Calibration Report: High N Sedimentary Site Base Case

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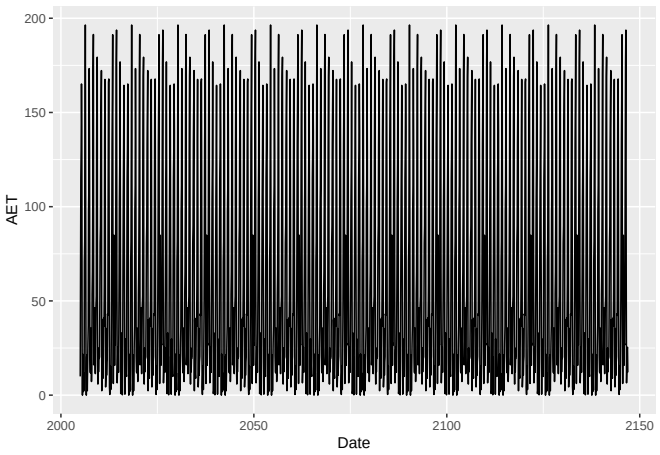
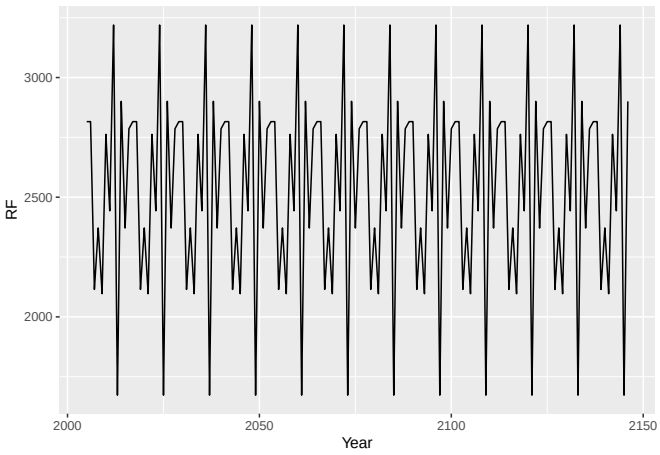
Hydrology





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	19.7	33.9	16.3	49.7	39.8	0.864	22.1	59.2	3.77	567	0.00312	62.6	24.8	4.61	55.7	25.3
Layer 2	24.0	47.5	17.9	68.1	63.6	1.438	23.2	66.6	2.50	885	0.00493	141.5	30.5	4.52	84.4	41.9
Layer 3	26.3	45.7	17.0	79.5	69.9	1.424	23.2	73.6	2.60	982	0.08155	183.0	38.3	4.42	90.6	49.7
Layer 4	26.5	29.3	25.8	73.9	62.1	1.043	22.6	69.9	1.75	591	0.03044	175.2	22.7	4.64	58.2	26.2
Layer 5	38.0	32.5	20.8	64.0	67.5	2.493	23.0	76.3	1.11	584	0.02323	176.3	20.0	4.70	58.7	24.7
Layer 6	35.0	40.8	15.5	75.8	71.8	1.629	22.8	82.9	1.20	595	0.01857	179.0	17.0	4.77	61.4	23.6
Layer 7	36.5	42.1	18.5	77.4	73.0	3.655	22.8	89.9	1.33	663	0.02273	183.3	19.0	4.72	67.3	27.4
Layer 8	35.3	42.9	17.6	77.1	75.1	3.157	22.8	95.4	1.20	684	0.05036	186.7	27.6	4.56	65.9	31.7

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	26	12	39	14	21	19.9	184	53	71	40	1.20	0.23	17	5.7	209	59	1.2	0.33	127	32	6.7	3.9	0	0	4.5
2	26	12	39	14	21	19.9	184	53	71	40	1.20	0.23	17	5.7	209	59	1.2	0.33	127	32	6.7	3.9	0	0	4.6
3	26	12	39	14	21	19.9	184	53	71	40	1.20	0.23	17	5.7	209	59	1.2	0.33	127	32	6.7	3.9	0	0	4.8
4	17	10	30	13	15	8.8	203	55	71	75	0.97	0.20	19	4.0	194	55	1.5	1.01	54	16	4.9	6.0	0	0	5.2
5	17	10	30	13	15	8.8	203	55	71	75	0.97	0.20	19	4.0	194	55	1.5	1.01	54	16	4.9	6.0	0	0	5.5
6	17	10	30	13	15	8.8	203	55	71	75	0.97	0.20	19	4.0	194	55	1.5	1.01	54	16	4.9	6.0	0	0	5.8
7	17	10	30	13	15	8.8	203	55	71	75	0.97	0.20	19	4.0	194	55	1.5	1.01	54	16	4.9	6.0	0	0	6.1
8	17	10	30	13	15	8.8	203	55	71	75	0.97	0.20	19	4.0	194	55	1.5	1.01	54	16	4.9	6.0	0	0	6.3

