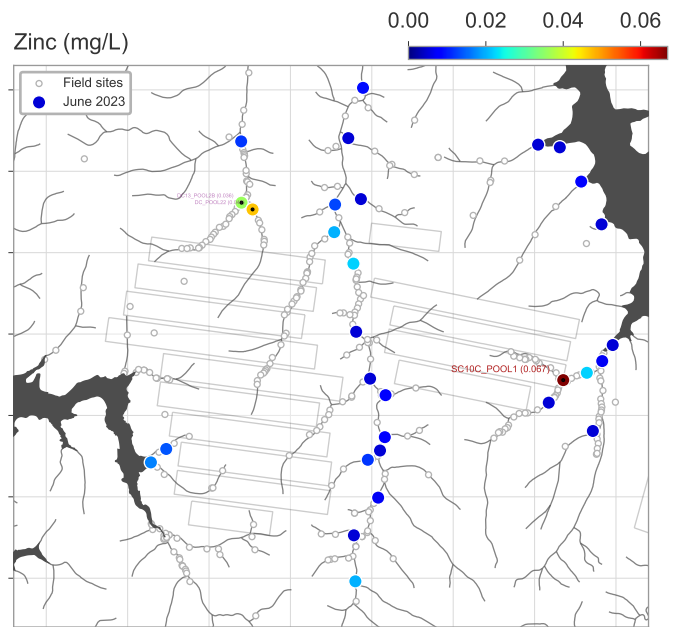
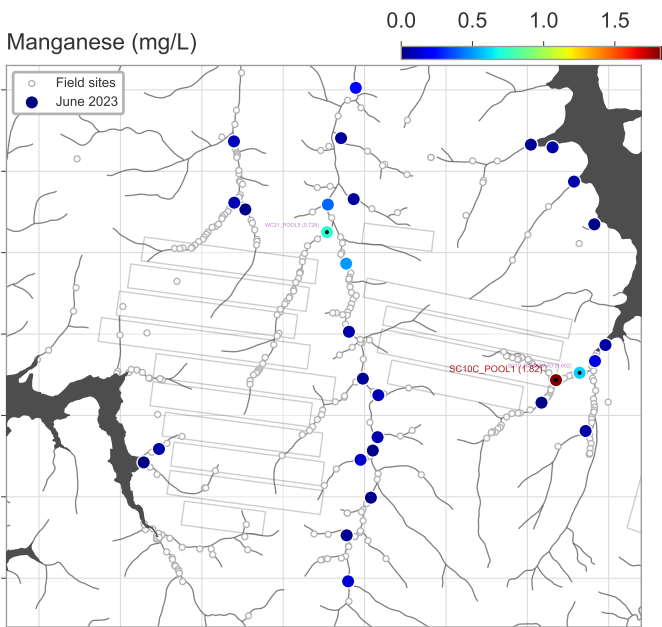
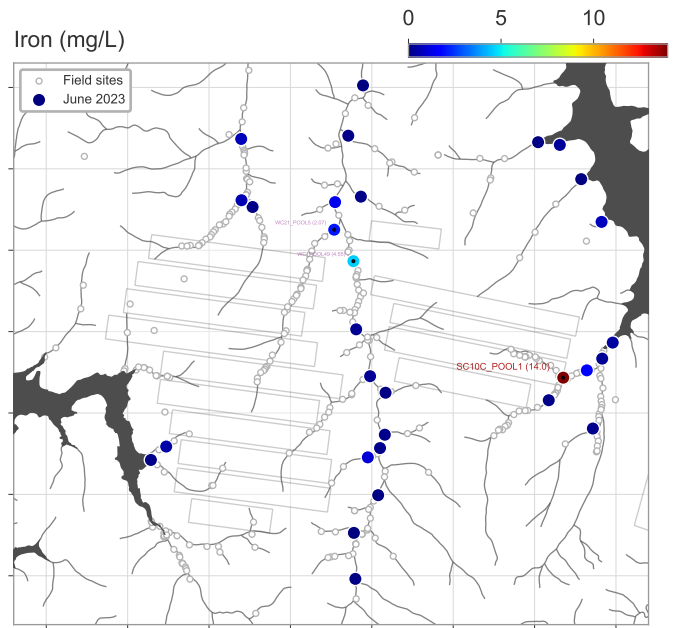
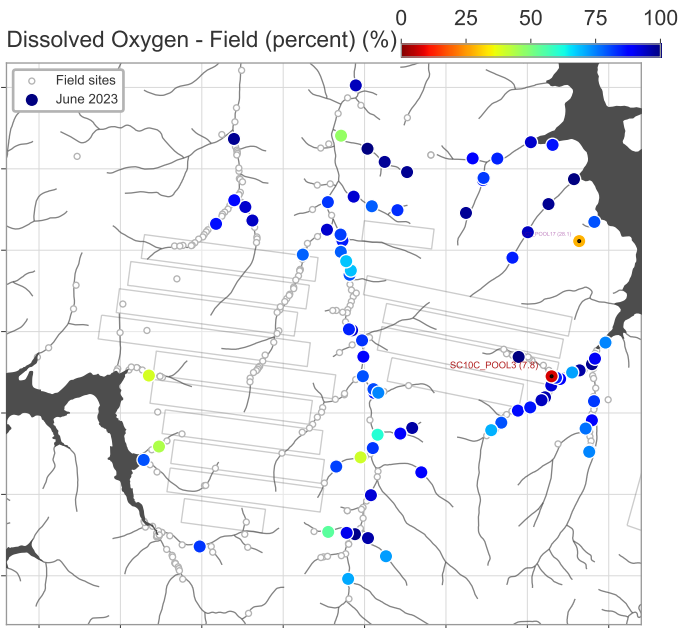
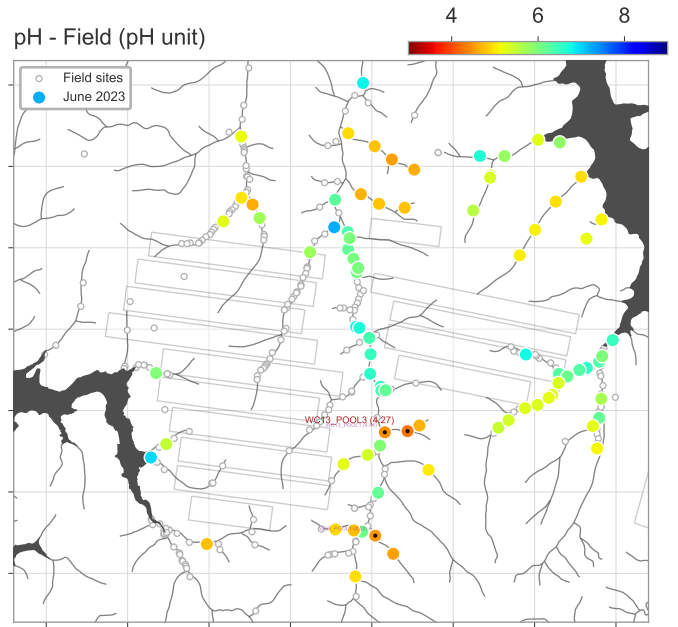
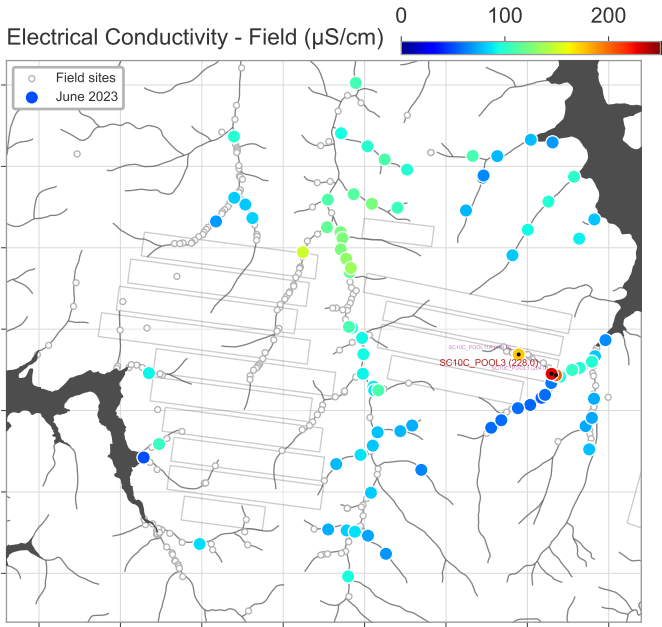
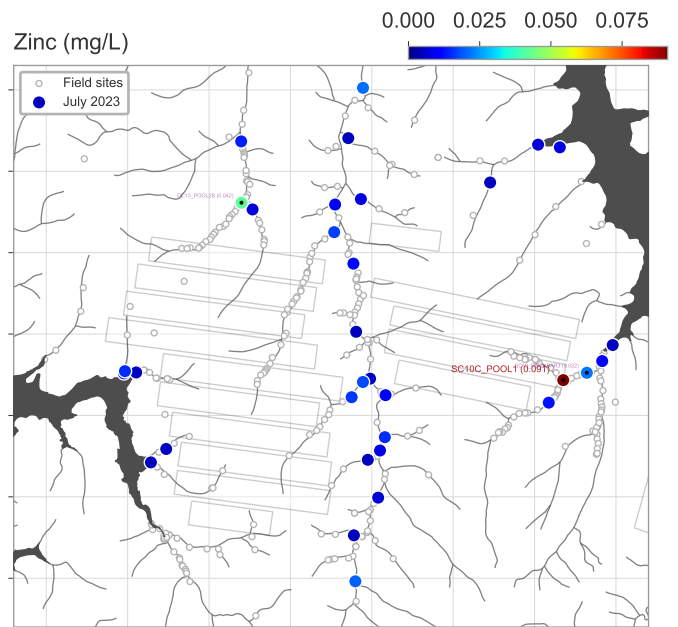
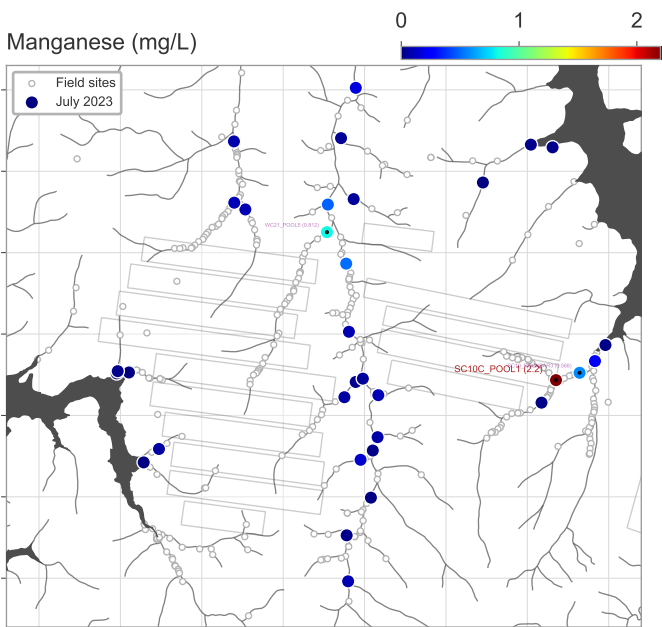
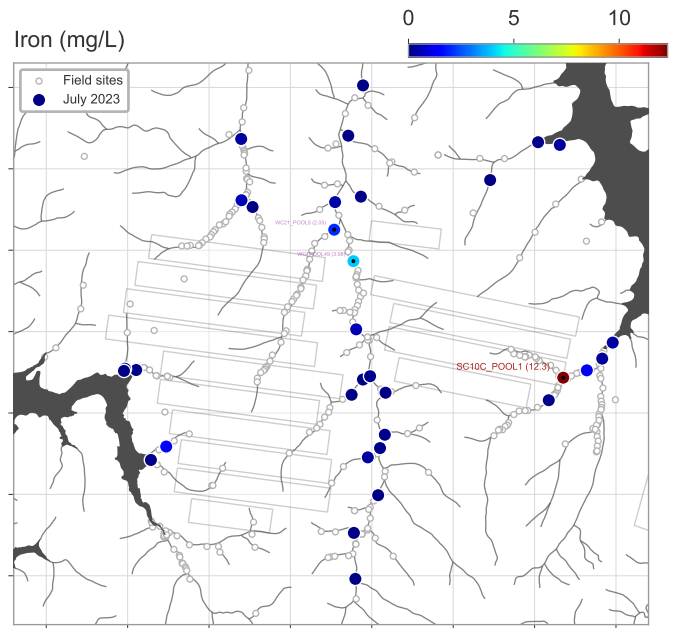
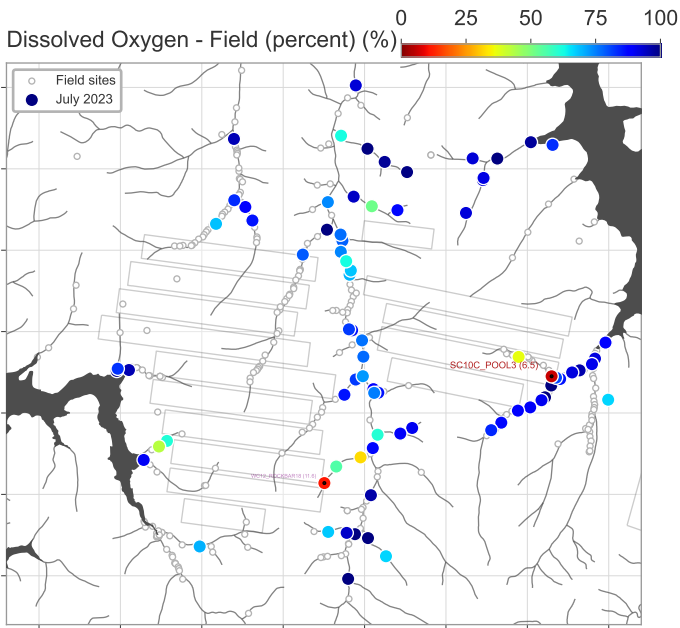
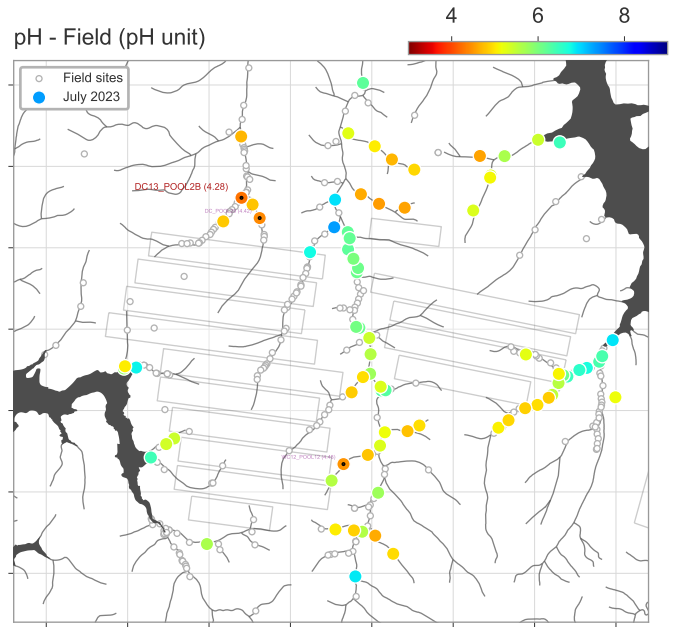
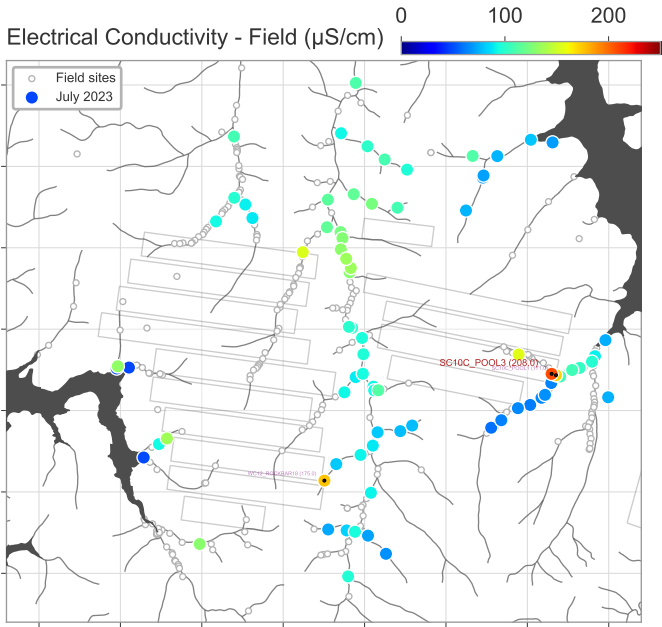


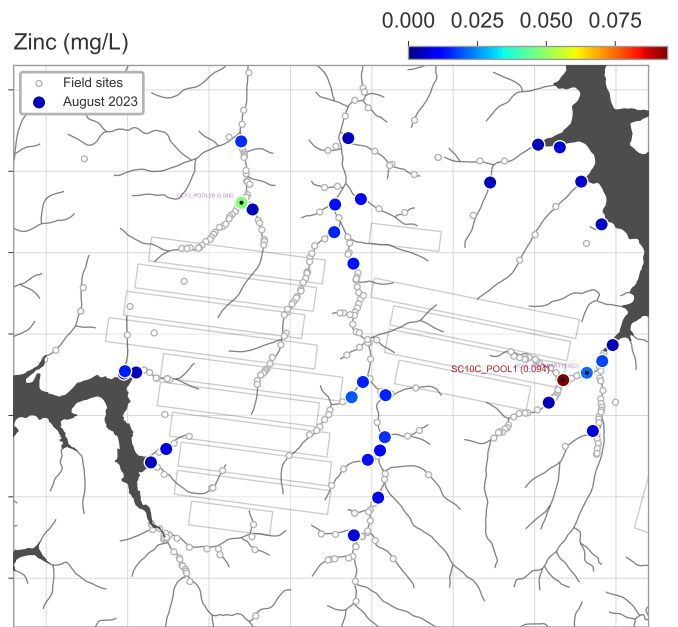
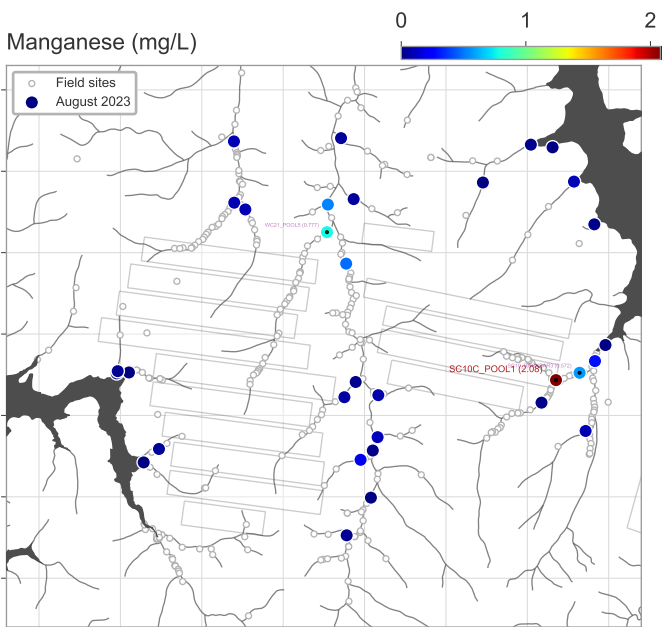
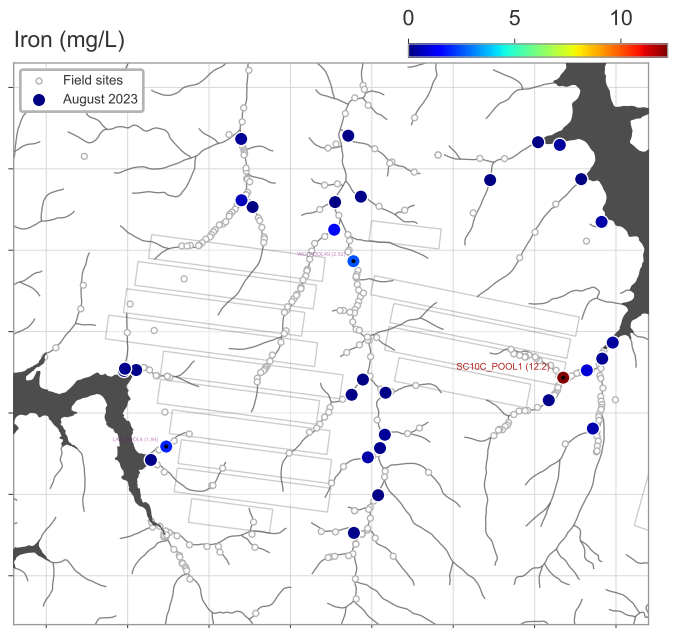
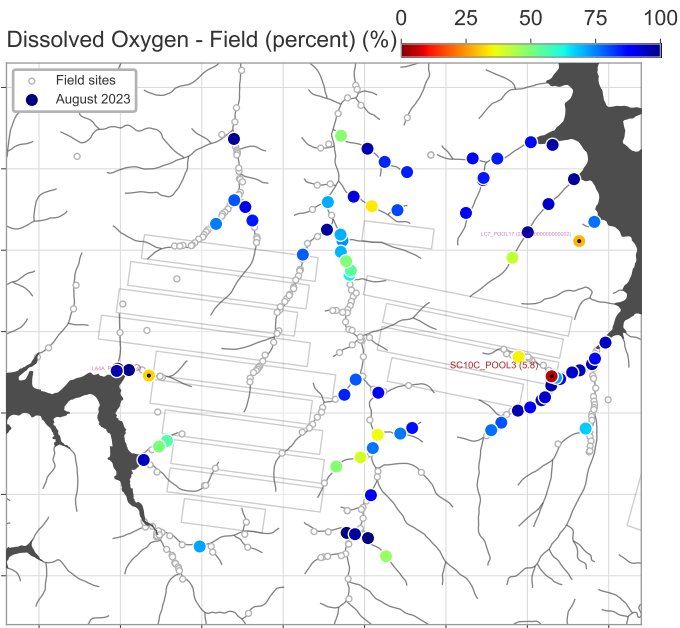
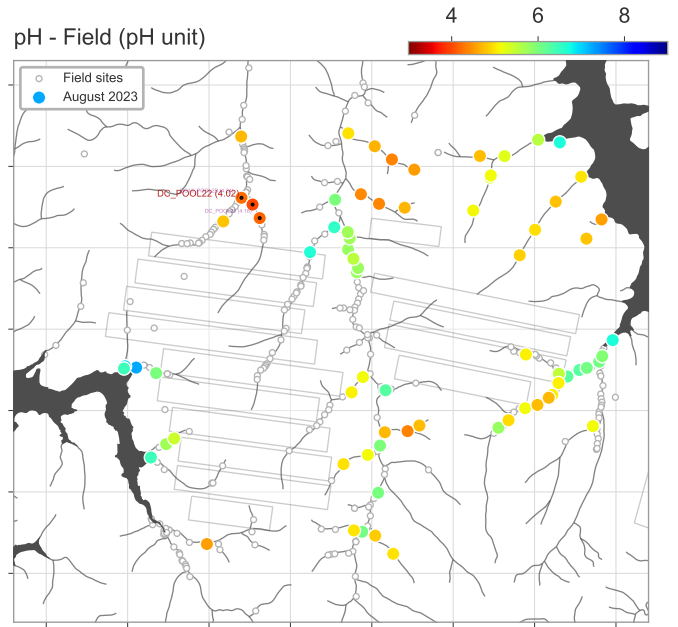
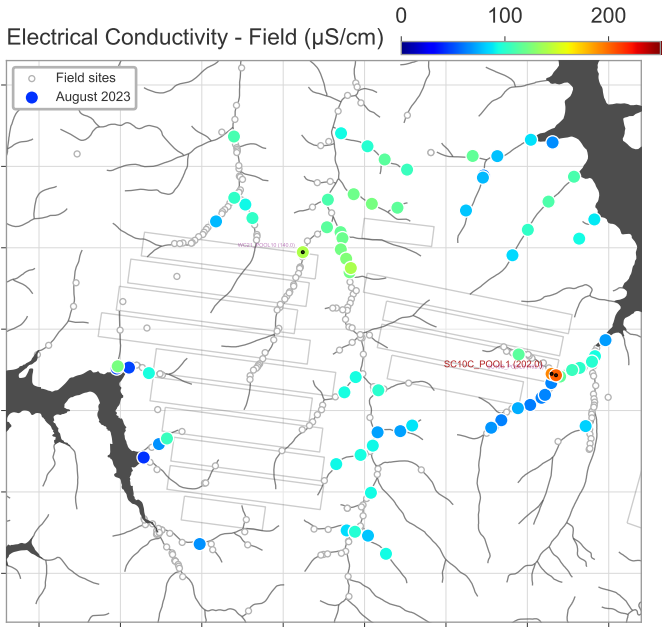
Dendrobium stream water quality June 2023



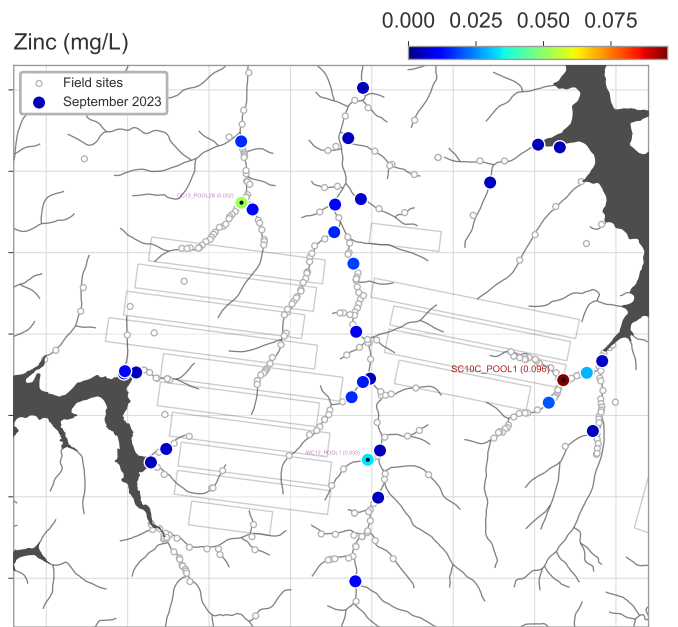
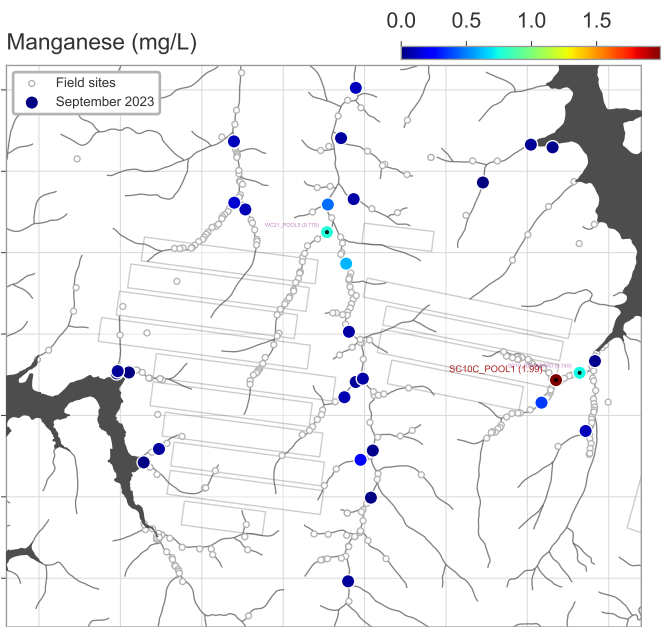
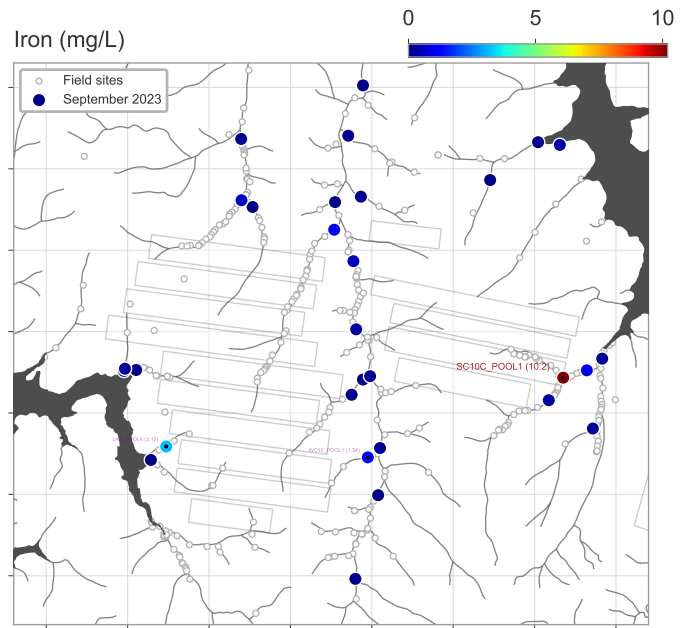
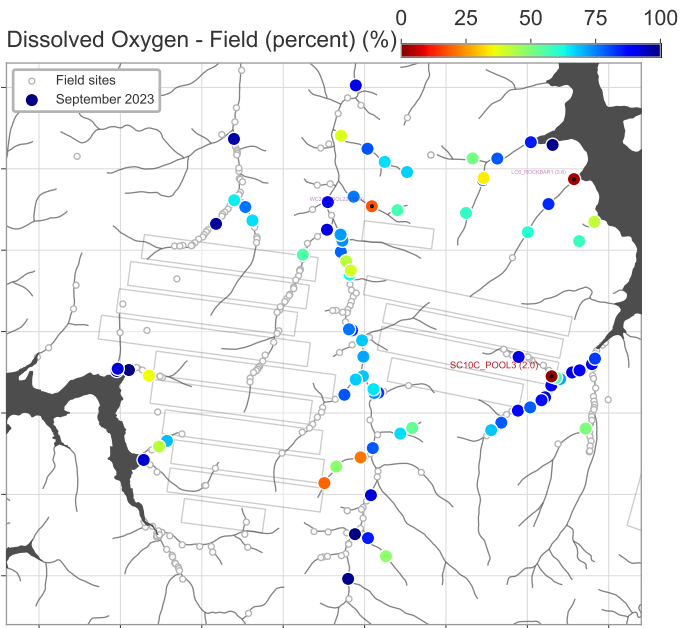
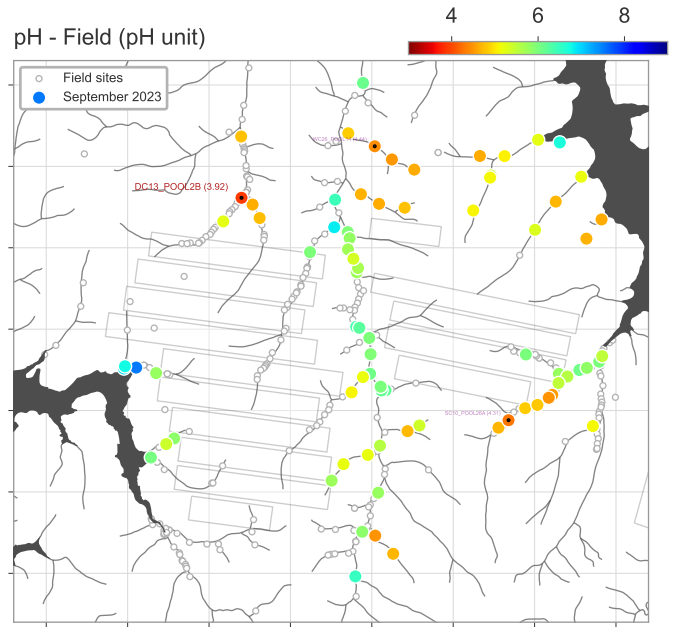
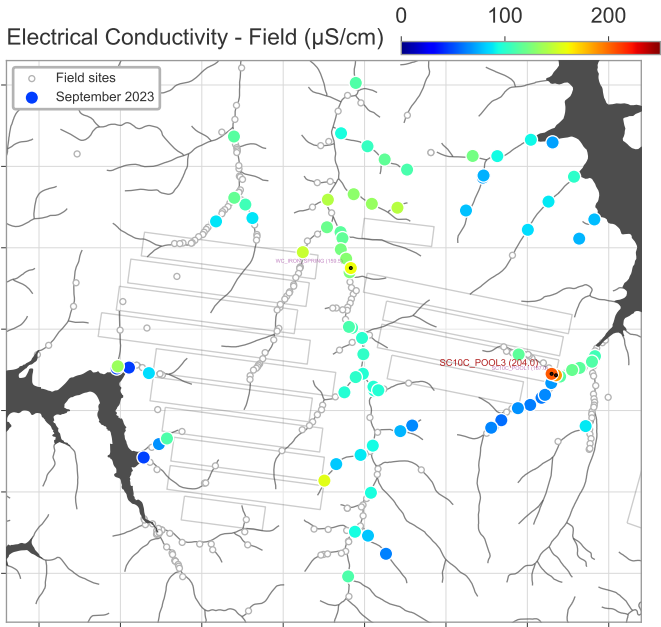
Dendrobium stream water quality July 2023



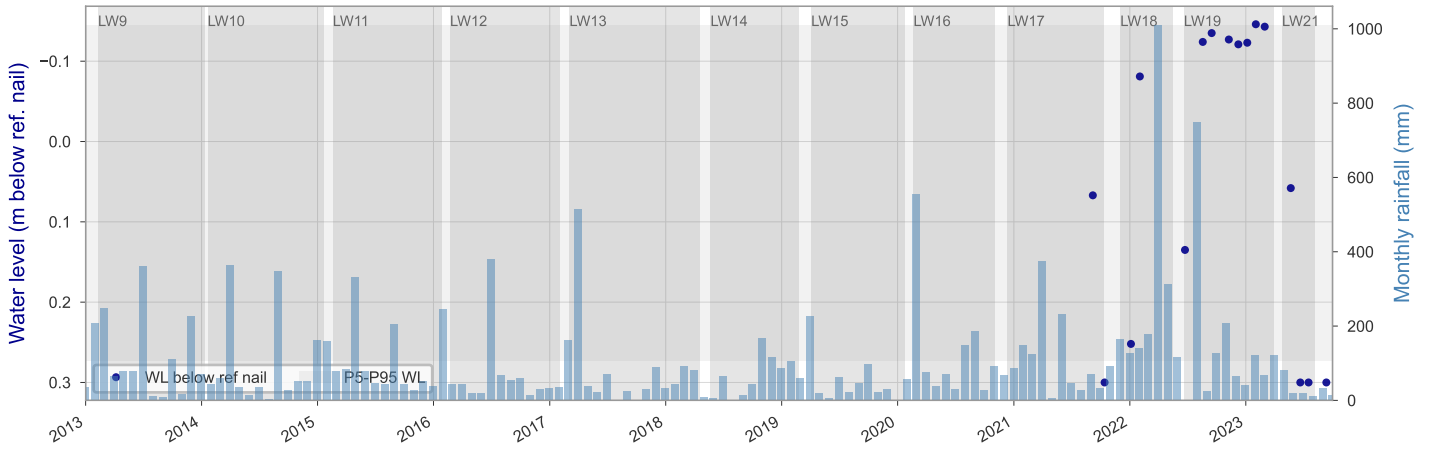
Dendrobium stream water quality August 2023



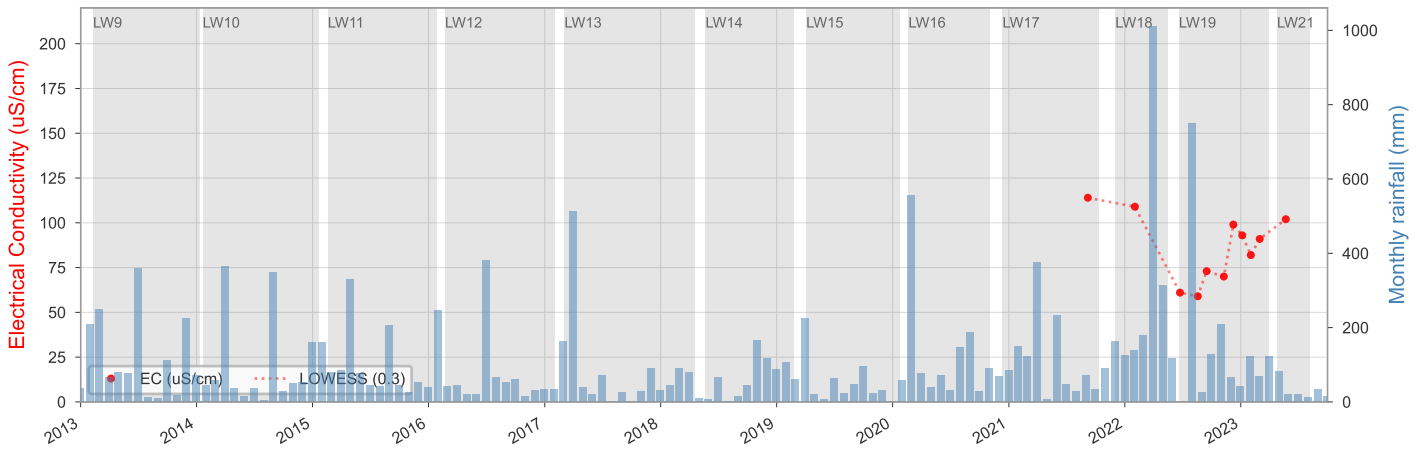
Dendrobium stream water quality September 2023



