Calibration Report: Low N Sedimentary Site Base Case

Kaveh Gholamhossein Siah

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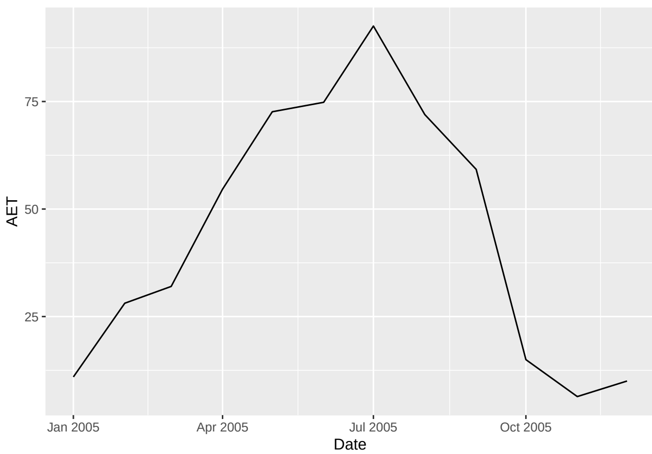
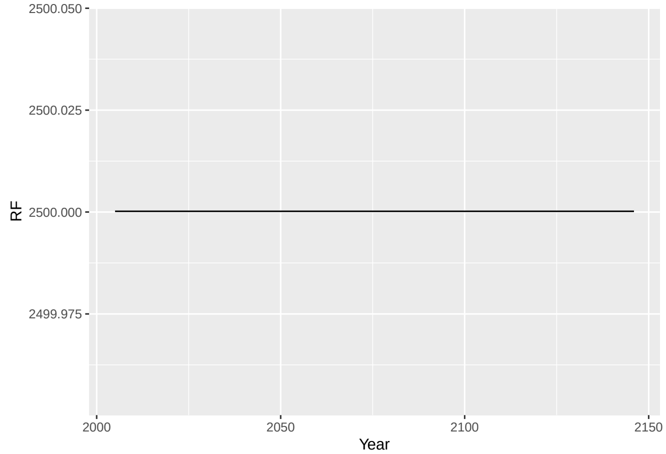
Hydrology





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	12.3	15.0	10.18	50.1	1.1323	2.242	9.13	50.2	0.494	157.8	0.000905	69.7	11.69	4.93	59.2	19.70
Layer 2	13.5	16.4	11.00	63.2	0.6317	1.814	11.94	55.8	0.238	175.5	0.000901	85.3	11.21	4.95	66.6	21.14
Layer 3	13.1	15.9	10.55	71.9	0.3559	1.394	11.99	59.5	0.221	165.8	0.000607	85.3	8.32	5.08	66.0	16.93
Layer 4	10.5	16.3	6.14	73.8	0.1769	0.755	14.00	61.0	0.208	106.4	0.000274	86.1	4.46	5.35	45.2	8.00
Layer 5	10.9	16.9	6.20	78.5	0.1148	0.574	14.17	65.4	0.142	97.6	0.000261	89.9	4.23	5.37	41.7	7.07
Layer 6	10.6	16.5	6.11	80.5	0.0932	0.368	14.23	69.2	0.162	68.6	0.000126	93.6	2.28	5.64	30.6	3.63
Layer 7	10.9	17.0	6.20	82.5	0.0854	0.335	14.29	72.8	0.160	62.9	0.000155	97.2	2.71	5.57	27.7	3.69
Layer 8	10.8	16.9	6.14	83.6	0.0796	0.319	14.27	75.6	0.137	49.8	0.000113	99.8	2.04	5.69	22.3	2.61

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	12.9	30	20	32	17	131	71	2.3	2.14	1.1	0.25	18	2.20	167	109	0.07	0.038	123	28	0.98	0.42	82	16	5.6
2	29	12.9	30	20	32	17	131	71	2.3	2.14	1.1	0.25	18	2.20	167	109	0.07	0.038	123	28	0.98	0.42	82	16	5.3
3	29	12.9	30	20	32	17	131	71	2.3	2.14	1.1	0.25	18	2.20	167	109	0.07	0.038	123	28	0.98	0.42	82	16	5.4
4	14	3.3	24	12	12	20	133	58	1.9	0.73	1.2	0.27	12	0.73	152	87	0.05	0.032	63	30	0.37	0.17	84	15	5.5
5	14	3.3	24	12	12	20	133	58	1.9	0.73	1.2	0.27	12	0.73	152	87	0.05	0.032	63	30	0.37	0.17	84	15	5.6
6	14	3.3	24	12	12	20	133	58	1.9	0.73	1.2	0.27	12	0.73	152	87	0.05	0.032	63	30	0.37	0.17	84	15	5.7
7	14	3.3	24	12	12	20	133	58	1.9	0.73	1.2	0.27	12	0.73	152	87	0.05	0.032	63	30	0.37	0.17	84	15	5.8
8	14	3.3	24	12	12	20	133	58	1.9	0.73	1.2	0.27	12	0.73	152	87	0.05	0.032	63	30	0.37	0.17	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

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	8.4	6.2	6.7	25	0.177	0.32	6.1	36	0.11	29	0.00010	49
2	2006	8.5	6.3	6.7	19	0.079	0.28	6.0	30	0.11	29	0.00013	49
8	2005	6.7	6.4	3.5	28	4.4e-02	0.1127	6.2	42	0.061	6.6	6.8e-06	42
8	2006	5.8	5.5	3.2	26	1.0e-07	0.0019	6.3	32	0.062	6.3	6.2e-06	48

Table 4: Actual Average Lysimeter Fluxes (2005)

Shallow.and.Deep.fluxes	Depth	NH4	NH4.SD	NO3	NO3.SD	TN	TN.SD	DOC	DOC.SD	TP	TP.SD	Cl	Cl.SD	SO4	SO4.SD	Ca	Ca.SD	Mg	Mg.SD	K	K.SD	Na	Na.SD	Al	Al.SD
NA	20	0.210049416	0.018413539	0.29063369	0.903104016	2.584976176	1.323438247	22.79330337	3.780780556	0.045545328	0.013708415	48.12893782	44.34049409	3.239059723	6.167872501	20.40967405	9.071287806	8.894951811	5.785746495	9.522967189	6.371362223	27.29467076	18.51377501	0.340716918	0.126564555
NA	100	0.18482098	0.037686163	0.058428056	0.56180591	0.782891773	1.207801926	7.454929603	2.86204934	0.02941534	0.012838737	38.85767377	30.20293147	4.342785568	2.358188679	7.924881994	1.716262595	6.693254137	3.118581853	2.39035473	6.086366362	27.76582547	13.72230984	0.162624321	0.037249254