[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

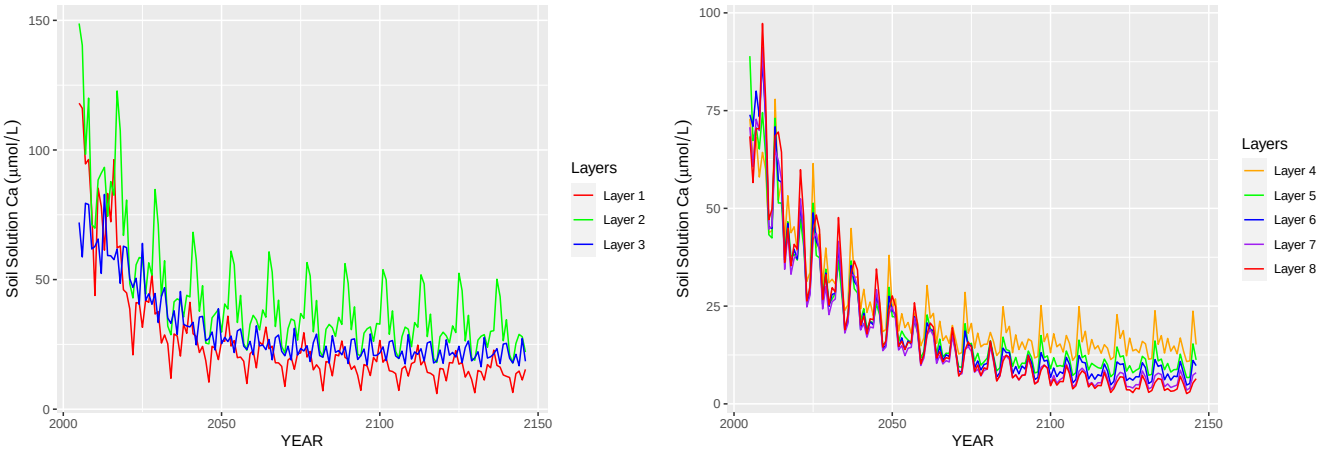


Figure 1: Monthly Calcium Concentrations by Soil Layer

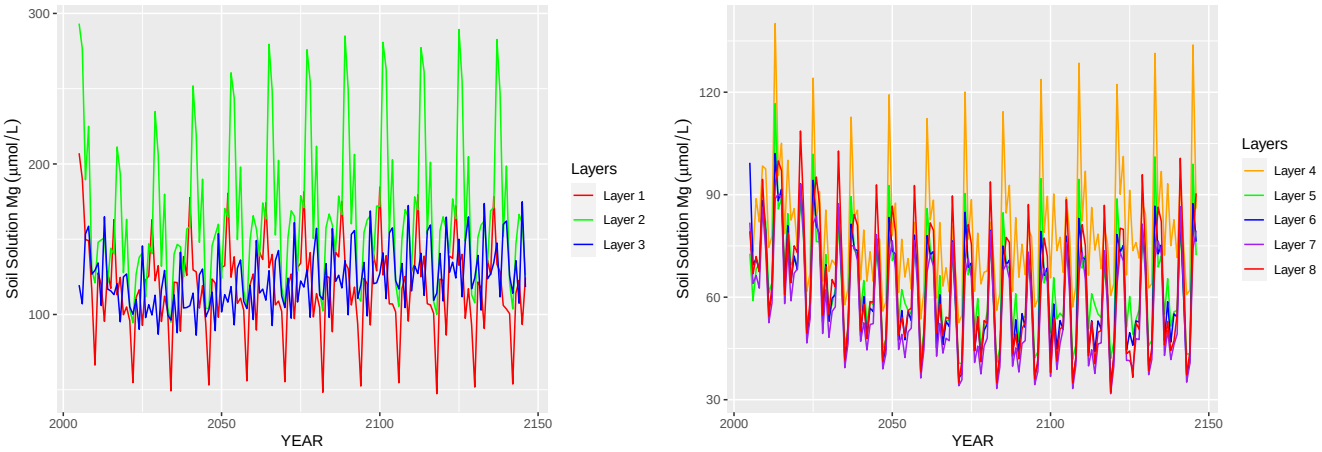


Figure 2: Monthly Magnesium Concentrations by Soil Layer

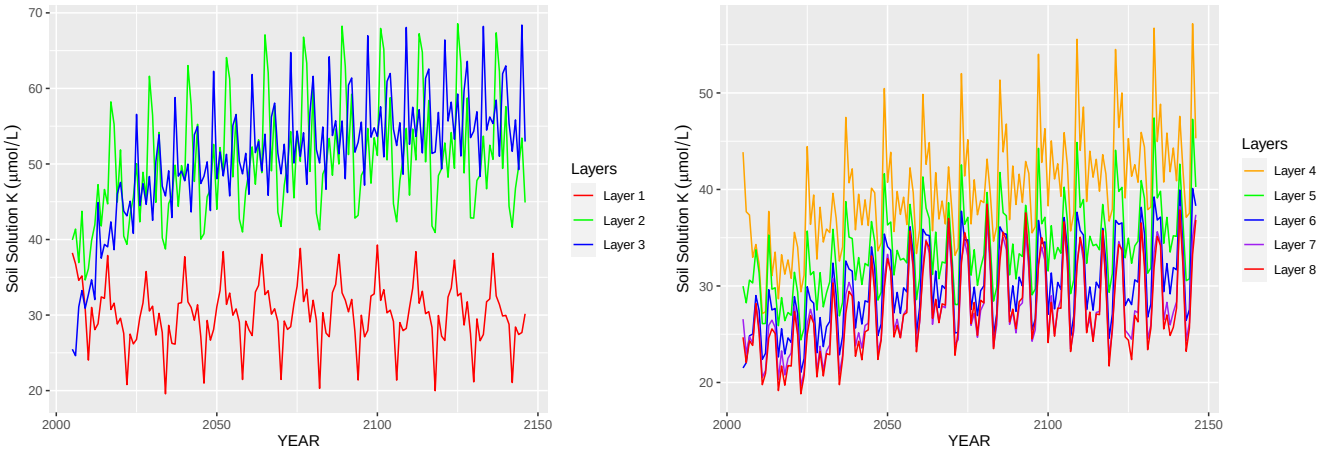


Figure 3: Monthly Potassium Concentrations by Soil Layer

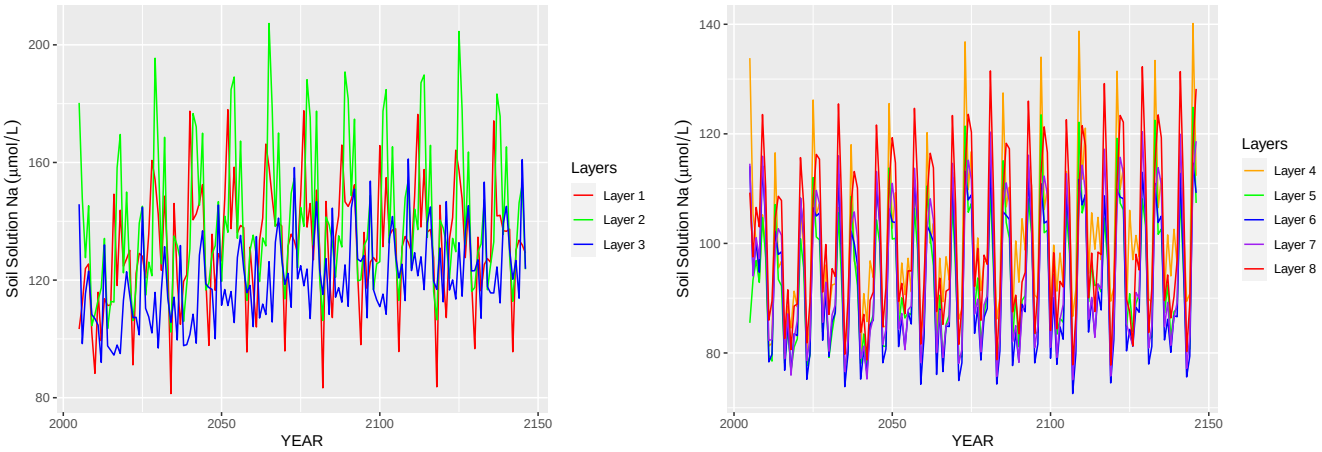


Figure 4: Monthly Sodium Concentrations by Soil Layer

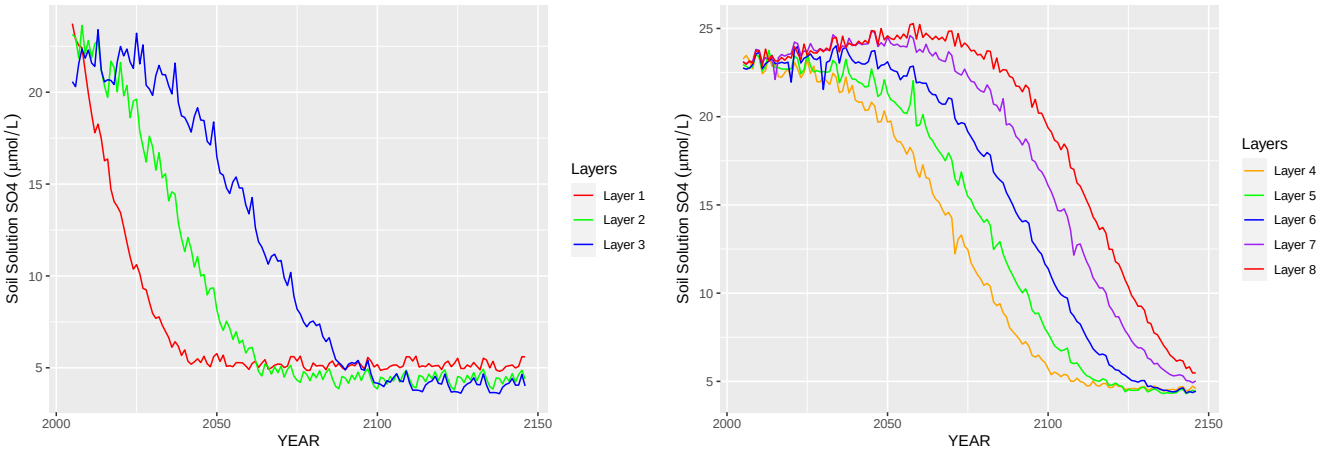


Figure 5: Monthly Sulfate Concentrations by Soil Layer

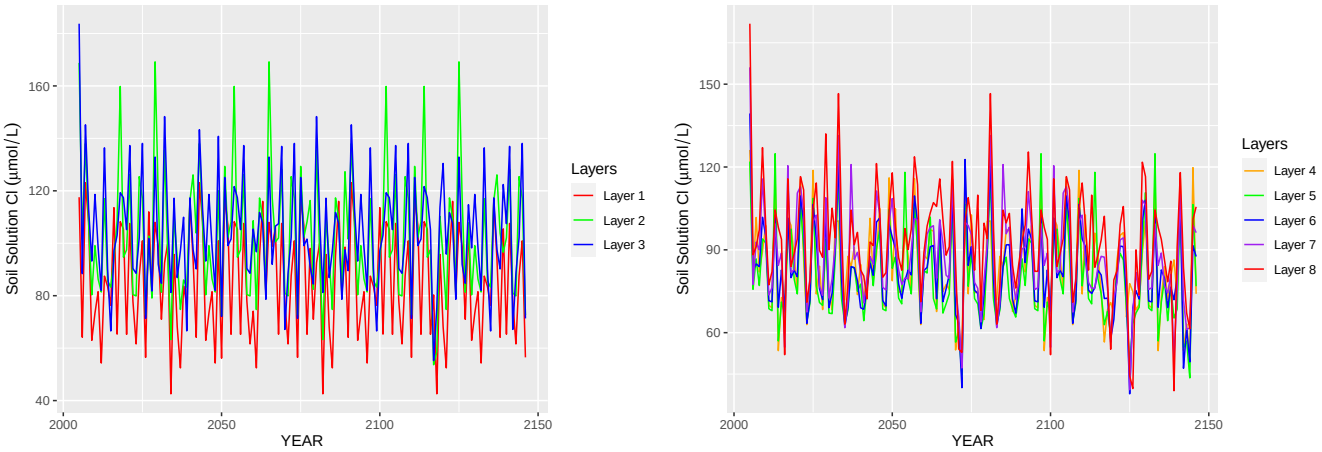


Figure 6: Monthly Chloride Concentrations by Soil Layer

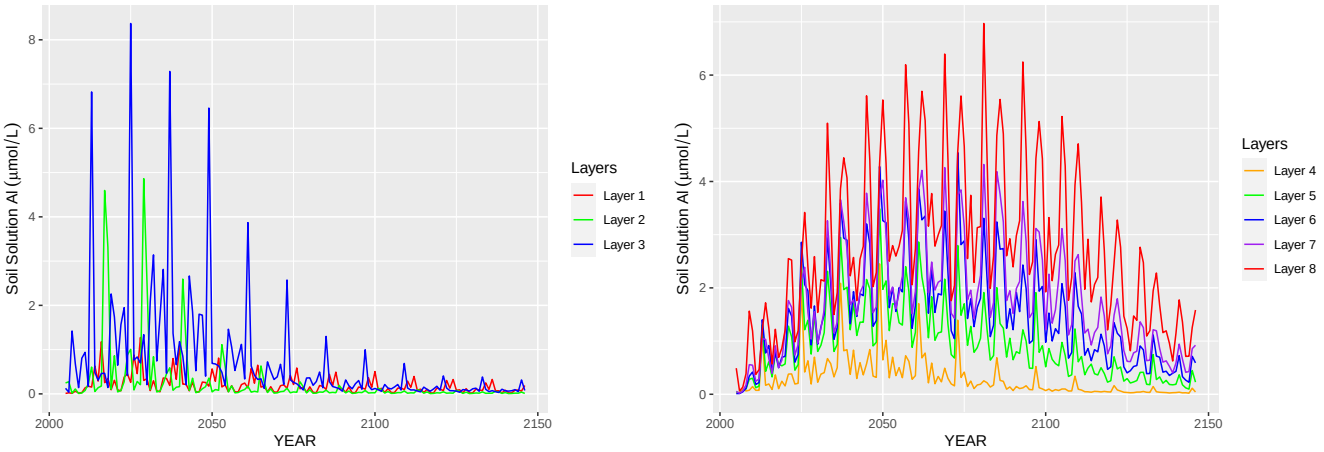


Figure 7: Monthly Aluminum Concentrations by Soil Layer

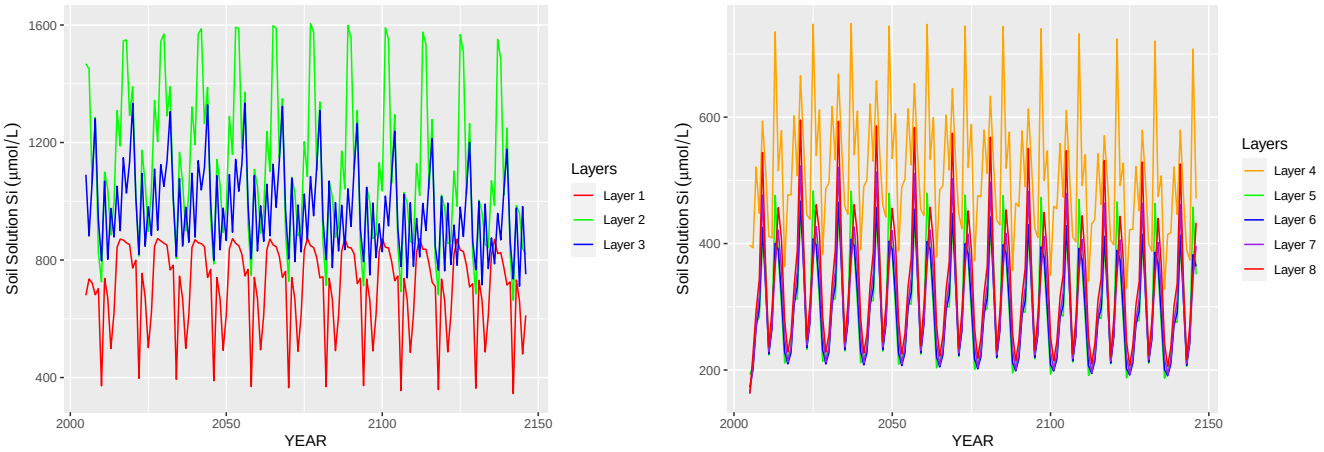


Figure 8: Monthly SiO2 Concentrations by Soil Layer

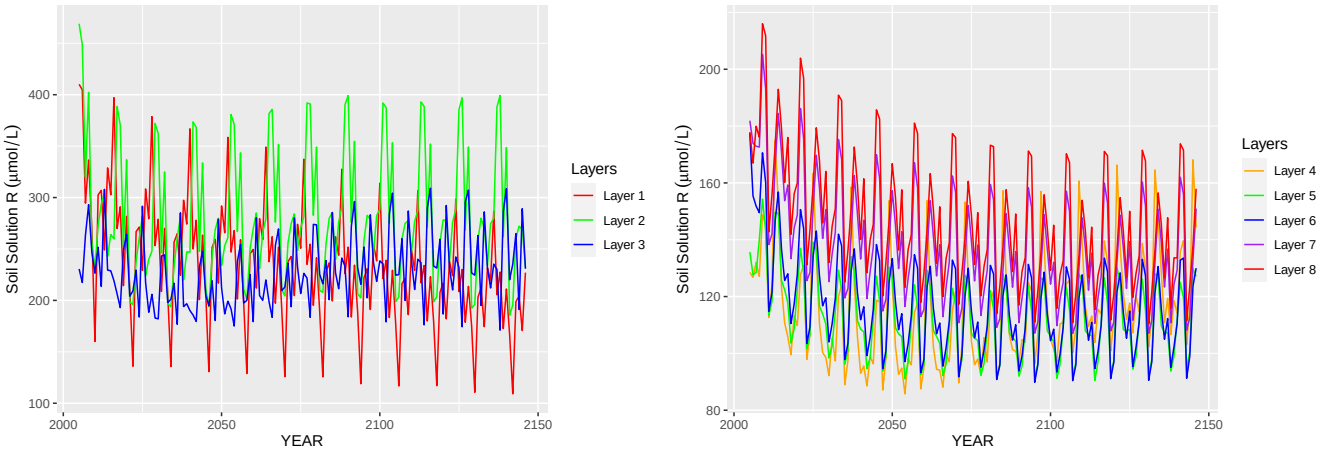


Figure 9: Monthly Organic Acid Base (R-) Concentrations by Soil Layer

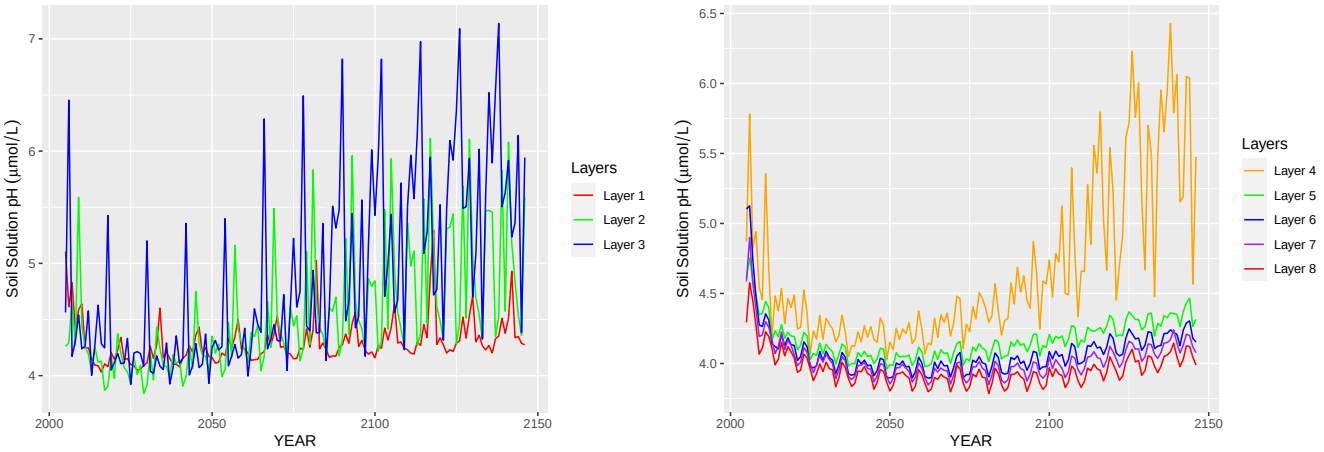


Figure 10: Monthly pH by Soil Layer

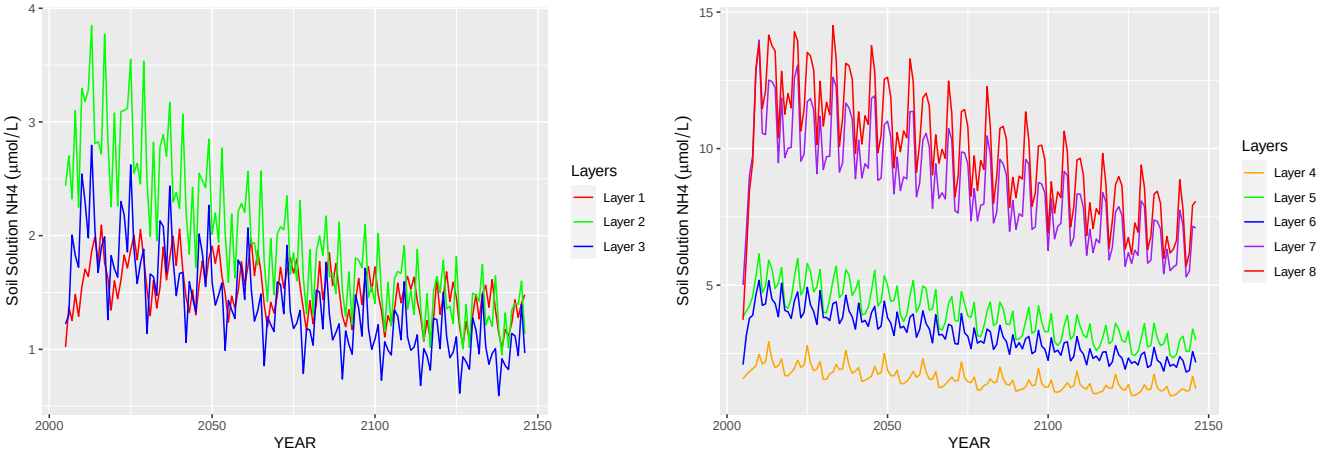


Figure 11: Yearly Ammonium concentration by Soil Layer

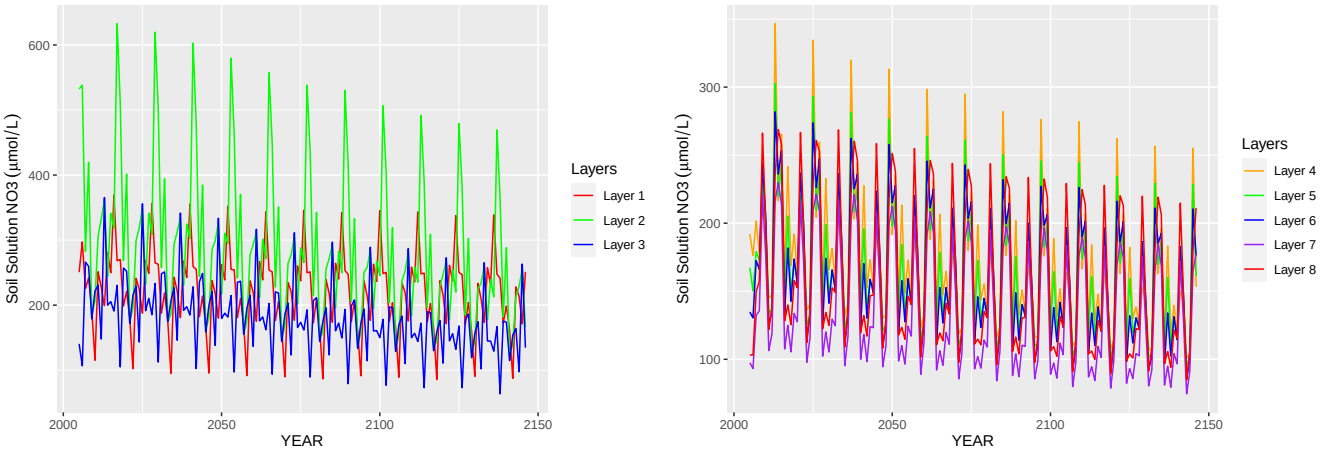


Figure 12: Yearly Nitrate concentration by Soil Layer

Lysimeter Comparisons

