Calibration Report: Low N Sedimentary Site Base Case

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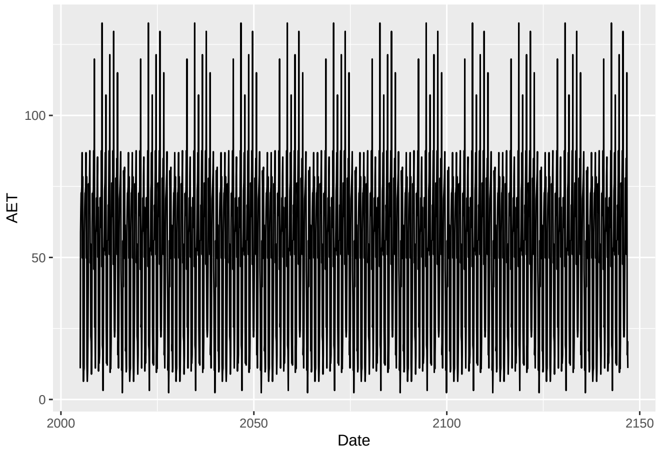
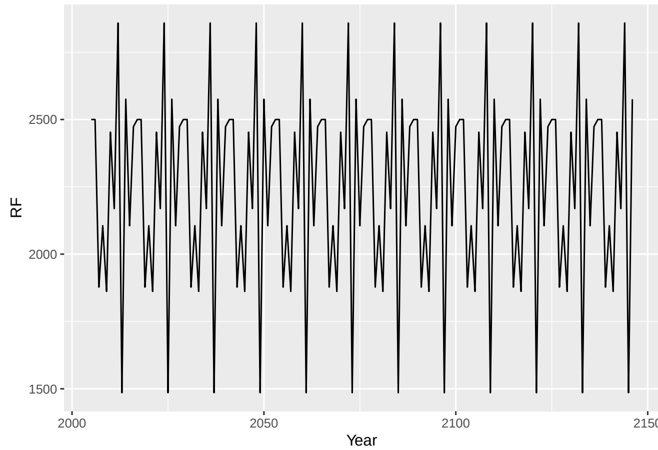
Hydrology





Soil Solution Results

Table 1: Average Soil Solution Concentrations of Reliable Months (2005-2006)

	μmol/L														
Soil Layer	Ca	Mg	K	Na	NO3	NH4	SO4	Cl	PO4	DOC	Al	Si	H+	pH	R	HR
Layer 1	7.80	6.02	11.38	41.9	0.794	0.6347	12.4	50.9	0.260	158	0.00895	14.0	12.10	4.92	17.1	5.50
Layer 2	10.53	8.10	13.87	50.5	0.321	0.1902	12.6	59.4	0.240	248	0.00712	30.6	10.34	4.99	27.2	8.20
Layer 3	11.96	9.15	14.39	56.7	0.120	0.0492	12.5	63.2	0.235	290	0.00485	43.0	7.82	5.11	32.9	8.57
Layer 4	9.11	12.99	5.10	60.9	0.135	0.1137	11.4	63.3	0.220	236	0.02489	54.2	4.40	5.36	28.6	5.19
Layer 5	9.96	14.26	5.25	67.7	0.164	0.3348	11.5	68.8	0.131	284	0.02492	57.5	4.39	5.36	34.2	6.31
Layer 6	10.39	14.88	5.34	71.3	0.192	0.3948	11.4	73.1	0.154	284	0.01886	61.4	3.45	5.46	34.8	5.78
Layer 7	11.78	16.79	5.69	75.5	0.213	0.5236	11.5	77.8	0.156	345	0.02076	66.1	3.74	5.43	41.7	7.48
Layer 8	12.50	17.83	5.83	78.3	0.223	0.5746	11.4	81.6	0.131	361	0.01851	68.5	3.34	5.48	44.0	7.47

Table 2: Lysimeter Measured Soil Solution Concentrations of Reliable Months (2005)

Layer	Ca	Ca SD	Mg	Mg SD	K	K SD	Na	Na SD	NO3	NO3 SD	NH4	NH4 SD	SO4	SO4 SD	Cl	Cl SD	*P*[a]	P SD	DOC	DOC SD	*Al*[b]	Al SD	*Si*[c]	Si SD	*pH*[d]
1	29	2.76	35	2.17	21	1.46	140	5.7	2.3	2.14	1.1	0.25	18	2.20	174	24	0.07	0.038	136	18	0.996	0.03594	82	16	5.6
2	29	2.76	35	2.17	21	1.46	140	5.7	2.3	2.14	1.1	0.25	18	2.20	174	24	0.07	0.038	136	18	0.996	0.03594	82	16	5.3
3	29	2.76	35	2.17	21	1.46	140	5.7	2.3	2.14	1.1	0.25	18	2.20	174	24	0.07	0.038	136	18	0.996	0.03594	82	16	5.4
4	16	0.84	24	0.83	17	0.89	125	8.0	1.9	0.73	1.2	0.27	12	0.73	159	18	0.05	0.032	68	12	0.021	0.00075	84	15	5.5
5	16	0.84	24	0.83	17	0.89	125	8.0	1.9	0.73	1.2	0.27	12	0.73	159	18	0.05	0.032	68	12	0.021	0.00075	84	15	5.6
6	16	0.84	24	0.83	17	0.89	125	8.0	1.9	0.73	1.2	0.27	12	0.73	159	18	0.05	0.032	68	12	0.021	0.00075	84	15	5.7
7	16	0.84	24	0.83	17	0.89	125	8.0	1.9	0.73	1.2	0.27	12	0.73	159	18	0.05	0.032	68	12	0.021	0.00075	84	15	5.8
8	16	0.84	24	0.83	17	0.89	125	8.0	1.9	0.73	1.2	0.27	12	0.73	159	18	0.05	0.032	68	12	0.021	0.00075	84	15	5.8