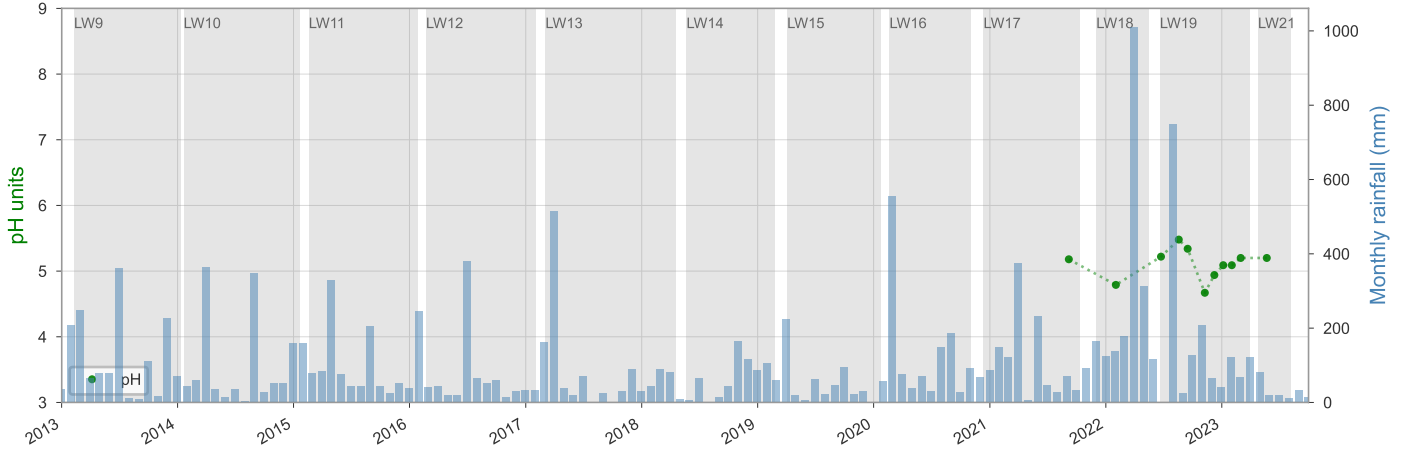
CR36_POOL44



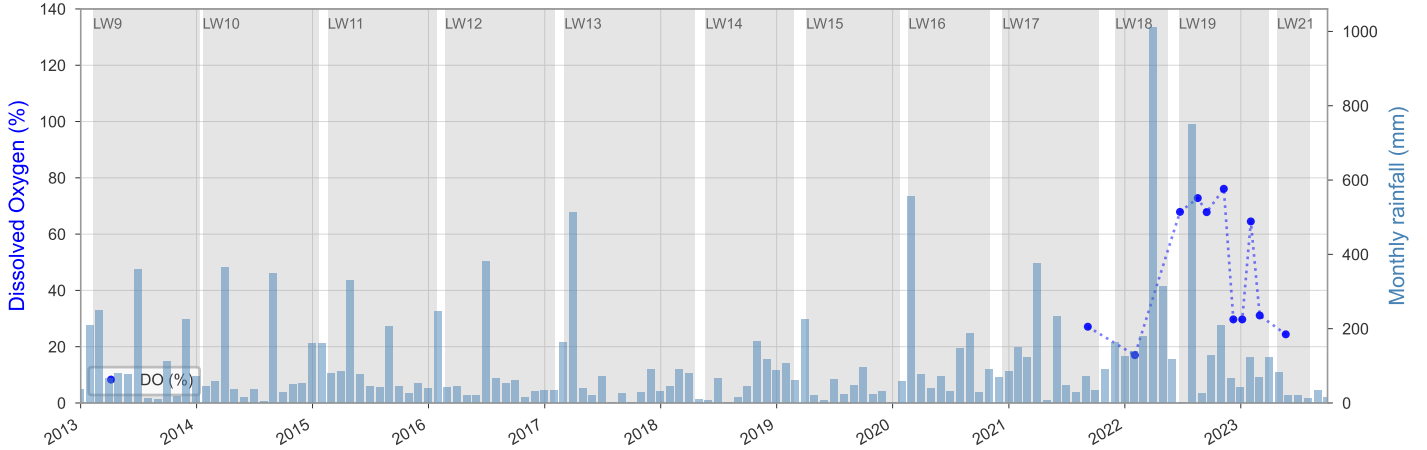
CR36_POOL44



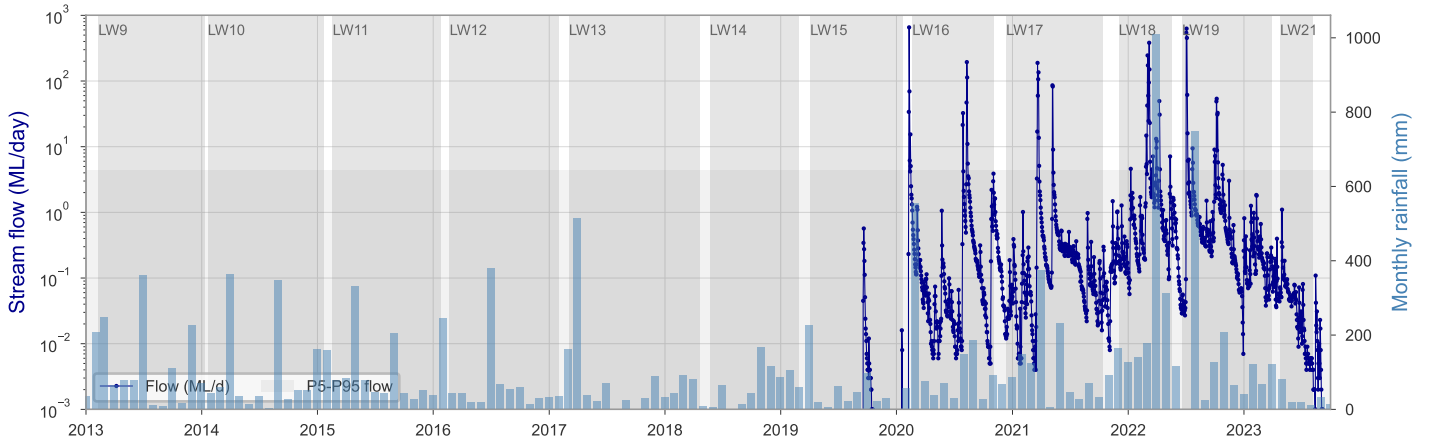
CR36_POOL44



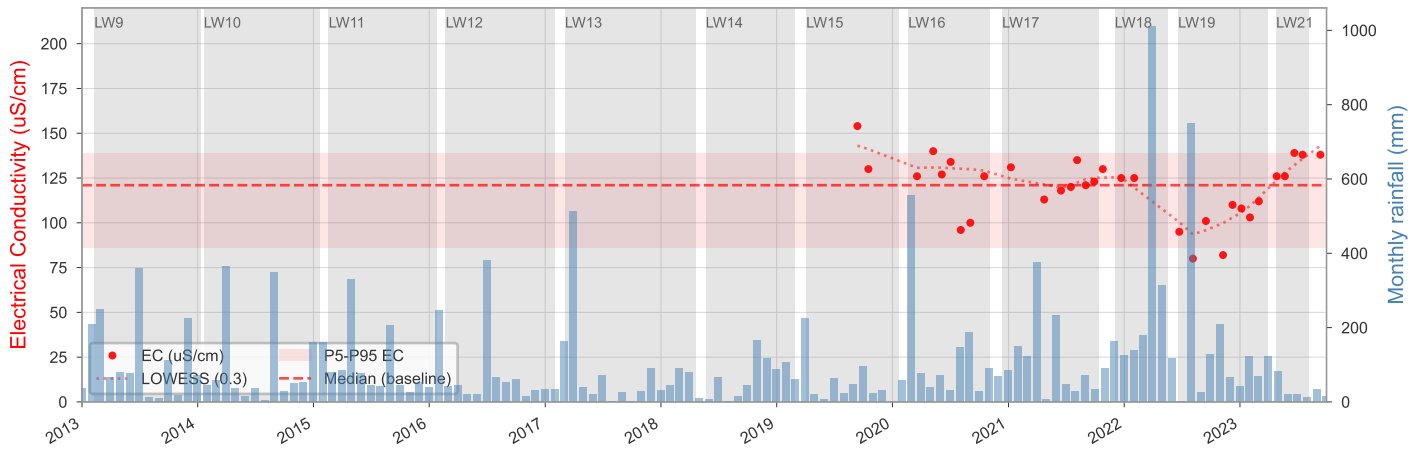
CR36_POOL44



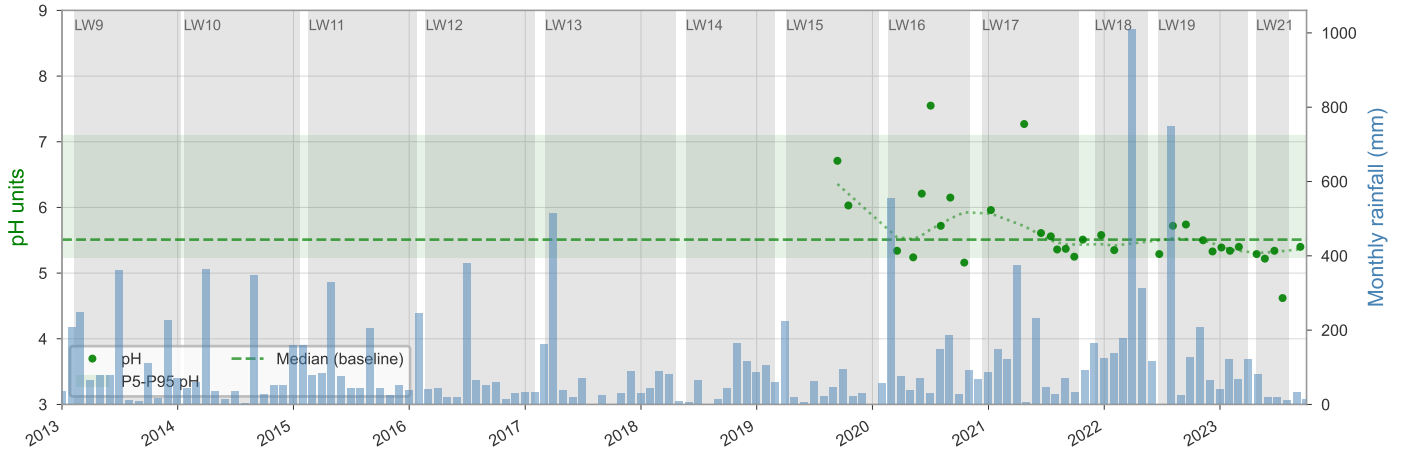
CR36S1



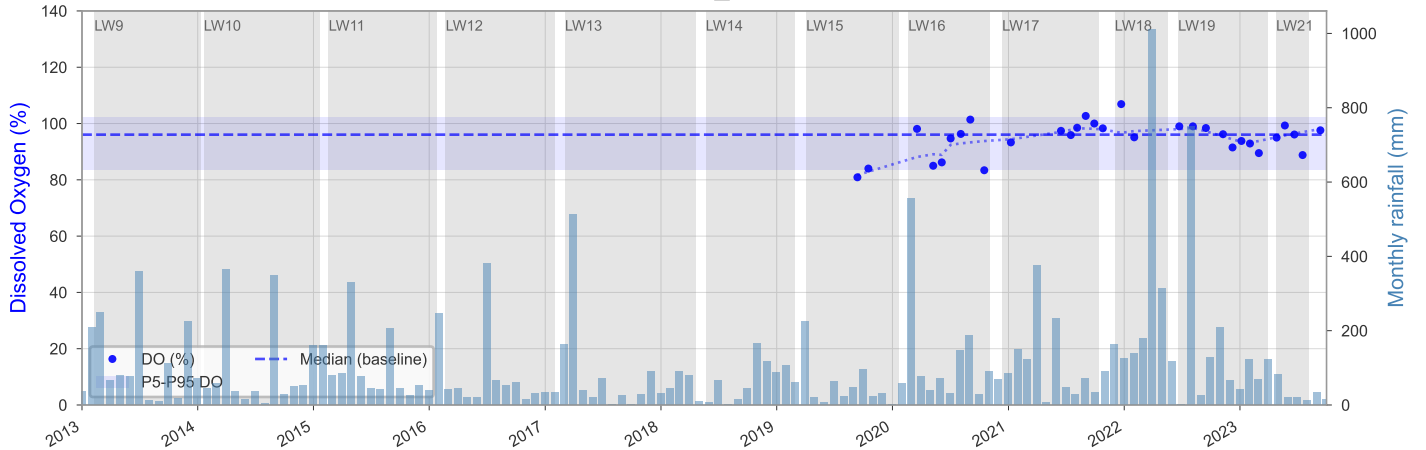
CR36_S1



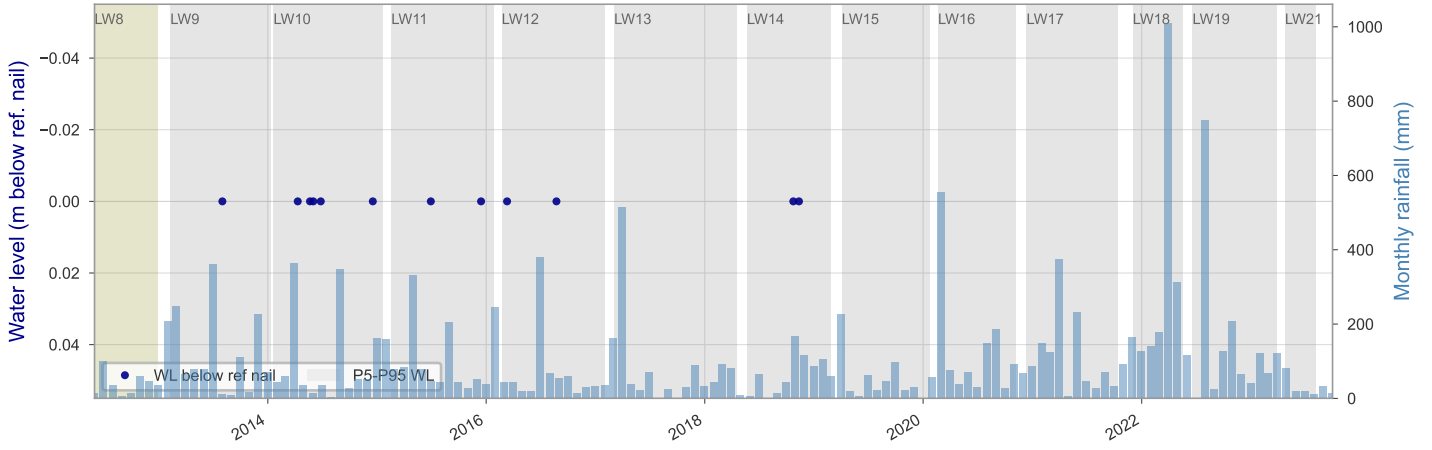
CR36_S1



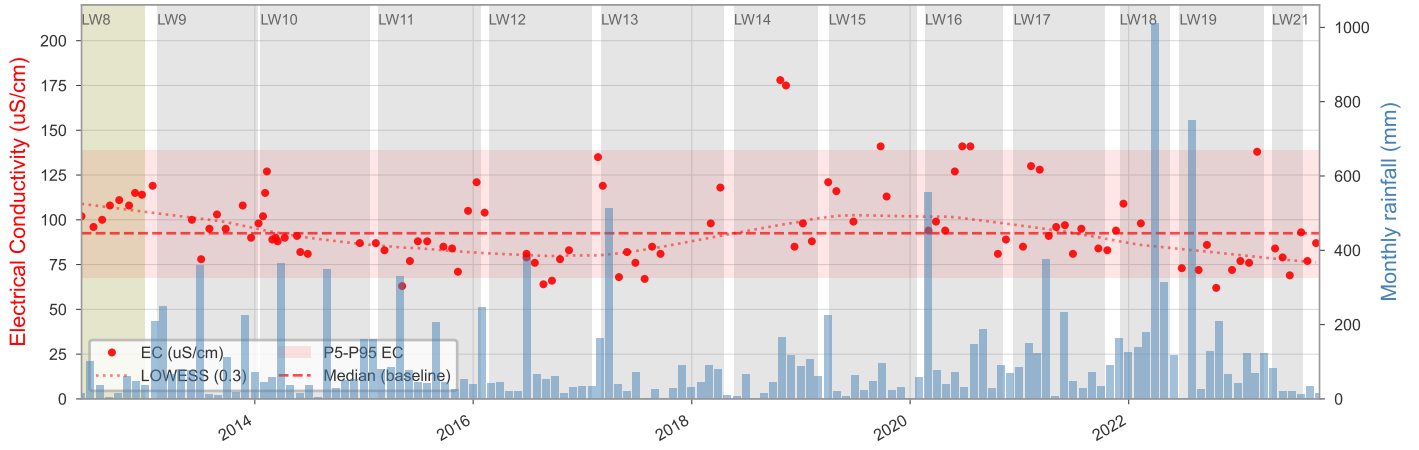
CR36_S1



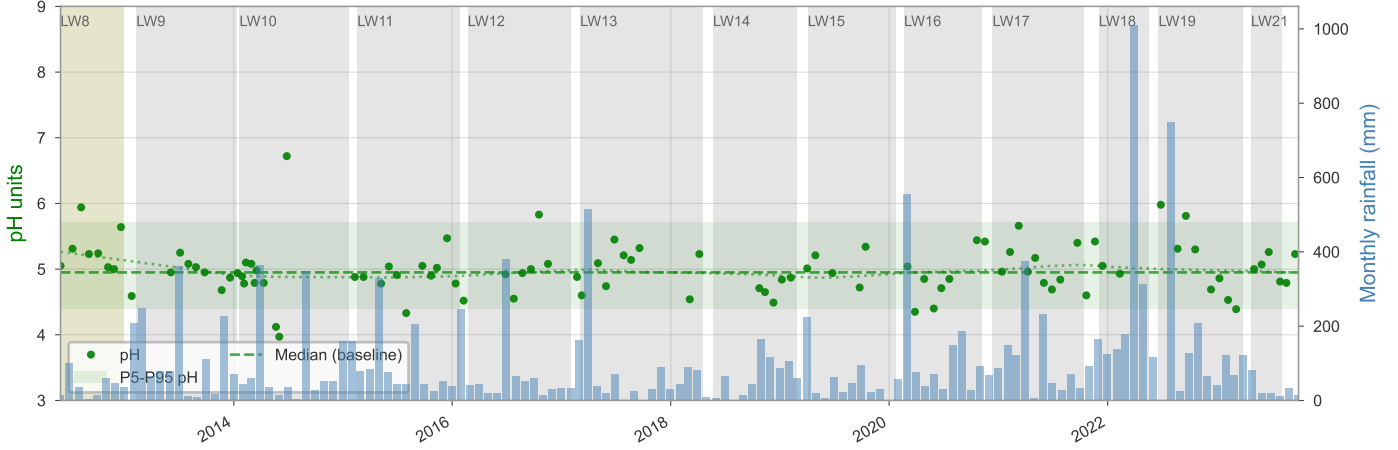
DC13_POOL10



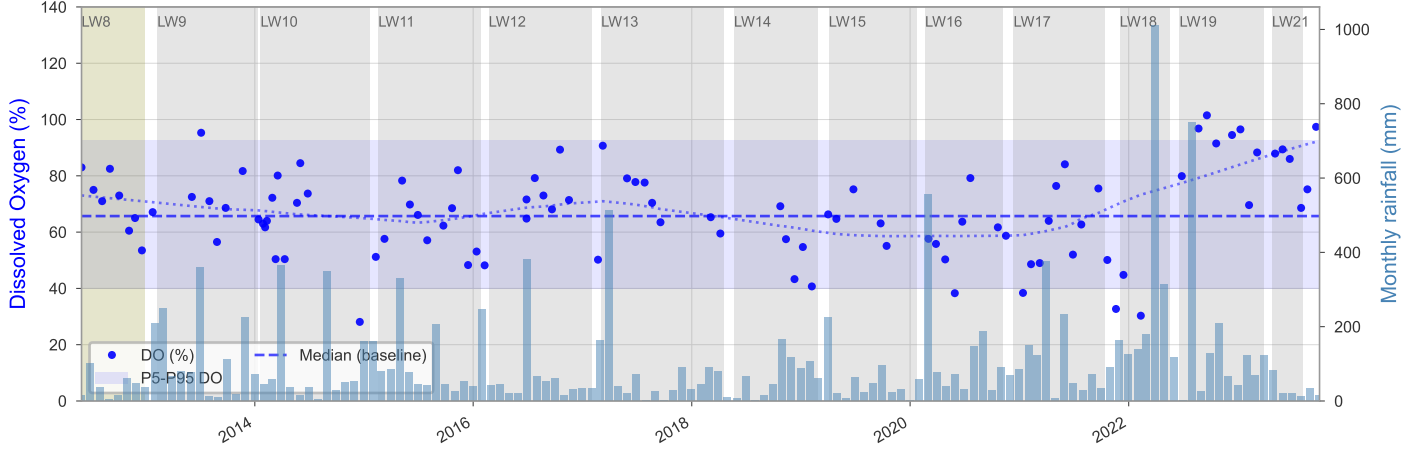
DC13_POOL10



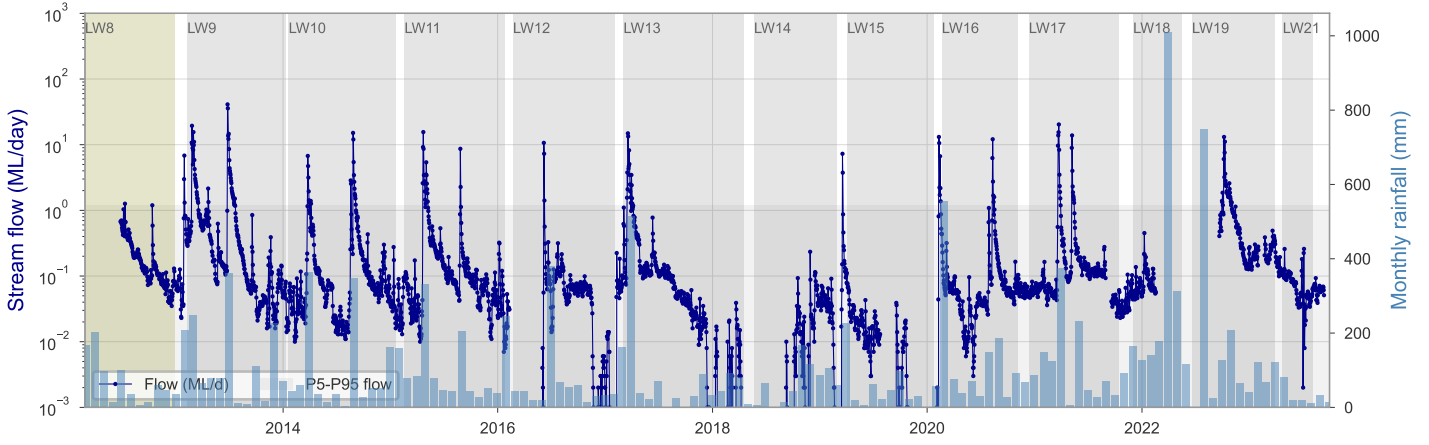
DC13_POOL10



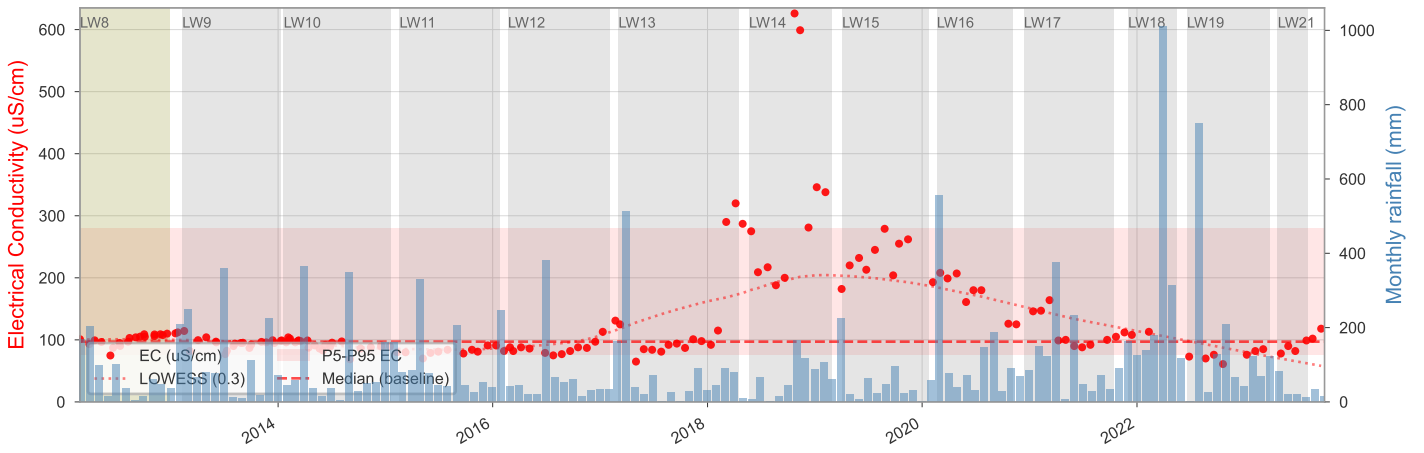
DC13_POOL10



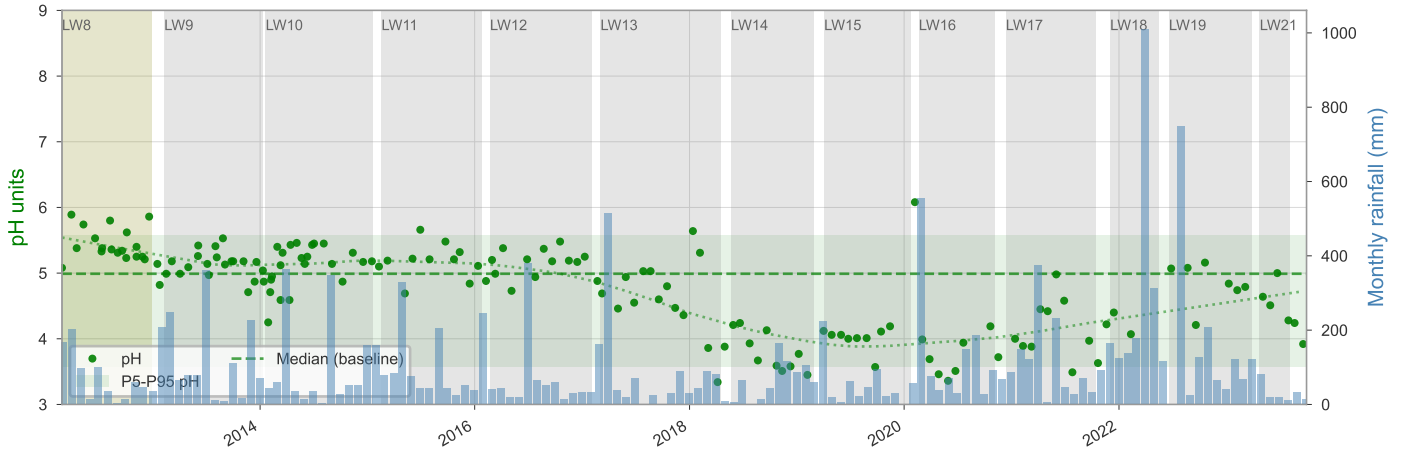
DC13S1



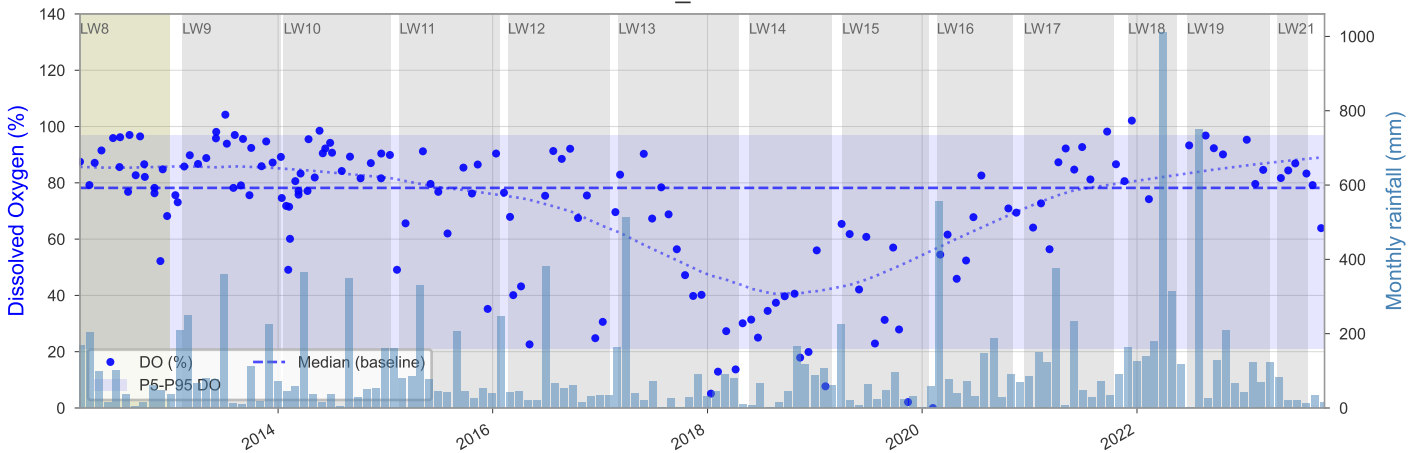
DC13_POOL2B



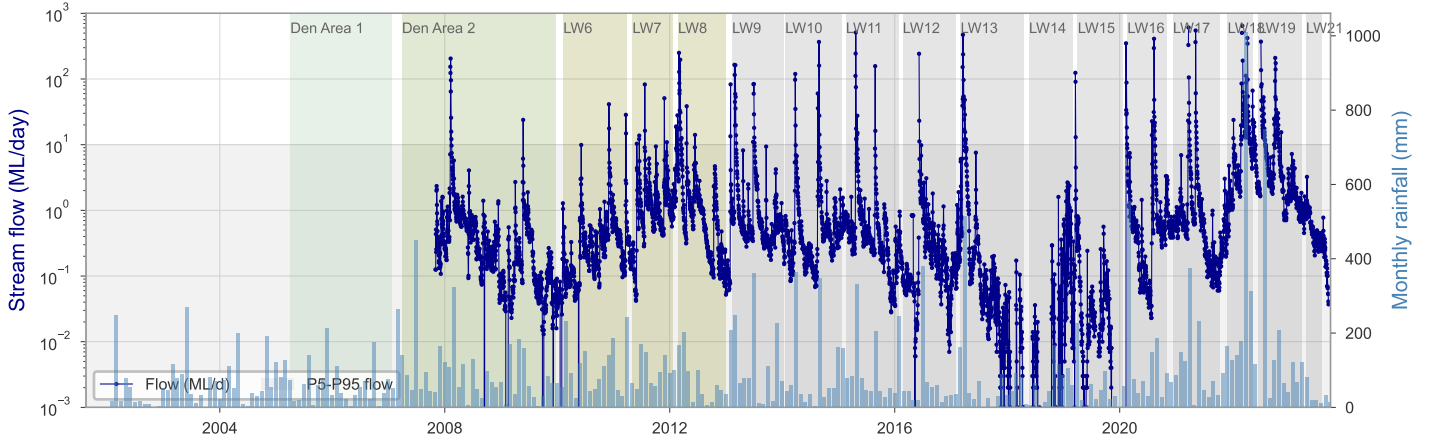
DC13_POOL2B



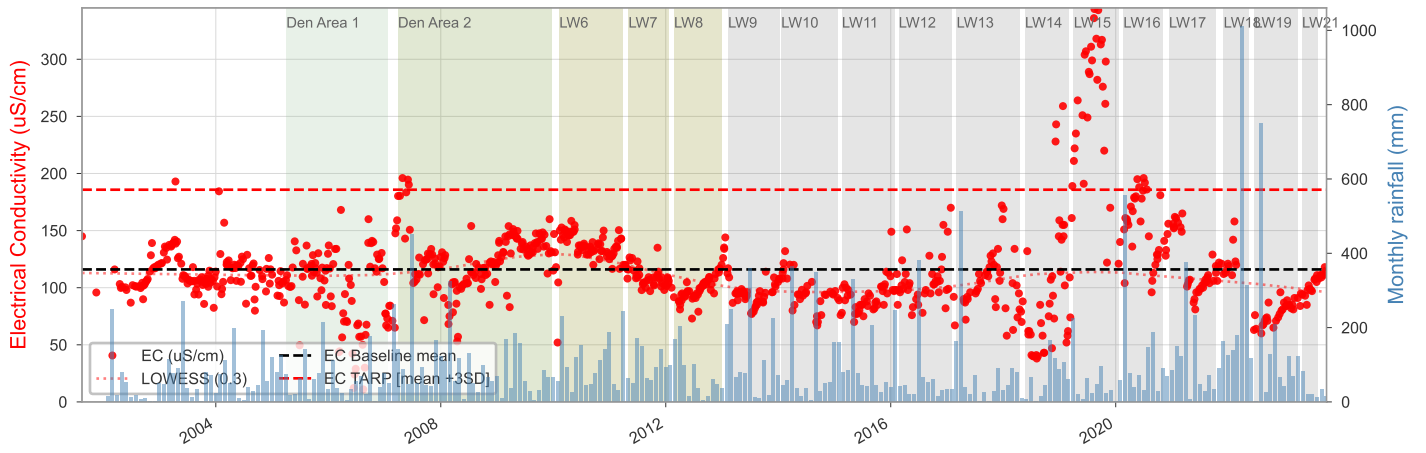
DC13_POOL2B



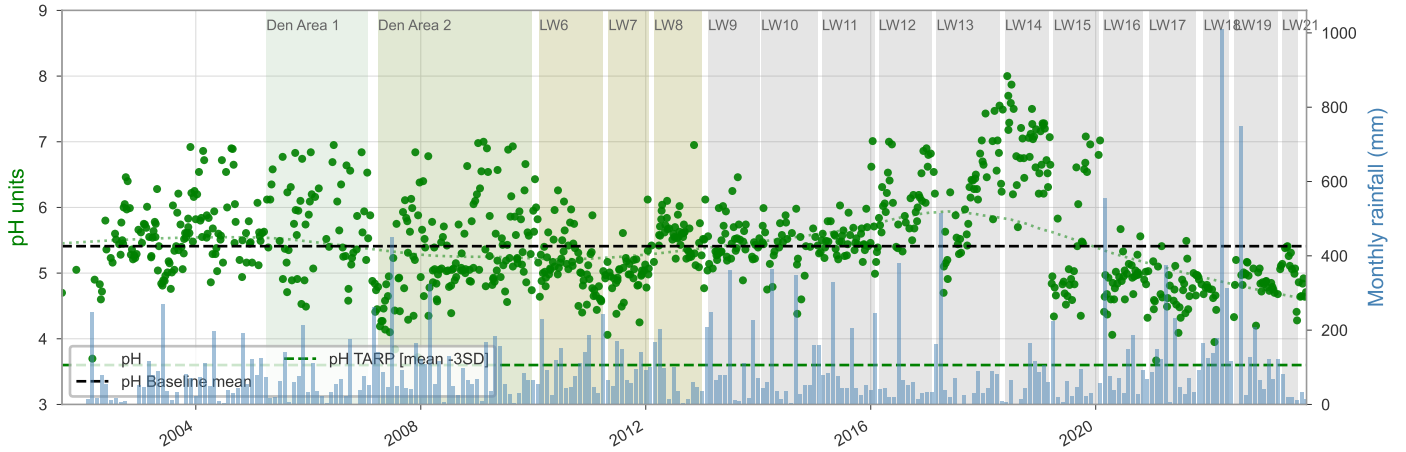
DCU



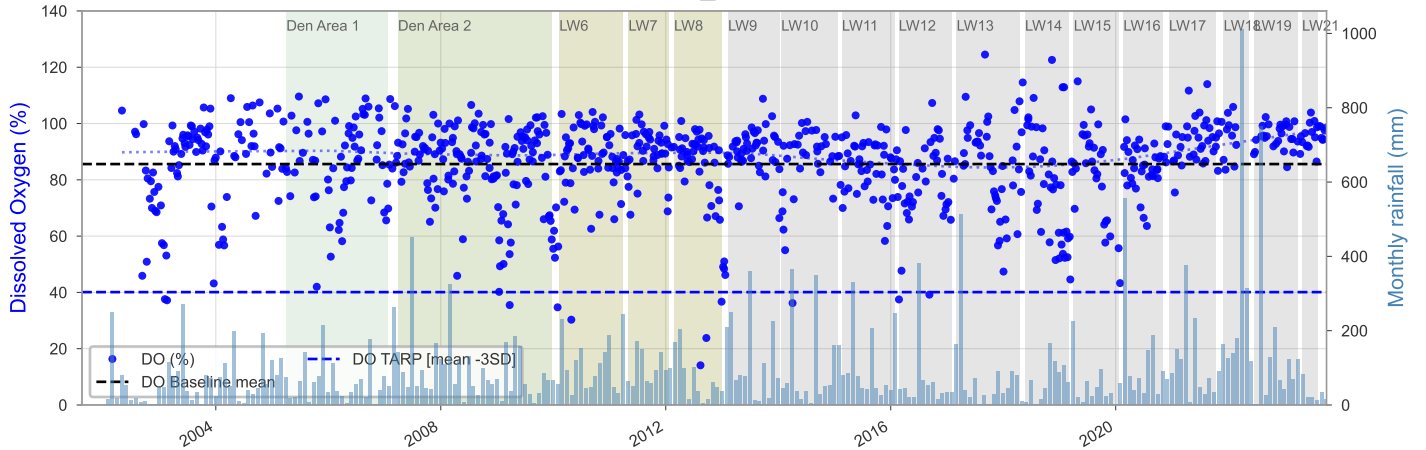
DCC_FR6



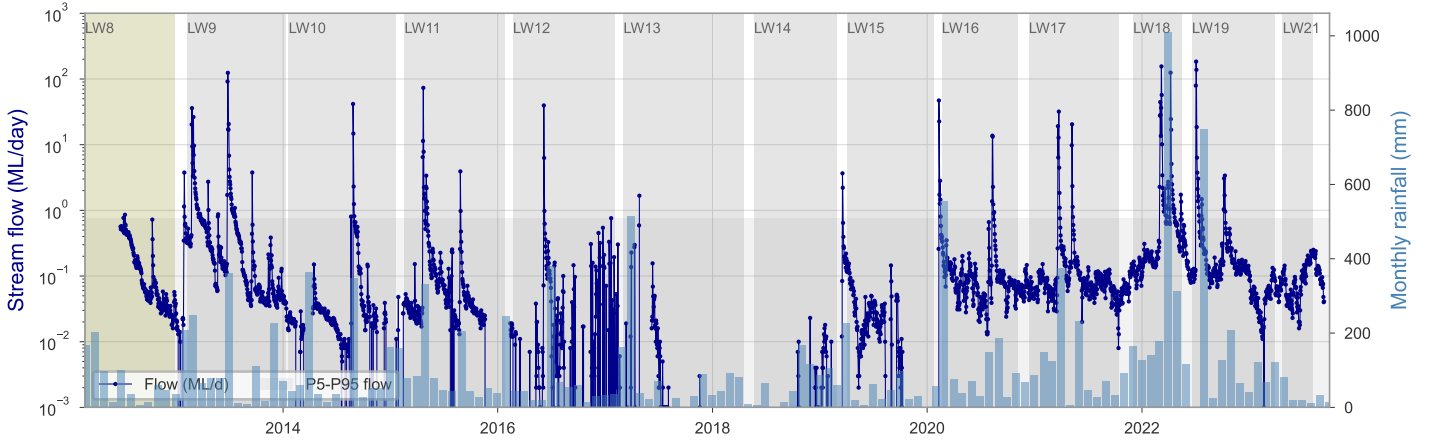
DCC_FR6



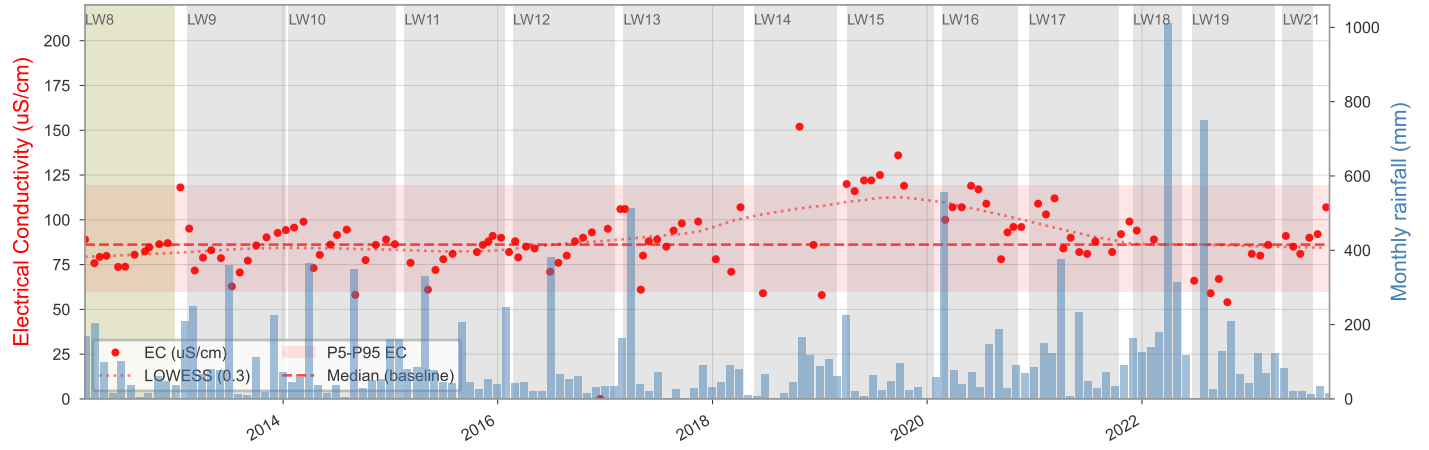
DCC_FR6



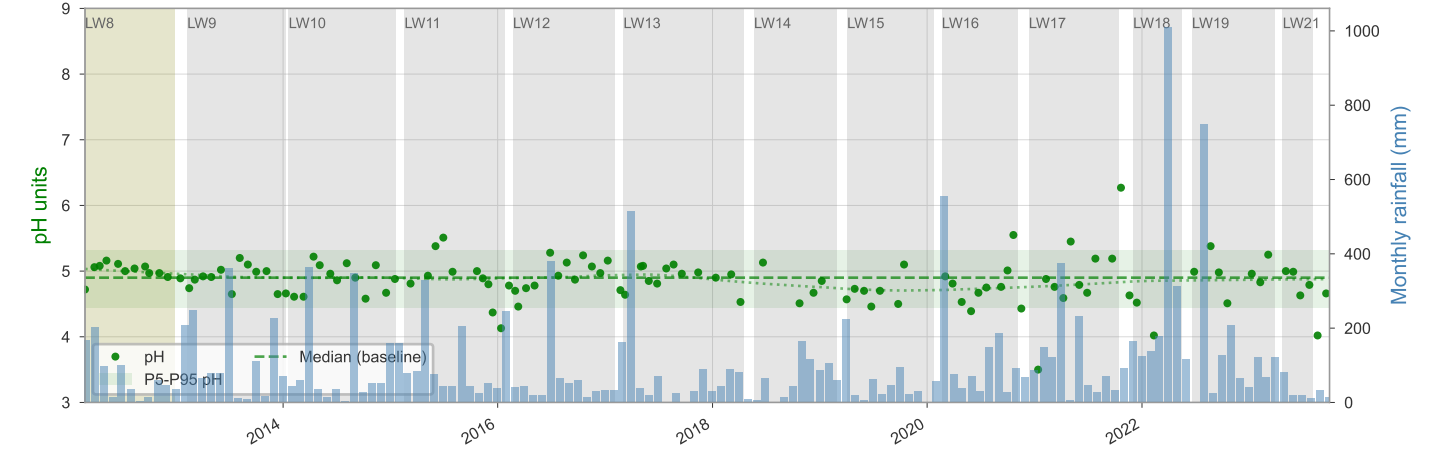
DCS2



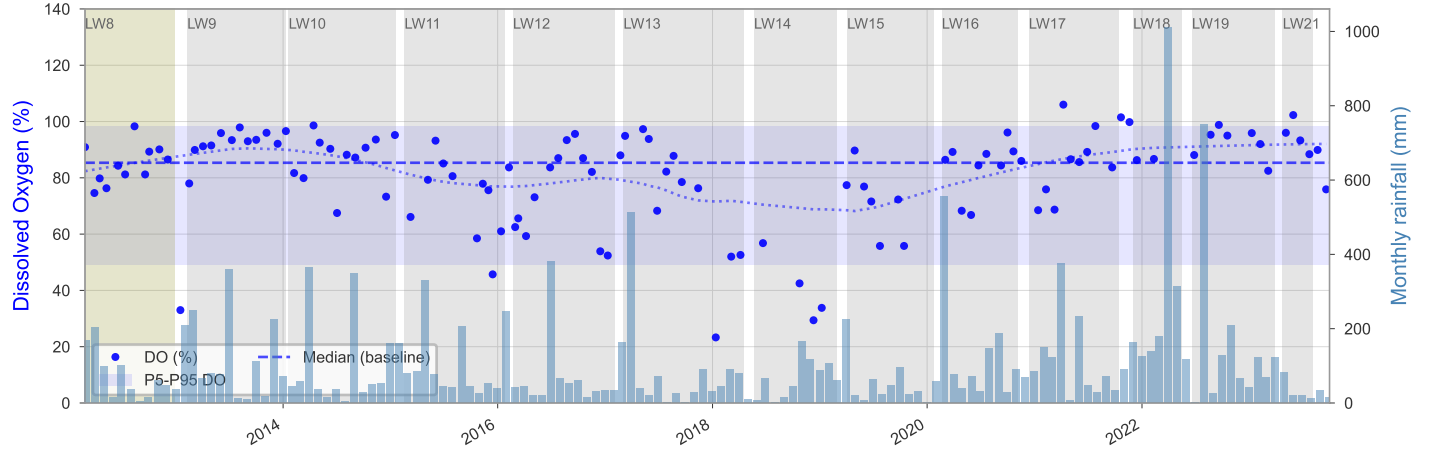
DC_POOL22



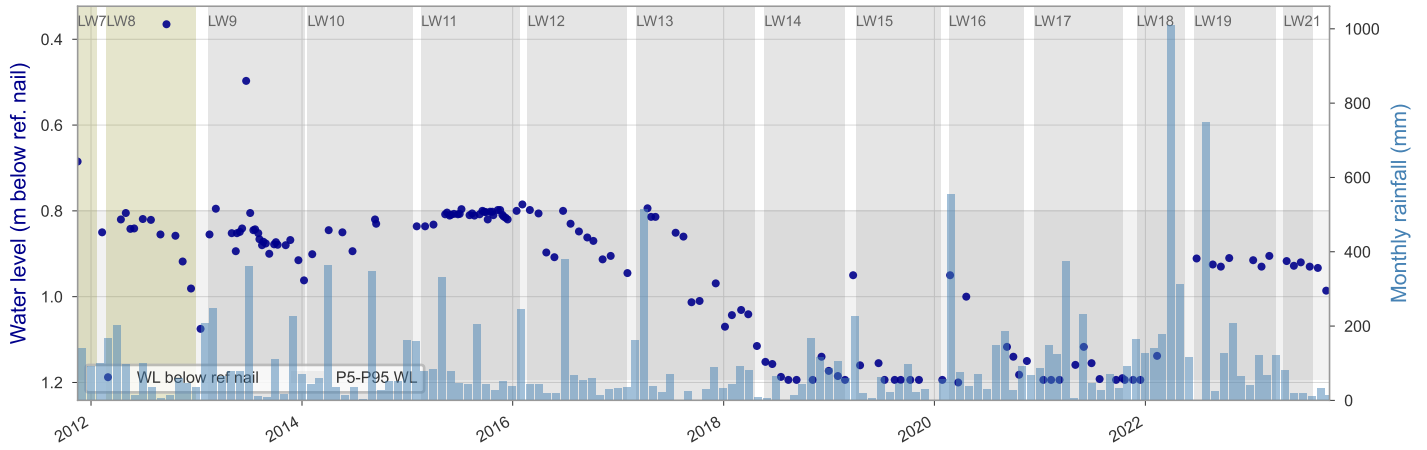
DC_POOL22



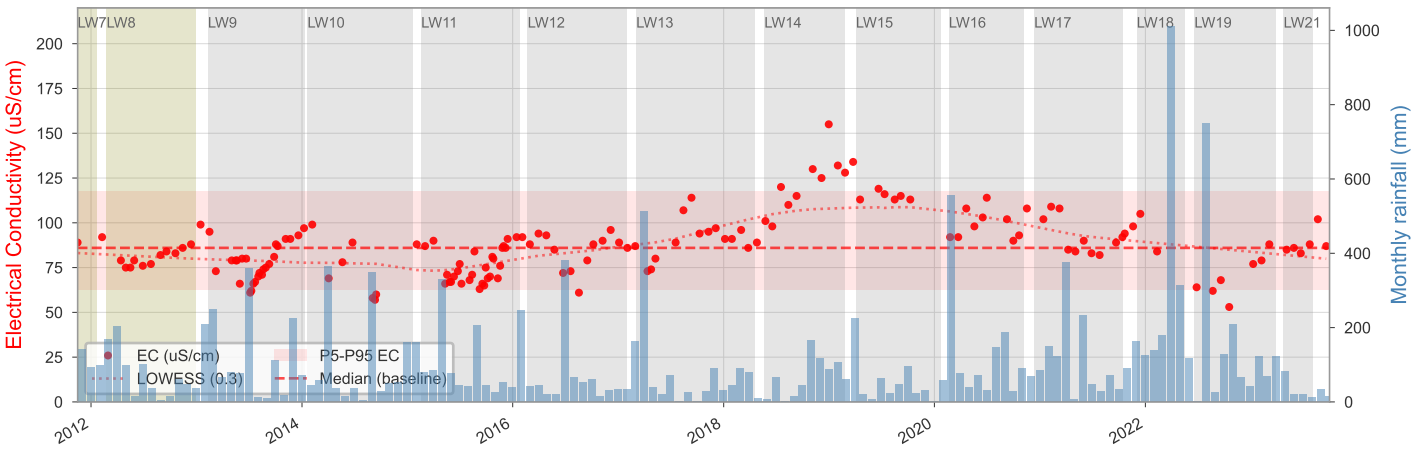
DC_POOL22



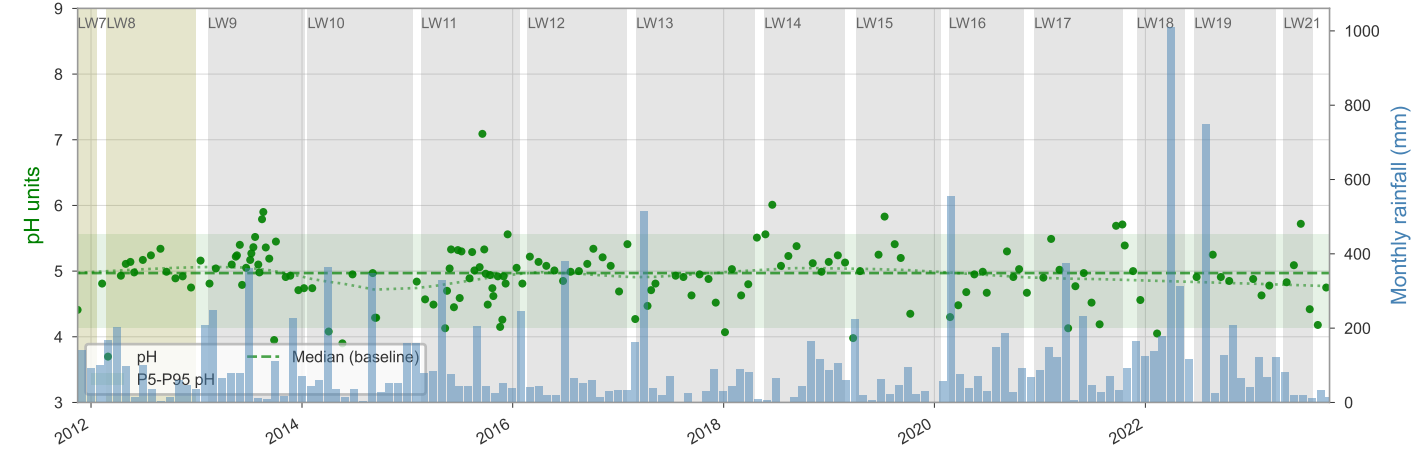
DC_POOL29



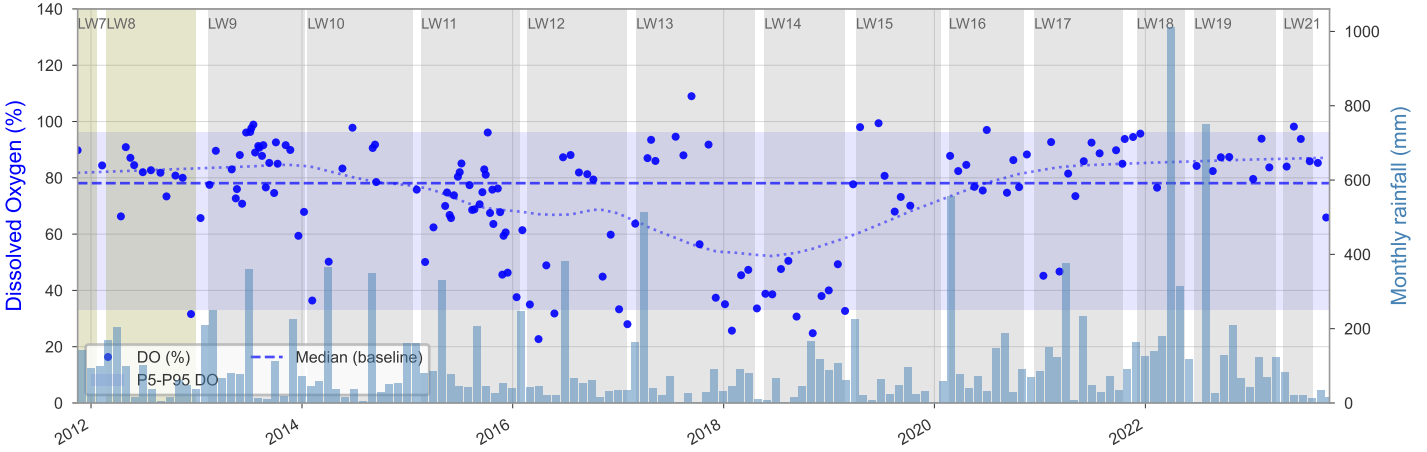
DC_POOL29



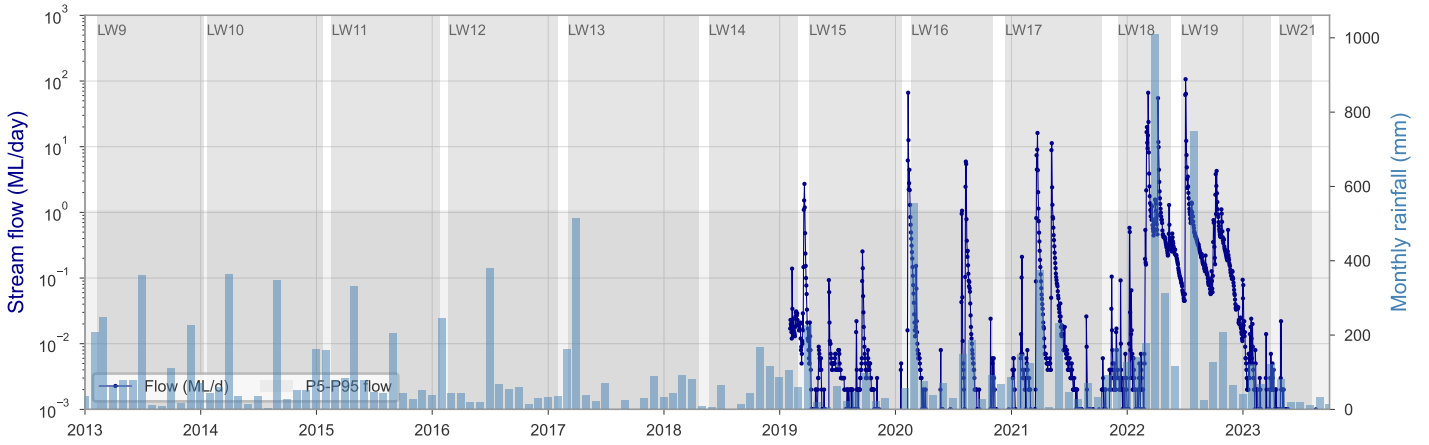
DC_POOL29



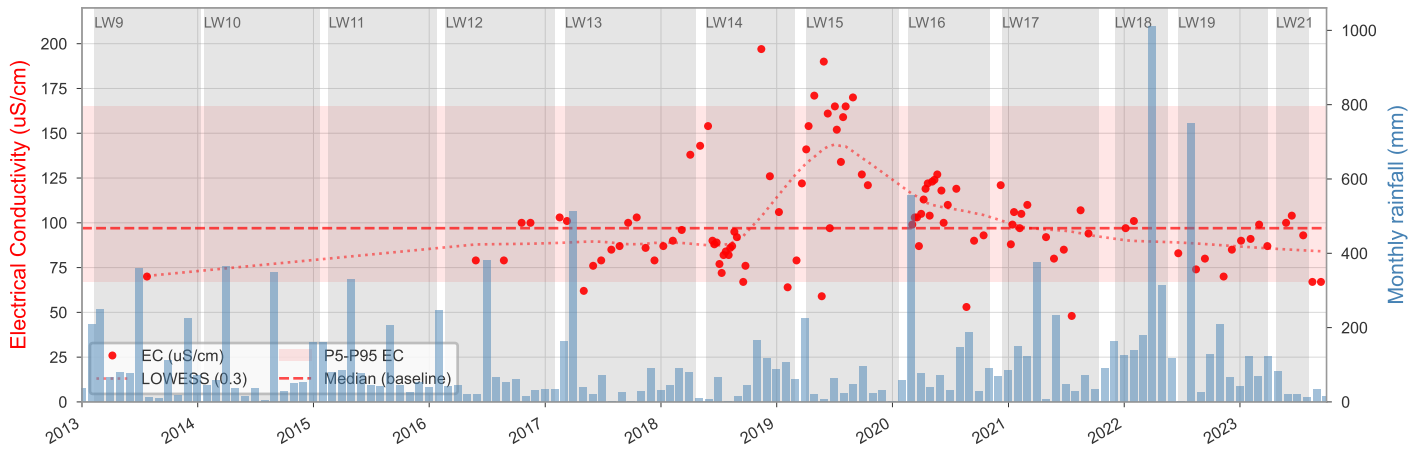
DC_POOL29



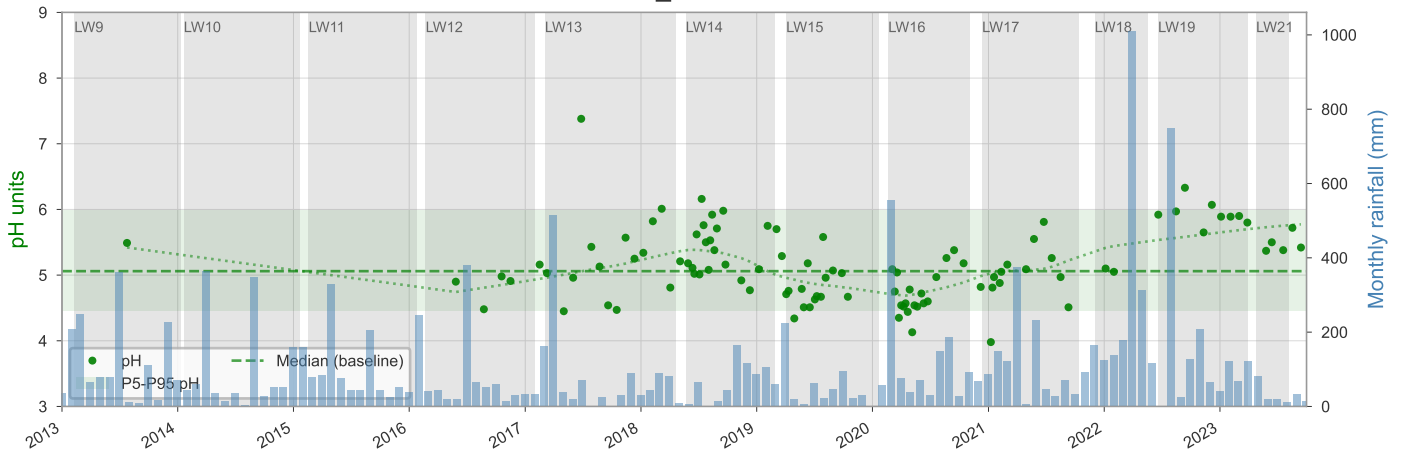
LA3S1



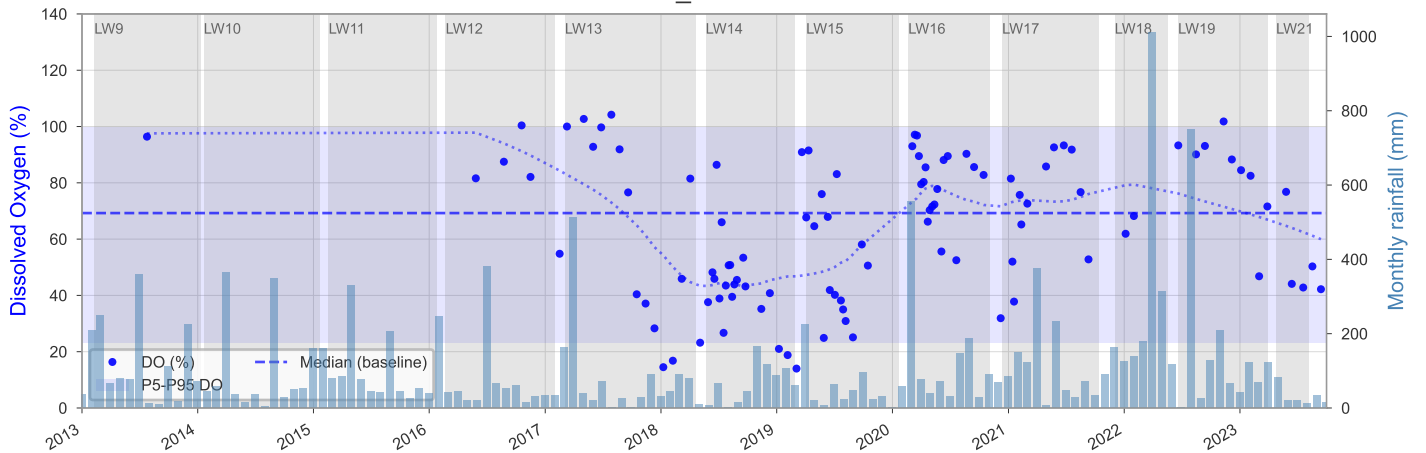
LA3_POOL4



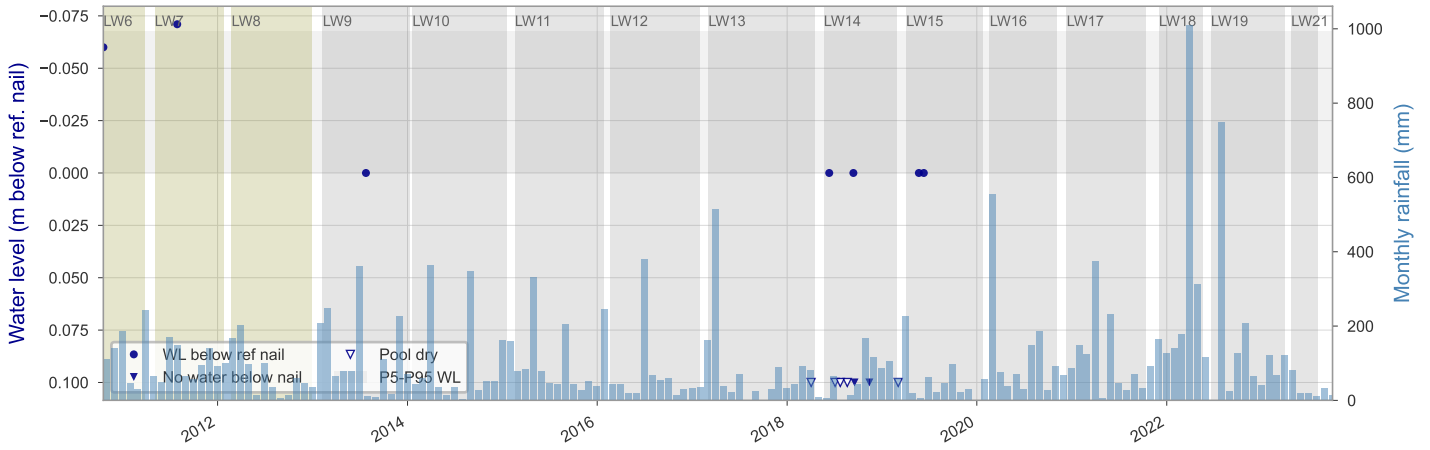
LA3_POOL4



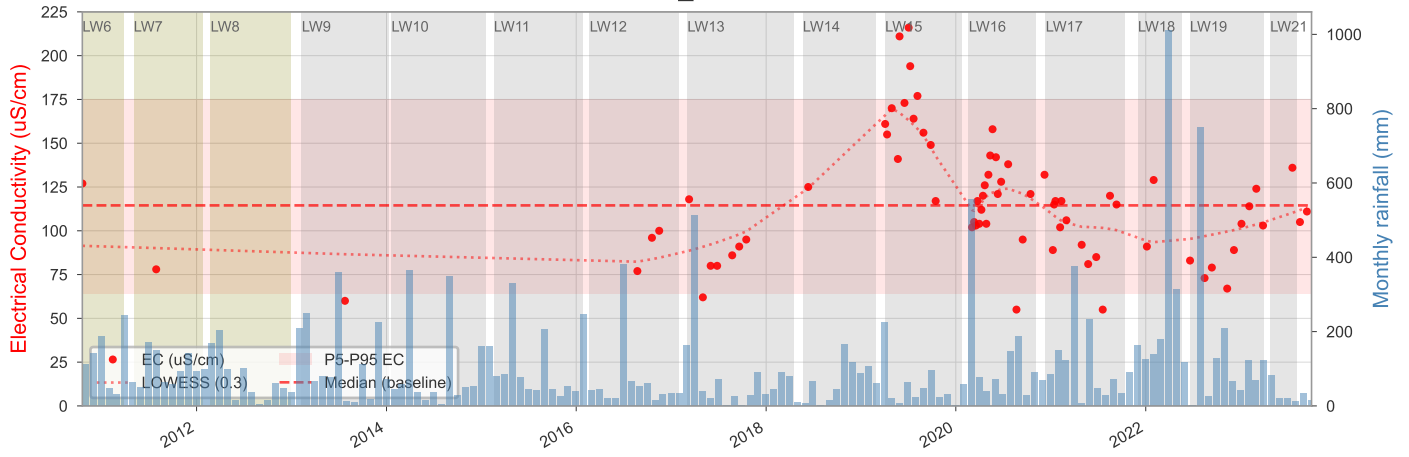
LA3_POOL4



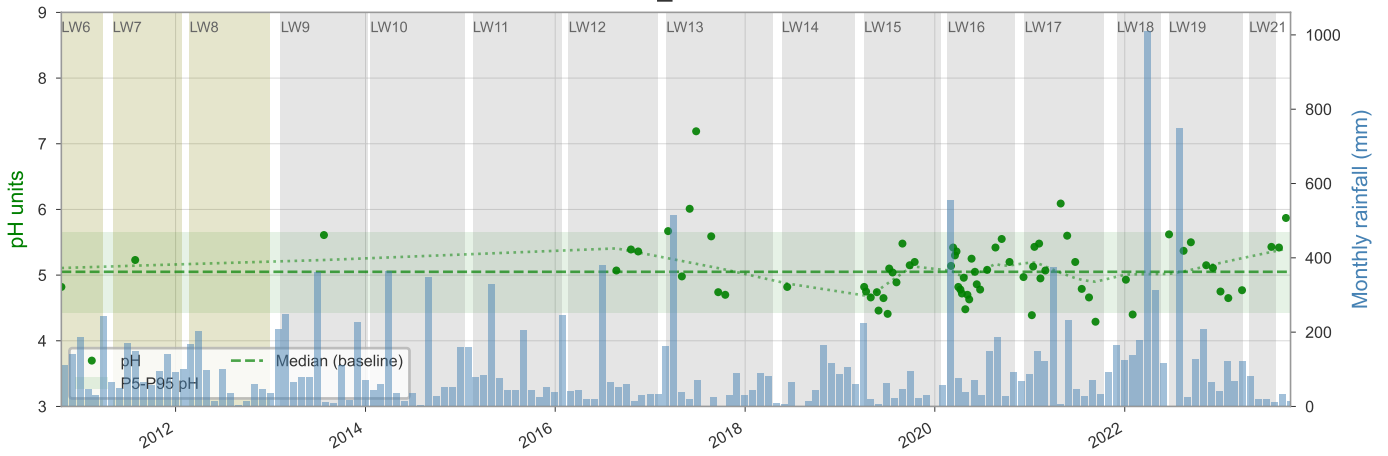
LA3_RB4B



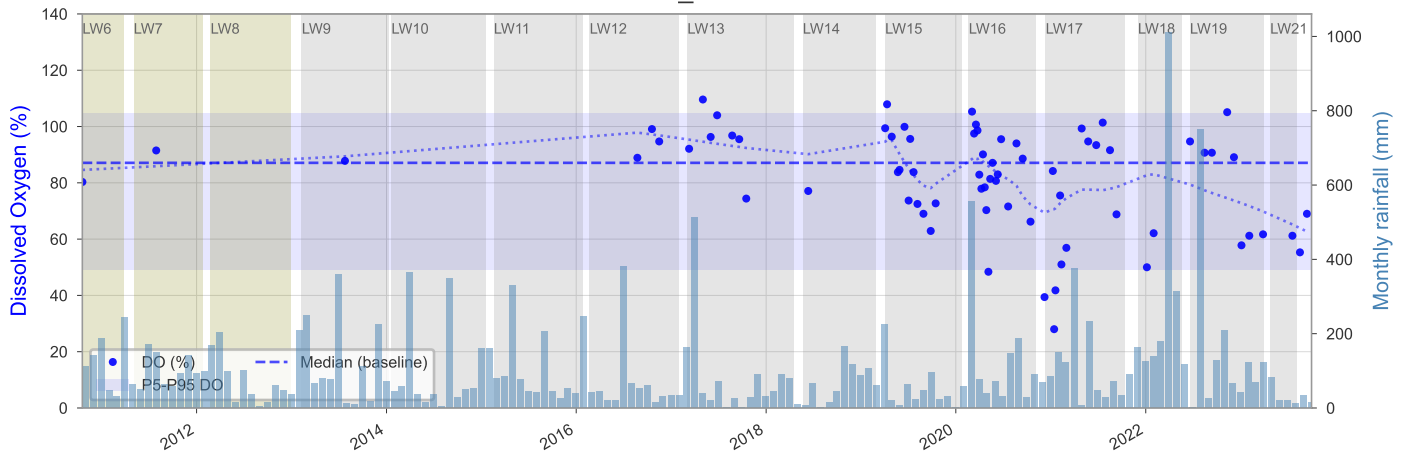
LA3_RB4B



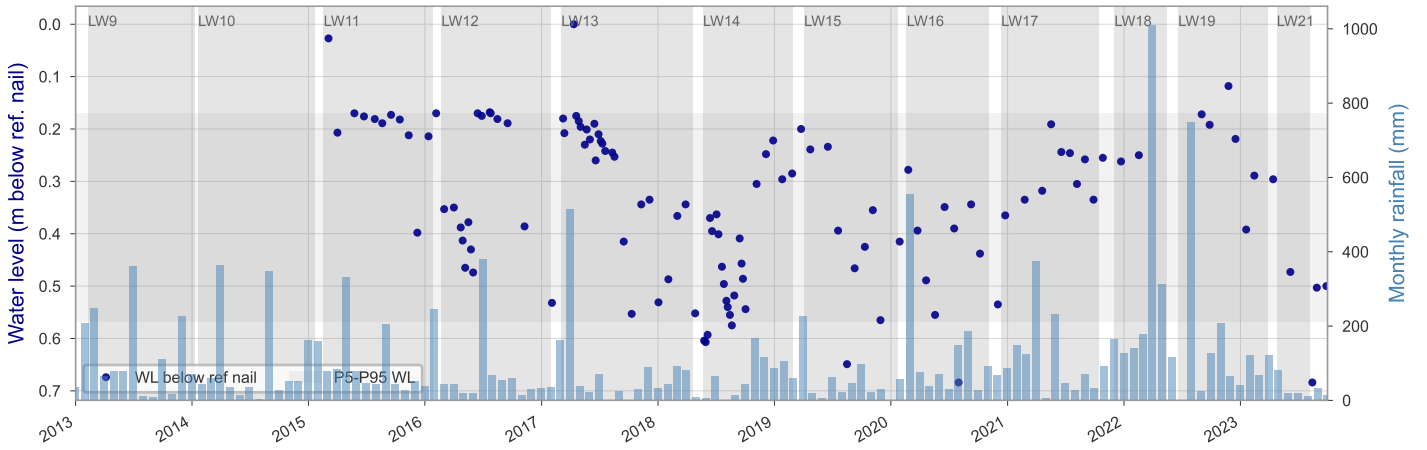
LA3_RB4B



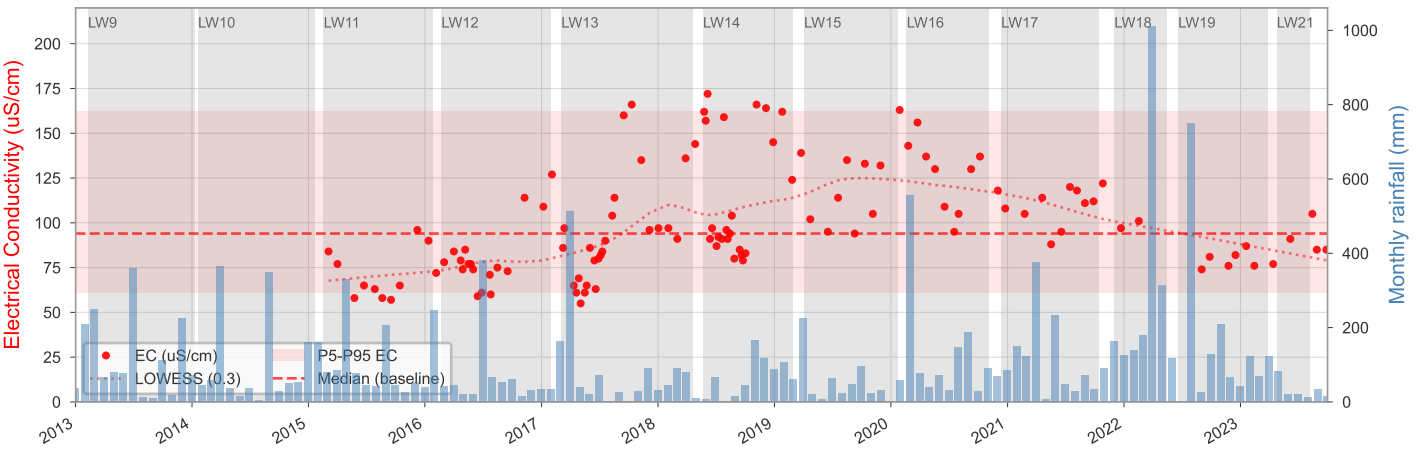
LA3_RB4B



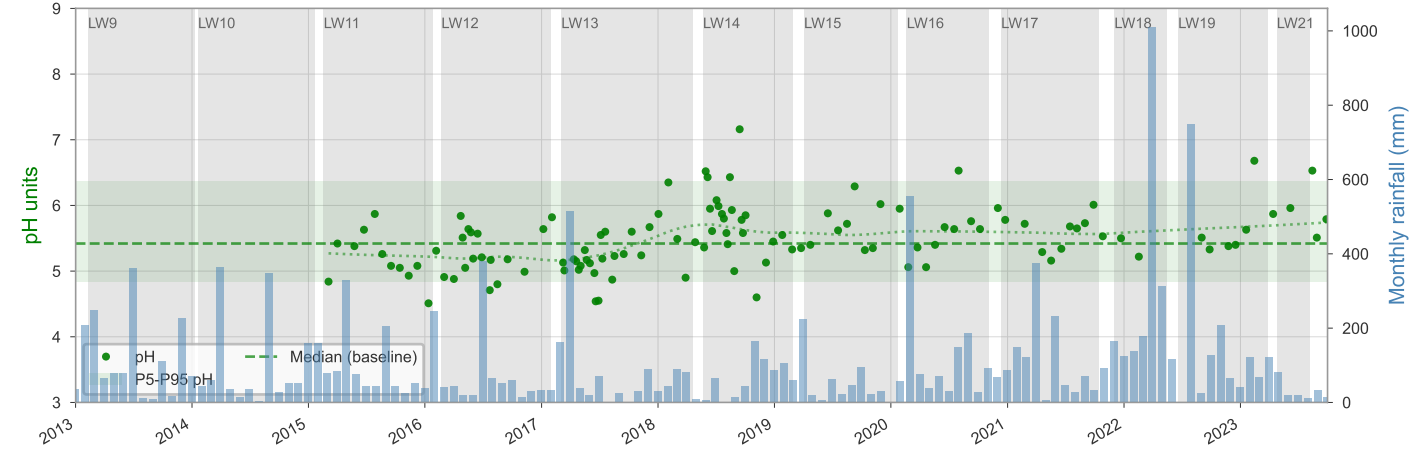
LA4A_POOL3



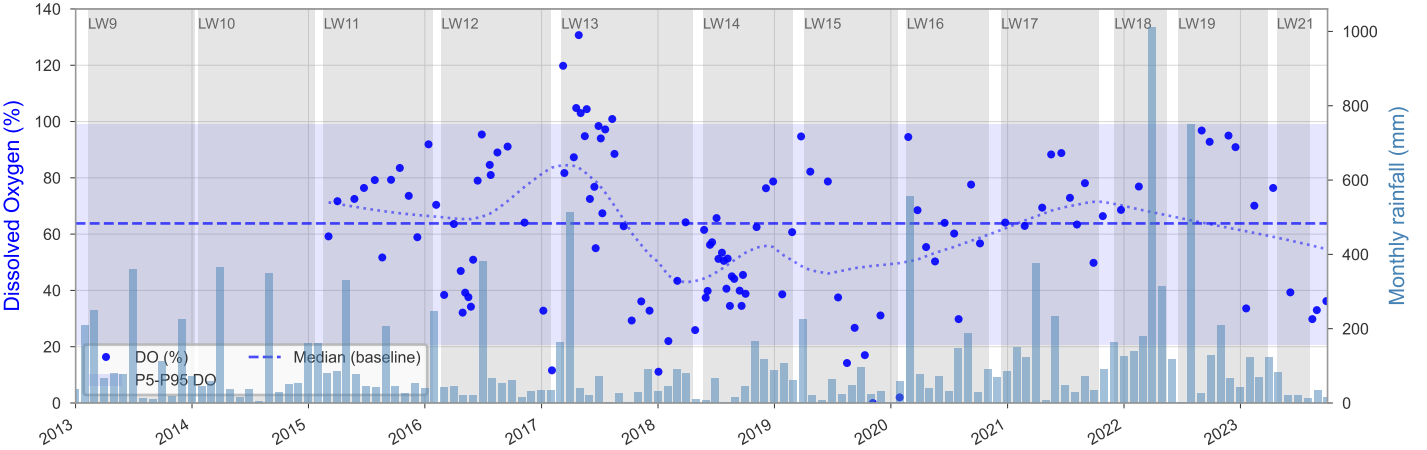
LA4A_POOL3



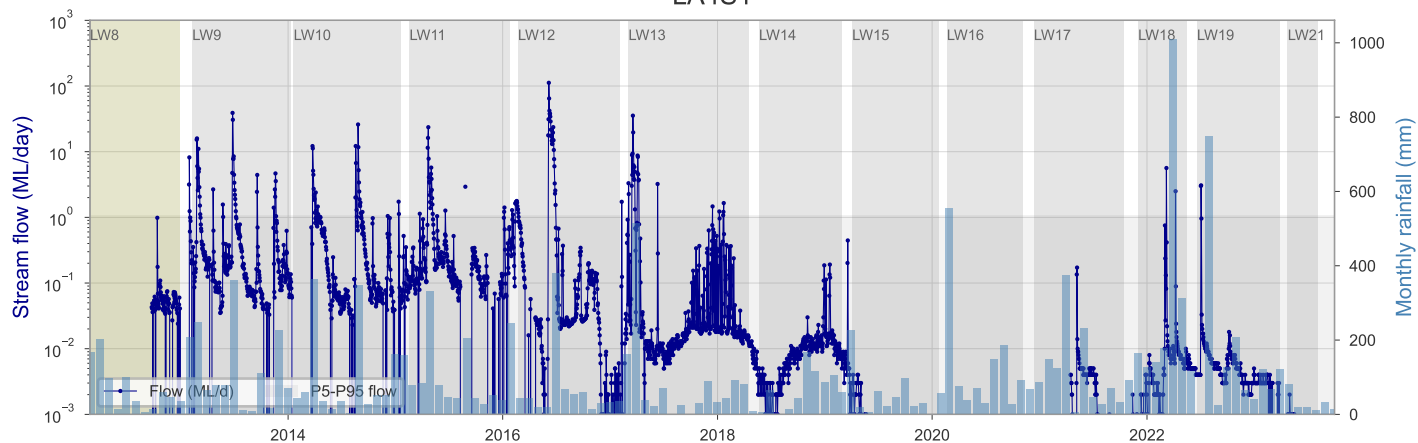
LA4A_POOL3



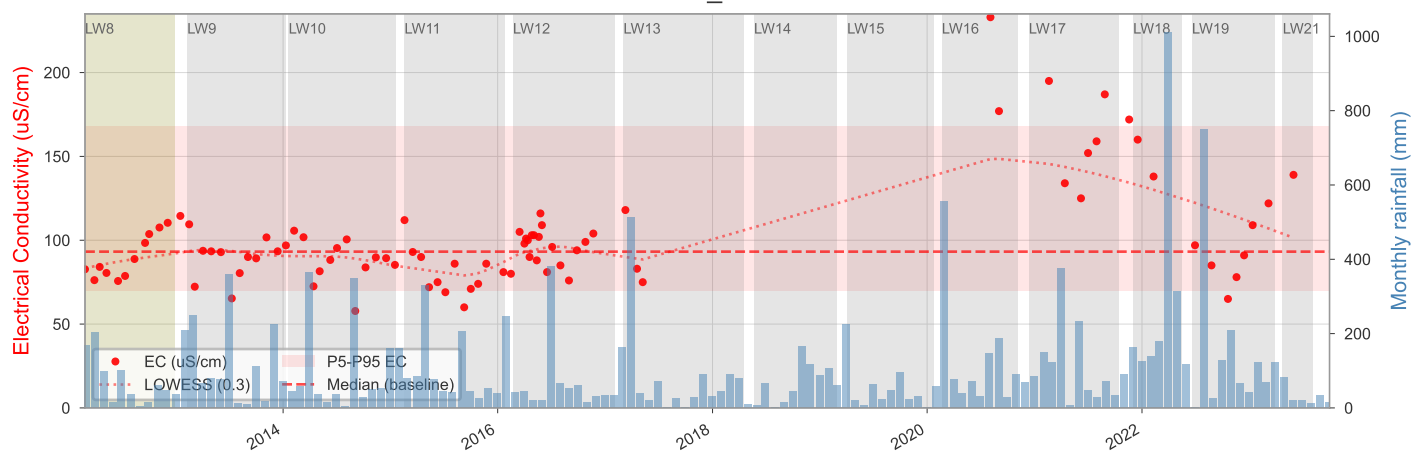
LA4A_POOL3



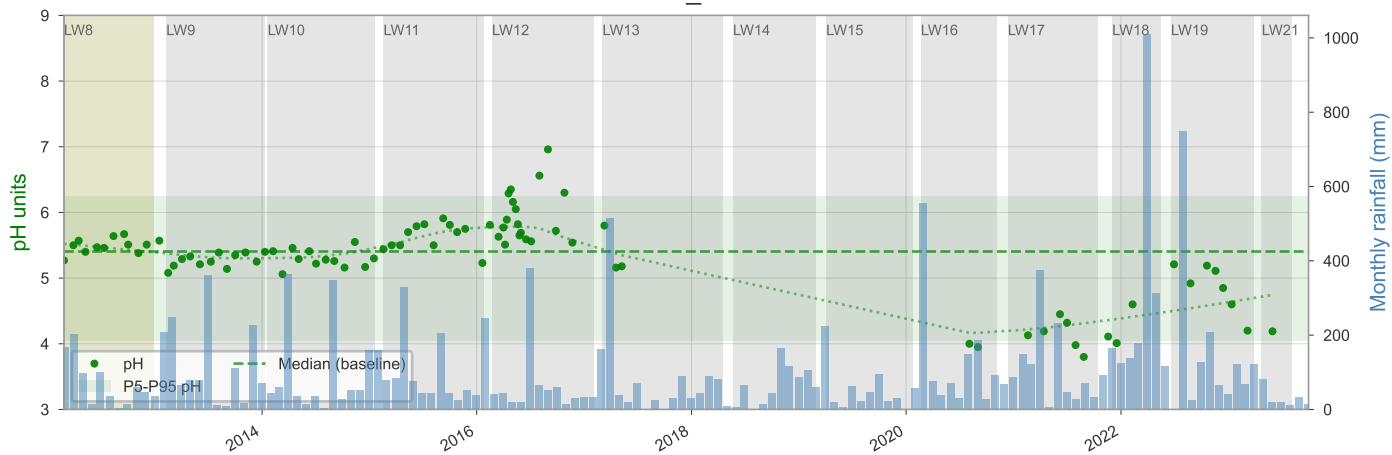
LA4S1



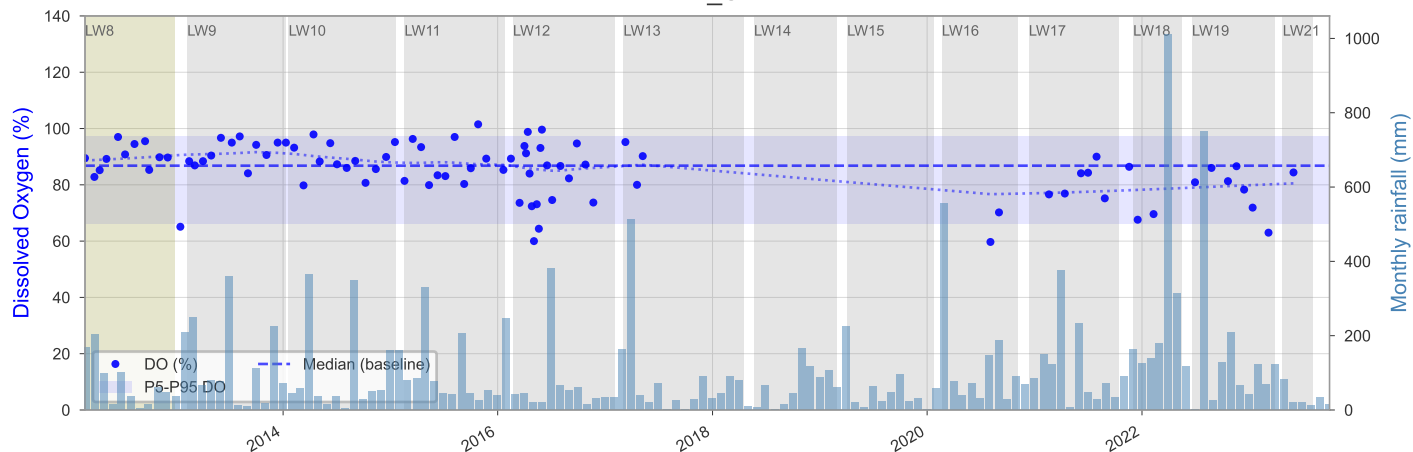
LA4_S1



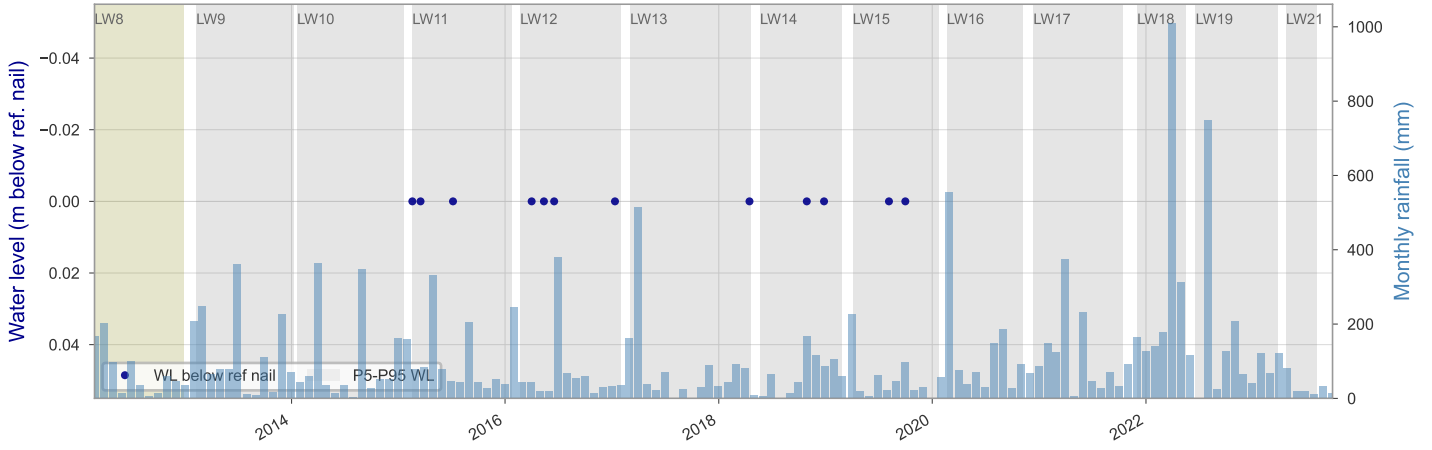
LA4_S1



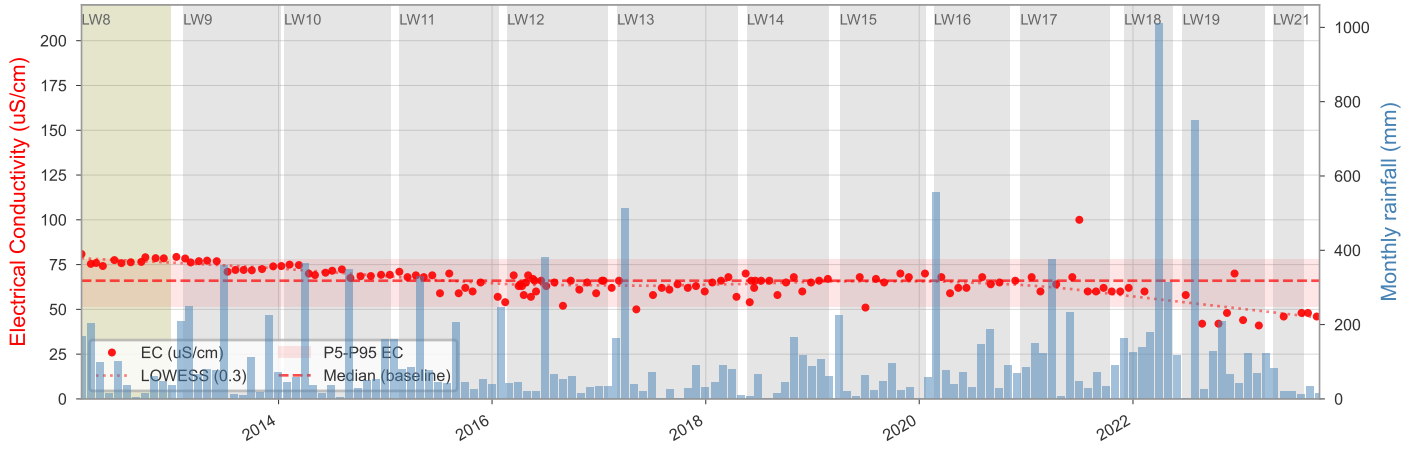
LA4_S1



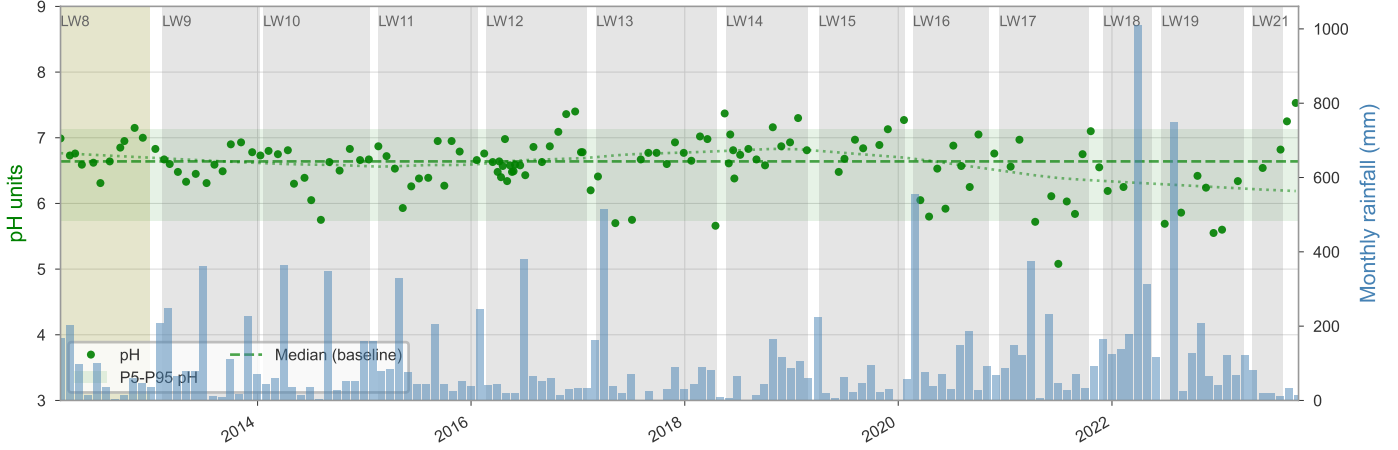
LA4_S2



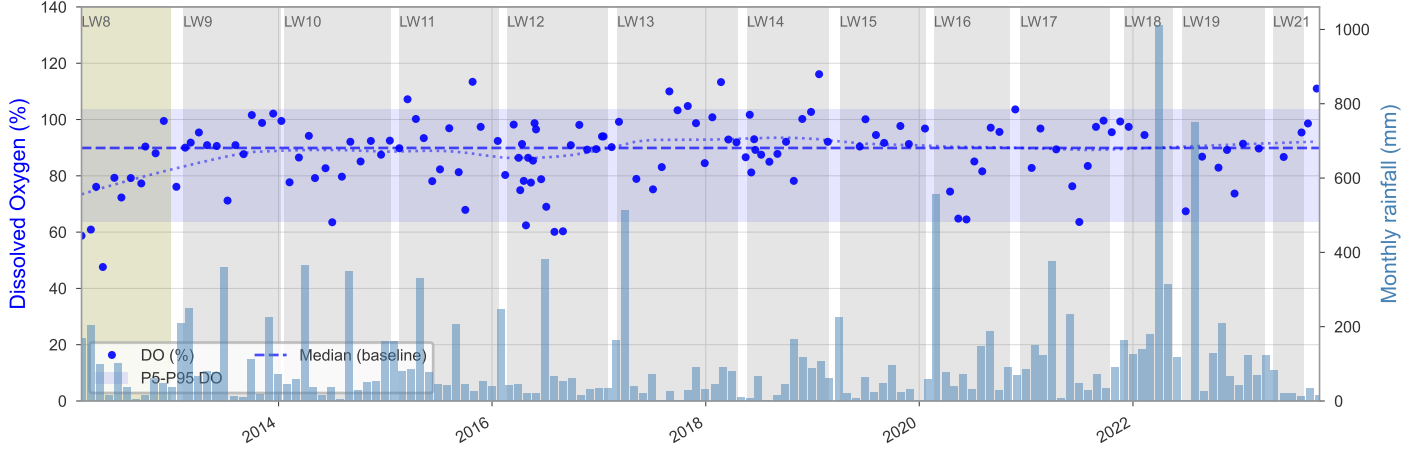
LA4_S2



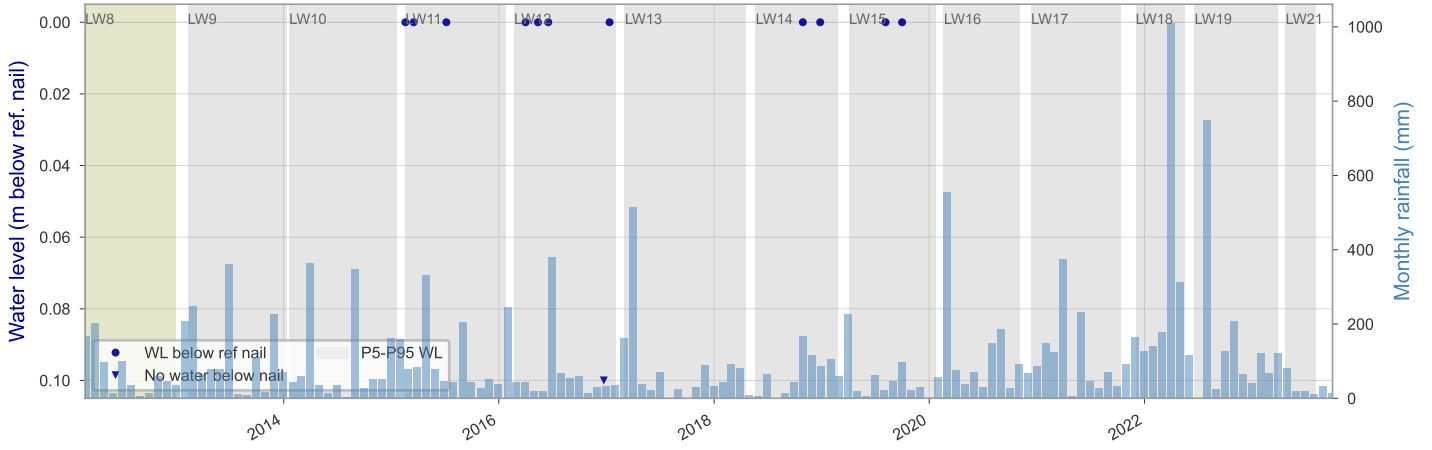
LA4_S2



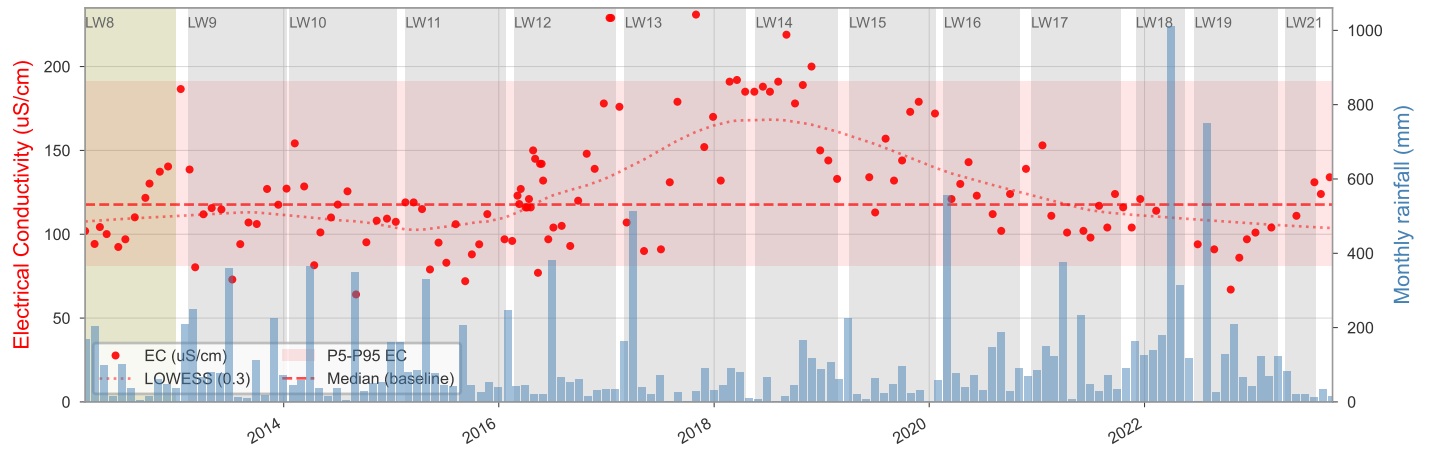
LA4_S2



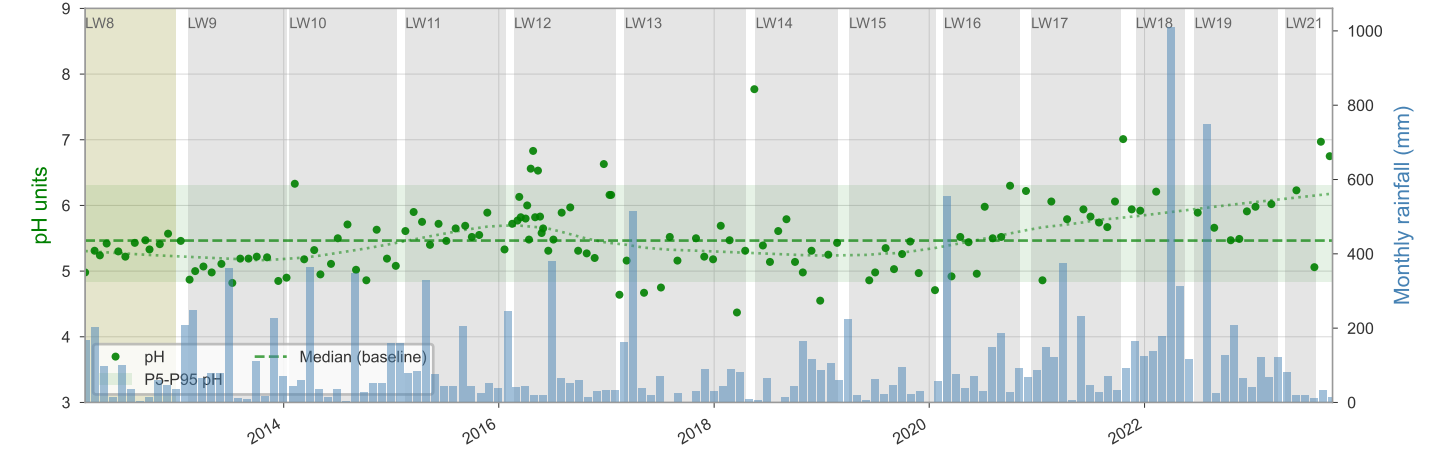
LA5_S1



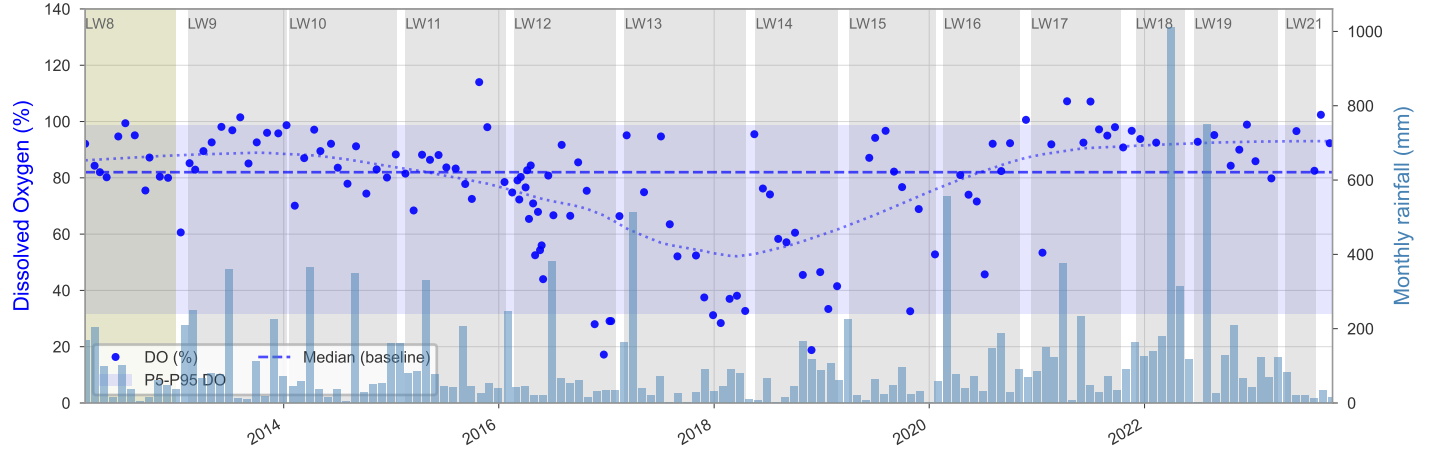
LA5_S1



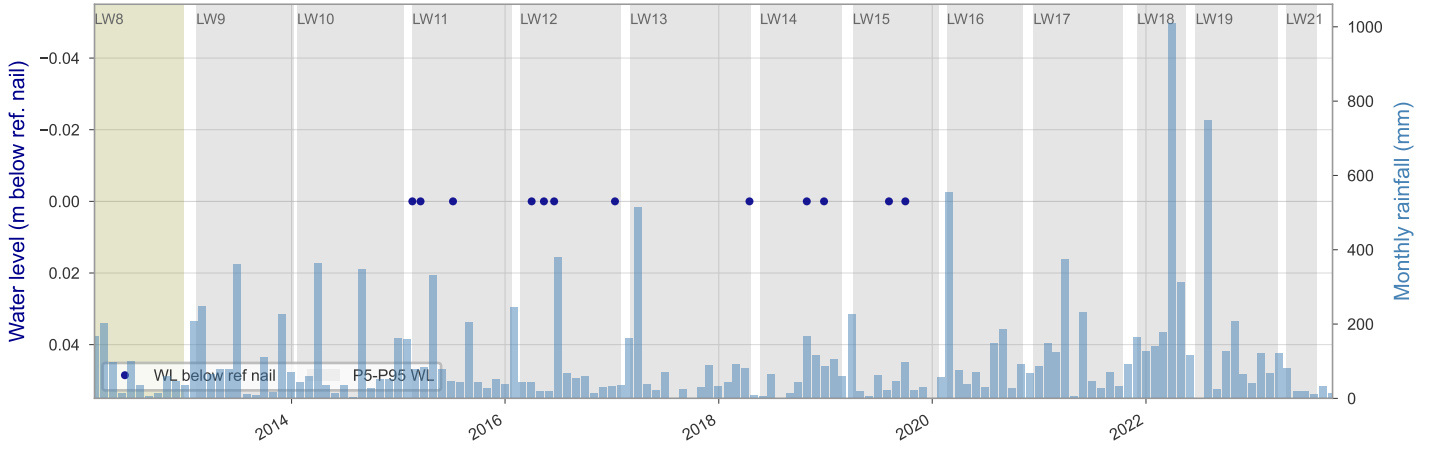
LA5_S1



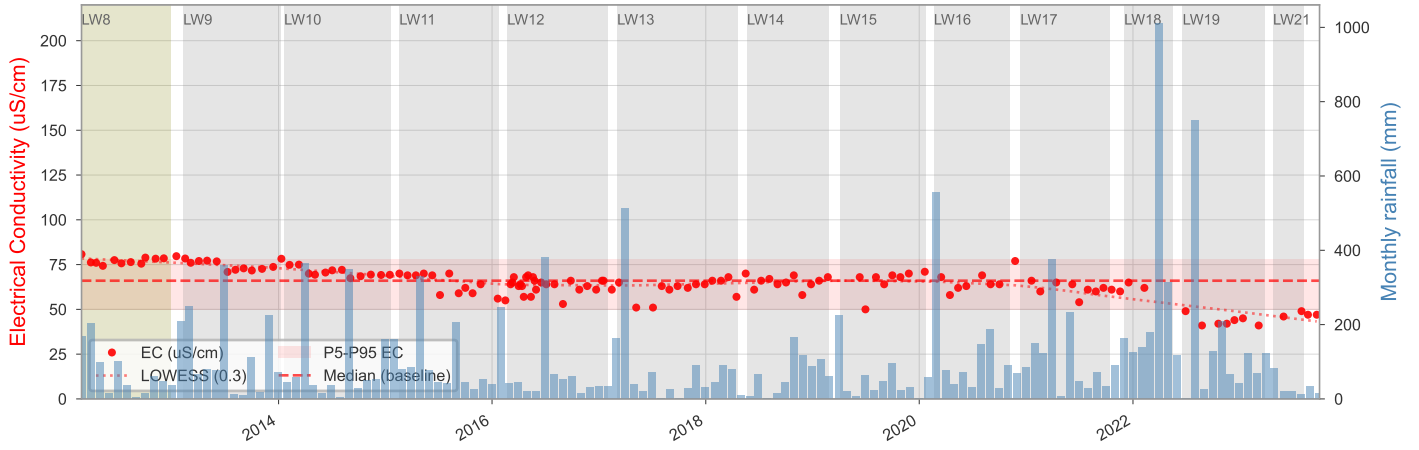
LA5_S1



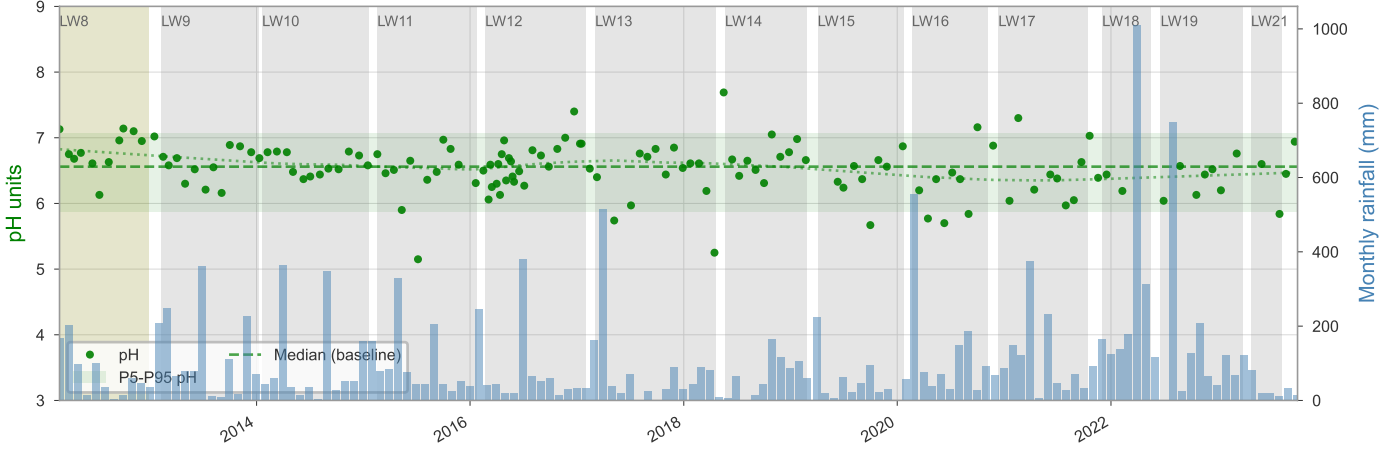
LA5_S2



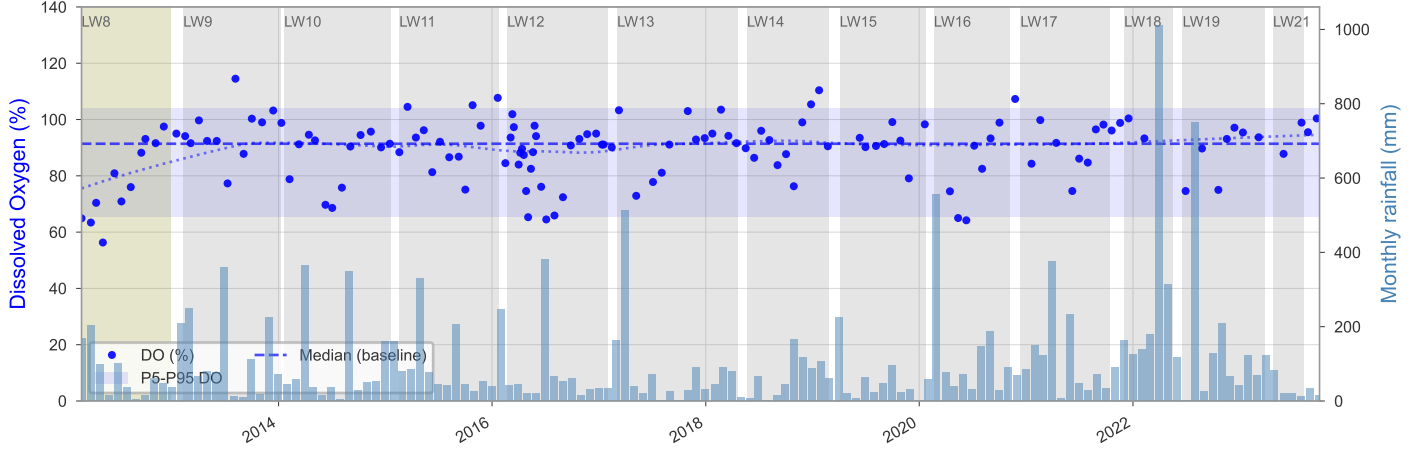
LA5_S2



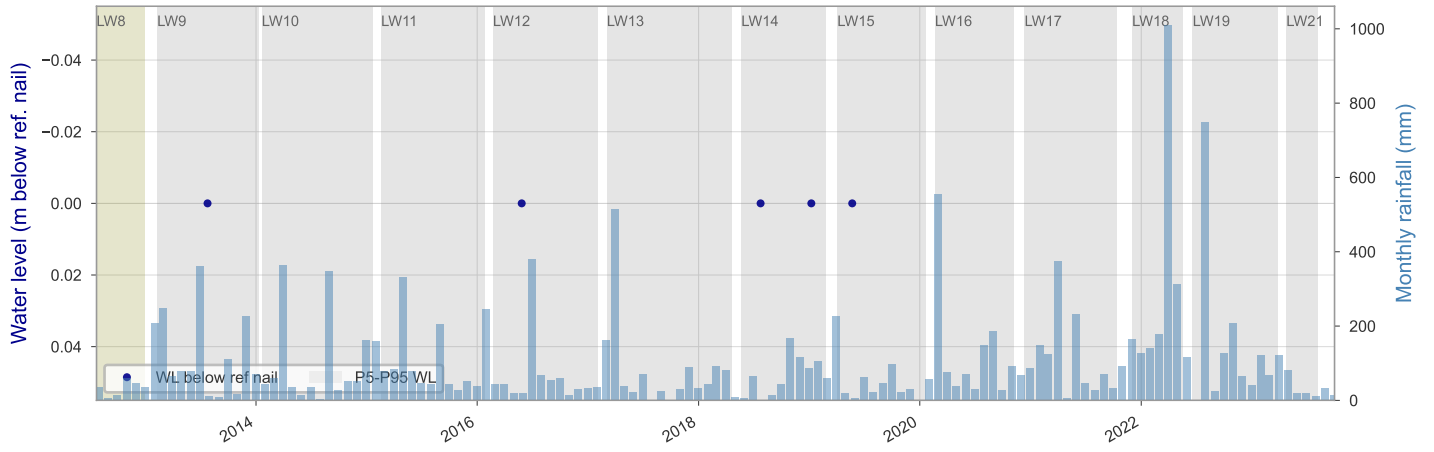
LA5_S2



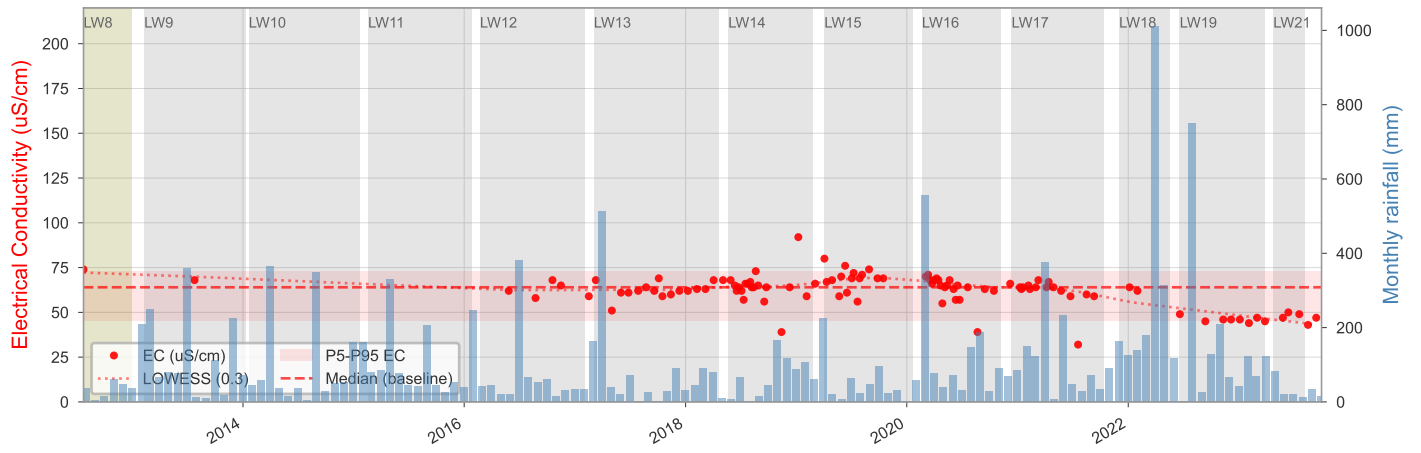
LA5_S2



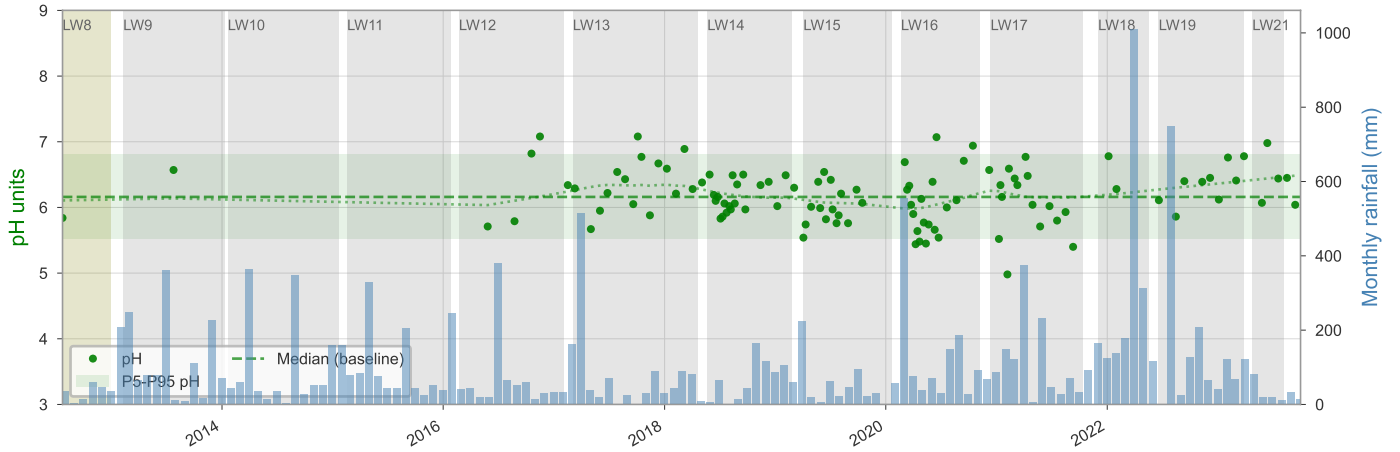
LA_1



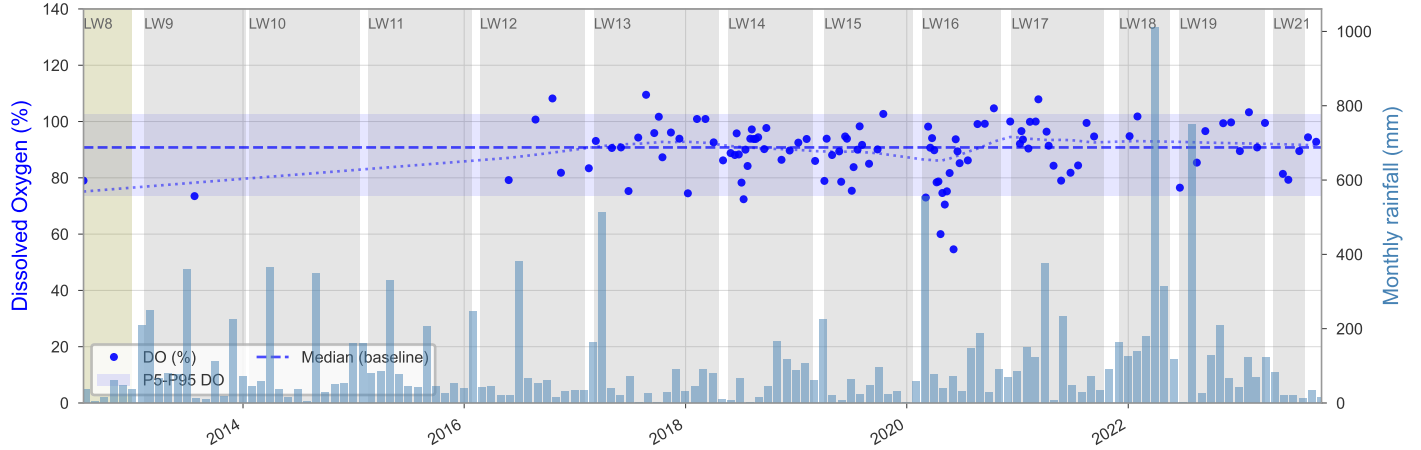
LA_1



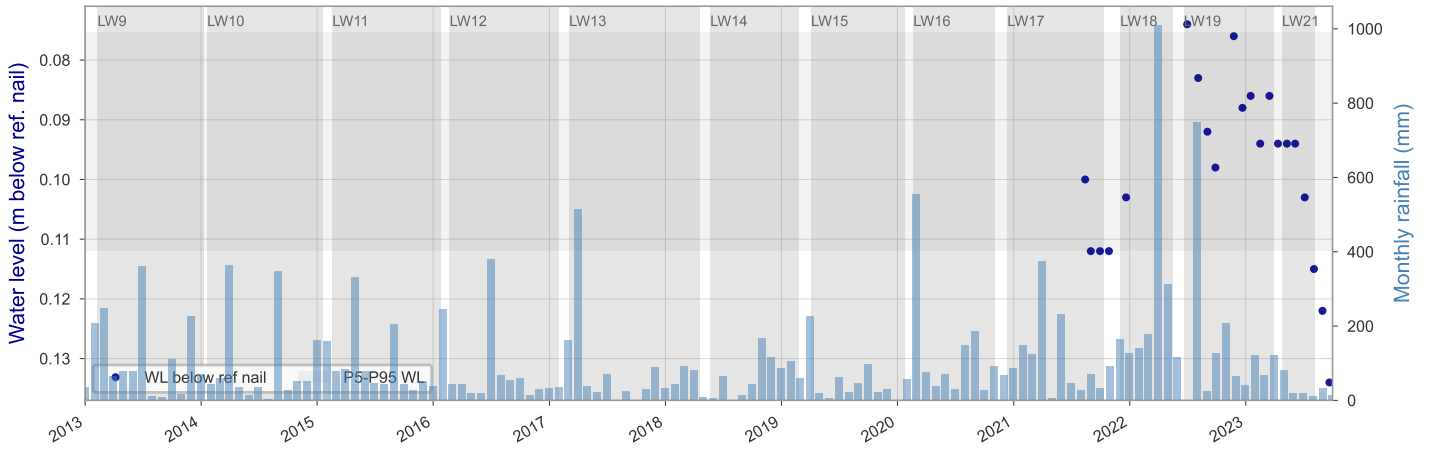
LA_1



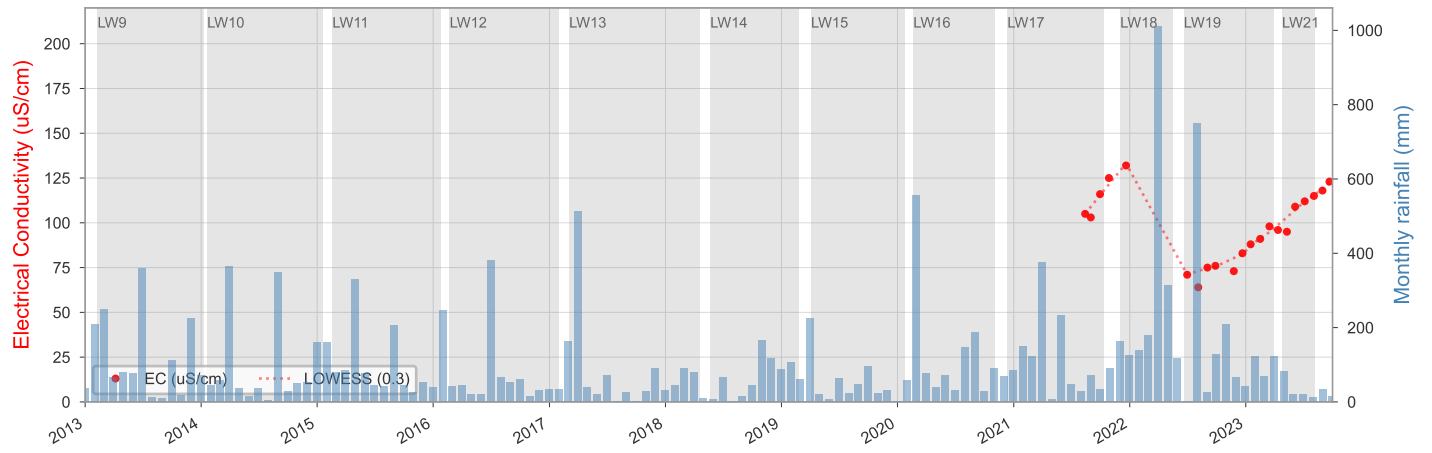
LA_1



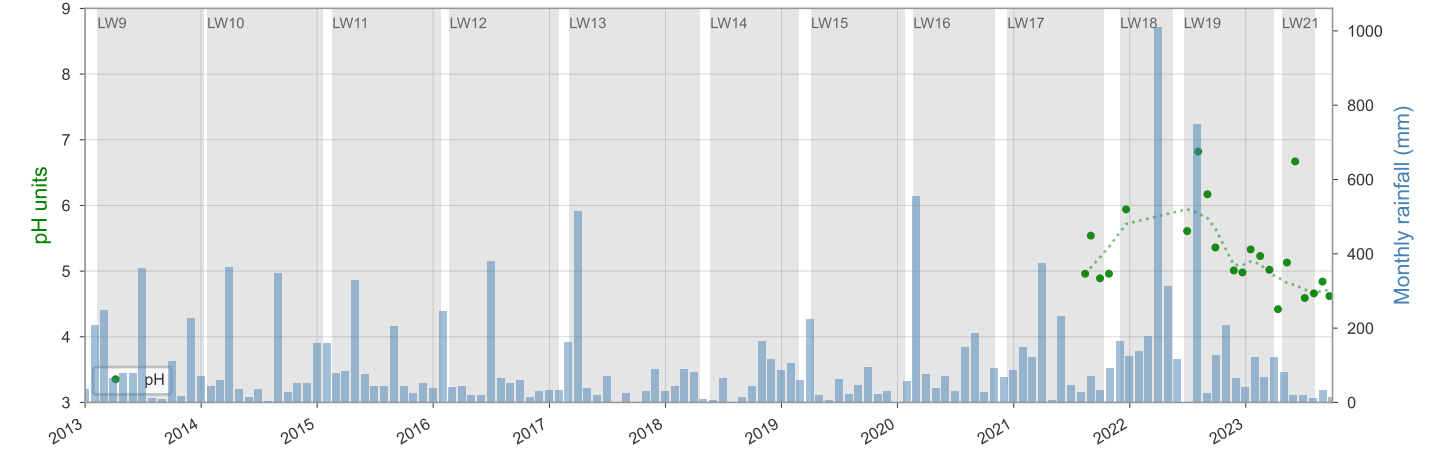
LC5A_POOL6



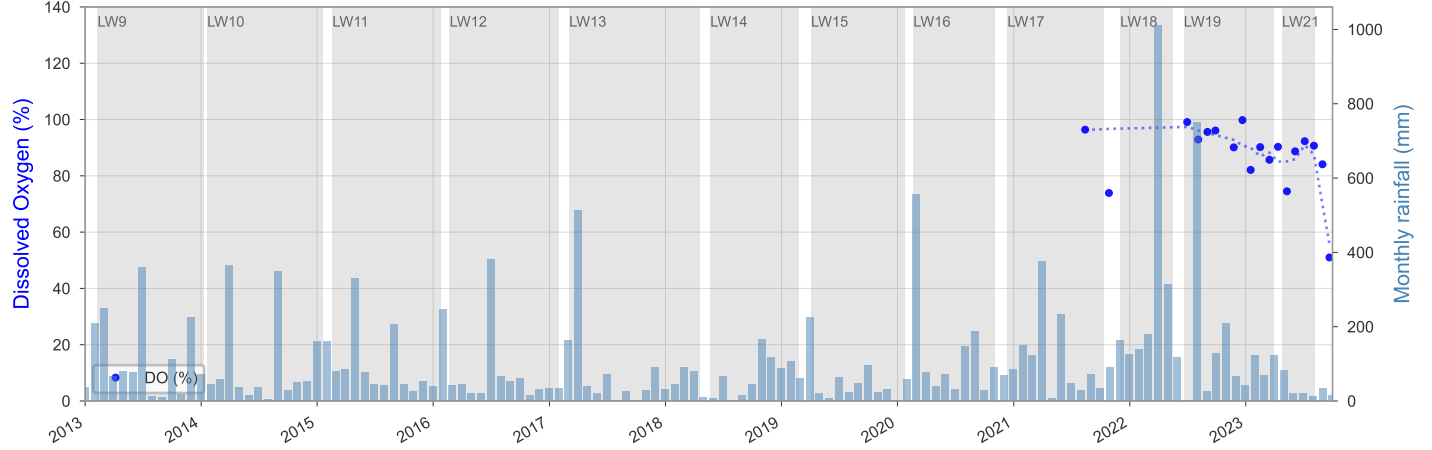
LC5A_POOL6



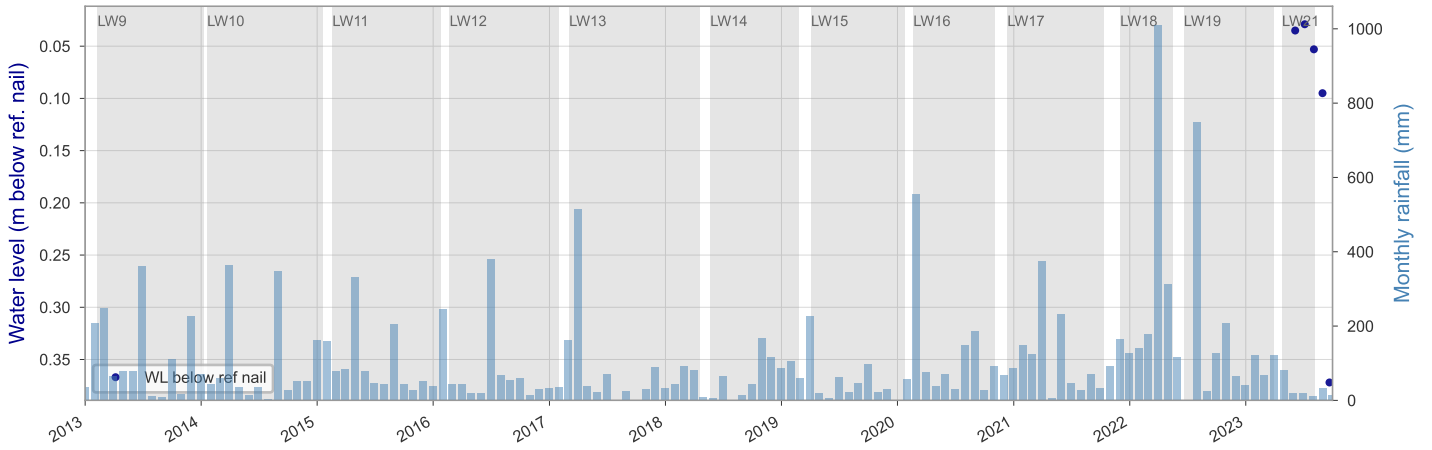
LC5A_POOL6



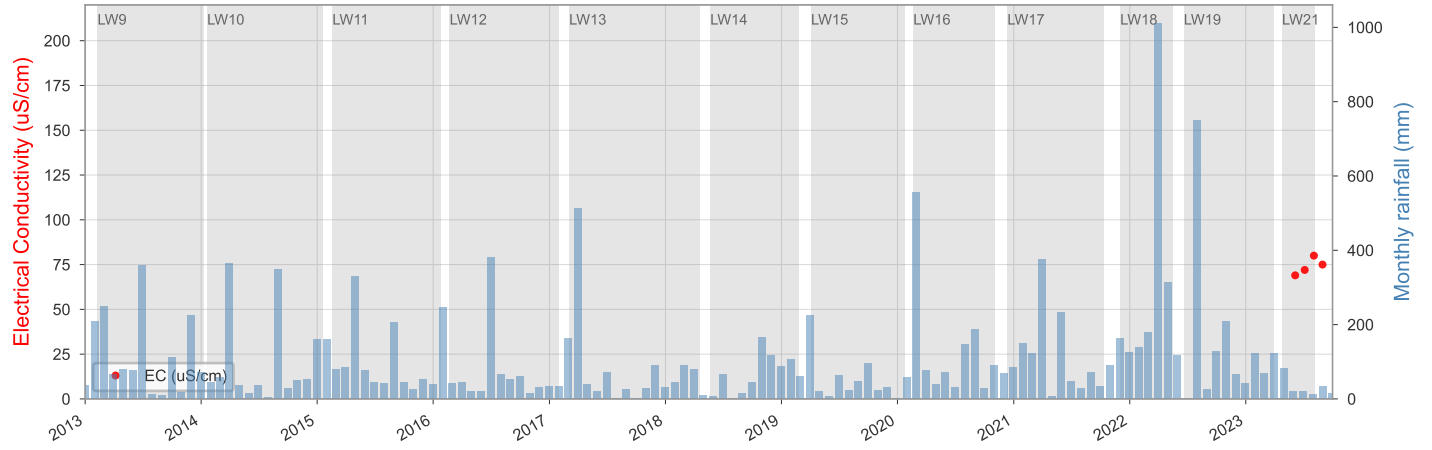
LC5A_POOL6



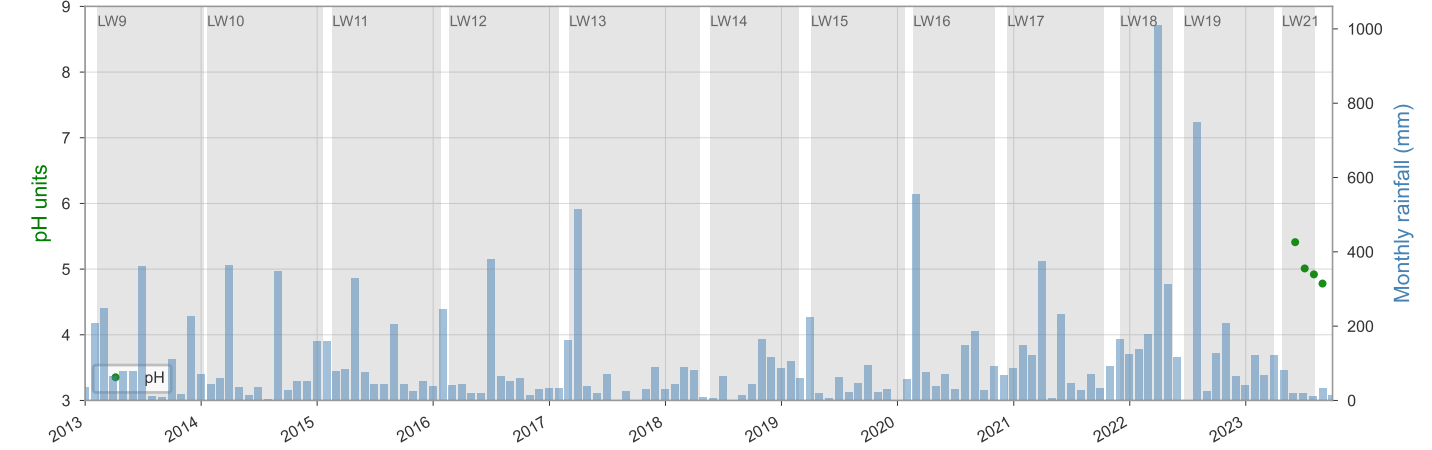
LC5B_POOL3



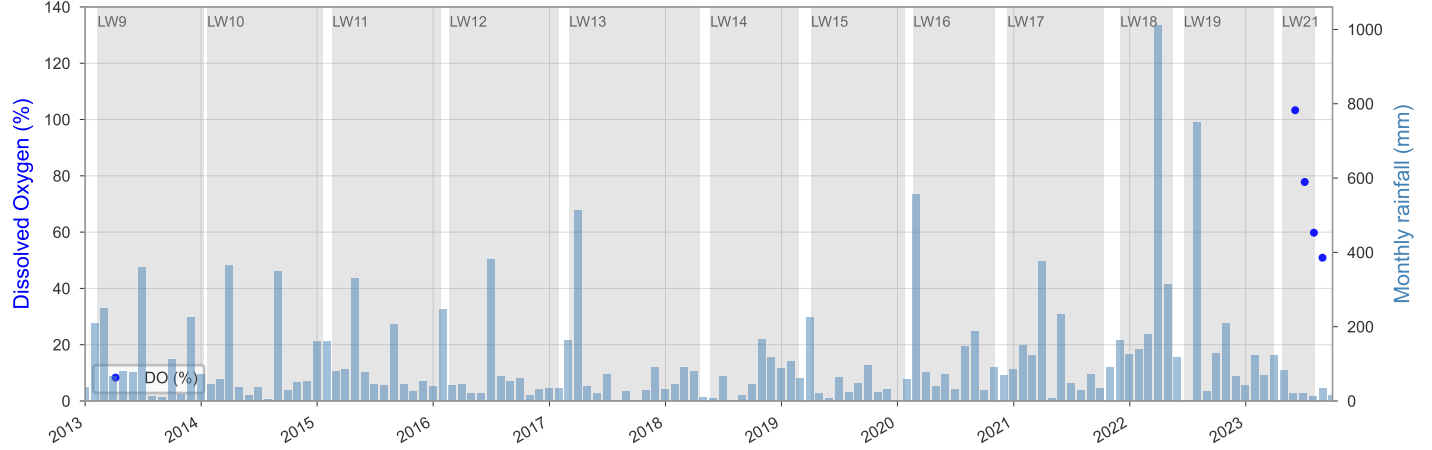
LC5B_POOL3



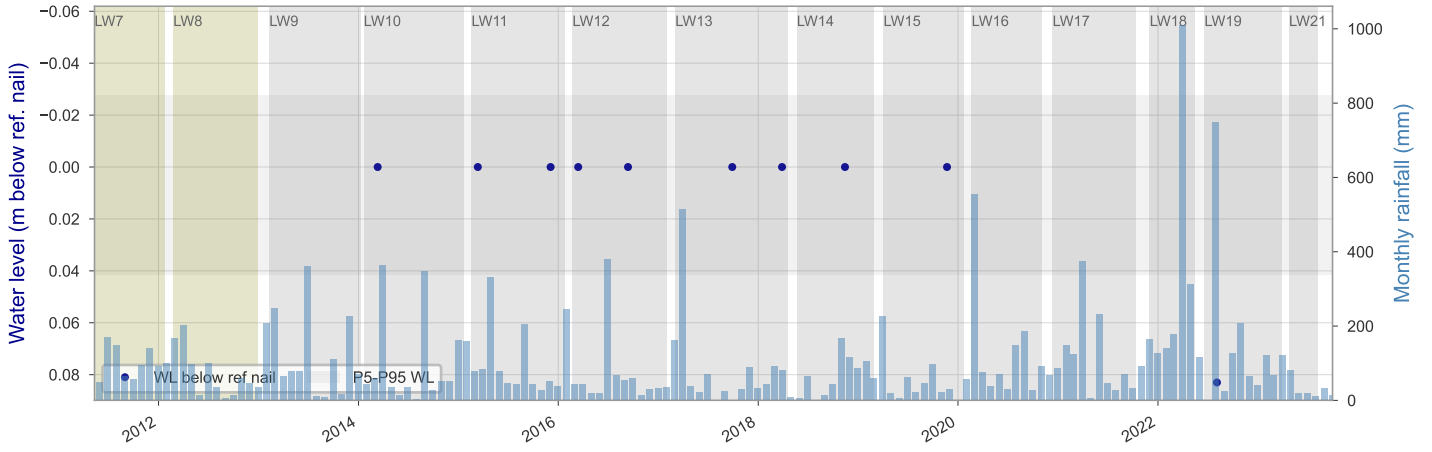
LC5B_POOL3



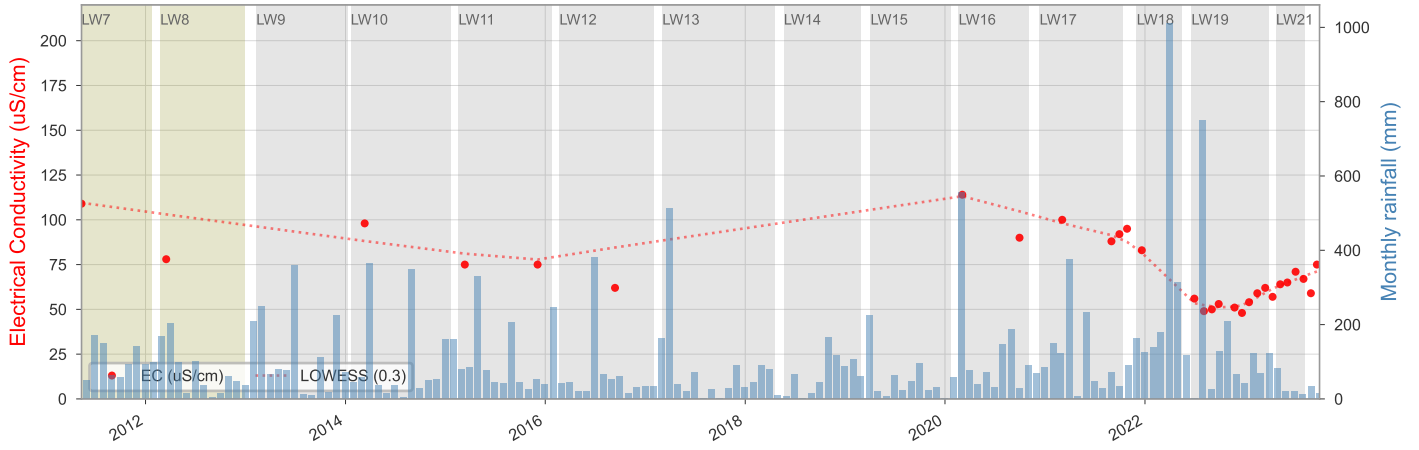
LC5B_POOL3



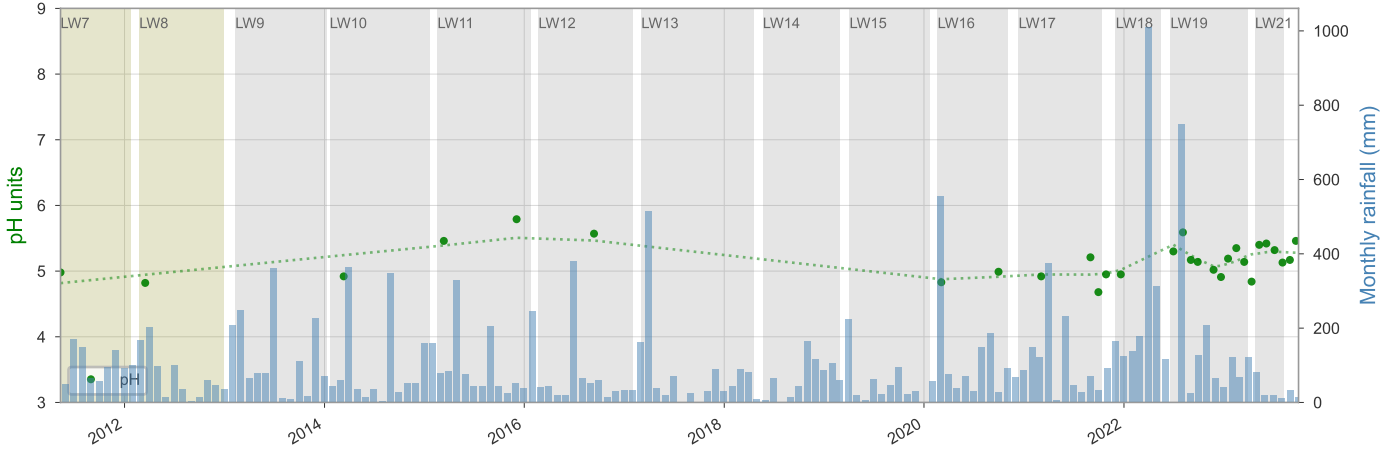
LC5_POOL12



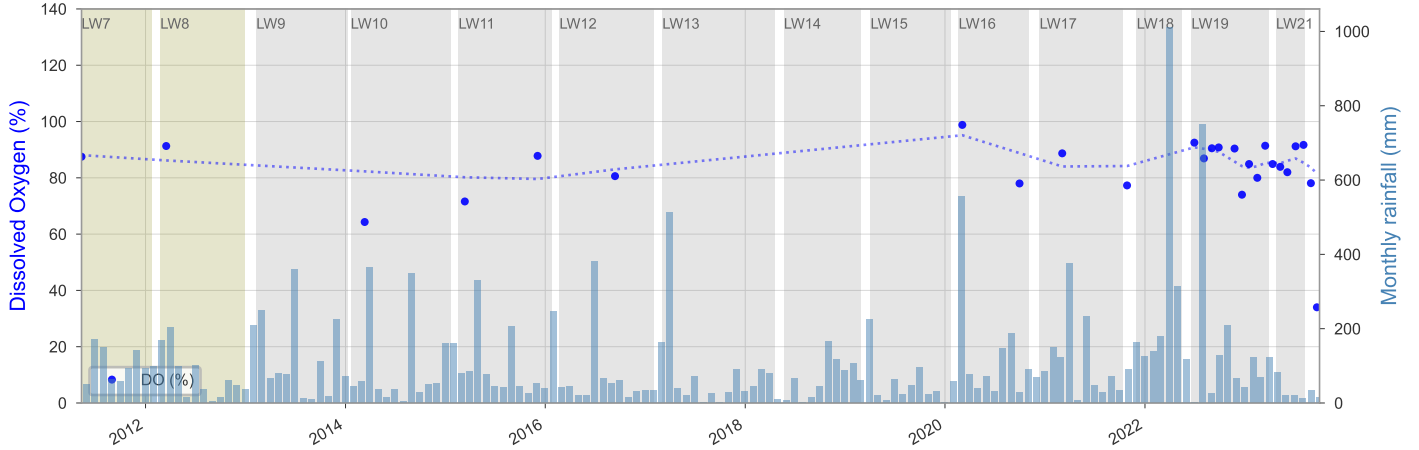
LC5_POOL12



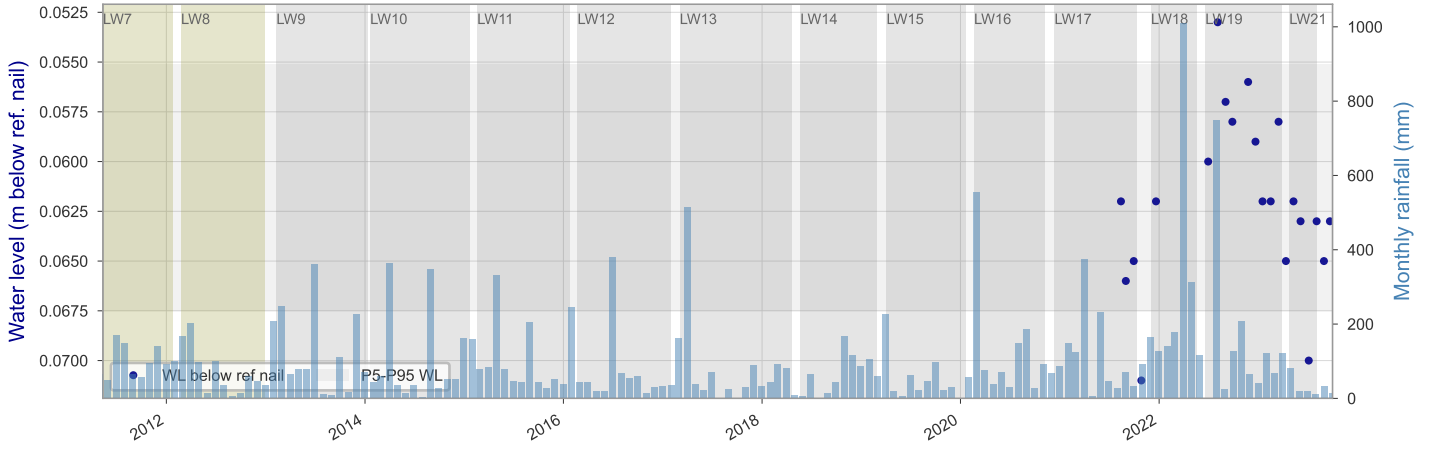
LC5_POOL12



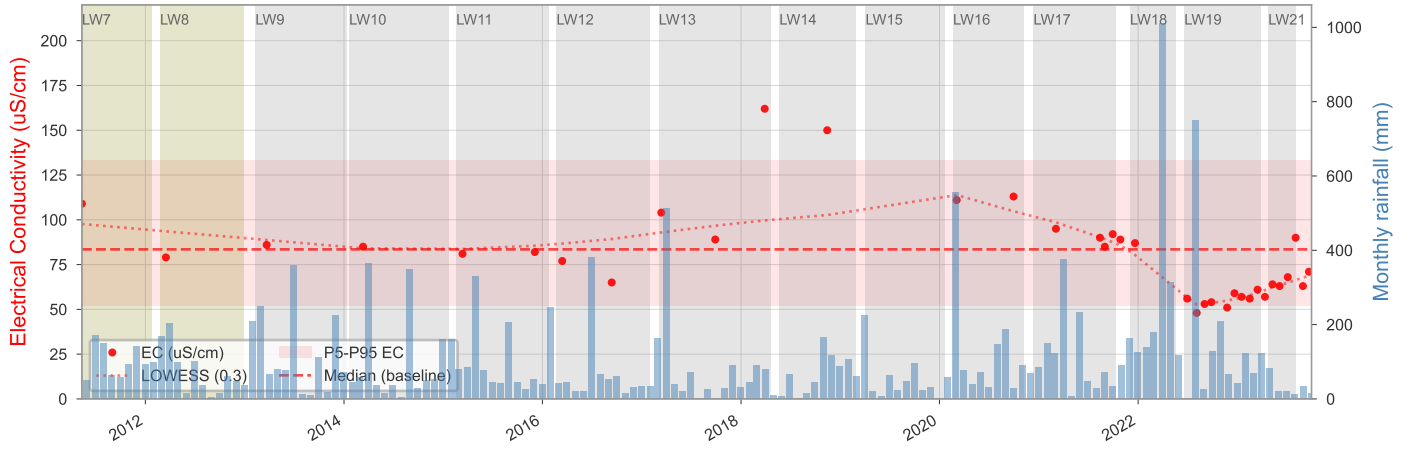
LC5_POOL12



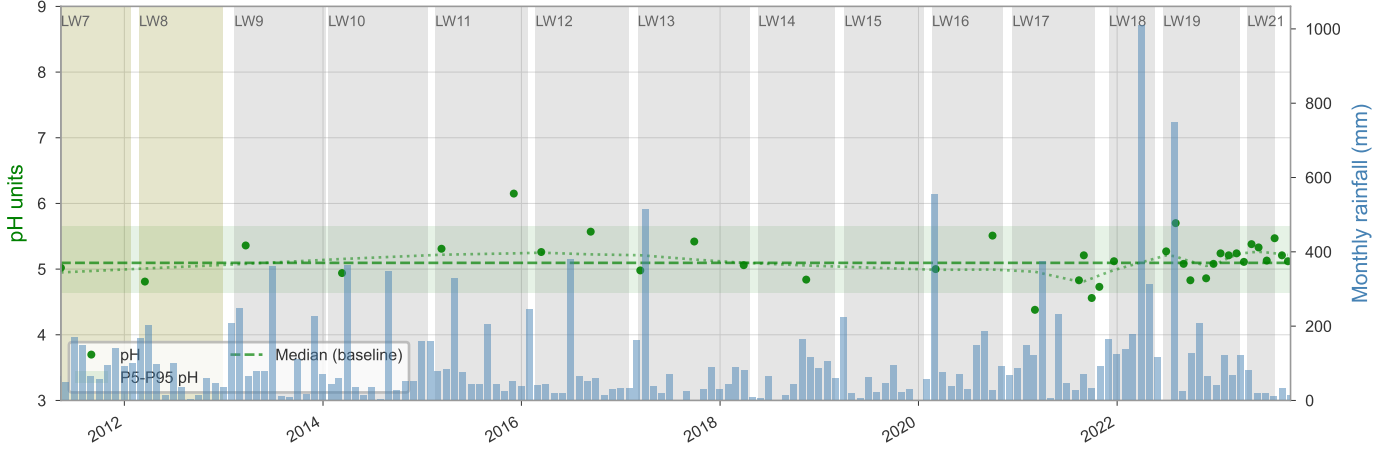
LC5_POOL13



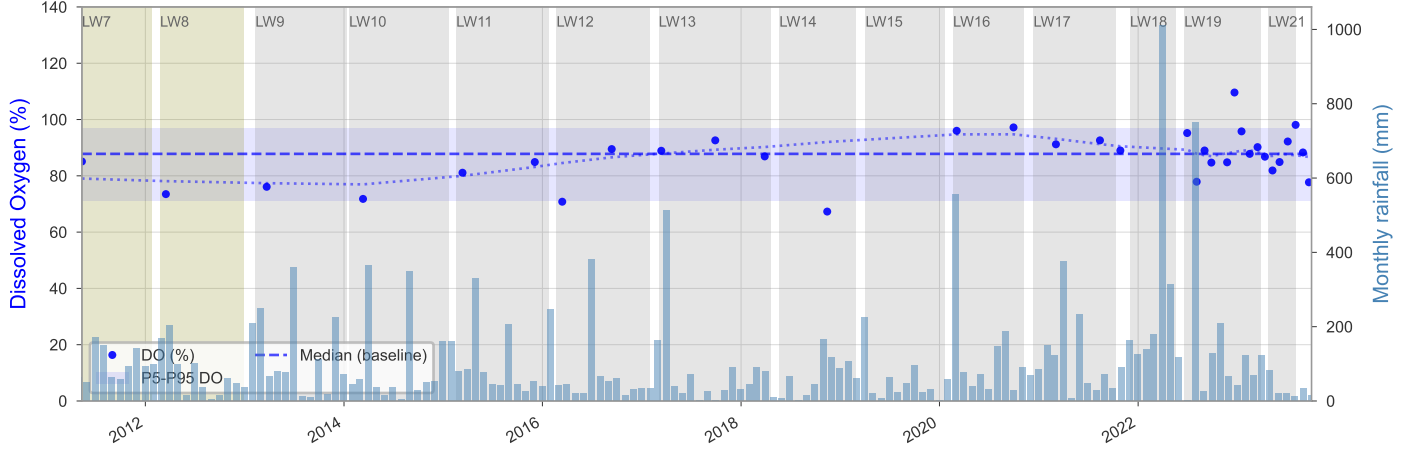
LC5_POOL13



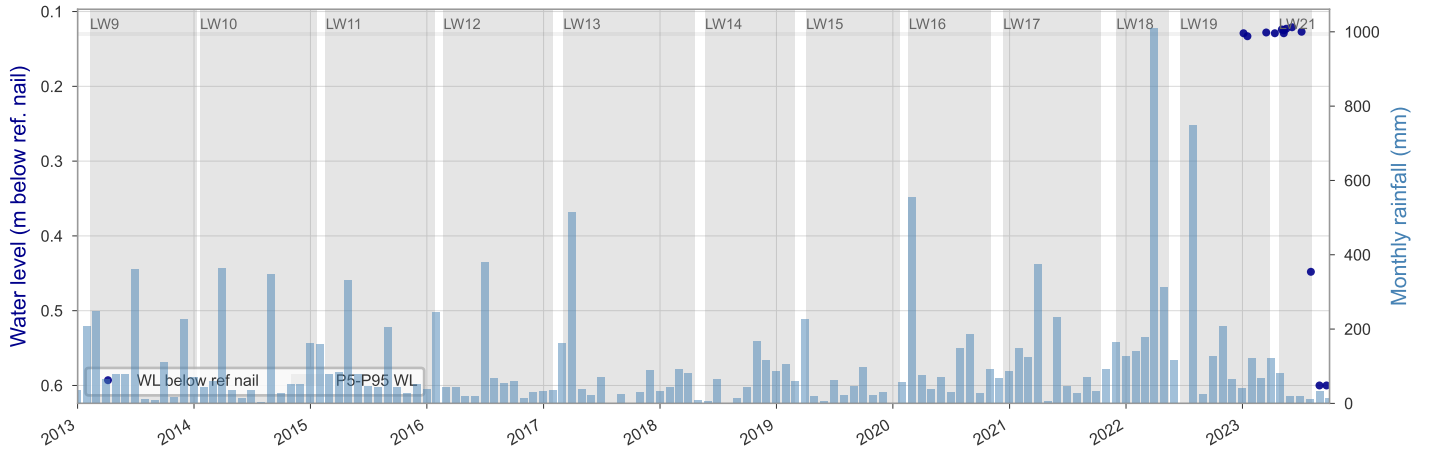
LC5_POOL13



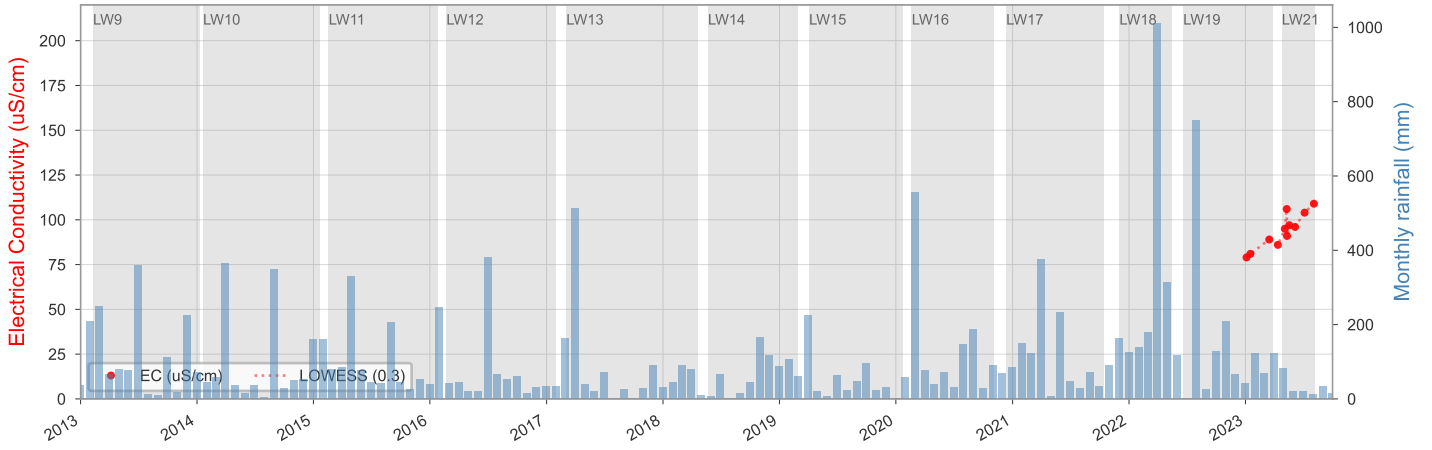
LC5_POOL13



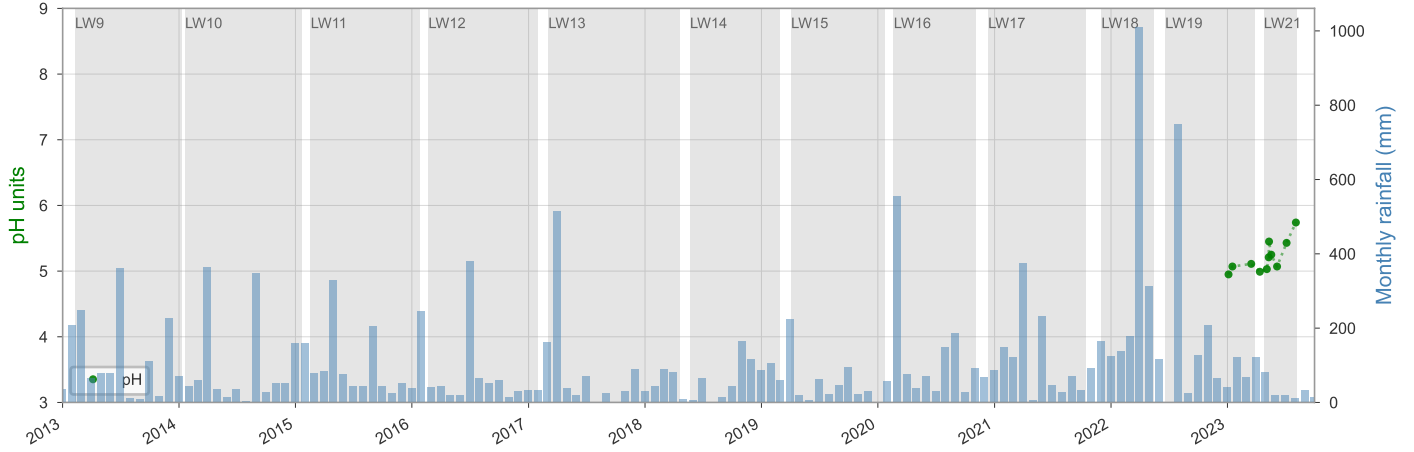
LC5_POOL26



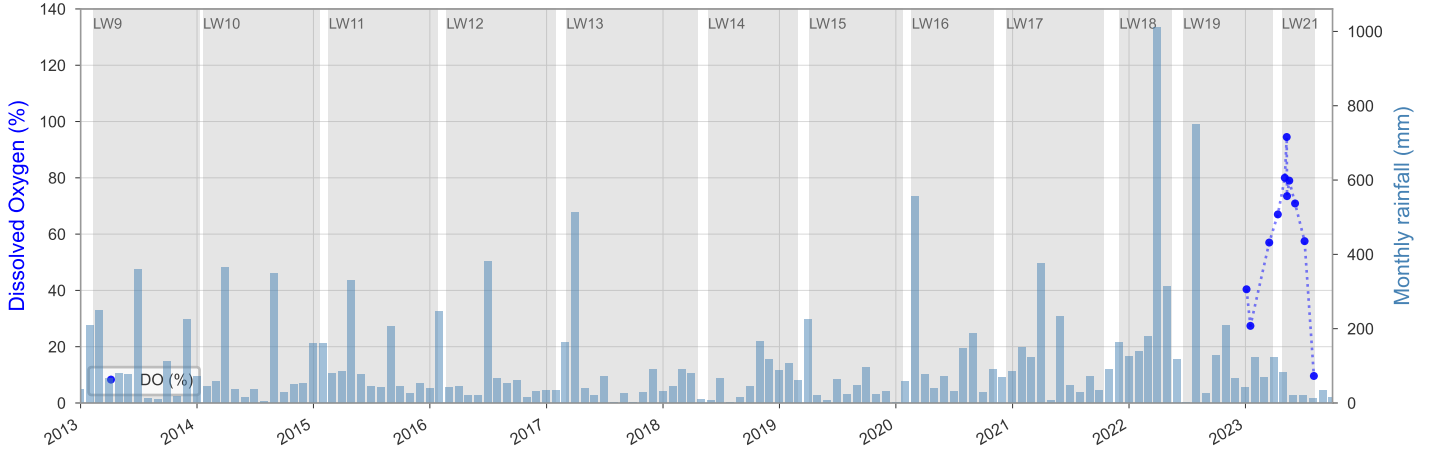
LC5_POOL26



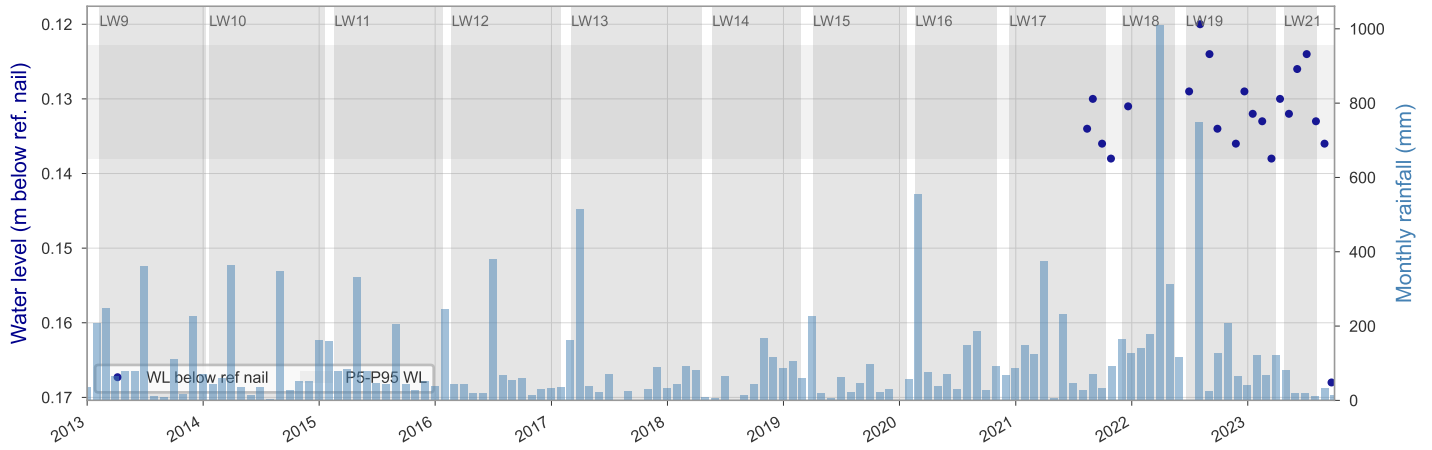
LC5_POOL26



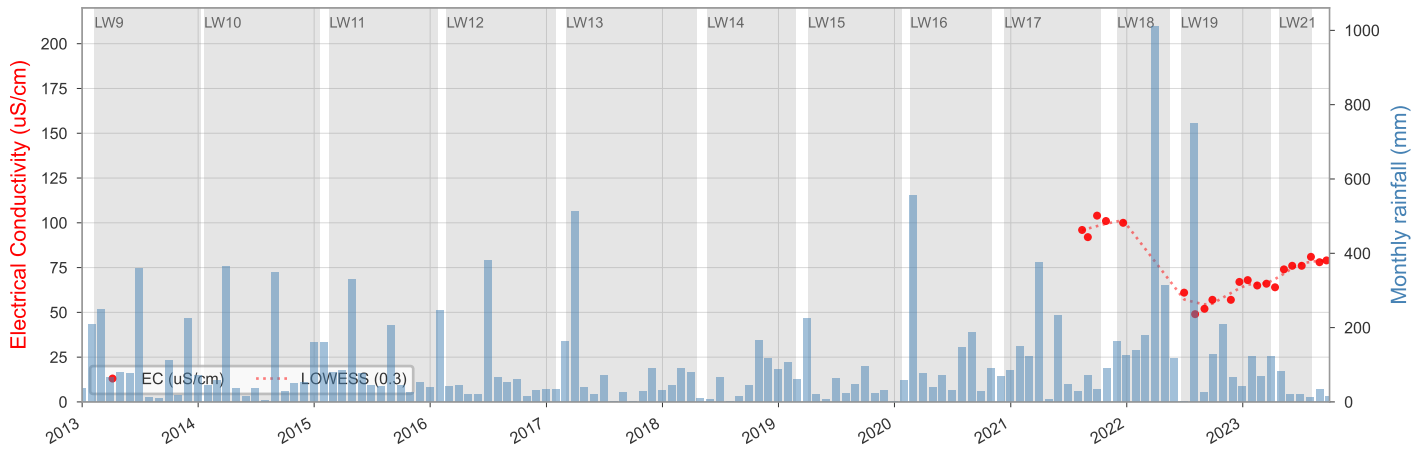
LC5_POOL26



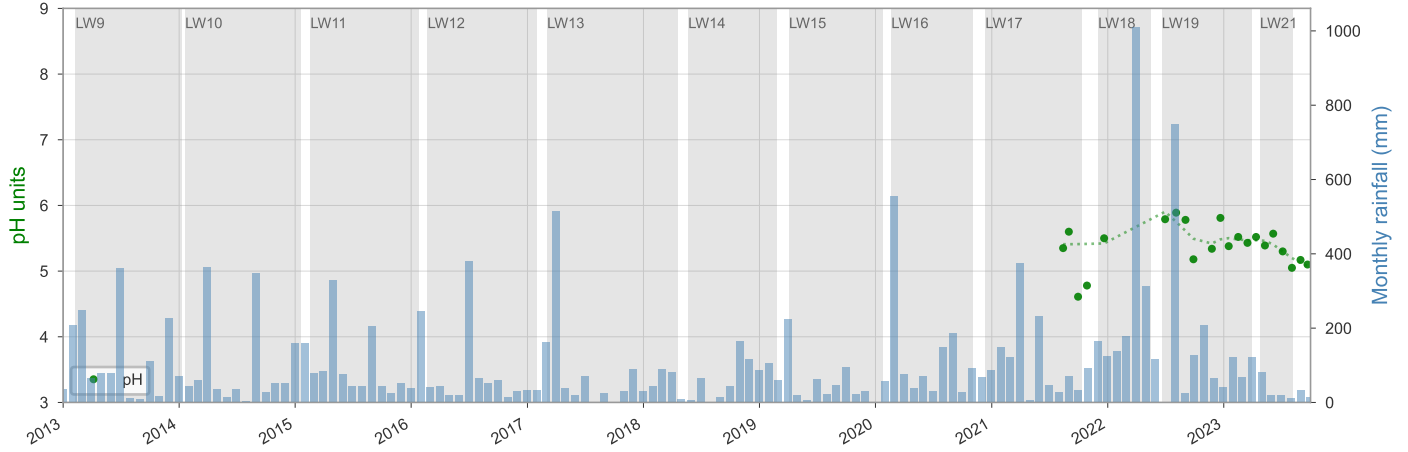
LC5_ROCKBAR11



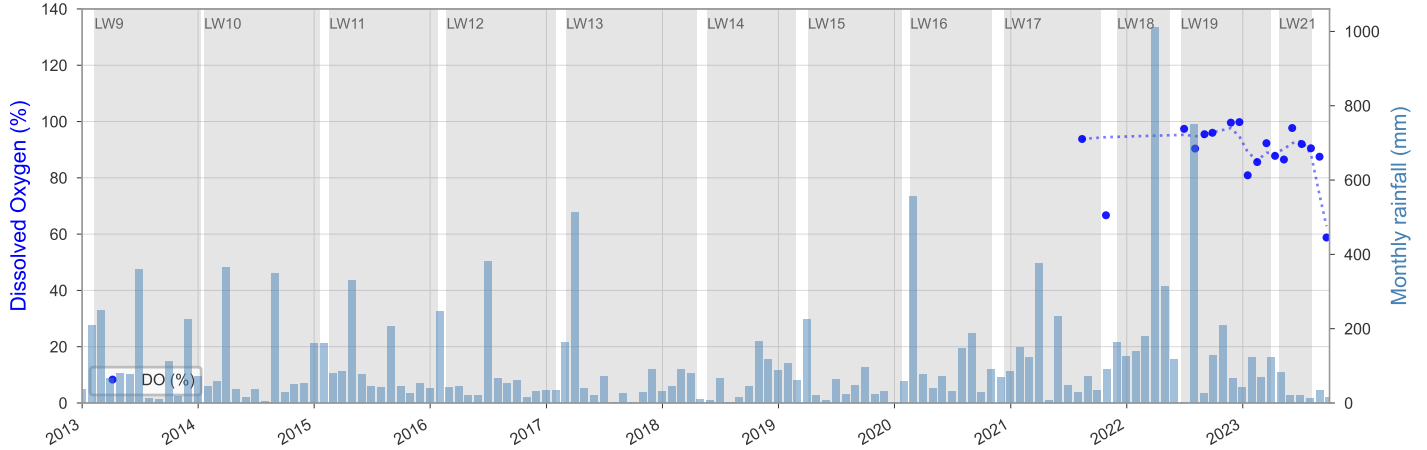
LC5_ROCKBAR11



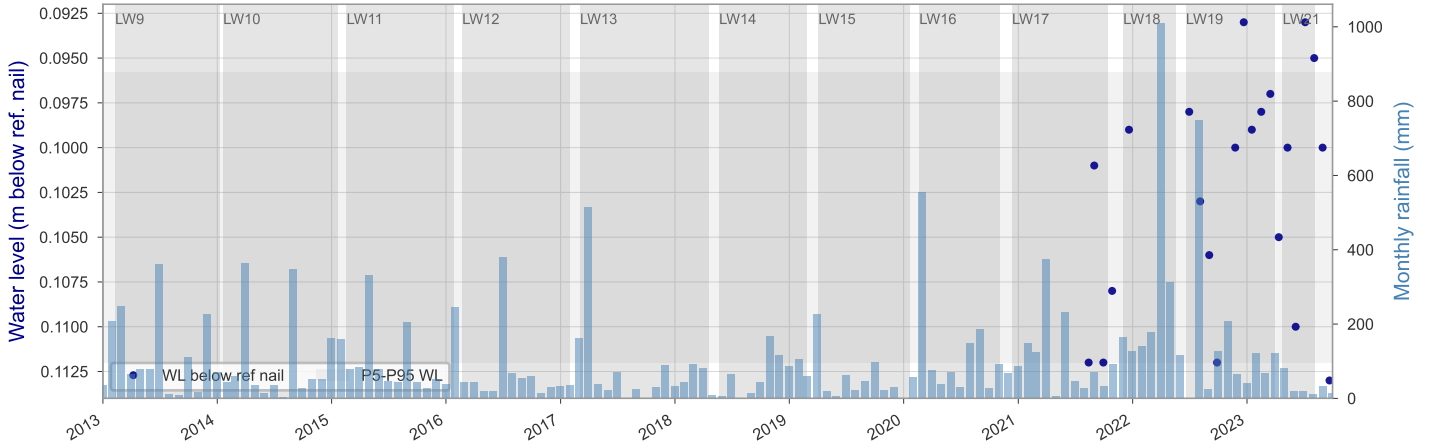
LC5_ROCKBAR11



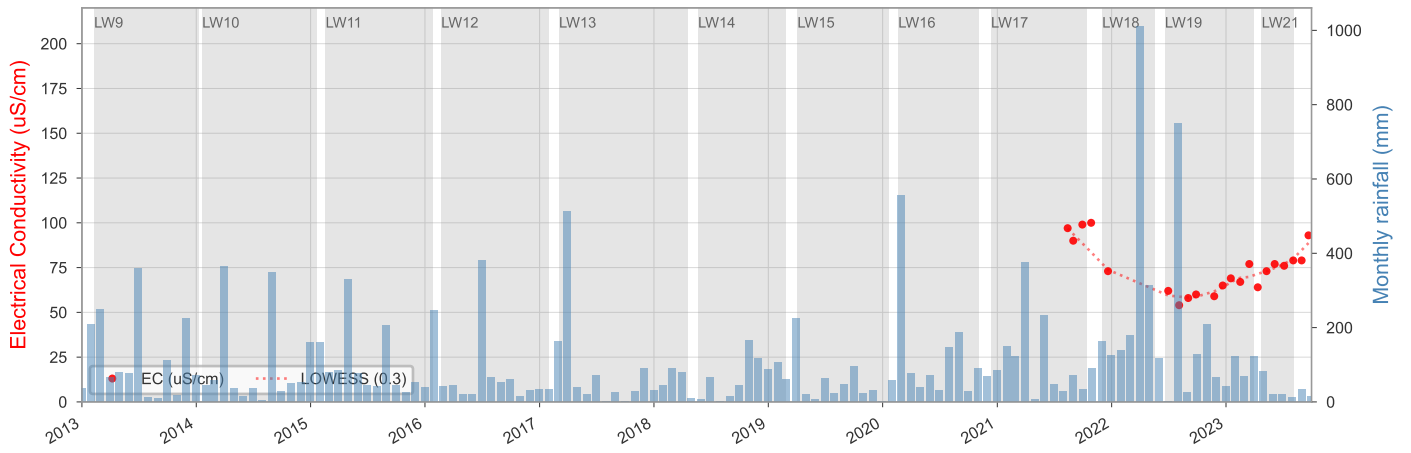
LC5_ROCKBAR11



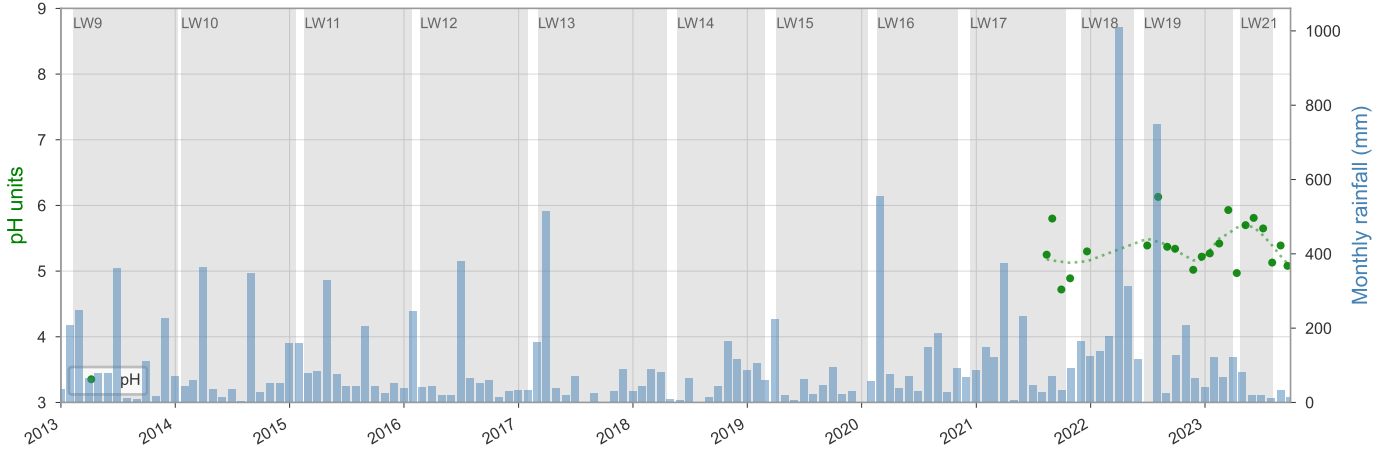
LC5_ROCKBAR7



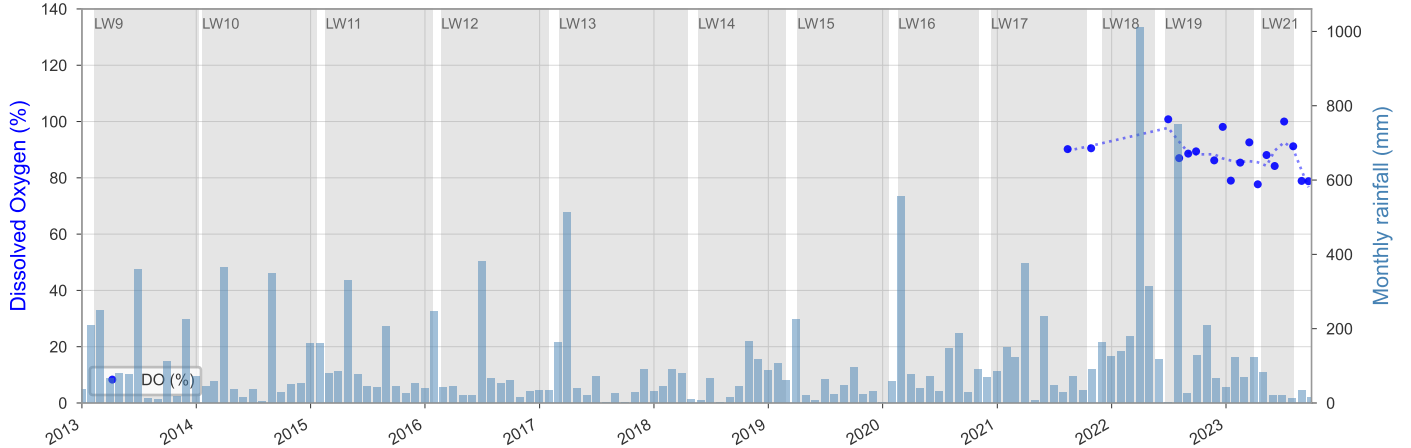
LC5_ROCKBAR7



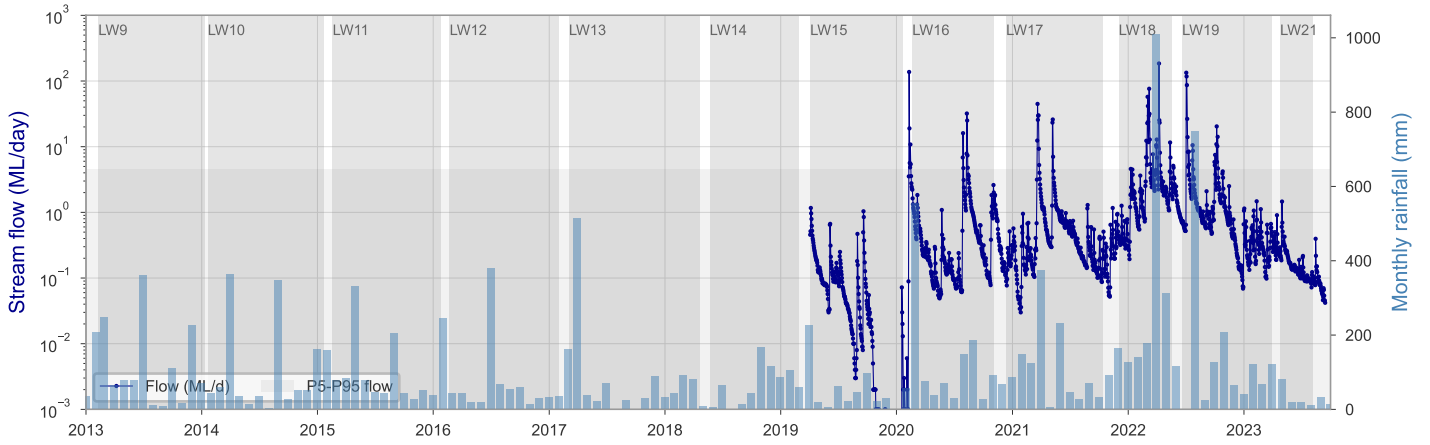
LC5_ROCKBAR7



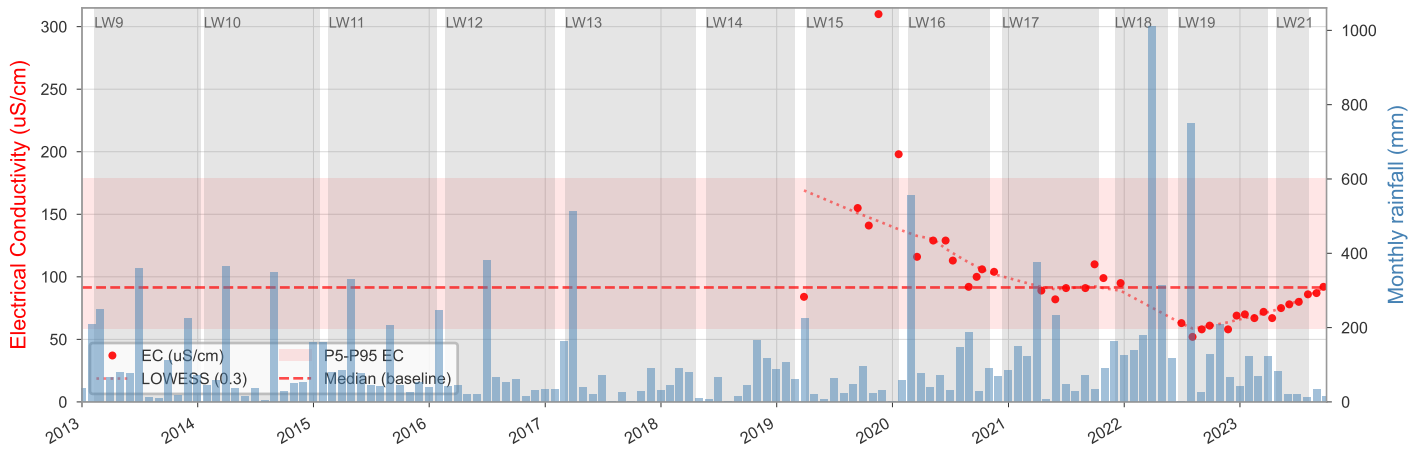
LC5_ROCKBAR7



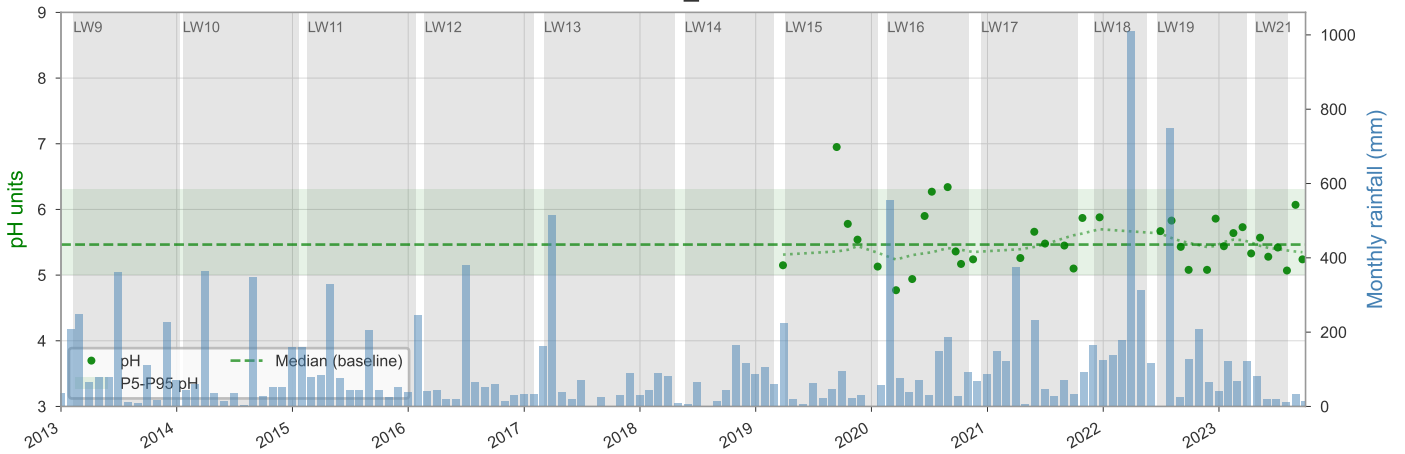
LC5S1



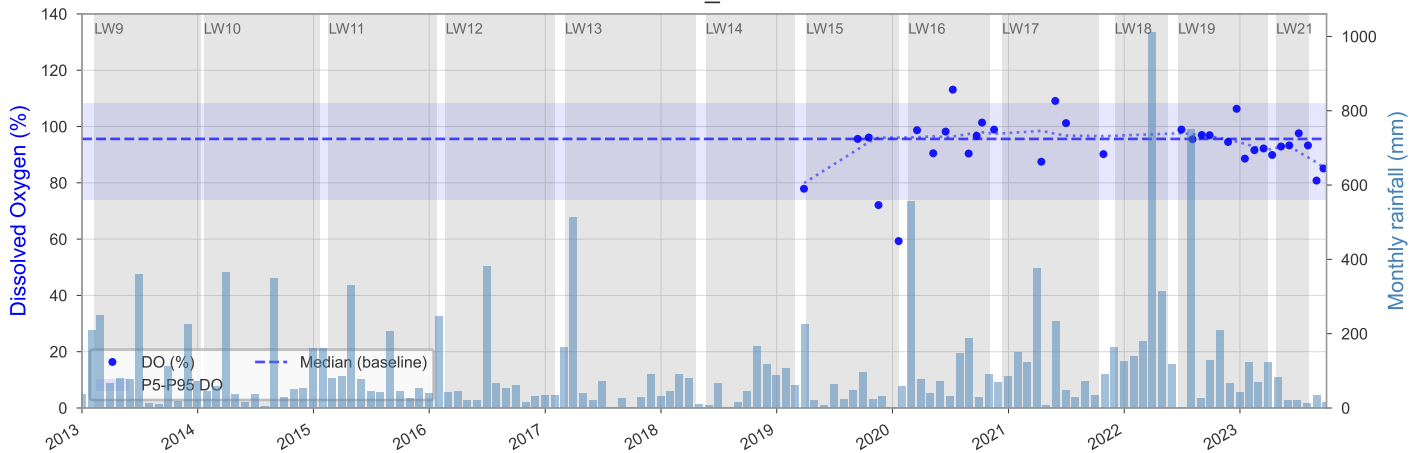
LC5_S1



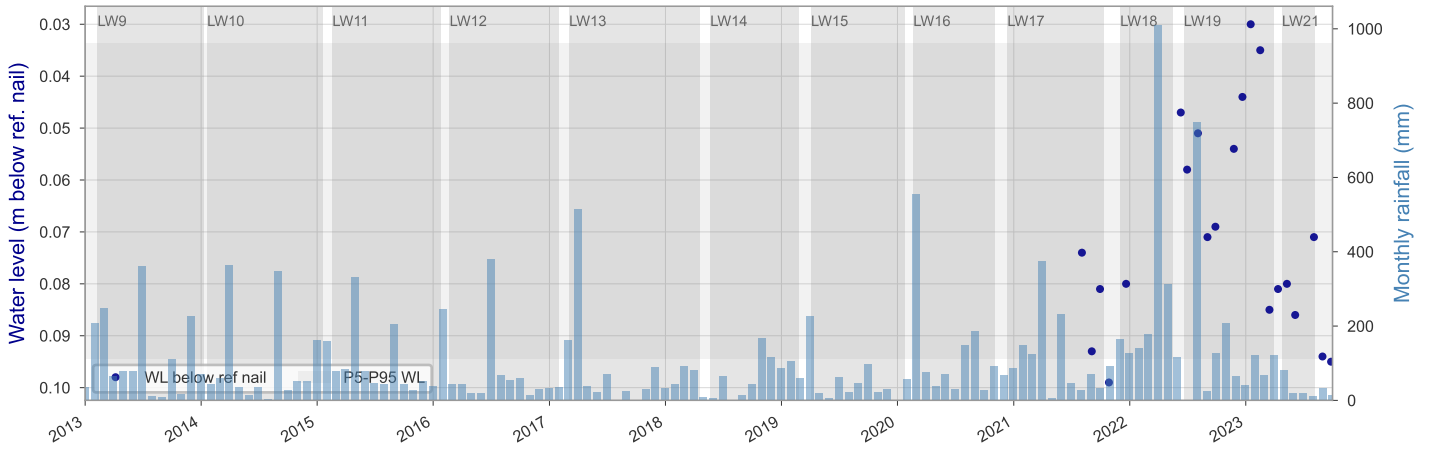
LC5_S1



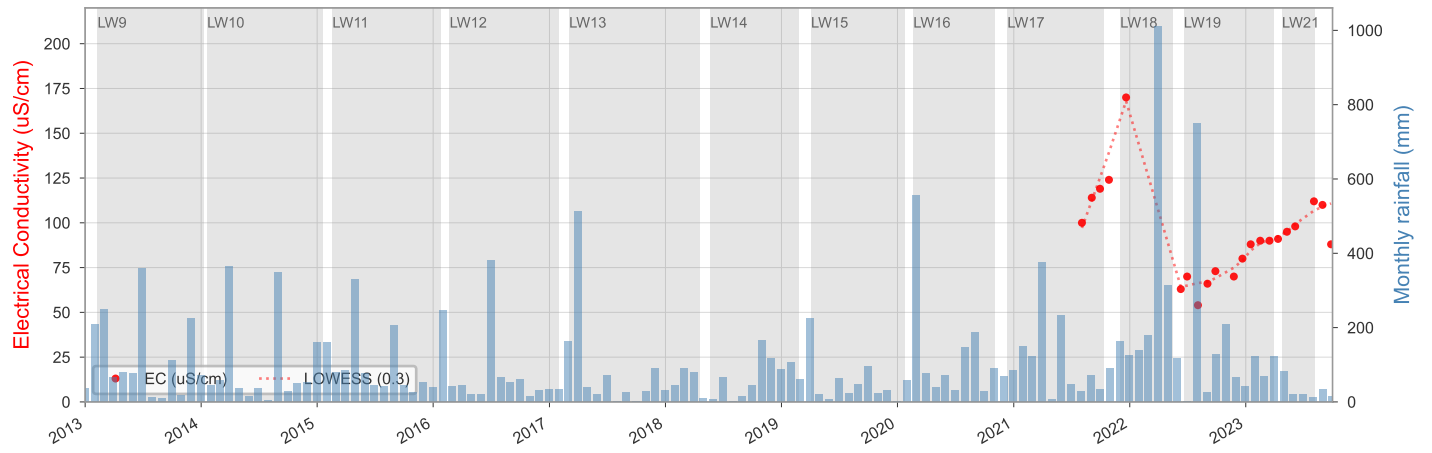
LC5_S1



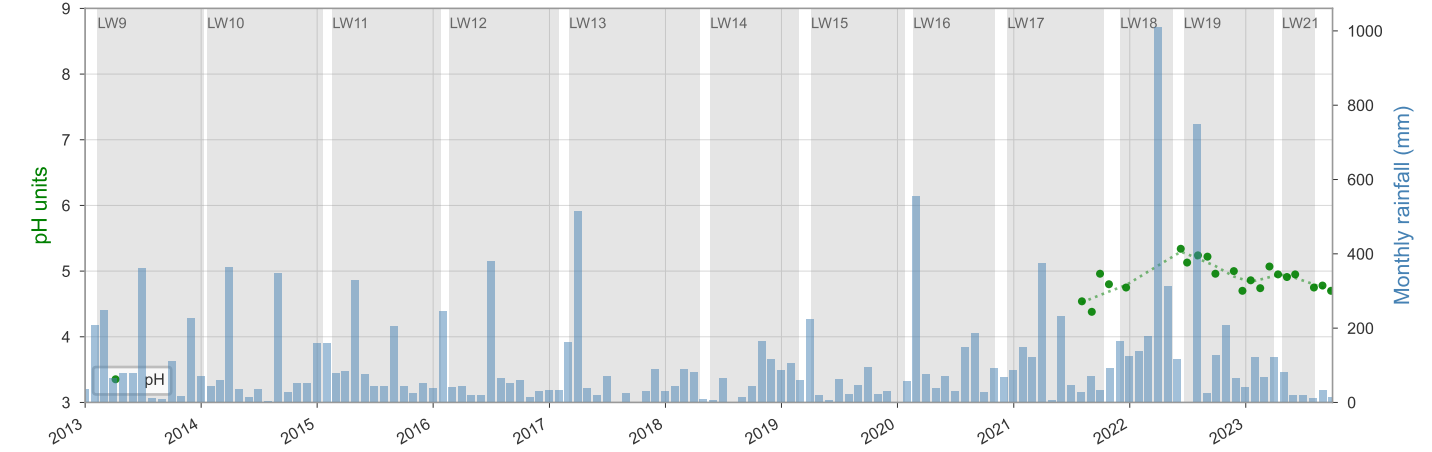
LC6_POOL16



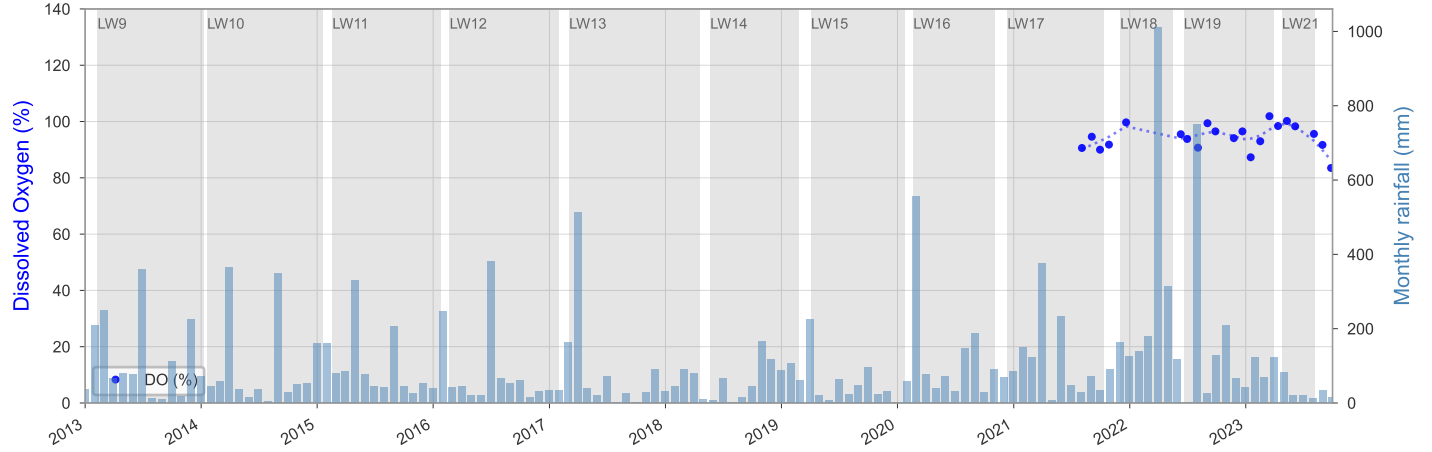
LC6_POOL16



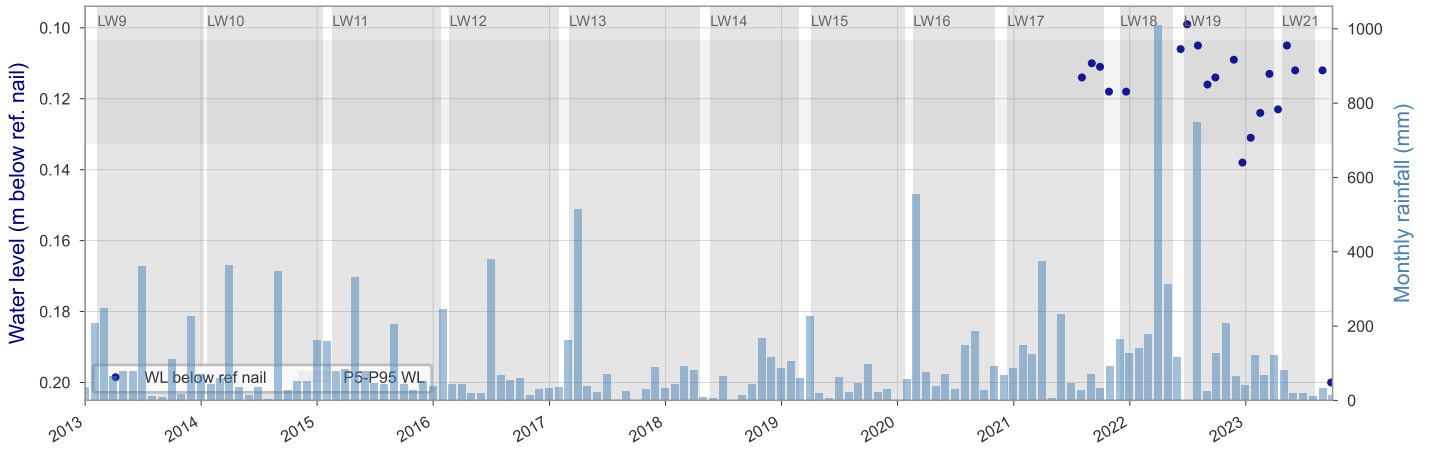
LC6_POOL16



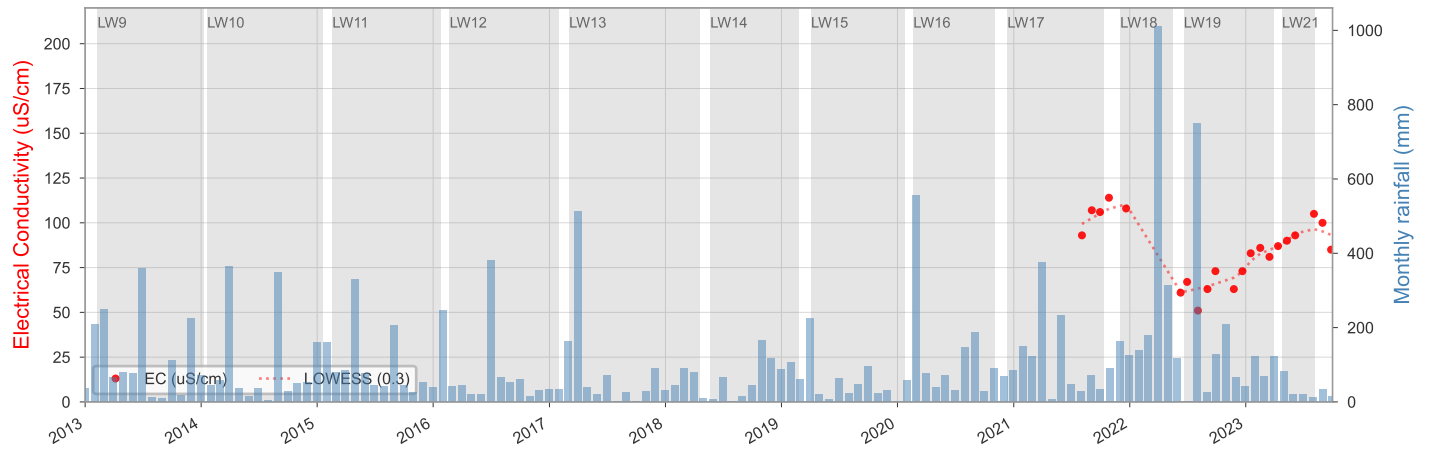
LC6_POOL16



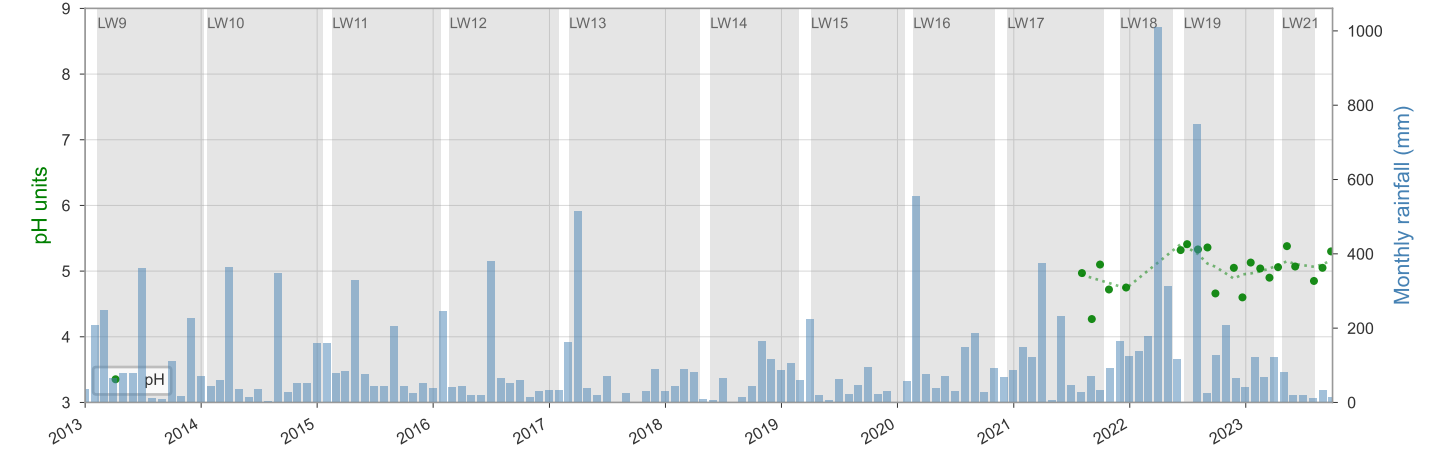
LC6_POOL36



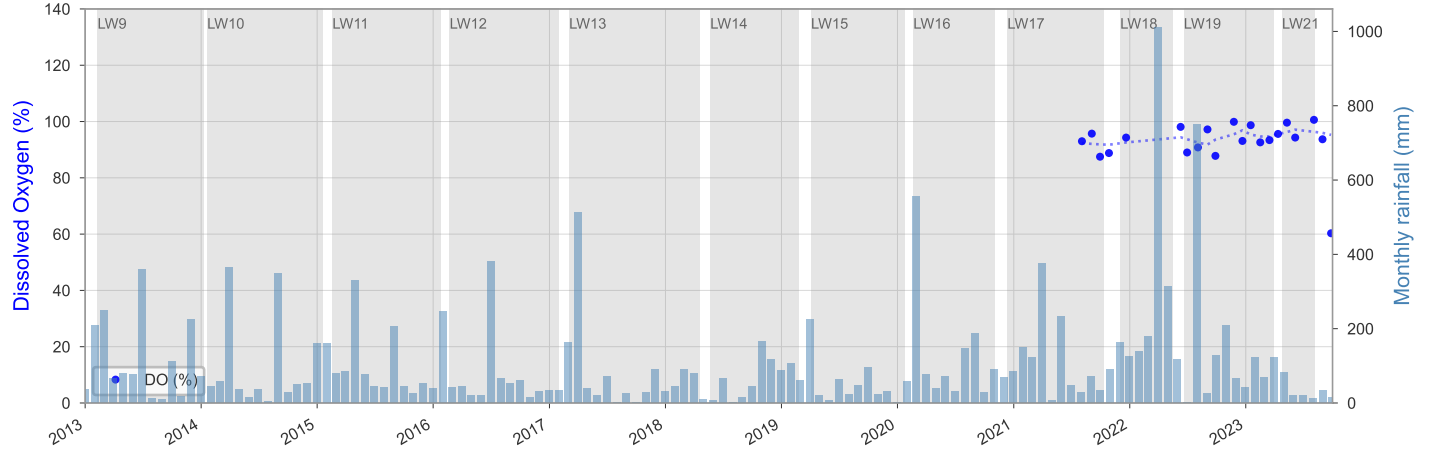
LC6_POOL36



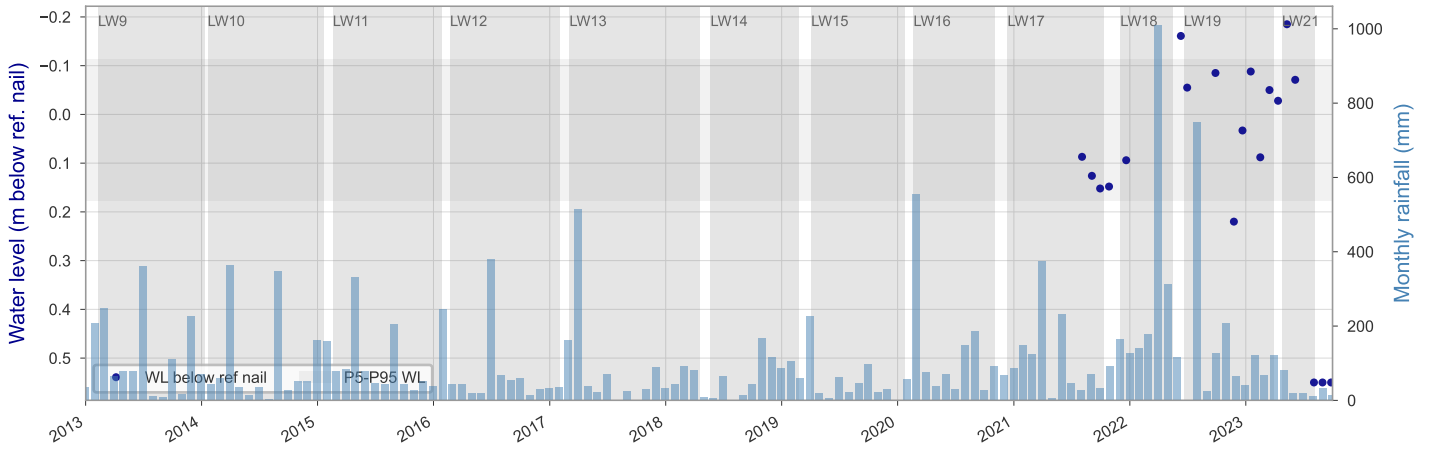
LC6_POOL36



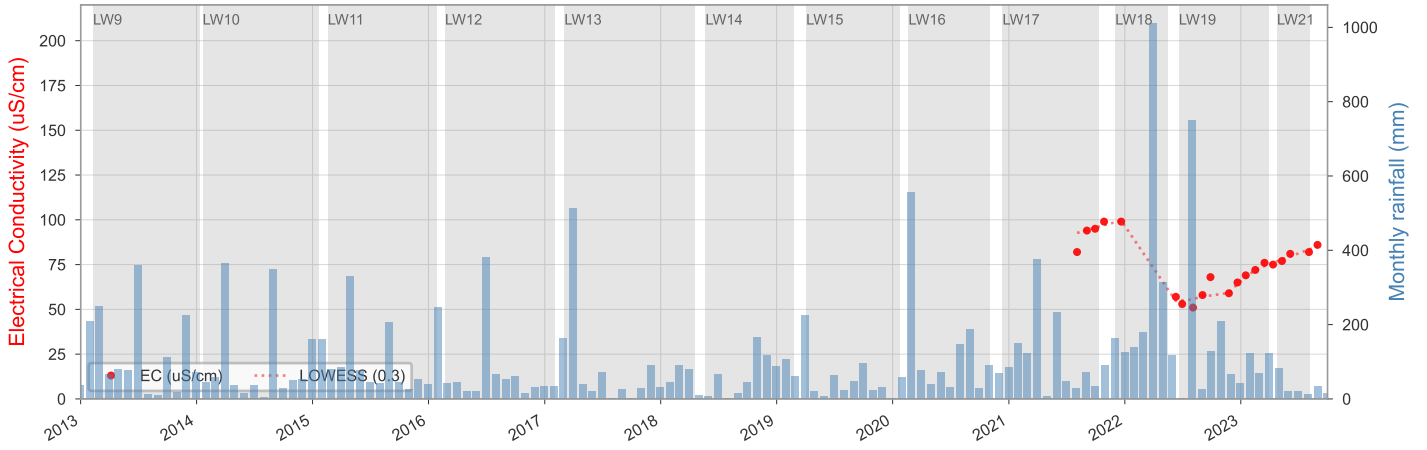
LC6_POOL36



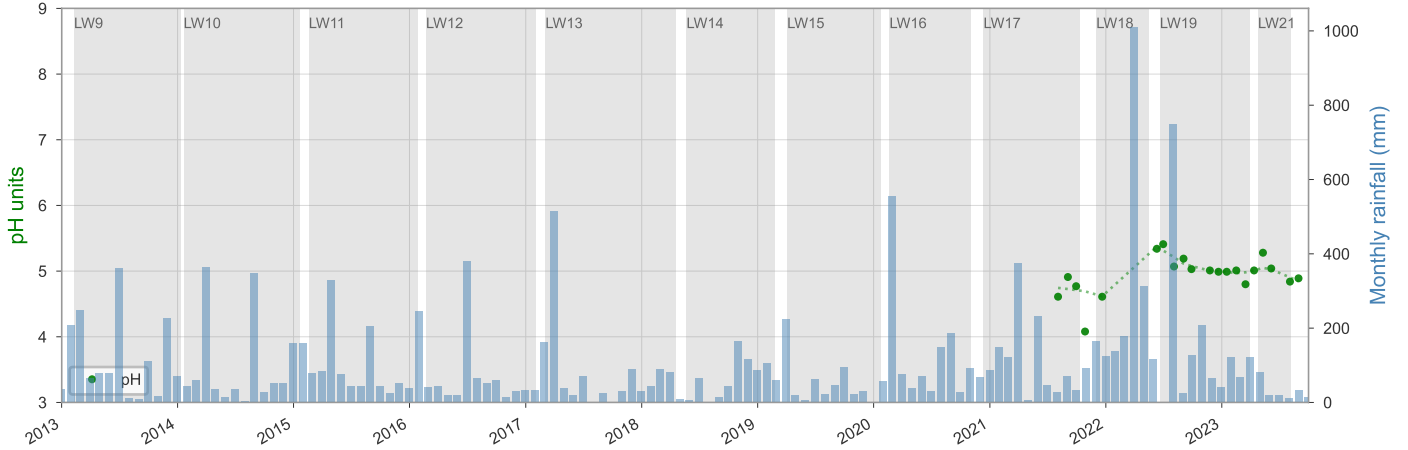
LC6_POOL51



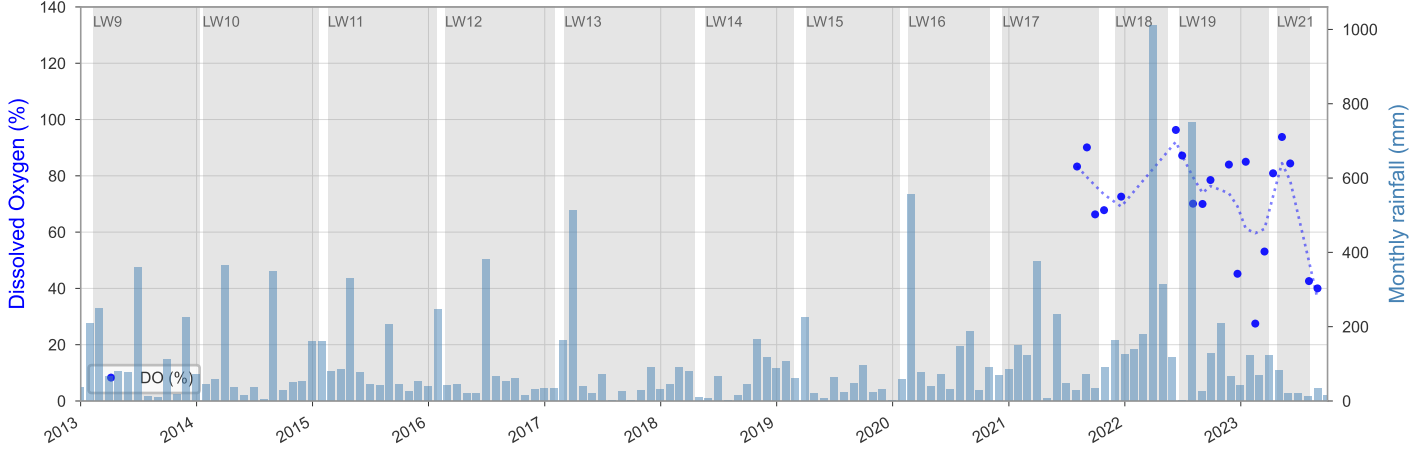
LC6_POOL51



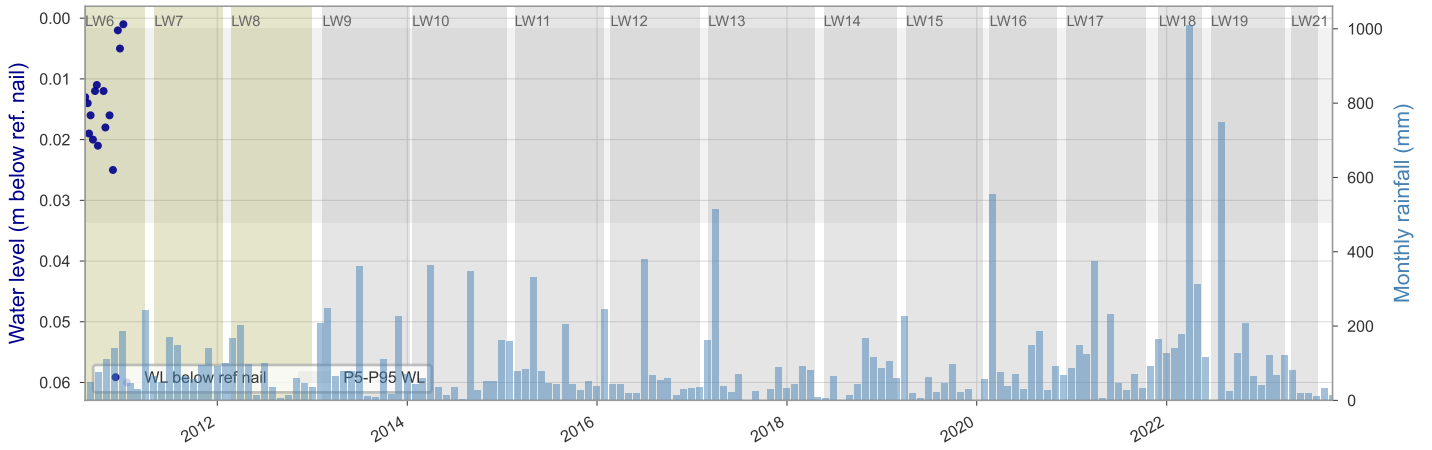
LC6_POOL51



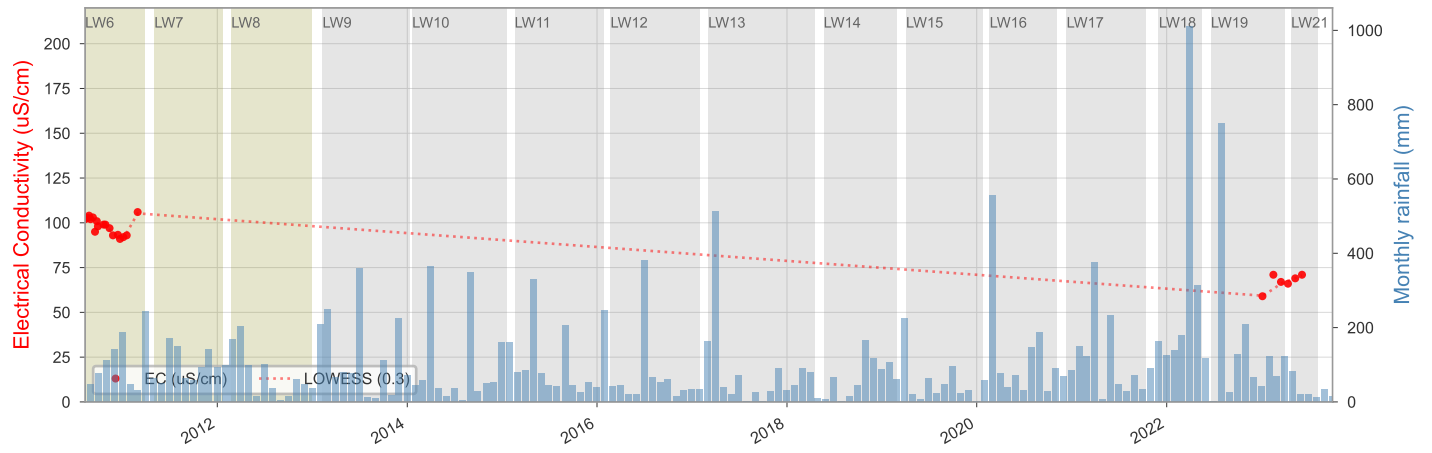
LC6_POOL51



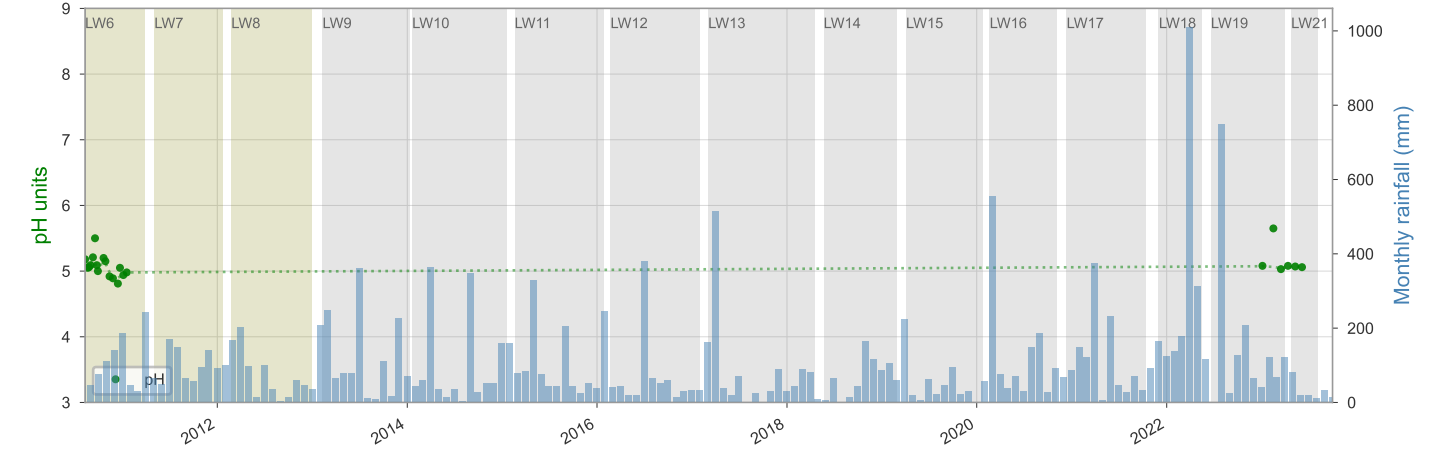
LC6_POOL57



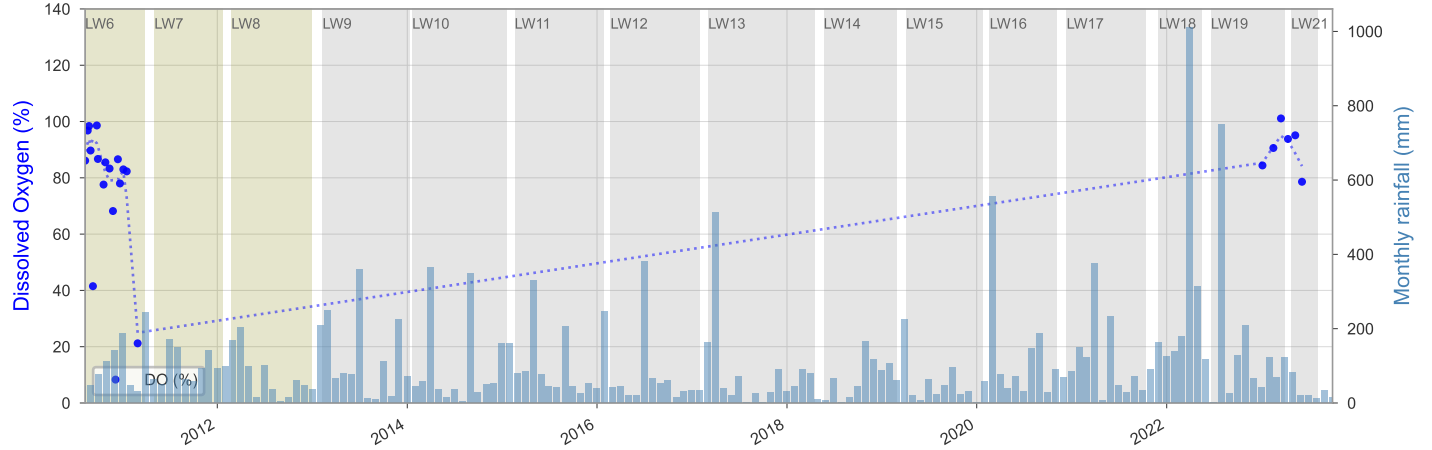
LC6_POOL57



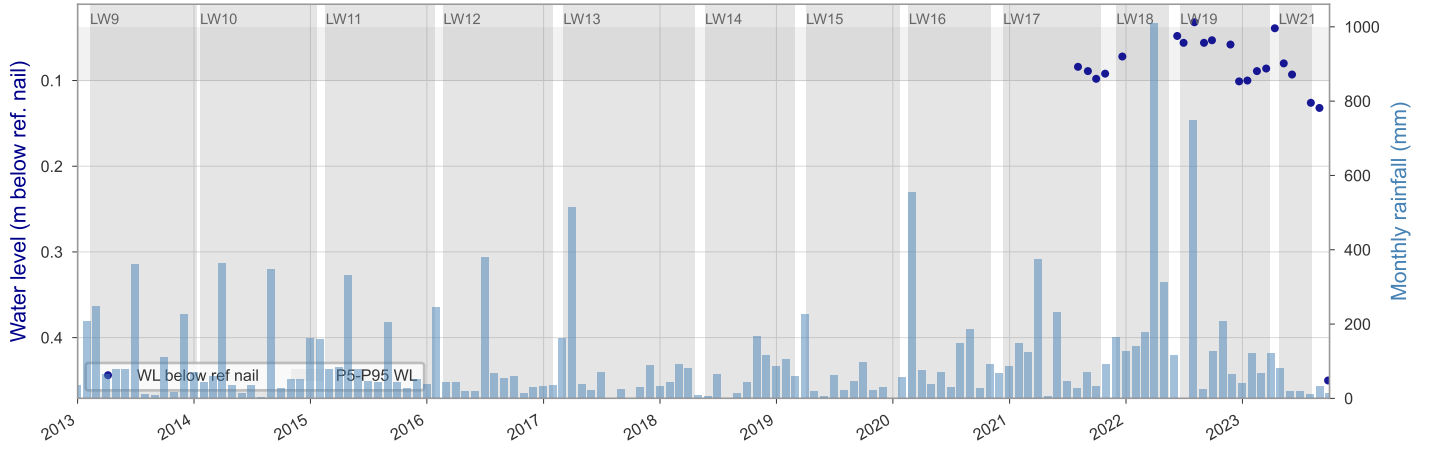
LC6_POOL57



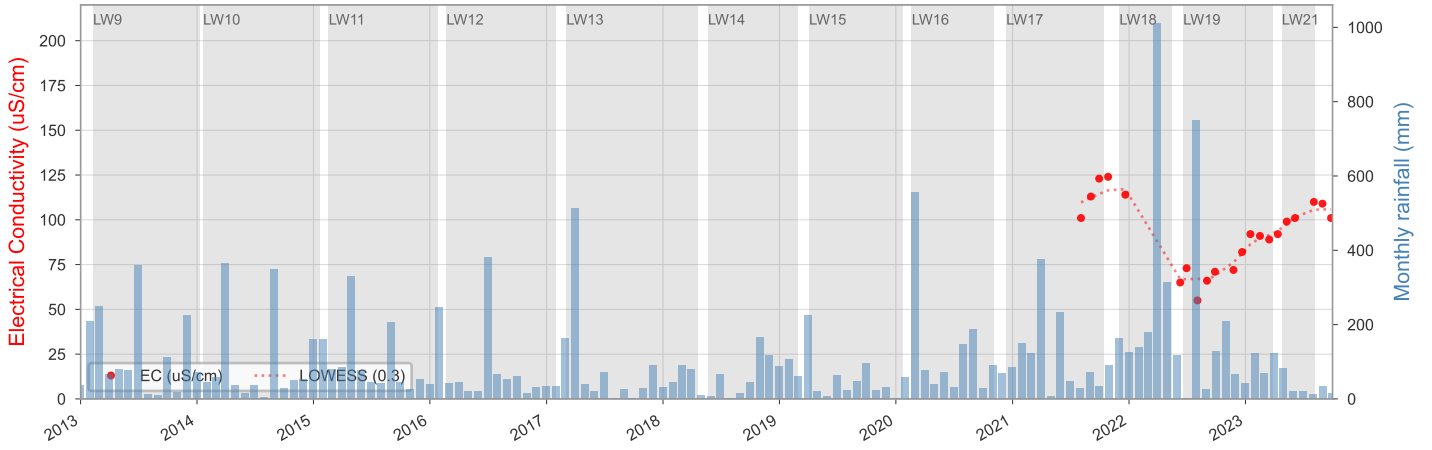
LC6_POOL57



