

Effects of charcoal production on carbon cycling in African biomes

Dabwiso Sakala and Maria J. Santos



**University of
Zurich^{UZH}**



24th May 2022

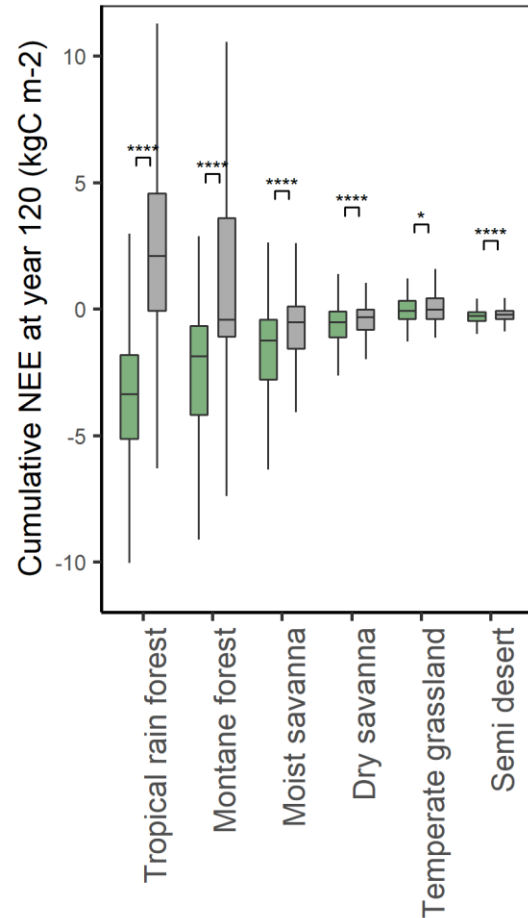


How did historical charcoal production impact the magnitude and direction of carbon fluxes in different biomes?

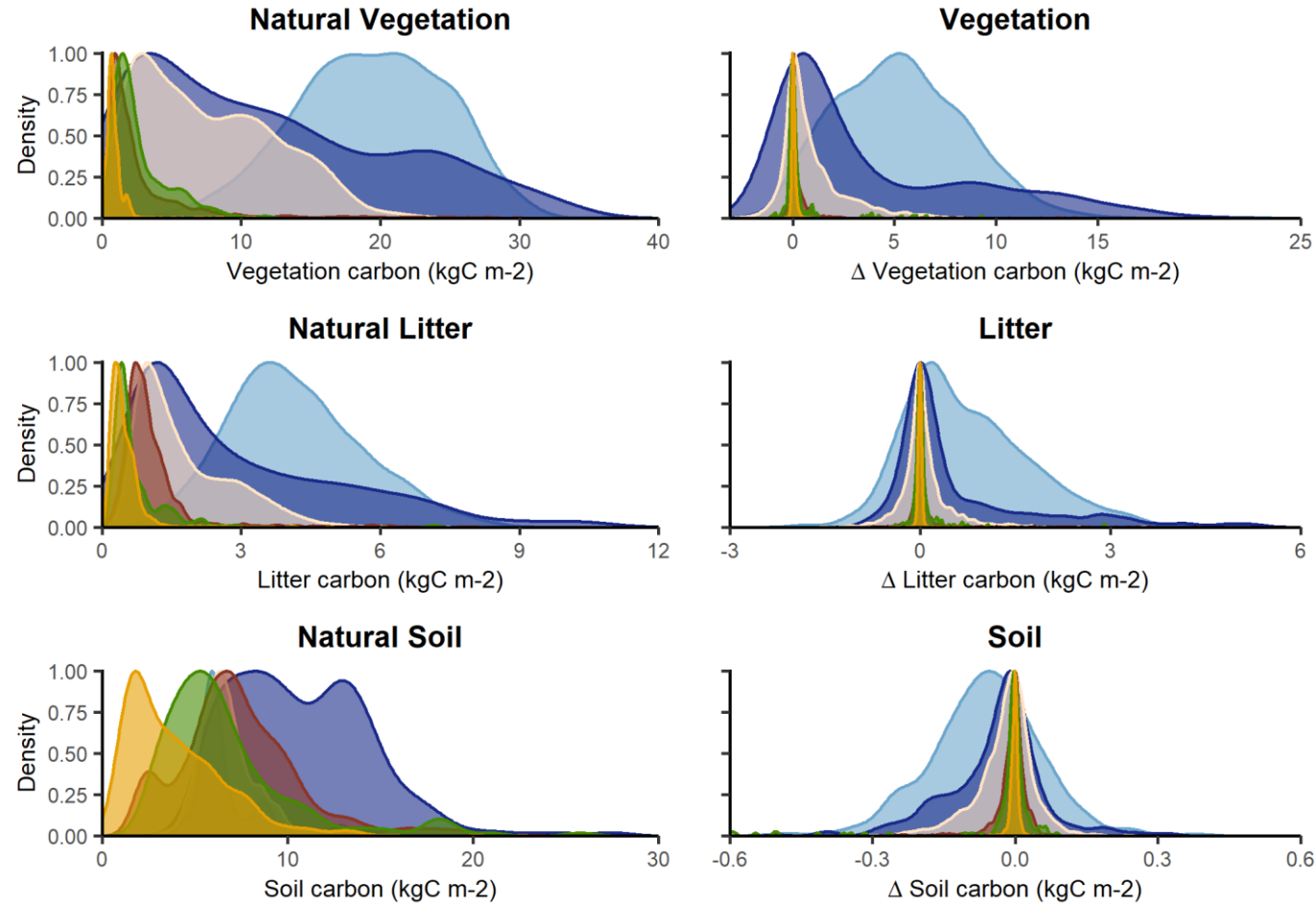
We simulated annual percentage forest cut for charcoal from 1961 to 2020 based on FAOSTAT data (simulated 120 years from 1901 to 2020)