[a] Average based on TP annual average

[b] Does not distinguish between organic-Al and free Al

[c] Model does not simulate Si uptake

[d] From Hynicka et al., 2017 (10-50cm) extrapolated to 1m

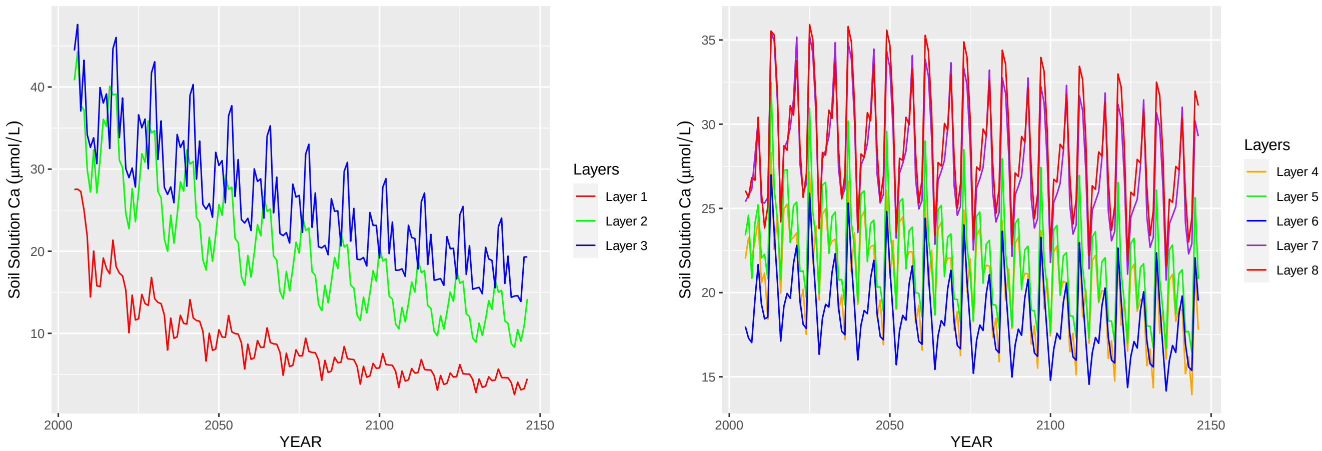


Figure 1: Monthly Calcium Concentrations by Soil Layer

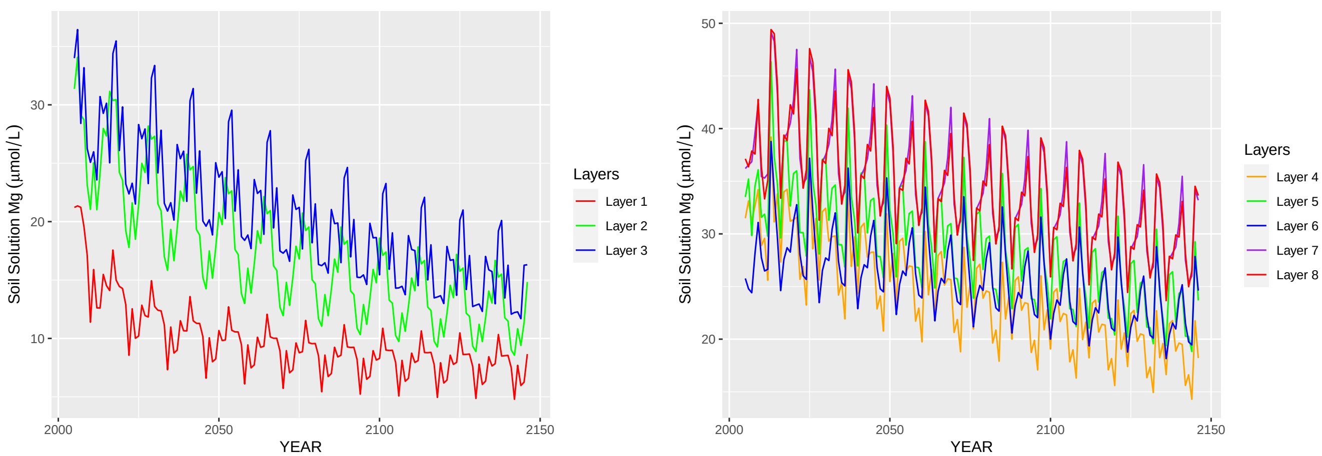


Figure 2: Monthly Magnesium Concentrations by Soil Layer

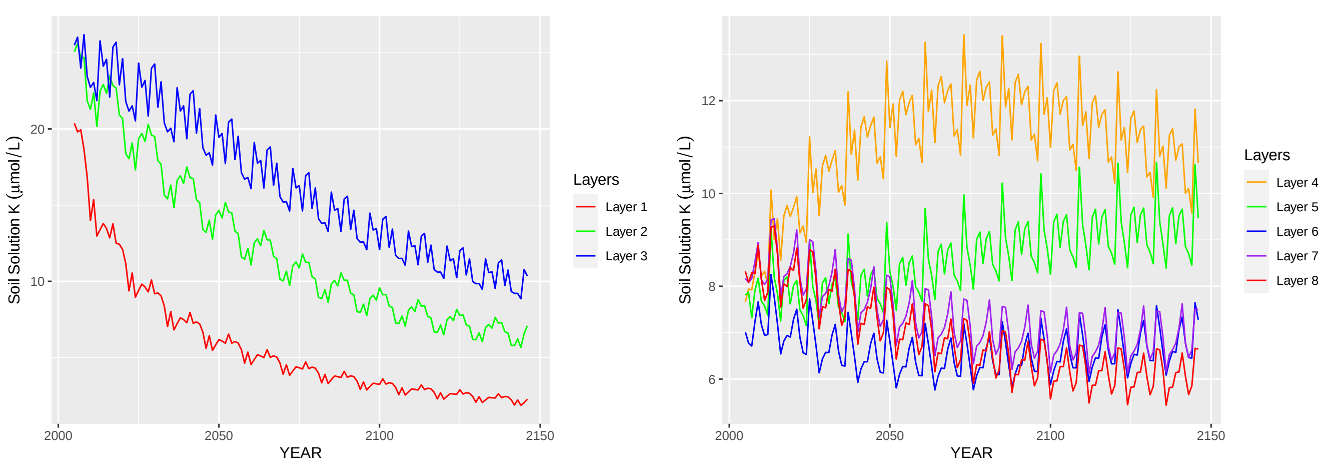


Figure 3: Monthly Potassium Concentrations by Soil Layer

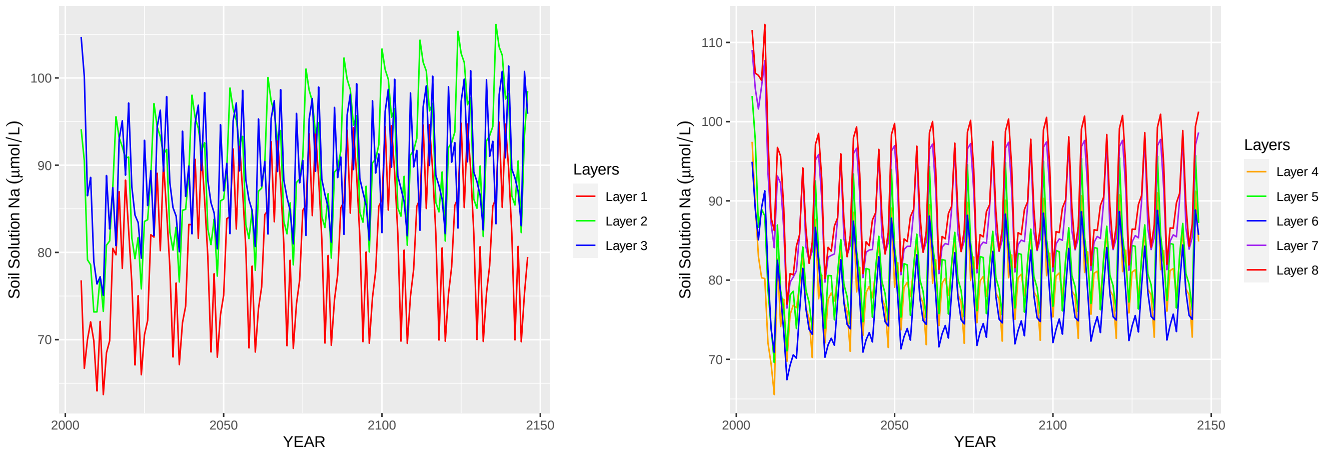


Figure 4: Monthly Sodium Concentrations by Soil Layer

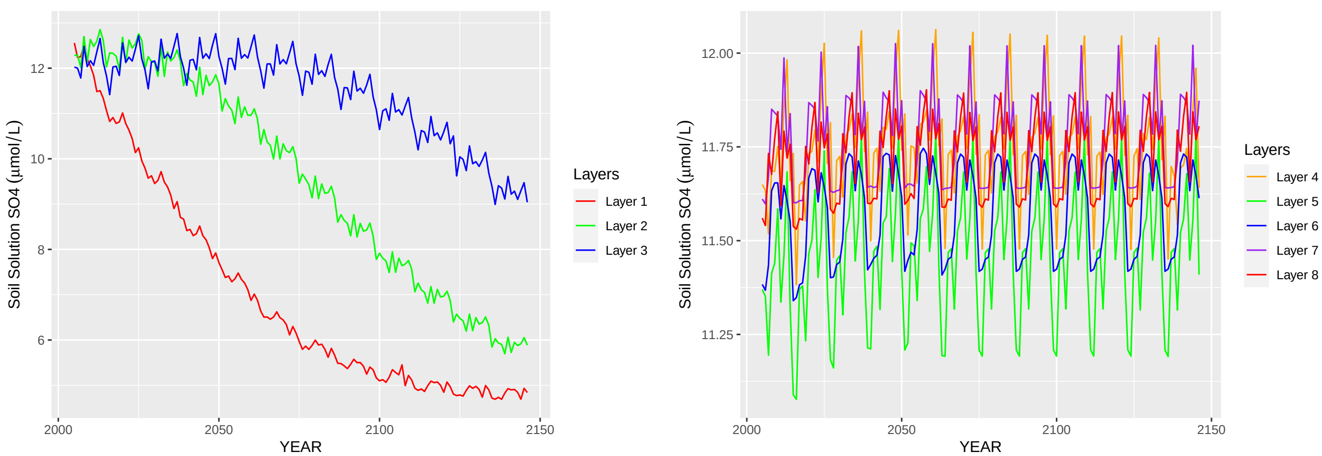


Figure 5: Monthly Sulfate Concentrations by Soil Layer

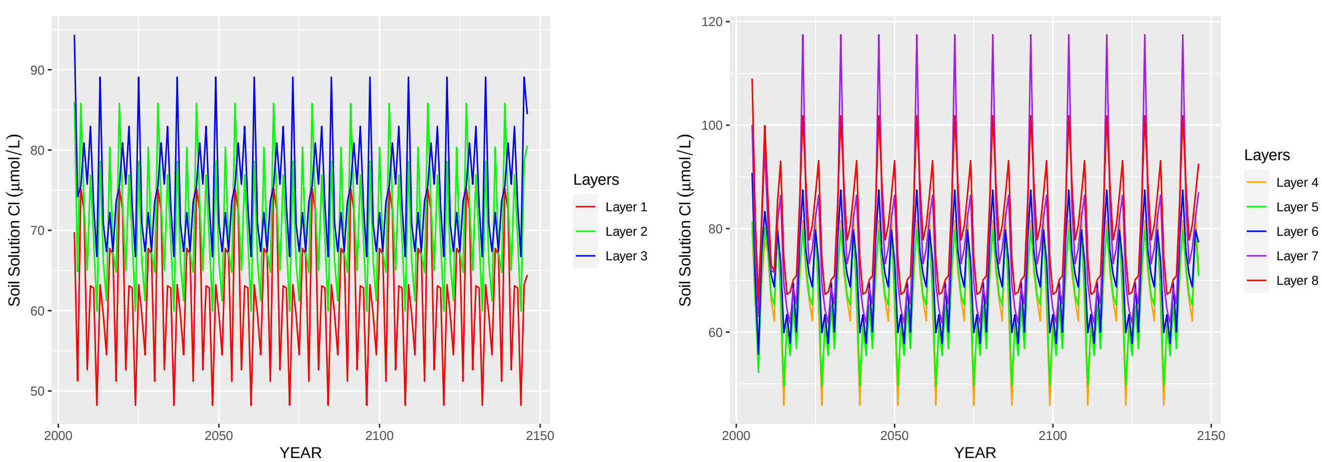


Figure 6: Monthly Chloride Concentrations by Soil Layer

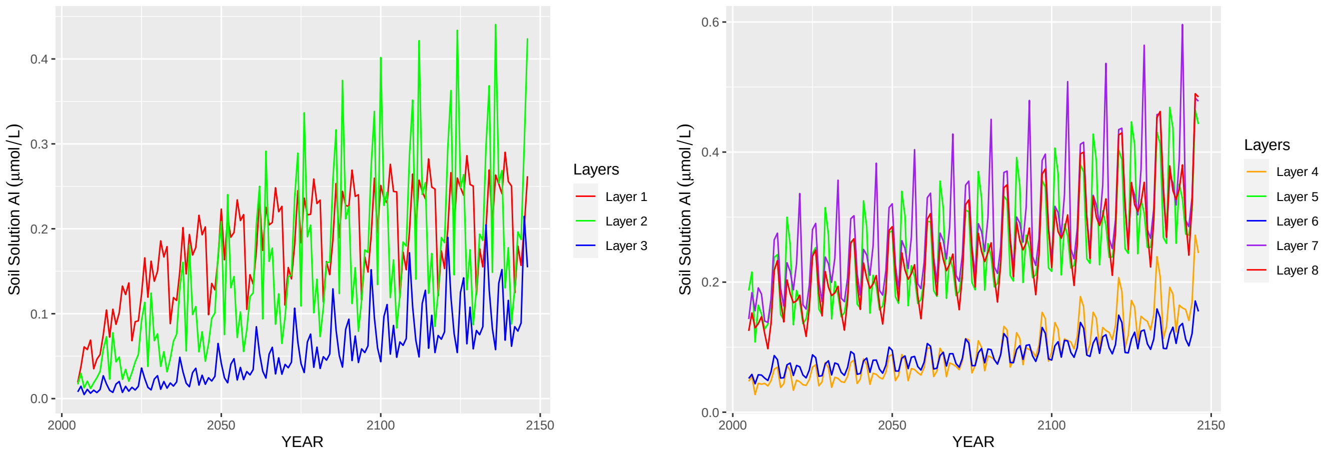


Figure 7: Monthly Aluminum Concentrations by Soil Layer

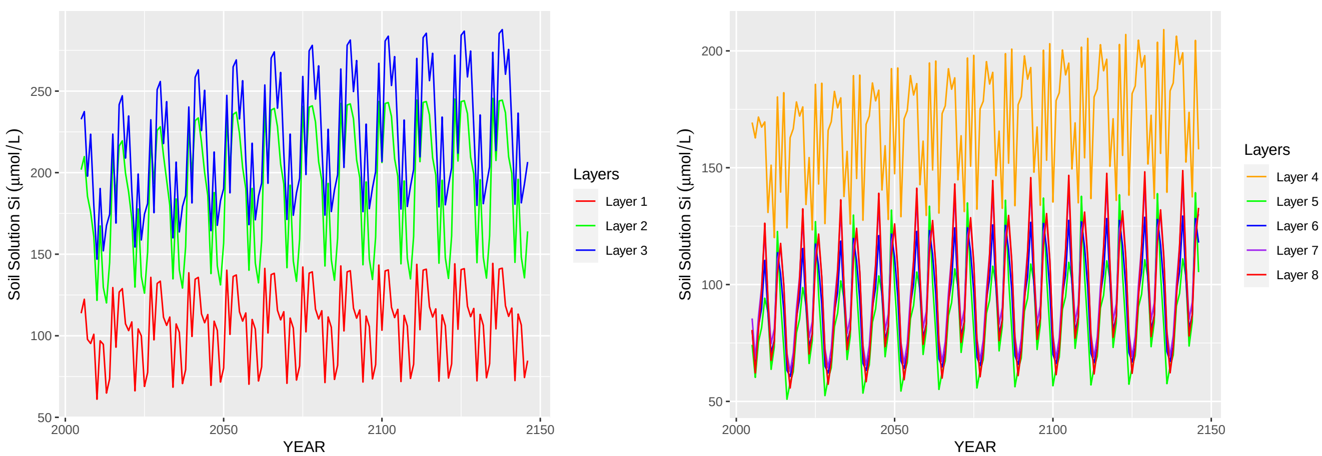


Figure 8: Monthly SiO2 Concentrations by Soil Layer

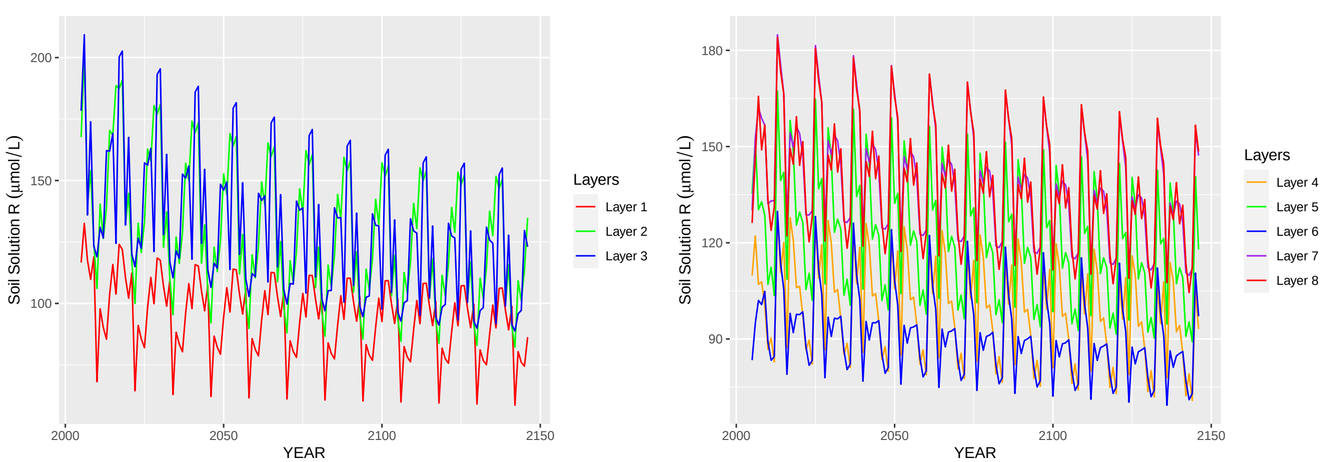