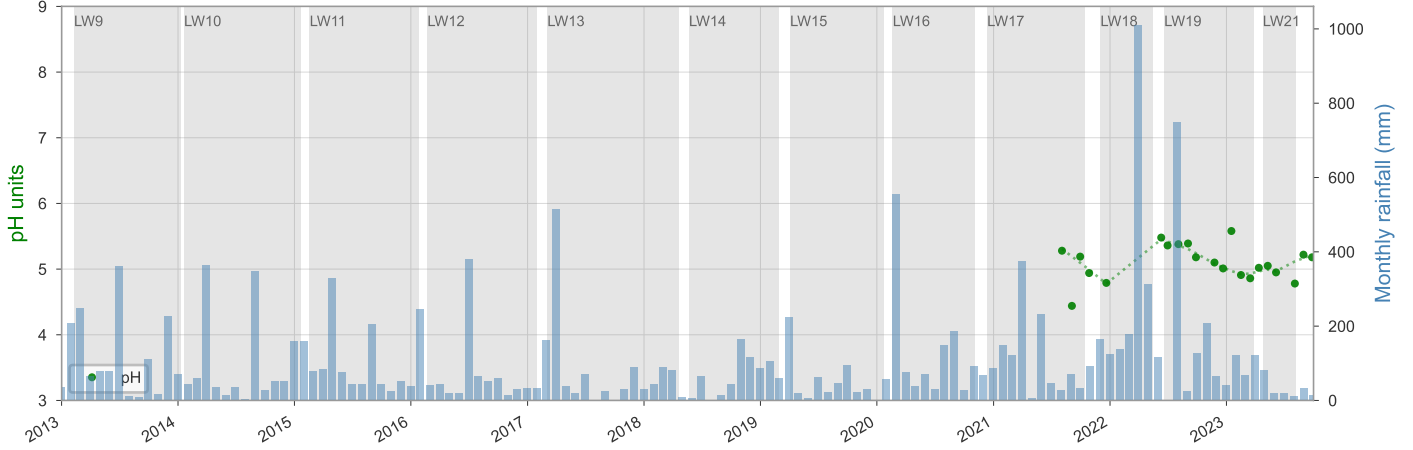
LC6_ROCKBAR1



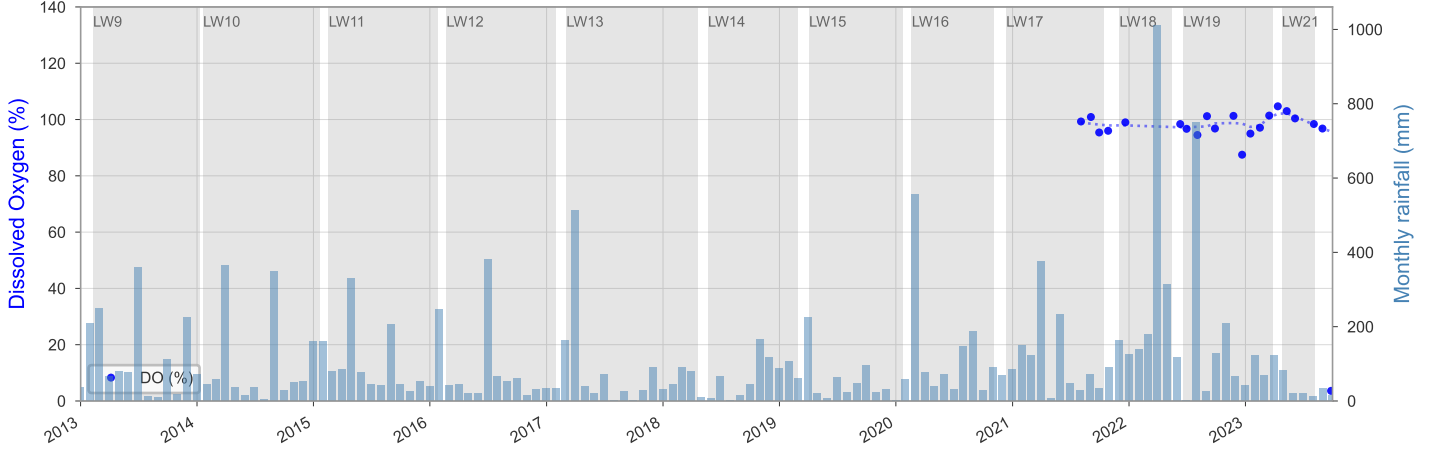
LC6_ROCKBAR1



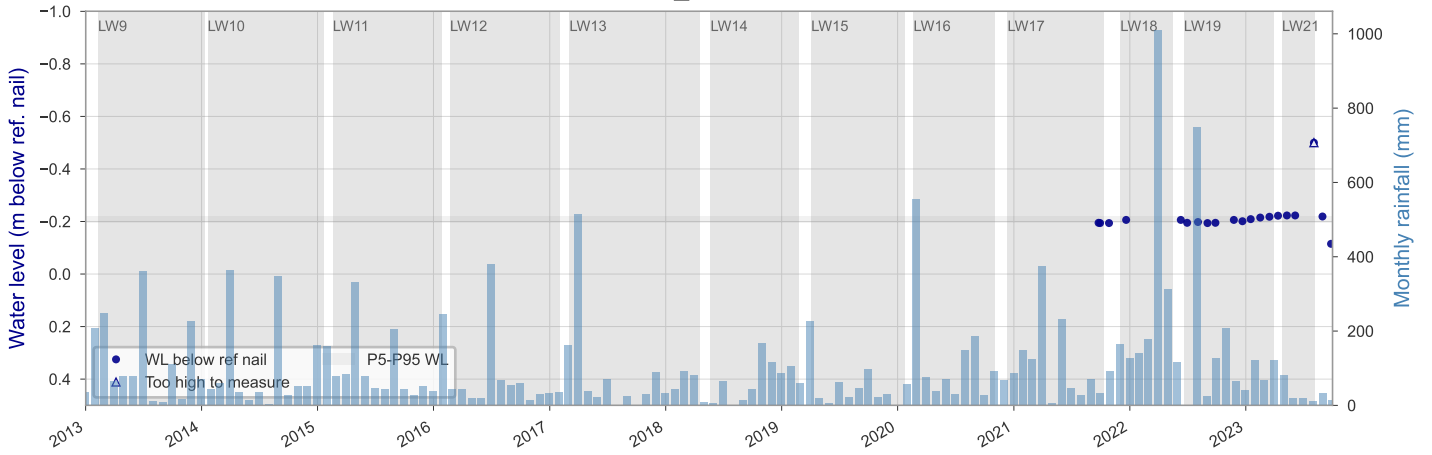
LC6_ROCKBAR1



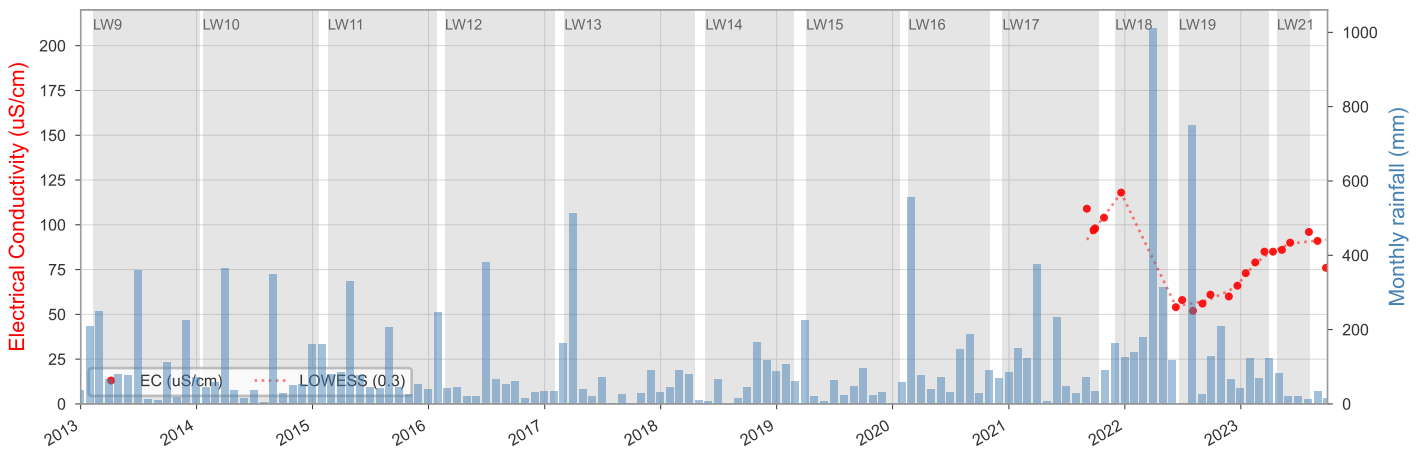
LC6_ROCKBAR1



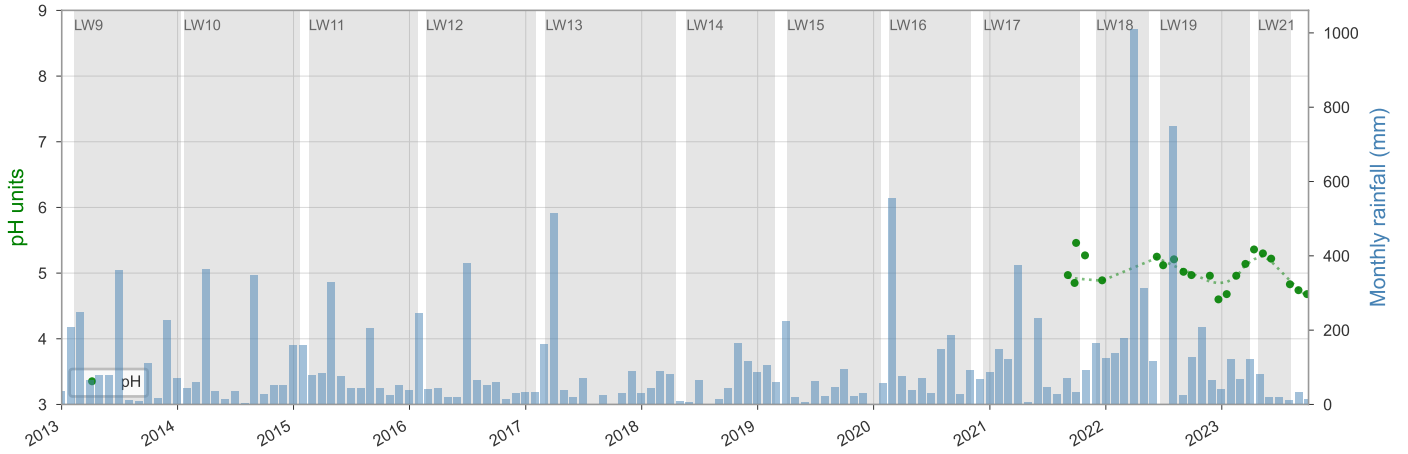
LC7_POOL17



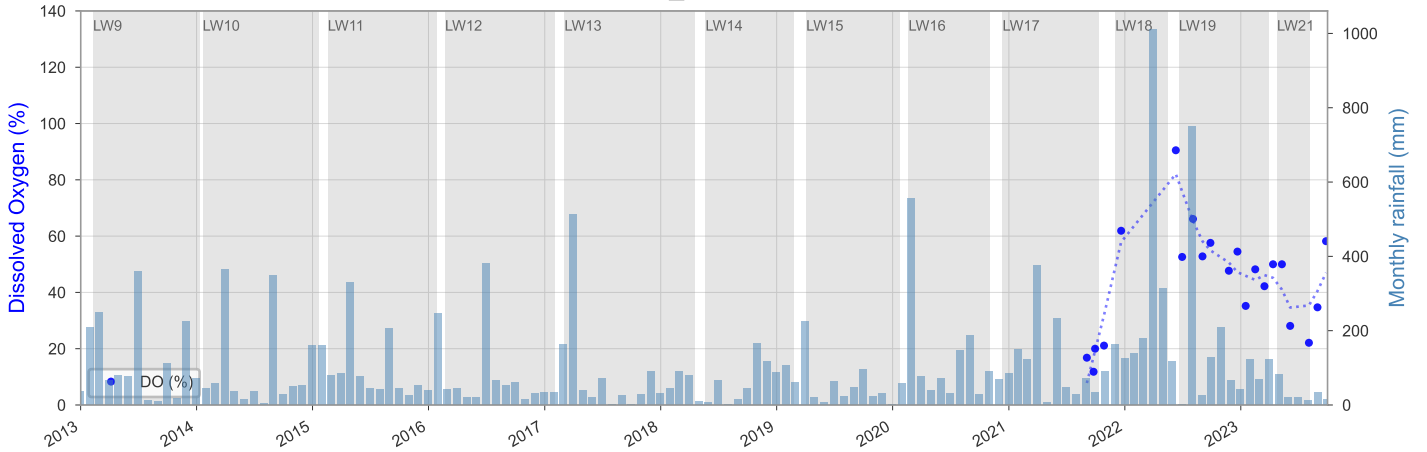
LC7_POOL17



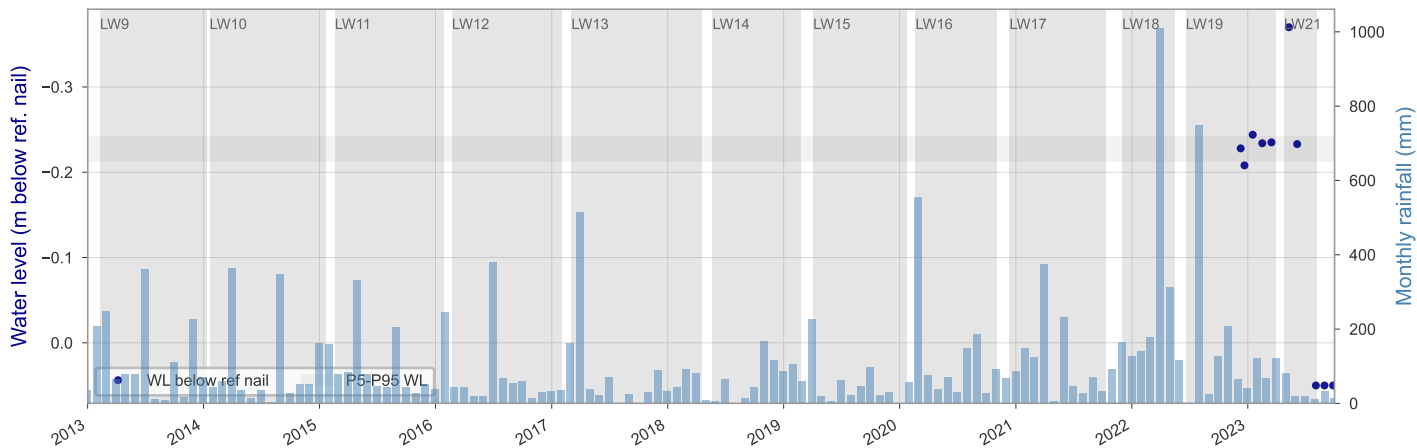
LC7_POOL17



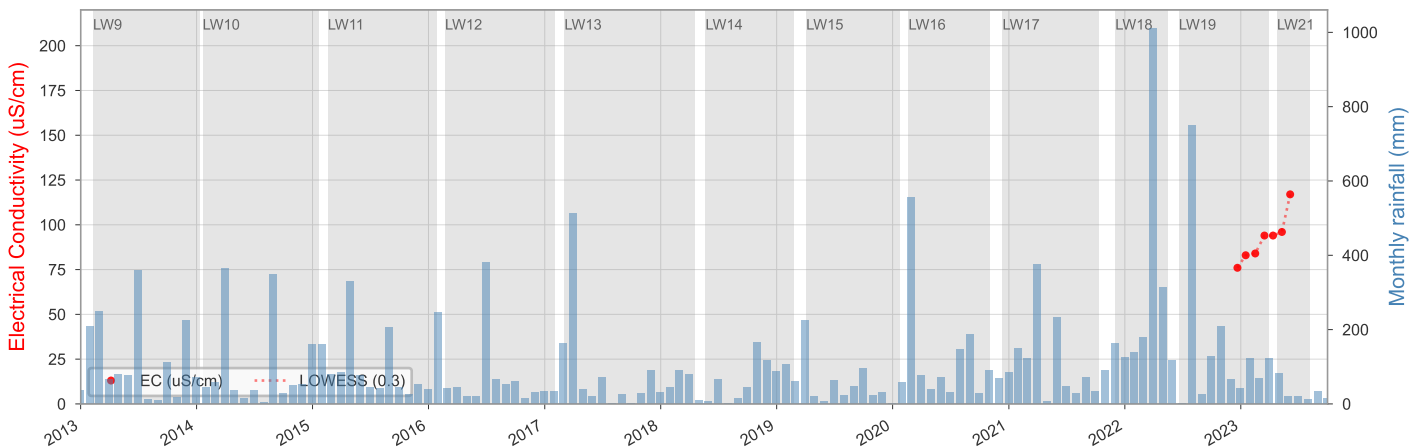
LC7_POOL17



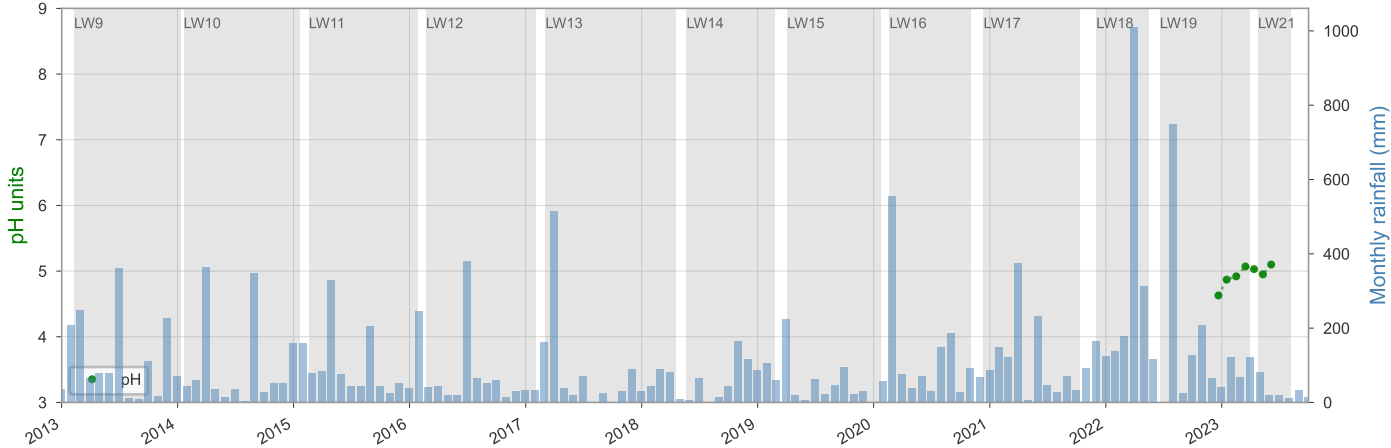
LC7_POOL18



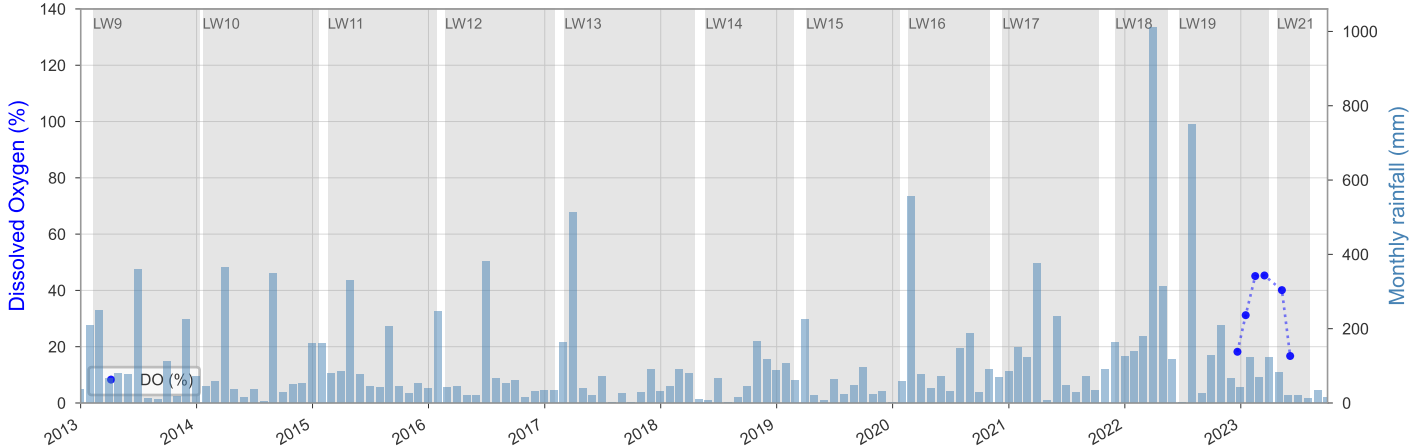
LC7_POOL18



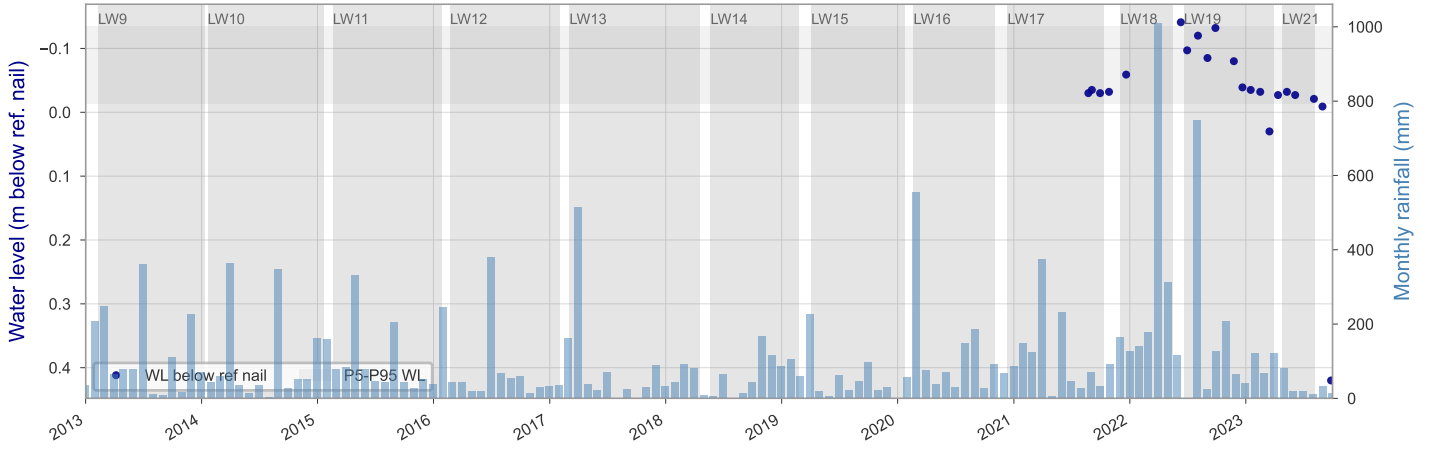
LC7_POOL18



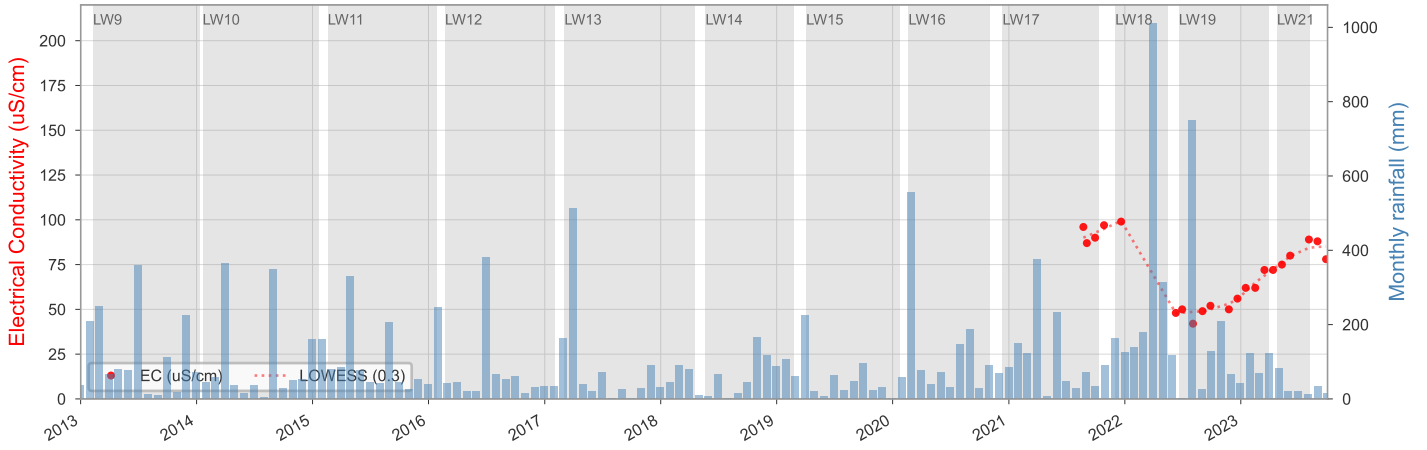
LC7_POOL18



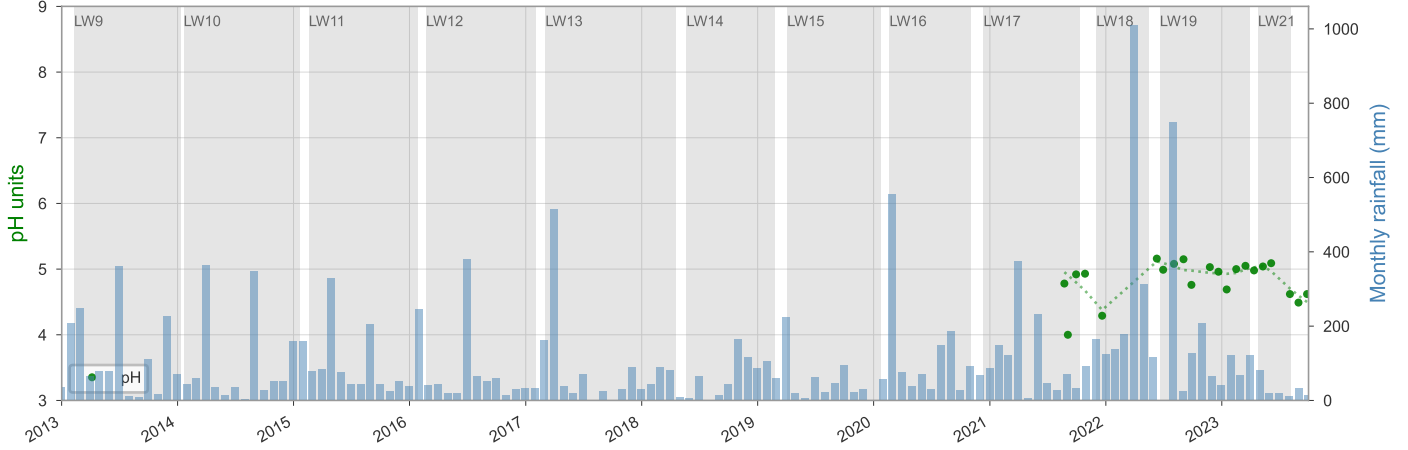
LC7_POOL2



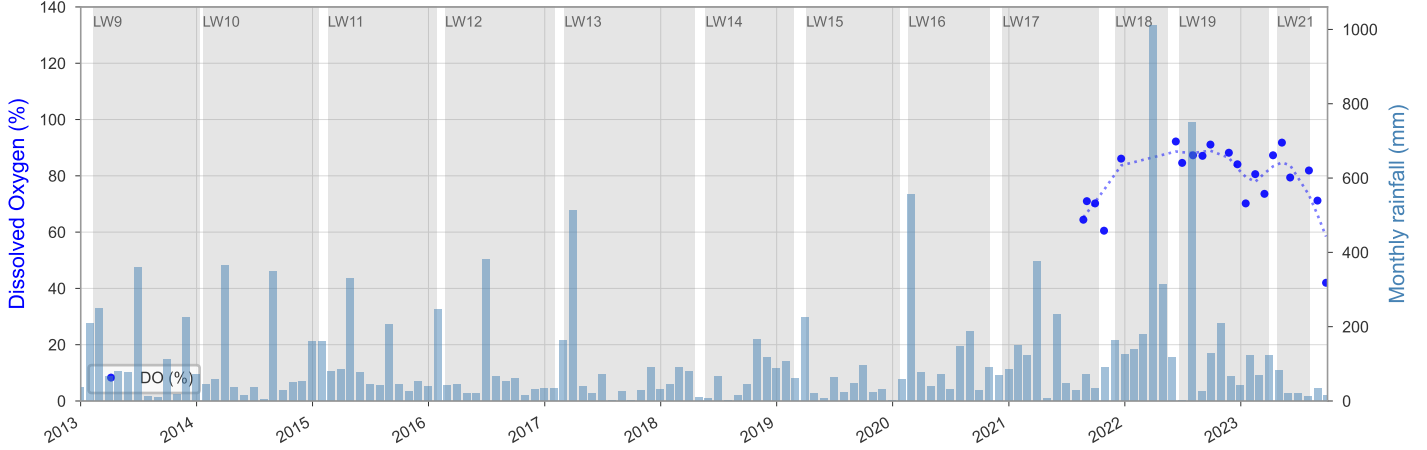
LC7_POOL2



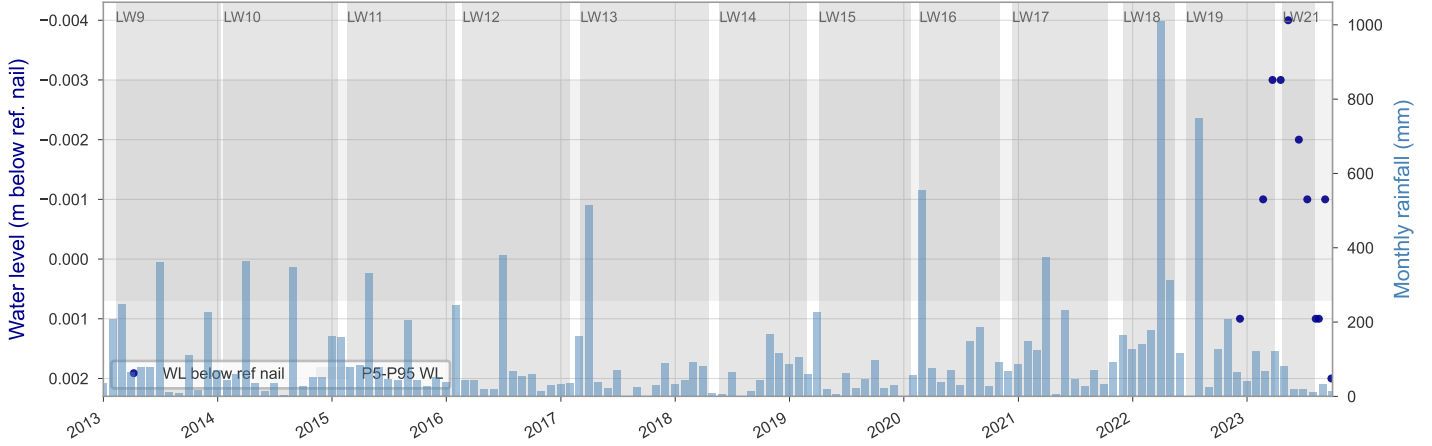
LC7_POOL2



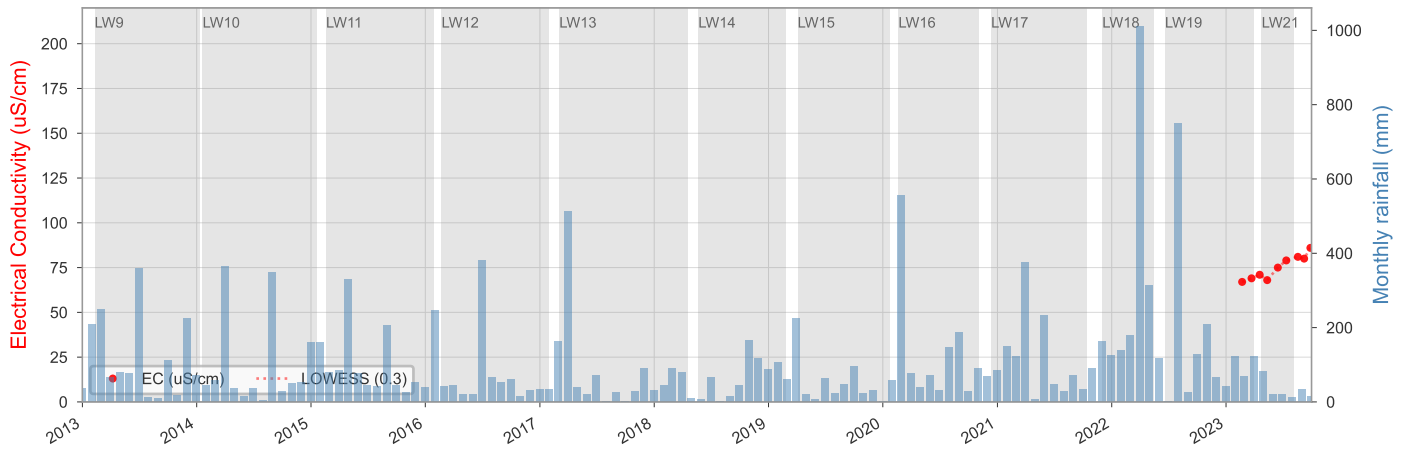
LC7_POOL2



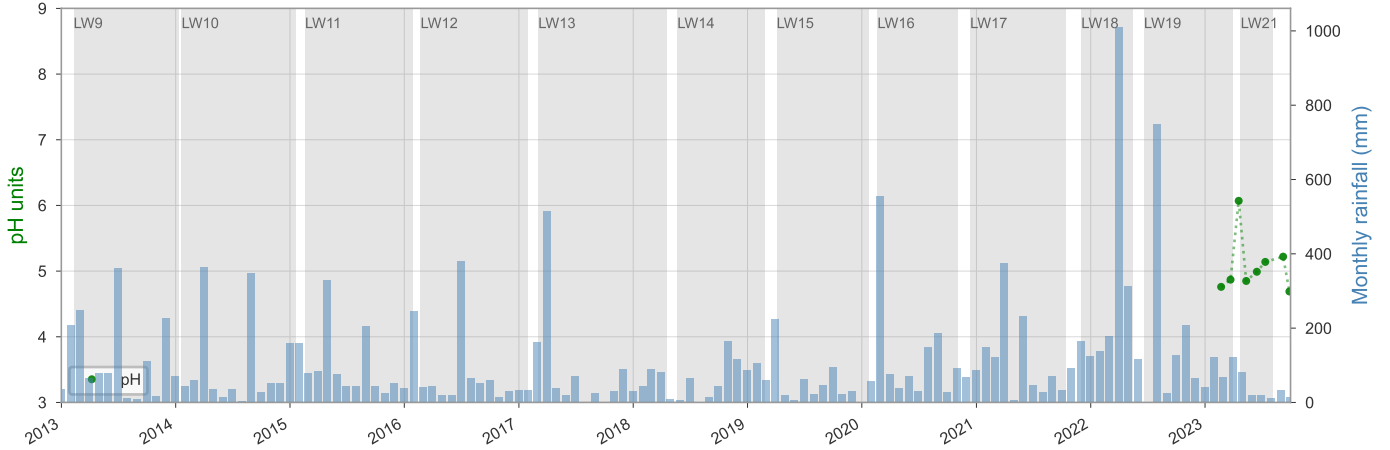
LC8_ROCKBAR3



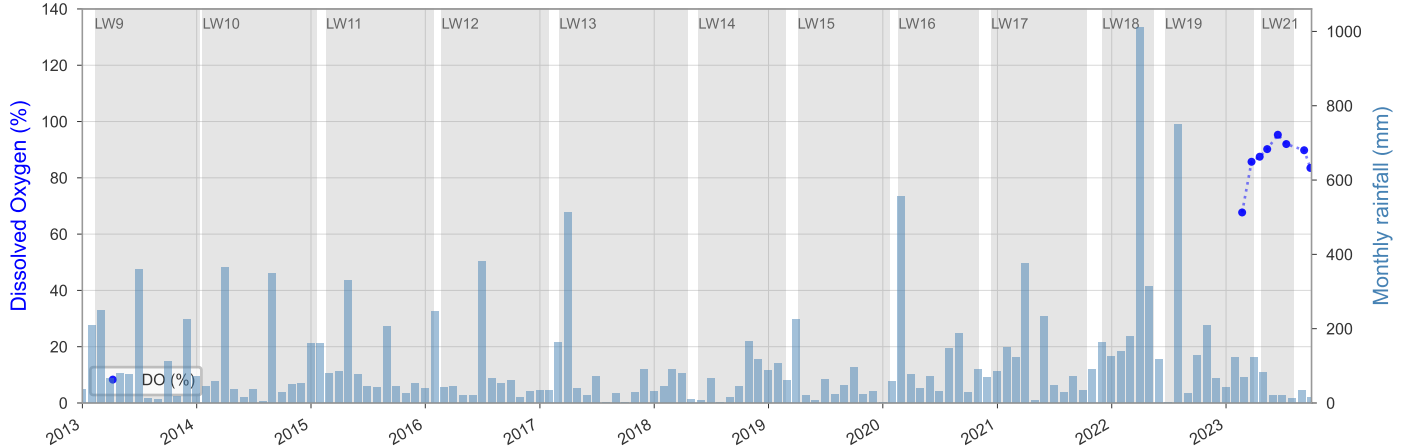
LC8_ROCKBAR3



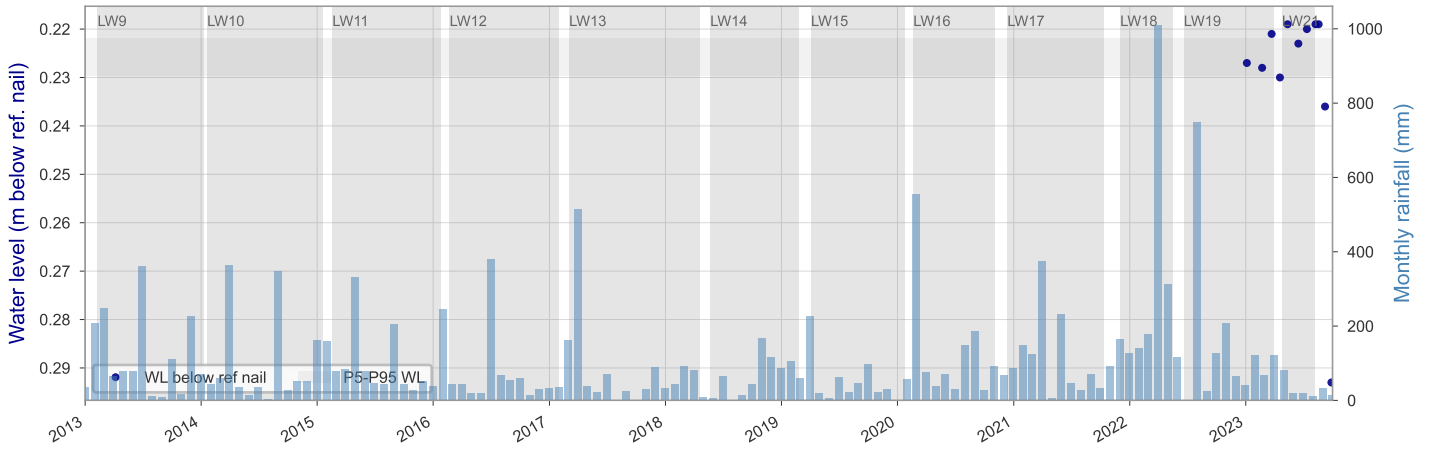
LC8_ROCKBAR3



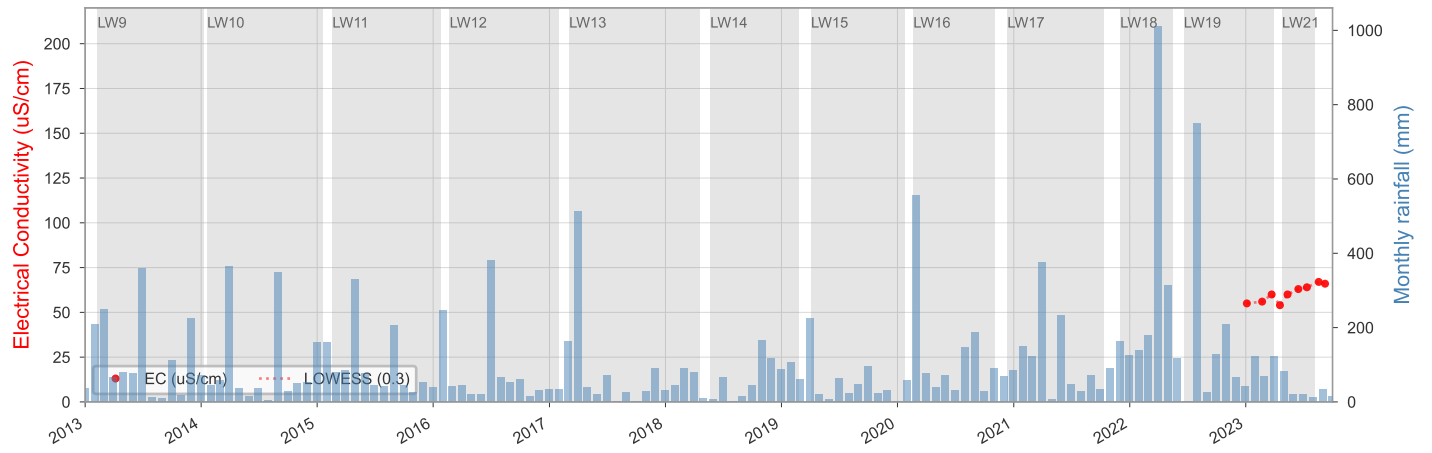
LC8_ROCKBAR3



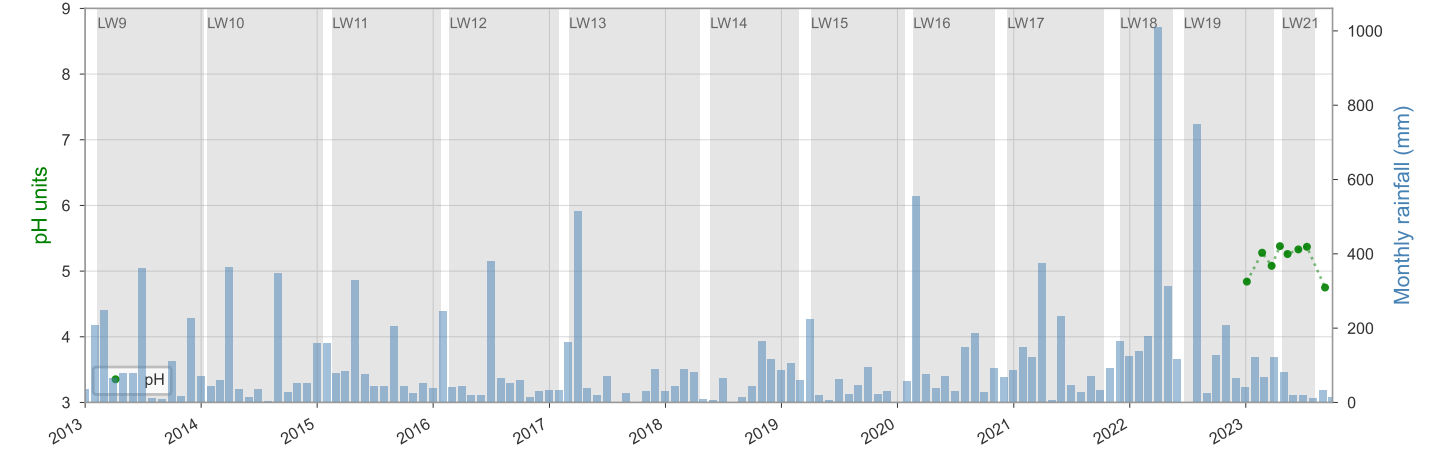
LC9A_POOL2



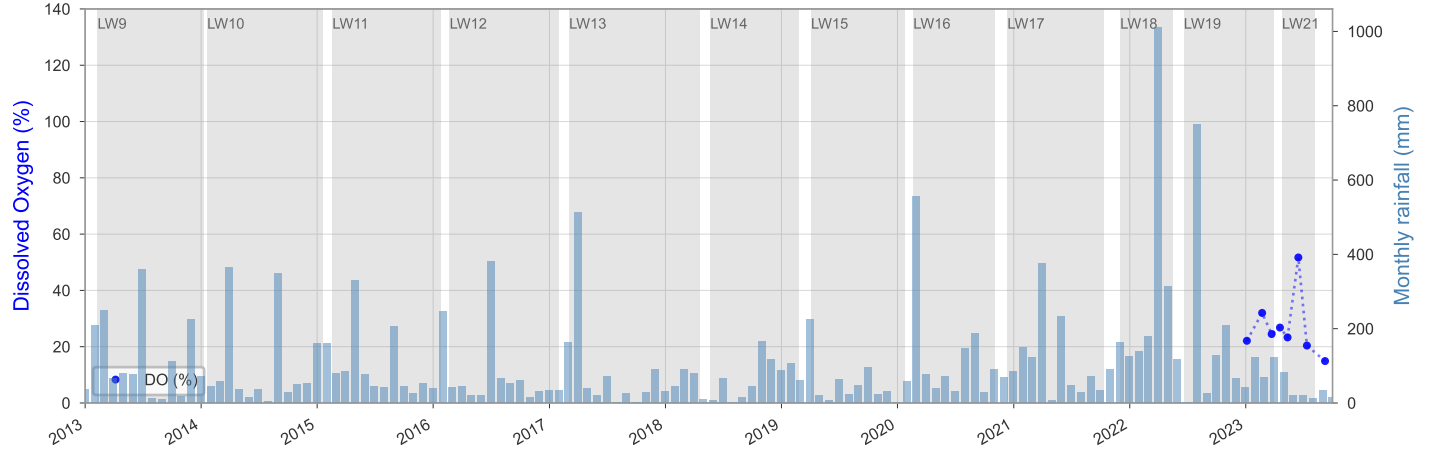
LC9A_POOL2



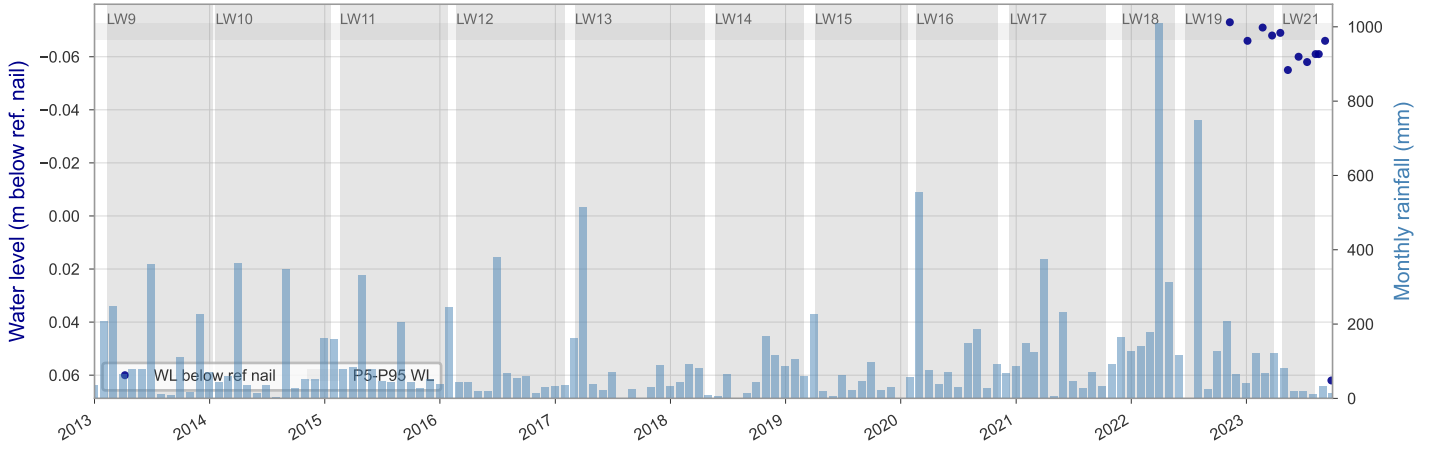
LC9A_POOL2



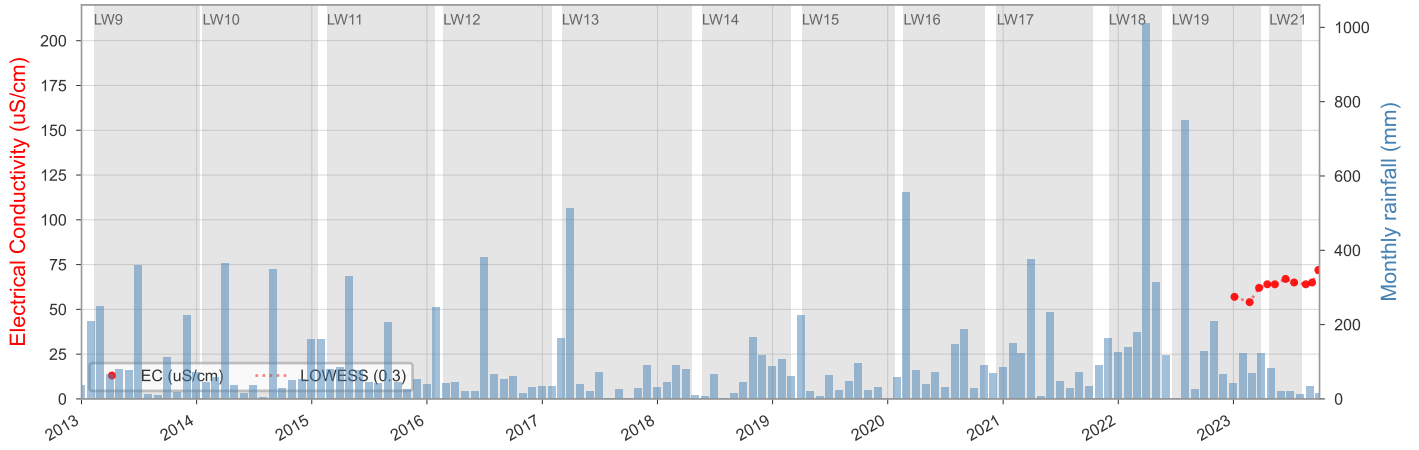
LC9A_POOL2



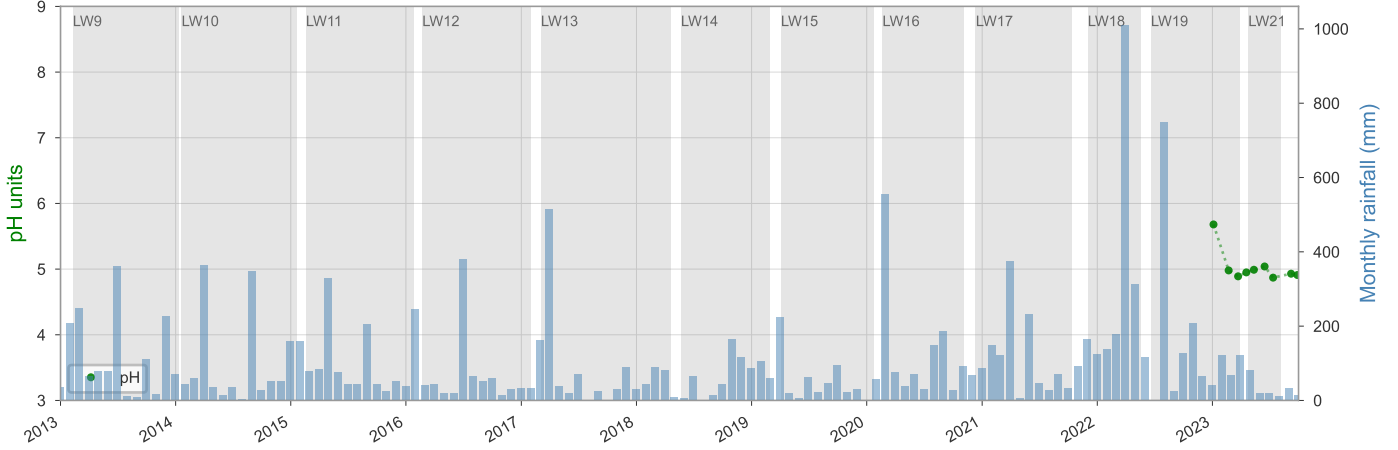
LC9_POOL15



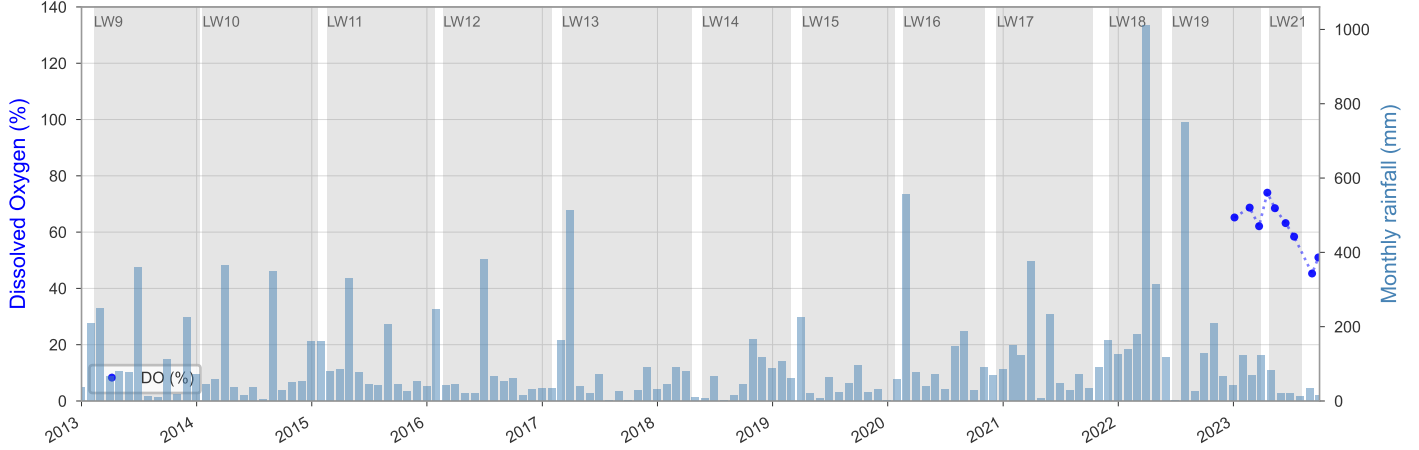
LC9_POOL15



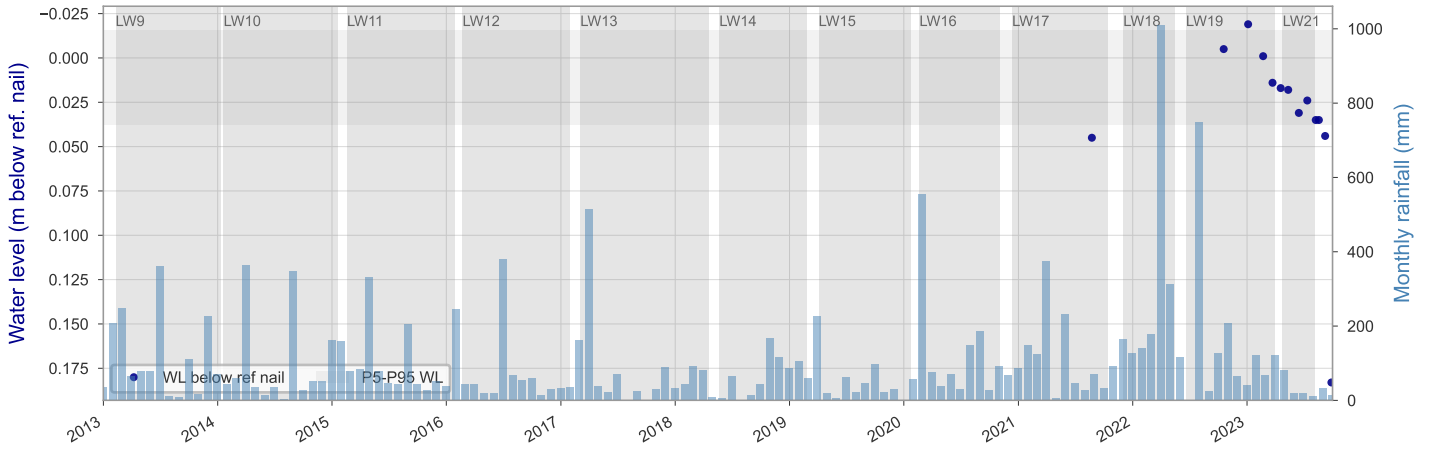
LC9_POOL15



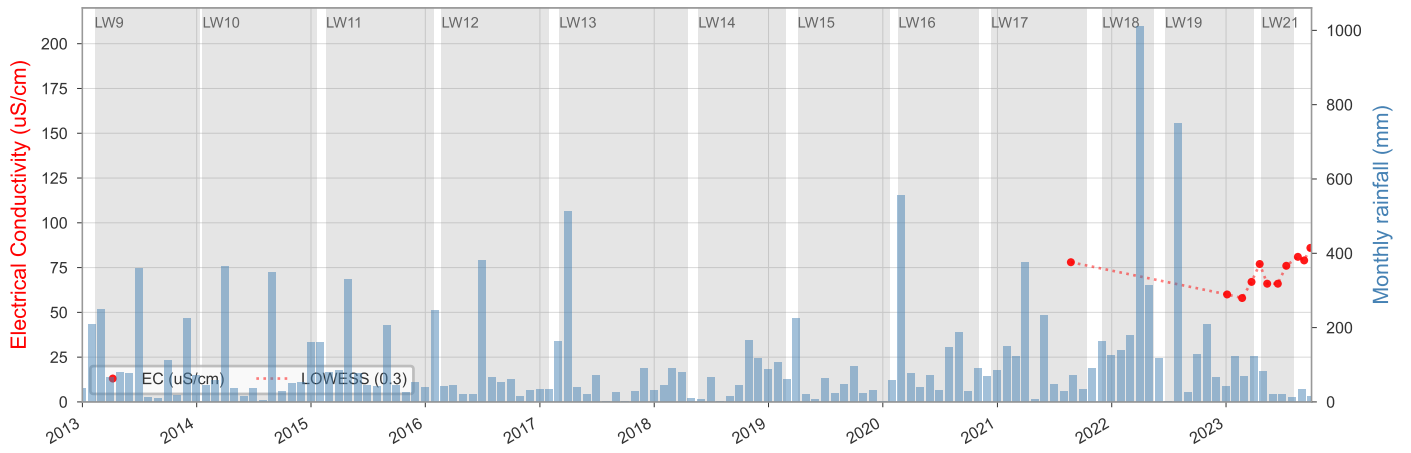
LC9_POOL15



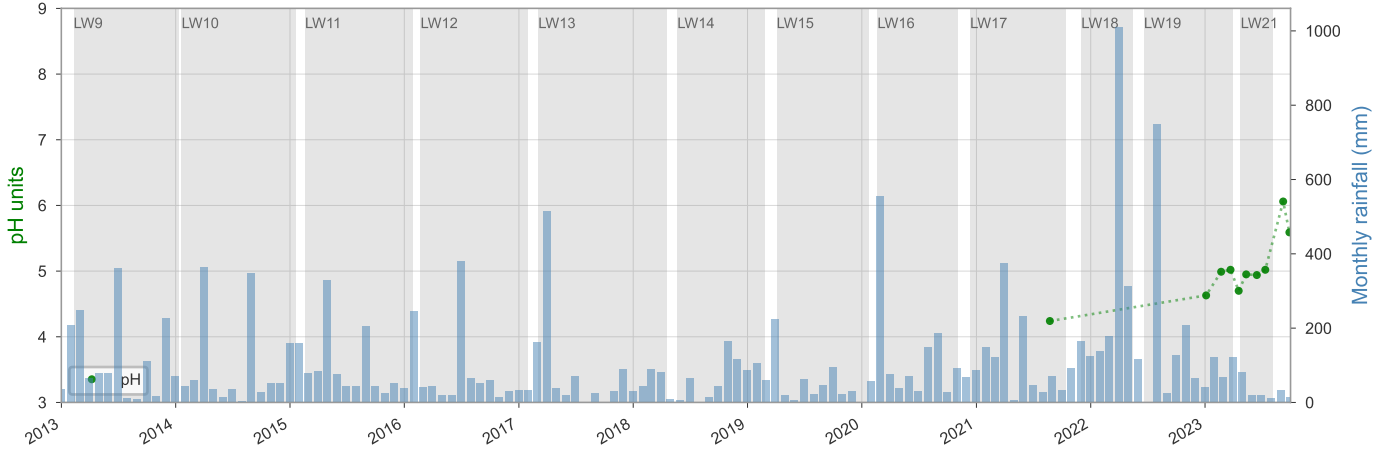
LC9_POOL2



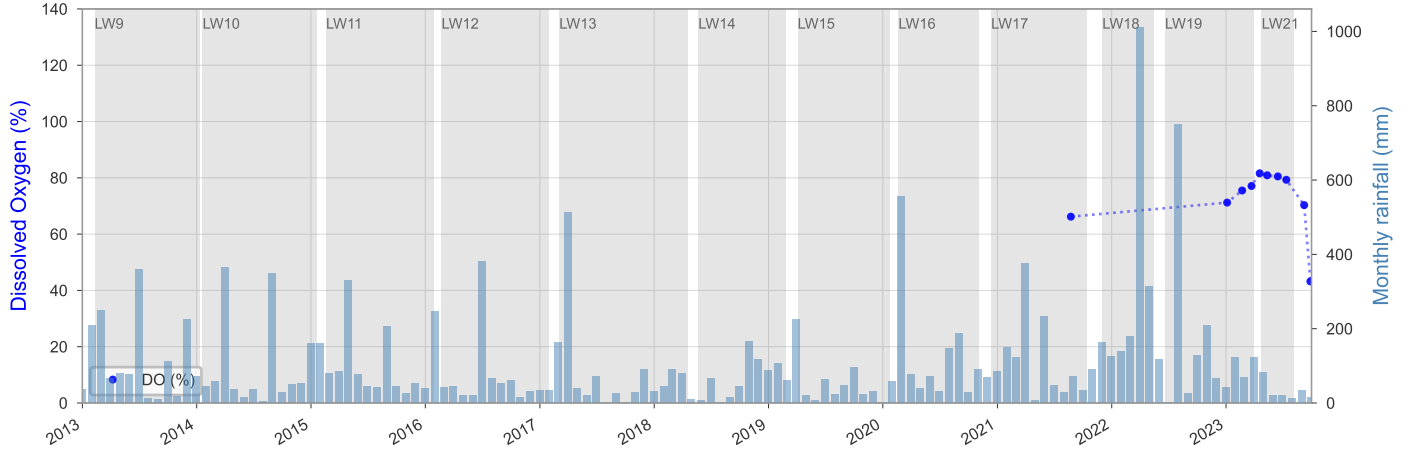
LC9_POOL2



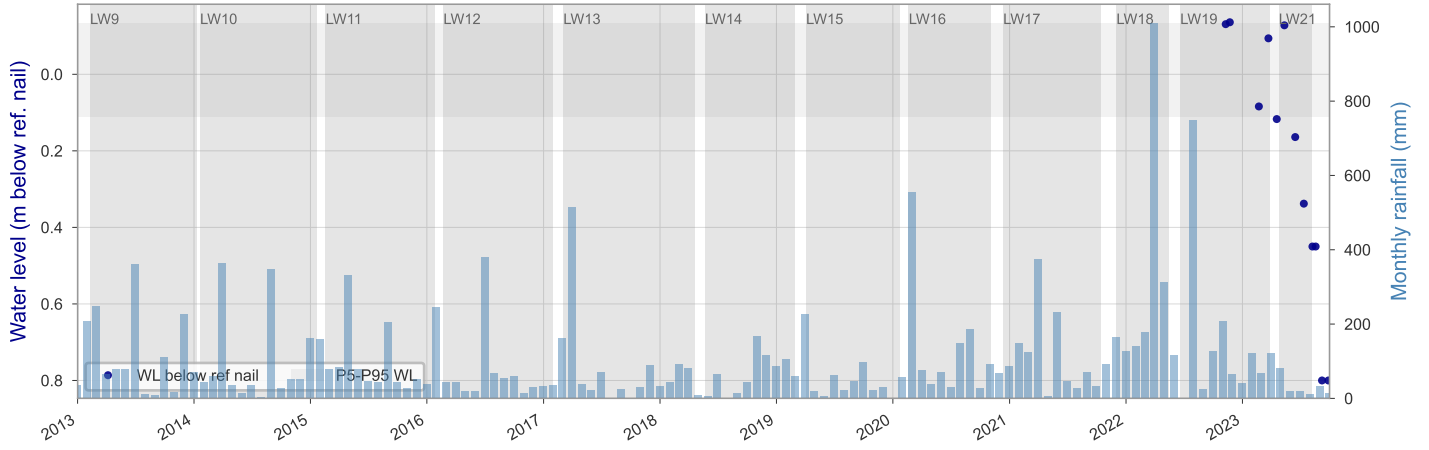
LC9_POOL2



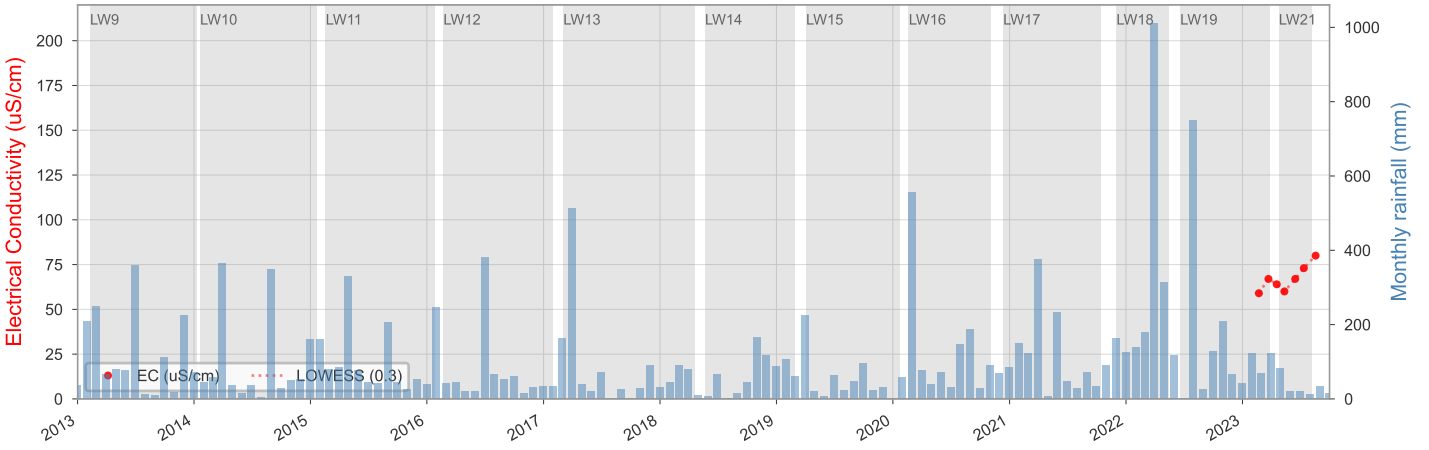
LC9_POOL2



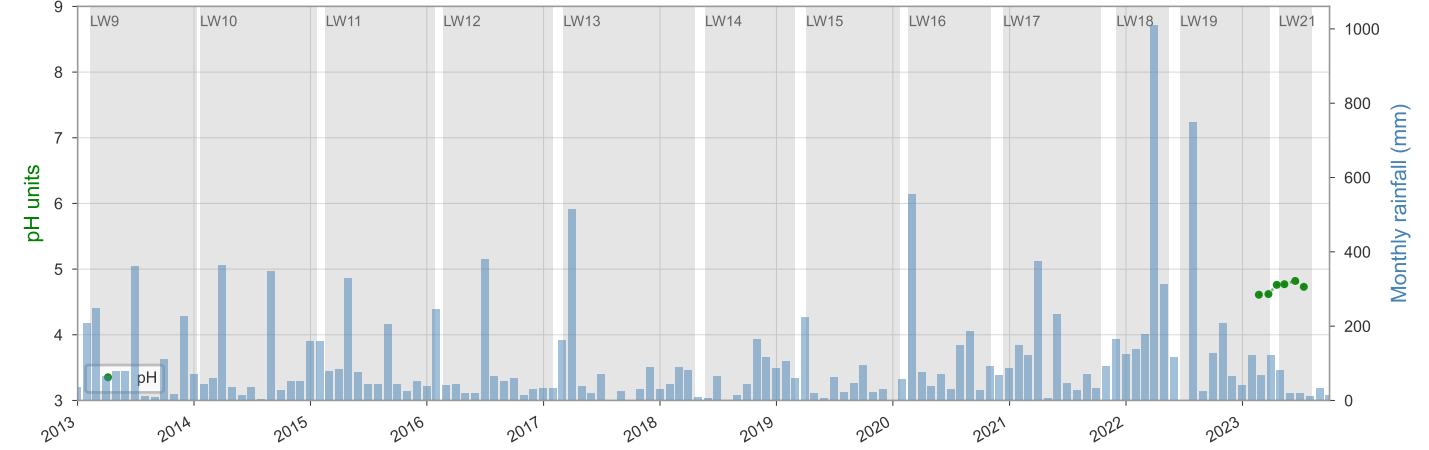
LC9_POOL24



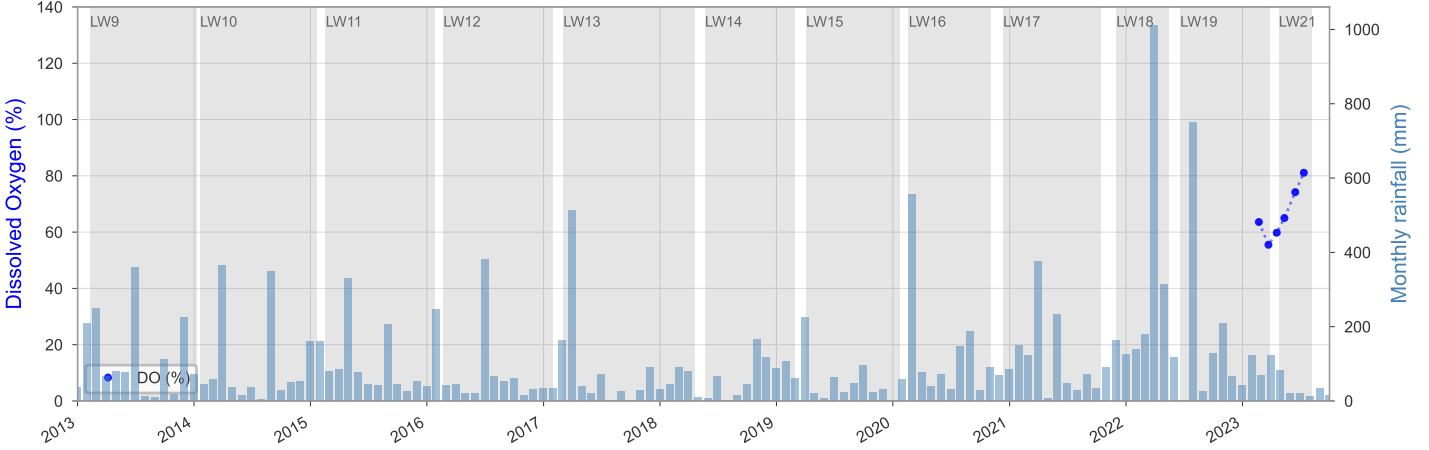
LC9_POOL24



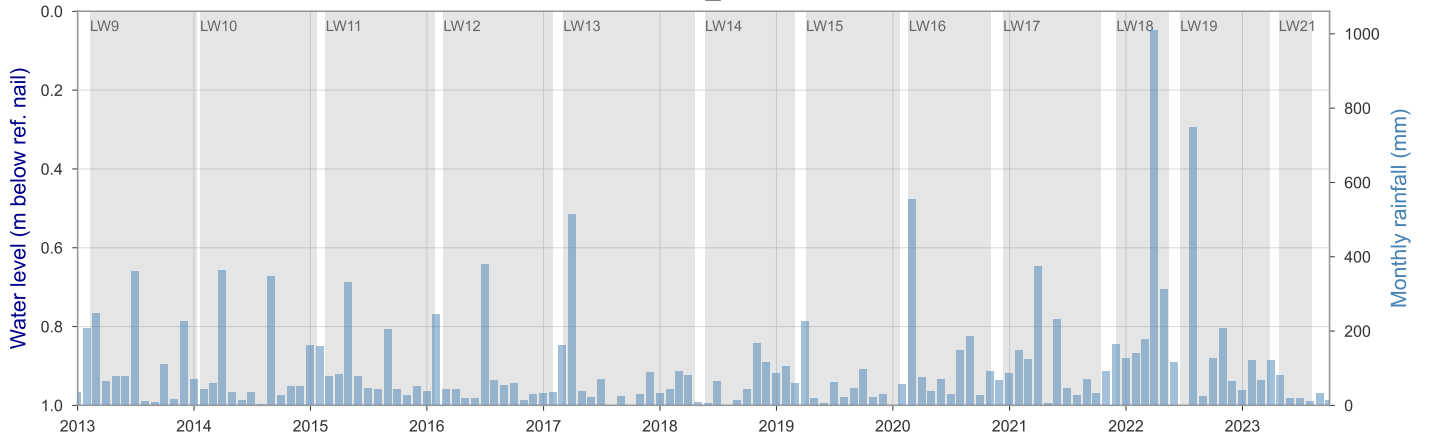
LC9_POOL24



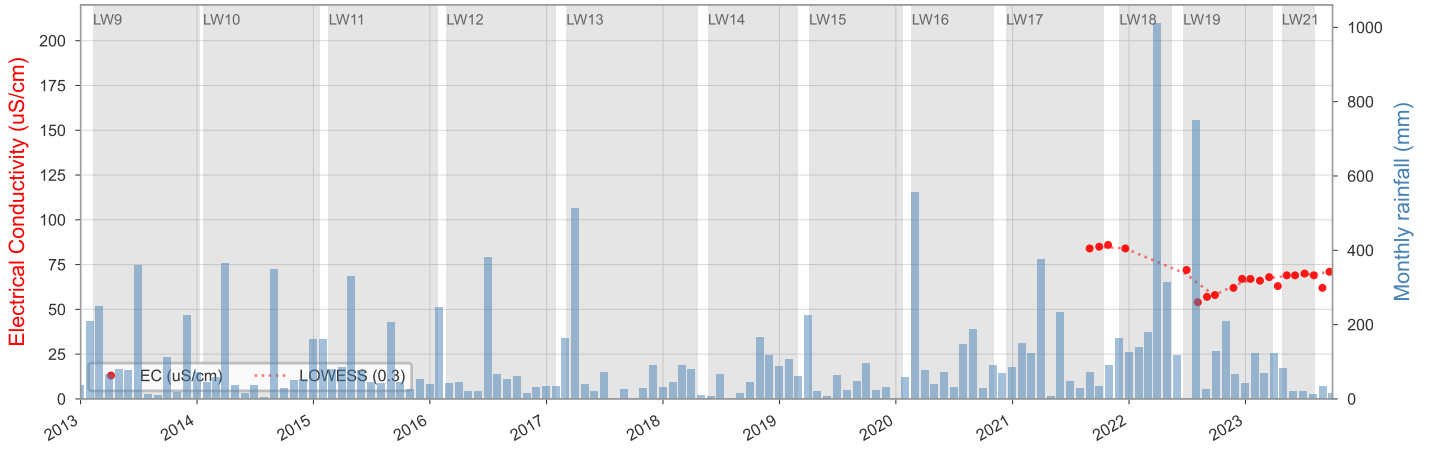
LC9_POOL24



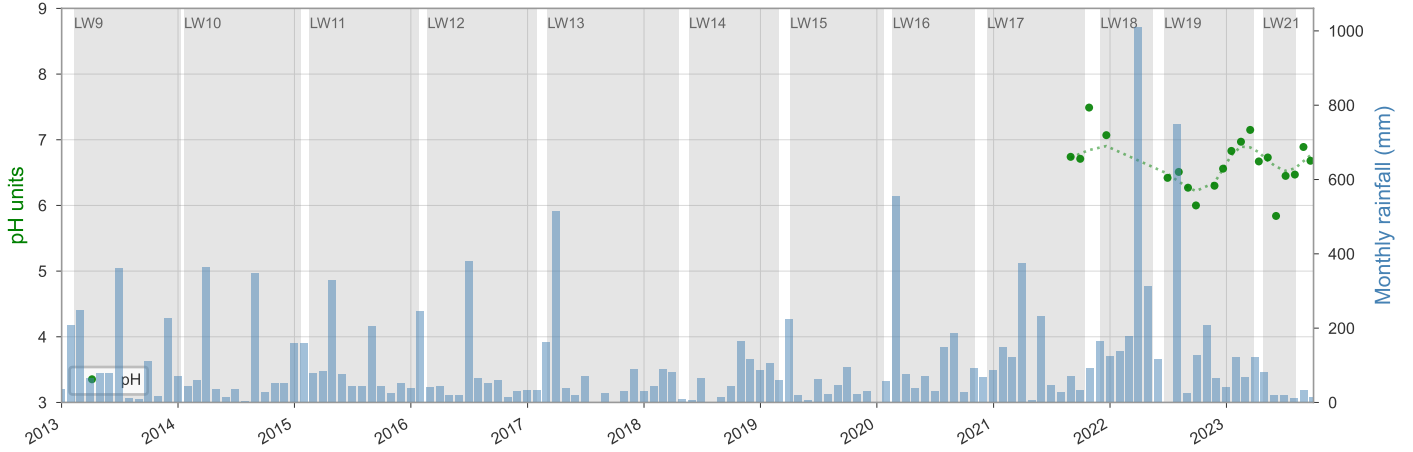
LC_1



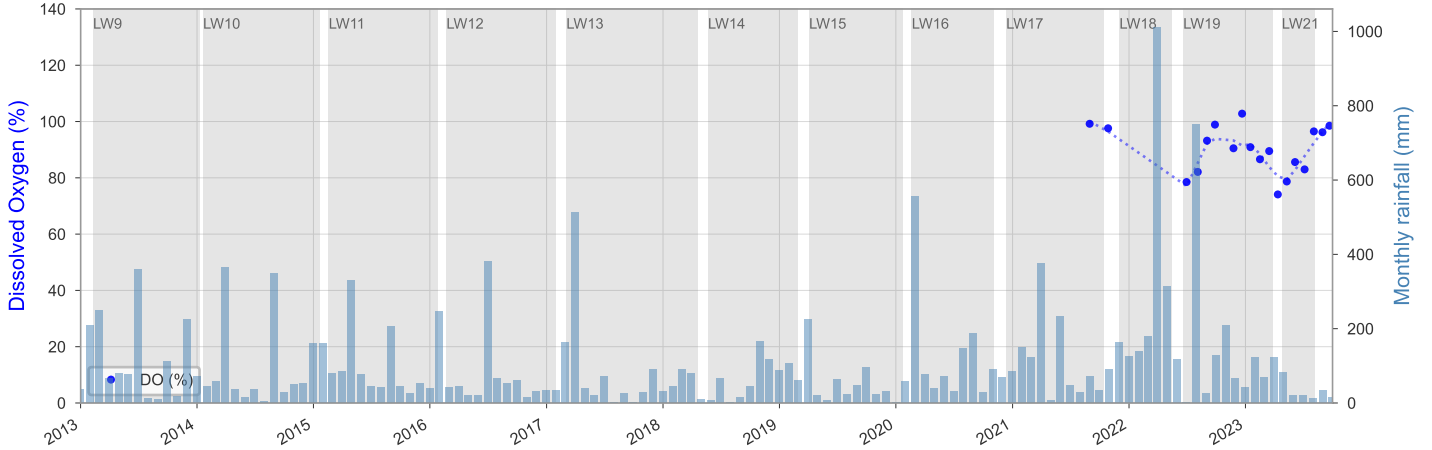
LC_1



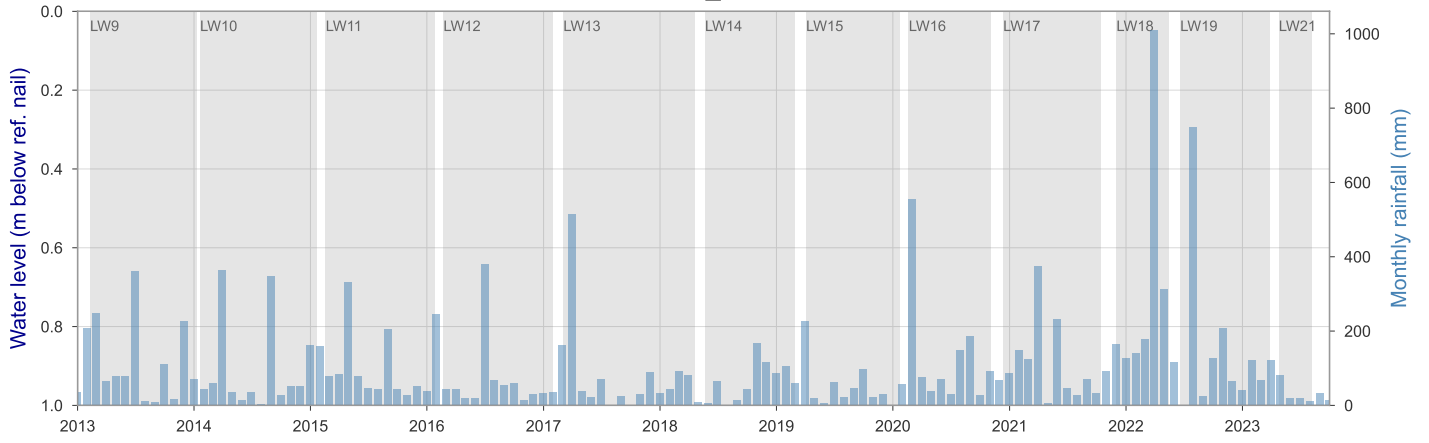
LC_1



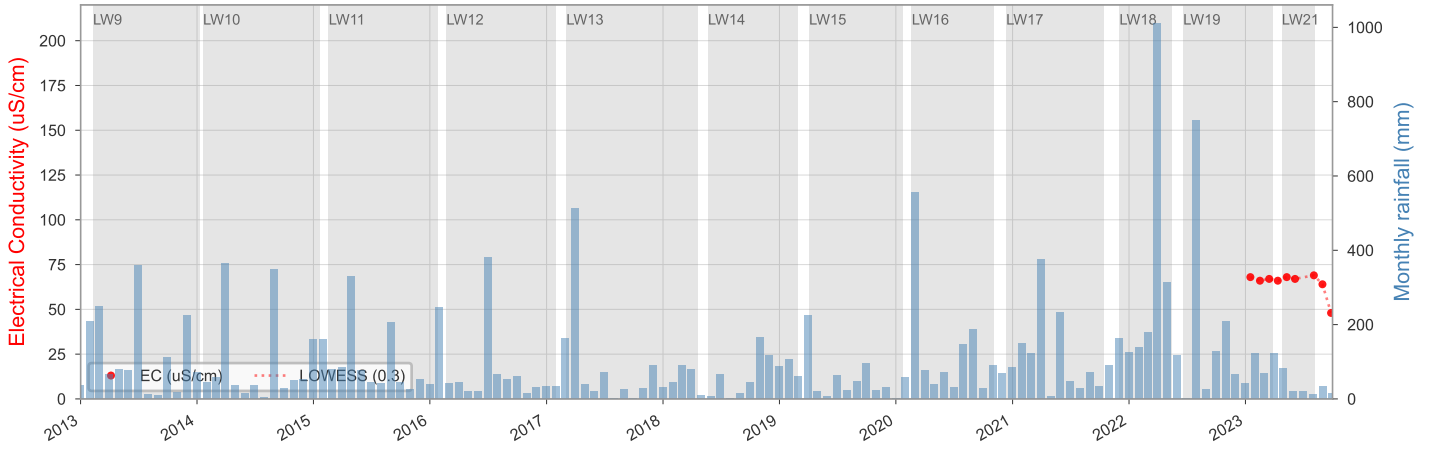
LC_1



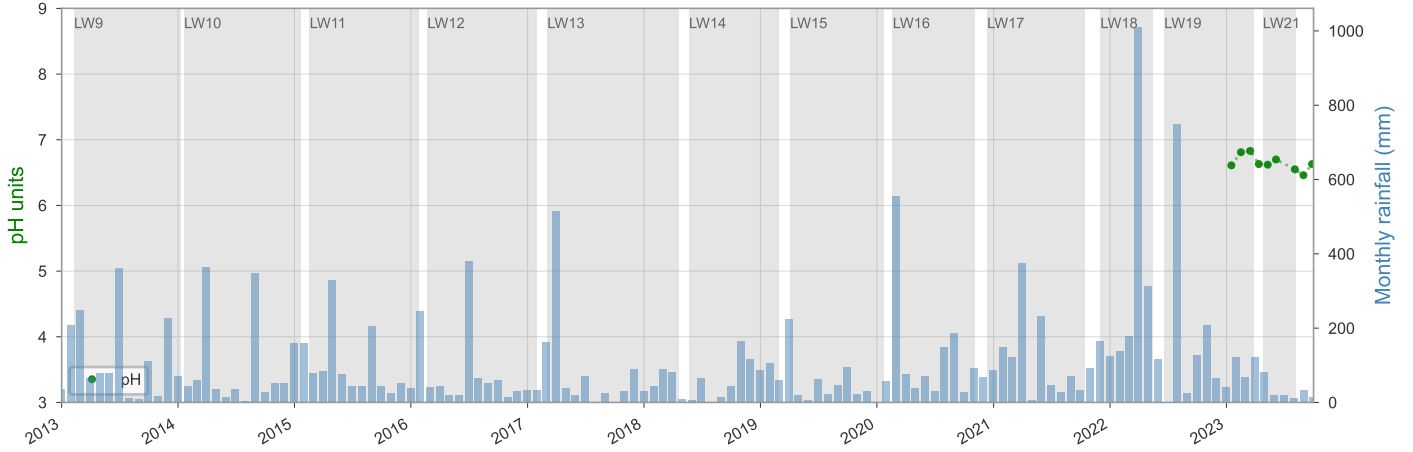
LC_2



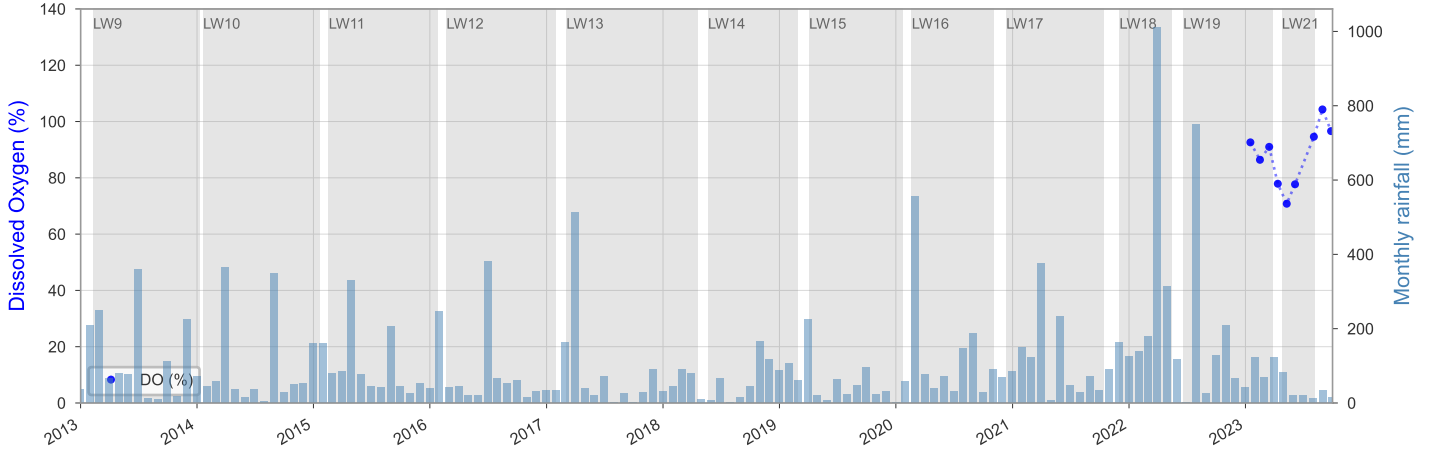
LC_2



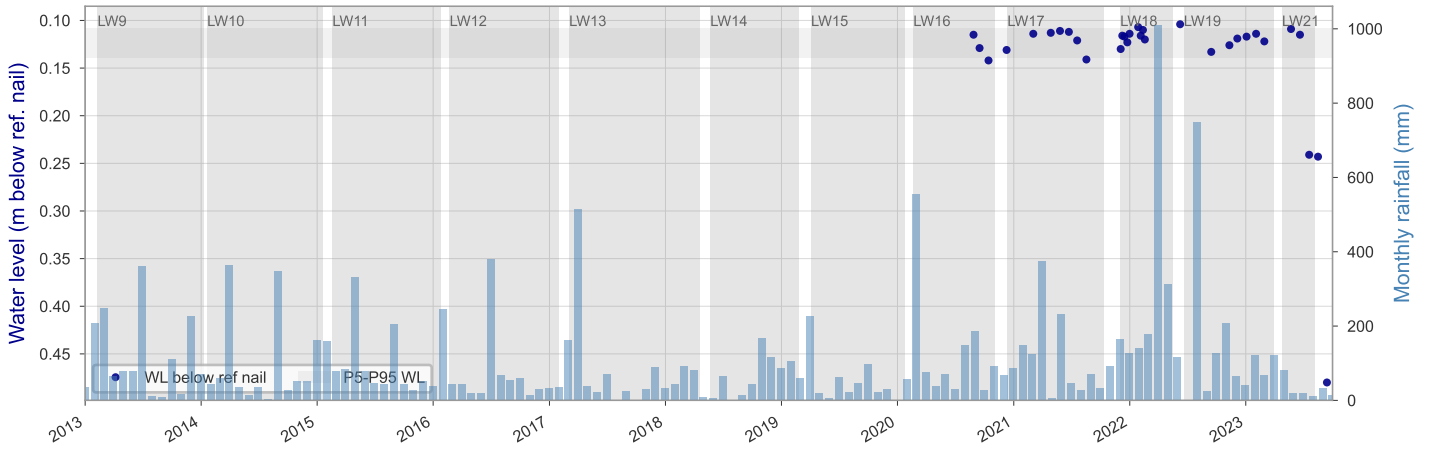
LC_2



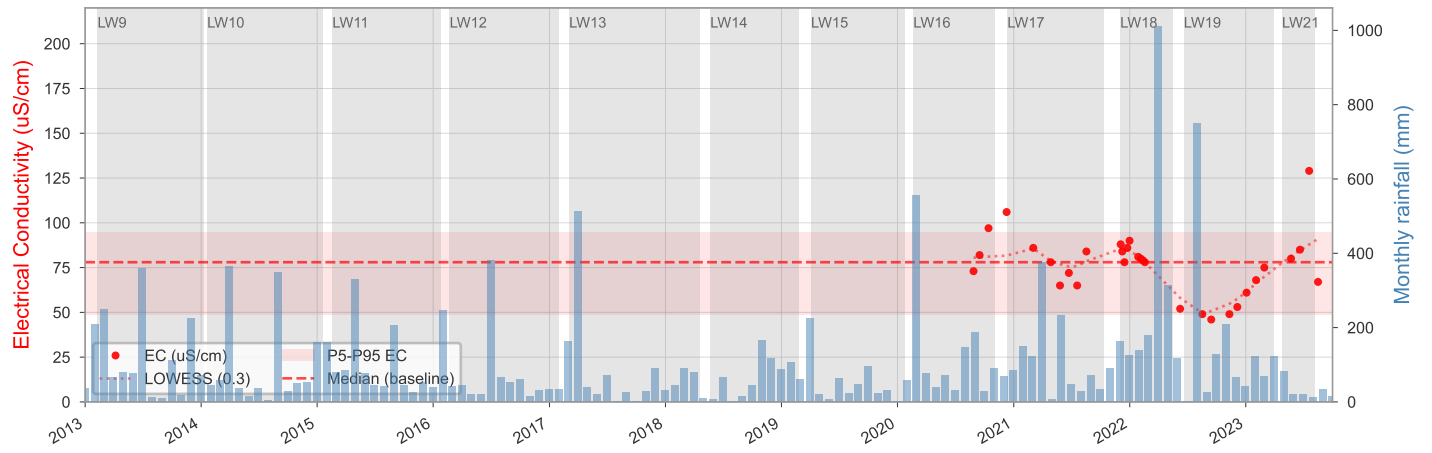
LC_2



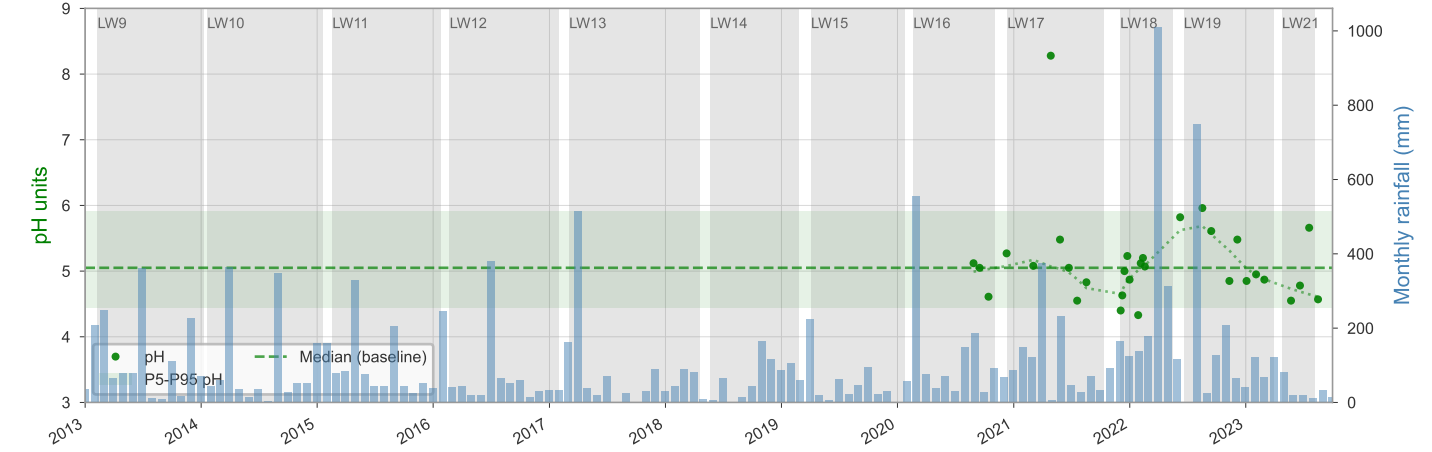
ND1_POOL23



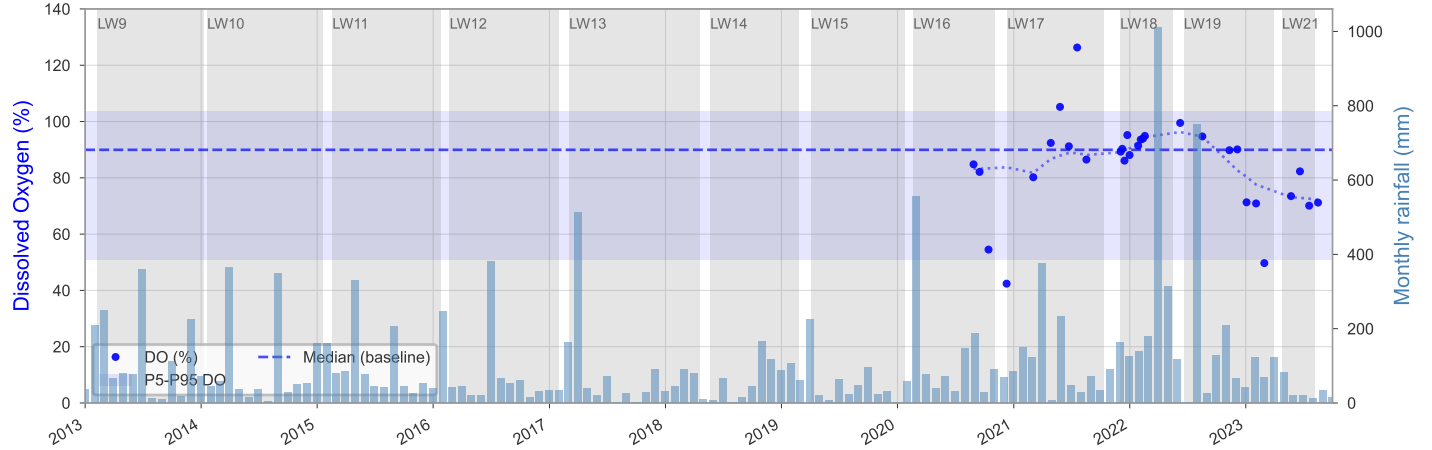
ND1_POOL23



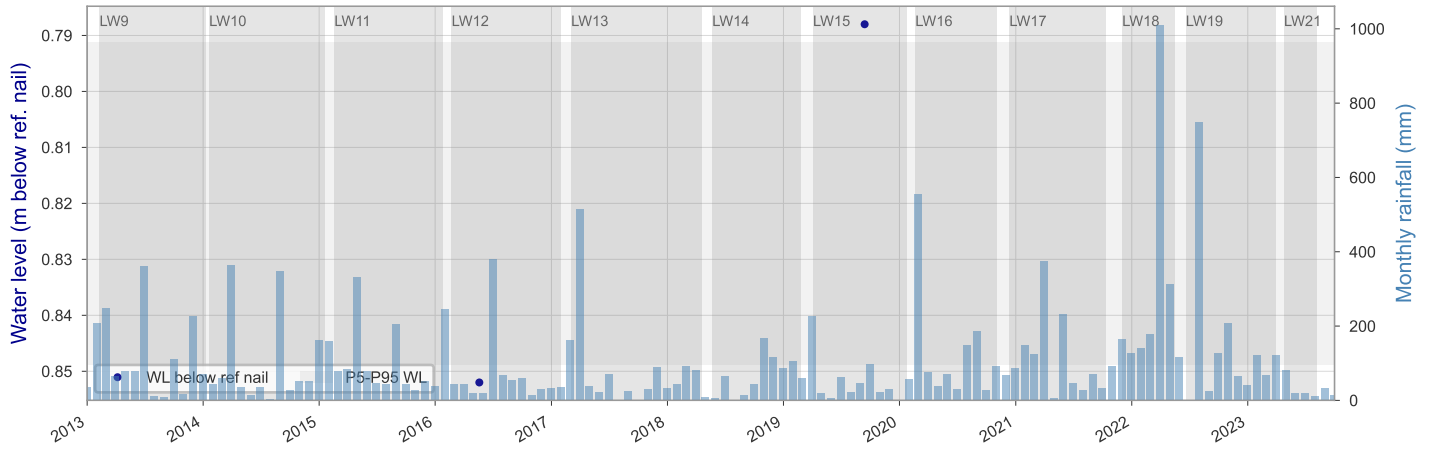
ND1_POOL23



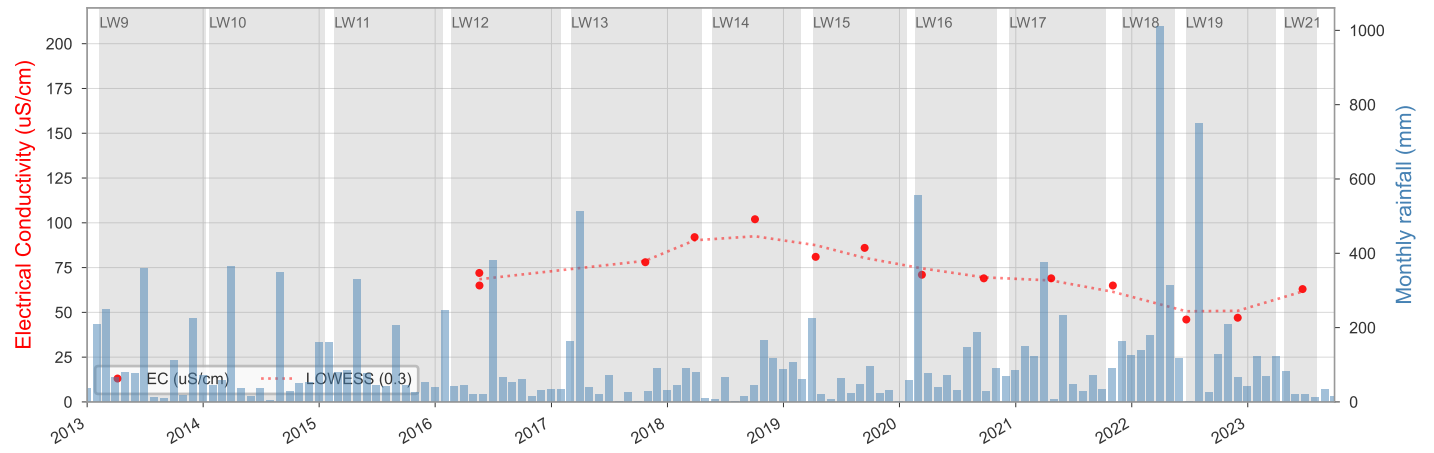
ND1_POOL23



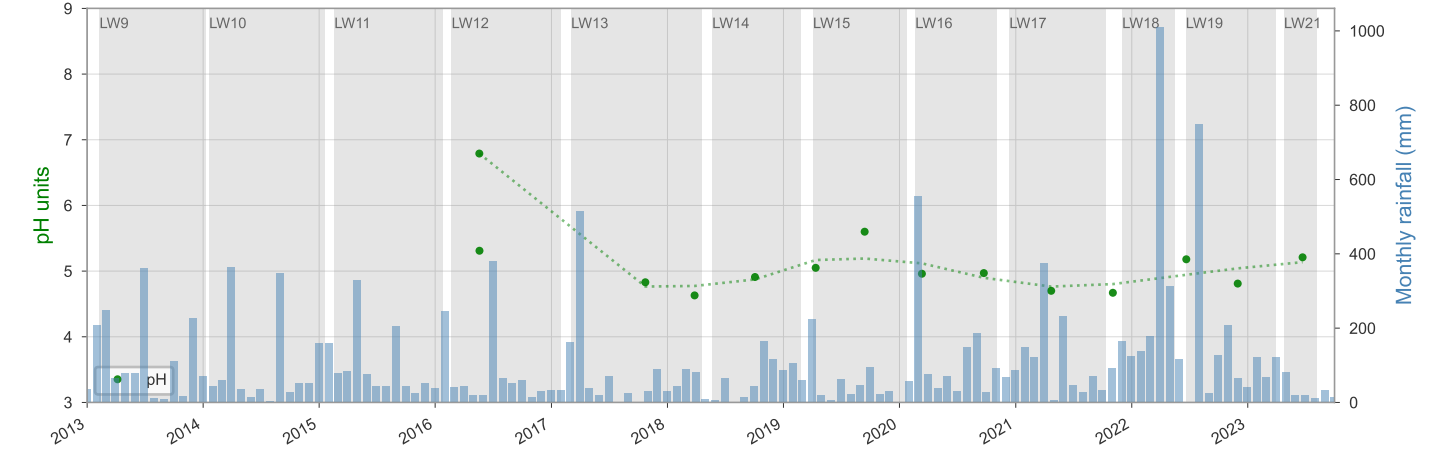
S22_POOL10



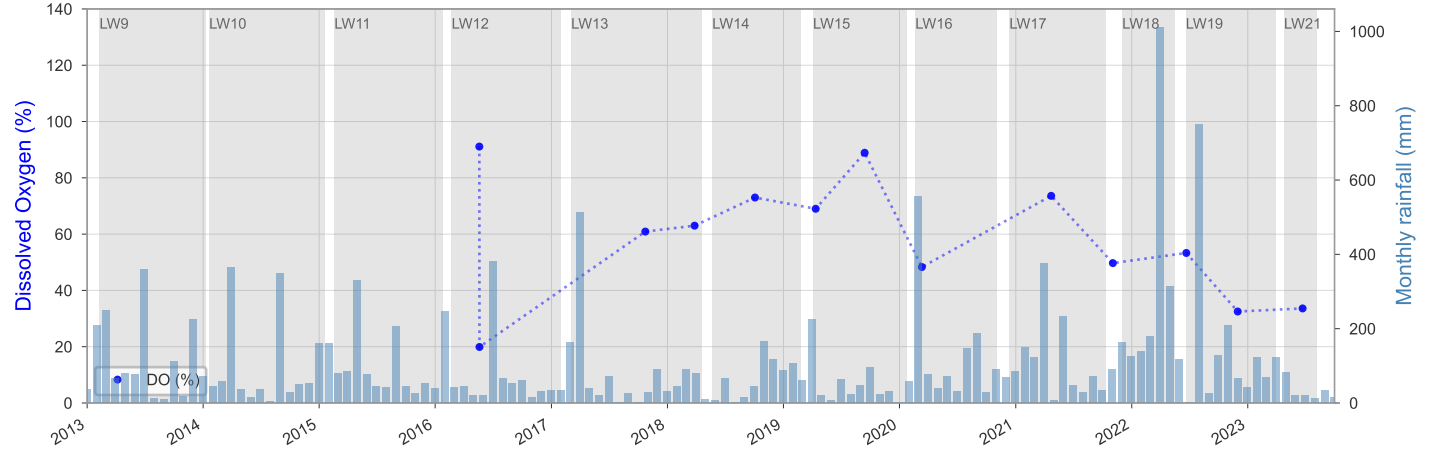
S22_POOL10



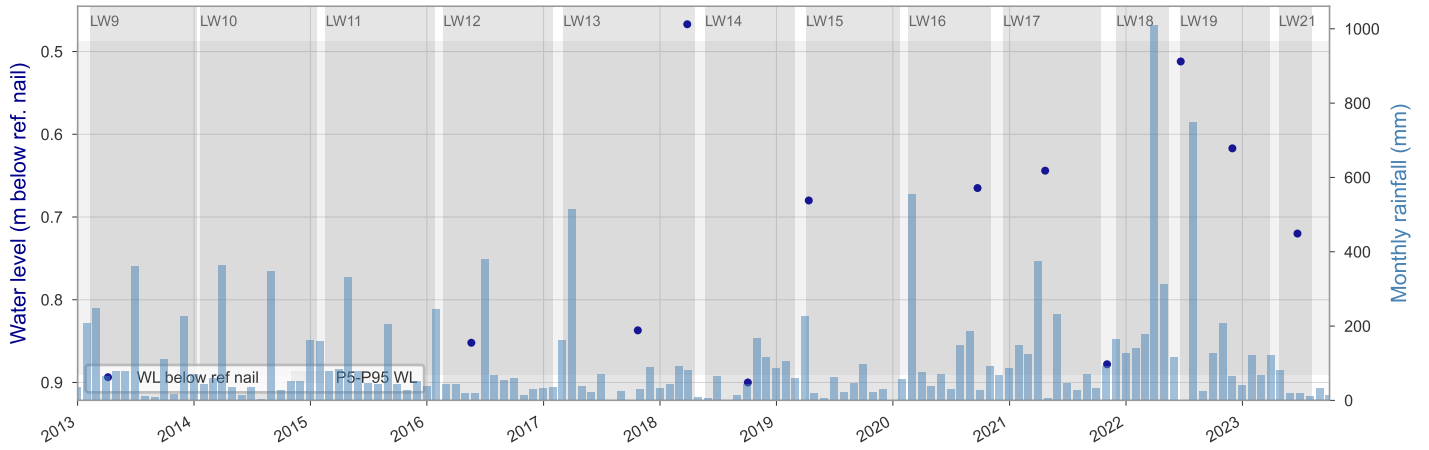
S22_POOL10



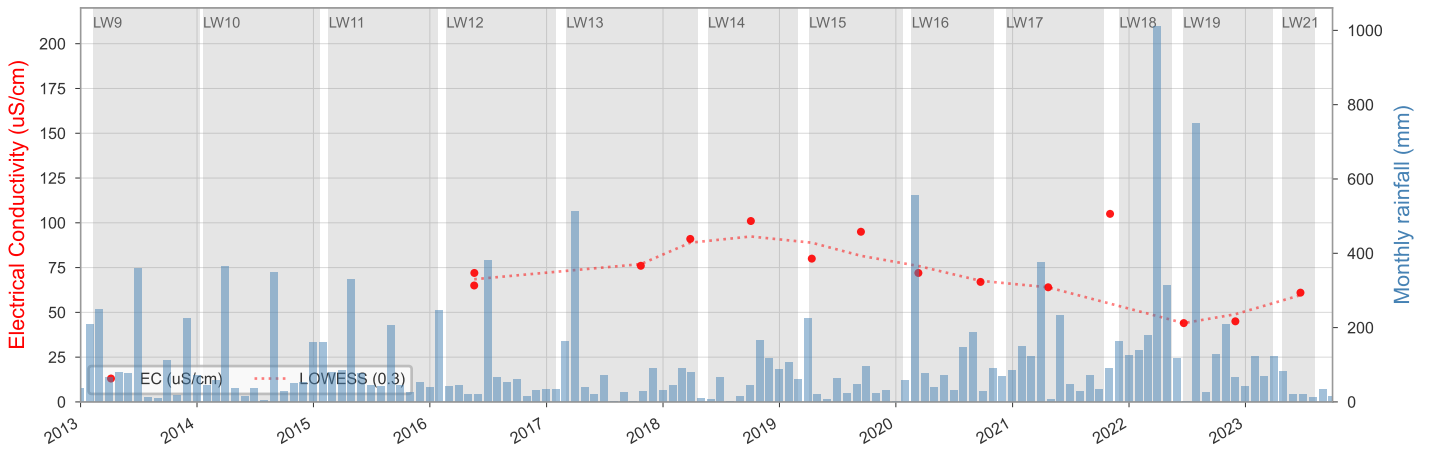
S22_POOL10



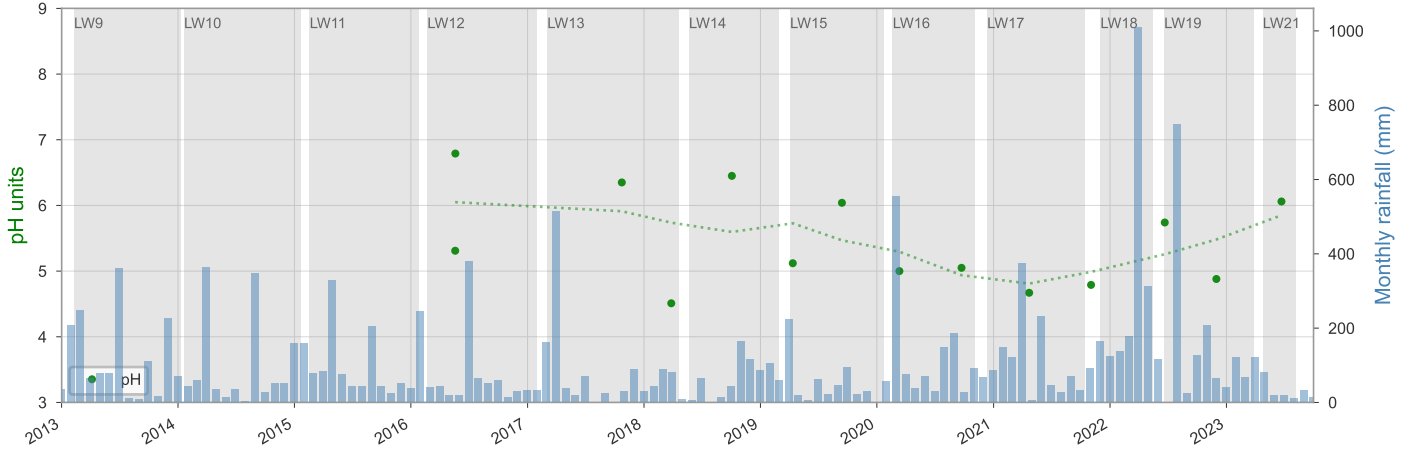
S22_POOL9



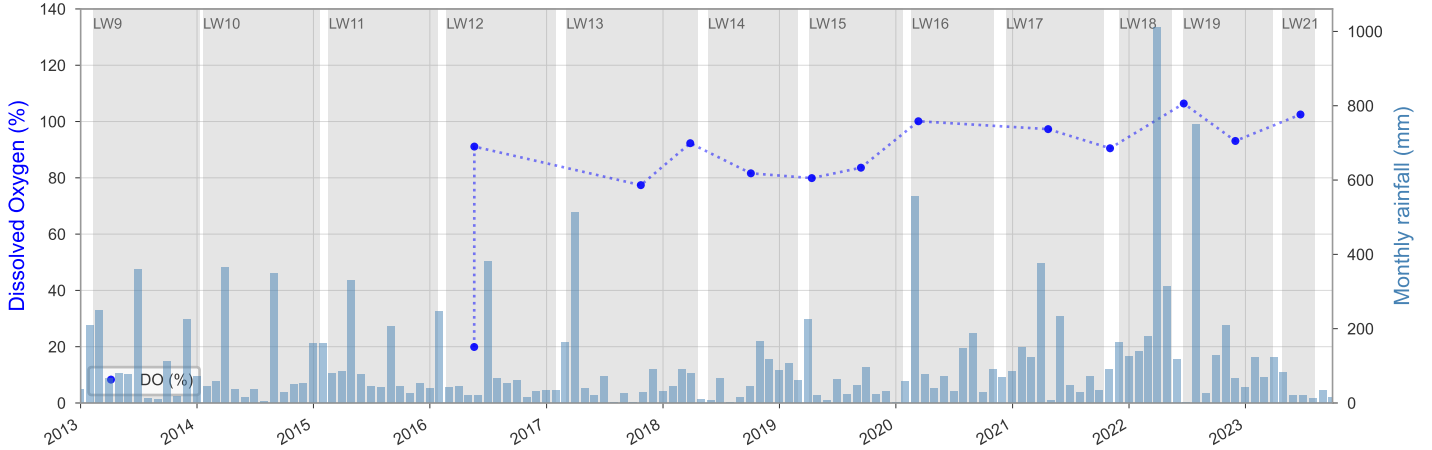
S22_POOL9



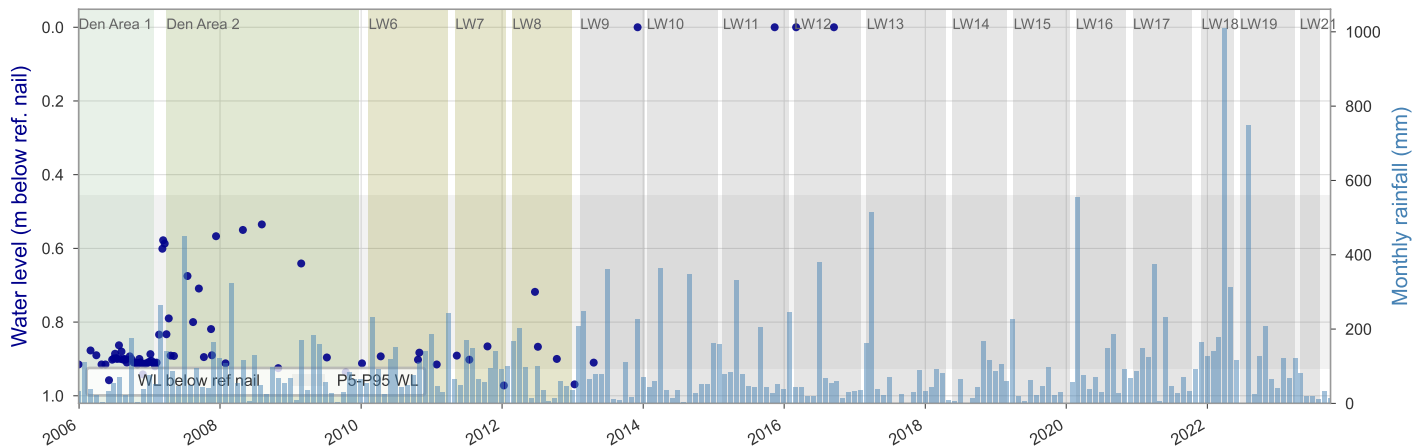
S22_POOL9



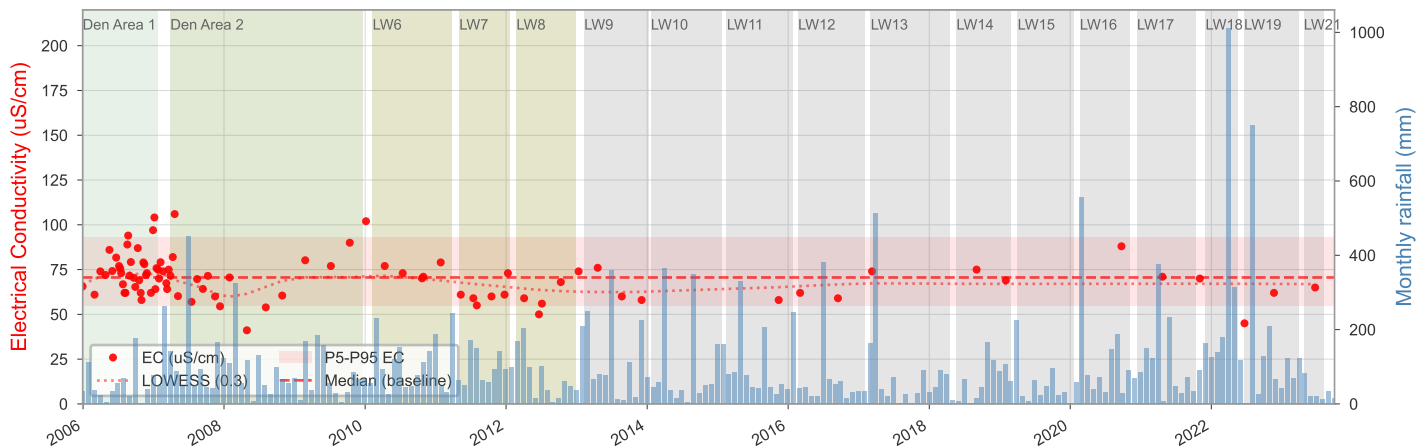
S22_POOL9



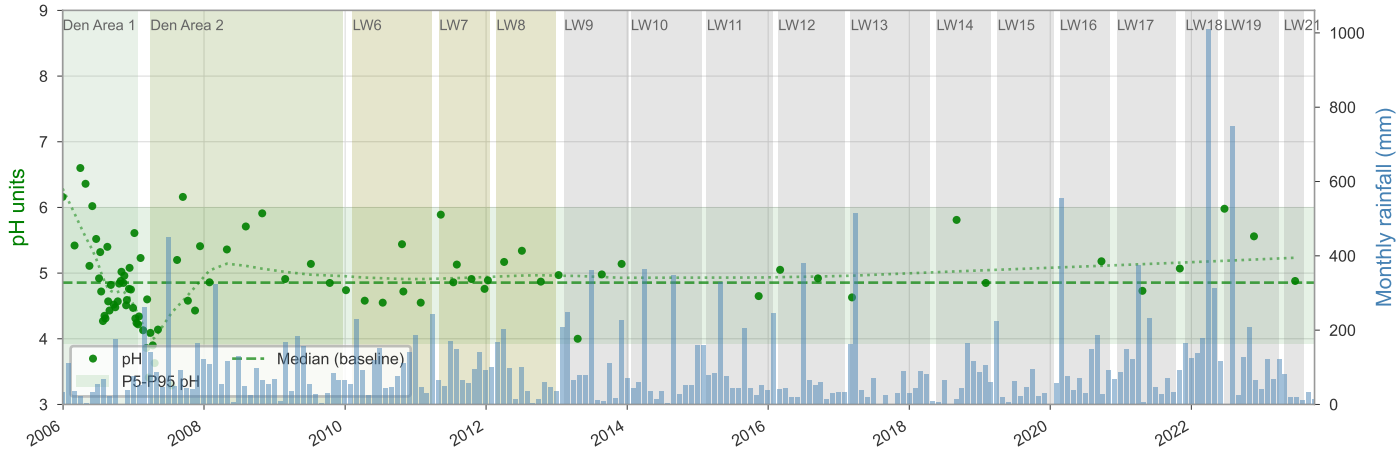
S24_POOL10



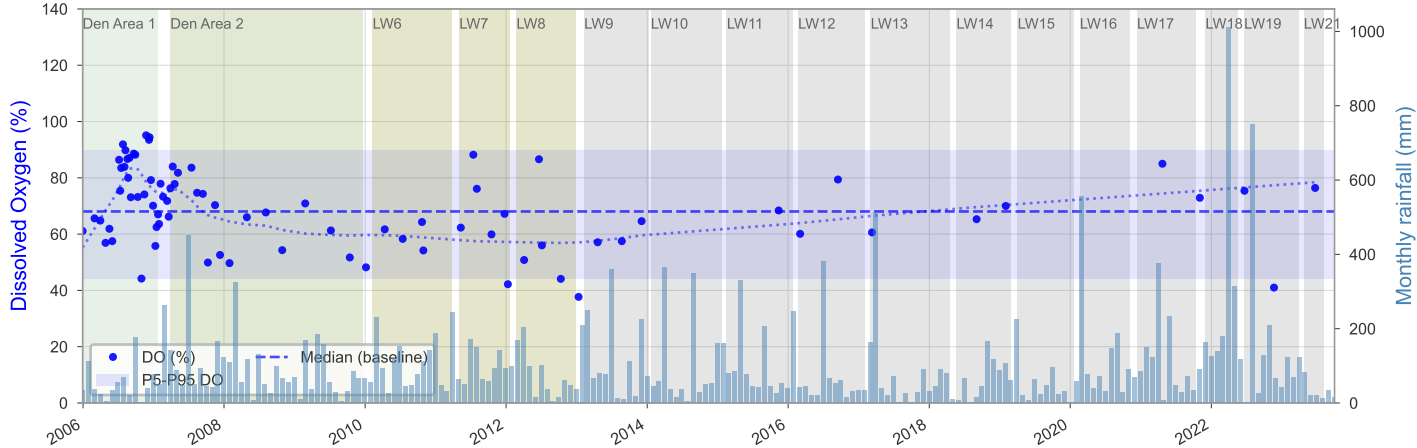
S24_POOL10



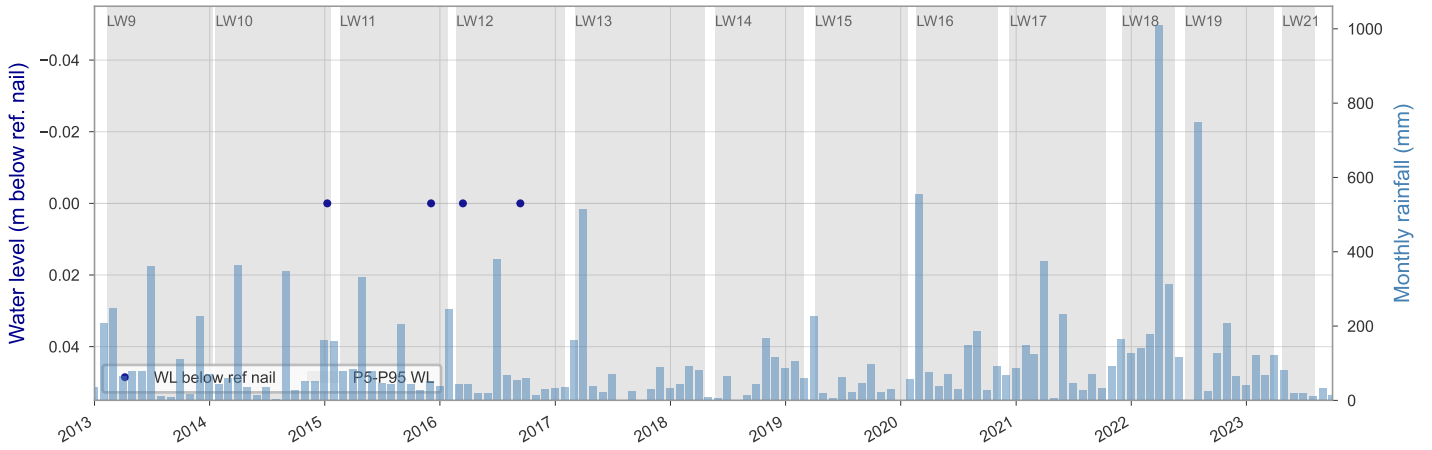
S24_POOL10



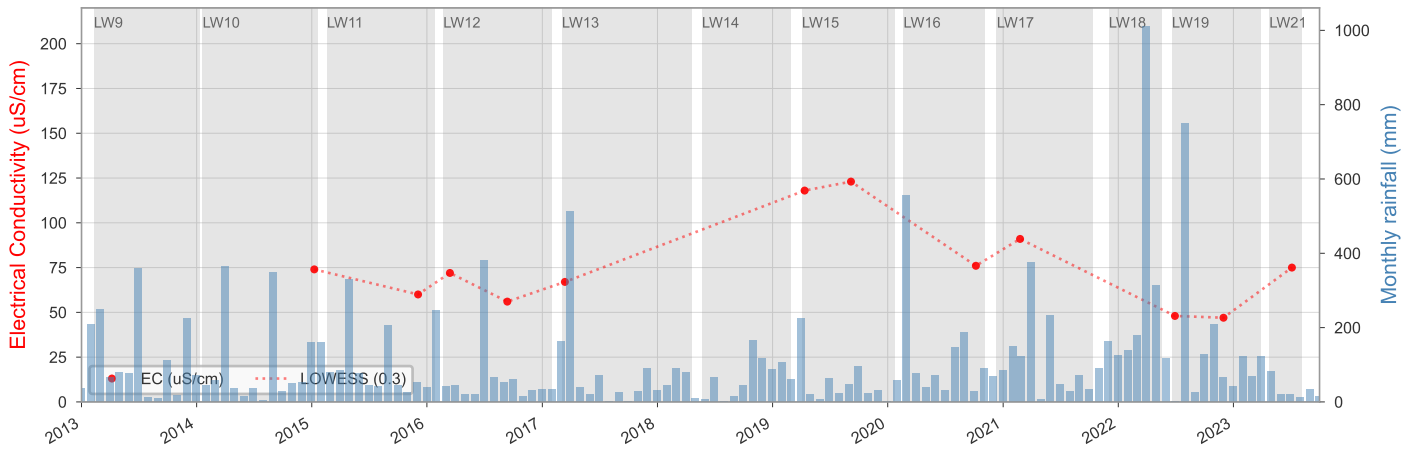
S24_POOL10



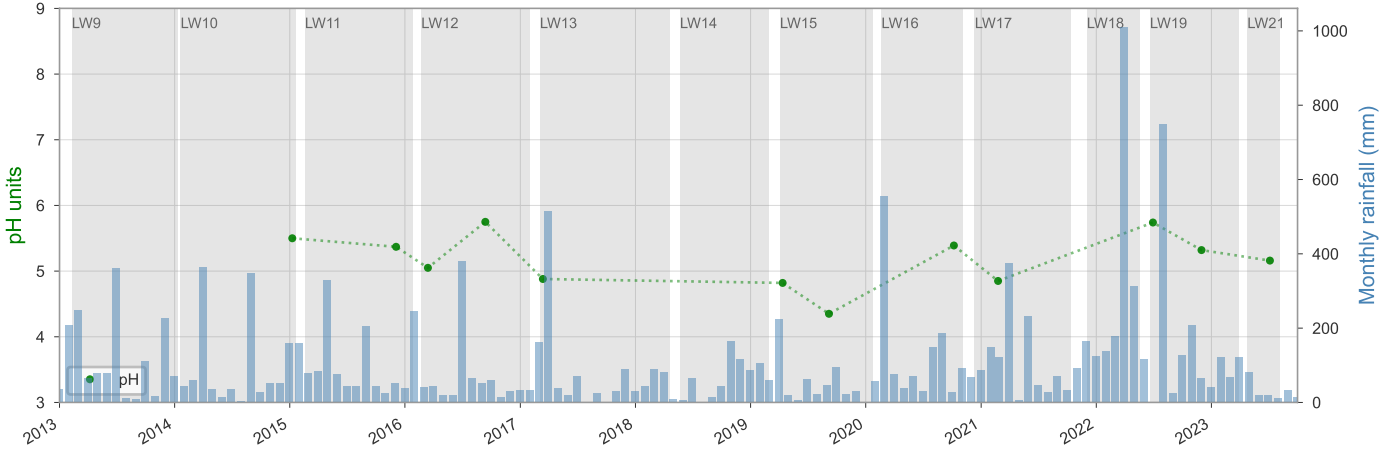
S84_POOL10



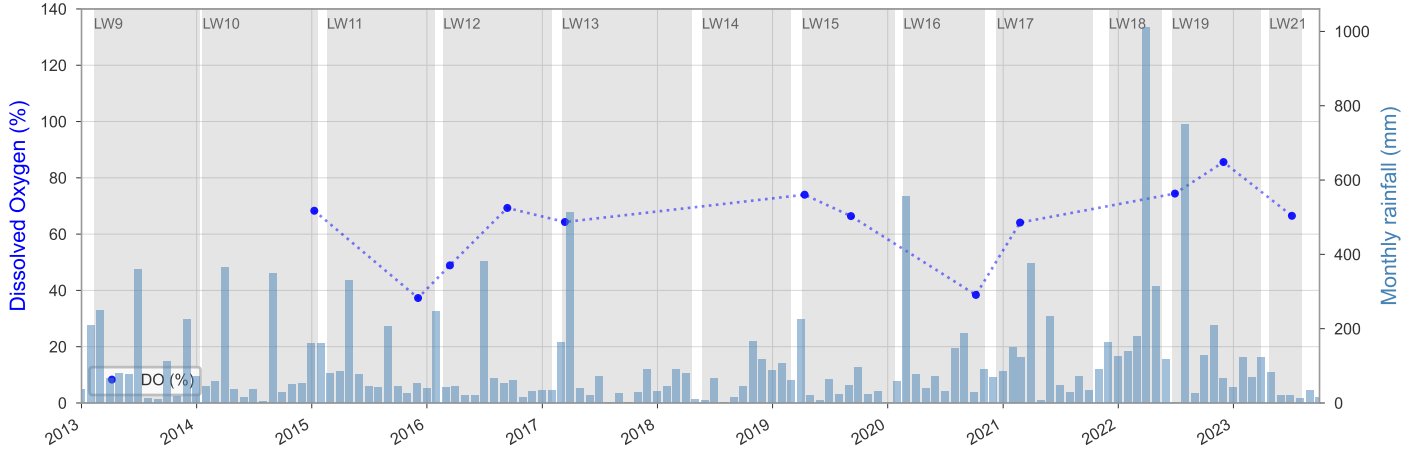
S84_POOL10



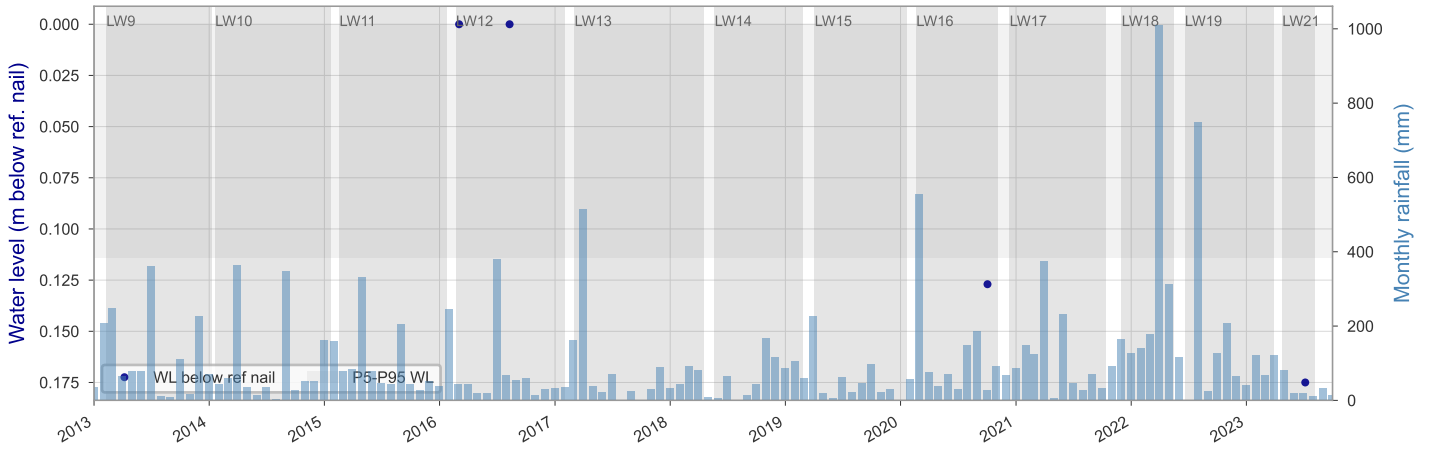
S84_POOL10



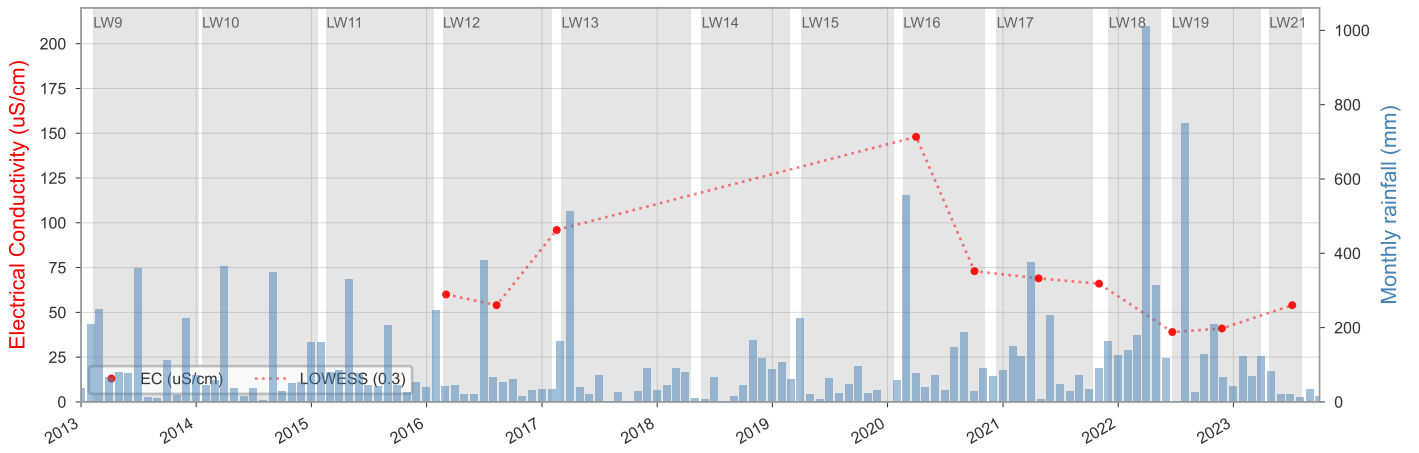
S84_POOL10



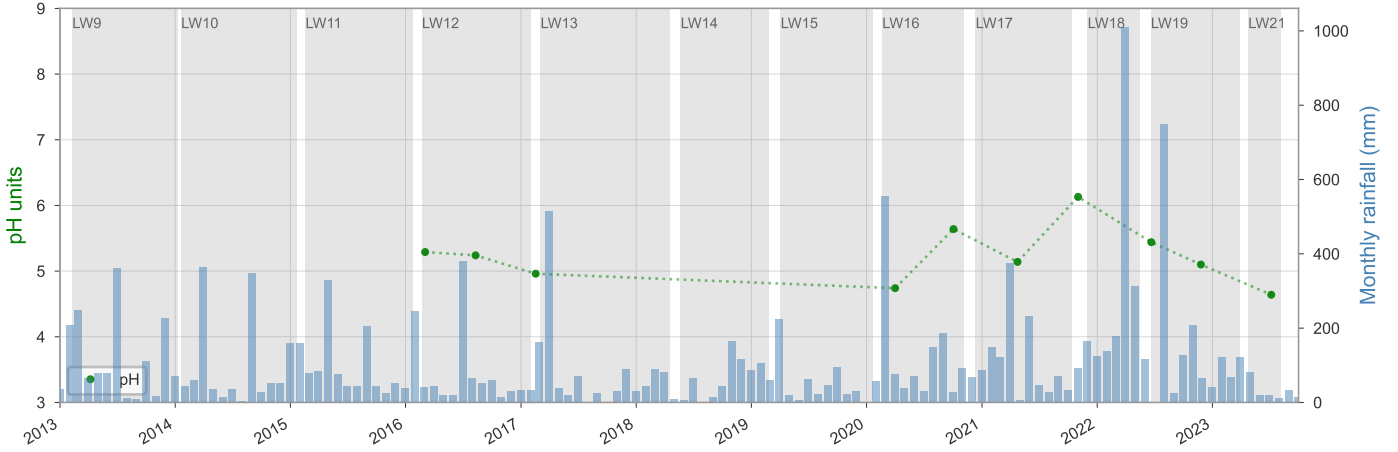
S88_POOL10



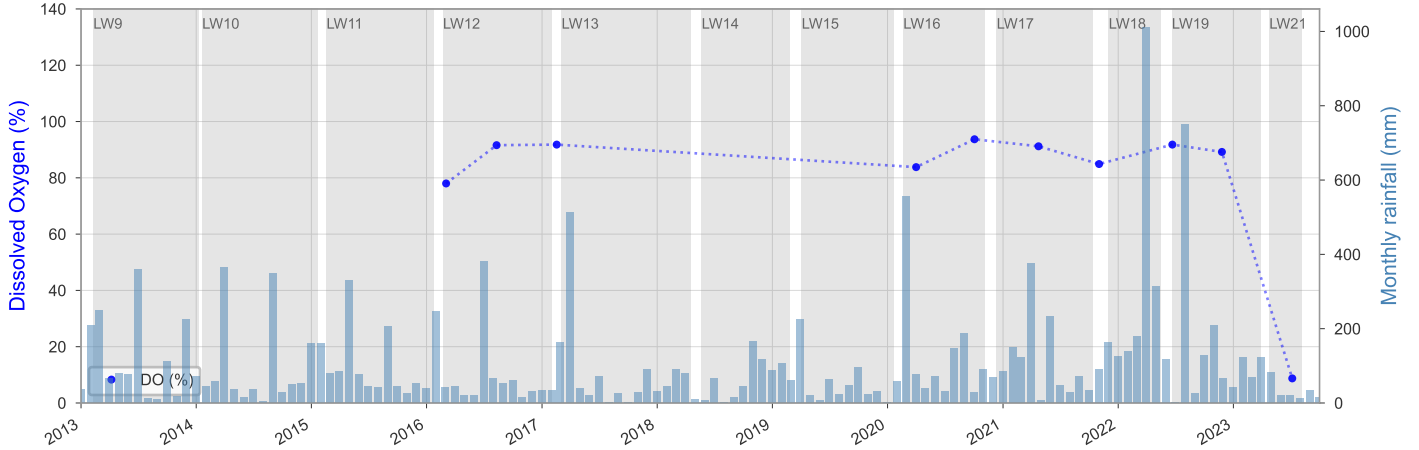
S88_POOL10



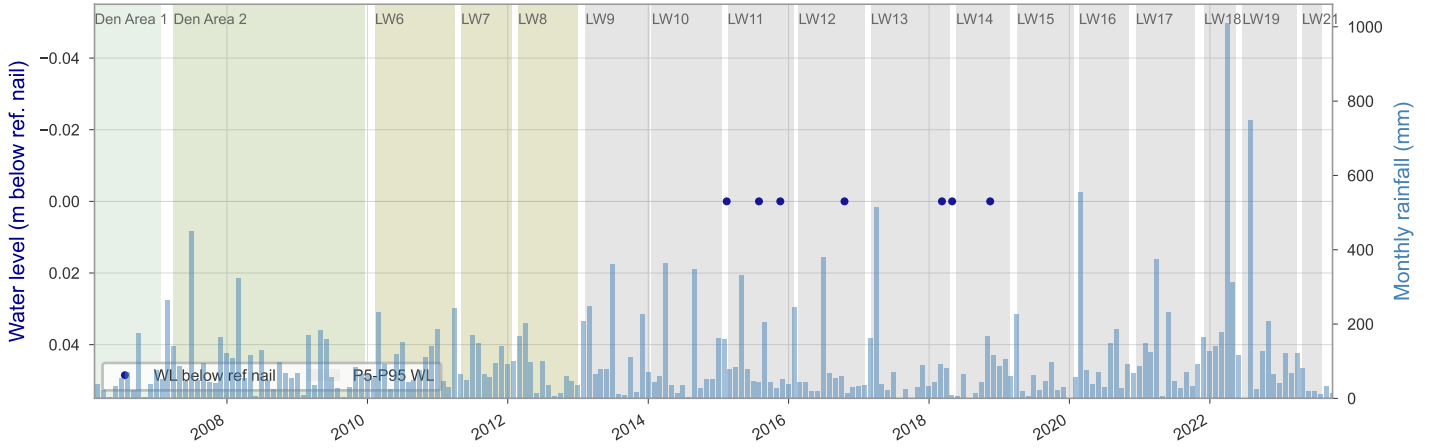
S88_POOL10



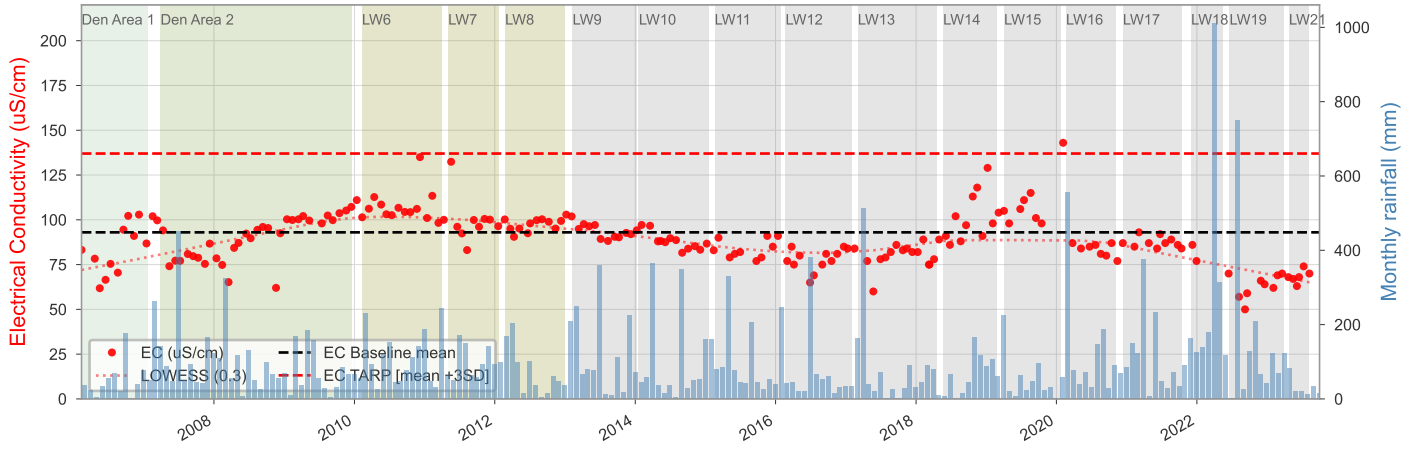
S88_POOL10



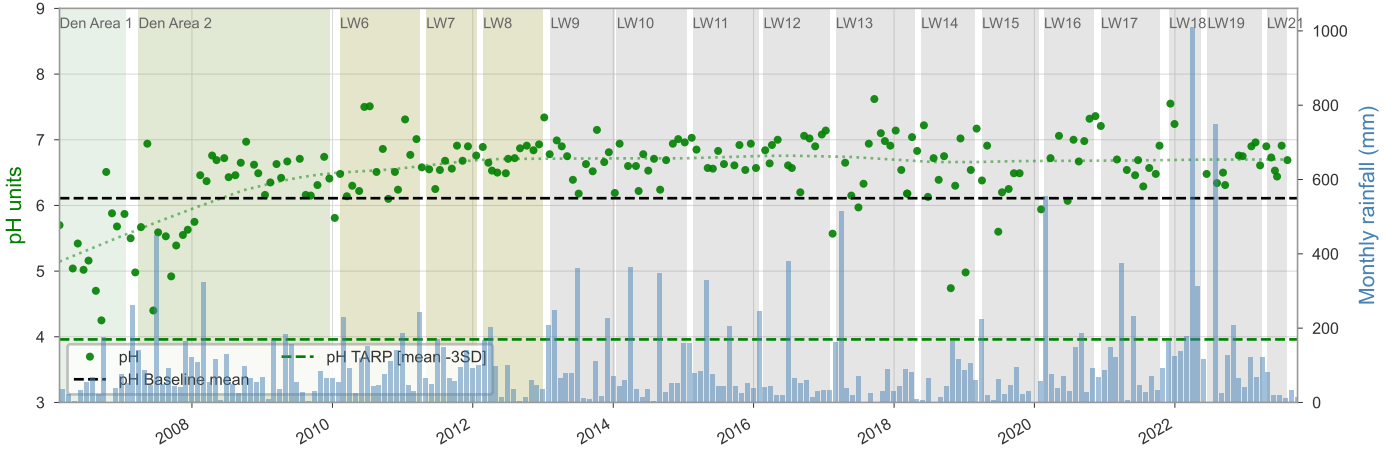
SANDY_CREEK_ARM



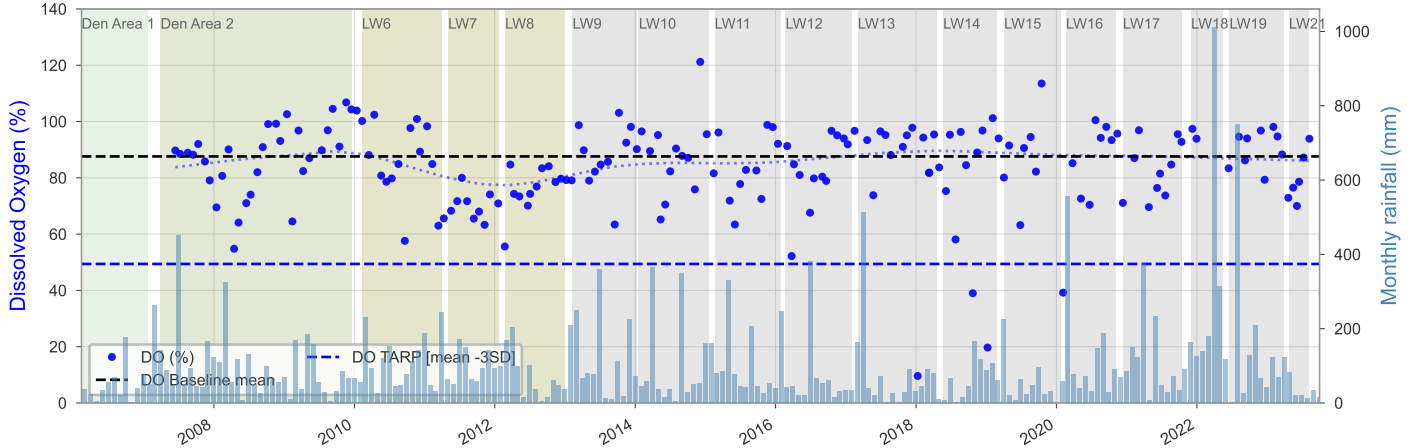
SANDY_CREEK_ARM



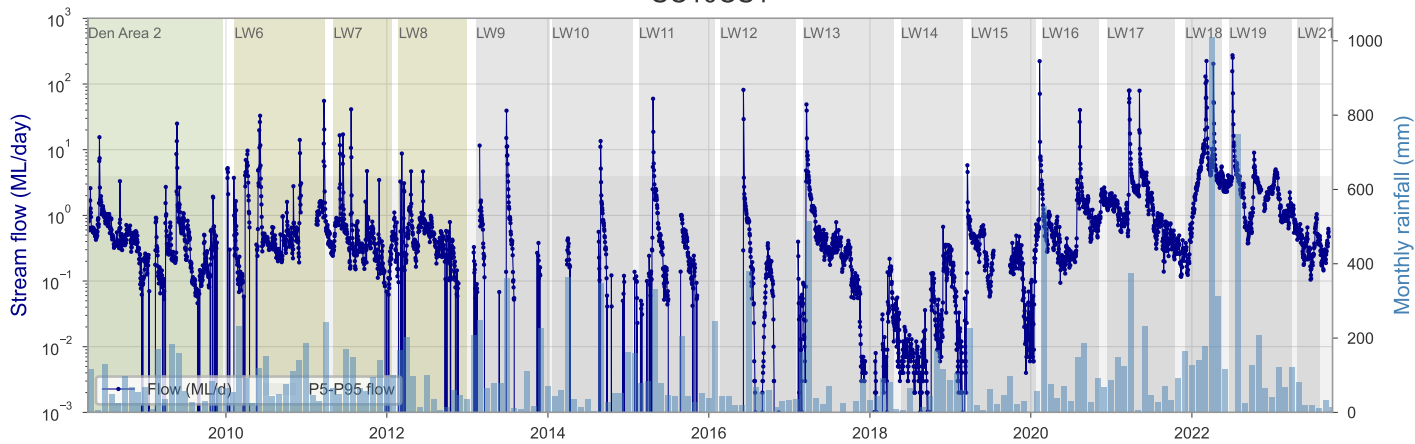
SANDY_CREEK_ARM



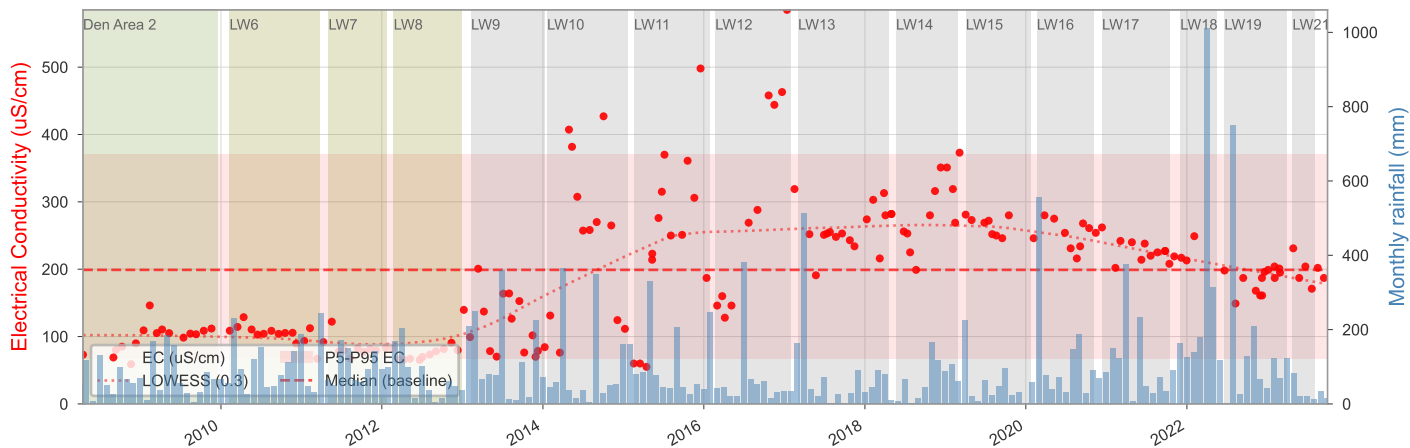
SANDY_CREEK_ARM



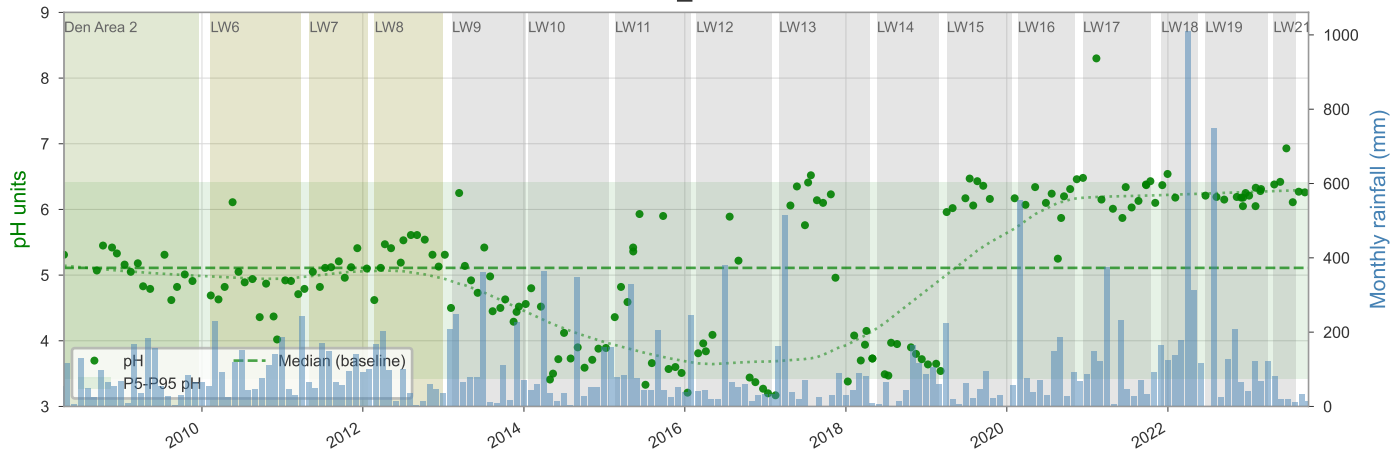
SC10CS1



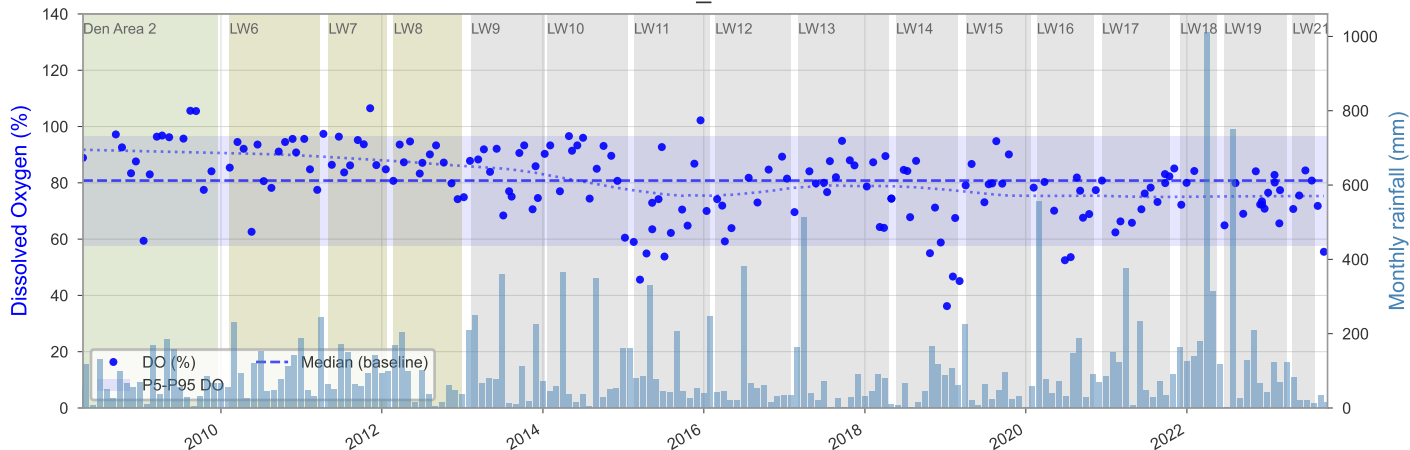
SC10C_POOL1



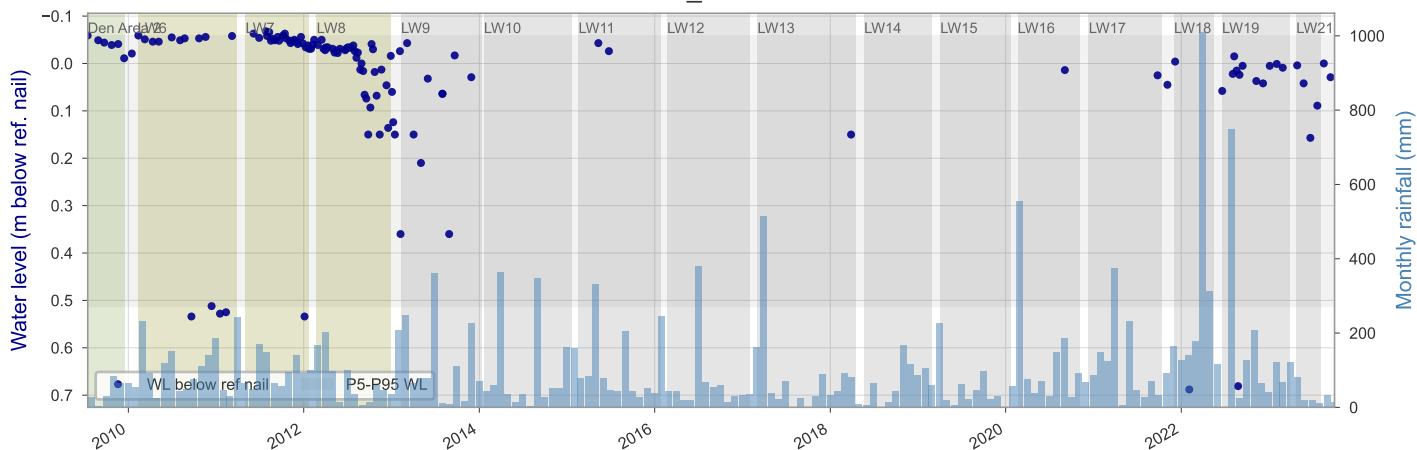
SC10C_POOL1



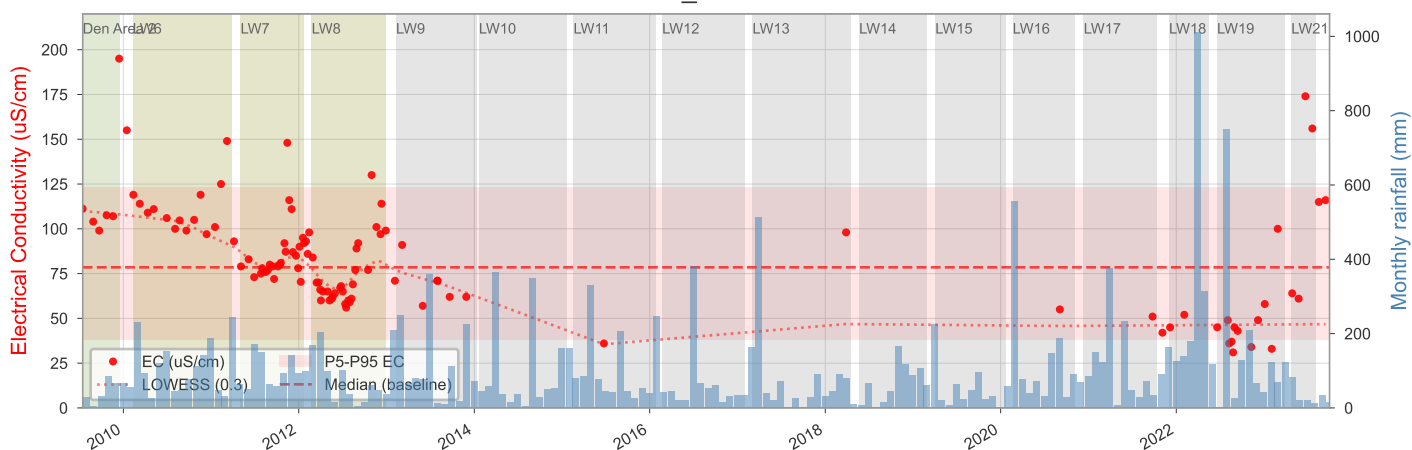
SC10C_POOL1



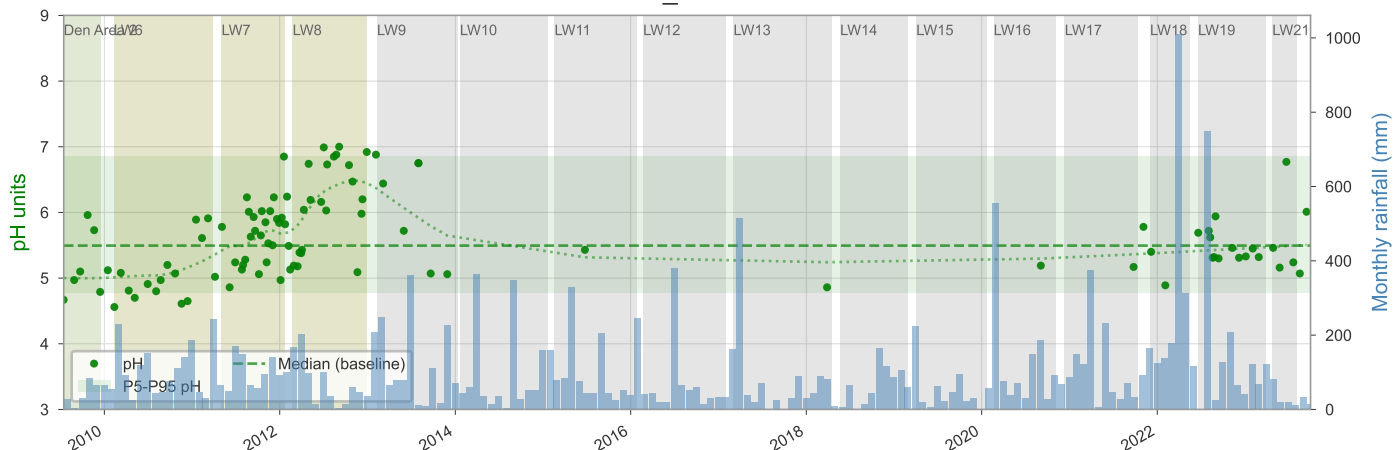
SC10C_POOL11A



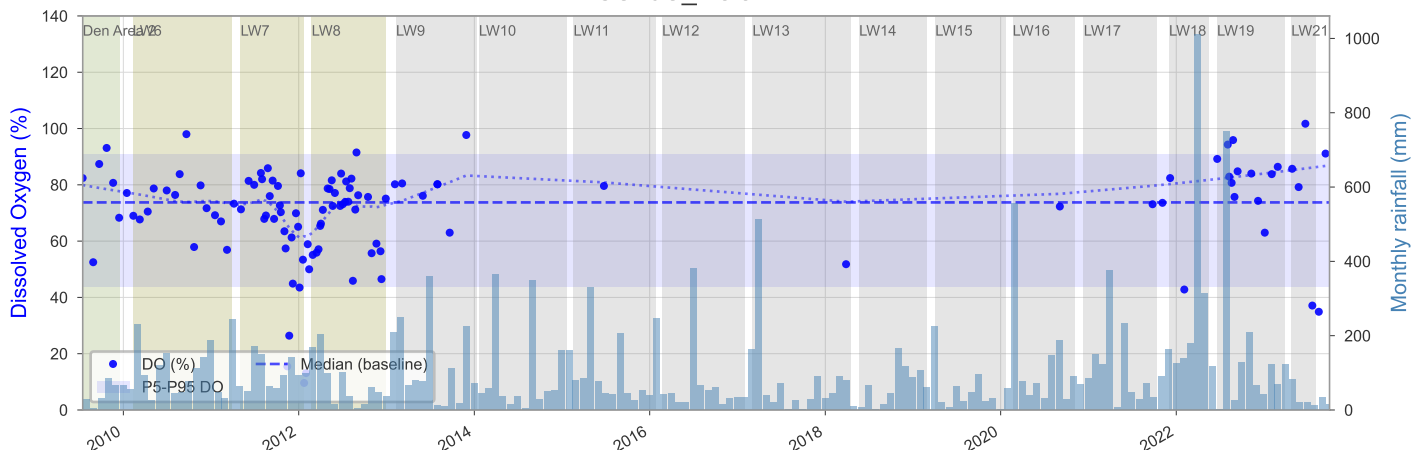
SC10C_POOL11A



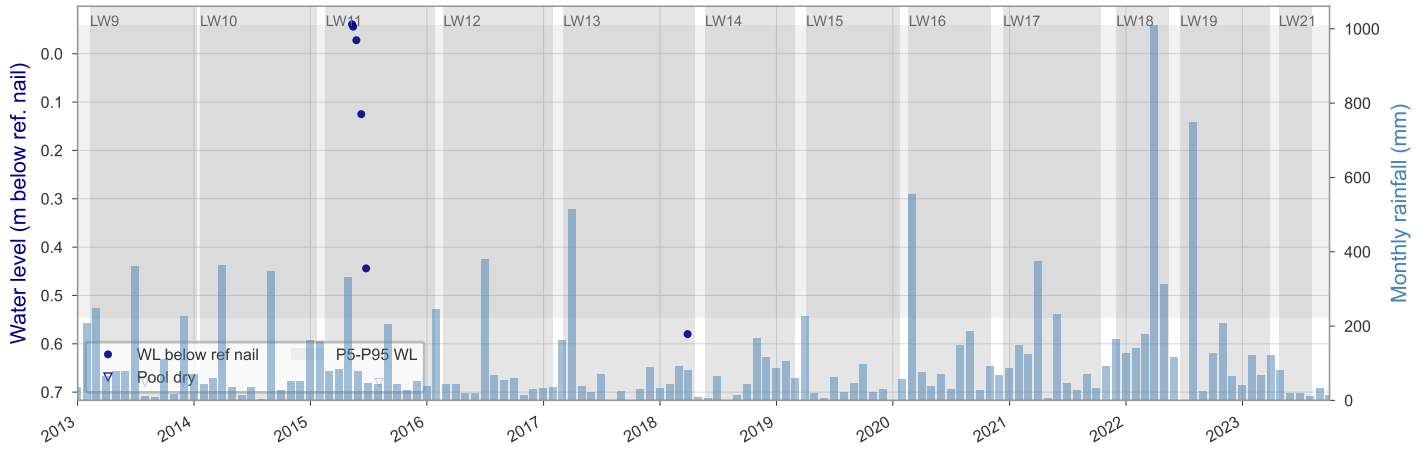
SC10C_POOL11A



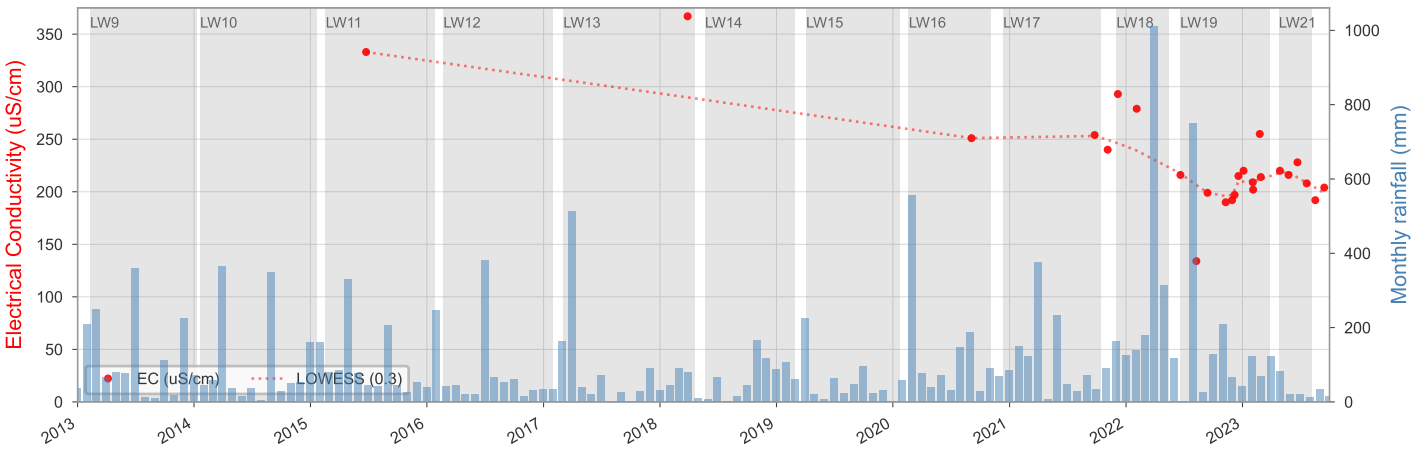
SC10C_POOL11A



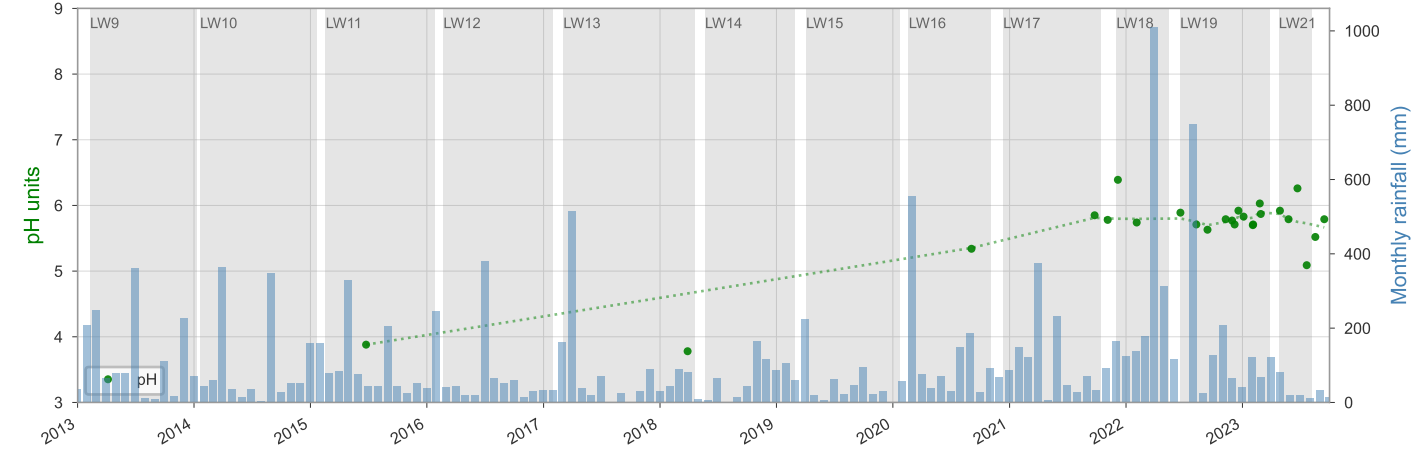
SC10C_POOL3



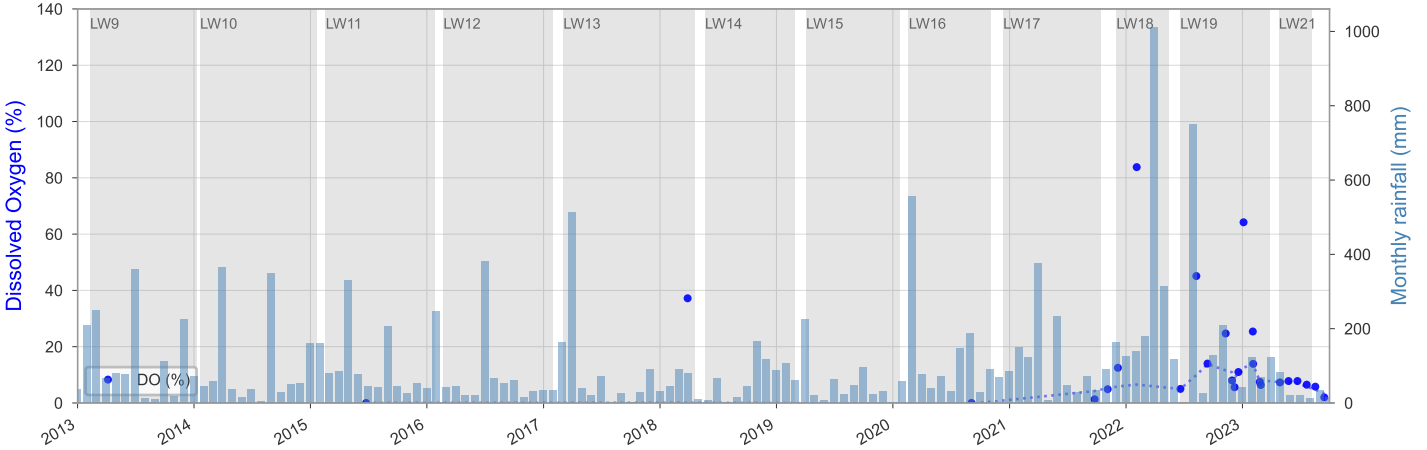
SC10C_POOL3



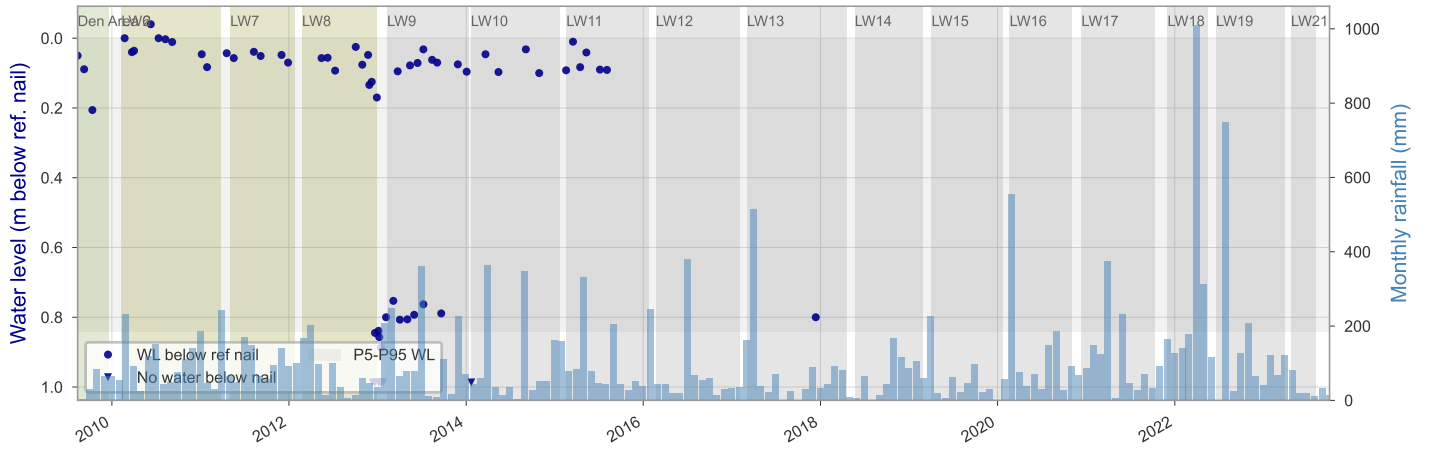
SC10C_POOL3



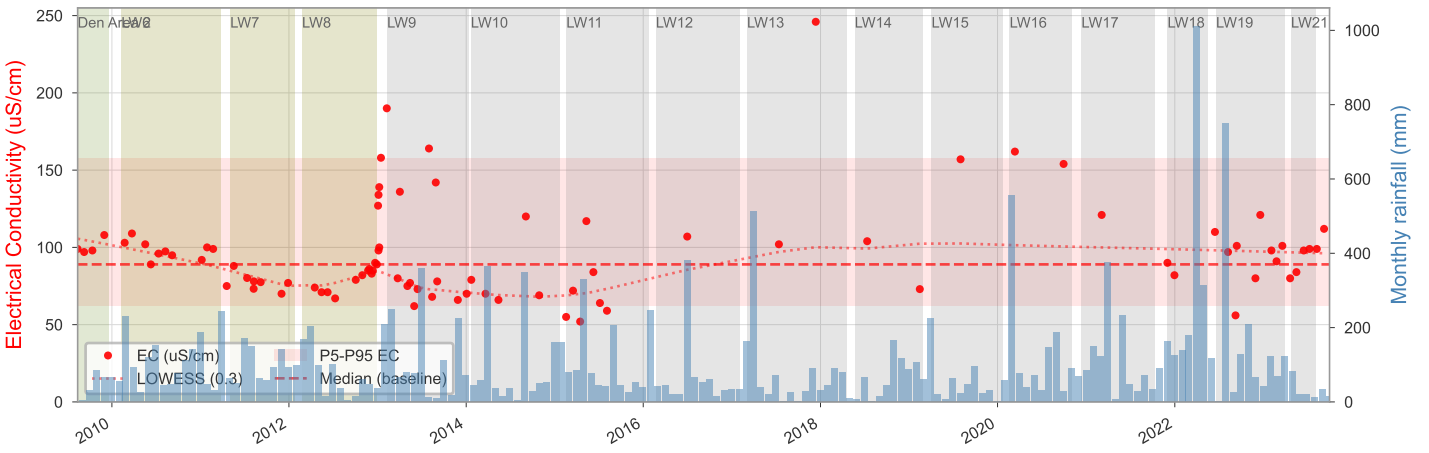
SC10C_POOL3



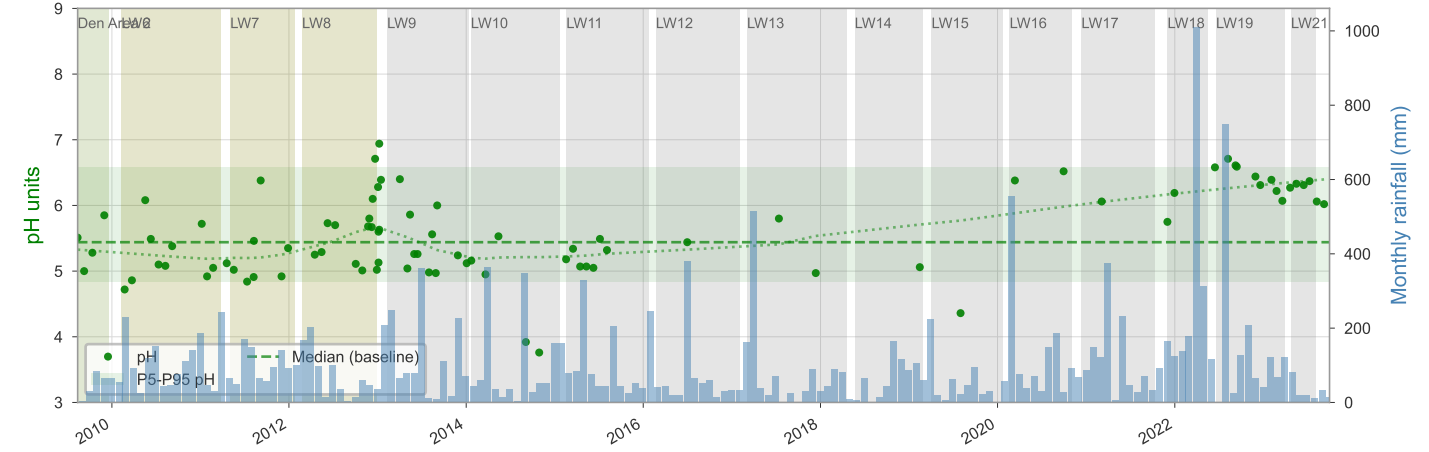
SC10_POOL1



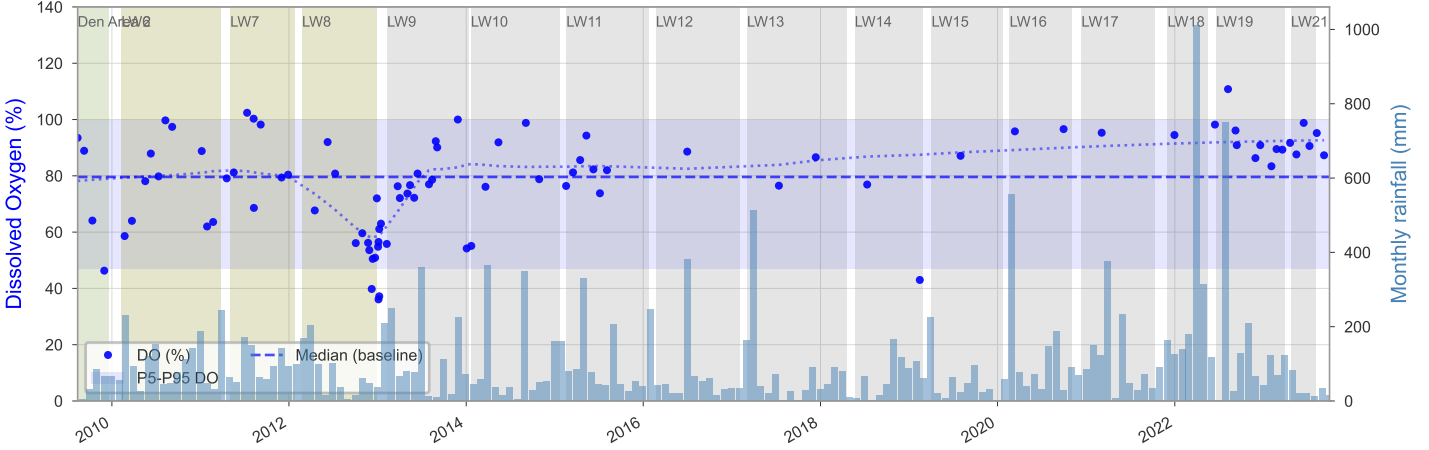
SC10_POOL1



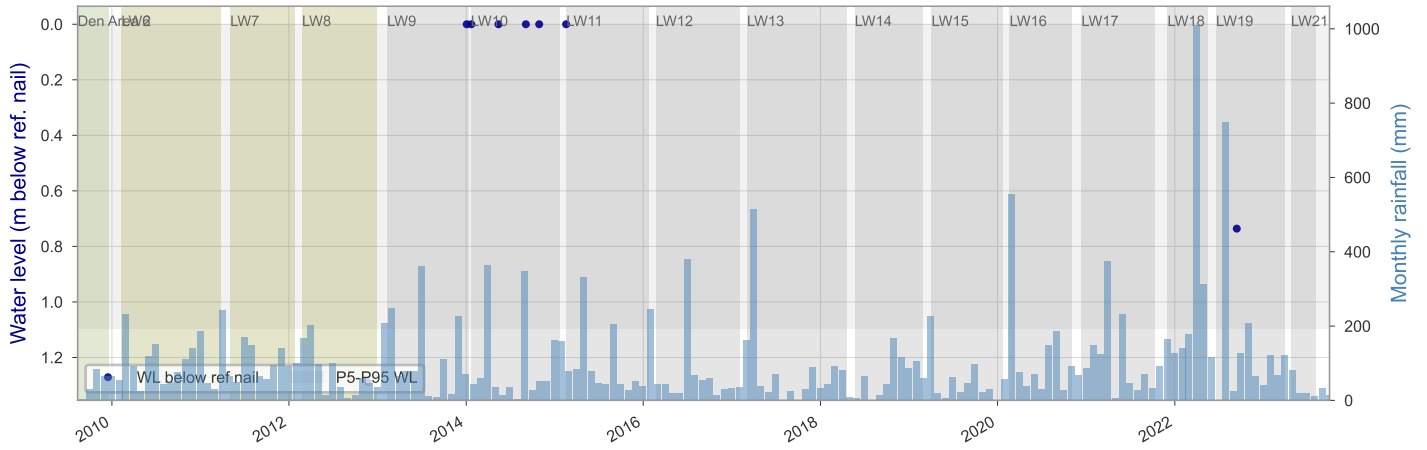
SC10_POOL1



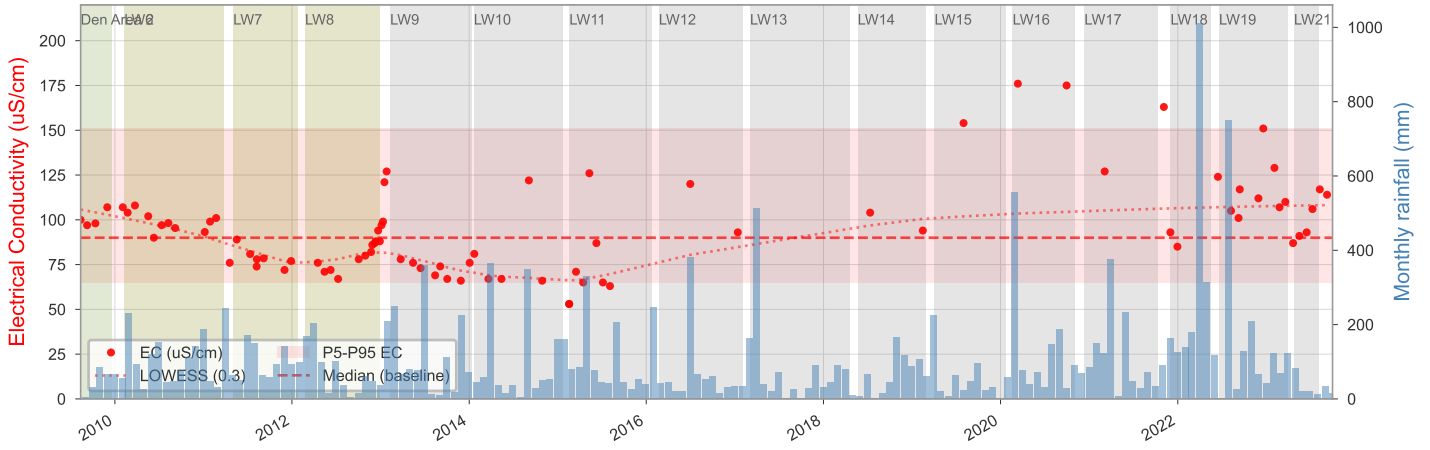
SC10_POOL1



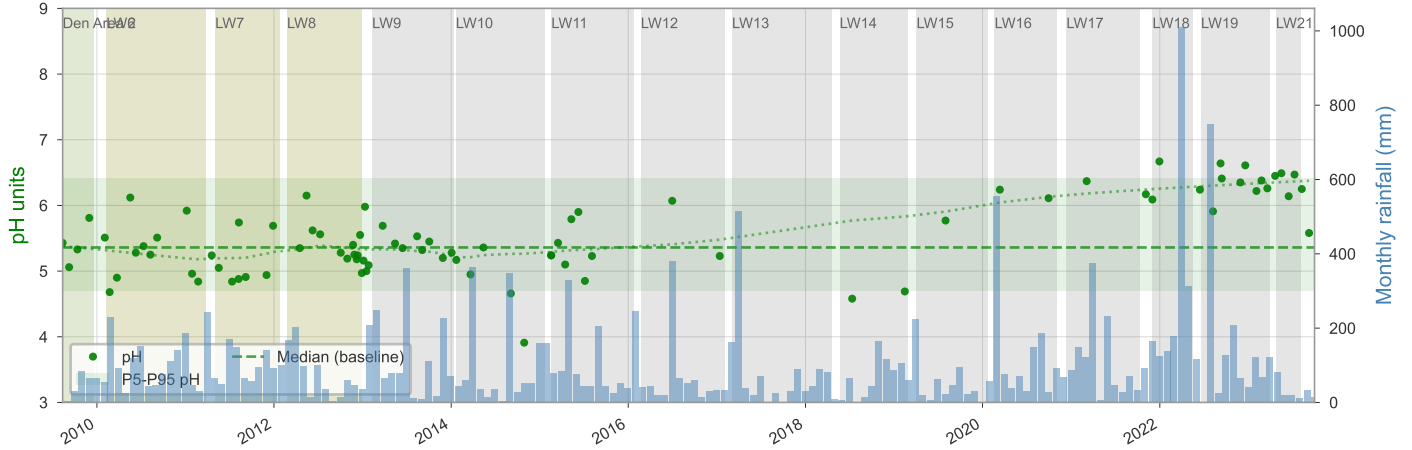
SC10_POOL10B



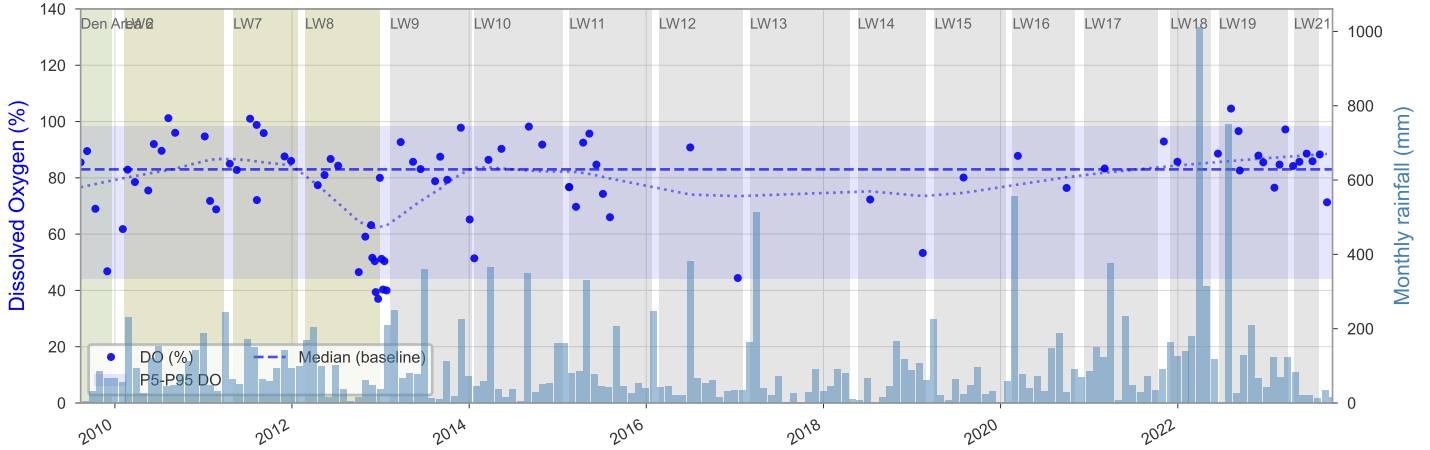
SC10_POOL10B



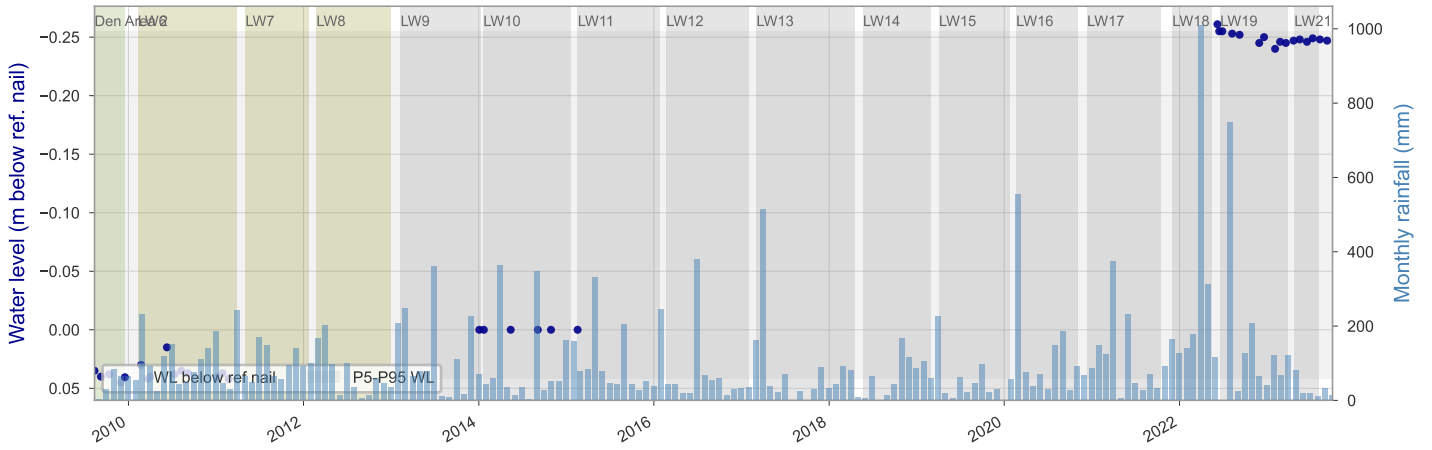
SC10_POOL10B



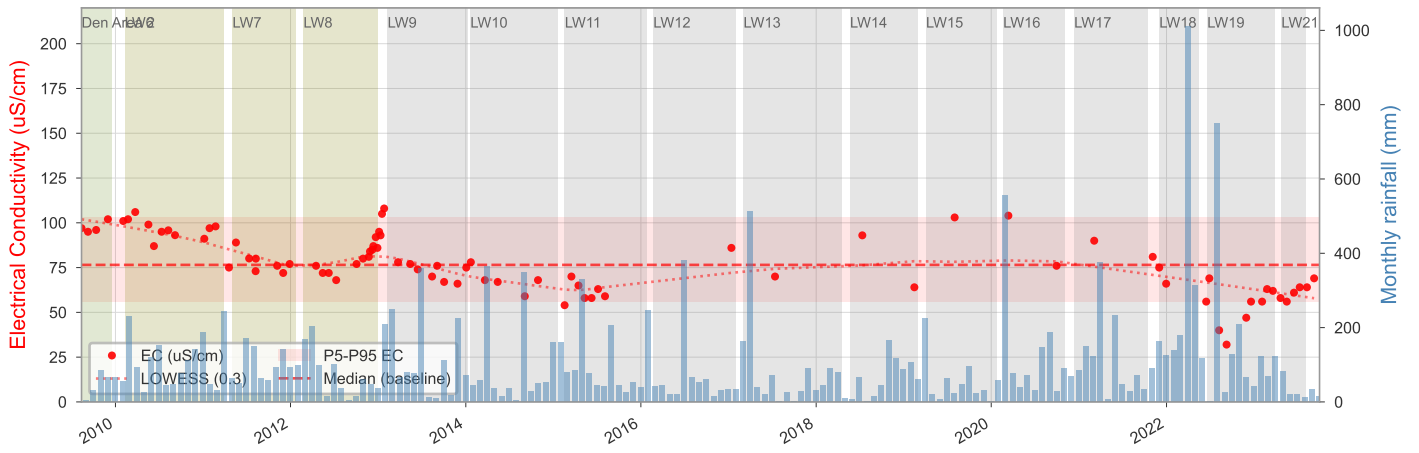
SC10_POOL10B



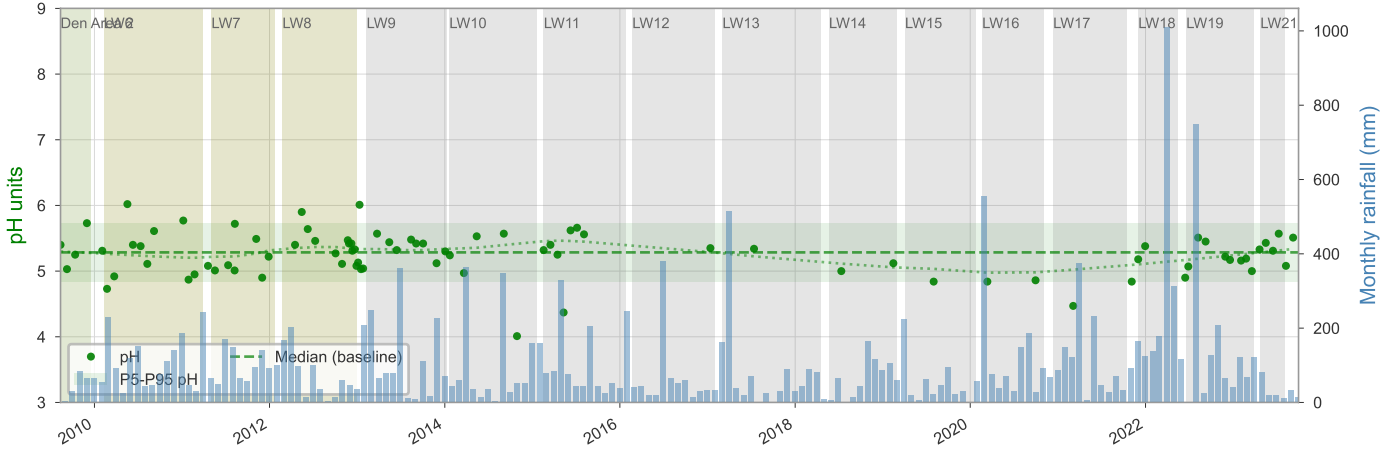
SC10_POOL11



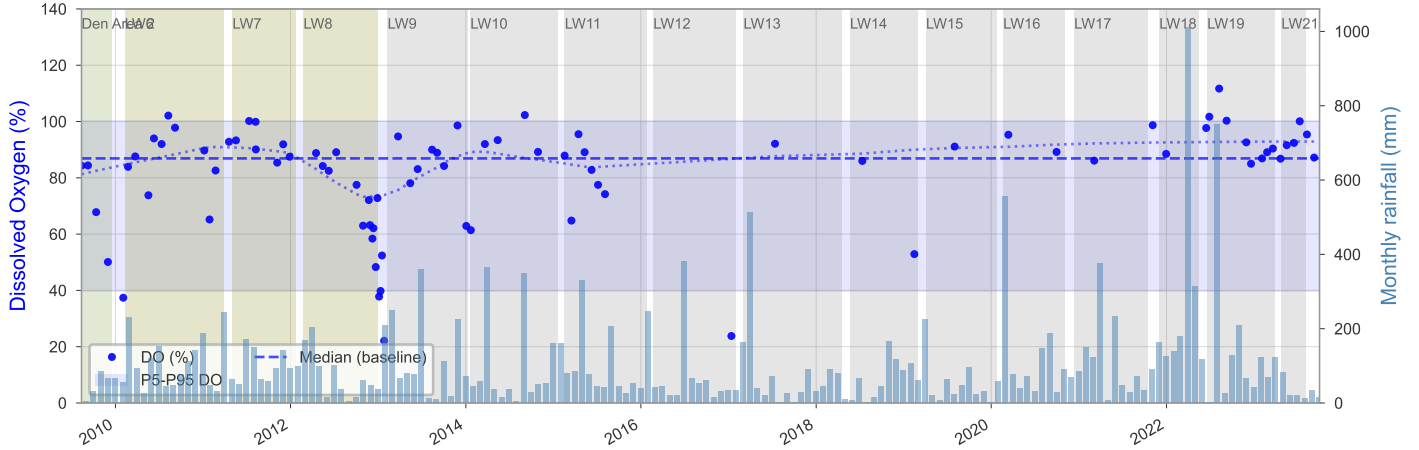
SC10_POOL11



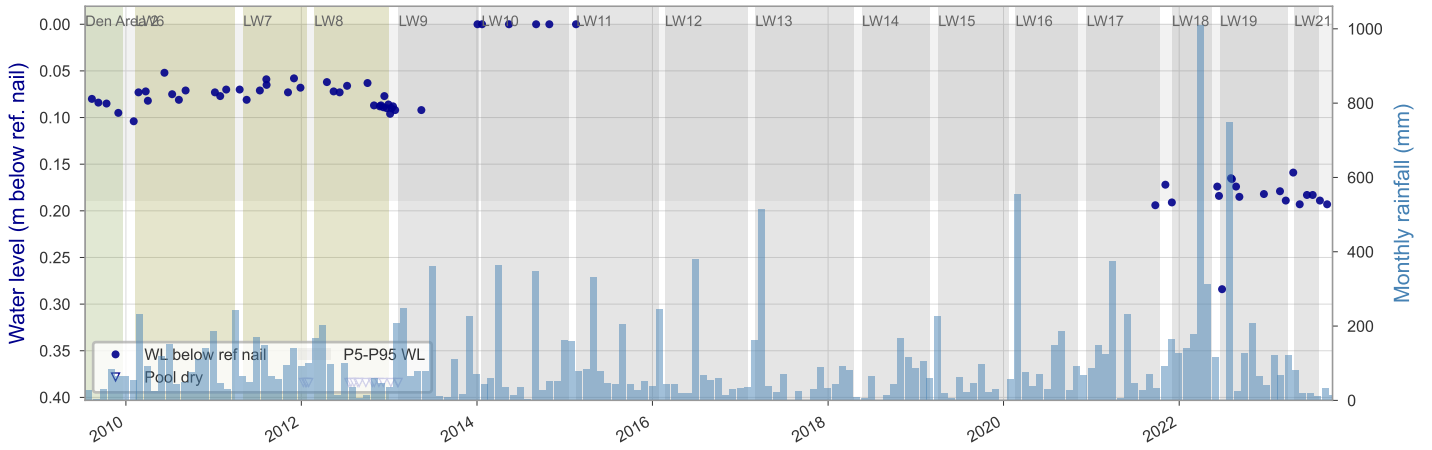
SC10_POOL11



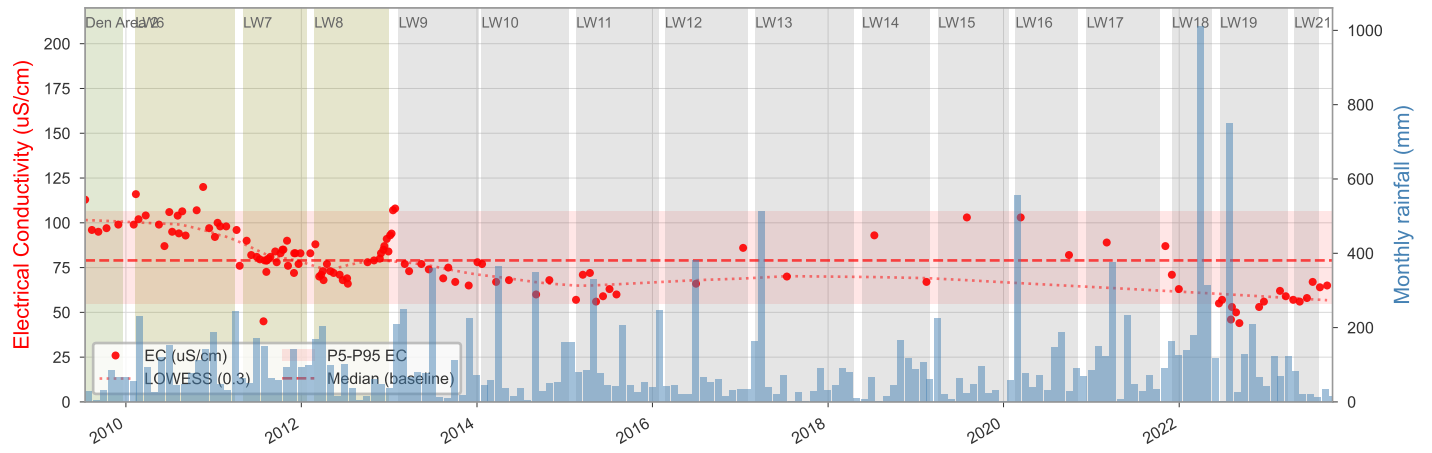
SC10_POOL11



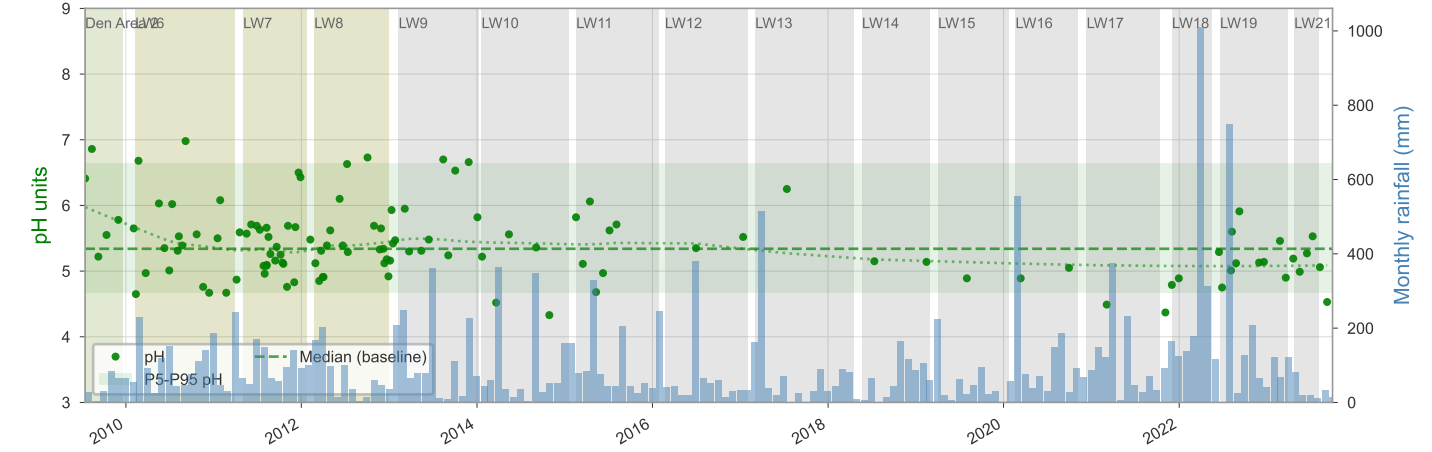
SC10_POOL14



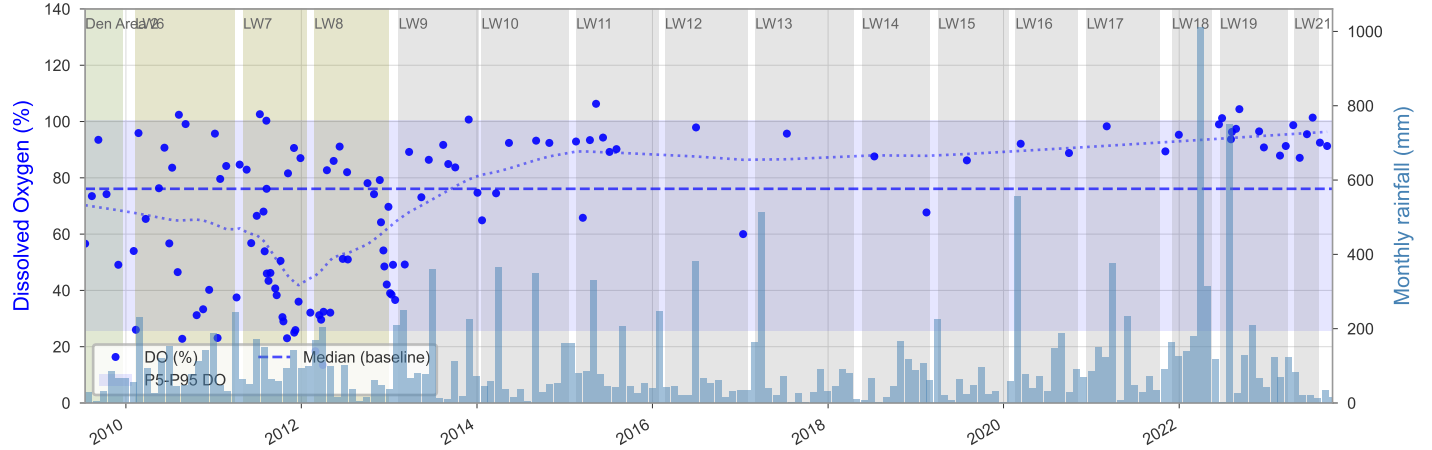
SC10_POOL14



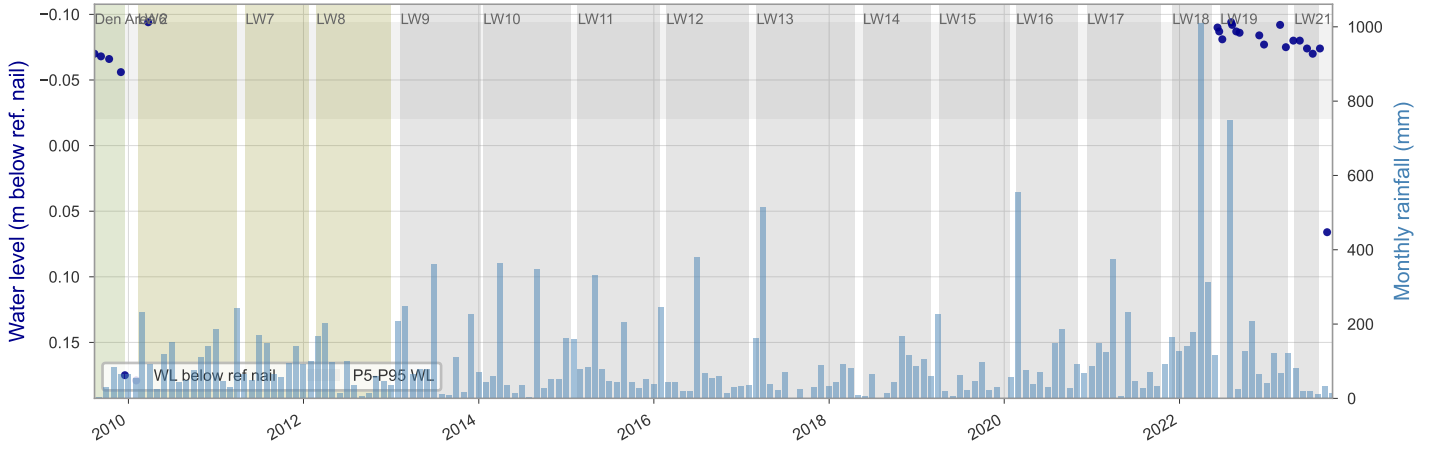
SC10_POOL14



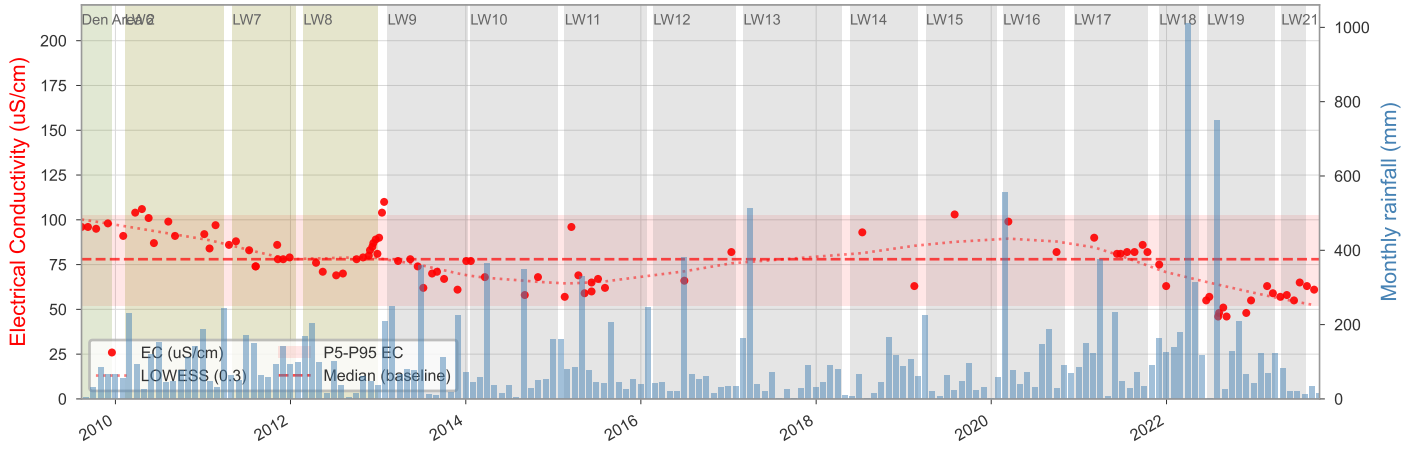
SC10_POOL14



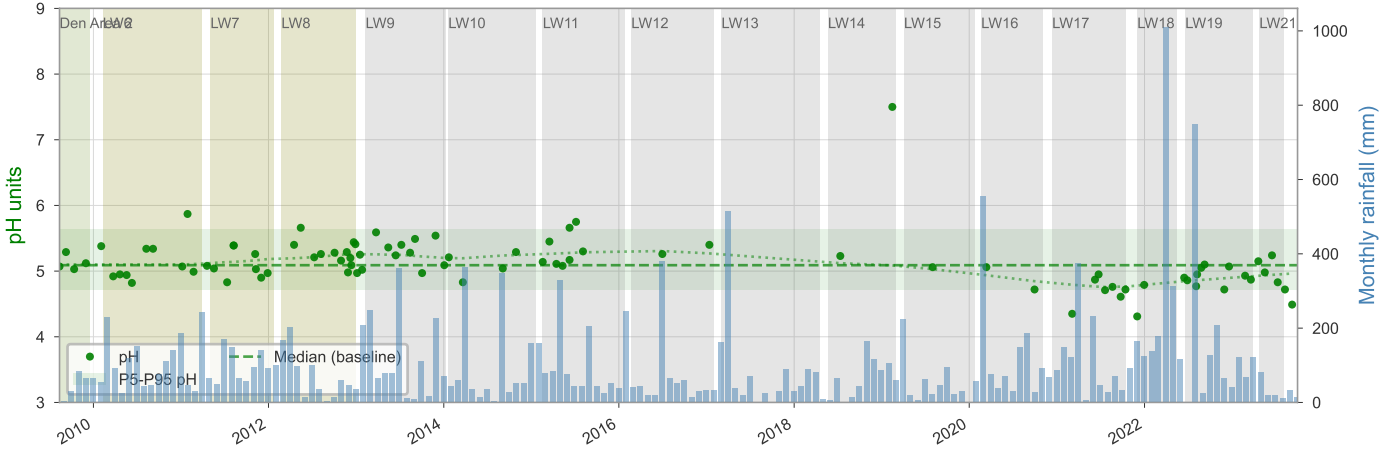
SC10_POOL15



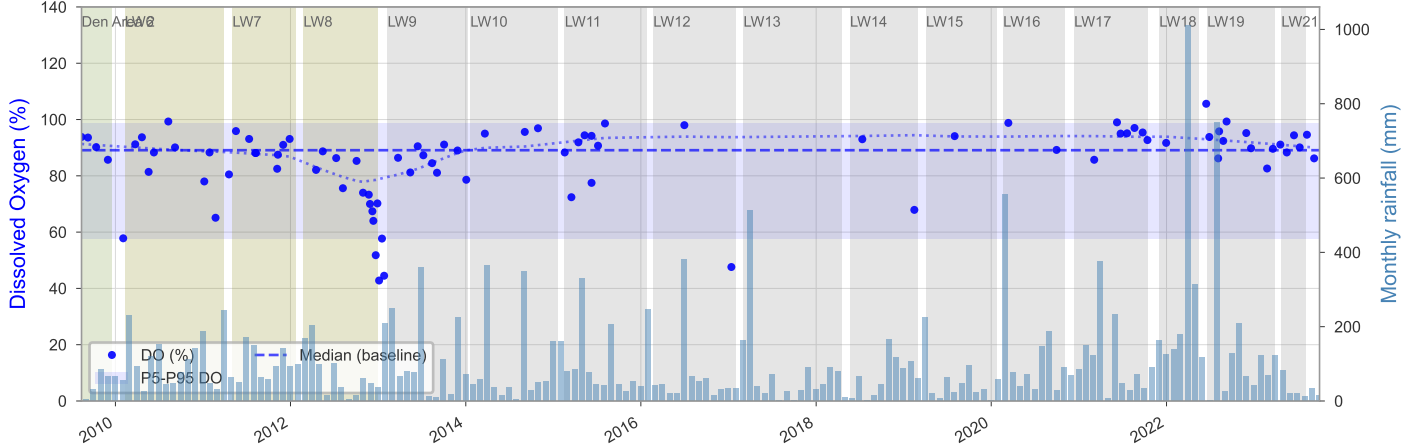
SC10_POOL15



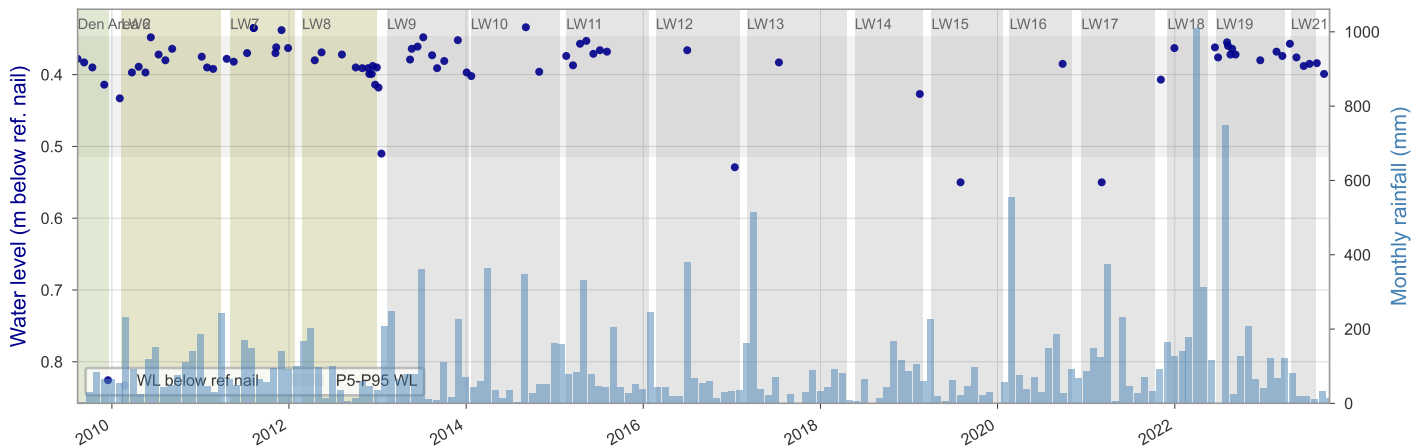
SC10_POOL15



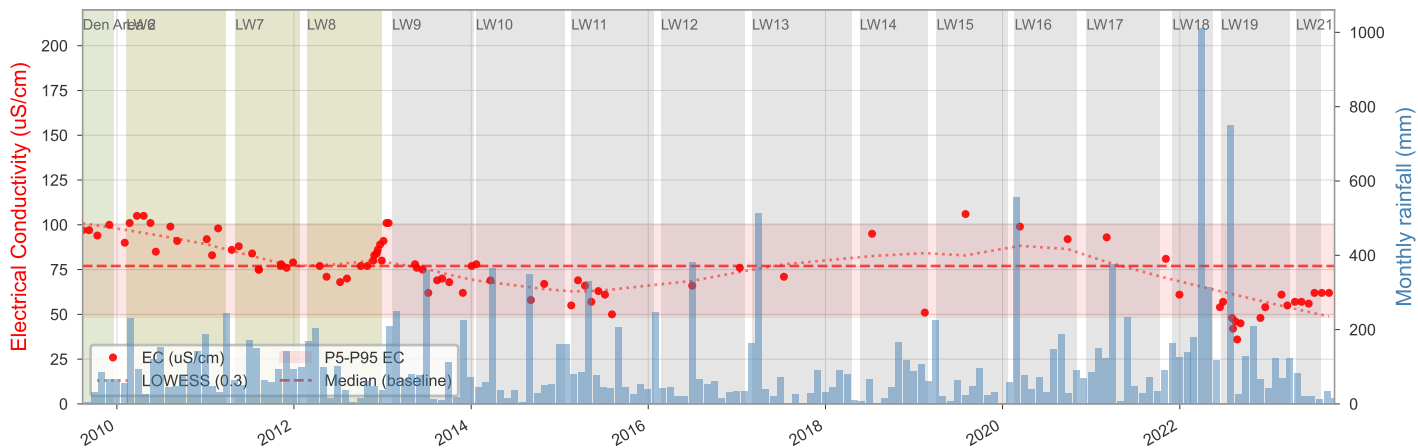
SC10_POOL15



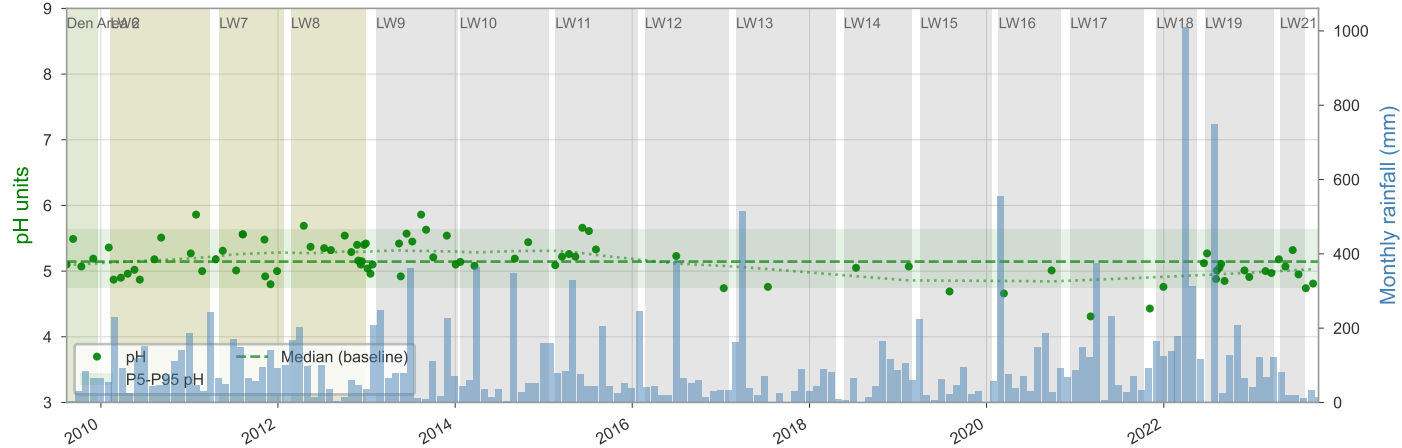
SC10_POOL21