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	14	17	10	26	14	0.18	11	42	0.62	136	0.00080	78
2	2006	14	16	11	20	14	0.25	11	33	0.62	138	0.00089	78
8	2005	21	16	10.1	26	17	0.44	10	61	0.25	94	0.0016	88
8	2006	18	13	9.3	24	18	0.84	11	36	0.26	104	0.0002	104

Table 4: Actual Average Lysimeter Fluxes (2005)

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
20	0.229397708	0.02625799	12.30588623	6.722478182	16.05235558	7.309006743	21.12339104	5.096905937	0.015397959	0.003889227	105.9925643	37.70978195	5.649289233	2.126040927	13.47783912	5.408656987	12.87762315	4.273119617	8.10235285	6.812182054	59.9514975	20.36448053	2.535789785	1.626778699
100	0.164329625	0.028797038	11.28300357	10.07491599	11.92309571	9.410848825	7.97033542	1.88597111	0.024684756	0.013652249	85.0476427	25.47478644	5.443988177	1.77087954	8.210009332	2.311254494	8.61409103	2.938574097	5.394473482	2.436873081	57.79132616	17.48643336	1.579743437	1.596641002

Weathering Results

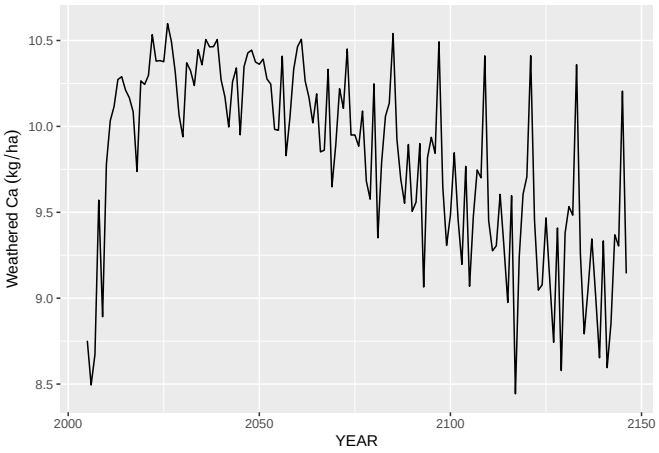


Figure 13: Calcium Weathering (All Layer)

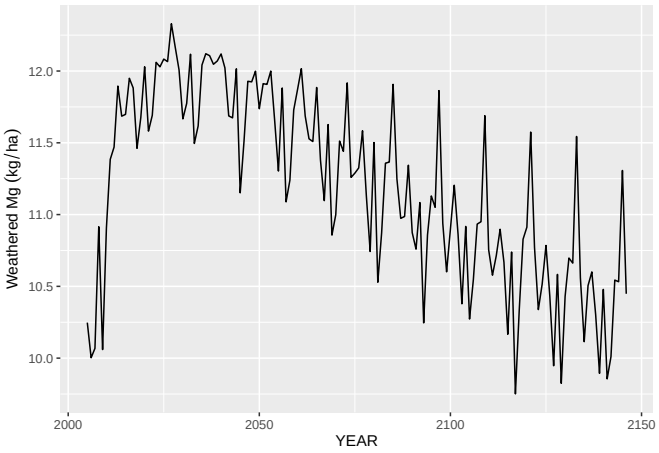


Figure 14: Magnesium Weathering (All Layer)

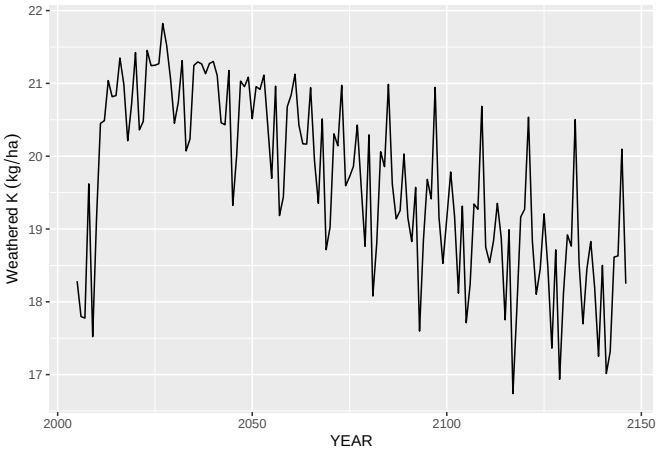


Figure 15: Potassium Weathering (All Layer)

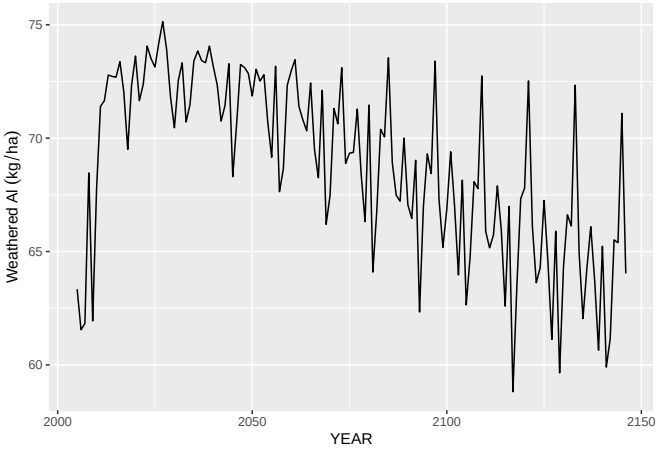


Figure 16: Aluminum Weathering (All Layer)