Figure 9: Monthly Organic Acid Base (R-) Concentrations by Soil Layer

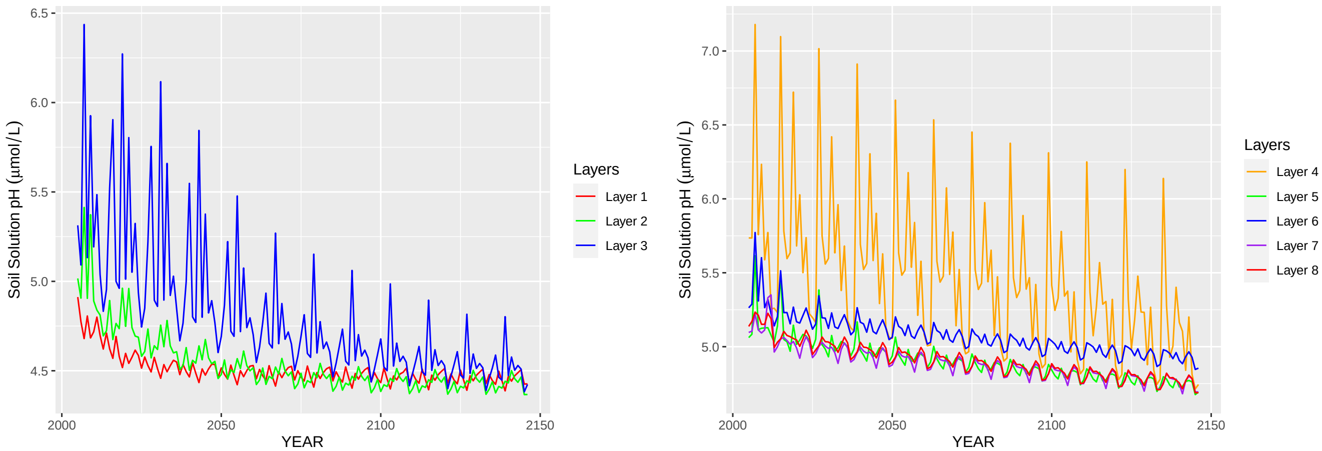


Figure 10: Monthly pH by Soil Layer

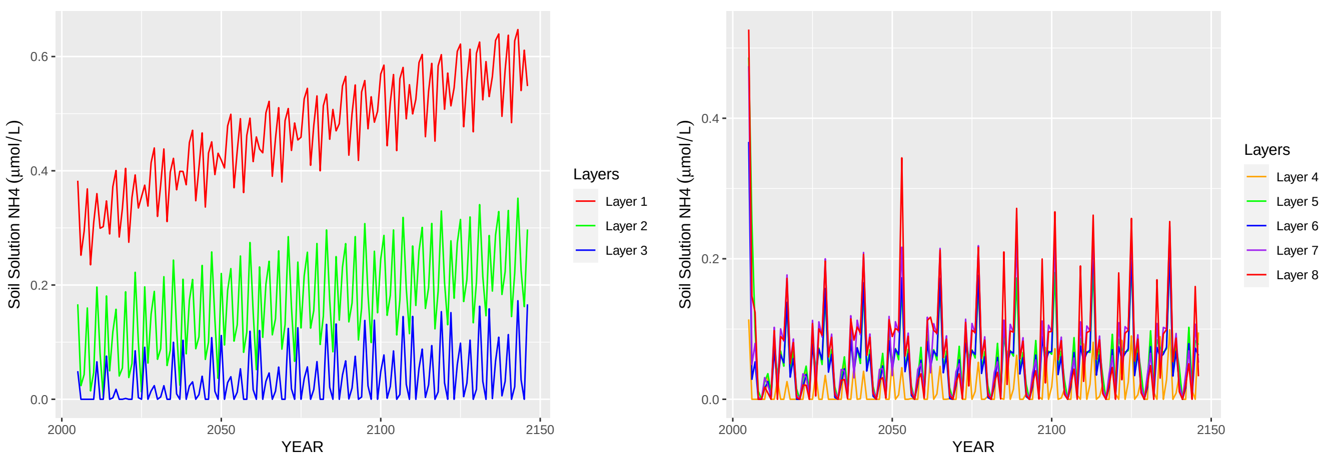


Figure 11: Yearly Ammonium concentration by Soil Layer

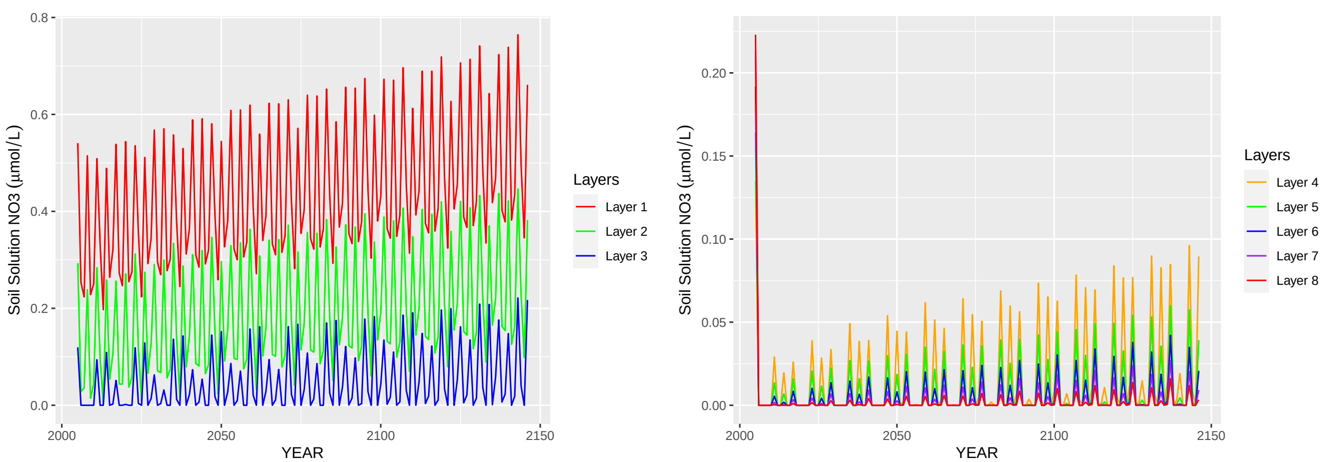


Figure 12: Yearly Nitrate concentration by Soil Layer

Table 3: Simulated Lysimeter Fluxes by Depth (2005-2006)

Depth	YEAR	Ca	Mg	K	Na	NO3	NH4	SO4	Cl	P	DOC	Al	Si
2	2005	6.7	3.1	8.3	18	0.128	0.0576	6	33	0.11	46	5.5e-05	17
2	2006	6.6	3.1	8.2	17	0.014	0.0099	6	30	0.12	52	9.6e-05	16
8	2005	7.1	6.1	3.1	25	0.094	0.1511	4.7	42	0.056	56	0.00040	30
8	2006	6.6	5.7	2.9	23	0.000	0.0079	4.7	32	0.054	67	0.00049	27

Lysimeter Leaching Layers

Weathering Results

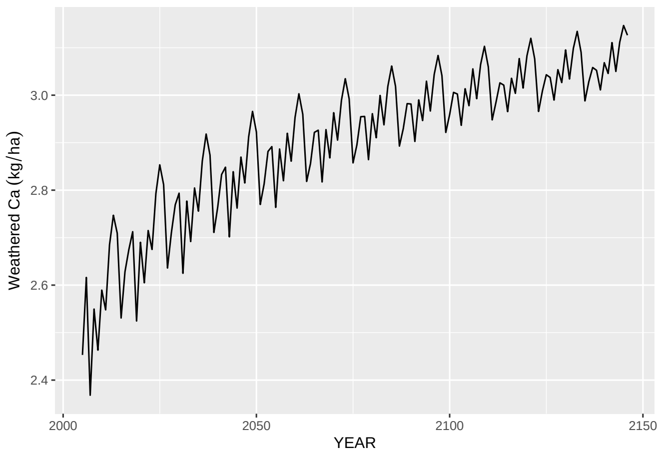


Figure 13: Calcium Weathering (All Layer)

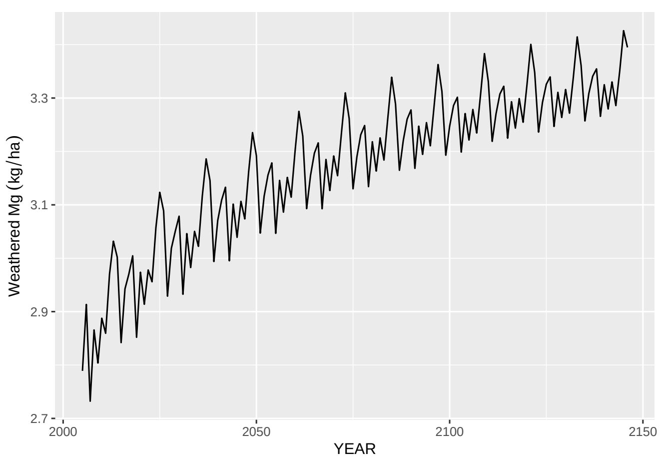


Figure 14: Magnesium Weathering (All Layer)

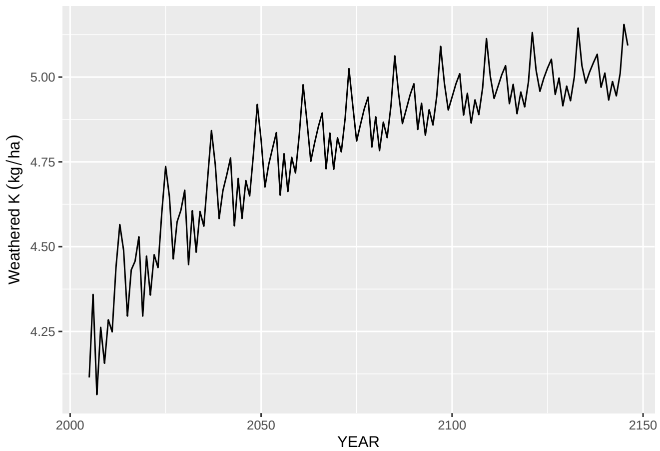


Figure 15: Potassium Weathering (All Layer)

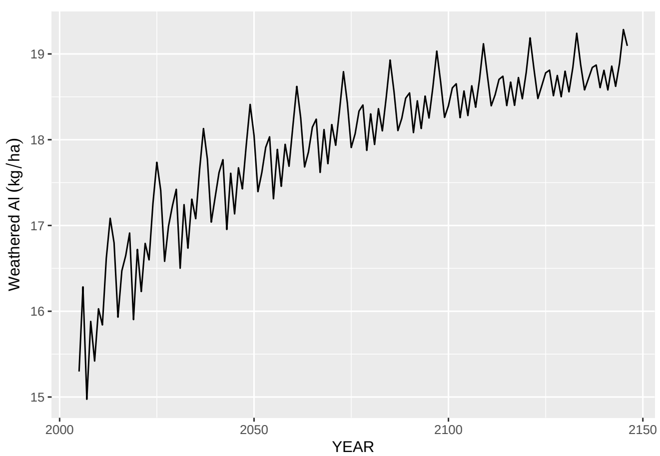


Figure 16: Aluminum Weathering (All Layer)