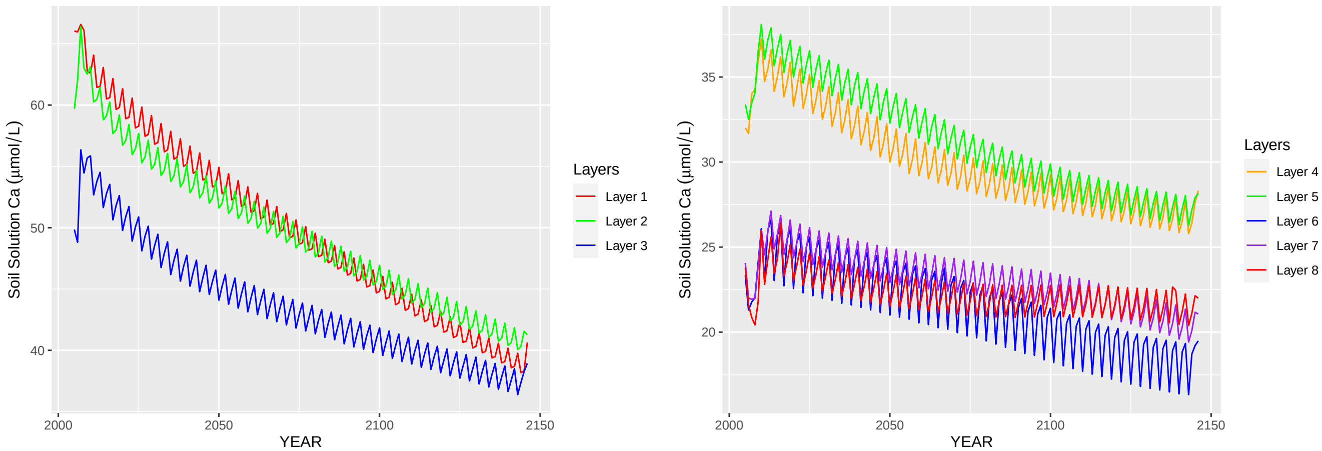


Figure 1: Average Annual Calcium Concentrations by Soil Layer

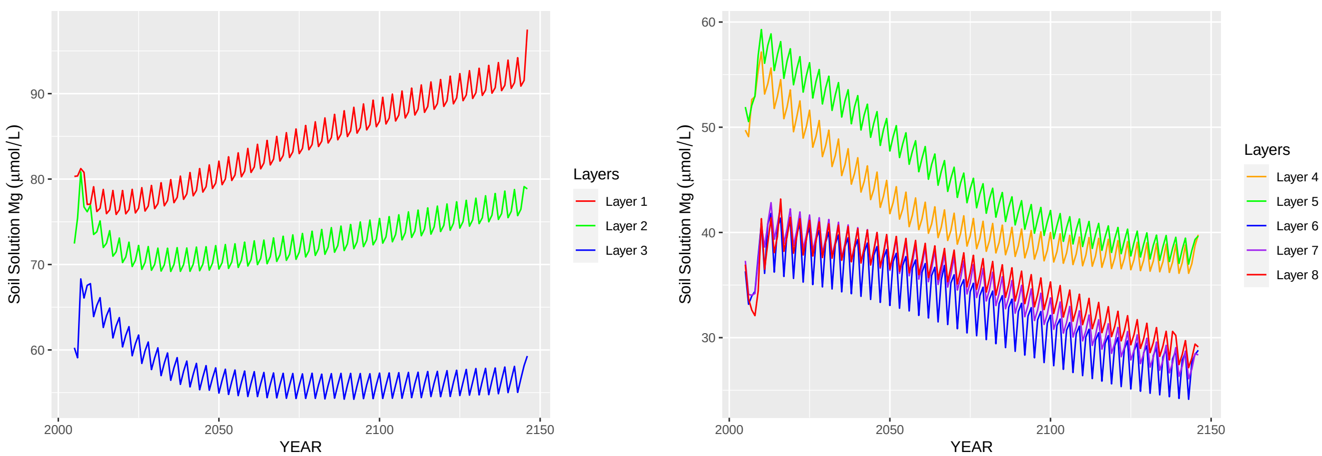


Figure 2: Average Annual Magnesium Concentrations by Soil Layer

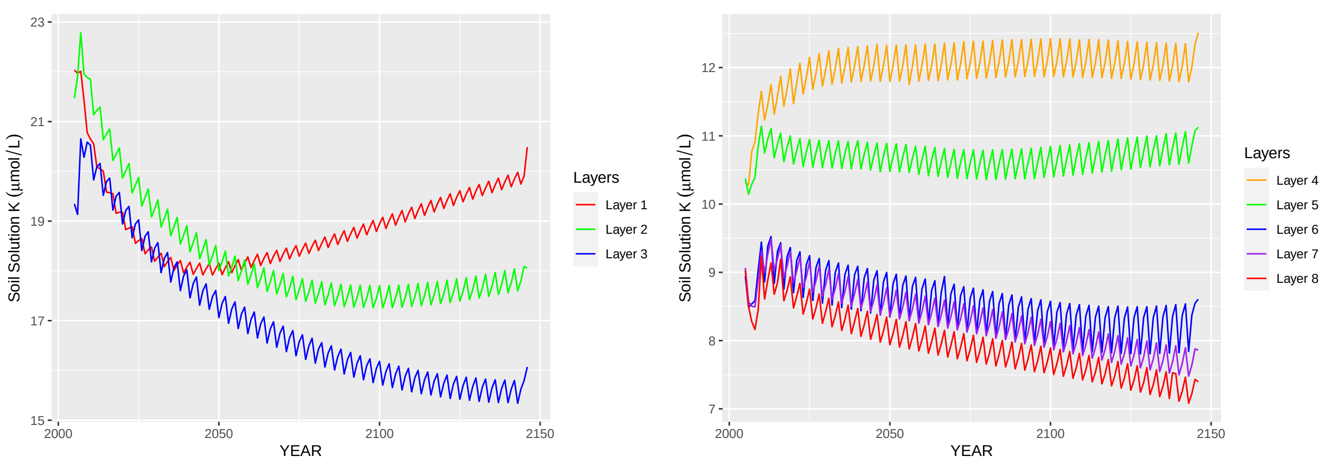


Figure 3: Average Annual Potassium Concentrations by Soil Layer

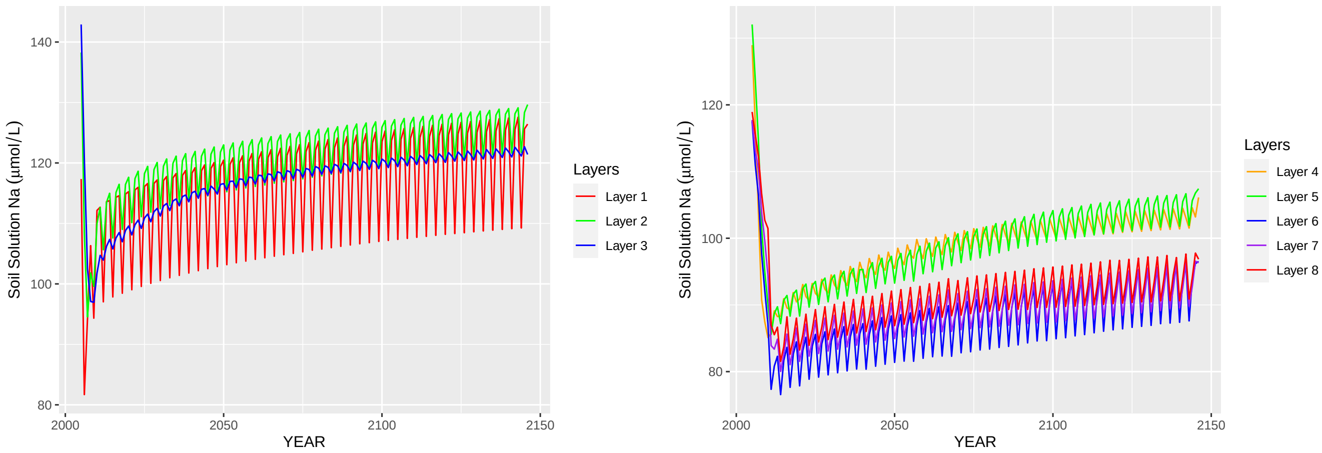


Figure 4: Average Annual Sodium Concentrations by Soil Layer

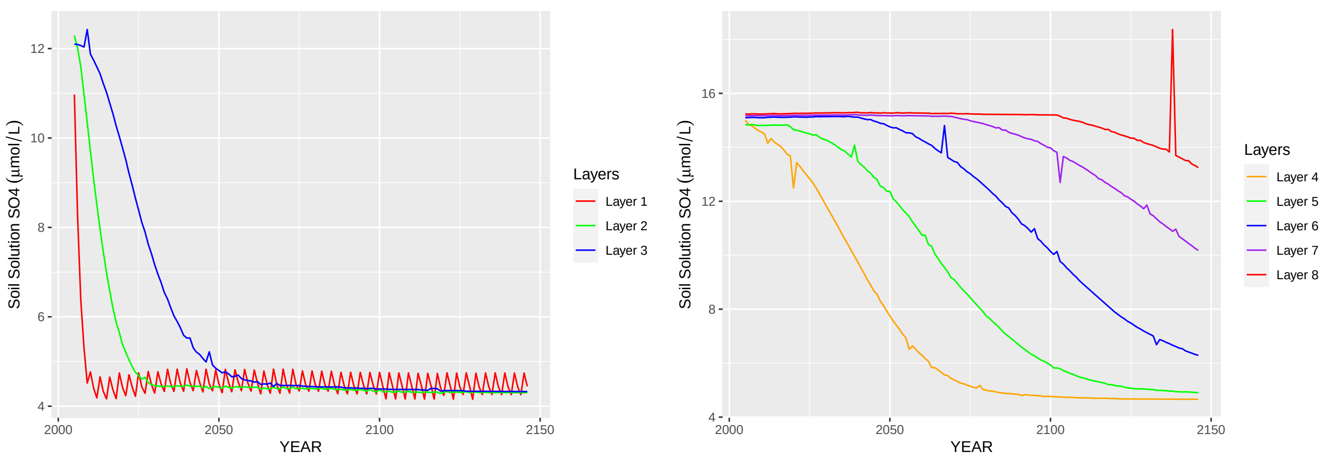


Figure 5: Average Annual Sulfate Concentrations by Soil Layer

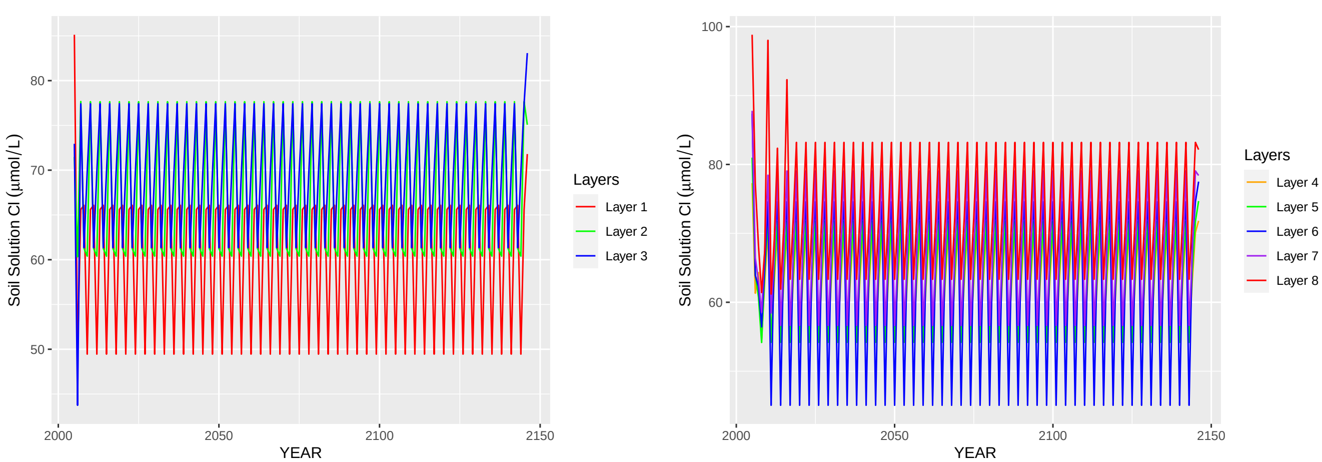


Figure 6: Average Annual Chloride Concentrations by Soil Layer

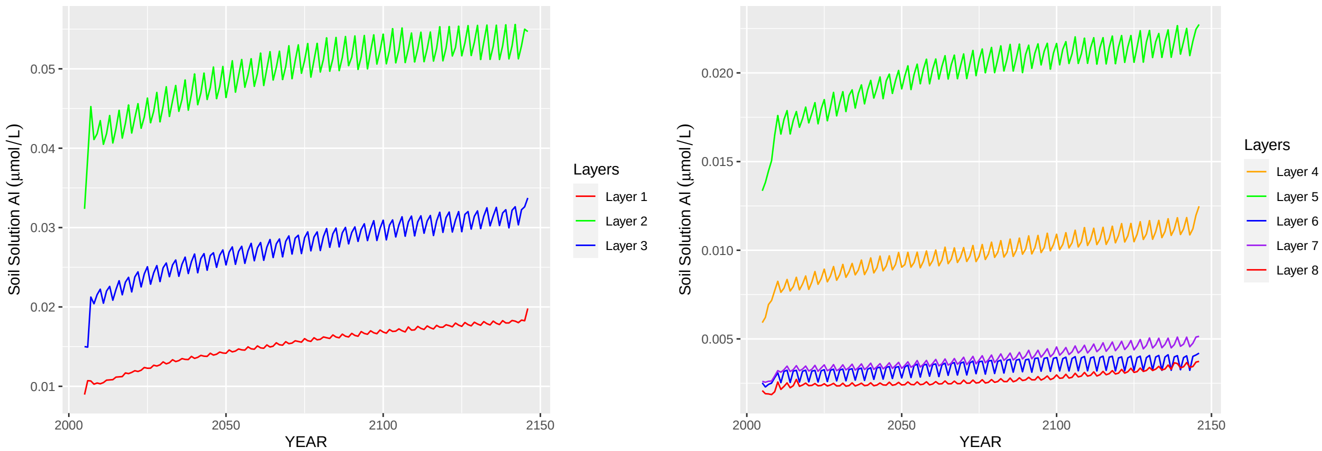


Figure 7: Monthly Aluminum Concentrations by Soil Layer

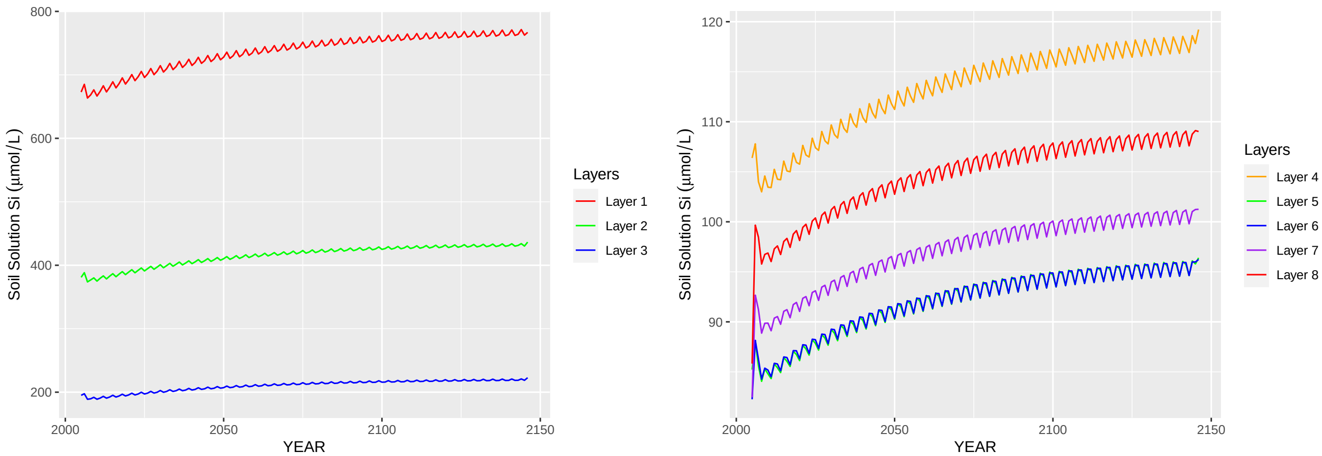


Figure 8: Monthly SiO2 Concentrations by Soil Layer