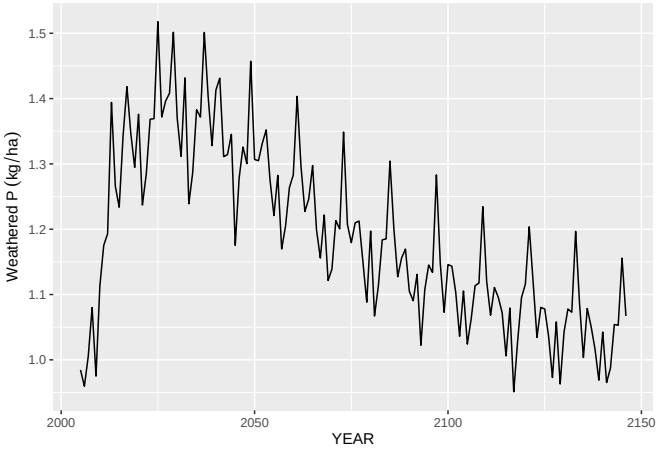


Figure 17: Phosphate Weathering (All Layer)

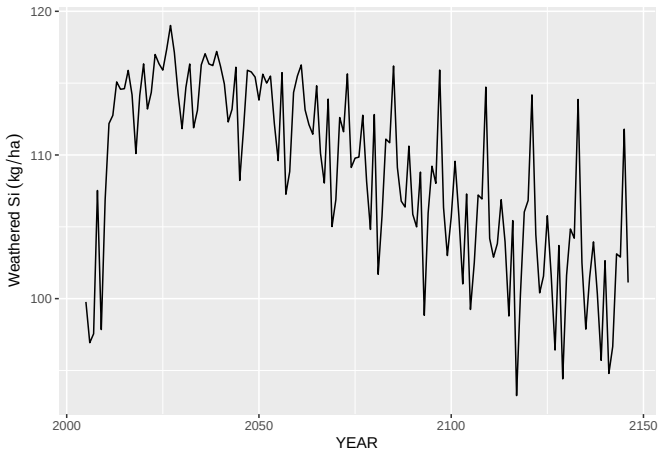


Figure 18: Silica Weathering (All Layer)

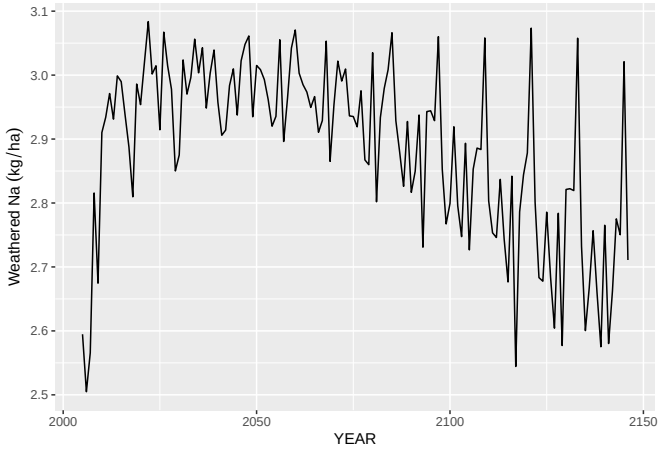
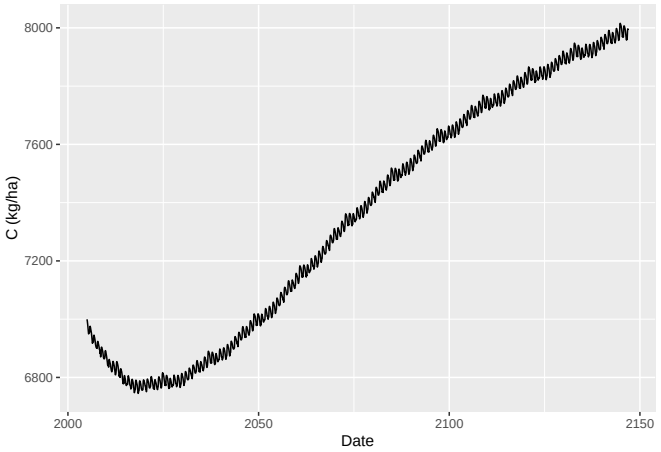
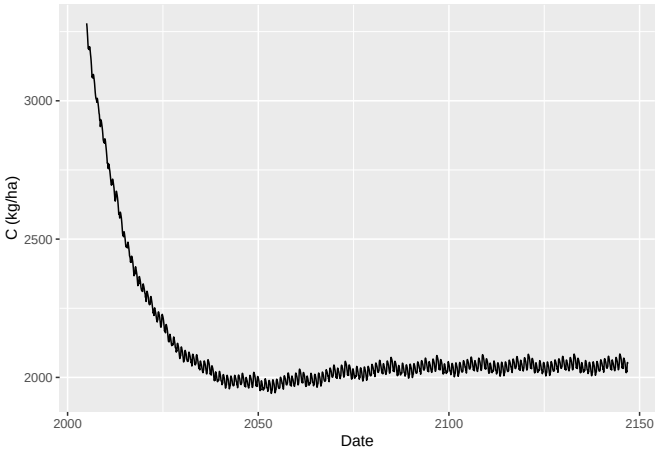


Figure 19: Sodium Weathering (All Layer)

Litter Pool Results

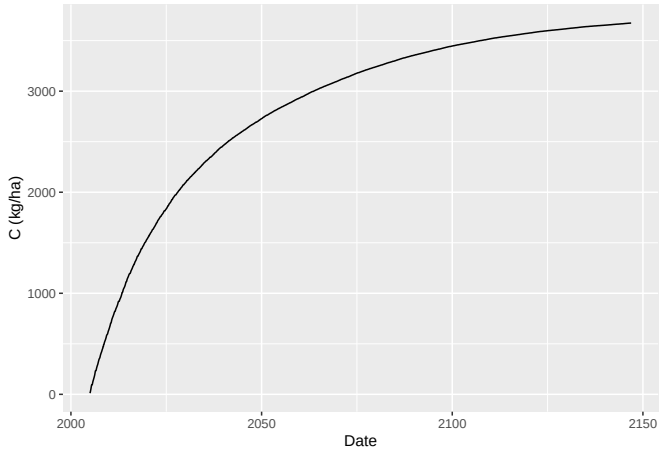


(a) Total forest floor carbon content (kg/ha)

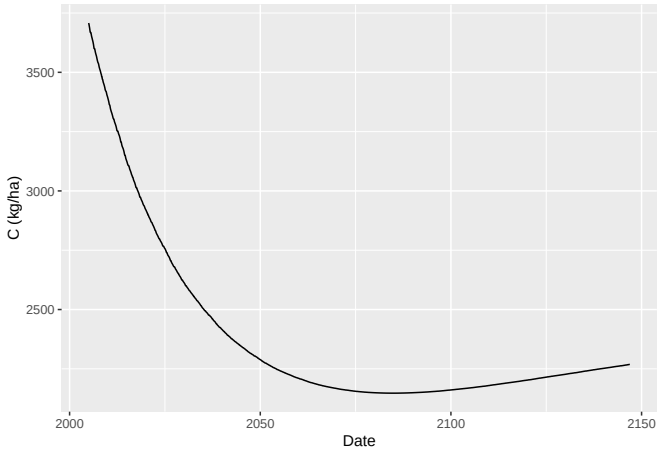


(b) Carbon content of coarse litter (kg/ha)

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



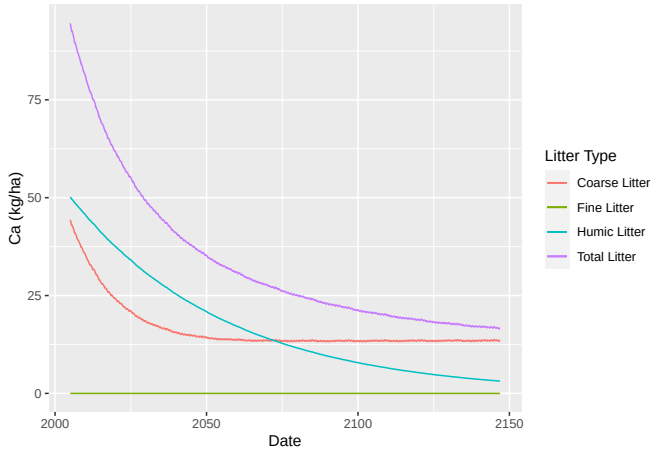
(a) Carbon content of fine litter (kg/ha)



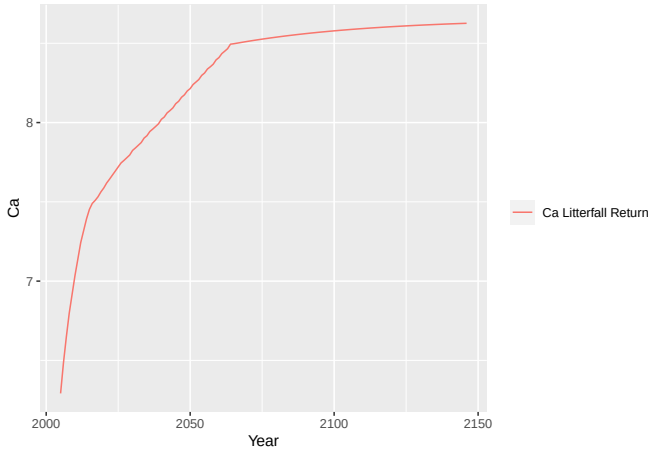
(b) Carbon content of humic litter (kg/ha)

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.



