nitrogen across ecosystems and over time. a, **b**, Logarithmic response ratios of the concentrations of C (**a**, $n = 41$) and N (**b**, $n = 38$) for the total dataset compiled and partitioned into different vegetation types (see Supplementary Tables 1 and 2 for statistics). The response ratio is defined as the concentration of C or N in elevated plots divided by the concentration in protected plots. **c**, **d**, Regressions between the response ratios of C (**c**, $n = 31$) or N (**d**, $n = 27$) and the length of time during which plots experienced contrasting fire frequencies, fitted for savanna grasslands (SG) plus broadleaf forests (BL) using a meta-regression. Pink dots represent data from needleleaf forests (NL), which were not used in the regression. **e**, **f**, Total fluxes of C (**e**) and N (**f**), determined as the absolute rate of change in soil C or N between the fire frequency treatments (negative values indicate losses under frequent burning). Dashed lines represent 95% confidence intervals (for **c**, **d**) and error bars represent either 95% confidence intervals (for **a**, **b**, **e**, **f**) or the variance around the logarithmic response ratio (for **c**, **d**; see ref. 19), with asterisks indicating significance at $P < 0.05$ and dots at $P < 0.10$ (Supplementary Tables 4 and 5).