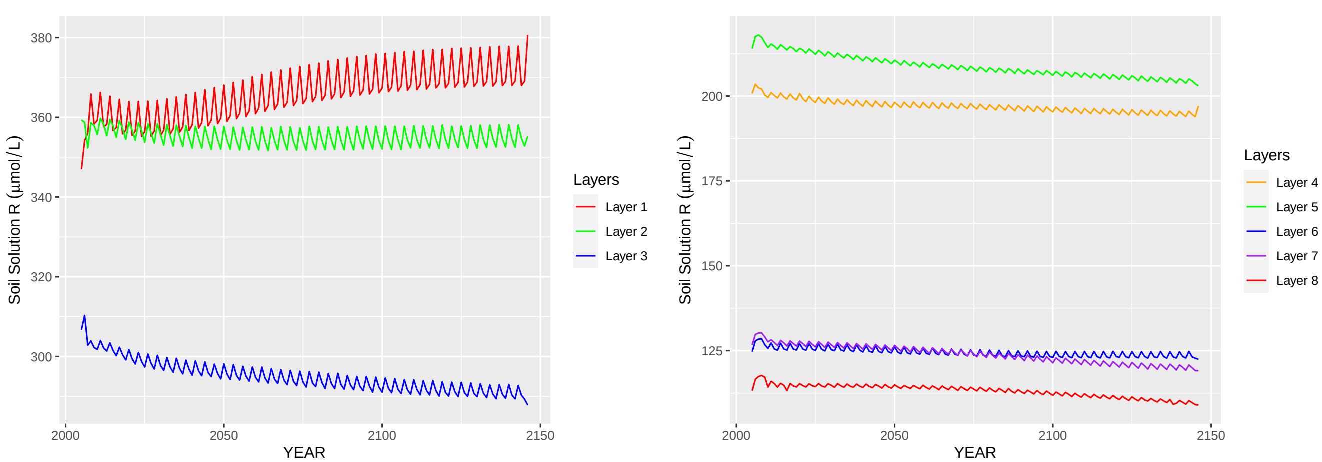


Figure 9: Monthly Organic Acid Base (R-) Concentrations by Soil Layer

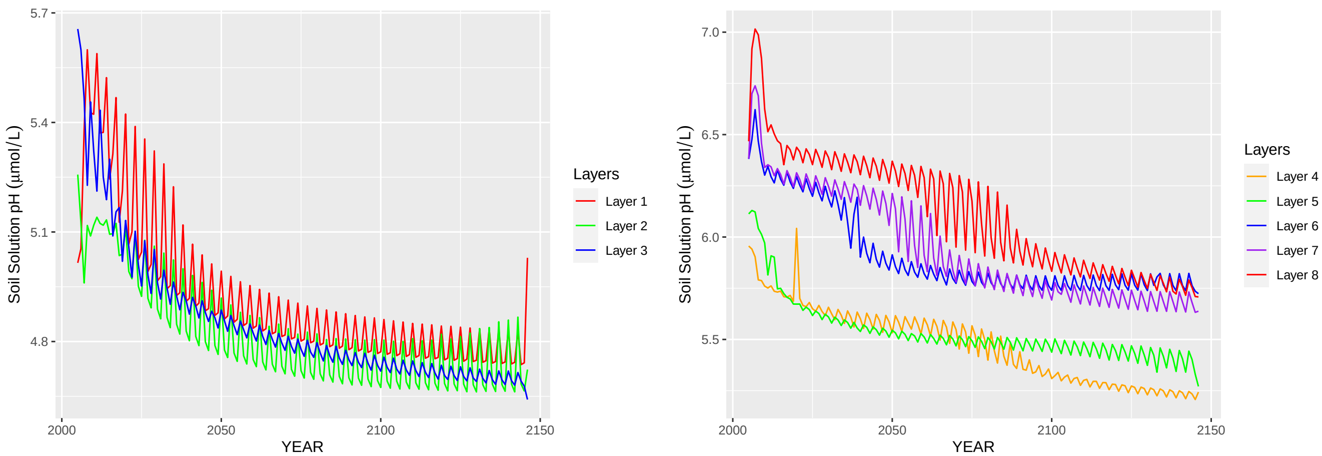


Figure 10: Monthly pH by Soil Layer

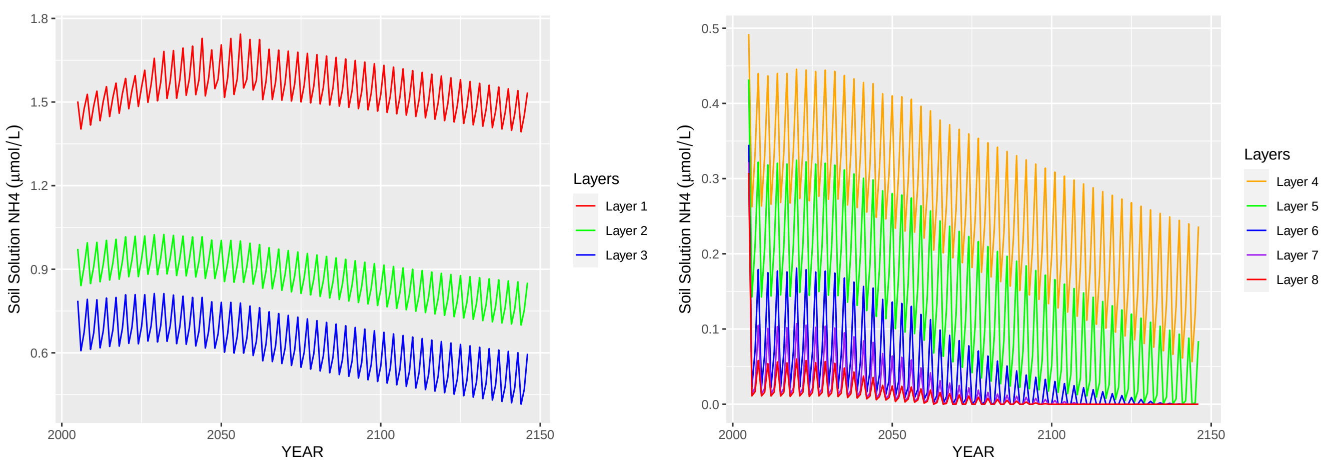


Figure 11: Yearly Ammonium concentration by Soil Layer

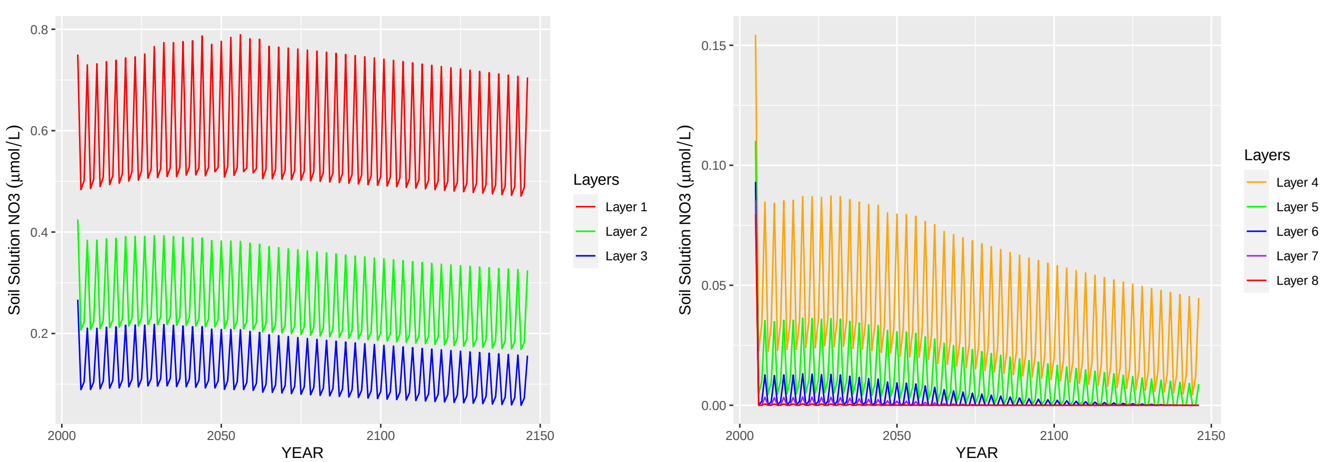


Figure 12: Yearly Nitrate concentration by Soil Layer

Weathering Results

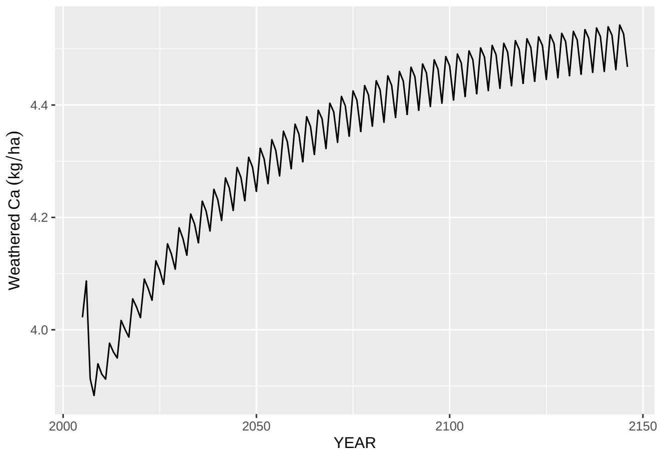


Figure 13: Calcium Weathering (All Layer)

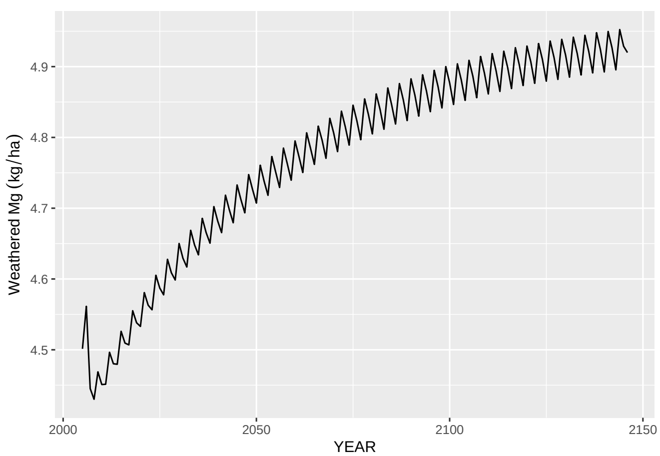


Figure 14: Magnesium Weathering (All Layer)

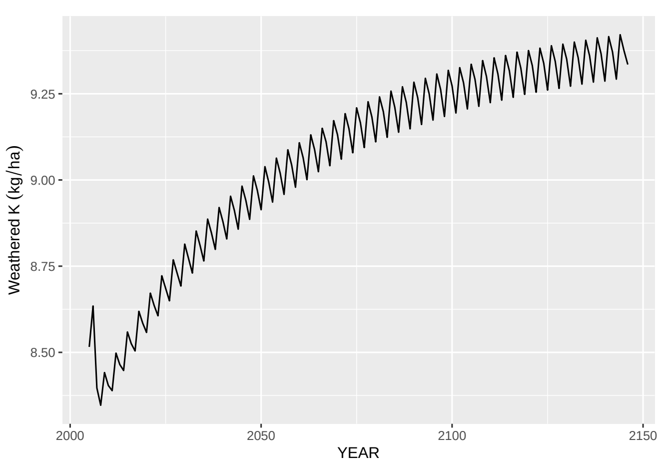


Figure 15: Potassium Weathering (All Layer)

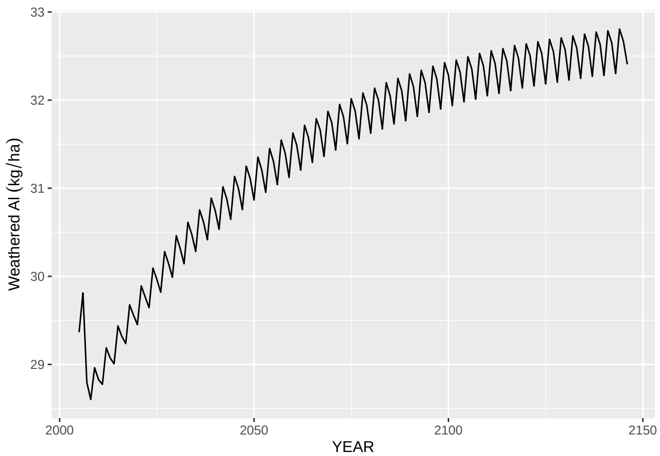


Figure 16: Aluminum Weathering (All Layer)

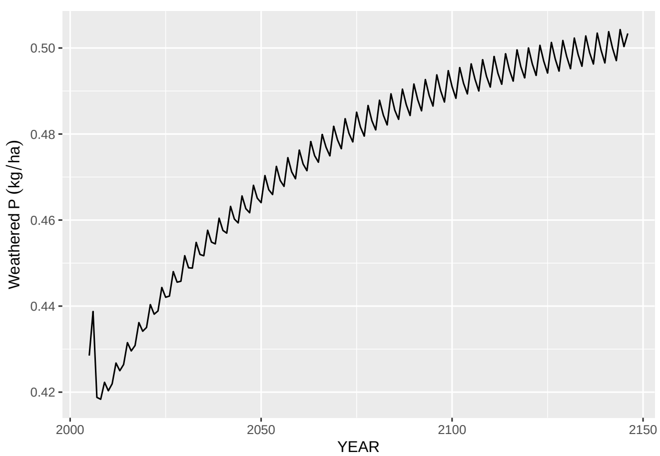


Figure 17: Phosphate Weathering (All Layer)