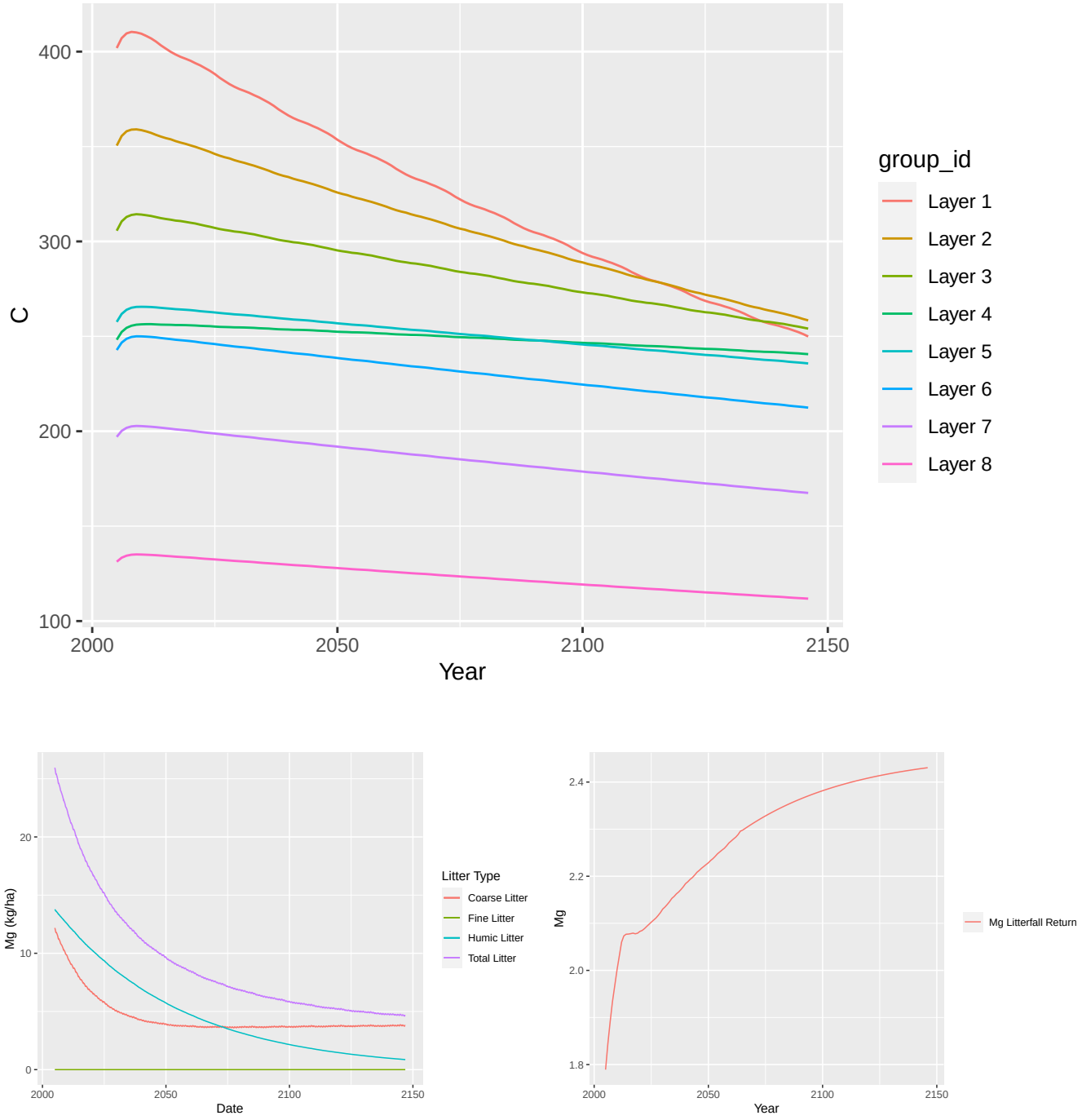
(a) Ca Content in each litter decomposition stage (kg/ha)



(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).

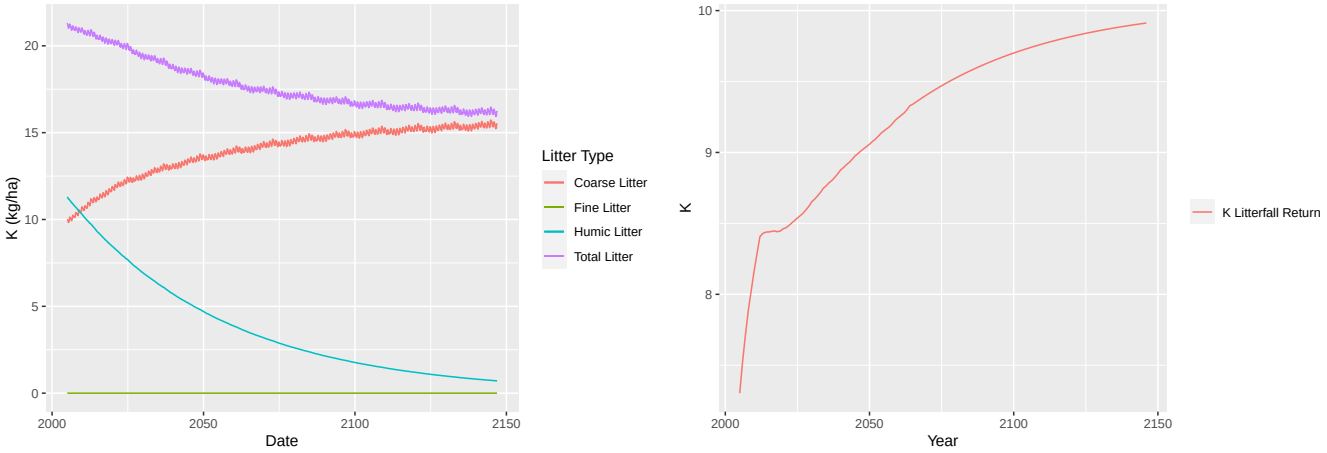
Soil Organic Matter Results



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

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

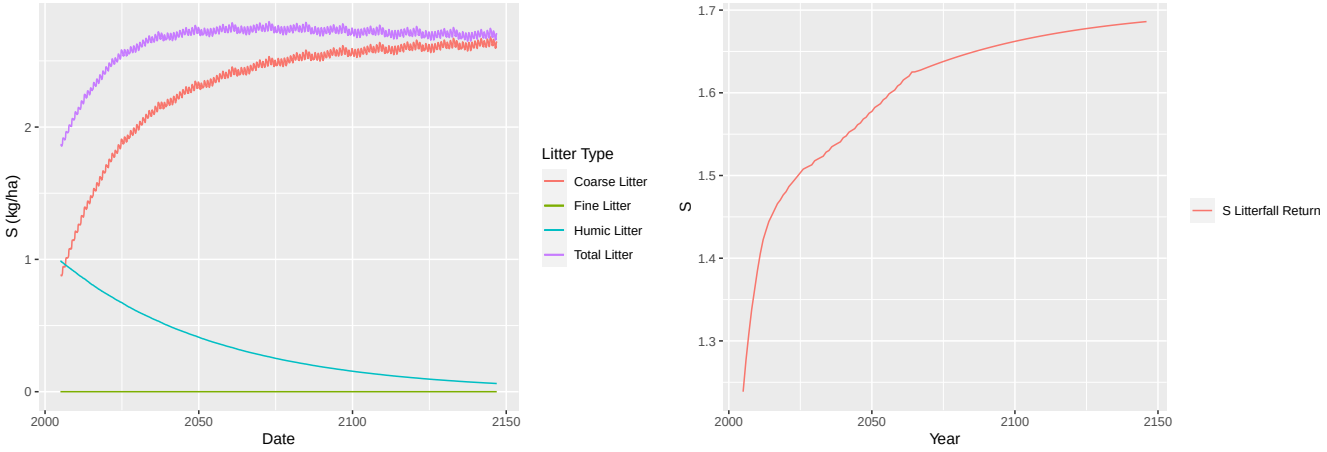
Figure 23: Forest Floor/O-horizon Mg content over time (a). and net annual Mg return in litterfall (b).



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

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

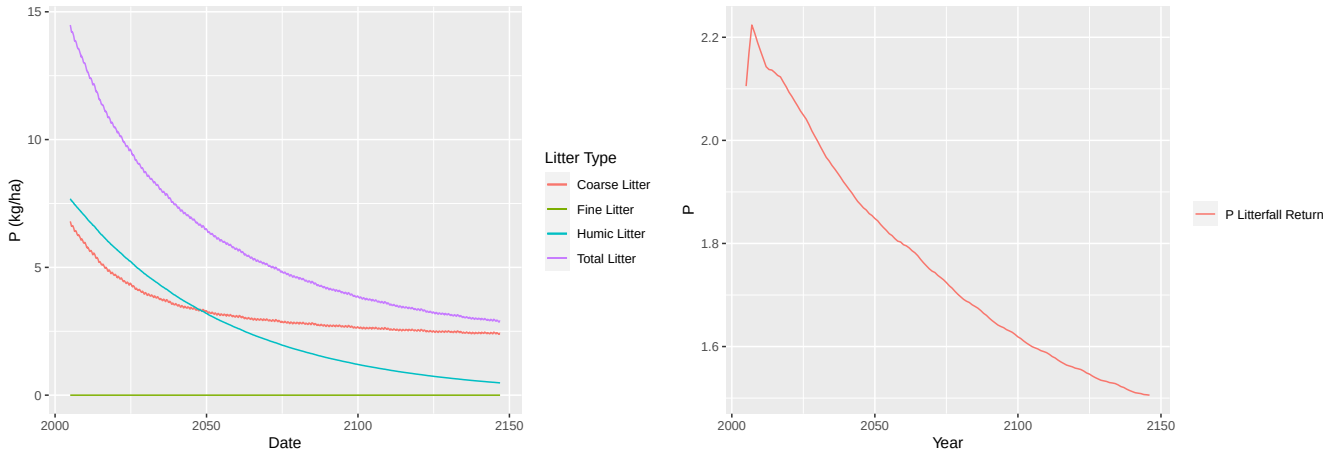
Figure 24: Forest Floor/O-horizon K content over time (a). and net annual K return in litterfall (b).



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

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

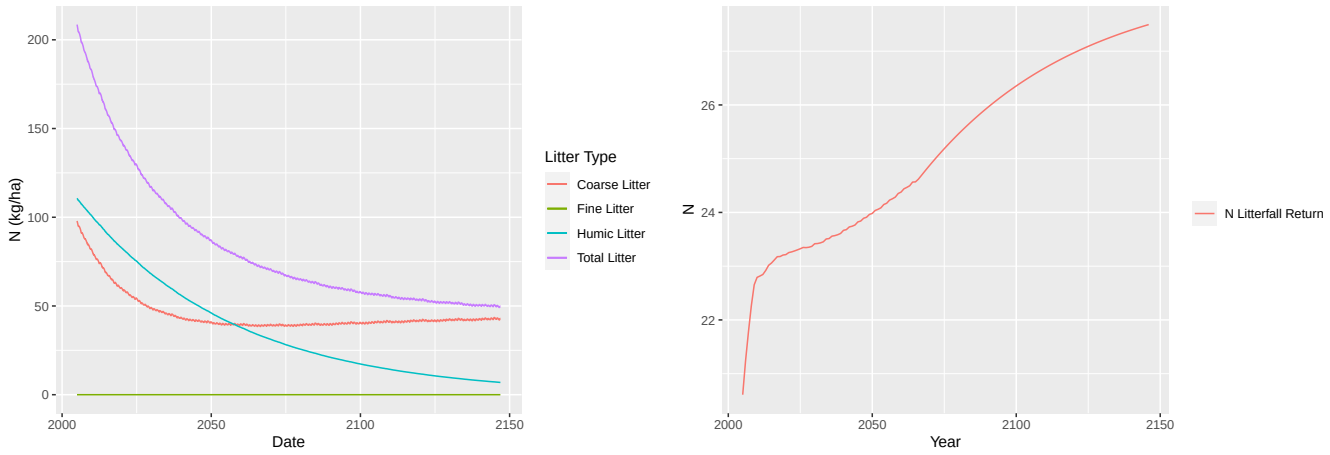
Figure 25: Forest Floor/O-horizon S content over time (a). and net annual S return in litterfall (b).



(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).



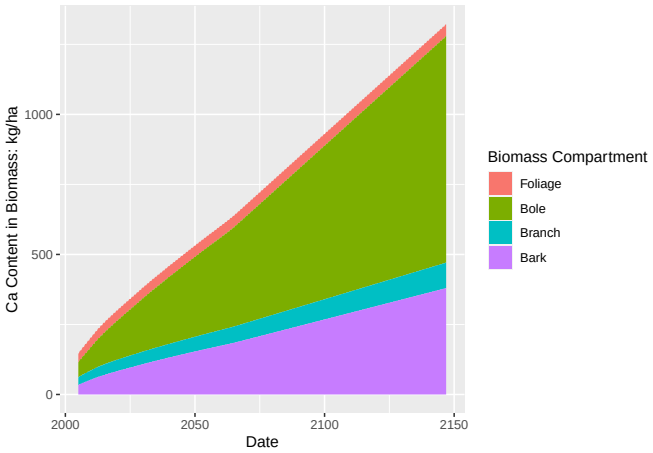
(a) N Content in each litter decomposition stage (kg/ha)

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

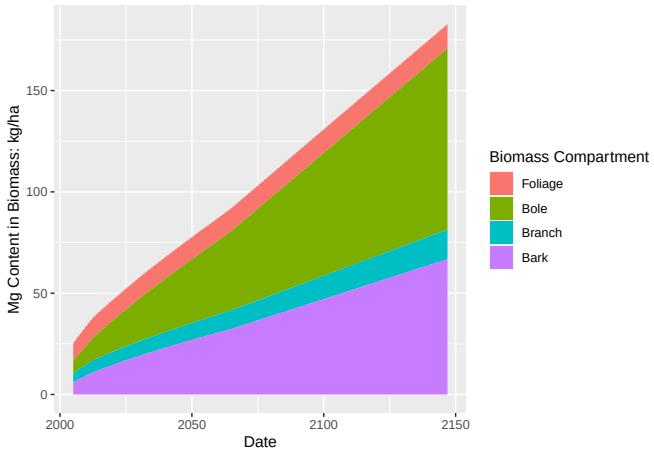
Figure 27: Forest Floor/O-horizon N content over time (a). and net annual N return in litterfall (b).