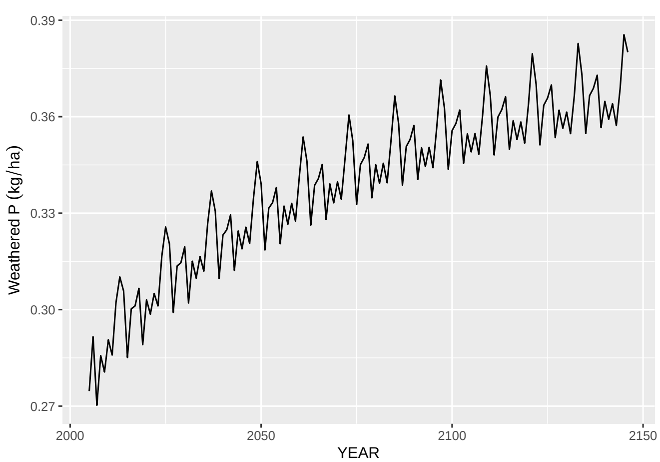


Figure 17: Phosphate Weathering (All Layer)

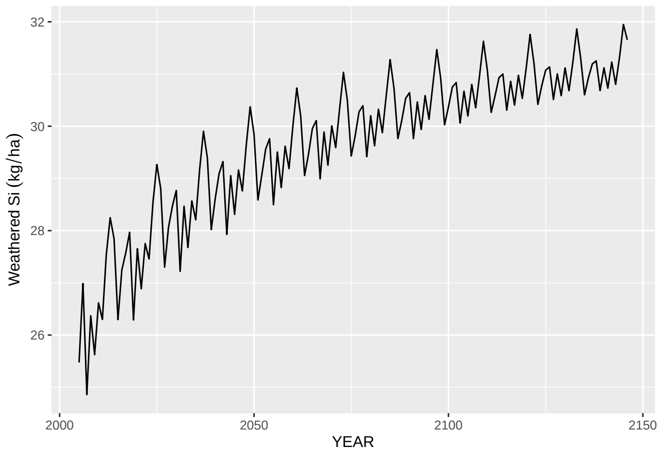


Figure 18: Silica Weathering (All Layer)

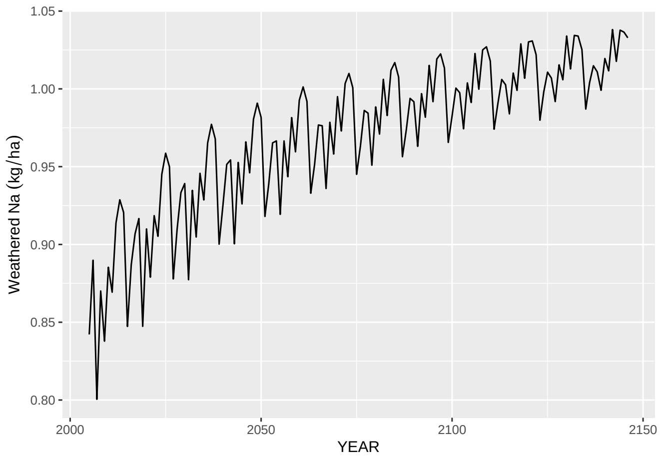
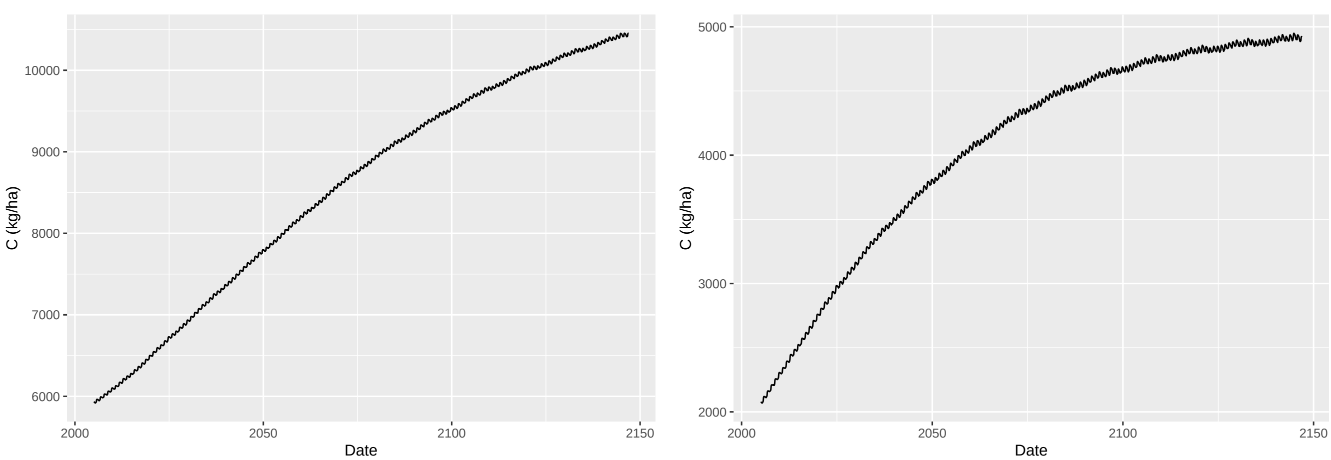


Figure 19: Sodium Weathering (All Layer)

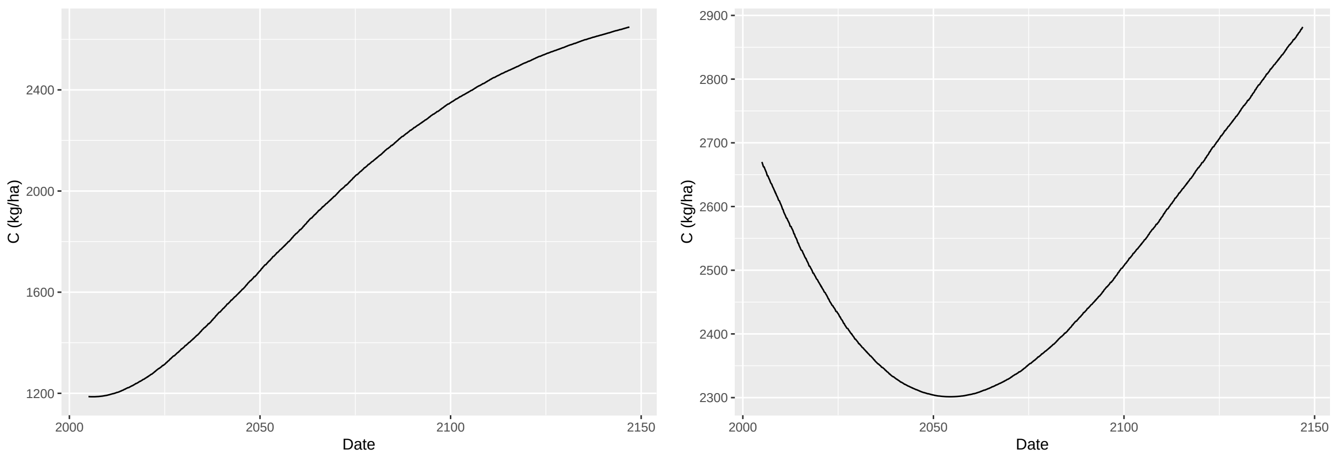
Litter Pool Results



(a) Total forest floor carbon content (kg/ha)

(b) Carbon content of coarse litter (kg/ha)

Figure 20: Forest Floor (O-Layer) Carbon Content Over Simulation Period

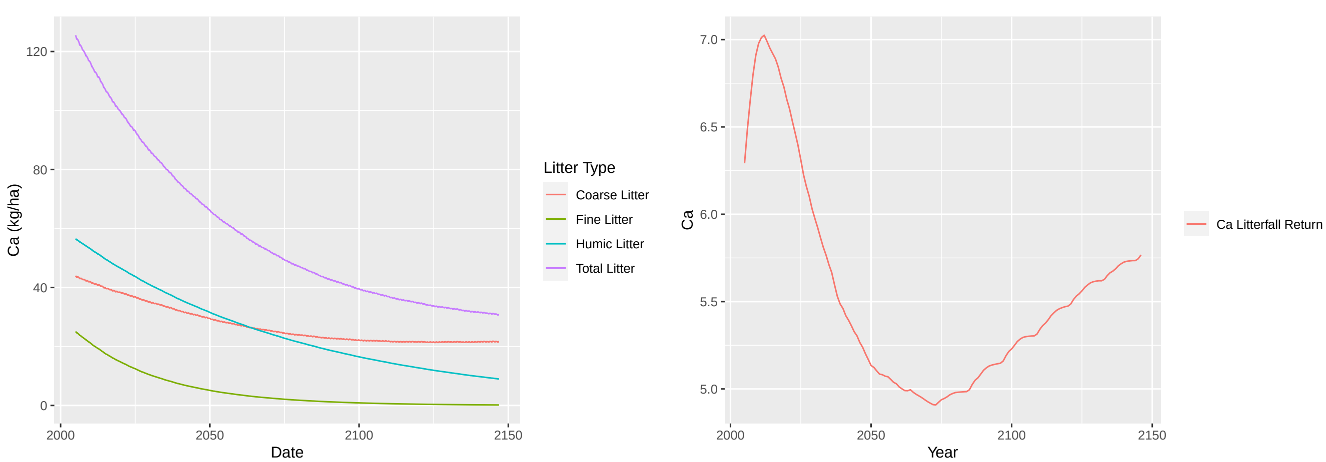


(a) Carbon content of fine litter (kg/ha)

(b) Carbon content of humic litter (kg/ha)

Figure 21: Forest Floor (O-Layer) Carbon Content Over Simulation Period

Note that the fine litter pool (the stage between humus and fresh/coarse litter) is growing in this model. This might deviate from observed behavior.

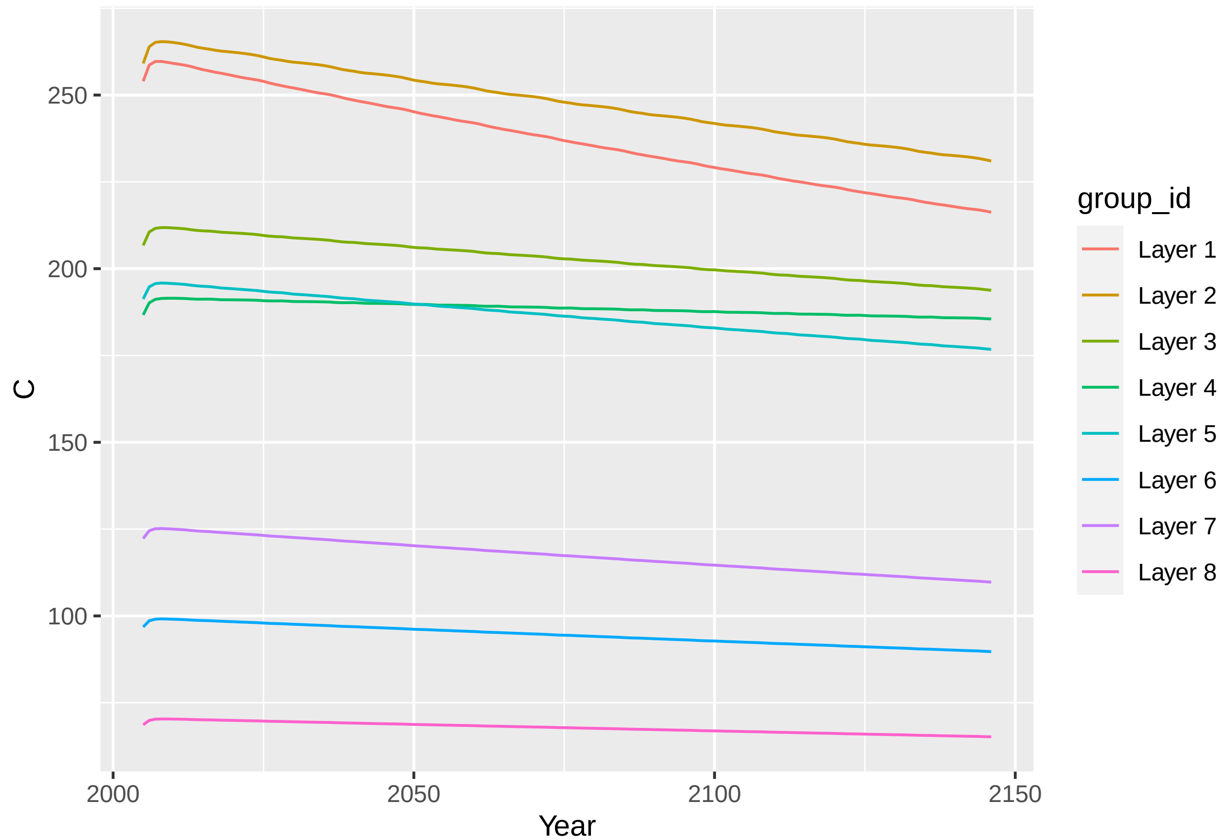


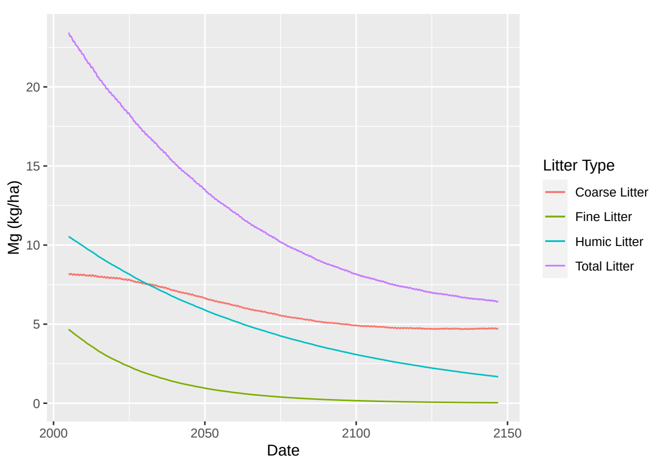
(a) Ca Content in each litter decomposition stage (kg/ha)