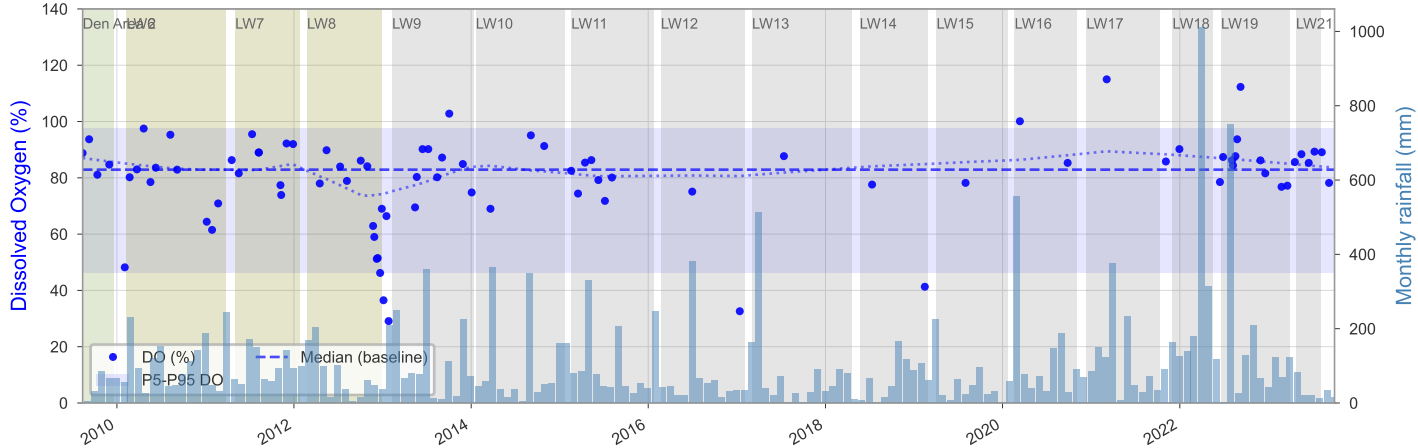
SC10_POOL21



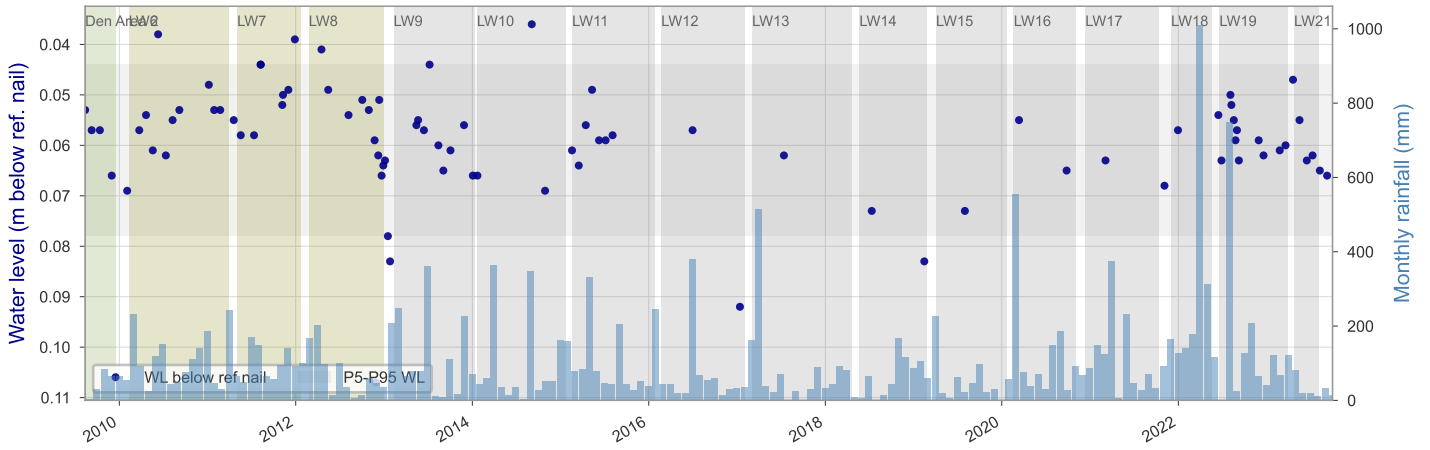
SC10_POOL21



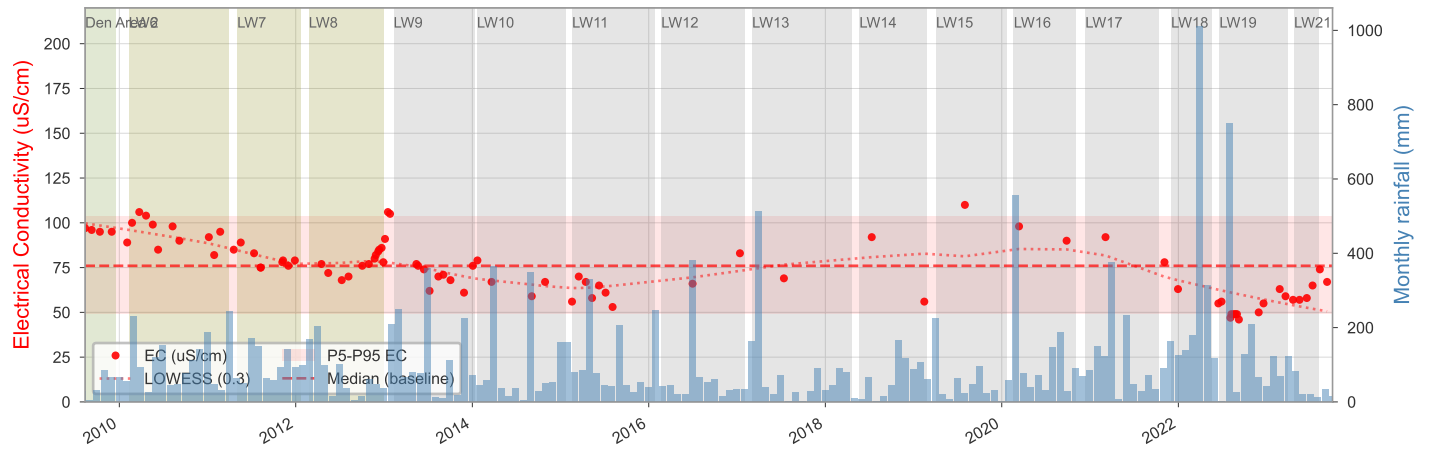
SC10_POOL21



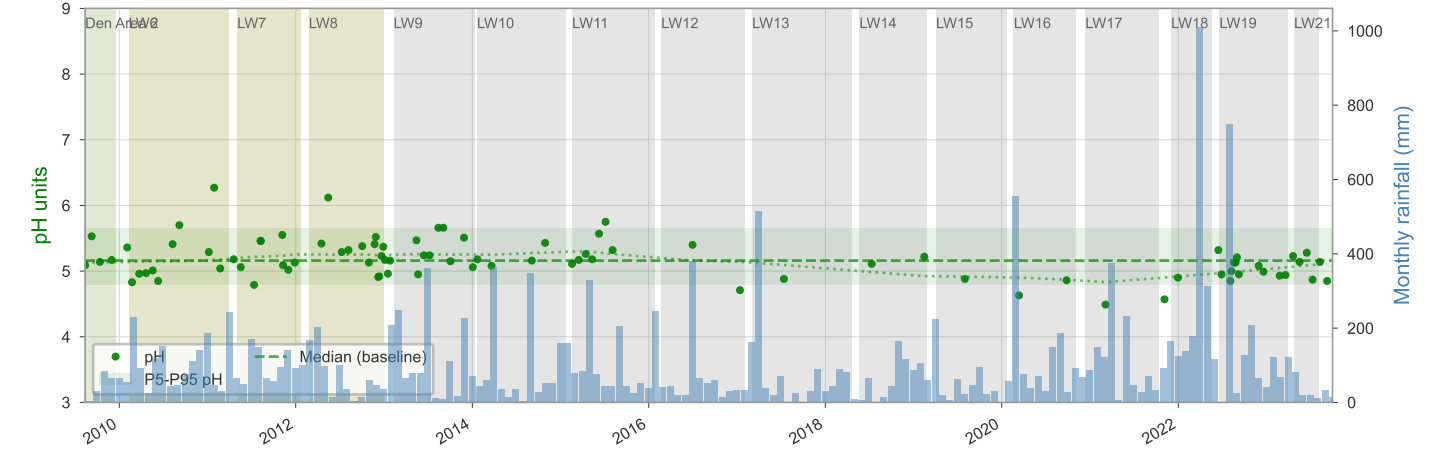
SC10_POOL23



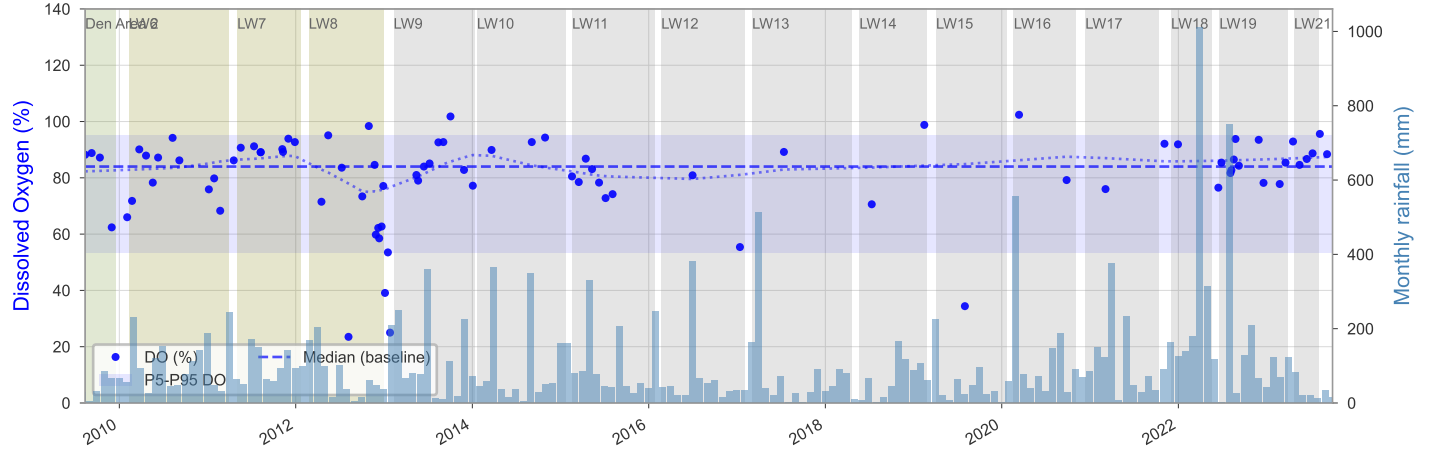
SC10_POOL23



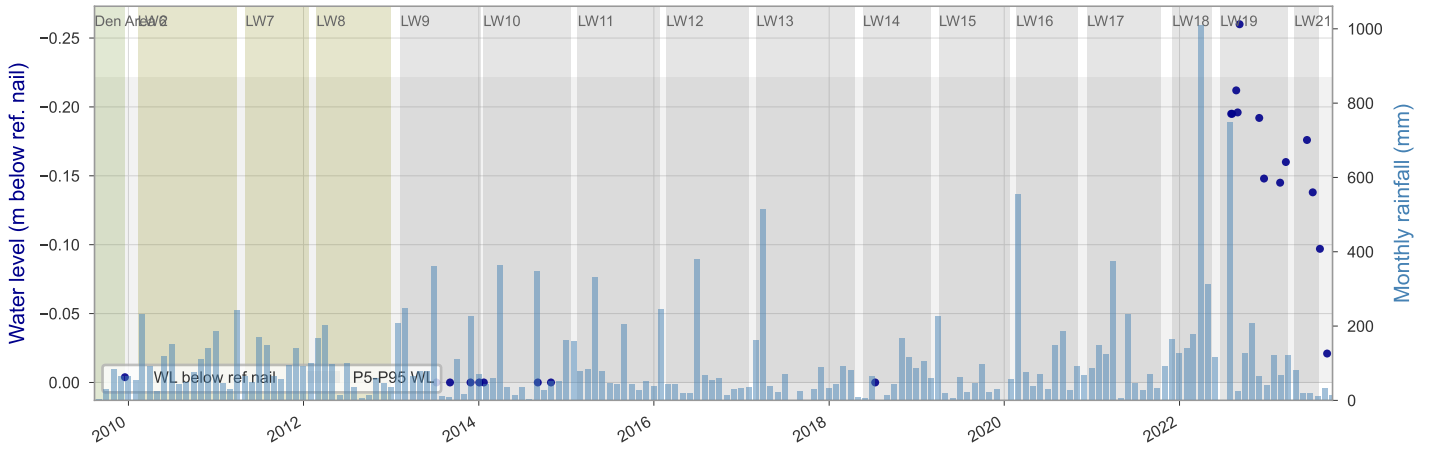
SC10_POOL23



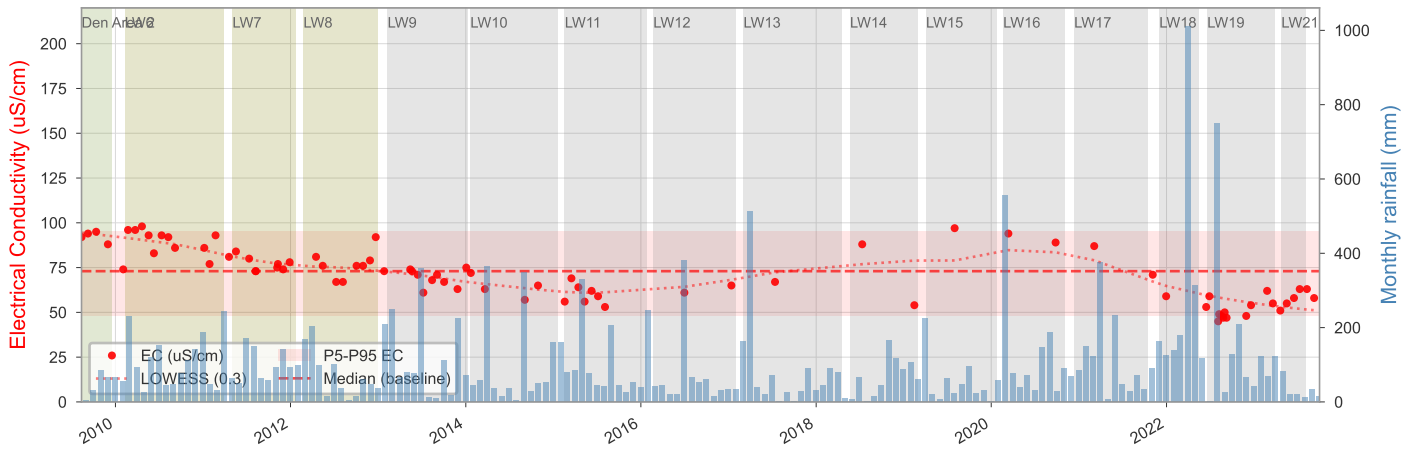
SC10_POOL23



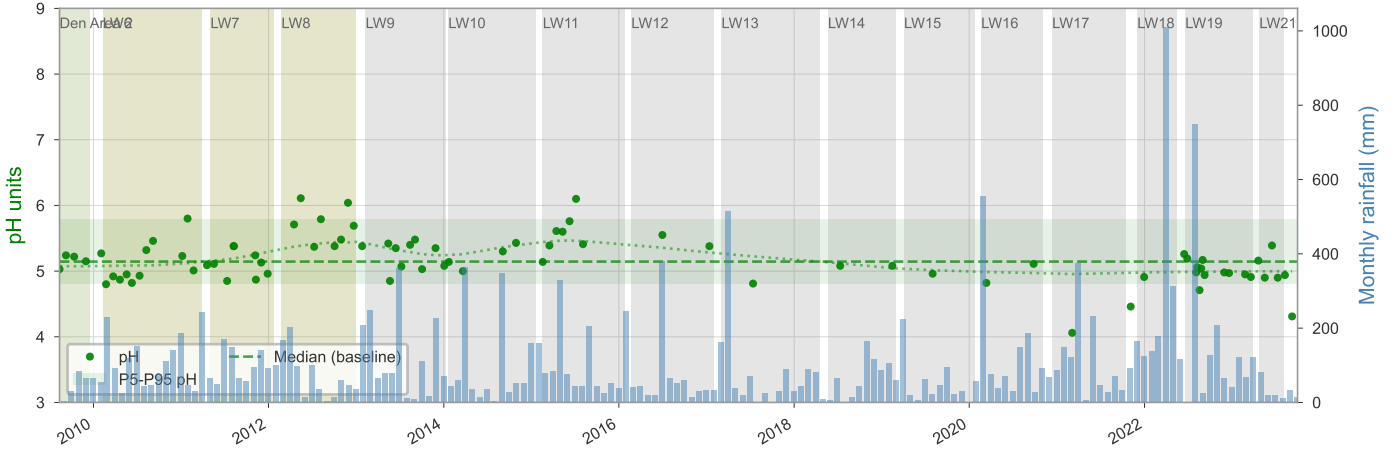
SC10_POOL26A



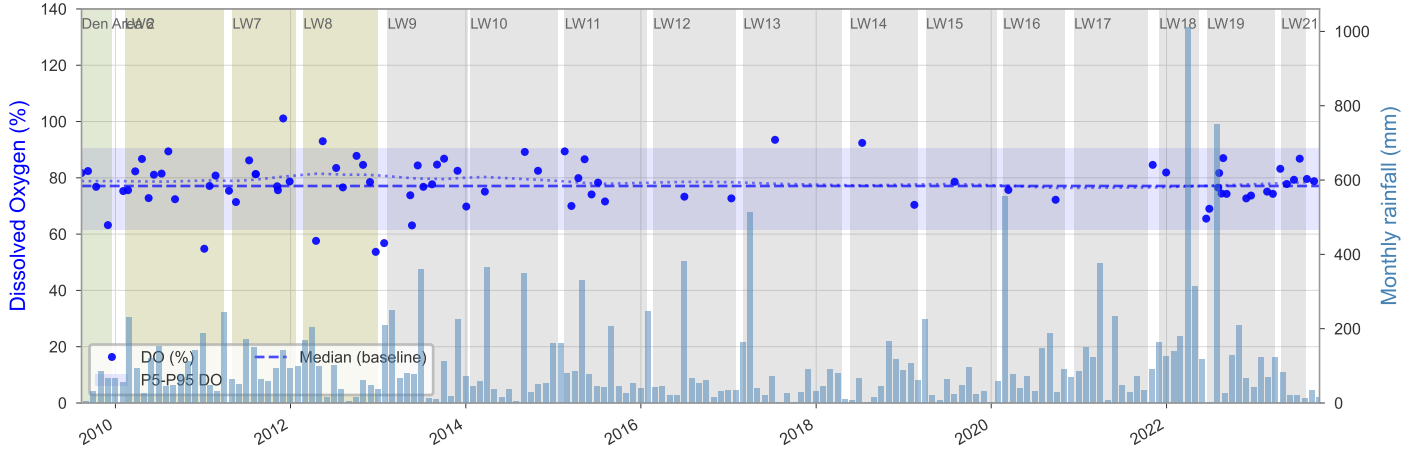
SC10_POOL26A



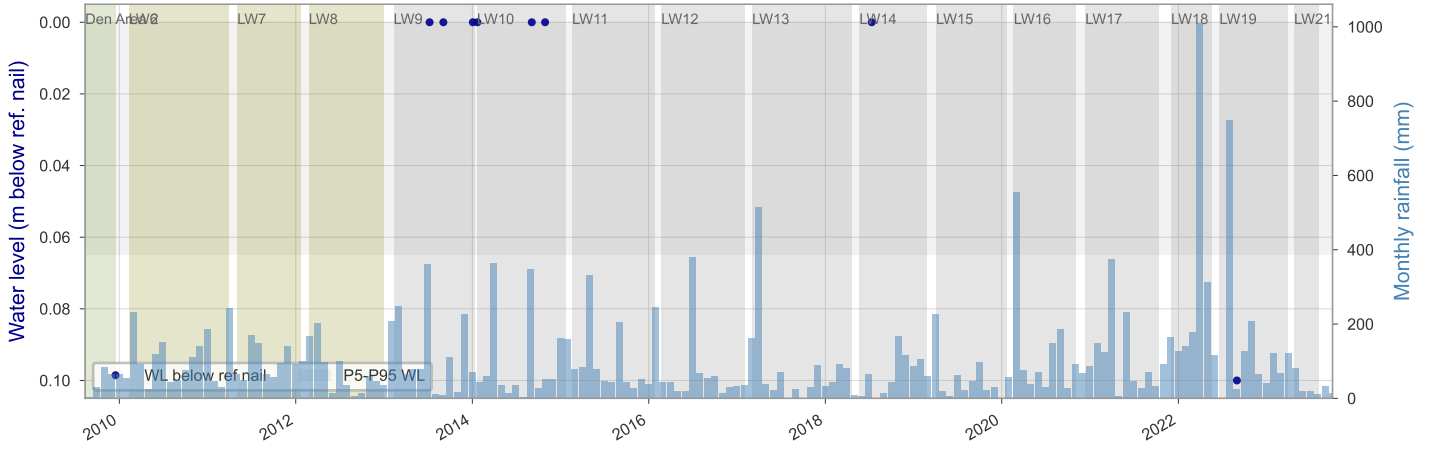
SC10_POOL26A



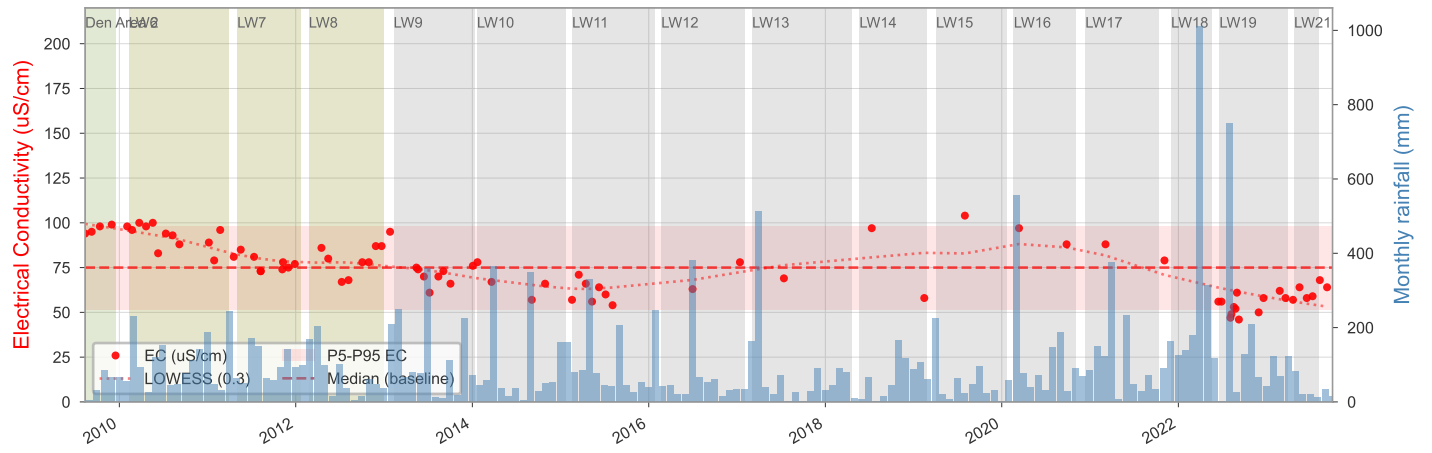
SC10_POOL26A



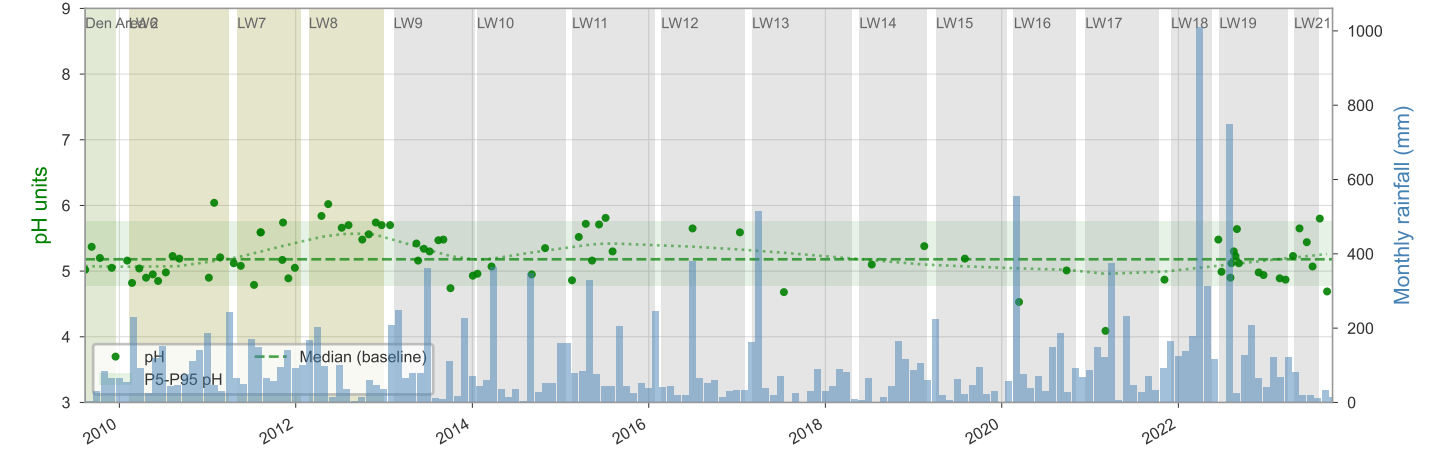
SC10_POOL31



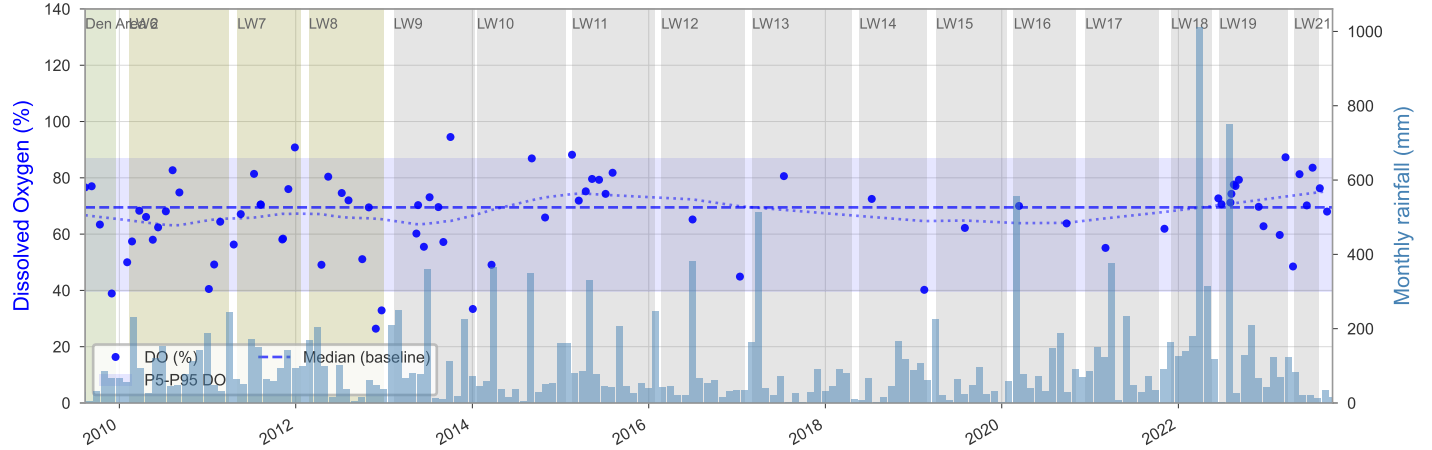
SC10_POOL31



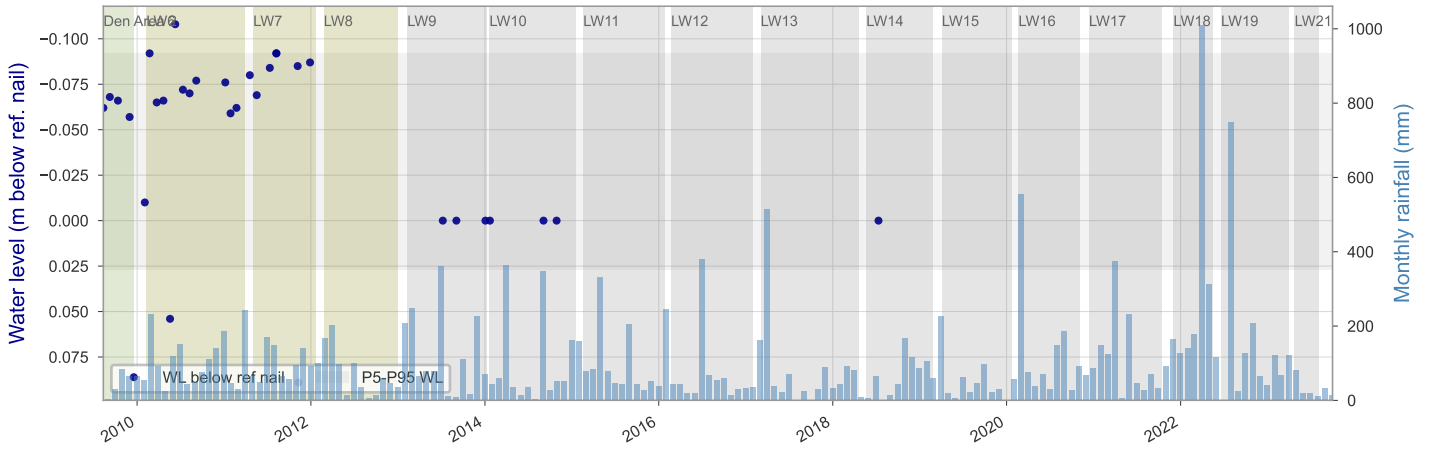
SC10_POOL31



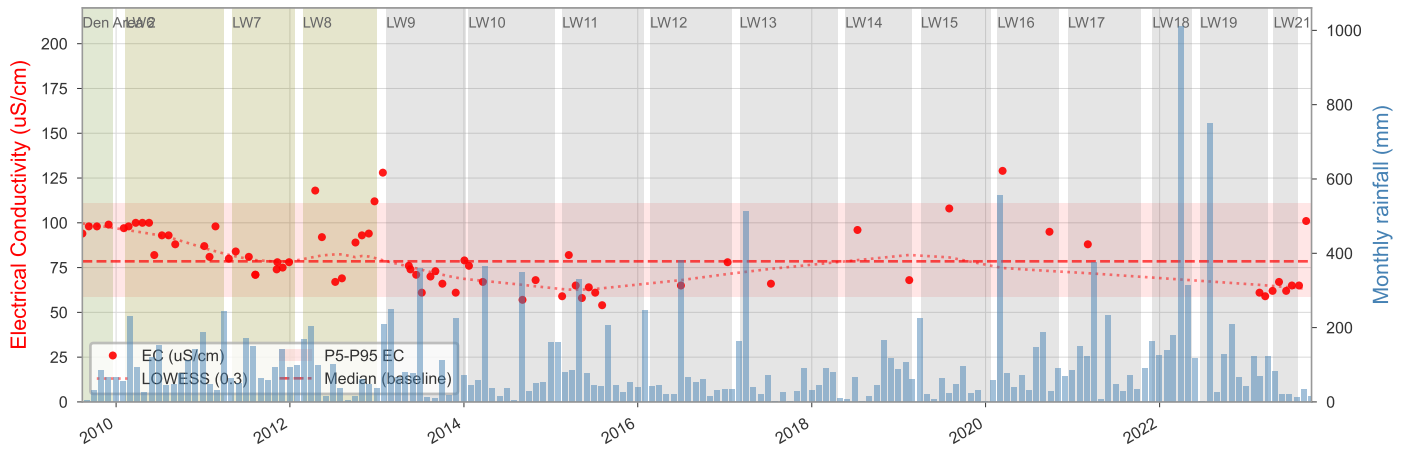
SC10_POOL31



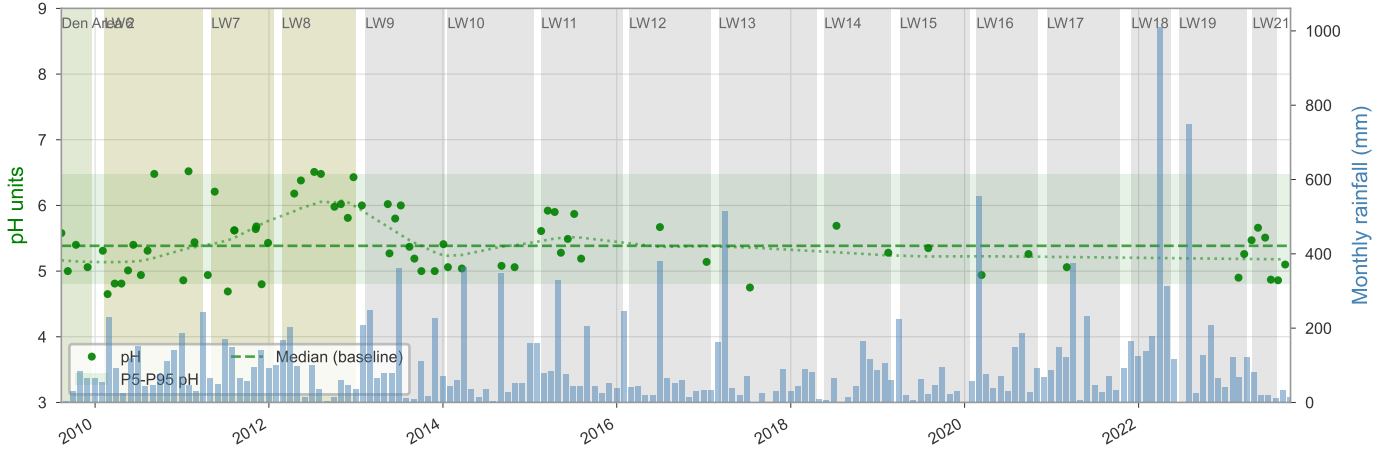
SC10_POOL34



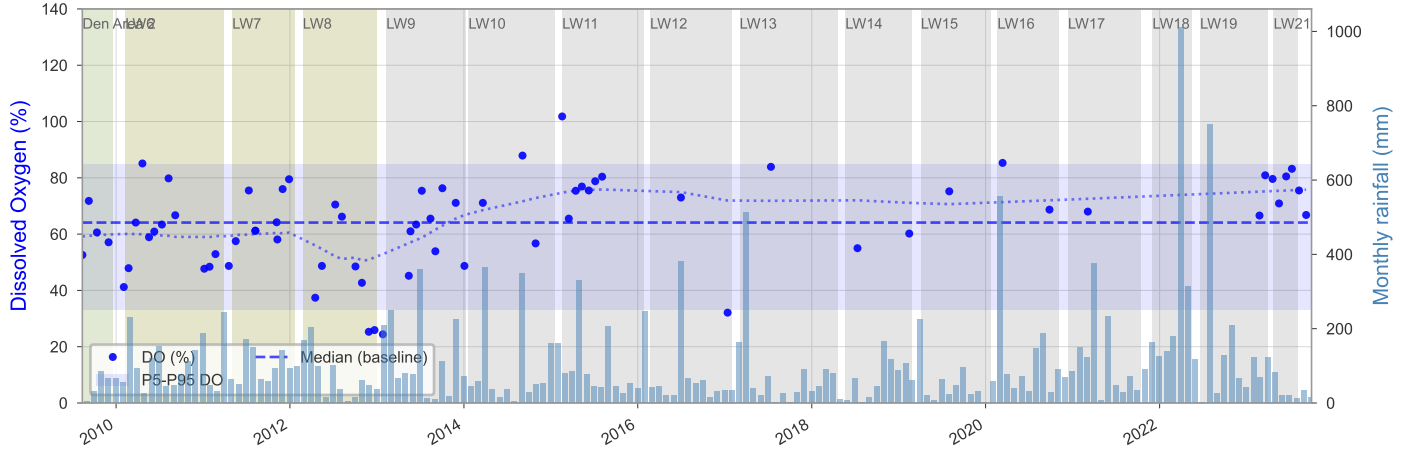
SC10_POOL34



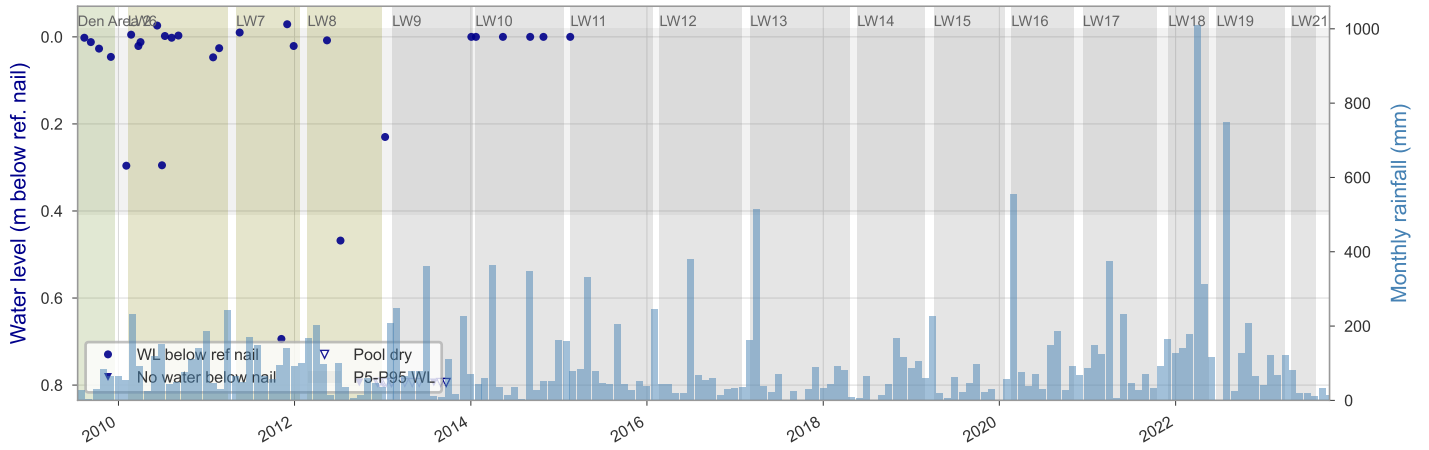
SC10_POOL34



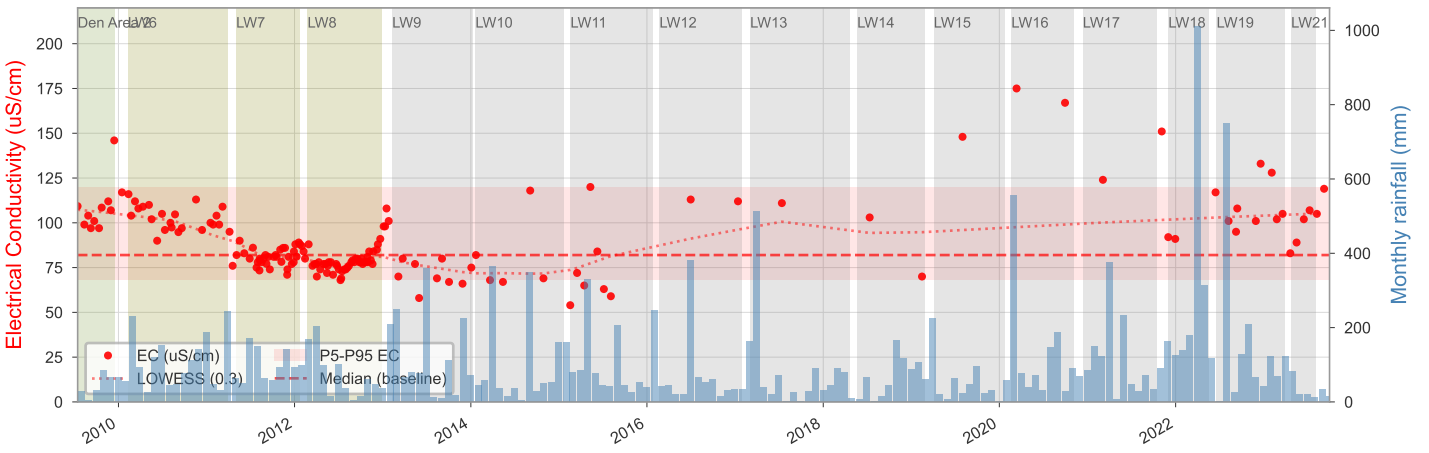
SC10_POOL34



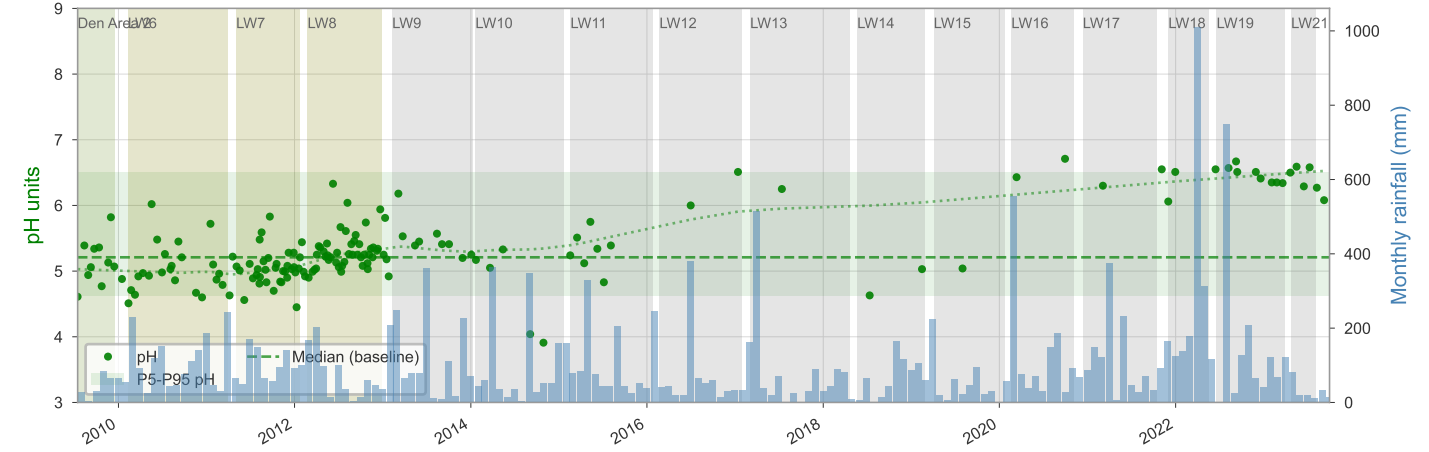
SC10_POOL4



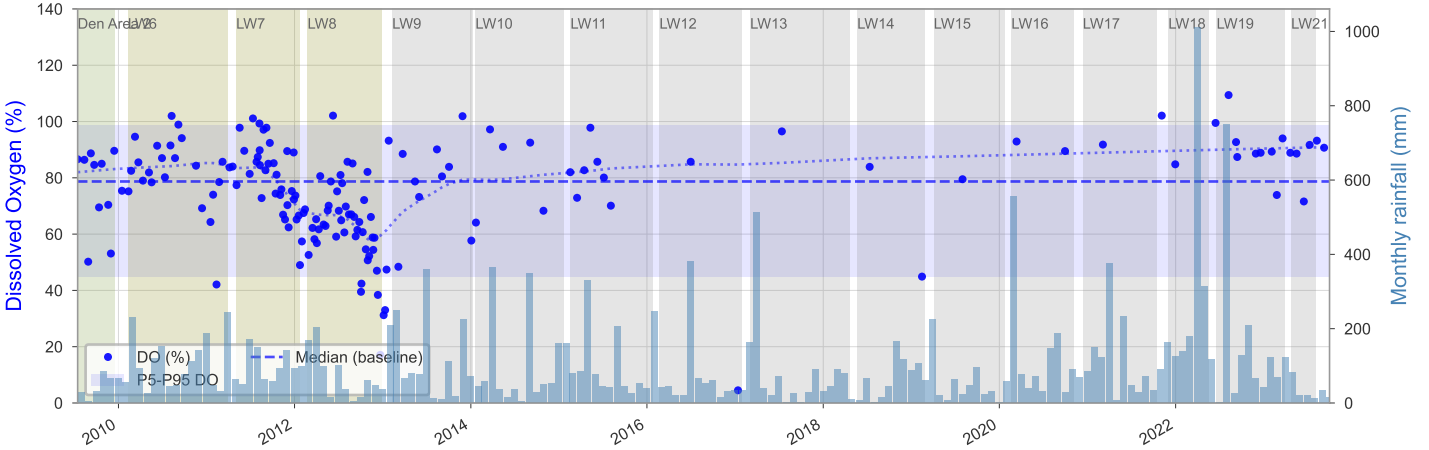
SC10_POOL4



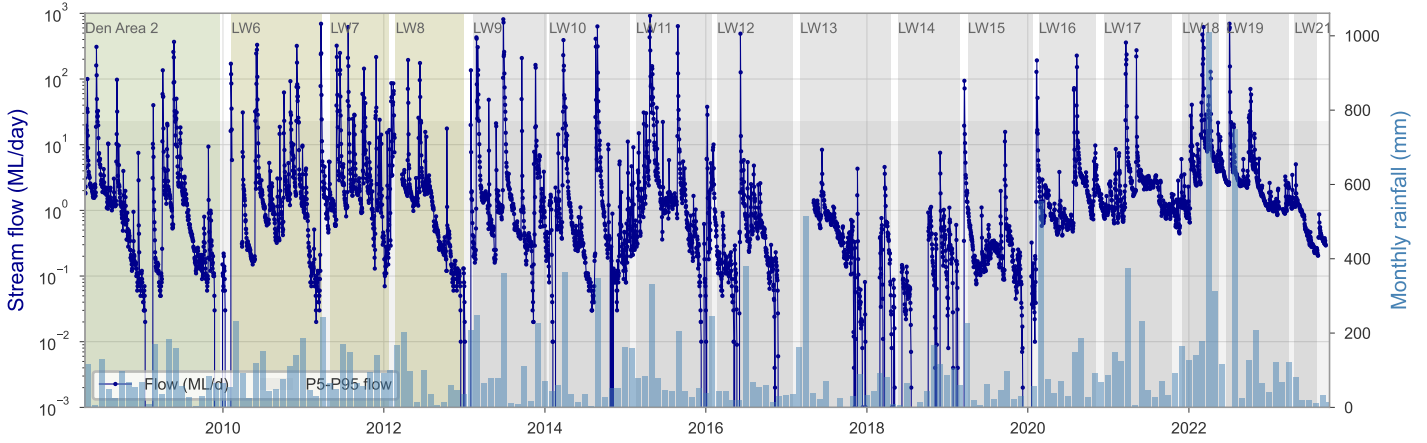
SC10_POOL4



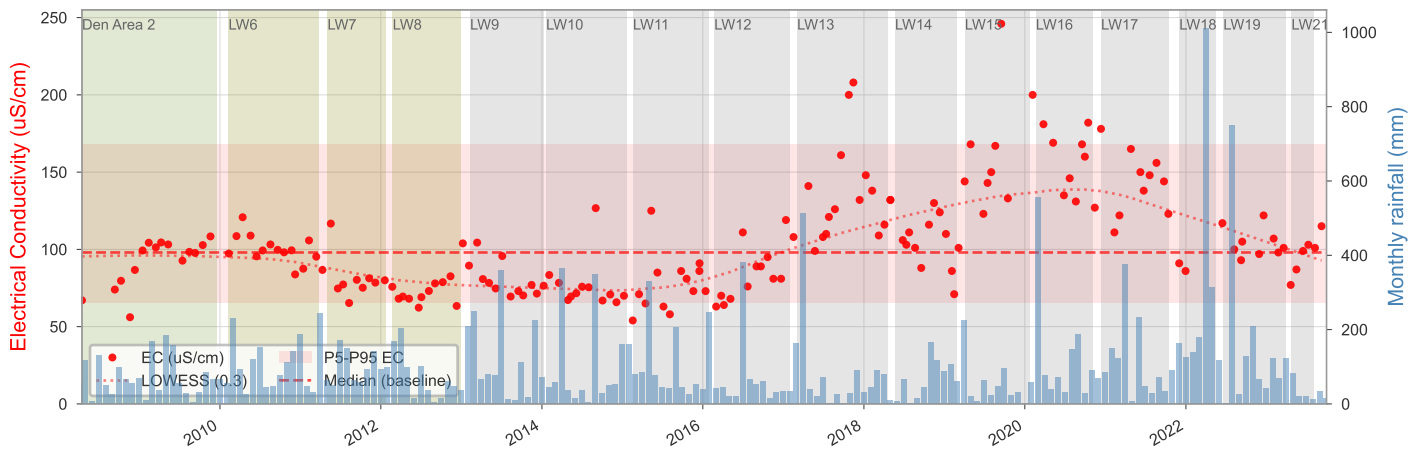
SC10_POOL4



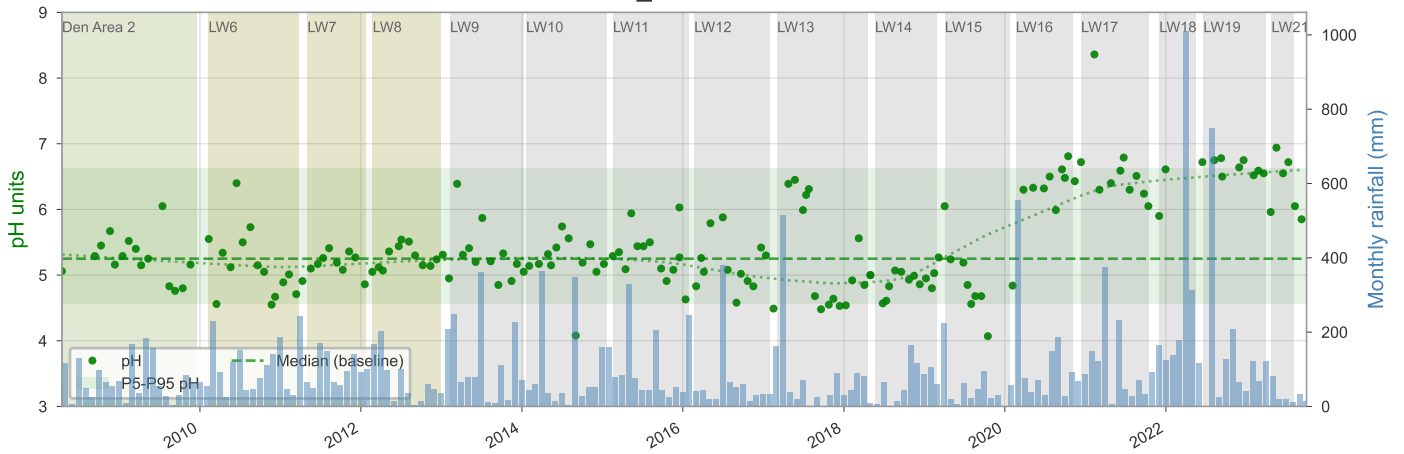
SC10S1



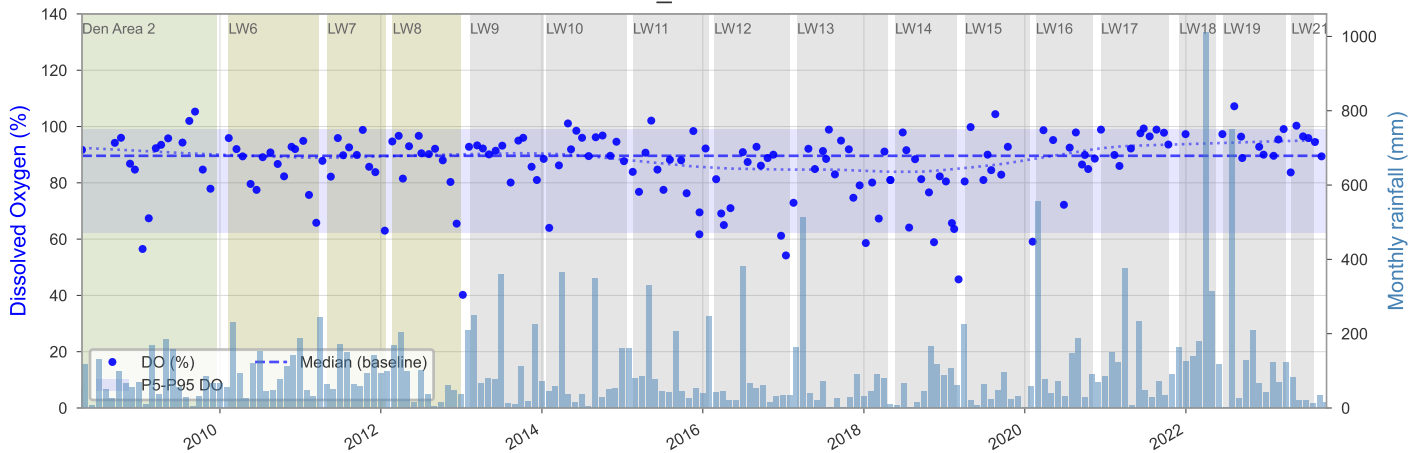
SC10_ROCKBAR3



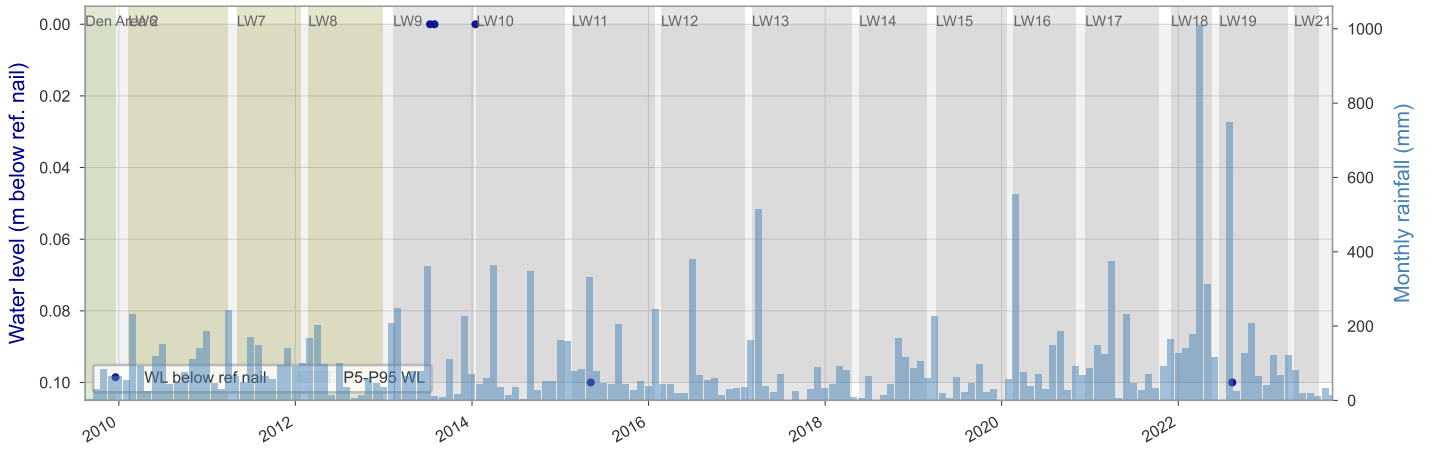
SC10_ROCKBAR3



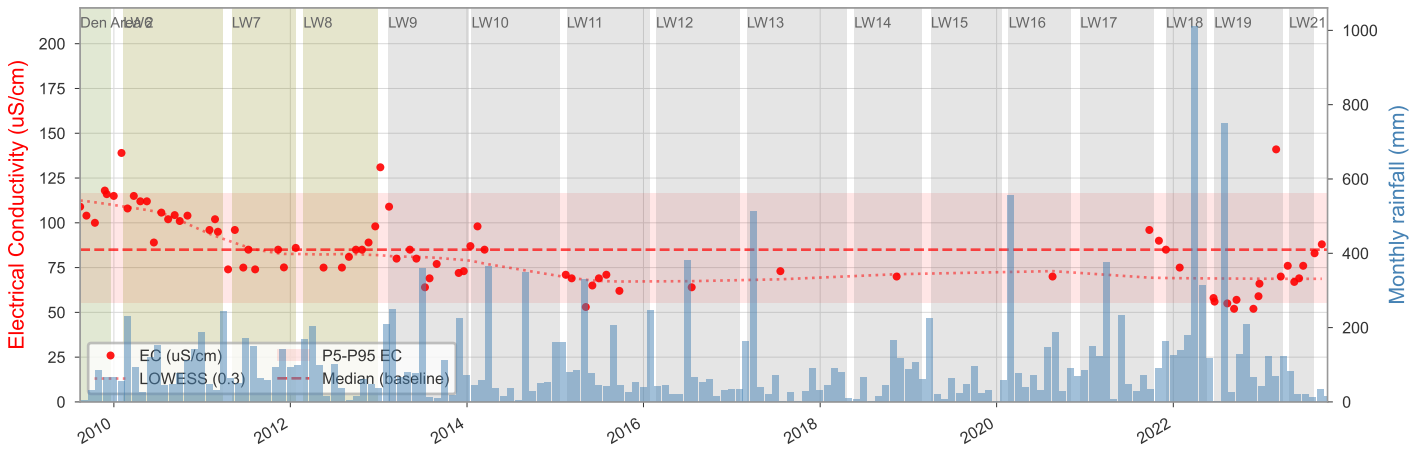
SC10_ROCKBAR3



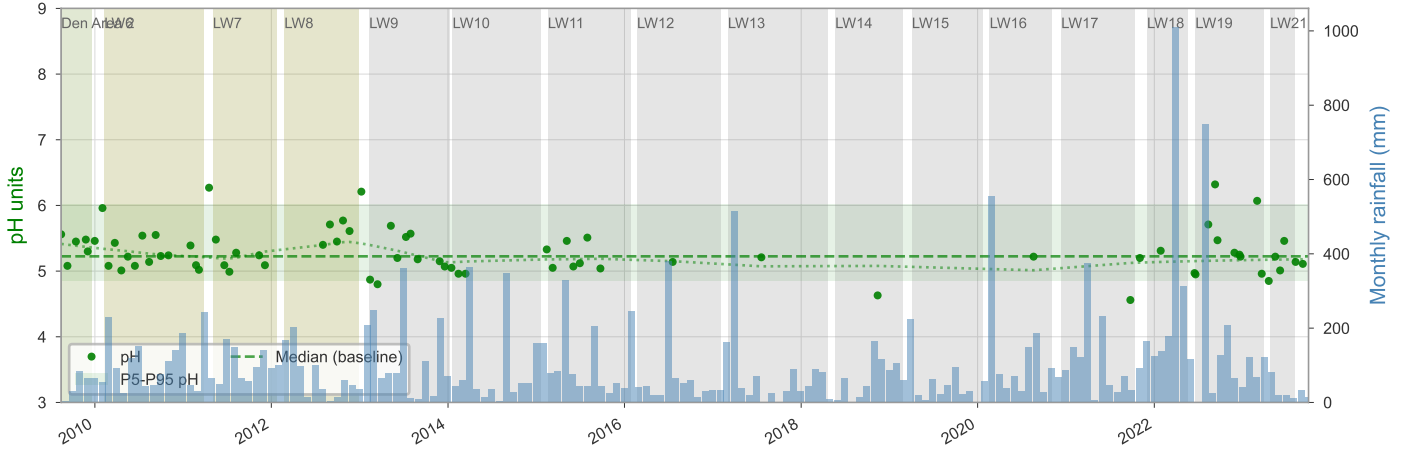
SC7_POOL1



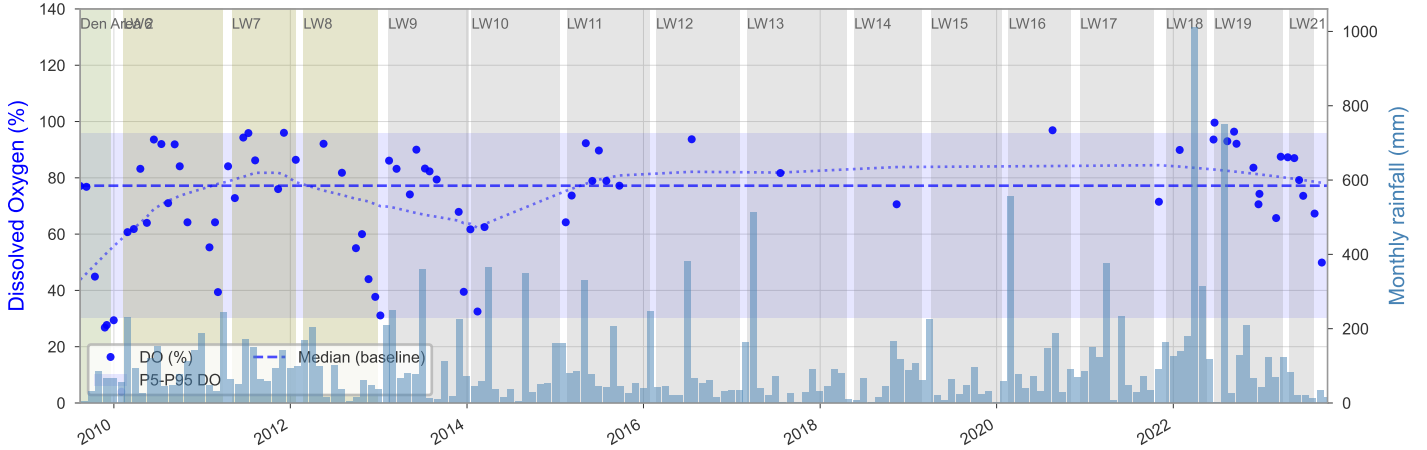
SC7_POOL1



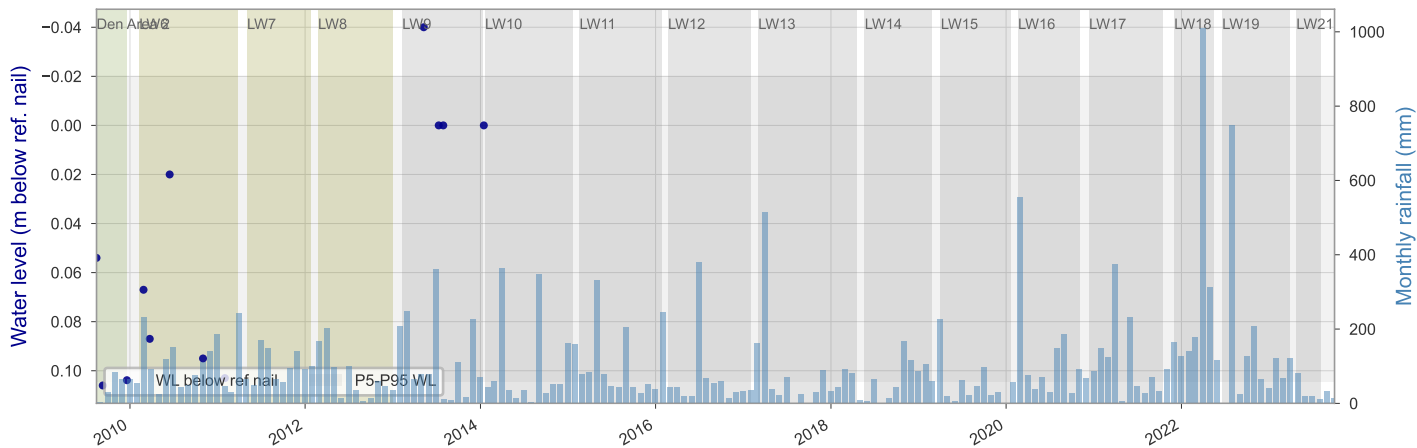
SC7_POOL1



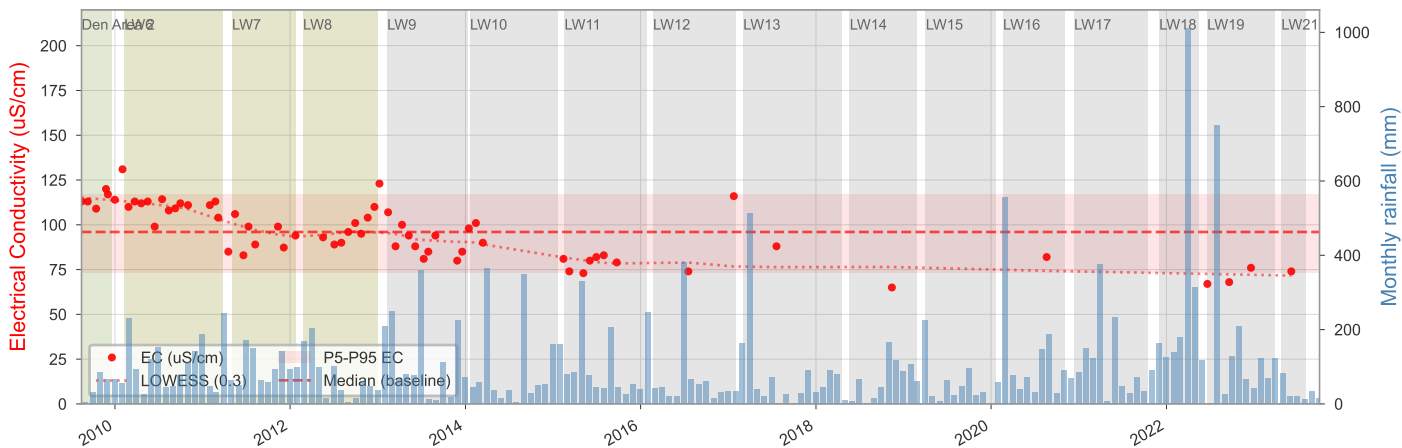
SC7_POOL1



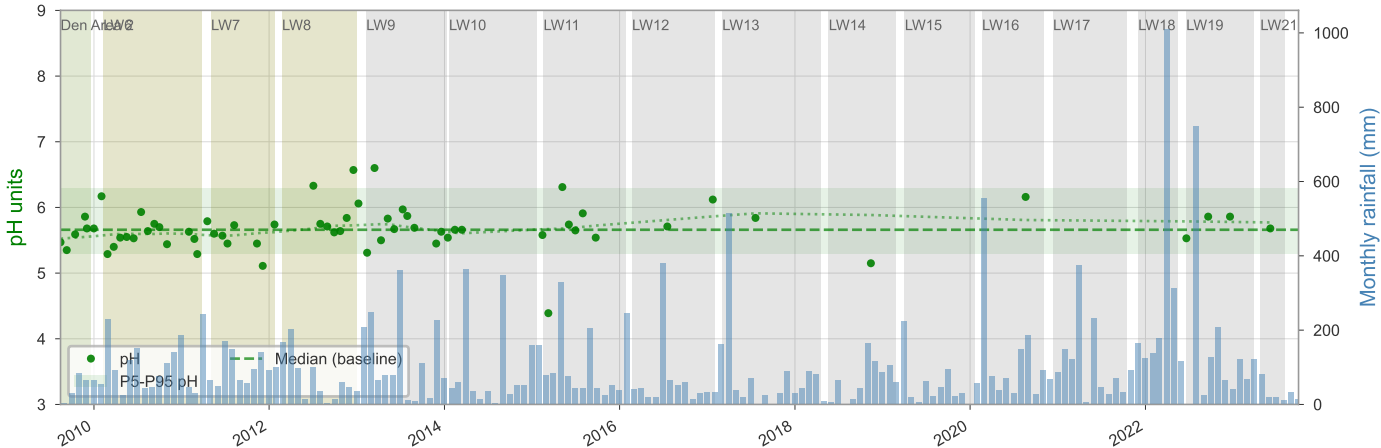
SCK_POOL12



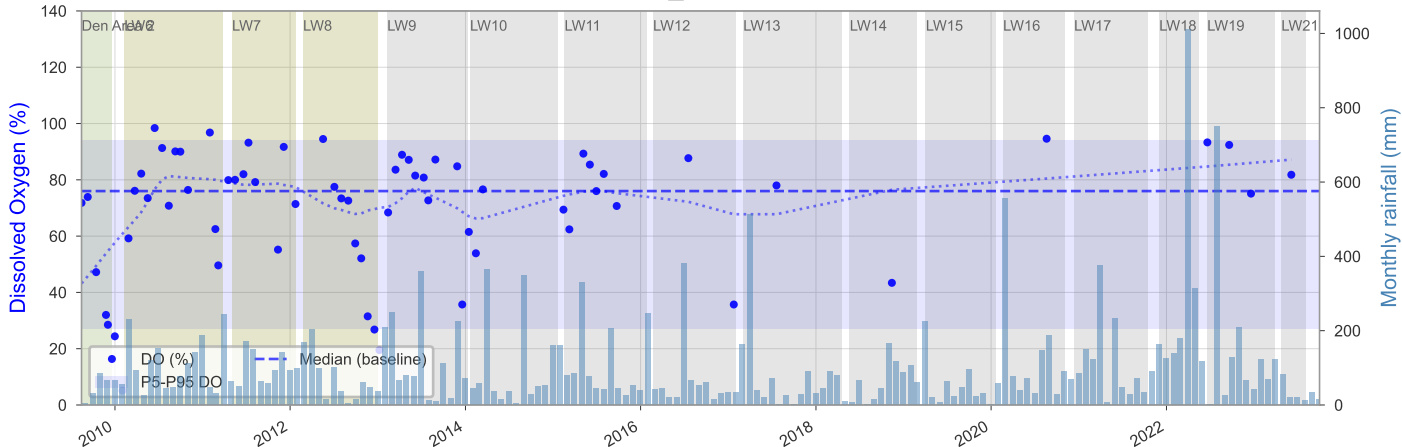
SCK_POOL12



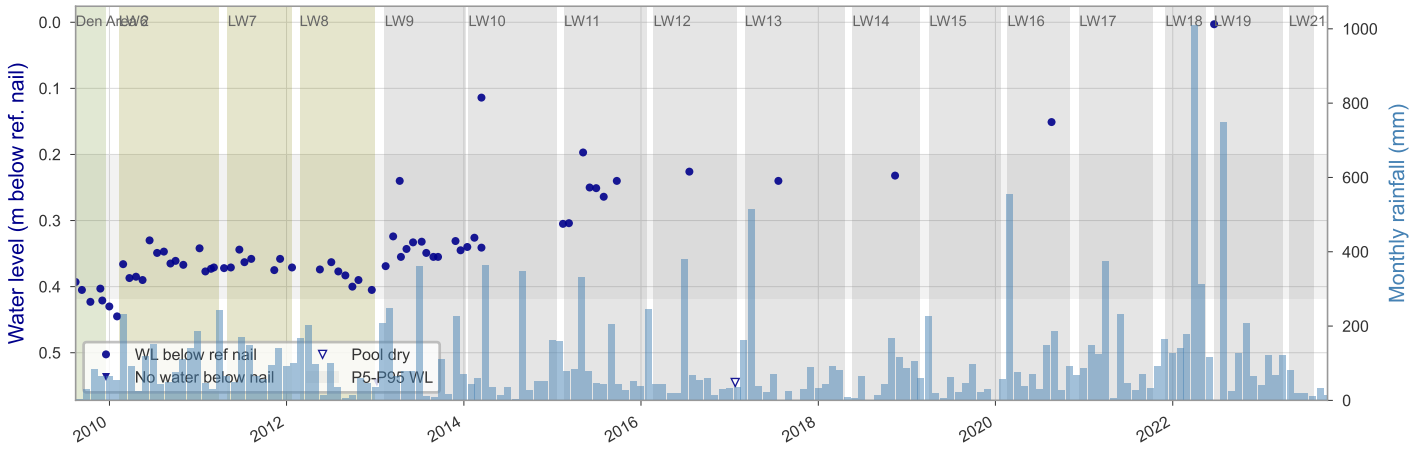
SCK_POOL12



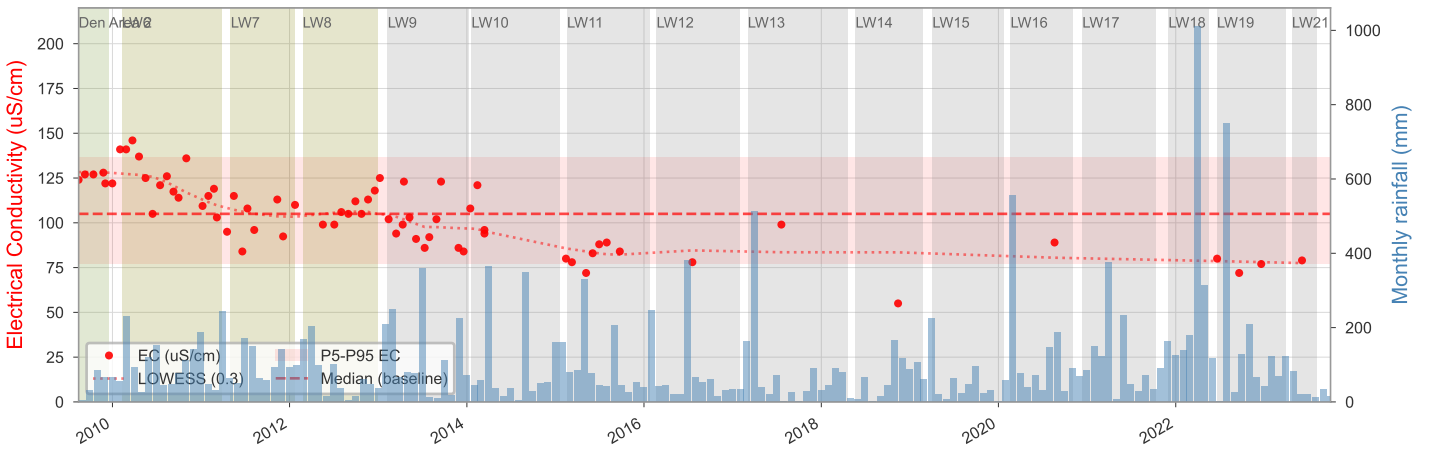
SCK_POOL12



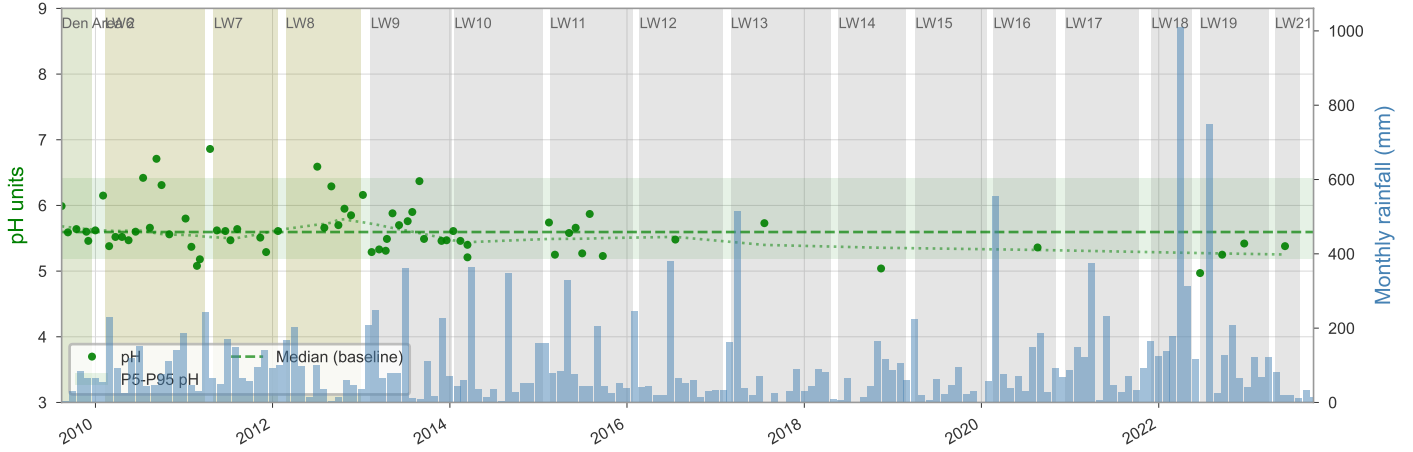
SCK_POOL23



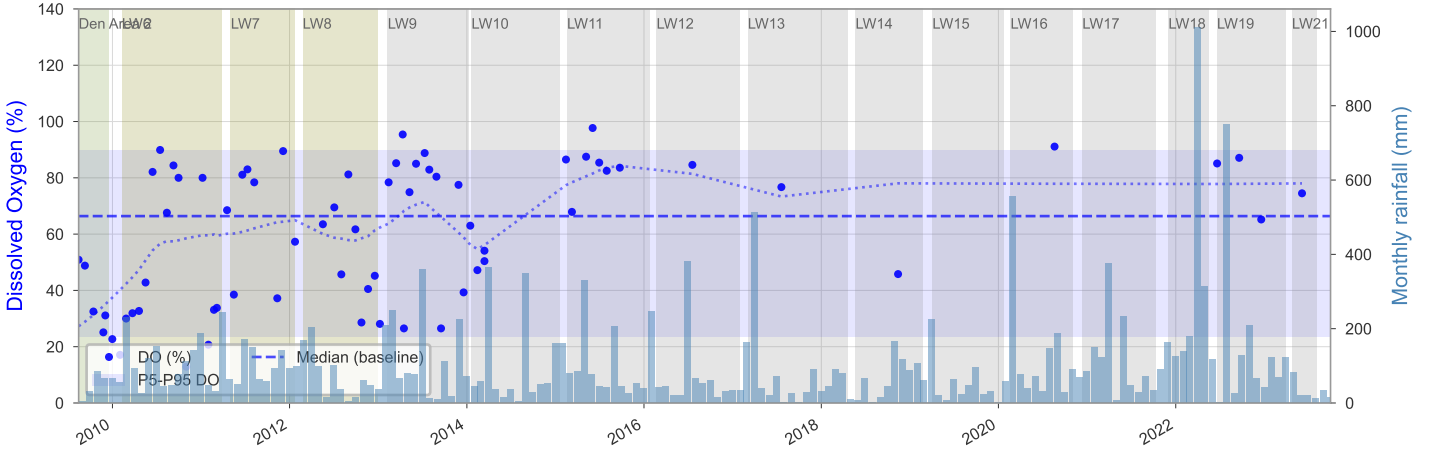
SCK_POOL23



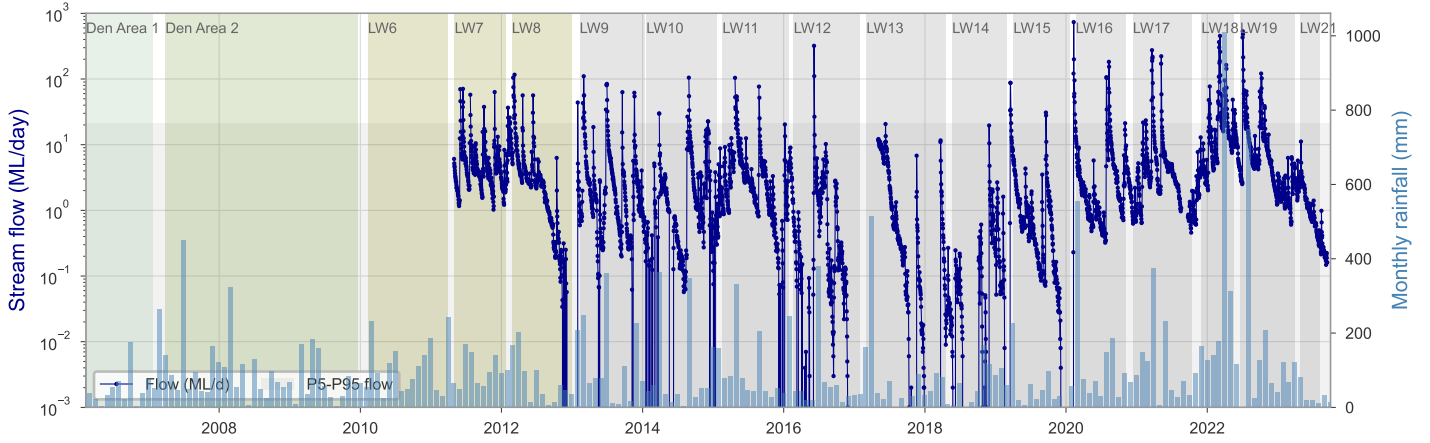
SCK_POOL23



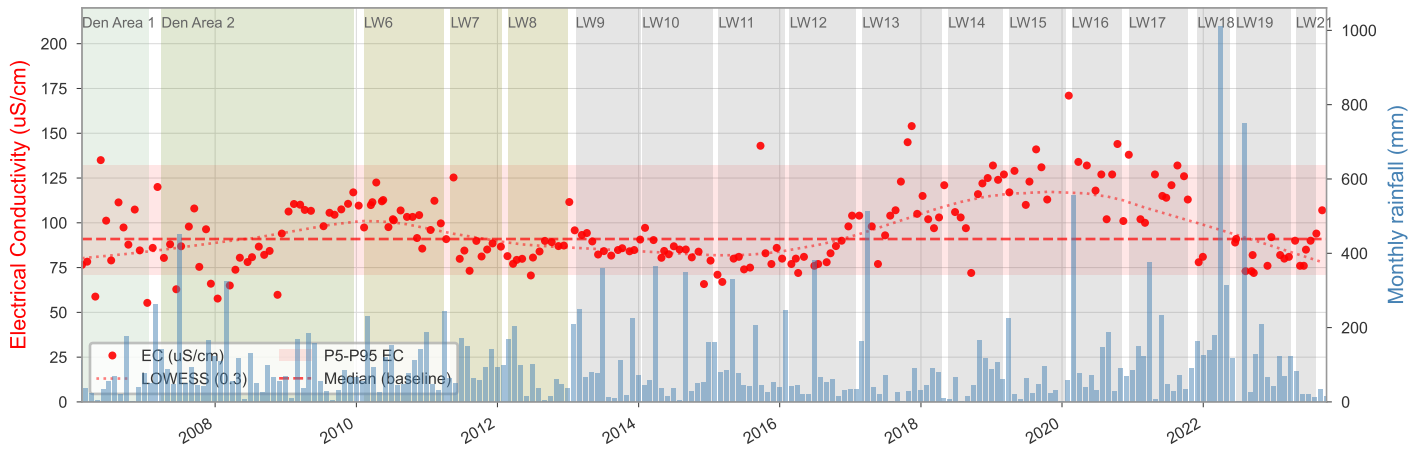
SCK_POOL23



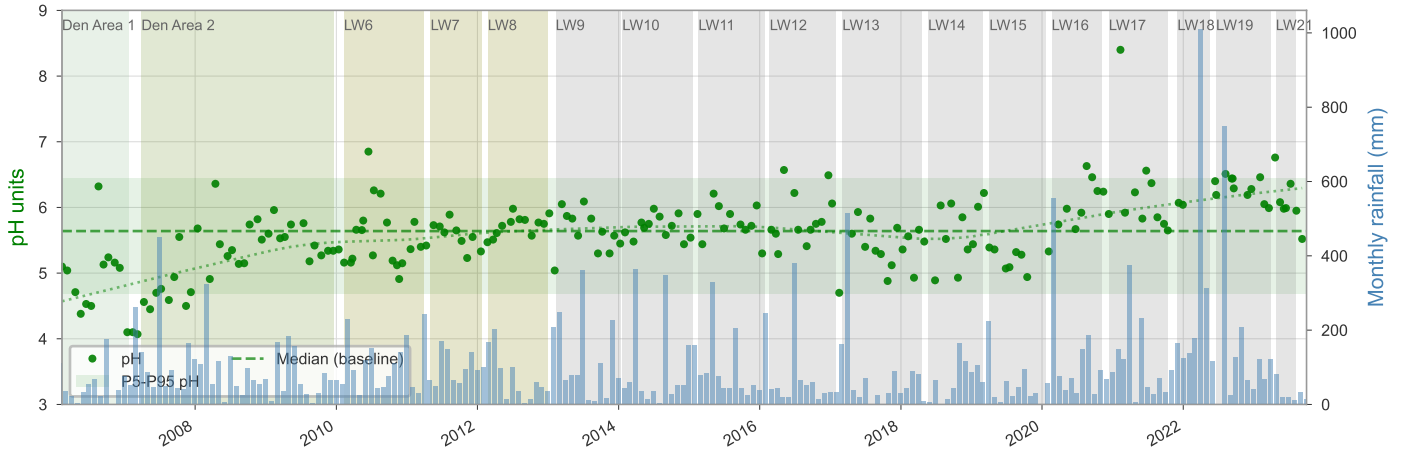
SCL2



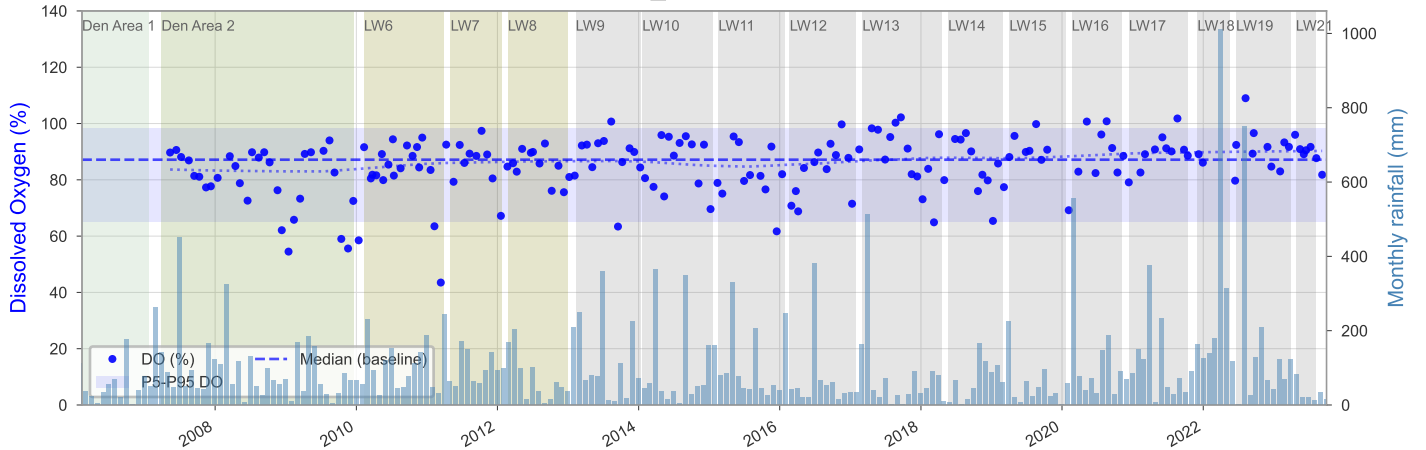
SCK_ROCKBAR5



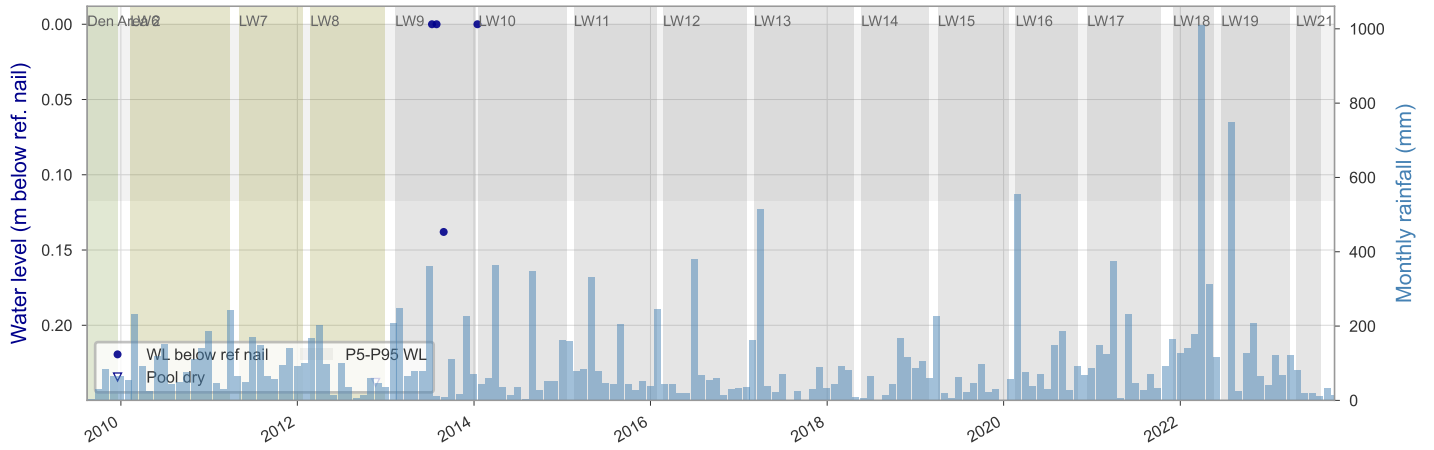
SCK_ROCKBAR5



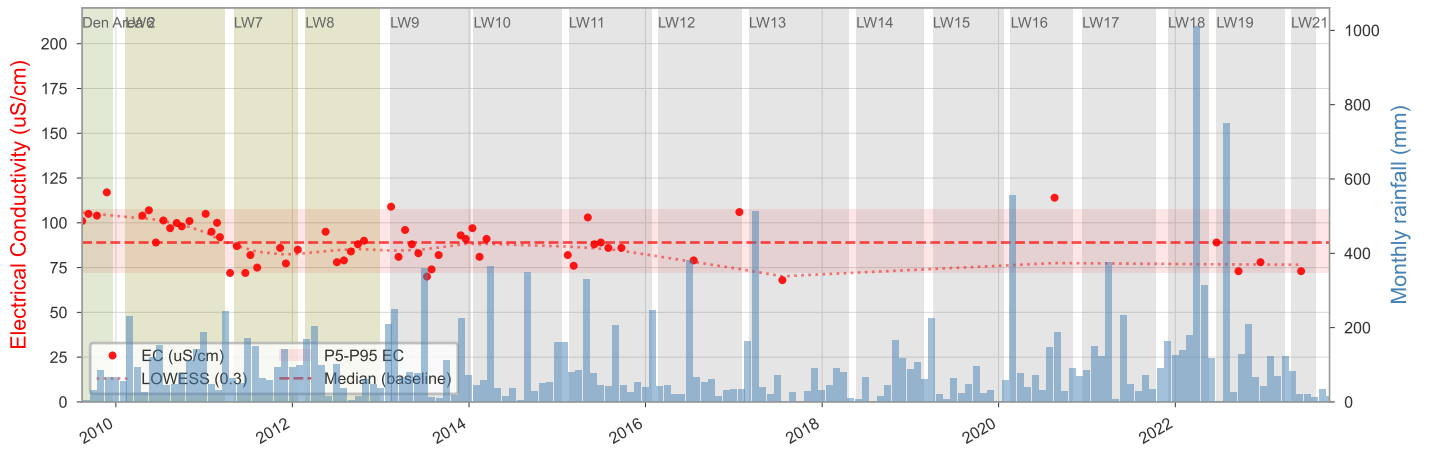
SCK_ROCKBAR5



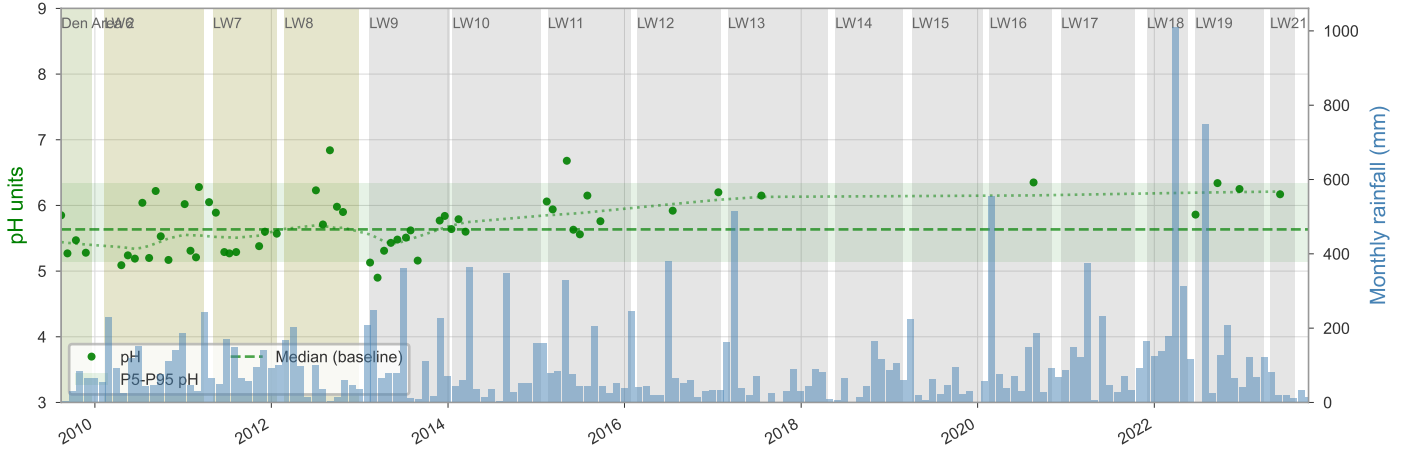
SCK_SC7



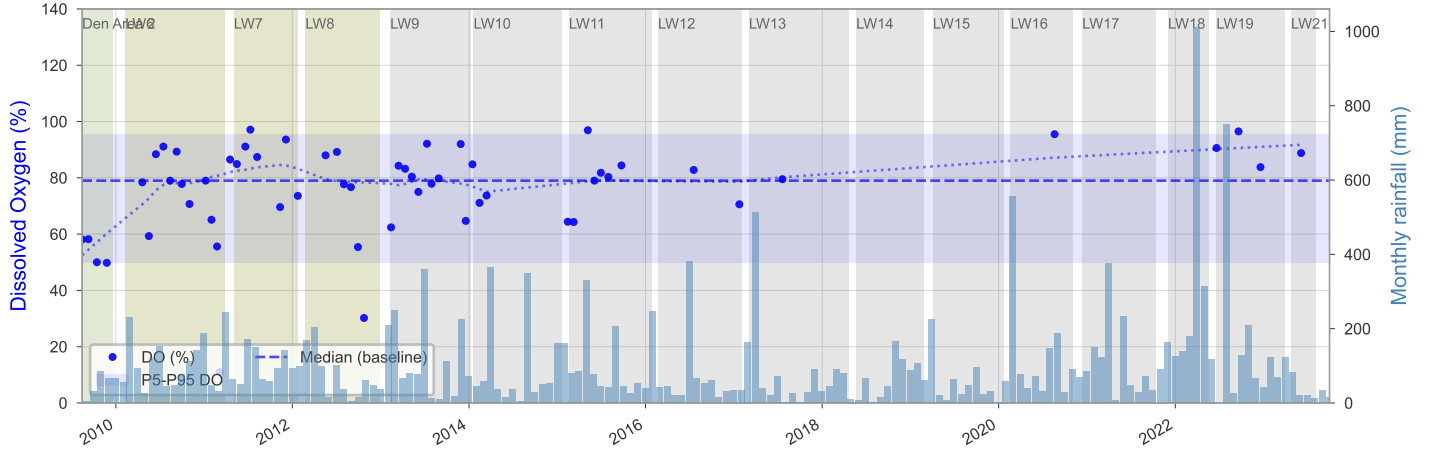
SCK_SC7



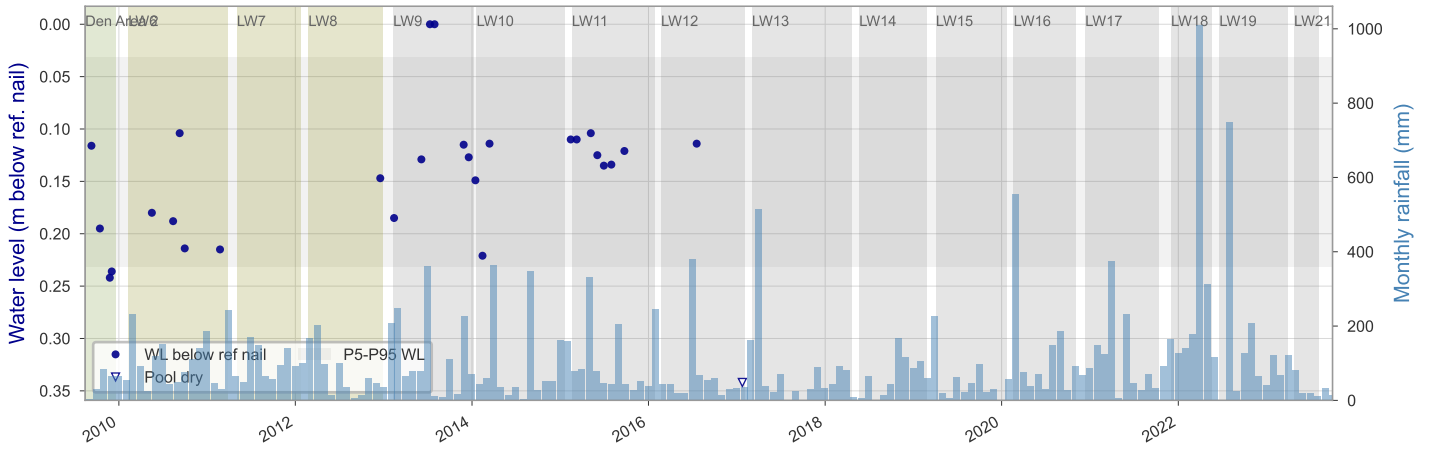
SCK_SC7



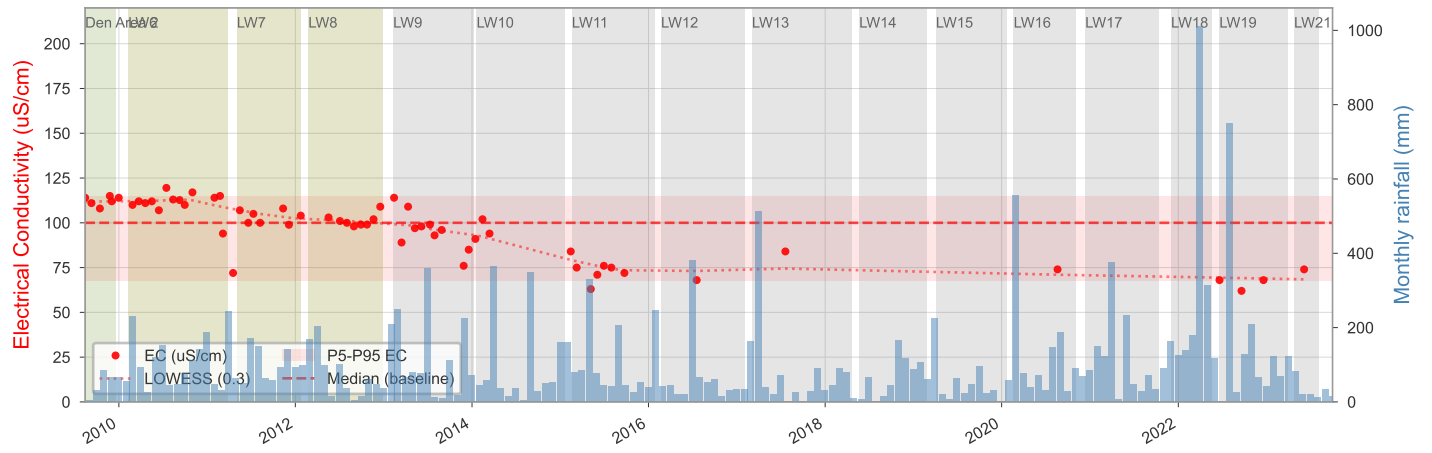
SCK_SC7



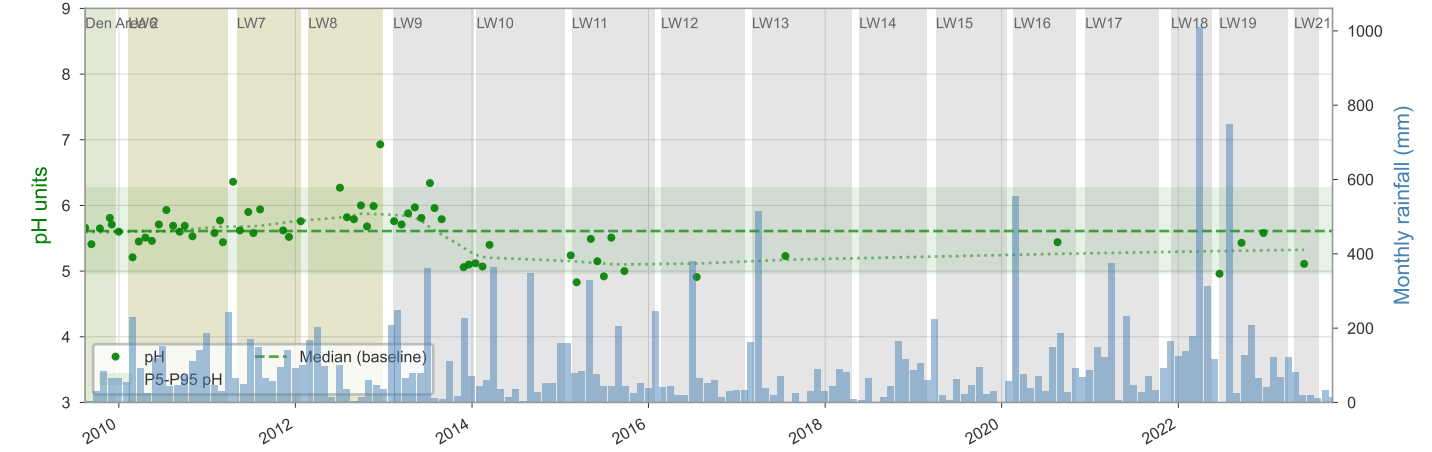
SCK_SC9



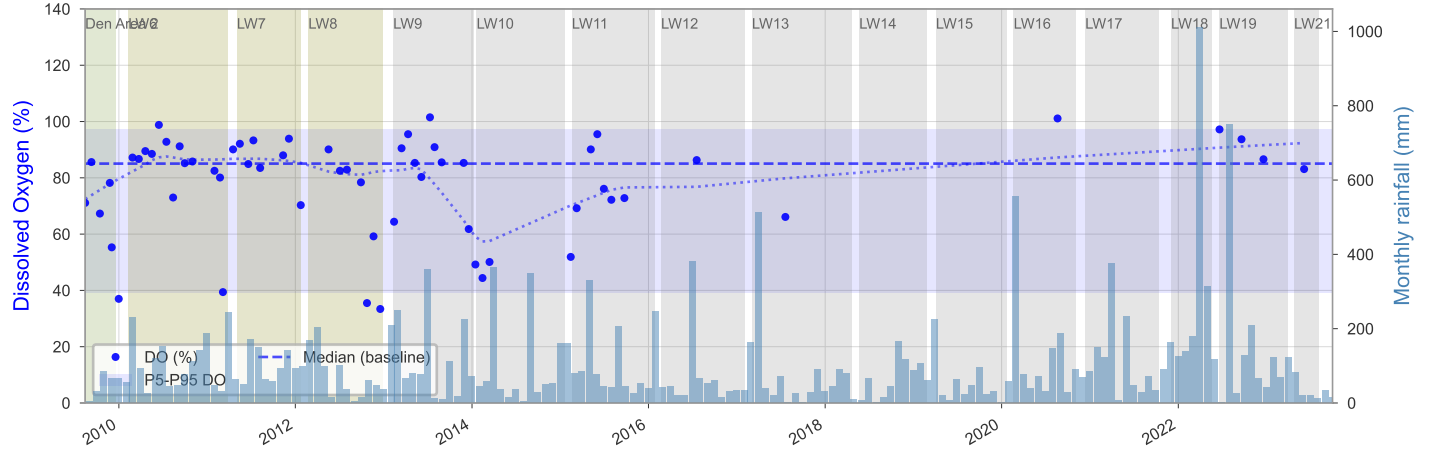
SCK_SC9



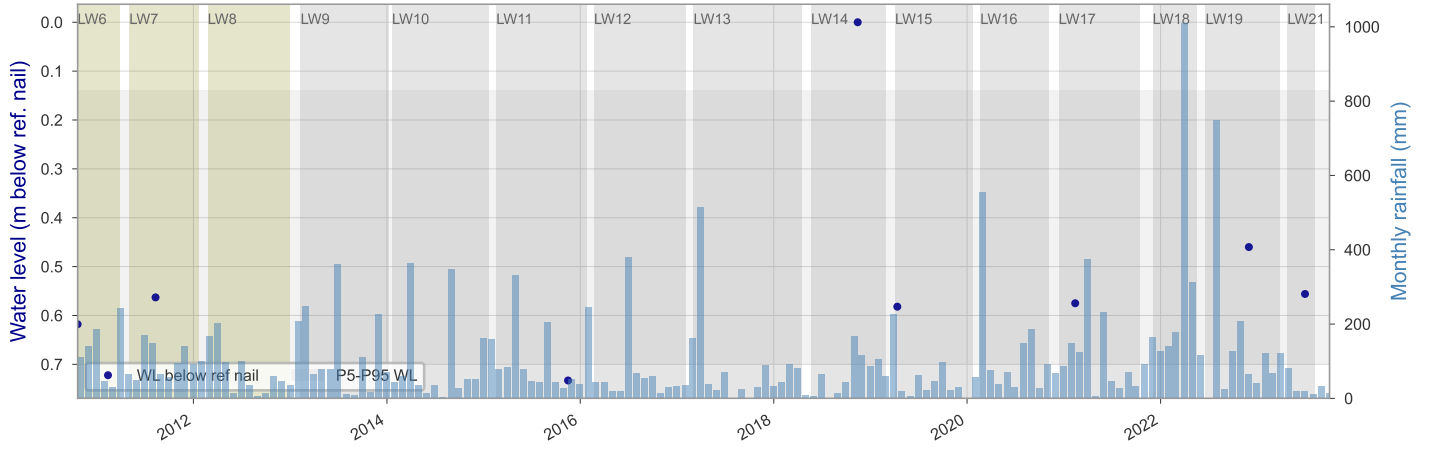
SCK_SC9



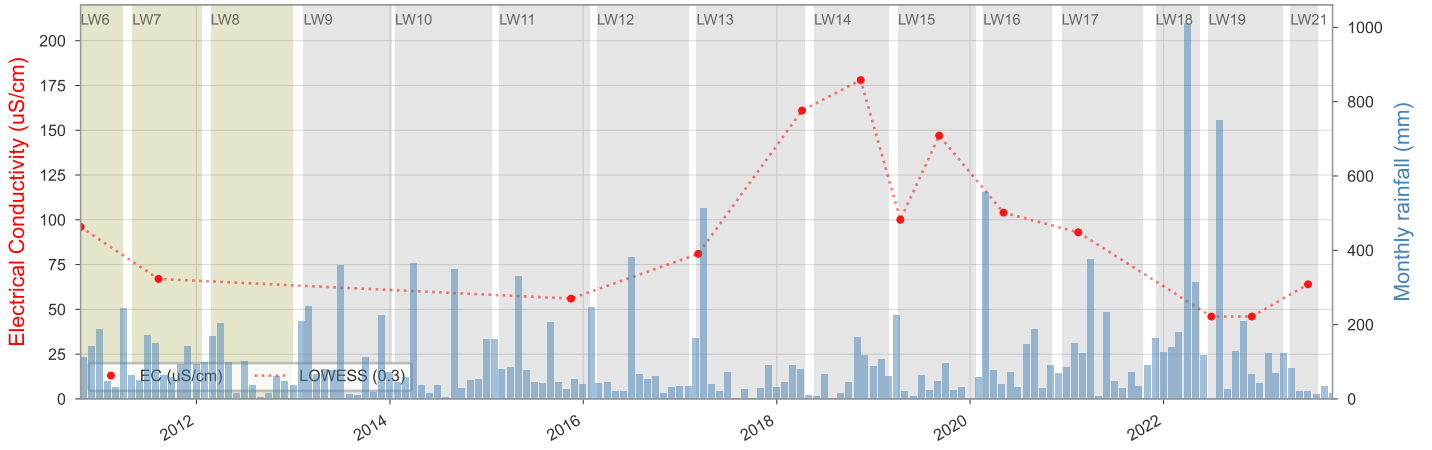
SCK_SC9



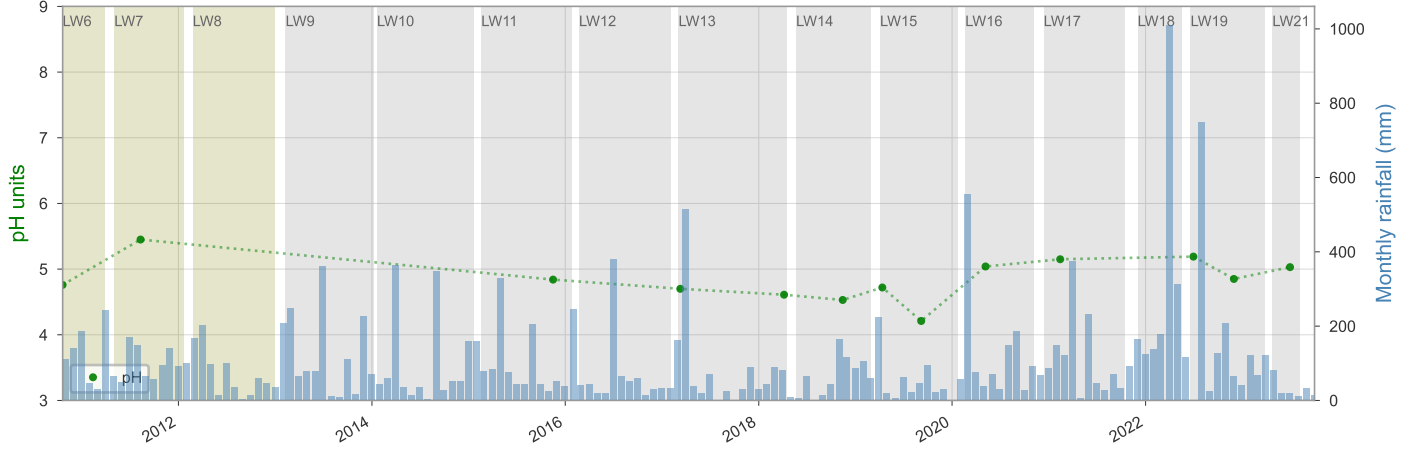
WC11_POOL20



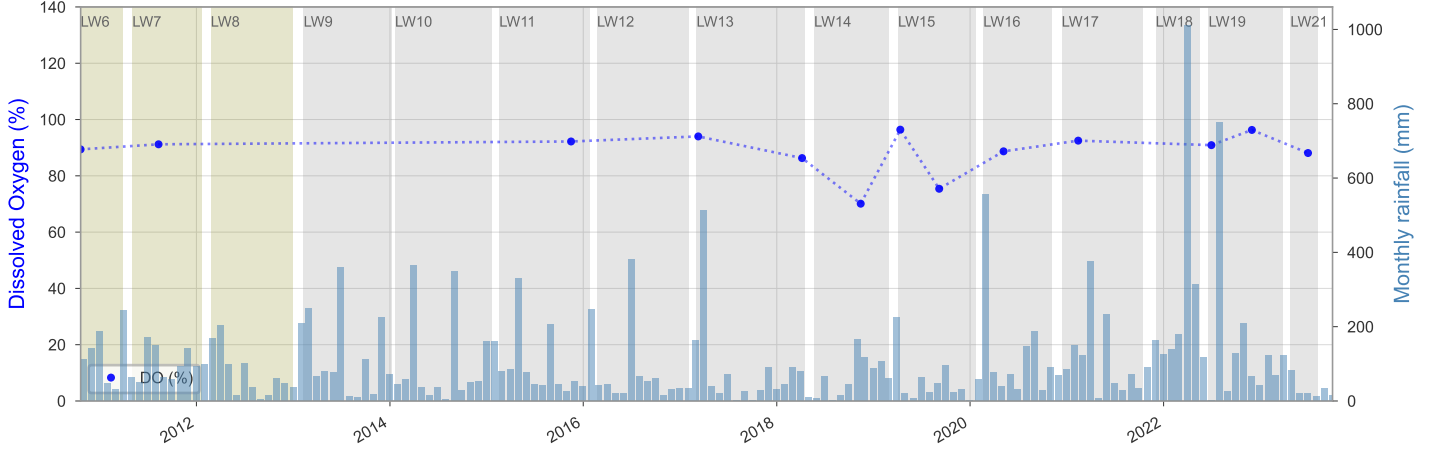
WC11_POOL20



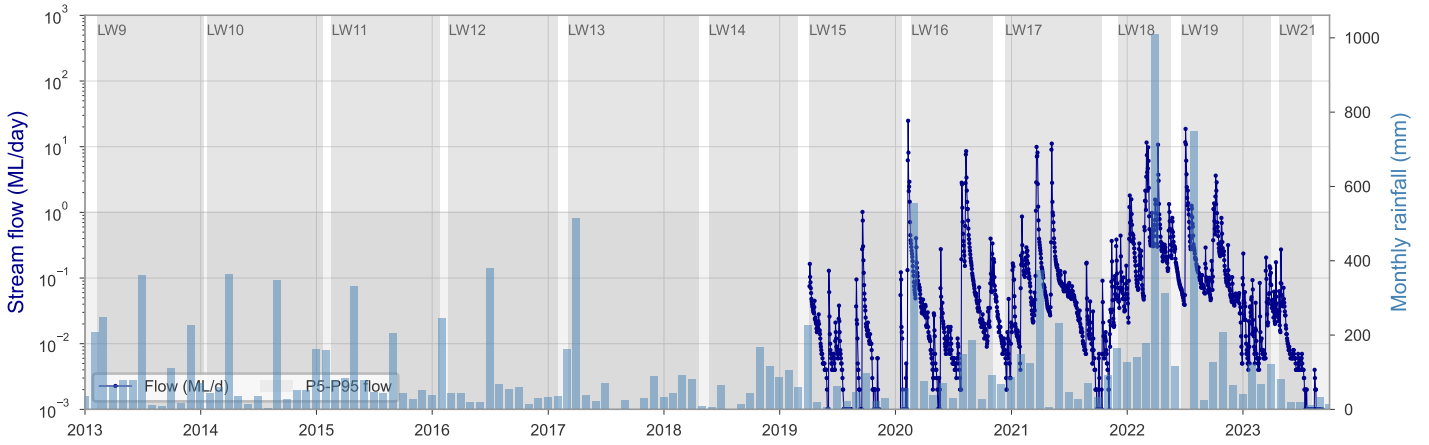
WC11_POOL20



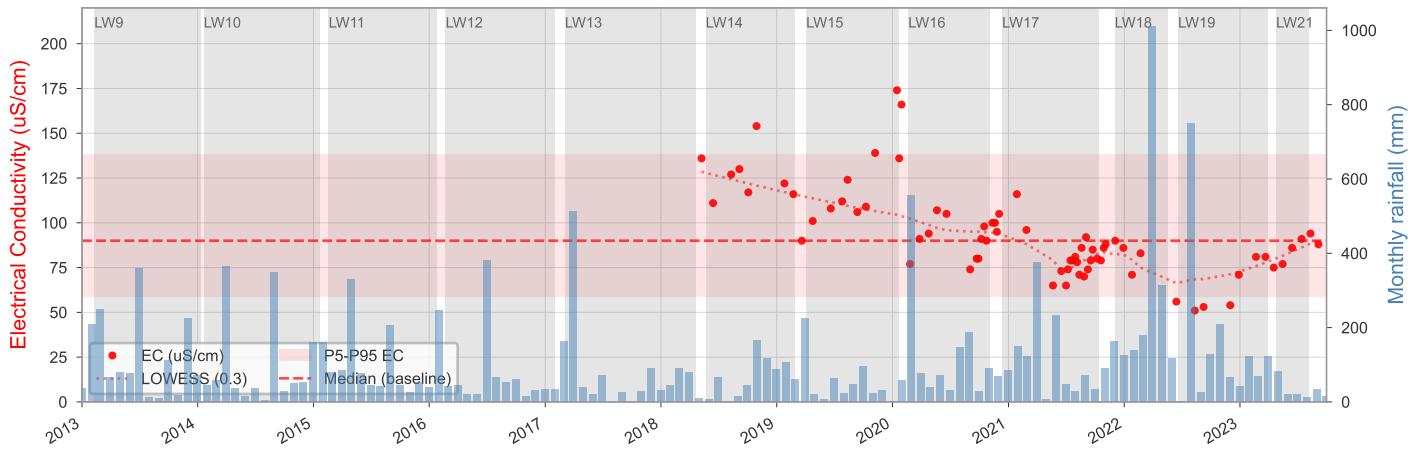
WC11_POOL20



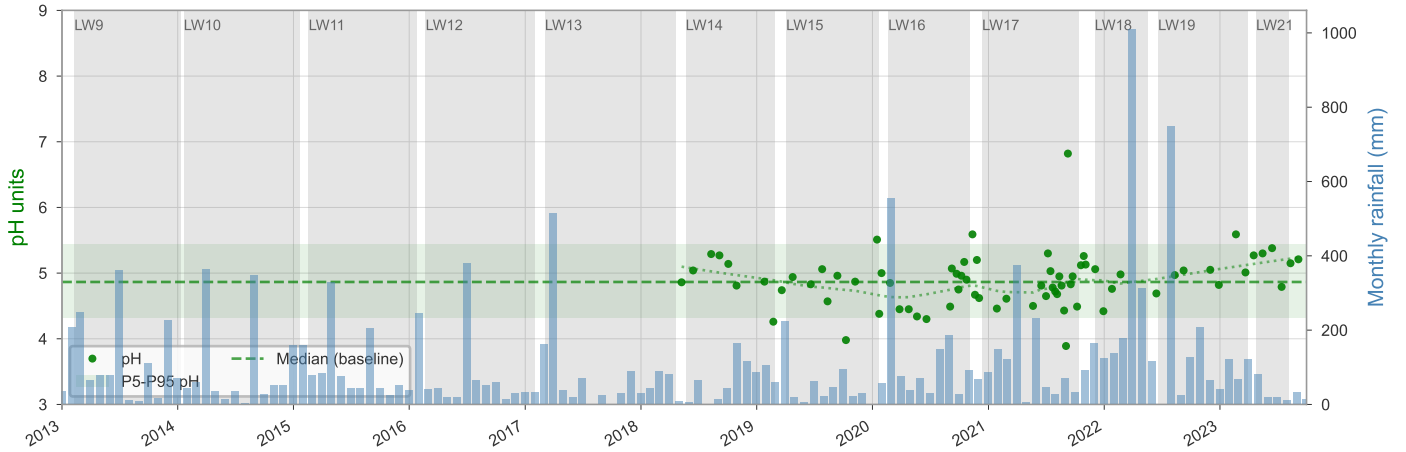
WC12S1



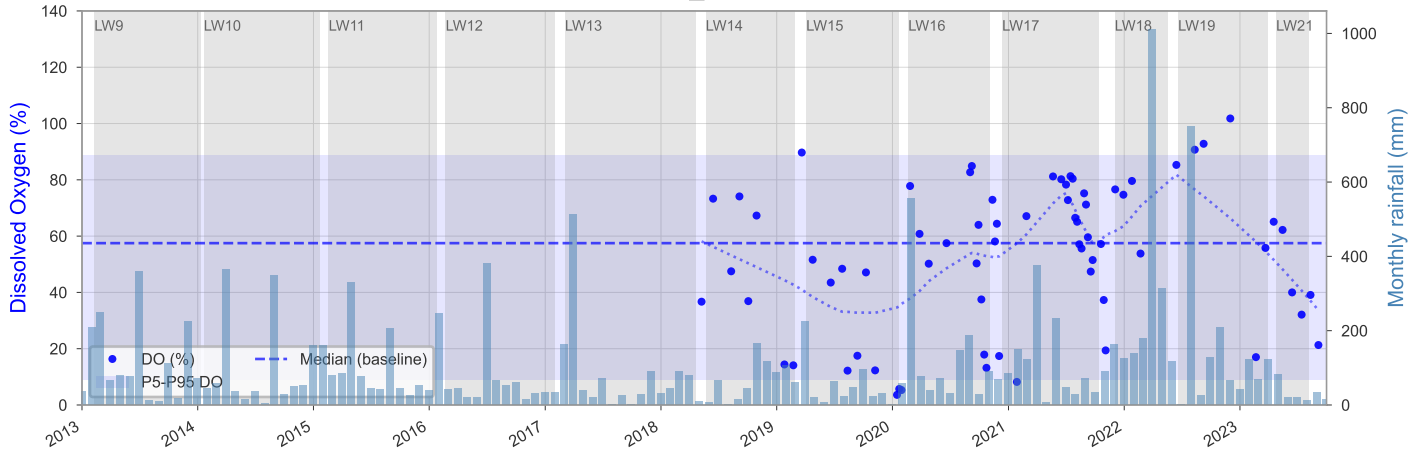
WC12_POOL1



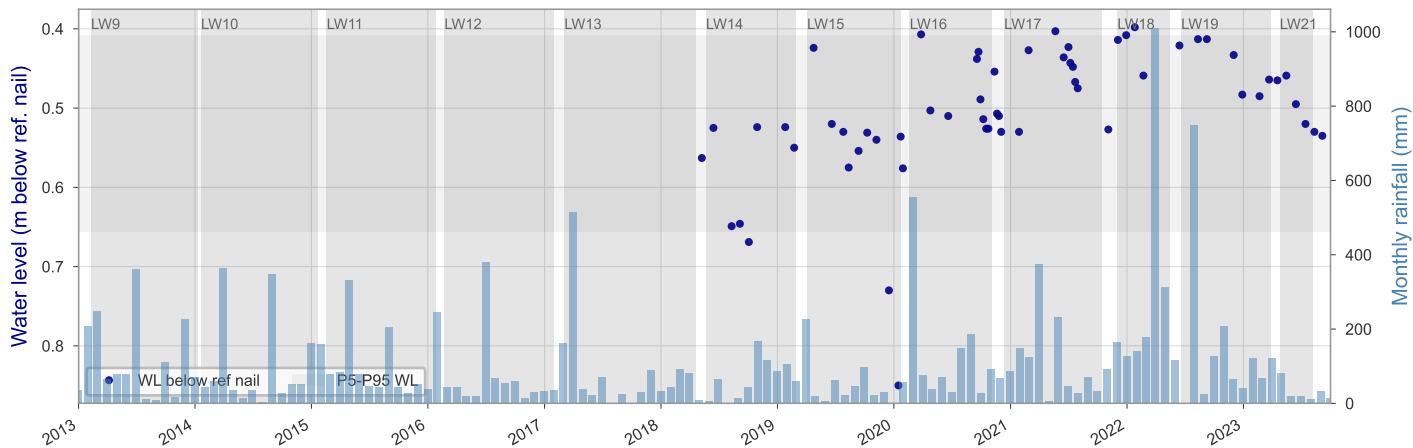
WC12_POOL1



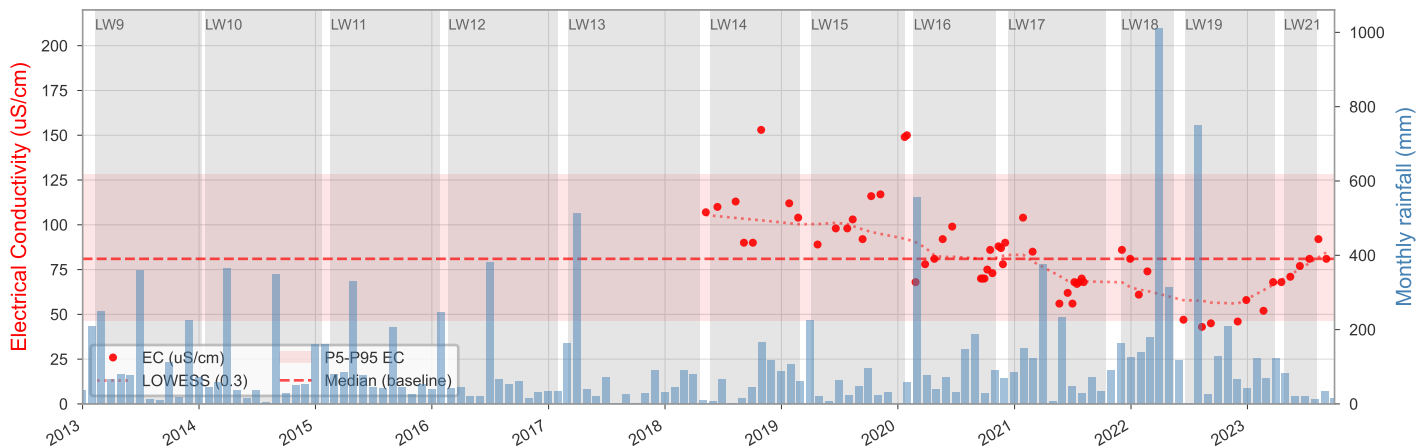
WC12_POOL1



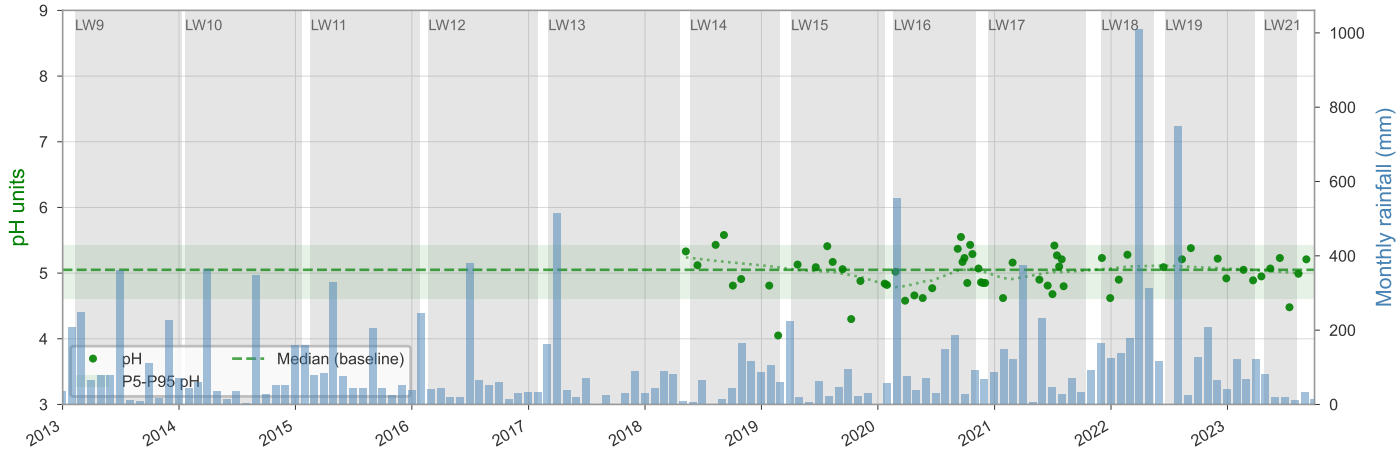
WC12_POOL12



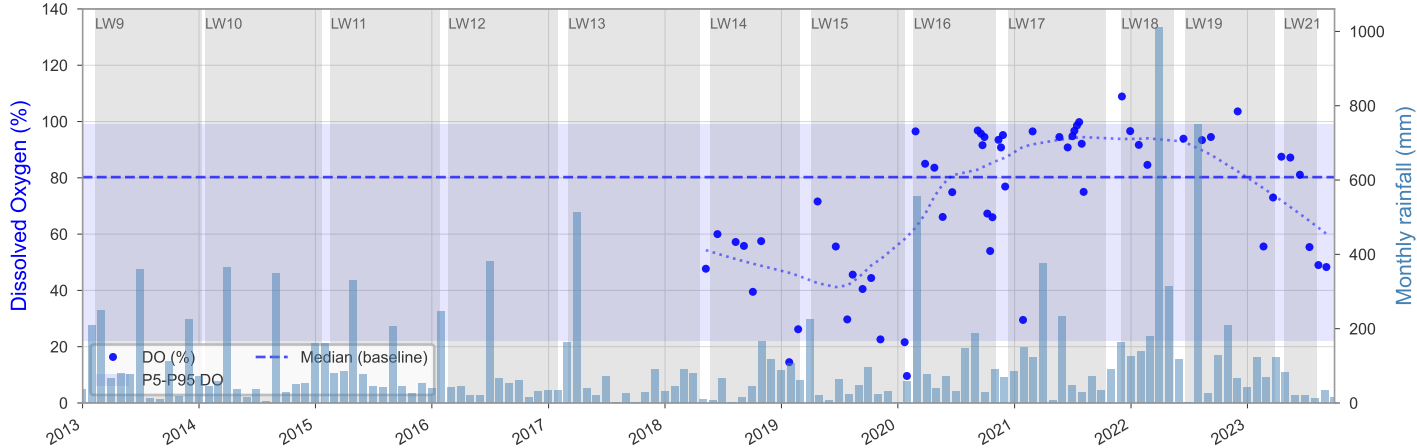
WC12_POOL12



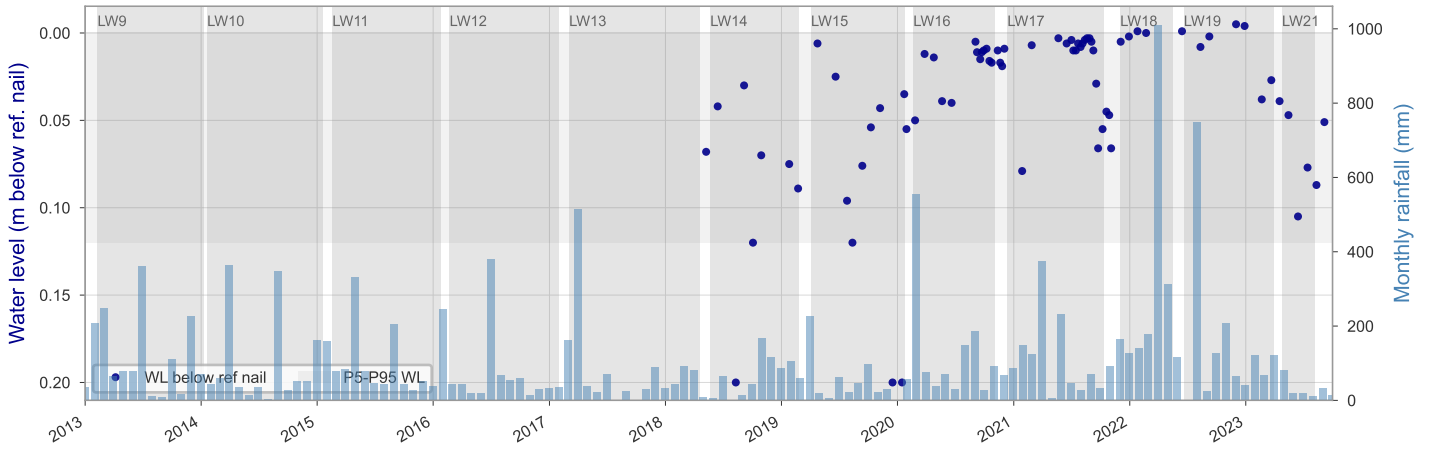
WC12_POOL12



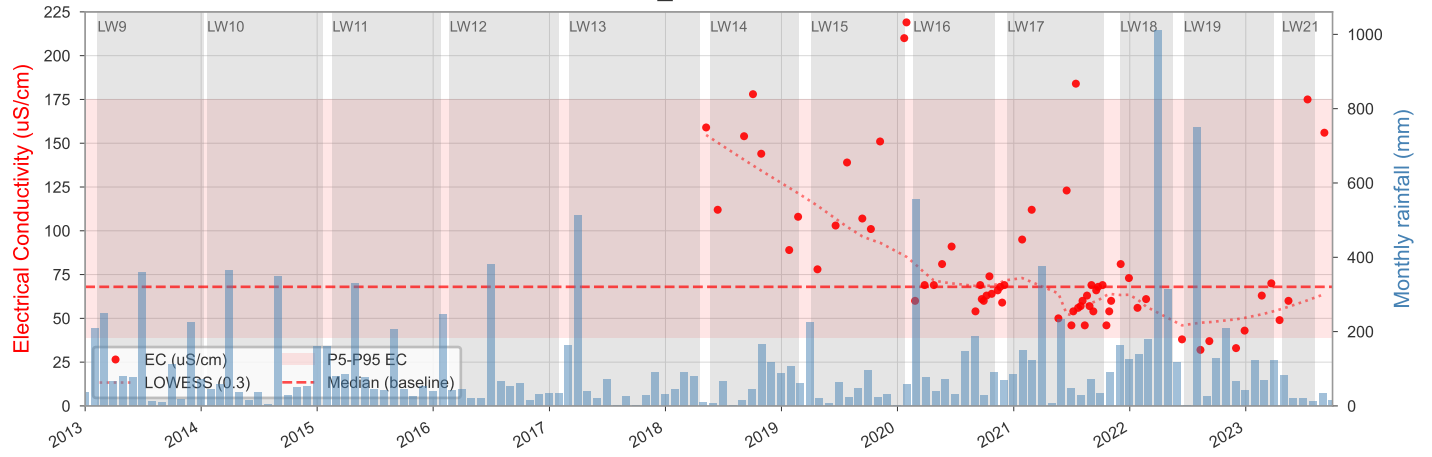
WC12_POOL12



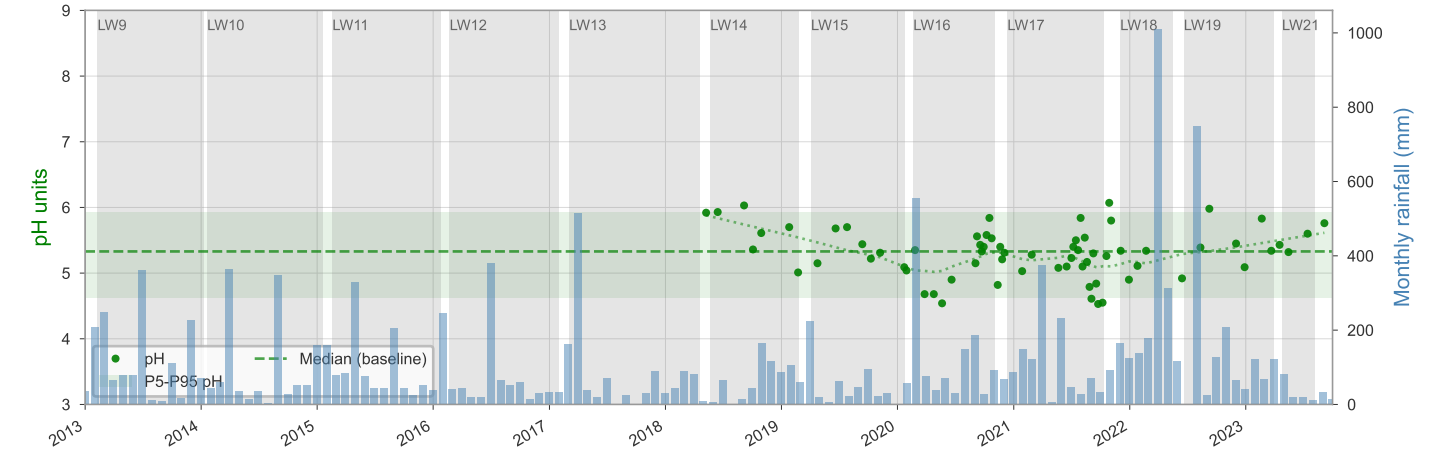
WC12_ROCKBAR18



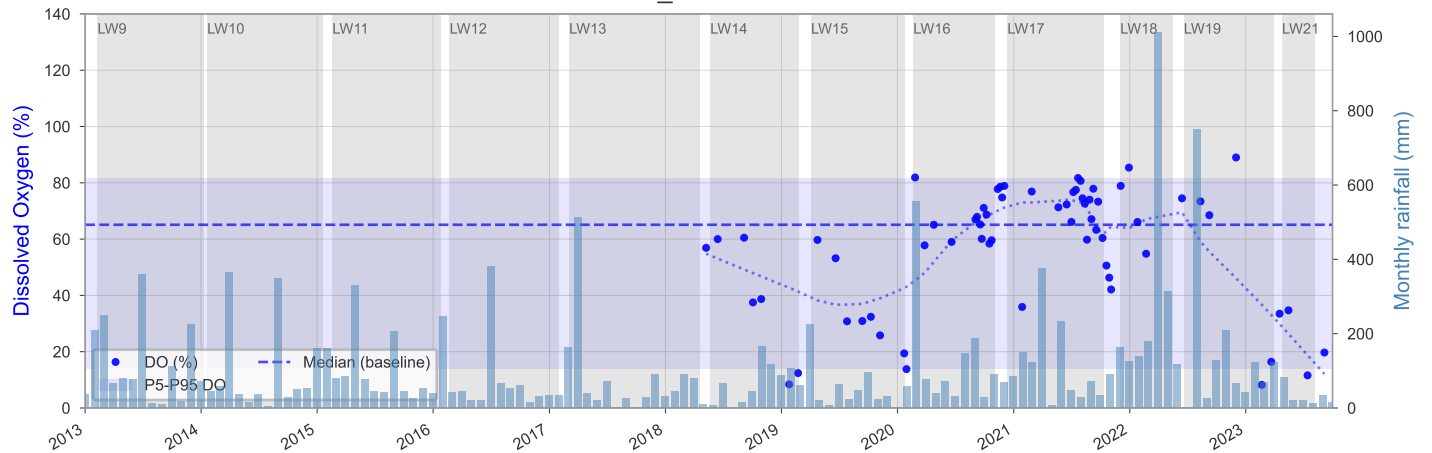
WC12_ROCKBAR18



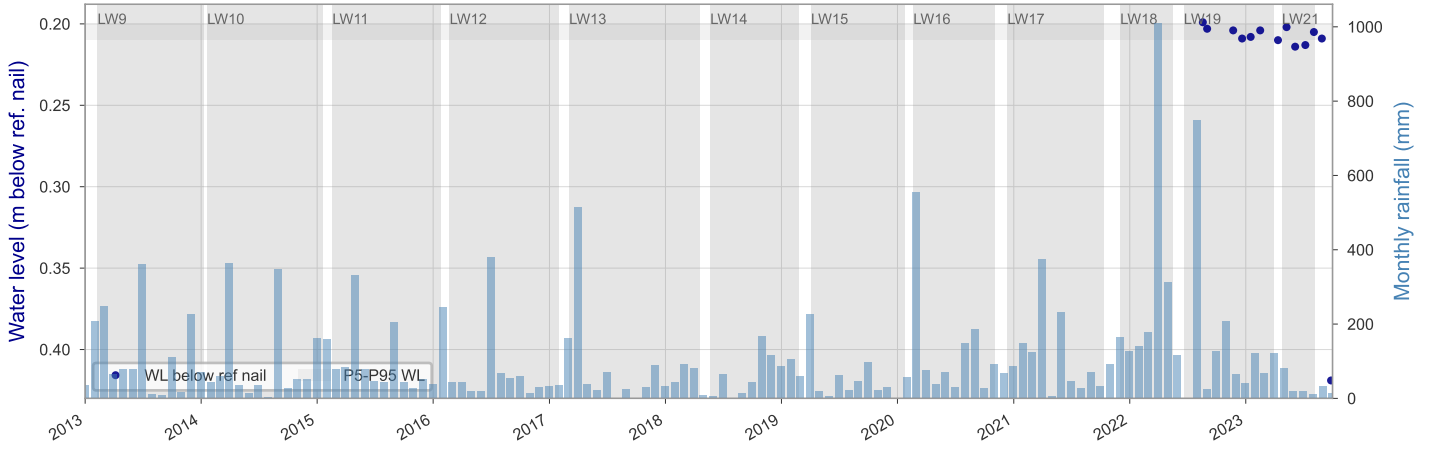
WC12_ROCKBAR18



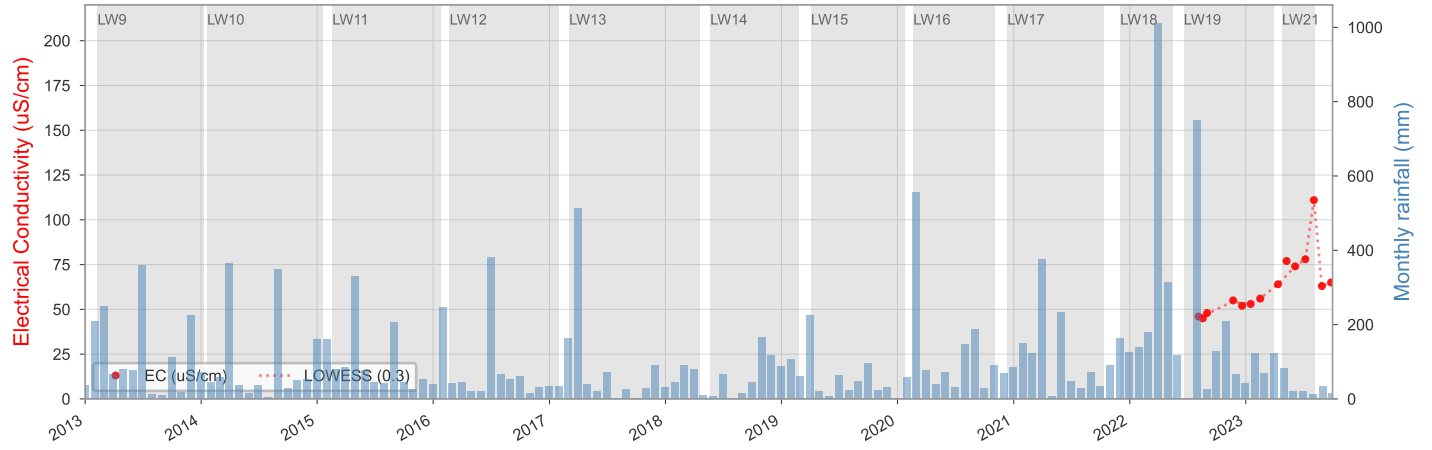
WC12_ROCKBAR18



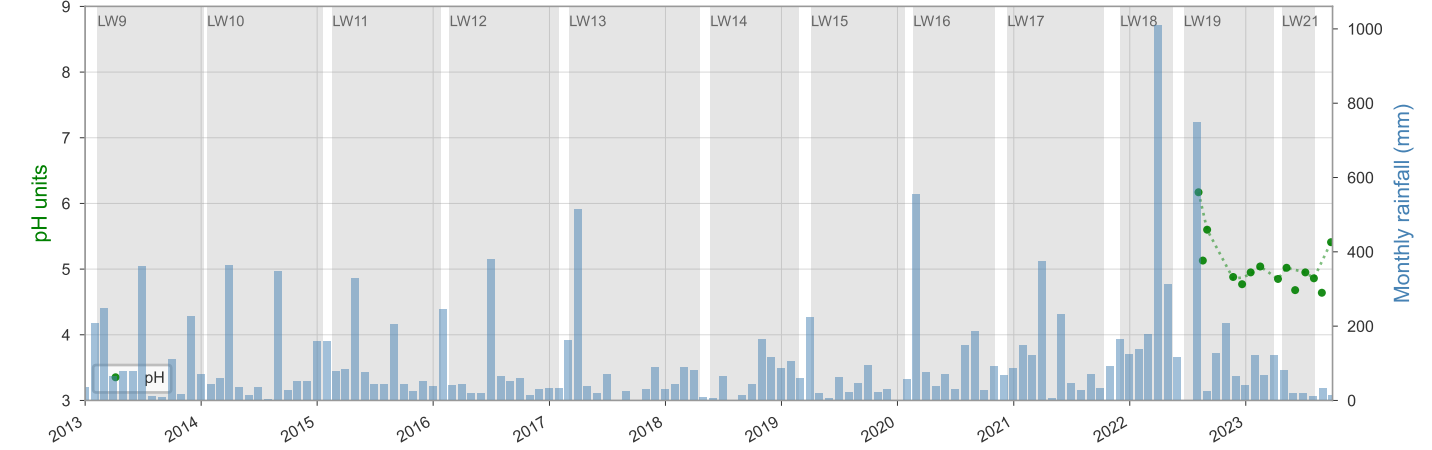
WC13A_POOL4



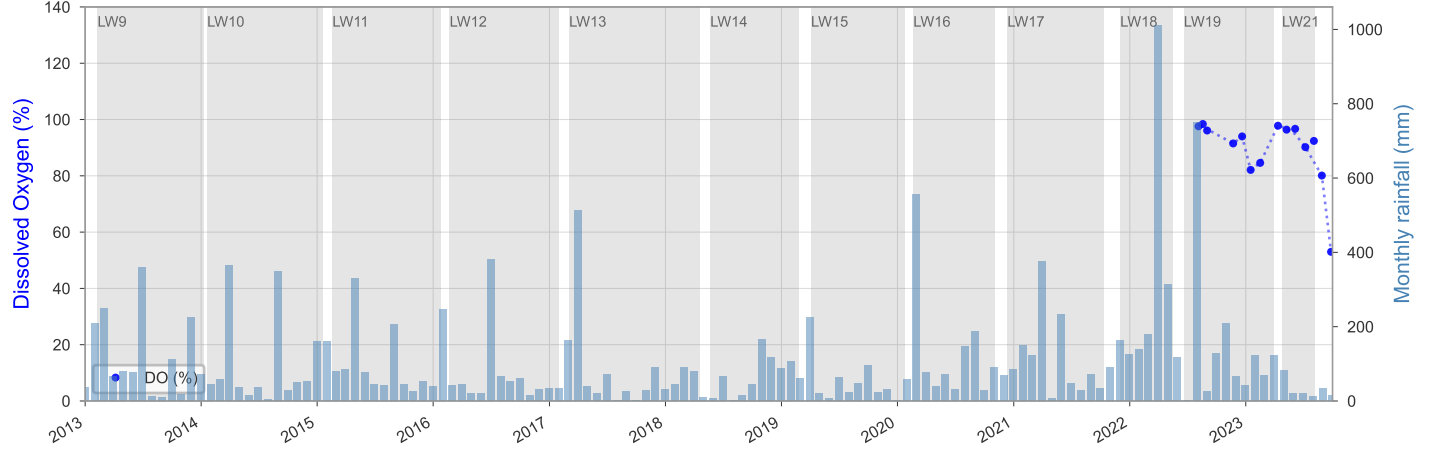
WC13A_POOL4



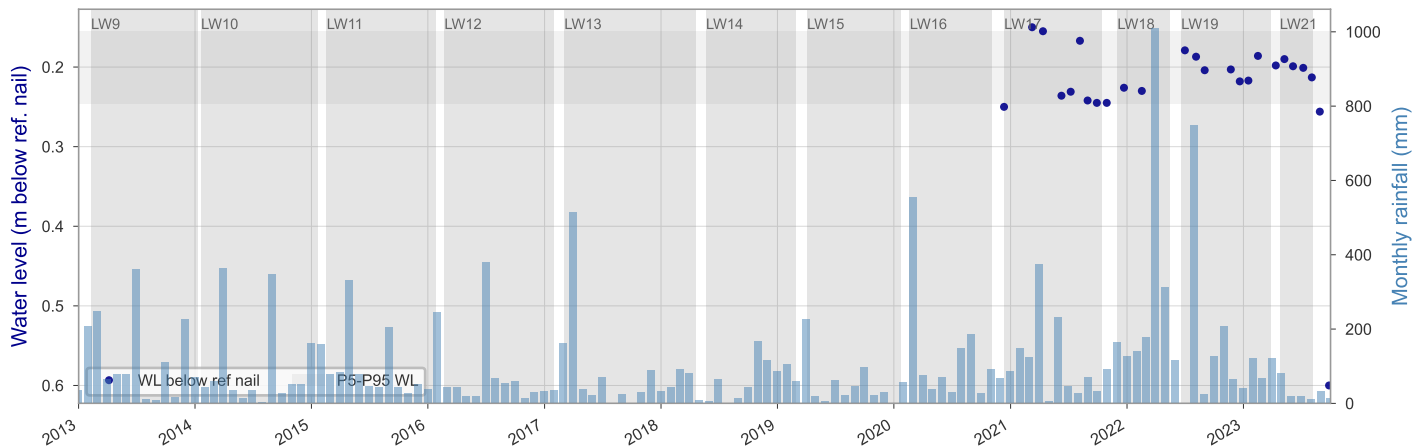
WC13A_POOL4



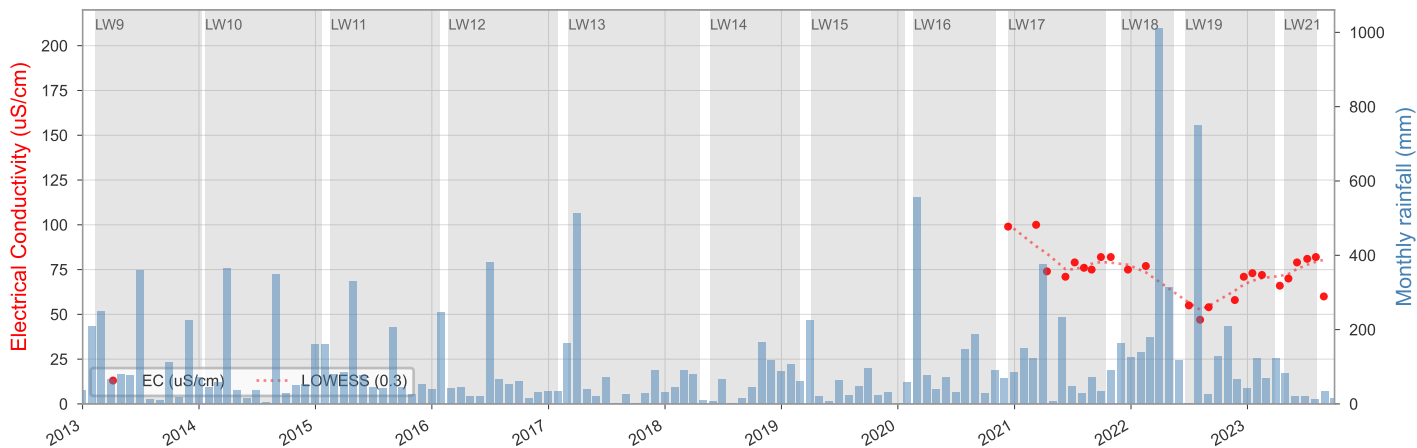
WC13A_POOL4



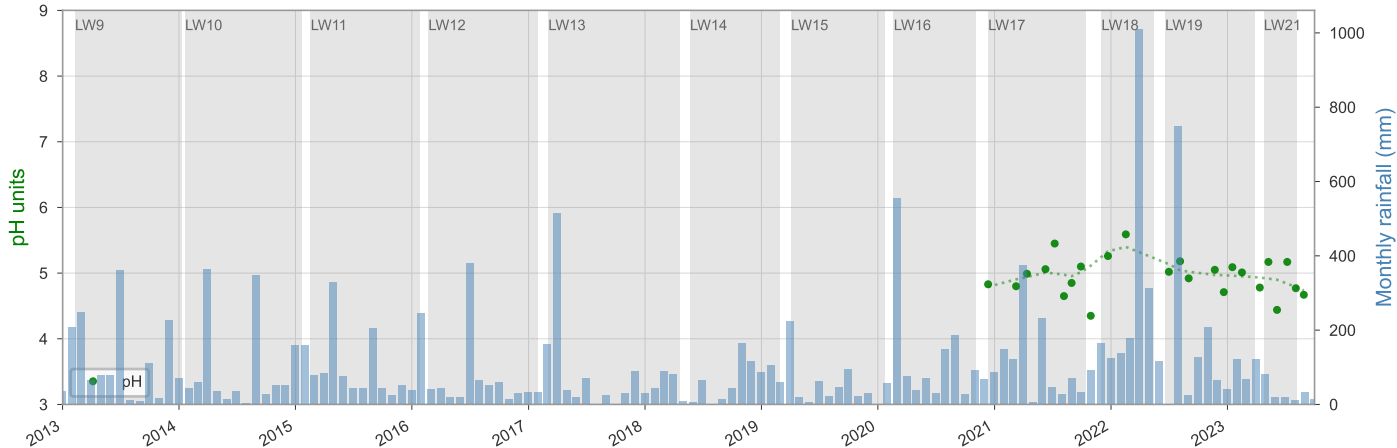
WC13_POOL1



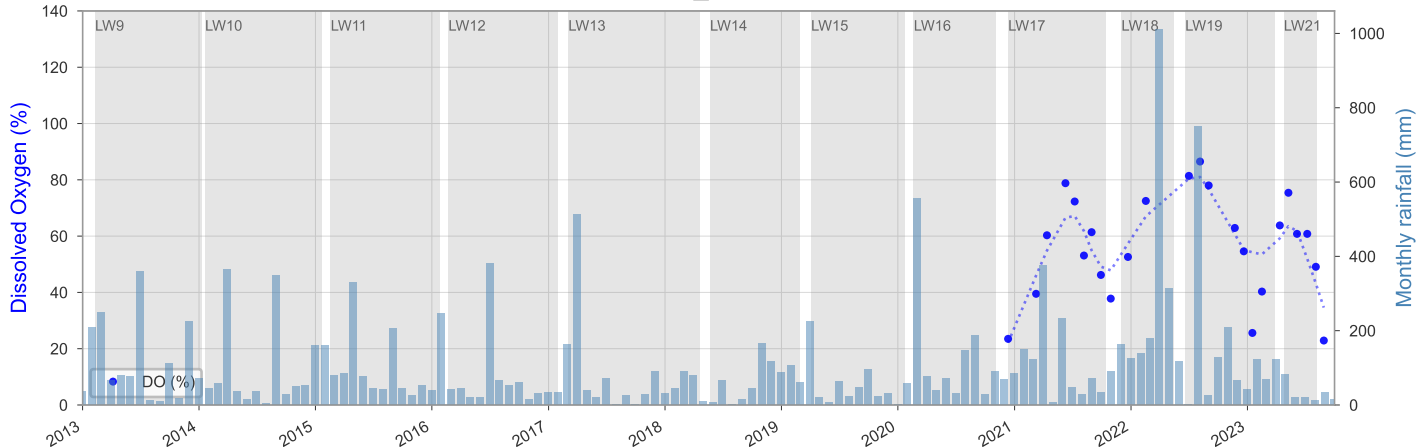
WC13_POOL1



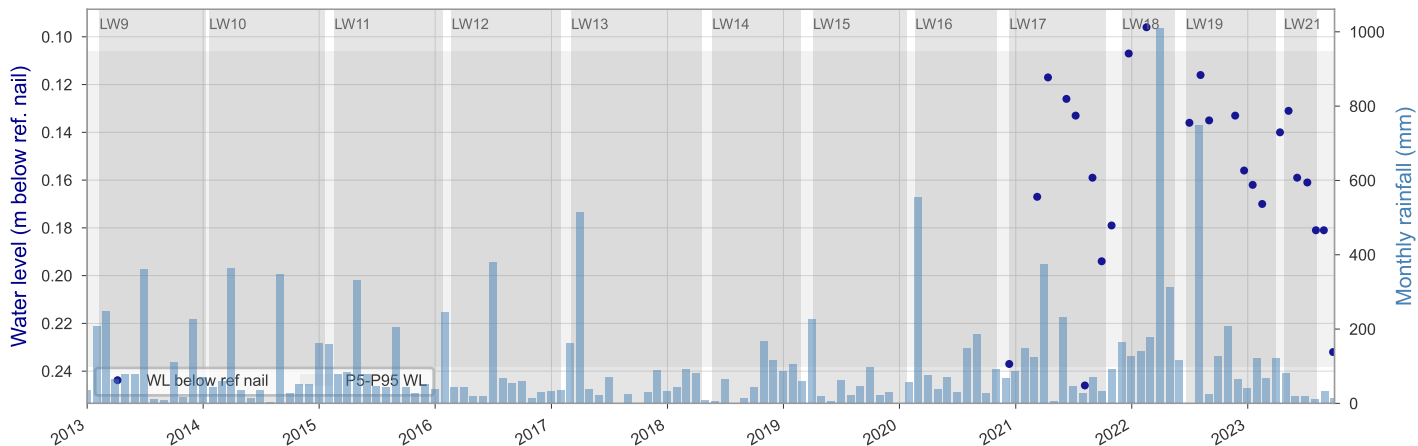
WC13_POOL1



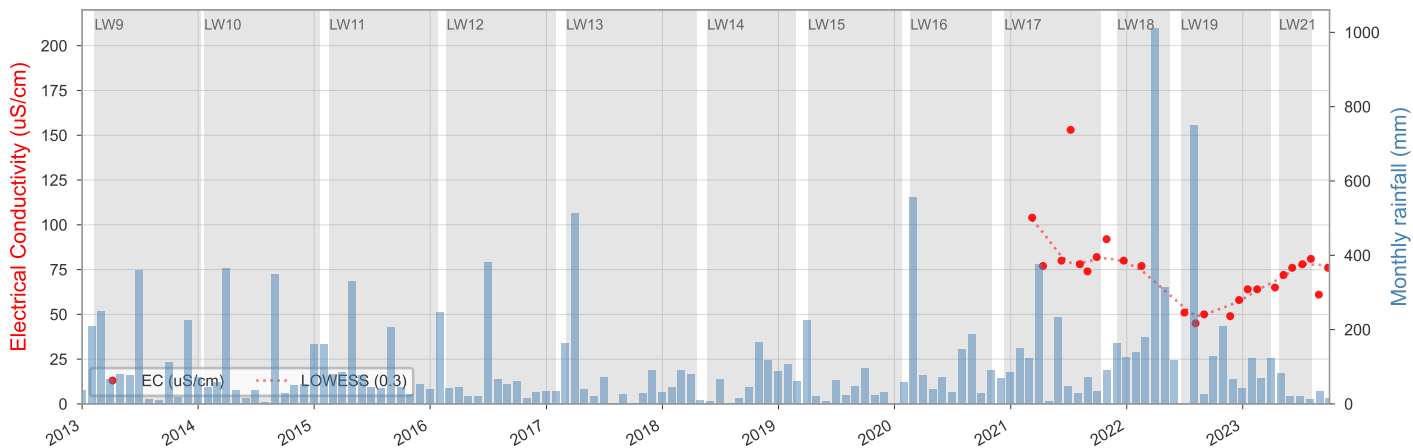
WC13_POOL1



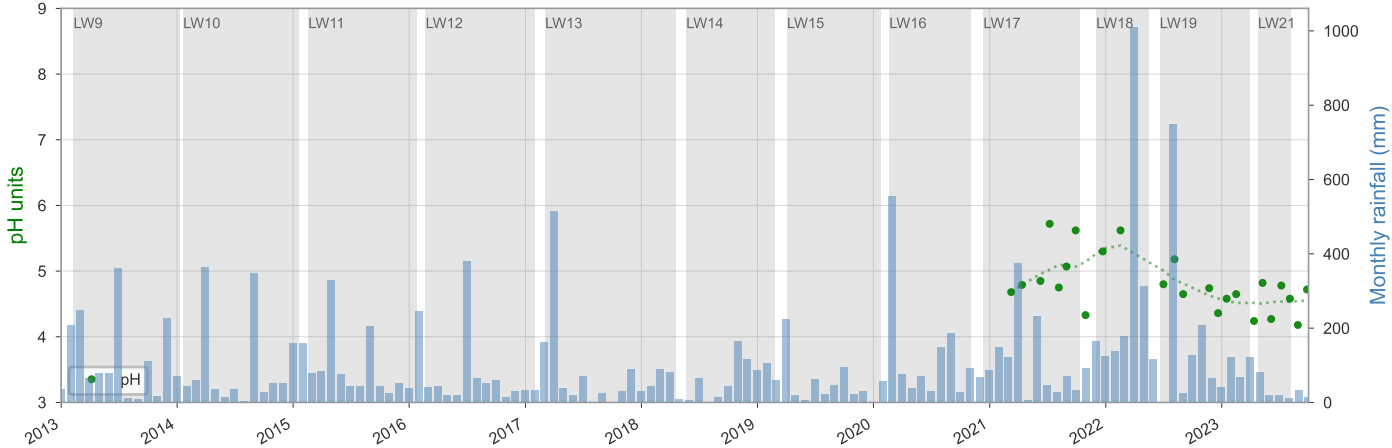
WC13_POOL3



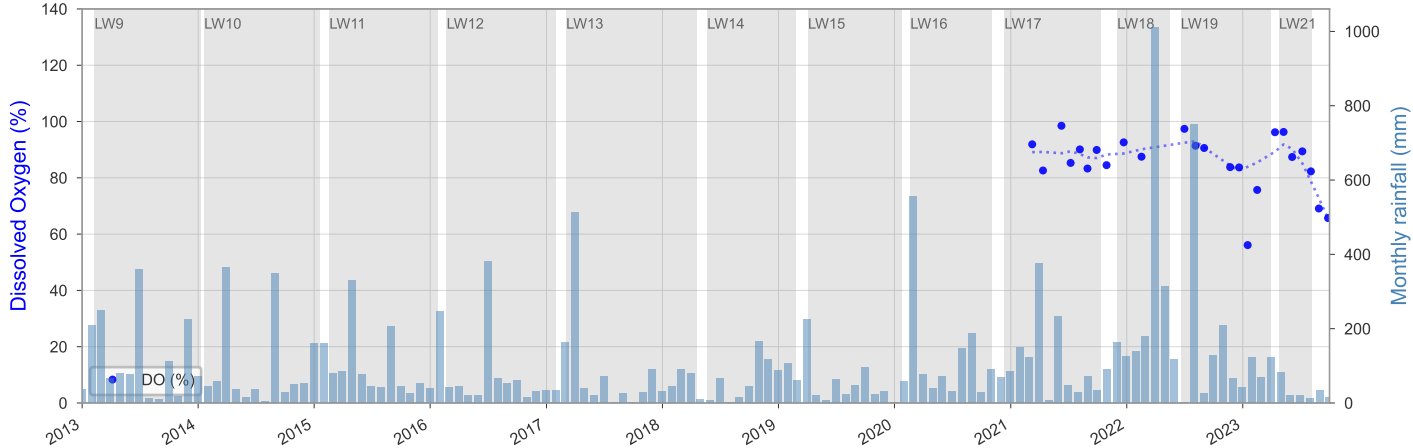
WC13_POOL3



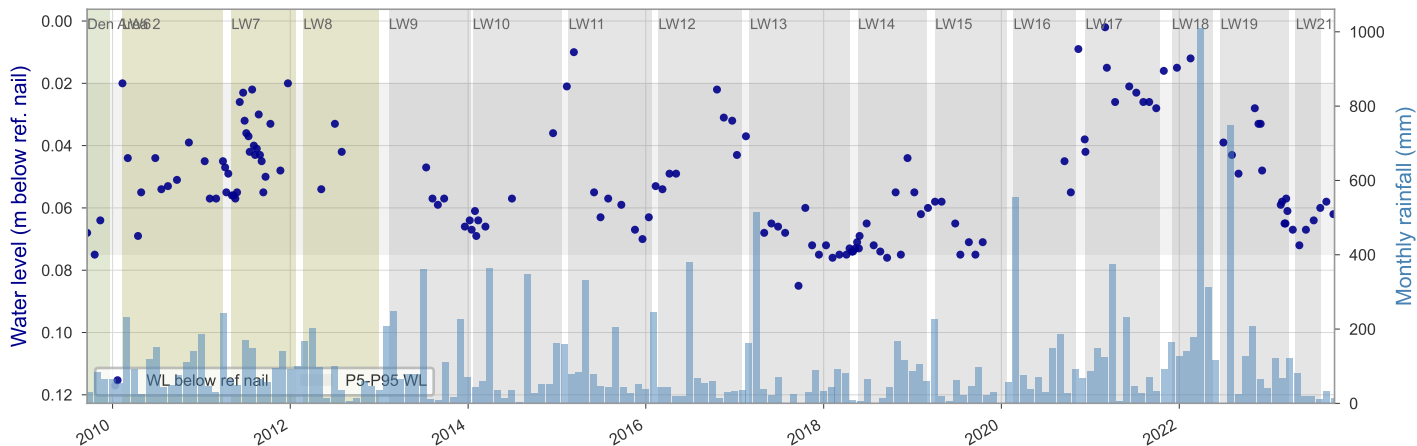
WC13_POOL3



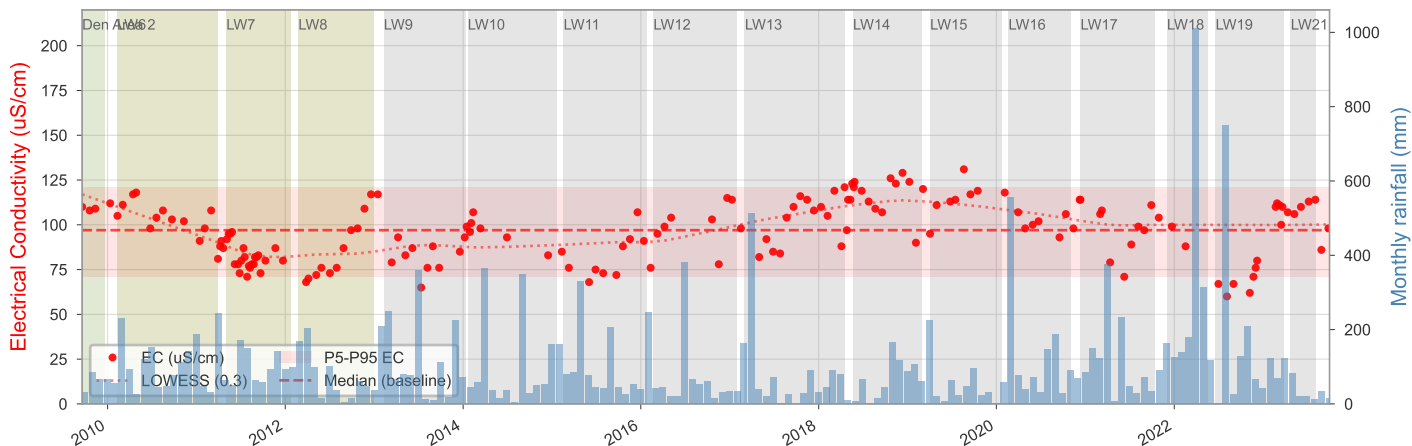
WC13_POOL3



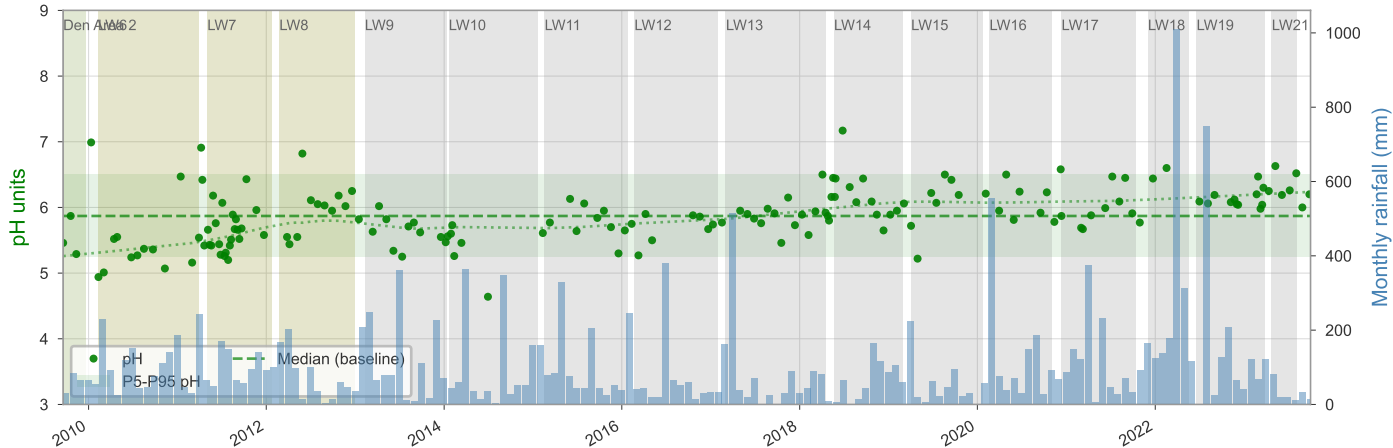
WC14_POOL3



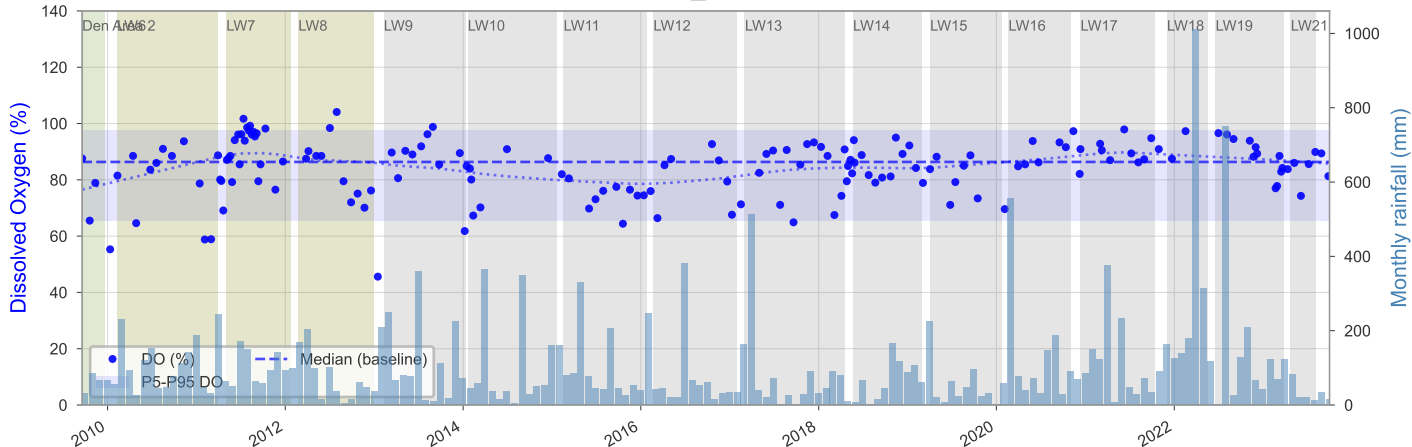
WC14_POOL3



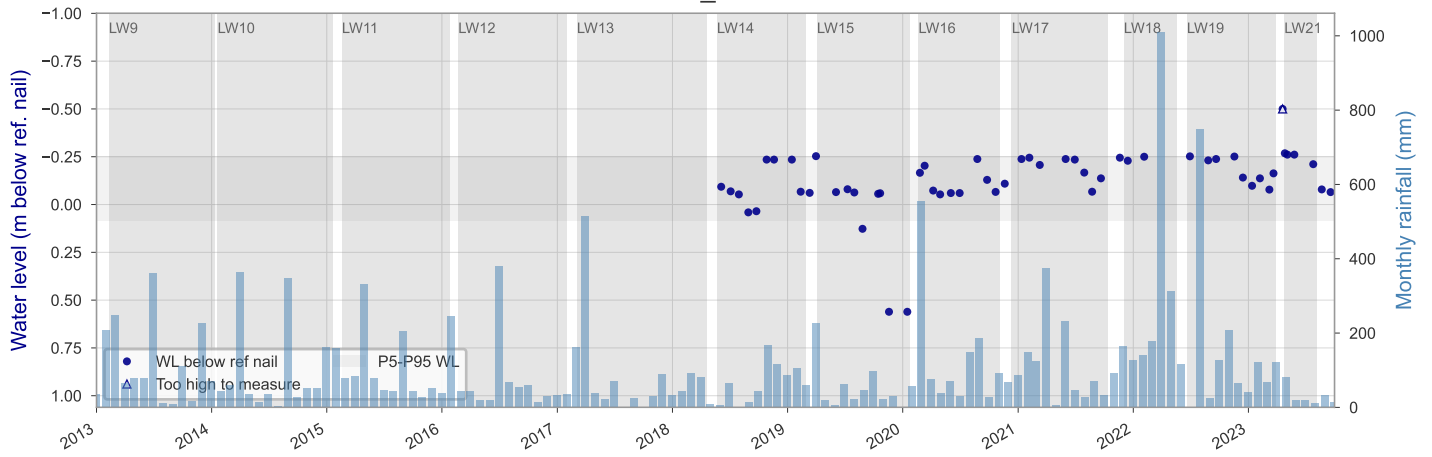
WC14_POOL3



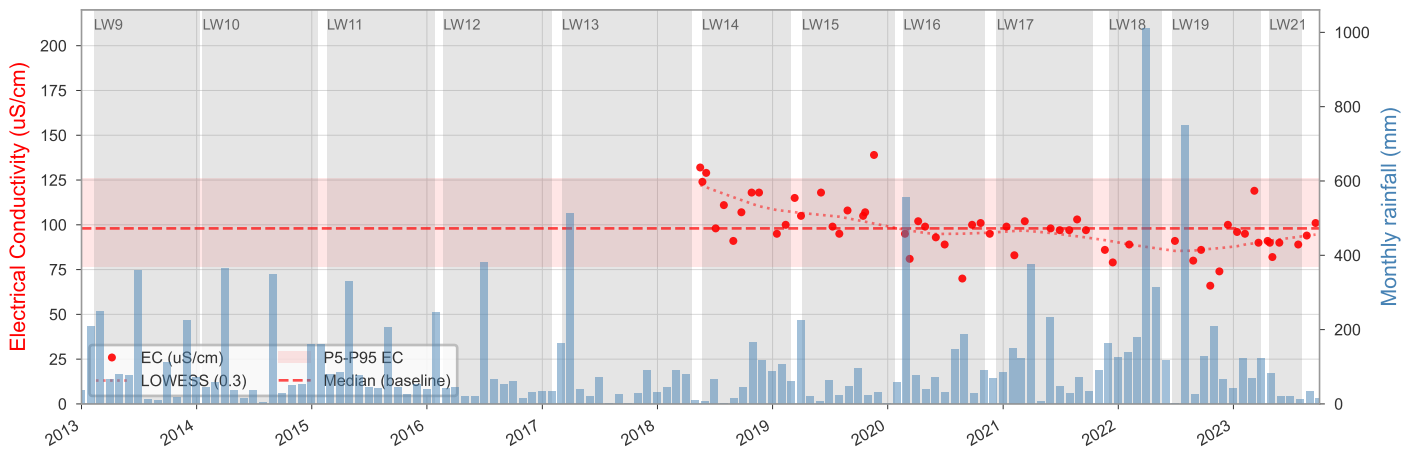
WC14_POOL3



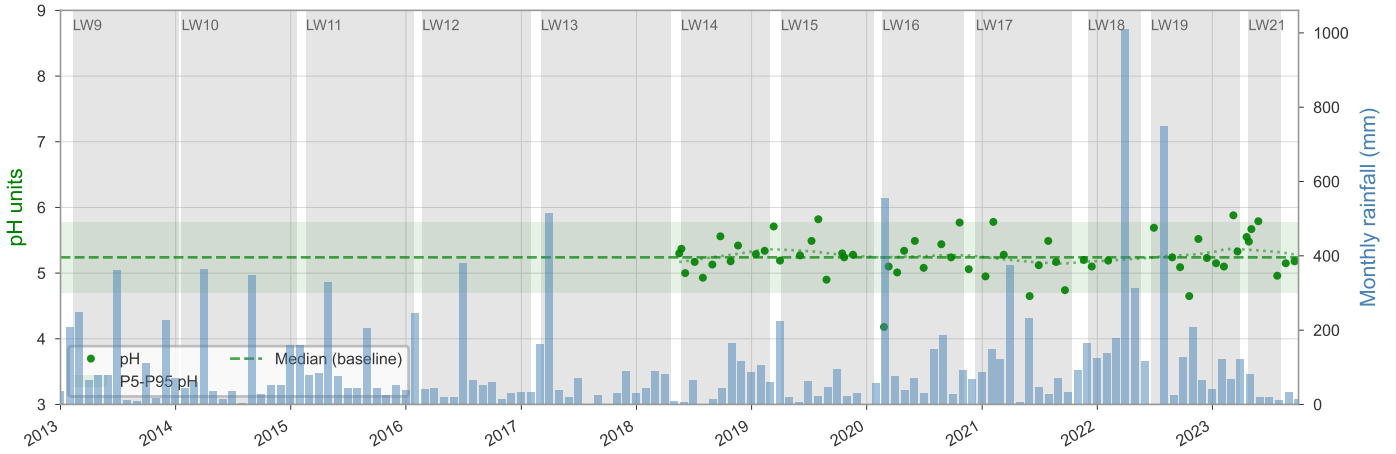
WC15_POOL2



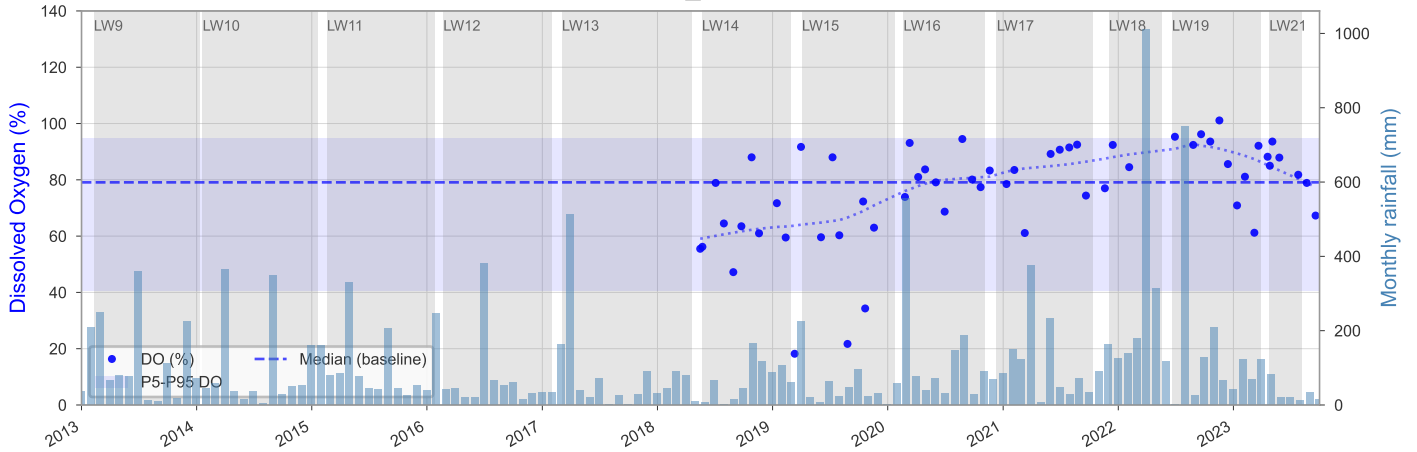
WC15_POOL2



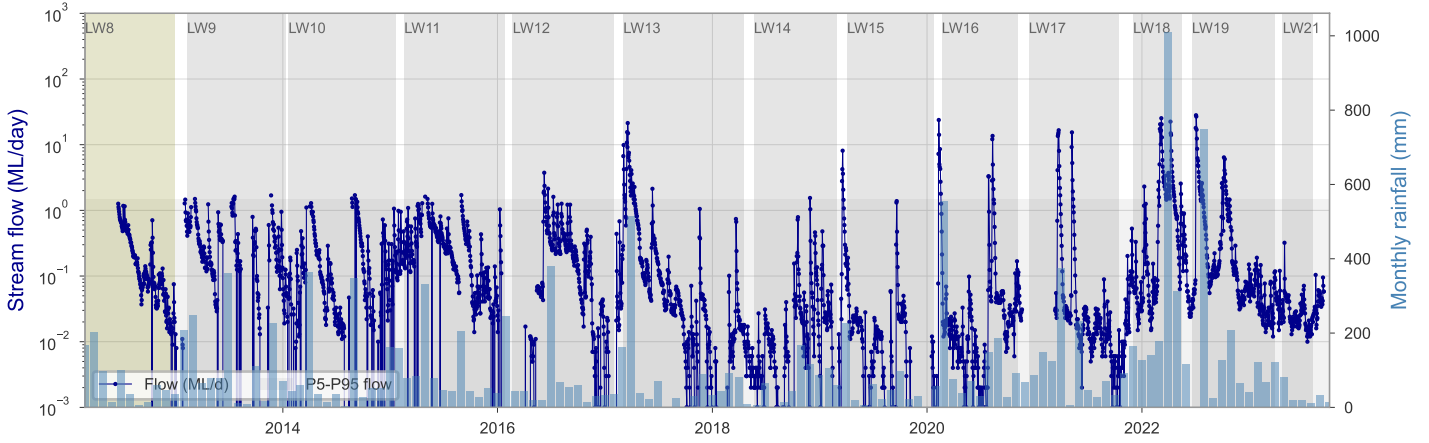
WC15_POOL2



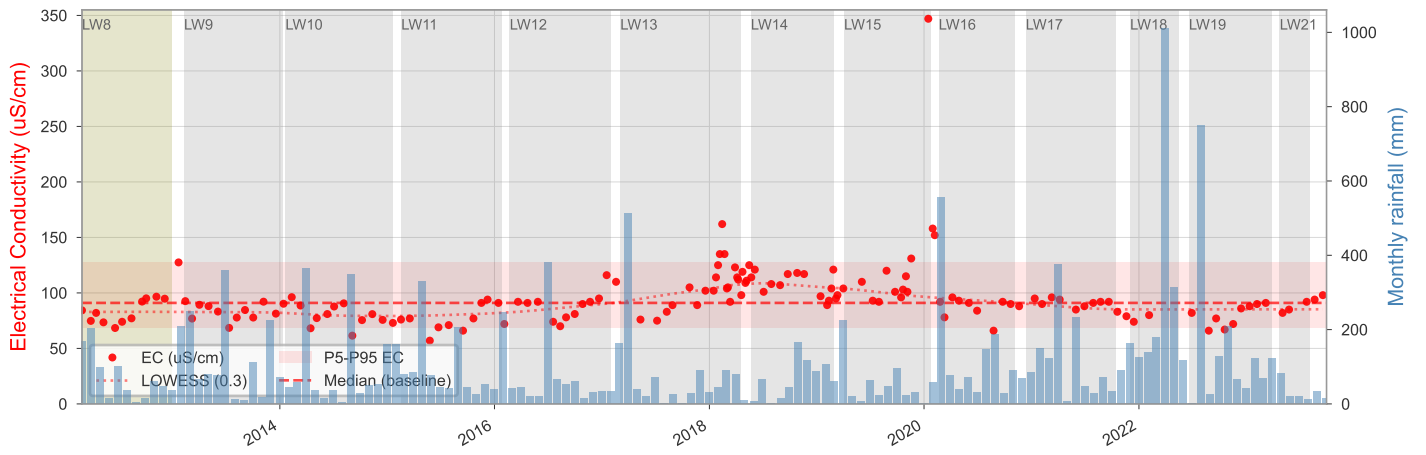
WC15_POOL2



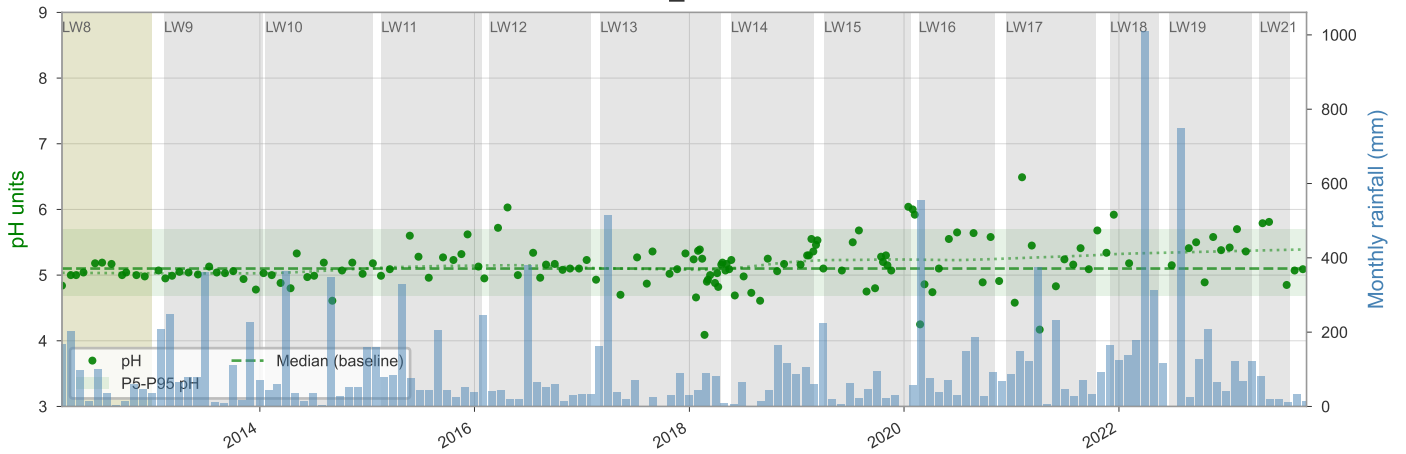
WC15S1



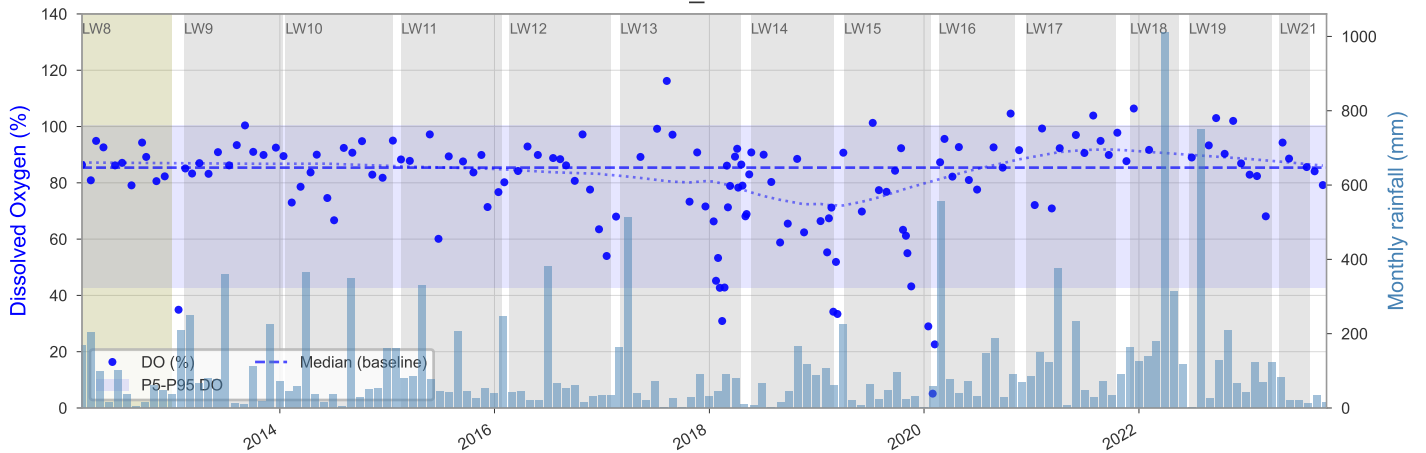
WC15_POOL9



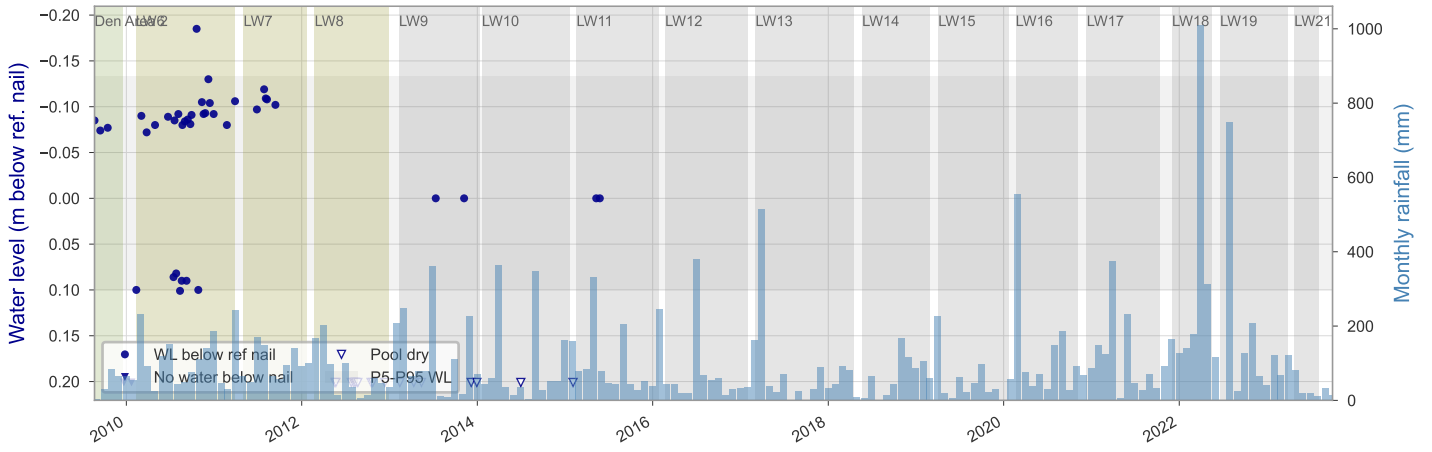
WC15_POOL9



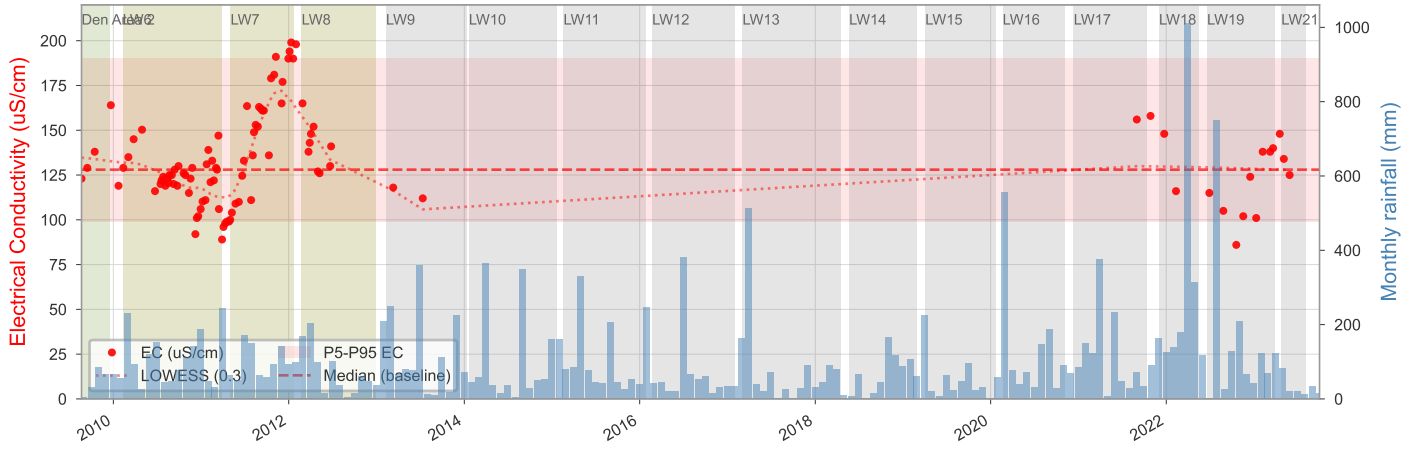
WC15_POOL9



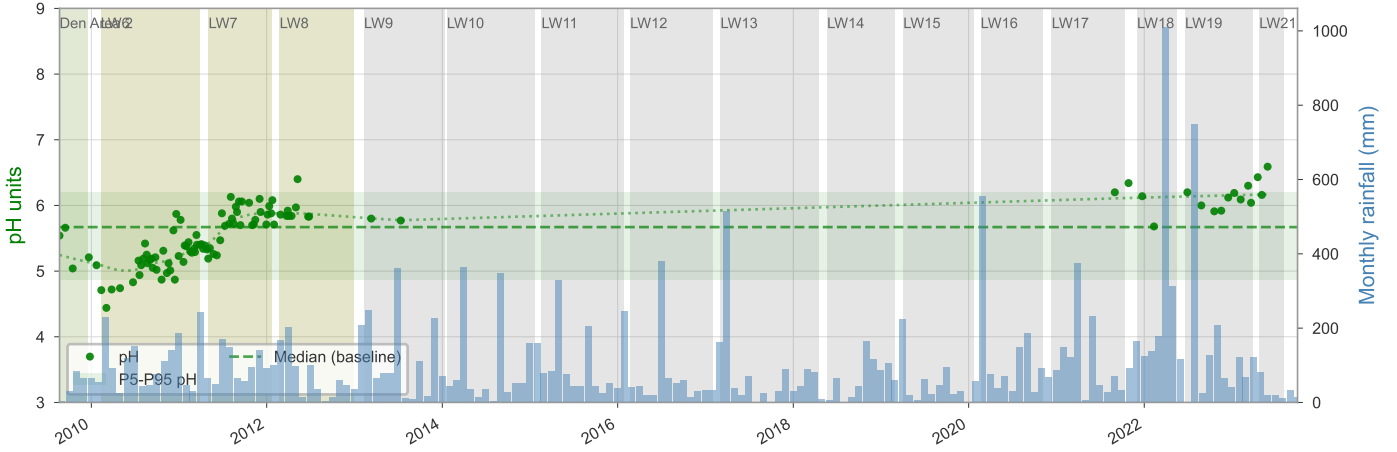
WC17_S12_POOL10



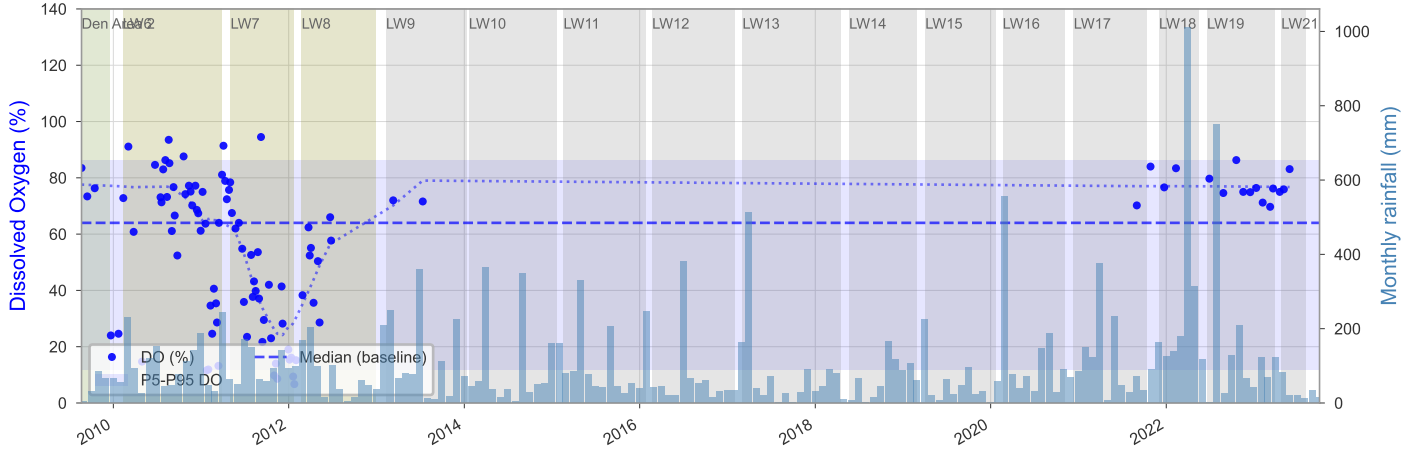
WC17_S12_POOL10



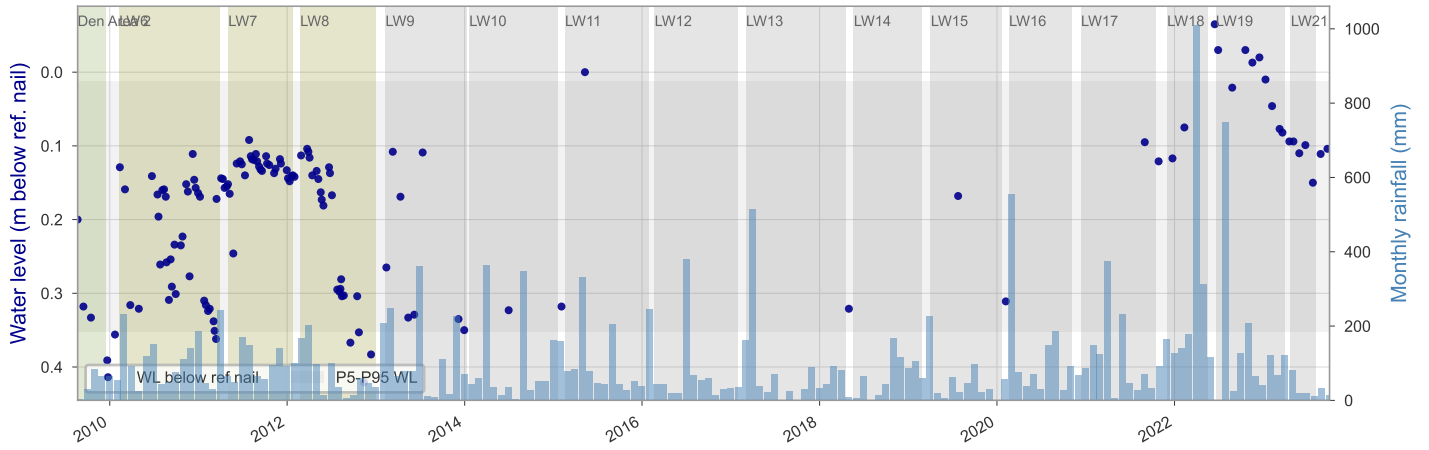
WC17_S12_POOL10



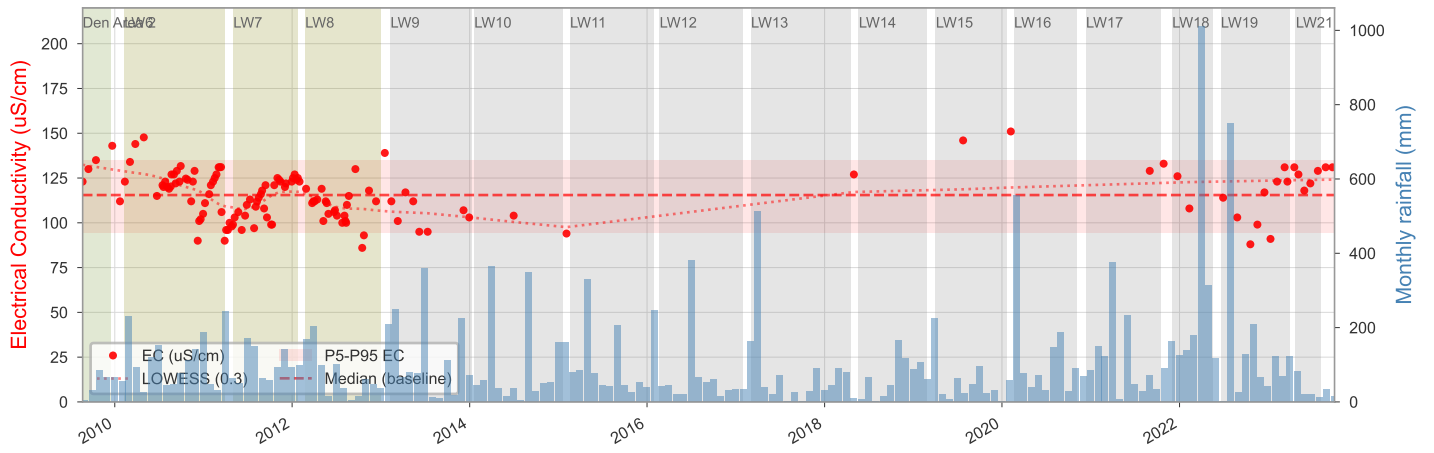
WC17_S12_POOL10



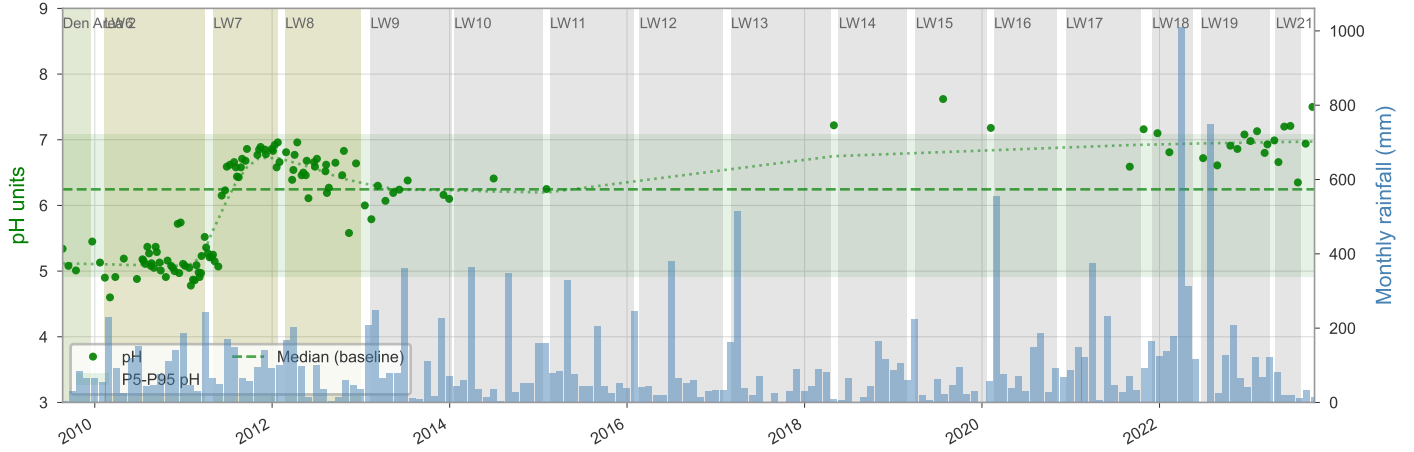
WC17_S12_POOL4



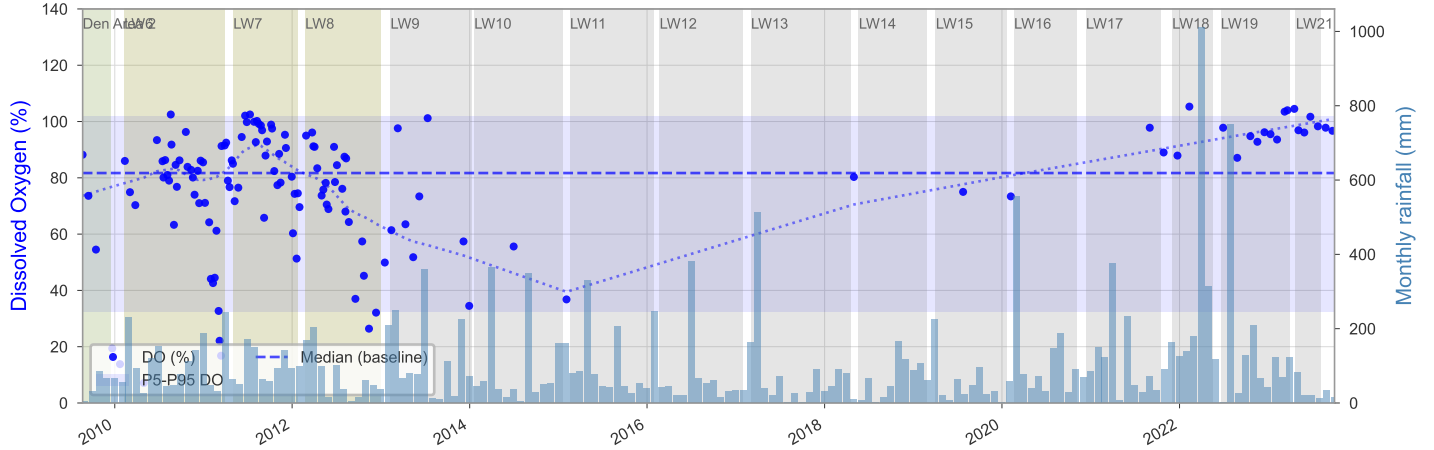
WC17_S12_POOL4



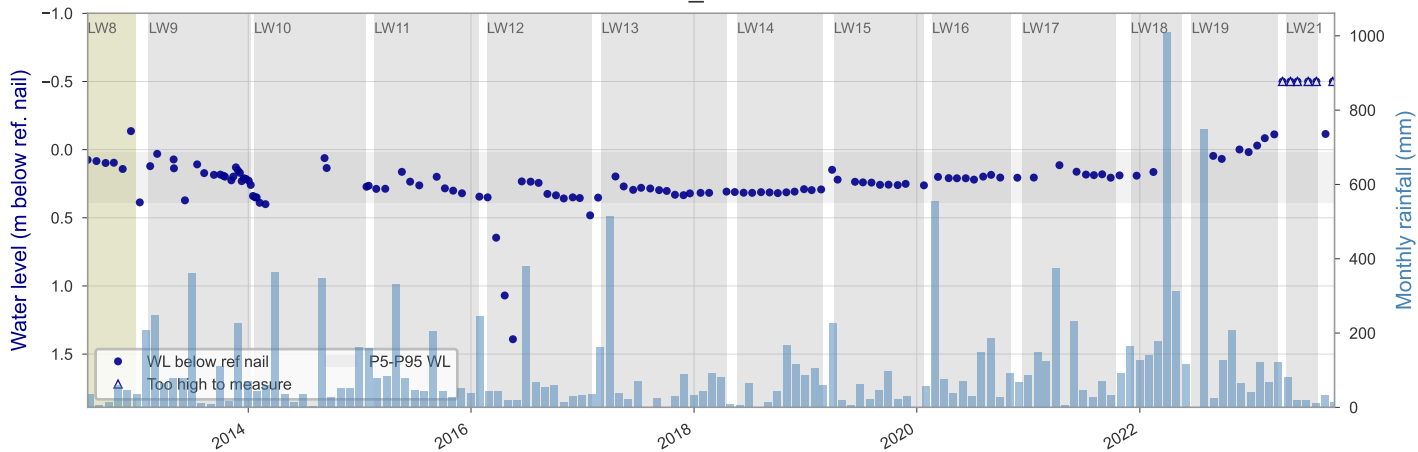
WC17_S12_POOL4



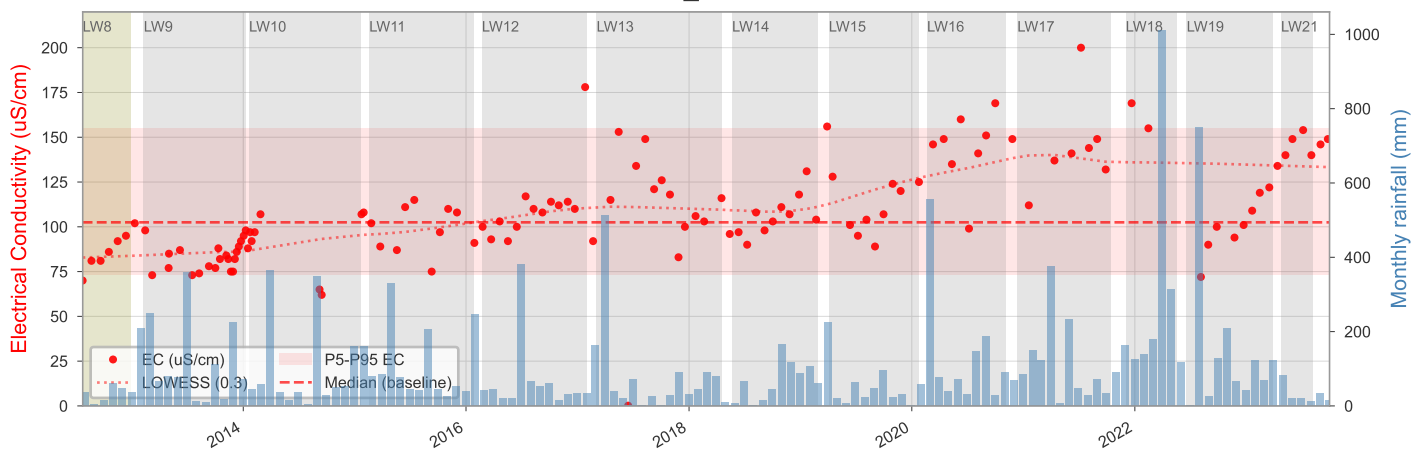
WC17_S12_POOL4



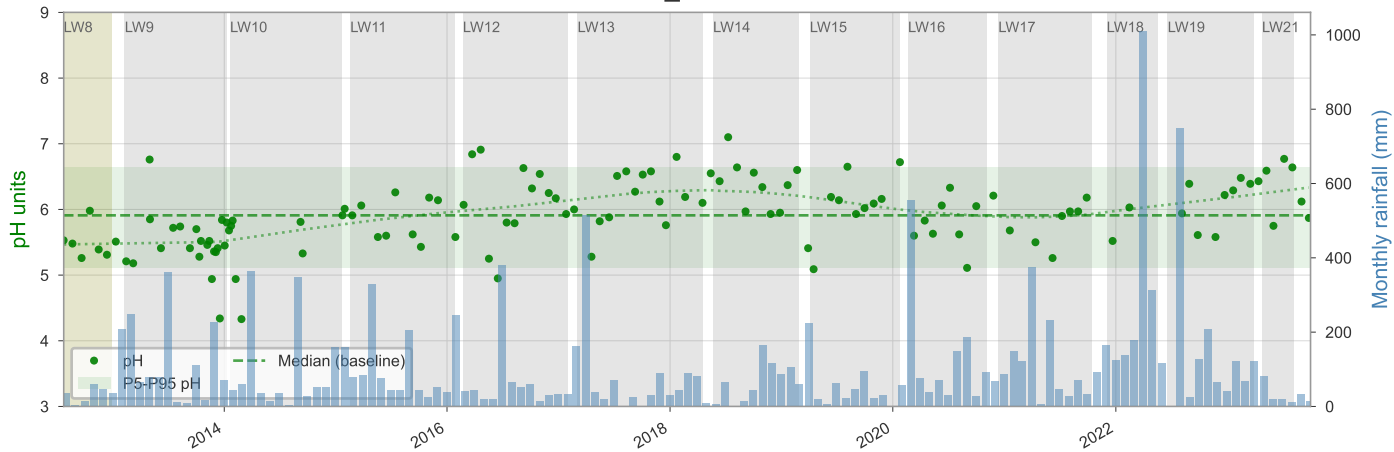
WC21_POOL10



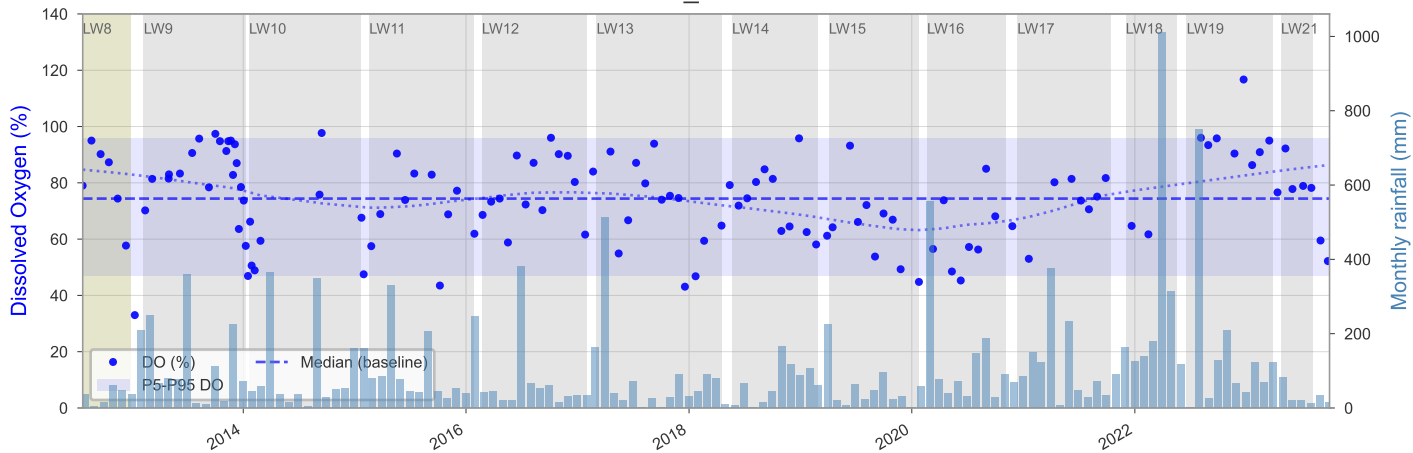
WC21_POOL10



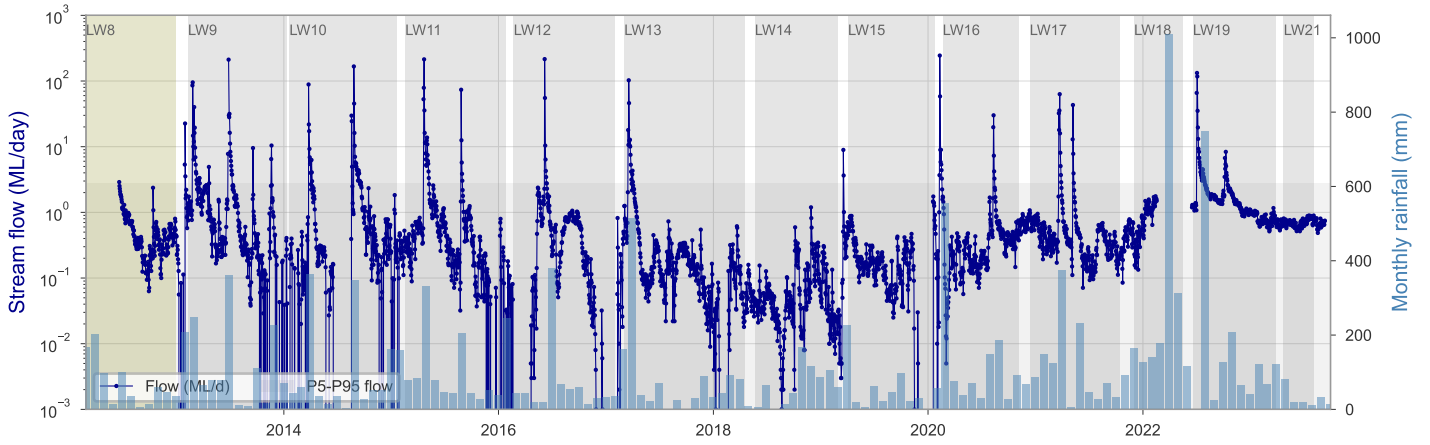
WC21_POOL10



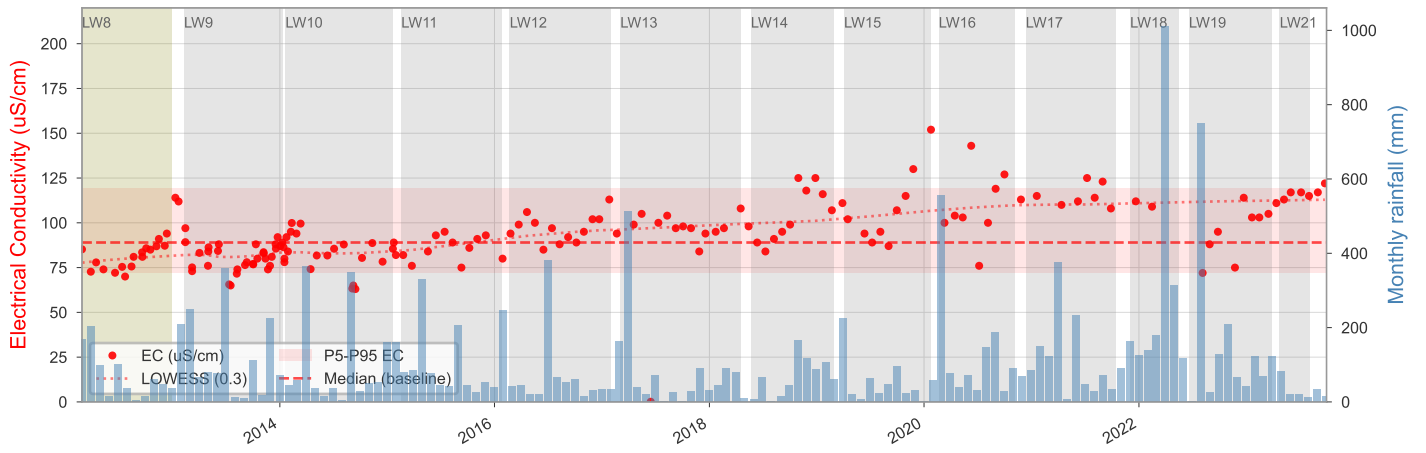
WC21_POOL10



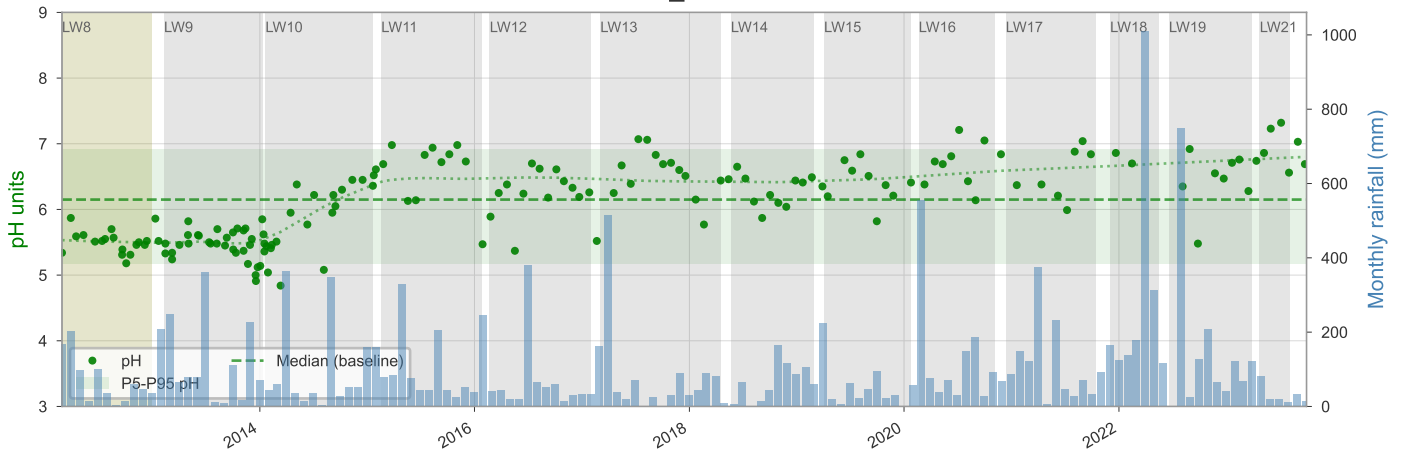
WC21S1



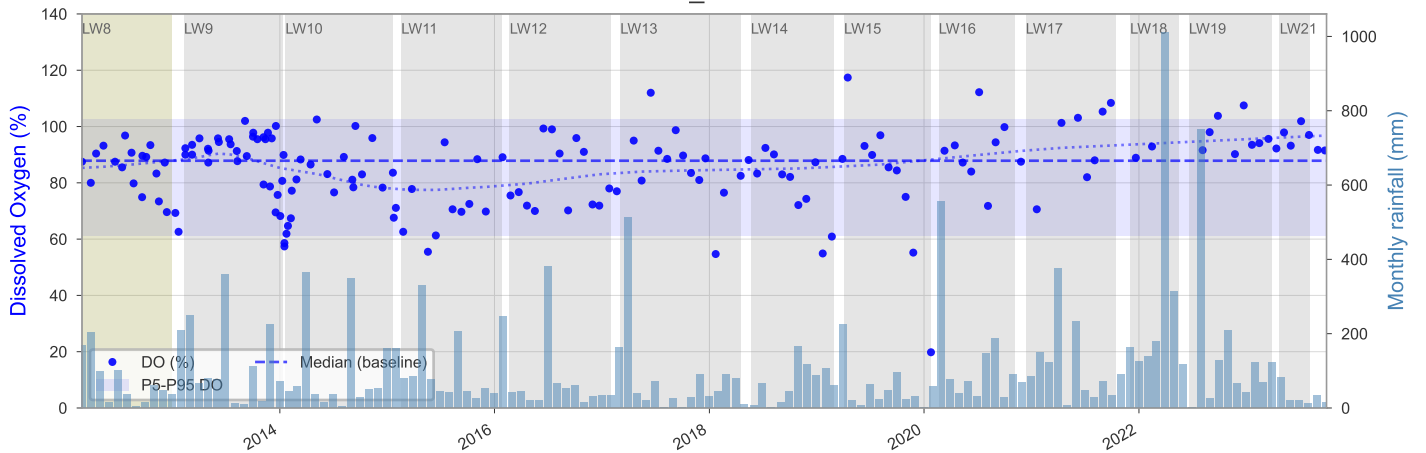