NEE cummulative at year 120			Mean vegetation carbon at year 120		
Biome	Natural (kgC m ⁻²)	Historical (kgC m ⁻²)	Biome	Natural (kgC m ⁻²)	Historical (kgC m ⁻²)
Tropical Rain Forest	-3.56 ± 2.59	2.46 ± 3.43	Tropical Rain Forest	19.40 ± 5.28	14.09 ± 3.23
Montane Forest	-2.73 ± 2.80	1.87 ± 4.94	Montane Forest	11.83 ± 8.92	7.87 ± 4.80
Moist Savanna	-1.79 ± 2.00	-0.79 ± 1.95	Moist Savanna	7.72 ± 4.92	6.76 ± 3.88
Dry Savanna	-0.97 ± 1.58	-0.30 ± 2.02	Dry Savanna	3.26 ± 4.57	2.63 ± 2.76
Temperate Grassland	0.13 ± 1.14	0.53 ± 2.20	Temperate Grassland	2.71 ± 2.07	2.32 ± 1.54
Semi Desert	-0.34 ± 0.59	-0.22 ± 0.69	Semi Desert	1.07 ± 1.85	0.95 ± 1.26
Mean litter carbon at year 120			Mean soil carbon at year 120		
Biome	Natural (kgC m ⁻²)	Historical (kgC m ⁻²)	Biome	NEE Natural (kgC m ⁻²)	Historical (kgC m ⁻²)
Tropical Rain Forest	4.17 ± 1.42	3.41 ± 0.93	Tropical Rain Forest	6.90 ± 2.17	6.96 ± 2.18
Montane Forest	2.92 ± 2.27	2.25 ± 1.27	Montane Forest	10.80 ± 3.77	10.84 ± 3.79
Moist Savanna	1.79 ± 1.04	1.73 ± 0.92	Moist Savanna	6.91 ± 1.78	6.93 ± 1.79
Dry Savanna	1.08 ± 0.85	1.03 ± 0.61	Dry Savanna	7.43 ± 3.37	7.44 ± 3.37
Temperate Grassland	0.75 ± 0.71	0.69 ± 0.51	Temperate Grassland	6.87 ± 3.91	6.90 ± 4.01
Semi Desert	0.48 ± 0.41	0.48 ± 0.36	Semi Desert	4.02 ± 2.80	4.03 ± 2.80

How did historical charcoal production impact the magnitude and direction of carbon fluxes in different biomes?



