Methods

Total terrestrial carbon uptake projections featured in the IPCC Third Assessment report (*S1*) were partitioned into tree and soil carbon accumulation using data provided in (*S2*).

In our calculations of likely future N supply, the low N supply limit is the sum of 0.64 Pg N from increased biological N fixation and 0.52 Pg N from N deposition. The high N supply limit is the sum of 2.87 Pg N from increased biological N fixation, 0.27 Pg N from reduced N leaching, and 2.98 Pg N from anthropogenic N deposition.

Three lines of evidence support the assumption that 5 to 10% of deposited nitrogen can support carbon storage. First, less than 5% of currently deposited nitrogen supports increased terrestrial carbon storage, assuming that 0.6 Pg C yr^{-1} of the current annual terrestrial carbon sink is a result of nitrogen deposition to forests with a C:N of 200 (*S3*) and that current rates of atmospheric nitrogen deposition to the terrestrial surface are 80 Tg per year (*S4*). Second, in ^{15}N tracer experiments, very low recovery in some forests indicates that a substantial fraction of the reactive nitrogen deposited to these ecosystems will not enhance their carbon storage (*S5*). Third, nitrogen deposition does not necessarily occur where nitrogen most strongly limits net primary production (*S3*), a spatial discrepancy that is likely to increase with greater nitrogen deposition in already industrialized areas.

The estimate that elevated CO_2 will increase N fixation by 10% (low) to 45% (high) broadly reflects the findings that elevated CO_2 sometimes (*S6*)—but not always (*S7*)—stimulates nitrogen fixation. However, it probably favors nitrogen accumulation, because the largest increases in nitrogen fixation are in intensively managed ecosystems (*S6*) that are not likely to be representative of much of the terrestrial surface.

The estimated decline in nitrogen leaching with CO_2 doubling by 0 to 20% reflects the range of responses from empirical studies, but may overestimate nitrogen accumulation, because elevated CO_2 can reduce NO_3 leaching in agricultural ecosystems (*S8*), but may have no effect in non-agricultural ecosystems (*S9*).

Higher rates of soil nitrogen mineralization caused by climate change (*S10*) will likely enhance nitrogen losses through both leaching and gaseous pathways, but we did not include these possible changes in our calculations, again favoring nitrogen accumulation in our scenarios of future nitrogen availability.

Increasing soil C:N from 15 to between 17.1 and 22.7 for the CO_2-only simulations, or between 15.4 and 18.3 for the combined simulations, would allow projected increases in soil carbon without additional nitrogen inputs. However, along a continuous gradient of atmospheric CO_2 from 200 to 550 ppmV, nitrogen mineralization declines as soil C:N increases (*S11*). Based on these experimental data, if soil C:N were to increase enough to fully accommodate projected soil carbon accumulation, a 23 to 84% decline in nitrogen mineralization would be expected for the CO_2-only simulations, and a 6 to 37% decline for the combined simulations.

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