WC21_POOL5



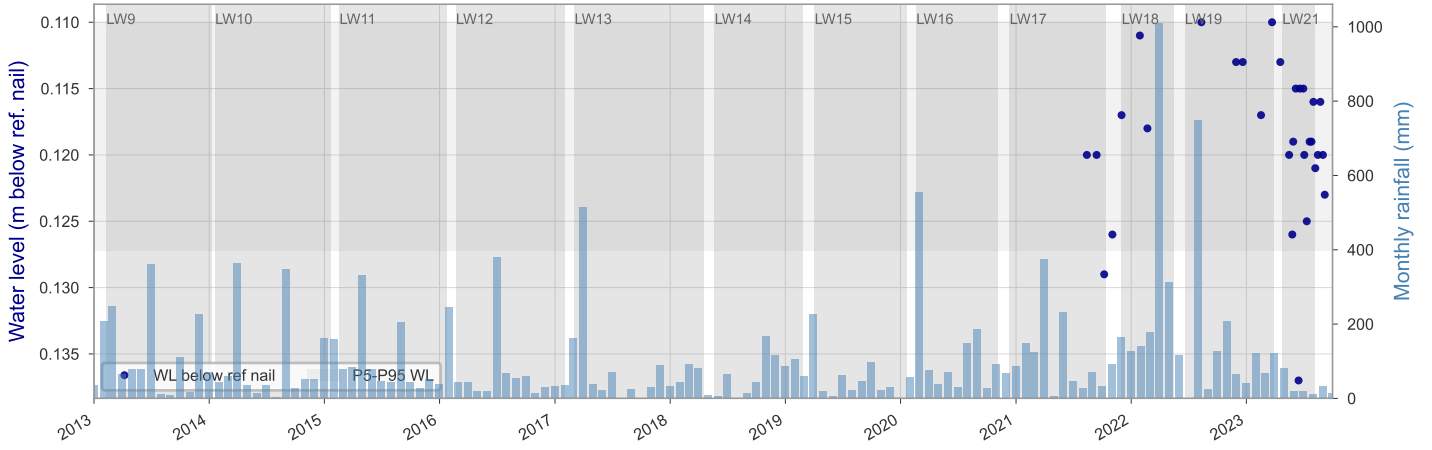
WC21_POOL5



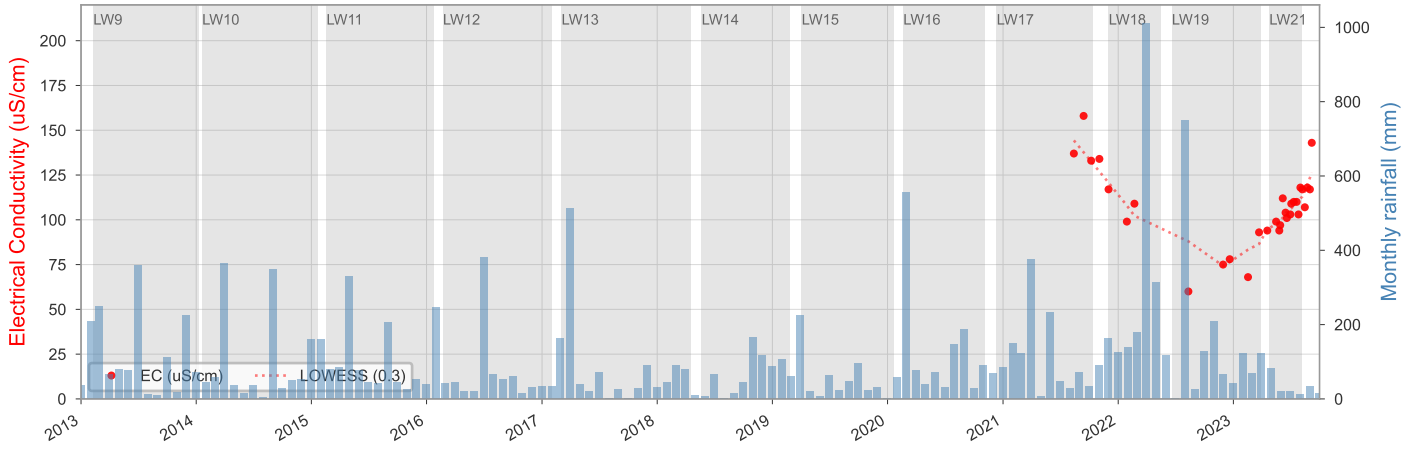
WC21_POOL5



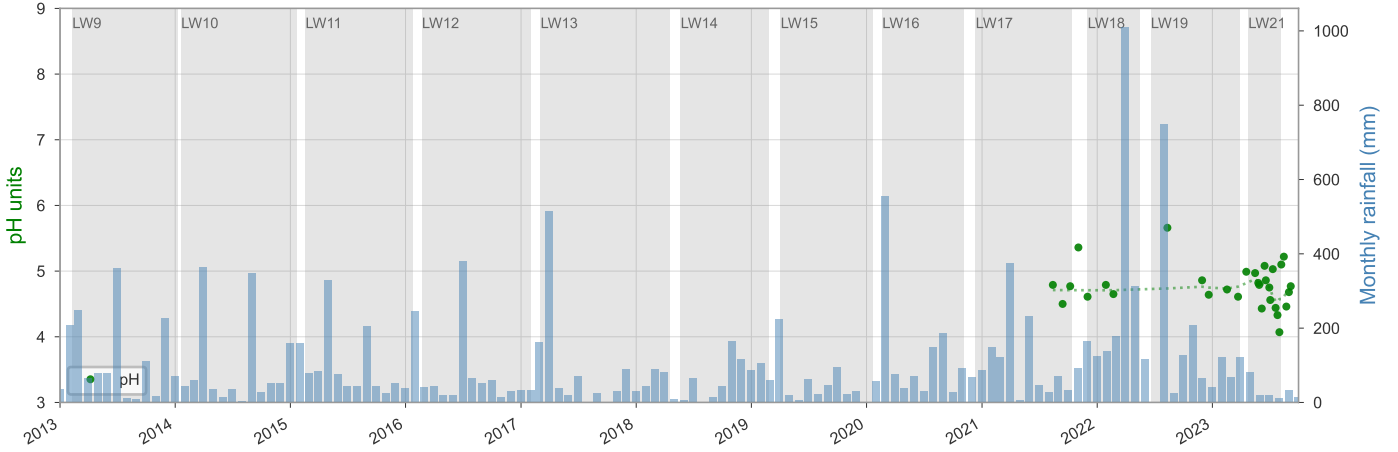
WC24A_POOL1



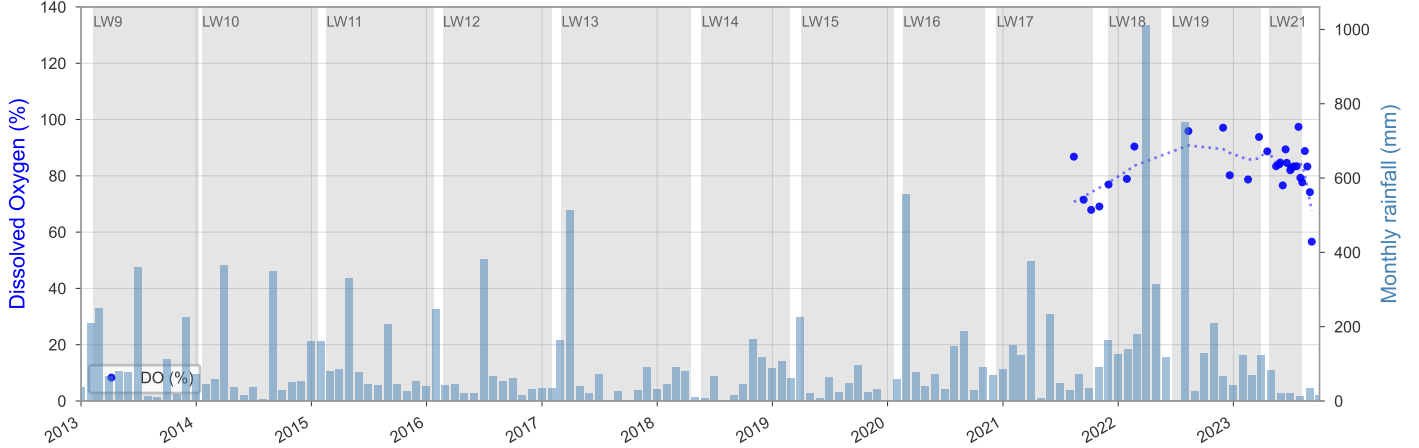
WC24A_POOL1



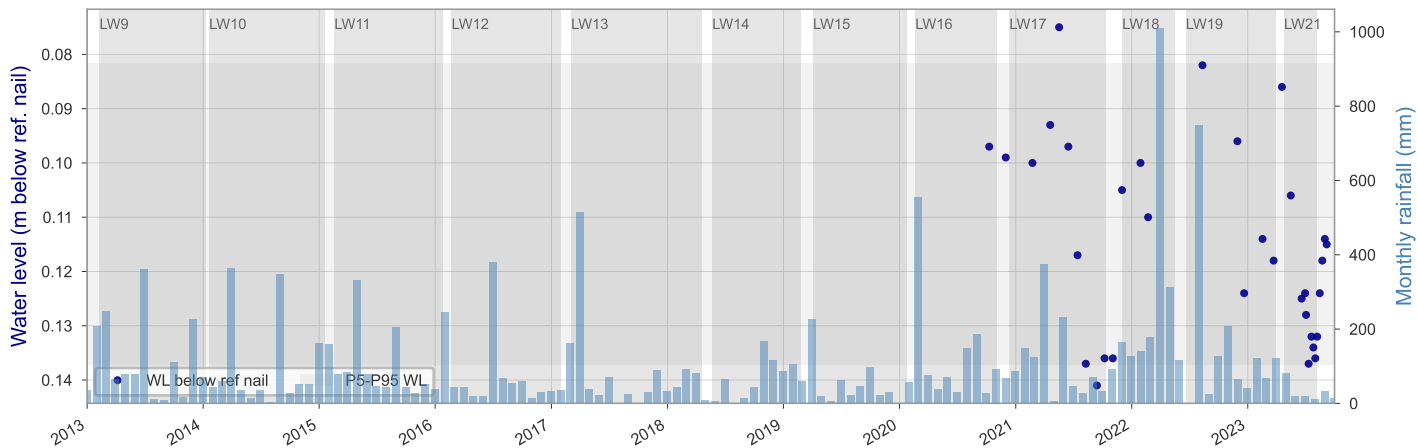
WC24A_POOL1



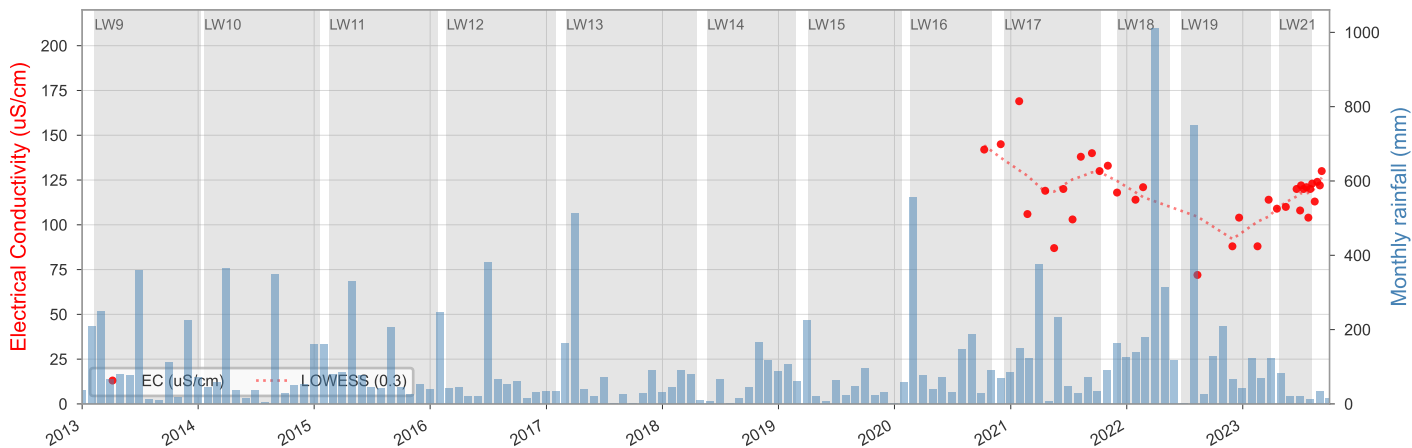
WC24A_POOL1



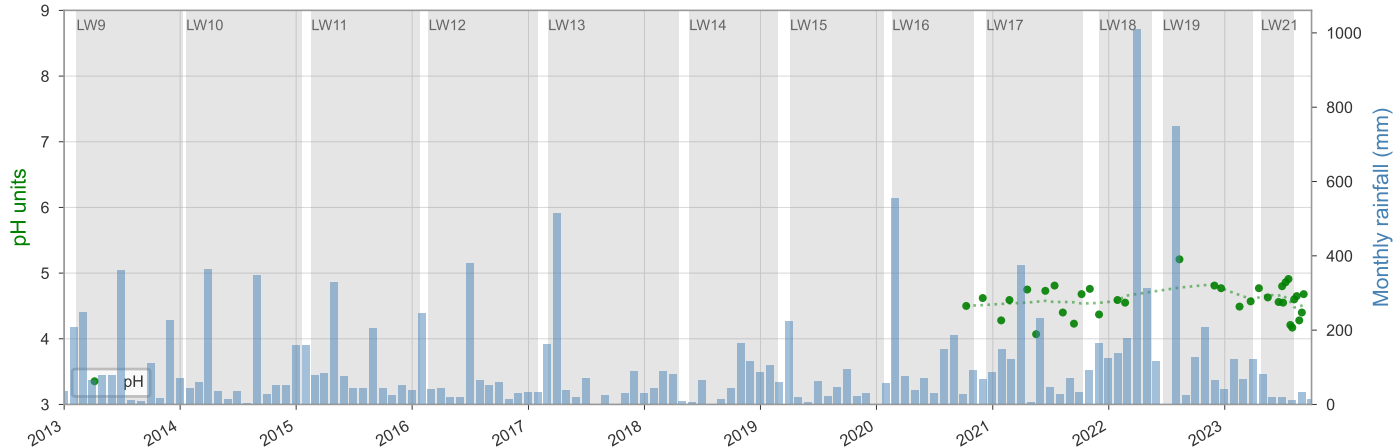
WC24_POOL10



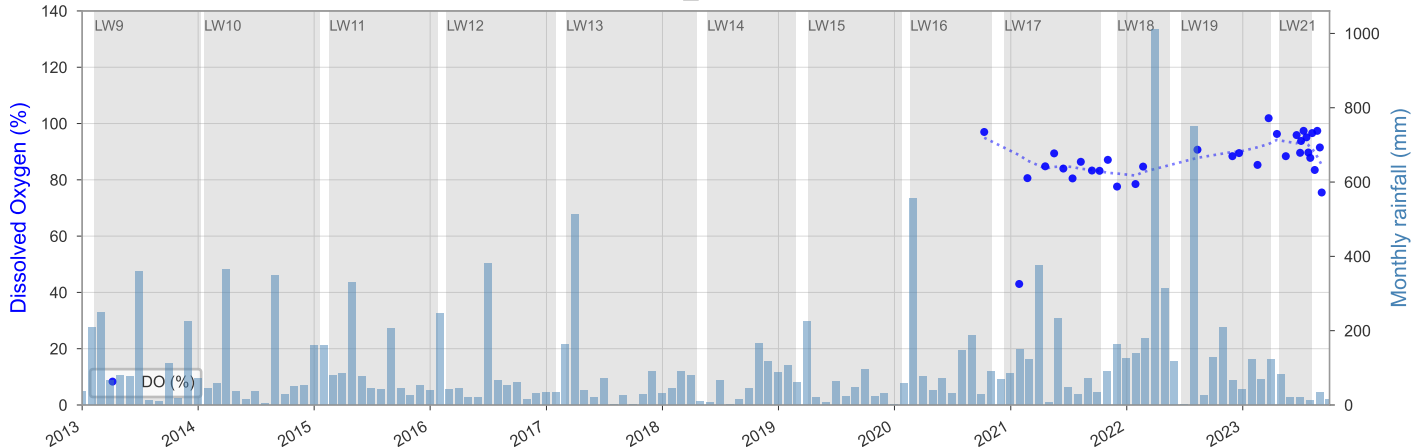
WC24_POOL10



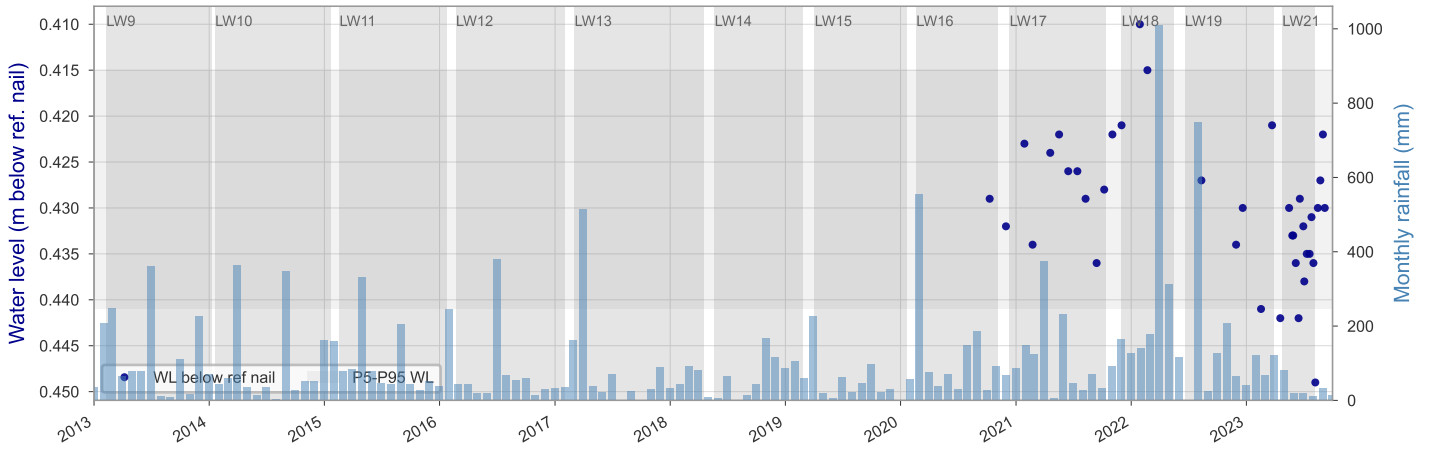
WC24_POOL10



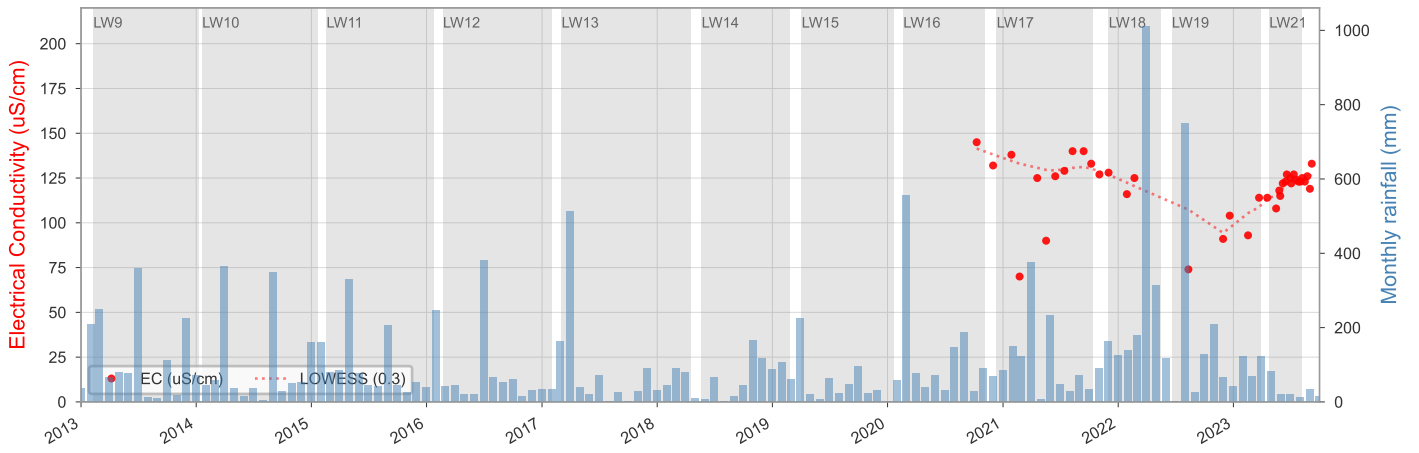
WC24_POOL10



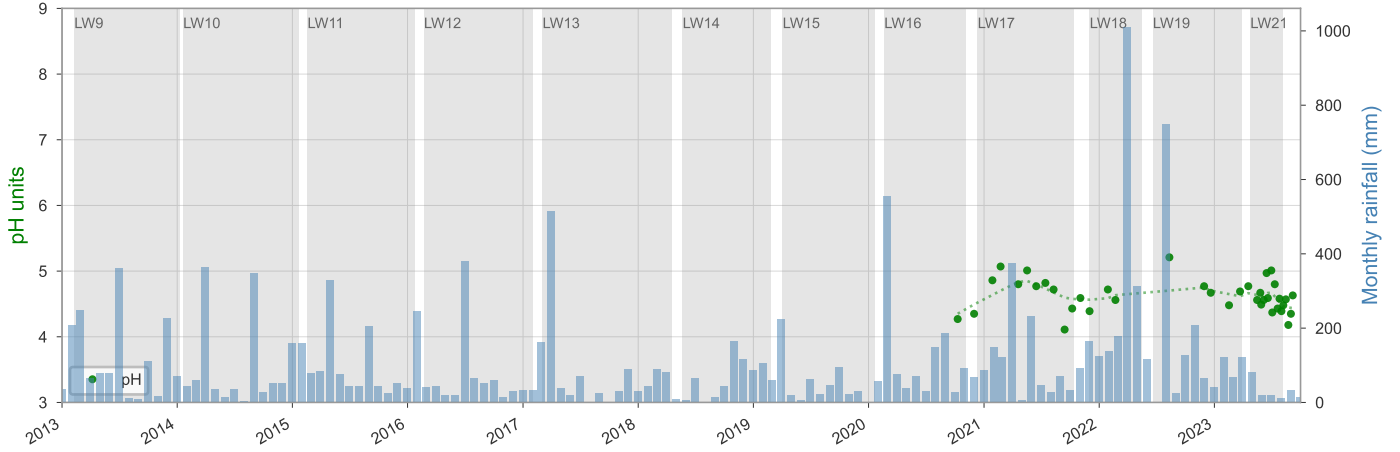
WC24_POOL22



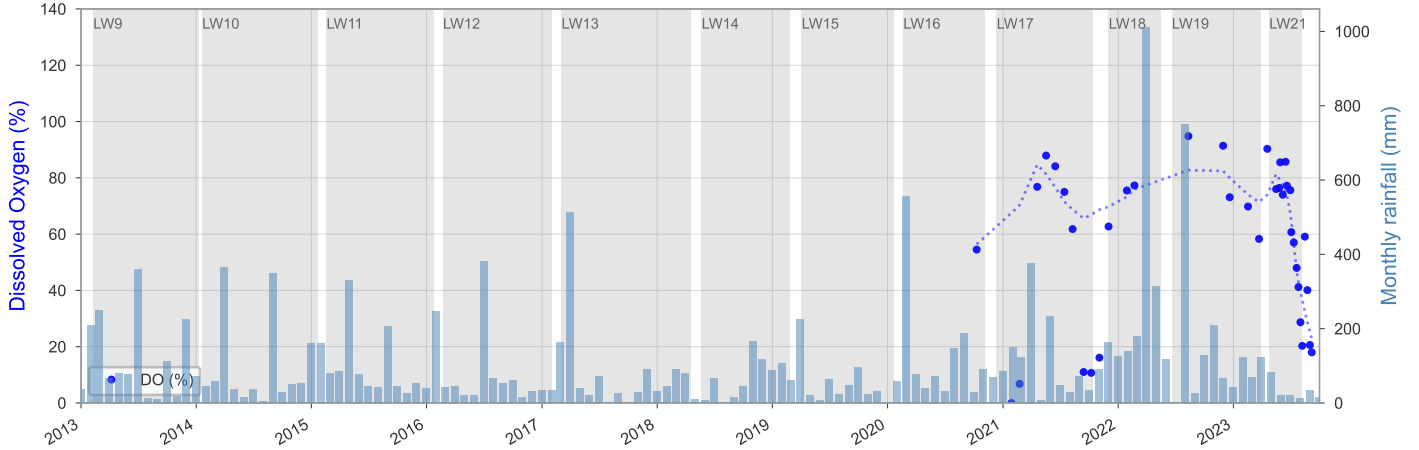
WC24_POOL22



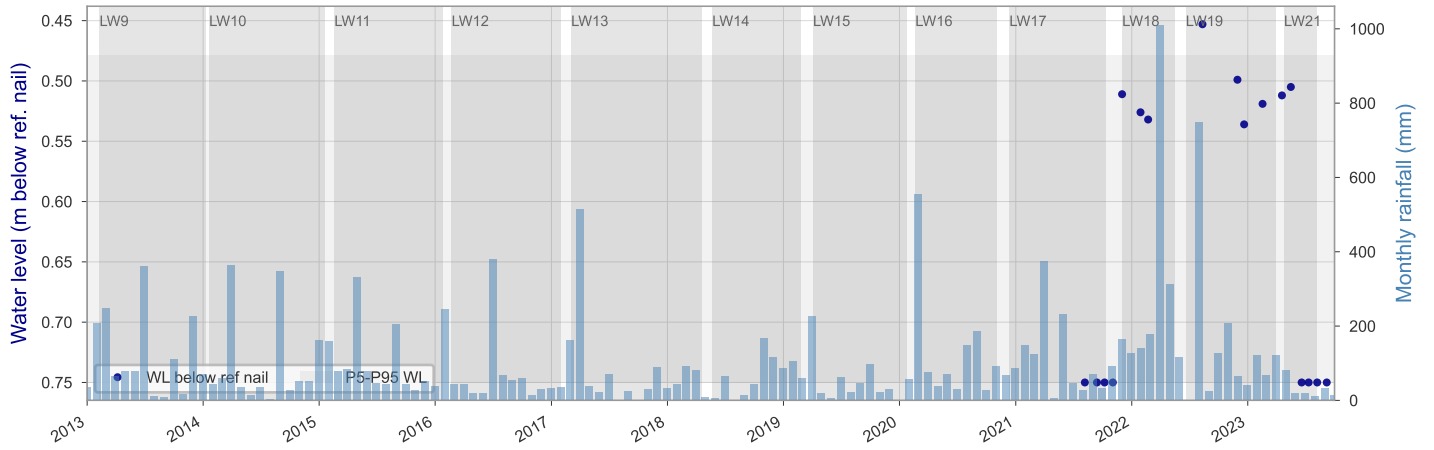
WC24_POOL22



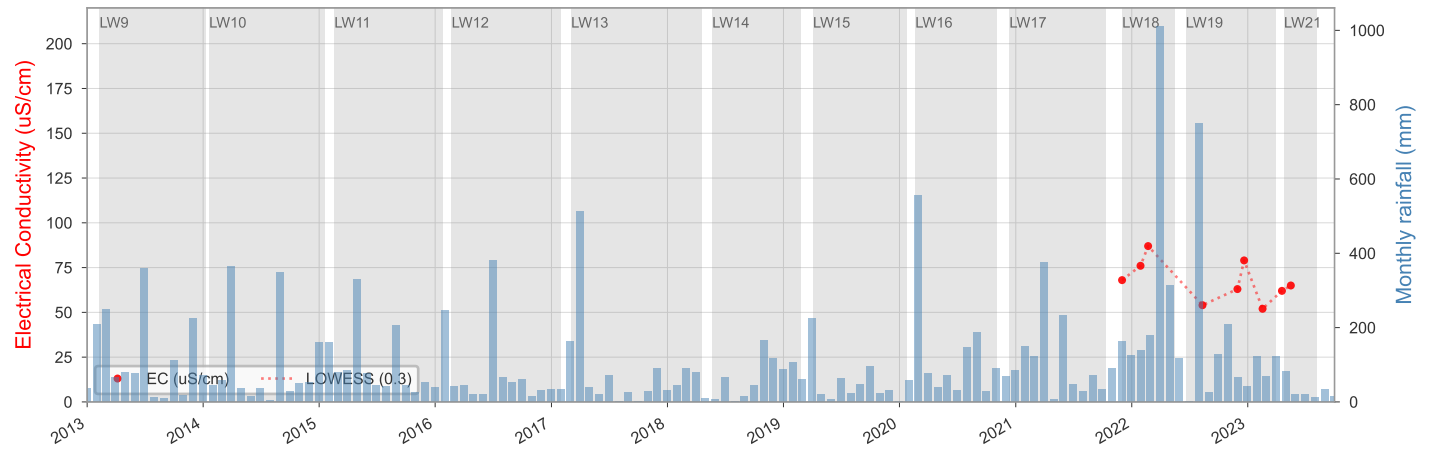
WC24_POOL22



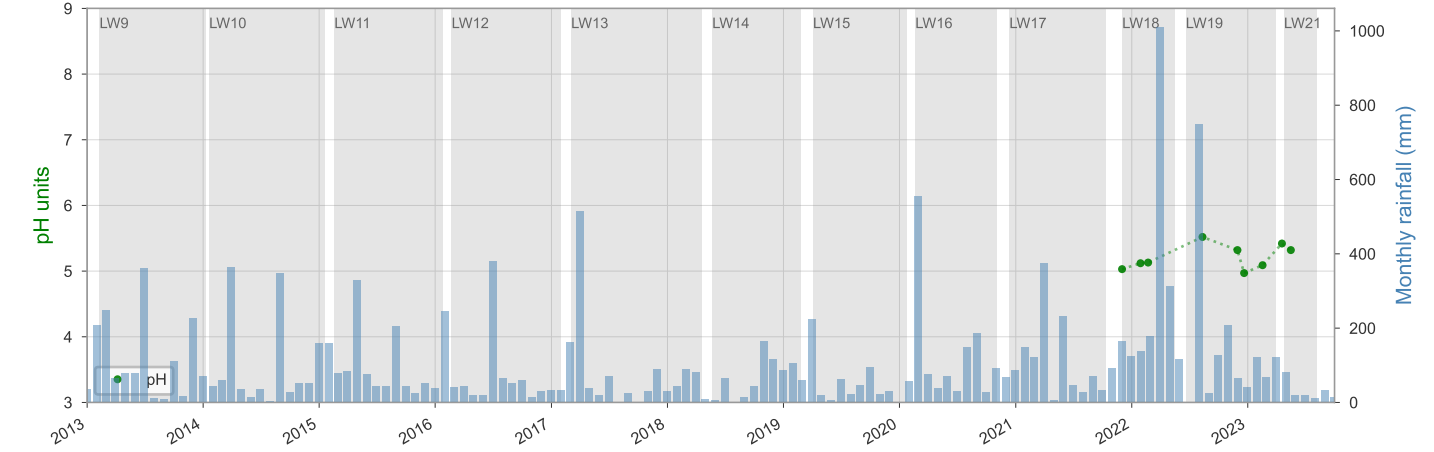
WC26A_POOL4



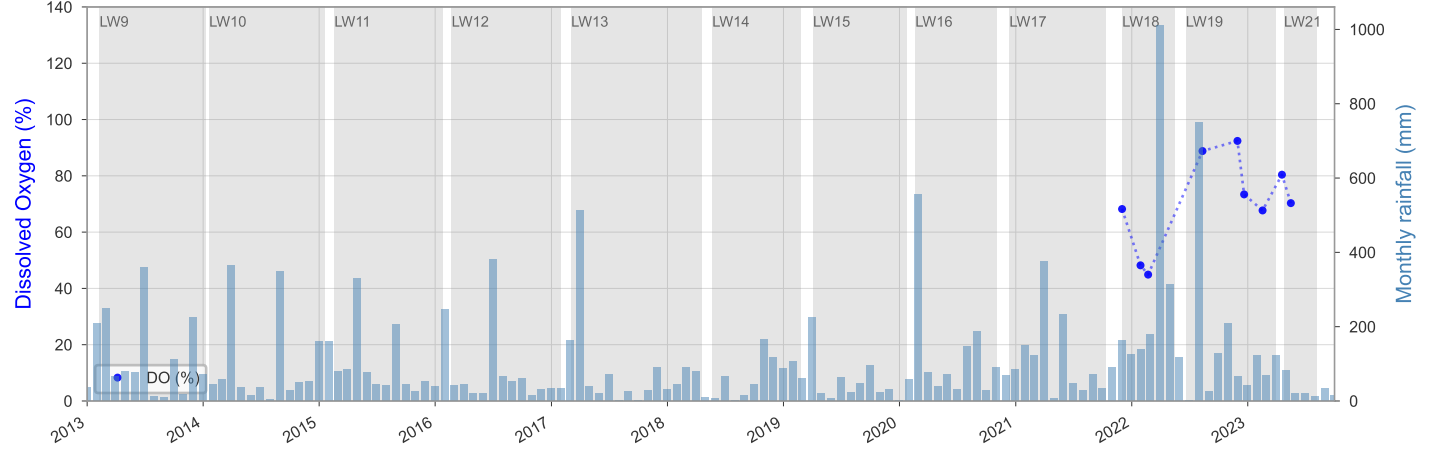
WC26A_POOL4



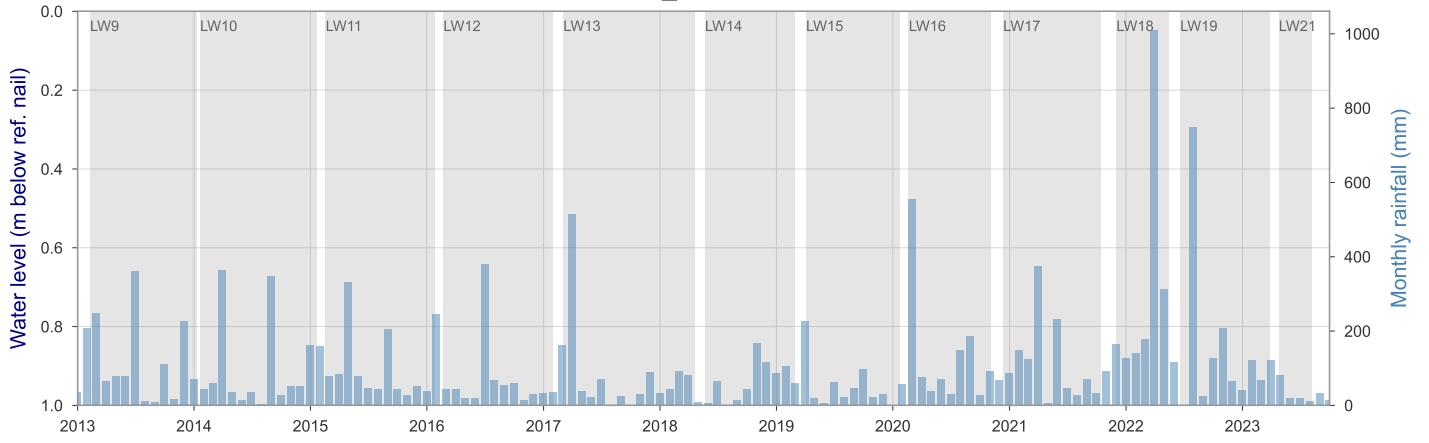
WC26A_POOL4



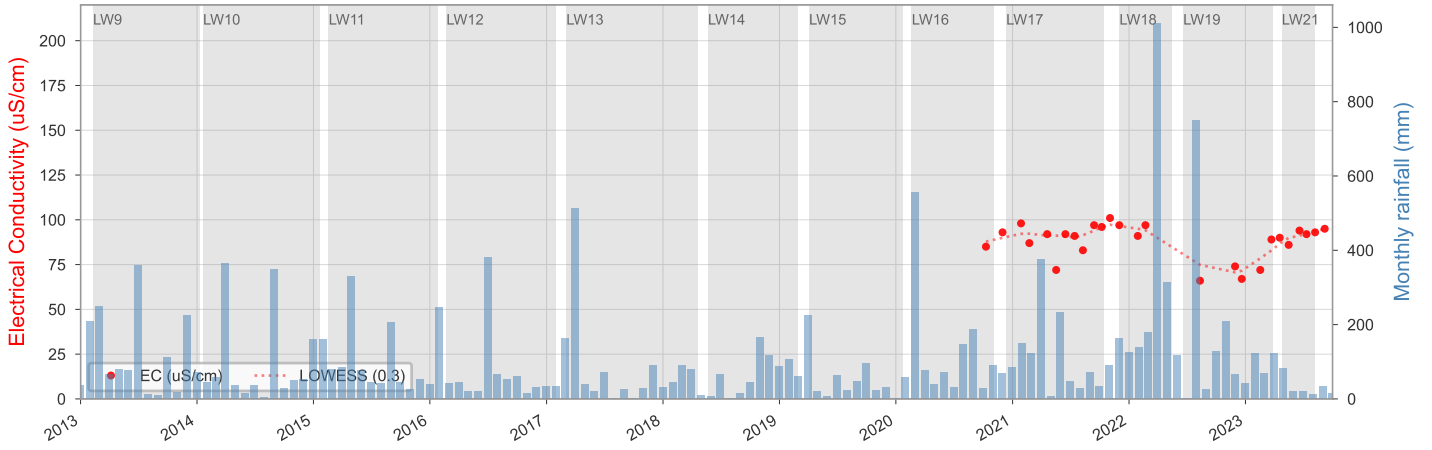
WC26A_POOL4



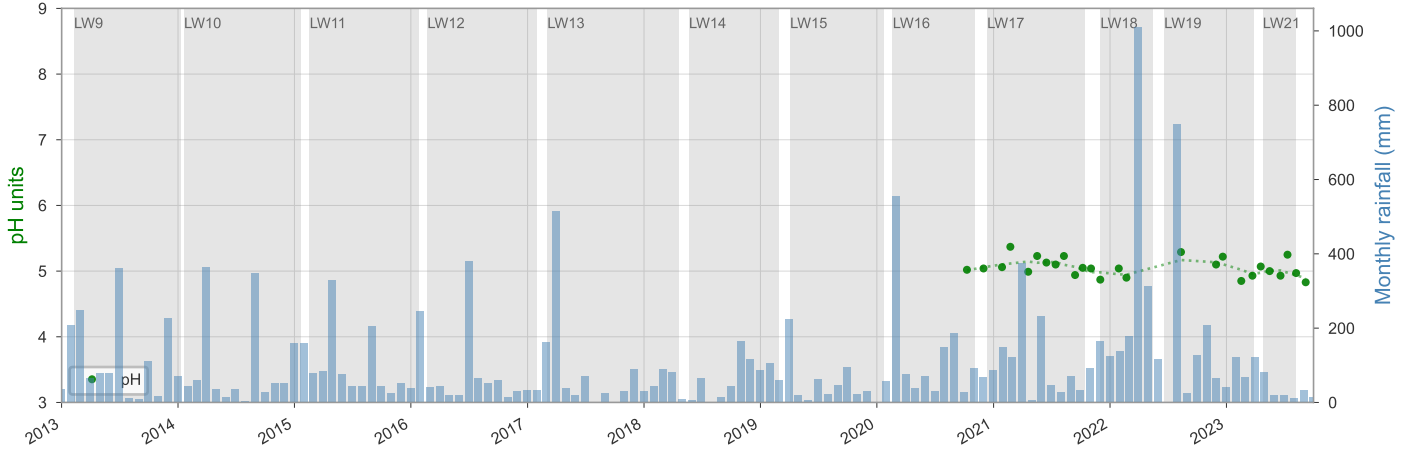
WC26_CHANNEL4



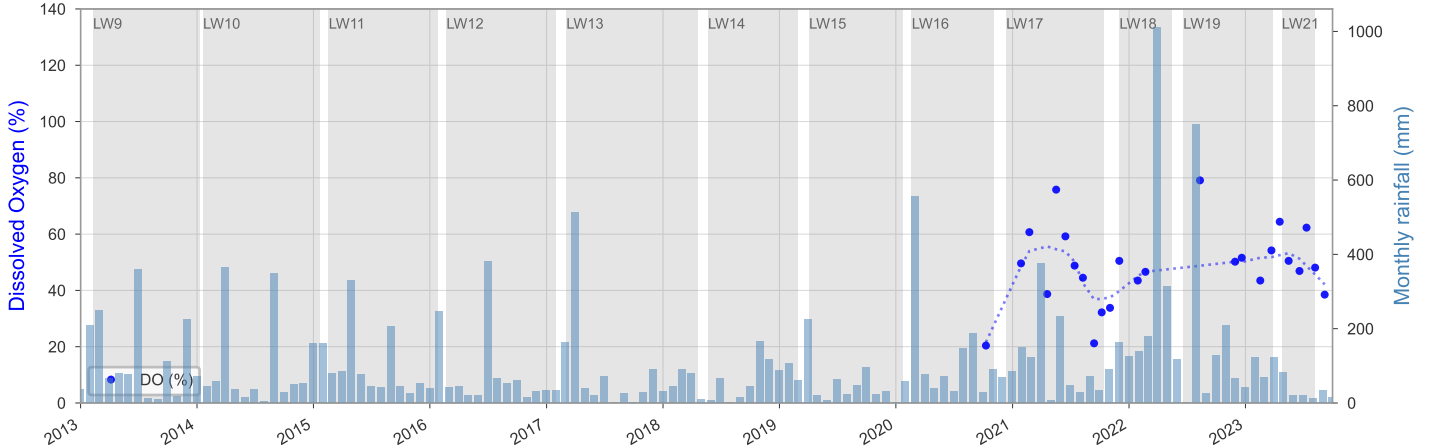
WC26_CHANNEL4



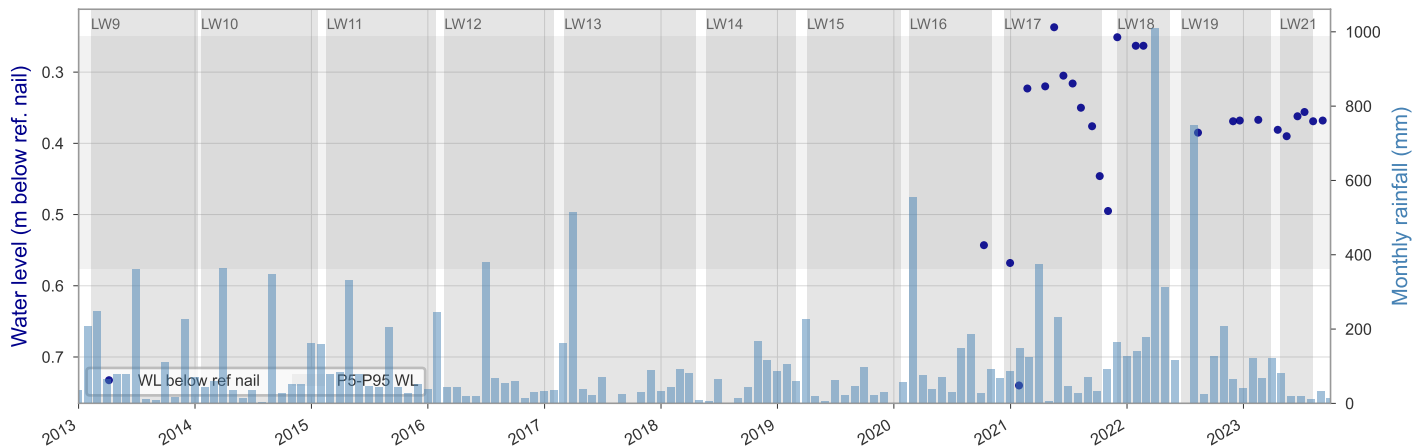
WC26_CHANNEL4



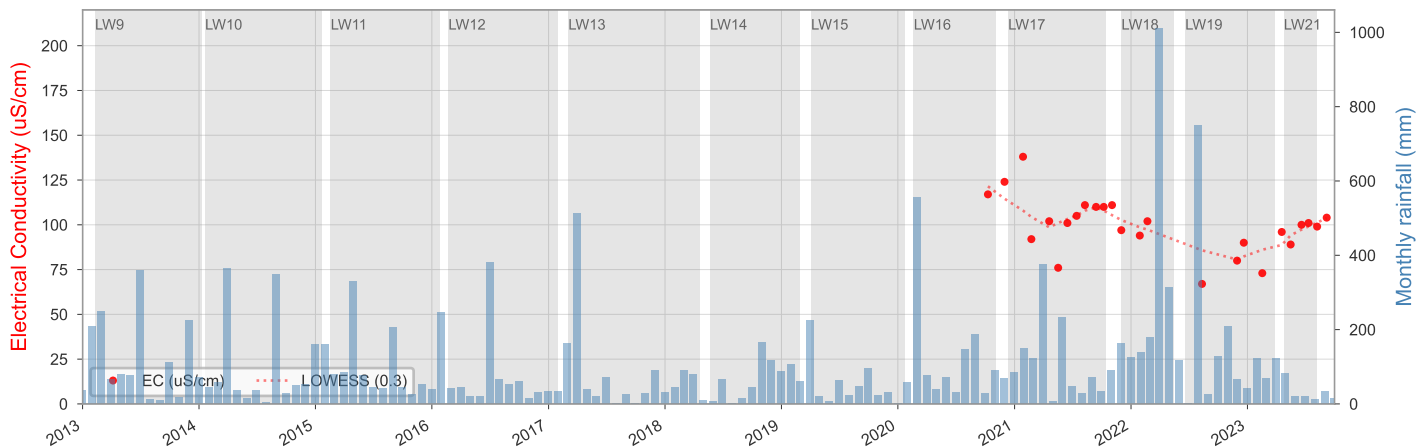
WC26_CHANNEL4



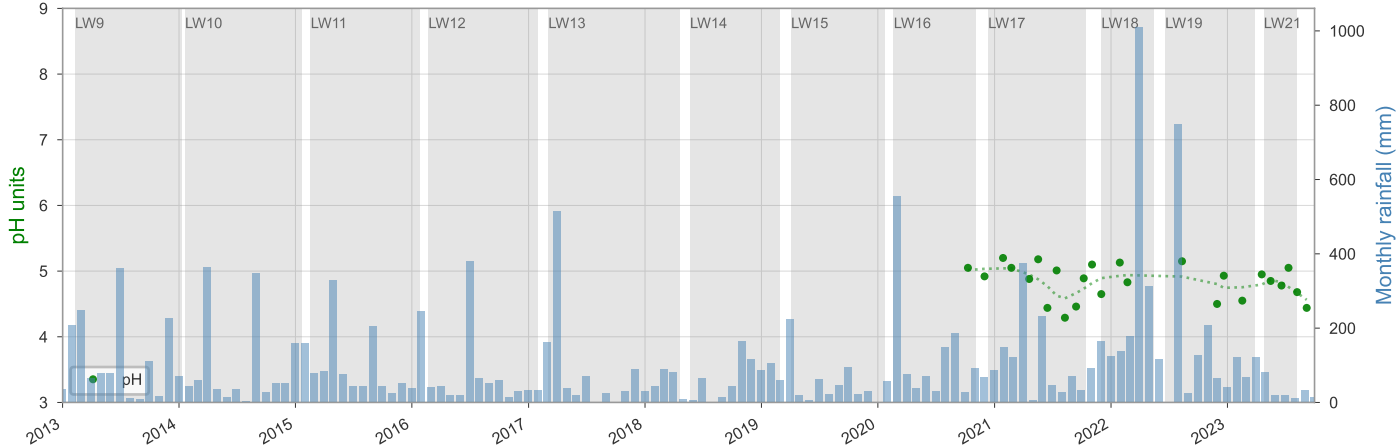
WC26_POOL14



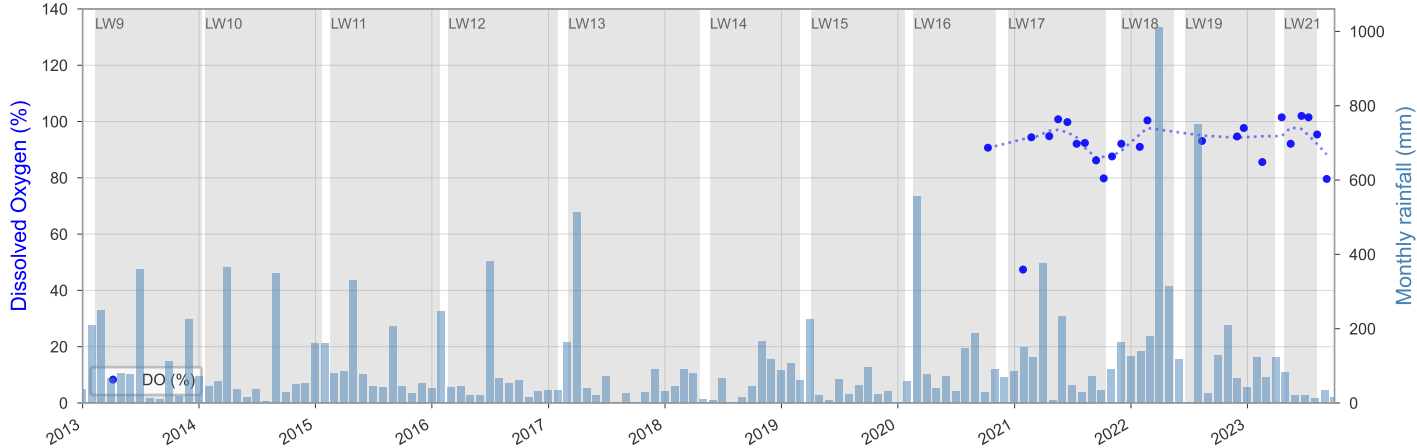
WC26_POOL14



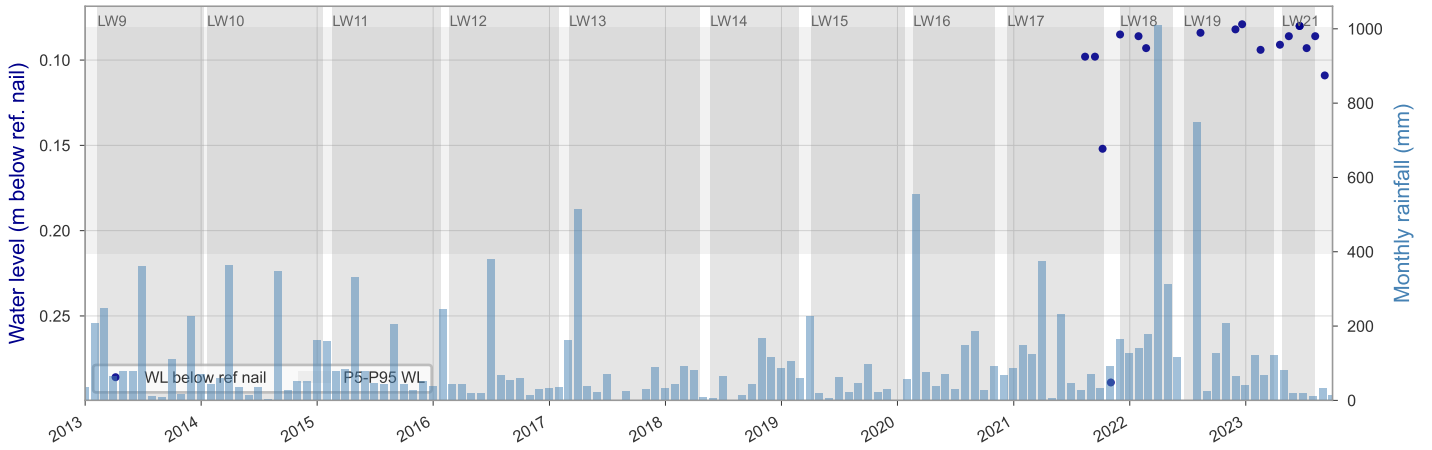
WC26_POOL14



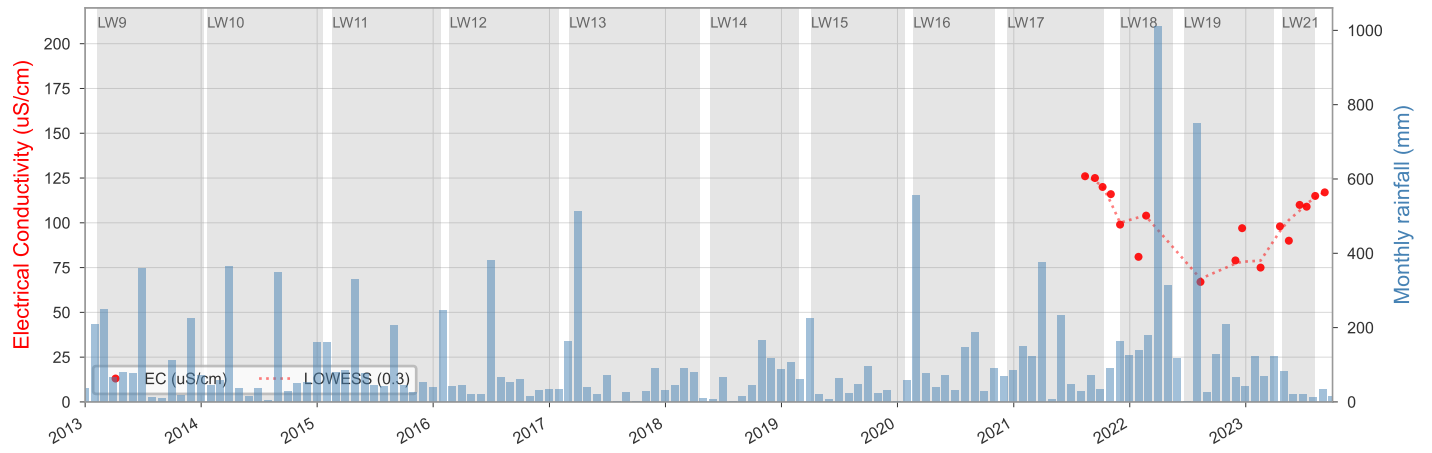
WC26_POOL14



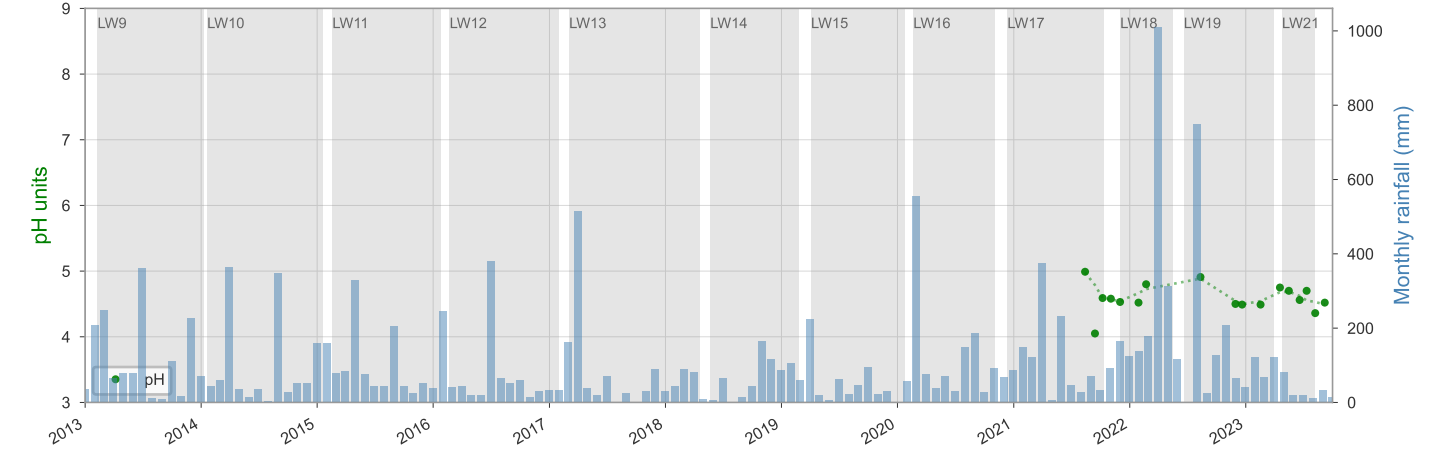
WC26_POOL19



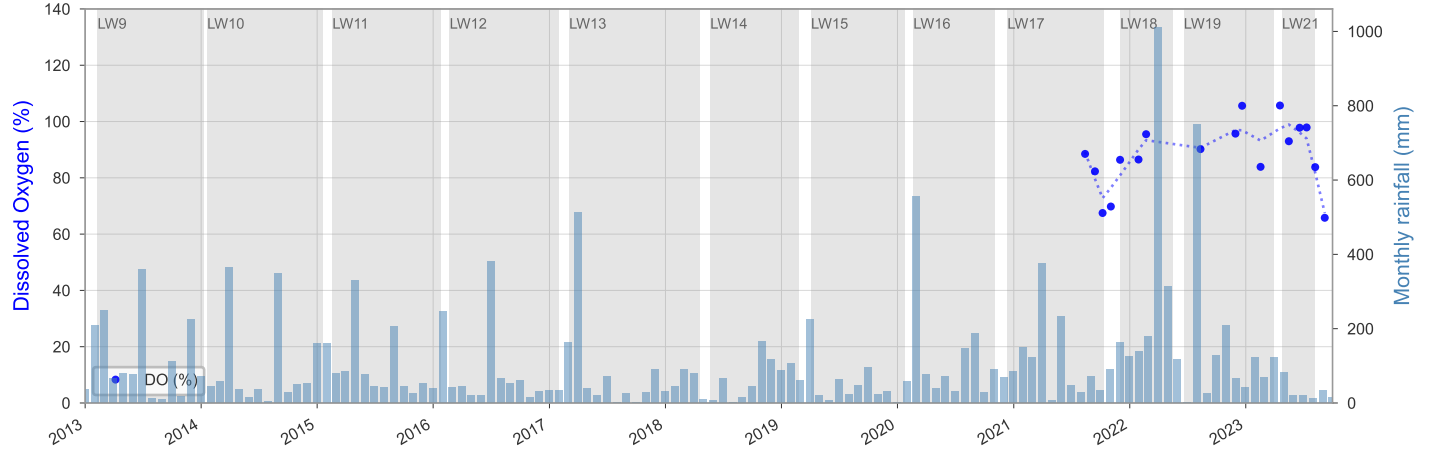
WC26_POOL19



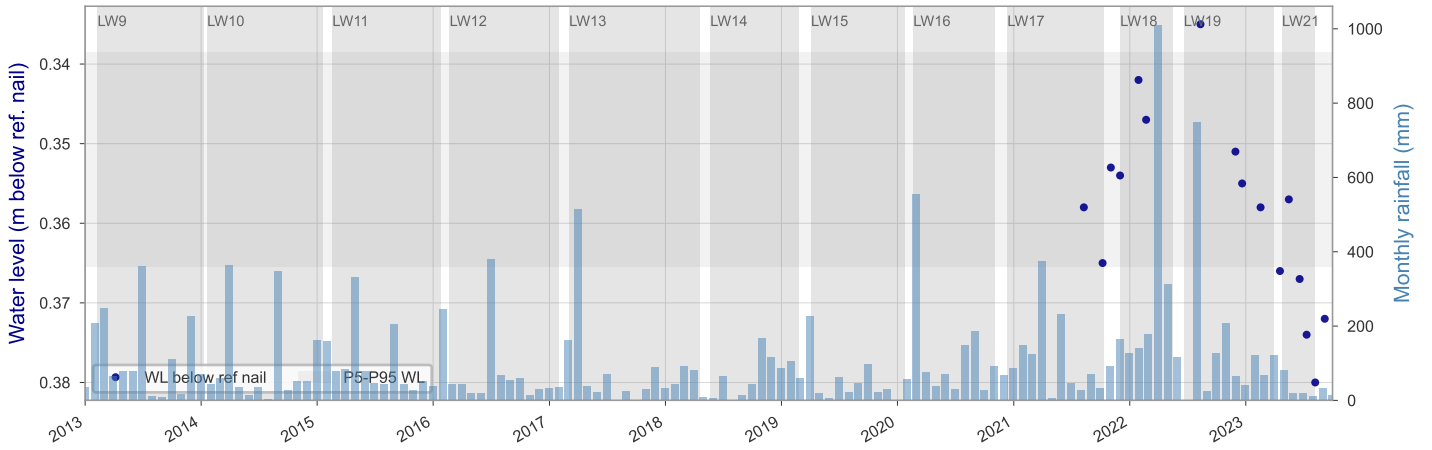
WC26_POOL19



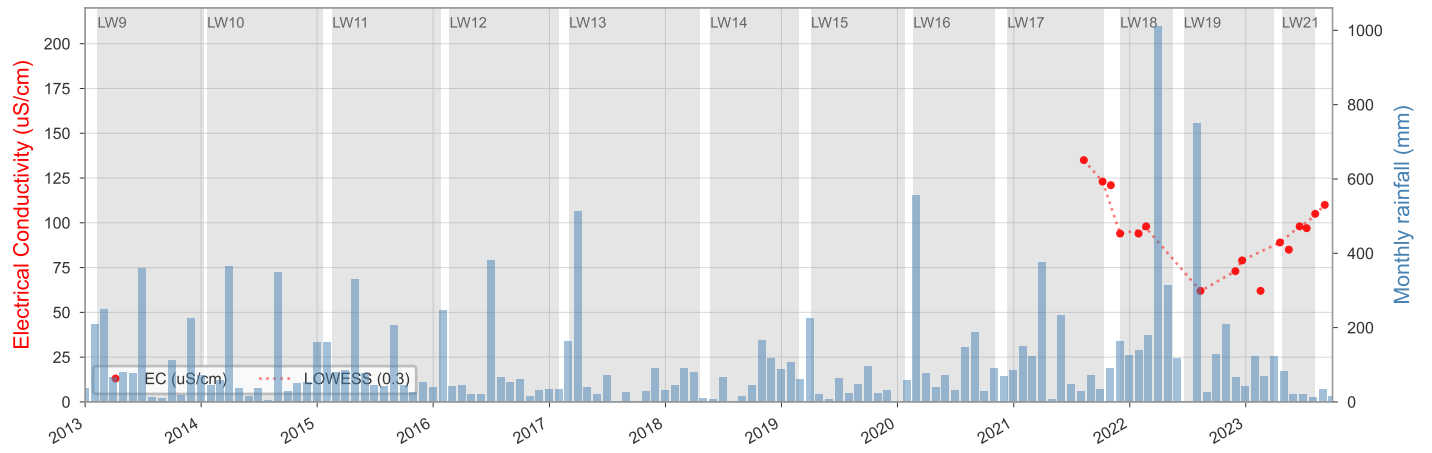
WC26_POOL19



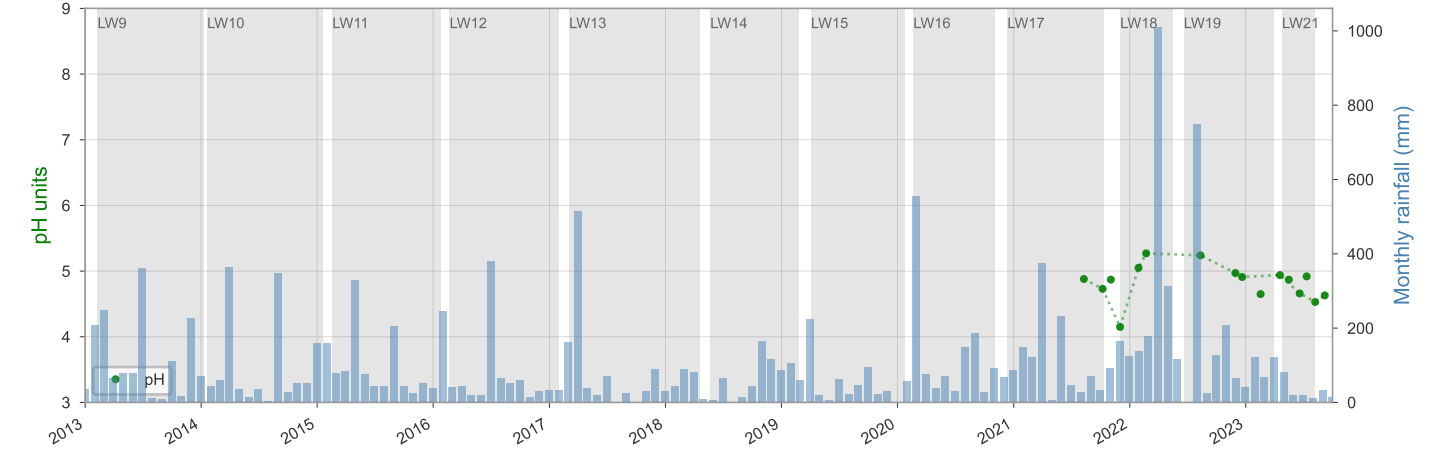
WC26_POOL32



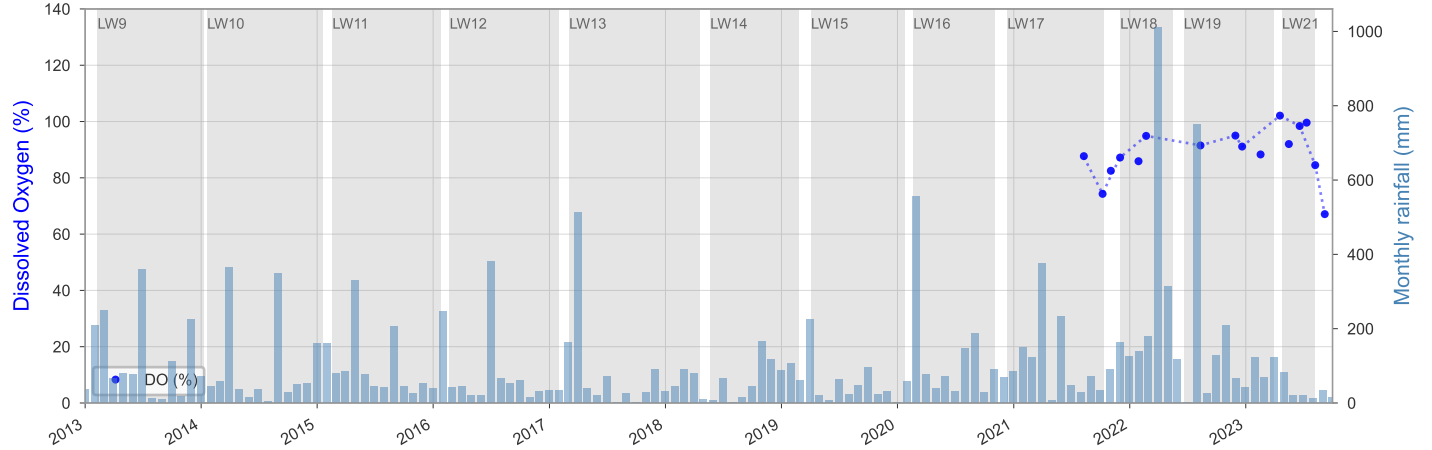
WC26_POOL32



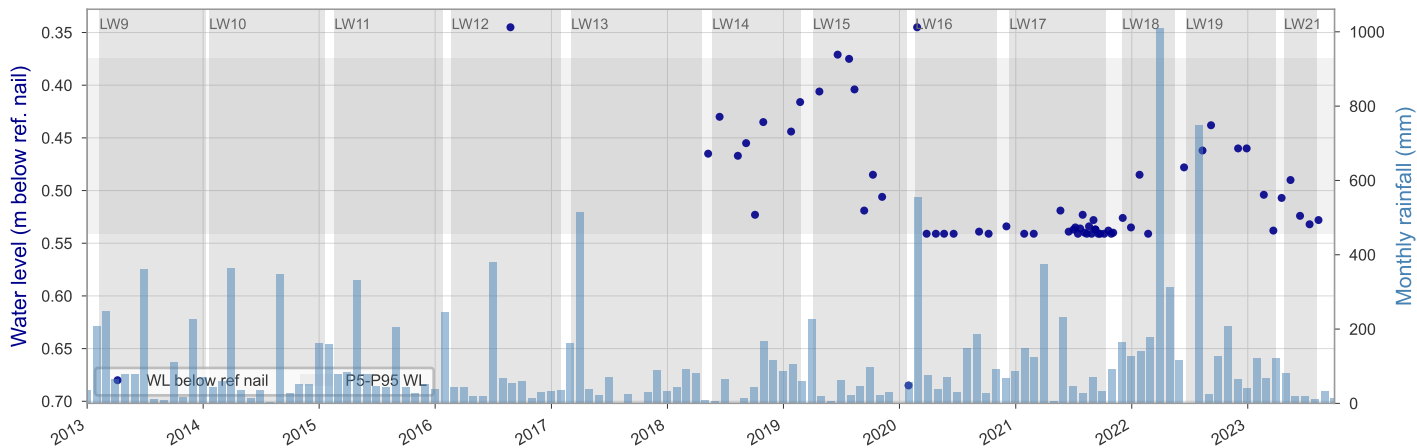
WC26_POOL32



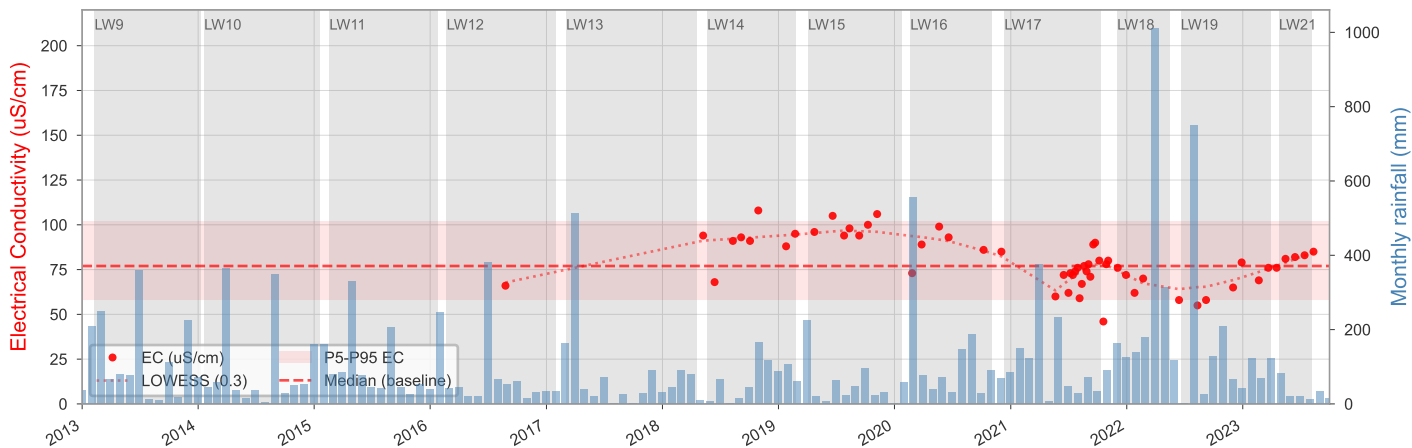
WC26_POOL32



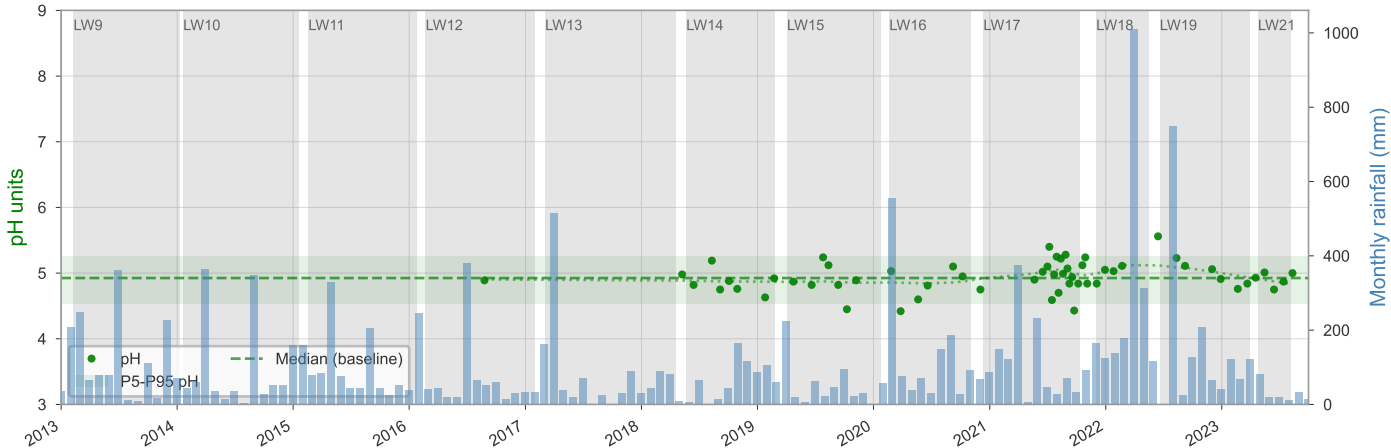
WC7_POOL1



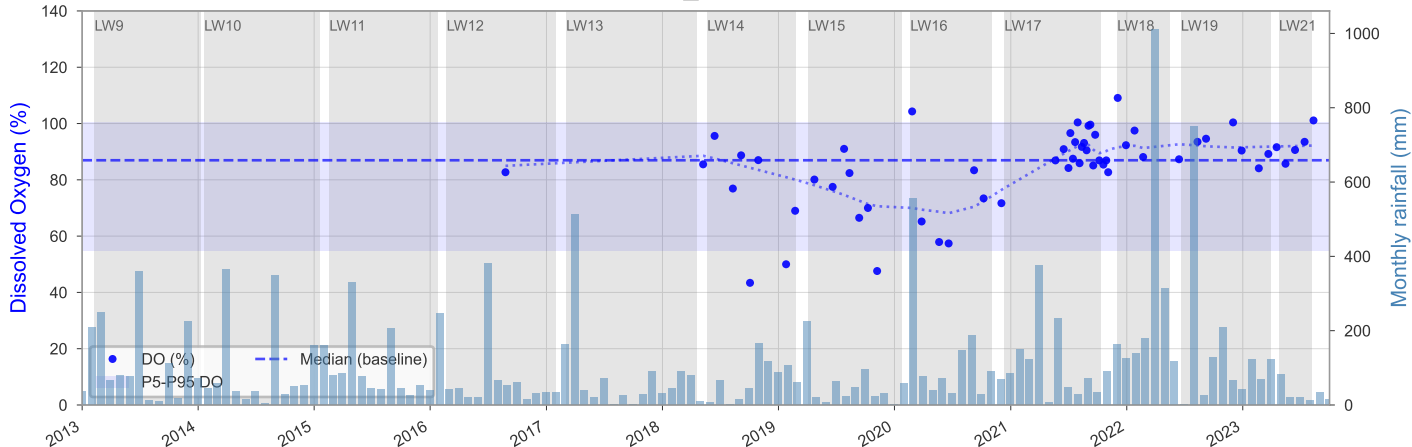
WC7_POOL1



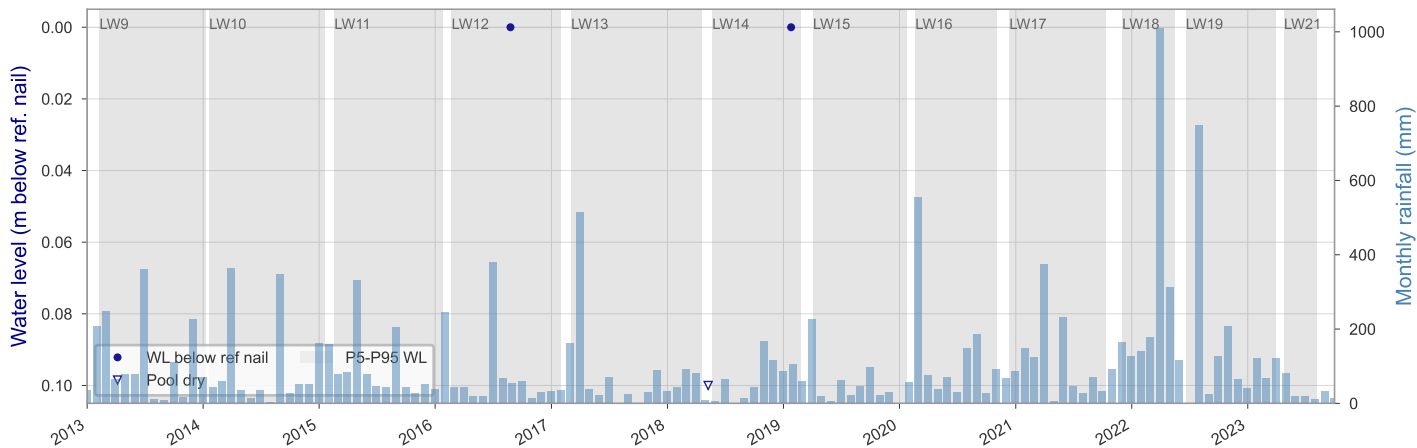
WC7_POOL1



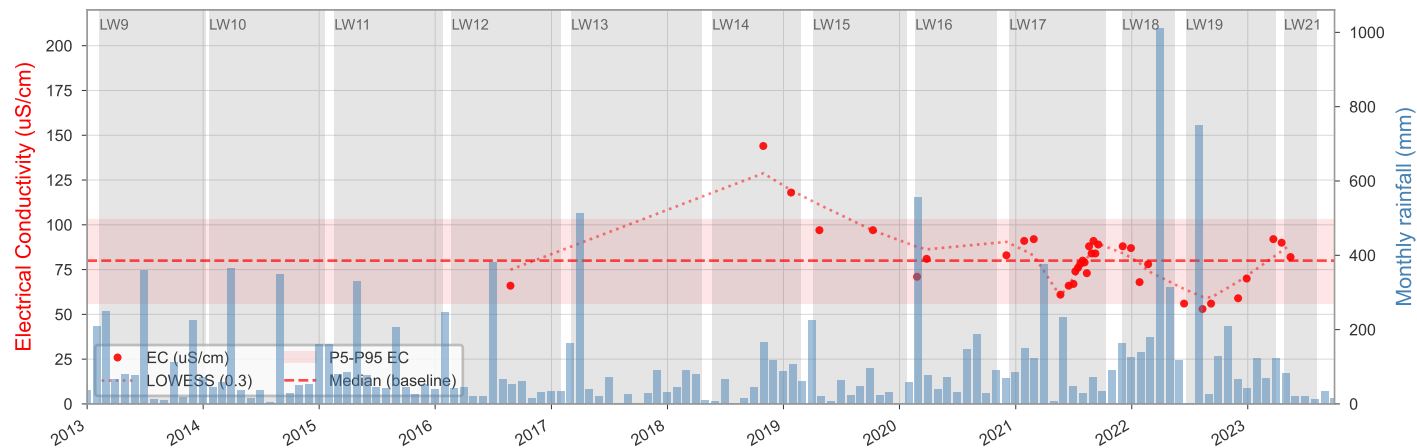
WC7_POOL1



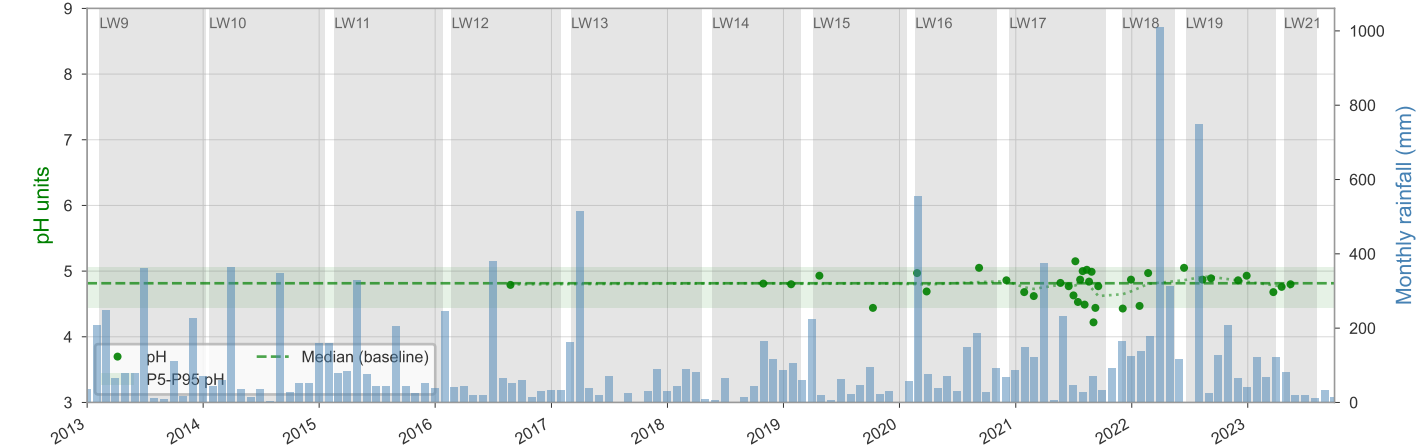
WC7_POOL14



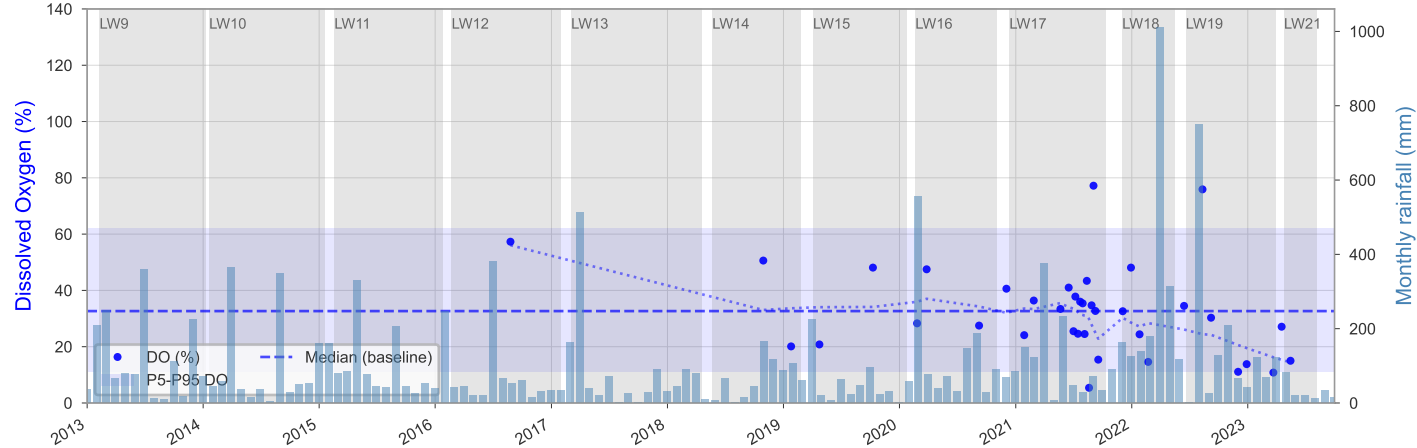
WC7_POOL14



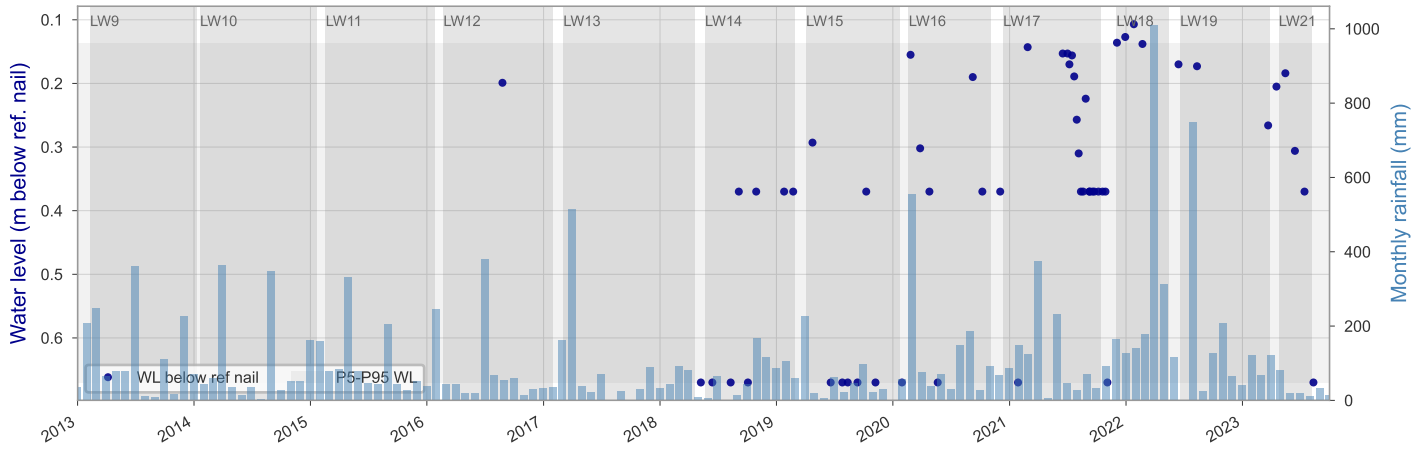
WC7_POOL14



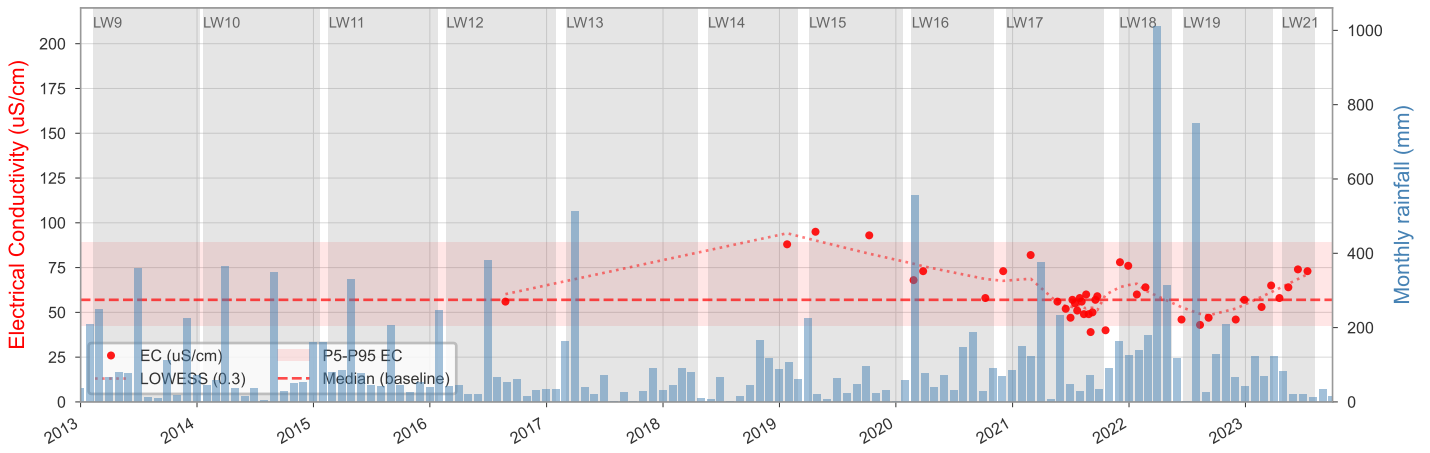
WC7_POOL14



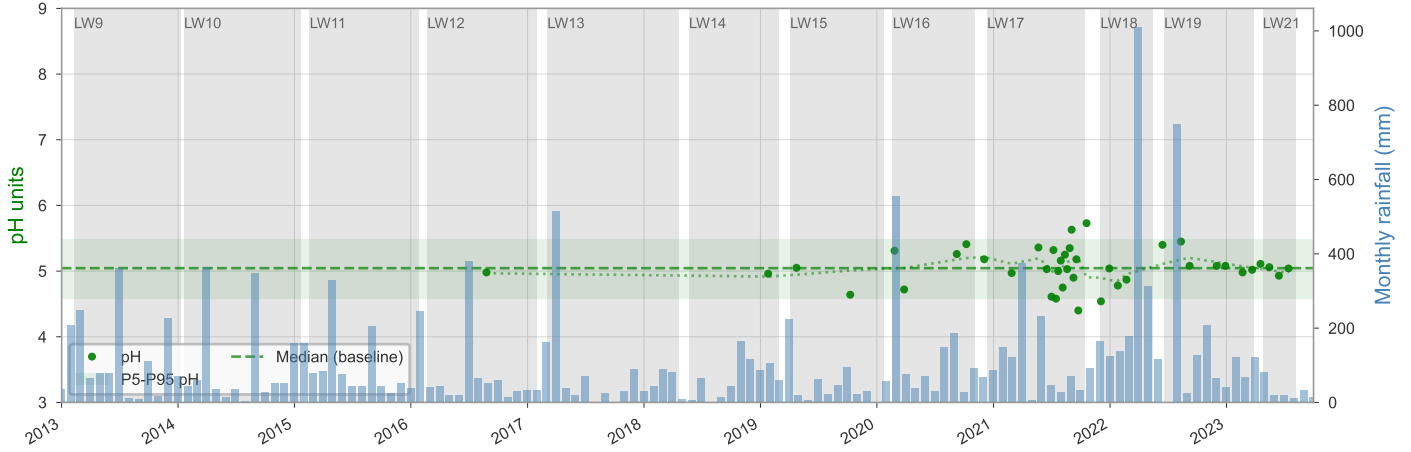
WC7_POOL9



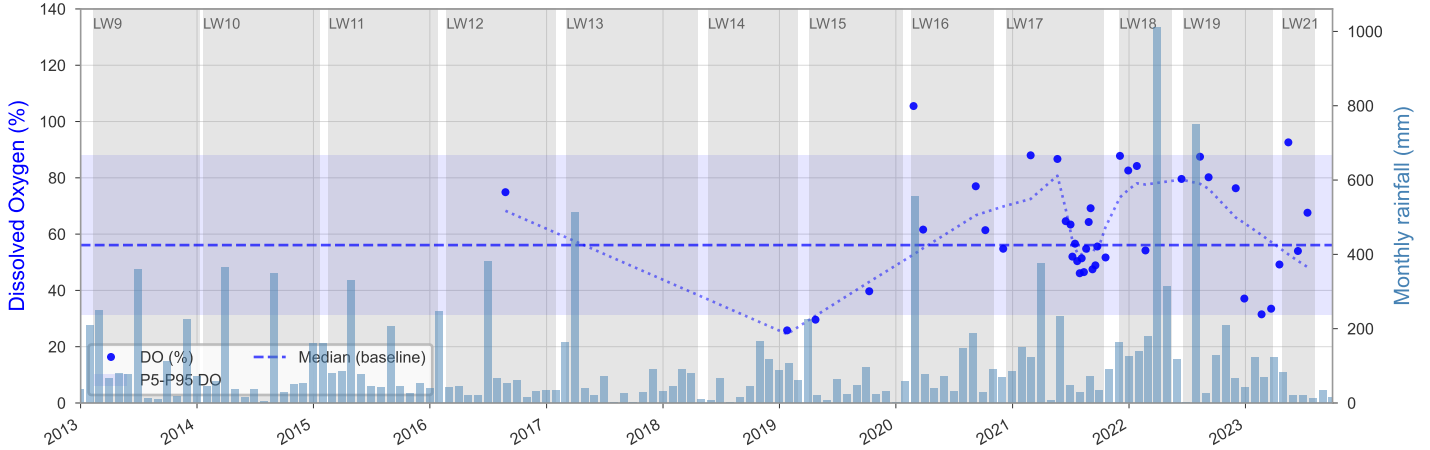
WC7_POOL9



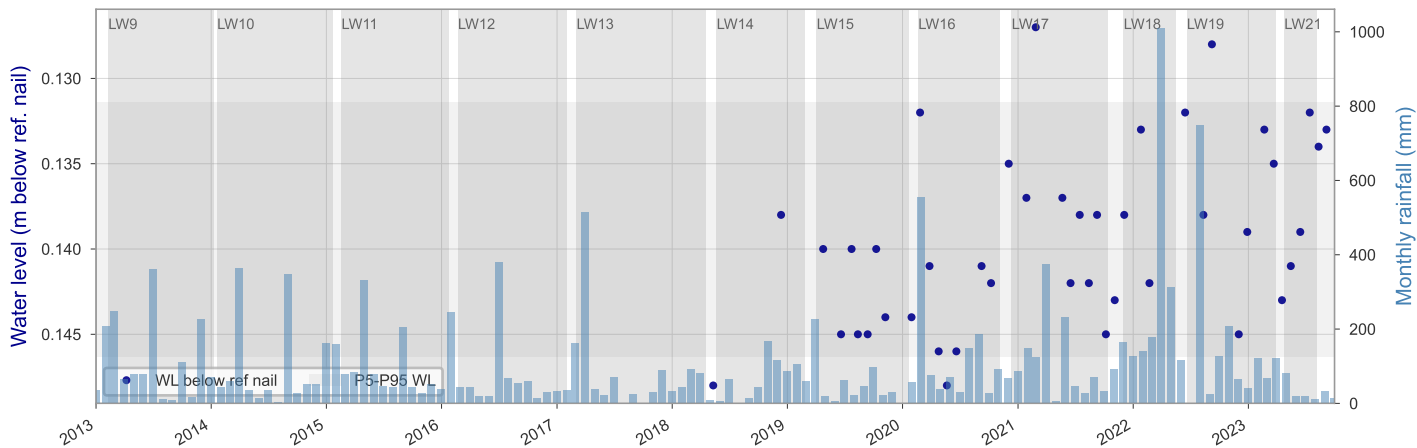
WC7_POOL9



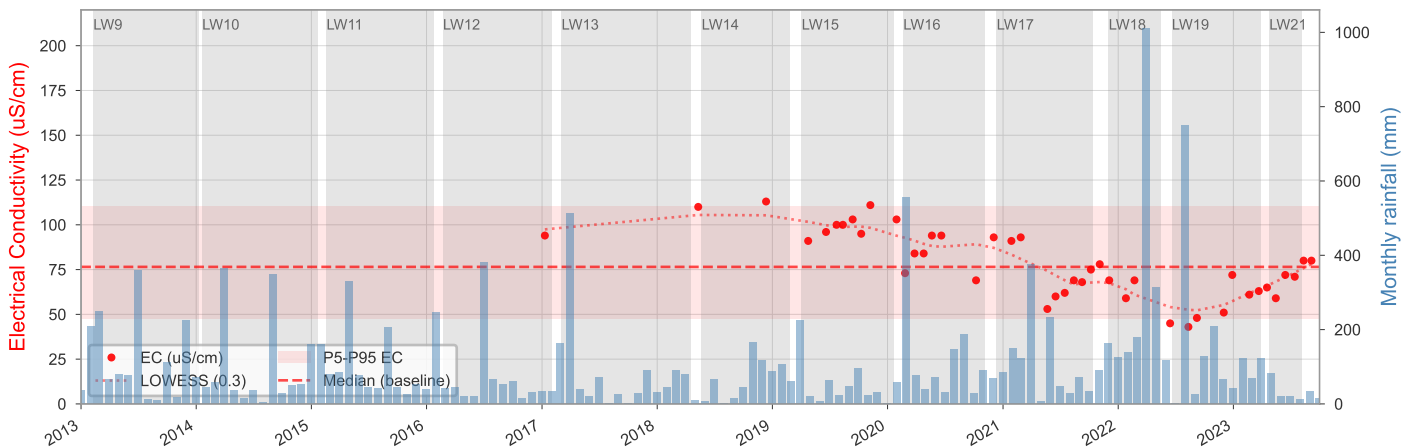
WC7_POOL9



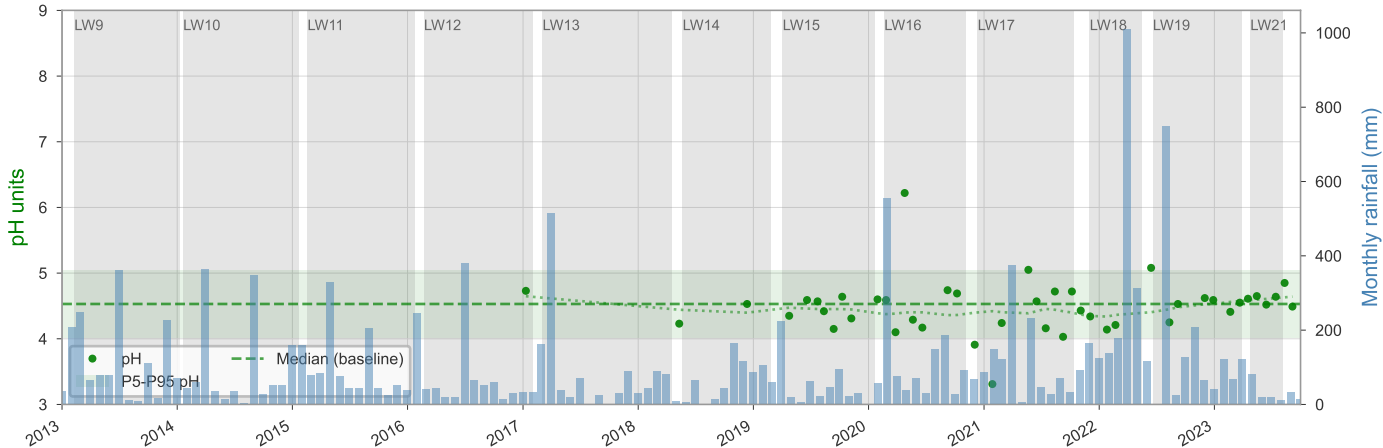
WC8_POOL1



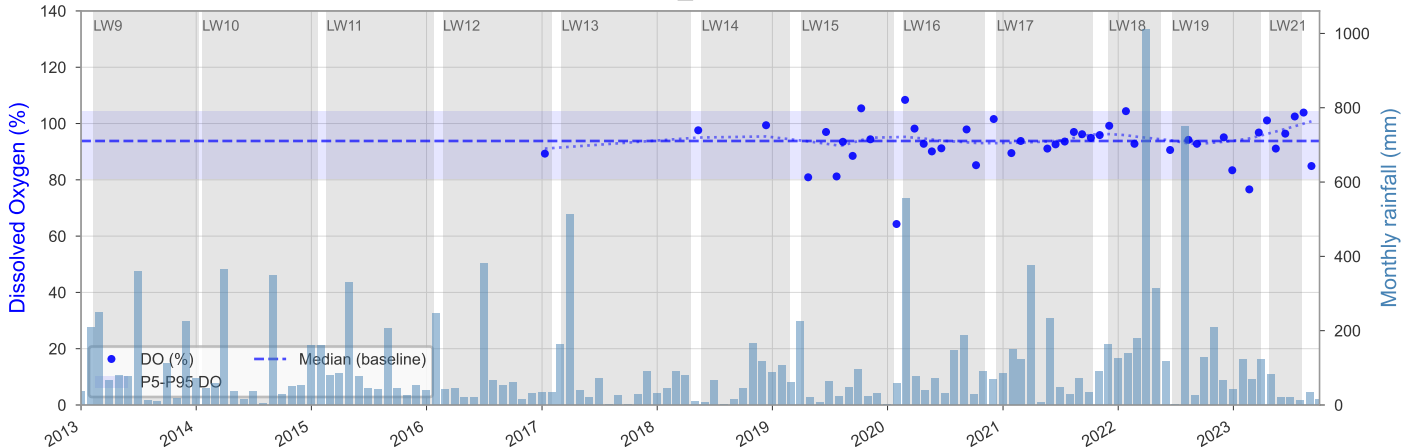
WC8_POOL1



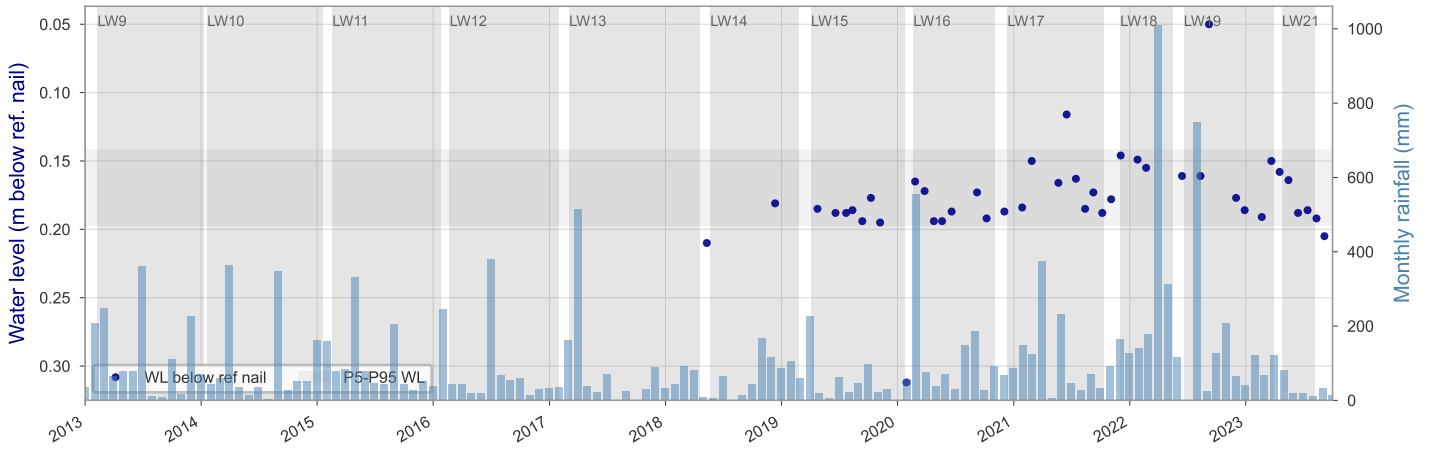
WC8_POOL1



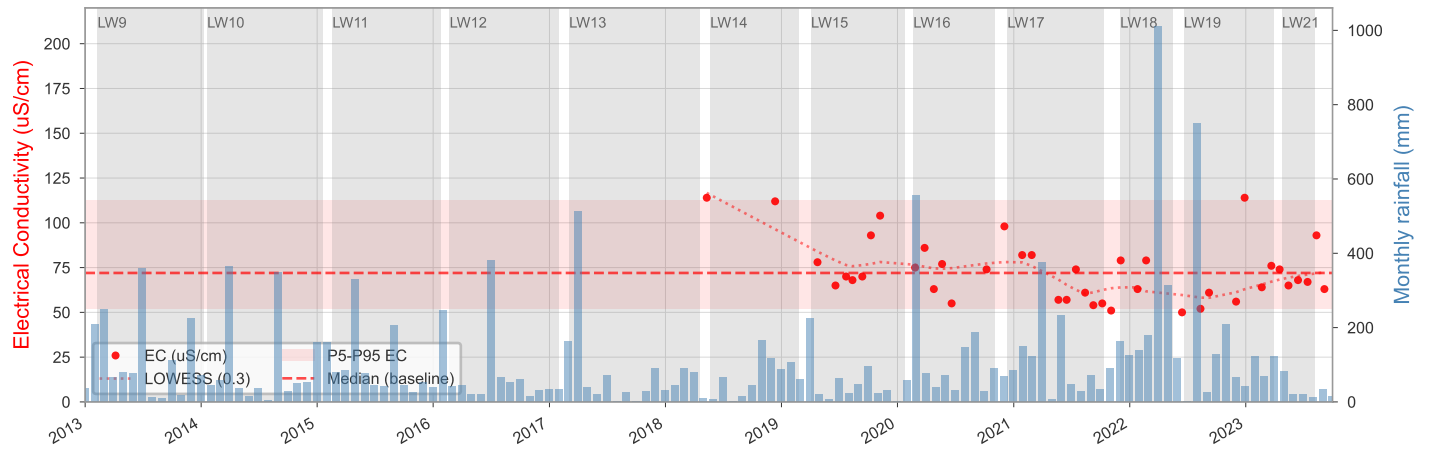
WC8_POOL1



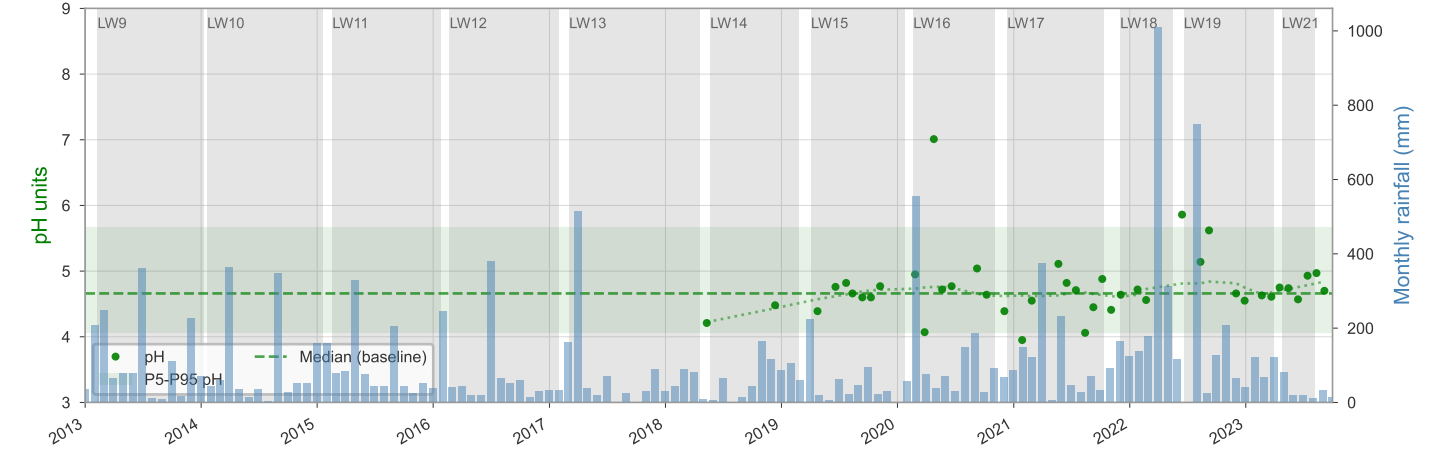
WC8_POOL10



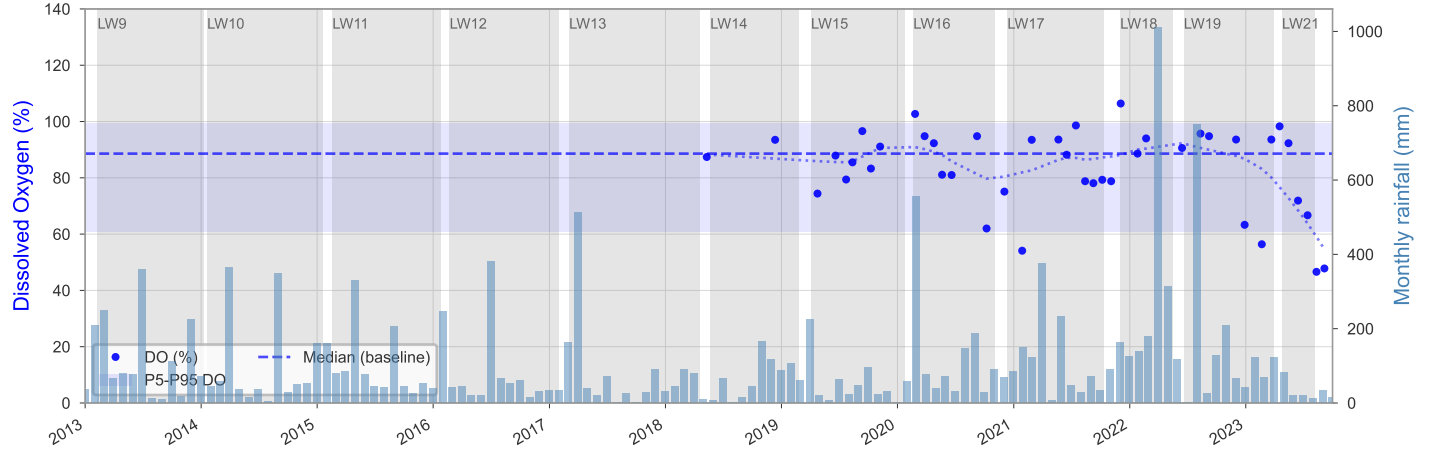
WC8_POOL10



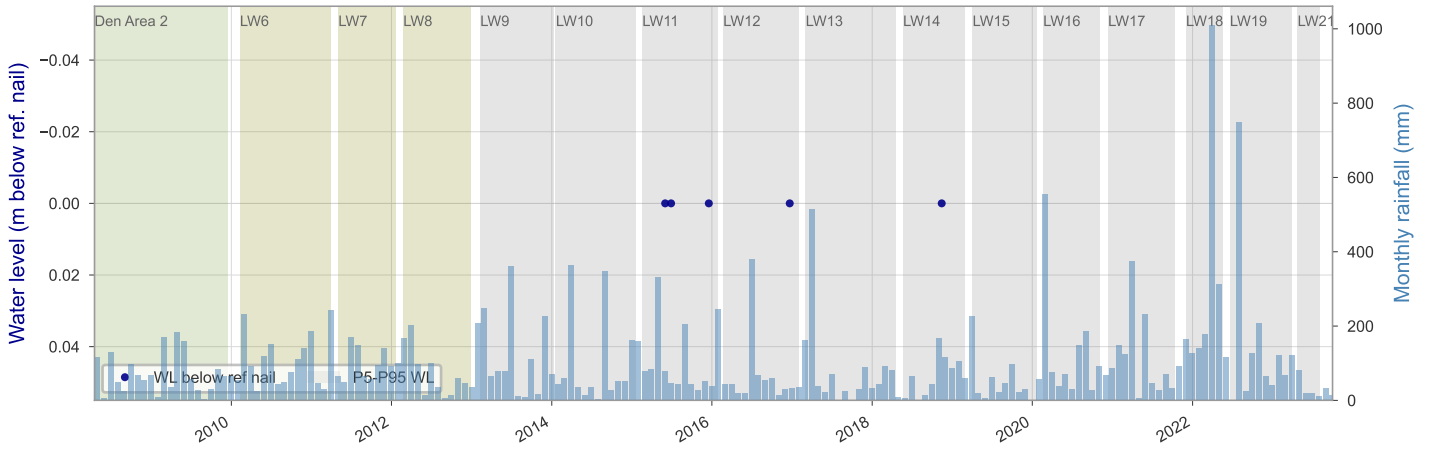
WC8_POOL10



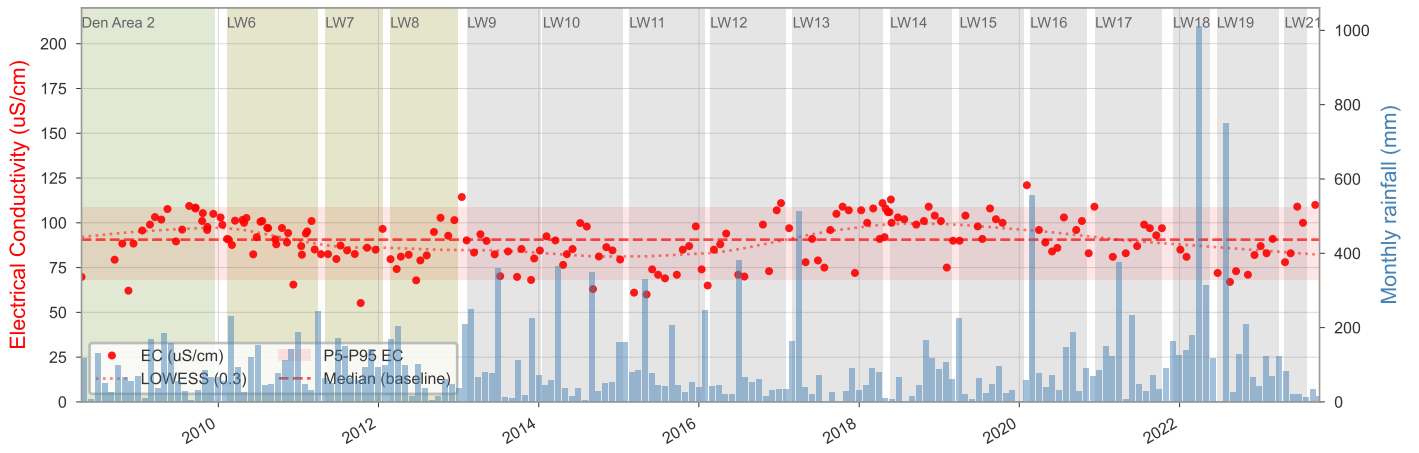
WC8_POOL10



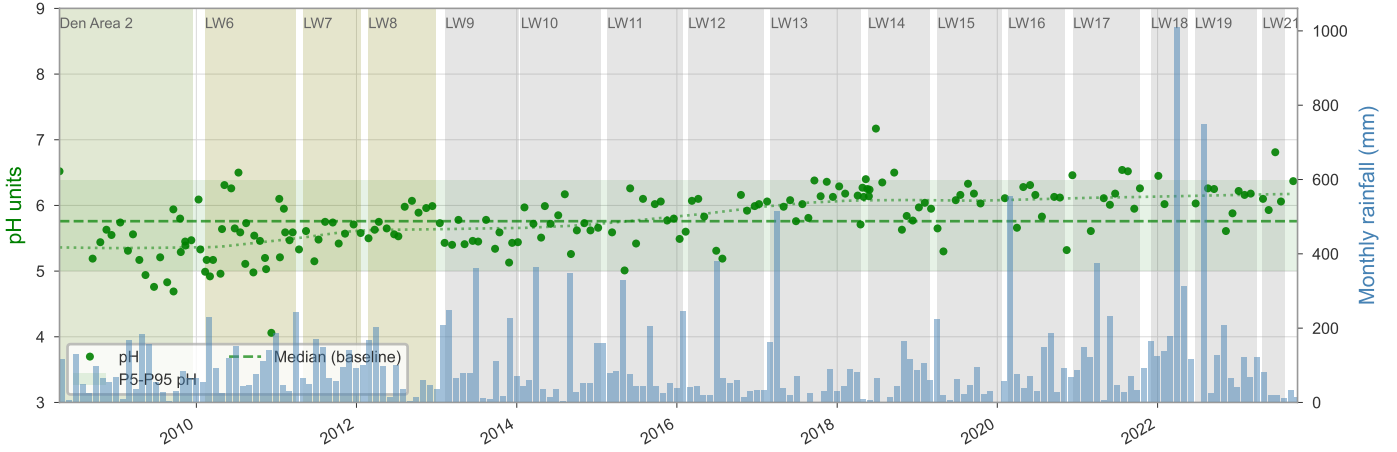
WC_CHANNEL14



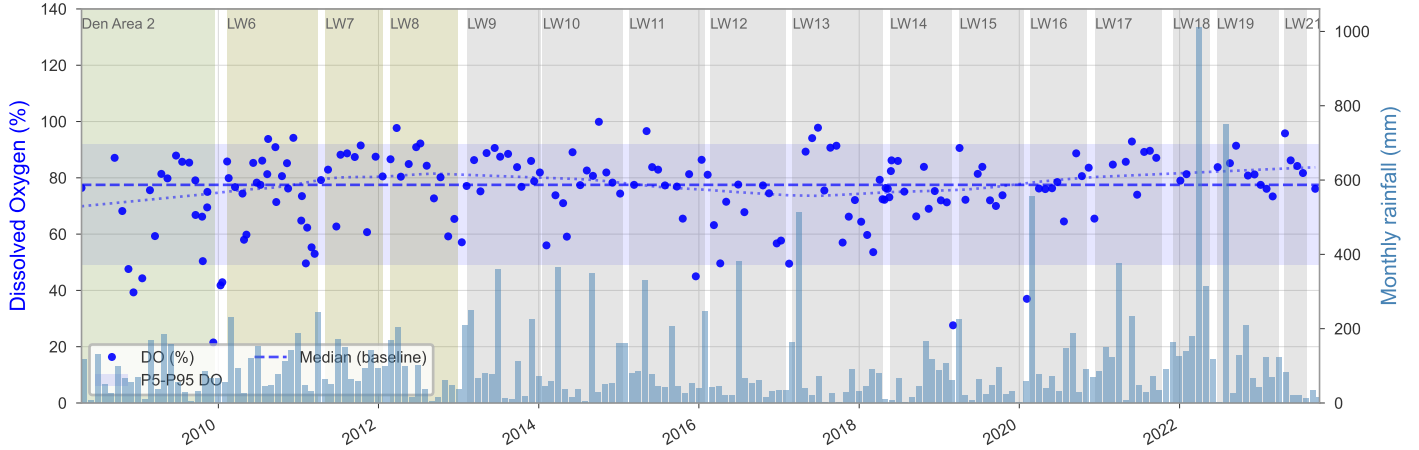
WC_CHANNEL14



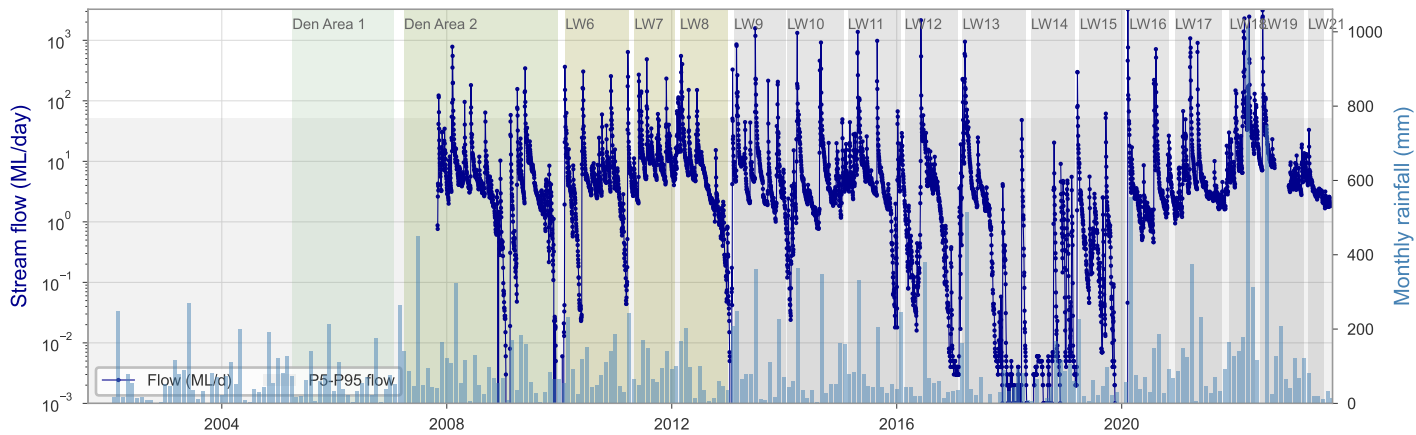
WC_CHANNEL14



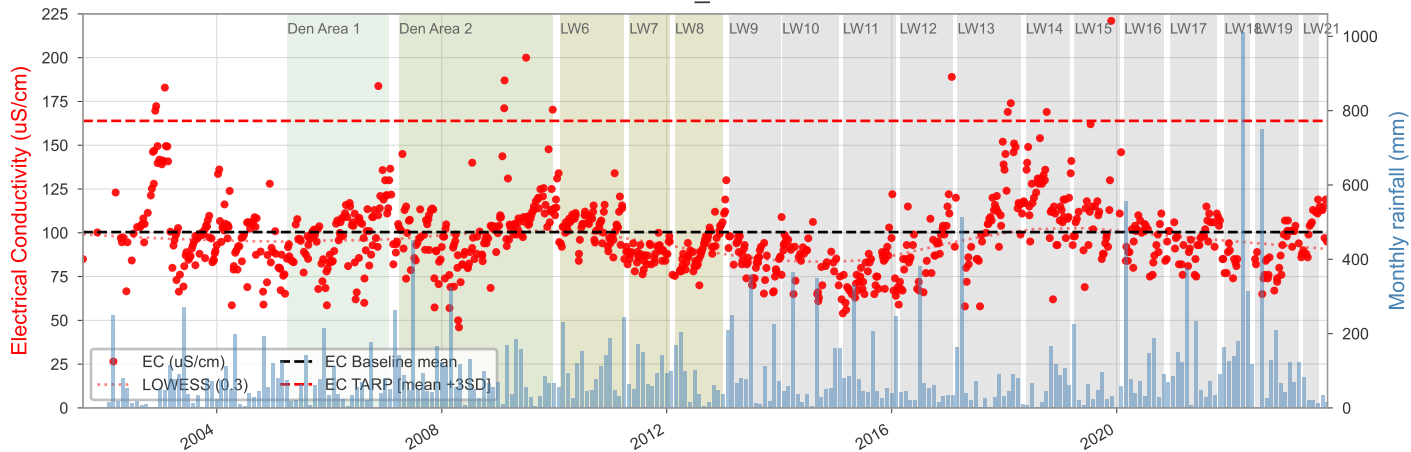
WC_CHANNEL14



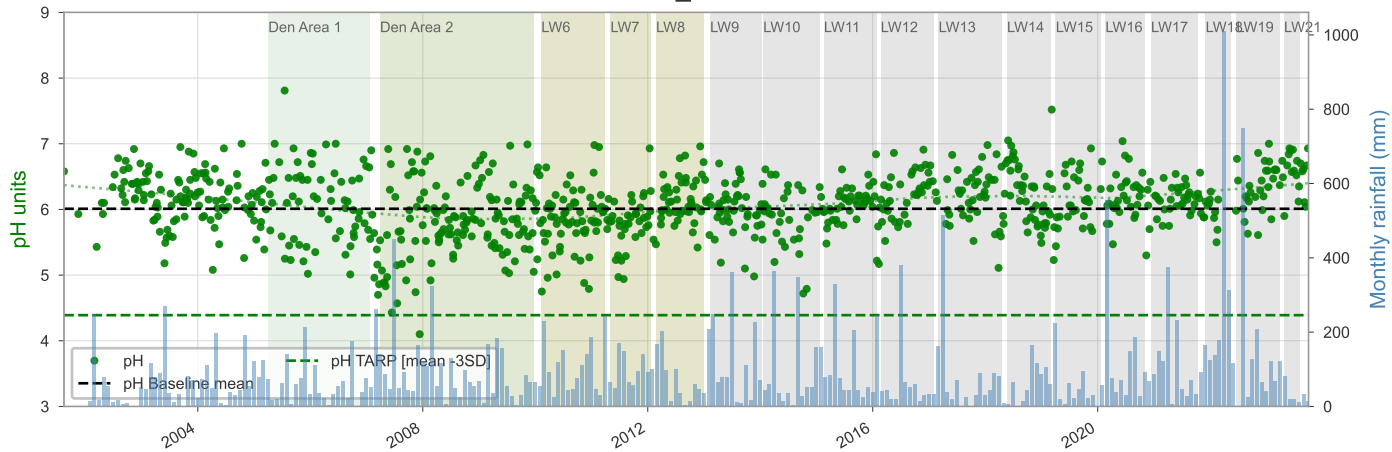
WWL



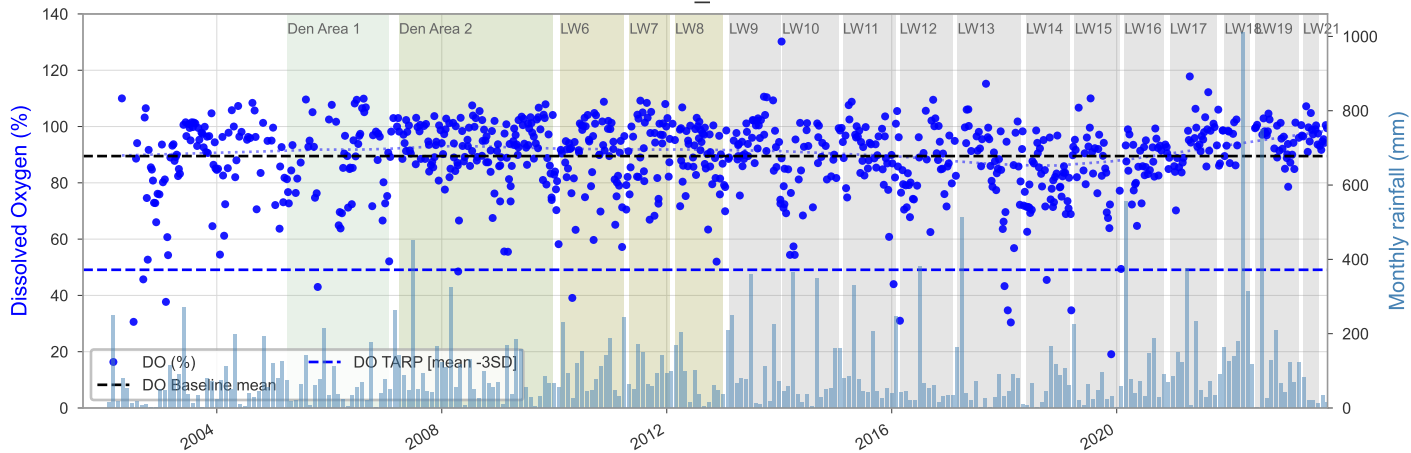
WC_FR6



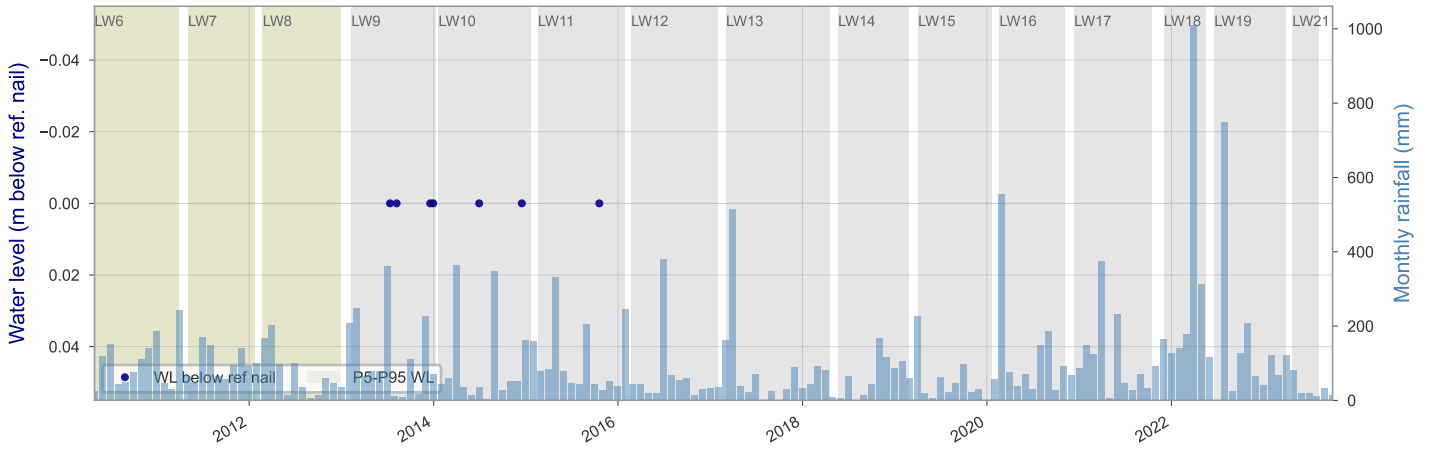
WC_FR6



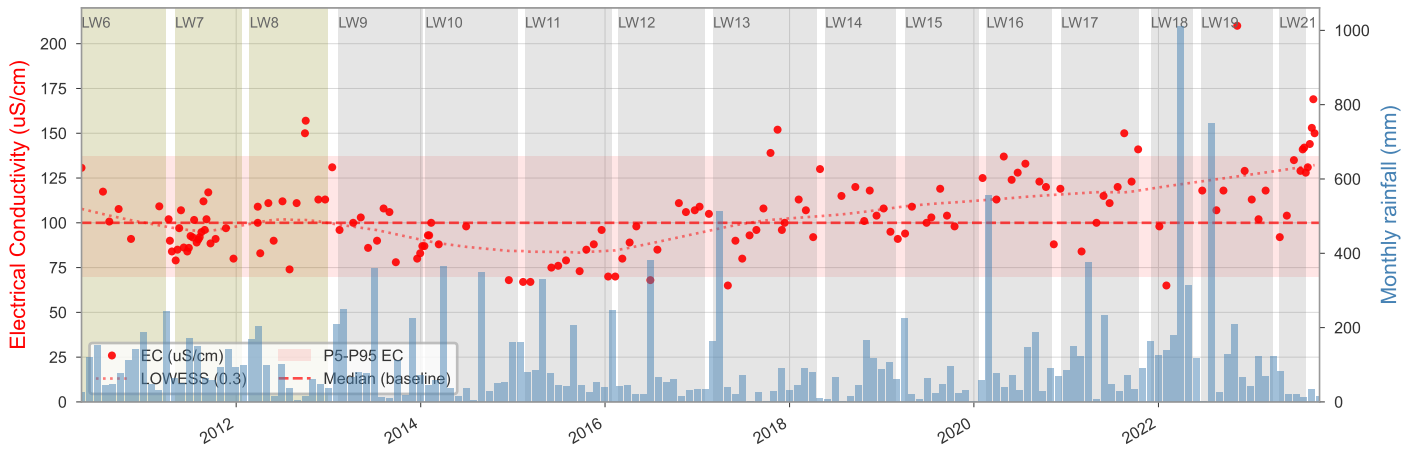
WC_FR6



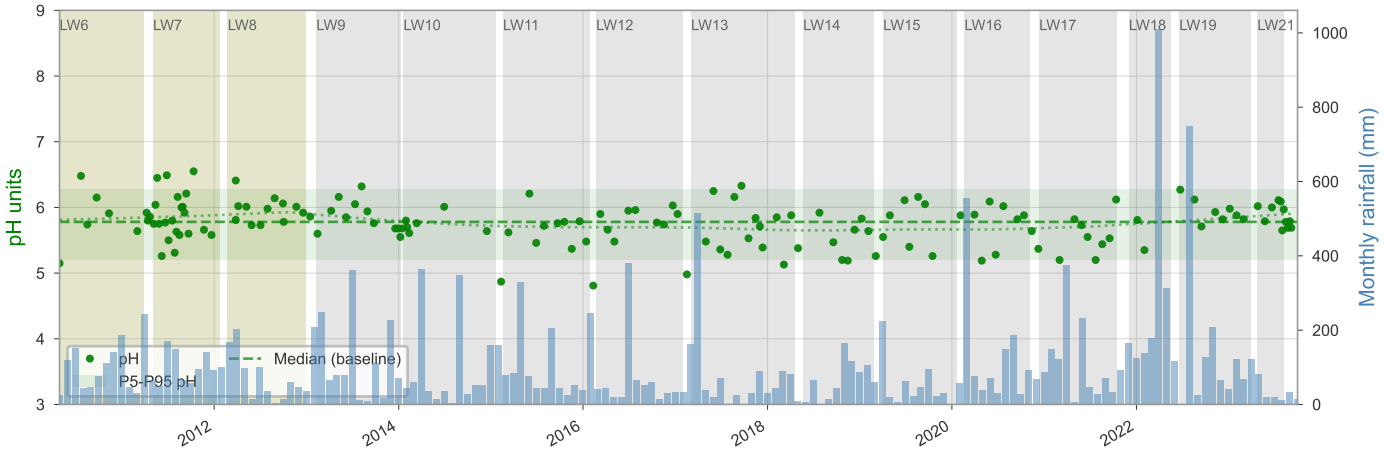
WC_IRON_SPRING



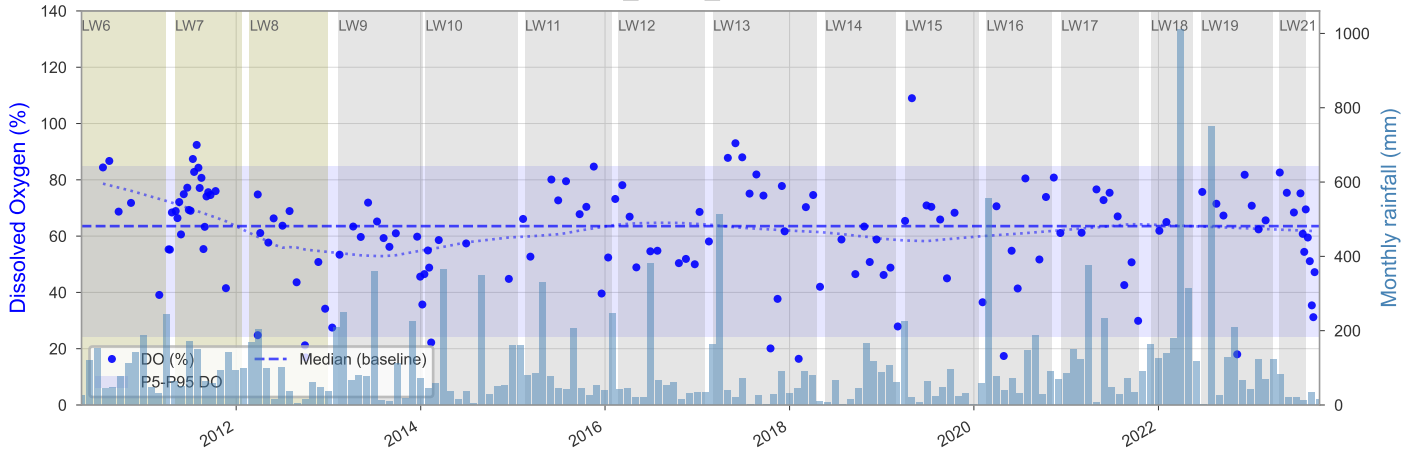
WC_IRON_SPRING



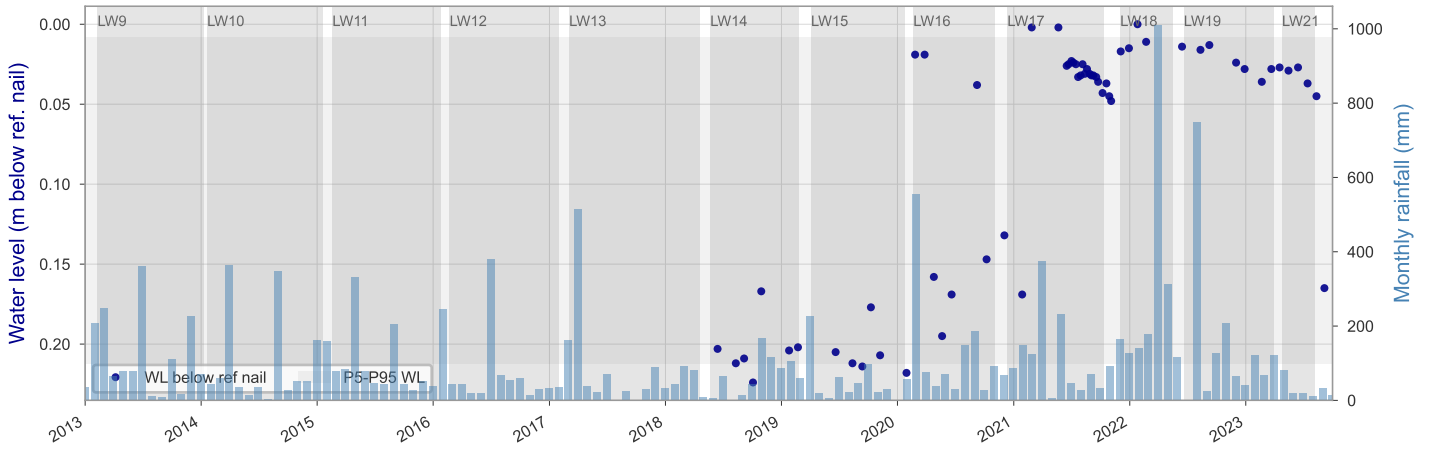
WC_IRON_SPRING



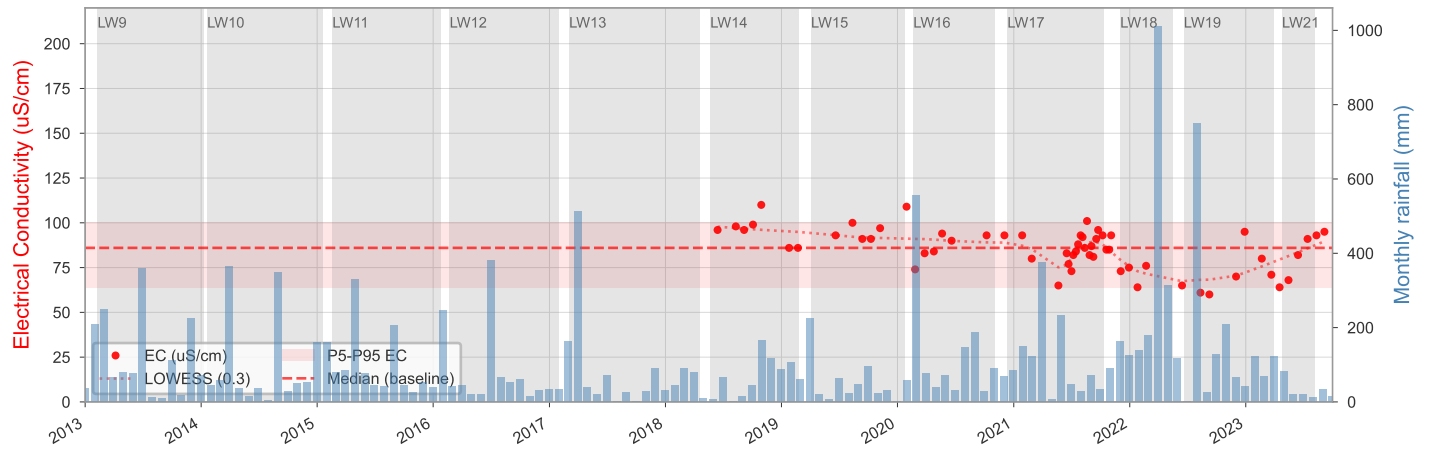
WC_IRON_SPRING



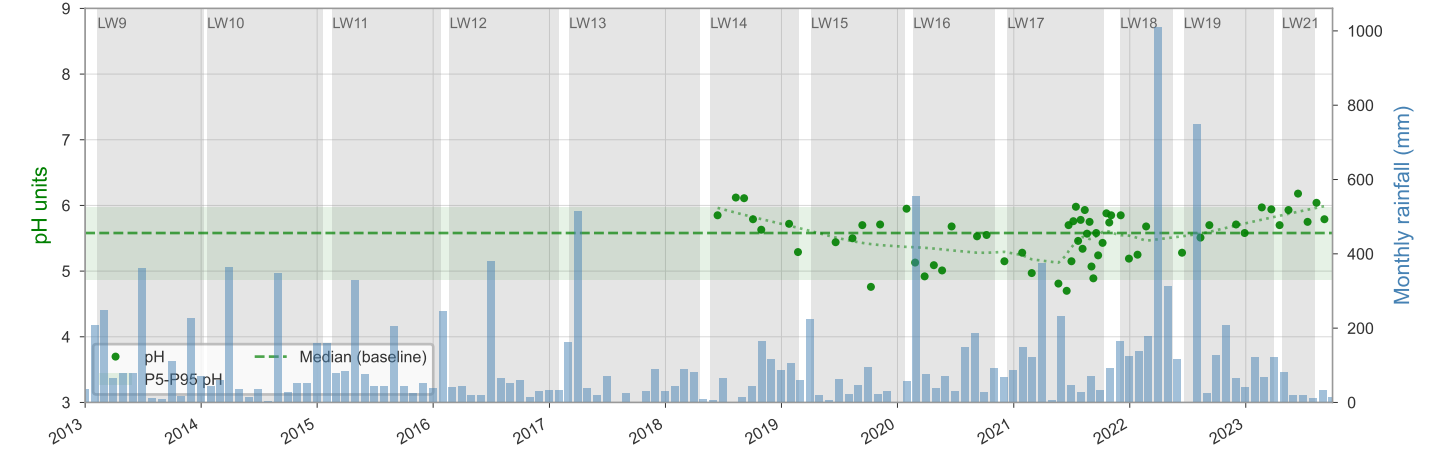
WC_POOL104



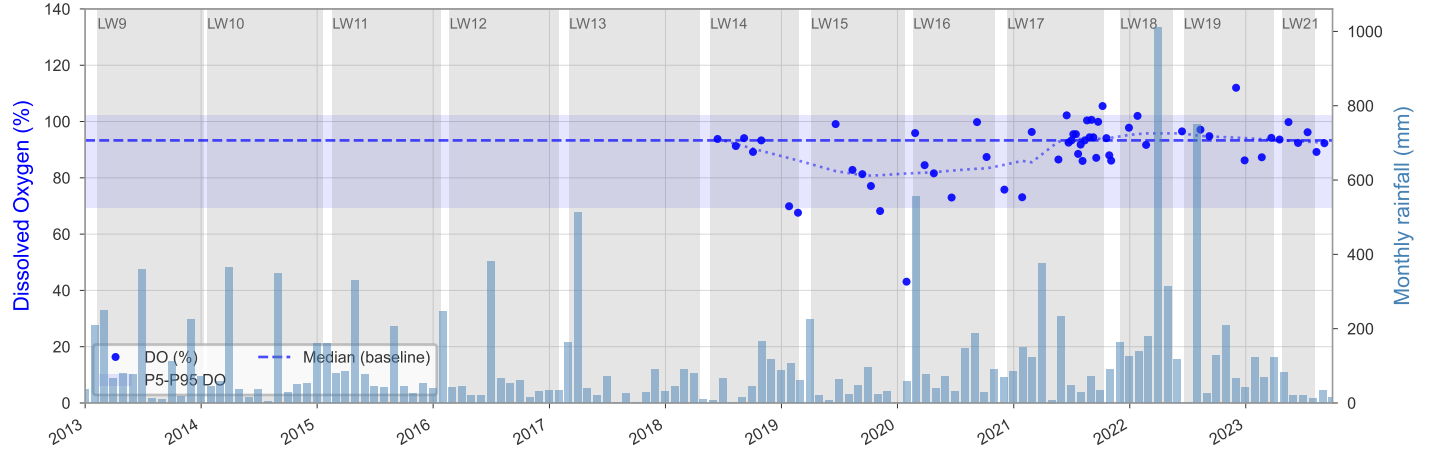
WC_POOL104



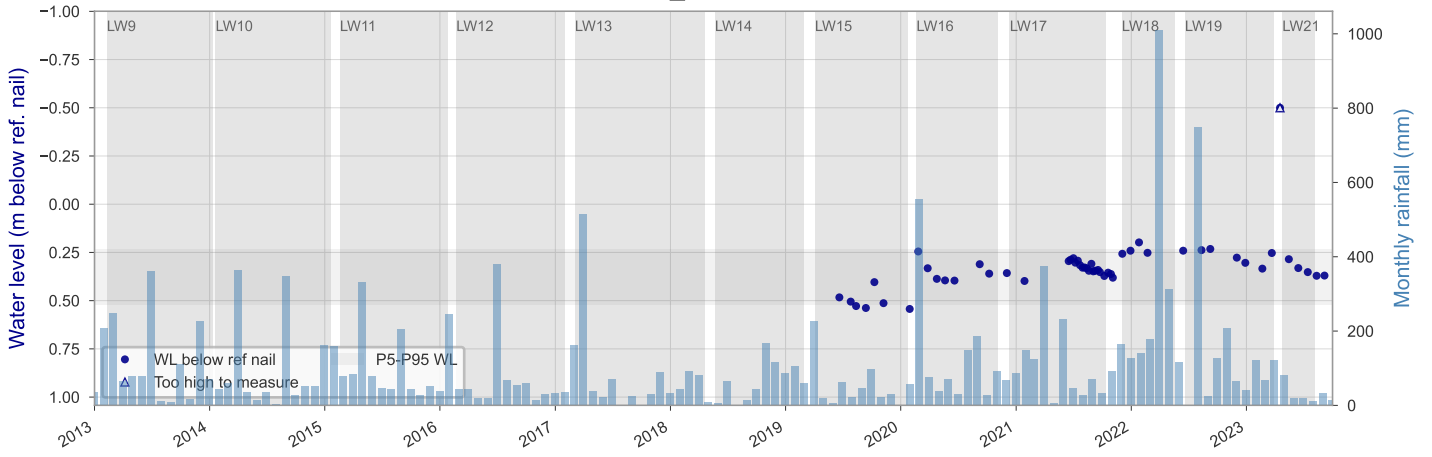
WC_POOL104



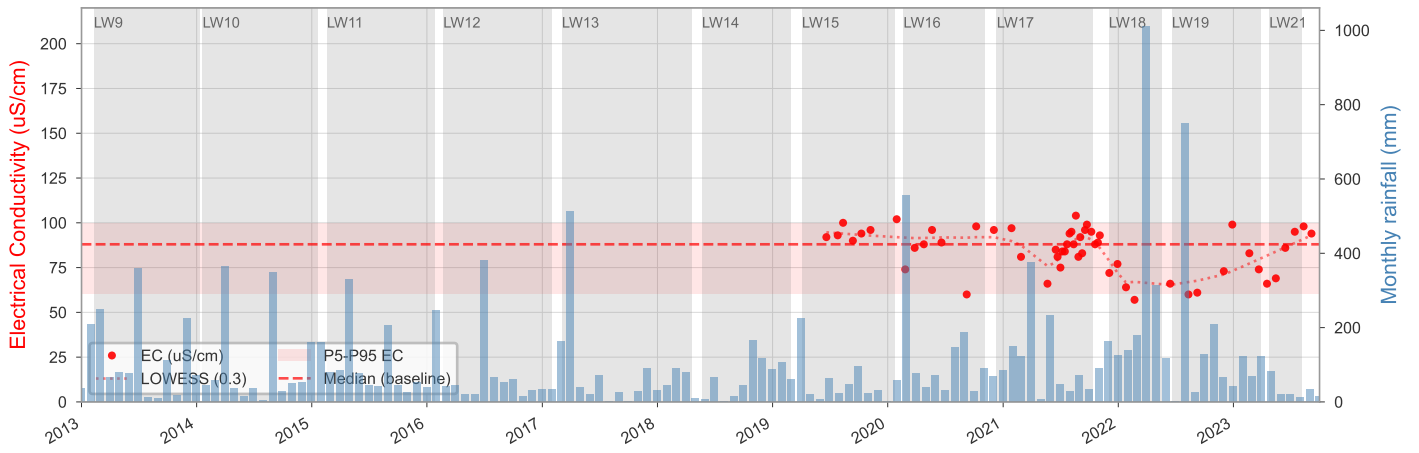
WC_POOL104



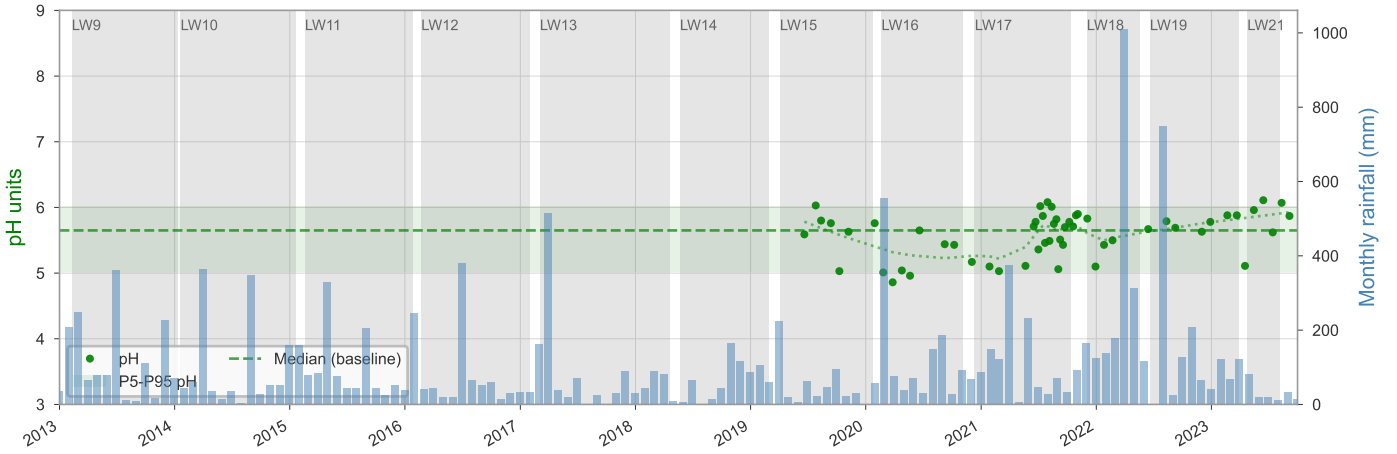
WC_POOL119



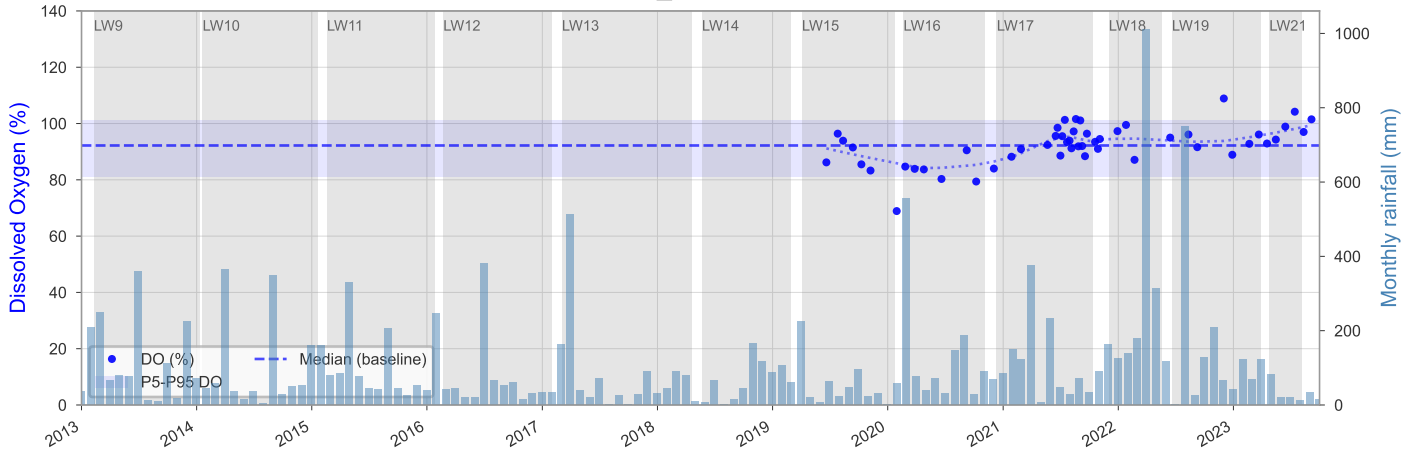
WC_POOL119



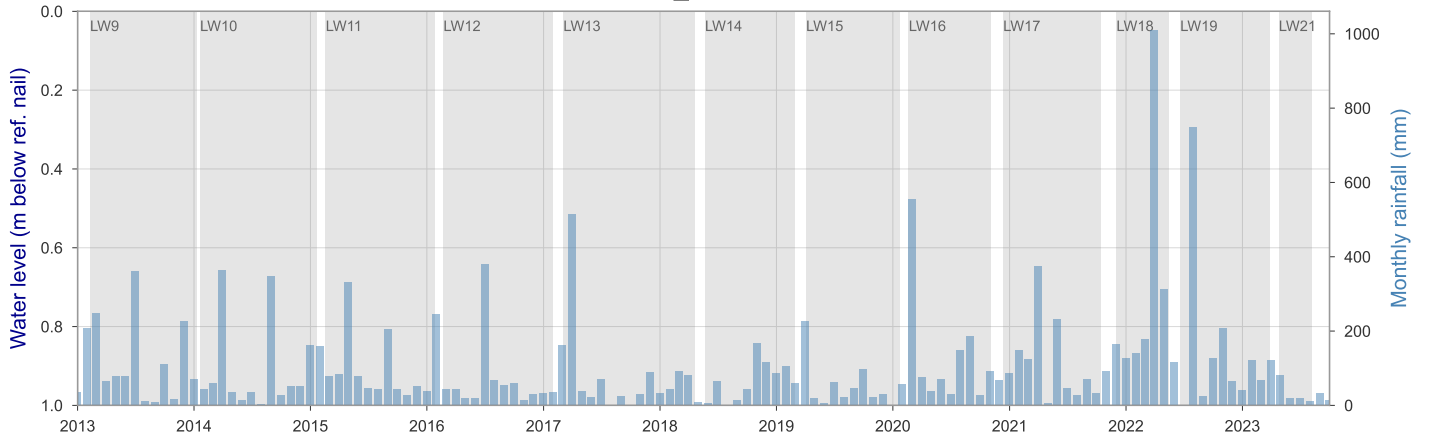
WC_POOL119



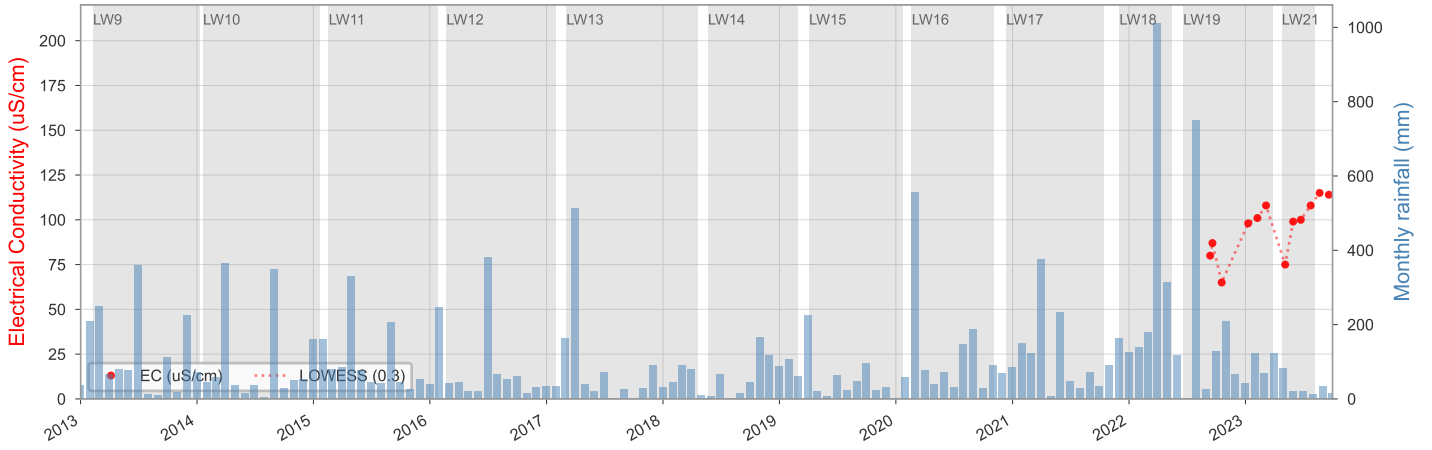
WC_POOL119



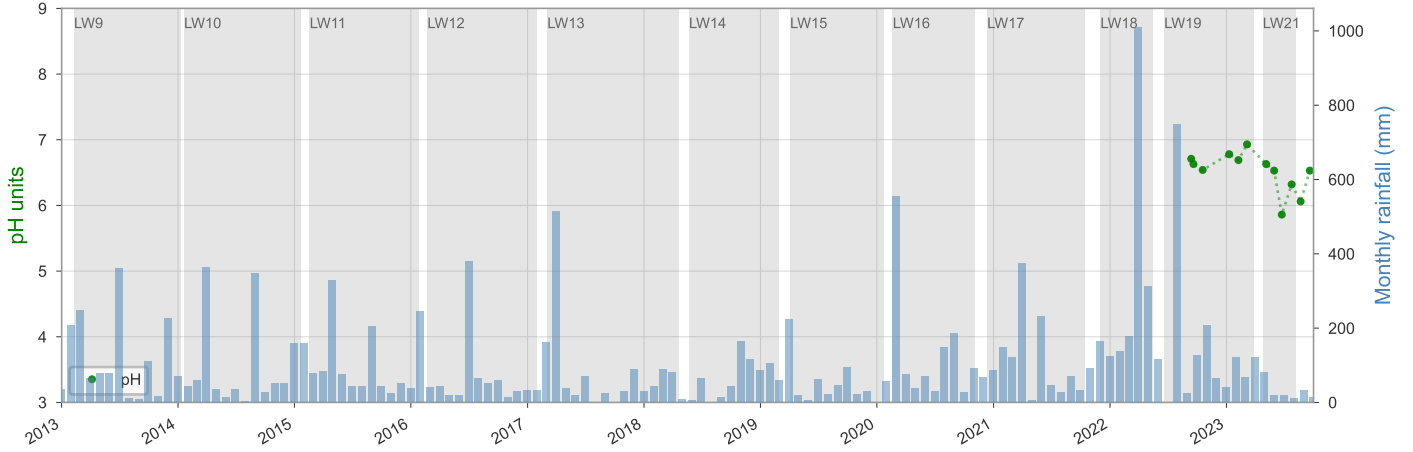
WC_POOL2



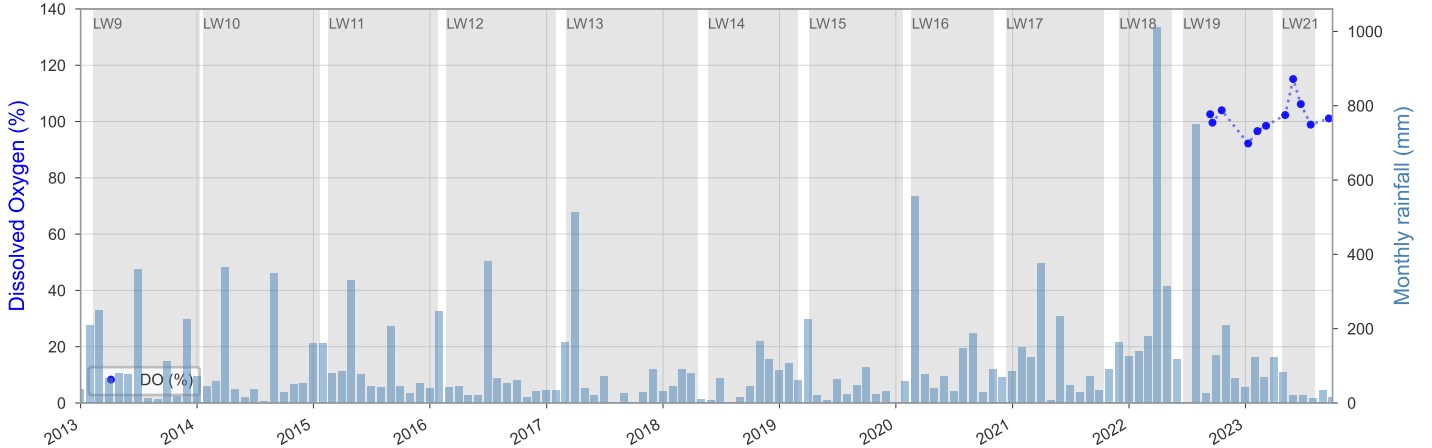
WC_POOL2



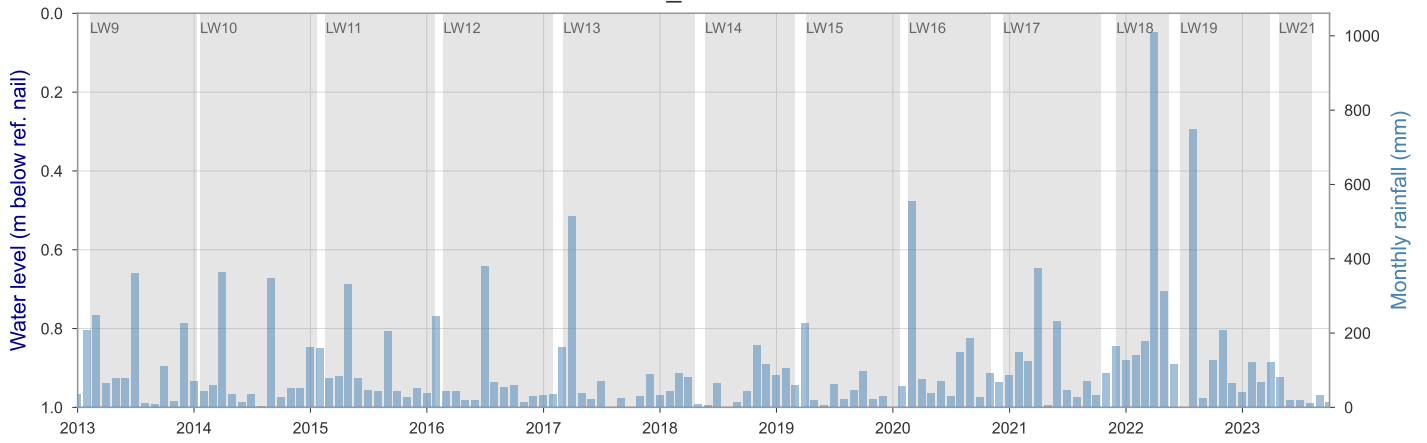
WC_POOL2



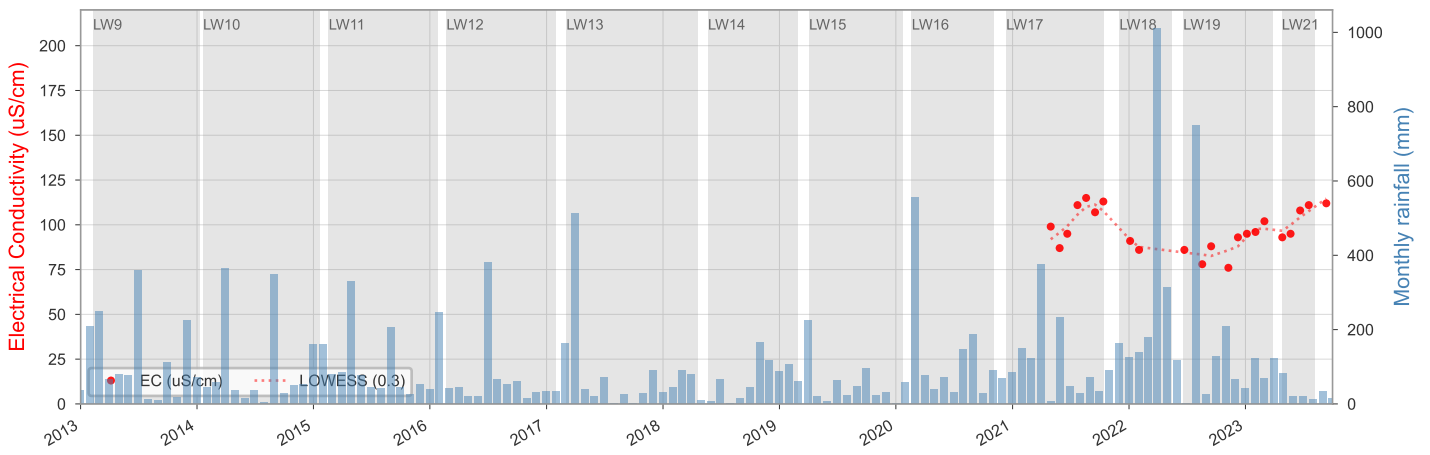
WC_POOL2



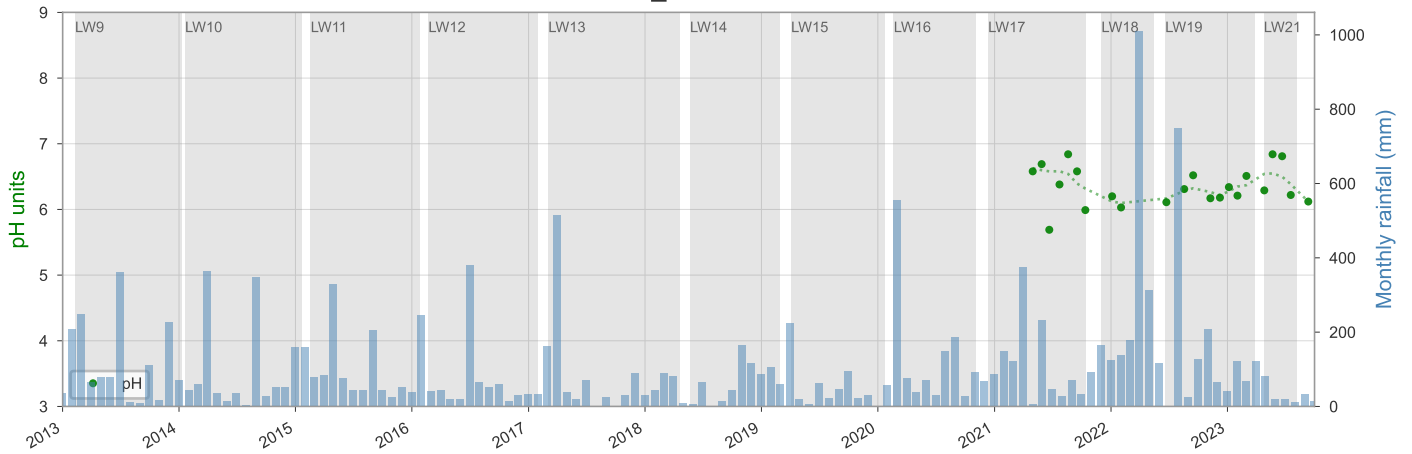
WC_POOL20



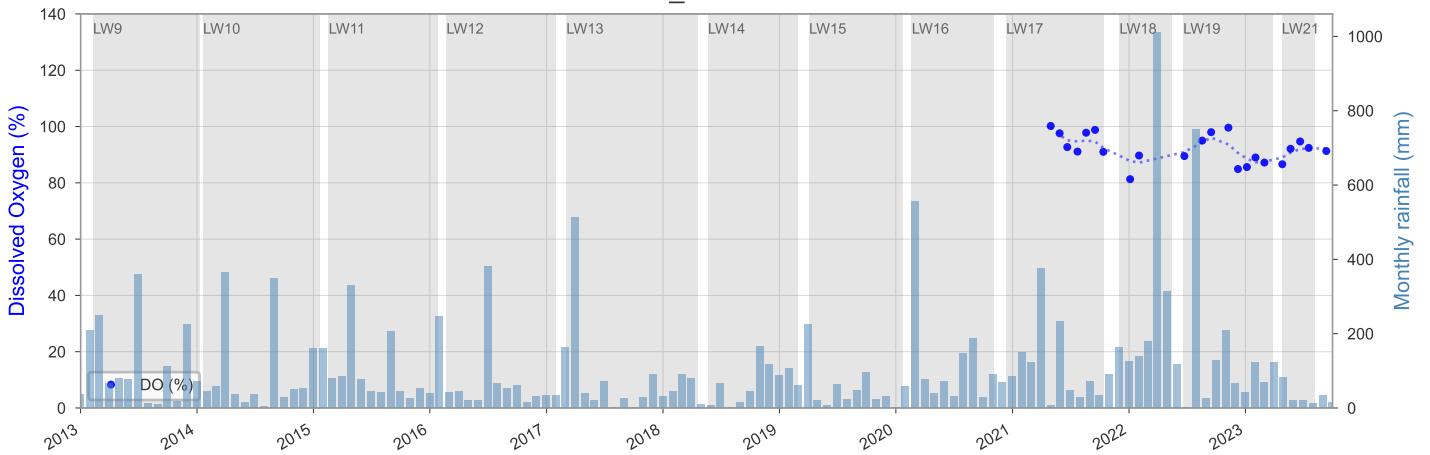
WC_POOL20



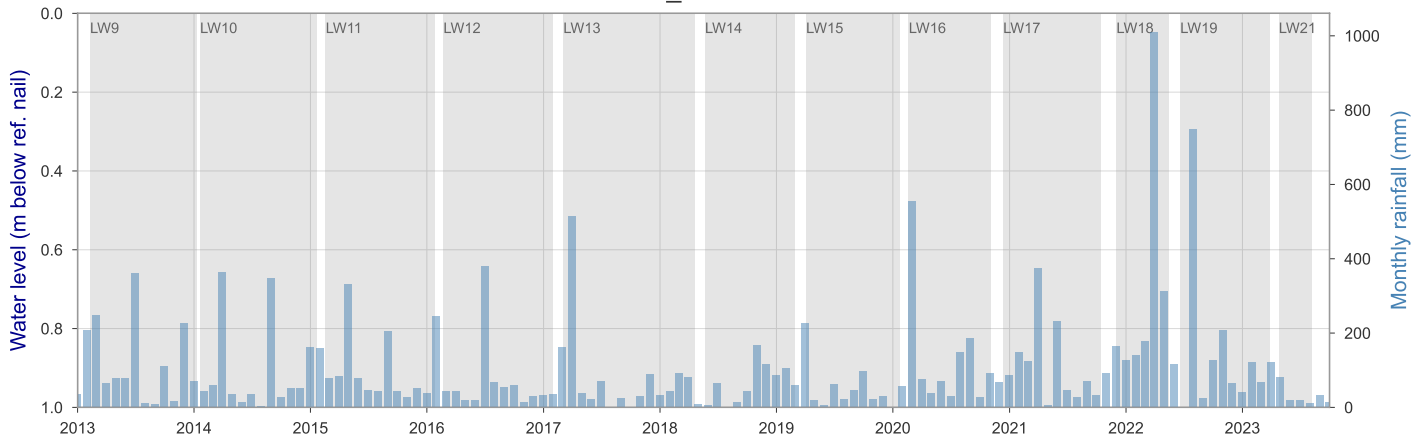
WC_POOL20



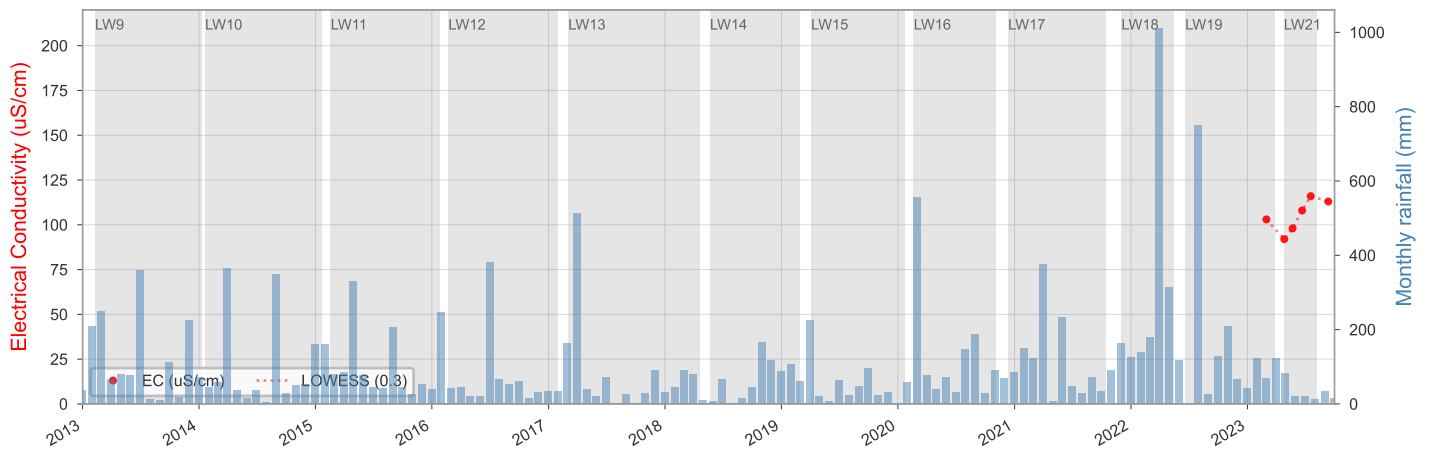
WC_POOL20



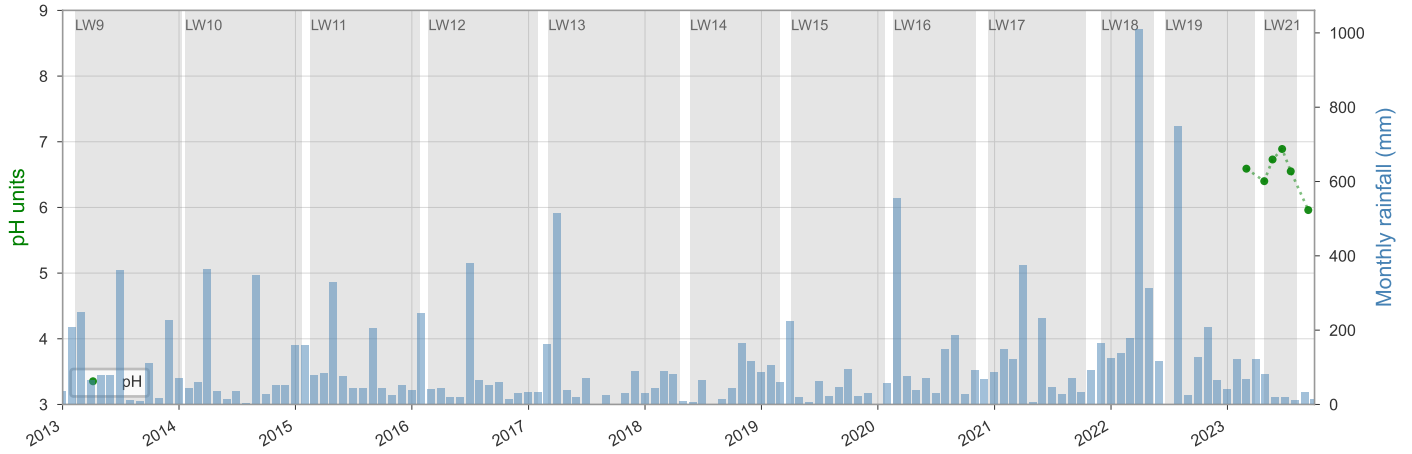
WC_POOL30



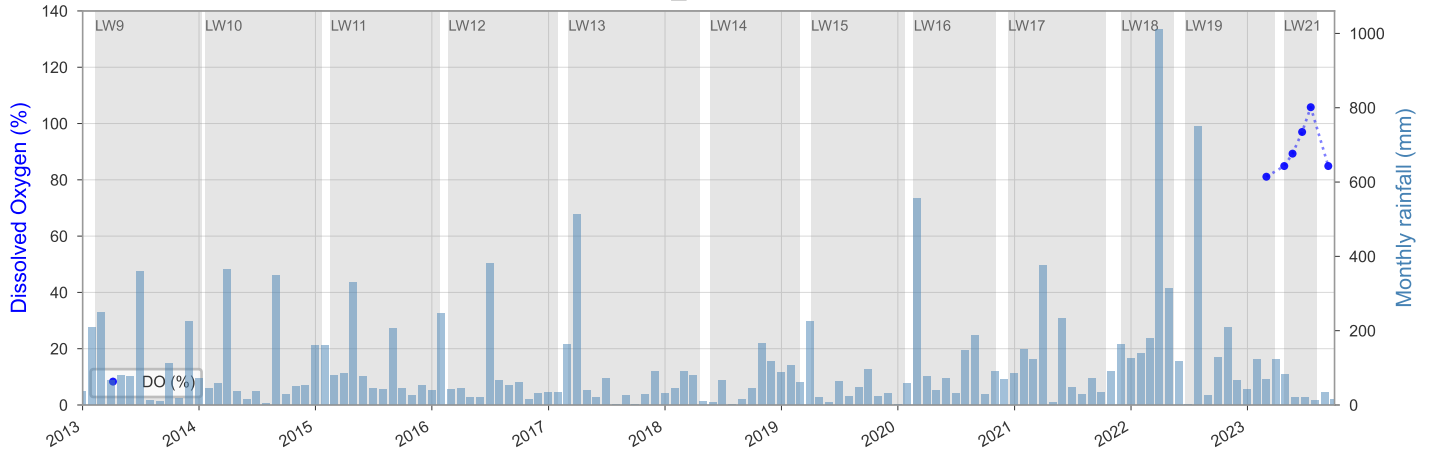
WC_POOL30



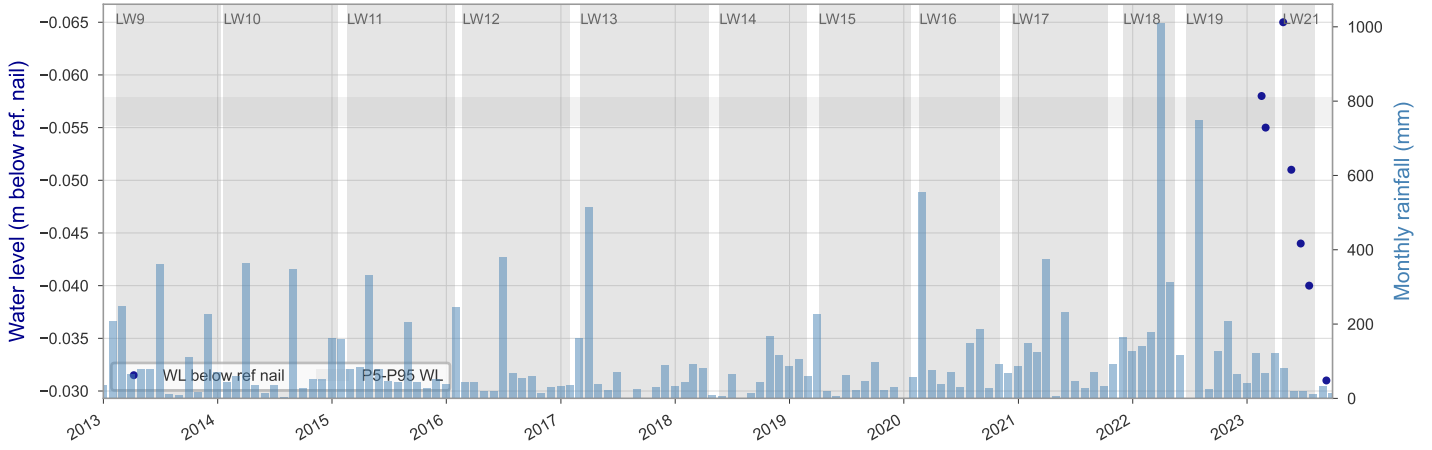
WC_POOL30



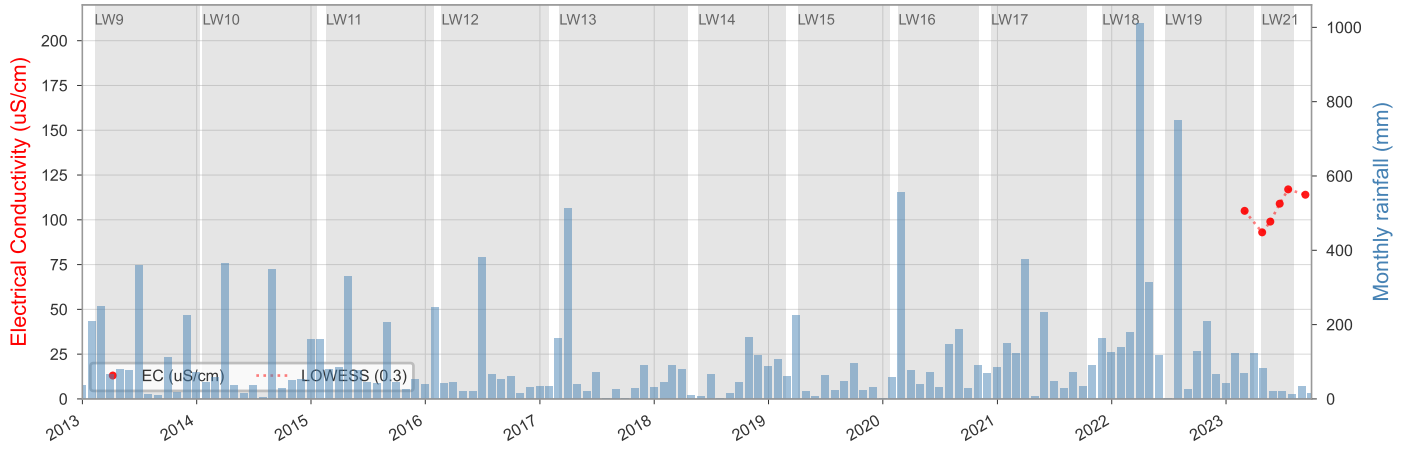
WC_POOL30



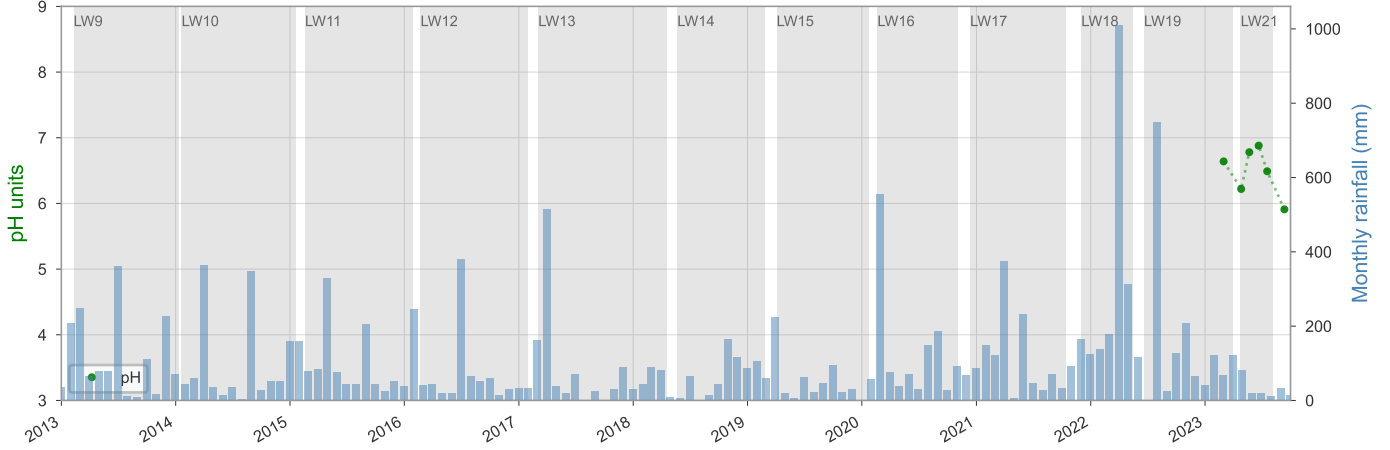
WC_POOL31



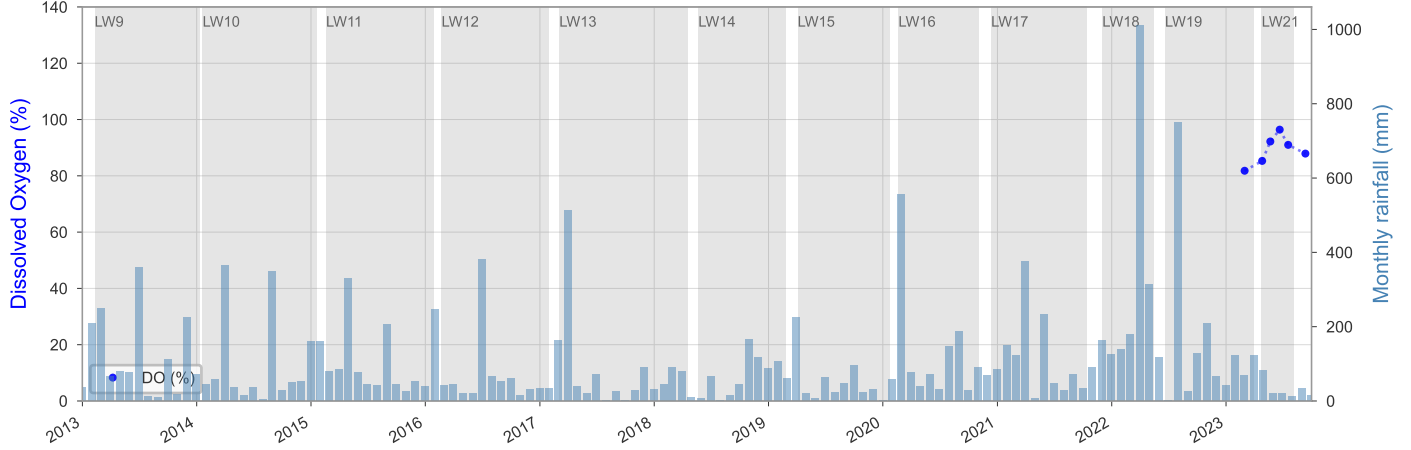
WC_POOL31



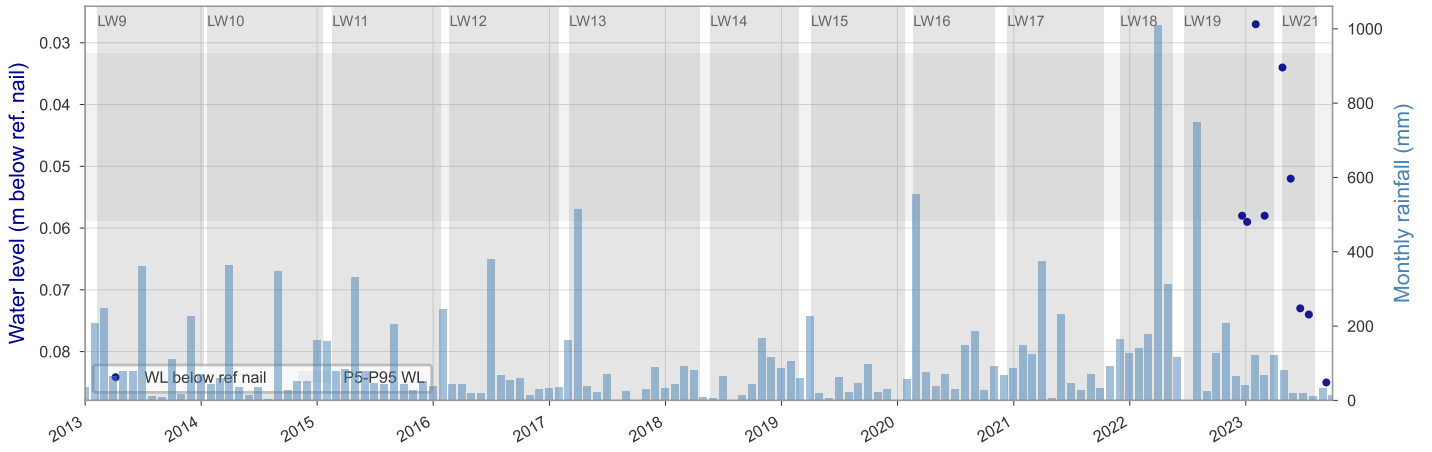
WC_POOL31



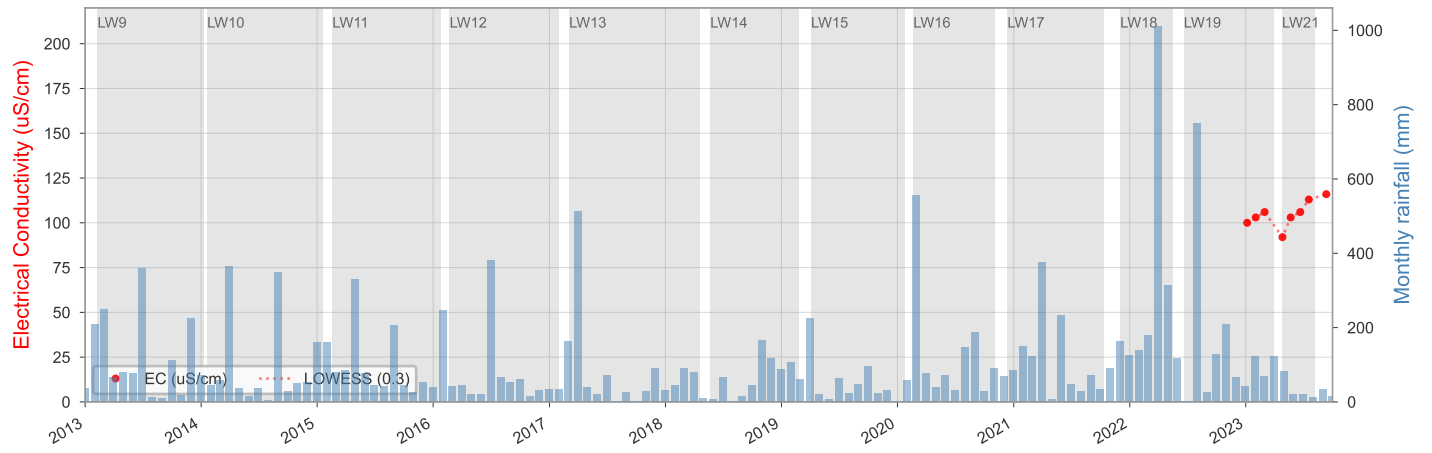
WC_POOL31



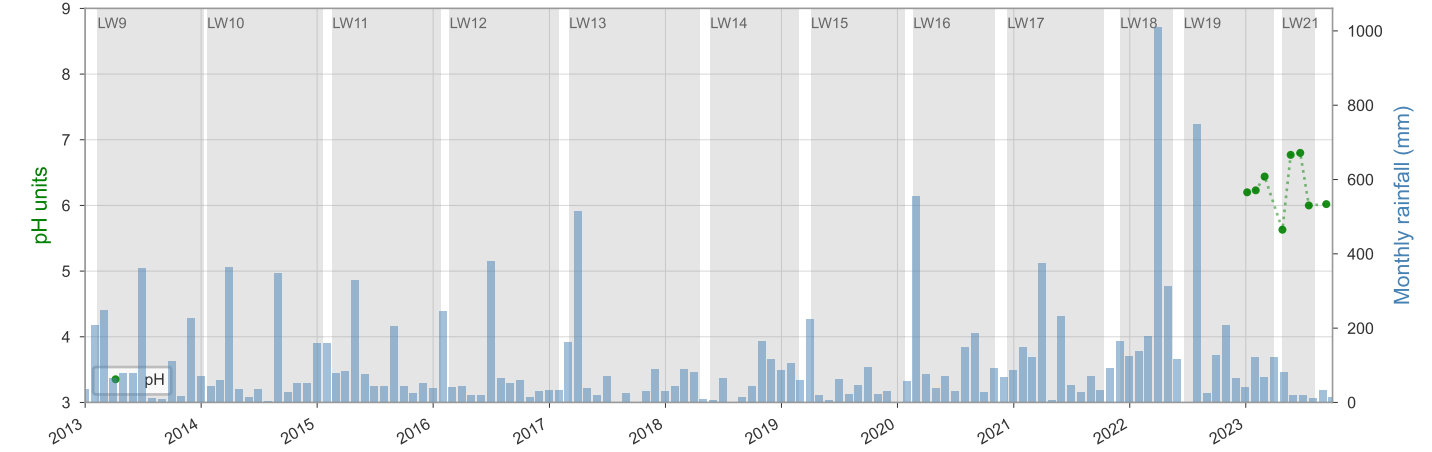
WC_POOL35



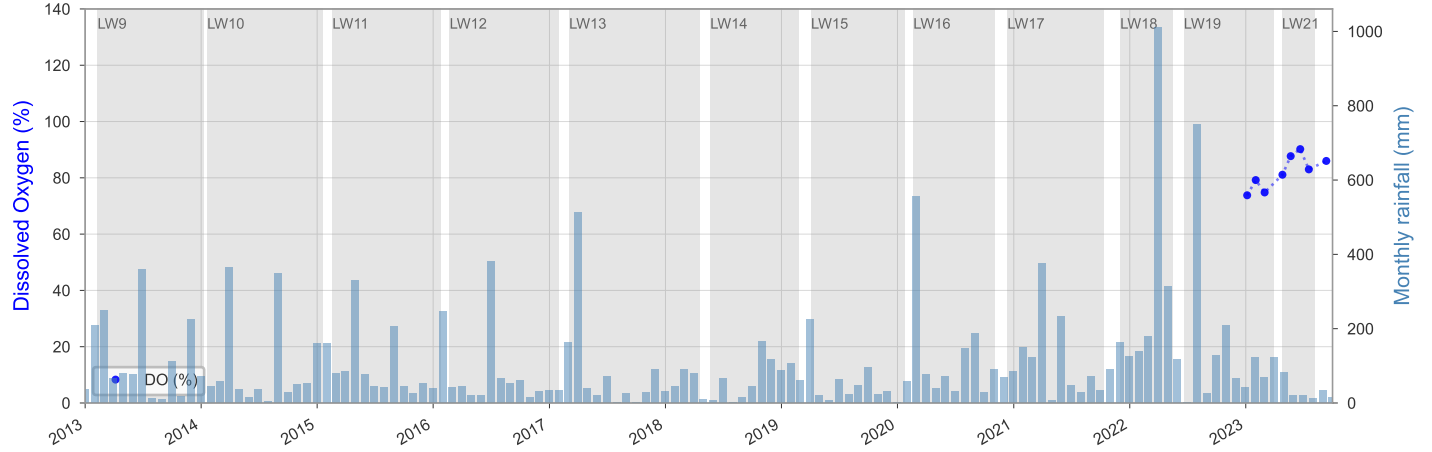
WC_POOL35



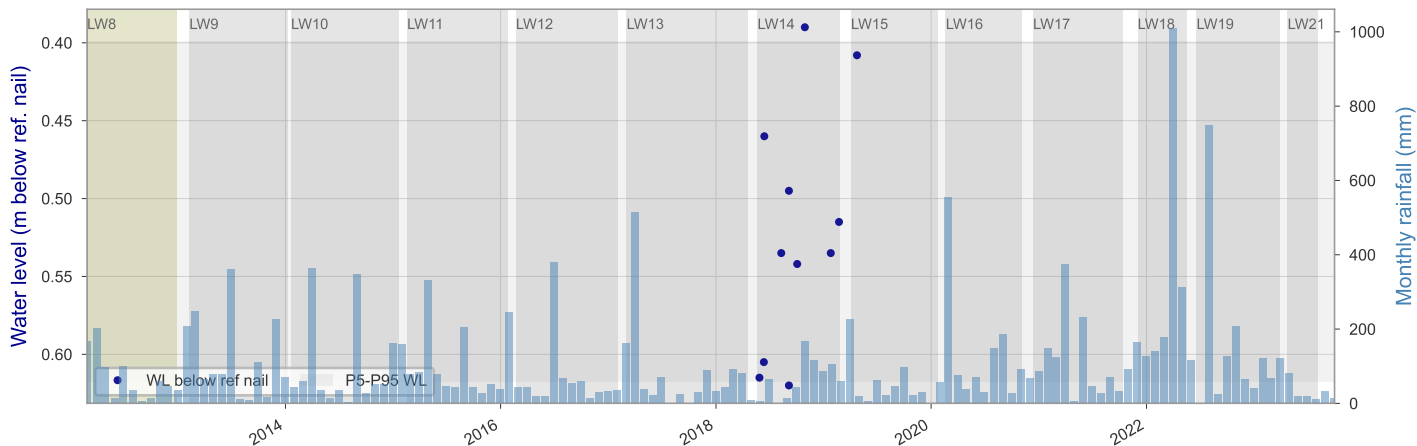
WC_POOL35



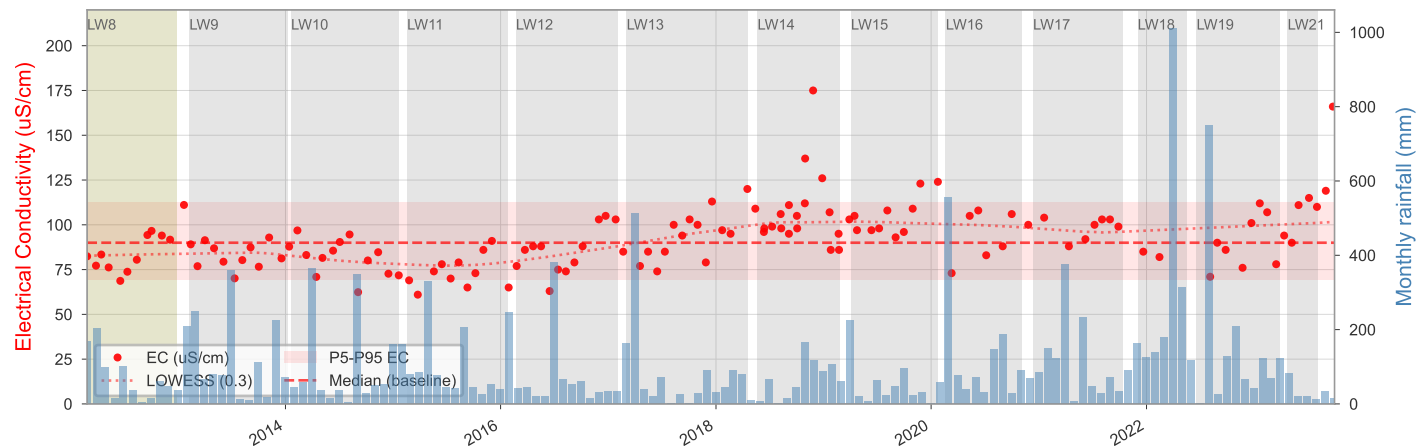
WC_POOL35



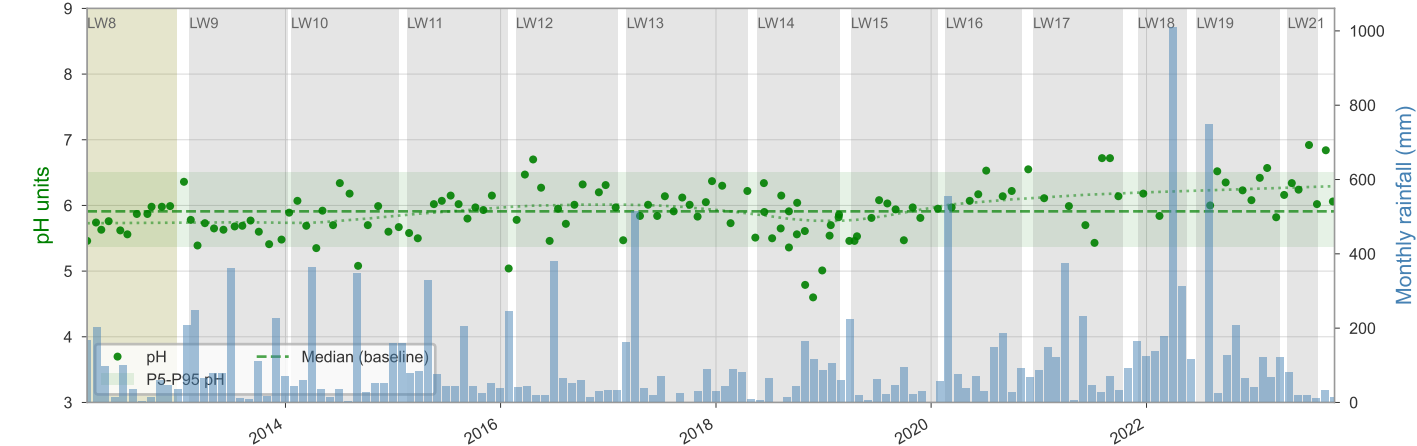
WC_POOL38



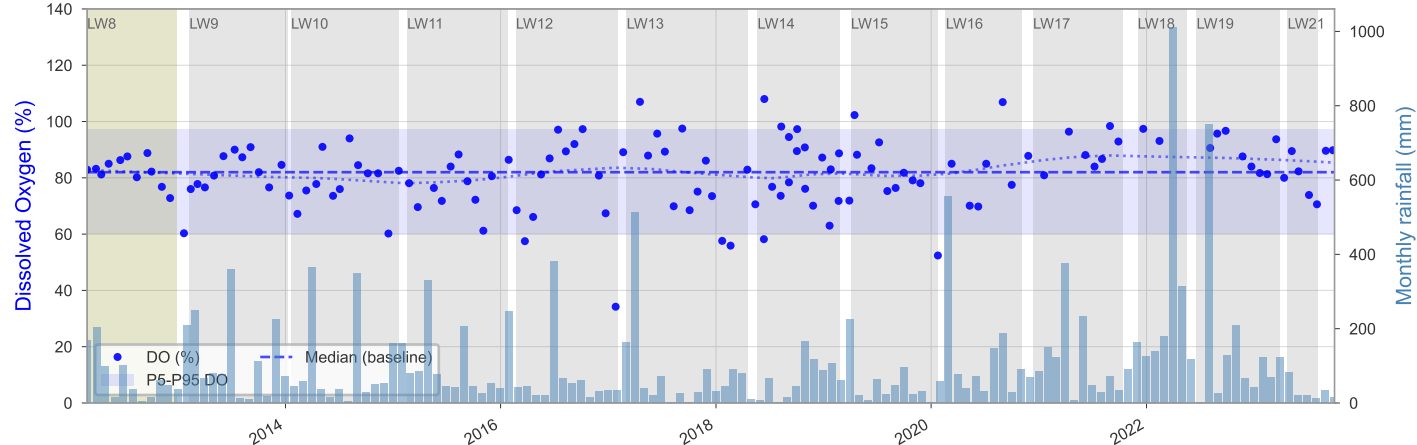
WC_POOL38



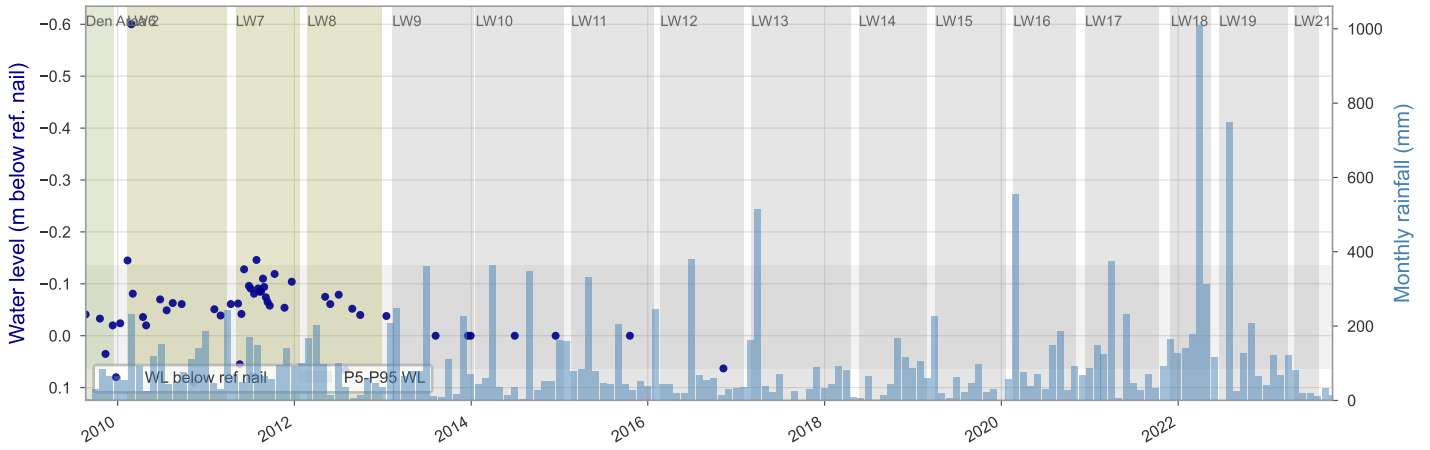
WC_POOL38



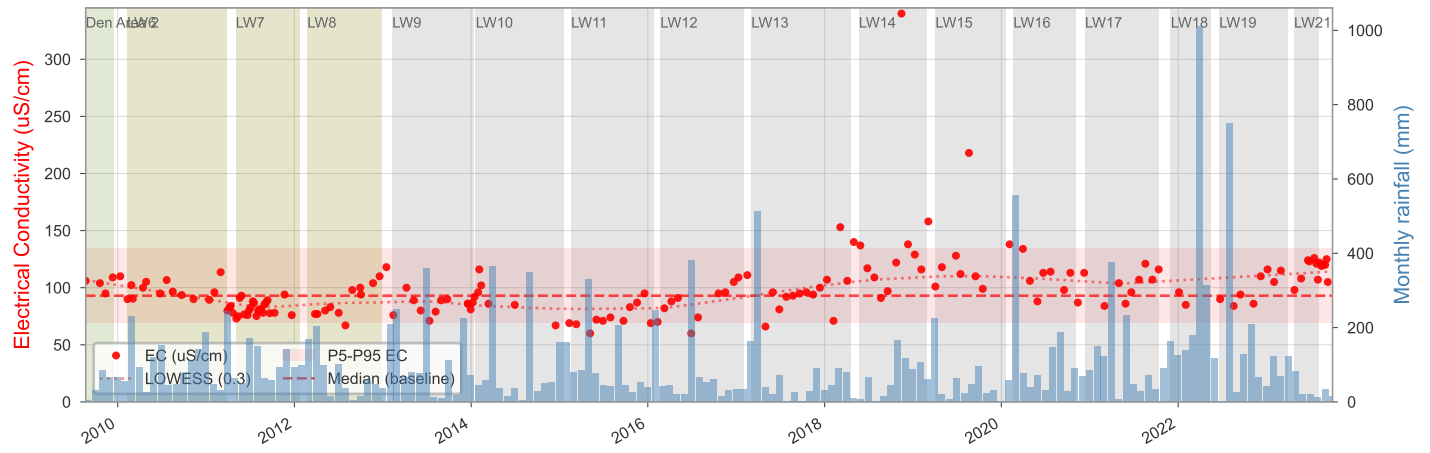
WC_POOL38



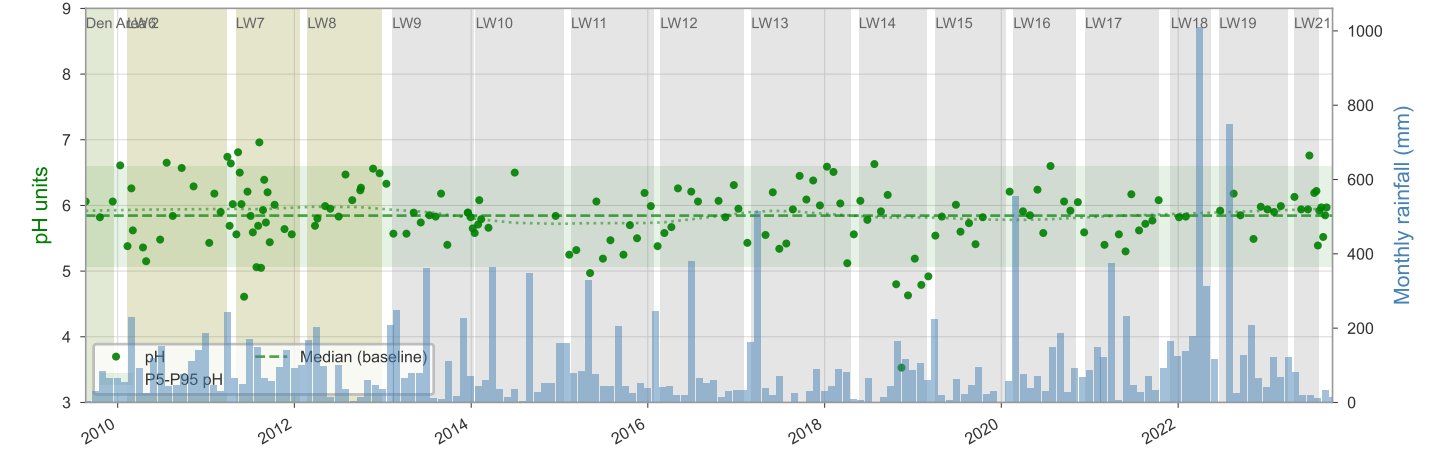
WC_POOL44



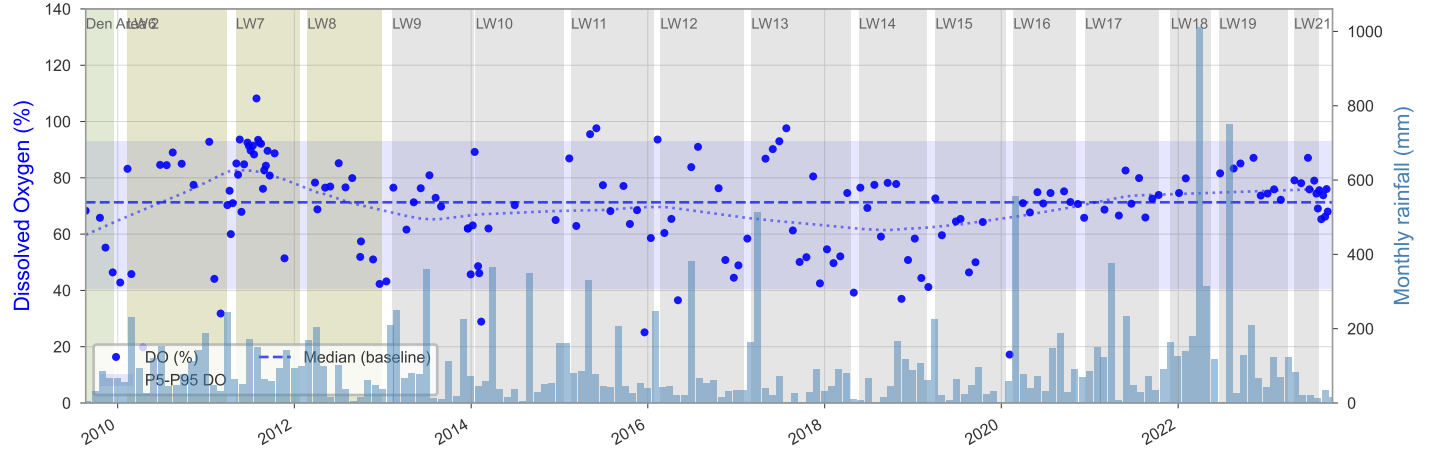
WC_POOL44



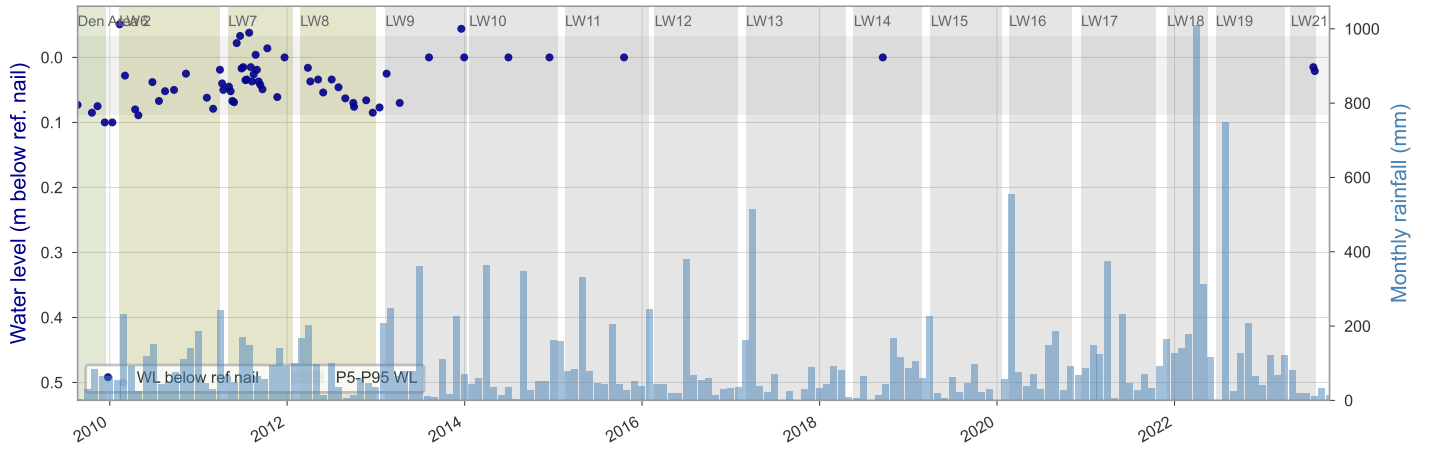
WC_POOL44



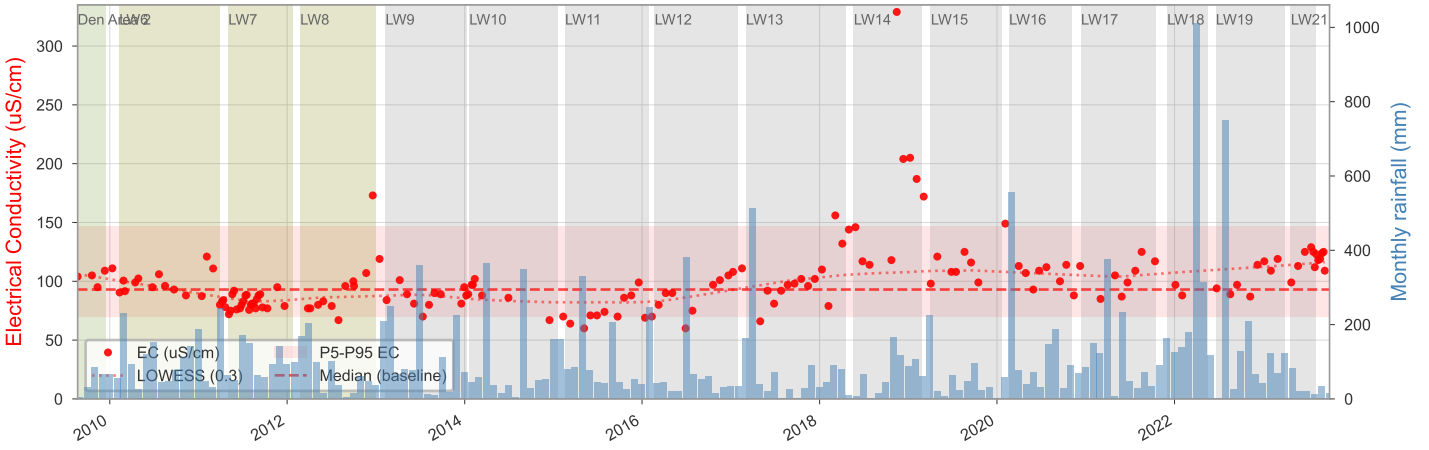
WC_POOL44



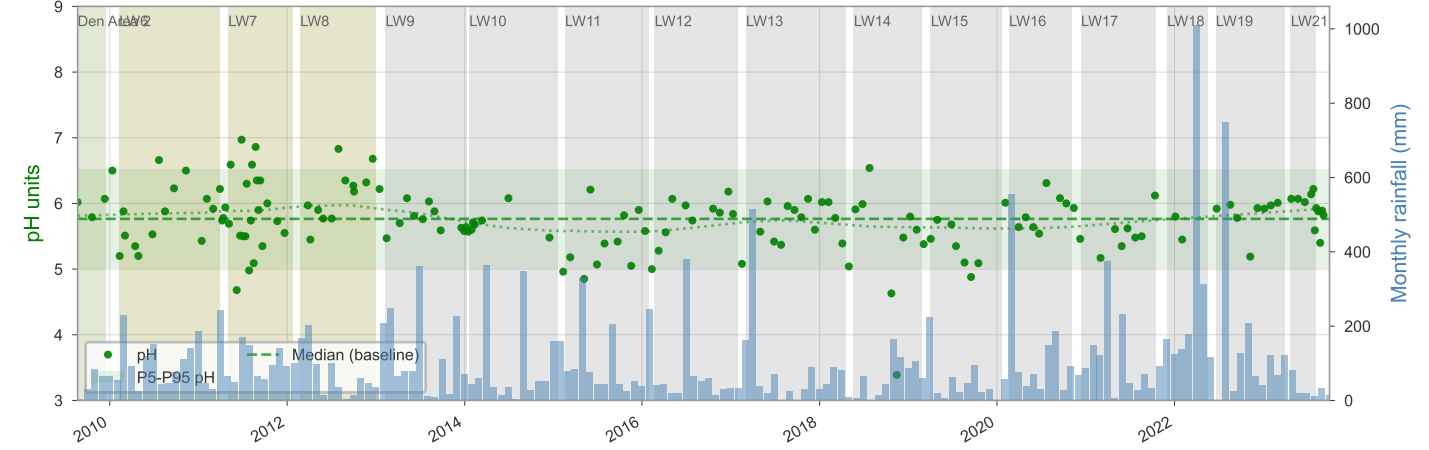
WC_POOL45



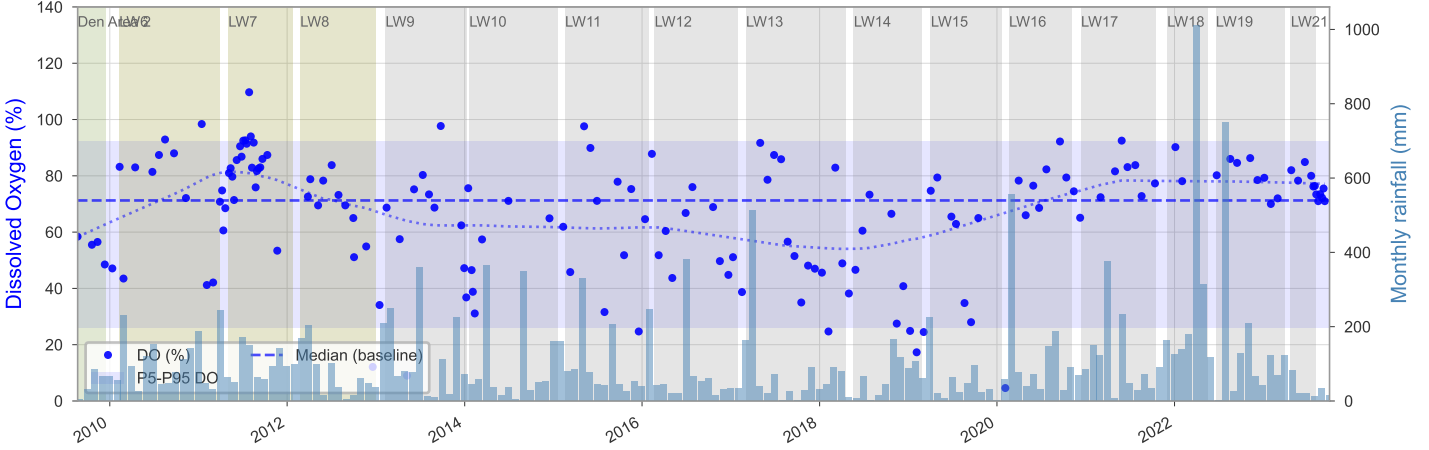
WC_POOL45



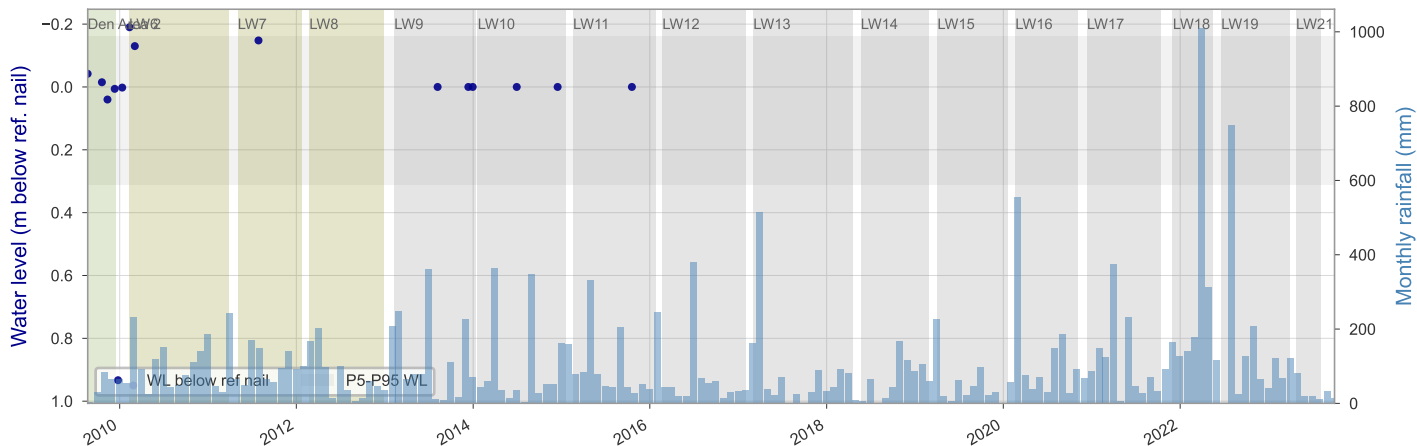
WC_POOL45



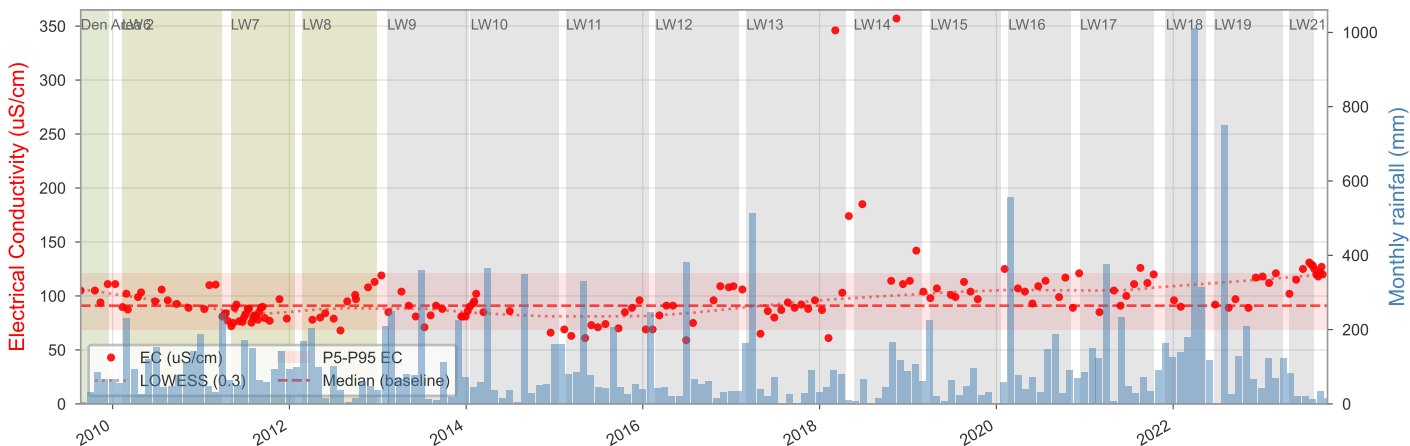