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.

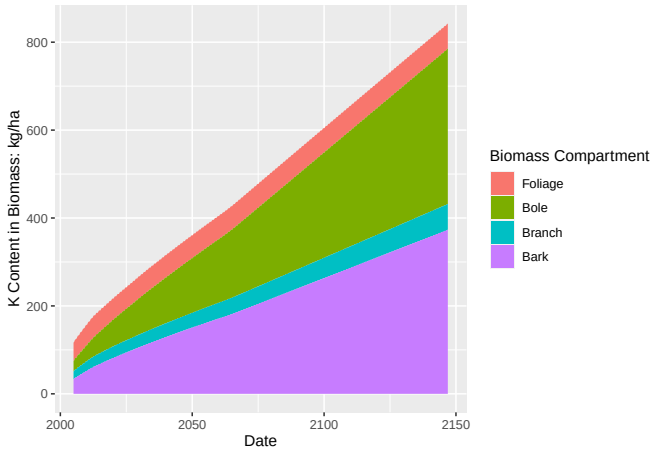
Tree Nutrient Content



(a) Calcium content in each biomass compartment

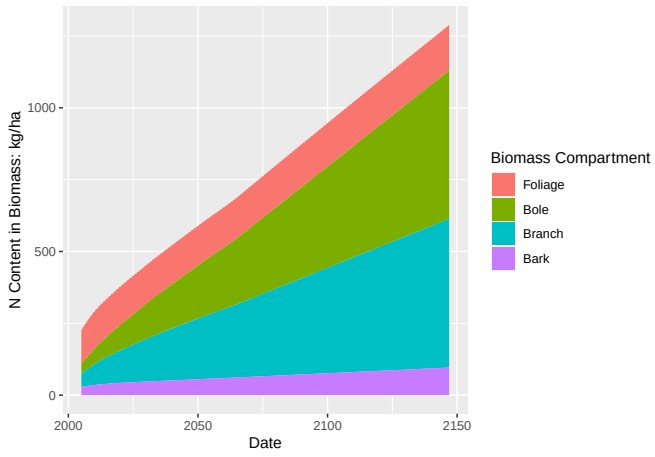


(b) Magnesium content in each biomass compartment

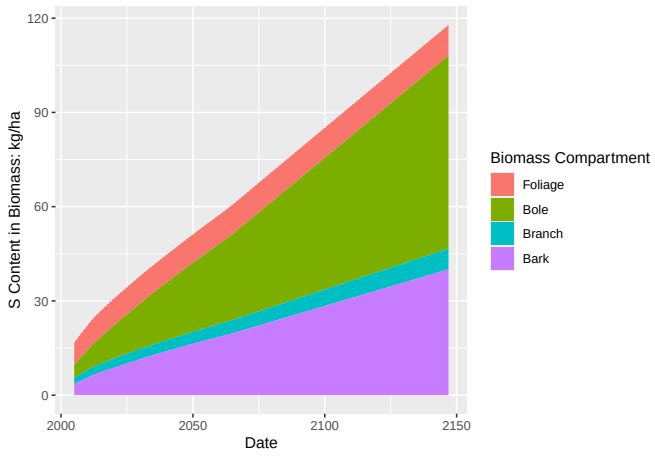


(c) Potassium content in each biomass compartment

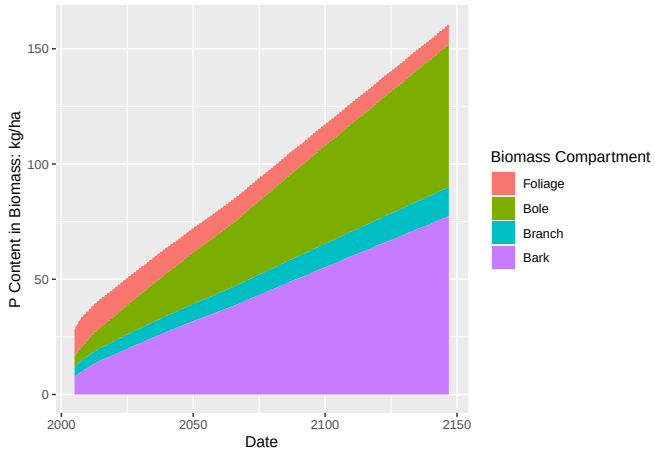
Figure 28: Base Cation Nutrient Content in Simulated Forest



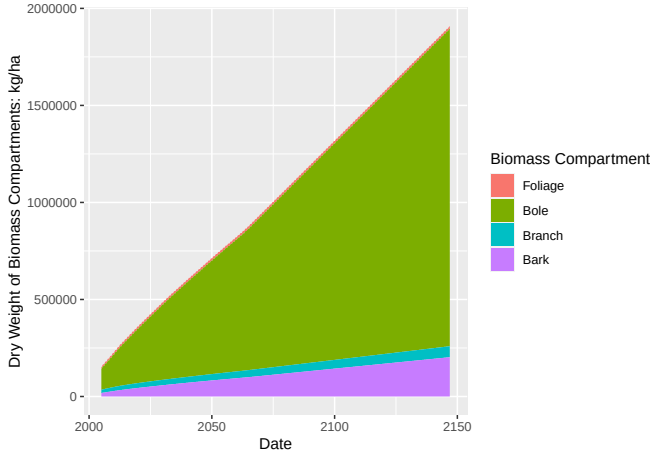
(a) Nitrogen content in each biomass compartment



(b) Sulfur content in each biomass compartment



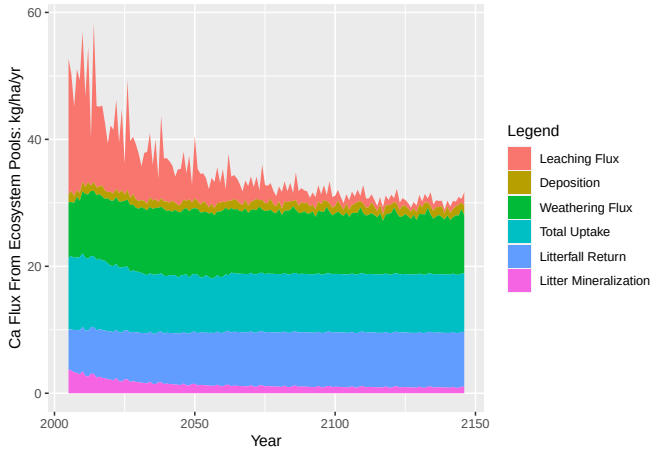
(c) Phosphorous content in each biomass compartment



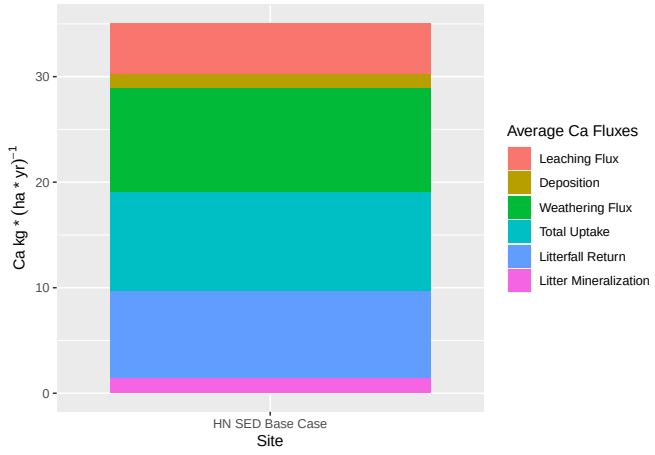
(d) Biomass of each compartment

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

Analysis 1: Stack Flux Data

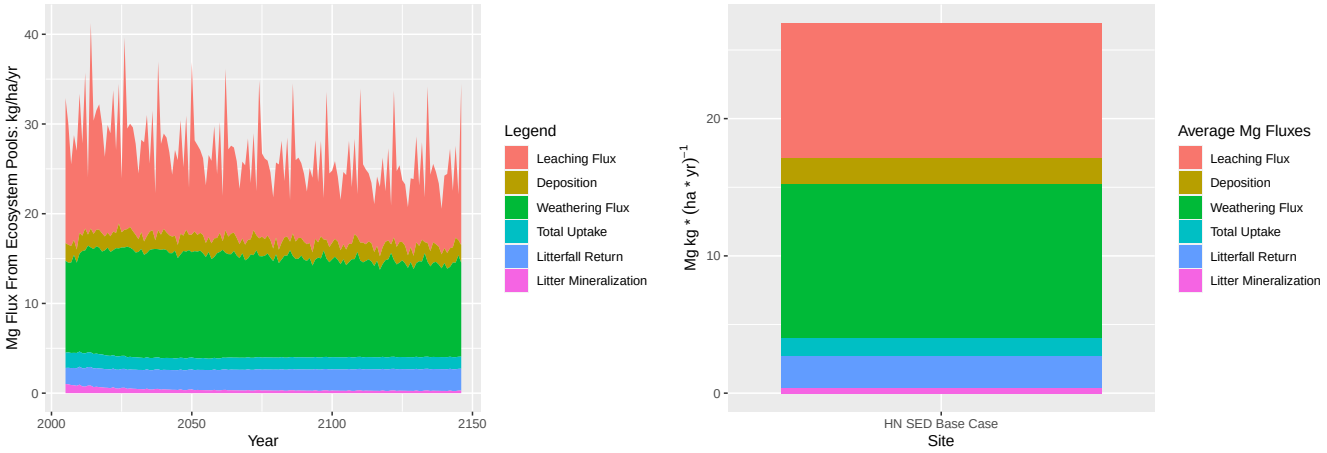


(a) Ca input and output fluxes over time



(b) Total Average Ca input and output fluxes

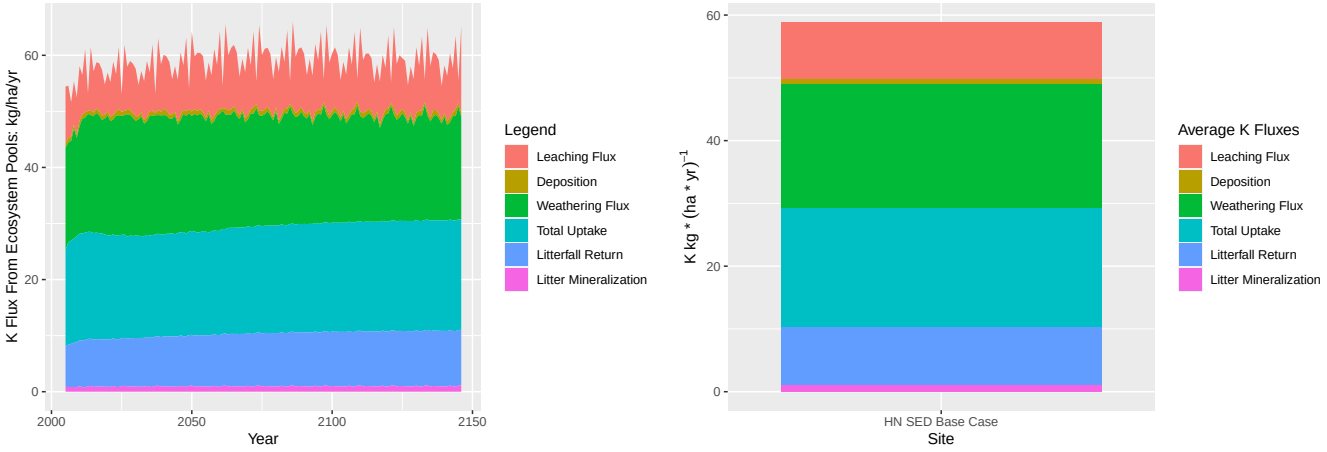
Figure 30: Calcium input and output comparison graphs