(b) Ca net annual return in litterfall (kg/ha)

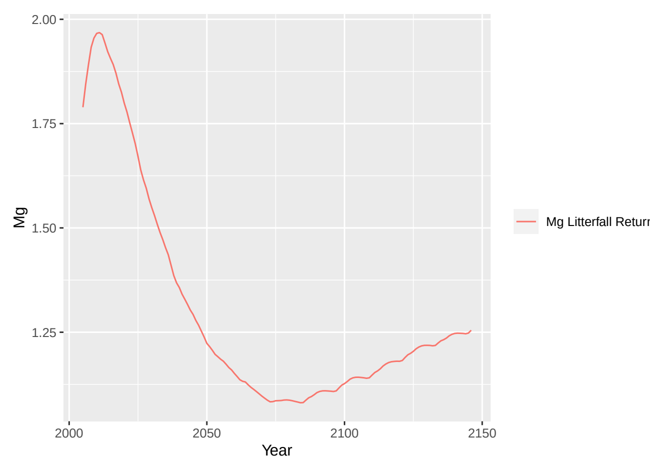
Figure 22: Forest Floor/O-horizon Ca content over time (a). and net annual Ca return in litterfall (b).

Soil Organic Matter Results



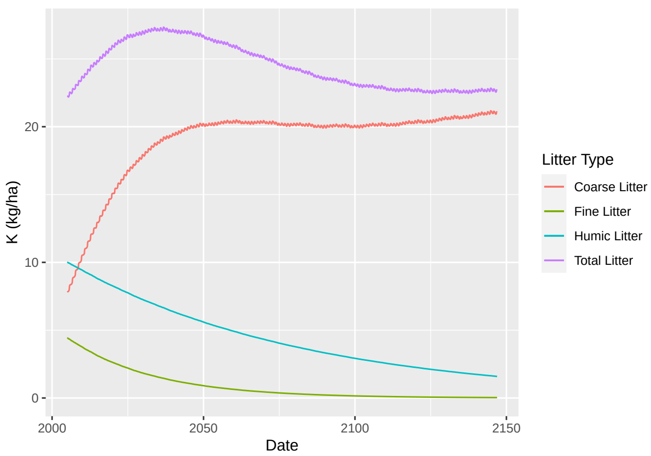


(a) Mg Content in each litter decomposition stage (kg/ha)

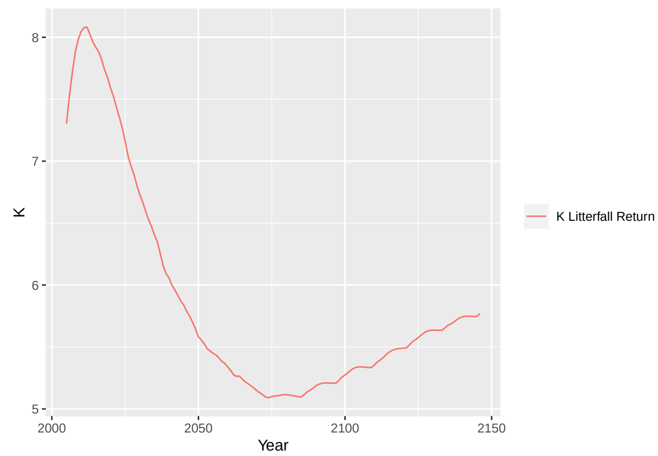


(b) Mg net annual return in litterfall (kg/ha)

Figure 23: Forest Floor/O-horizon Mg content over time (a). and net annual Mg return in litterfall (b).

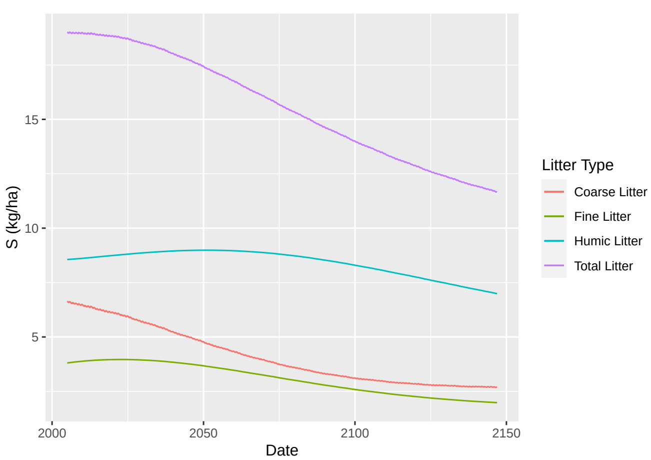


(a) K Content in each litter decomposition stage (kg/ha)

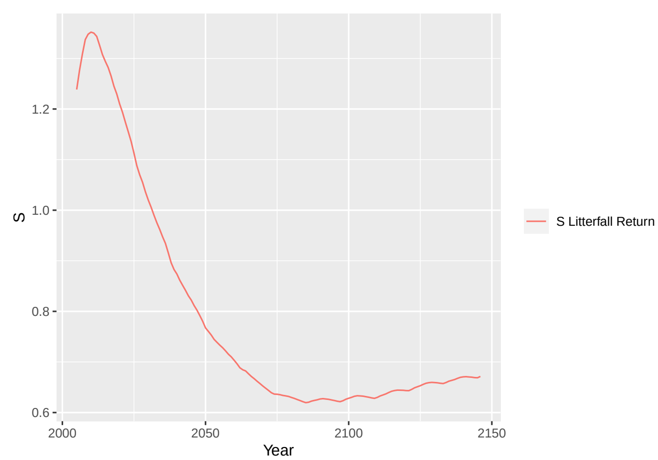


(b) K net annual return in litterfall (kg/ha)

Figure 24: Forest Floor/O-horizon K content over time (a). and net annual K return in litterfall (b).

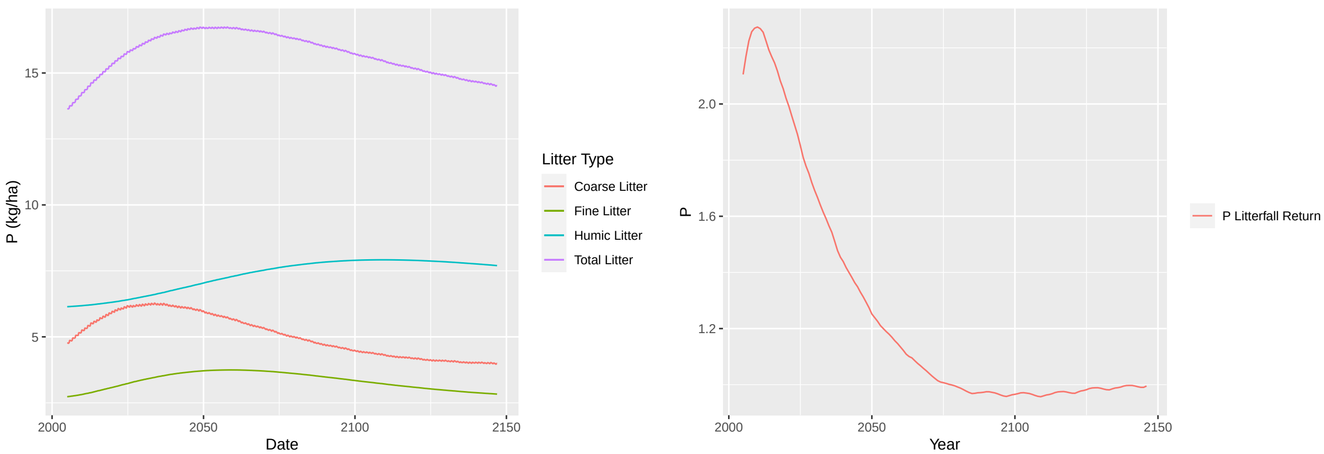


(a) S Content in each litter decomposition stage (kg/ha)



(b) S net annual return in litterfall (kg/ha)

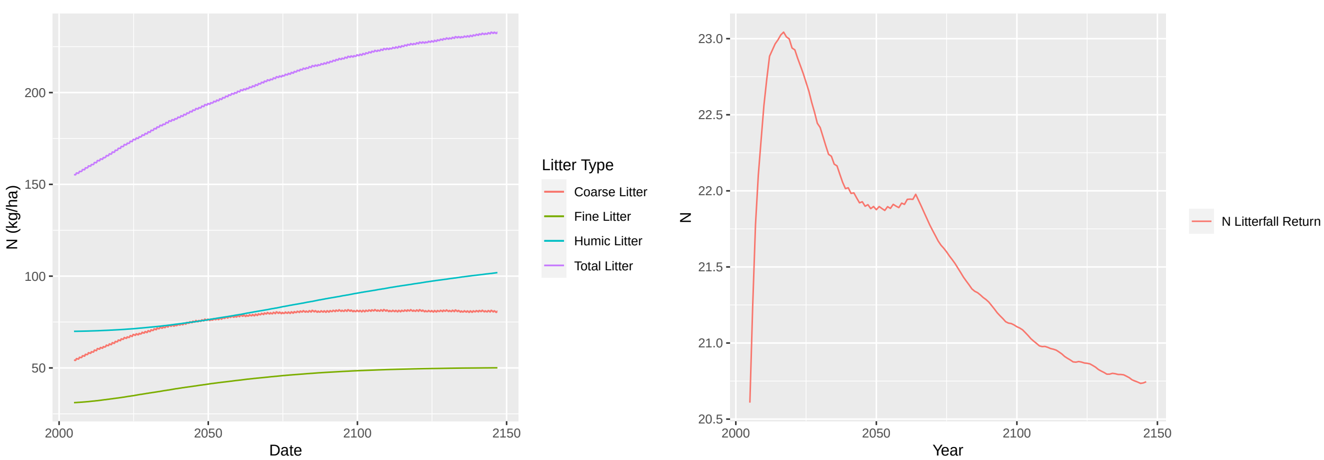
Figure 25: Forest Floor/O-horizon S content over time (a). and net annual S return in litterfall (b).



(a) P Content in each litter decomposition stage (kg/ha)

(b) P net annual return in litterfall (kg/ha)

Figure 26: Forest Floor/O-horizon P content over time (a). and net annual P return in litterfall (b).