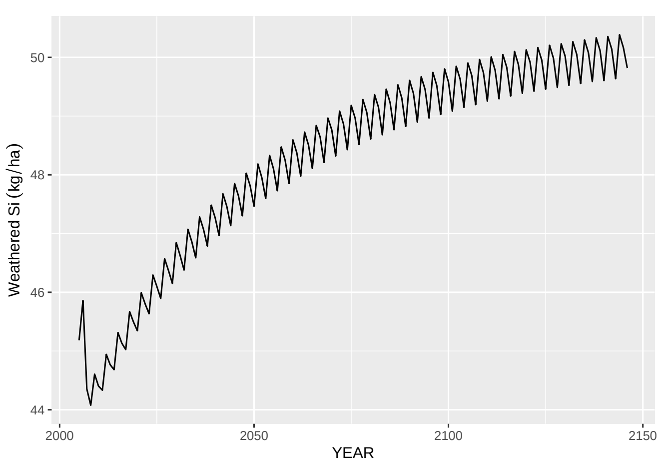


Figure 18: Silica Weathering (All Layer)

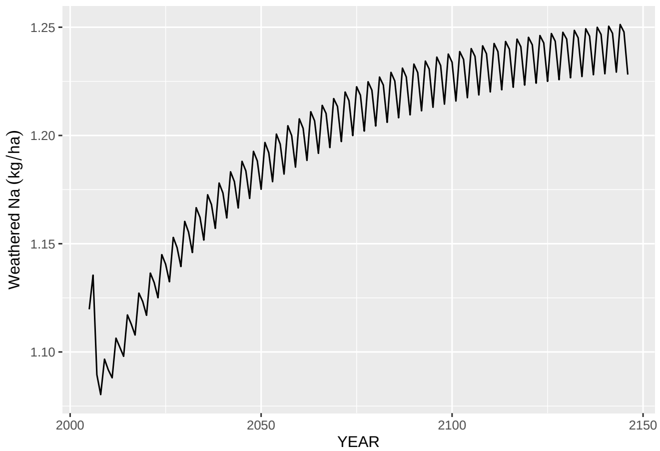
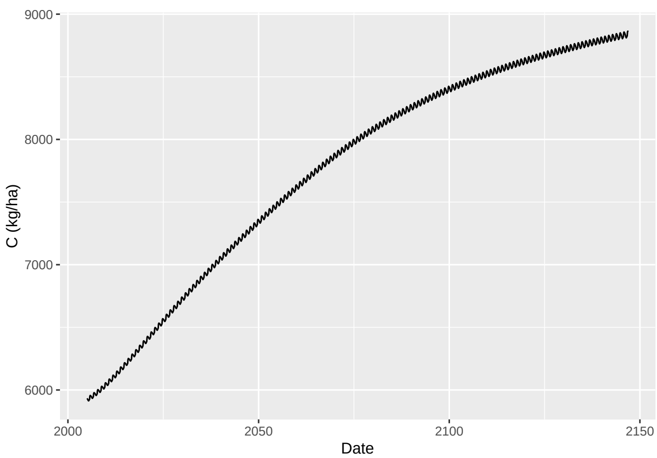
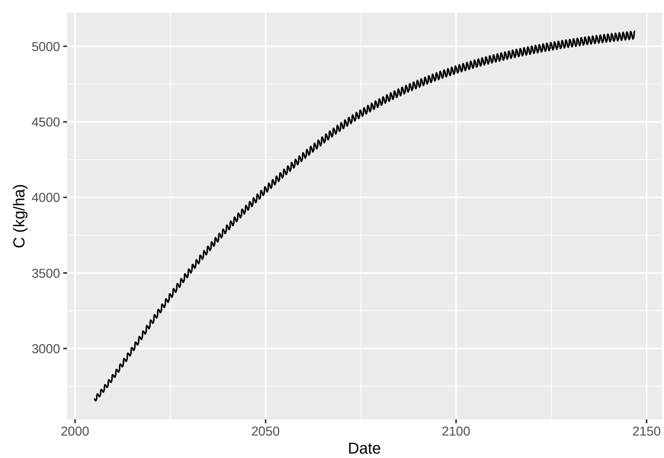


Figure 19: Sodium Weathering (All Layer)

Litter Pool Results

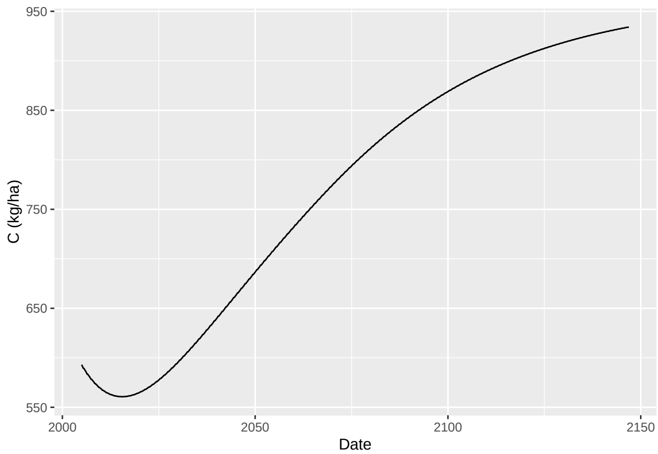


(a) Total forest floor carbon content (kg/ha)

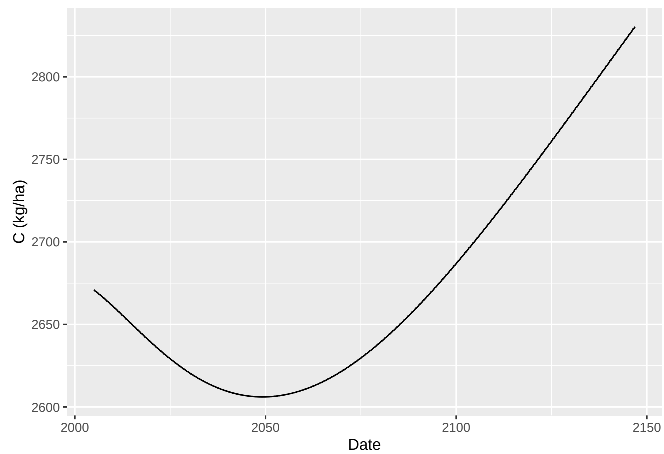


(b) Carbon content of coarse litter (kg/ha)

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



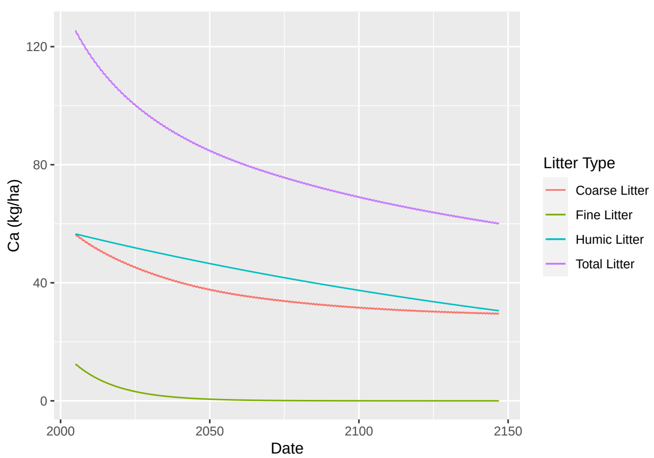
(a) Carbon content of fine litter (kg/ha)



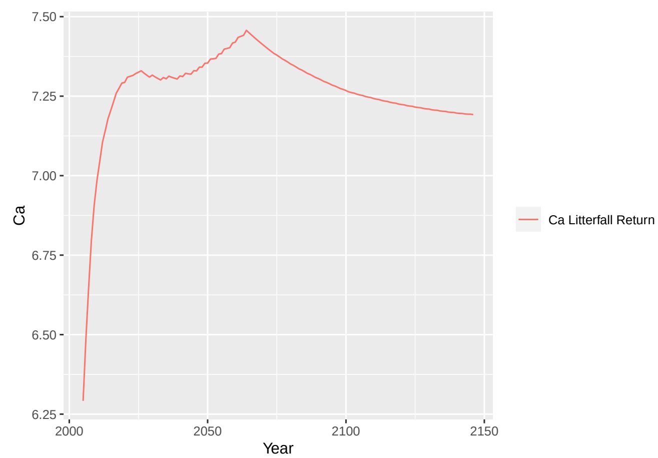
(b) Carbon content of humic litter (kg/ha)

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.



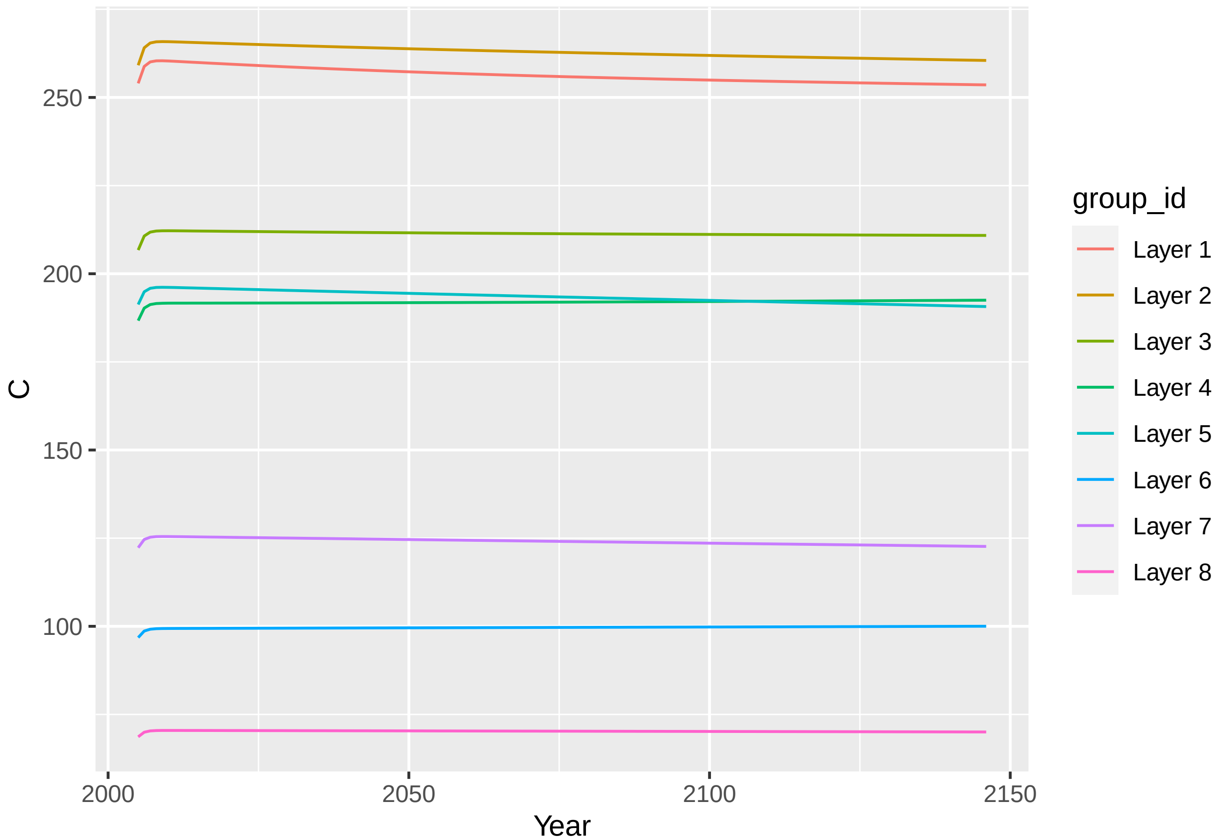
(a) Ca Content in each litter decomposition stage (kg/ha)