(a) Mg input and output fluxes over time

(b) Total Average Mg input and output fluxes

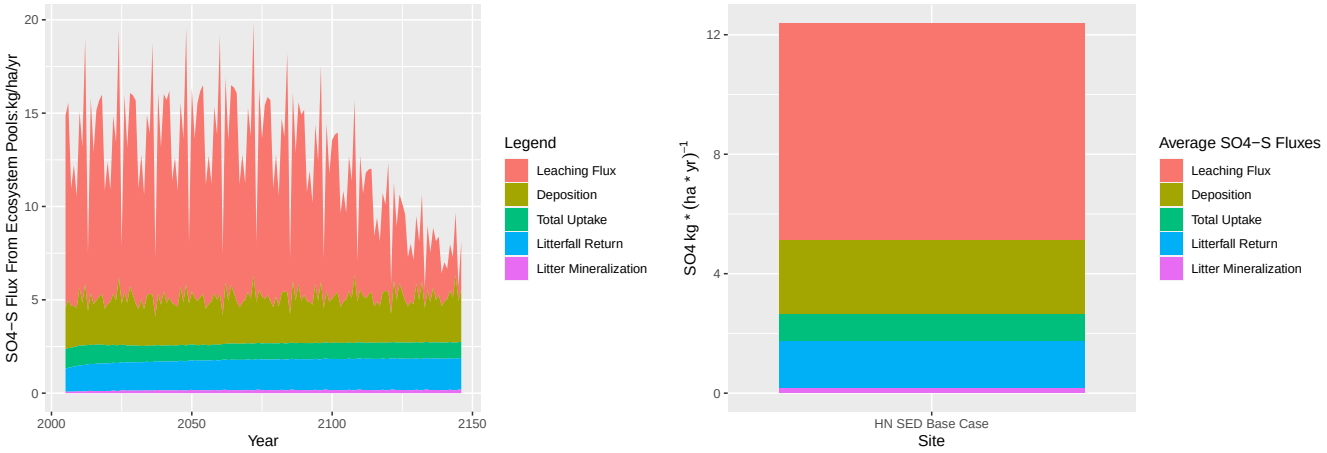
Figure 31: Magnesium input and output comparison graphs