WC_POOL45



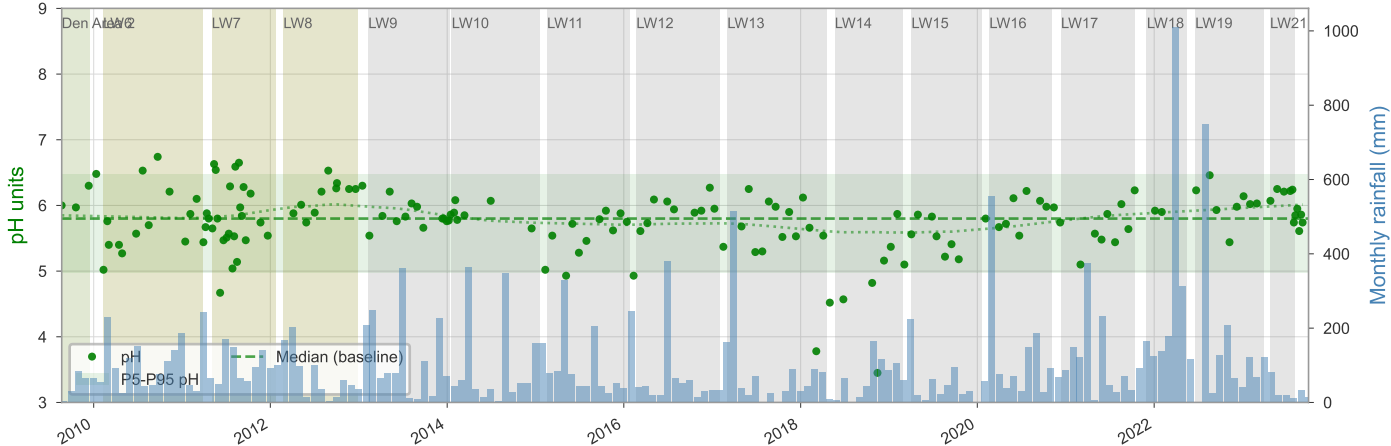
WC_POOL46



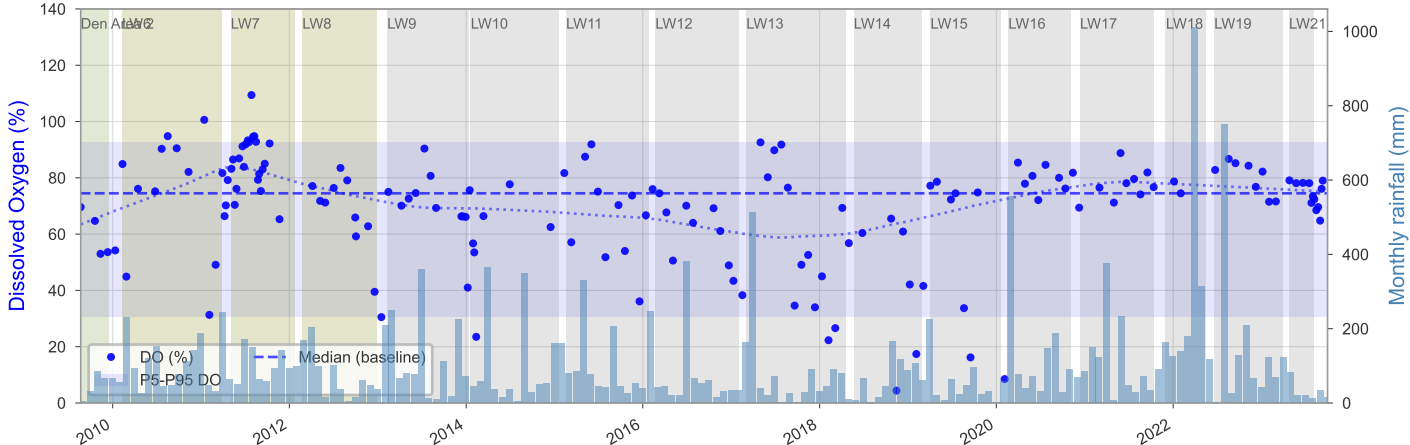
WC_POOL46



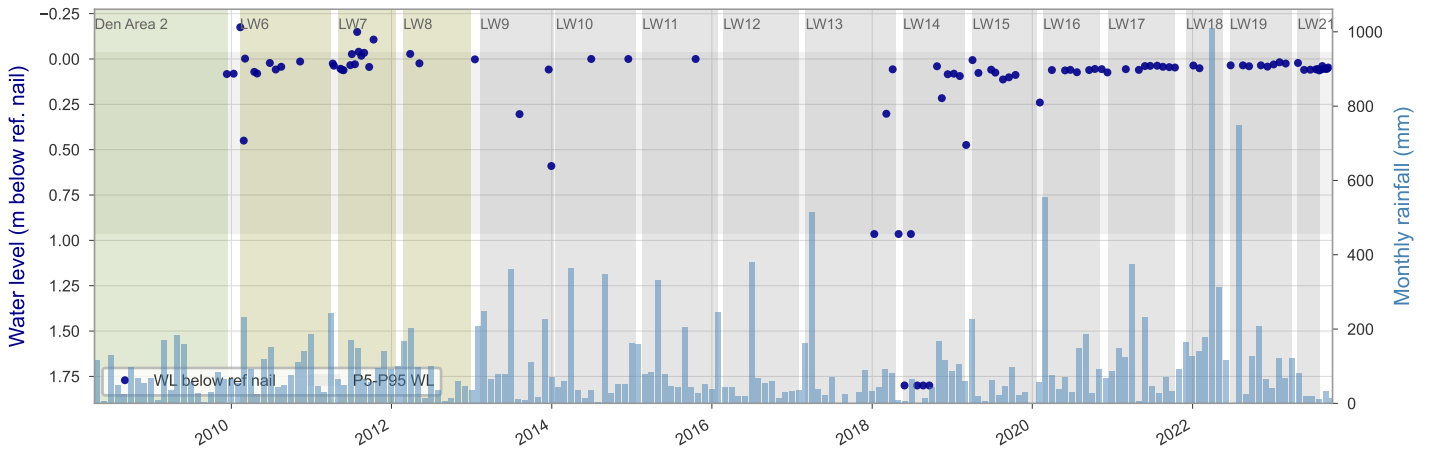
WC_POOL46



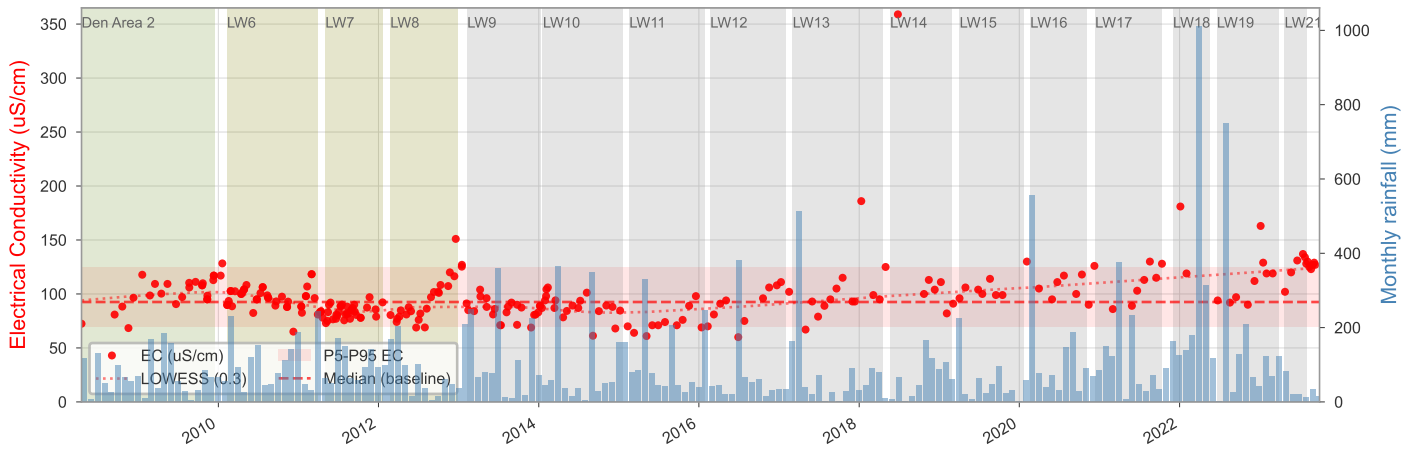
WC_POOL46



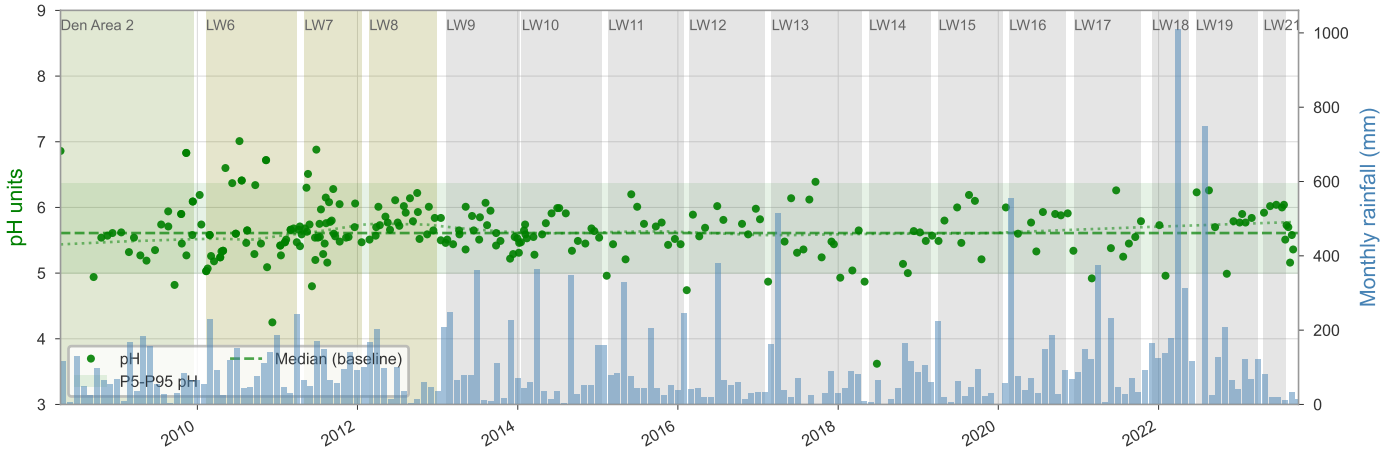
WC_POOL49



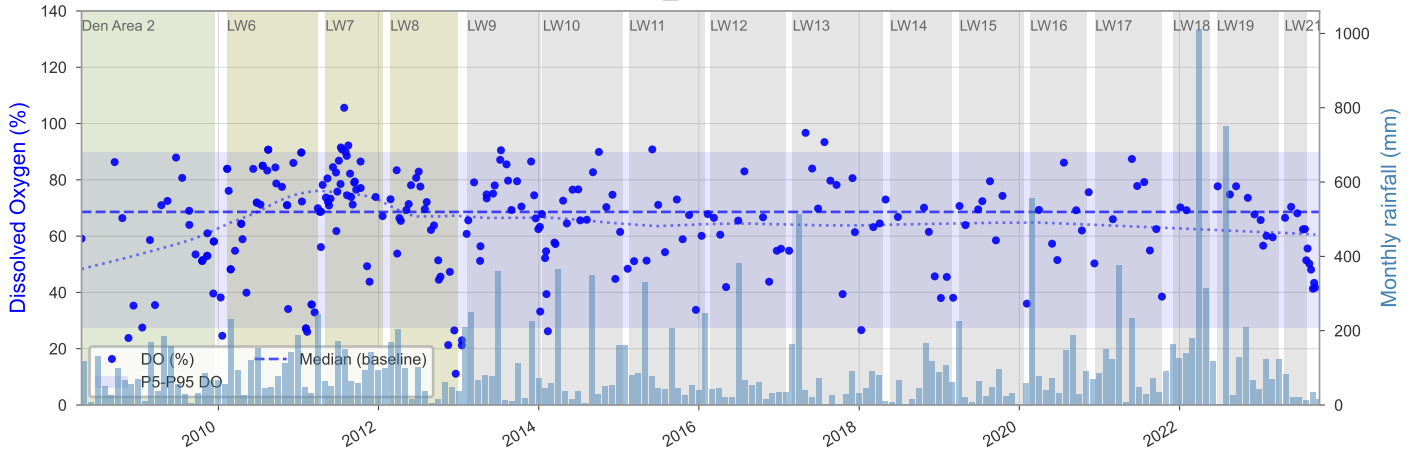
WC_POOL49



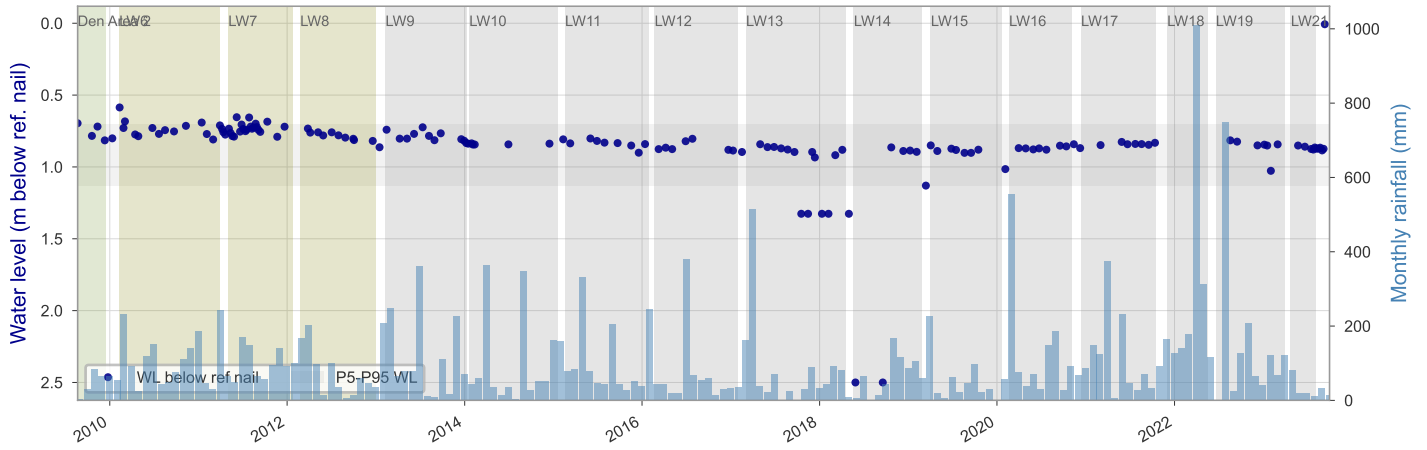
WC_POOL49



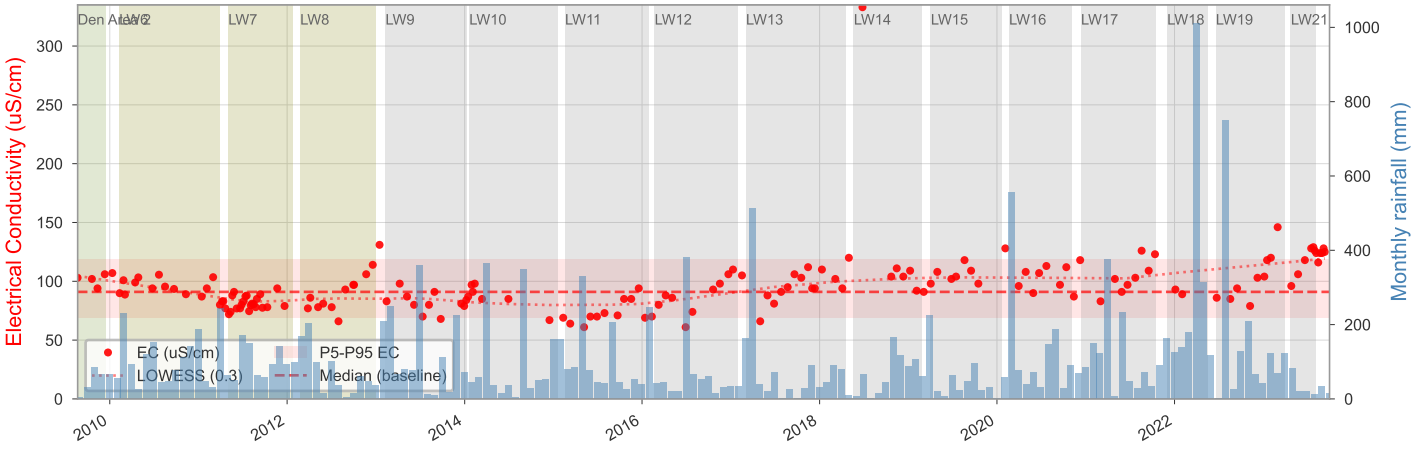
WC_POOL49



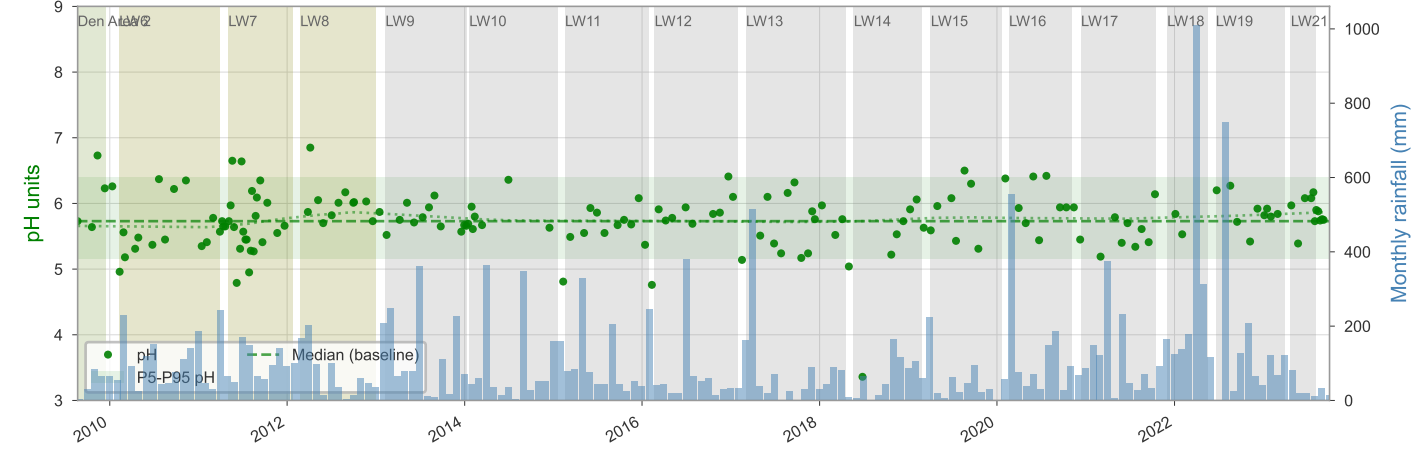
WC_POOL50



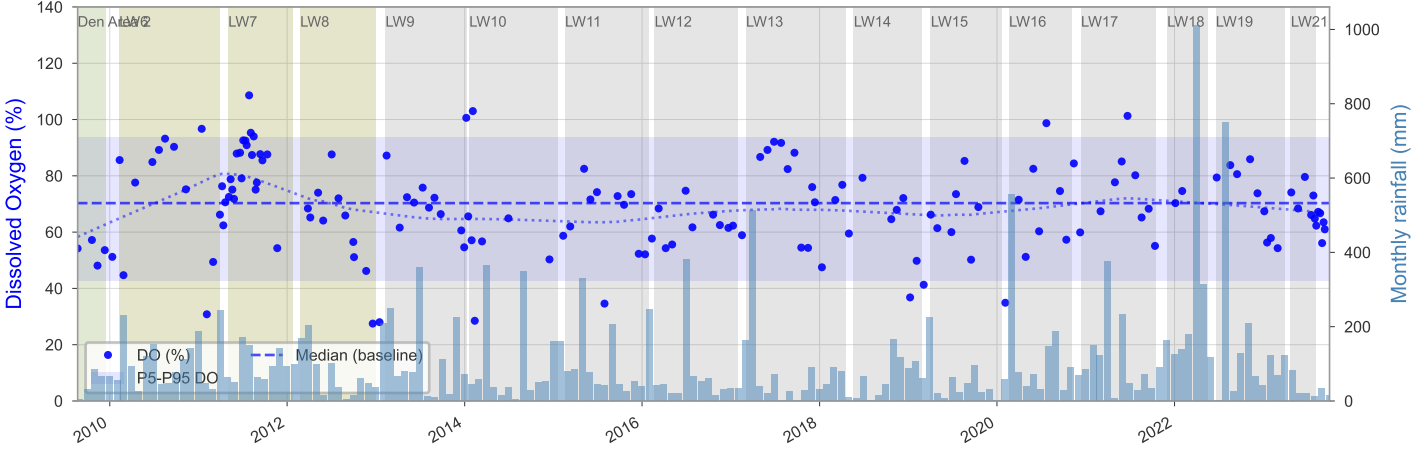
WC_POOL50



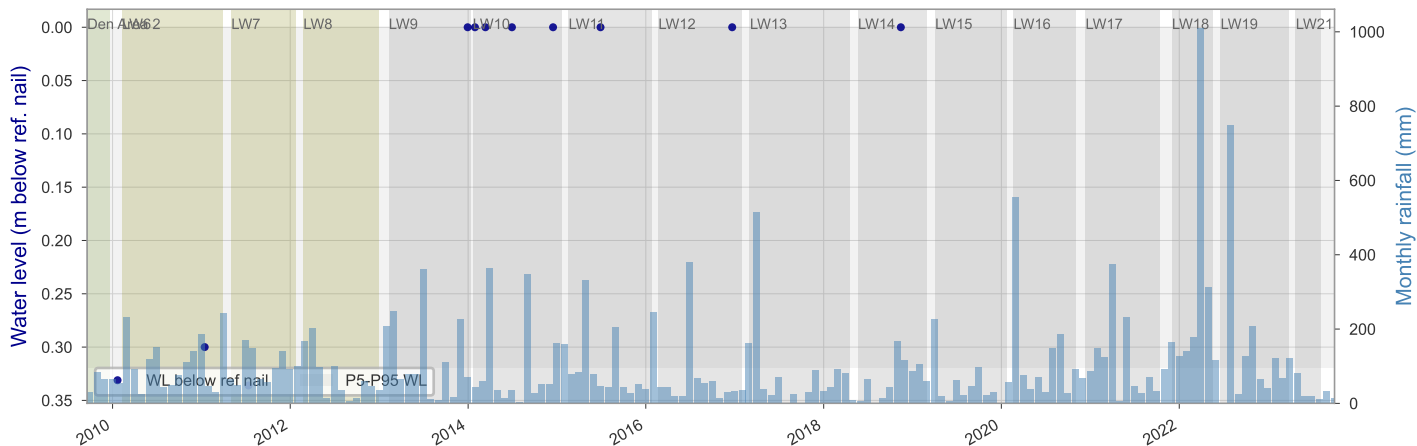
WC_POOL50



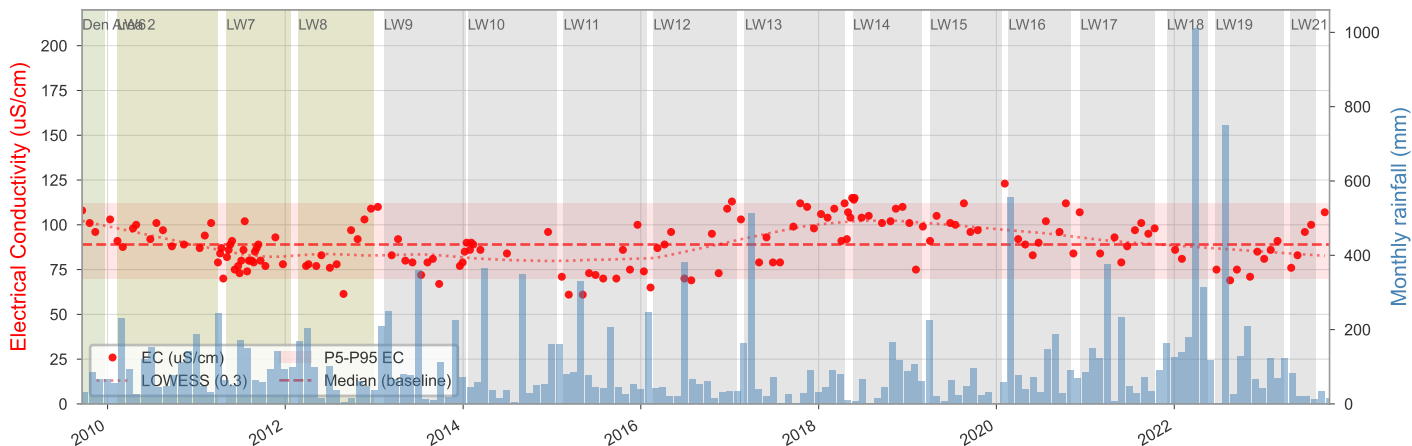
WC_POOL50



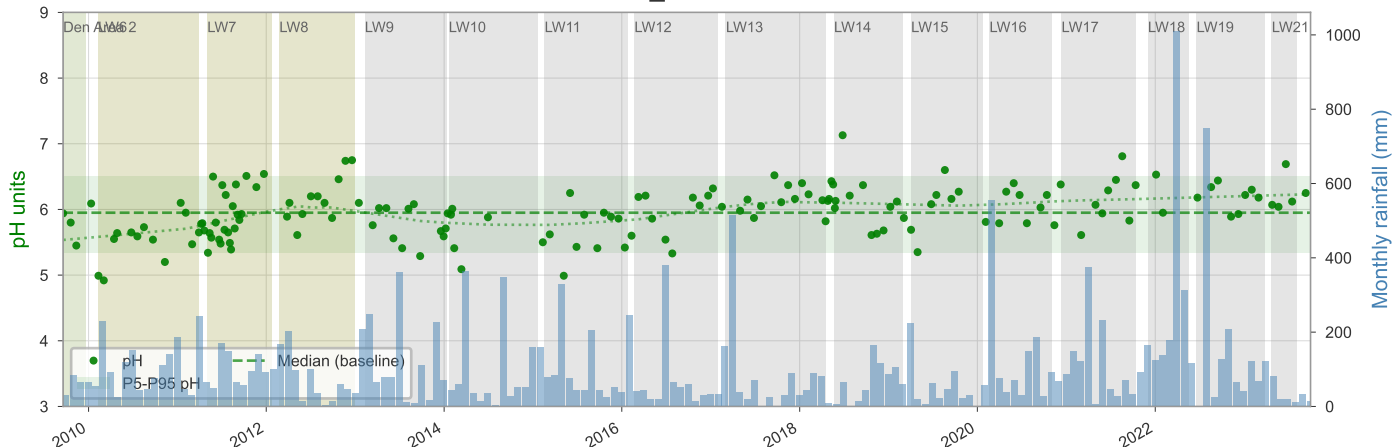
WC_POOL53



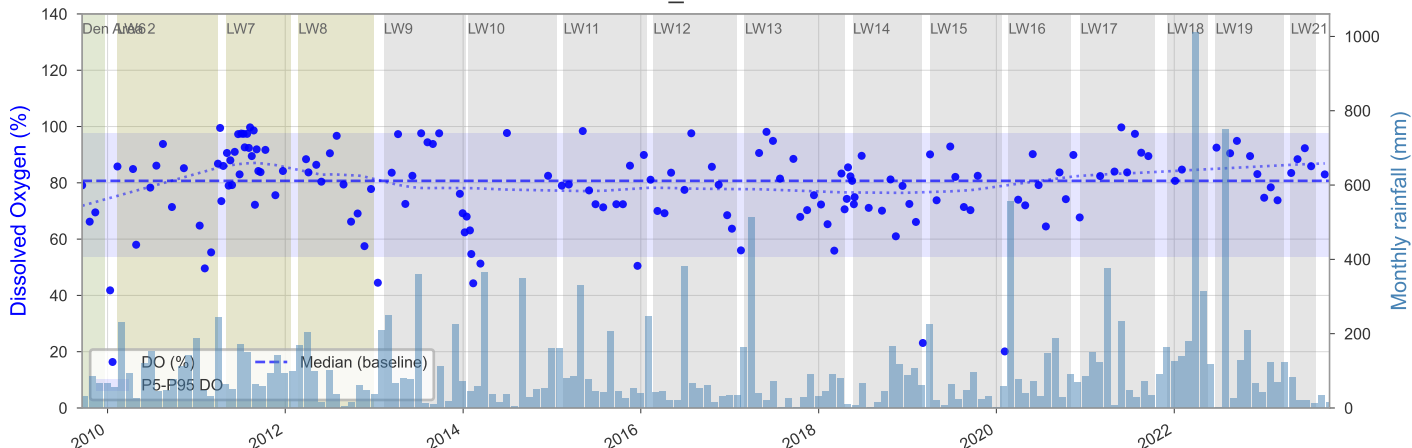
WC_POOL53



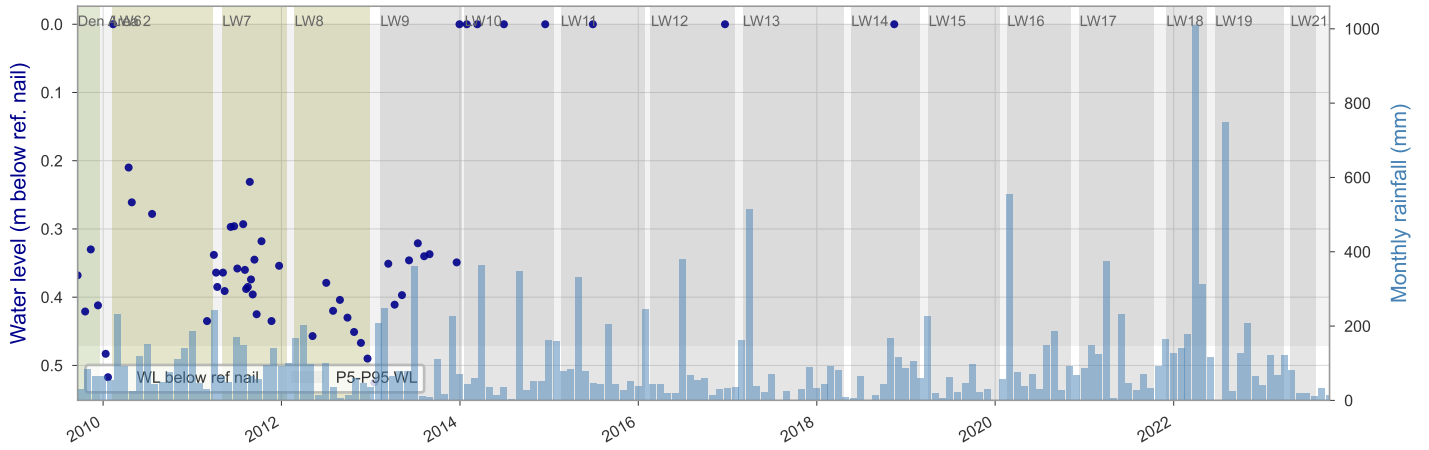
WC_POOL53



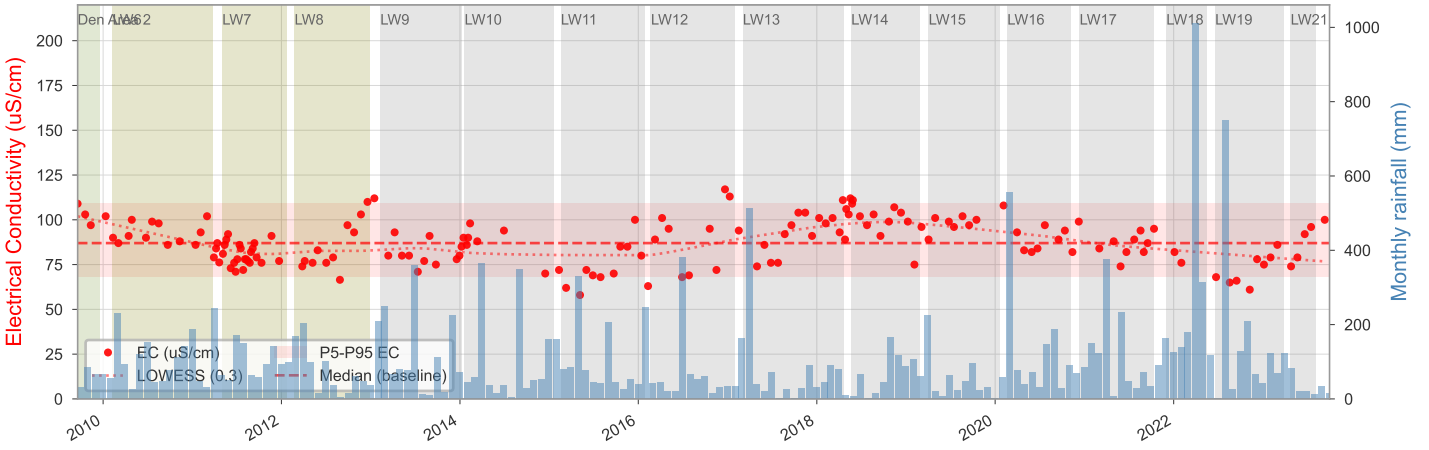
WC_POOL53



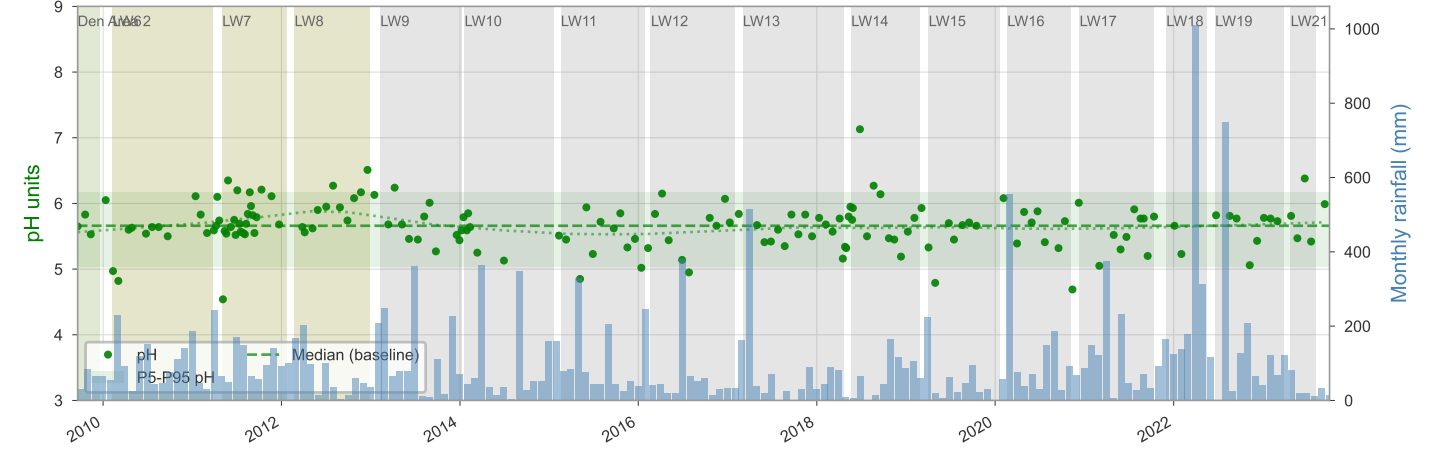
WC_POOL55



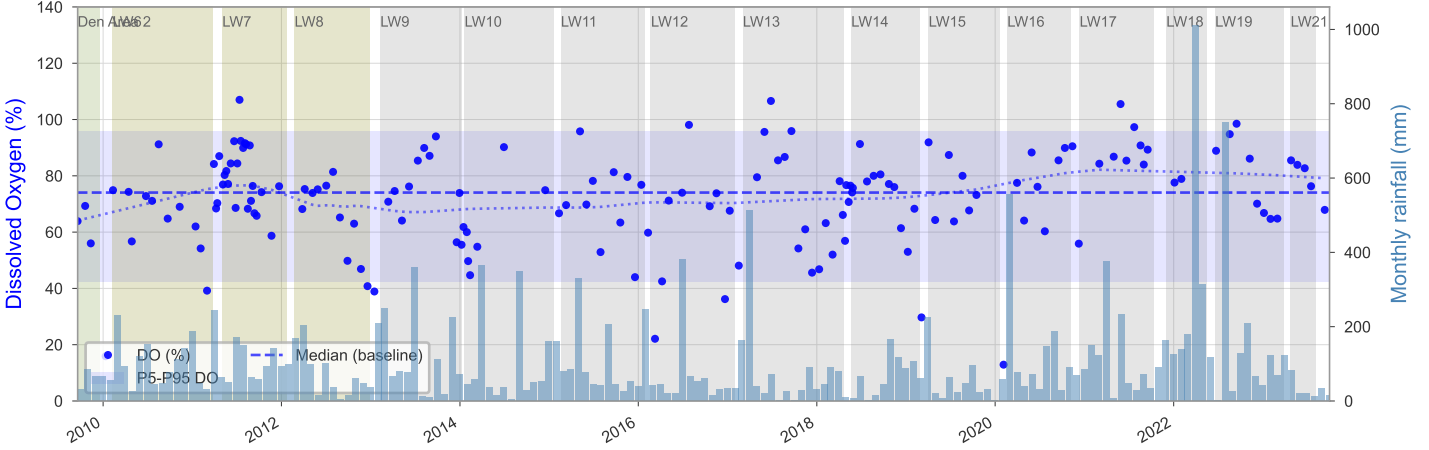
WC_POOL55



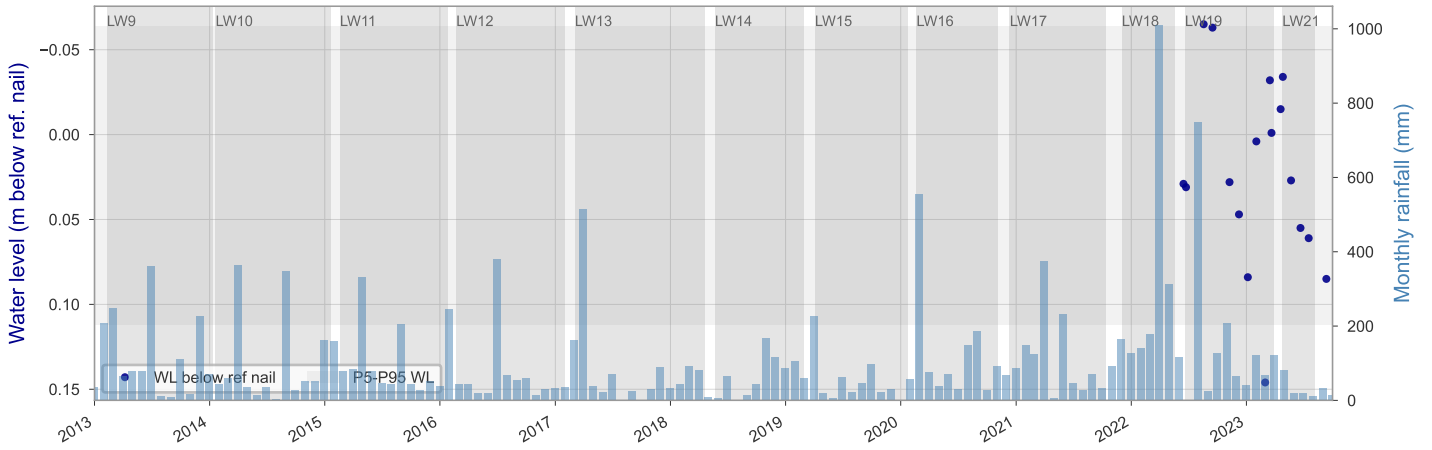
WC_POOL55



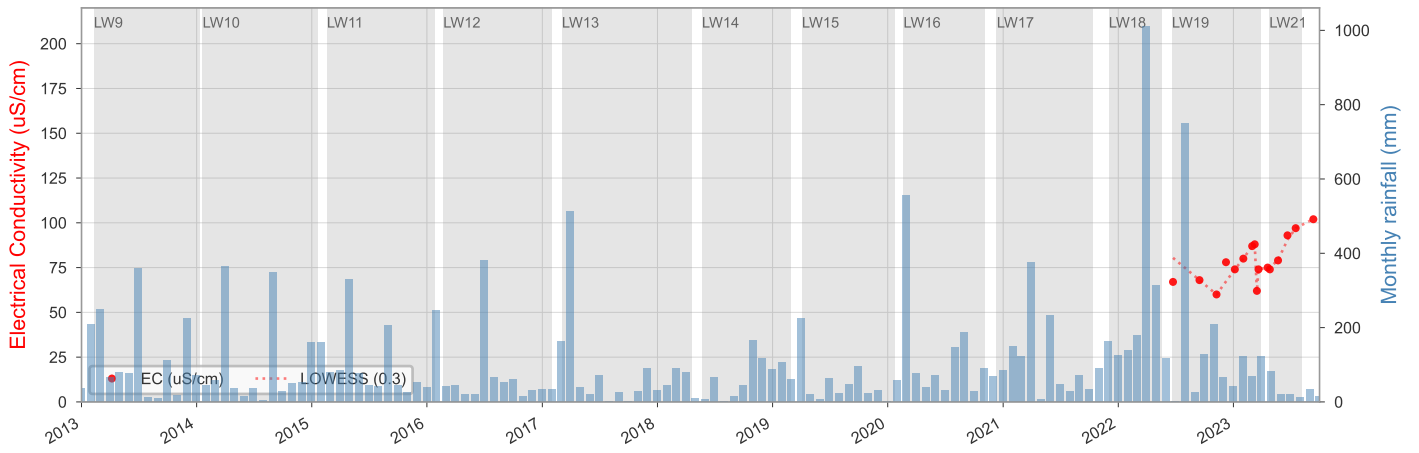
WC_POOL55



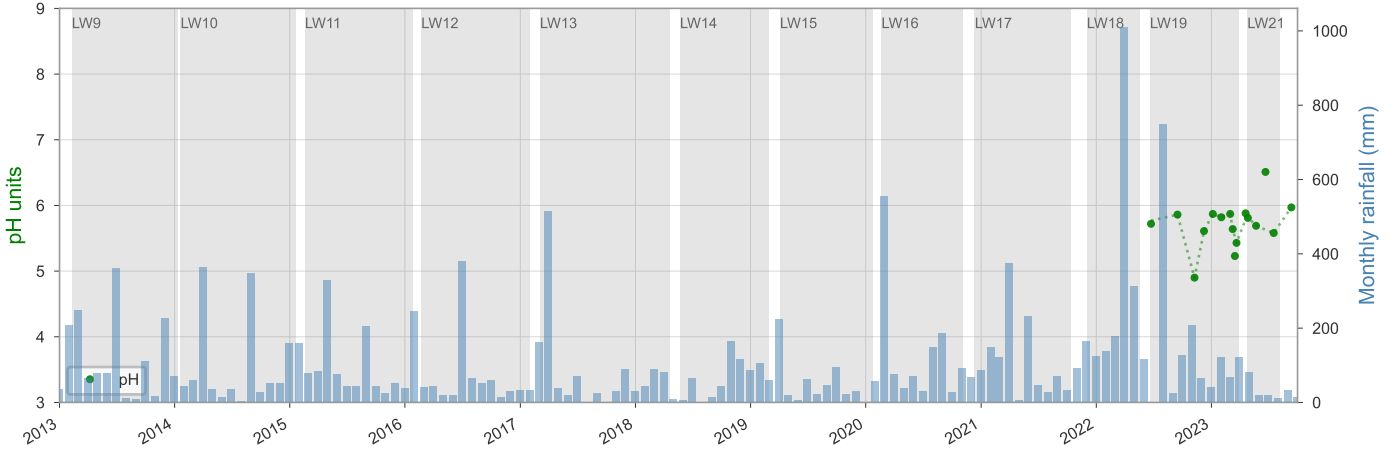
WC_POOL59



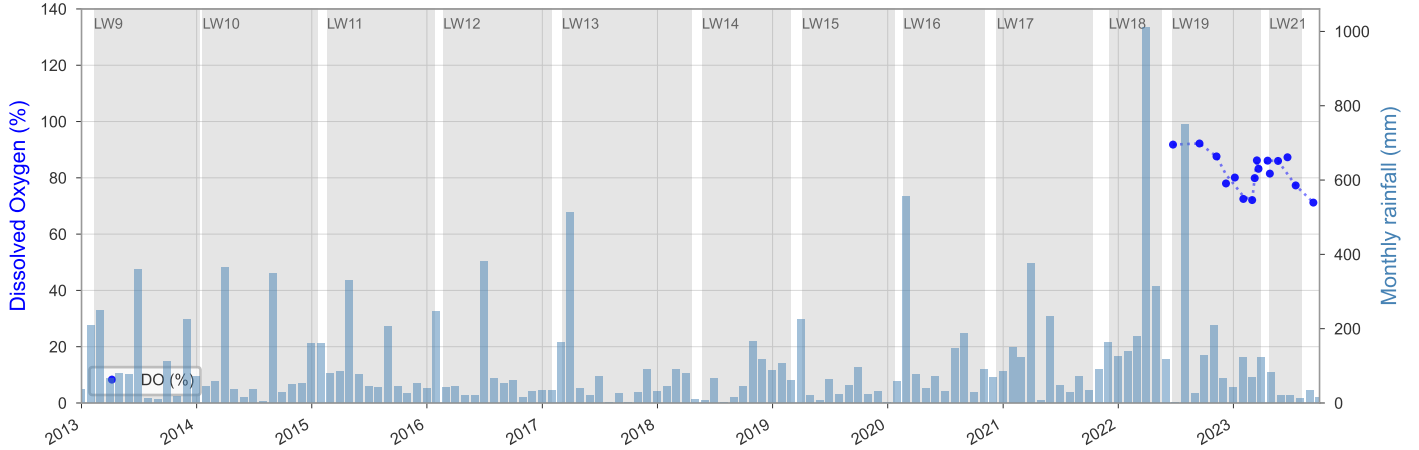
WC_POOL59



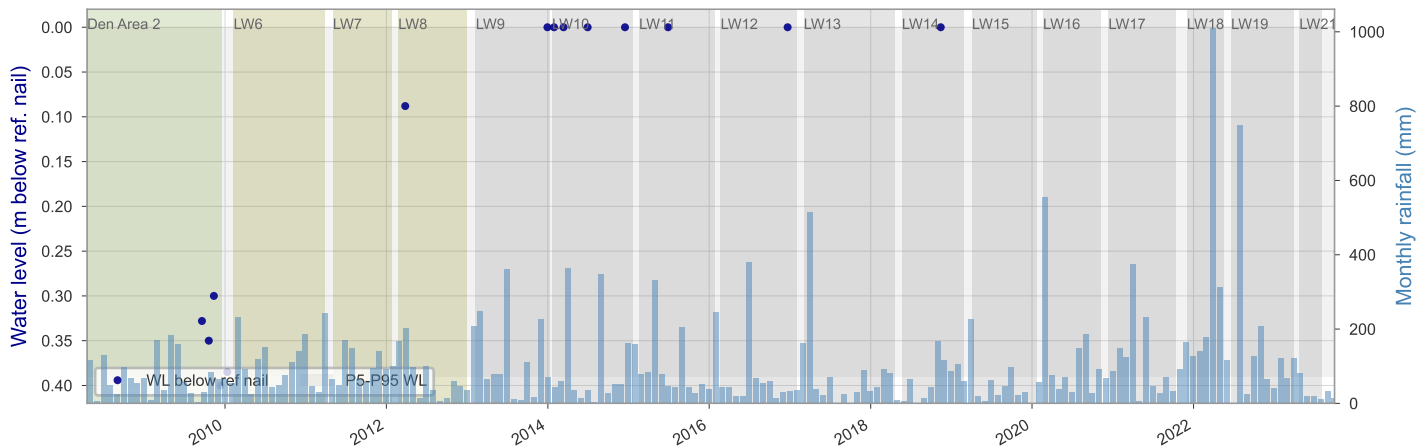
WC_POOL59



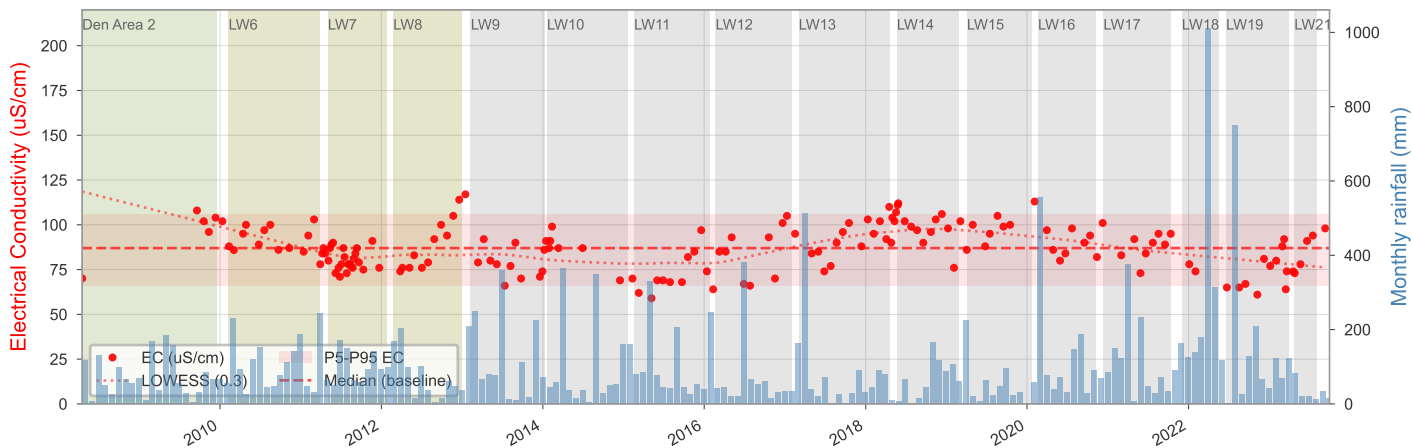
WC_POOL59



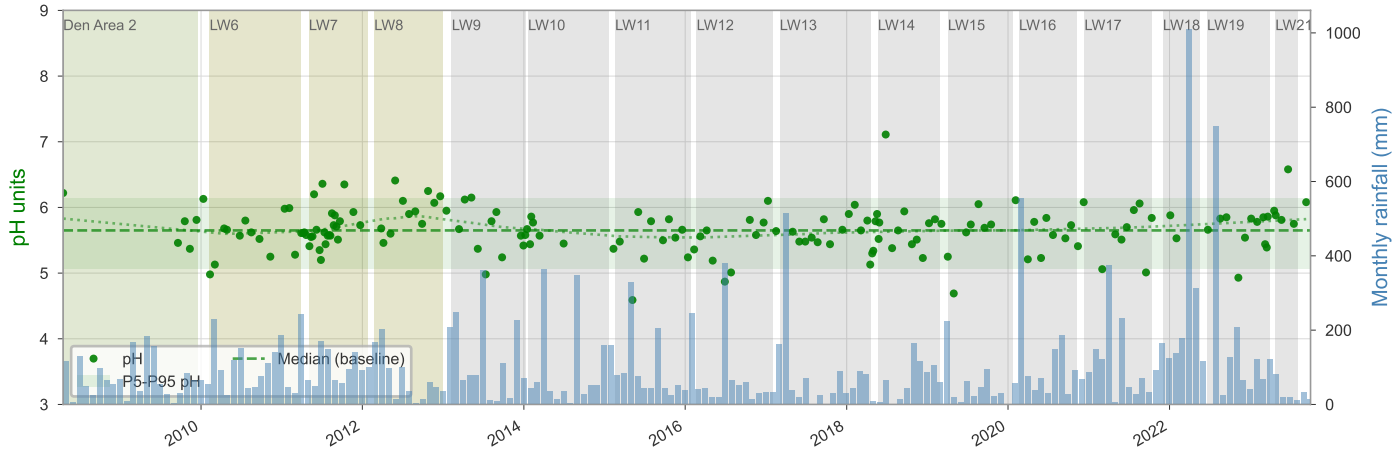
WC_POOL69



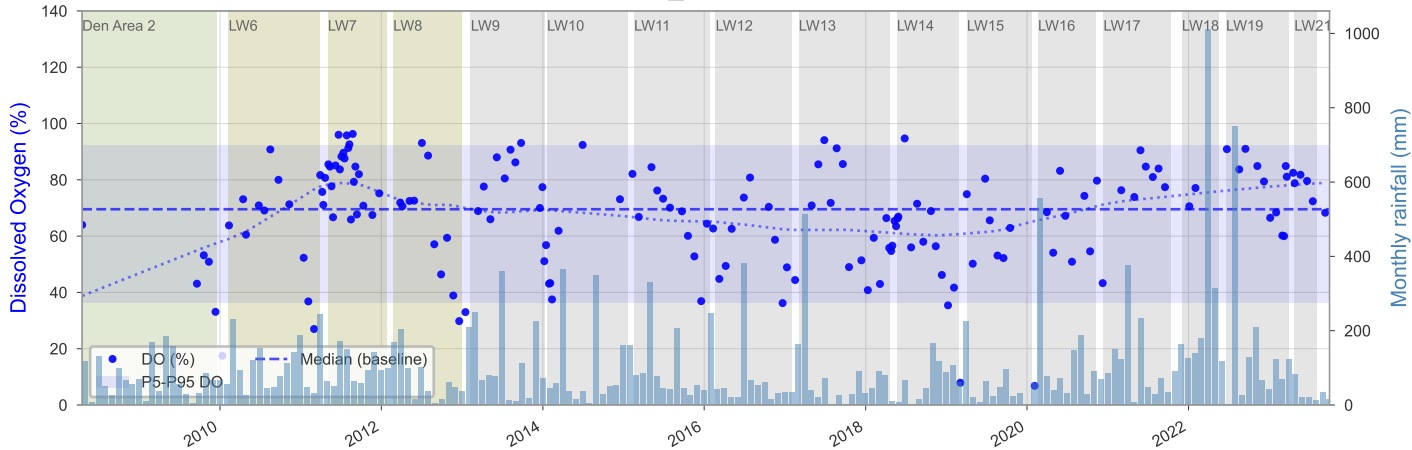
WC_POOL69



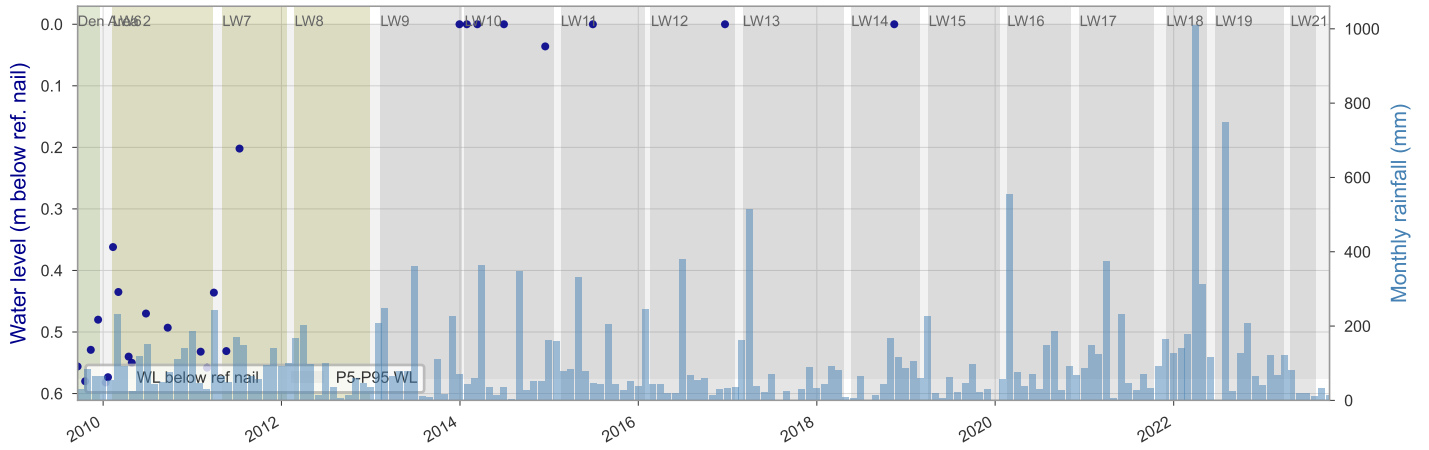
WC_POOL69



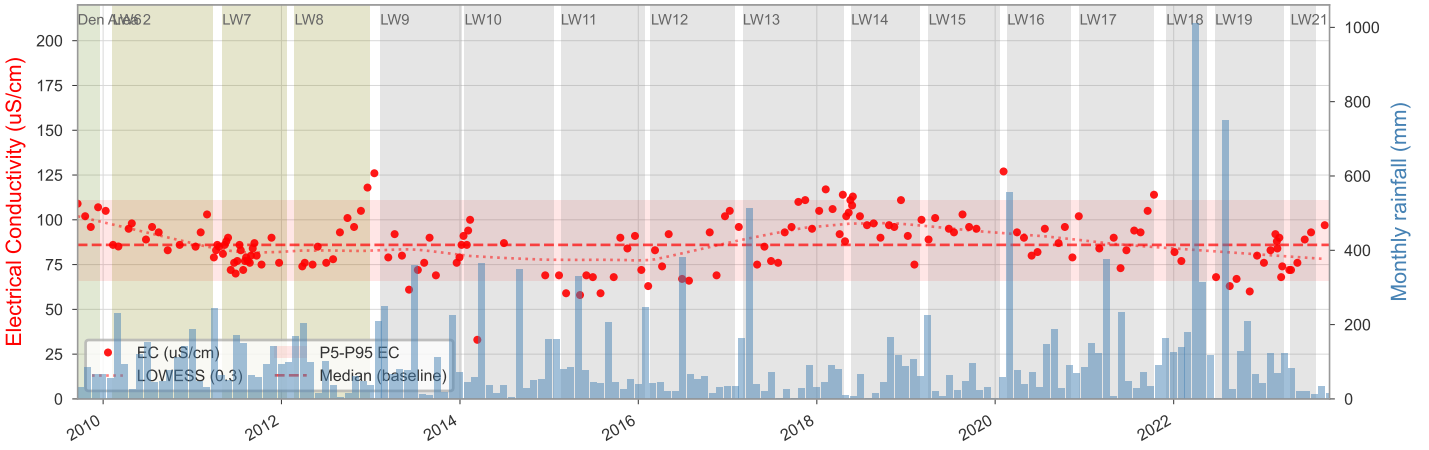
WC_POOL69



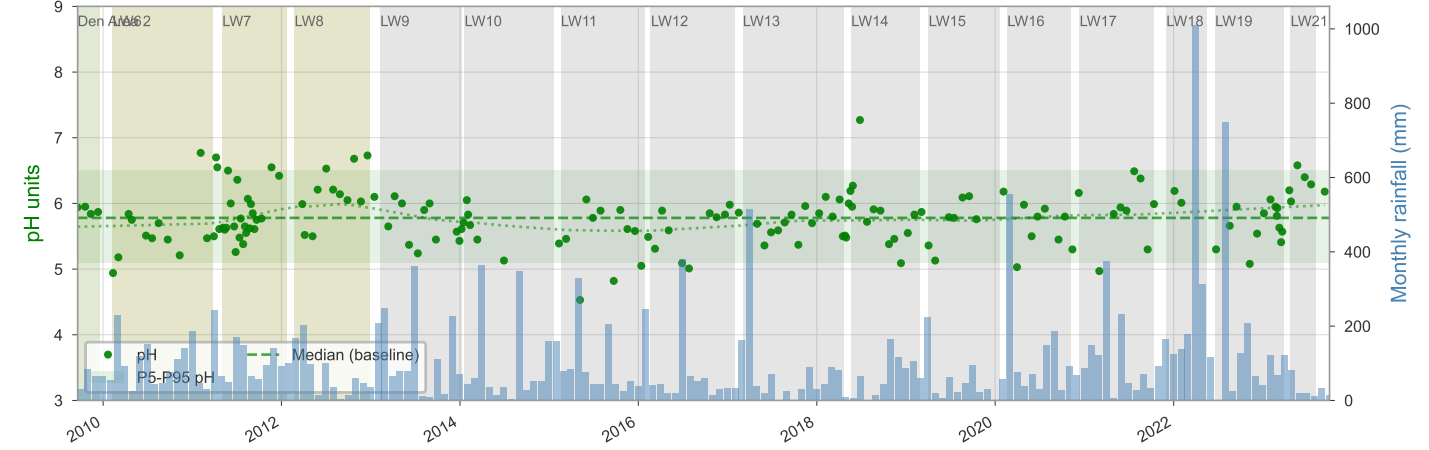
WC_POOL72A



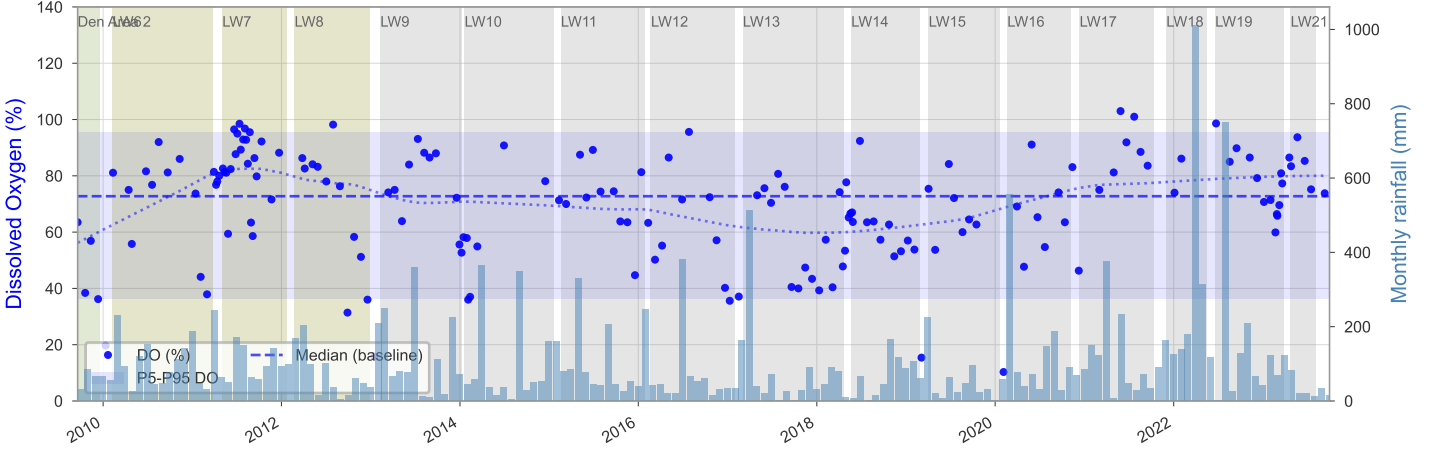
WC_POOL72A



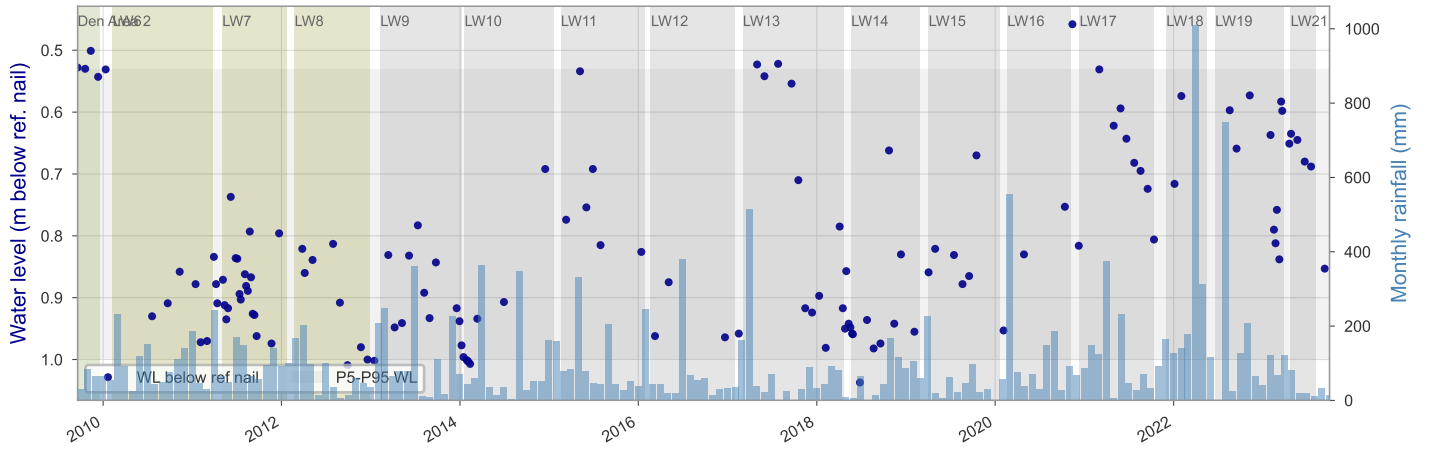
WC_POOL72A



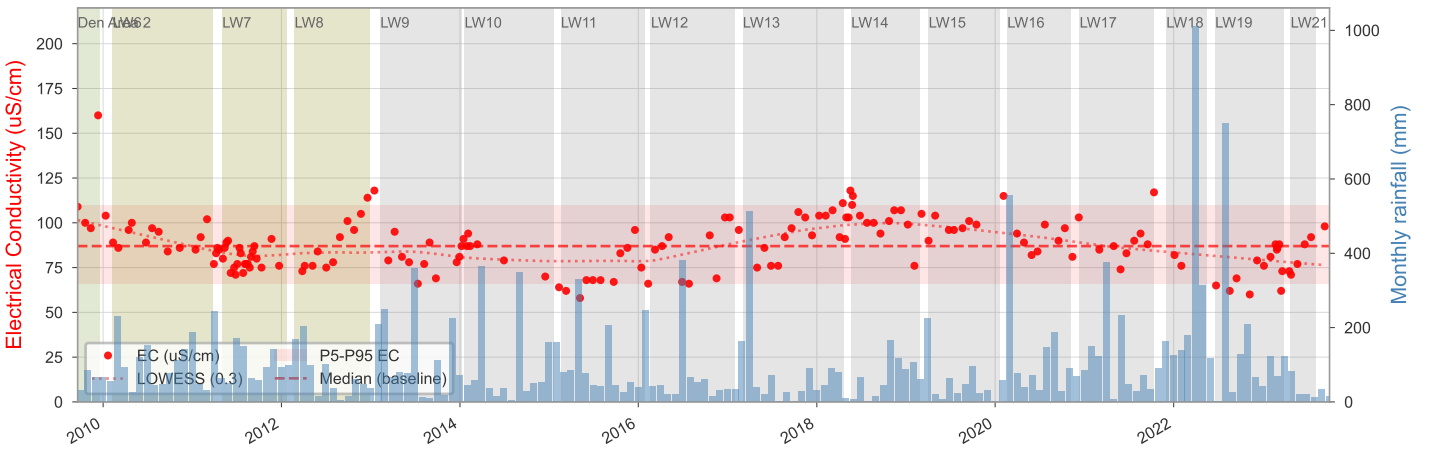
WC_POOL72A



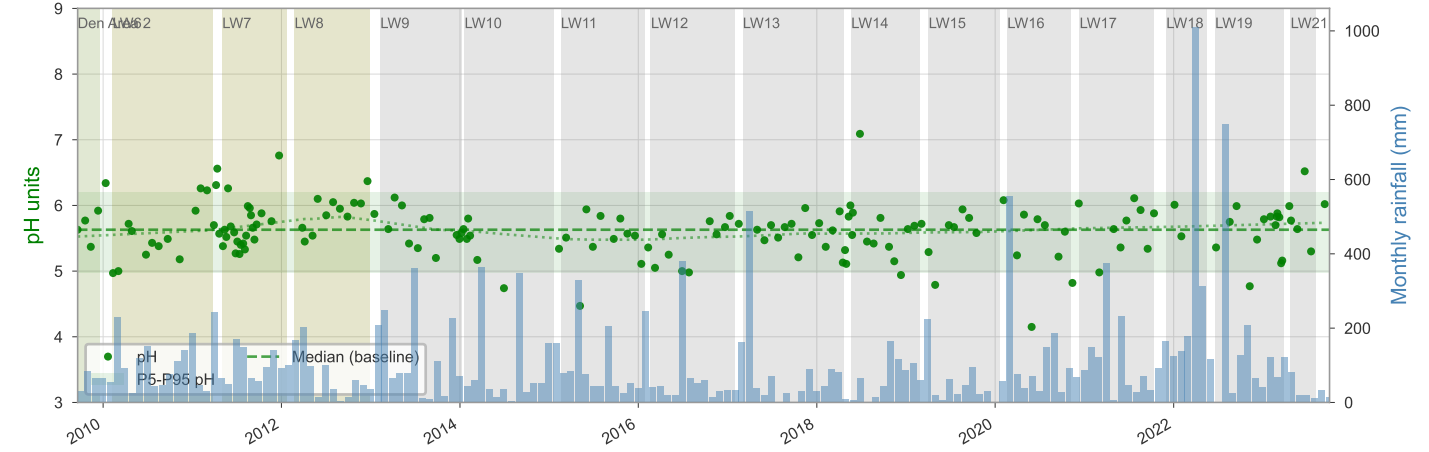
WC_POOL72B



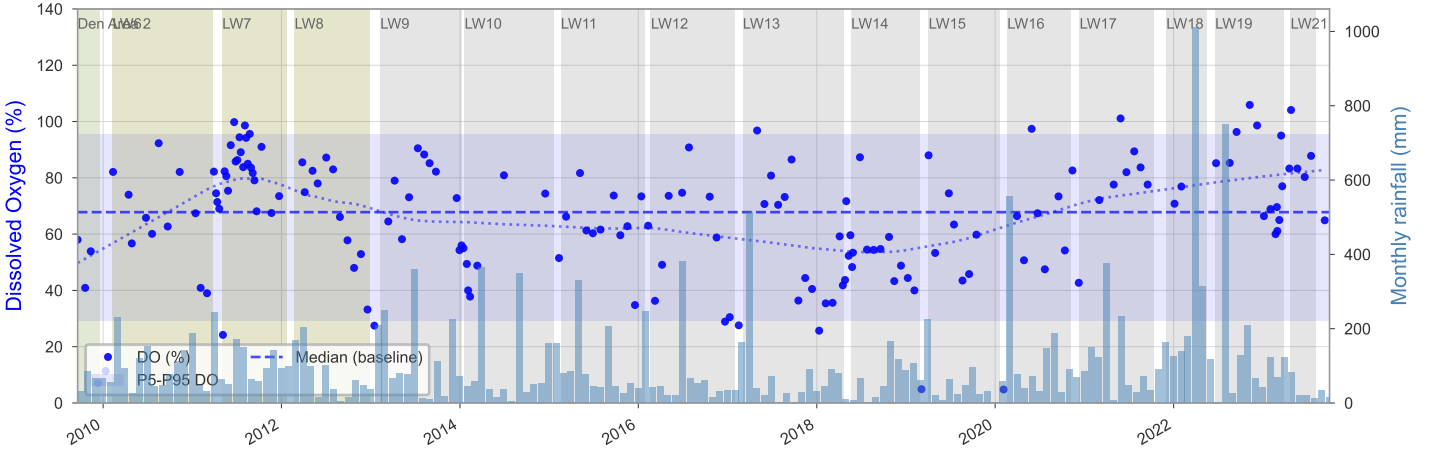
WC_POOL72B



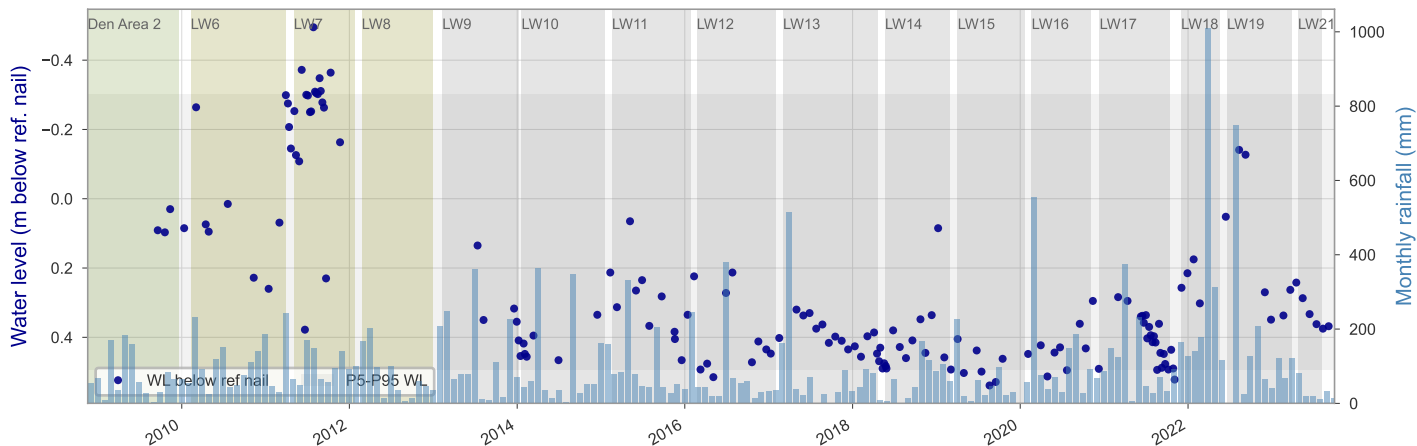
WC_POOL72B



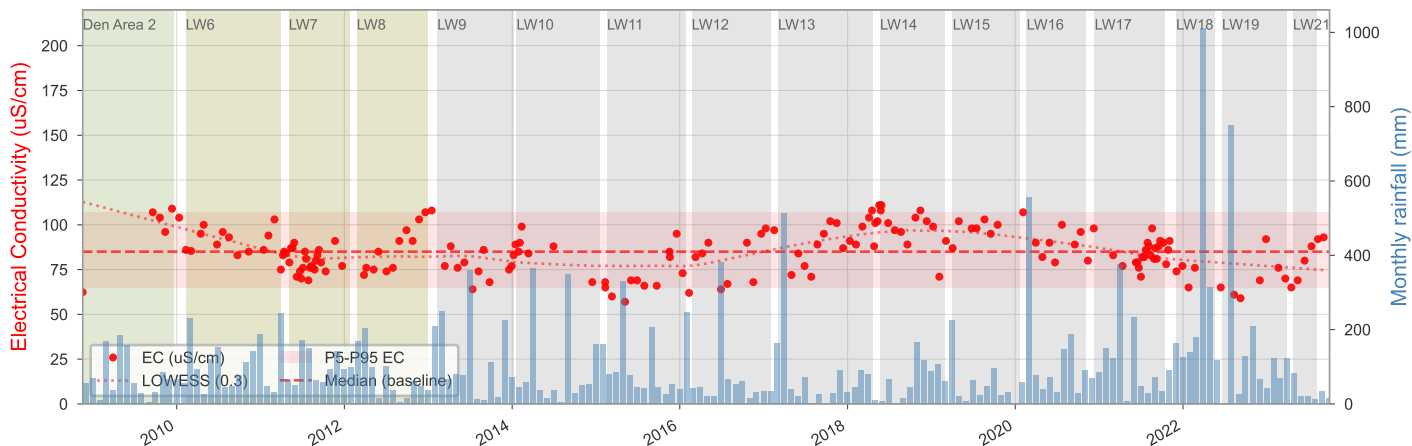
WC_POOL72B



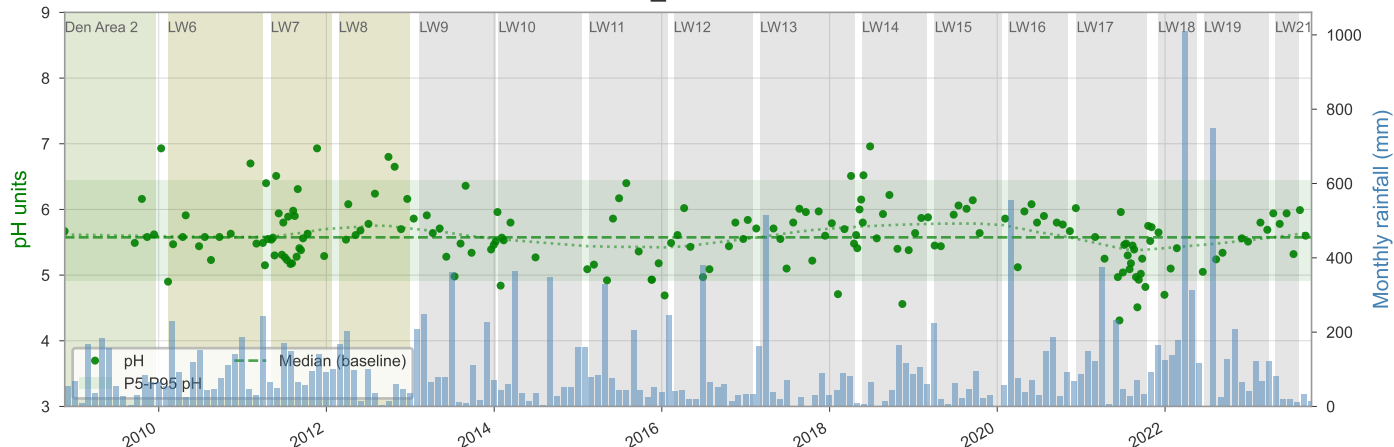
WC_POOL87



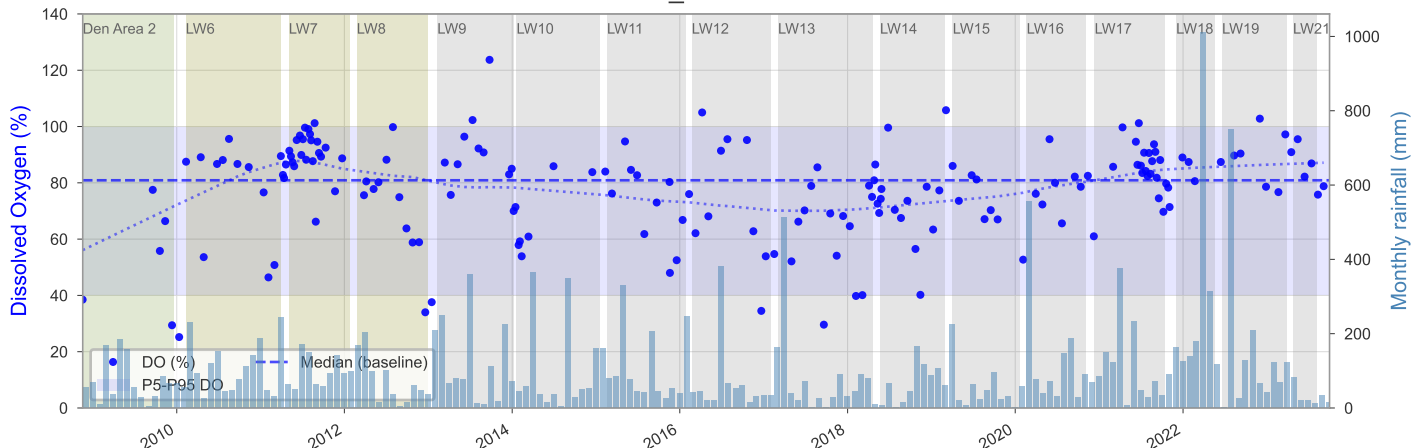
WC_POOL87



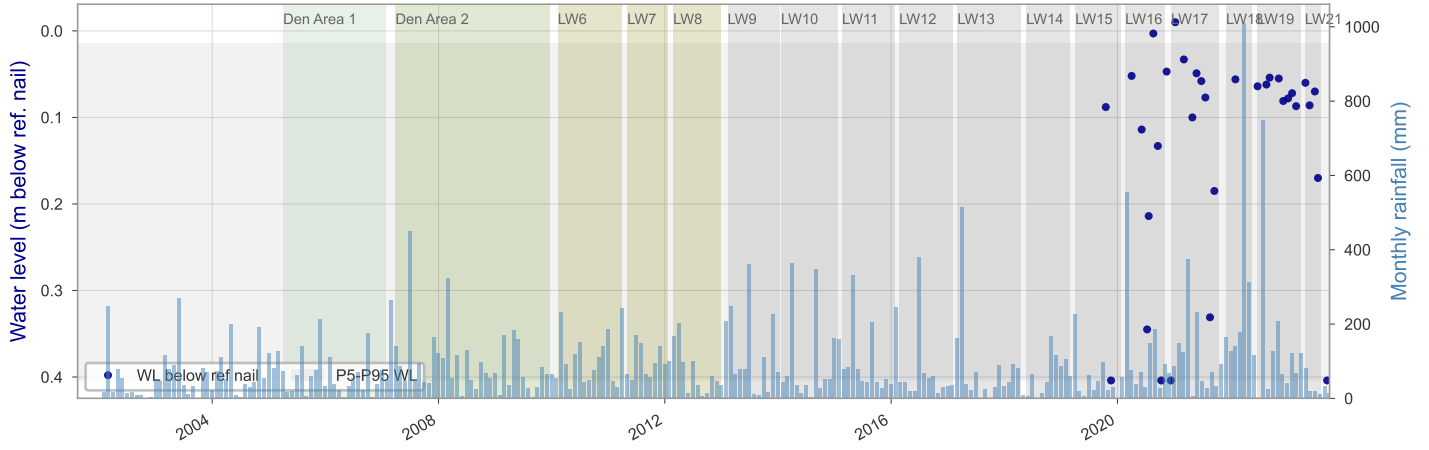
WC_POOL87



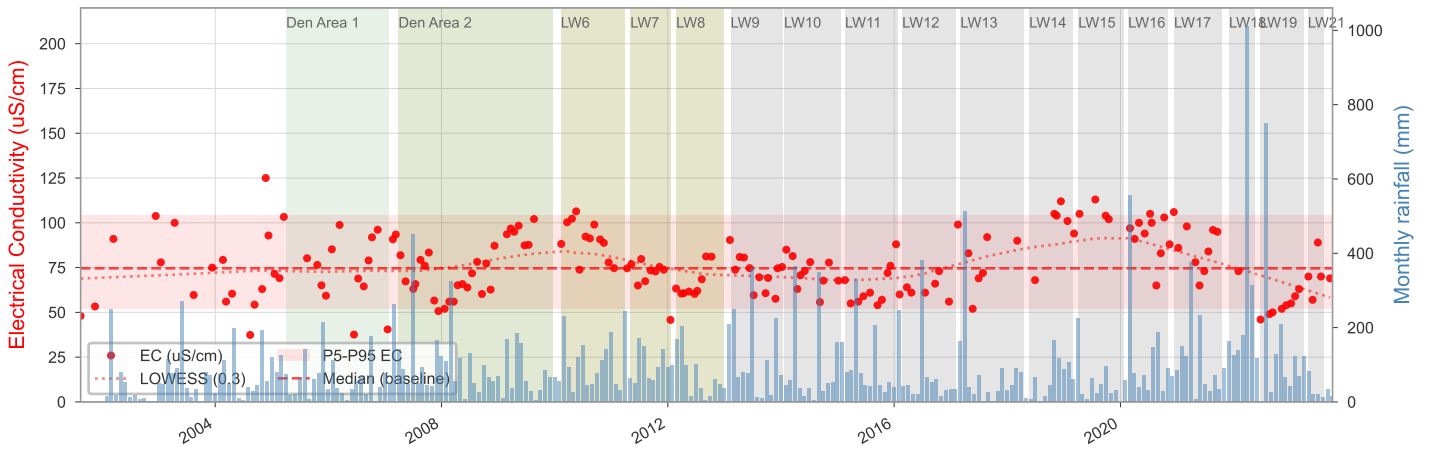
WC_POOL87



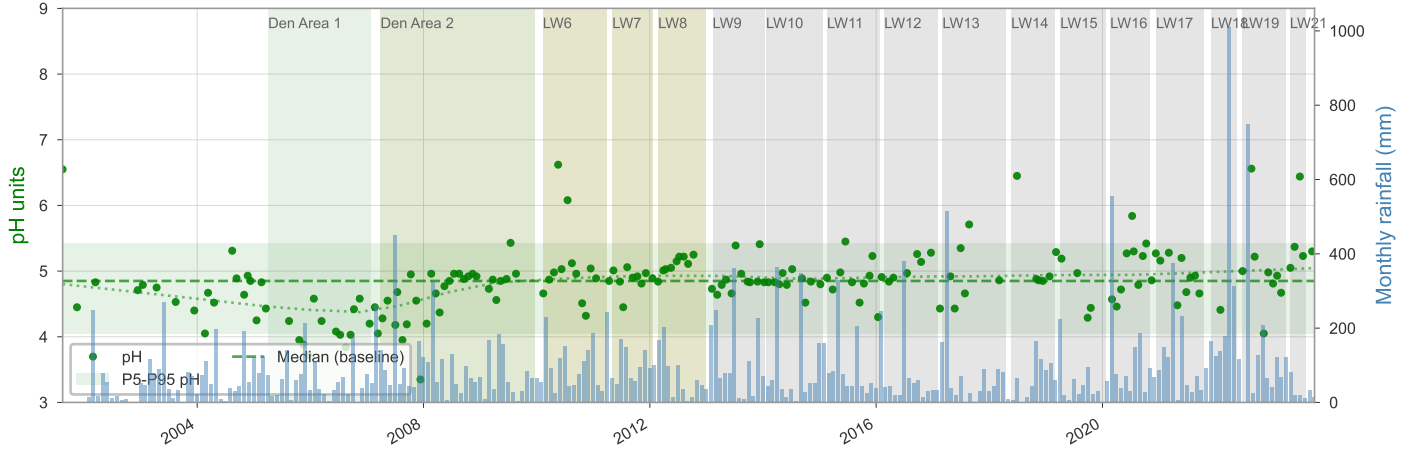
WWU1



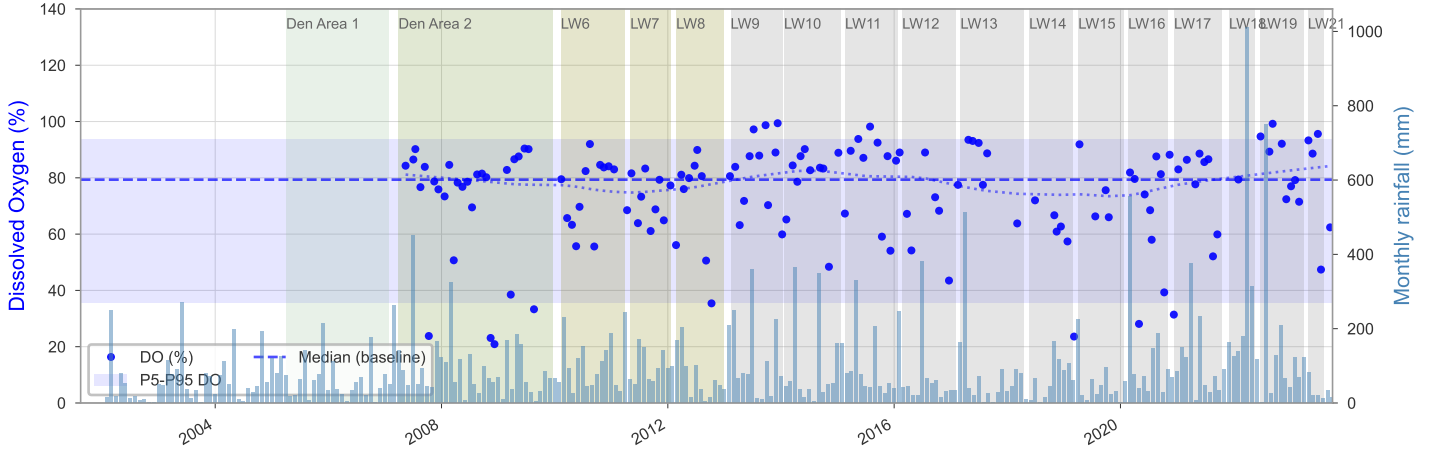
WWU1



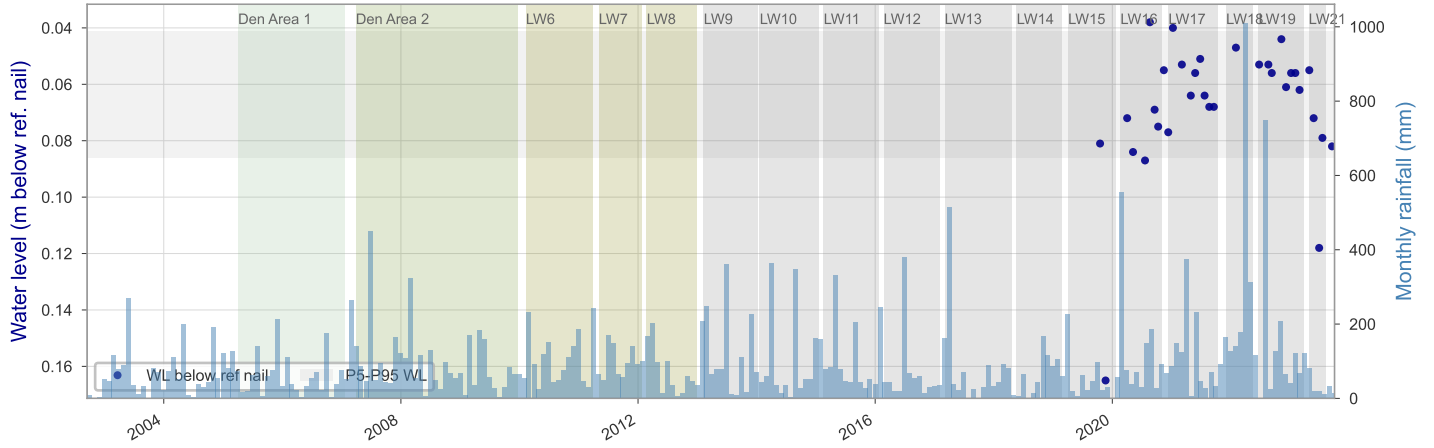
WWU1



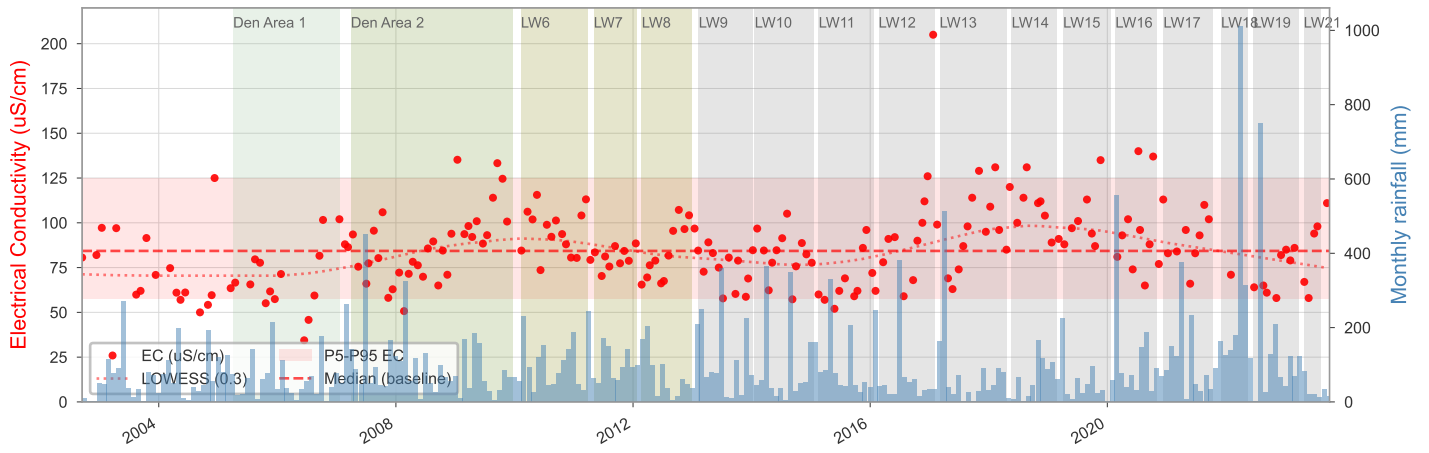
WWU1



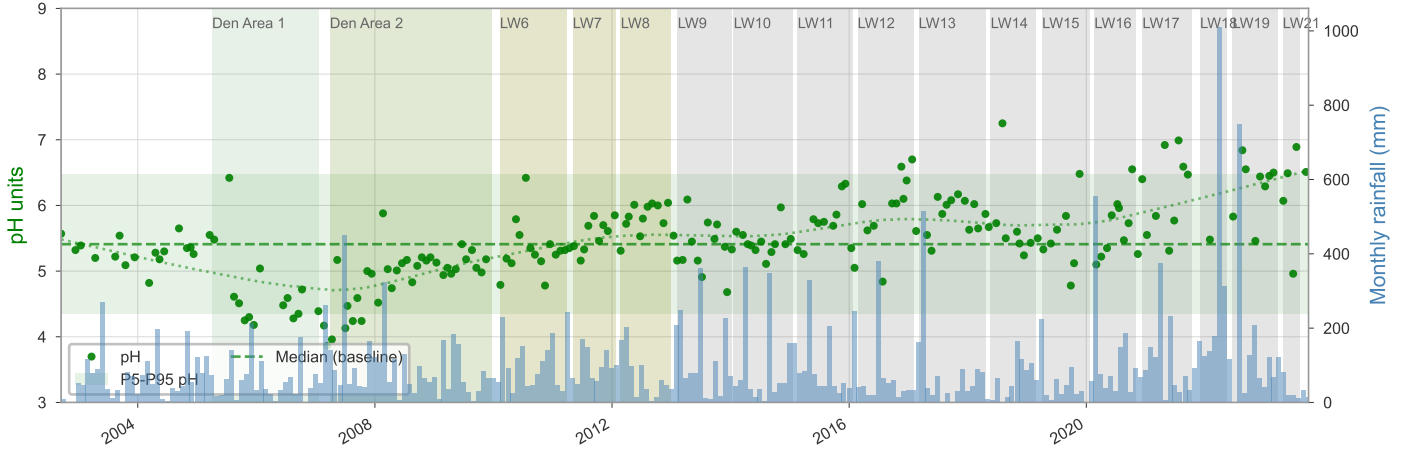
WWU4



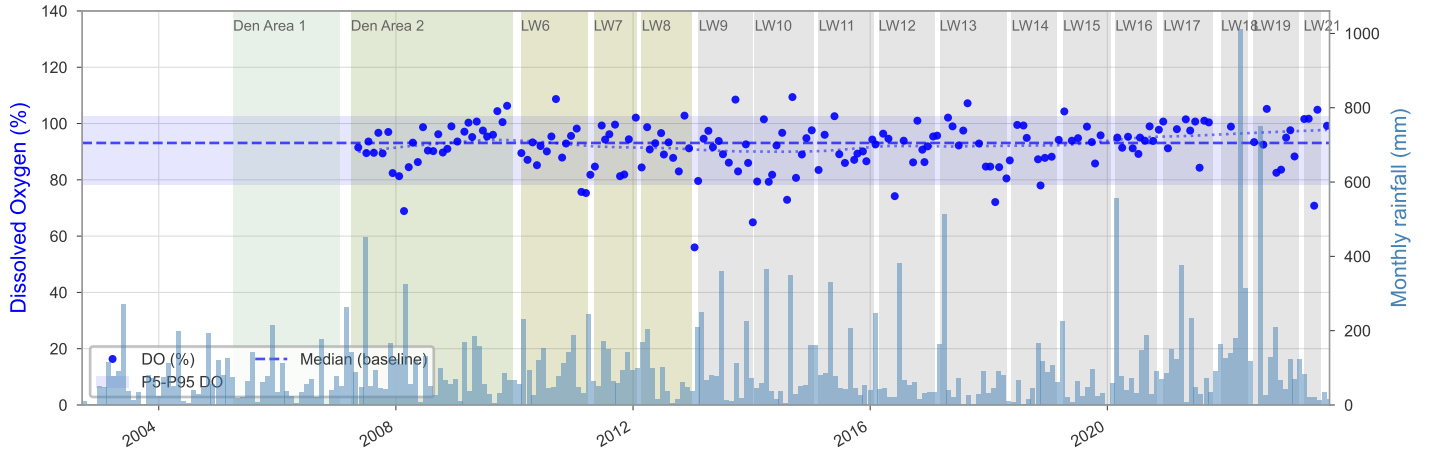
WWU4

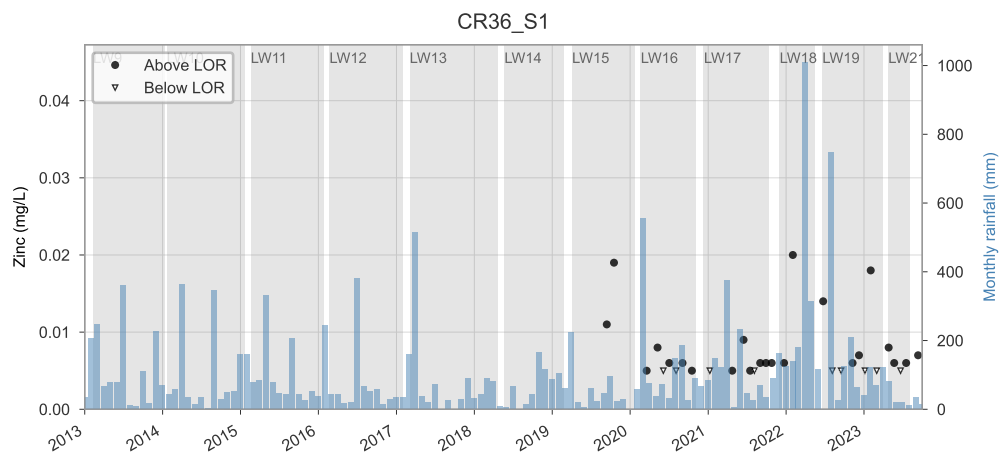
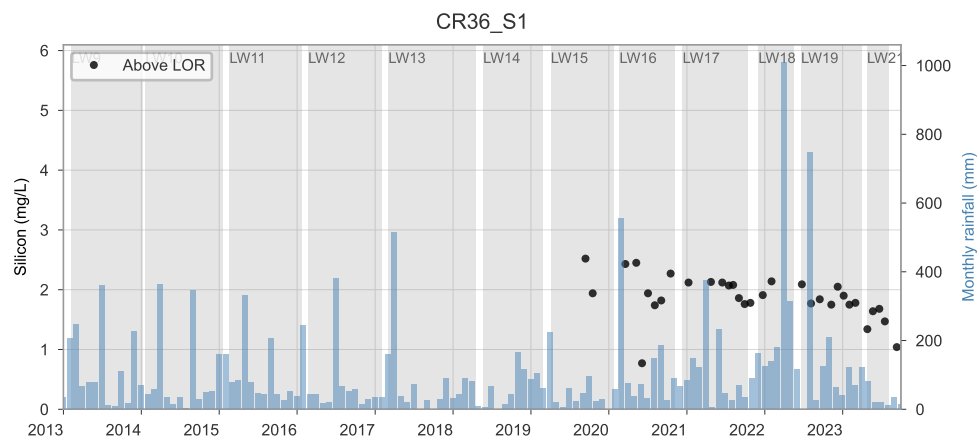
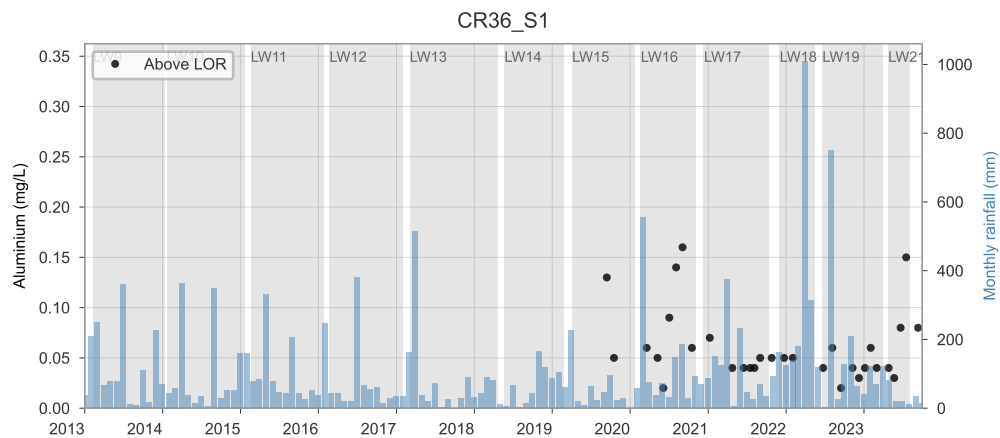
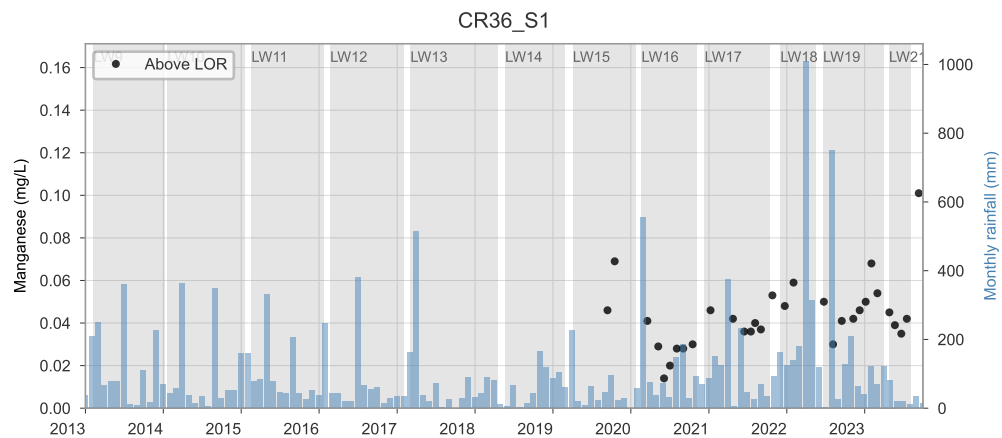
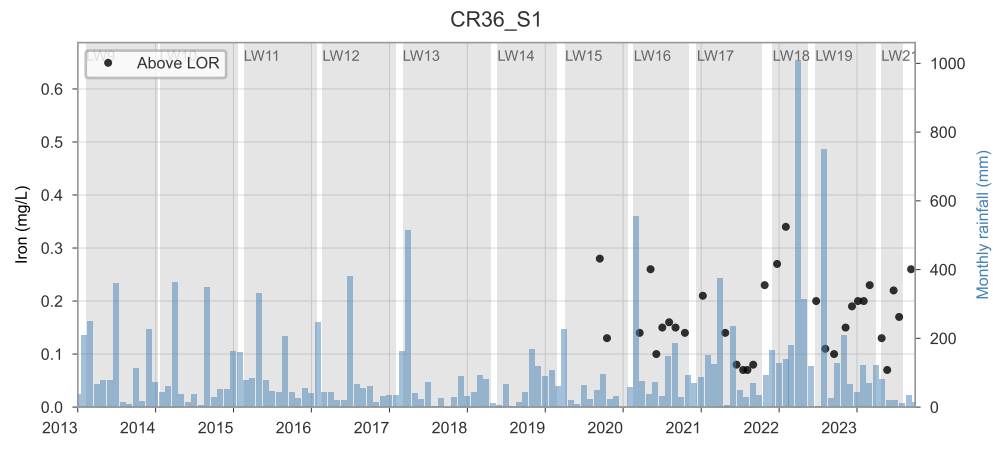
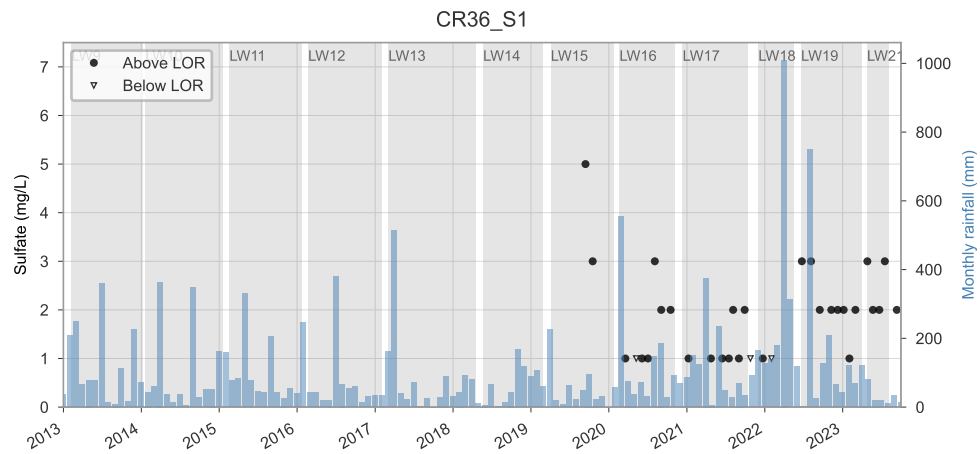


WWU4

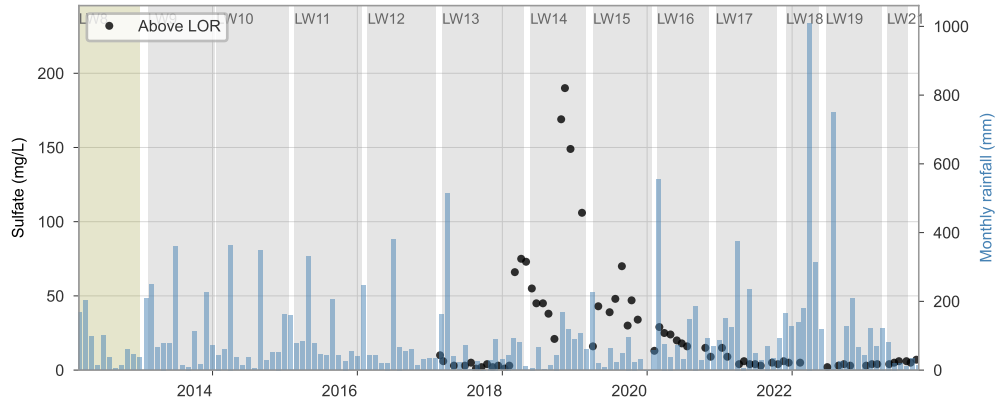


WWU4

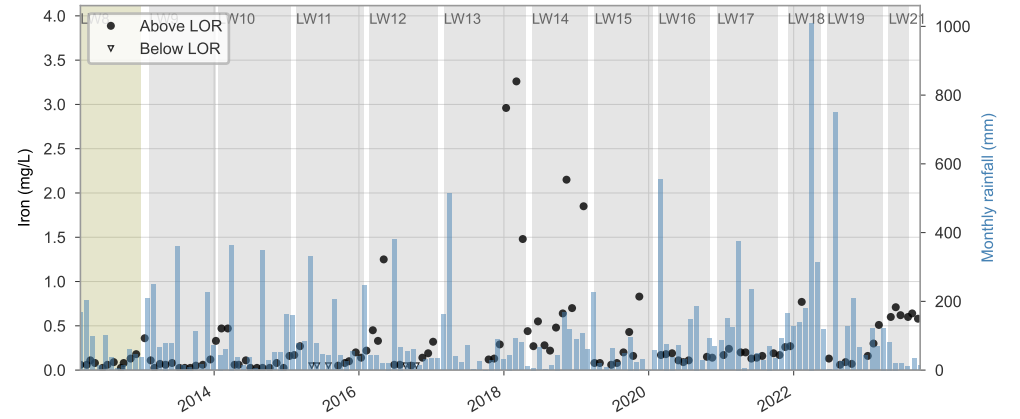




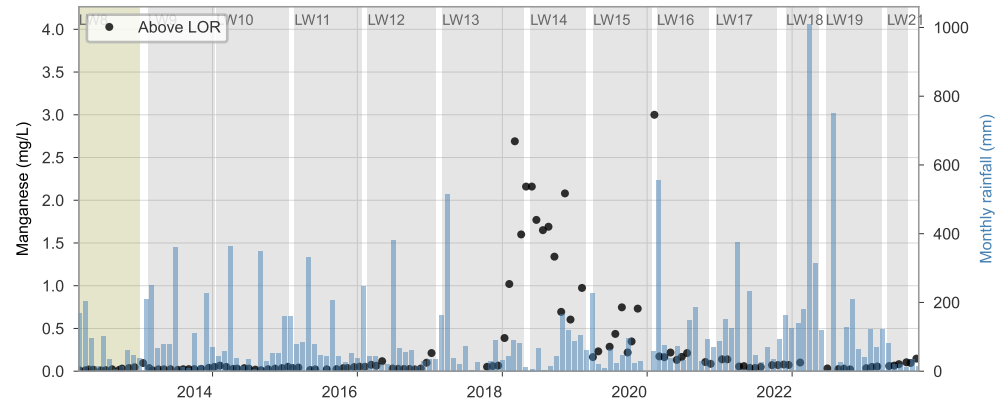
DC13_POOL2B



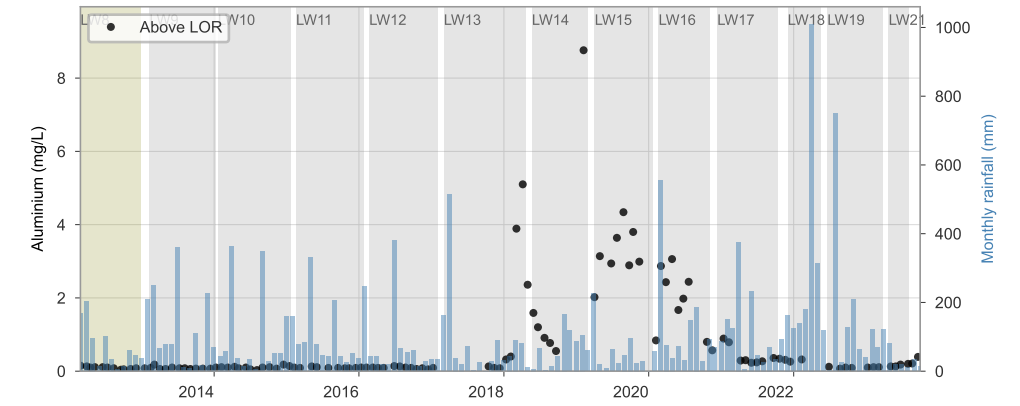
DC13_POOL2B



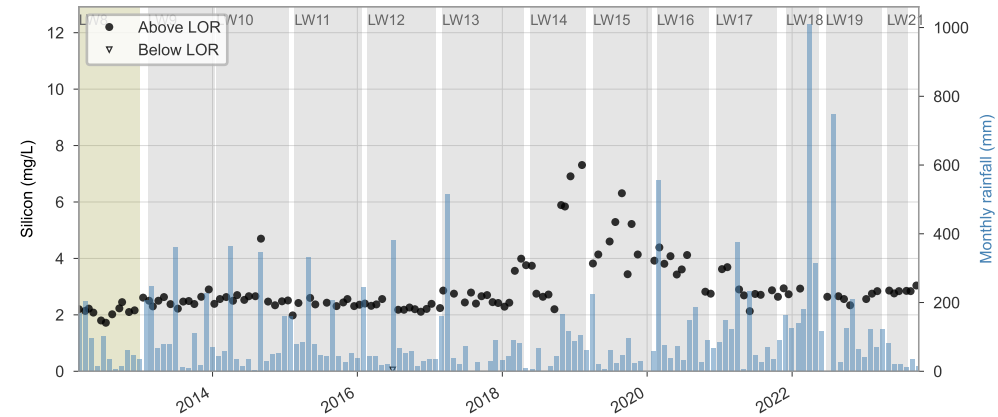
DC13_POOL2B



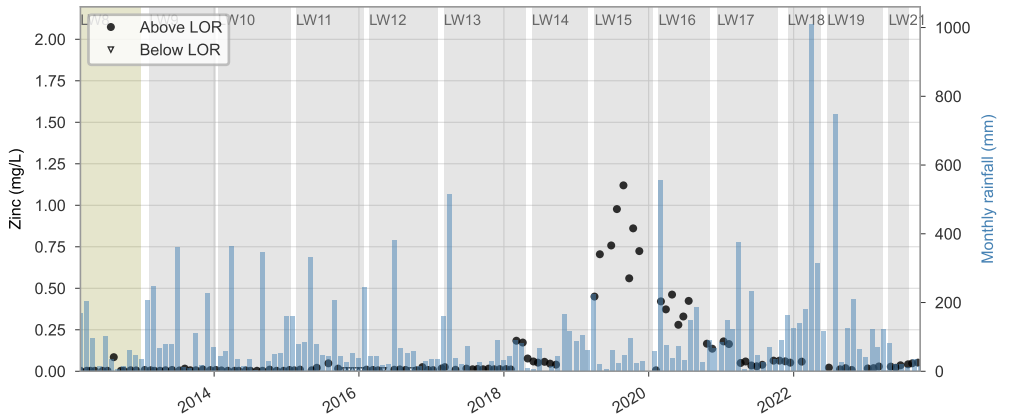
DC13_POOL2B



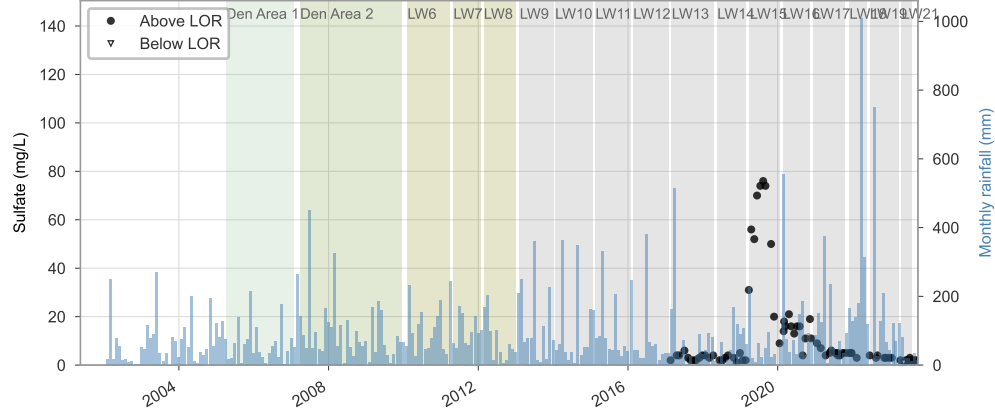
DC13_POOL2B



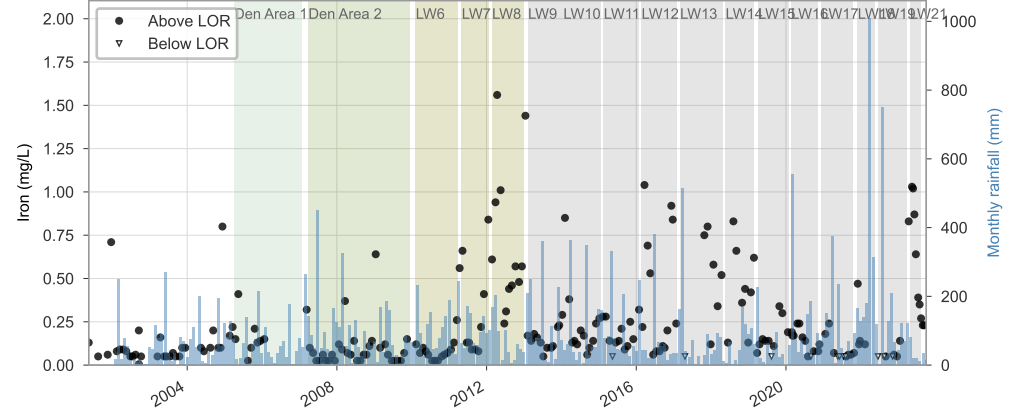
DC13_POOL2B



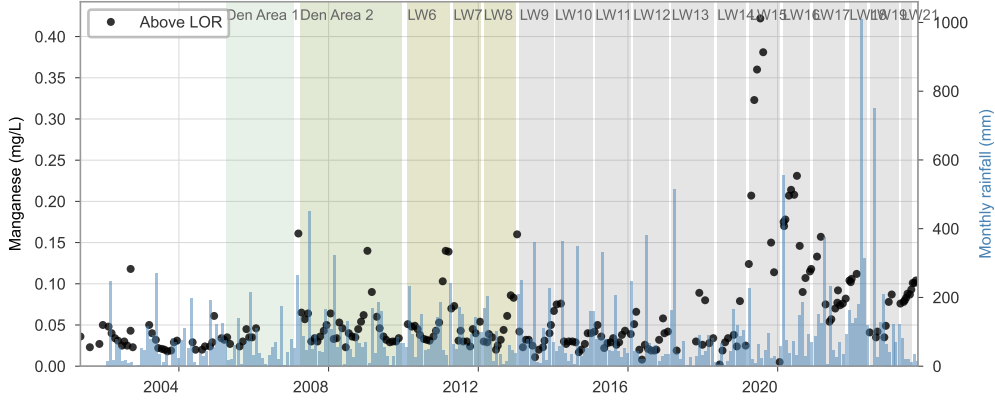
DCC_FR6



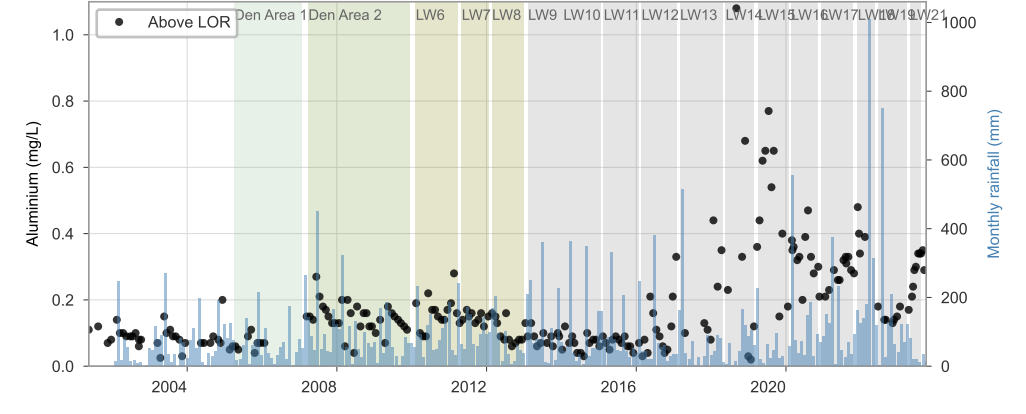
DCC_FR6



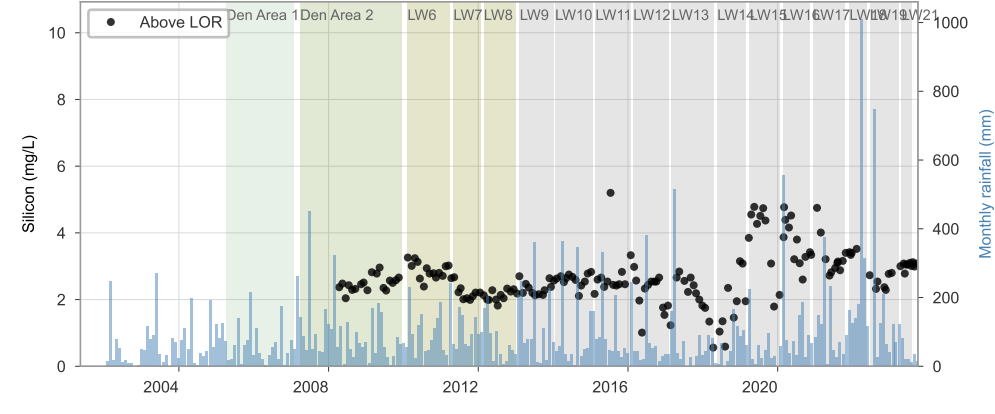
DCC_FR6



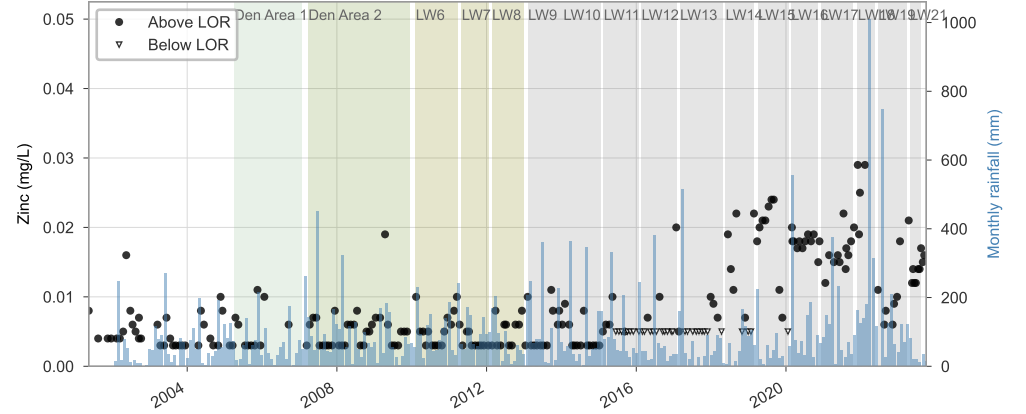
DCC_FR6

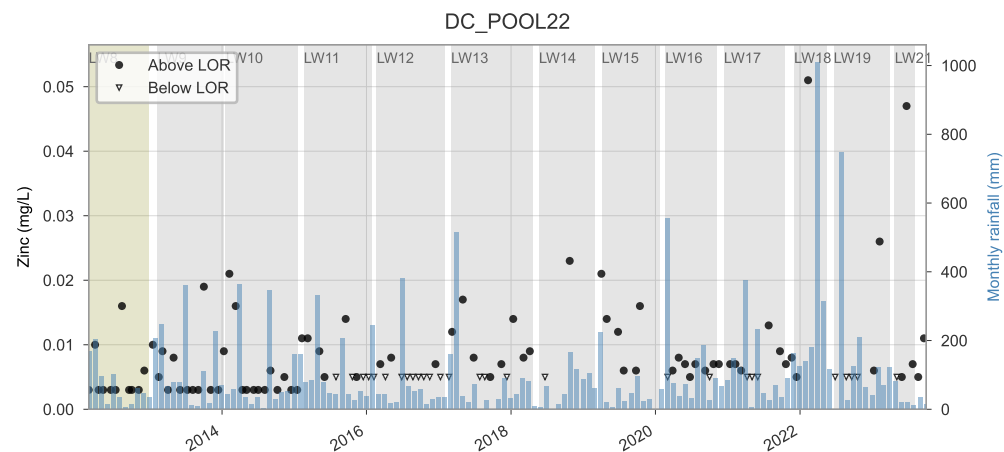
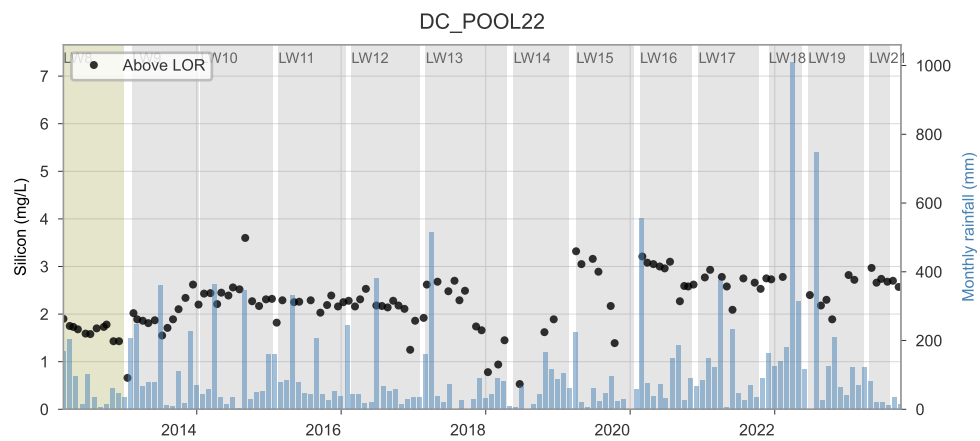
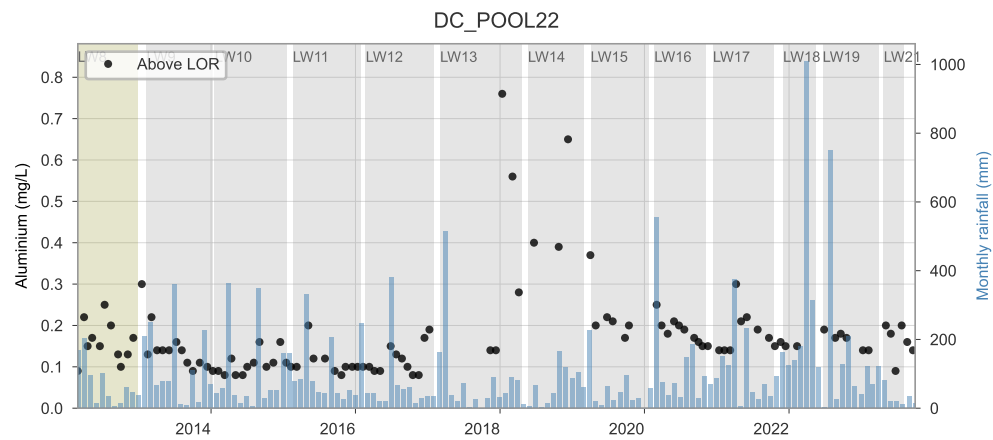
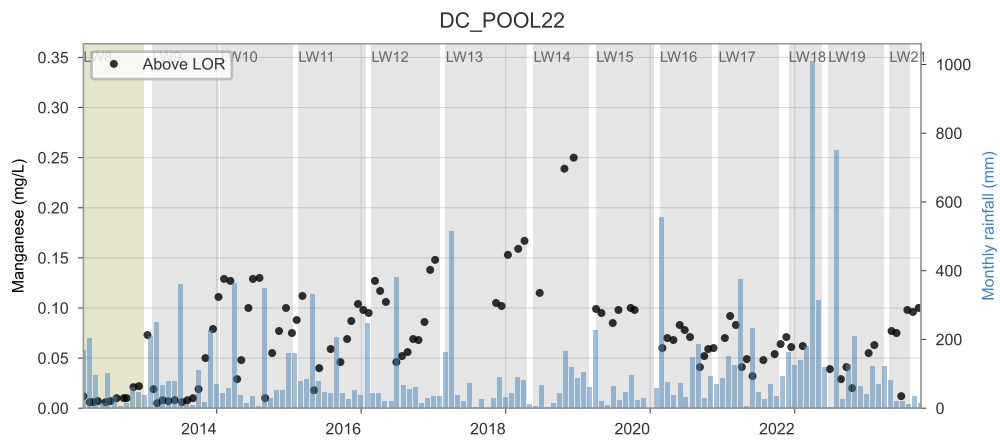
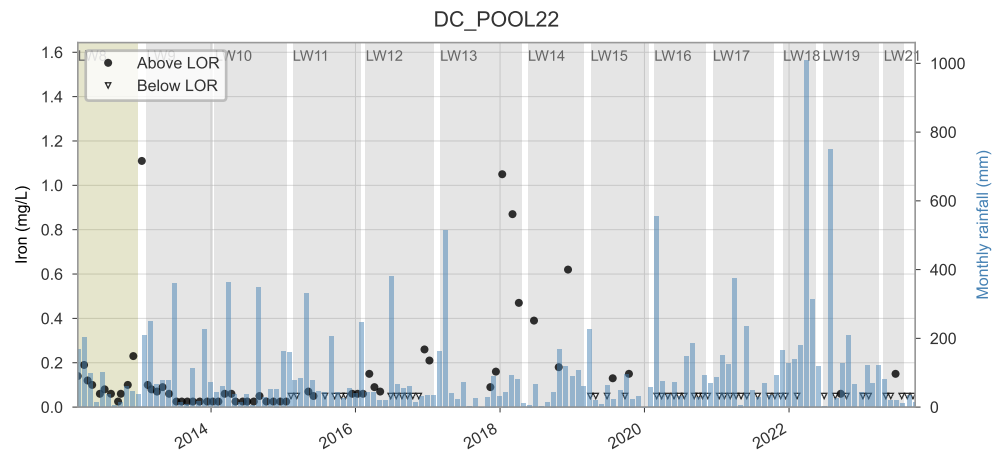
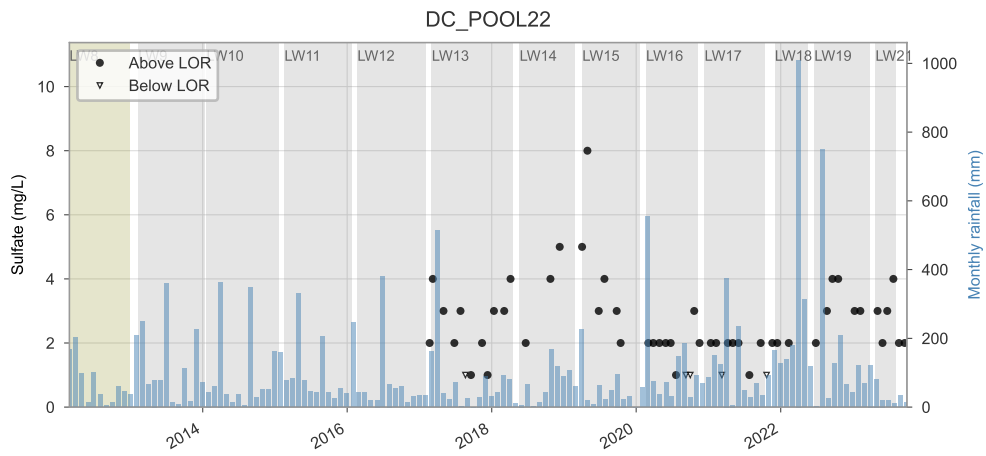


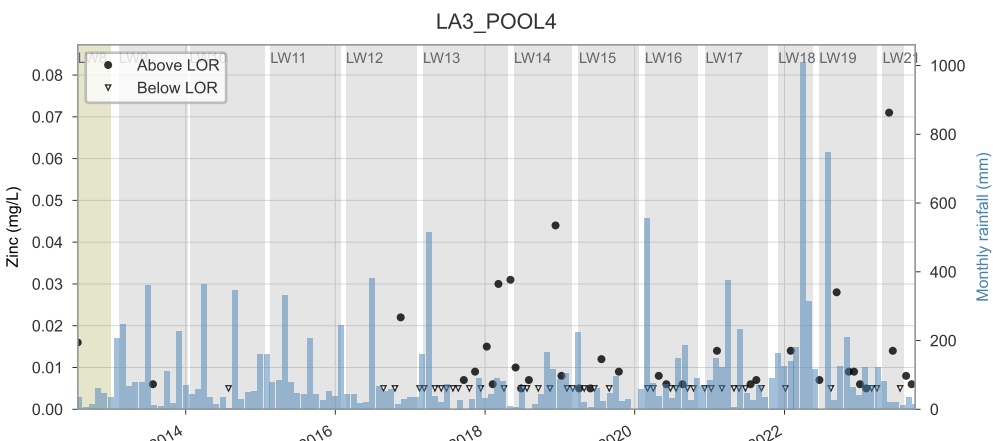
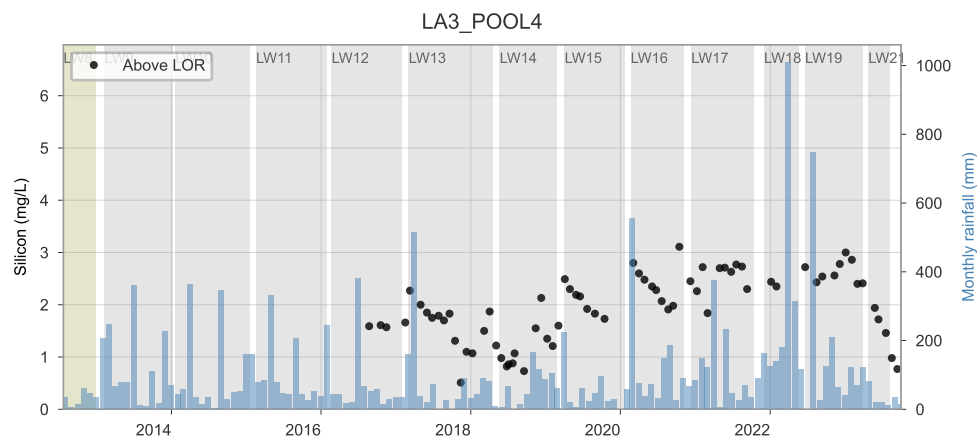
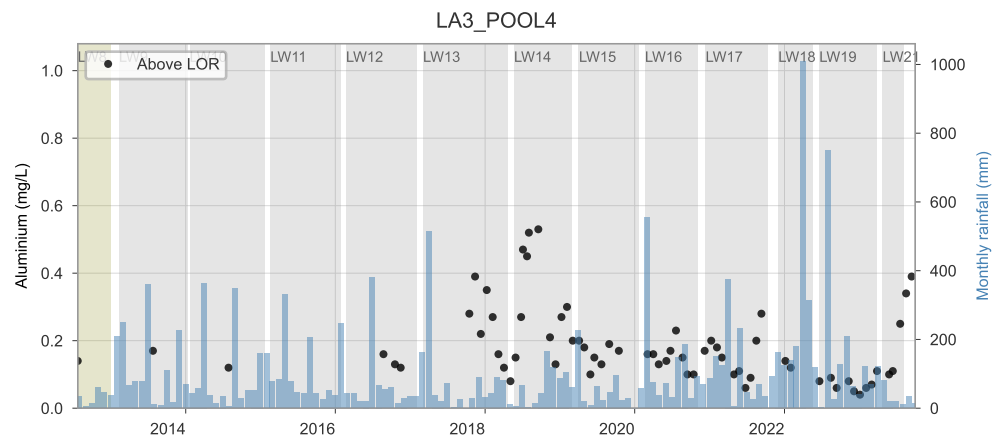
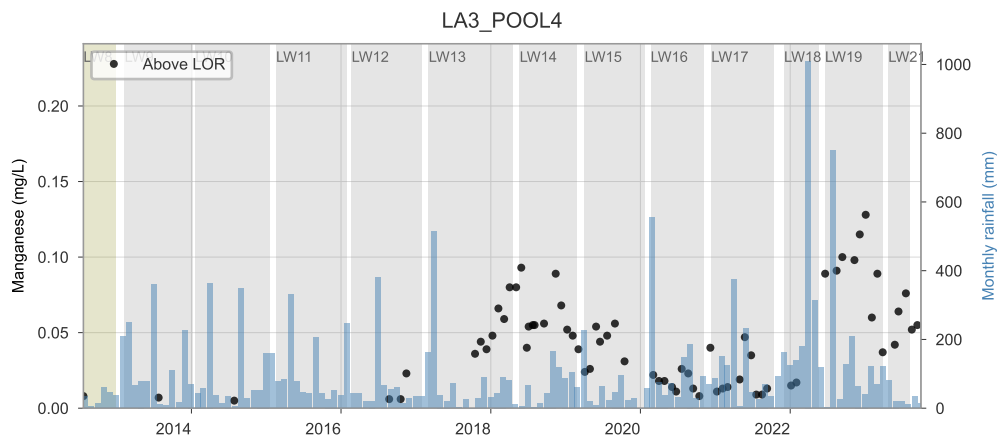
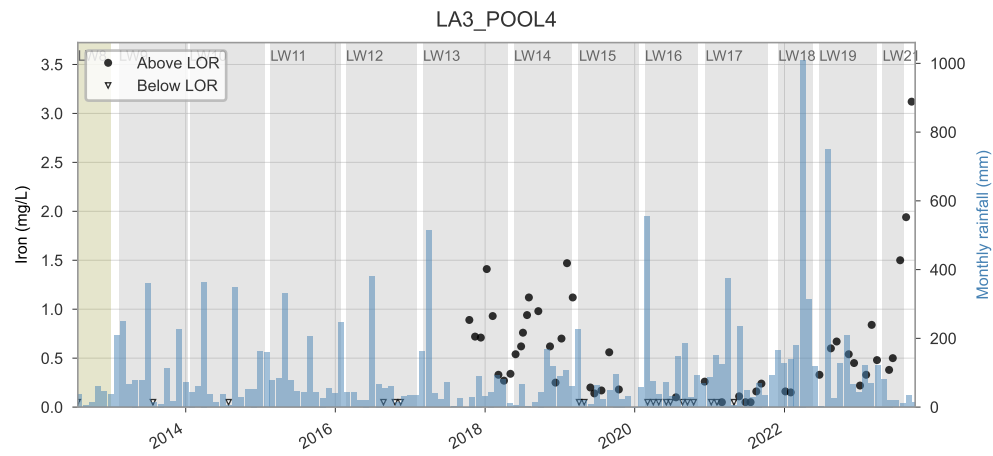
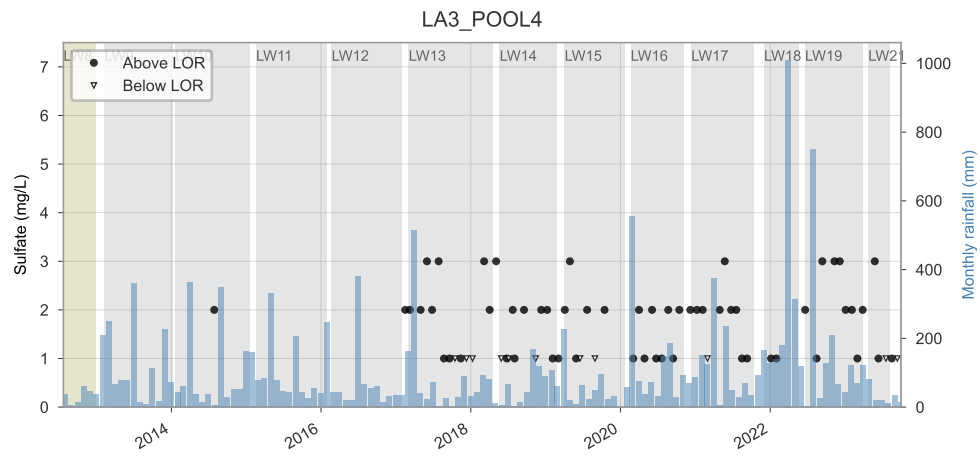
DCC_FR6

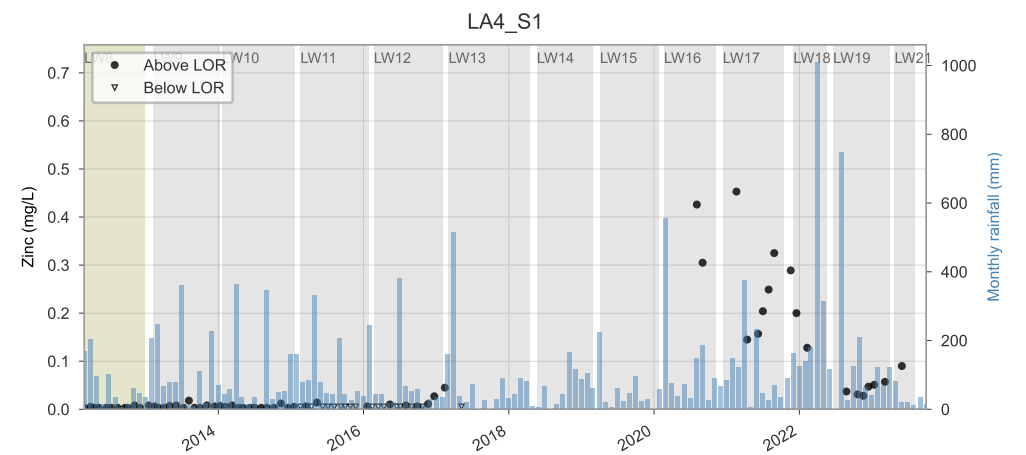
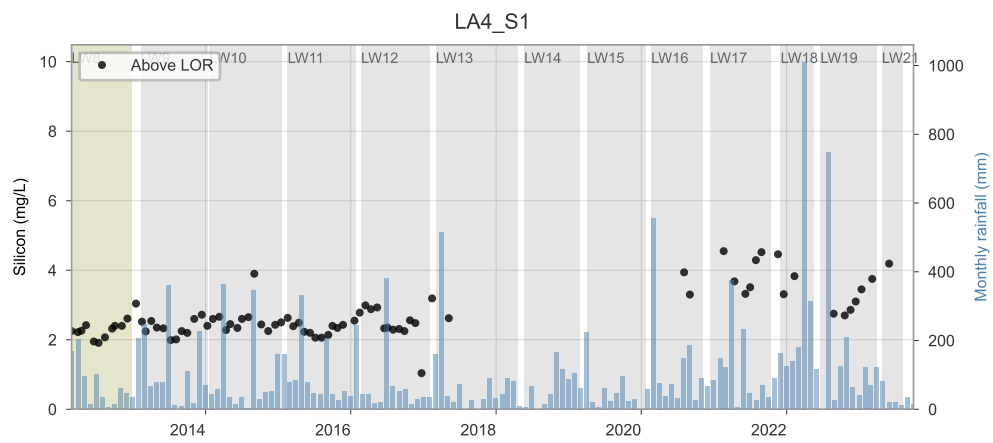
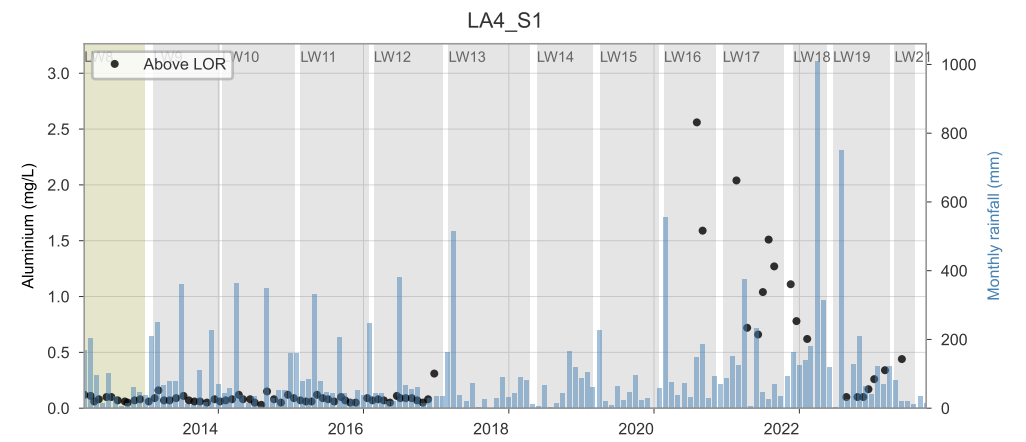
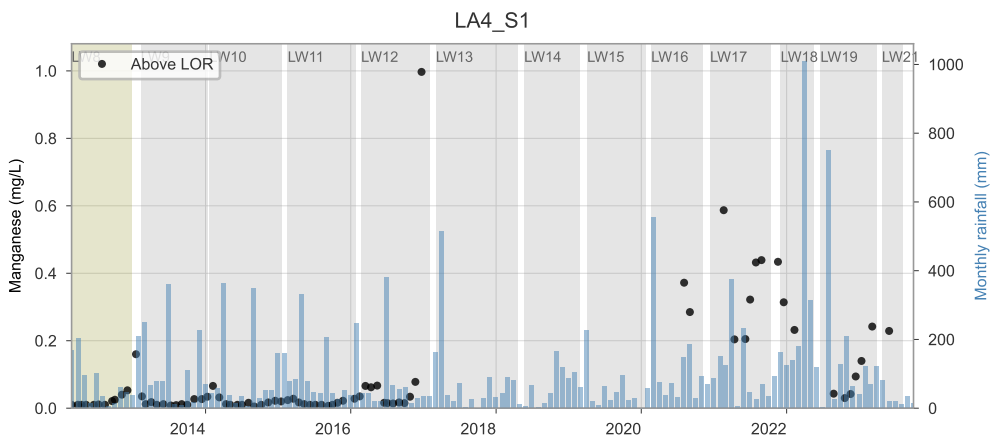
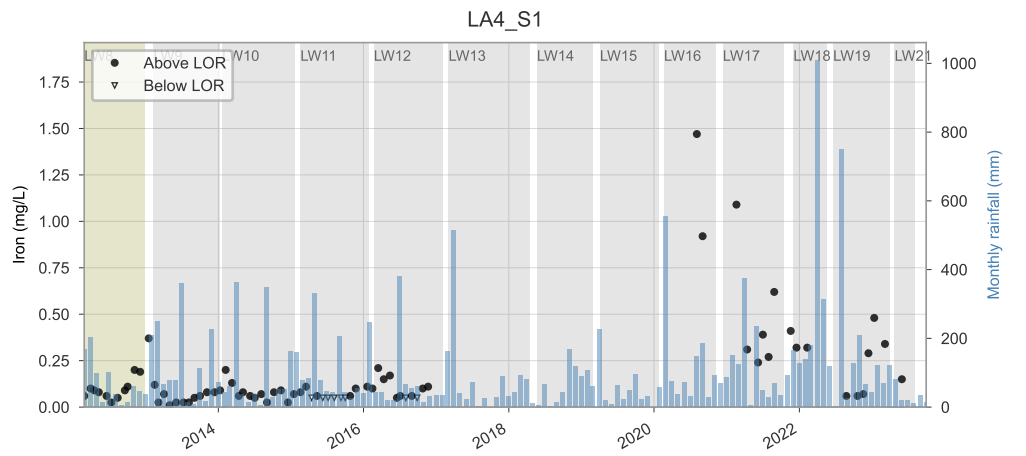
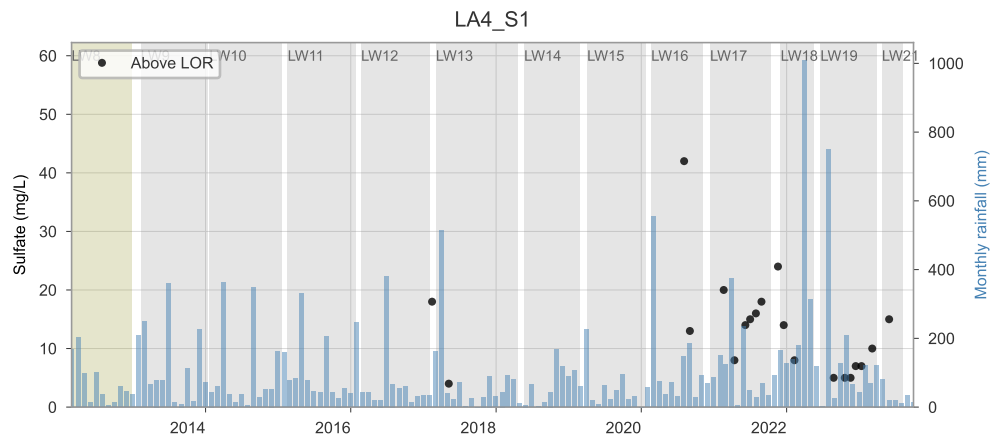


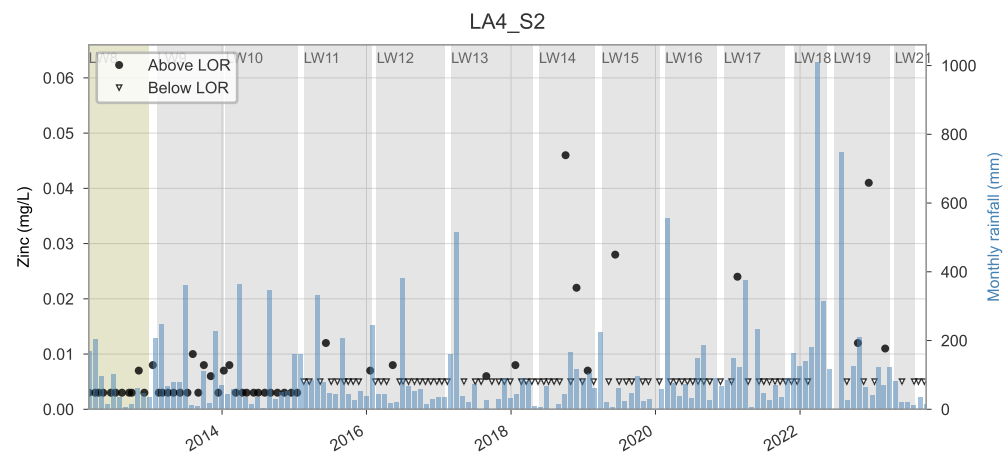
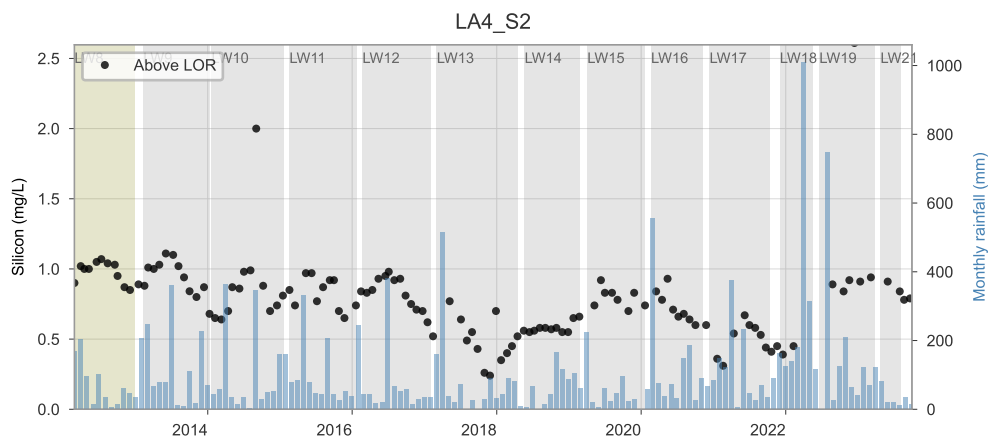
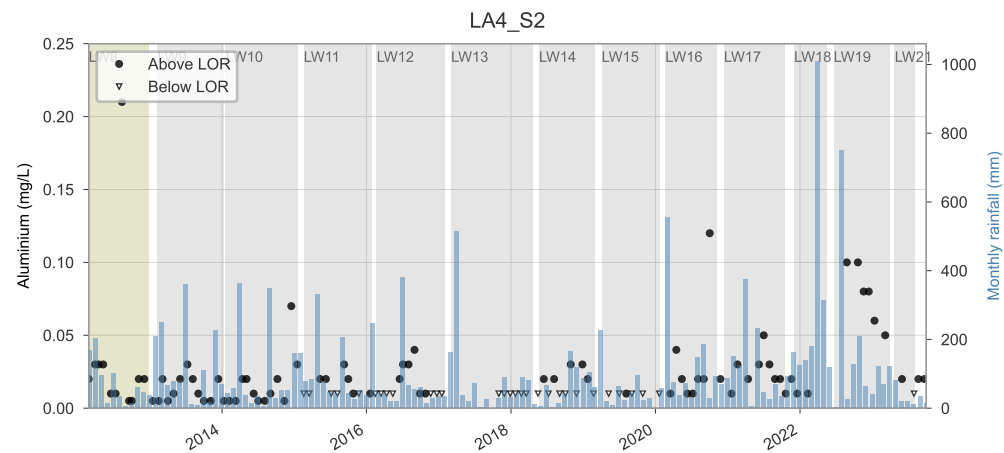
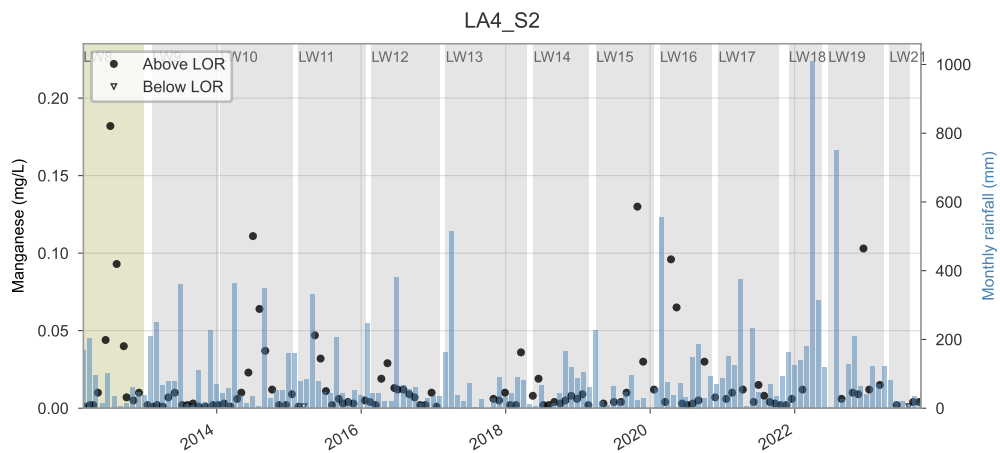
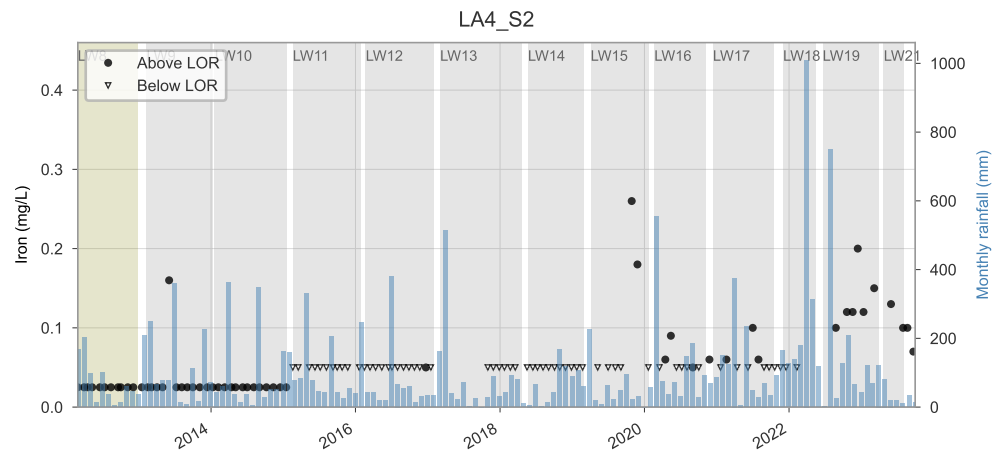
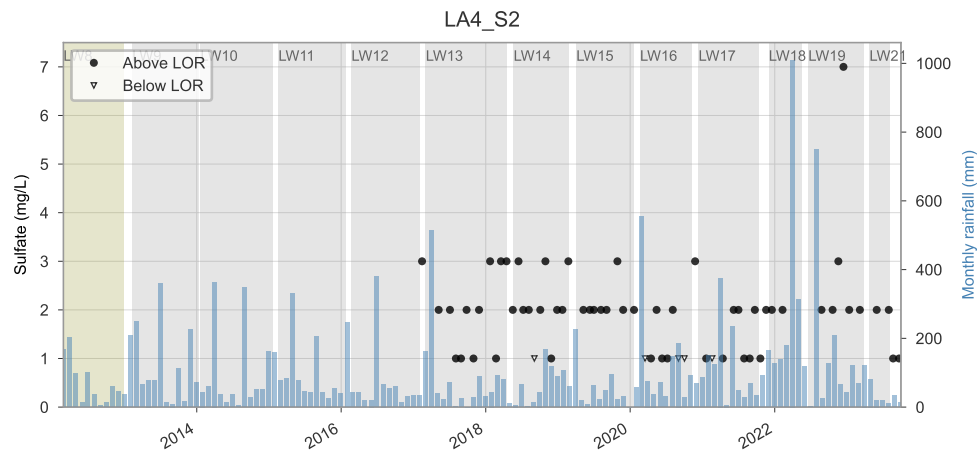
DCC_FR6



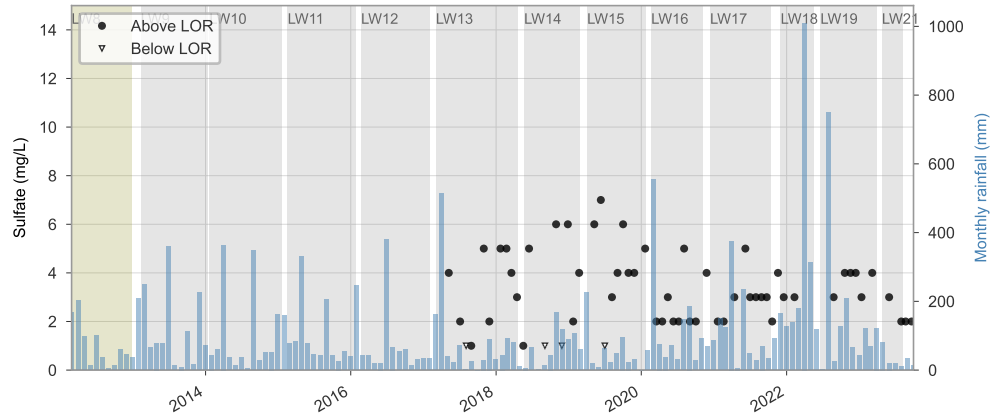




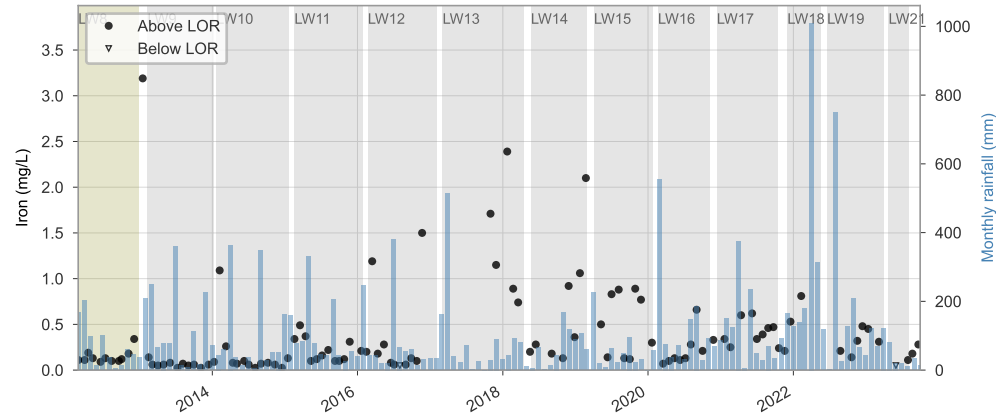




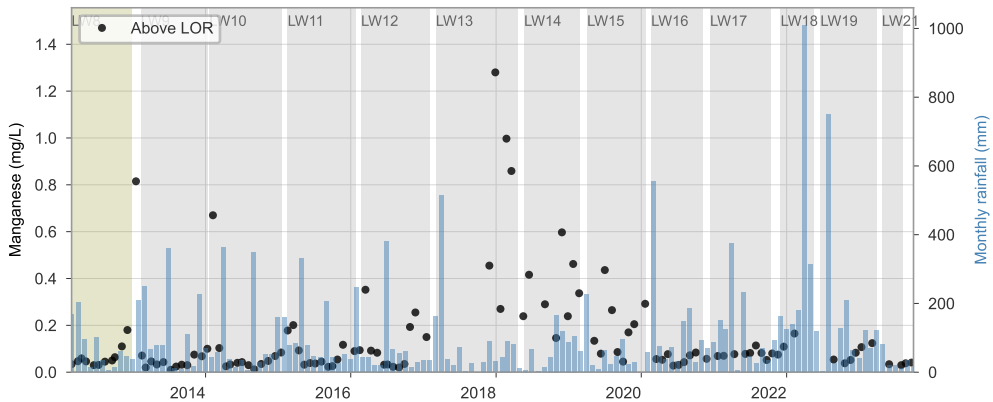
LA5_S1



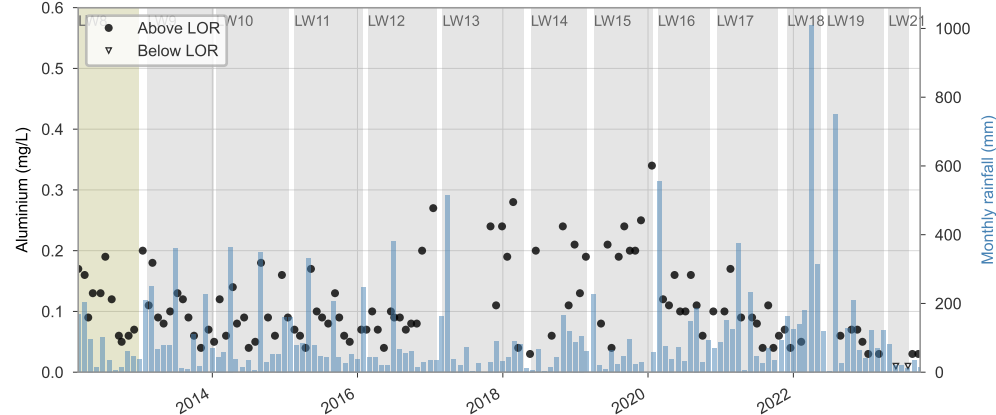
LA5_S1



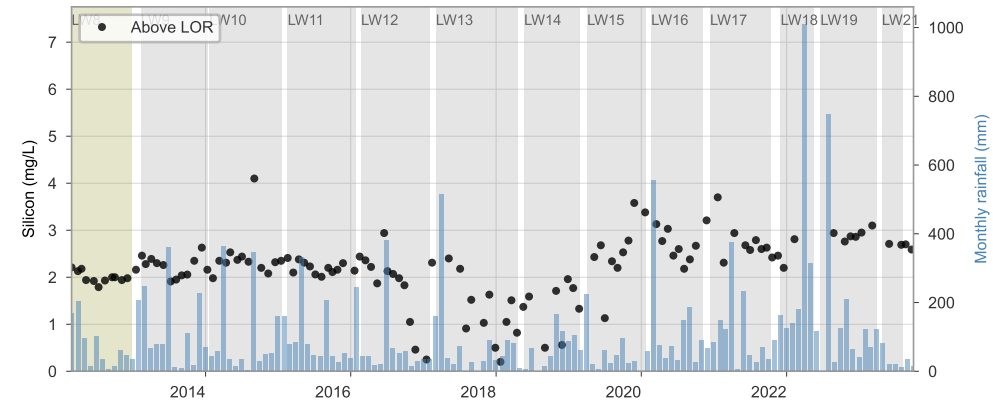
LA5_S1



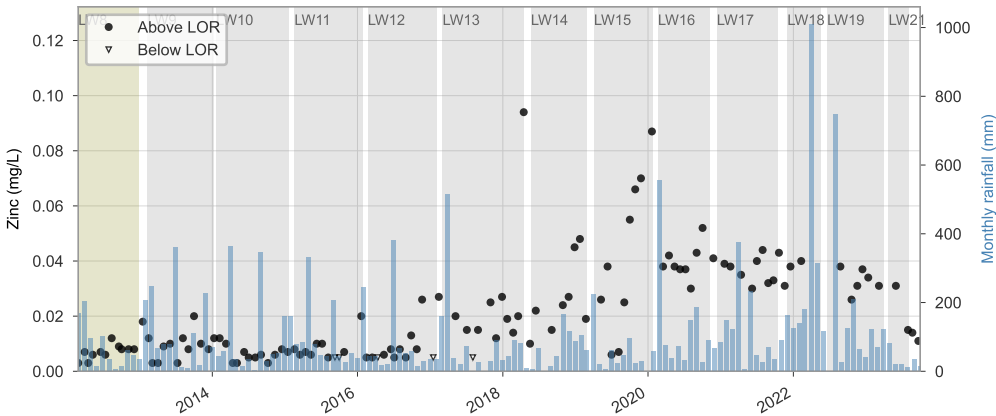
LA5_S1



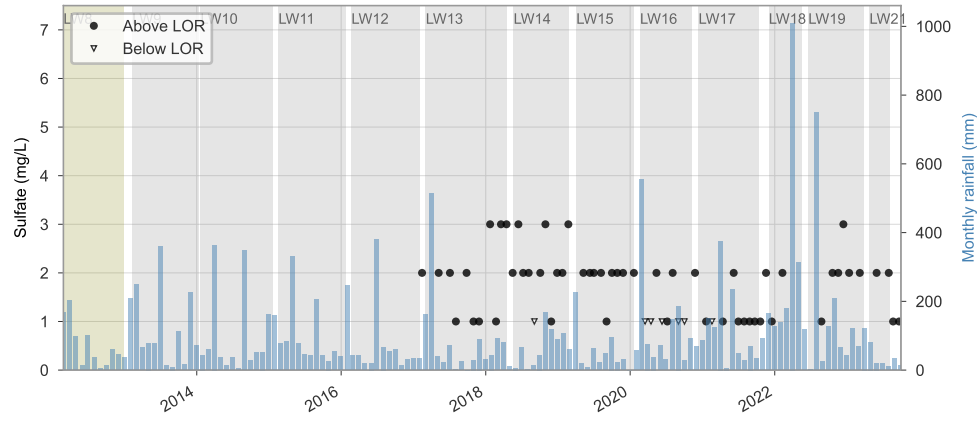
LA5_S1



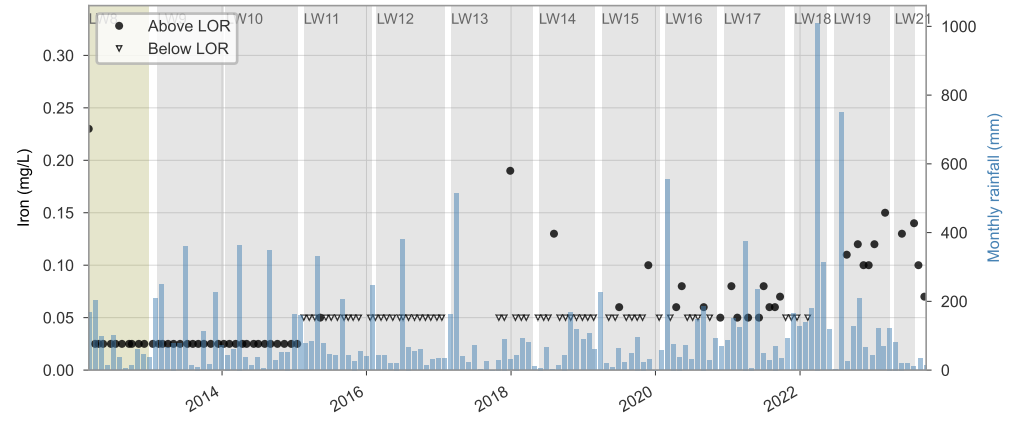
LA5_S1



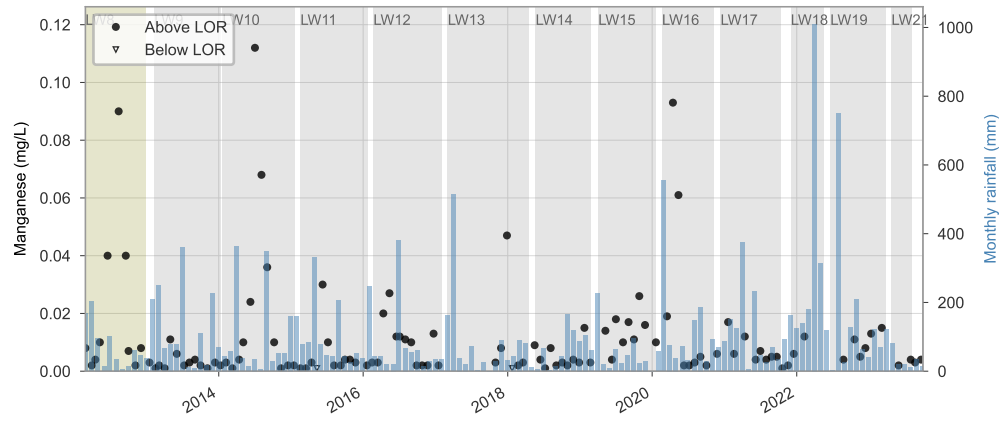
LA5_S2



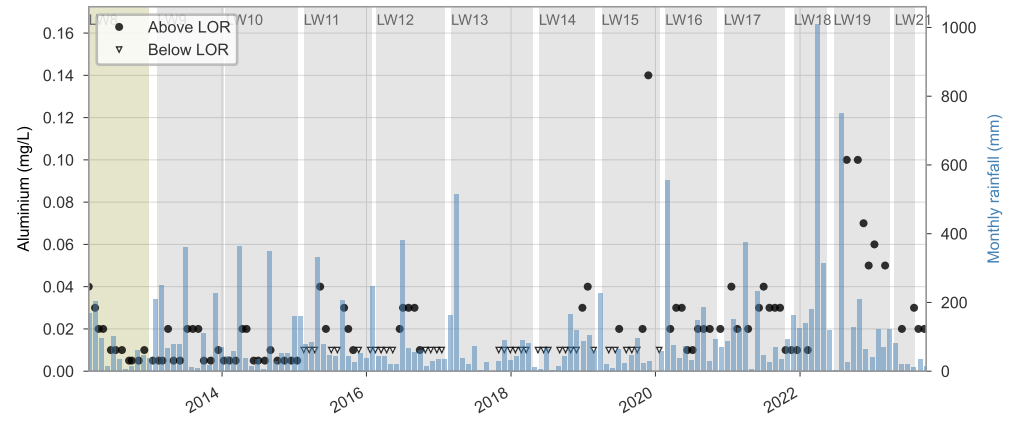
LA5_S2



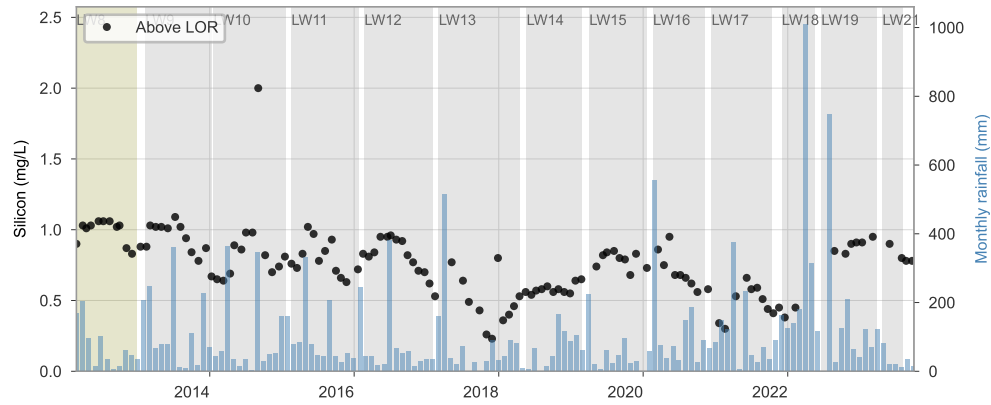
LA5_S2



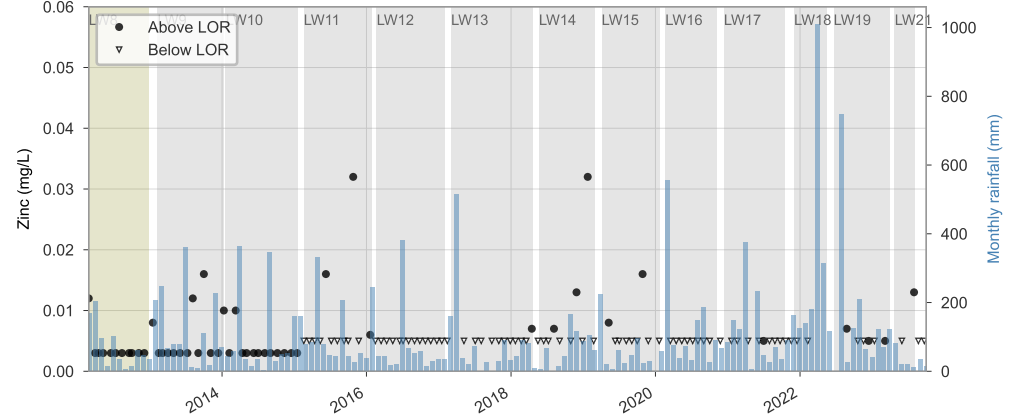
LA5_S2

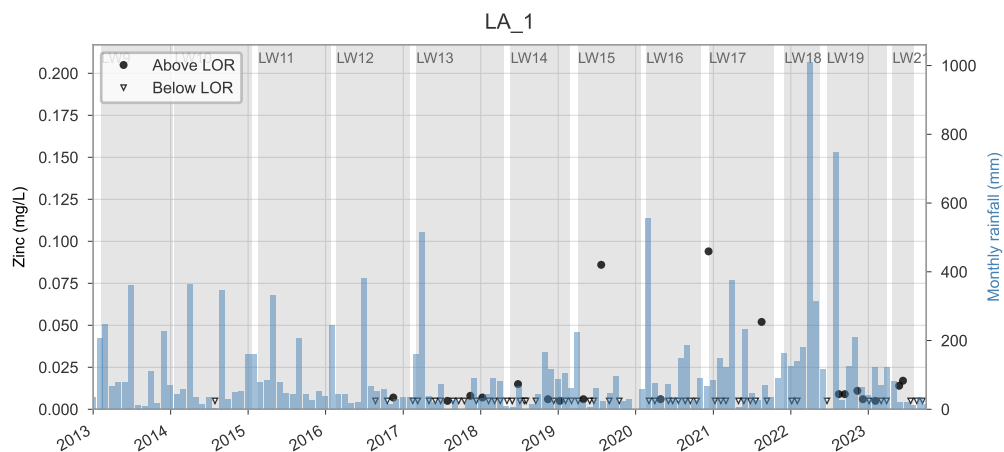
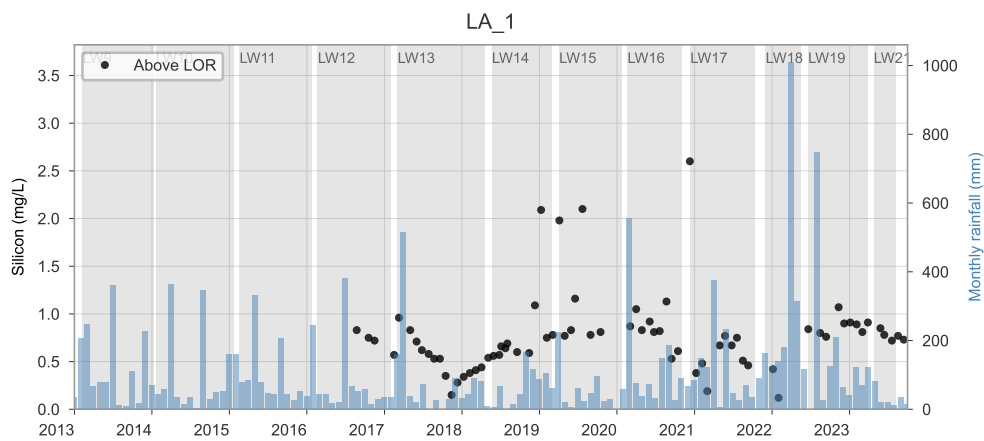
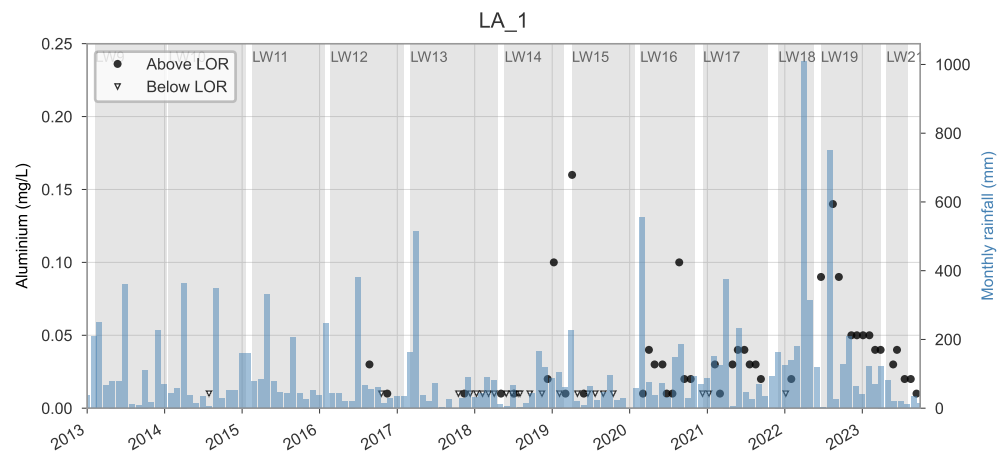
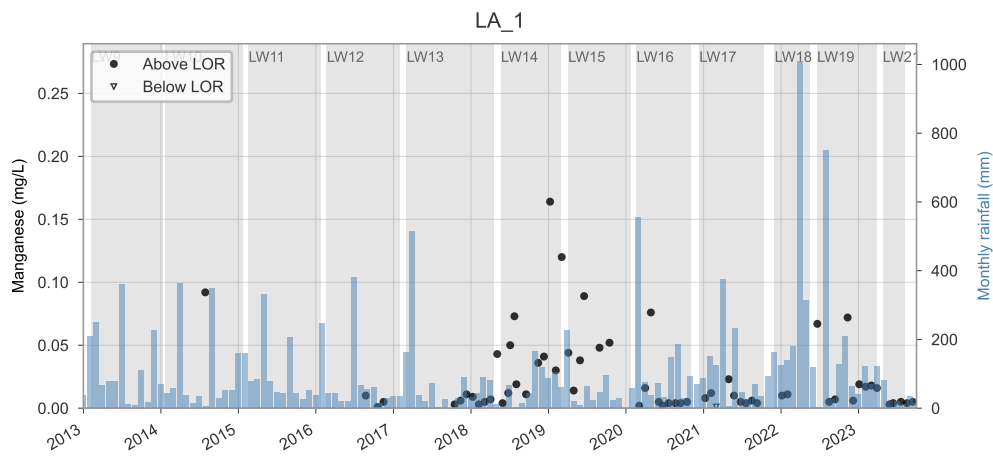
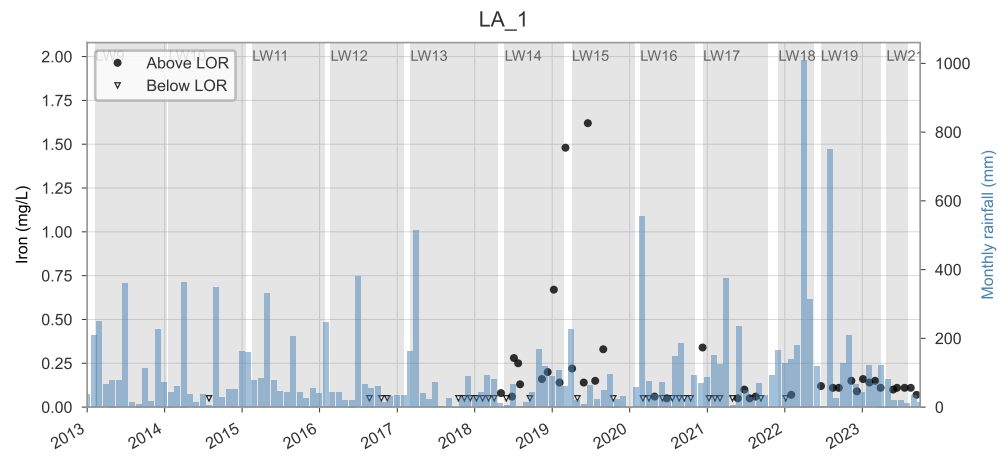
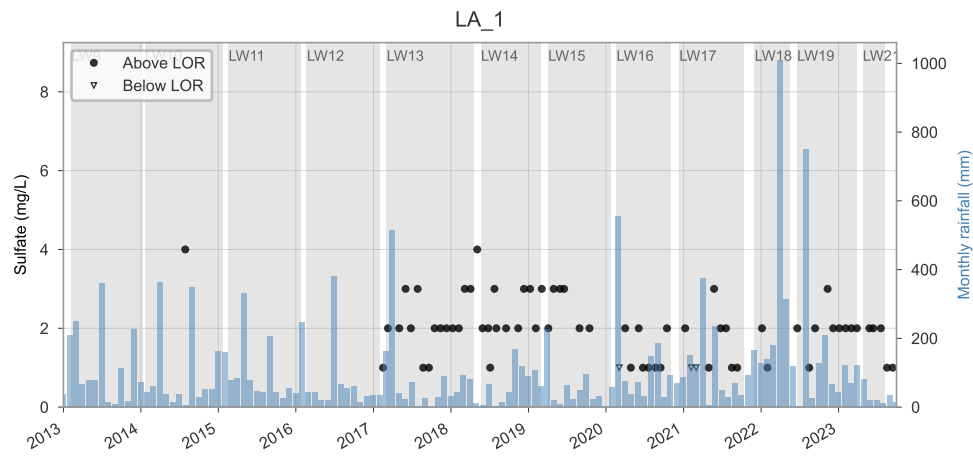


LA5_S2

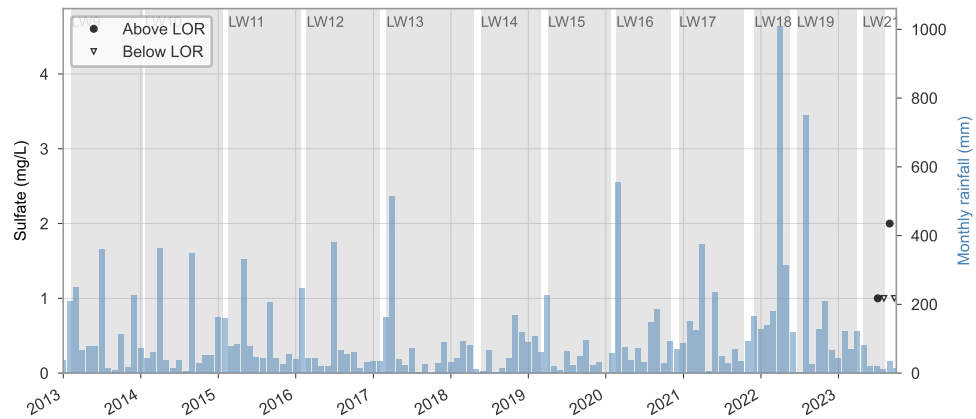


LA5_S2

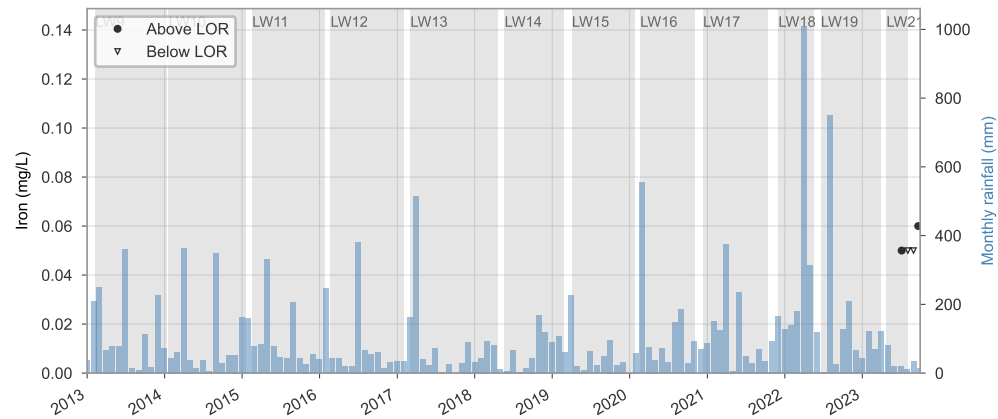




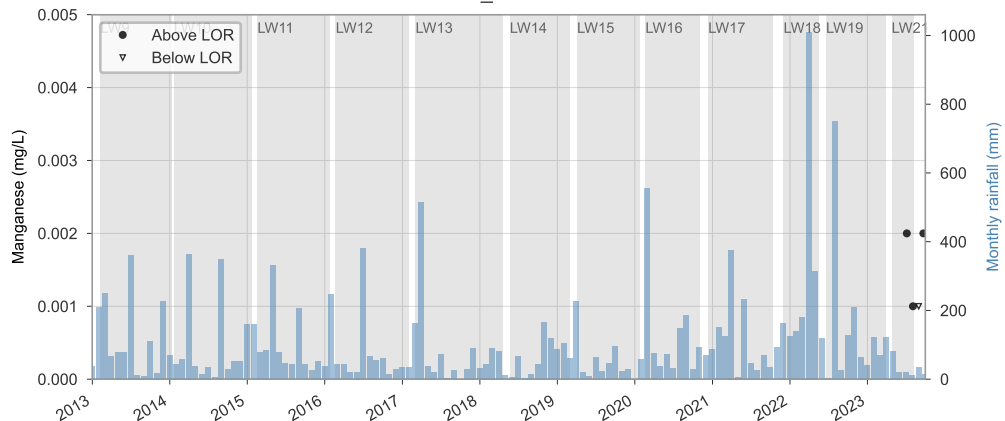
LC5_POOL13



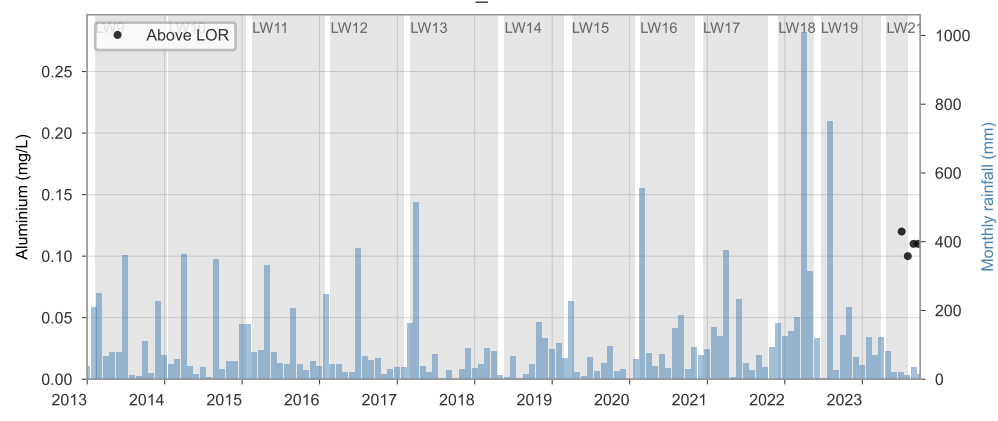
LC5_POOL13



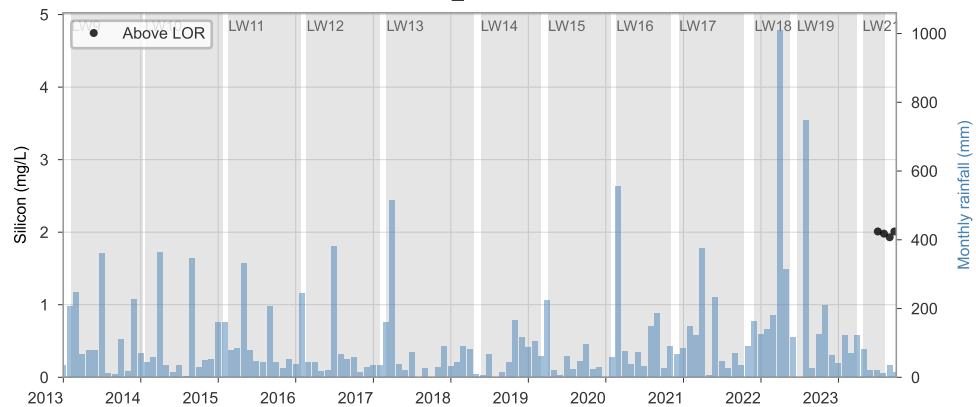
LC5_POOL13



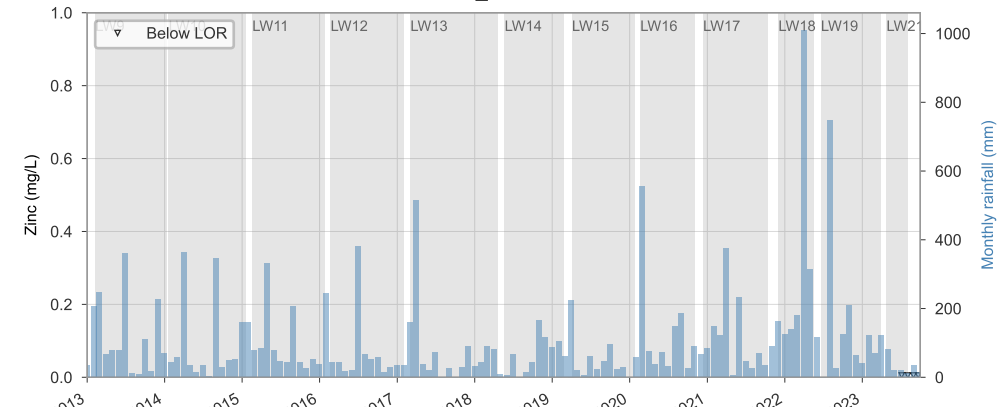
LC5_POOL13

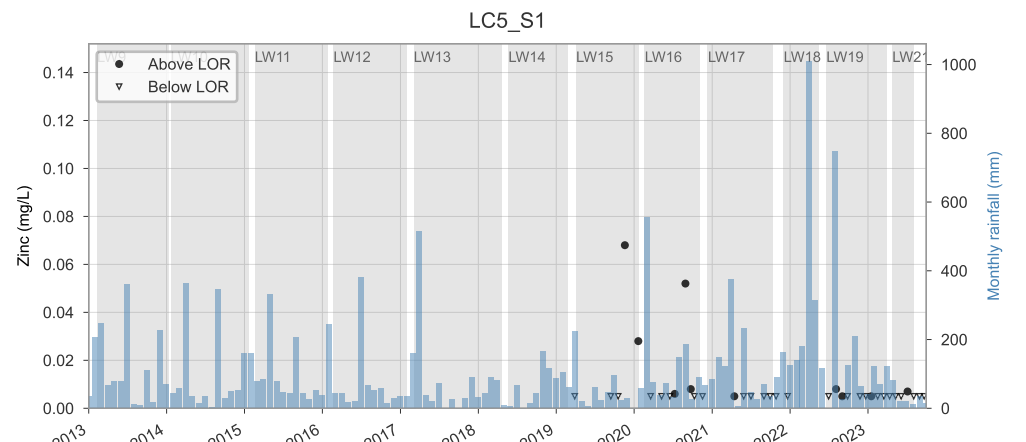
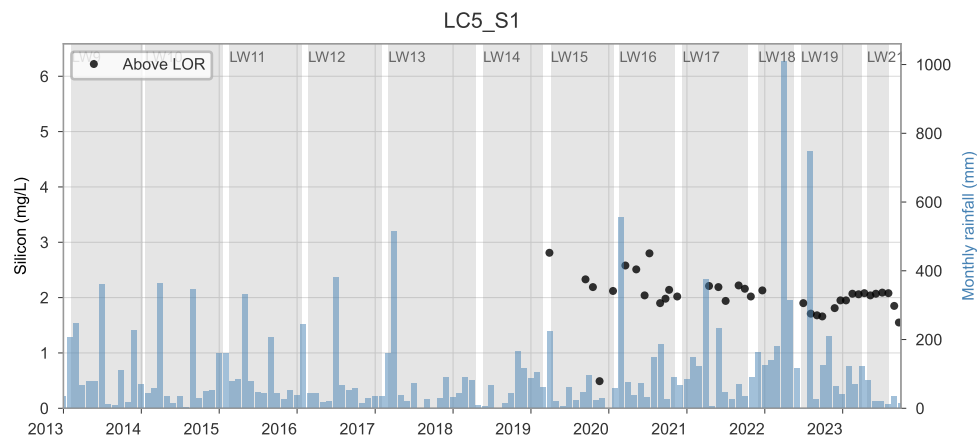
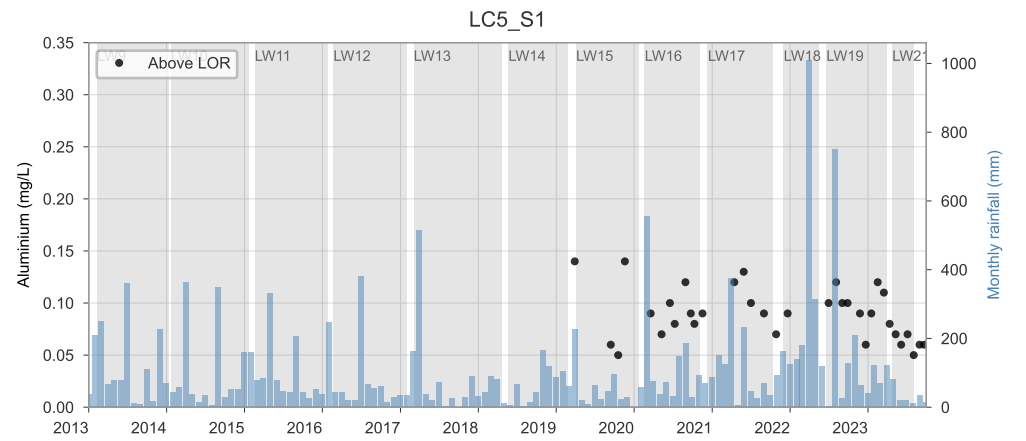
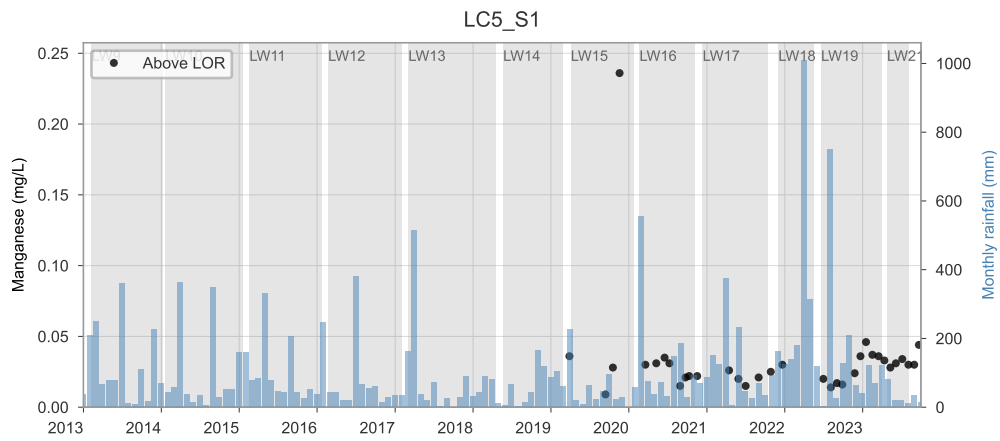
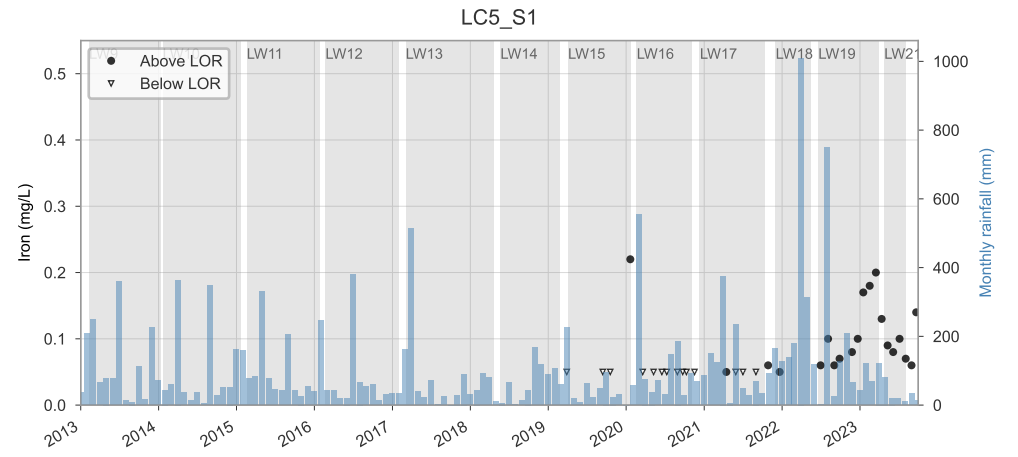
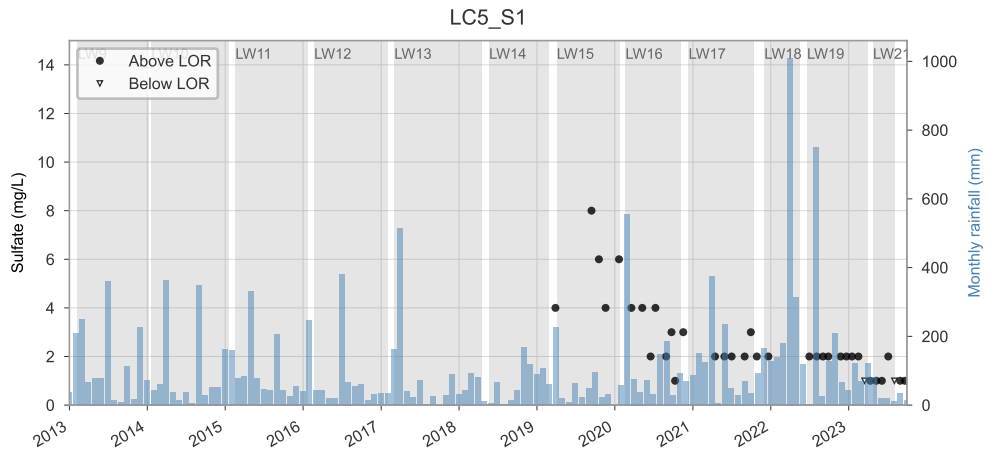