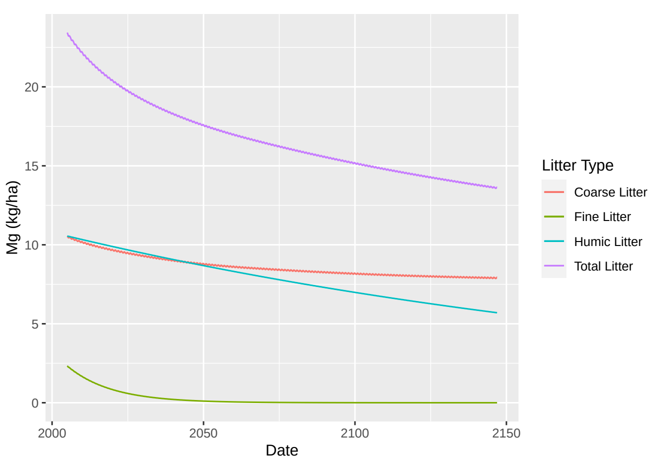


(b) Ca net annual return in litterfall (kg/ha)

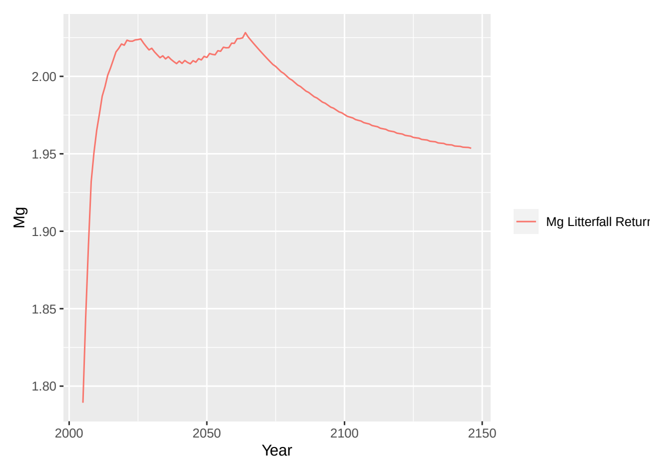
Figure 22: Forest Floor/O-horizon Ca content over time (a). and net annual Ca return in litterfall (b).

Soil Organic Matter Results



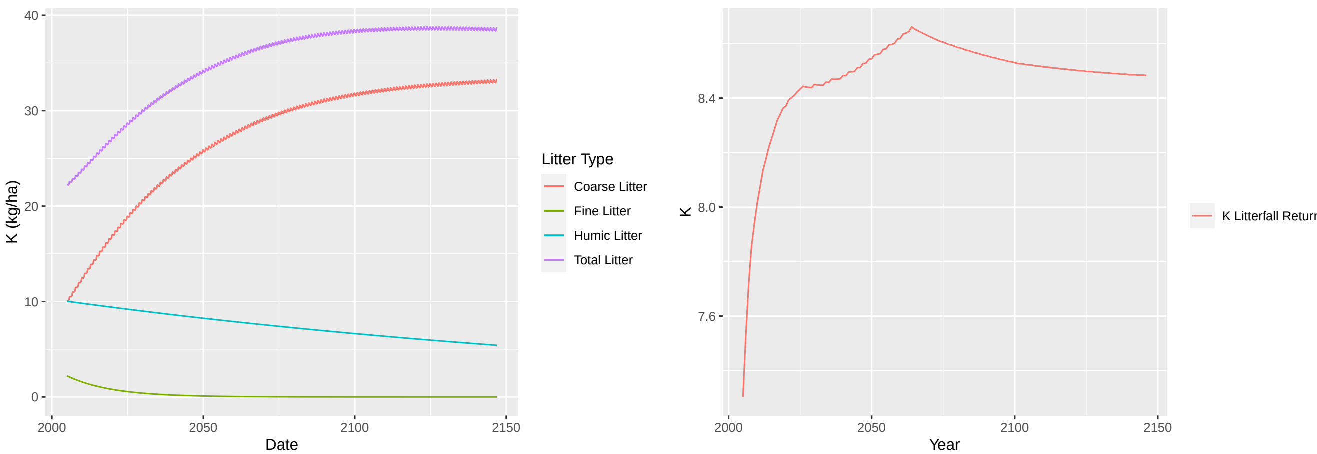


(a) Mg Content in each litter decomposition stage (kg/ha)



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

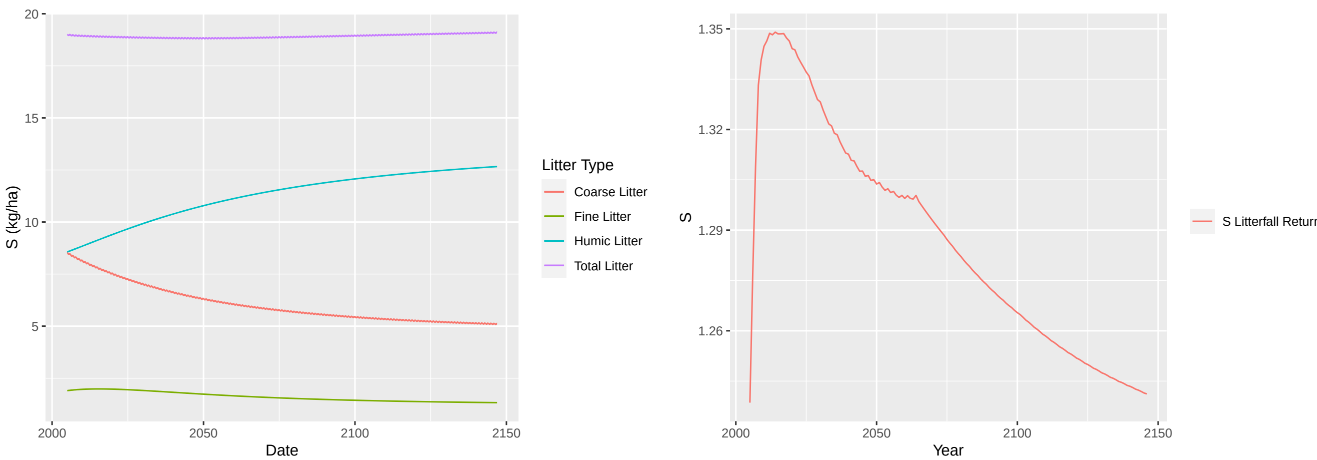
Figure 23: Forest Floor/O-horizon Mg content over time (a). and net annual Mg return in litterfall (b).



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

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

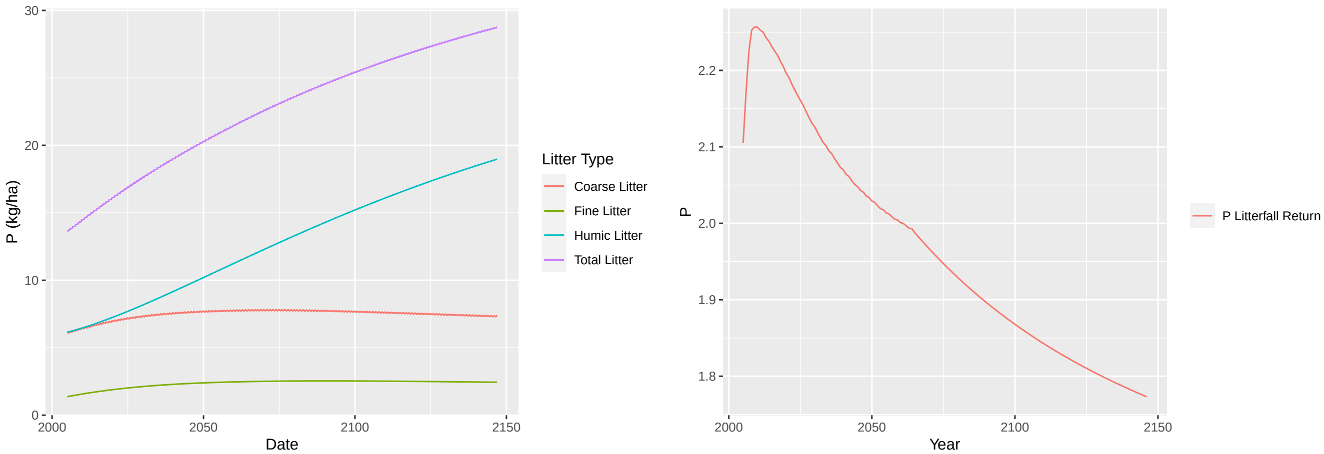
Figure 24: Forest Floor/O-horizon K content over time (a). and net annual K return in litterfall (b).



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

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

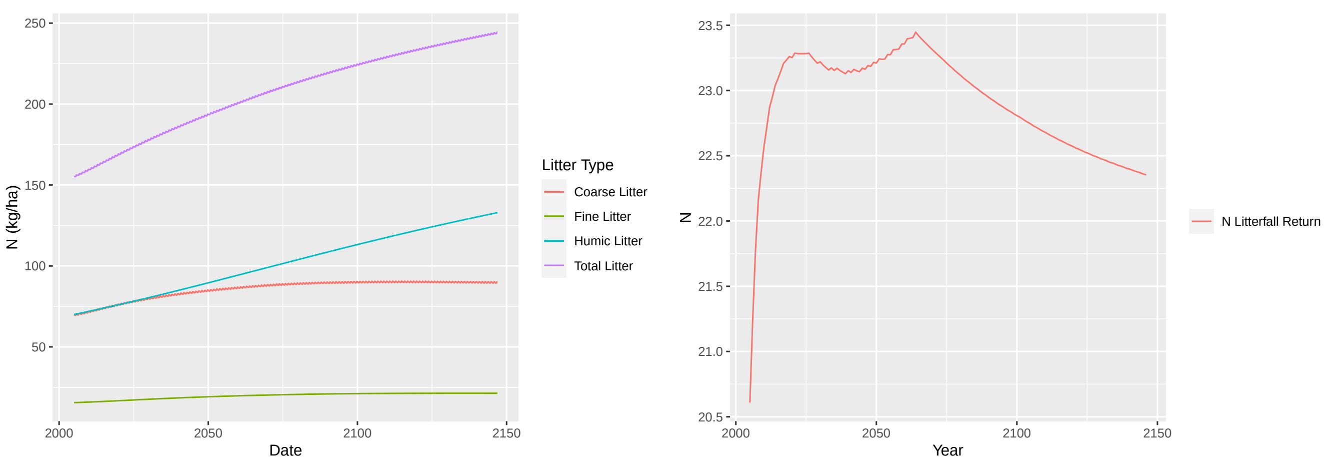
Figure 25: Forest Floor/O-horizon S content over time (a). and net annual S return in litterfall (b).



(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).



