Appendix 1: Research on global change and soil nutrients

Table A1. Summary of previous research on global change and nitrogen availability.

Author	Global change factor examined	Experimental system	Effect on soil nitrogen	Proposed mechanisms
Niklaus et al., 1998	Elevated CO_2	Annual calcareous grassland (FACE)	CO_2 increased microbial N pools, decreased plant-available N, had no effect on plant N pools	Increased N mineralization or N retention
Hungate et al., 1999	Elevated CO_2	Florida scrub oak (chambers)	CO_2 increased N fixation, decreased leaching and N mineralization, increased immobilization	Stimulation of microbial and plant N demand; altered C cycling
Hungate et al., 1997	Elevated CO_2	California annual grassland (chambers)	CO_2 increased gross N mineralization and plant N uptake	Increase in soil moisture
Arnone, 1997	Elevated CO_2	Alpine grassland (chambers)	CO_2 had no effect on plant N uptake or soil N availability	No change in soil moisture
Hu et al., 2001	Elevated CO_2	California annual grassland (chambers)	CO_2 increased plant N uptake and decreased soil N availability (especially in later growing season)	Plant demand for N increased; plants outcompeted microbes
Williams et al., 2001	Elevated CO_2	Kansas prairie (chambers)	CO_2 had no effect on N transformations, but increased microbial N demand	Greater amounts of C and water available to microbes
Gloser et al., 2000	Elevated CO_2 and N deposition	*Lolium perenne* monoculture (FACE)	CO_2 had no effect on N mineralization, N loss or plant N uptake	No change in soil moisture; downregulation of NO_3^- uptake by plants
Hagedorn et al., 2002	Elevated CO_2 and N deposition	Spruce and beech forest (chambers)	CO_2 increased NH_4^+ in calcareous sand, decreased NH_4^+ in acidic loam; decreased NO_3^- in both soils	Microbial immobilization of N; changes in root uptake kinetics
Gorrisen & Cotrufo, 1999	Elevated CO_2 and N deposition	Three grass species in pots (greenhouse)	CO_2 decreased plant N content; did not affect microbial biomass N or N mineralization	Microbes did not successfully compete with plants for N
Hungate et al., 1997	Elevated CO_2 and N deposition	California annual grassland (chambers)	CO_2 increased N immobilization, decreased nitrification; no effect on gross mineralization	Increased root production and C:N ratio stimulate microbes

Table A1. (continued)

Diaz et al., 1993	Elevated CO_2 and N deposition	Tall herb community (greenhouse)	CO_2 increased soil microbial N at both low and high N availability; plants showed N deficiency	Microbes more active; competed successfully with plants for N
Zak et al., 1993	Elevated CO_2 and N deposition	*Populus tremuloides* (chambers)	CO_2 increased net N mineralization and total plant biomass; total N unaffected	Below-ground C inputs stimulated microbial turnover rates
Zak et al., 2000*b*	Elevated CO_2 and N deposition	*Populus tremuloides* (chambers)	CO_2 had no effect on N mineralization, immobilization, or nitrification	Root exudates made up an insignificant fraction of soil carbon
Martin-Olmedo et al., 2002	Elevated CO_2 and N deposition	*Hordeum disticum* (chambers)	CO_2 increased total N taken up by plants, increased microbial biomass; total and inorganic N in soil unaffected; denitrification unaffected	Enhanced nutrient release from soil organic matter (microbial processes speeded up)
Mikan et al., 2000	Elevated CO_2 and organic N	Aspen monoculture (chambers)	CO_2 increased plant N uptake; gross N mineralization not affected	Both microbial immobilization and microbial turnover increased, canceling out
Niklaus et al., 2001	Elevated CO_2 and plant species diversity	Annual calcareous grassland (FACE)	CO_2 and high species diversity both reduced soil nitrate	Decrease in nitrification rates, increase in soil moisture leading to more effective N uptake by plants
Reich et al., 2001	Elevated CO_2, N deposition, plant species diversity	Minnesota prairie (FACE)	CO_2 had no effect on N mineralization; increased plant N content and decreased N min. under increased sp. diversity	Niche complimentarity and positive interspecies interactions
Thayer et al., 2002	Elevated CO_2, water, and N	California annual grassland (chambers)	Water and CO_2 increased community N pools; nitrogen addition decreased community N pools	Changes in plant biomass and species composition
Loiseau & Soussana, 2000	Elevated CO_2, temperature, and N deposition	*Lolium perenne* monoculture (chambers)	CO_2 had no effect on total soil N, but increased N immobilization late in season; temperature helped to reverse this effect	Microbes competed successfully with plants for N; warming increased microbial turnover
Tscherko et al., 2001	Elevated T	Forbs and grasses (greenhouse)	Temperature had no effect on microbial biomass N or N mineralization	Undeveloped soil and root profile, excessive water content