LC5_POOL13

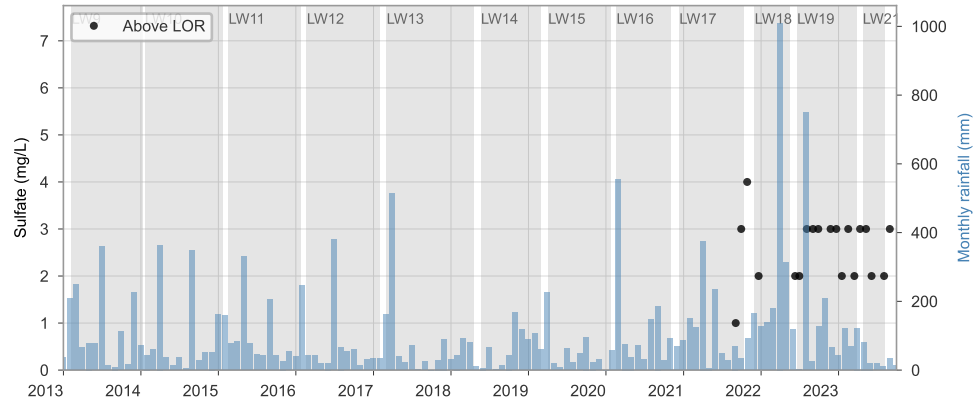


LC5_POOL13

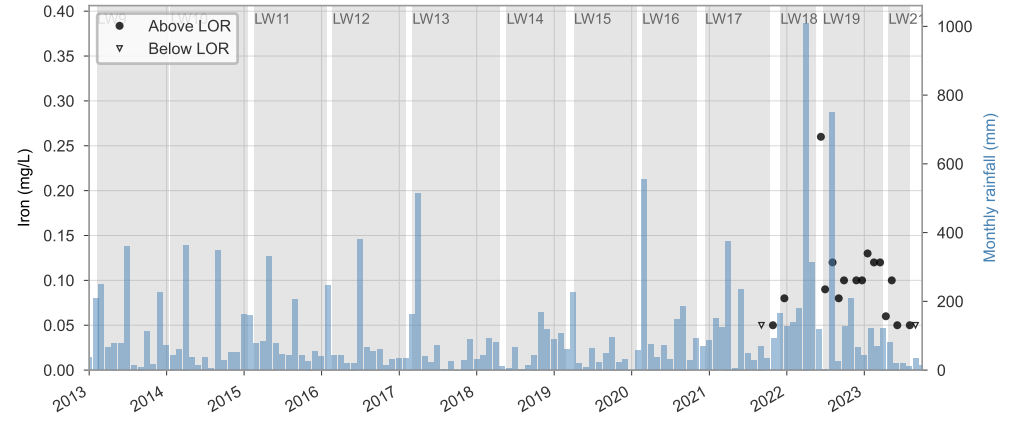




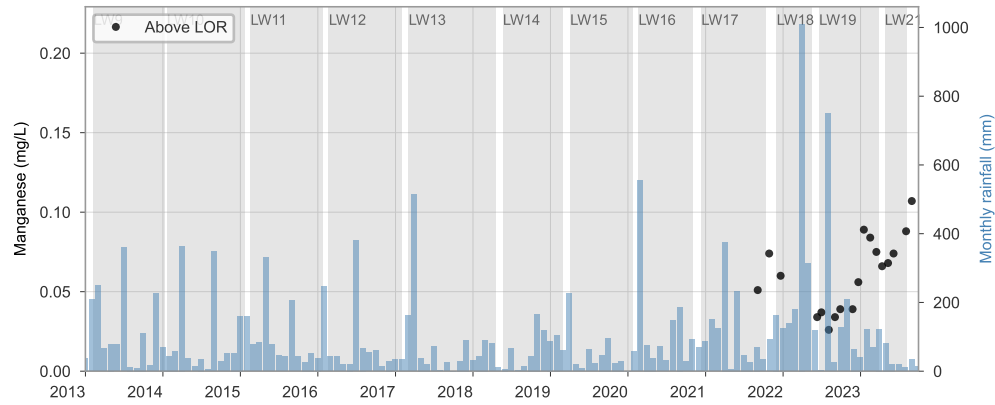
LC6_ROCKBAR1



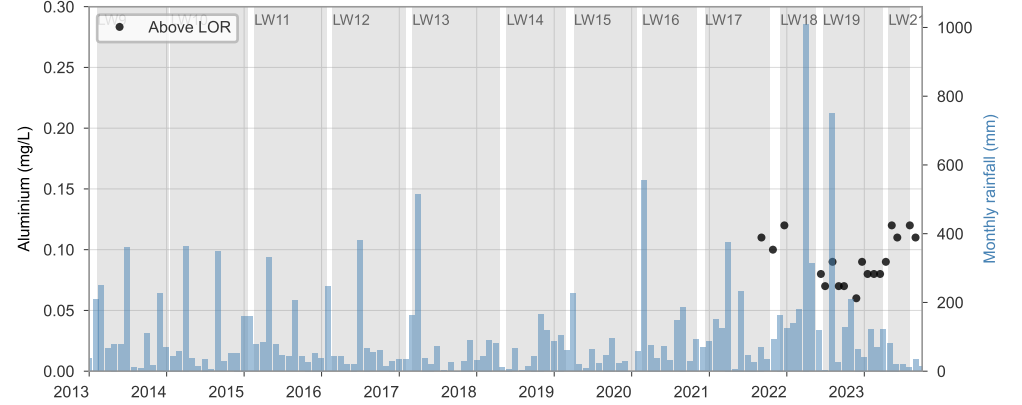
LC6_ROCKBAR1



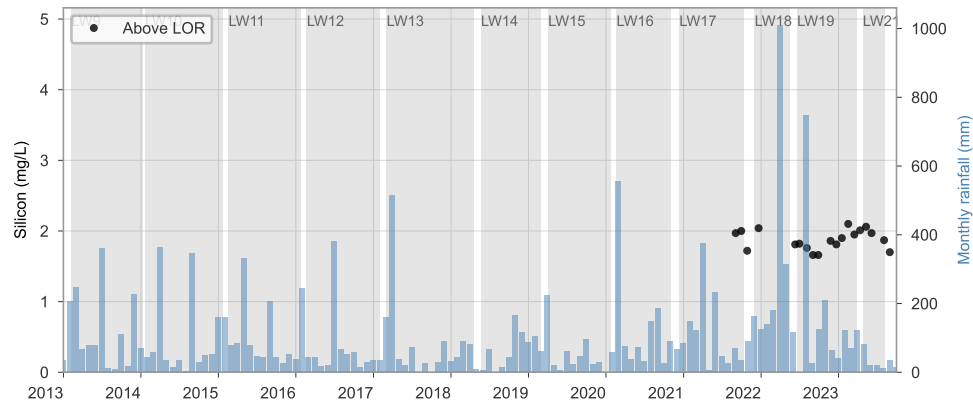
LC6_ROCKBAR1



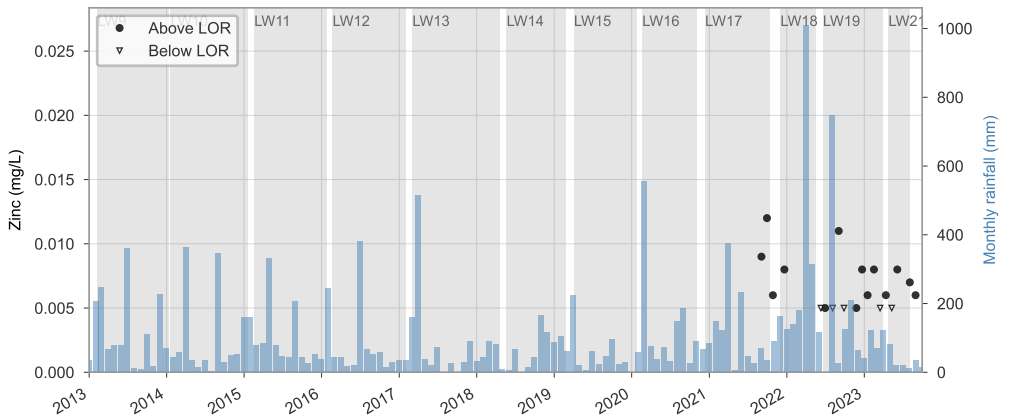
LC6_ROCKBAR1



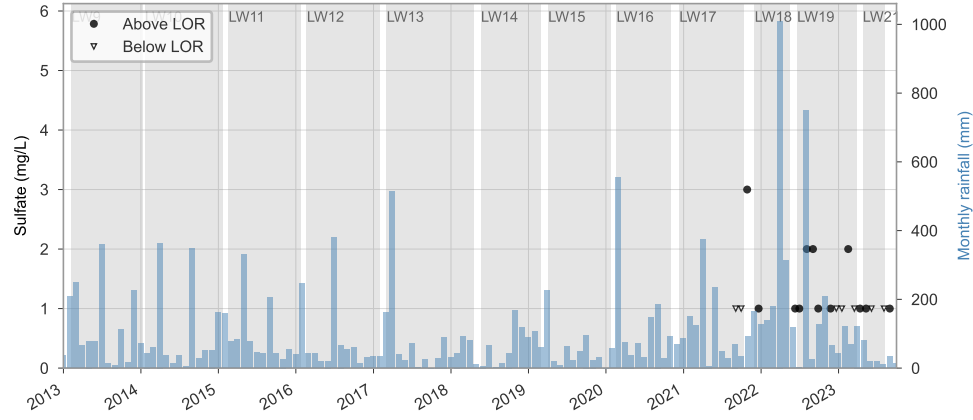
LC6_ROCKBAR1



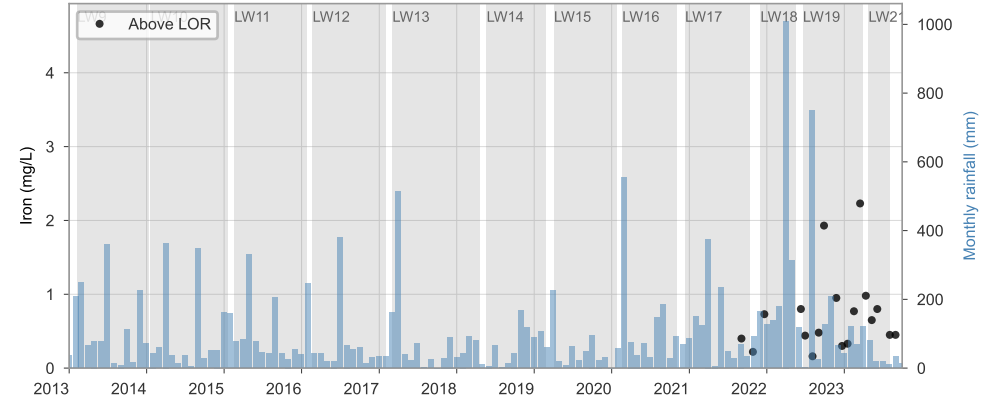
LC6_ROCKBAR1



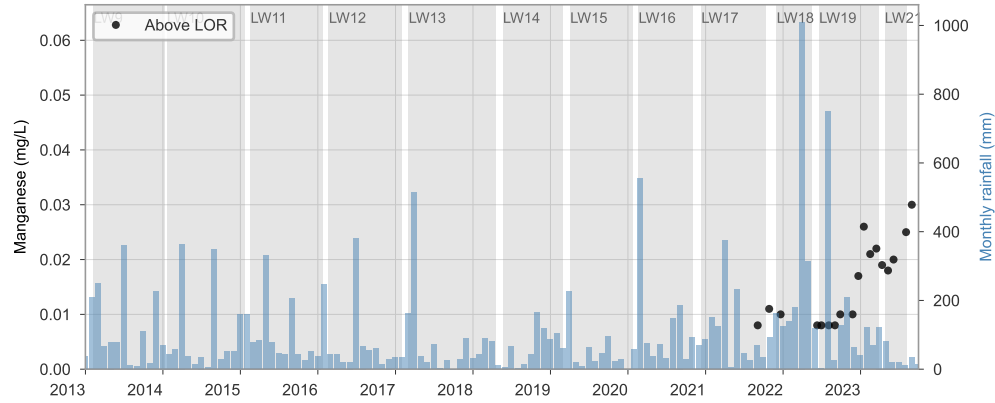
LC7_POOL2



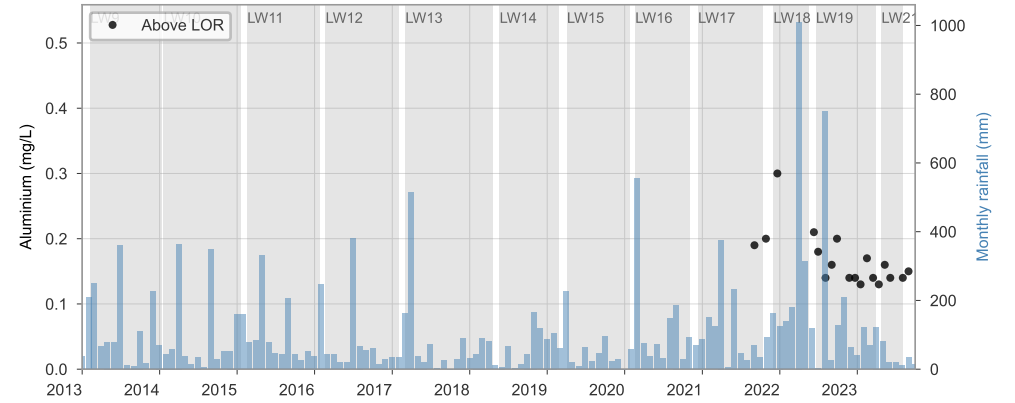
LC7_POOL2



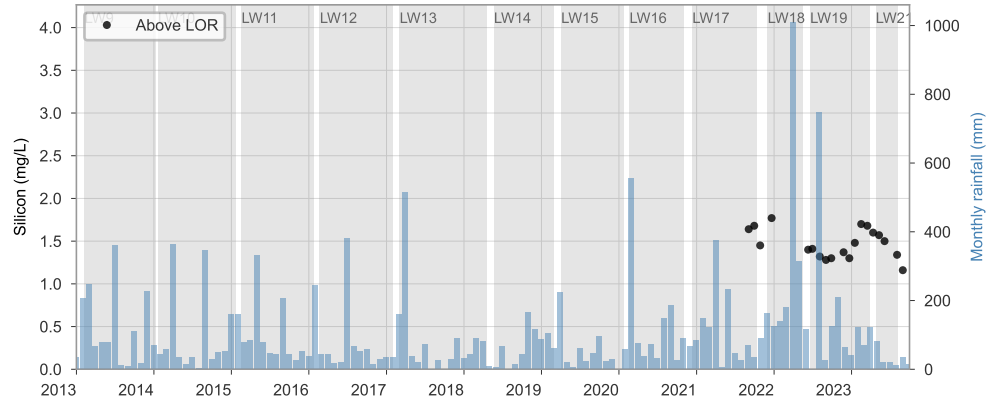
LC7_POOL2



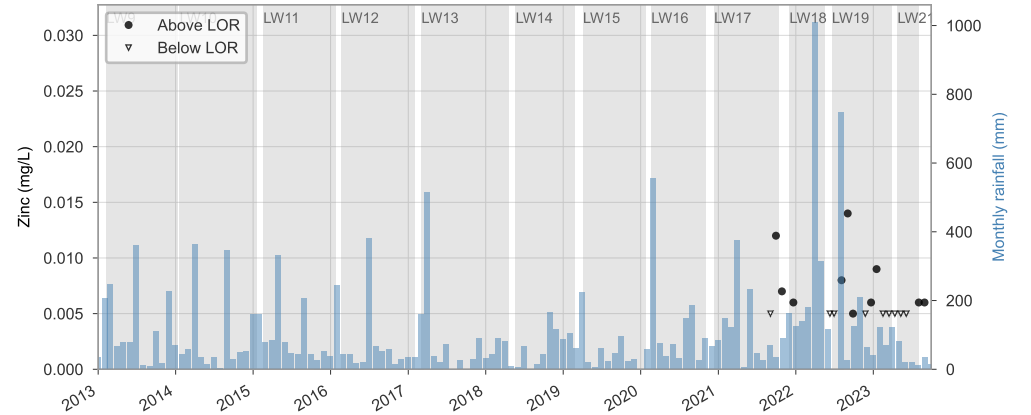
LC7_POOL2



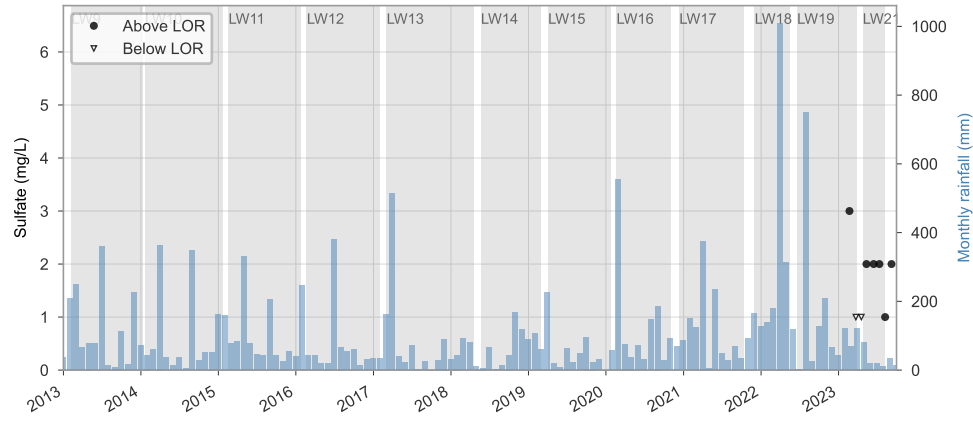
LC7_POOL2



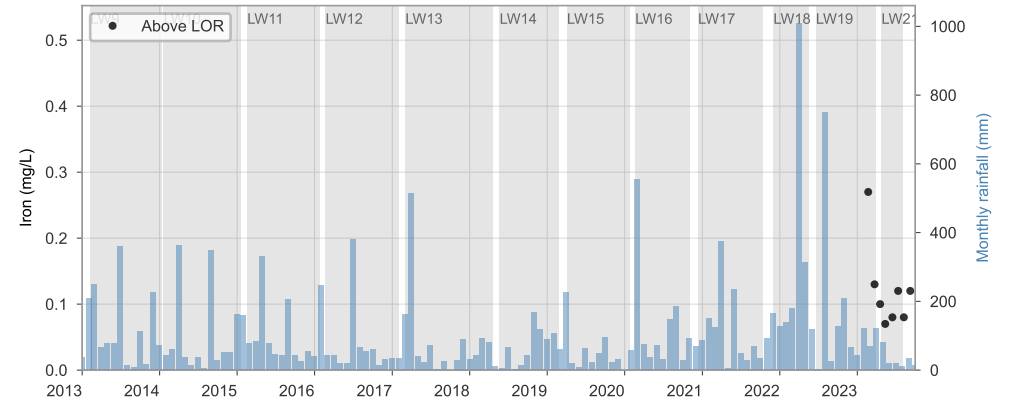
LC7_POOL2



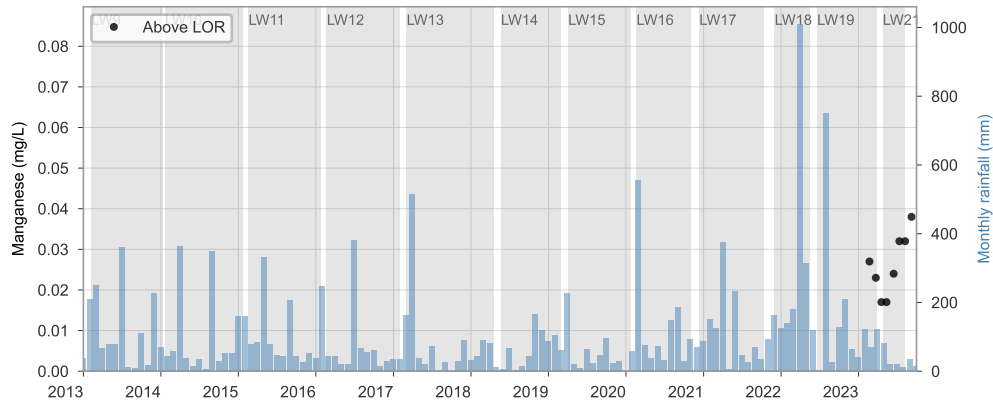
LC9_POOL2



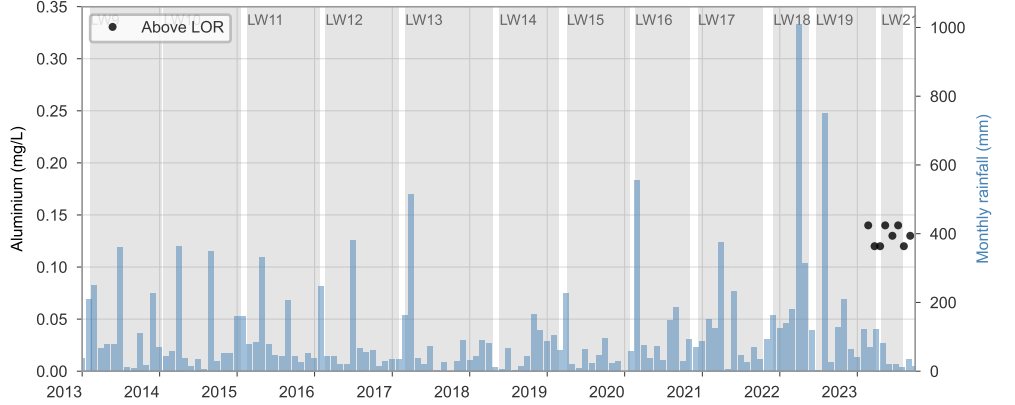
LC9_POOL2



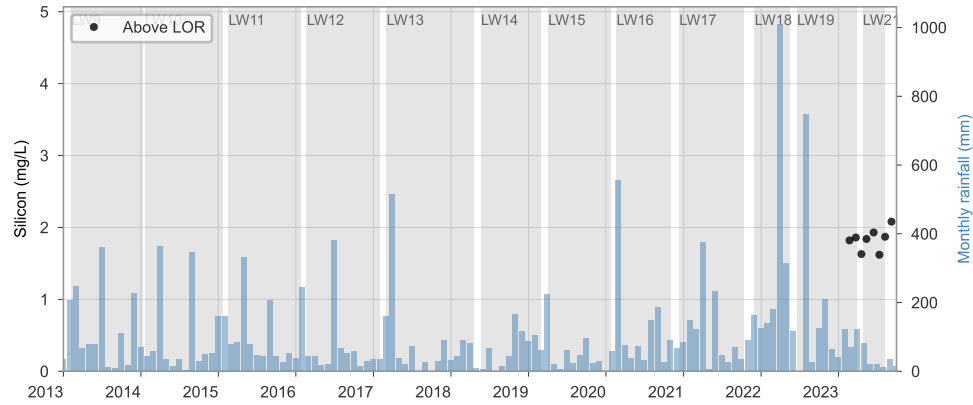
LC9_POOL2



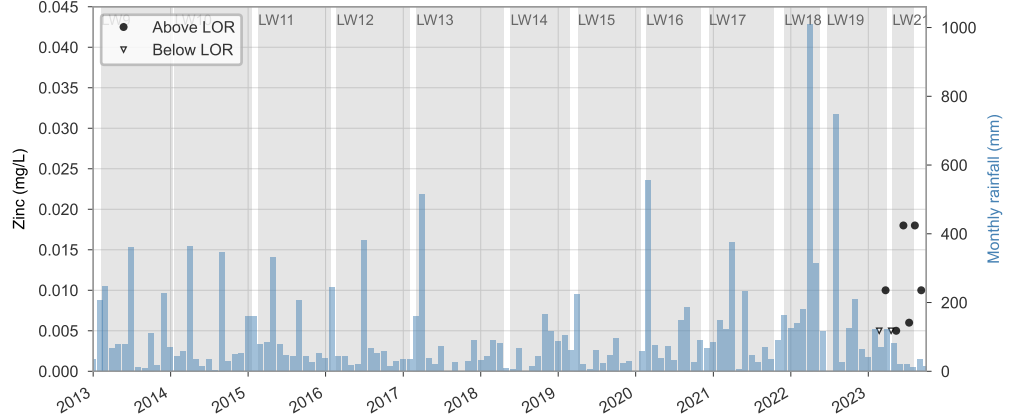
LC9_POOL2

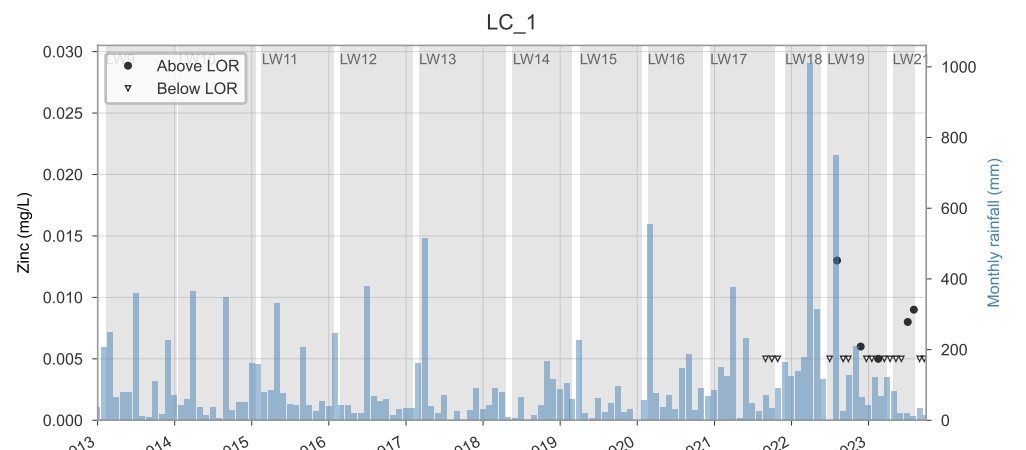
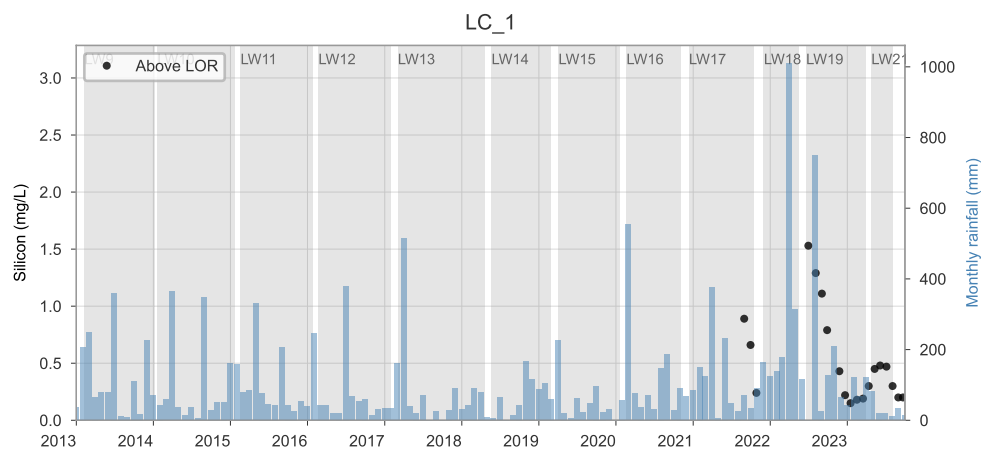
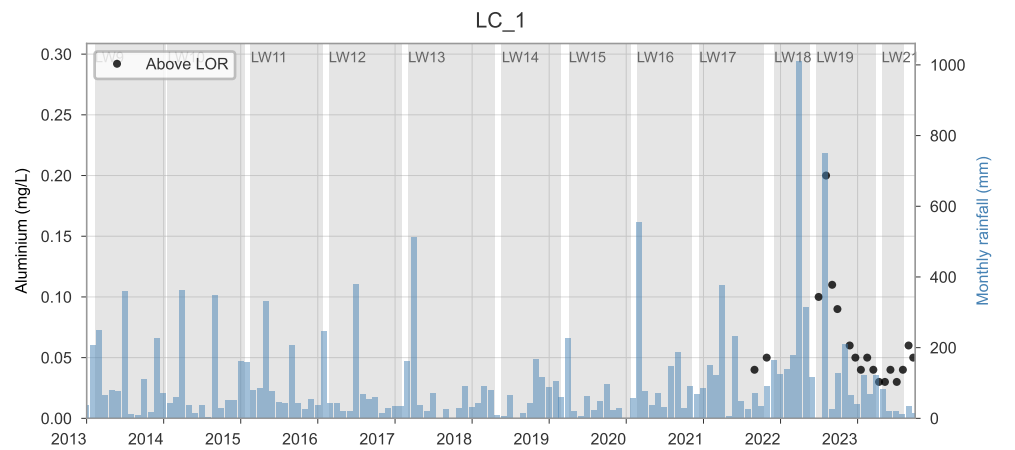
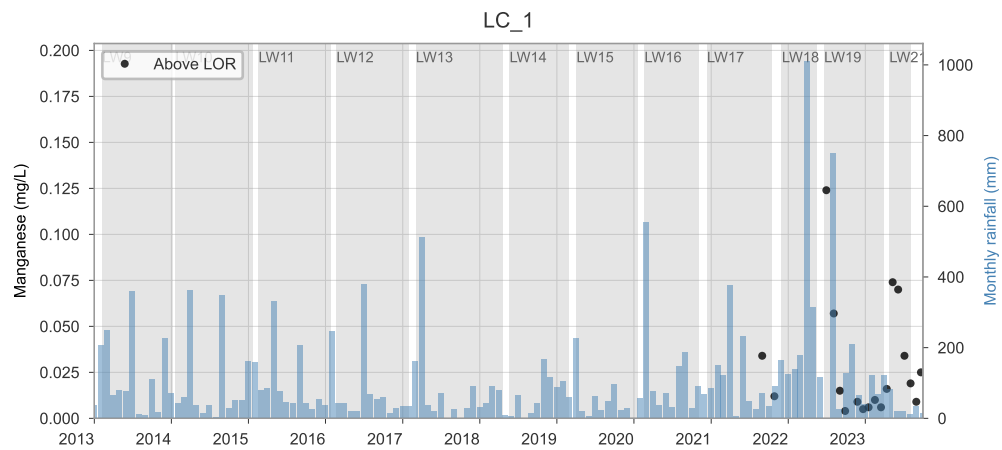
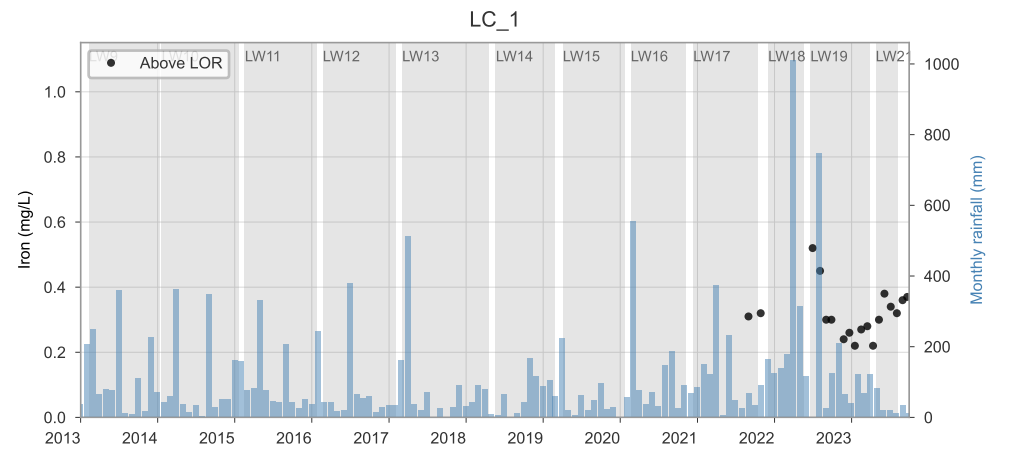
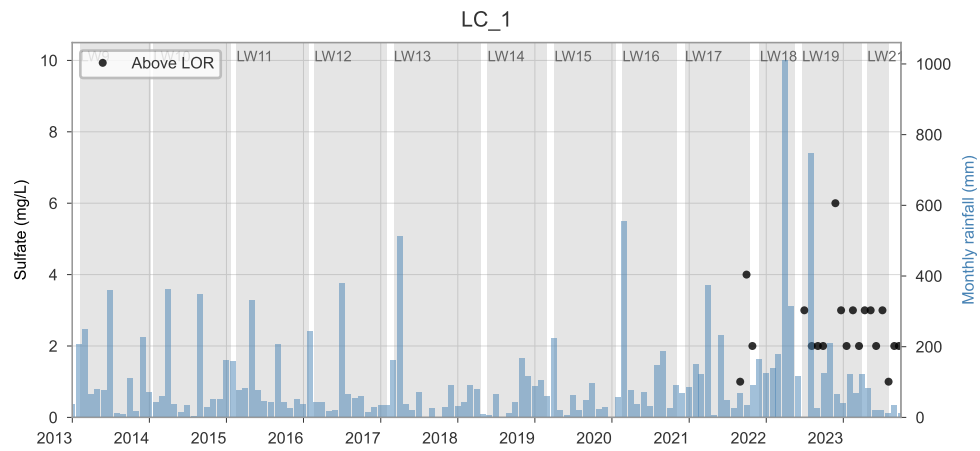


LC9_POOL2

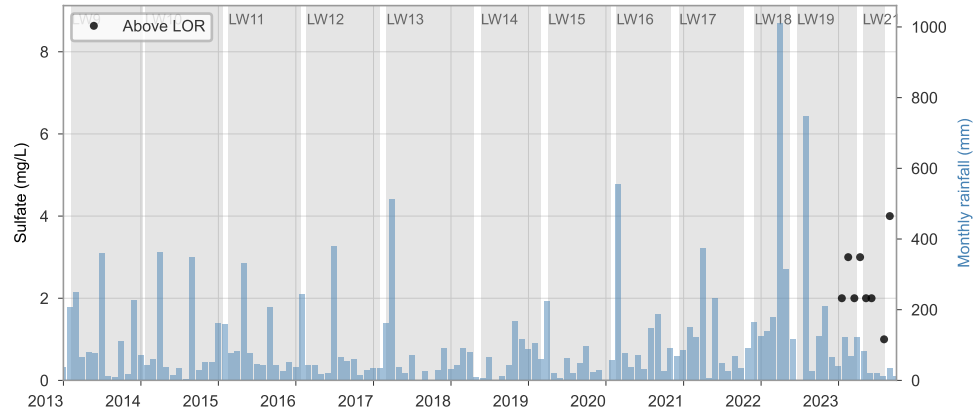


LC9_POOL2

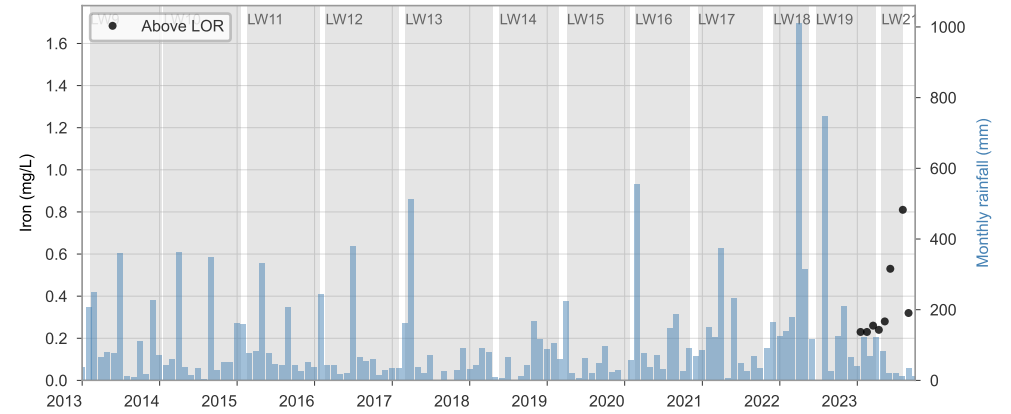




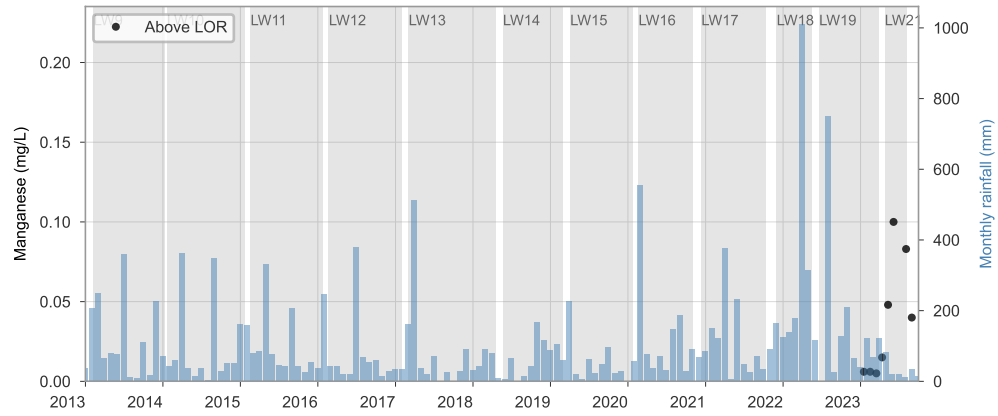
LC_2



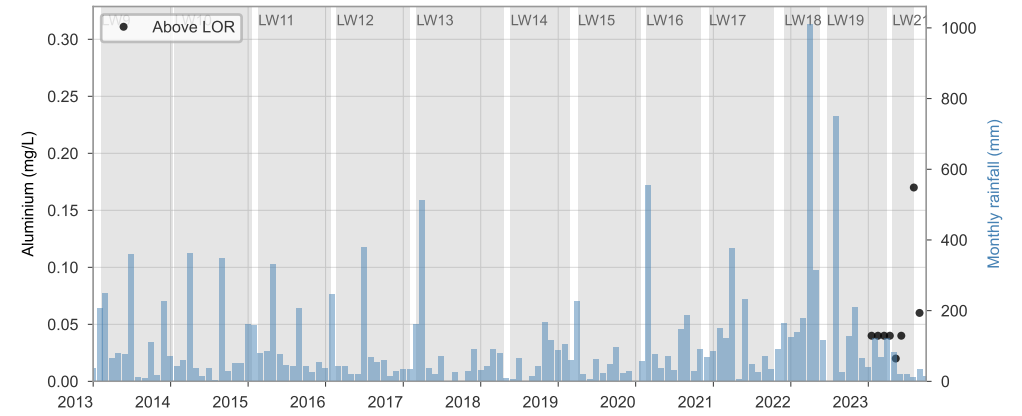
LC_2



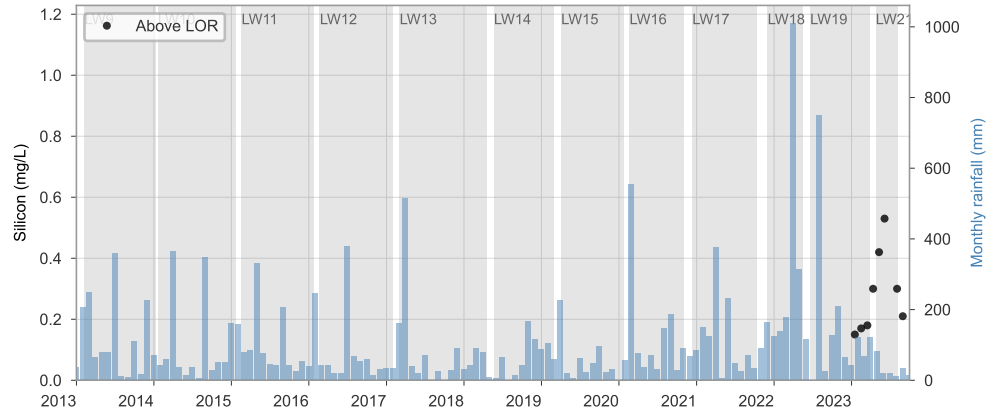
LC_2



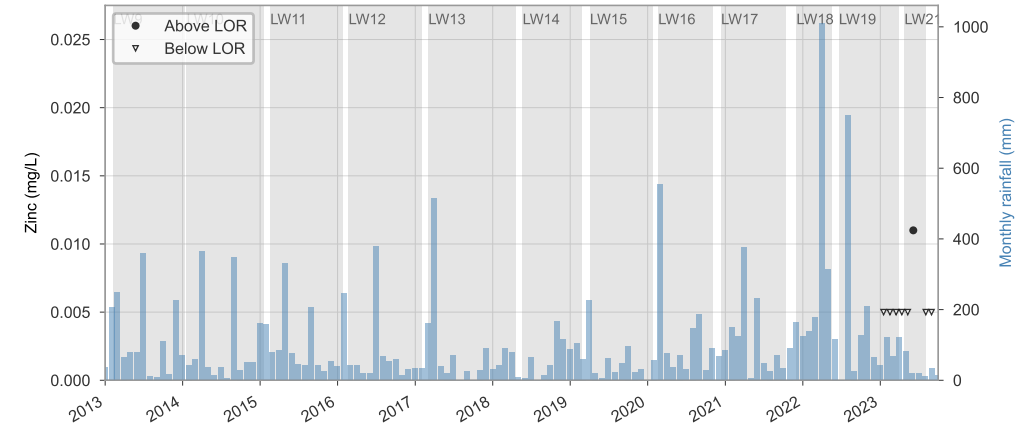
LC_2

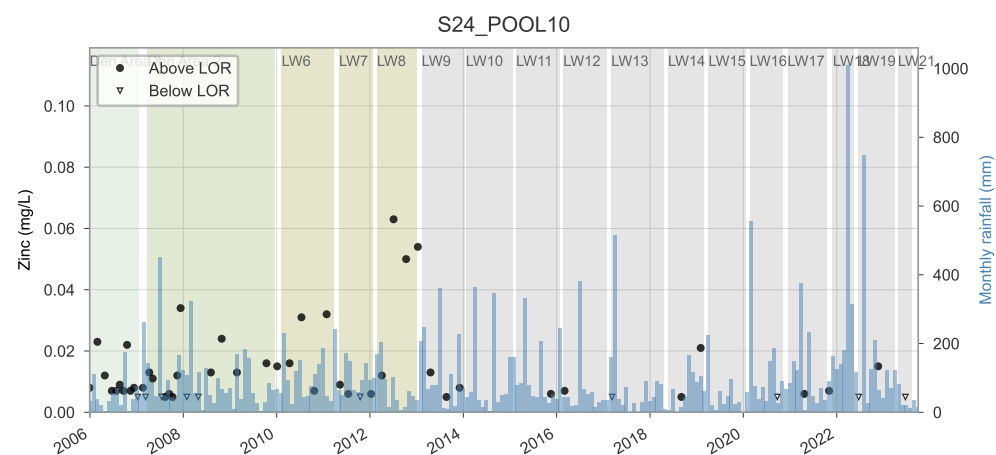
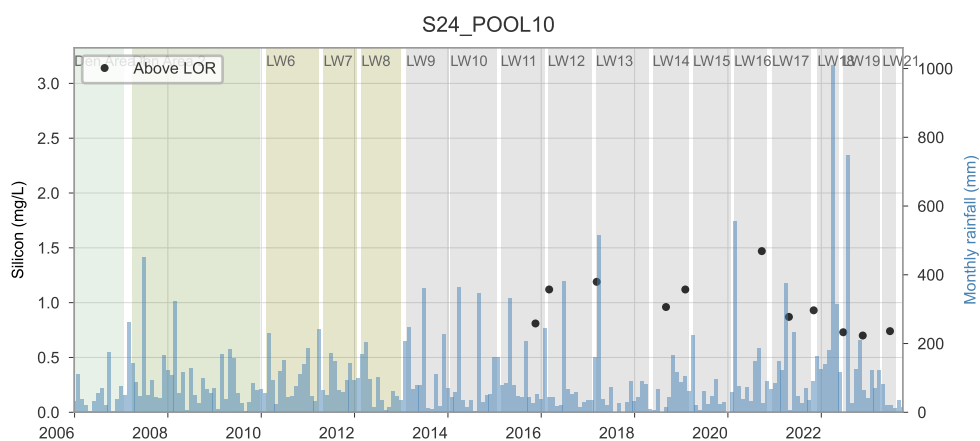
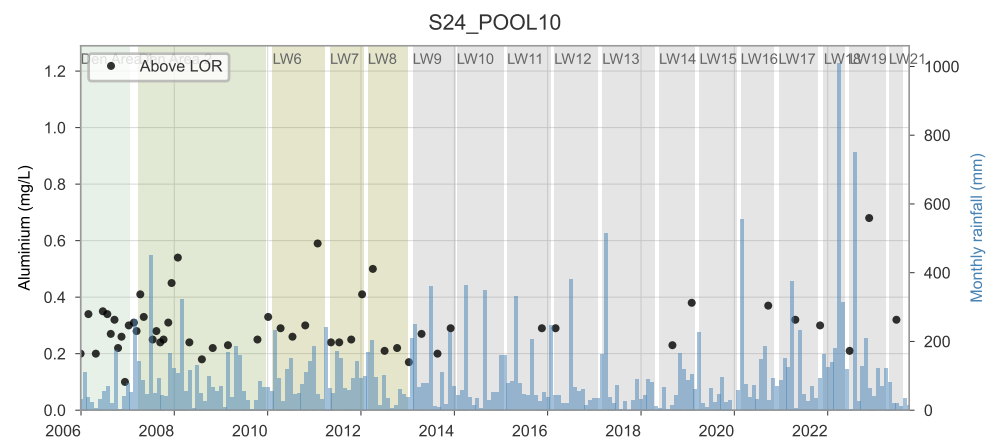
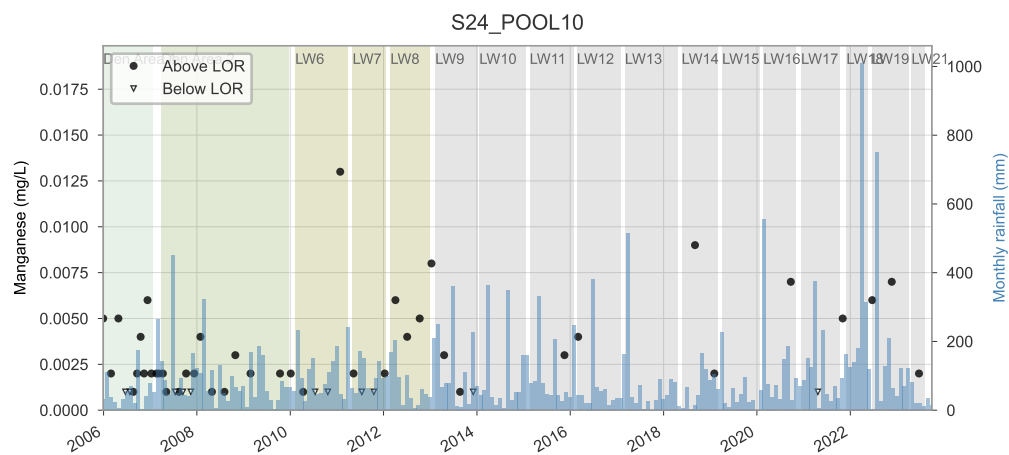
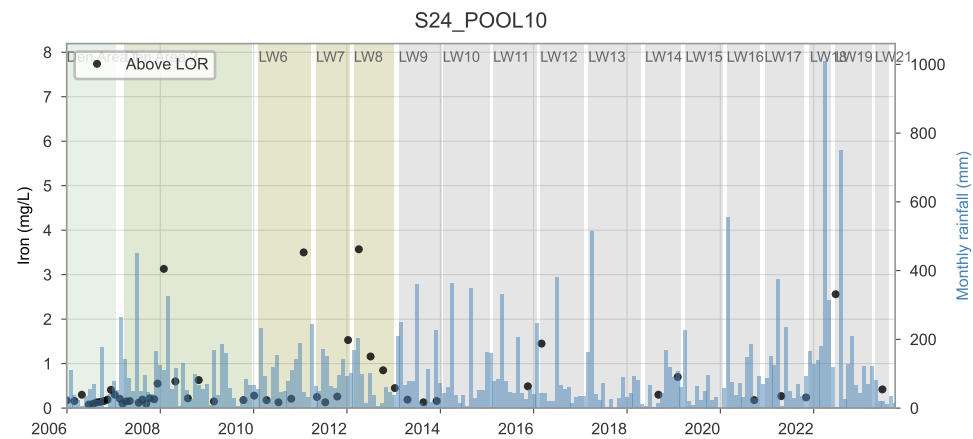
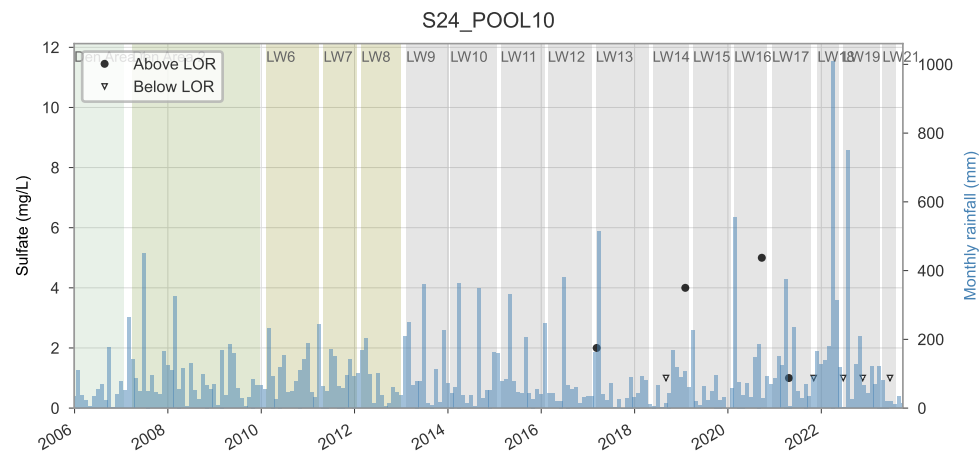


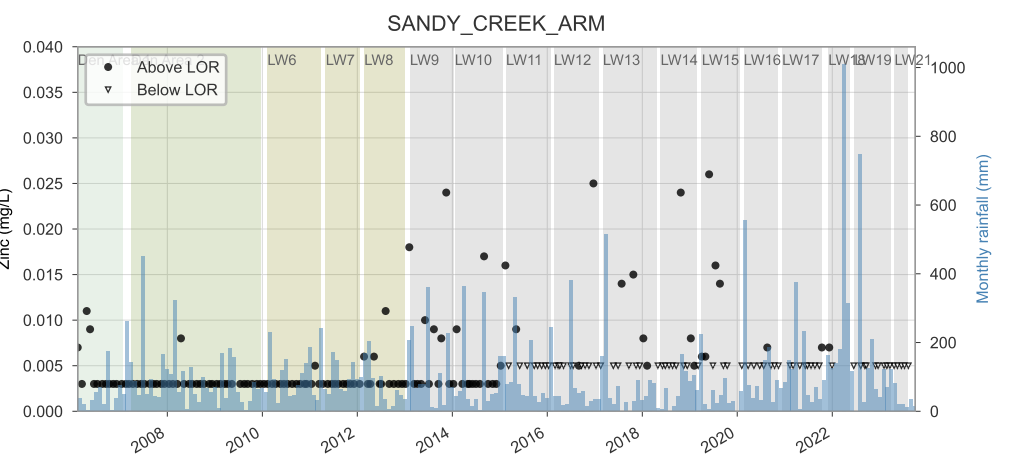
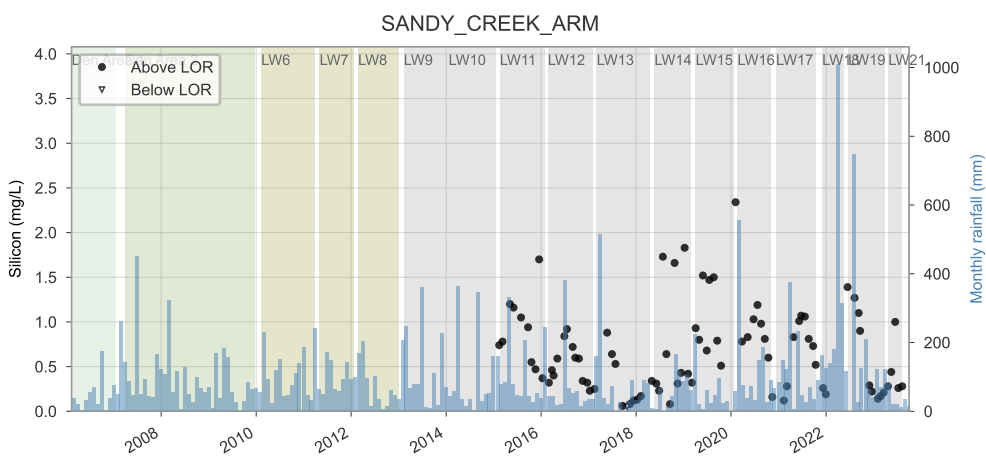
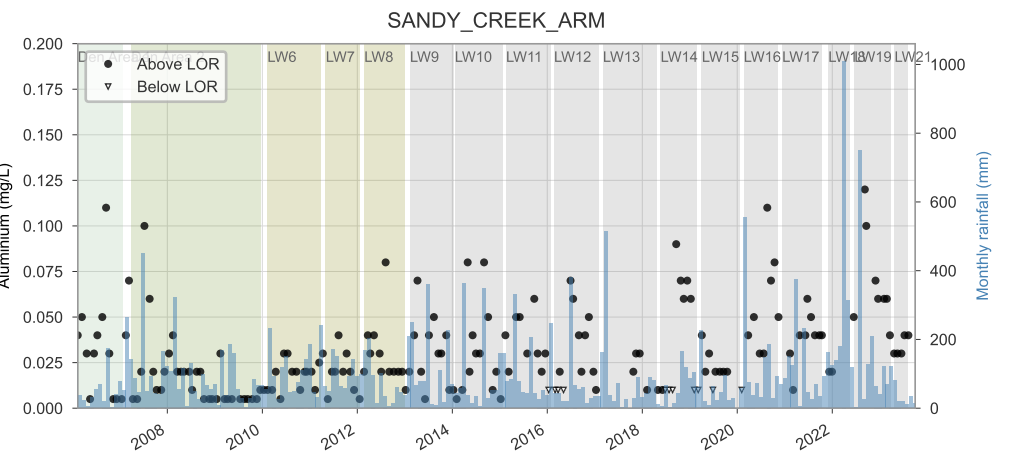
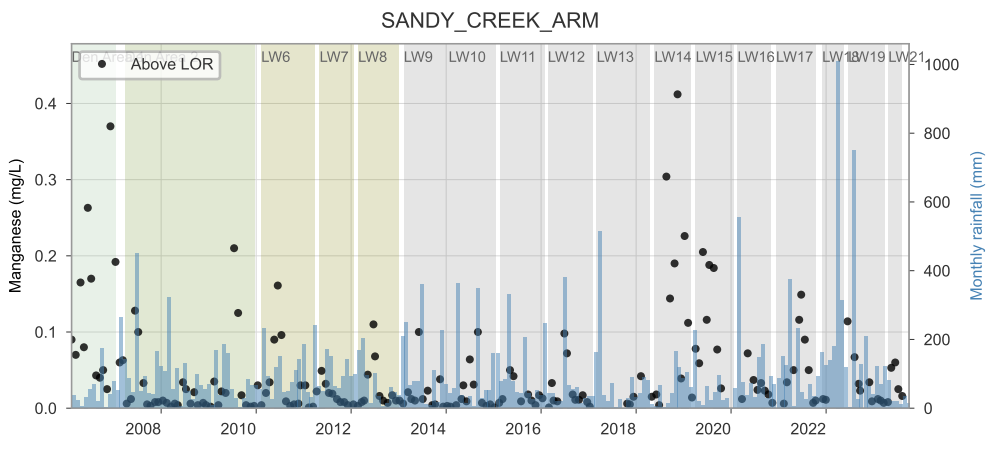
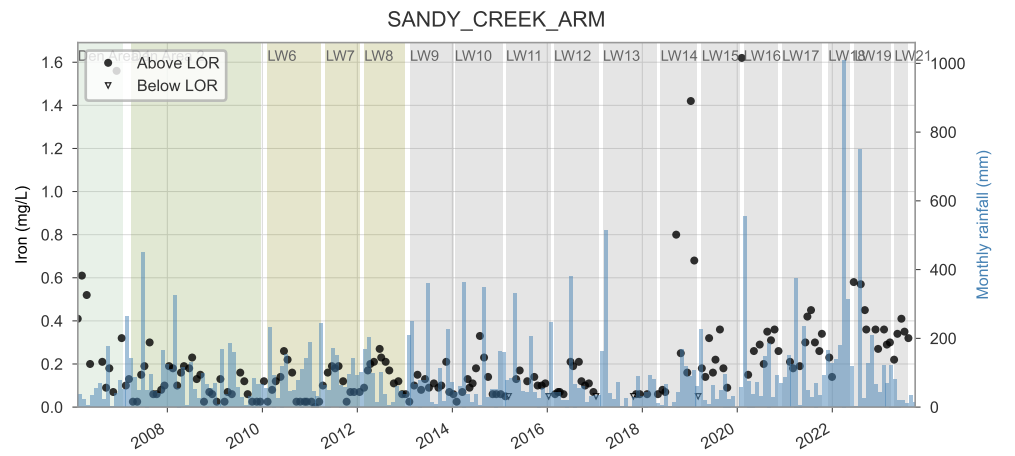
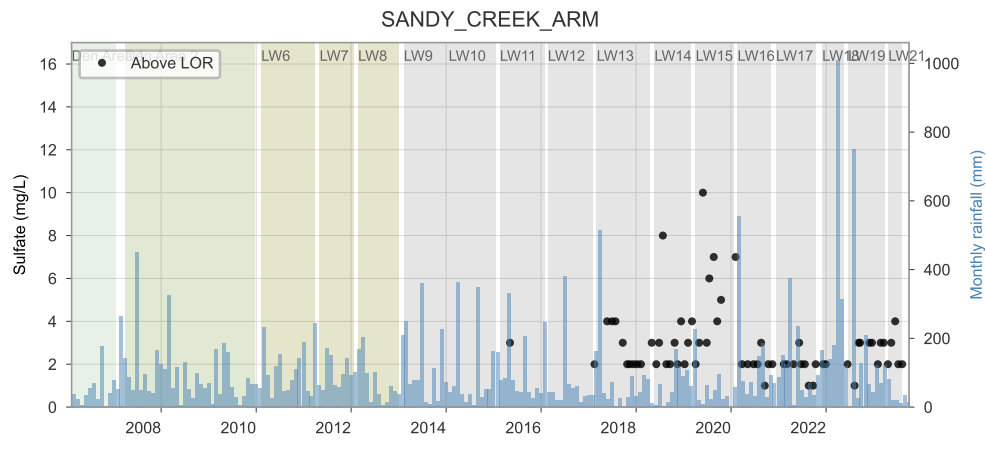
LC_2



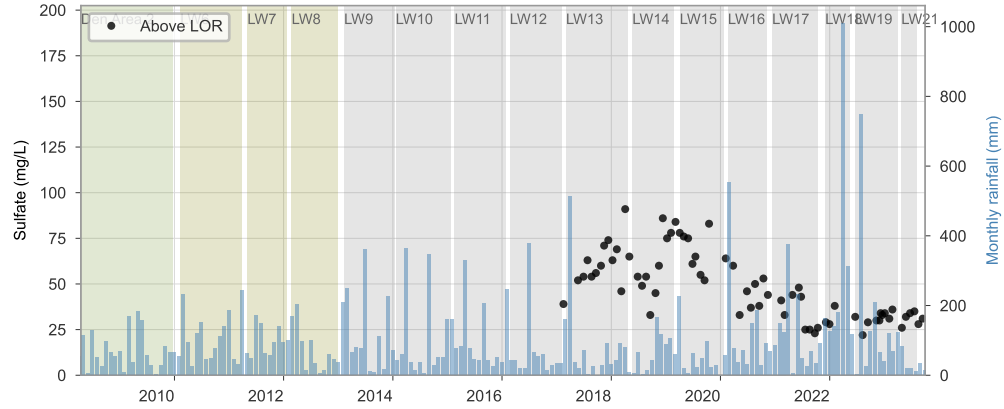
LC_2



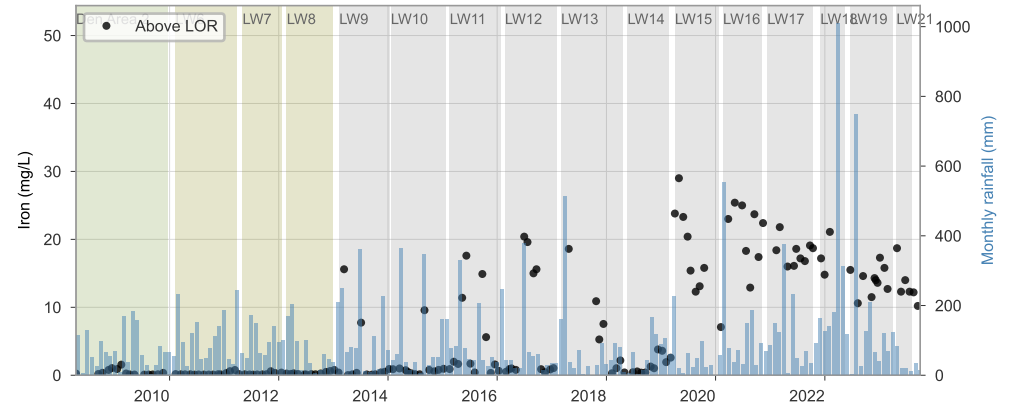




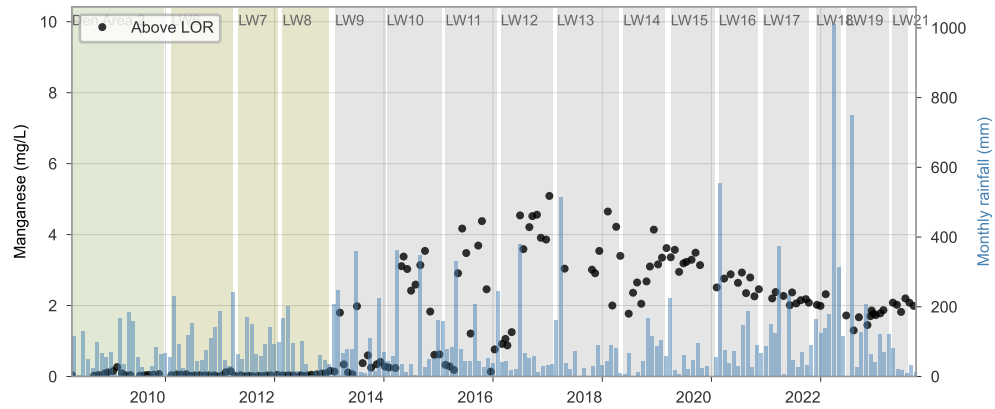
SC10C_POOL1



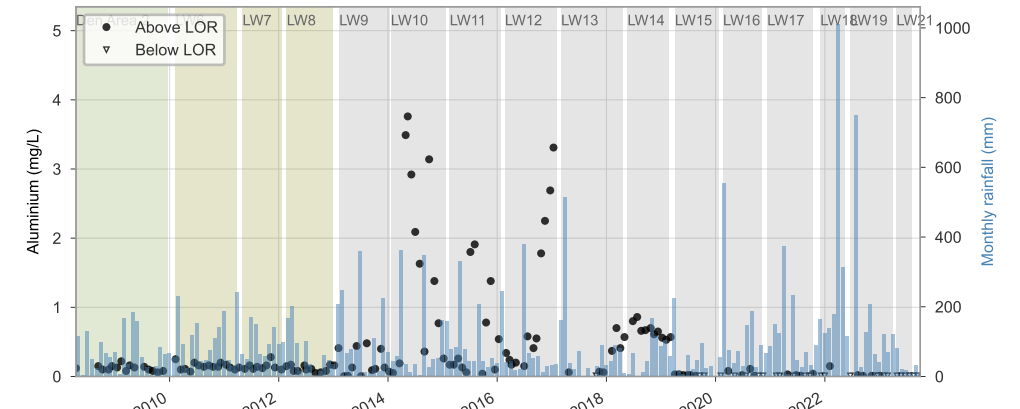
SC10C_POOL1



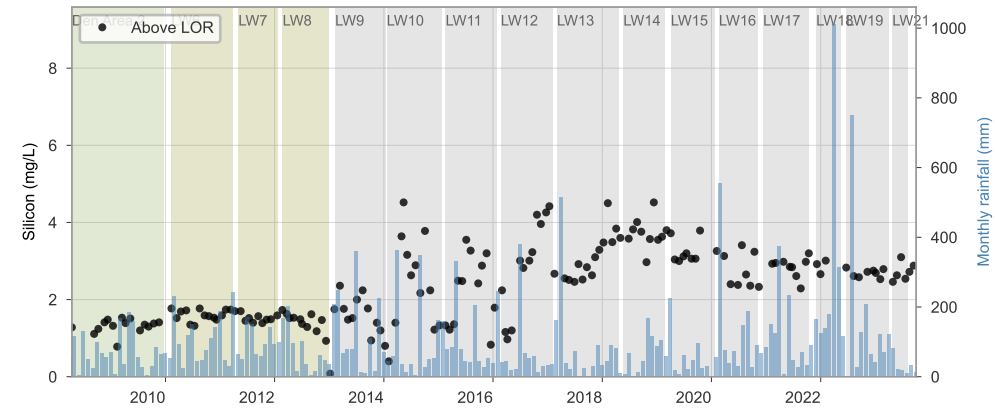
SC10C_POOL1



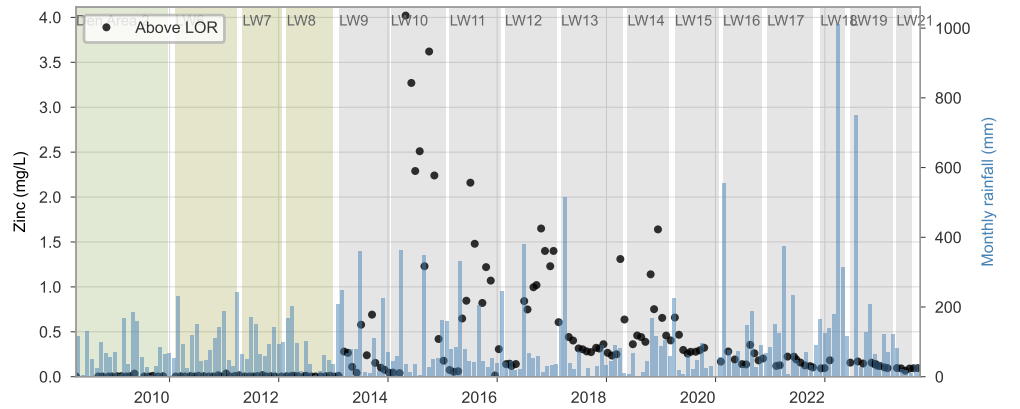
SC10C_POOL1



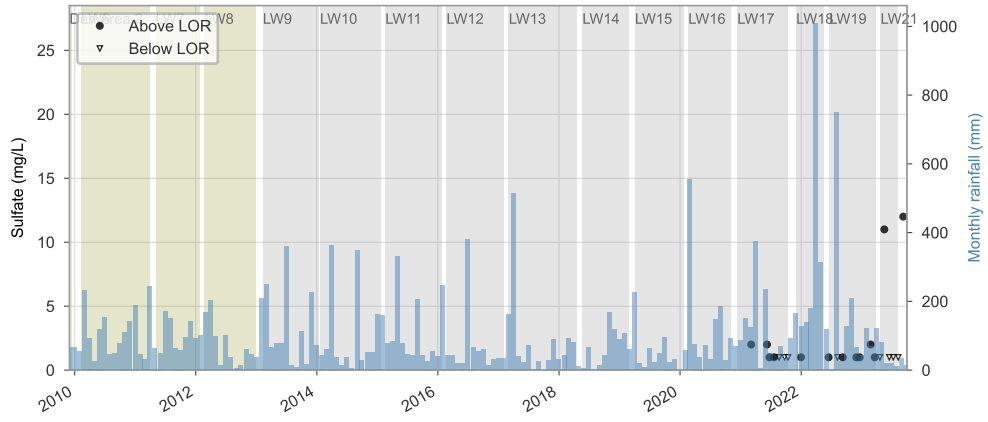
SC10C_POOL1



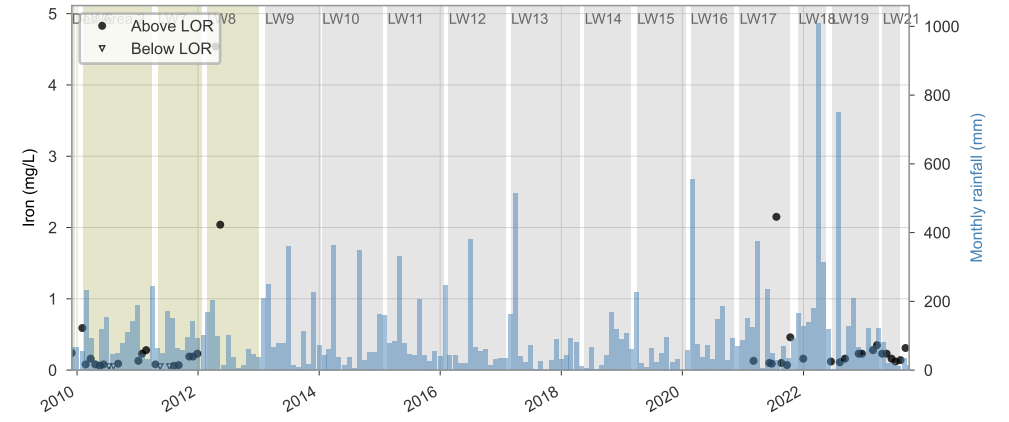
SC10C_POOL1



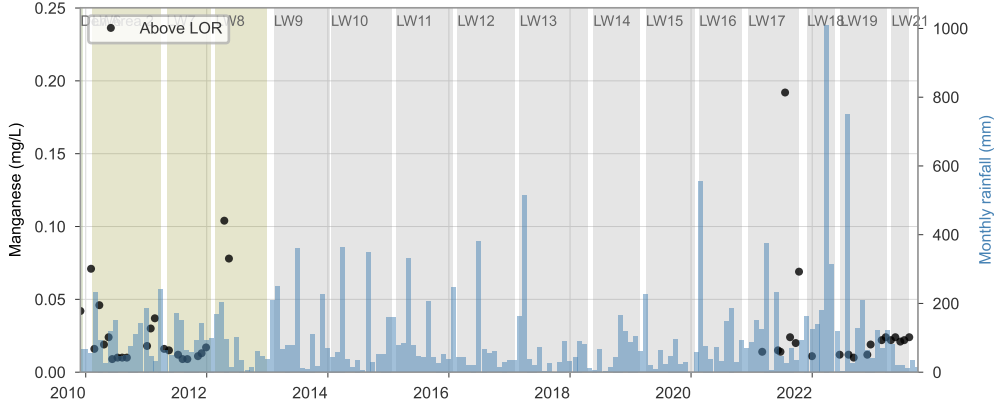
SC10_POOL15



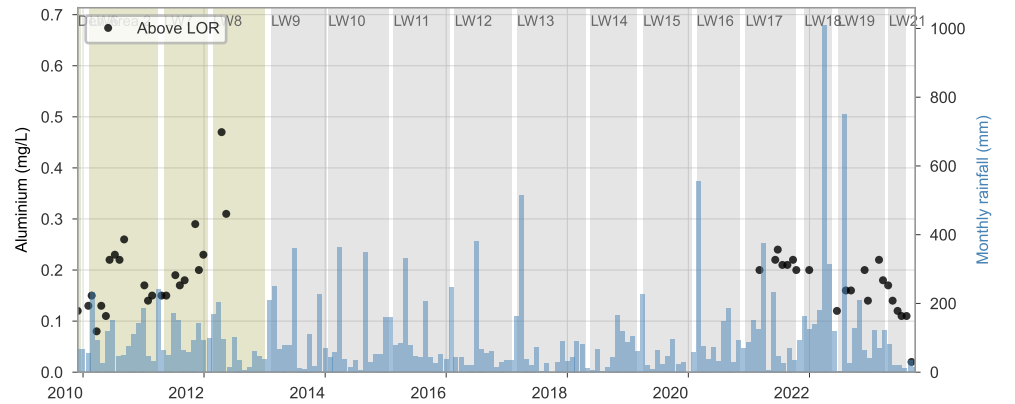
SC10_POOL15



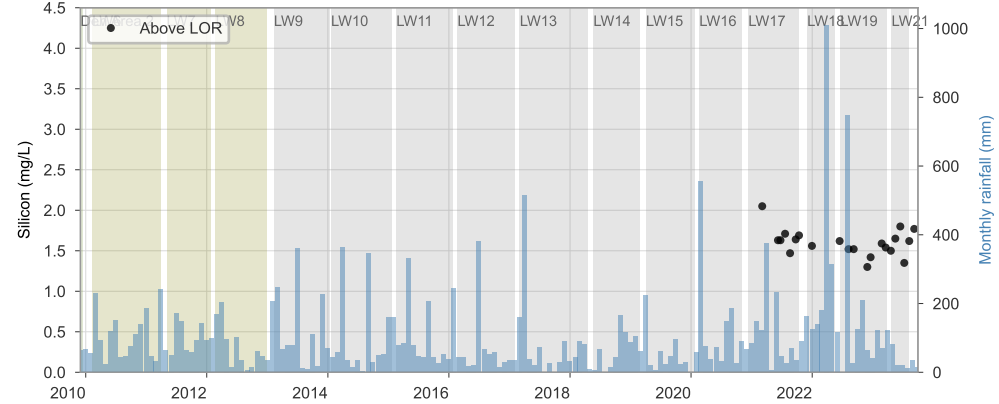
SC10_POOL15



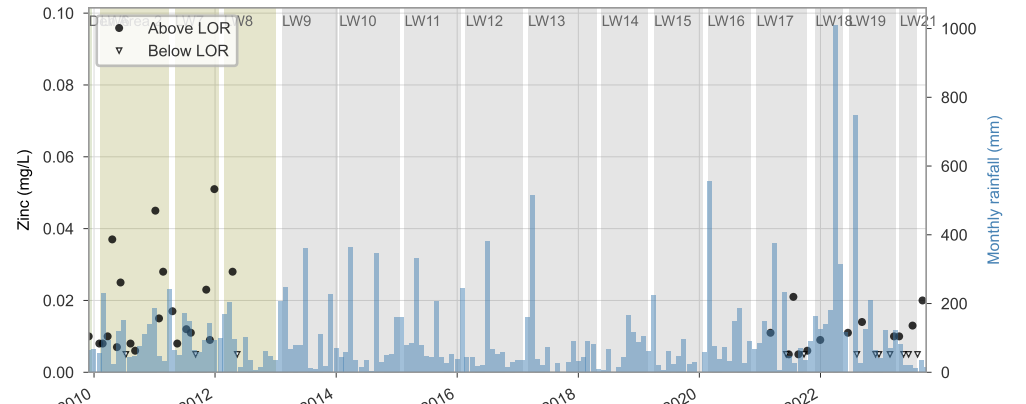
SC10_POOL15



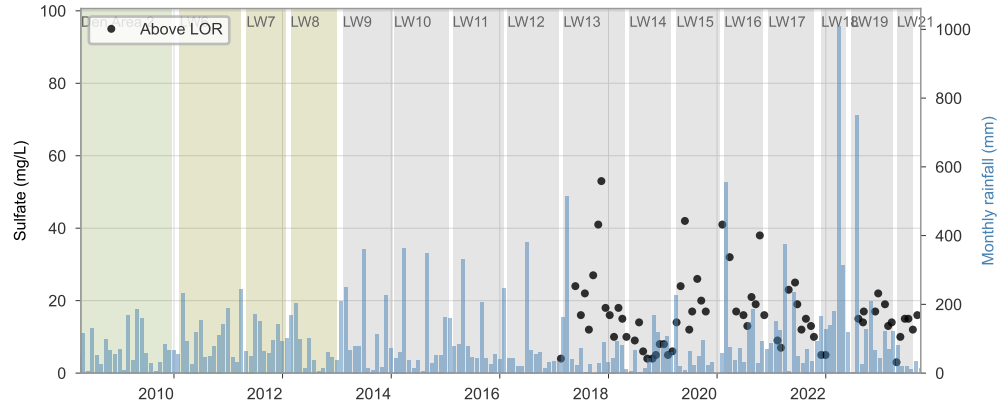
SC10_POOL15



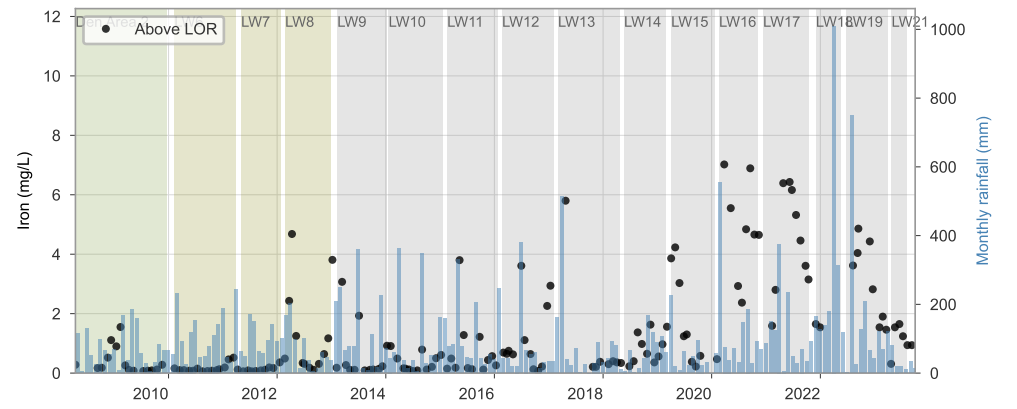
SC10_POOL15



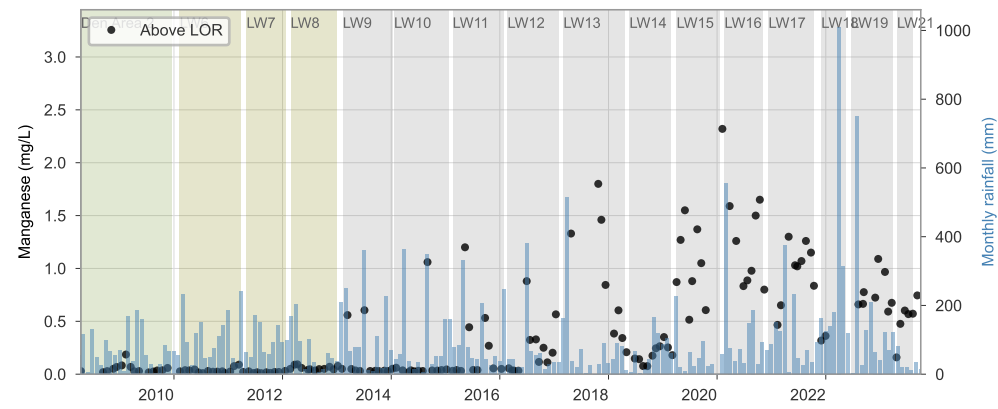
SC10_ROCKBAR3



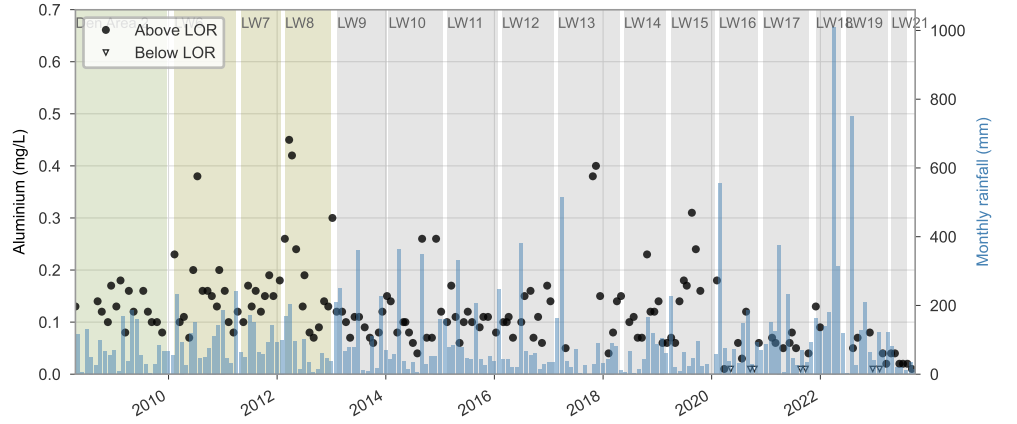
SC10_ROCKBAR3



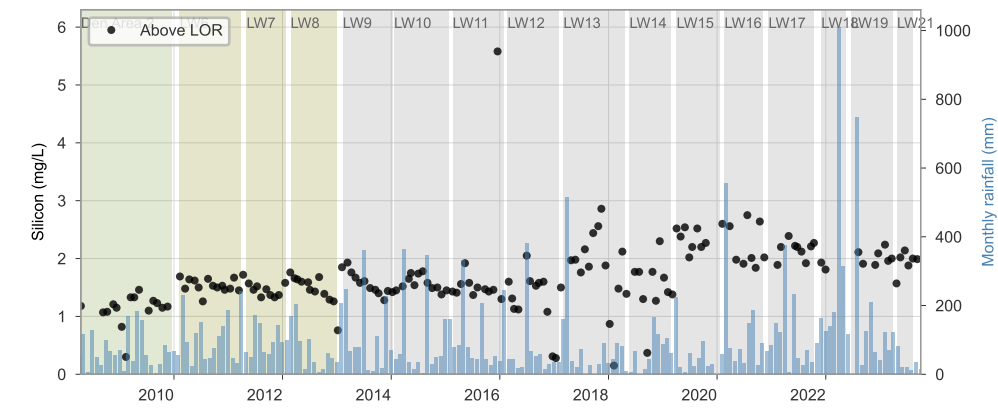
SC10_ROCKBAR3



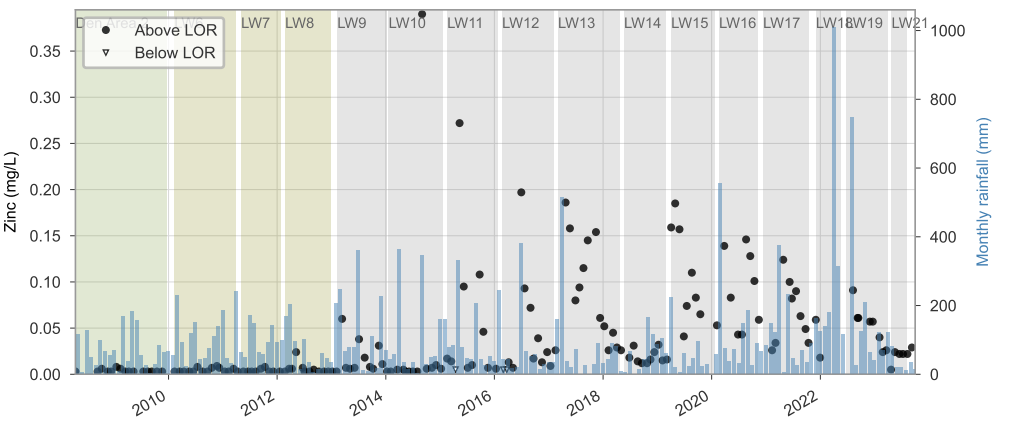
SC10_ROCKBAR3

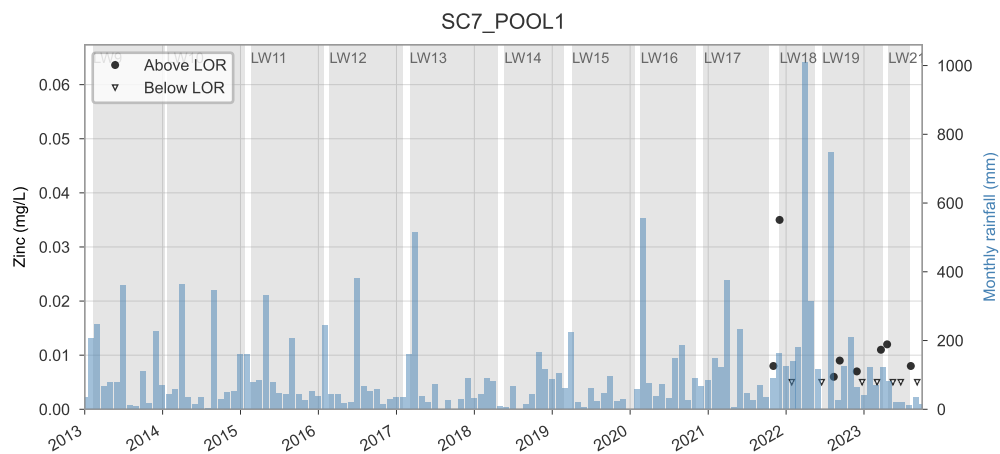
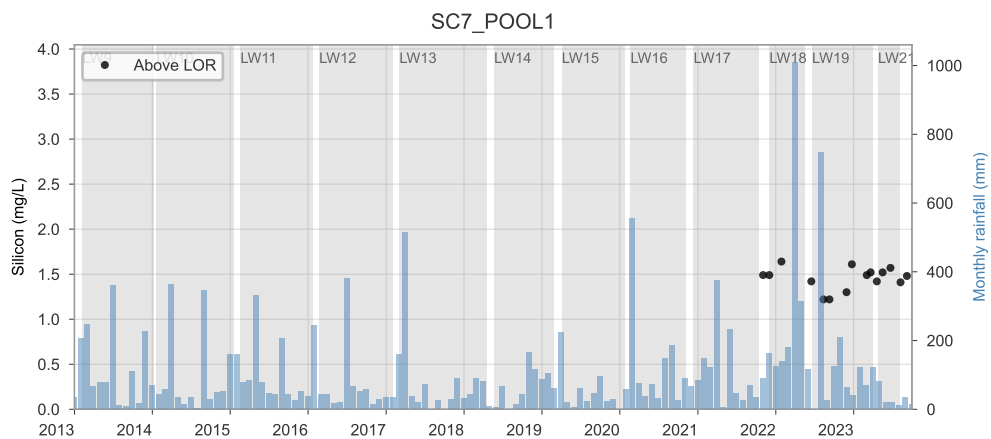
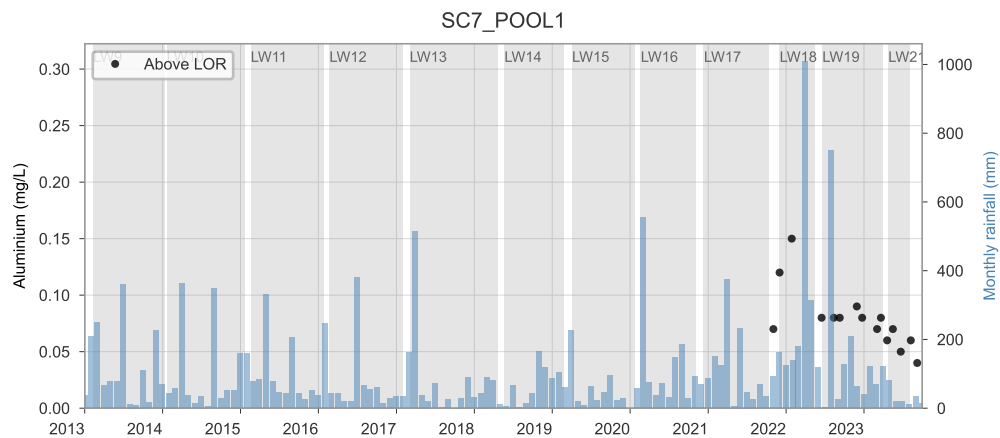
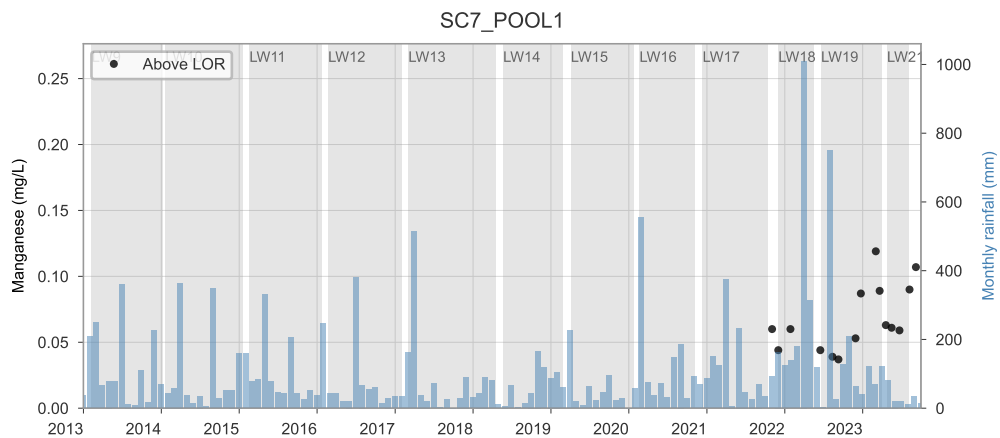
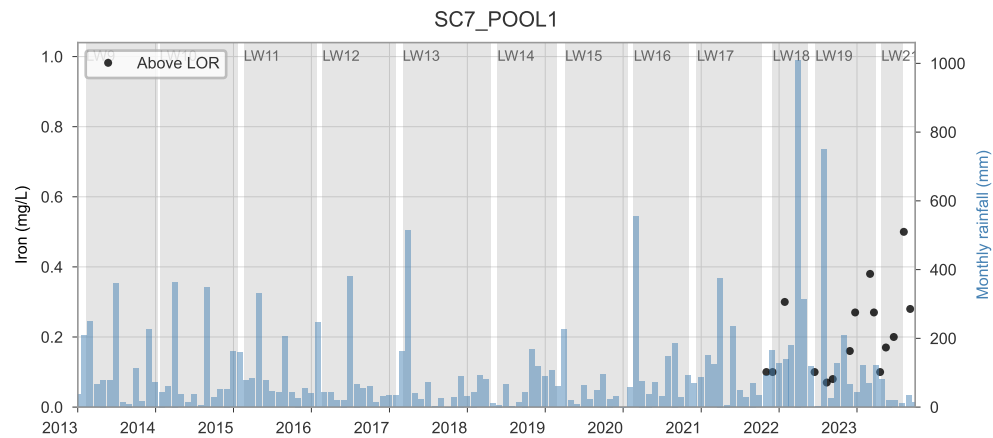
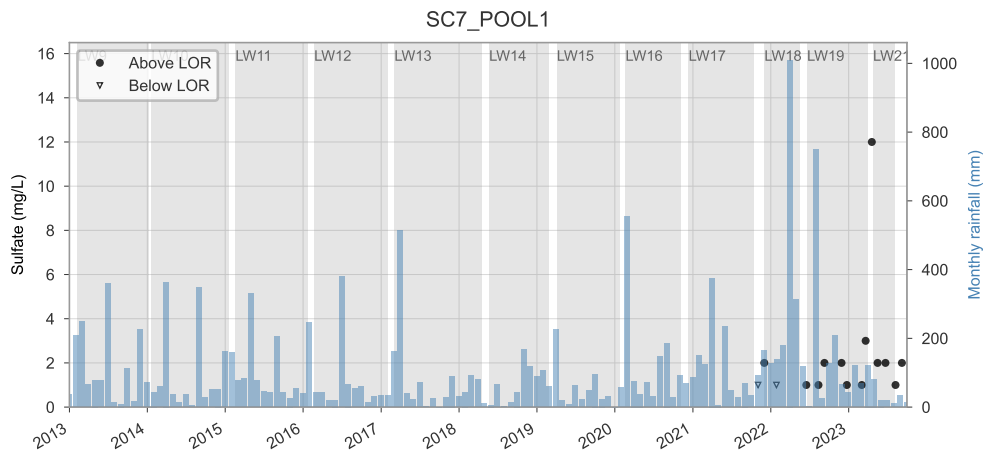


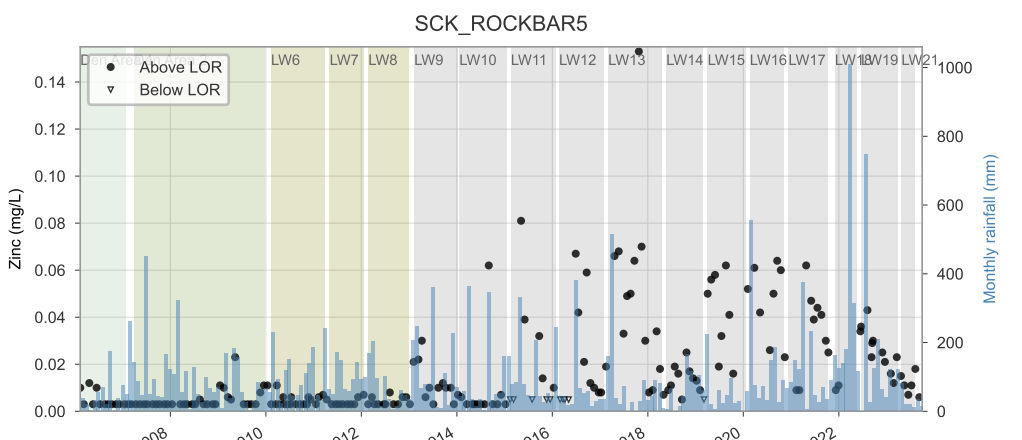
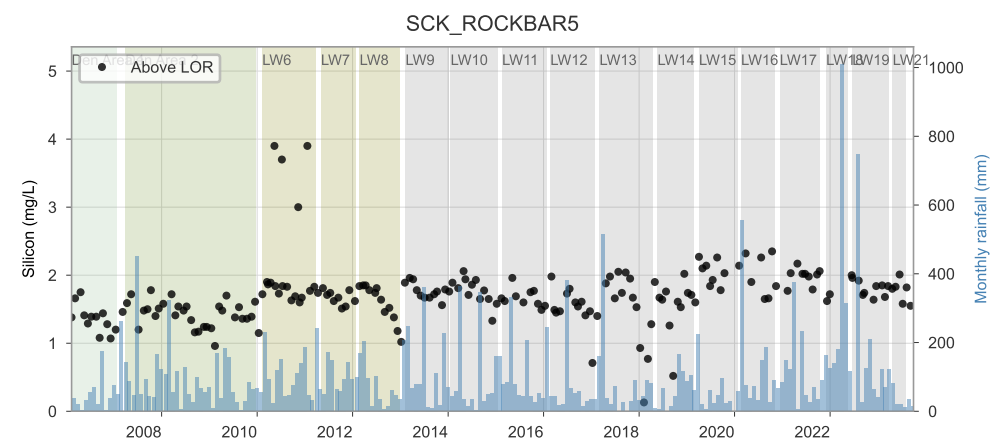
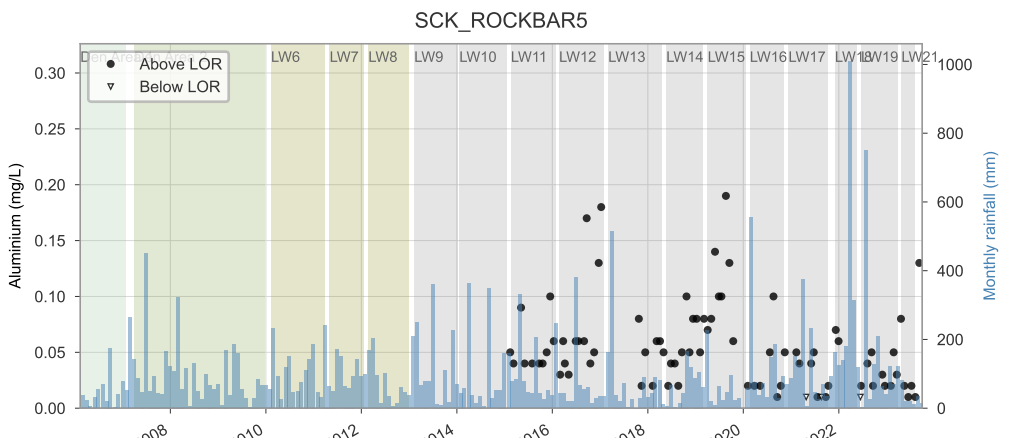
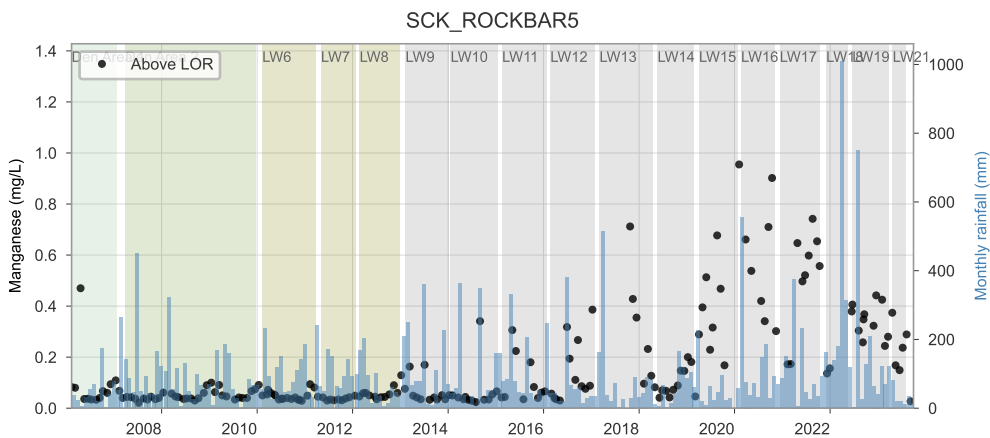
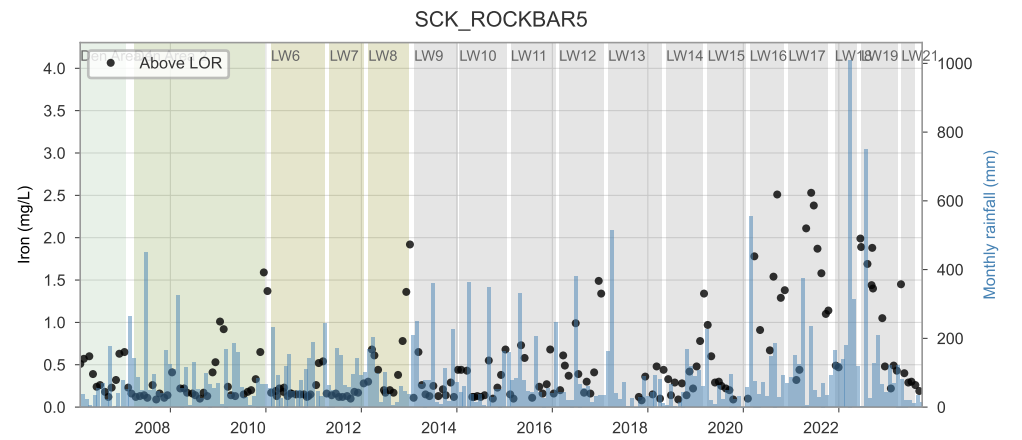
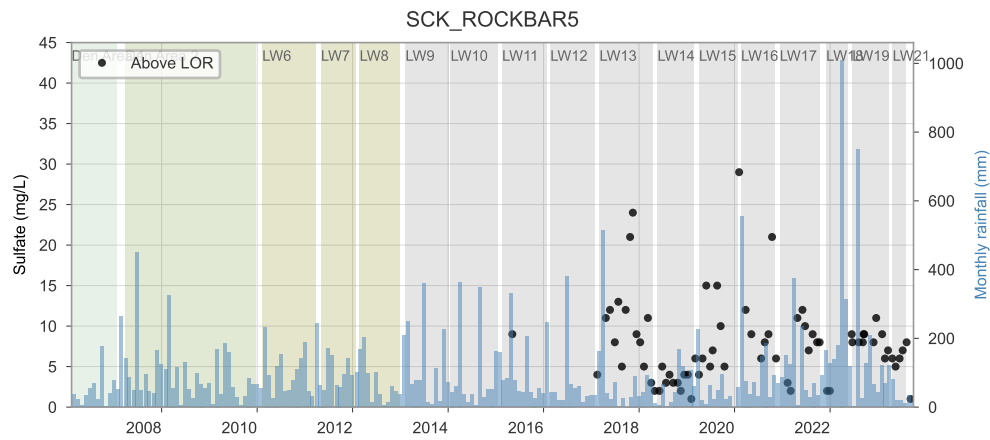
SC10_ROCKBAR3

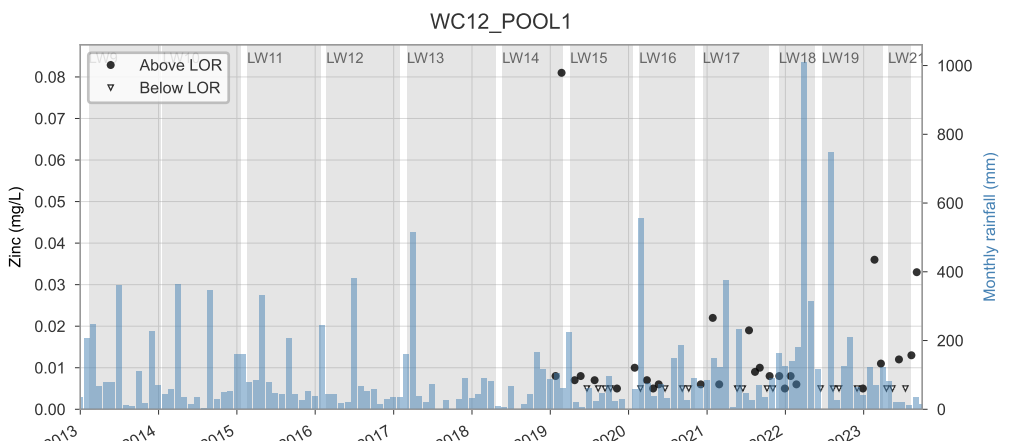
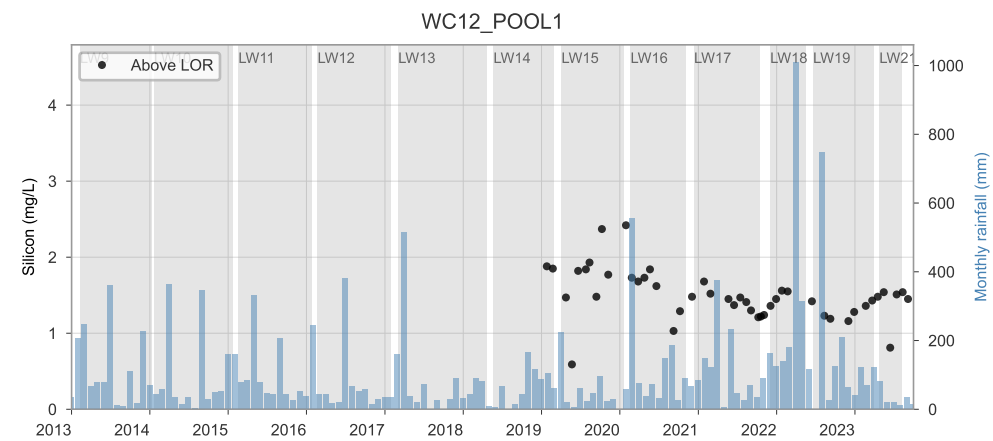
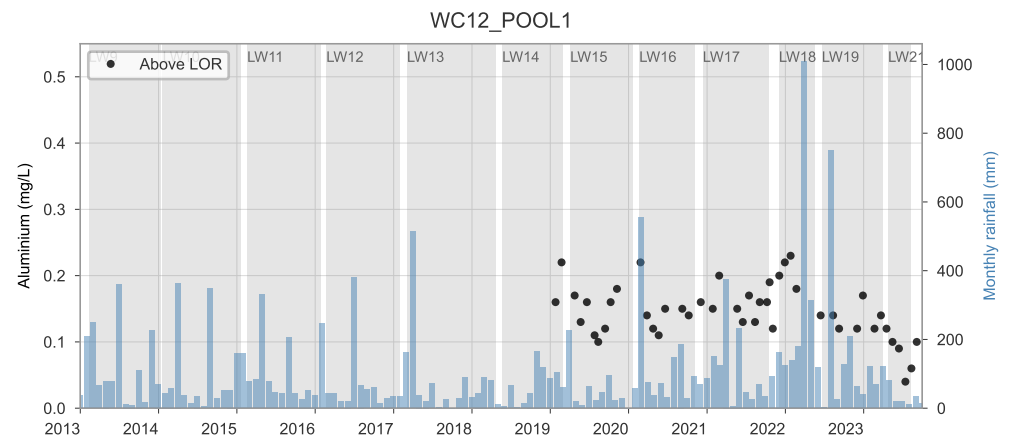
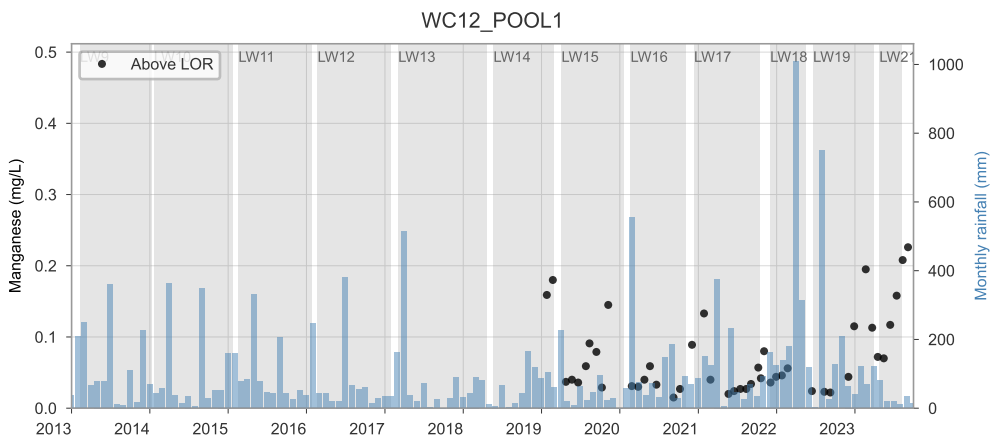
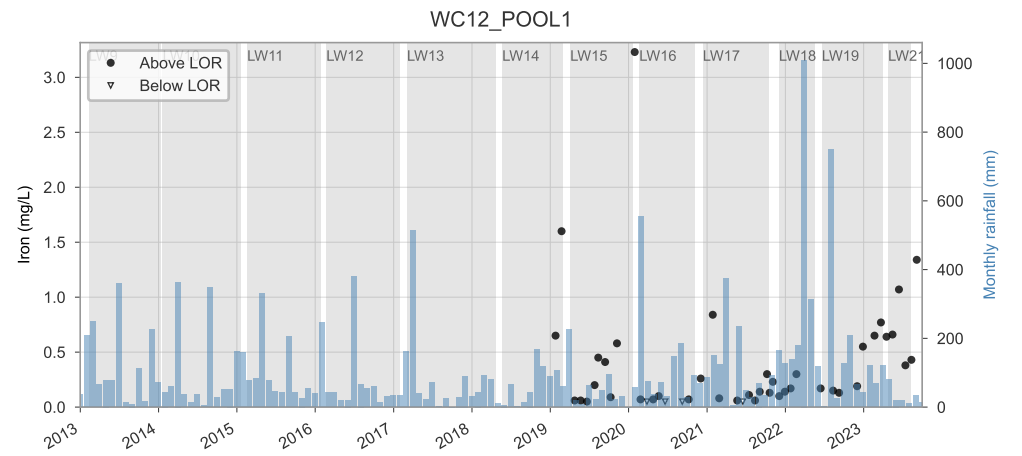
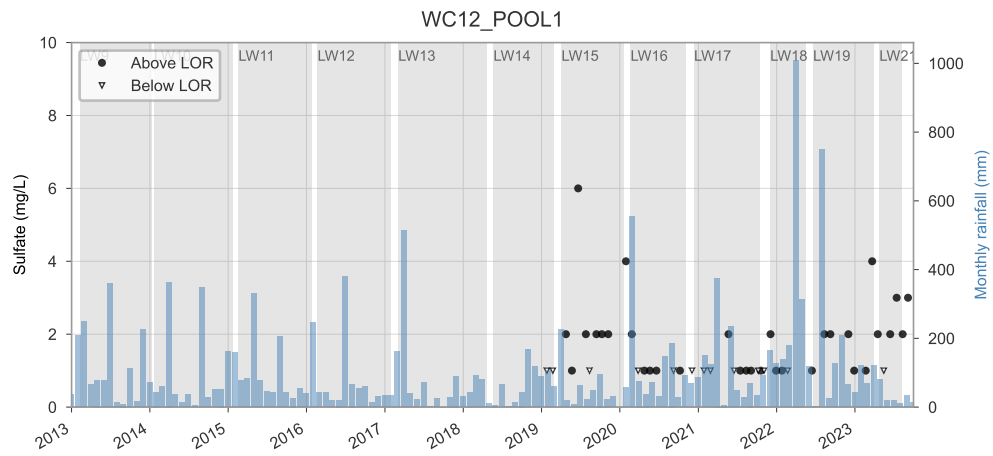


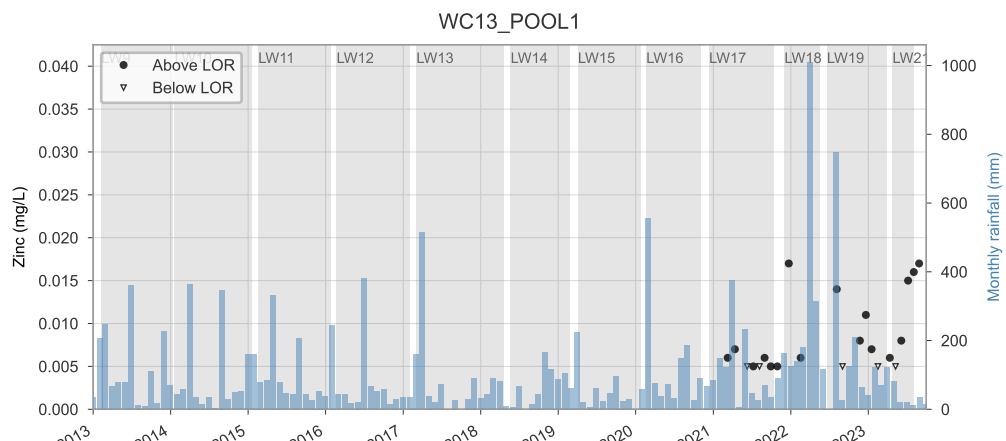
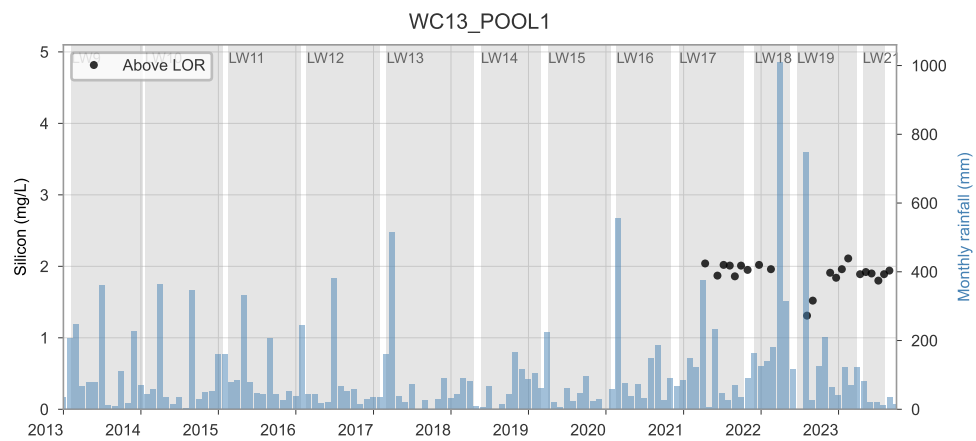
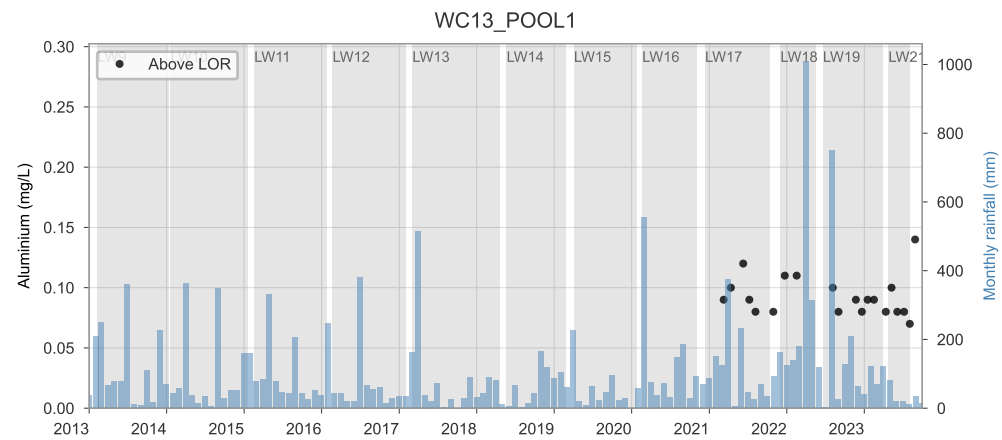
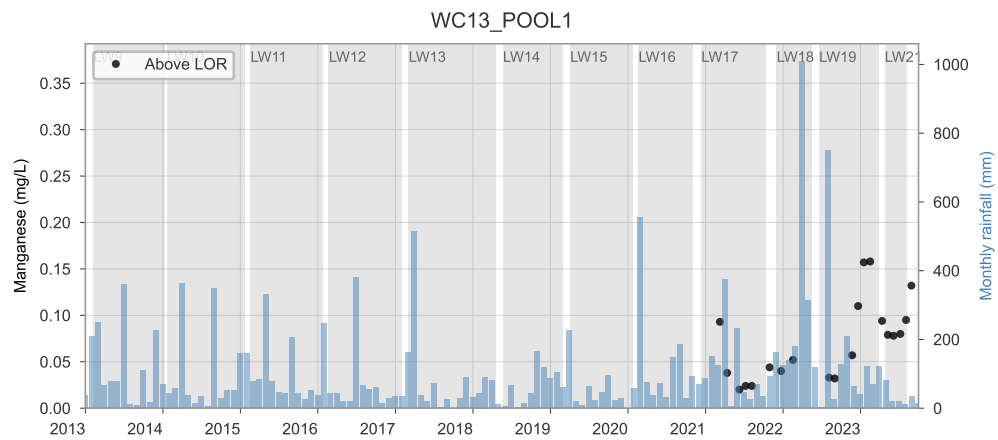
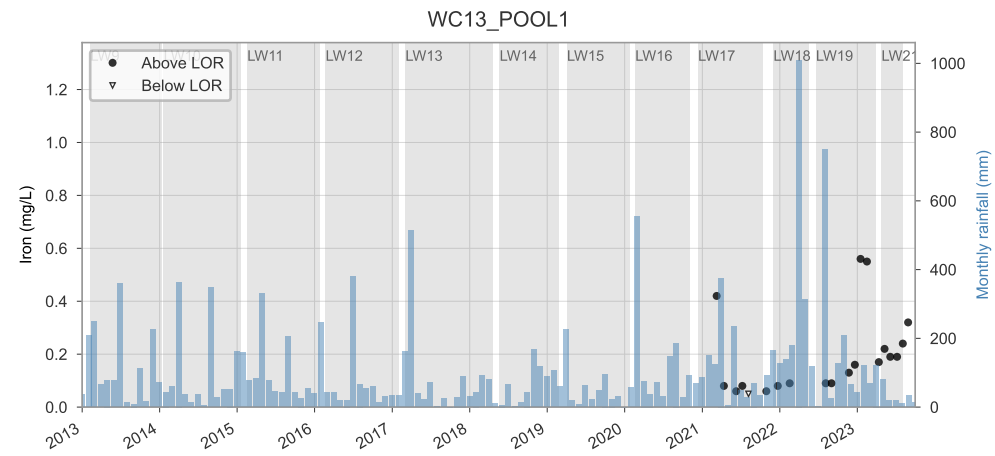
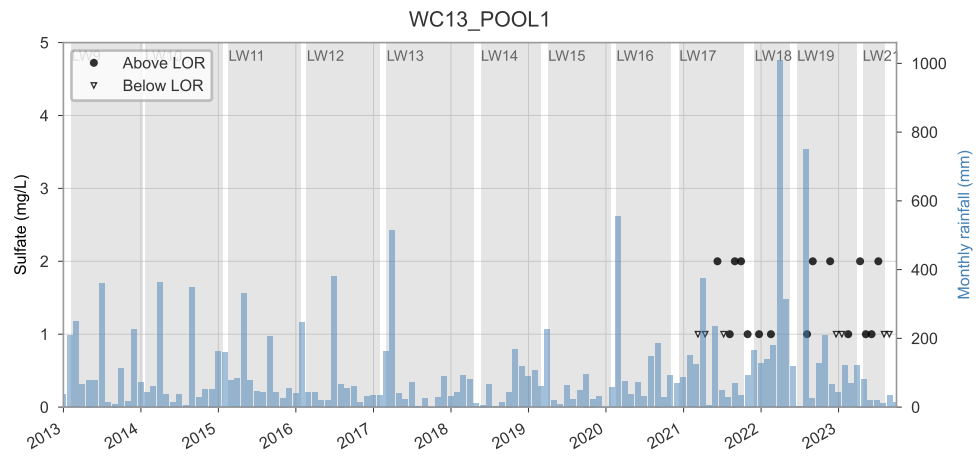
SC10_ROCKBAR3

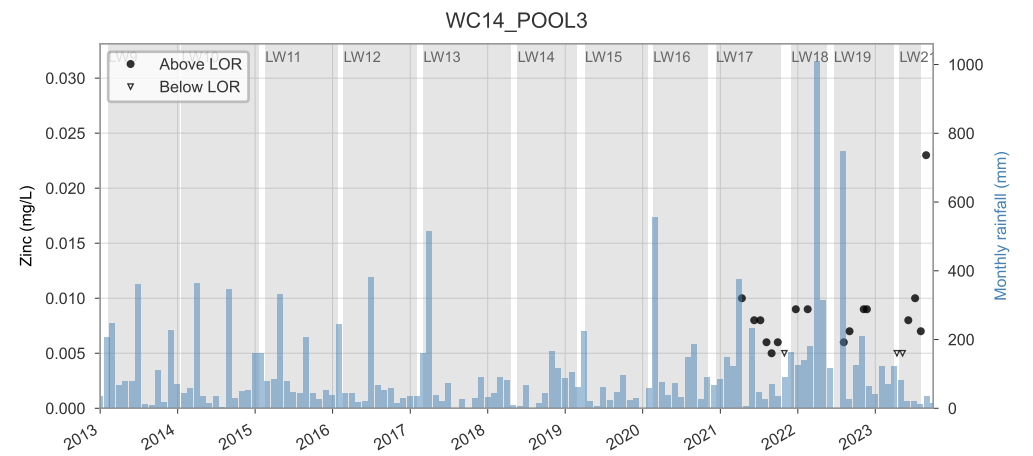
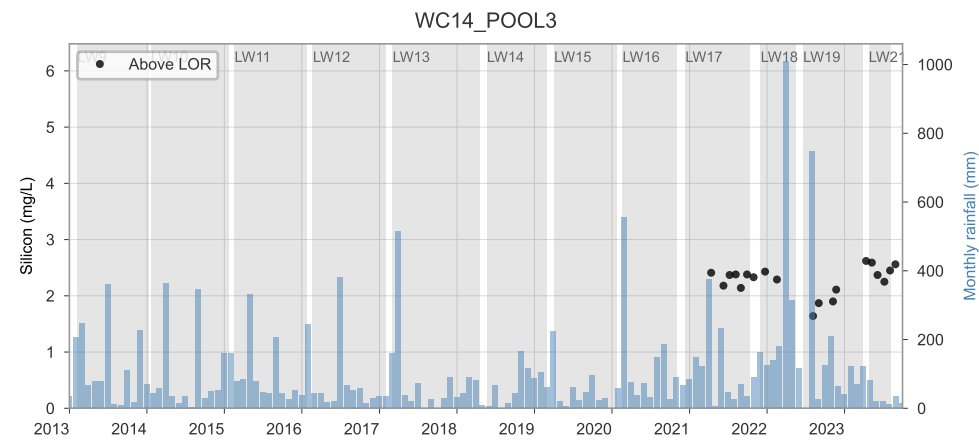
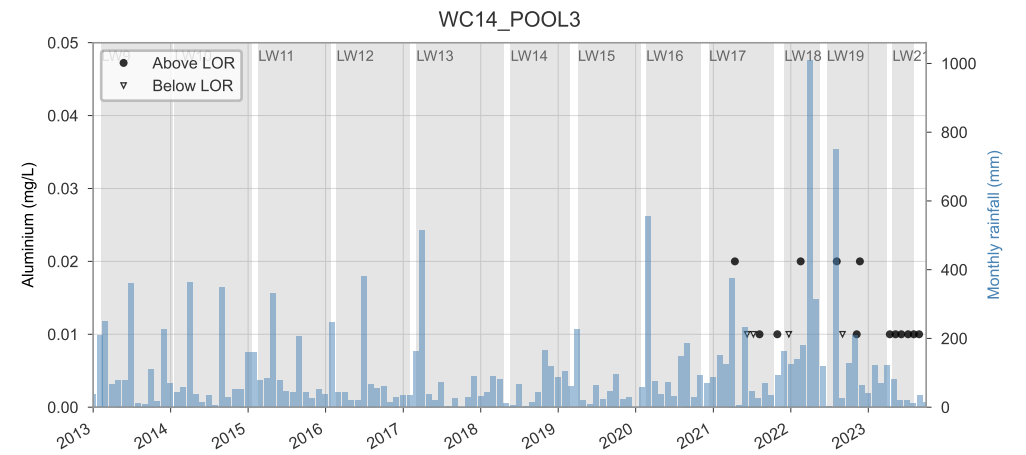
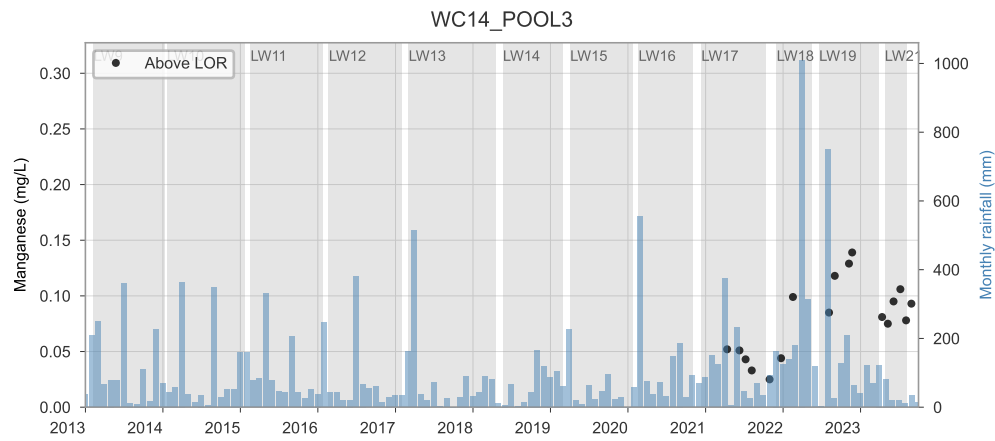
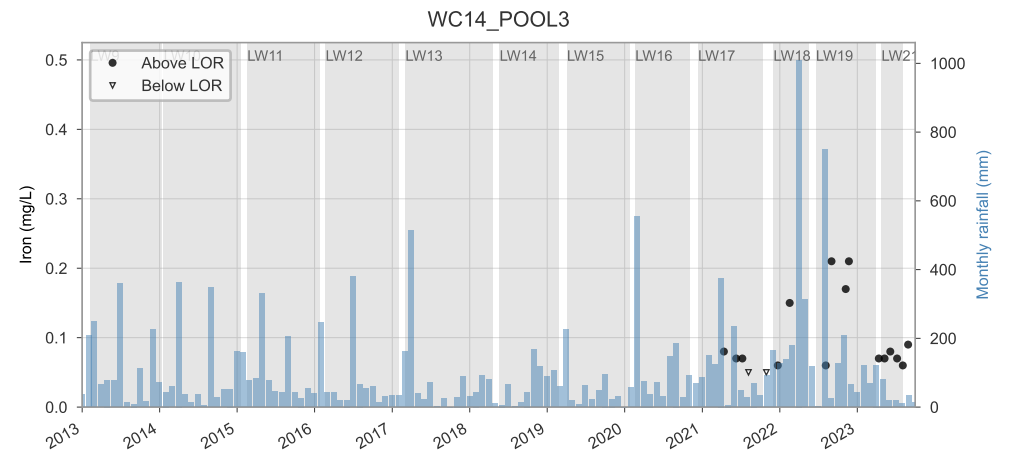
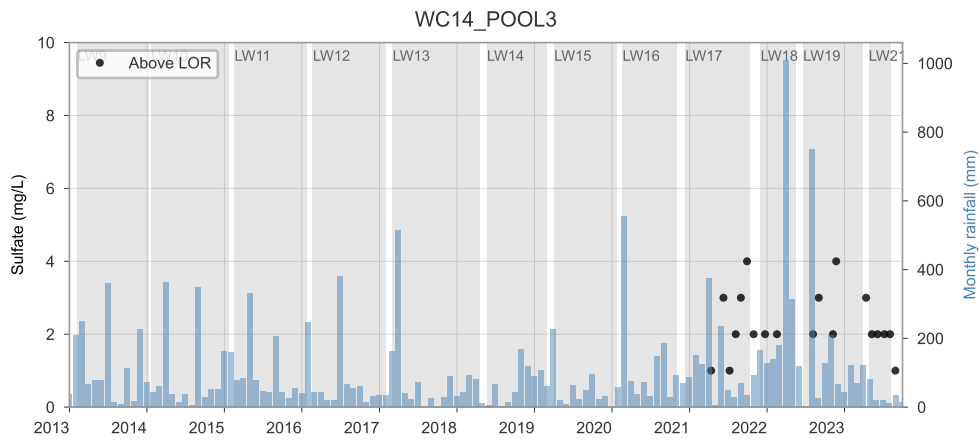


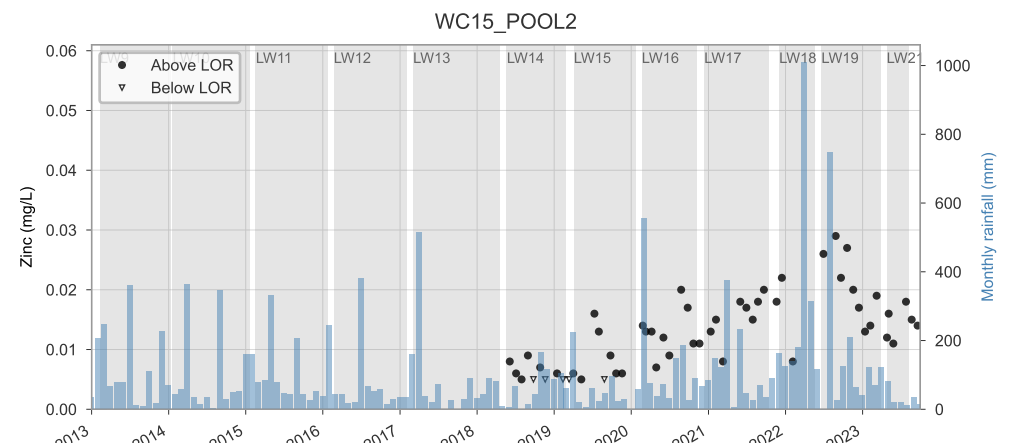
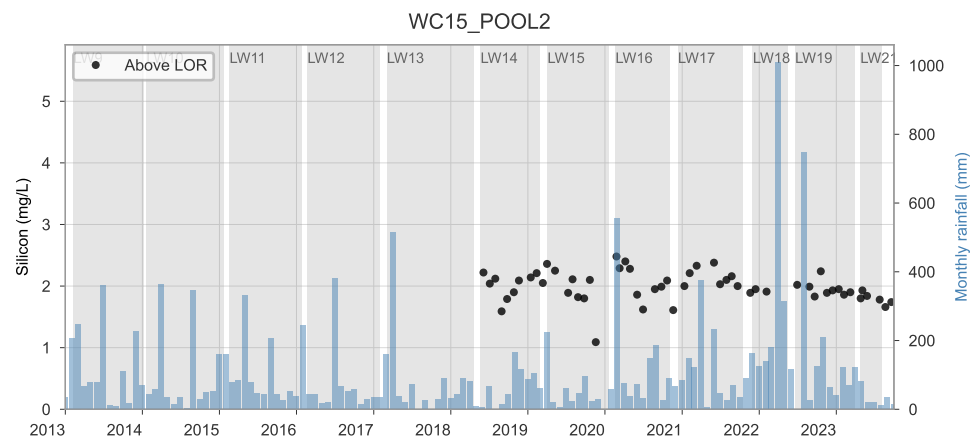
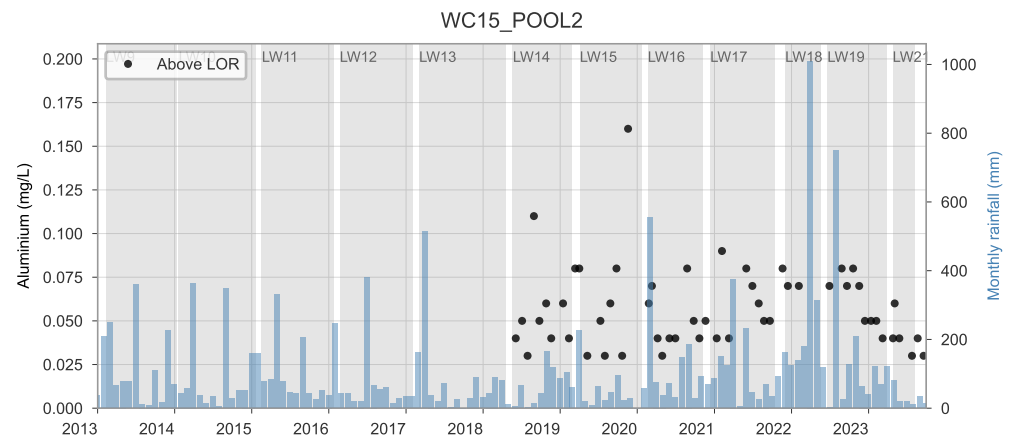
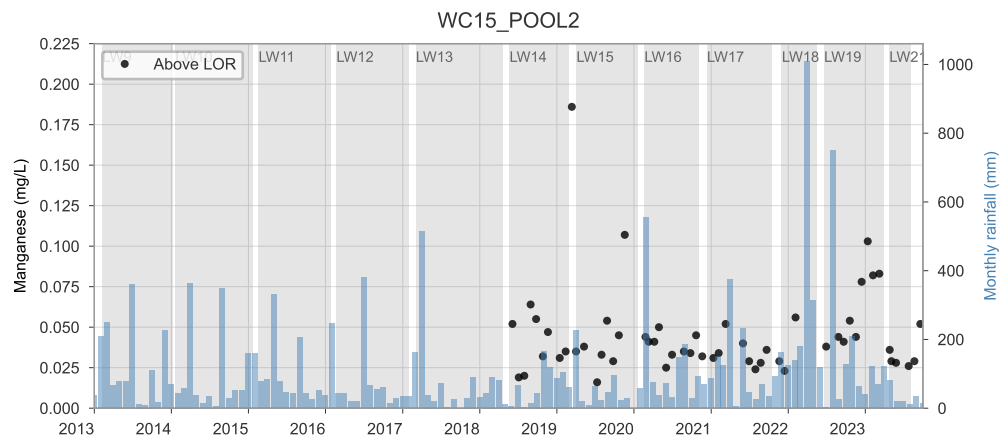
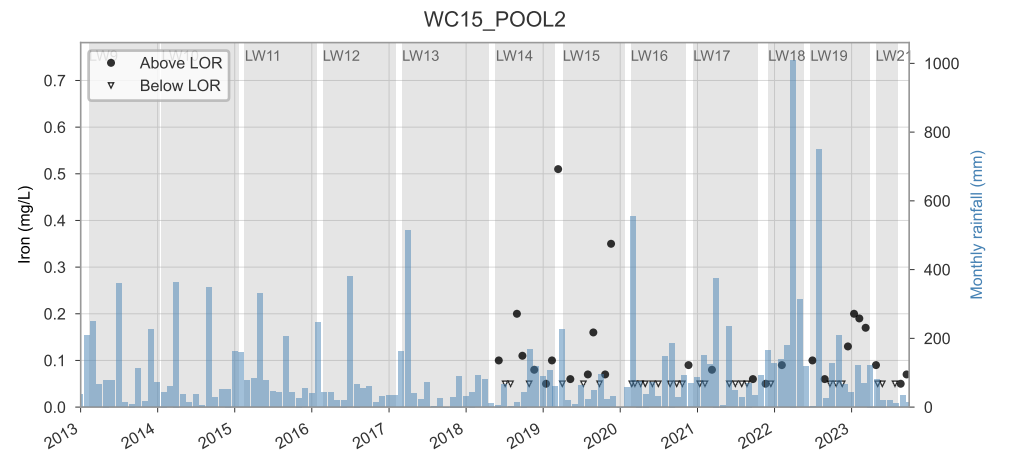
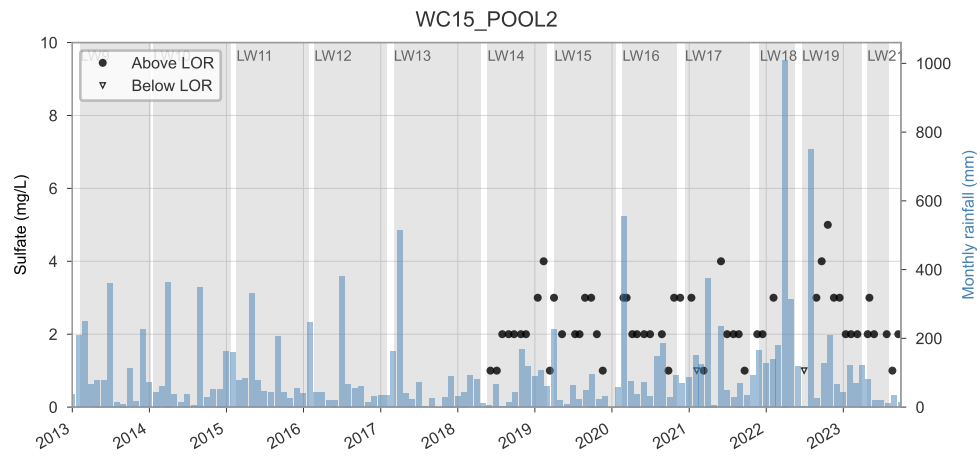


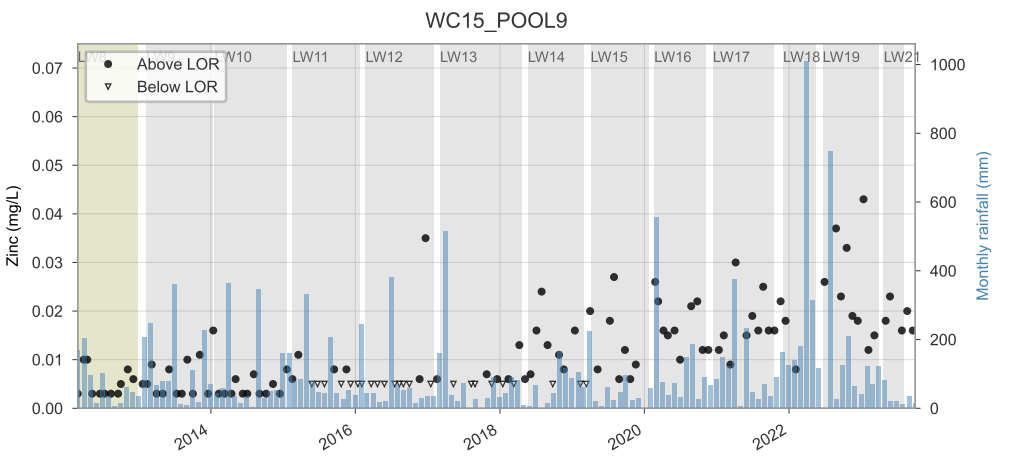
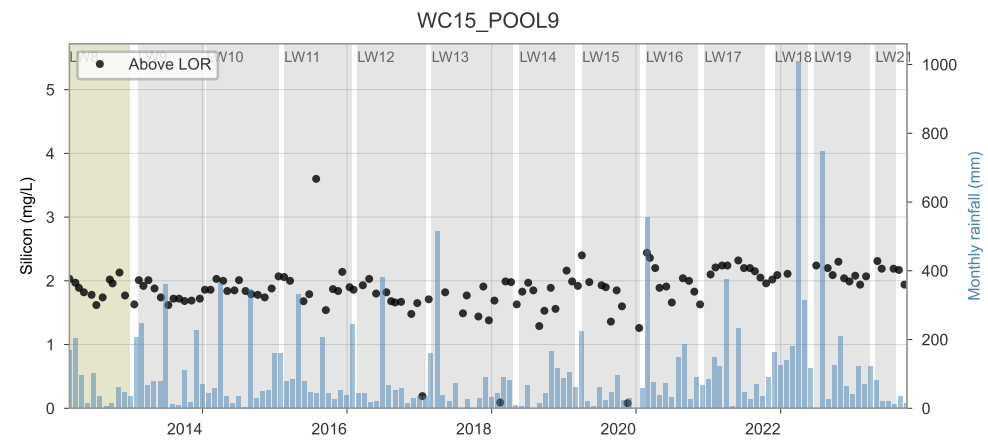
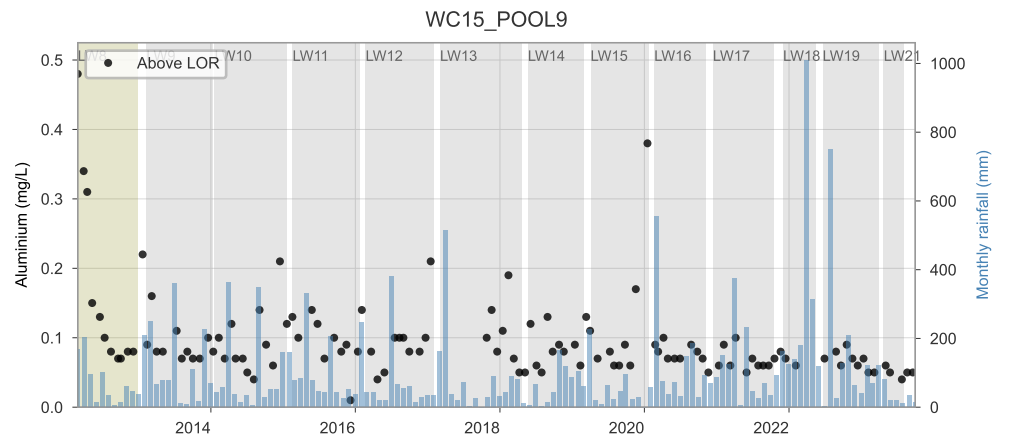
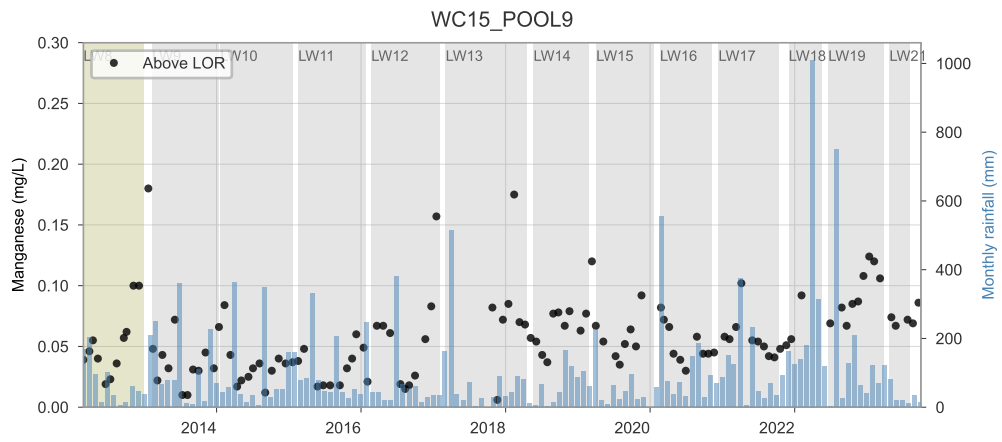
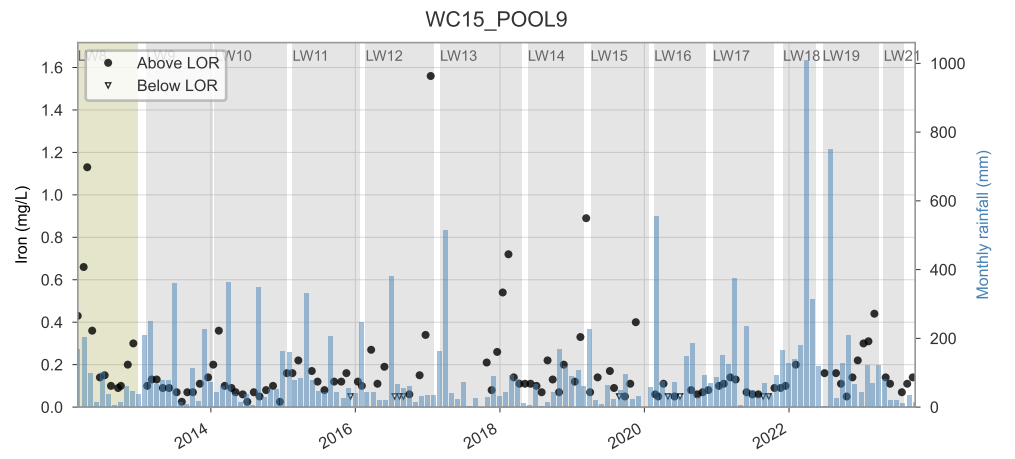
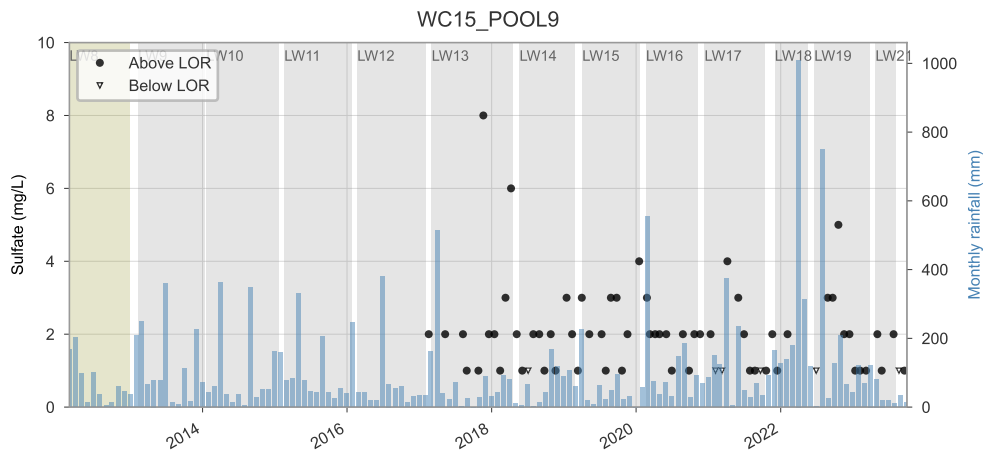


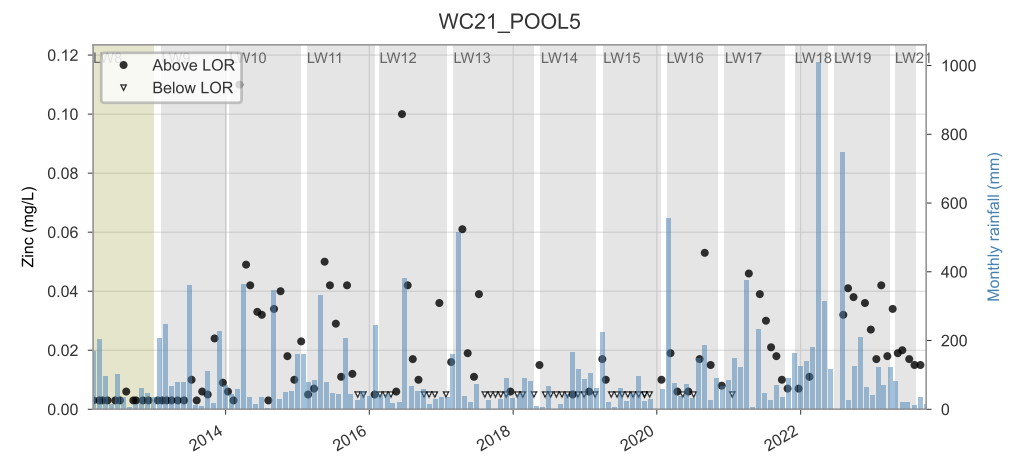
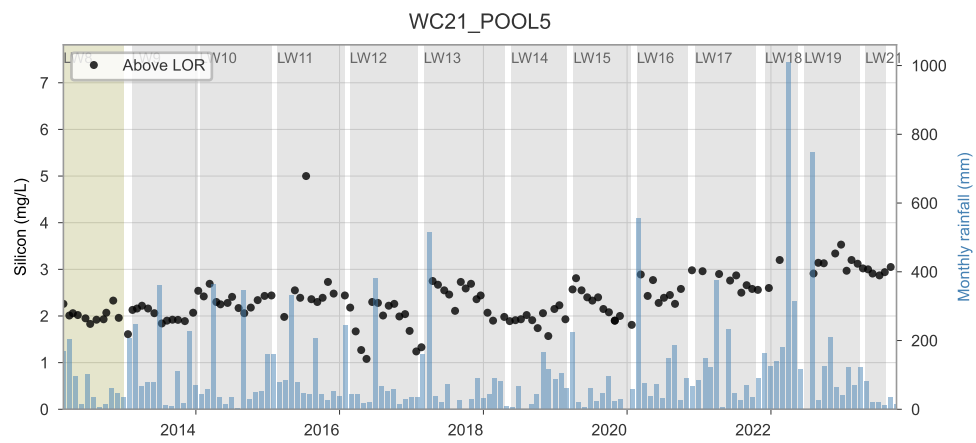
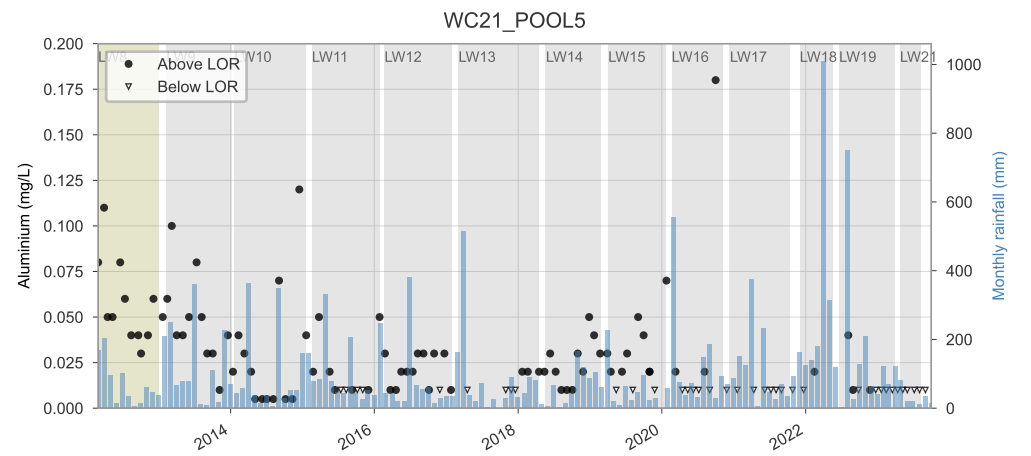
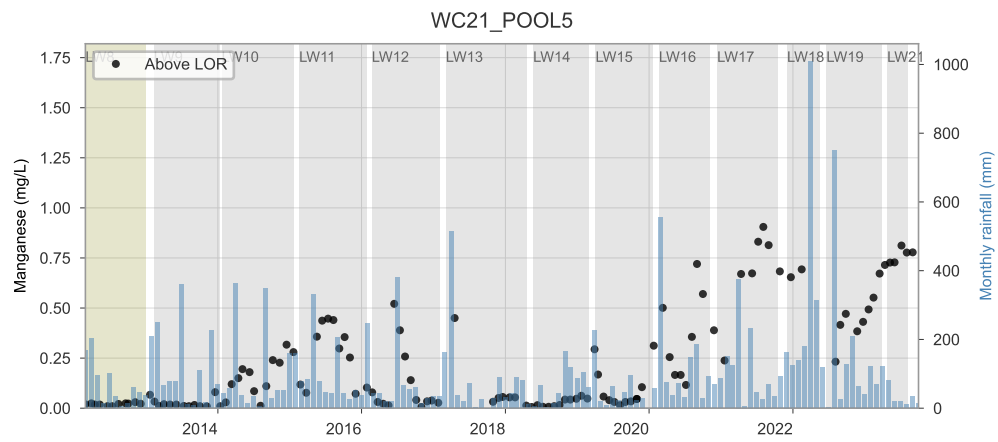
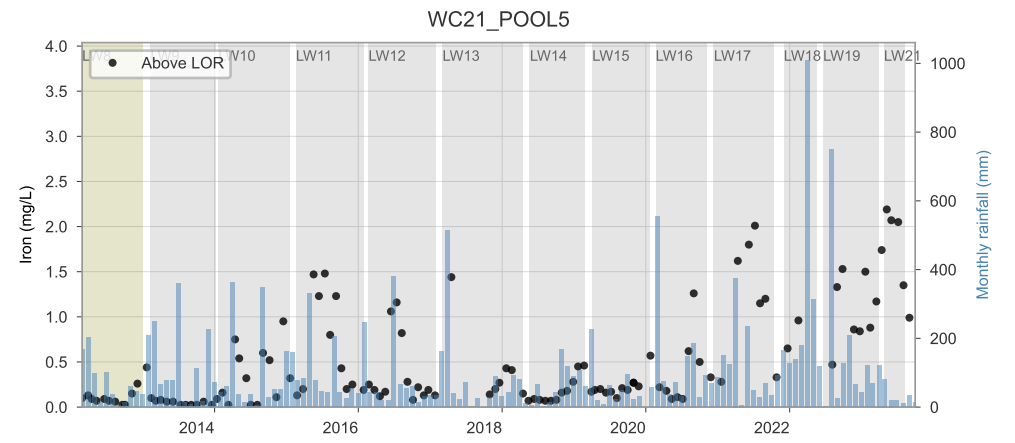
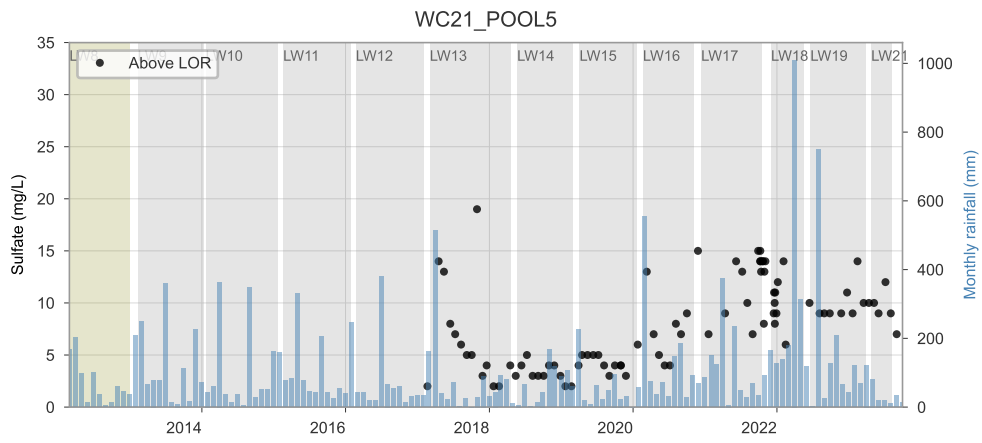




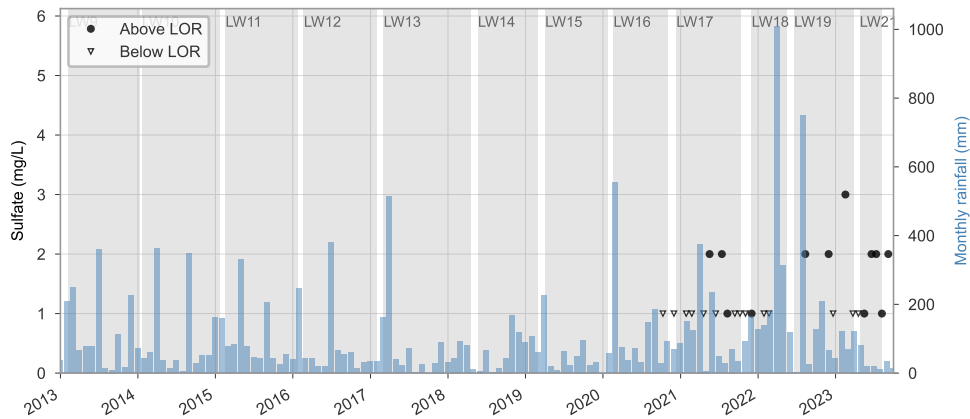




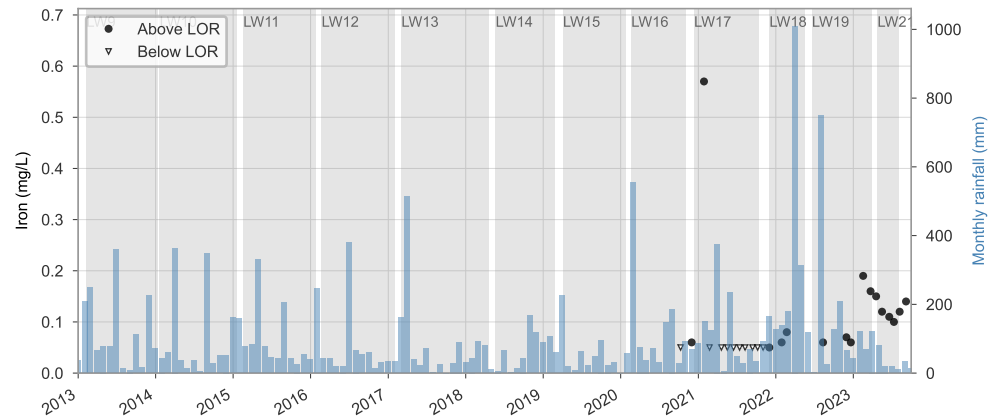




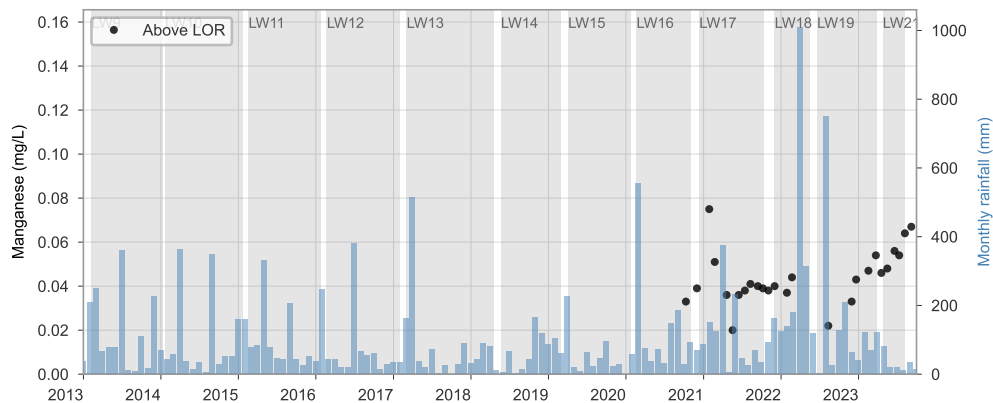
WC24_POOL10



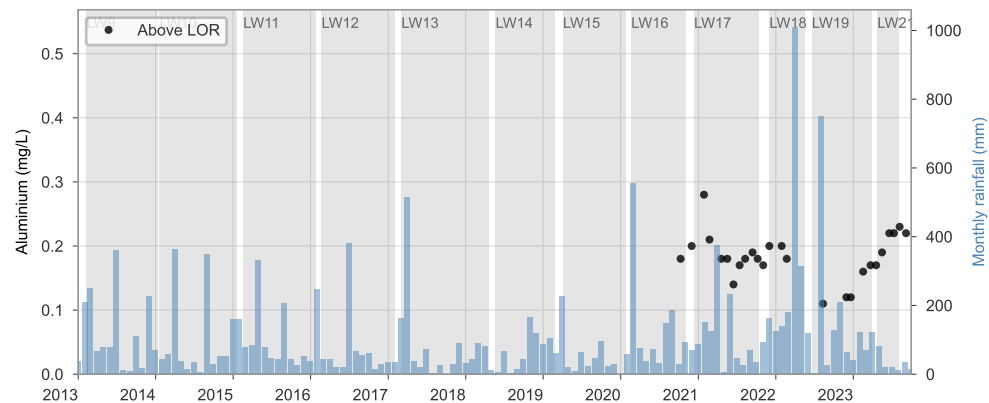
WC24_POOL10



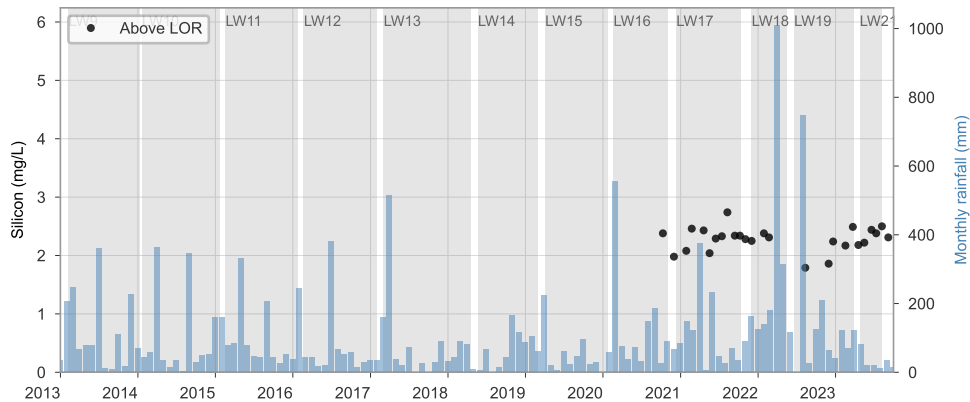
WC24_POOL10



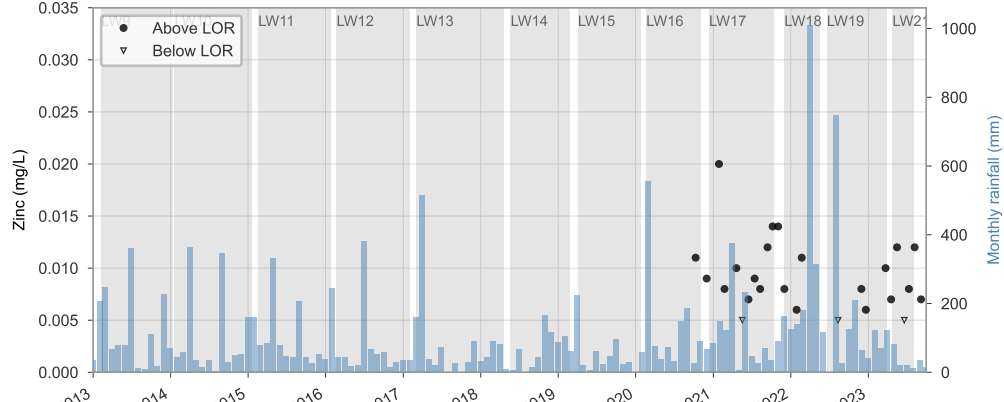
WC24_POOL10

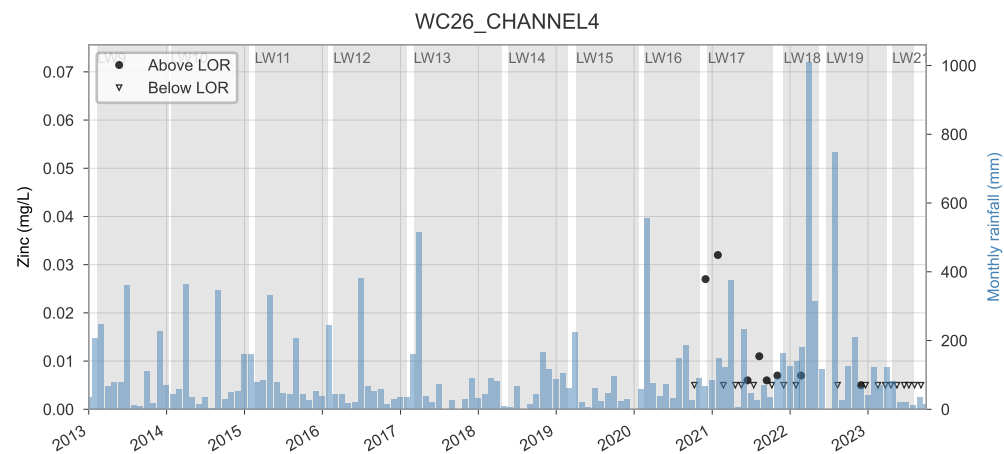
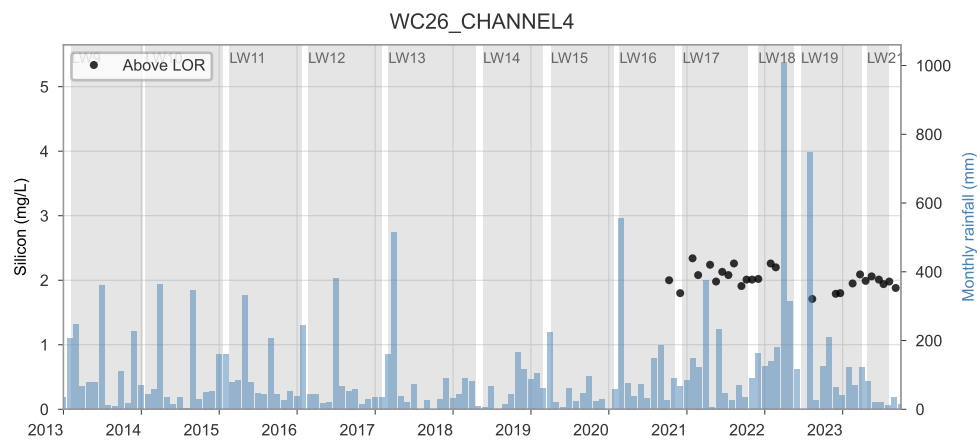
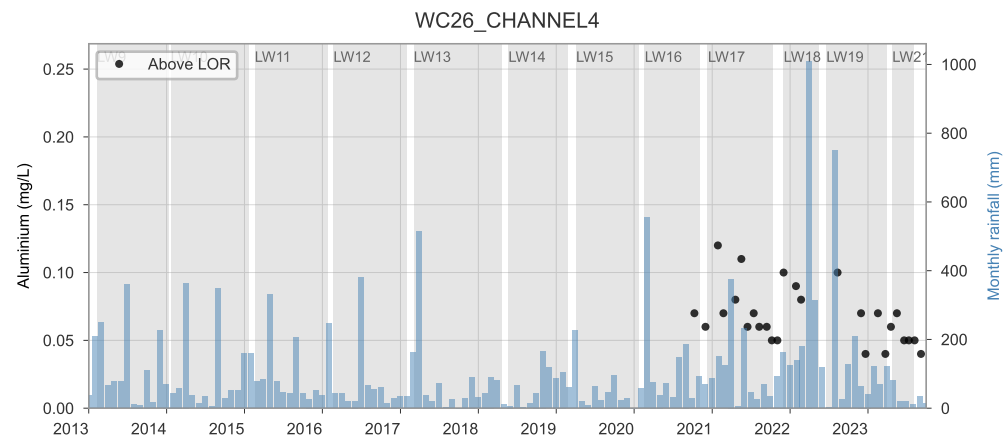
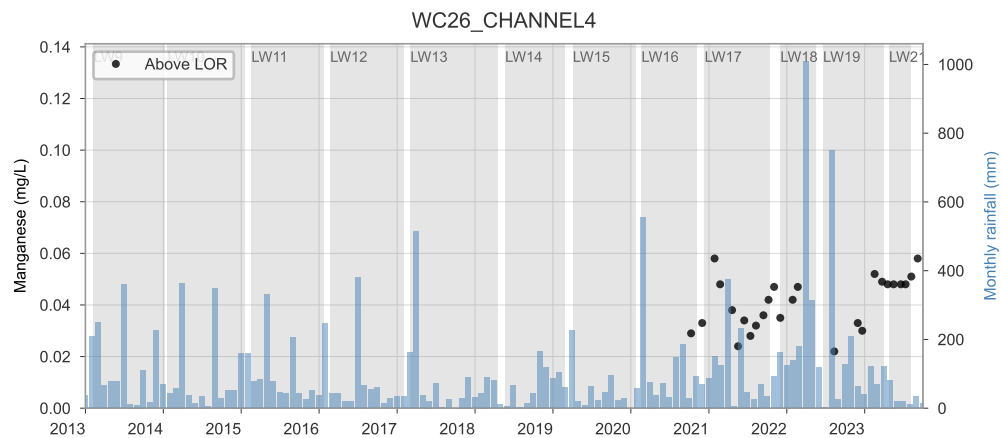
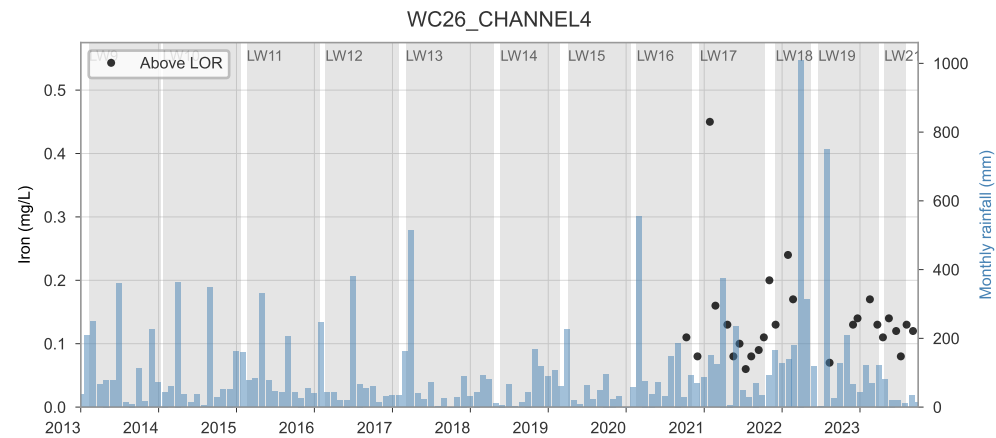
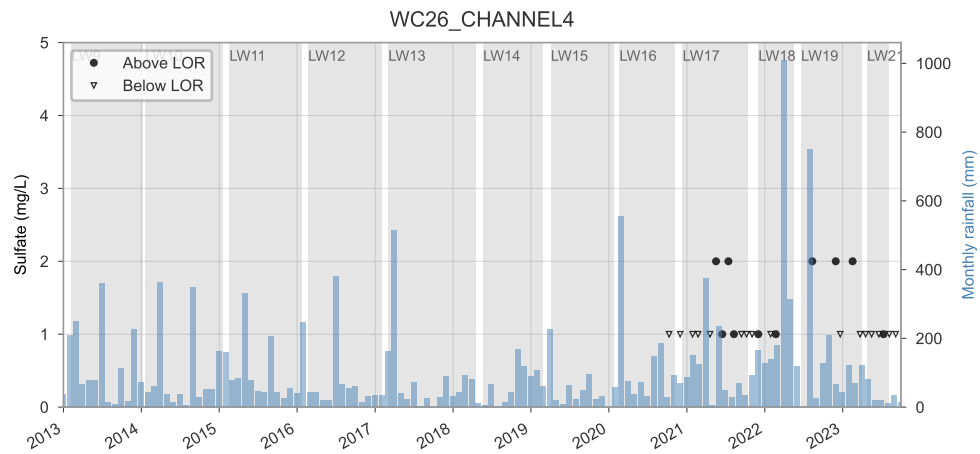


WC24_POOL10

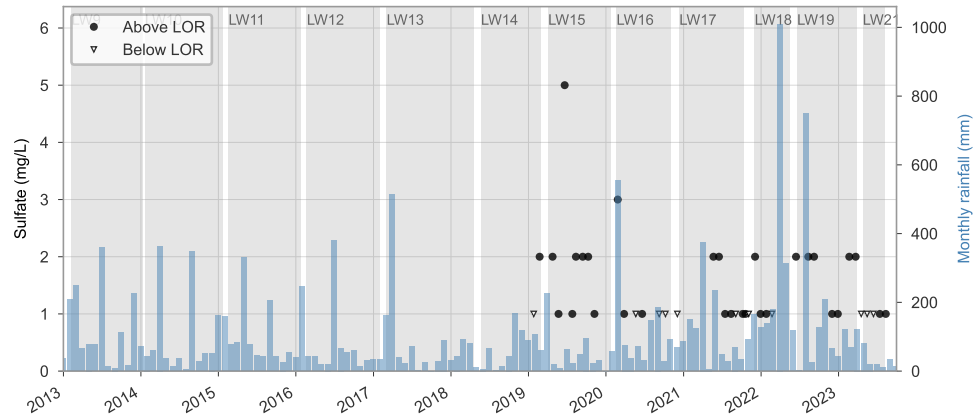


WC24_POOL10

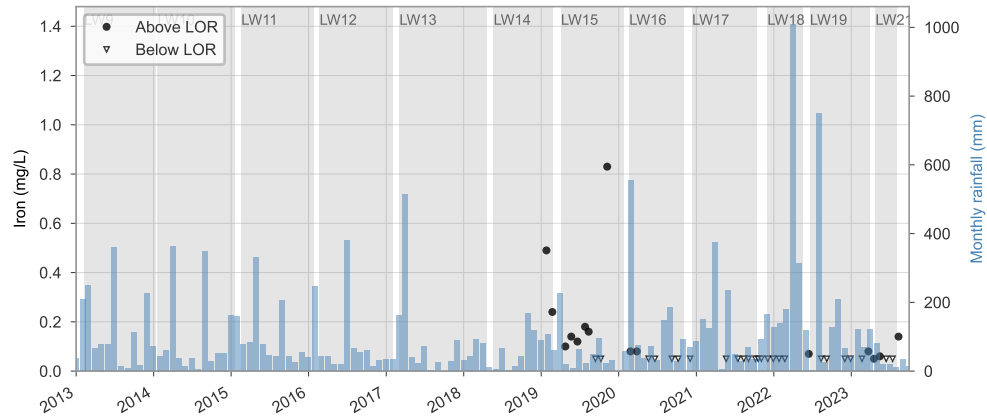




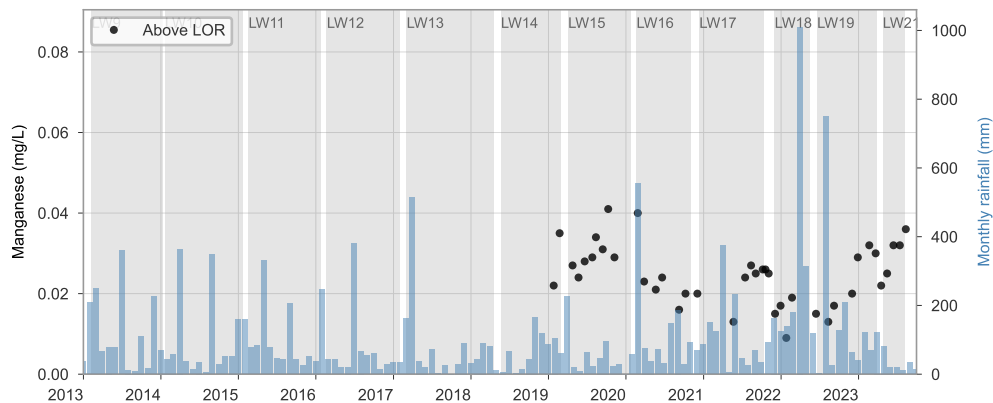
WC7_POOL1



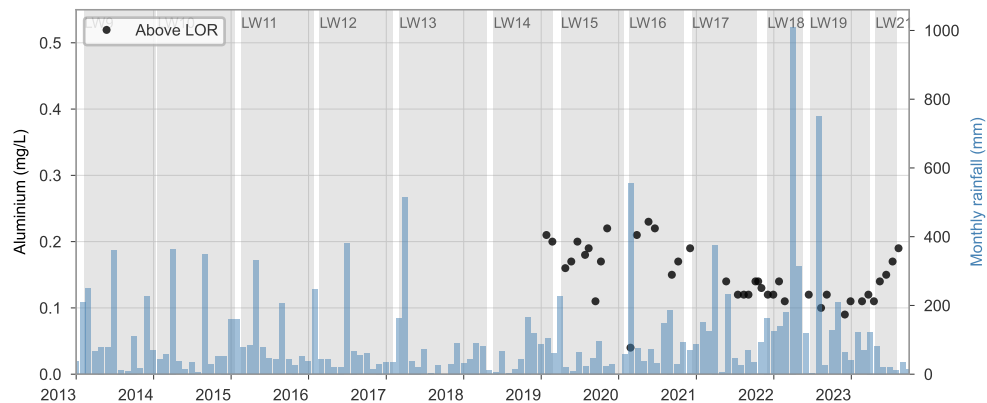
WC7_POOL1



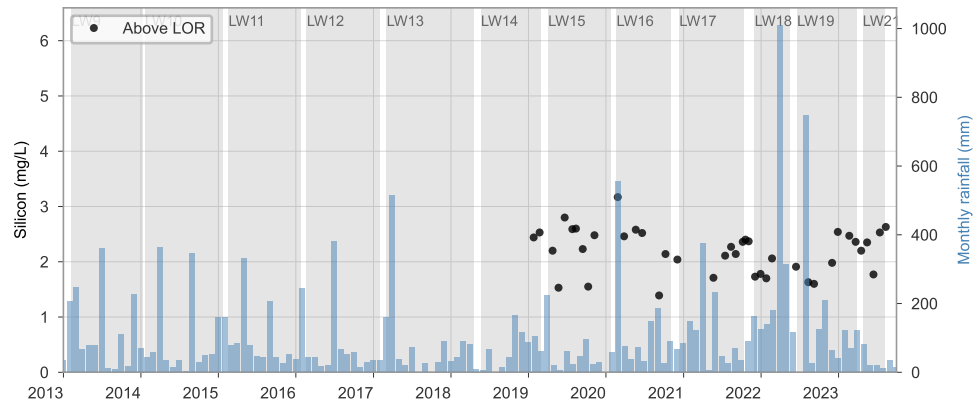
WC7_POOL1



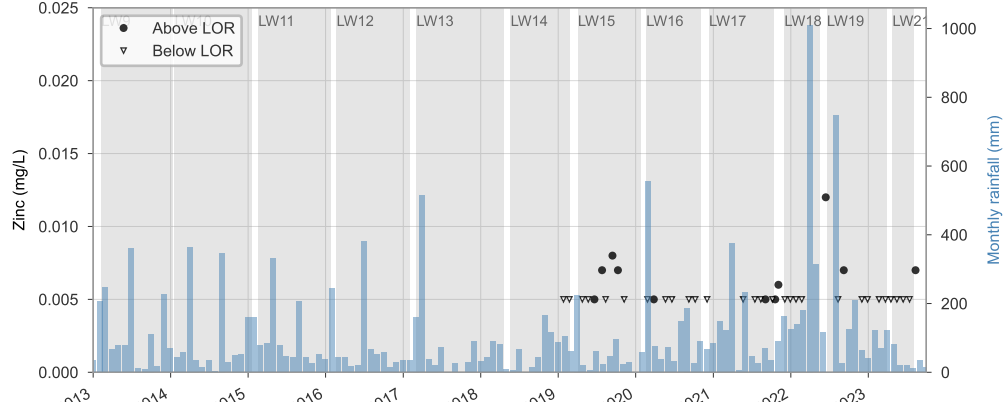
WC7_POOL1

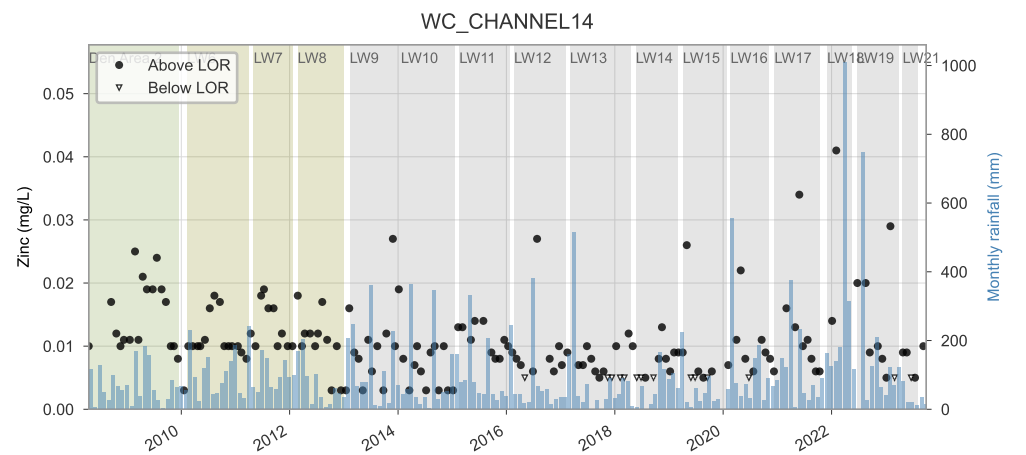
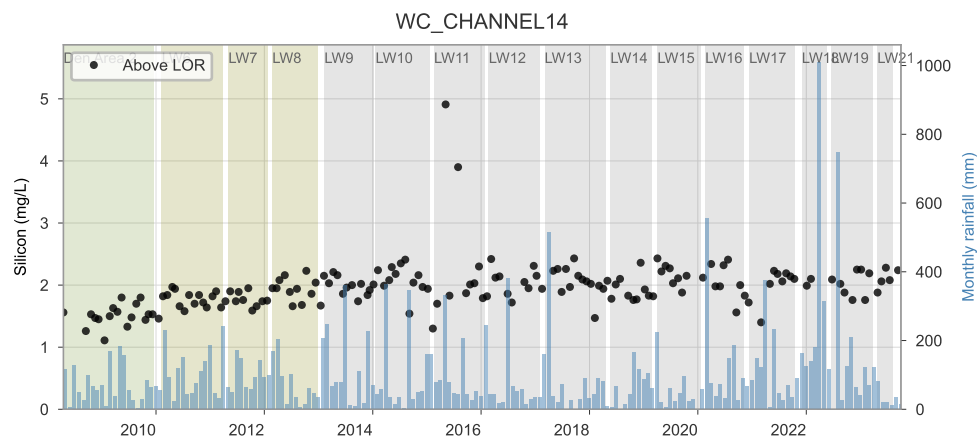
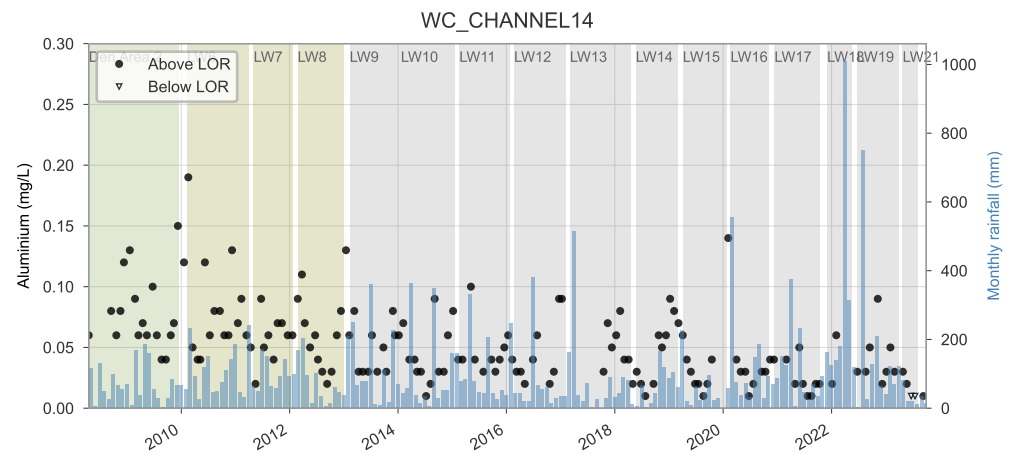
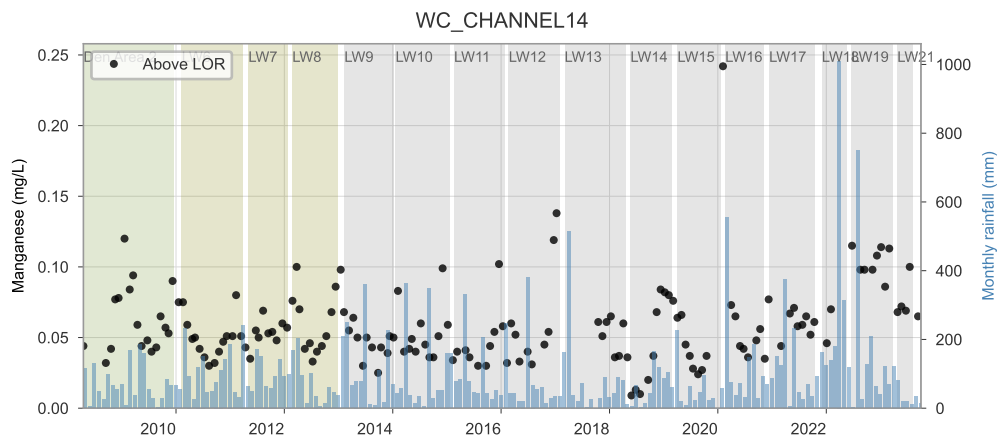
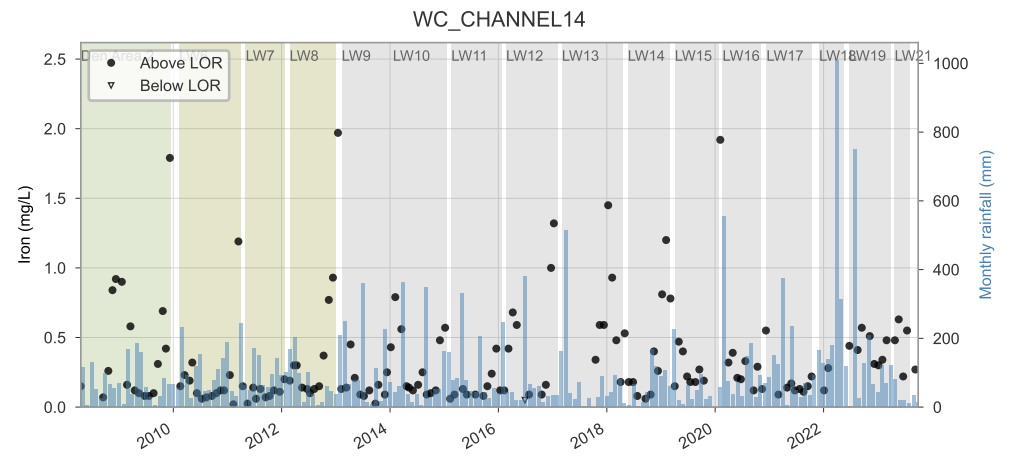
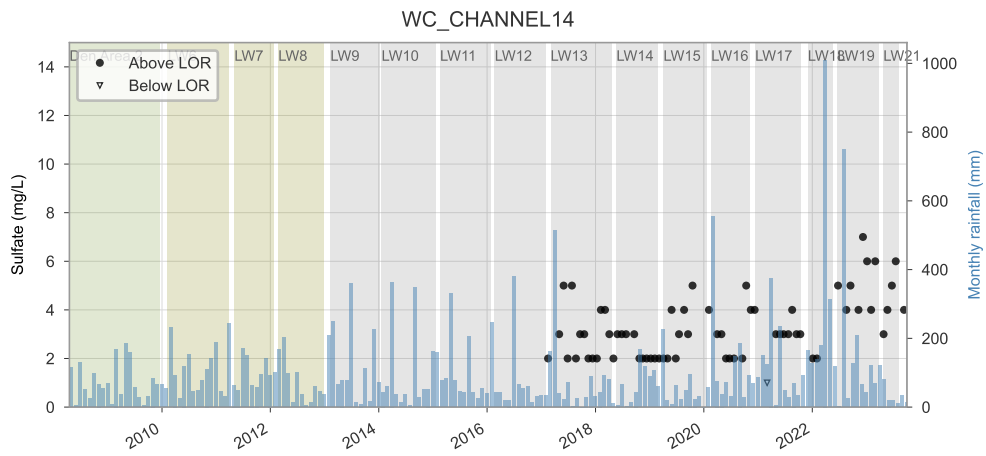


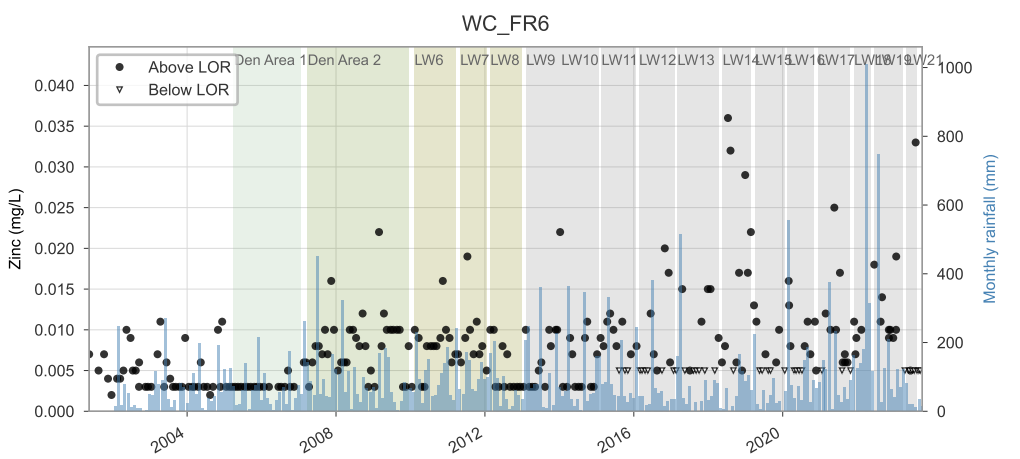
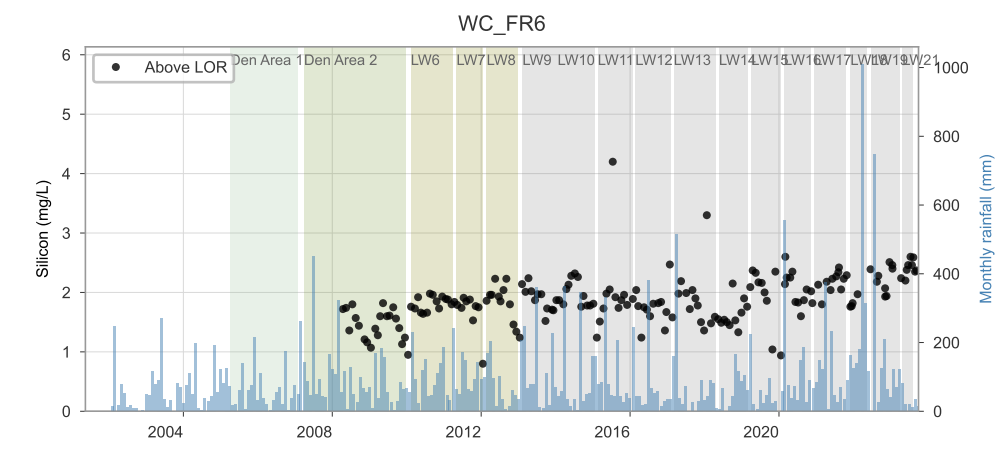
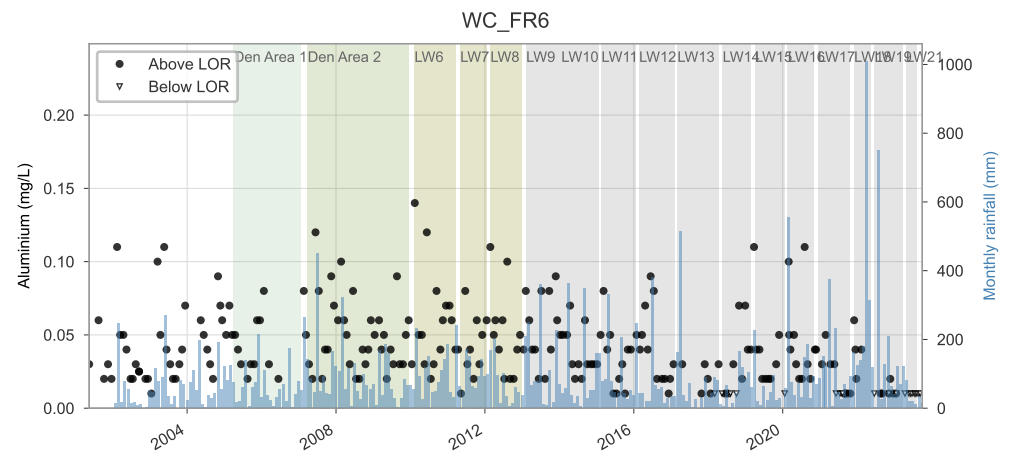
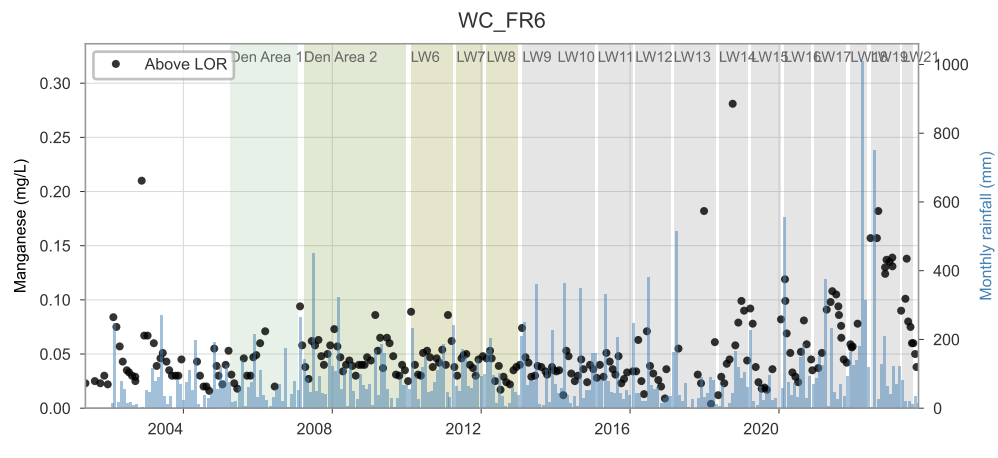
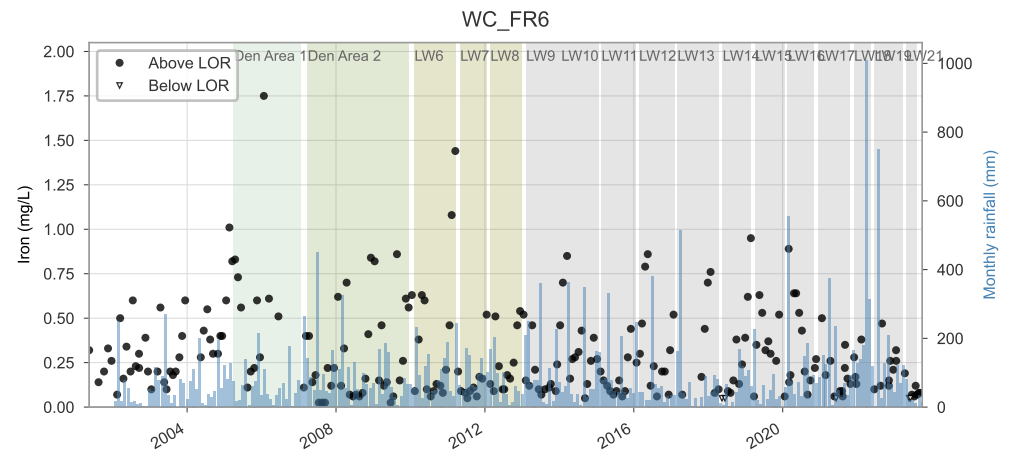
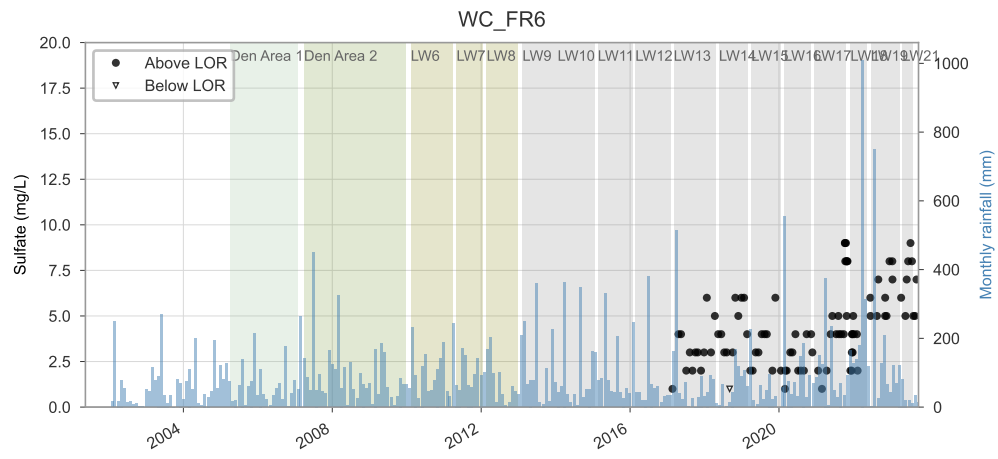
WC7_POOL1