(a) K input and output fluxes over time

(b) Total Average K input and output fluxes

Figure 32: Potassium input and output comparison graphs

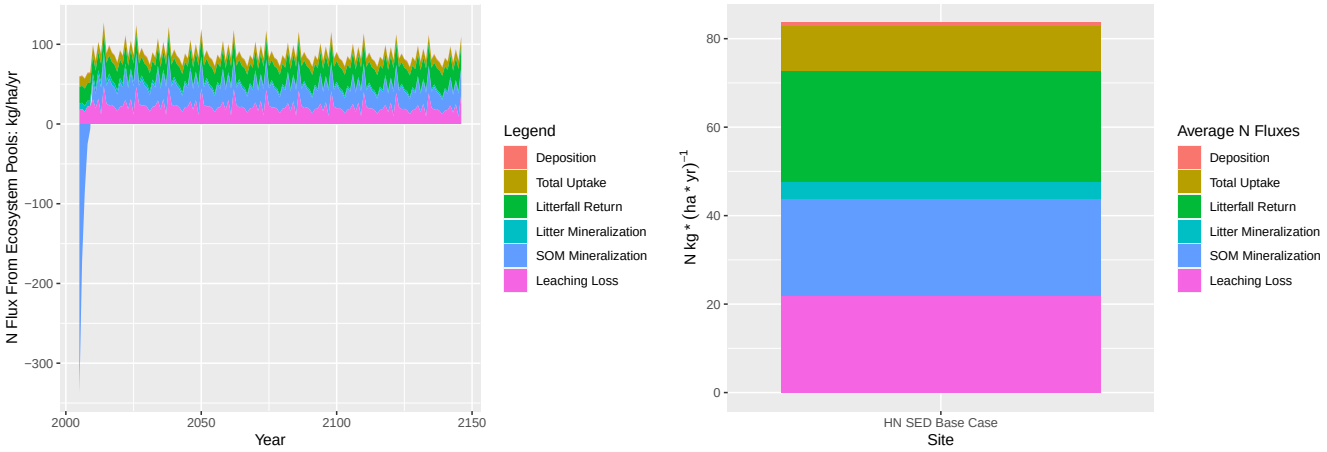


(a) S input and output fluxes over time

(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

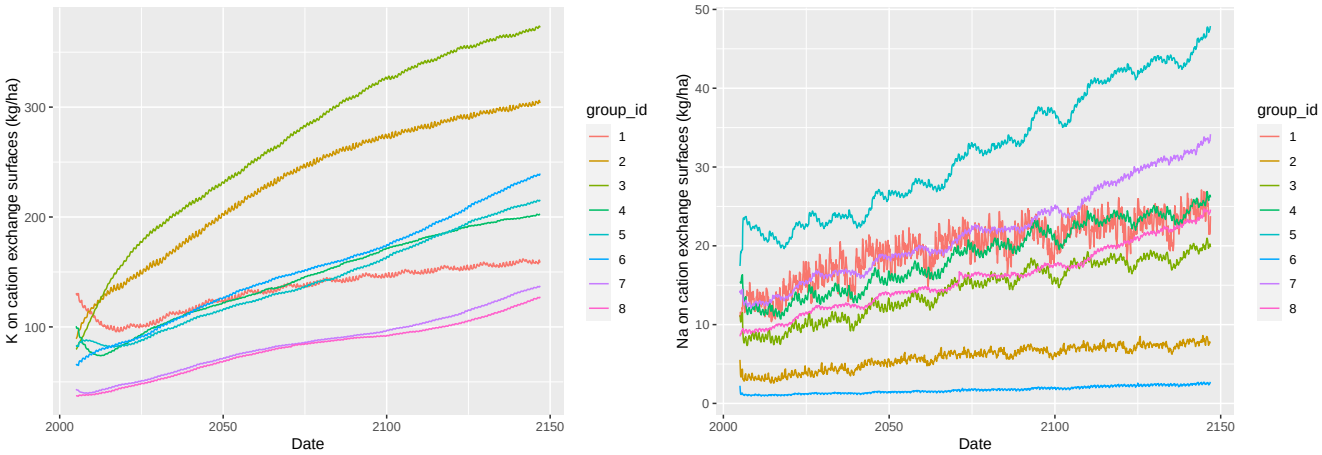


Figure 36: Potassium and Sodium CEC adsorption over time

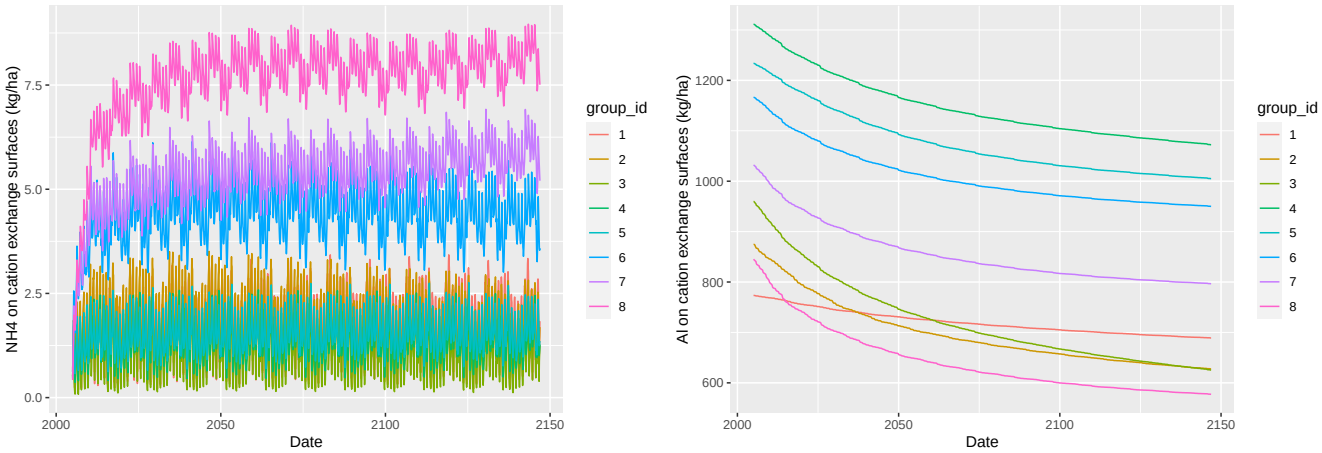
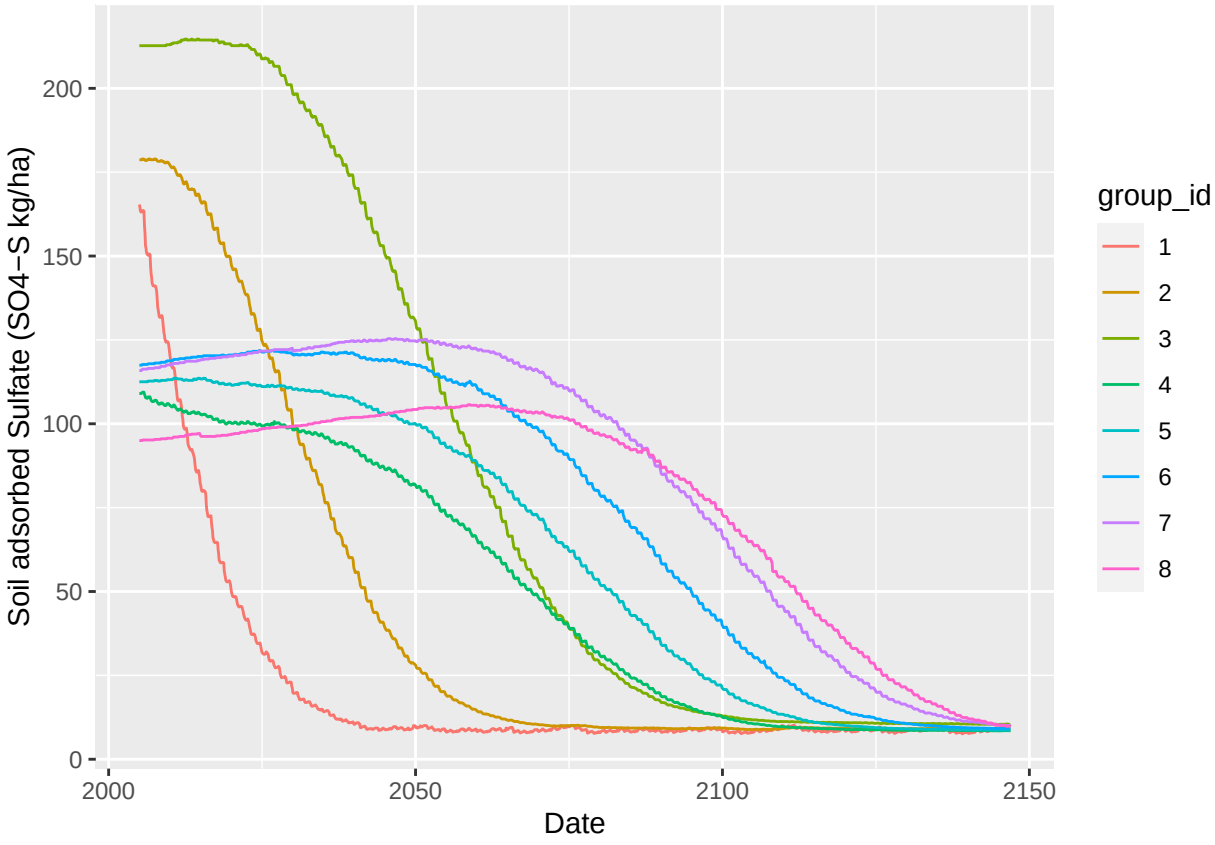
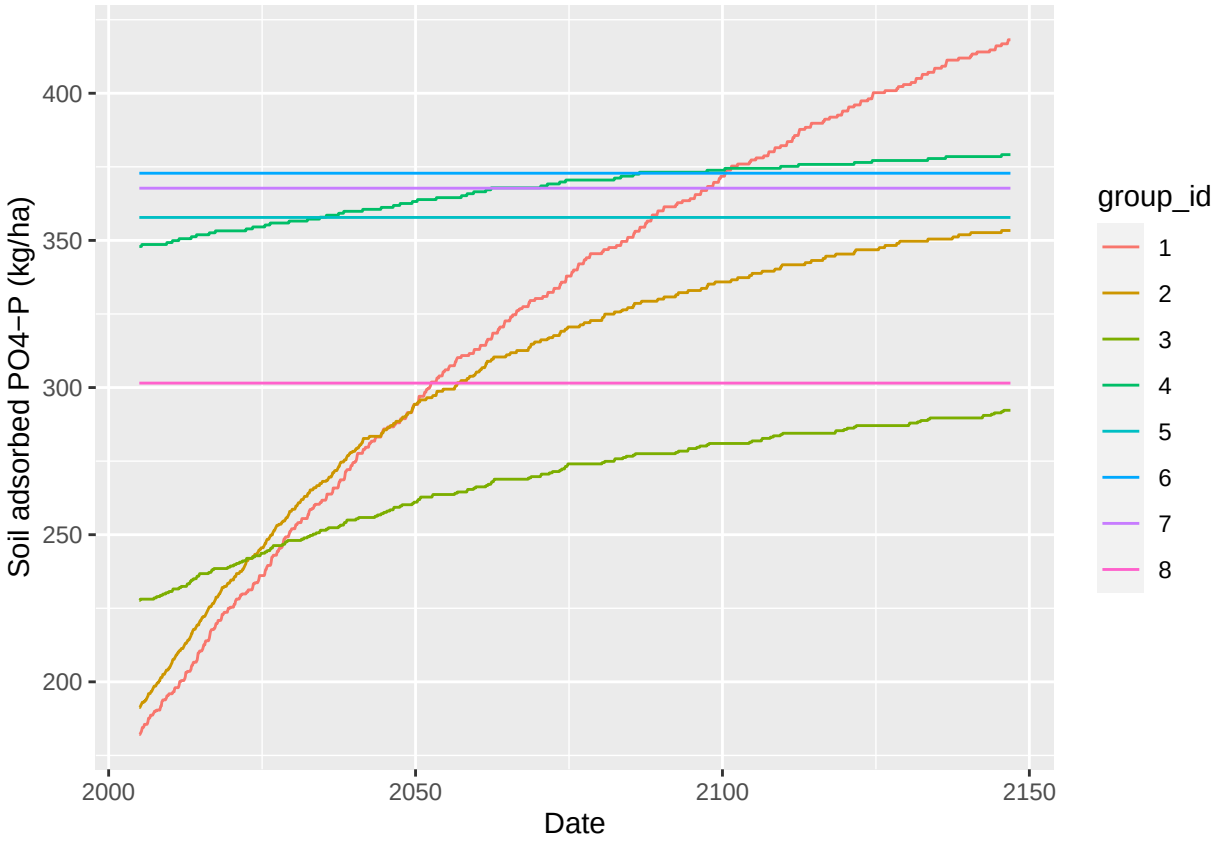
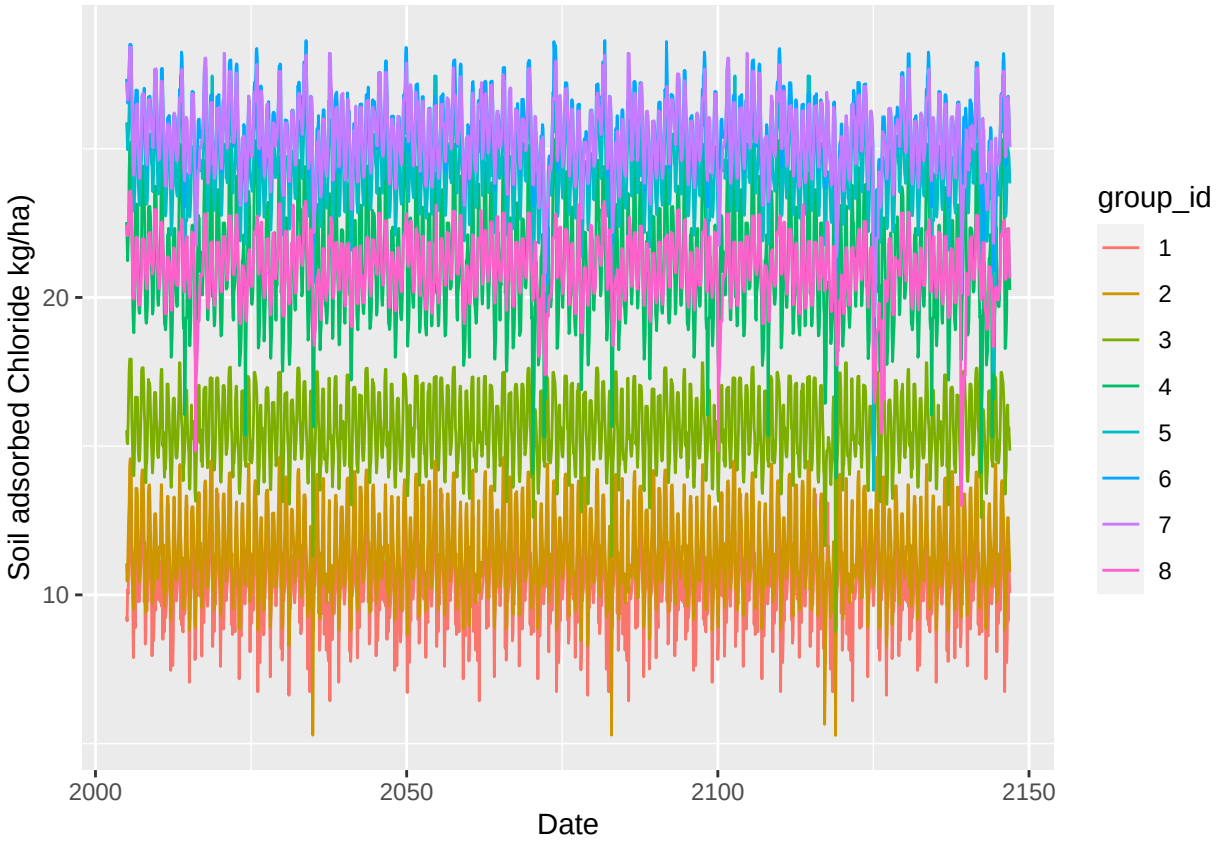


Figure 37: Ammonium and Aluminum CEC adsorption over time

Anion Exchange Capacity



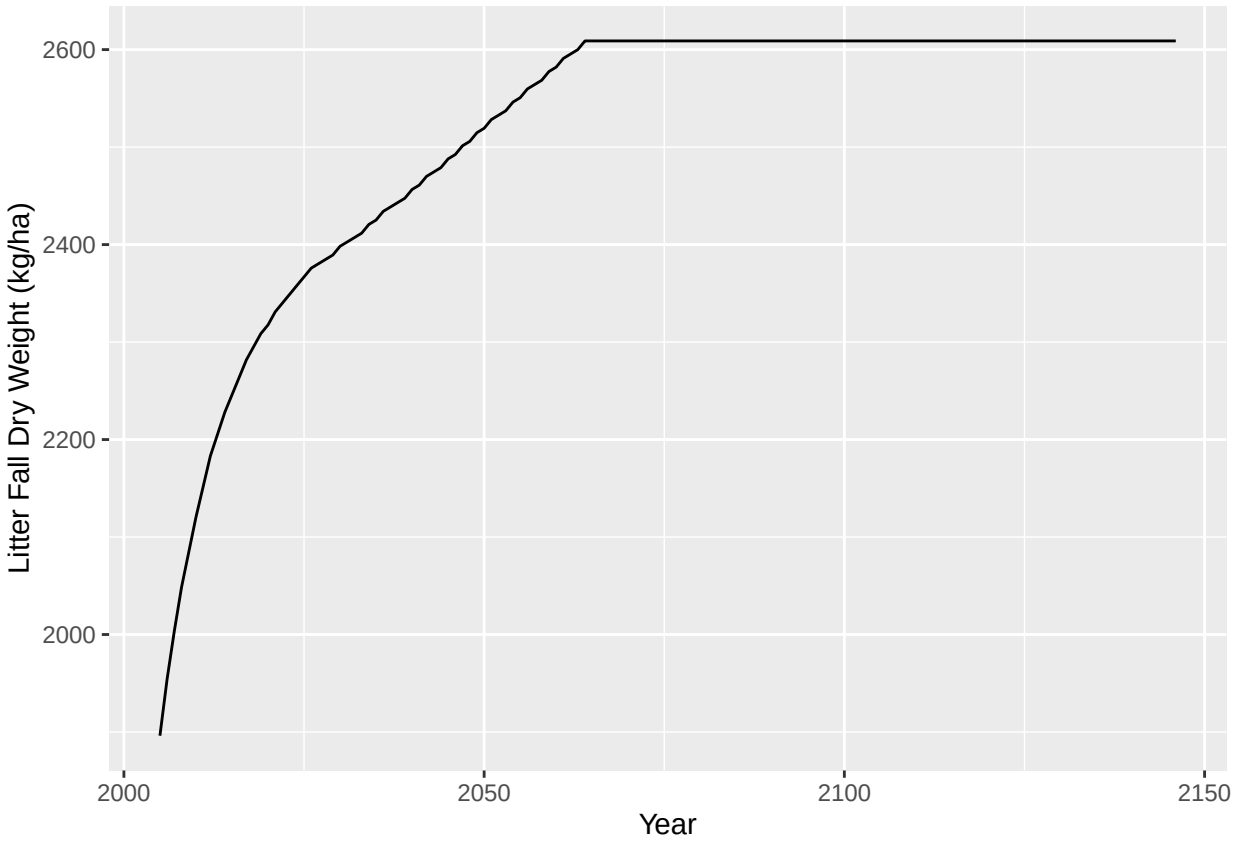




Phosphate seems stable, generally. It should be noted that P uptake is not being modeled in the foliage (it should remain constant so far) and that phosphate adsorption parameters are completely borrowed from the Burgundy site. As for sulfate, I purged the model of the AEC sulfate pool and relegated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