■ natural ■ managed

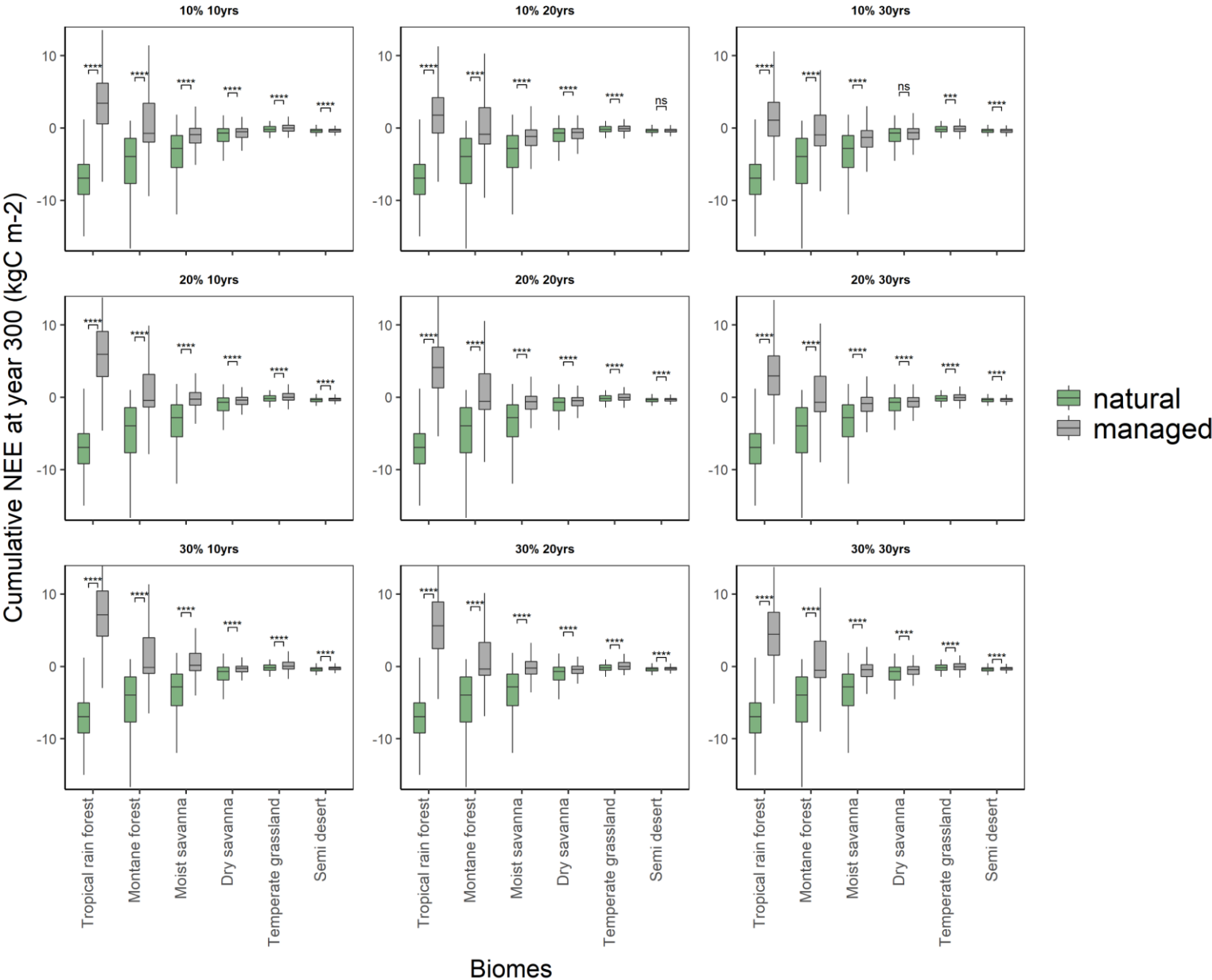


■ Tropical rain forest ■ Montane forest ■ Moist savanna ■ Dry savanna ■ Temperate grassland ■ Semi desert

Negative values indicate carbon sink while positive values are for carbon loss

How does the magnitude and direction of carbon fluxes in different biomes vary with charcoal production?