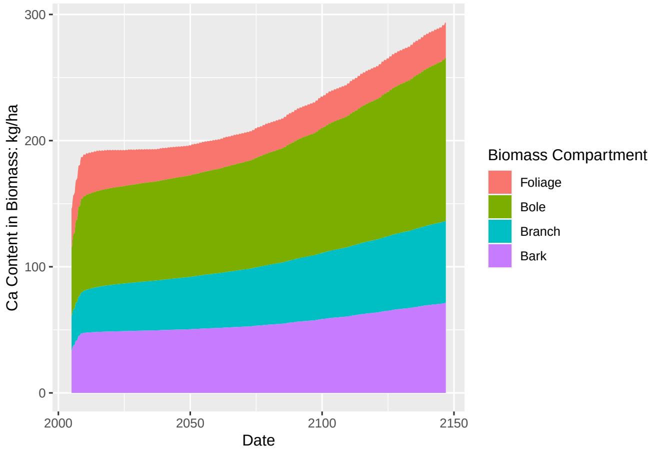
(a) N Content in each litter decomposition stage (kg/ha)

(b) N net annual return in litterfall (kg/ha)

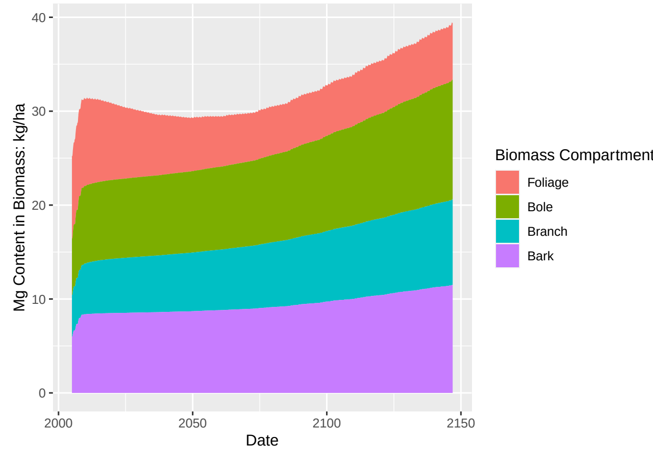
Figure 27: Forest Floor/O-horizon N content over time (a). and net annual N return in litterfall (b).

I plotted the litterfall return rate and the O-horizons next to each other to show that the inability of the O-horizon to build up certain nutrients is not an issue with nutrient release (these values can be set to be very low, such as 0.05 for Ca and Mg, and losses are still observed), but likely due to a gradual depletion of the soil for specific nutrients. The site builds up with N in the O-horizon, and this likely implies that the system is not limited by N, but that base cations are becoming increasingly limited over time, with the exception of K.

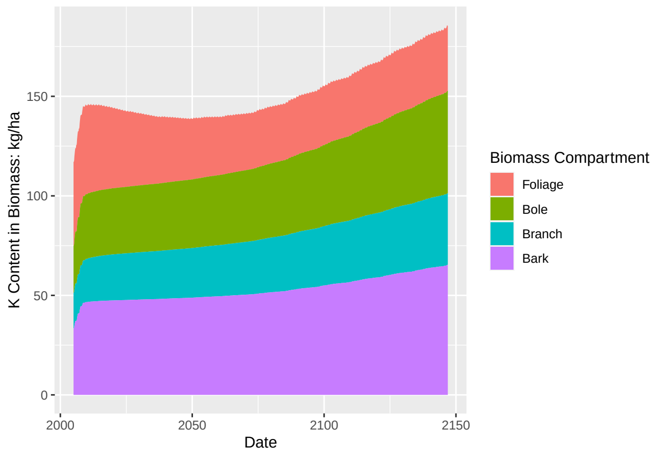
Tree Nutrient Content



(a) Calcium content in each biomass compartment

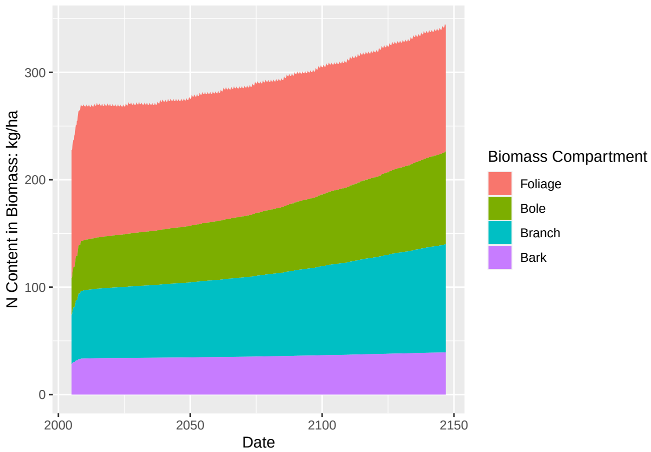


(b) Magnesium content in each biomass compartment

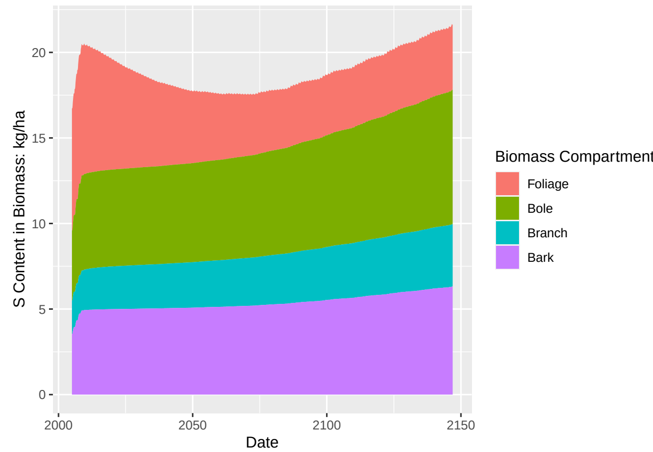


(c) Potassium content in each biomass compartment

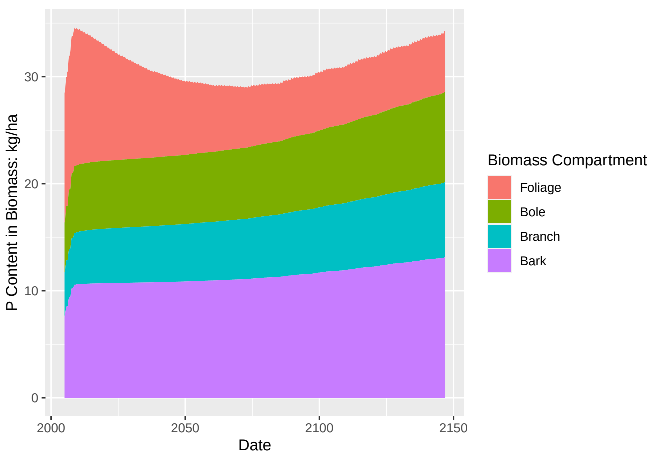
Figure 28: Base Cation Nutrient Content in Simulated Forest



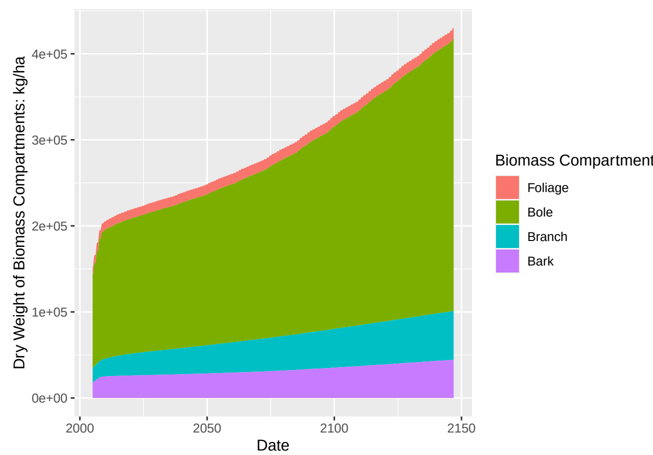
(a) Nitrogen content in each biomass compartment