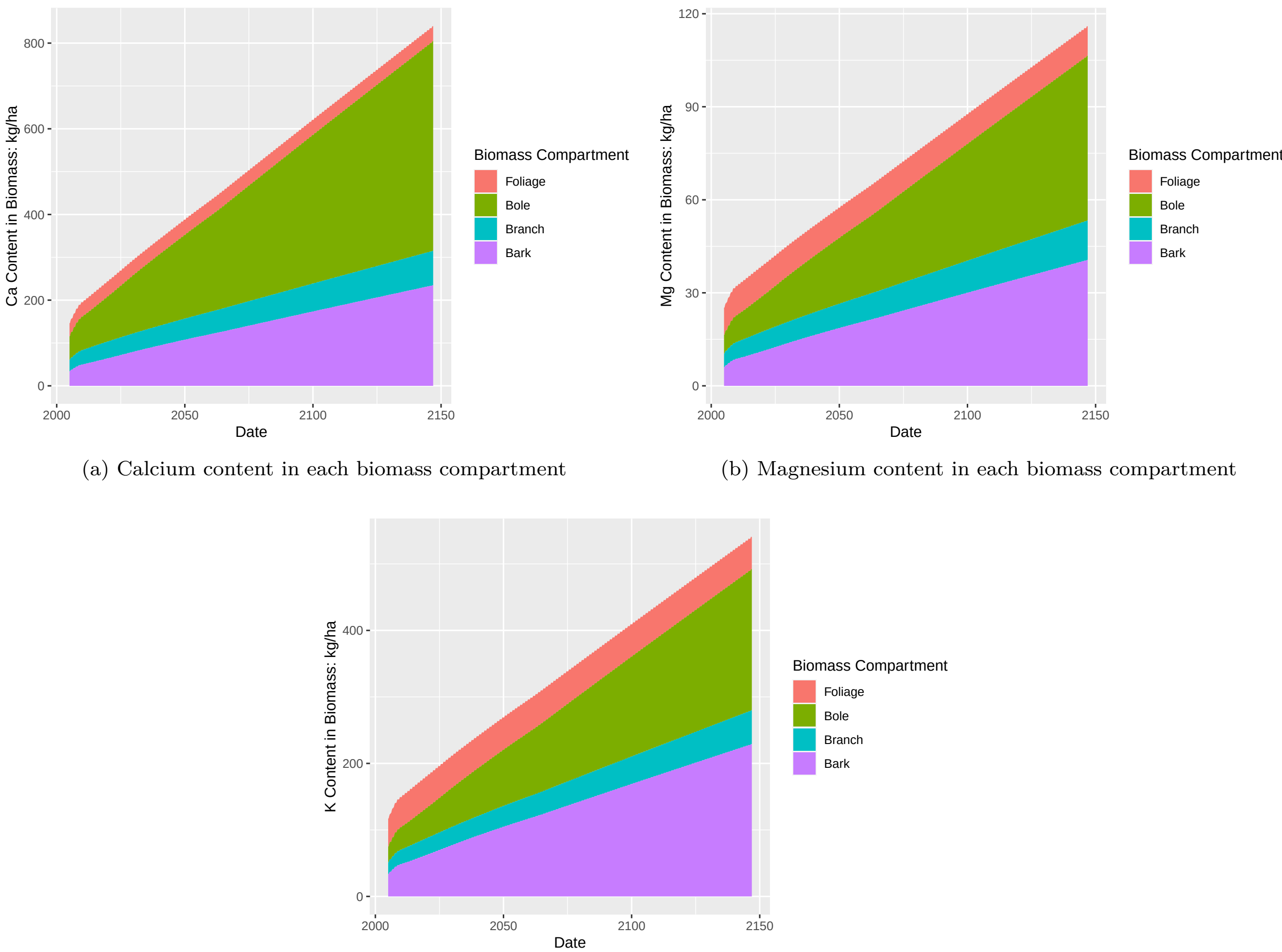
(a) N Content in each litter decomposition stage (kg/ha)

(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

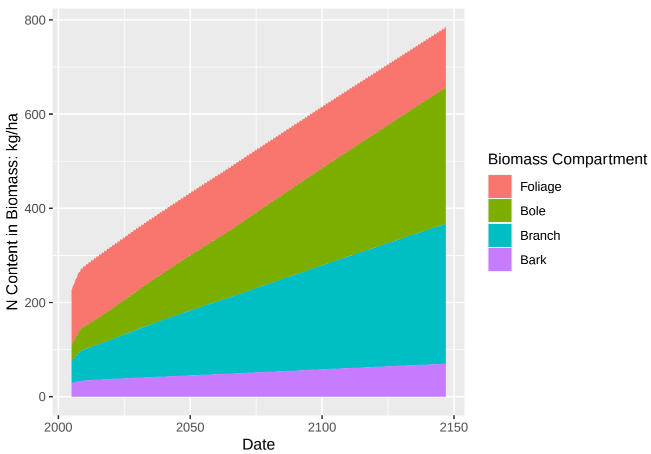


(a) Calcium content in each biomass compartment

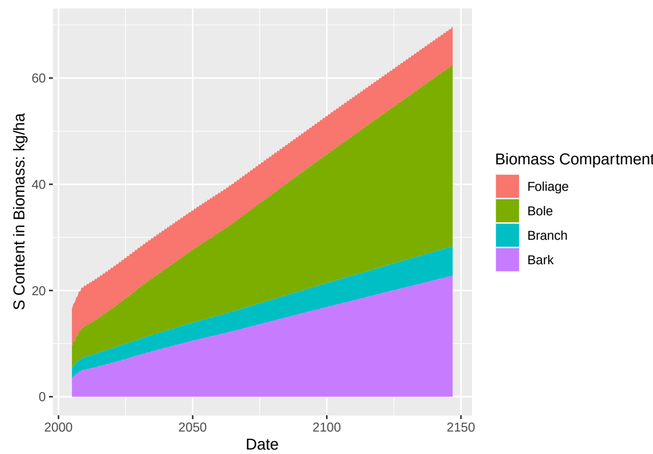
(b) Magnesium content in each biomass compartment

(c) Potassium content in each biomass compartment

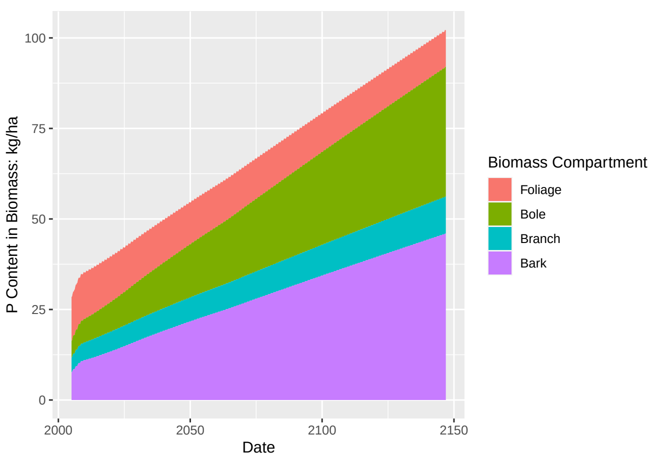
Figure 28: Base Cation Nutrient Content in Simulated Forest



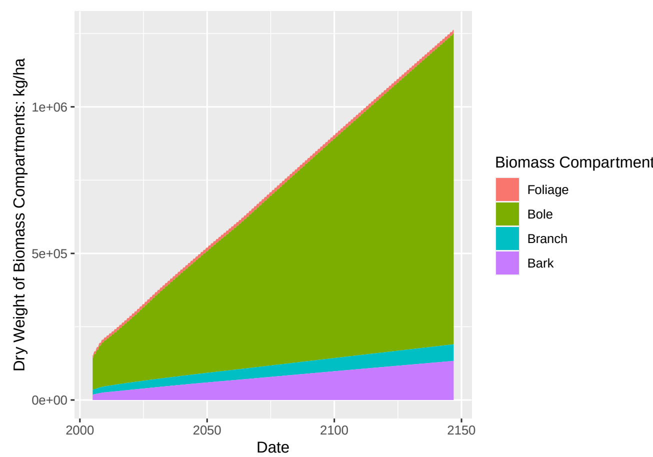
(a) Nitrogen content in each biomass compartment



(b) Sulfur content in each biomass compartment



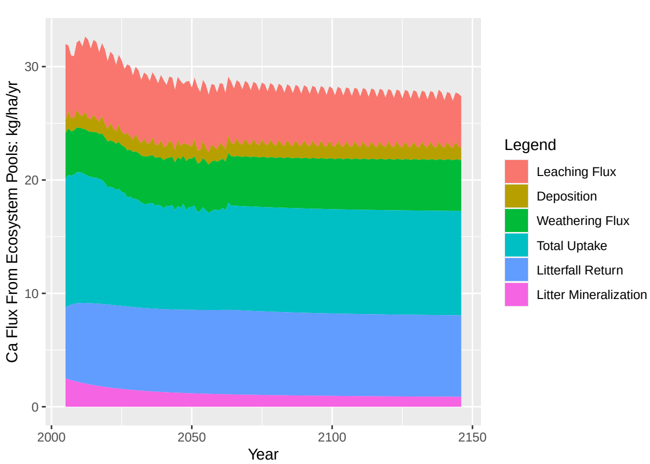
(c) Phosphorous content in each biomass compartment