We varied charcoal management regimes by percentage forest cut (10%, 20%, 30%) and rotation frequency (10, 20, 30 years) (simulated 300 years from 1901 to 2200)



How does the magnitude and direction of carbon fluxes in different biomes vary with charcoal production?

				Cumulative NEE at year 300 (kgC m ⁻²)						
	Natural	10%10yrs	10%20yrs	10%30yrs	20%10yrs	20%20yrs	20%30yrs	30%10yrs	30%20yrs	30%30yrs
Tropical Rain Forest	-7.27 ± 3.20	3.53 ± 3.90	2.04 ± 3.64	1.47 ± 3.57	6.17 ± 4.33	4.19 ± 3.94	3.10 ± 3.74	7.98 ± 4.58	5.85 ± 4.24	4.66 ± 3.97
Montane Forest	-5.67 ± 5.31	1.11 ± 5.35	0.40 ± 4.99	-0.02 ± 4.75	2.48 ± 6.02	1.39 ± 5.43	0.86 ± 5.10	3.54 ± 6.60	2.32 ± 5.82	1.56 ± 5.40
Moist Savanna	-3.49 ± 3.04	-1.10 ± 2.11	-1.46 ± 2.07	-1.66 ± 2.07	-0.08 ± 2.23	-0.73 ± 2.10	-1.04 ± 2.06	0.74 ± 2.50	-0.08 ± 2.19	-0.48 ± 2.13
Dry Savanna	-1.64 ± 2.68	-0.70 ± 2.18	-0.84 ± 2.08	-0.92 ± 2.08	-0.35 ± 2.35	-0.57 ± 2.15	-0.71 ± 2.09	-0.10 ± 2.55	-0.34 ± 2.27	-0.51 ± 2.18
Temperate Grassland	-0.08 ± 1.08	0.28 ± 1.45	0.18 ± 1.40	0.11 ± 1.36	0.46 ± 1.68	0.33 ± 1.59	0.19 ± 1.38	0.61 ± 1.89	0.45 ± 1.64	0.29 ± 1.51
Semi Desert	-0.59 ± 1.38	-0.39 ± 0.83	-0.44 ± 0.79	-0.46 ± 0.86	-0.31 ± 0.89	-0.37 ± 0.81	-0.41 ± 0.80	-0.24 ± 0.98	-0.31 ± 0.83	-0.36 ± 0.80

How does the magnitude and direction of carbon fluxes in different biomes vary with charcoal production?

				Vegetation carbon at year 300 (kgC m-2)						
	Natural	10%10yrs	10%20yrs	10%30yrs	20%10yrs	20%20yrs	20%30yrs	30%10yrs	30%20yrs	30%30yrs
Tropical Rain Forest	22.10 ±5.89	12.41 ±2.29	13.30 ±2.77	13.44 ±2.87	9.83 ±1.49	11.05 ±1.96	11.53 ±2.20	8.04 ±1.16	9.31 ±1.47	9.80 ±1.66
Montane Forest	14.09 ±10.19	7.97±4.01	8.36 ±4.34	8.37 ±4.37	6.57 ±3.09	7.24 ±3.56	7.40 ±3.69	5.53 ±2.43	6.24 ±2.92	6.59 ±3.15
Moist Savanna	9.05 ±5.73	6.67 ±3.27	6.93 ±3.51	7.03 ± 3.54	5.60 ±2.57	6.08 ±2.91	6.25 ±3.03	4.75 ±2.03	5.32 ±2.46	5.55 ±2.60
Dry Savanna	3.82 ±5.25	2.96 ±2.81	3.05 ±2.93	3.10 ±3.00	2.59 ±2.25	2.74 ±2.51	2.83 ±2.60	2.30 ±1.83	2.48 ±2.11	2.57 ±2.22
Temperate Grassland	2.86 ±2.22	2.52 ±1.67	2.59 ±1.74	2.63 ±1.79	2.30 ±1.36	2.39 ±1.47	2.48 ±1.61	2.11 ±1.12	2.25 ±1.31	2.35 ±1.42
Semi Desert	1.27 ±2.48	1.11 ±1.35	1.14 ±1.43	1.15 ±1.47	1.01 ± 1.12	1.06 ±1.25	1.09 ±1.31	0.95 ±0.92	1.00 ±1.07	1.03 ±1.13

How does the magnitude and direction of carbon fluxes in different biomes vary with charcoal production?