(b) Sulfur content in each biomass compartment



(c) Phosphorous content in each biomass compartment

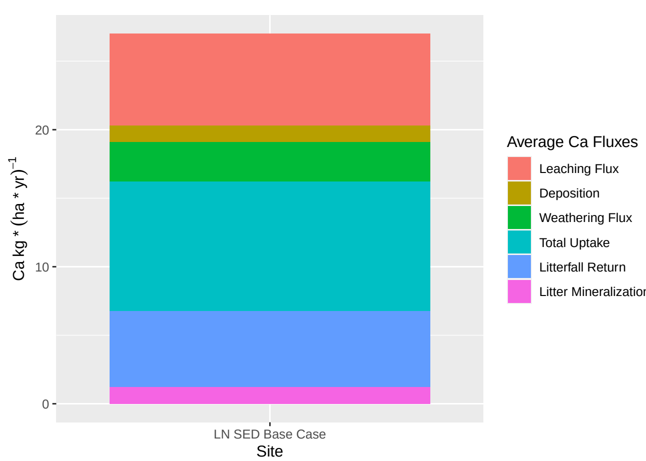


(d) Biomass of each compartment

Figure 29: N, S, and P Nutrient Contents and biomass per compartment

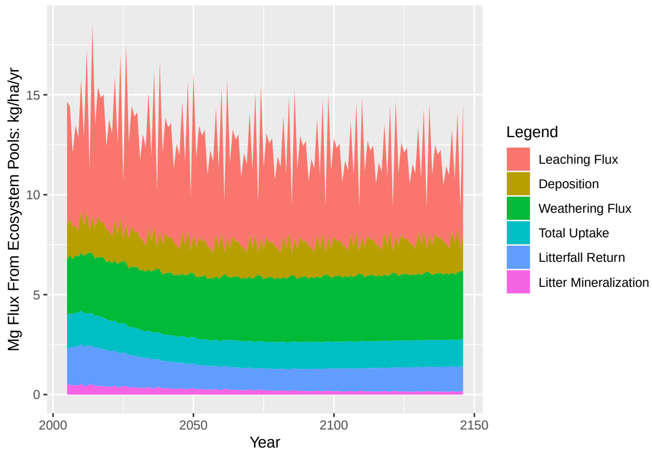
Analysis 1: Stack Flux Data

(a) Ca input and output fluxes over time

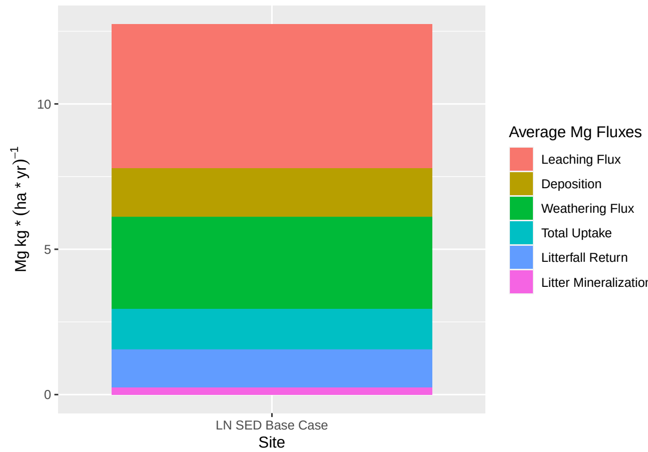


(b) Total Average Ca input and output fluxes

Figure 30: Calcium input and output comparison graphs

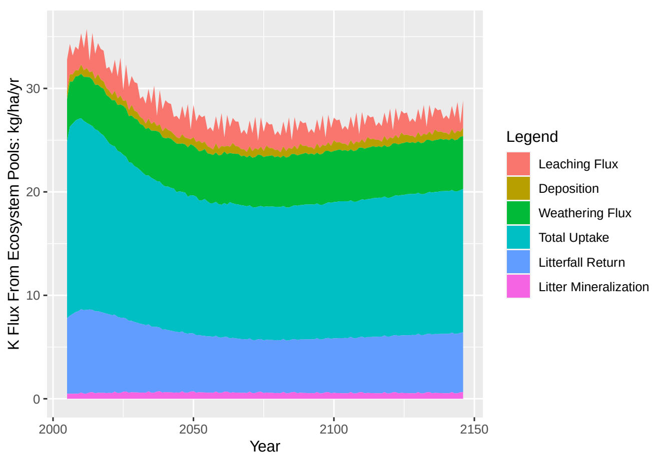


(a) Mg input and output fluxes over time

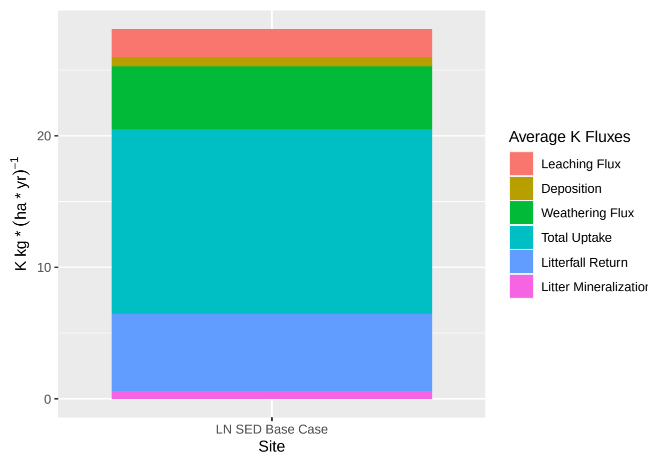


(b) Total Average Mg input and output fluxes

Figure 31: Magnesium input and output comparison graphs

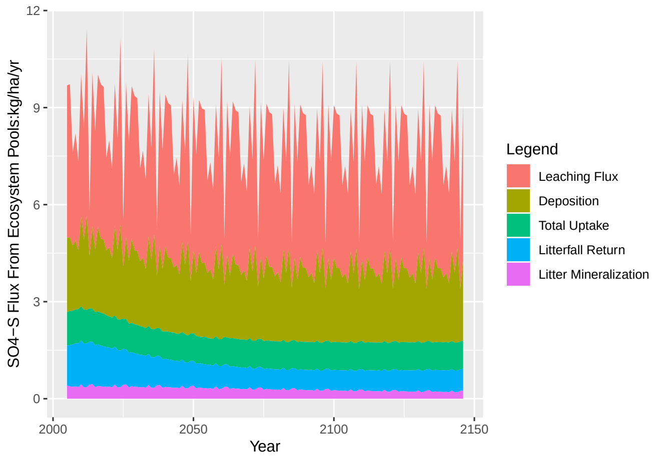


(a) K input and output fluxes over time

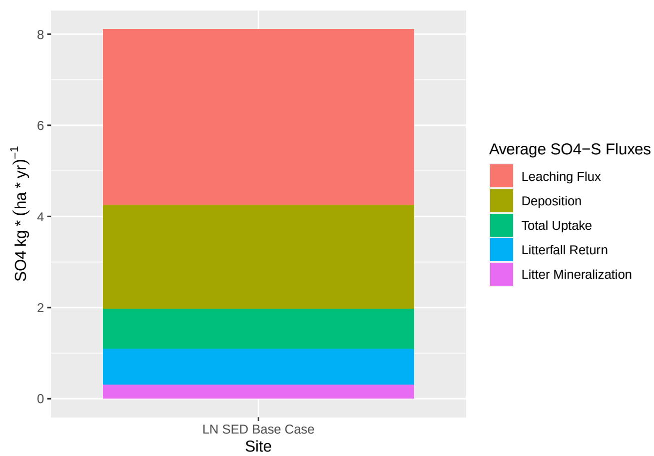


(b) Total Average K input and output fluxes

Figure 32: Potassium input and output comparison graphs



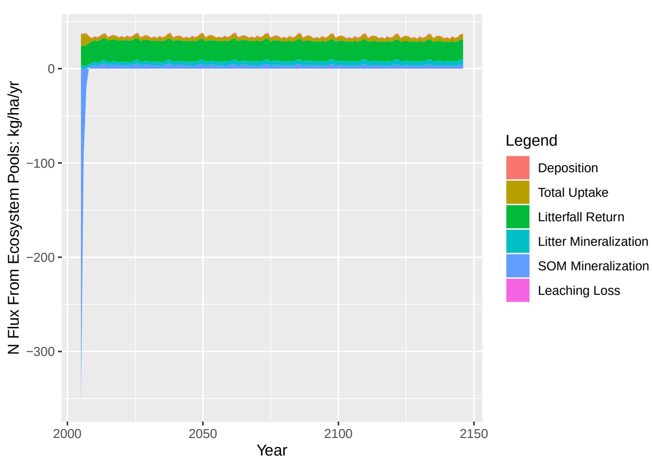
(a) S input and output fluxes over time



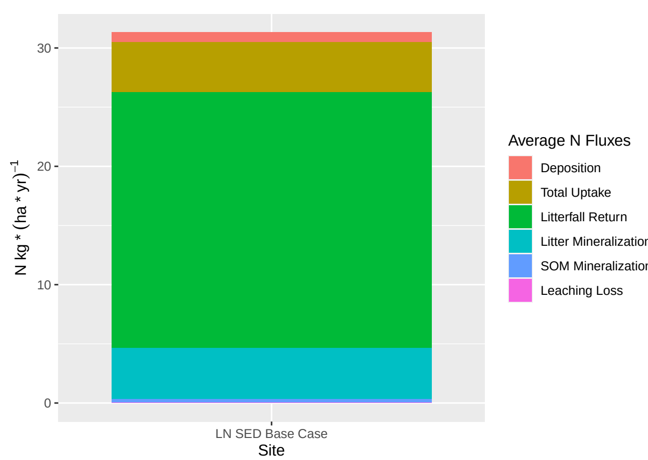
(b) Total Average S input and output fluxes

Figure 33: Sulfur input and output comparison graphs

I added back a reasonably large sulfate pool, this caused enhanced S losses which were unrealistic. This likely implies that the system had too much S going through it.



(a) N input and output fluxes over time



(b) Total Average N input and output fluxes

Figure 34: Nitrogen input and output comparison graphs

Notice how SOM mineralization starts off highly negative (-358 kg/ha/yr N); implying a large net N uptake in the microbial pool. The mineralization then balances out and steadily returns N to the soil over time, behaving normally. I do need the microbial pool to help calibrate the N cycle, but I may need to reduce the CEC stabilized N and decrease the N-uptake in the microbial pool. These results likely imply too much N is going through the system and that the microbial pool is too large of an N pool.