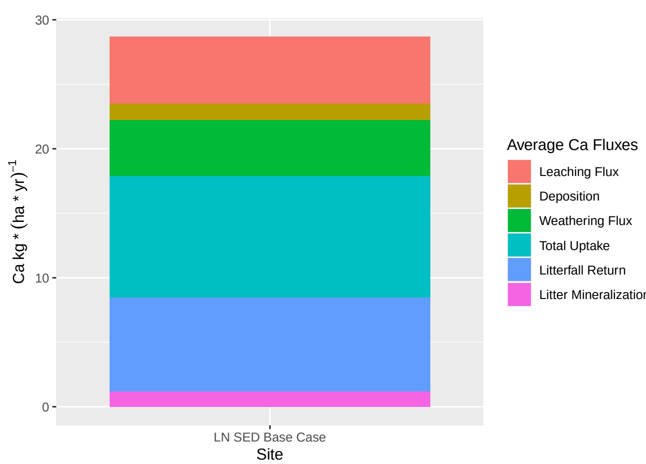
(d) Biomass of each compartment

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

Analysis 1: Stack Flux Data

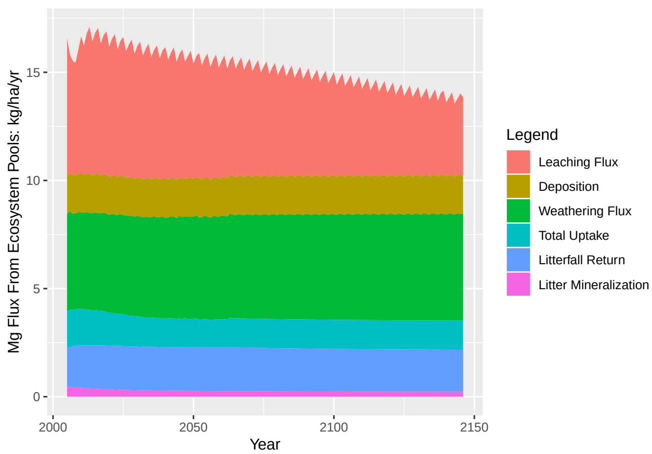


(a) Ca input and output fluxes over time

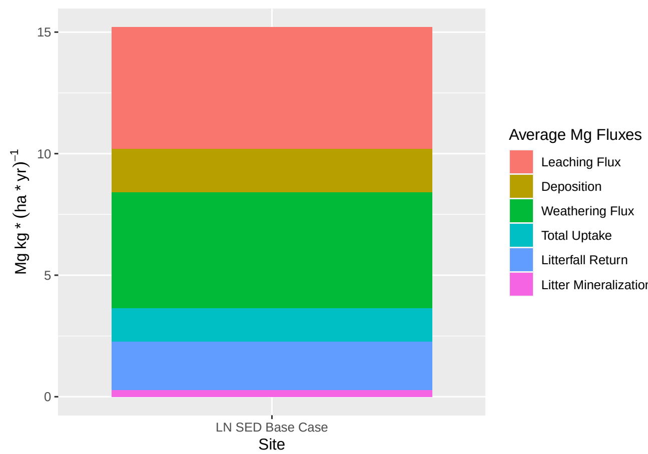


(b) Total Average Ca input and output fluxes

Figure 30: Calcium input and output comparison graphs

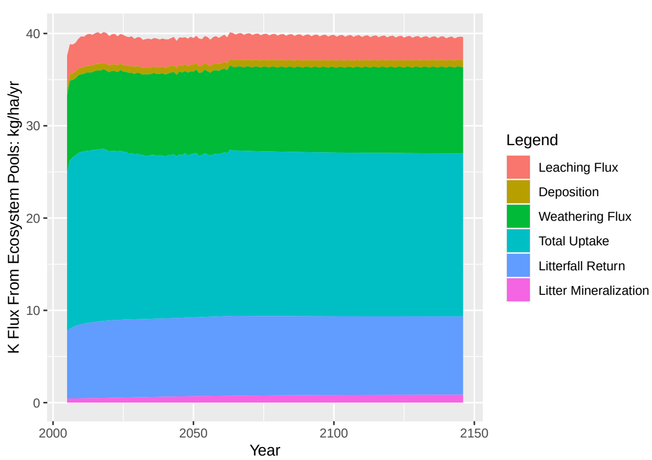


(a) Mg input and output fluxes over time

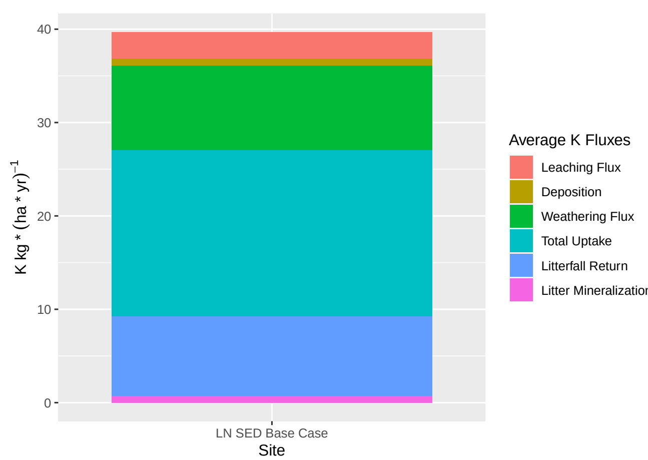


(b) Total Average Mg input and output fluxes

Figure 31: Magnesium input and output comparison graphs

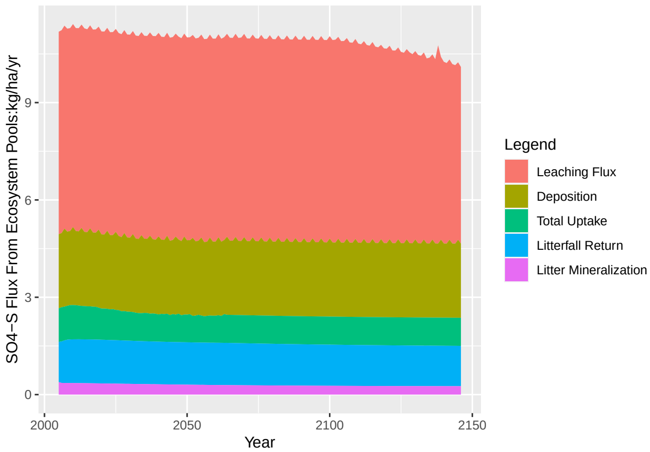


(a) K input and output fluxes over time

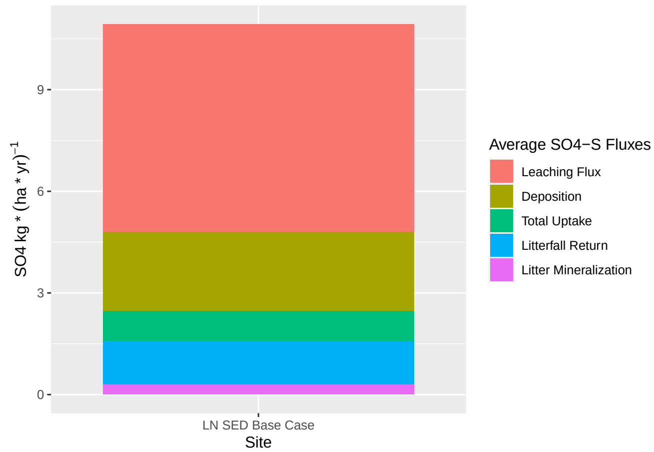


(b) Total Average K input and output fluxes

Figure 32: Potassium input and output comparison graphs



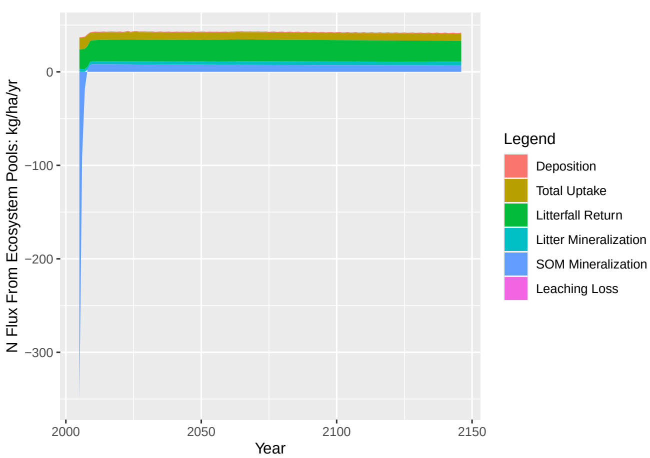
(a) S input and output fluxes over time



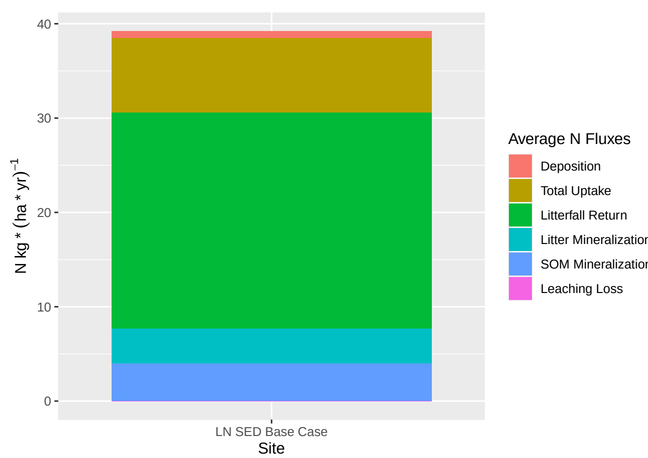
(b) Total Average S input and output fluxes