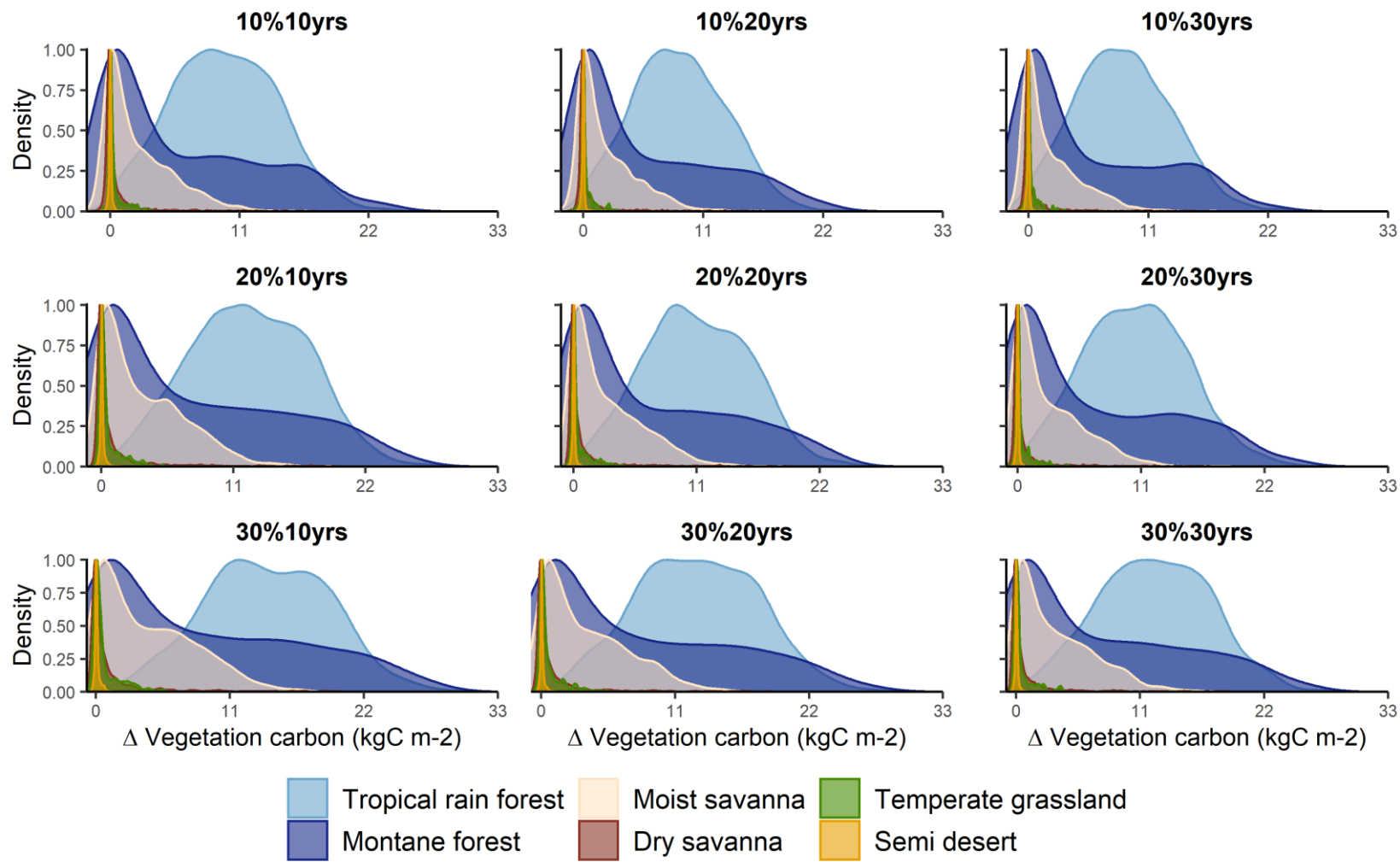
				Litter carbon at year 300 (kgC m-2)						
	Natural	10%10yrs	10%20yrs	10%30yrs	20%10yrs	20%20yrs	20%30yrs	30%10yrs	30%20yrs	30%30yrs
Tropical Rain Forest	4.99 ±1.172	3.80 ±0.92	4.42 ±1.14	4.88 ±1.35	3.74 ±0.84	4.53 ±1.11	5.15 ±1.21	3.73 ±0.79	4.61 ±1.64	5.32 ±1.29
Montane Forest	3.46 ±2.59	2.72 ±1.60	3.08 ±1.96	3.51 ±2.35	2.74 ±1.53	3.20 ±1.97	3.60 ±2.32	2.73 ±1.50	3.26 ±1.97	3.71 ±2.38
Moist Savanna	2.09 ±1.30	2.03 ±1.09	2.15 ±1.22	2.26 ±1.34	2.06 ±1.05	2.25 ±1.24	2.41 ±1.41	2.07 ±1.02	2.36 ±1.28	2.55 ±1.45
Dry Savanna	1.18 ±1.08	1.09 ±0.74	1.14 ±0.89	1.19 ±1.02	1.11 ±0.72	1.18 ±0.92	1.24 ±1.07	1.13 ±0.72	1.21 ±0.93	1.29 ±1.13
Temperate Grassland	0.79 ±0.78	0.77 ±0.67	0.79 ±0.69	0.83 ±0.75	0.79 ±0.65	0.84 ±0.73	0.88 ±0.83	0.81 ±0.64	0.86 ±0.74	0.92 ±0.85
Semi Desert	0.51 ±2.48	0.48 ±0.45	0.49 ±0.52	0.50 ±0.56	0.48 ±0.44	0.50 ±0.53	0.51 ±0.61	0.48 ±0.44	0.50 ±0.53	0.52 ±0.63