Cation Exchange Capacity

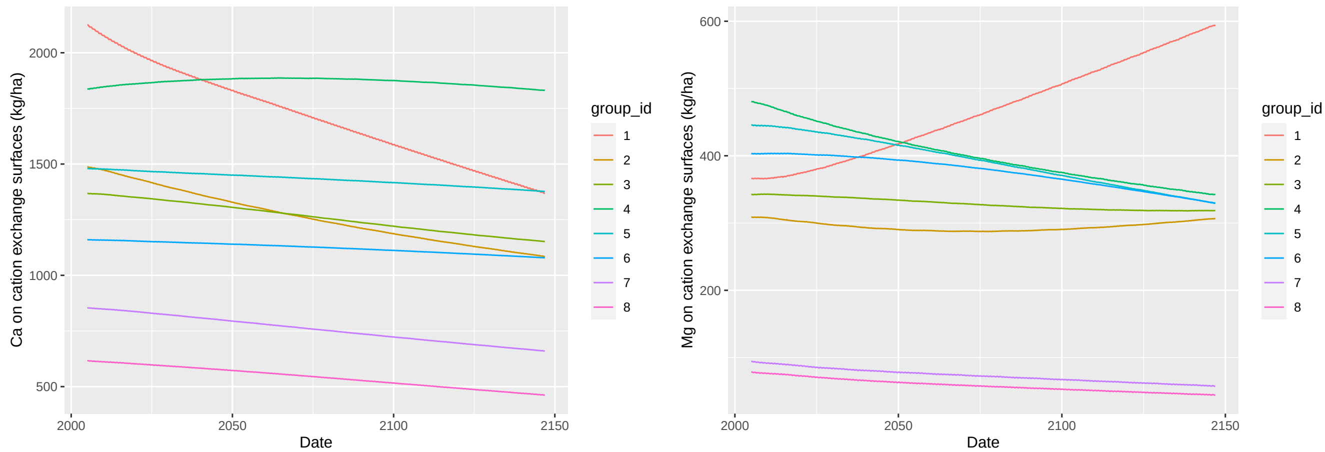


Figure 35: Calcium and Magnesium CEC adsorption over time

Figure 36: Potassium and Sodium CEC adsorption over time

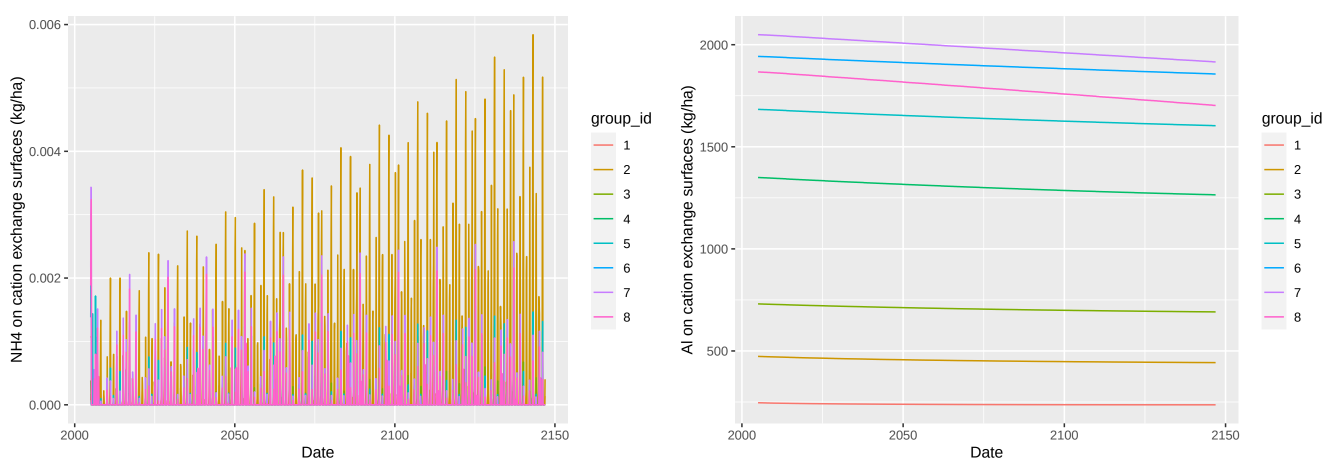
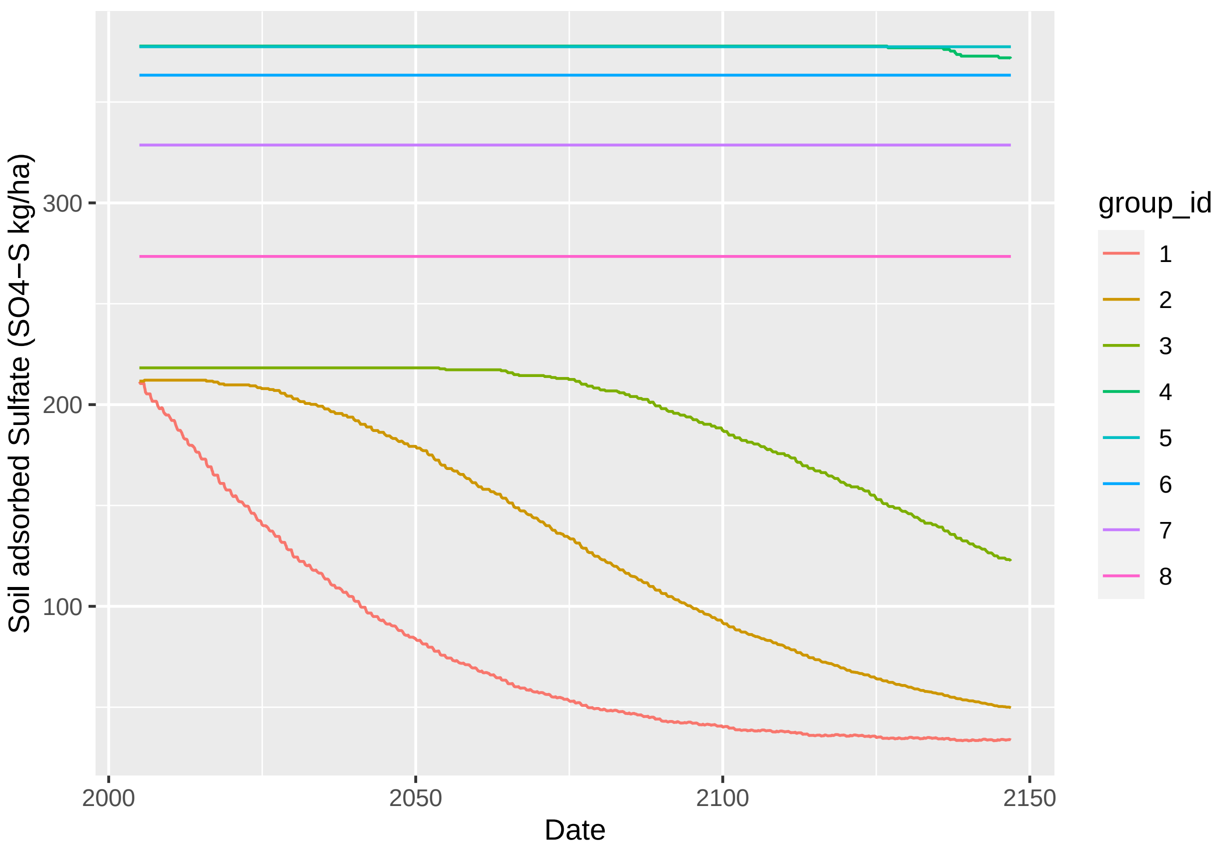
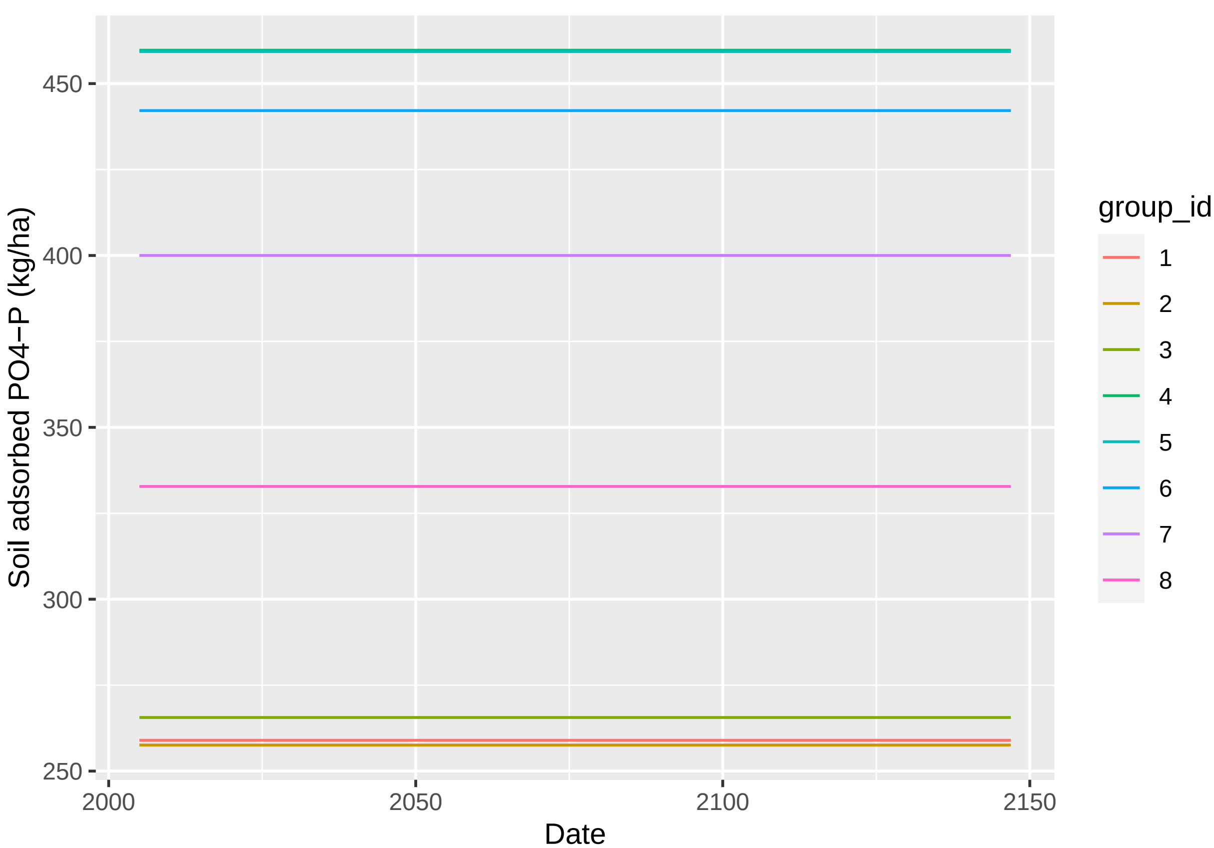
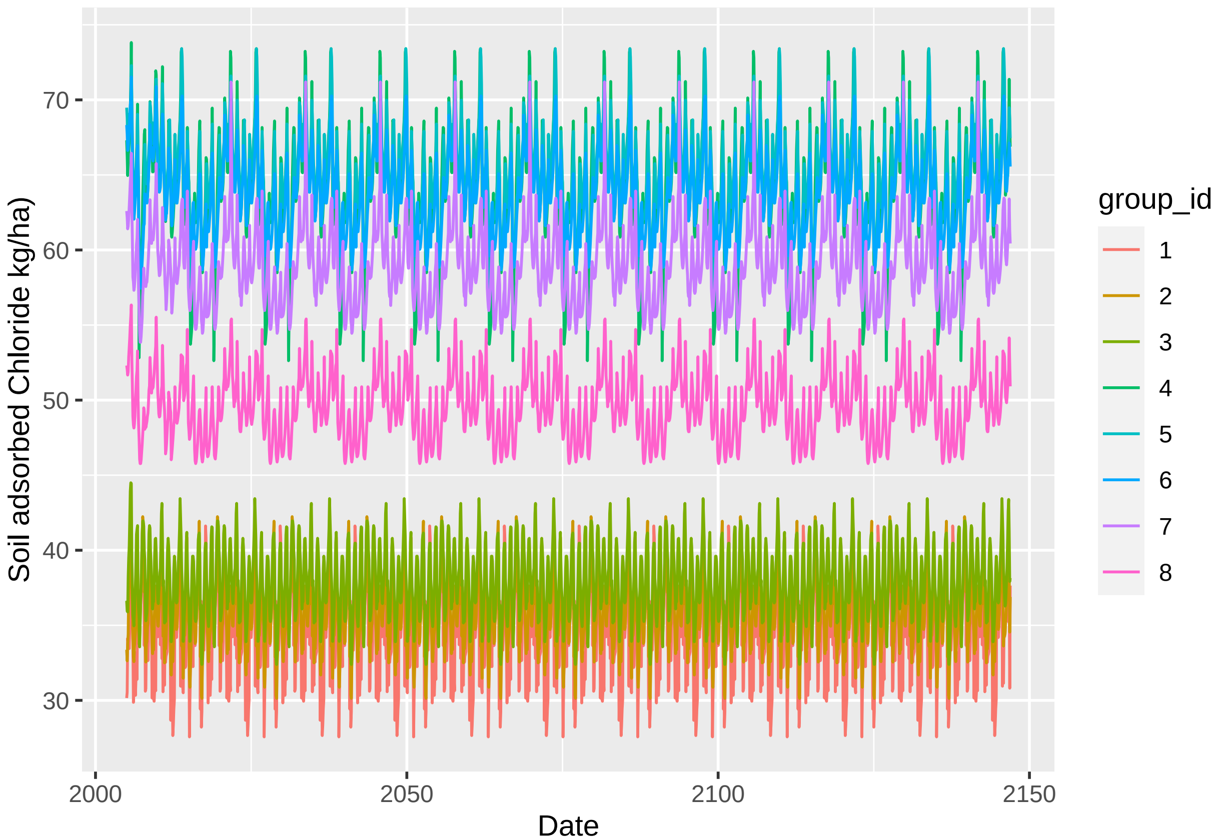


Figure 37: Ammonium and Aluminum CEC adsorption over time

Anion Exchange Capacity



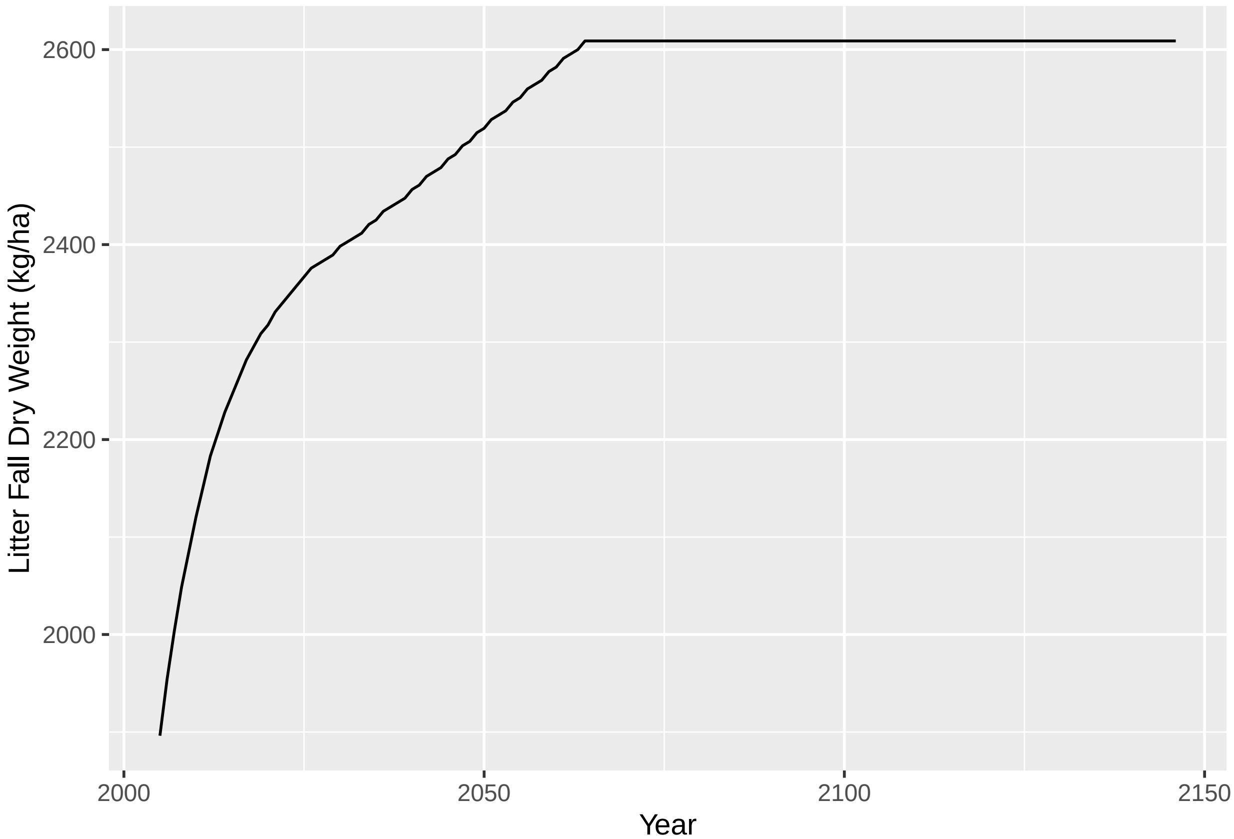




Phosphate seems stable, generally. It should be noted that P uptake is not being modeled in the foliage (it should remain constant so far) and that phosphate adsorption parameters are completely borrowed from the Burgundy site. As for sulfate, I purged the model of the AEC sulfate pool and relegated all soil S to the SOM organic pool.

I further note that the ALSEA rain chemistry seems to be lacking in Na and Cl, when I completely take away Cl adsorption, I don't get anywhere near the concentration of Cl measured in the lysimeters, like I do for sulfate.

Other



Litter Fall Dry Weight (kg/ha)
2600
2400
2200
2000
2000
2050
2100
2150
Year