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

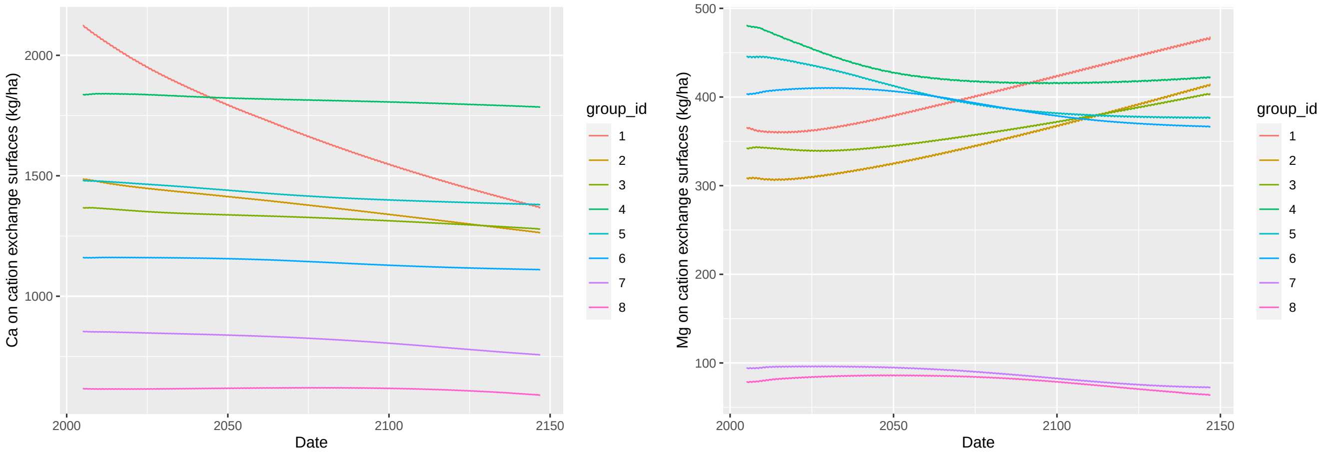


Figure 35: Calcium and Magnesium CEC adsorption over time

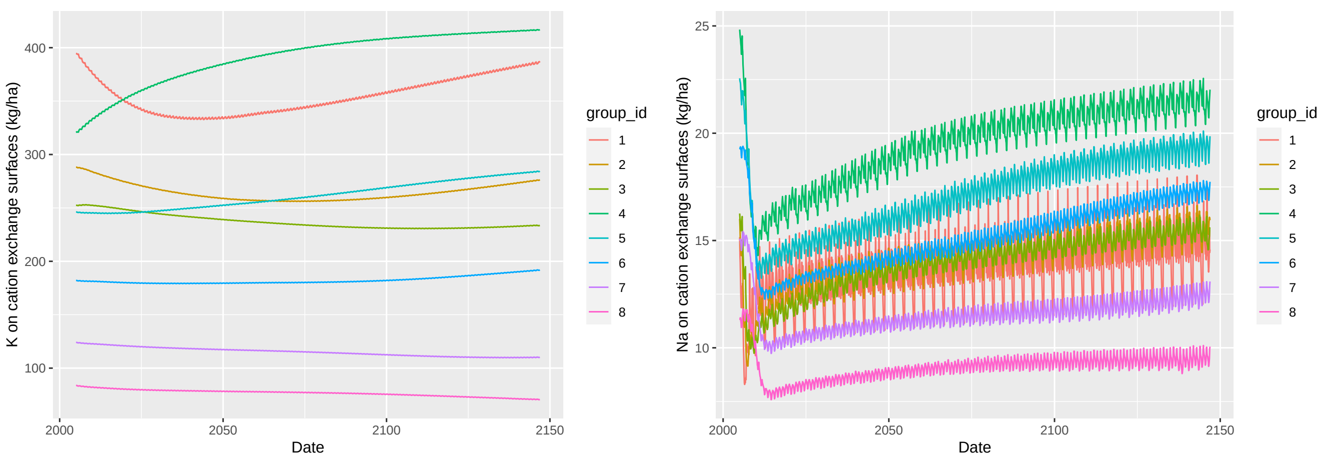


Figure 36: Potassium and Sodium CEC adsorption over time

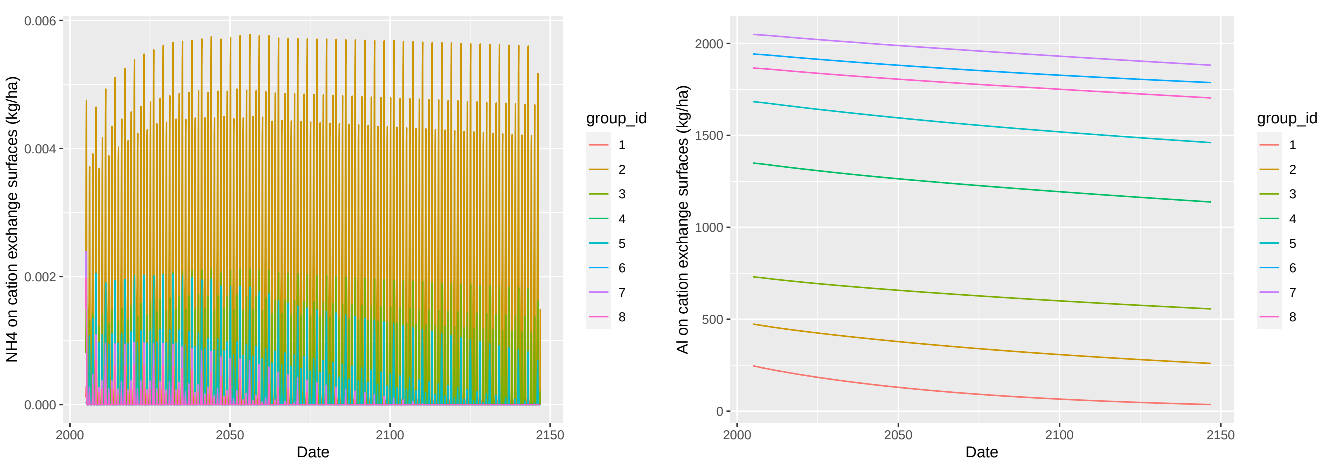
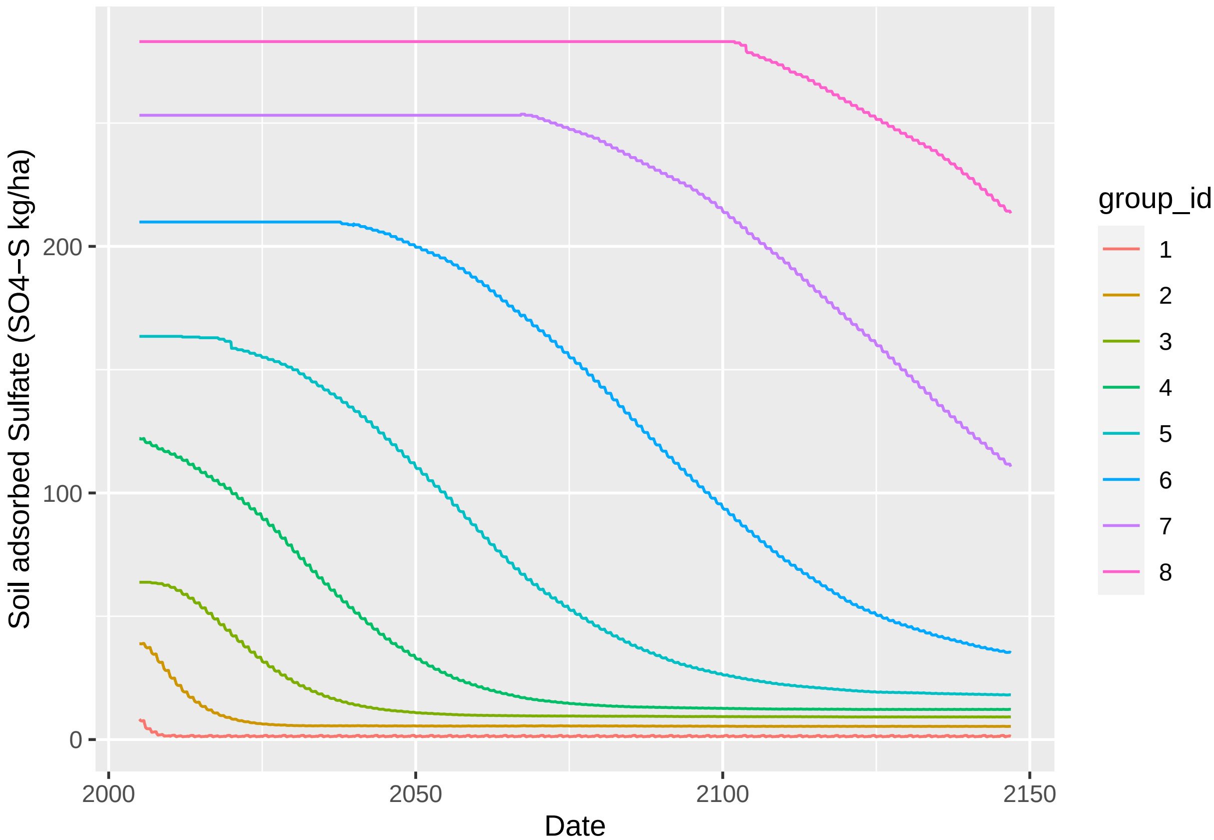
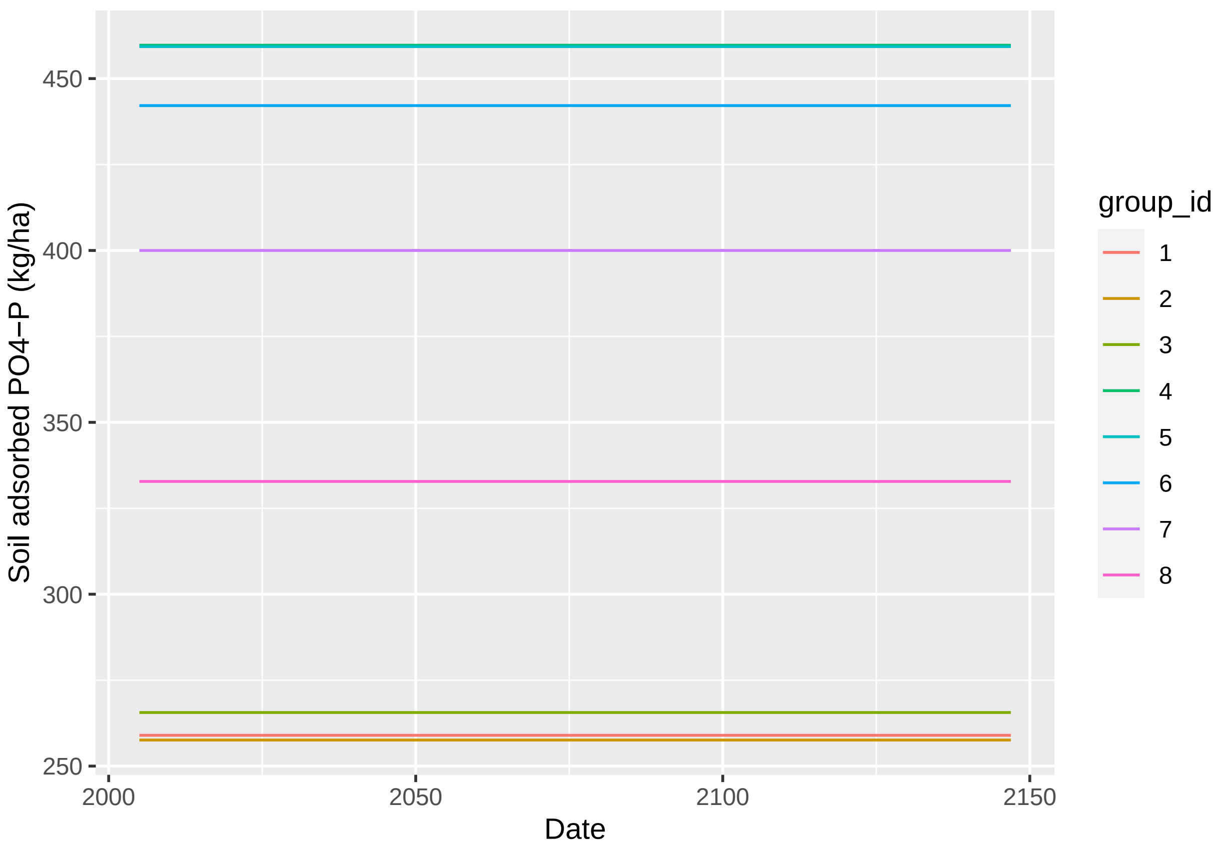
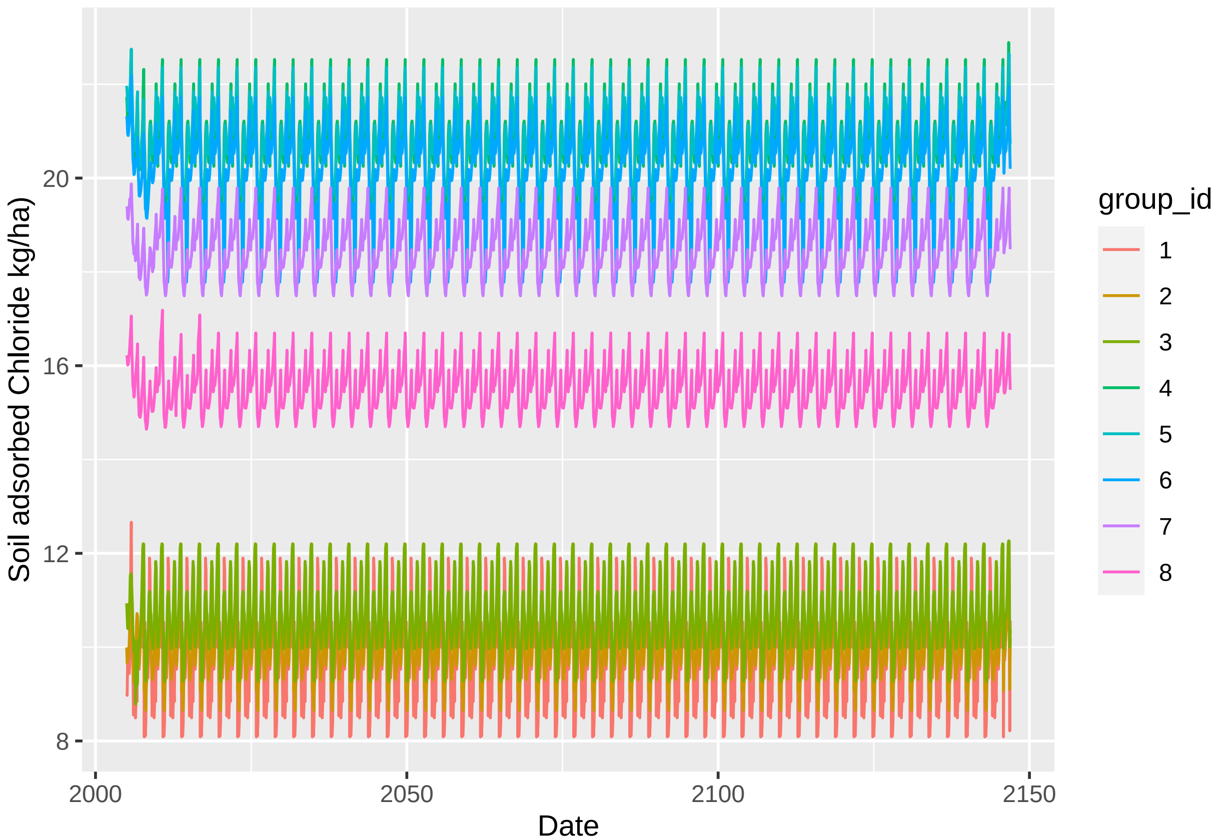


Figure 37: Ammonium and Aluminum CEC adsorption over time

Anion Exchange Capacity



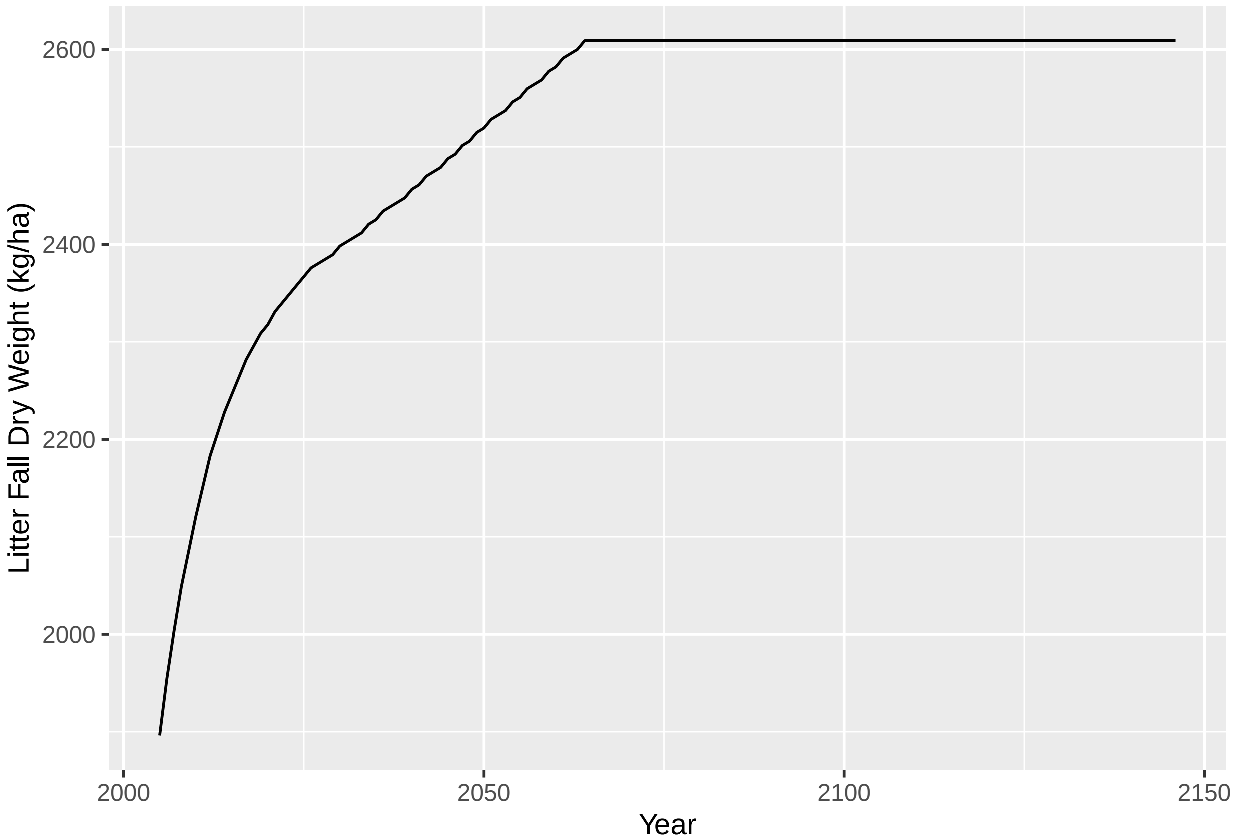




Phosphate seems stable, generally. It should be noted that P uptake is not being modeled in the foliage (it should remain constant so far) and that phosphate adsorption parameters are completely borrowed from the Burgundy site. As for sulfate, I purged the model of the AEC sulfate pool and relegated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



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