How does the magnitude and direction of carbon fluxes in different biomes vary with charcoal production?

				Soil carbon at year 300 (kgC m-2)						
	Natural	10%10yrs	10%20yrs	10%30yrs	20%10yrs	20%20yrs	20%30yrs	30%10yrs	30%20yrs	30%30yrs
Tropical Rain Forest	7.08 ±2.19	7.17 ±2.23	7.15 ±2.22	7.12 ±2.21	7.17 ±2.22	7.14 ±2.22	7.12 ±2.20	7.15 ±2.22	7.13 ±2.22	7.12 ±2.21
Montane Forest	10.95 ±3.81	11.02 ±3.84	10.99 ±3.82	10.97 ±3.83	11.03 ±3.84	11.00 ±3.83	10.97 ±3.82	11.03 ±3.84	11.00 ±3.83	10.97 ±3.81
Moist Savanna	6.99 ±1.78	7.04 ±1.79	7.03 ±1.79	7.01 ±1.78	7.06 ±1.79	7.03 ±1.79	7.02 ±1.78	7.07 ±1.79	7.04 ±1.79	7.03 ±1.78
Dry Savanna	7.43 ±3.29	7.44 ±3.29	7.44 ±3.29	7.43 ±3.29	7.45 ±3.29	7.44 ±3.29	7.44 ±3.29	7.46 ±3.28	7.45 ±3.29	7.44 ±3.29
Temperate Grassland	6.88 ±3.89	6.89 ±3.90	6.88 ±3.89	6.88 ±3.88	6.90 ±3.91	6.89 ±3.89	6.89 ±3.90	6.91 ±3.92	6.90 ±3.91	6.89 ±3.90
Semi Desert	4.05 ±2.79	4.05 ±2.79	4.05 ±2.79	4.05 ±2.79	4.05 ±2.79	4.05 ±2.79	4.05 ±2.79	4.05 ±2.80	4.05 ±2.79	4.05 ±2.79

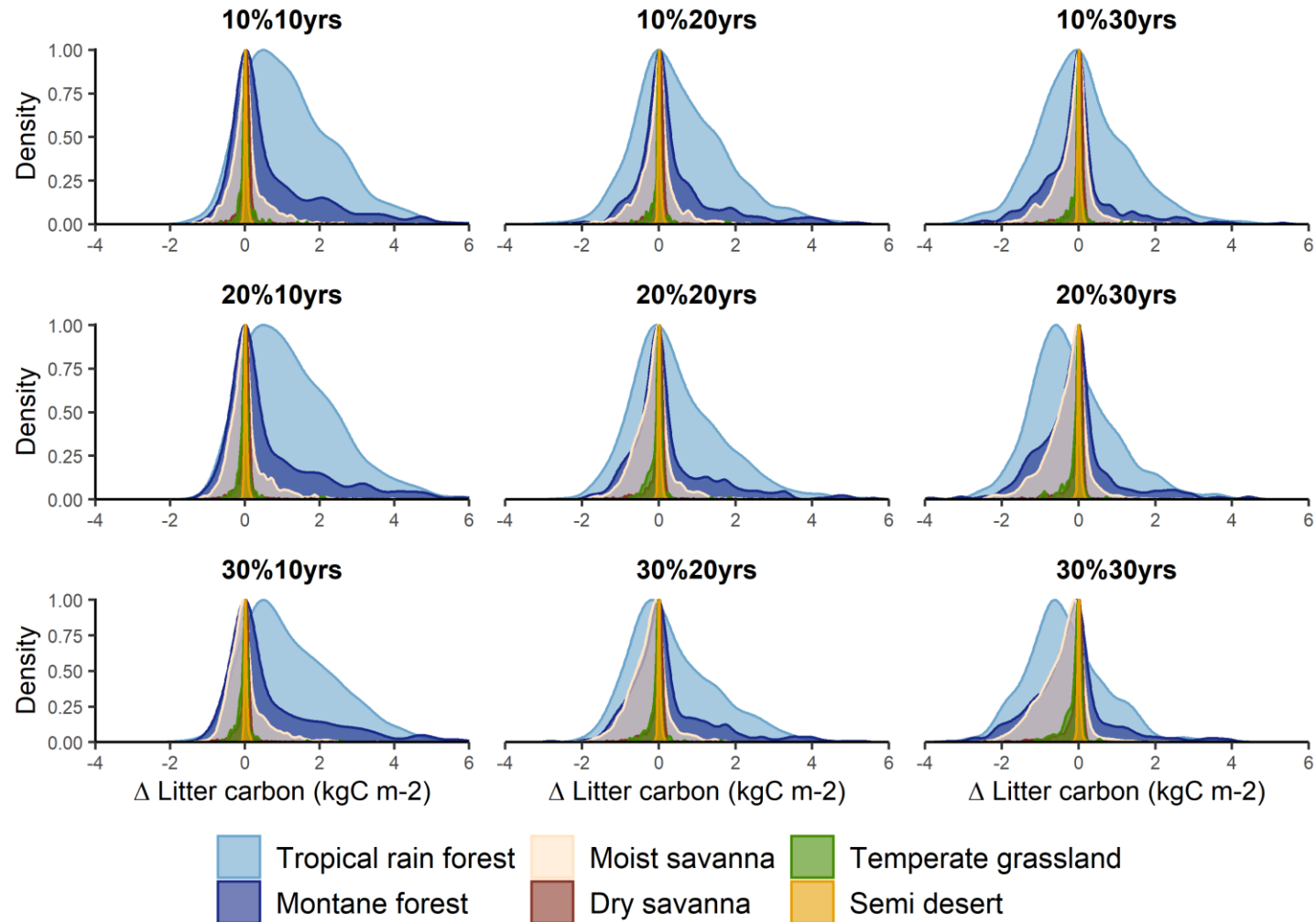
How does the magnitude and direction of carbon fluxes in different biomes vary with charcoal production?

Difference in vegetation carbon pool between natural and managed forest



How does the magnitude and direction of carbon fluxes in different biomes vary with charcoal production?

Difference in litter carbon pool between natural and managed forest



How does the magnitude and direction of carbon fluxes in different biomes vary with charcoal production?

Difference in soil carbon pool between natural and managed forest