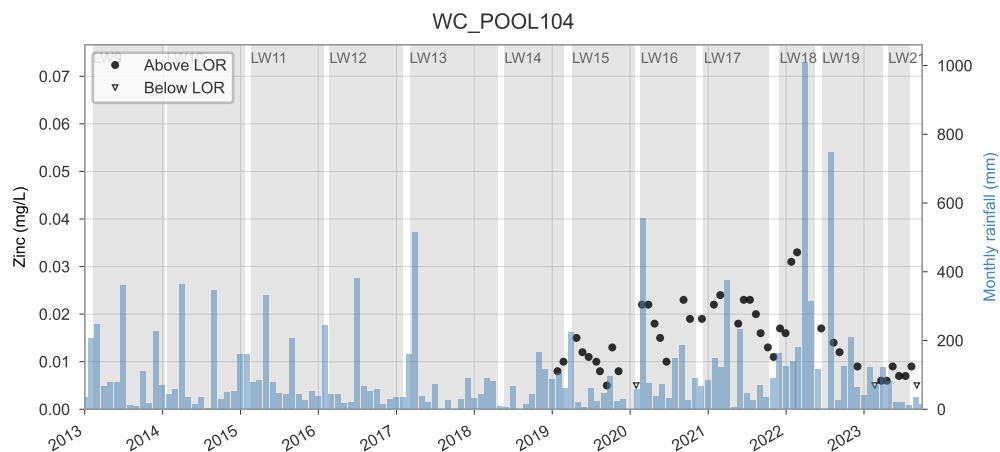
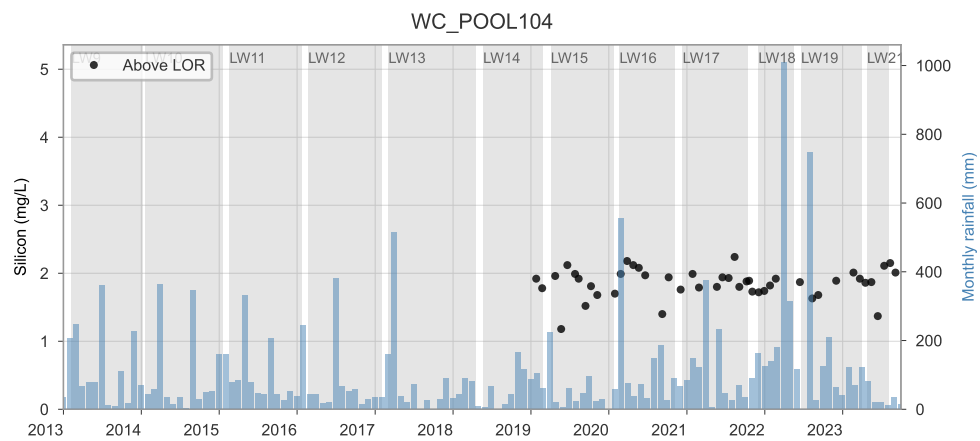
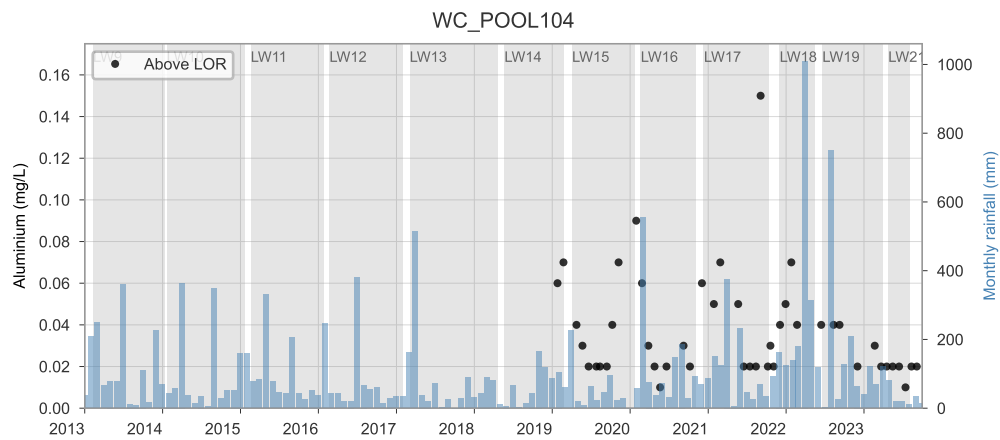
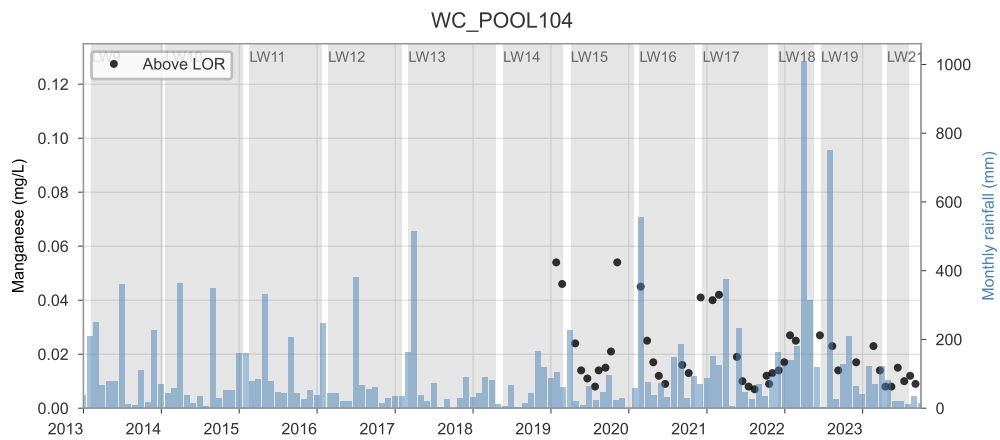
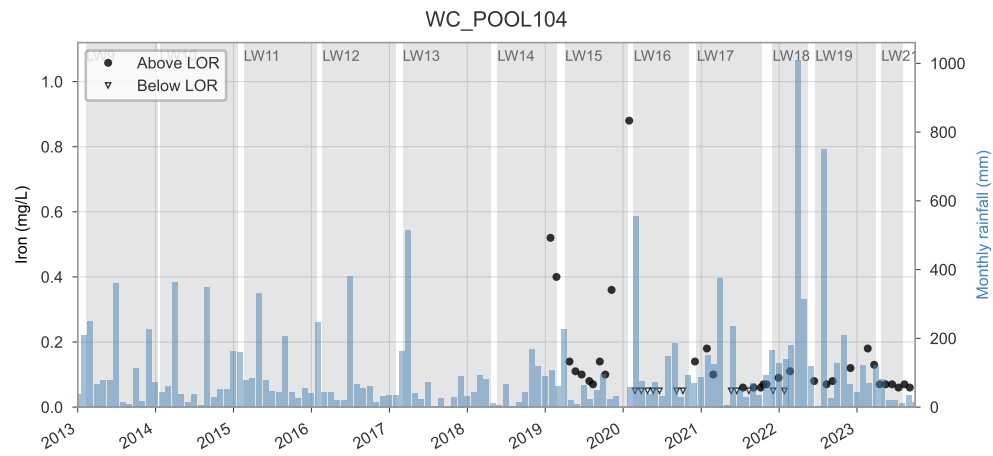
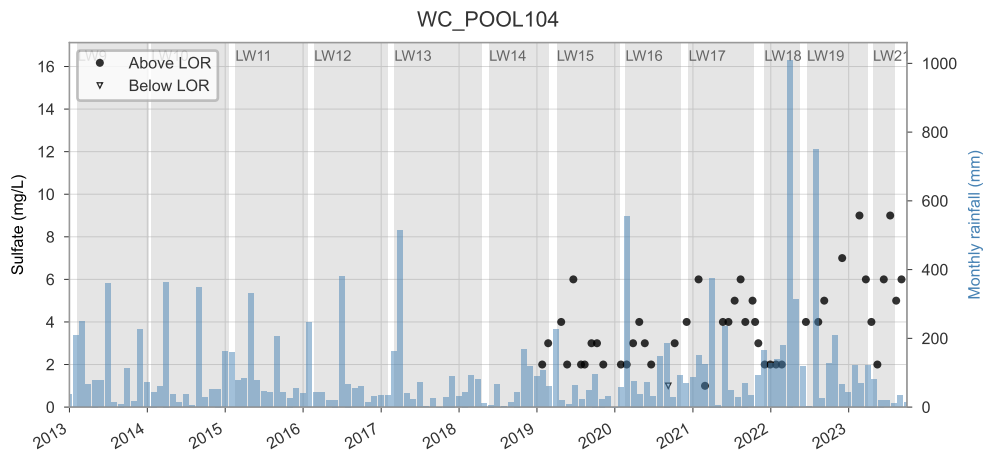


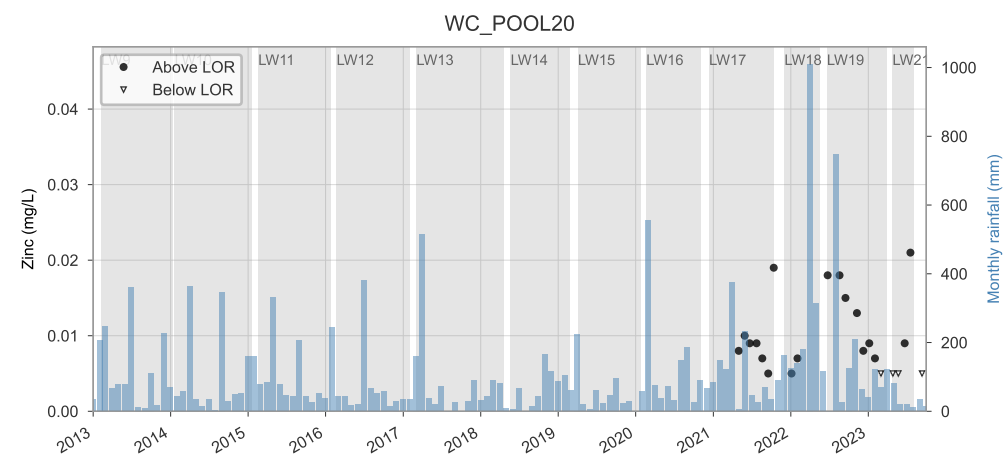
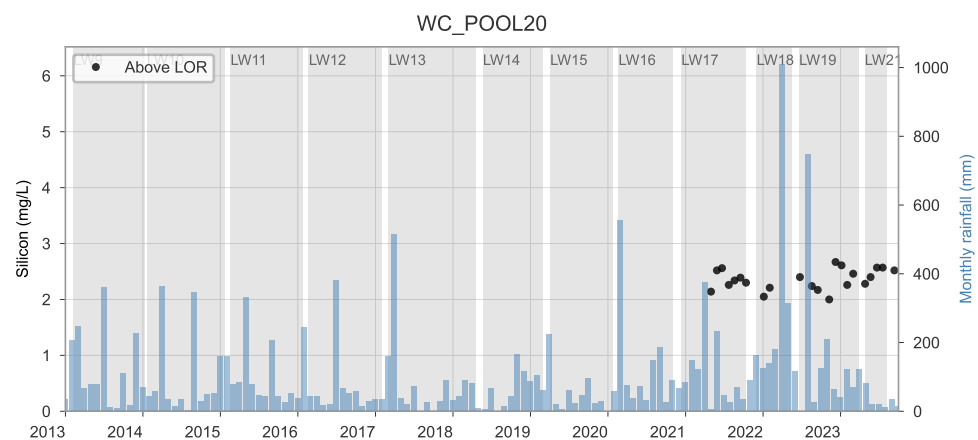
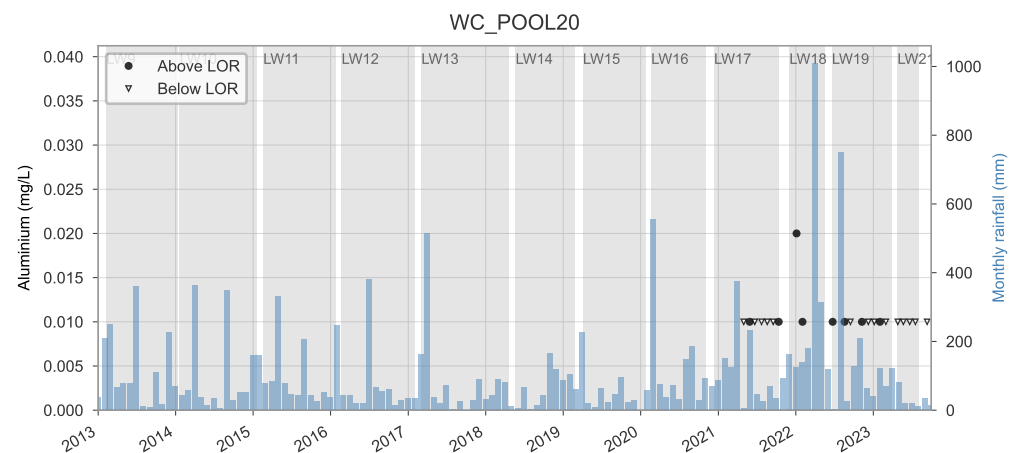
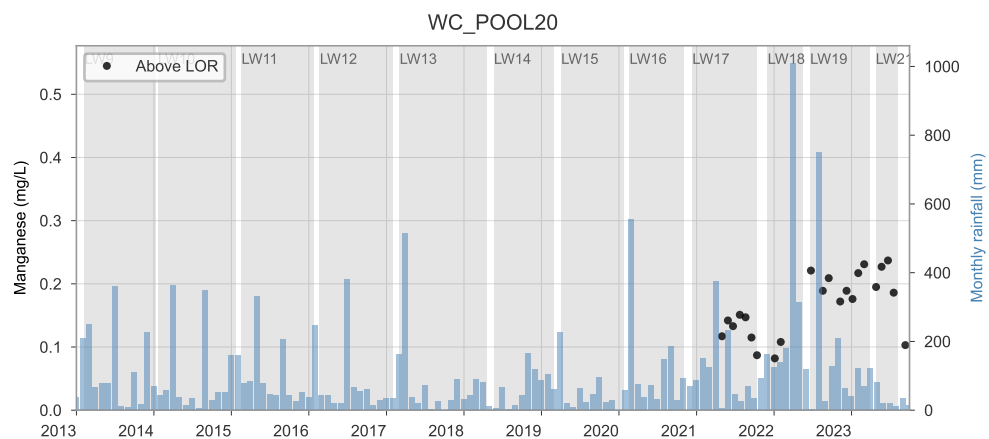
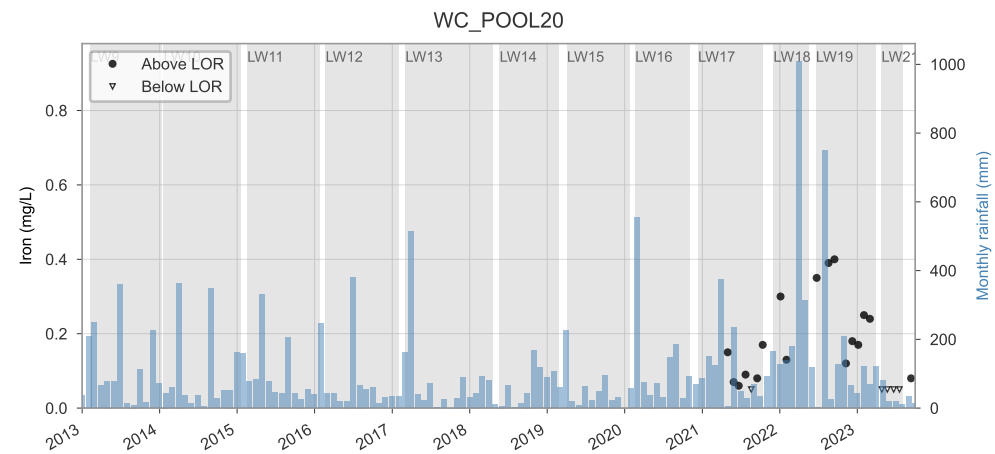
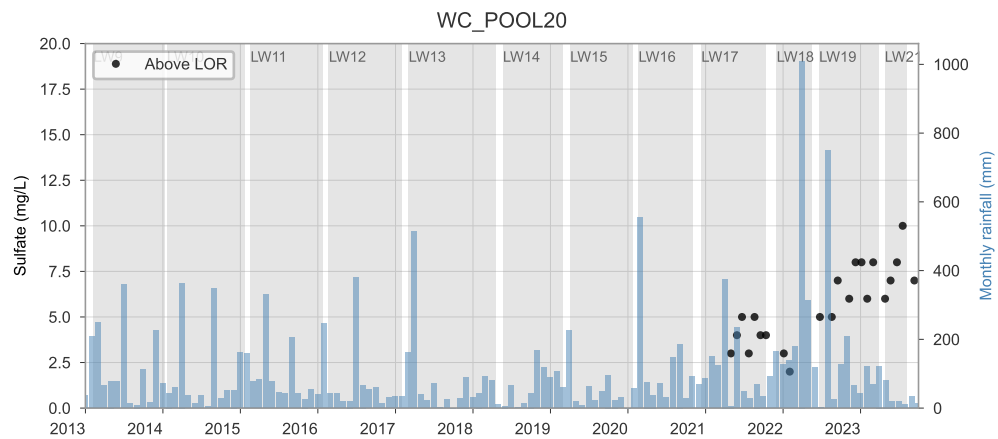
WC7_POOL1

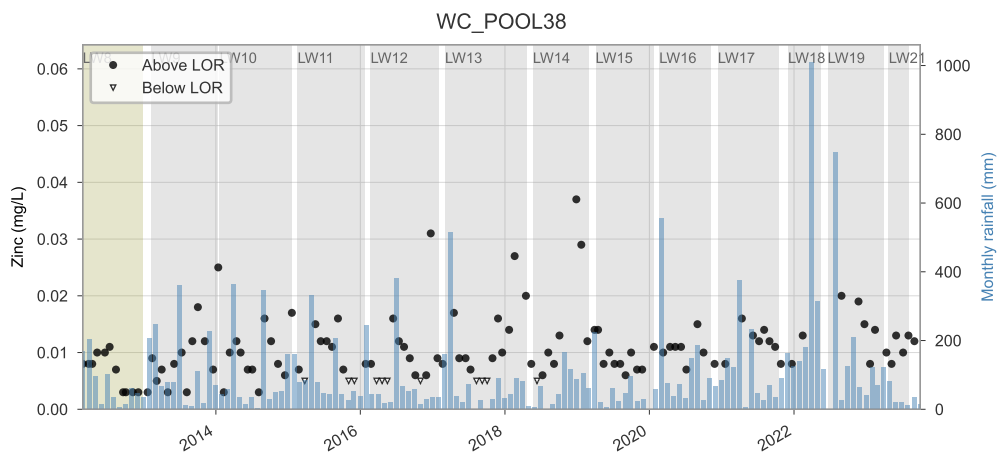
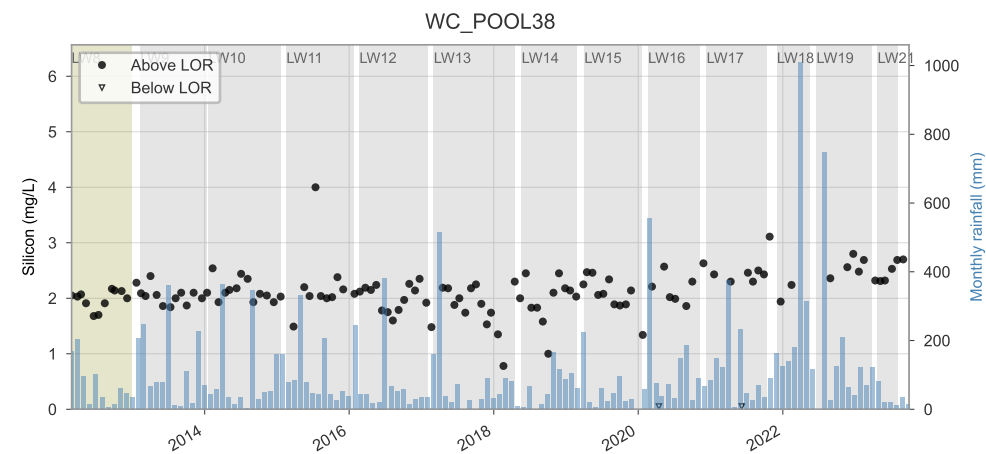
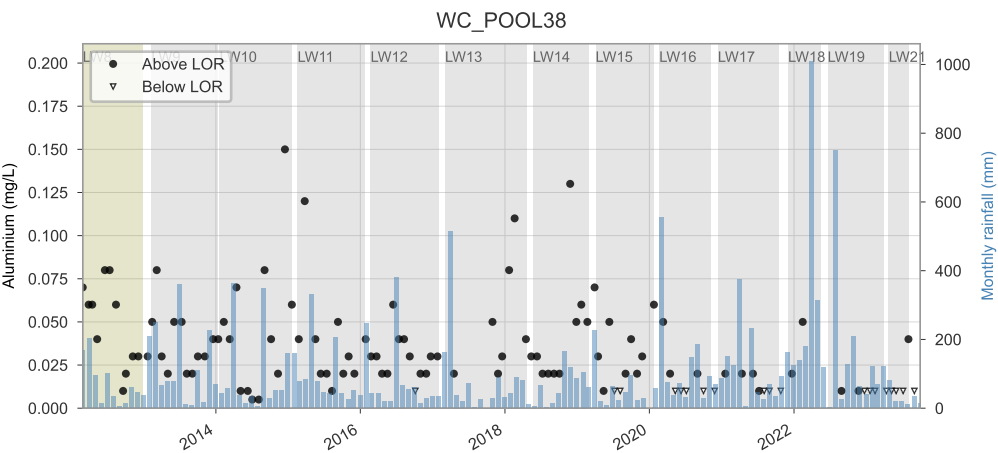
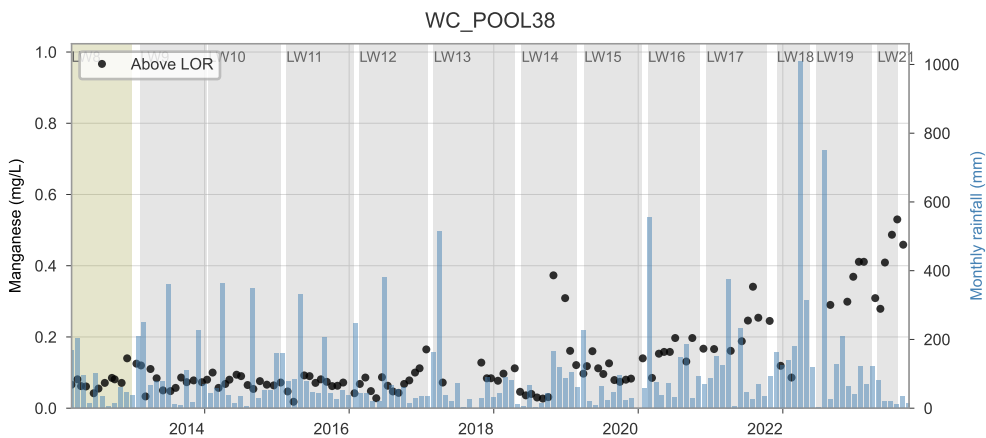
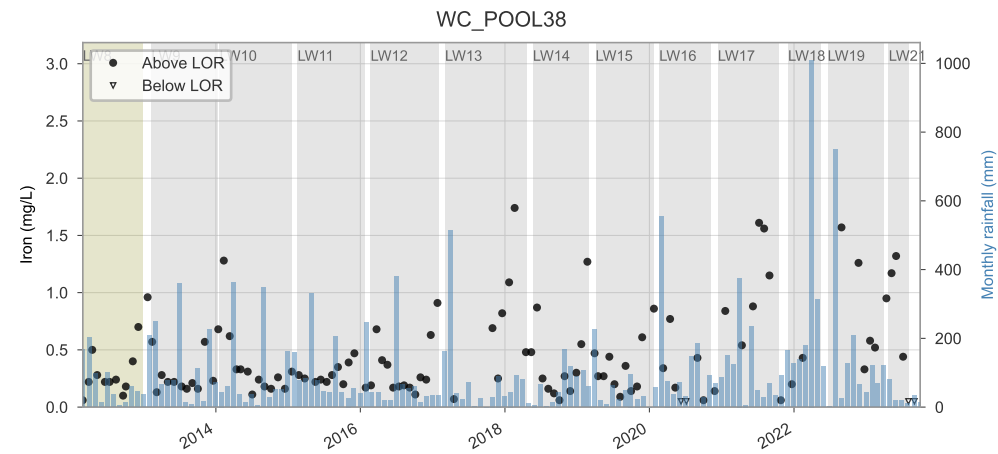
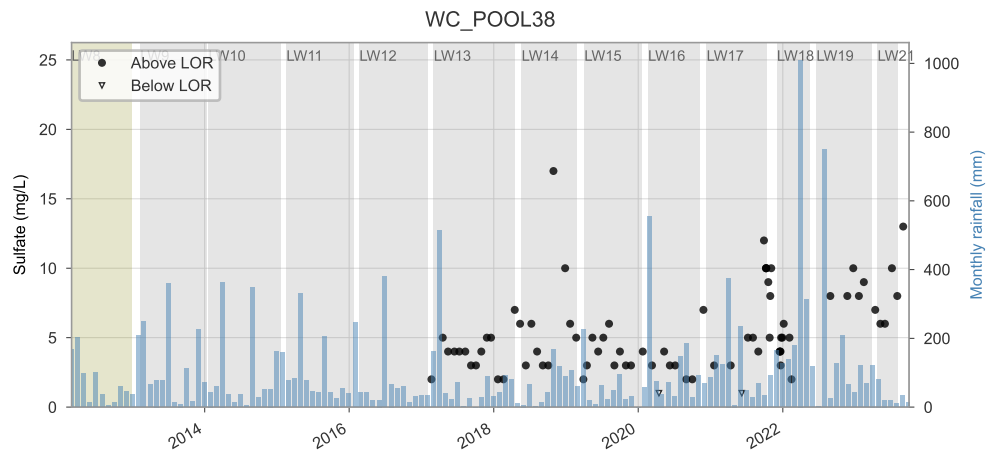


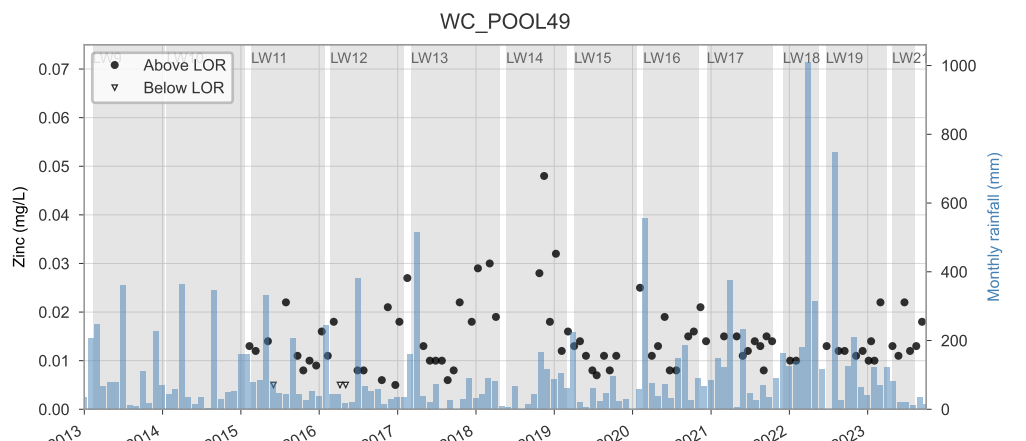
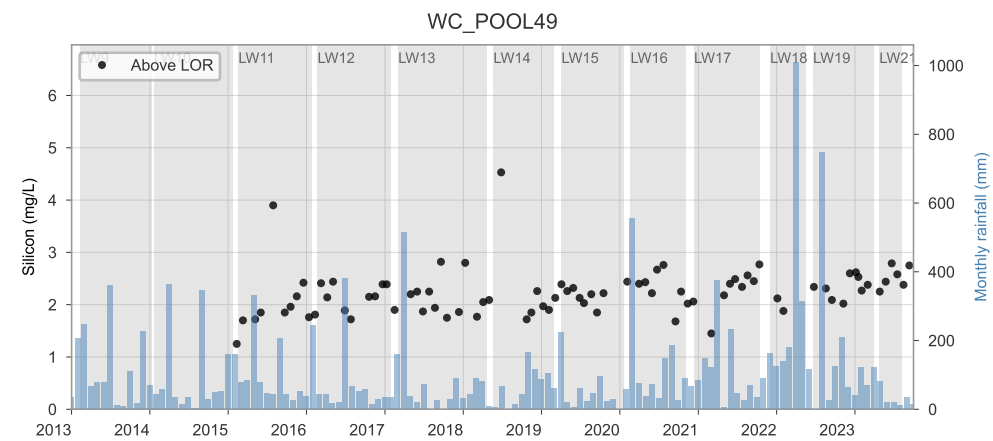
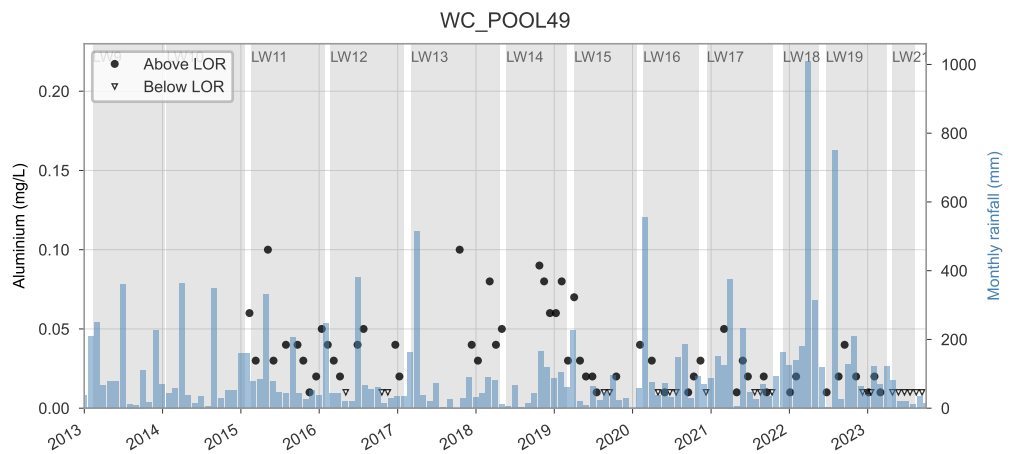
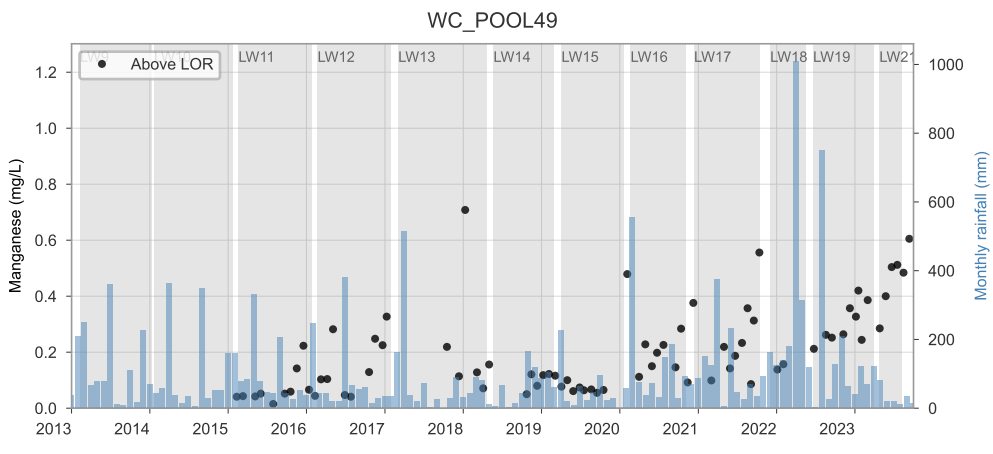
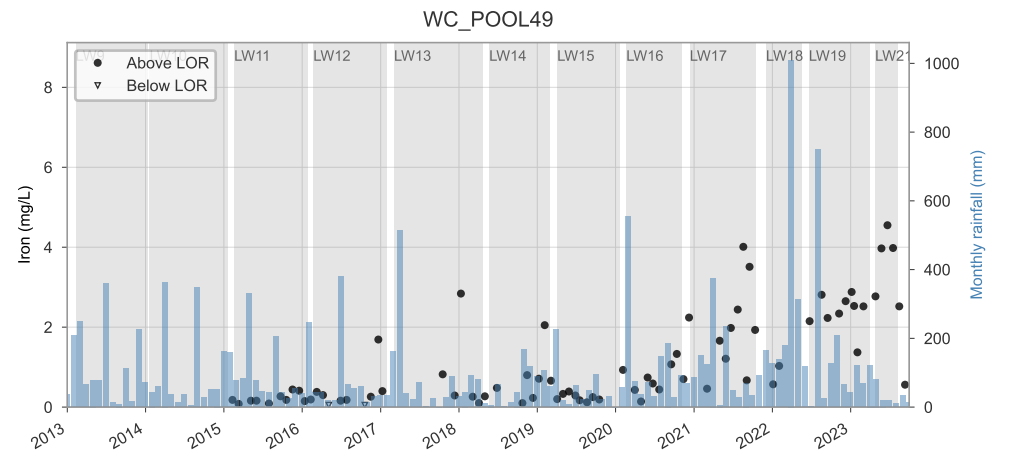
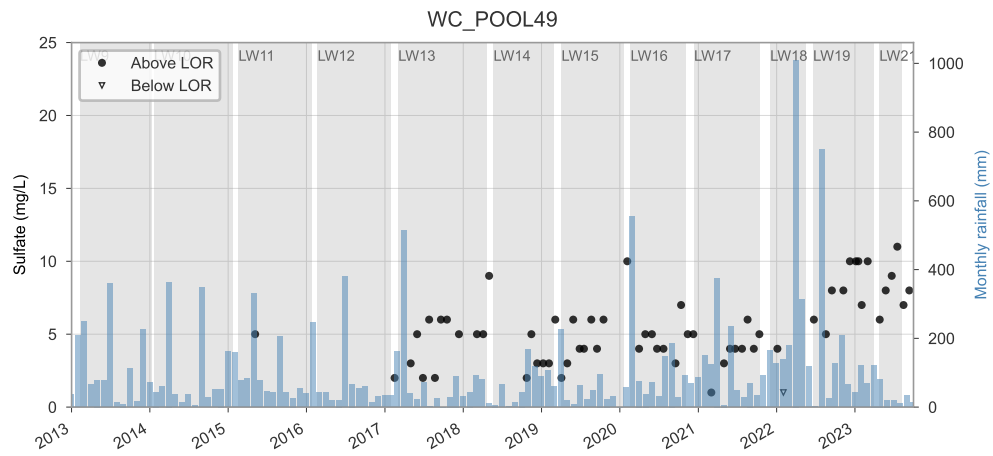


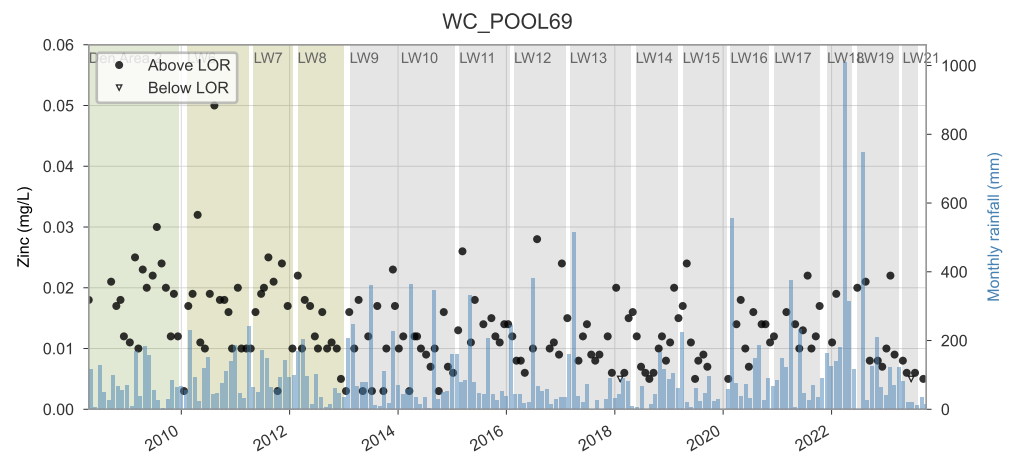
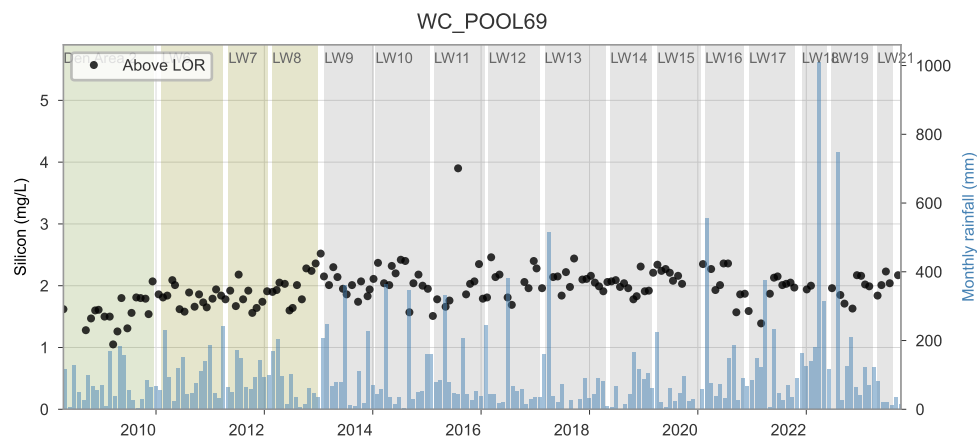
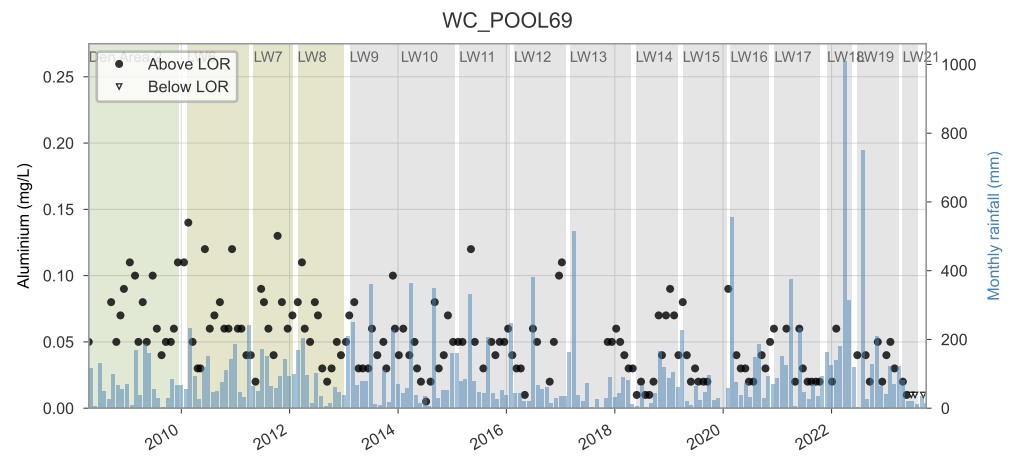
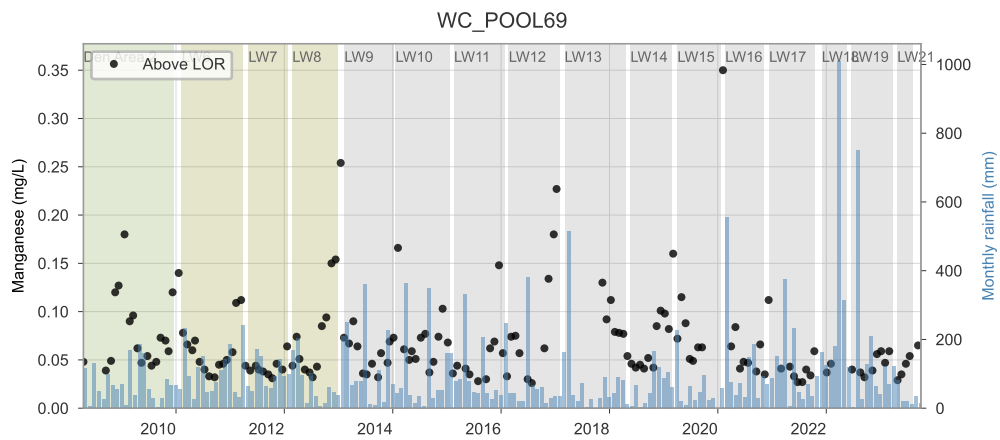
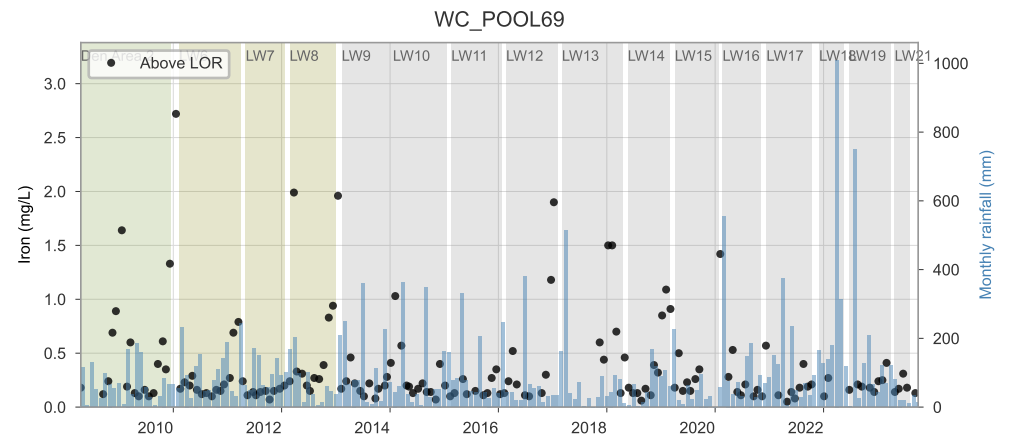
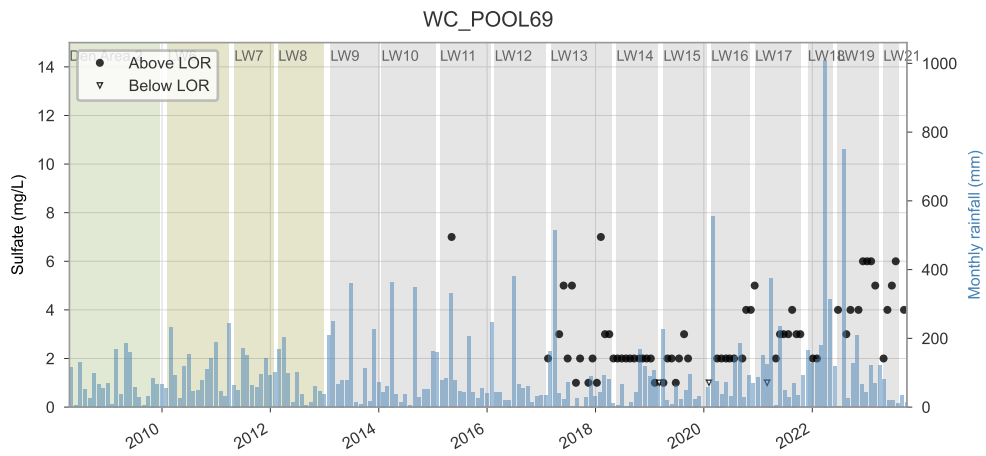


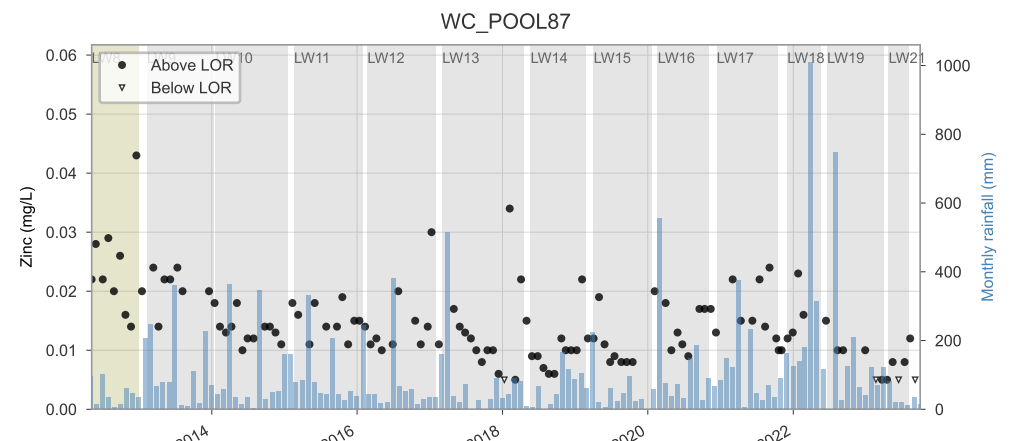
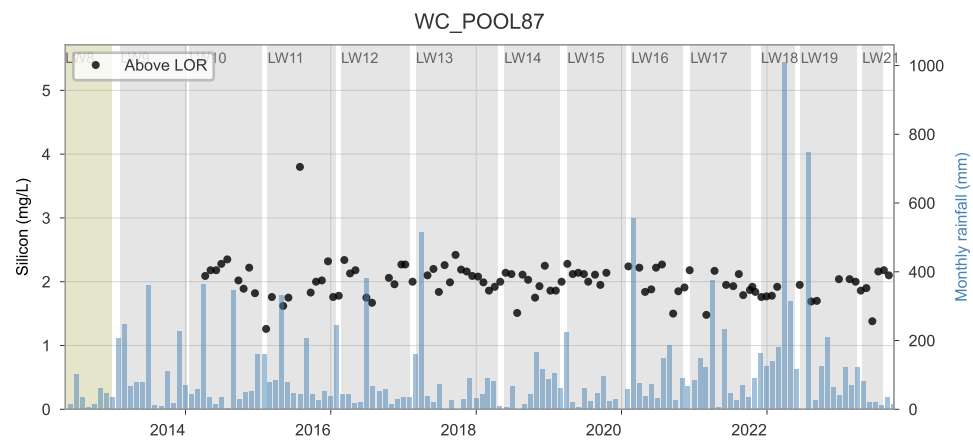
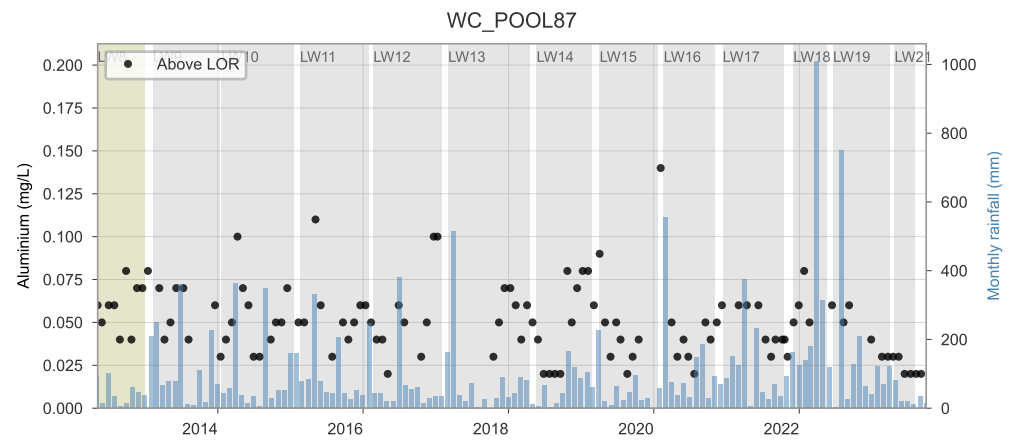
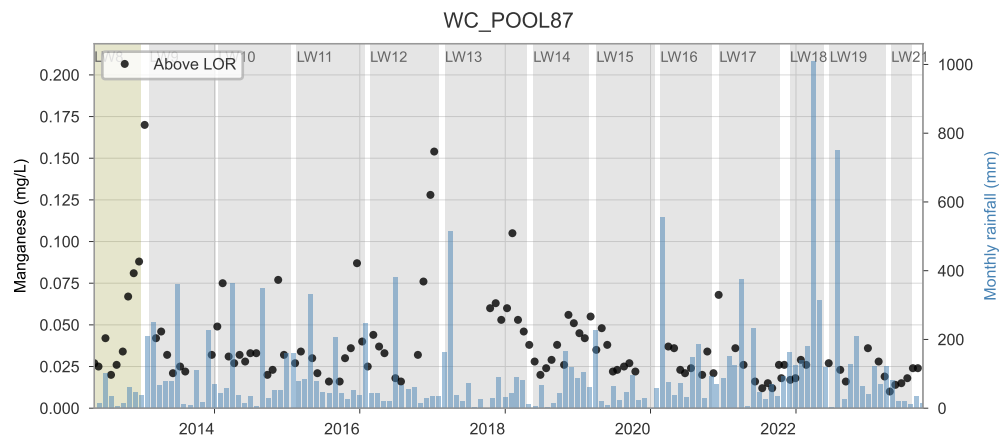
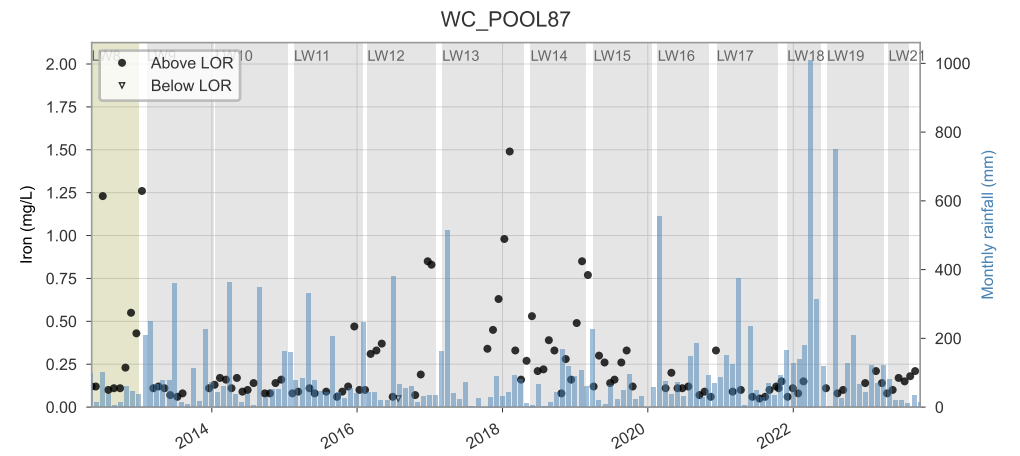
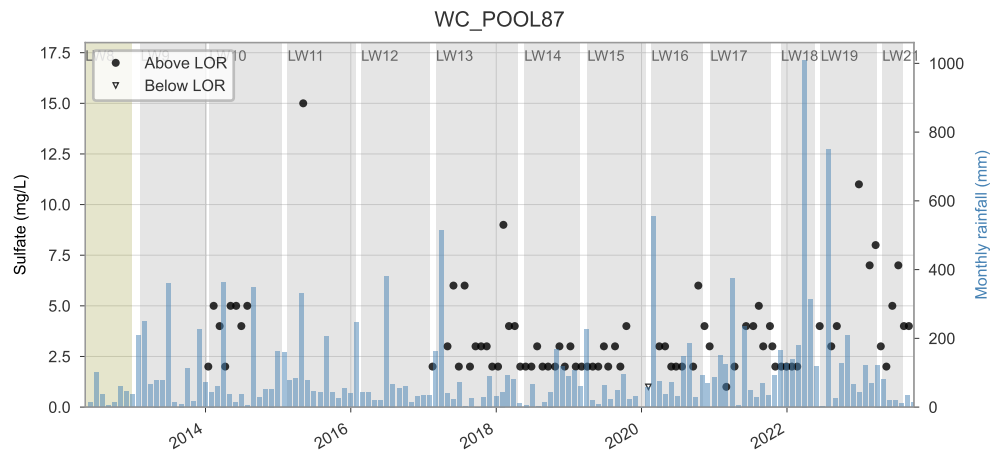


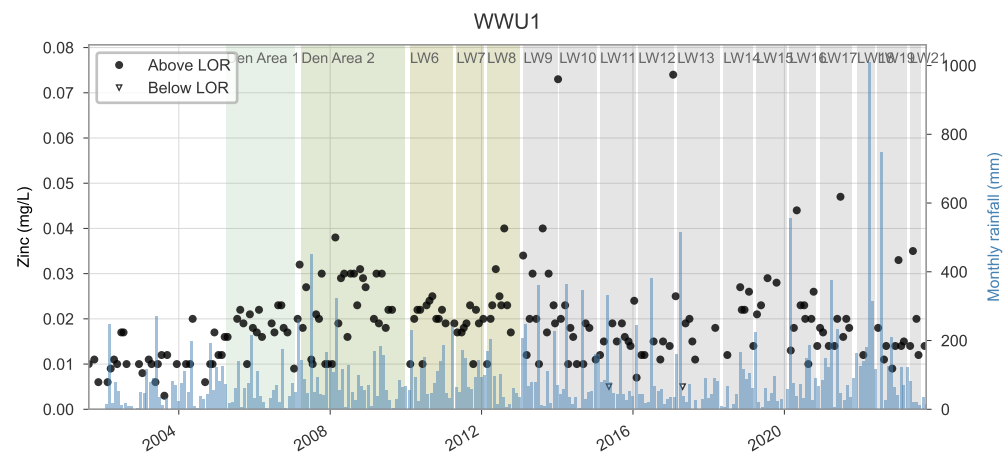
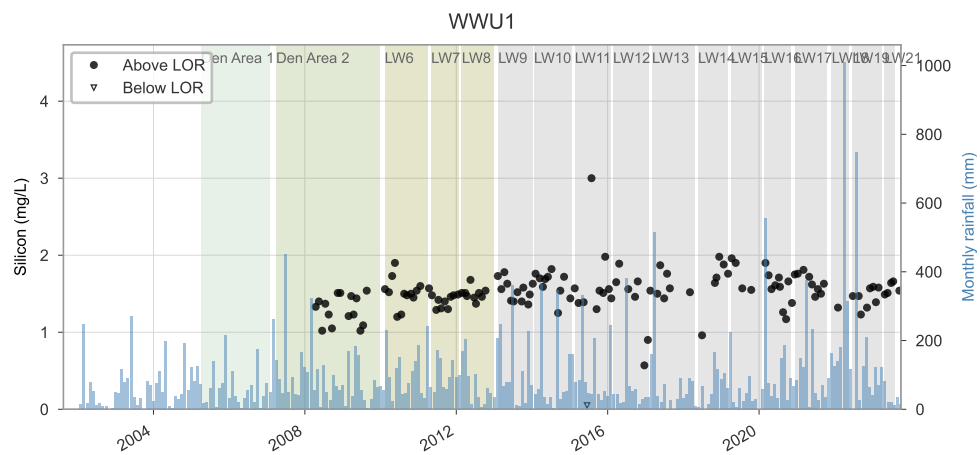
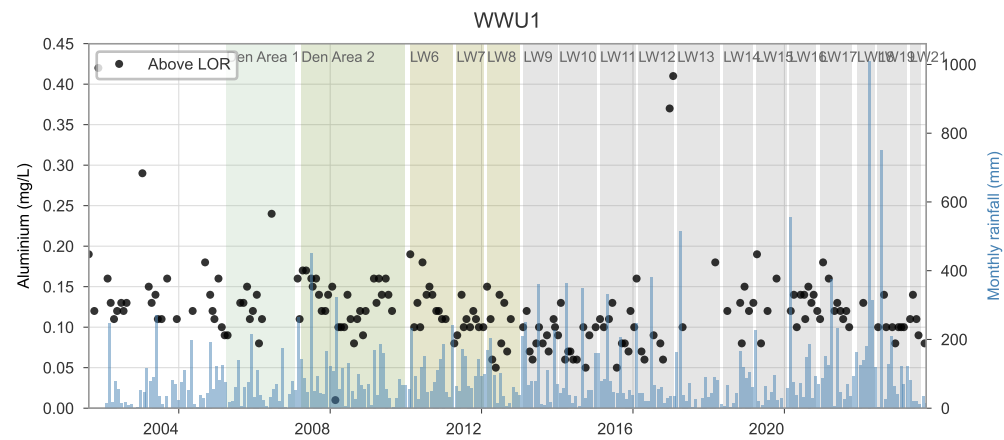
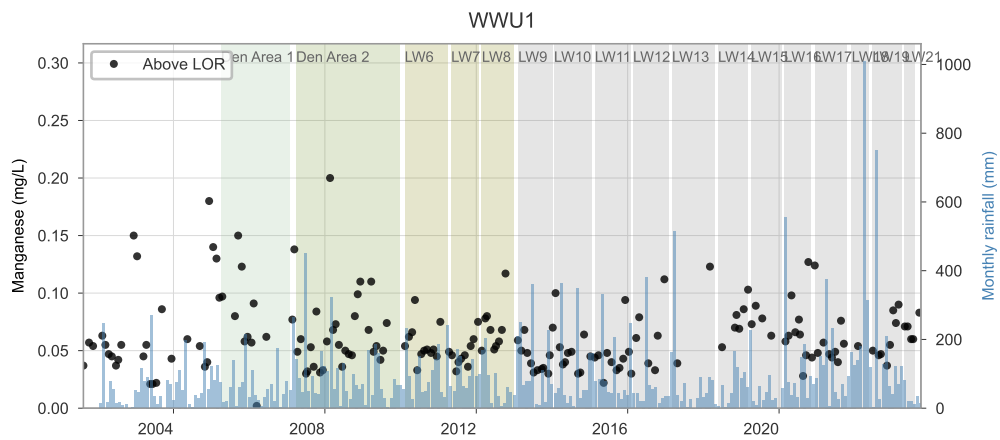
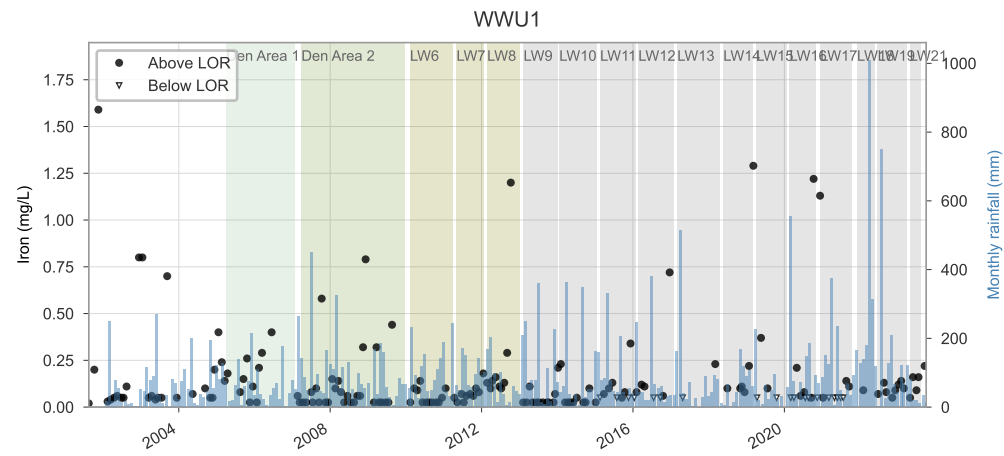
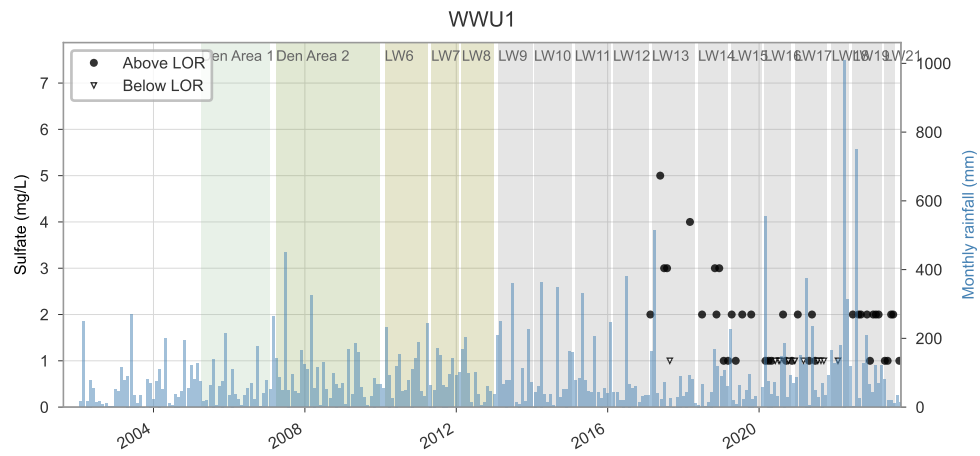


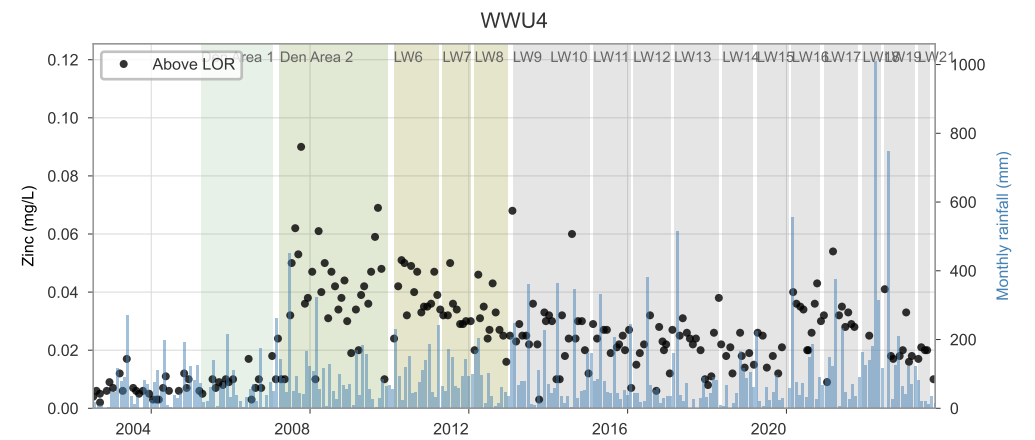
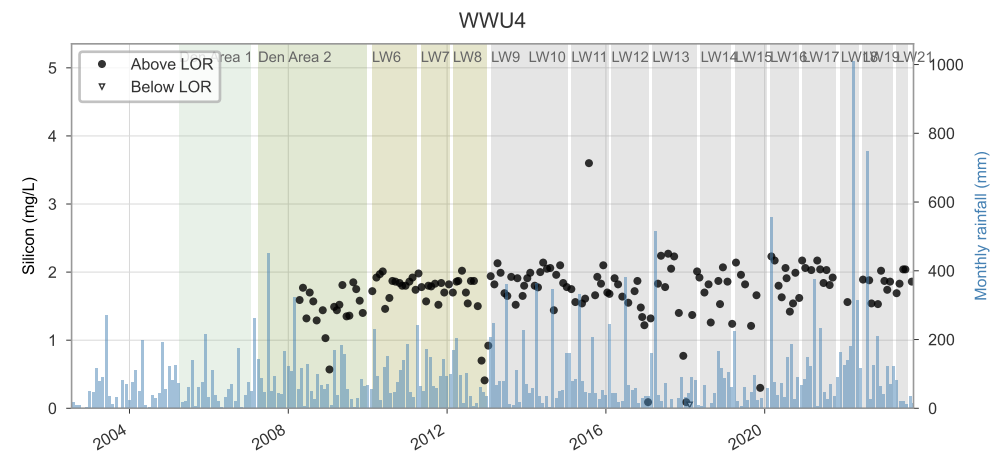
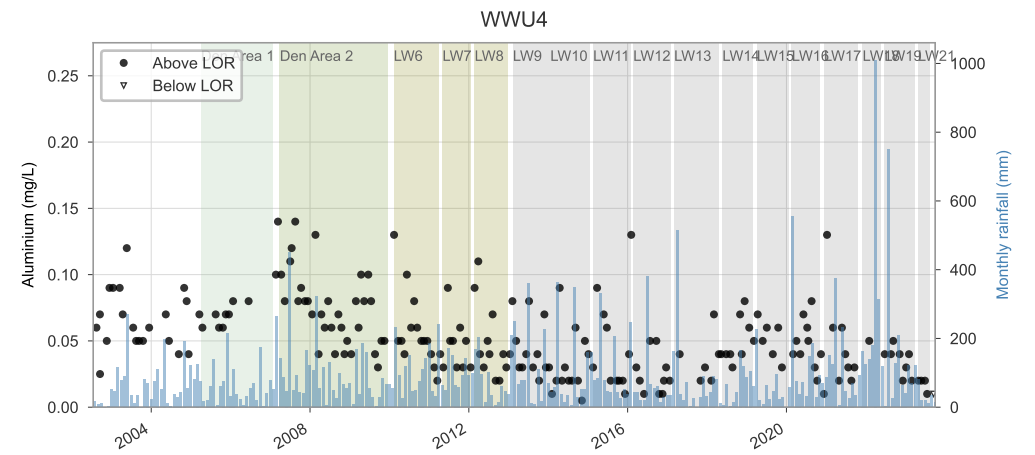
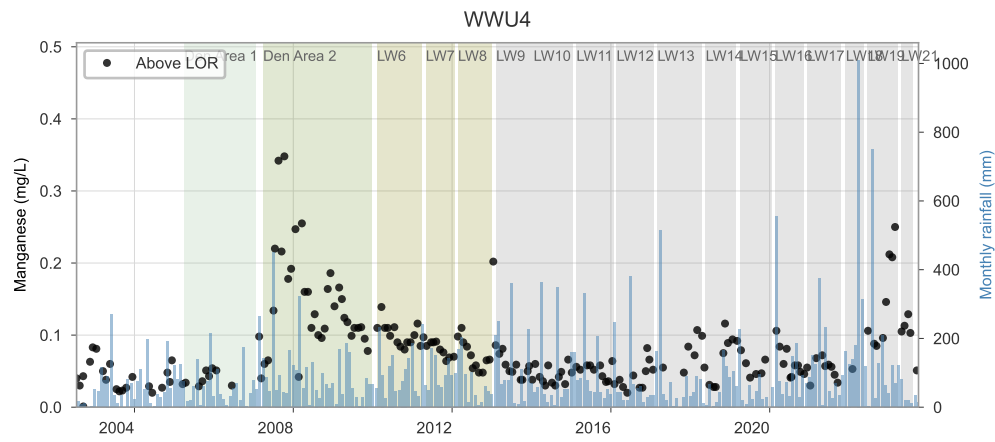
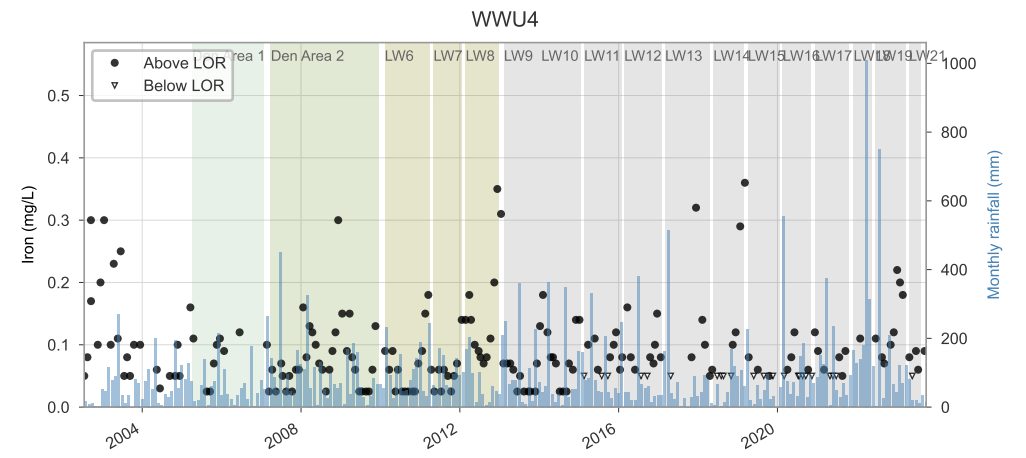
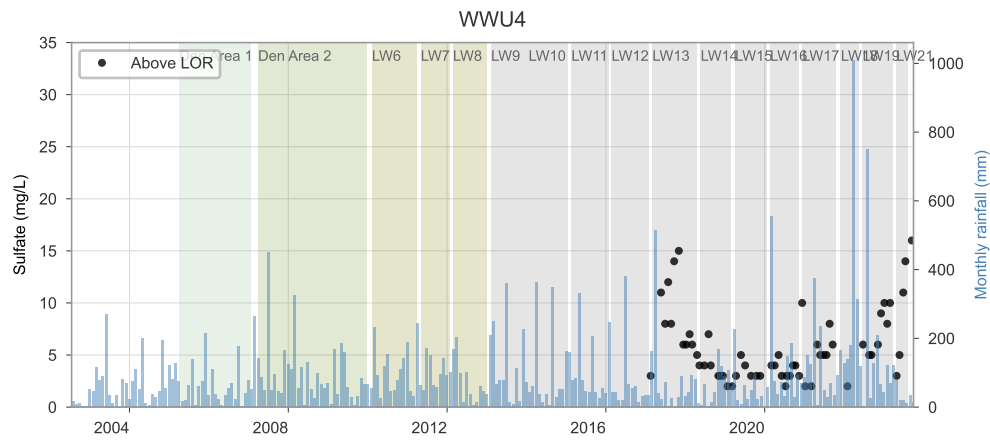








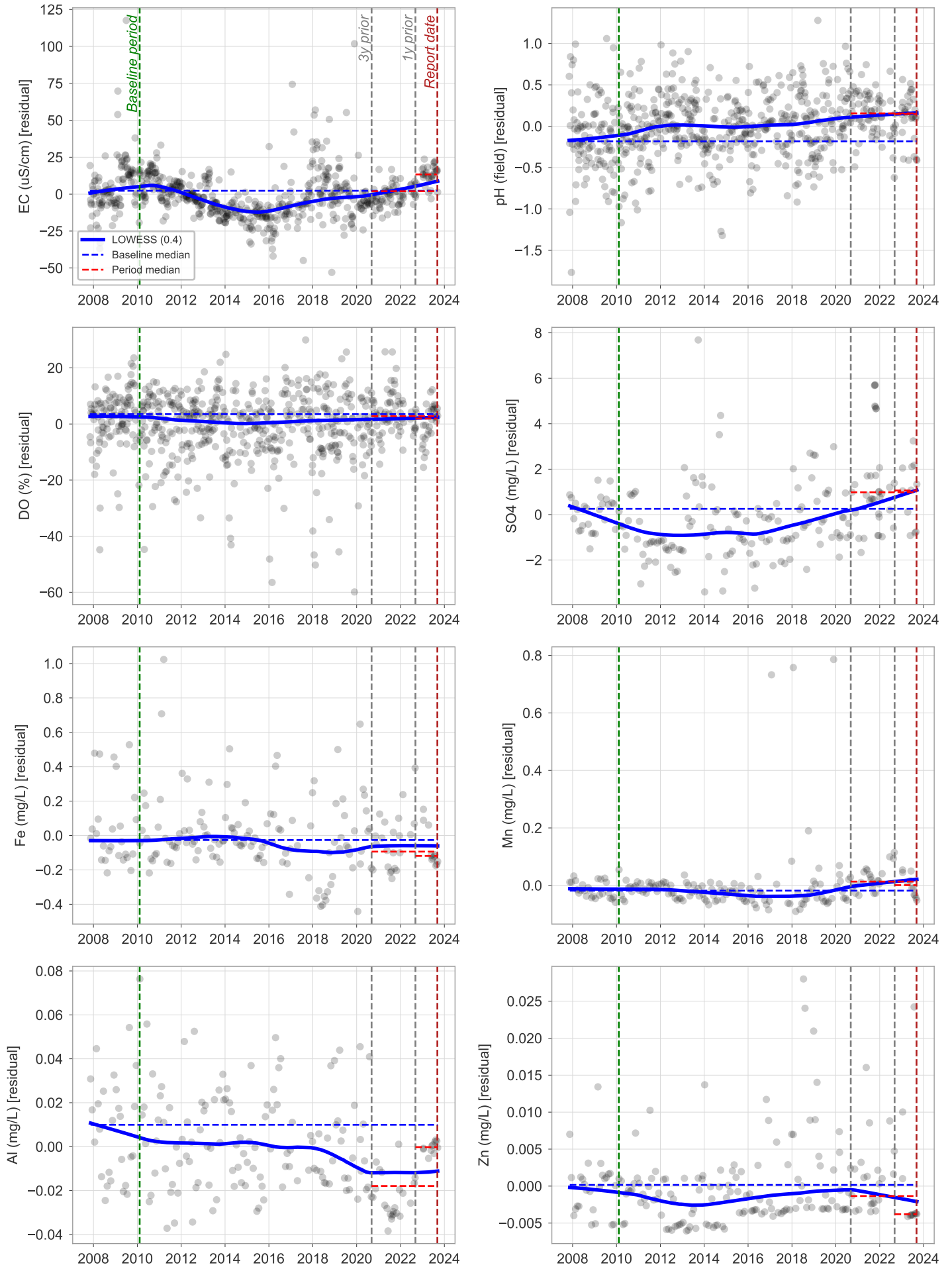




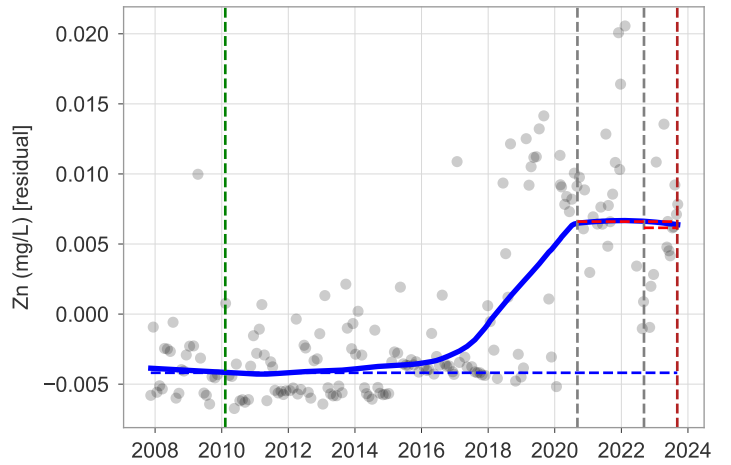
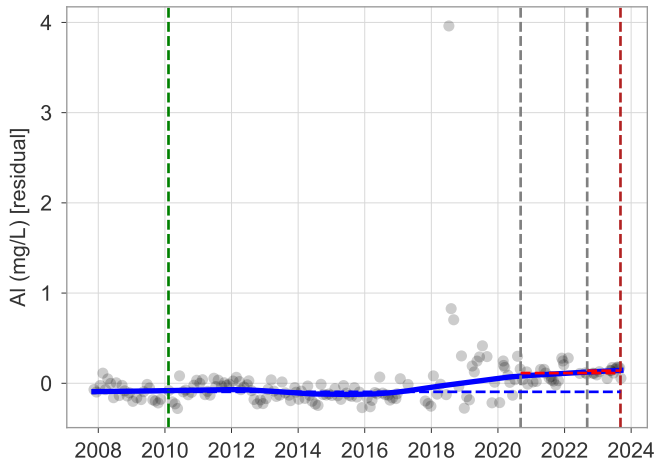
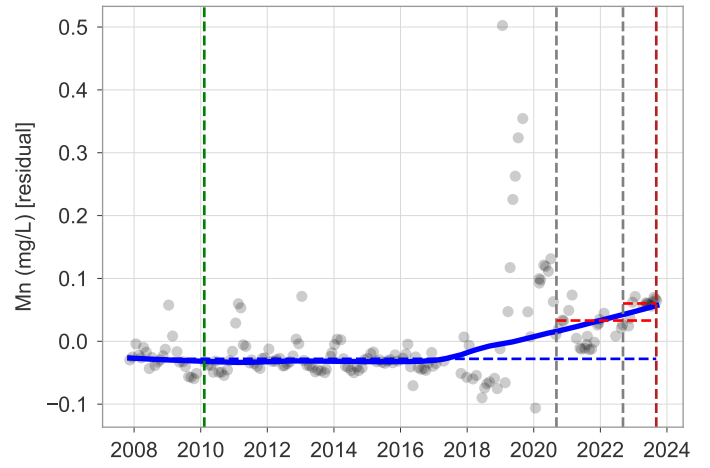
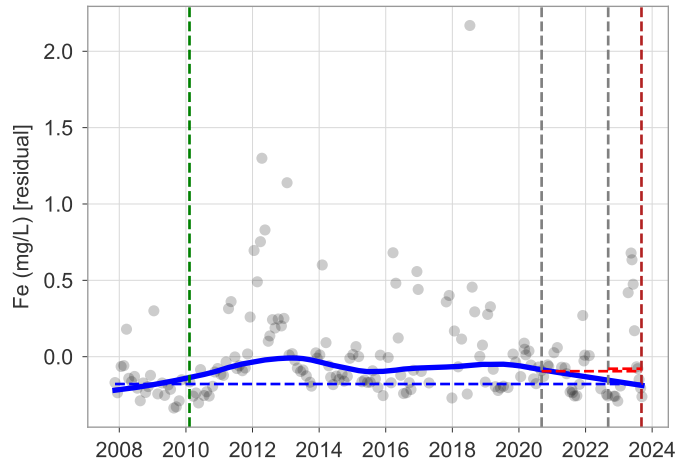
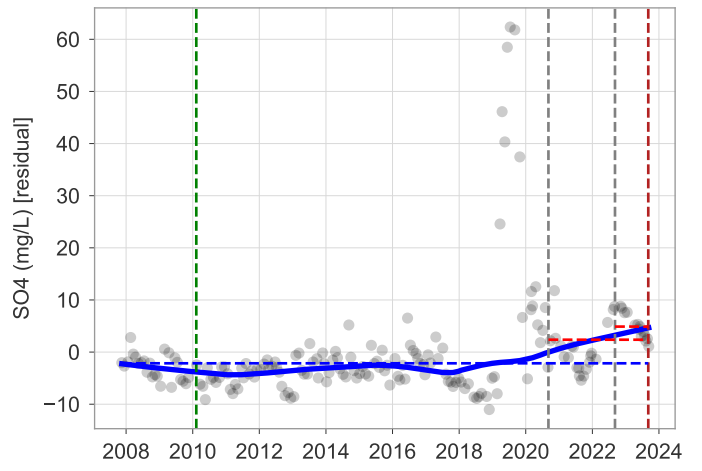
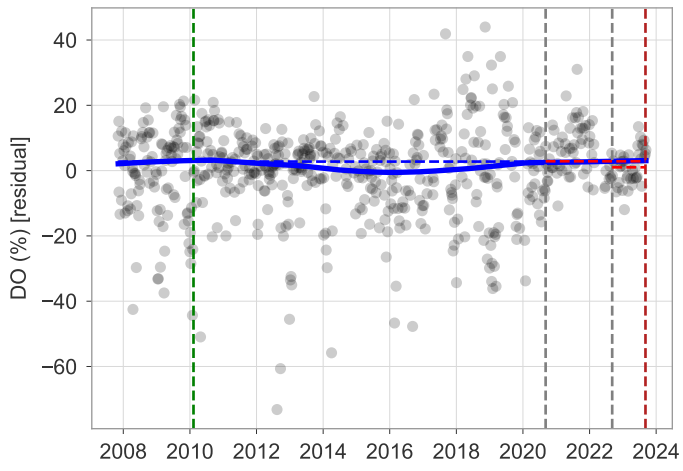
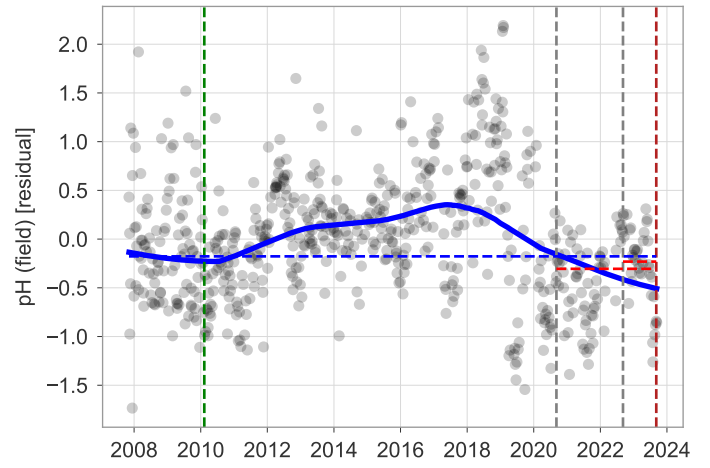
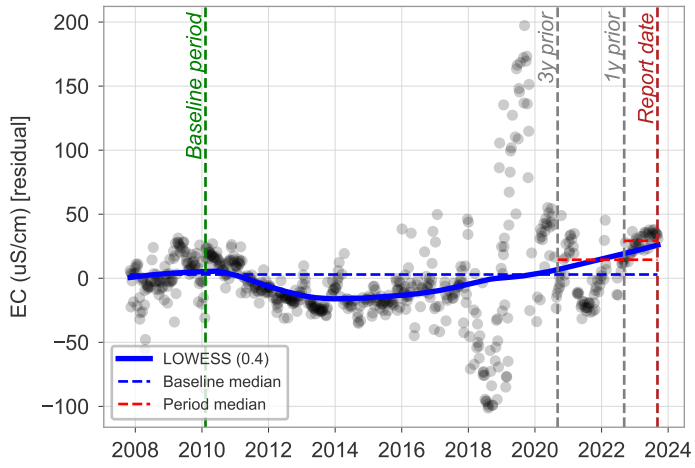
Appendix A2: Water quality trend analysis

Analysis of water quality trends in flow-corrected data: Post-Longwall 21 (to 6/9/2023)																										
WQ_site	Stream_gauge	Param	Theil-Sen slope (p-val) ⁽¹⁾		Mann-Kendall trend (p-val) ⁽²⁾		Trend (p<0.05)		Raw data statistics			Raw data		Interpretation		Size Effect ⁽⁵⁾		Flow-corrected statistics ⁽³⁾			Flow-corrected		Interpretation		Size Effect	
			1-year slope	3-year slope	1-year	3-year	1-year	3-year	1-year	3-year	Baseline	1-year	3-years	1-year	3-years	1-year	3-year	1-year	3-year	Baseline	1-year	3-years	1-year	3-years	1-year	3-year
WC_FR6	WWL	EC_us/cm	3.10E-02	1.98E-02	1.95E-02	2.95E-12	Increasing	Increasing	99	101	94	0.486	0.041			0.06	0.14	2.263	13.338	1.988	0.001	0.835	>Baseline		0.29	0.01
WC_FR6	WWL	pH_field	1.49E-05	-1.21E-04	9.87E-01	1.34E-01			5.84	6.59	6.215	0.000	0.000			0.54	0.42	-0.183	0.147	0.156	0.000	0.000			0.32	0.38
WC_FR6	WWL	DO_%	3.75E-02	-2.39E-03	3.17E-03	2.49E-01			93.75	95.75	95.45	0.191	0.207			0.11	0.09	3.512	1.944	2.773	0.180	0.867			0.11	0.01
WC_FR6	WWL	SO4_mg/L	2.33E-04	1.03E-04	1.00E+00	8.45E-01			4	7	5	0.000	0.001	>Baseline	>Baseline	0.77	0.39	0.255	1.061	0.982	0.143	0.007		>Baseline	0.24	0.32
WC_FR6	WWL	Fe_mg/L	-1.29E-03	6.60E-06	9.15E-03	9.62E-01			0.155	0.075	0.14	0.054	0.194			0.32	0.17	-0.026	-0.119	-0.094	0.153	0.166			0.24	0.18
WC_FR6	WWL	Mn_mg/L	-4.12E-04	-8.51E-06	3.58E-04	6.18E-01			0.044	0.085	0.077	0.000	0.000	>Baseline	>Baseline	0.65	0.57	-0.018	0.001	0.013	0.143	0.002		>Baseline	0.24	0.40
WC_FR6	WWL	Zn_mg/L	2.36E-06	-1.03E-06	4.84E-01	2.80E-01			0.0085	0.005	0.007	0.359	0.831			0.15	0.03	0.000	-0.004	-0.001	0.297	0.845			0.17	0.03
WC_FR6	WWL	Al_mg/L	2.62E-05	3.44E-05	2.86E-02	1.22E-04	Increasing	Increasing	0.05	0.01	0.01	0.000	0.000			0.77	0.68	0.010	0.000	-0.018	0.514	0.000			0.11	0.51
DCC_FR6	DCU	EC_us/cm	5.04E-02	4.96E-02	2.74E-06	8.04E-11	Increasing	Increasing	123	90	105	0.000	0.000			0.58	0.32	2.918	29.224	14.468	0.000	0.001	>Baseline	>Baseline	0.67	0.22
DCC_FR6	DCU	pH_field	-2.09E-03	2.02E-04	1.26E-04	8.98E-02	Decreasing		5.27	4.875	4.84	0.000	0.000	<Baseline	<Baseline	0.39	0.52	-0.177	-0.231	-0.305	0.372	0.002		<Baseline	0.07	0.21
DCC_FR6	DCU	DO_%	2.54E-02	-3.50E-03	5.56E-03	7.92E-02			88.6	95.4	94.9	0.000	0.000			0.39	0.35	2.764	1.020	2.860	0.787	0.068			0.02	0.12
DCC_FR6	DCU	SO4_mg/L	-2.12E-02	4.56E-03	5.20E-06	1.68E-01			3	2	4	0.002	0.274			0.51	0.14	-2.151	4.891	2.373	0.000	0.000	>Baseline	>Baseline	0.80	0.57
DCC_FR6	DCU	Fe_mg/L	1.99E-04	-1.14E-05	8.58E-01	8.24E-01			0.065	0.35	0.1	0.002	0.072	>Baseline		0.50	0.24	-0.179	-0.079	-0.095	0.115	0.076			0.26	0.23
DCC_FR6	DCU	Mn_mg/L	9.04E-05	6.63E-05	1.00E-01	9.67E-05		Increasing	0.0415	0.083	0.0825	0.000	0.000	>Baseline	>Baseline	0.59	0.61	-0.028	0.060	0.033	0.000	0.000	>Baseline	>Baseline	0.79	0.75
DCC_FR6	DCU	Zn_mg/L	2.04E-05	-9.84E-07	7.63E-02	6.25E-01			0.005	0.014	0.015	0.000	0.000	>Baseline	>Baseline	0.72	0.76	-0.004	0.006	0.007	0.000	0.000	>Baseline	>Baseline	0.75	0.78
DCC_FR6	DCU	Al_mg/L	2.57E-04	1.17E-04	4.29E-03	4.63E-03	Increasing	Increasing	0.13	0.24	0.285	0.000	0.000	>Baseline	>Baseline	0.61	0.72	-0.095	0.139	0.113	0.000	0.000	>Baseline	>Baseline	0.79	0.78
SCK_ROCKBAR5	SC10S1	EC_us/cm	1.16E-02	-1.23E-02	4.35E-01	1.87E-01			96.4	82	91	0.063	0.494			0.30	0.09	0.174	10.949	13.388	0.000	0.000	>Baseline	>Baseline	0.69	0.61
SCK_ROCKBAR5	SC10S1	pH_field	-8.82E-04	-6.40E-04	3.06E-01	4.65E-05	Decreasing		5.42	6.28	6.23	0.000	0.000			0.76	0.78	-0.200	0.145	0.306	0.002	0.000			0.49	0.66
SCK_ROCKBAR5	SC10S1	DO_%	2.13E-02	1.83E-03	1.53E-01	4.15E-01			78.8	90.7	90.3	0.001	0.000			0.56	0.56	-5.793	1.967	2.107	0.002	0.000			0.50	0.53
SCK_ROCKBAR5	SC10S1	SO4_mg/L	-6.60E-03	-4.03E-03	1.53E-01	2.23E-02			2	8	8	0.000	0.000	>Baseline	>Baseline	0.83	0.75	-2.587	1.780	2.299	0.000	0.000	>Baseline	>Baseline	0.79	0.77
SCK_ROCKBAR5	SC10S1	Fe_mg/L	-3.44E-03	-1.56E-03	8.76E-03	1.24E-04			0.2	0.455	1.29	0.005	0.000	>Baseline	>Baseline	0.46	0.62	-0.327	-0.253	0.671	0.200	0.000		>Baseline	0.21	0.51
SCK_ROCKBAR5	SC10S1	Mn_mg/L	-2.82E-04	-3.26E-04	3.81E-01	2.23E-02			0.046	0.306	0.368	0.000	0.000	>Baseline	>Baseline	0.80	0.85	-0.128	0.134	0.182	0.000	0.000	>Baseline	>Baseline	0.80	0.85
SCK_ROCKBAR5	SC10S1	Zn_mg/L	-4.90E-05	-3.55E-05	8.76E-03	1.00E-03			0.003	0.0195	0.025	0.000	0.000	>Baseline	>Baseline	0.74	0.79	-0.014	0.002	0.005	0.000	0.000	>Baseline	>Baseline	0.67	0.74
SCK_ROCKBAR5	SC10S1	Al_mg/L	-1.12E-04	6.37E-06	1.65E-02	6.24E-01			0	0.02	0.02	0.000	0.000	>Baseline	>Baseline	0.00	0.00	0.000	-0.016	-0.016	0.000	0.000			0.00	0.00
WWU4	WWU	EC_us/cm	1.81E-02	9.96E-03	1.00E+00	1.70E-01			88.4	80.5	83	0.171	0.467			0.23	0.10	-0.990	9.158	7.574	0.104	0.181			0.27	0.19
WWU4	WWU	pH_field	-3.96E-04	-4.84E-04	8.62E-01	1.30E-01			5.05	6.445	6.4	0.000	0.000			0.64	0.77	-0.535	0.282	0.330	0.003	0.000			0.50	0.71
WWU4	WWU	DO_%	4.67E-02	1.13E-04	3.81E-01	1.00E+00			95.4	96.3	97.8	0.729	0.187			0.06	0.19	3.453	5.362	5.497	0.622	0.295			0.08	0.15
WWU4	WWU	SO4_mg/L	1.09E-02	3.66E-05	4.84E-01	9.08E-01			8	8.5	5	0.686	0.007			0.07	0.38	1.532	-1.616	-1.647	0.004	0.000			0.49	0.56
WWU4	WWU	Fe_mg/L	-2.78E-04	-1.34E-08	2.16E-01	1.00E+00			0.08	0.095	0.08	0.218	1.000			0.21	0.00	0.004	-0.008	-0.011	0.812	0.712			0.04	0.05
WWU4	WWU	Mn_mg/L	7.07E-05	1.35E-05	6.01E-01	2.75E-01			0.124	0.121	0.072	0.956	0.001			0.01	0.46	0.043	-0.001	-0.019	0.060	0.000			0.32	0.61
WWU4	WWU	Zn_mg/L	1.70E-05	-3.11E-06	7.26E-02	3.91E-01			0.039	0.019	0.028	0.001	0.001			0.58	0.47	0.009	-0.001	-0.001	0.009	0.003			0.44	0.42
WWU4	WWU	Al_mg/L	-2.95E-05	2.50E-05	2.91E-01	1.14E-02		Increasing	0.06	0.02	0.03	0.000	0.000			0.68	0.63	0.013	-0.001	-0.007	0.007	0.000			0.45	0.62
Notes:	1. Theil-Sen slope is the median of the slopes between all pairs of x-y points in the data. It is a non parametric estimator of median slope																									
	2. Mann-Kendall test for serial correlation (p-value): the probability of obtaining a correlation result at least as extreme due to chance. Results significant at the 95% level are indicated in bold (values <0.05)																									
	3. Flow-corrected statistics are the median values for the periods indicated, based on the flow-corrected residuals (not actual measurement values)																									
	4. Mann-Whitney U test: A non parametric rank-sum test for the difference in means between two samples (in this case, observations in different time intervals). Expressed as a p-value with significance at the 95% level indicated in bold .																									
	5. Rank-biserial correlation coefficient (r). Quantifies the effect size of the observed difference between the two groups based on sample size. <0.1: Small effect, 0.1-0.3: Medium effect, >0.3: Large effect																									

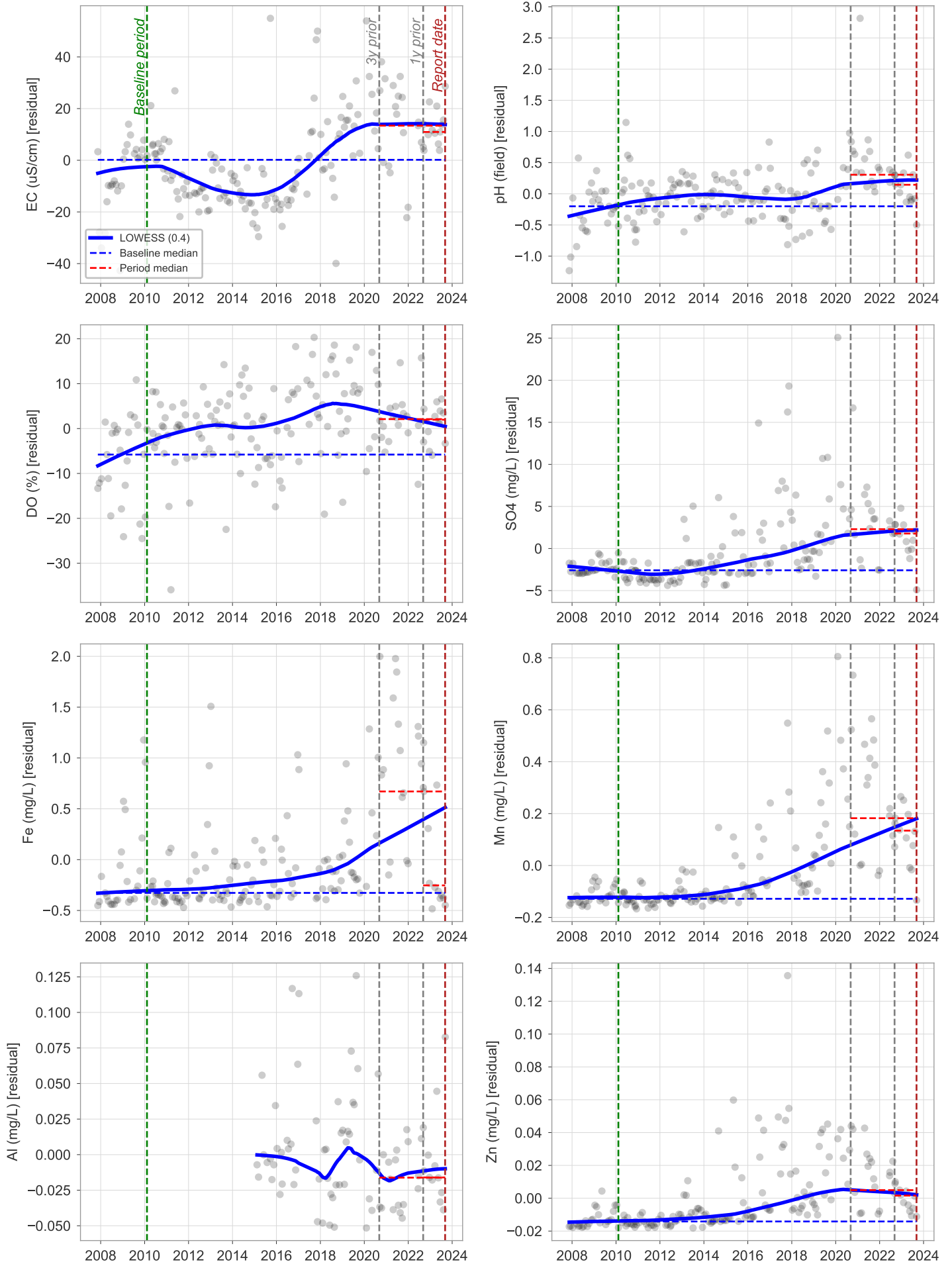
WC_FR6 Flow-corrected time series



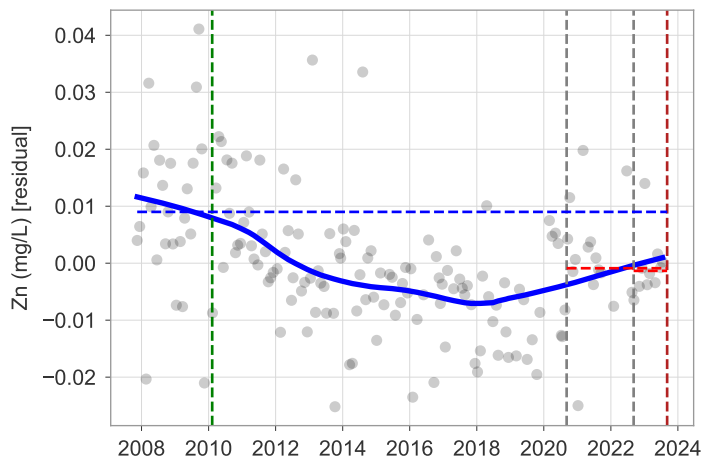
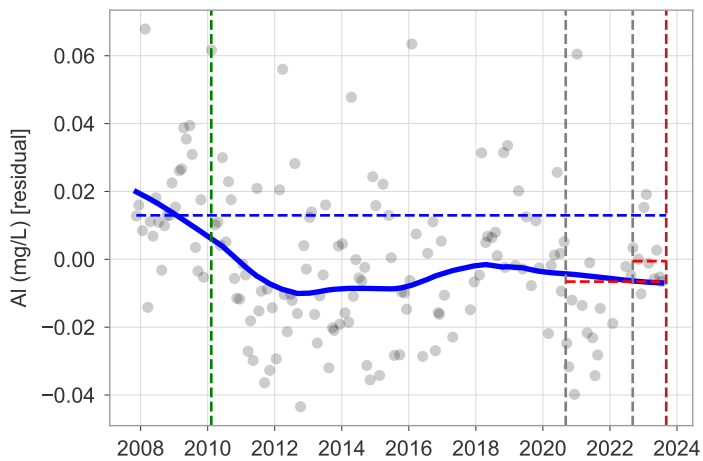
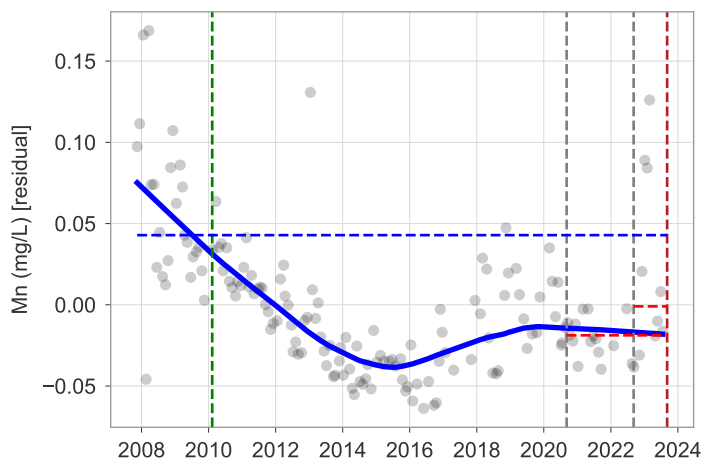
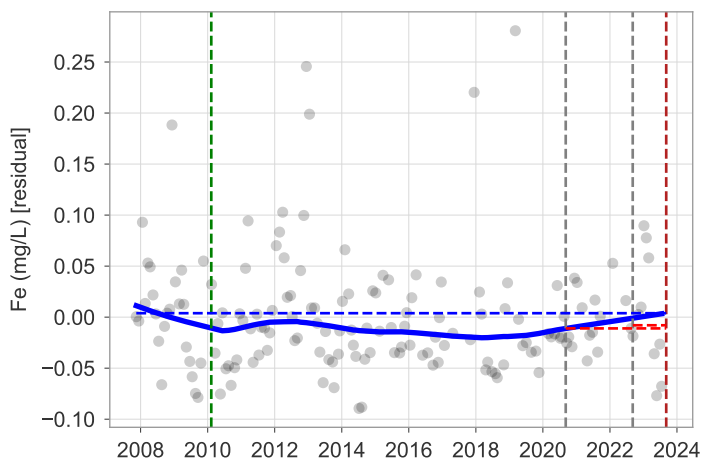
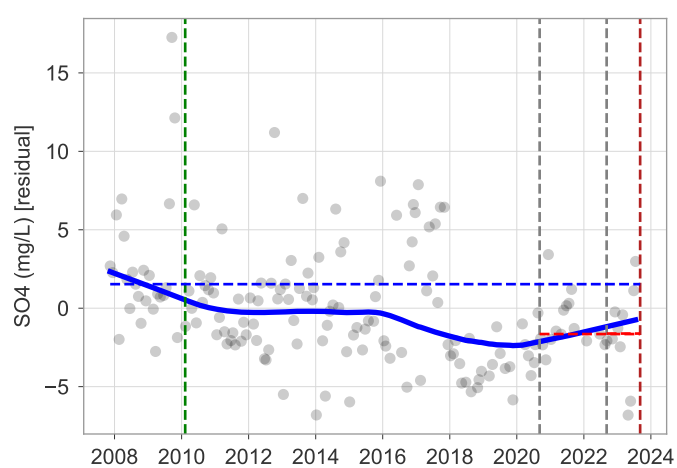
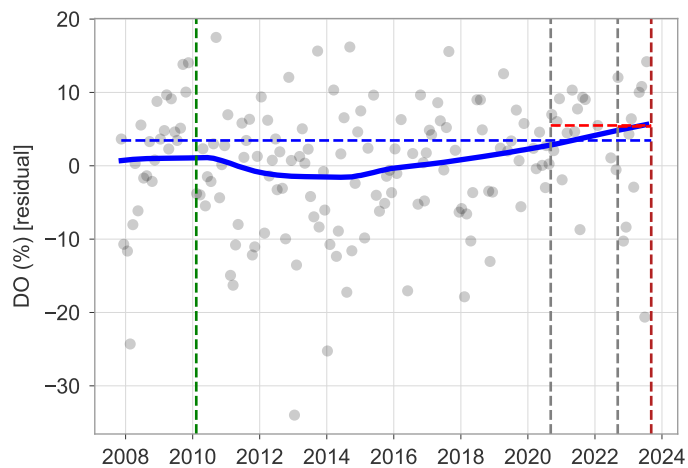
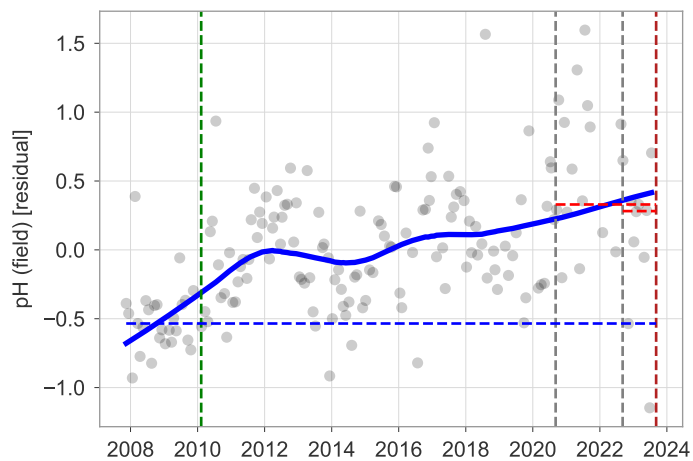
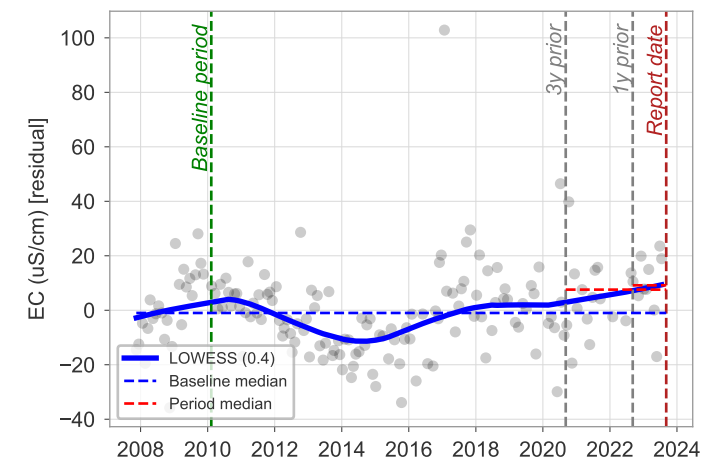
DCC_FR6 Flow-corrected time series



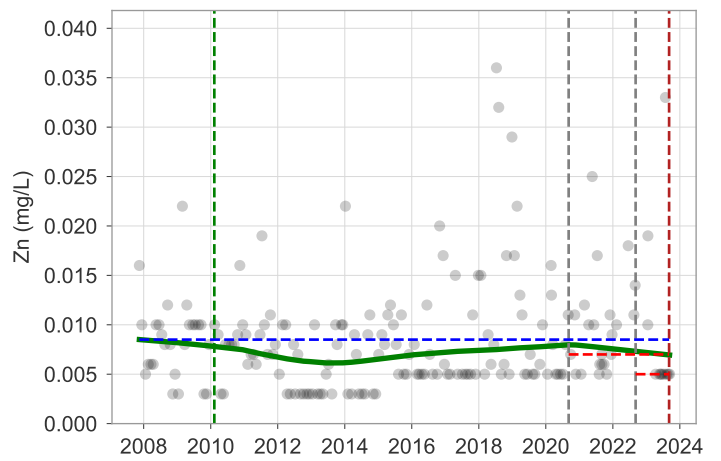
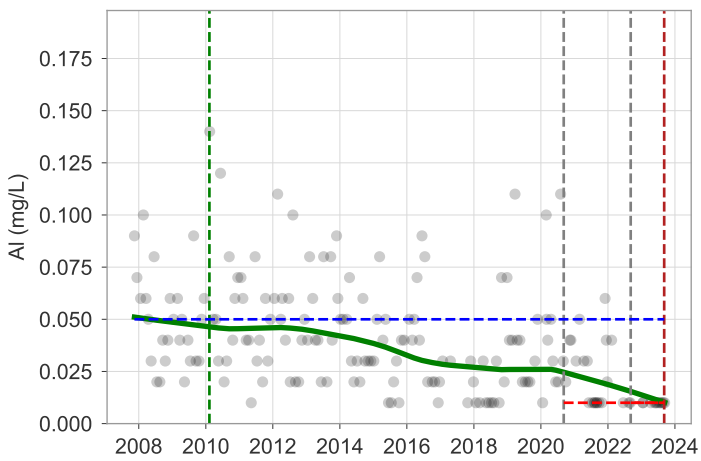
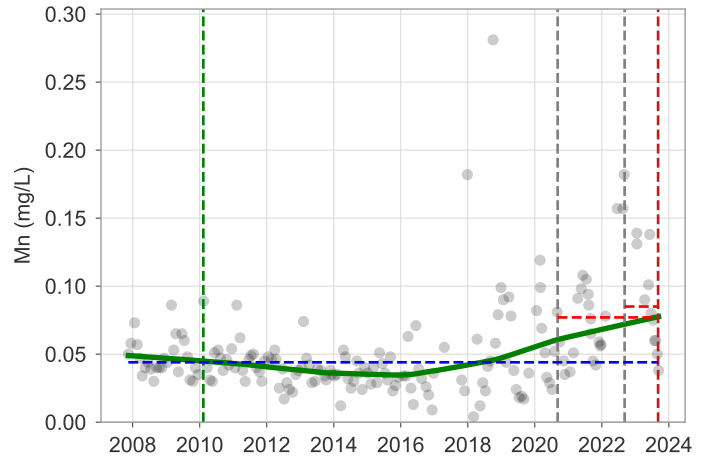
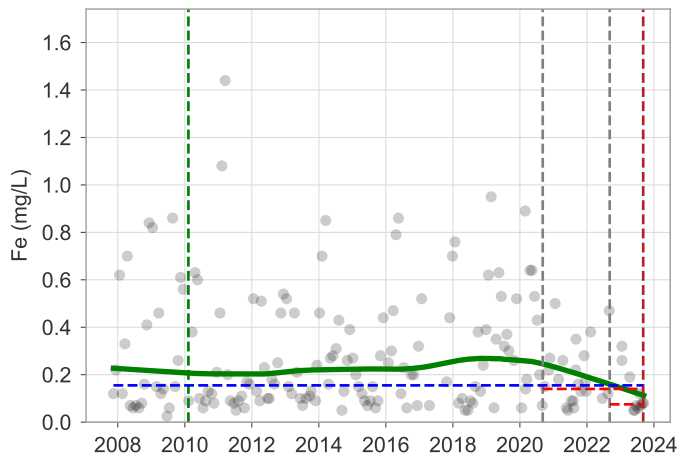
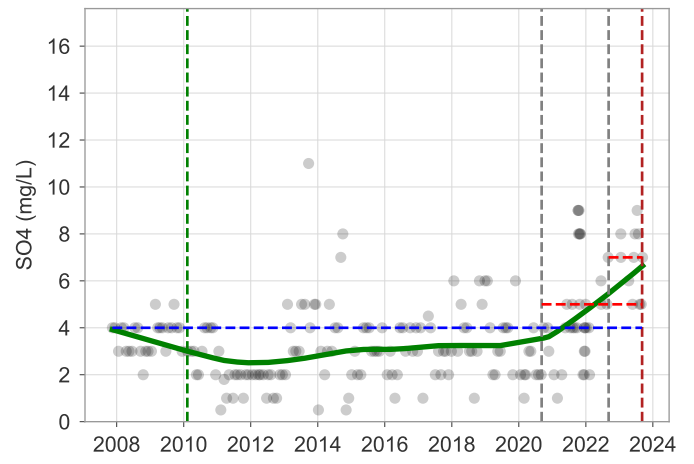
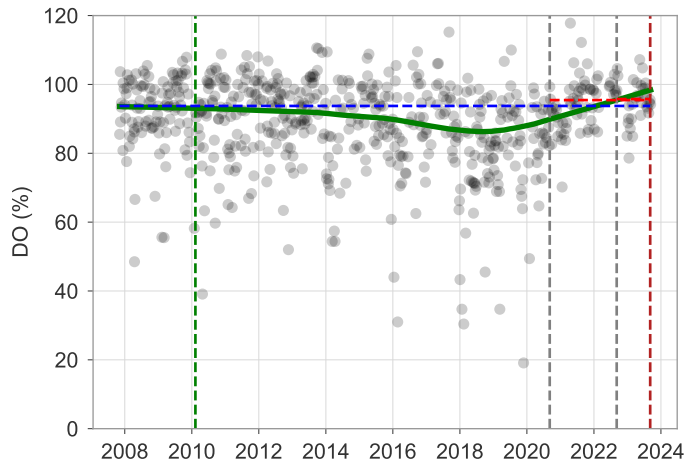
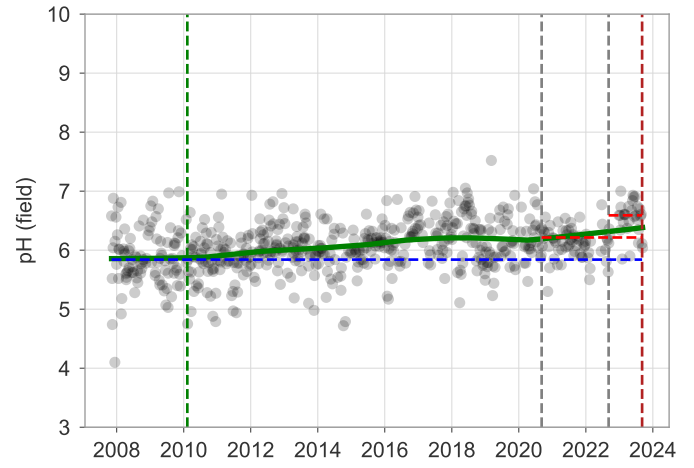
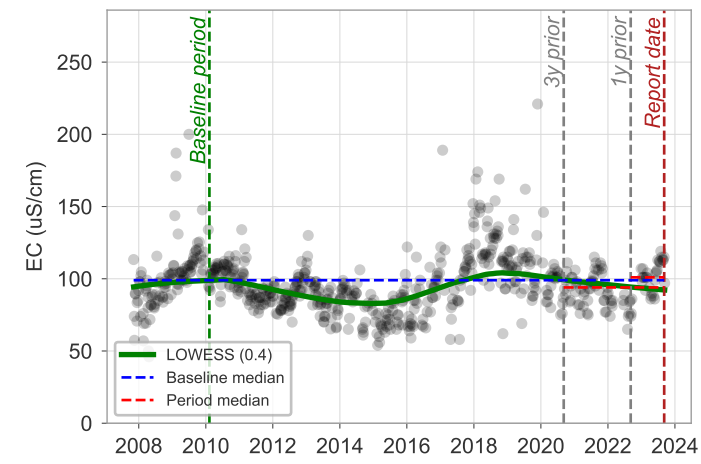
SCK_ROCKBAR5 Flow-corrected time series



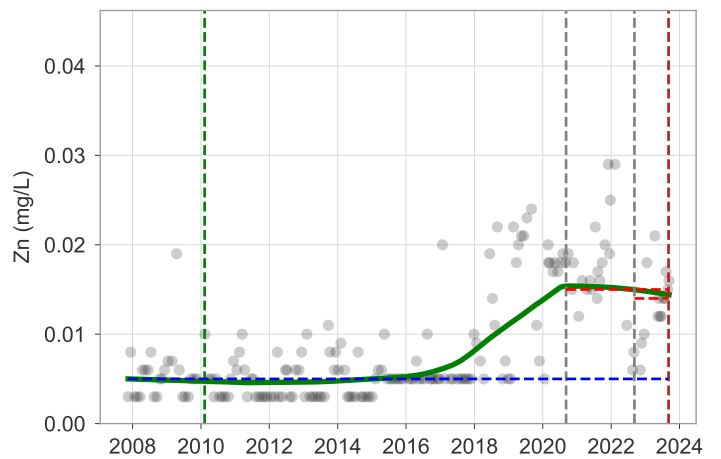
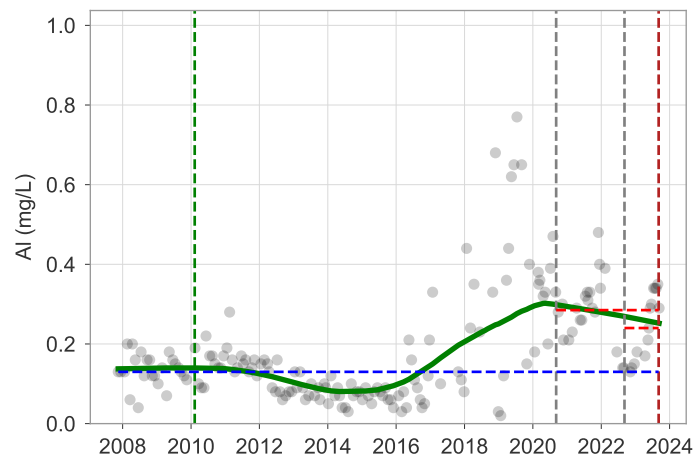
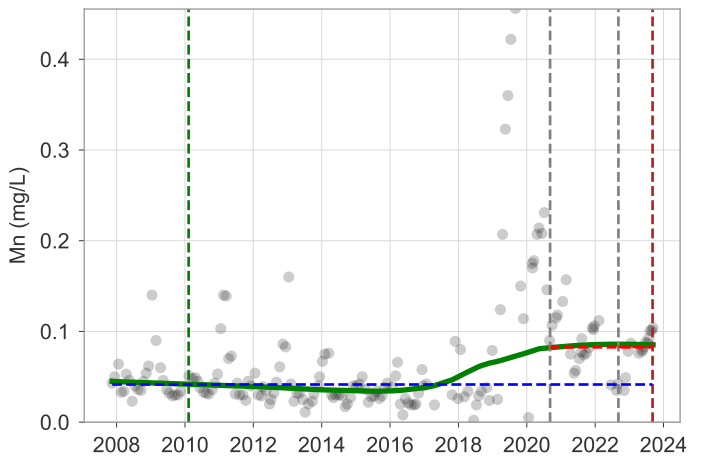
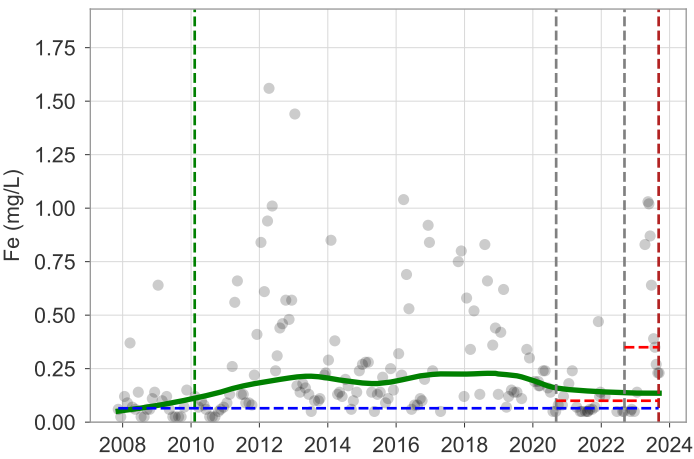
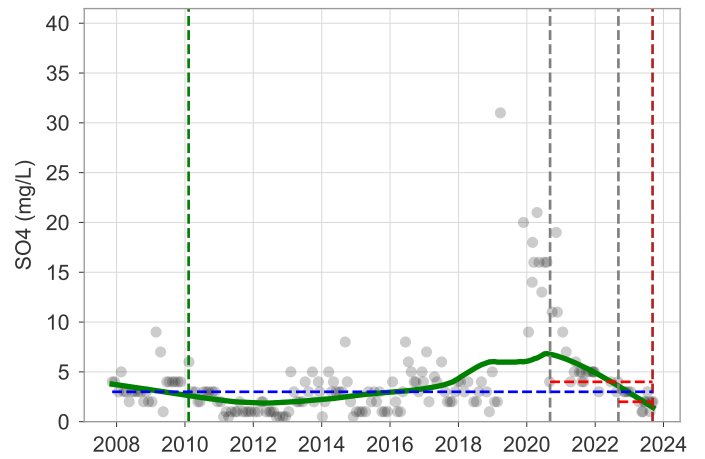
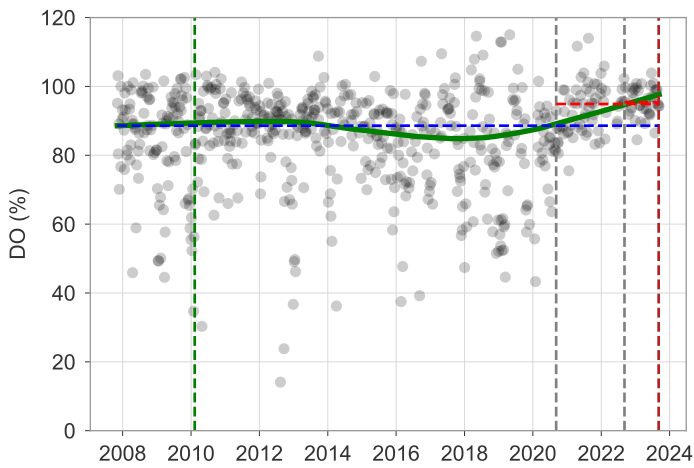
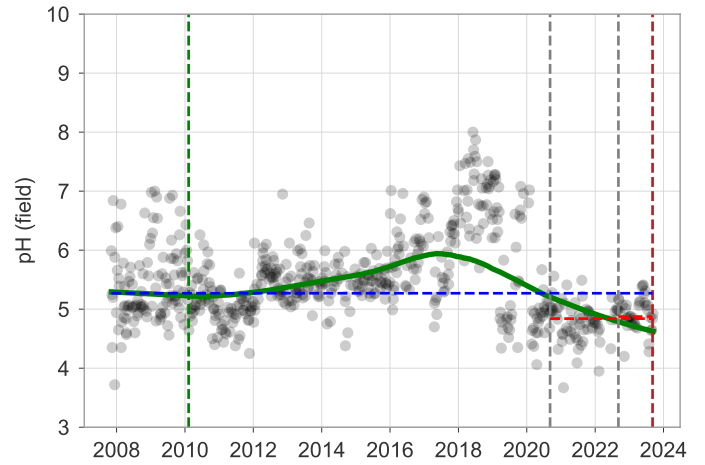
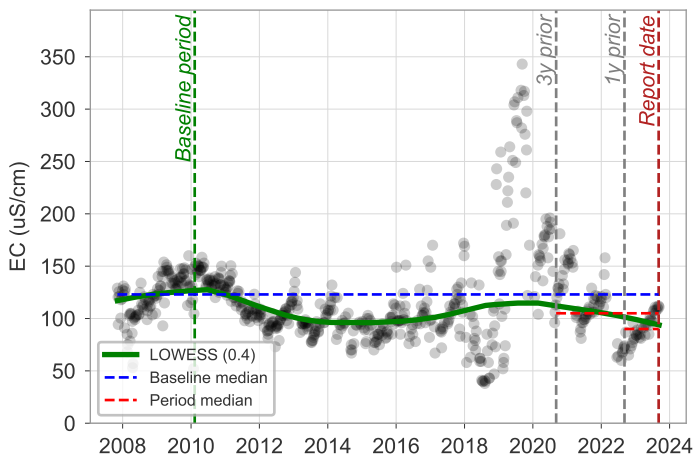
WWU4 Flow-corrected time series



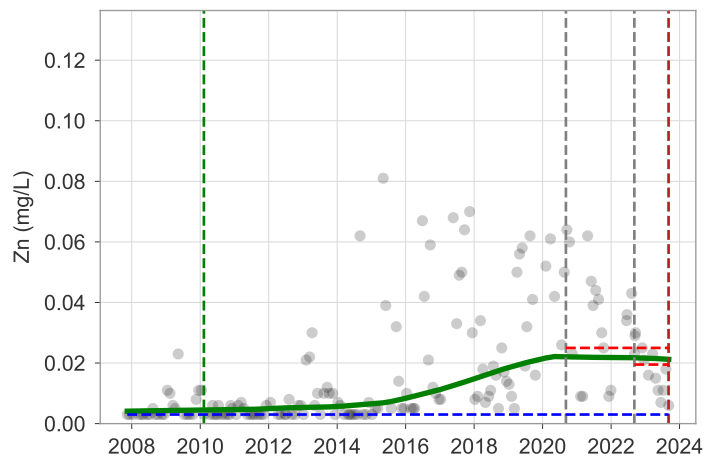
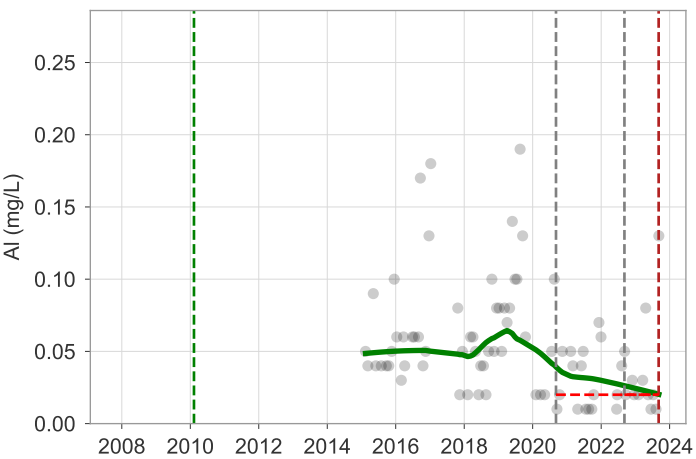
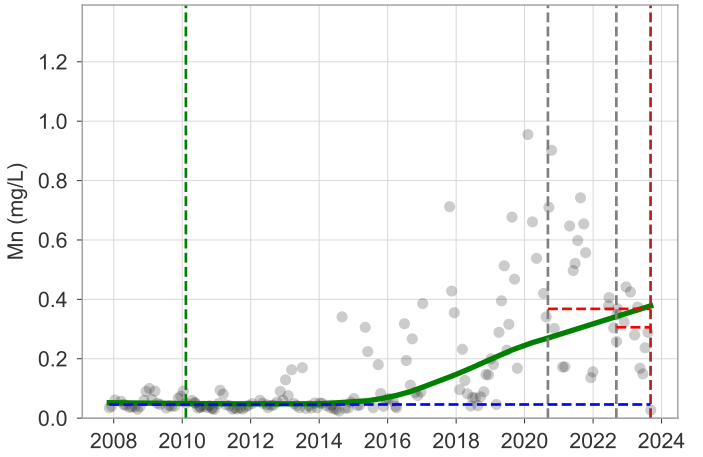
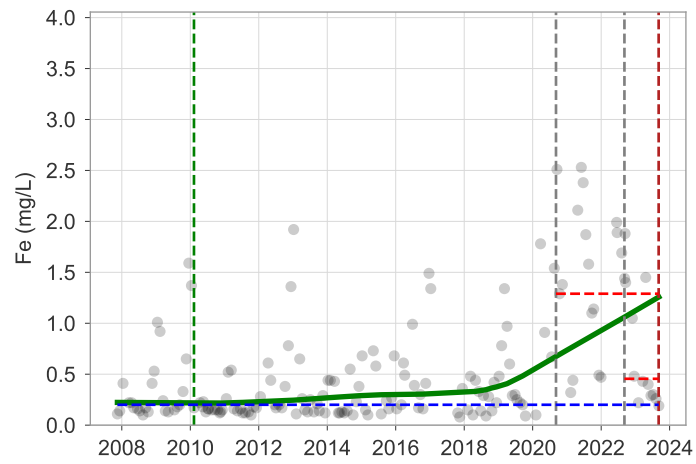
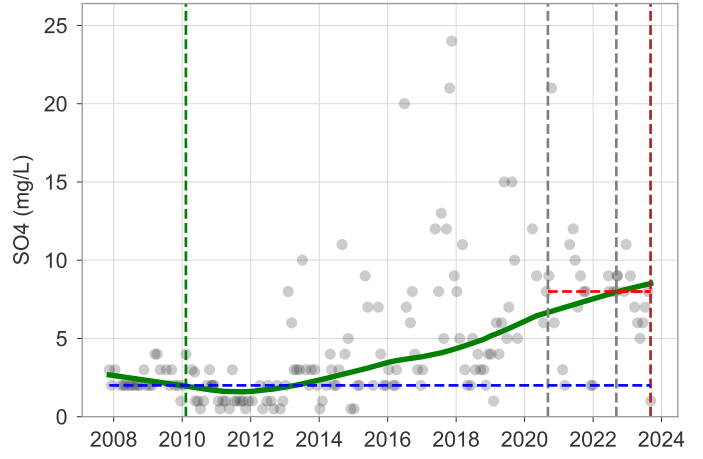
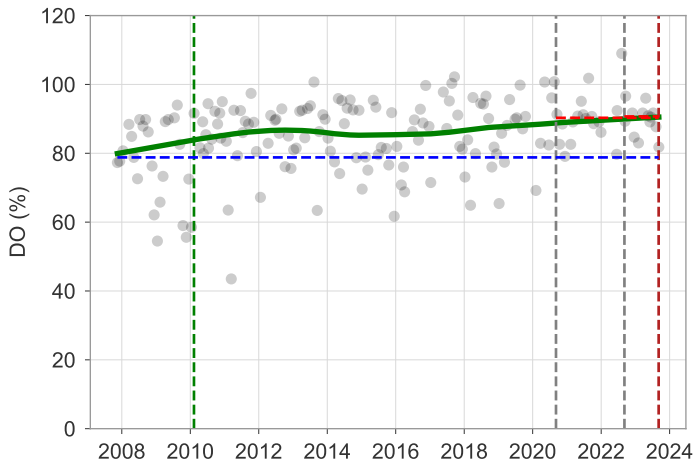
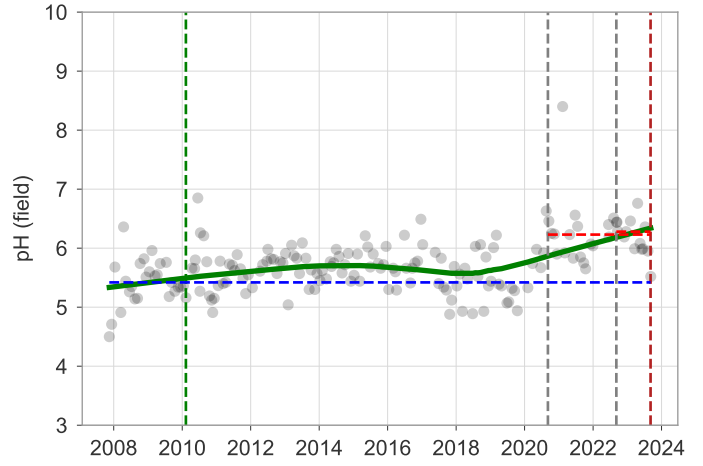
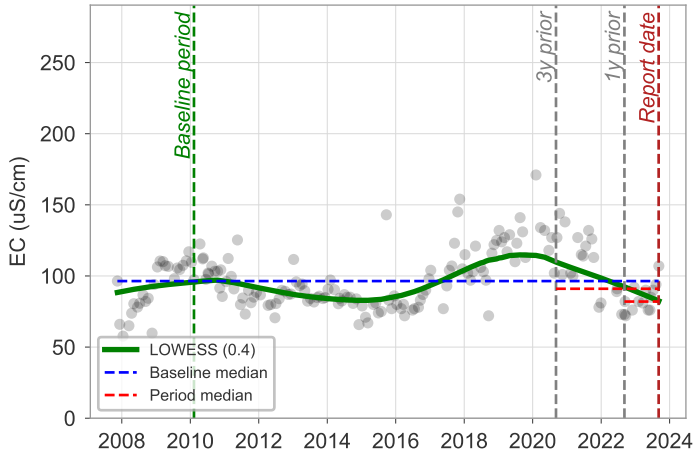
WC_FR6 Raw (observed data) time series



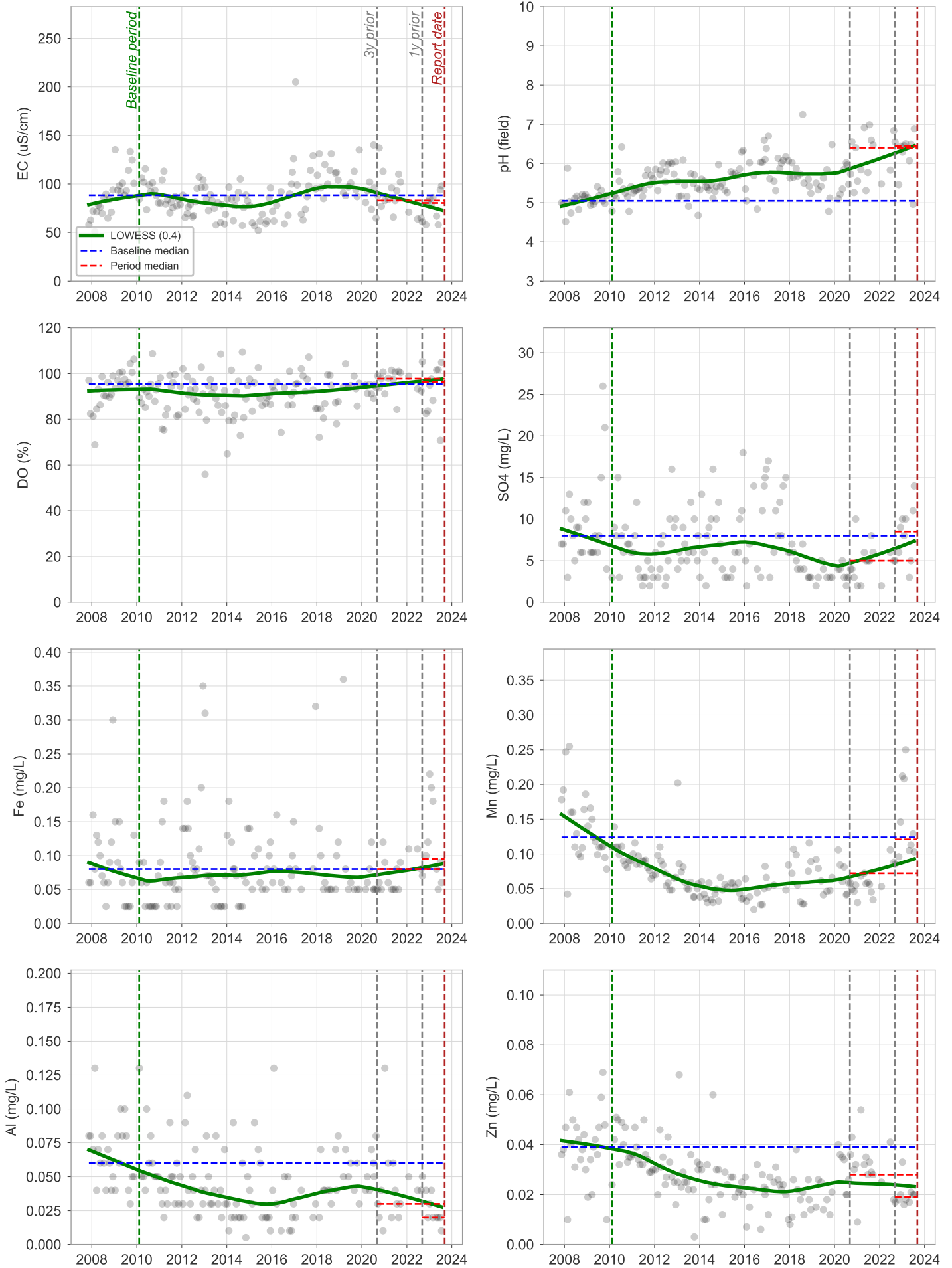
DCC_FR6 Raw (observed data) time series



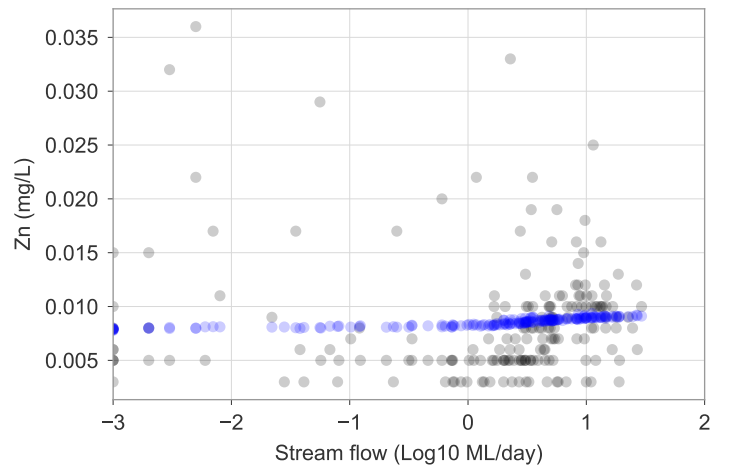
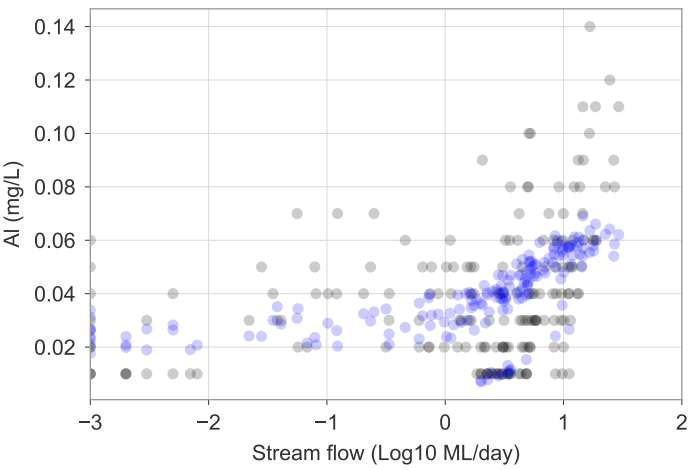
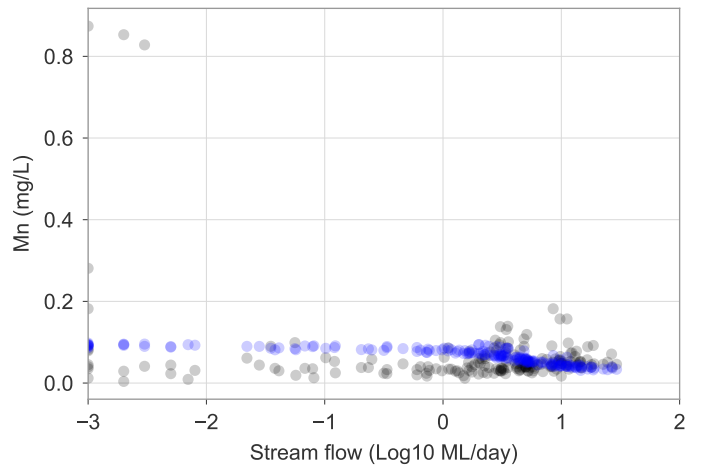
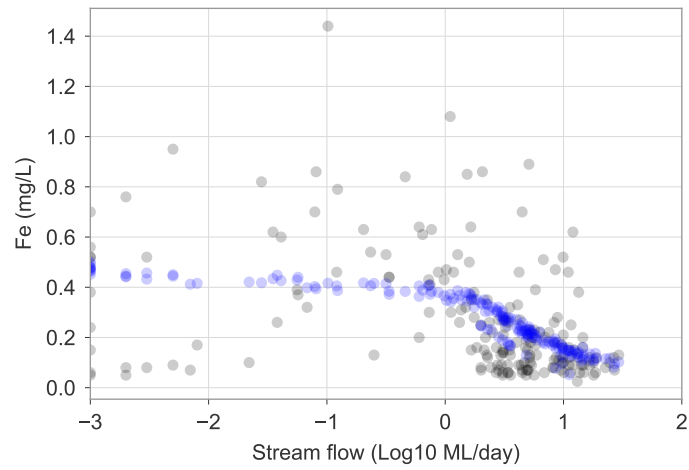
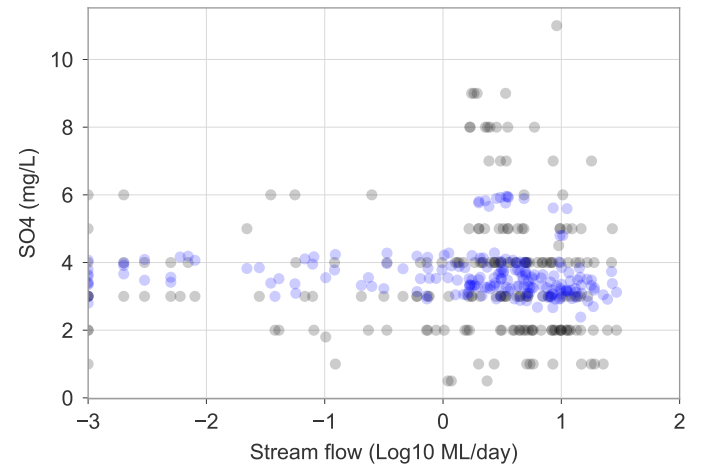
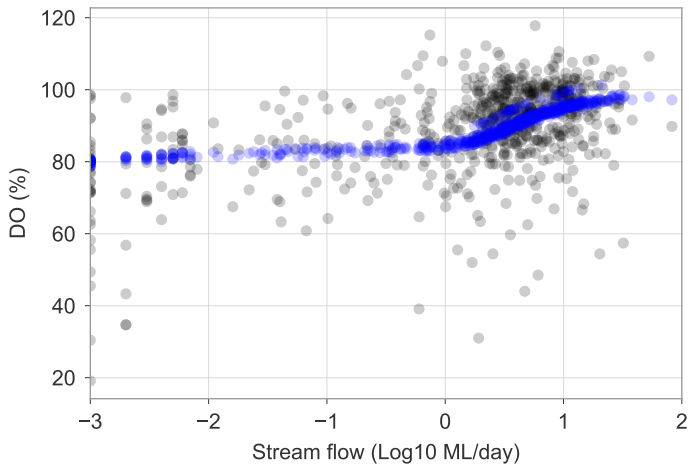
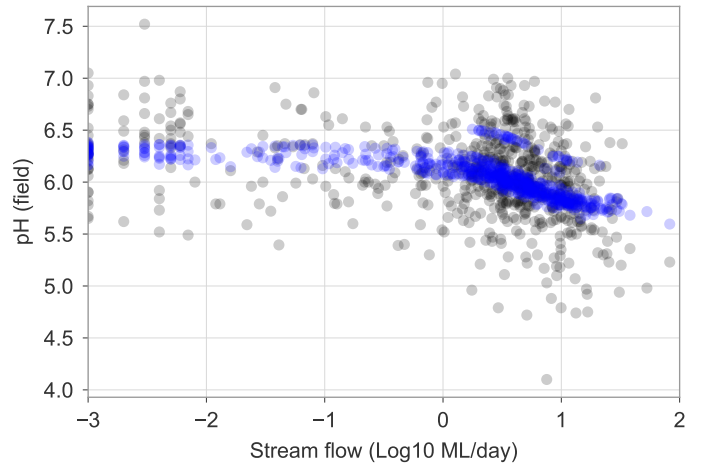
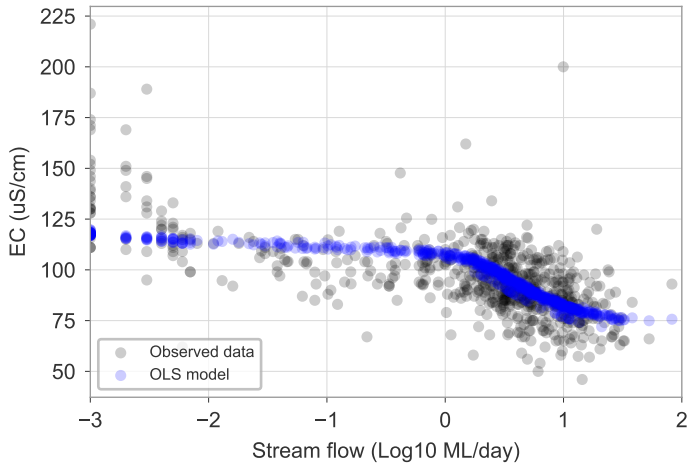
SCK_ROCKBAR5 Raw (observed data) time series



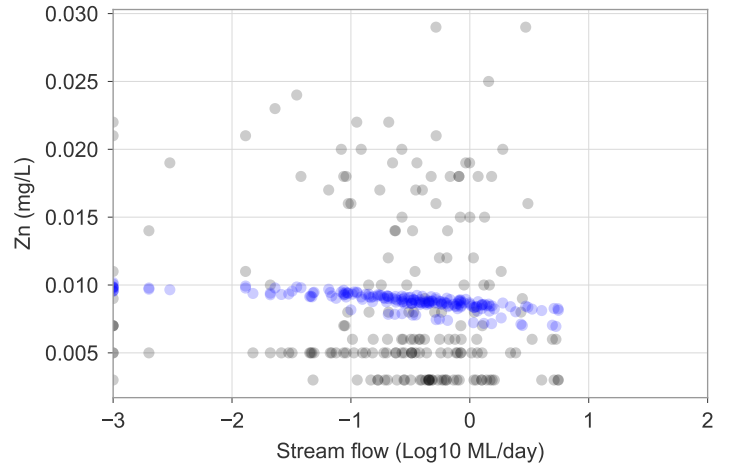
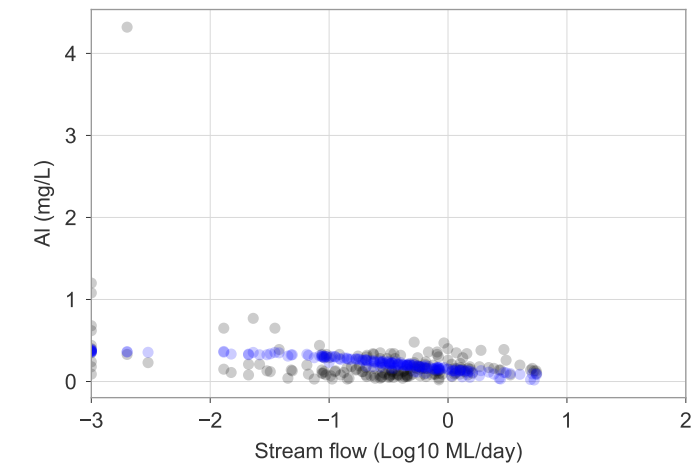
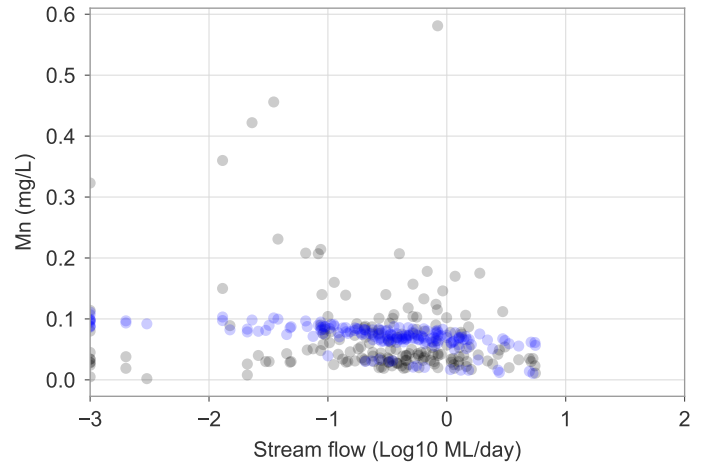
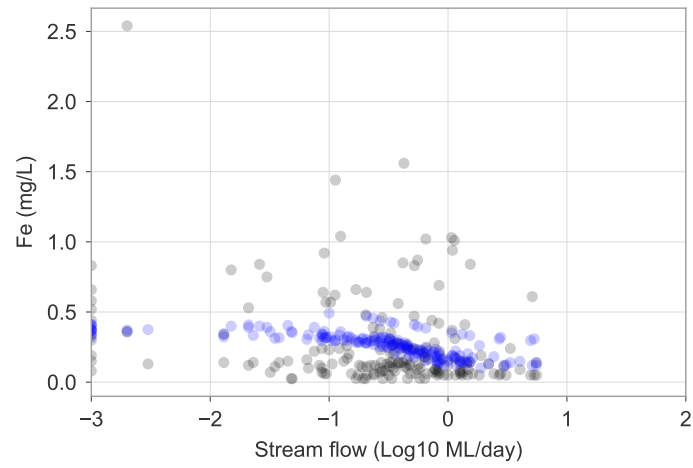
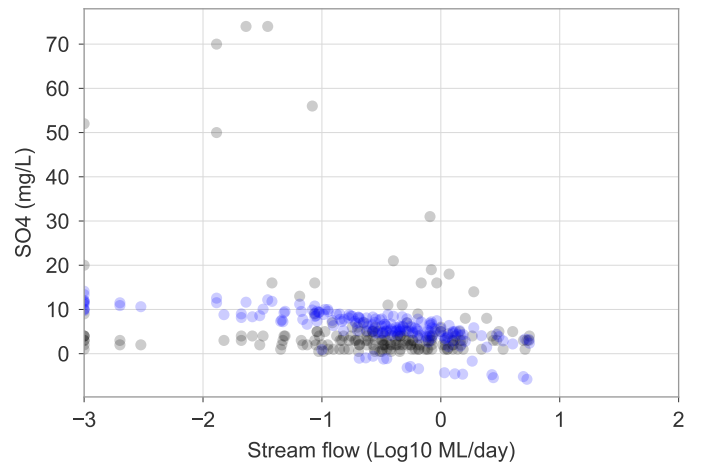
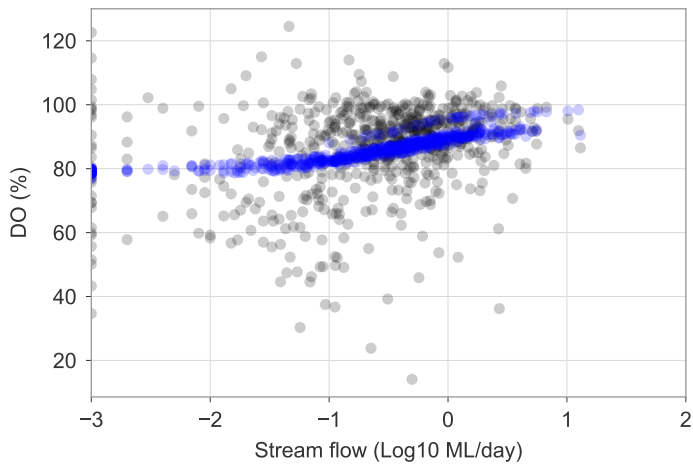
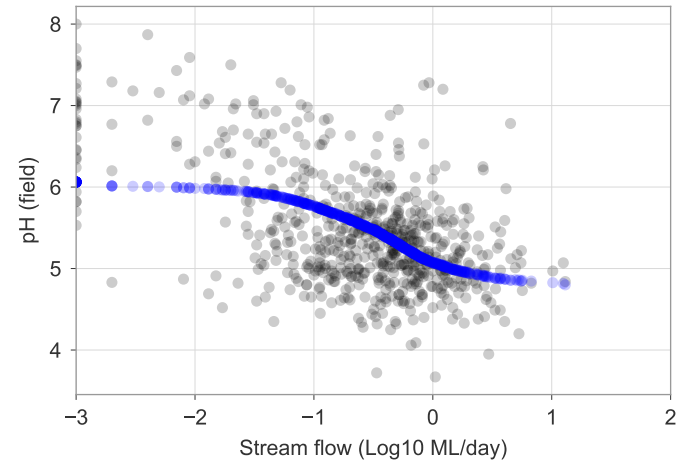
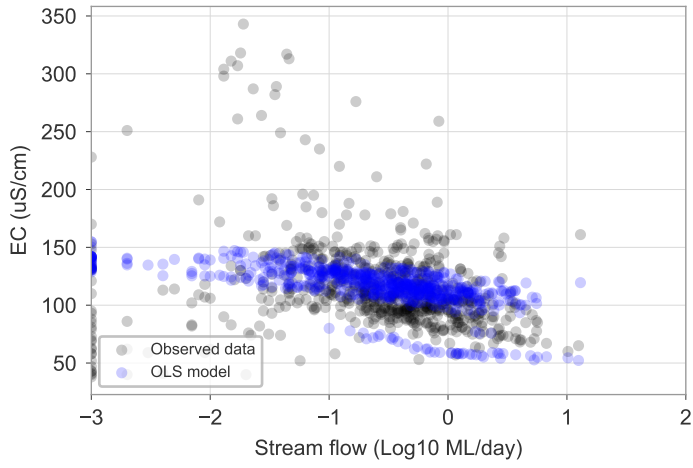
WWU4 Raw (observed data) time series



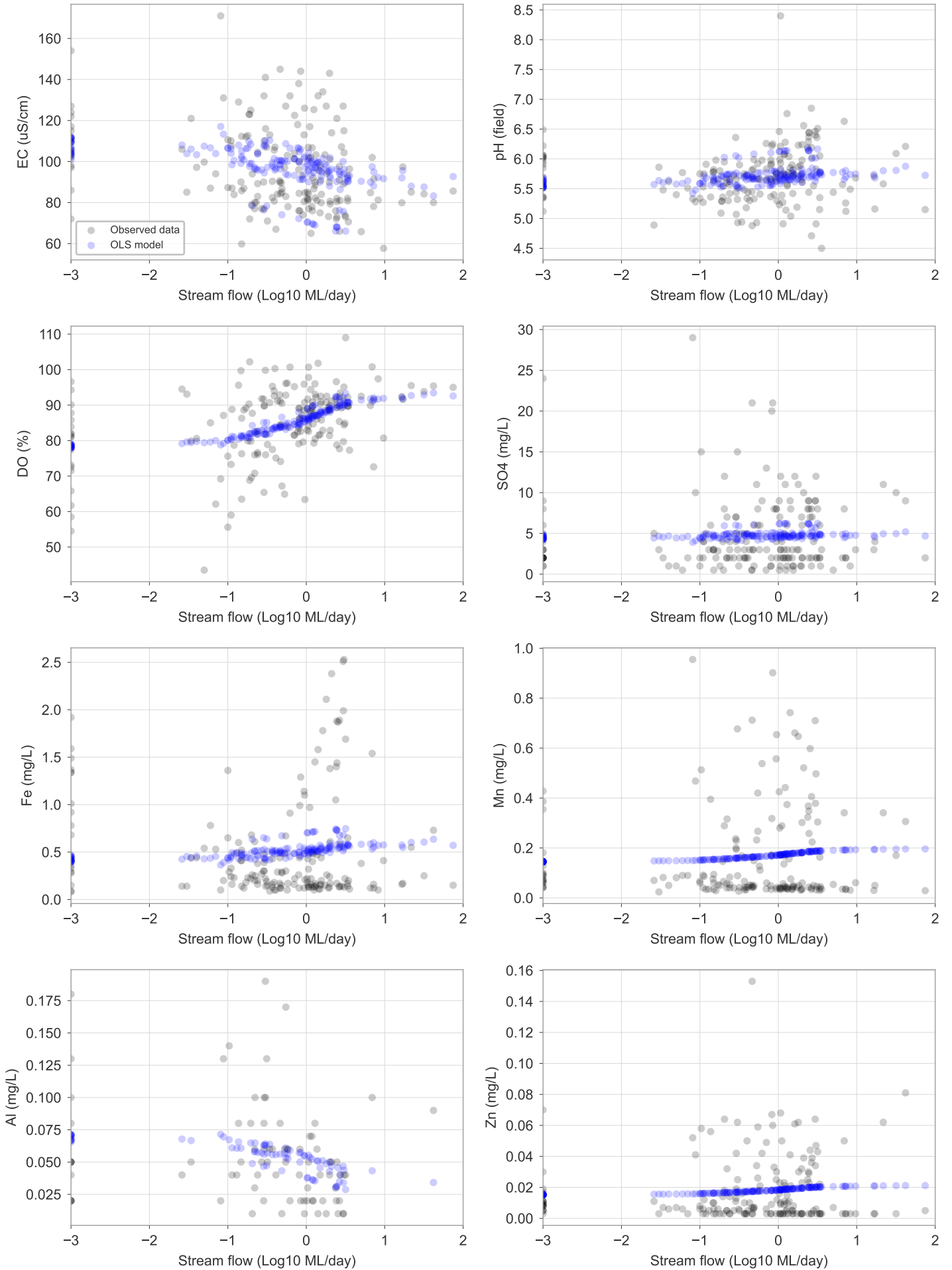
WC_FR6 Water quality - flow correlation



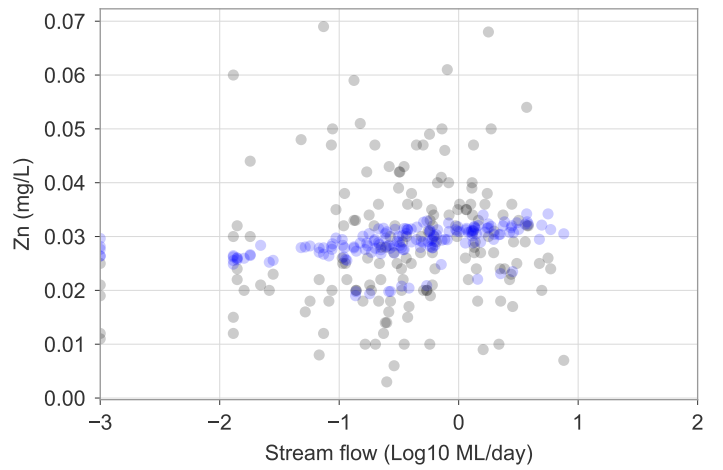
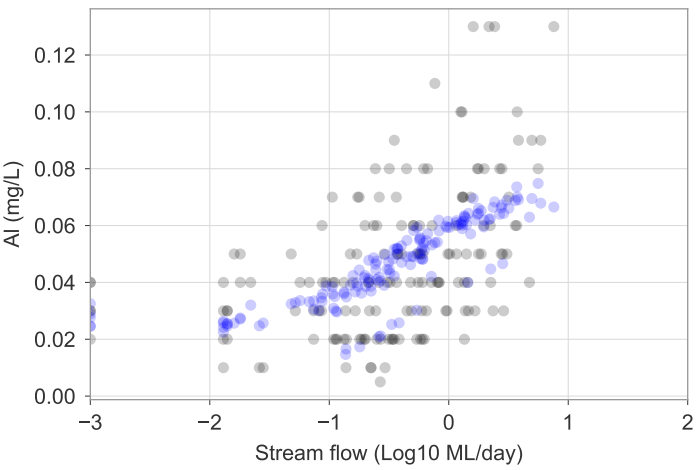
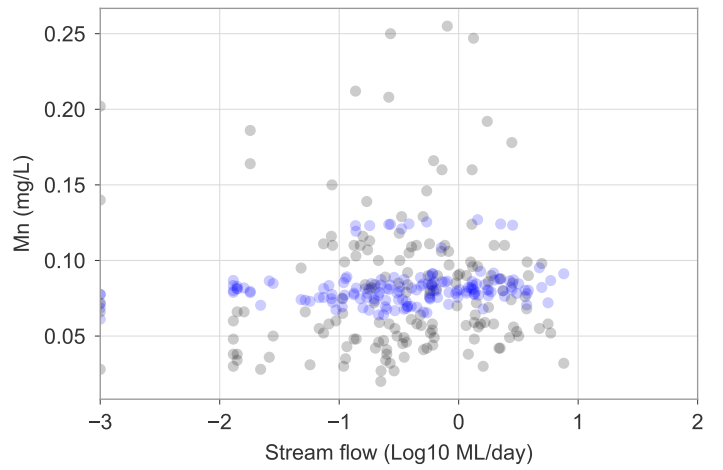
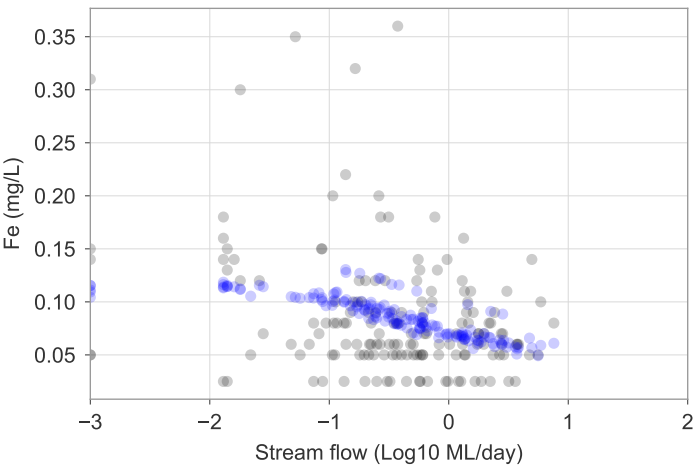
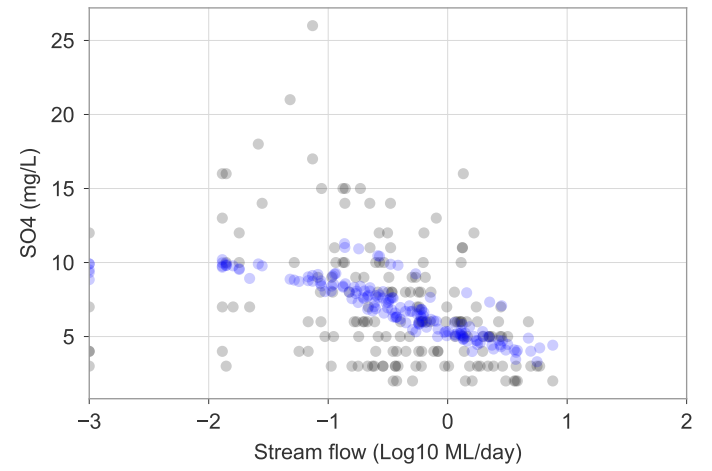
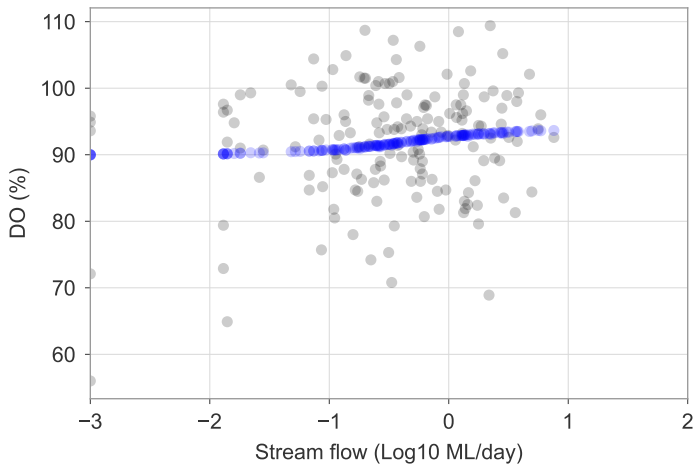
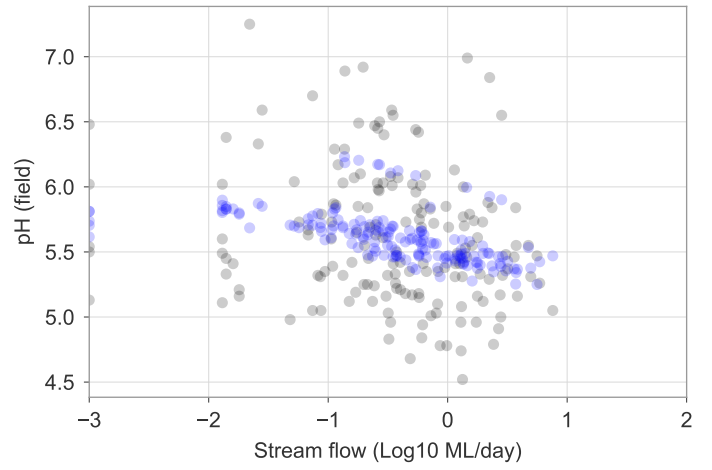
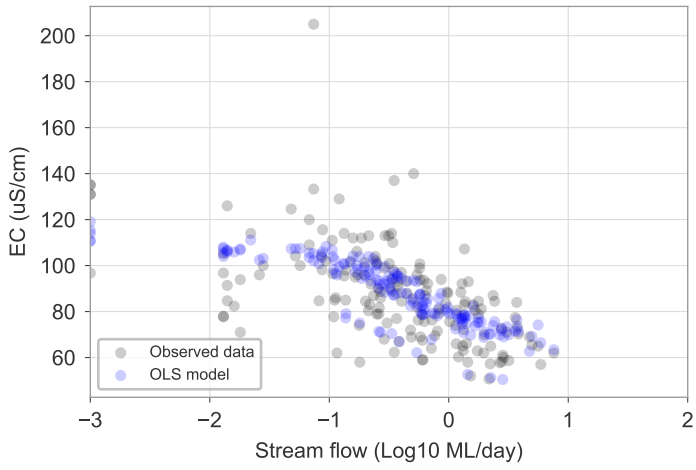
DCC_FR6 Water quality - flow correlation



SCK_ROCKBAR5 Water quality - flow correlation



WWU4 Water quality - flow correlation



Appendix B: Rainfall data

Monitoring Data

The geographic distribution of the various data sources at which rainfall and stream flow is measured around Dendrobium are shown on Figure B1.

Rainfall data

Rainfall data for the Dendrobium area is available from three primary sources (Figure B1):

- A series of rainfall gauges owned by IMC (“site data”) and currently operated by the hydrographic consultants ALS;
- A rainfall gauge (“Browns Road”) operated by WaterNSW (located within Area 3B); and
- Series of “infilled” data available from the SILO service, a cooperative initiative of the Queensland Government’s Department of Environment and Science (DES) and the Australian Bureau of Meteorology (BoM).

The details of the various data sources is summarised in Table B1.

Measurement uncertainty

Based on manufacturers specifications¹, “the Hyquest Solutions TB3 Model Tipping Bucket Rain Gauge is recognised as the world standard for measuring rainfall and precipitation in remote and unattended locations. The TB3 is the rain gauge of choice to the Australian Bureau of Meteorology and other organisations world wide.”

ALS have instructed that the manufacturer’s stated accuracy is:

Rainfall intensity	Accuracy
0-250 mm per hour	+/-2%
250-500 mm per hour	+/-3%
Measurement range	700 mm per hour

These accuracies are independent of the siting of the gauge itself. ALS have stated that the siting of the gauges has been carried out consistent with RMS, 2016², which is itself compiled from Australian Standards. ALS can provide further information on request.

¹ <https://www.hyquestsolutions.com/products-services/products-hardware/meteorology/model-tb3-tipping-bucket-rain-gauge/>

² NSW RMS, 2016. Automatic weather stations: QA specification R272. Edition 1, rev 1, May 2016.

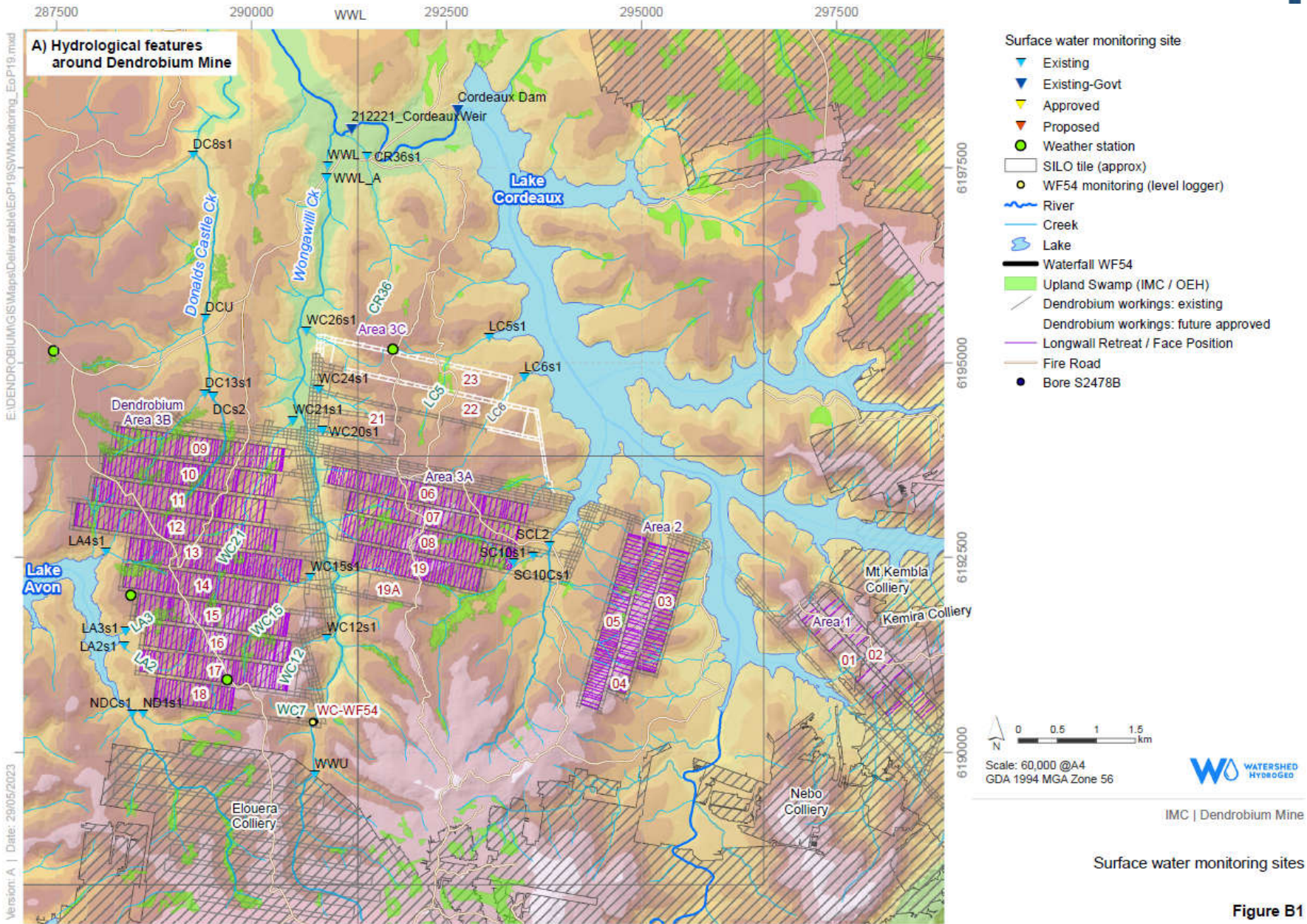


Figure B1 Location of rainfall and flow data sources

Table B1 Rainfall data sources

SITE_NAME	ID	EASTING (Z56)	NORTHING (Z56)	Z_ELEVATION [MAHD]	OPERATOR	START DATE	MEASUREMENT FREQUENCY	GAUGE TYPE	LOGGER
Dendrobium "Centroid" A3A		291815	6195170	403.1	IMC	28/10/2007	event based and midnight timestamp	Hyquest Tipping Bucket Rain Gauge model TB3 / 0.5mm	Hyquest Minilog
DA3B Weather Station		288458	6192012	413.4	IMC	1/06/2012	event based and midnight timestamp, 15 minute on CR800	Hyquest Tipping Bucket Rain Gauge model TB3 / 0.5mm	Hyquest Minilog and Campbells Scientific CR800
DA5 Rainfall Gauge		287468	6195153	401.6	IMC	19/07/2017	event based and midnight timestamp	Hyquest Tipping Bucket Rain Gauge model TB3 / 0.5mm	Hyquest Minilog
DA6 Rainfall Gauge		291749	6200383	352.4	IMC	17/06/2017	event based and midnight timestamp	Hyquest Tipping Bucket Rain Gauge model TB3 / 0.5mm	Hyquest Minilog
Cordeaux Site Rain Gauge		294658	6199531	373.5	IMC	1/01/2002	data recorded @ 00:00 for previous 24 hrs		
Browns Road	568061	289690	6190930	442.0	WaterNSW	31/03/1983	data recorded @ 00:00 for previous 24 hrs		
SILO Data drill - "A3B"		Long: 150.70	Lat: -34.40		SILO	1/01/1900	24hr total to 9am, interpolated and averaged for 0.05x0.05 degree tile		
SILO Data drill - "A3A-A2"		Long: 150.75	Lat: -34.40		SILO	1/01/1900	24hr total to 9am, interpolated and averaged for 0.05x0.05 degree tile		
SILO Data drill - "A3C"		Long: 150.75	Lat: -34.35		SILO	1/01/1900	24hr total to 9am, interpolated and averaged for 0.05x0.05 degree tile		

Notes:
 IMC sites maintained by ALS.
 Browns Road data obtained from WaterNSW.
 SILO data from <https://www.longpaddock.qld.gov.au/silo/datadrill/>

A comparison of the recent data from these sources is presented below.

Figure B2 shows recent annual totals (since the commencement of Dendrobium Mine). For these, the SILO records and Dendrobium’s Area 3B record is 100% complete, Area 3A (Centroid) is 100% complete, while the WaterNSW Browns Road record is 94.5% complete.

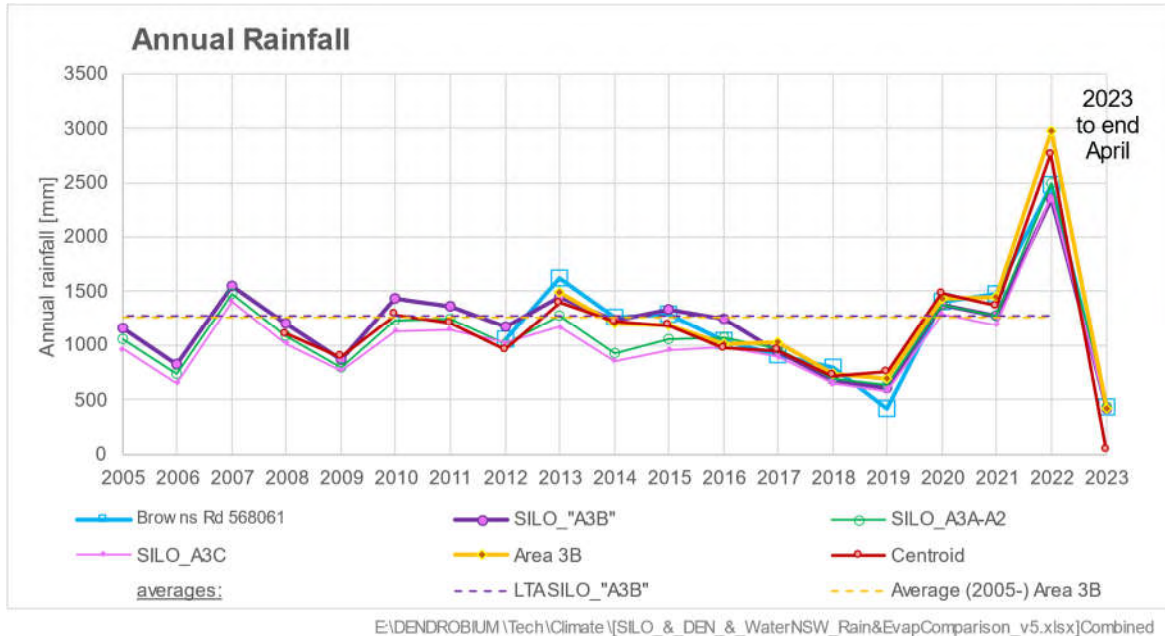


Figure B2 Annual rainfall totals

Figure B2 shows that the different records show some variability in annual totals. 2013, 2020 and 2021 were the wettest years of the recent period, until 2022, which is the record annual rainfall total at Dendrobium (as it was across much of eastern NSW). In the wettest years, the variability between the different monitoring records shown above, from minimum to maximum, was 14%, 7%, 23% and 21% in 2013, 2020, 2021 and 2022) respectively.

In 2019 (the driest of the selected years), the variability was 44%. All stations show the same broad trends across those selected years, including the severe and persistent rainfall deficit in 2017-2019, and the return to higher rainfall across 2020-21 and then the record rainfall of 2022.

Rainfall to the end of April-2023 is approximately 400-440 mm at the stations reviewed here, suggesting near-average conditions for 2023.

There was variation in which station or data source was wettest or driest in each year but in terms of cumulative rainfall 2013-2022 to date (excluding 2012 because the Area 3B gauge did not commence until May that year), there is 10% difference between the four monitoring records shown on Figure B2.

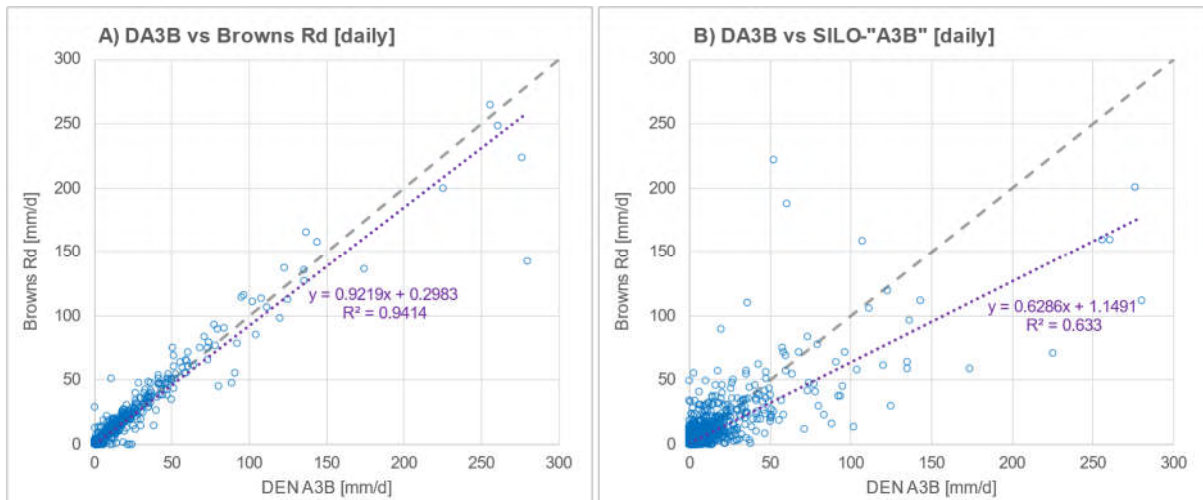


Figure B3 Correlation of daily rainfall around Area 3B

Figure B3 shows a comparison of daily totals for the three stations most relevant to Area 3B.

Figure B3a shows that the A3B station and the Browns Road station, which are 1.6 km apart, are highly correlated ($R^2 = 0.94$). Figure B3b shows that there is a substantially weaker correlation between the local SILO record and the Browns Road station (and therefore, also with the A3B record) ($R^2 = 0.63$).

To assess this further, the accumulated rainfall for the available record during the period 2005-2020 is plotted on Figure B4. The A3B rainfall is not included here due to that record beginning in 2012.

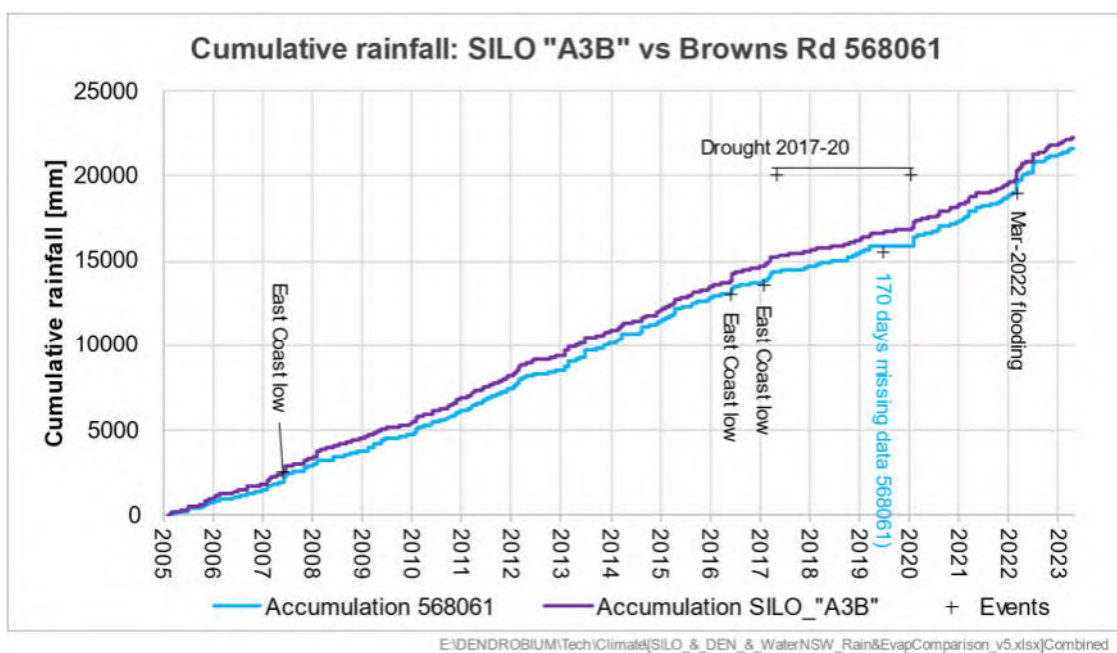


Figure B4 Rainfall accumulation near to the Area 3B domain

Figure B4 indicates that while there is a weaker correlation on a daily basis, and some significant variances in total rainfall on specific days (Figure B3b), the correlation is strong overall. That is, the accumulation shows very similar trends through the 17 year record, and the overall total accumulated rainfall varies by 3% to the end of April-2023.

This analysis of the data indicates that broadly there is general agreement in the data on a monthly or annual timeframe, but that short-term differences exist. These differences may be due to:

- Measurement error (in the case of the site data, Browns Road and the raw BoM data behind the SILO “Data Drill” record);
- Mismatch in timing between totals to midnight (site and Browns Road data) versus totals to 9am (BoM / SILO records);
- Interpolation or infilling errors due to temporal or spatial infilling or averaging (in the SILO data);
- True variations in rainfall in space and time due to weather patterns, e.g. topographic effects and/or the effects of localised weather systems.

These measurement errors or true variations will propagate into any rainfall-runoff modelling and simulation of daily flow around Area 3B. Smaller catchments will be less prone to spatial variation in rainfall across the catchment, but maybe affected by not having a truly local rainfall record. Therefore, while the rainfall gauging network at Dendrobium (including SILO and WaterNSW data) is considered adequate, the potential localisation of rainfall patterns will result in some unavoidable discrepancies between modelled and observed flows.

Appendix C: Flow gauge data

Flow data for the Dendrobium area is available from a series of flow gauges owned by IMC and currently operated by the hydrographic consultants ALS. The details of these are summarised in Table C1.

These gauging stations provide estimates of stream flow via:

- (A) A structure behind which water pools and flows over. Structures can be:
 - a. natural, e.g. a rock bar, or
 - b. man-made, e.g. a half-pipe flume.
- (B) A sensor and logger that measure and record the water level (“stage”) in the pool at 15-minute intervals
- (C) A “rating curve” which is a chart or graph of discharge (flow) versus stage for each gauging station. The rating curve is developed via periodic measurements of flow in the channel at a known water level.
- (D) Estimates of mean daily flow are then provided.

IMC commissioned an independent hydrologist (Enviromon) to systematically identify and quantify the accuracy or error involved in each part of the process (Enviromon, 2019 and Enviromon, 2020). This process has been carried out for a selection of gauging sites (provided in C5, below), and is currently being applied to the remaining in gauging sites, with some fine-tuning of the method for gauging sites where ‘underflow’ occurs (i.e. flow beneath the monitoring structure). The objective is to re-assess each gauging station for each future End of Panel report, and to use the results to reduce uncertainty where practicable (i.e. additional data-gathering and improved measurement methods).

Table C1 Flow gauge information

Watercourse	Site	Area	Easting (z56)	Northing (z56)	Z_Elevation [mAHD]	Catchment area [km ²]	Installation	Structure type		Logger
Wongawilli Ck	WWU	u/s A3B	290808	6189716	352.94	3.211	Stainless Steel housing	Natural control		Orpheus
Wongawilli Ck	WWL	d/s A3A,B	290975	6197526	261.86	20.079	Stainless Steel housing	Natural control		Diver
Wongawilli Ck	WWL_A	d/s A3A,B	290962	6197370	263.22	19.602	PVC housing	Half pipe	225 mm	Orpheus
WC21	WC21S1	A3B	290529	6194255	283.07	2.434	Stainless Steel housing	Natural control		Diver
WC15	WC15S1	A3B	290754	6192239	324.71	1.192	PVC housing	Natural control		Diver
WC12	WC12S1	A3B	290964	6191459	322.34	0.380	Polypipe housing	Weir and half pipe flume	150 mm	Orpheus
LA2	LA2S1	A3B	288364	6191364	324.65	0.824	Polypipe housing	Weir and half pipe flume	150 mm	Orpheus
LA3	LA3S1	A3B	288385	6191548	323.82	0.375	Polypipe housing	Weir and half pipe flume	150 mm	Orpheus
LA4	LA4S1	A3B	288134	6192565	322.98	0.817	Stainless Steel housing	Modified control	150 mm	Diver
ND1	ND1S1	A3B	288607	6190491	325.11	1.130	Polypipe housing#	Weir and half pipe flume	150 mm	Orpheus
NDC1	NDC1S1	A3B	288473	6190485	324.4	3.747	PVC housing#	Weir and half pipe flume	225 mm	Orpheus
DC13	DC13S1	A3B	289401	6194605	339.50	1.638	PVC housing	Natural control		Diver
Donalds Castle	DCS2	A3B	289502	6194572	341.27	1.084	PVC housing	Natural control		Diver
Donalds Castle	DCU	A3B	289407	6195577	322.42	6.219	Stainless Steel housing	Natural control		Diver
SC10	SC10S1	A3A	293608	6192516	333.03	2.771	Stainless Steel housing	Natural control		Diver, recently updated to Orpheus
SC10C	SC10CS1	A3A	293358	6192433	340.78	0.817	Stainless Steel housing	Natural control		Diver
Sandy Ck	SCL2	A3A	293819	6192648	328.61	7.029	Stainless Steel housing	Modified control (leaky)		Diver
	2022205	A3A	293819	6192648	328.61	7.029	WaterNSW site	Modified control (leaky)		Unknown
LC5	LC5S1	A3A,C	293043	6195327	318.1	1.861	Polypipe housing#	Weir and half pipe flume	225 mm	Orpheus
CR36	CR36S1	A3C	291487	6197650	272.82	1.7	PVC housing	Weir and half pipe flume	225 mm	Orpheus
WC20	WC20s1	A3C	290906	6194133	303.86	0.39	PVC housing	Weir and half pipe flume	150 mm	Orpheus

Watercourse	Site	Area	Easting (z56)	Northing (z56)	Z_Elevation [mAHD]	Catchment area [km ²]	Installation	Structure type		Logger
WC24	WC24s1	A3C	290863	6194658	286.9	0.5	PVC housing	Weir and half pipe flume	150 mm	Orpheus
WC26	WC26s1	A3C	290703	6195411	277.85	0.55	PVC housing	Weir and half pipe flume	150 mm	Orpheus
LC6	LC6s1	A3C	293571	6194873	314.5	1.17	PVC housing	Weir and half pipe flume	150 mm	Orpheus
LC7	LC7S1	A3C					<i>proposed</i>			
LC9	LC9S1	A3C					<i>proposed</i>			
LA8	LA8S1	A5	285764	6193225	331.56	0.93	Polypipe housing	Weir and half pipe flume	150 mm	Orpheus
LA13A	LA13AS1	A5	285401	6194826	319.93	1.04	Polypipe housing	Weir and half pipe flume	150 mm	Orpheus level, Diver EC
LA13	LA13S1	A5	285384	6194777	320.35	2.79	PVC housing	Weir and half pipe flume	225 mm	Orpheus
AR31	AR31S1	A5	283999	6197770	270.7	2.96	Polypipe housing	Weir and half pipe flume	225 mm	Orpheus level, Diver EC
AR32	AR32S1	A5	283945	6197576	266.1	1.5	PVC housing	Weir and half pipe flume	150 mm	Orpheus
AR19	AR19S1	A5	285584	6198528	382.91	3.53	Polypipe housing	Weir and half pipe flume	225 mm	Orpheus level, Diver EC
DC8	DC8S1	A5	289249	6197663	301.2	2.61	Polypipe housing	Weir and half pipe flume	225 mm	Orpheus level, Diver EC
CR29	CR29S1	A6	289969	6201109	257.13	2.33	Polypipe housing	Weir and half pipe flume	225 mm	Orpheus level, Diver EC
CR31	CR31S1	A6	290062	6200056	248.33	2.55	Polypipe housing	Weir and half pipe flume	225 mm	Orpheus level, Diver EC

Reference Sites

O'Hares Ck	213200	Wedderburn	300657	6217589	166.87	73.0		V-notch		
------------	--------	------------	--------	---------	--------	------	--	---------	--	--

alternative Reference Site

Bomaderry Ck	215016	Bomaderry	279354	6142065	25.822	31.0	Vandalised, stolen 2019	Natural rock bar and boulders		Vandalised, stolen 2019*
Cordeaux R	2122204	Cordeaux Dam No.1	295413	6188702		9.3^				

Notes:

IMC gauging stations operated by ALS. *Italicised text* = to be confirmed.

plastic housing/pipes damaged in 2022 during flooding.

Reference gauge data from WaterNSW.

* WaterNSW advise that Bomaderry Creek gauging site repeatedly vandalised, equipment stolen (2019-20) and not yet replaced.

^ not from WaterNSW - estimated in GIS

Table C2 ALS data quality codes

DATA QUALITY CODE	DESCRIPTION	
1	Good continuous records	Notes: Negative values of these codes may be shown on the data quality charts shown later in this Appendix. These indicate where a record has been processed or infilled.
2	Reliable Edited Data	
3	Unreliable Edited Data	
5	Non-Continuous Data	
55	Fair quality data	
69	Fair Quality Rating Extrapolated	
104	Records estimated	
109	Poor quality data	
140	Level below CTF (cease-to-flow)	
145	Discharge not reliable Rating under review	
150	Rating table extrapolated due to inadequate gauging information	
151	Data not yet available	
160	Water level below sensor	
161	Poor quality data from debris affecting sensor	
205	Data lost	
255	No data exists	

Table C3 Data quality assessment for Reference Gauges

Watercourse	Gauge Id	Gauge Name	Start Date	End Date	No. of Records	% available	% suspect	% infilled	Status
Wongawilli Ck	300024	WWU	2/11/2007	06/09/2023	5586	99.2%	2.2%	0.8%	Primary Reference
O'Hares Creek	213200	Wedderburn (213200)	2/02/1978	12/07/2023	16513	99.9%	0.0%	0.0%	Primary Reference
Bomaderry Creek	215016	Bomaderry Creek at Bomaderry (215016)	4/07/2003	10/05/2020	6156	99.0%	1.0%		Alternative Reference – equipment vandalised, not viable.

Additional Reference Sites might be adopted for future analysis – a subset of Area 5 sites (LA8S1, DC8S1, AR19S1) will continue to be monitored and be used as Reference Sites.

* WaterNSW advise that Bomaderry Creek gauging site repeatedly vandalised, equipment stolen (2019-20) and after May-2020, not yet replaced.

Table C4 Data quality assessment for Area 3A and 3B and 3C and relevant Assessment Sites

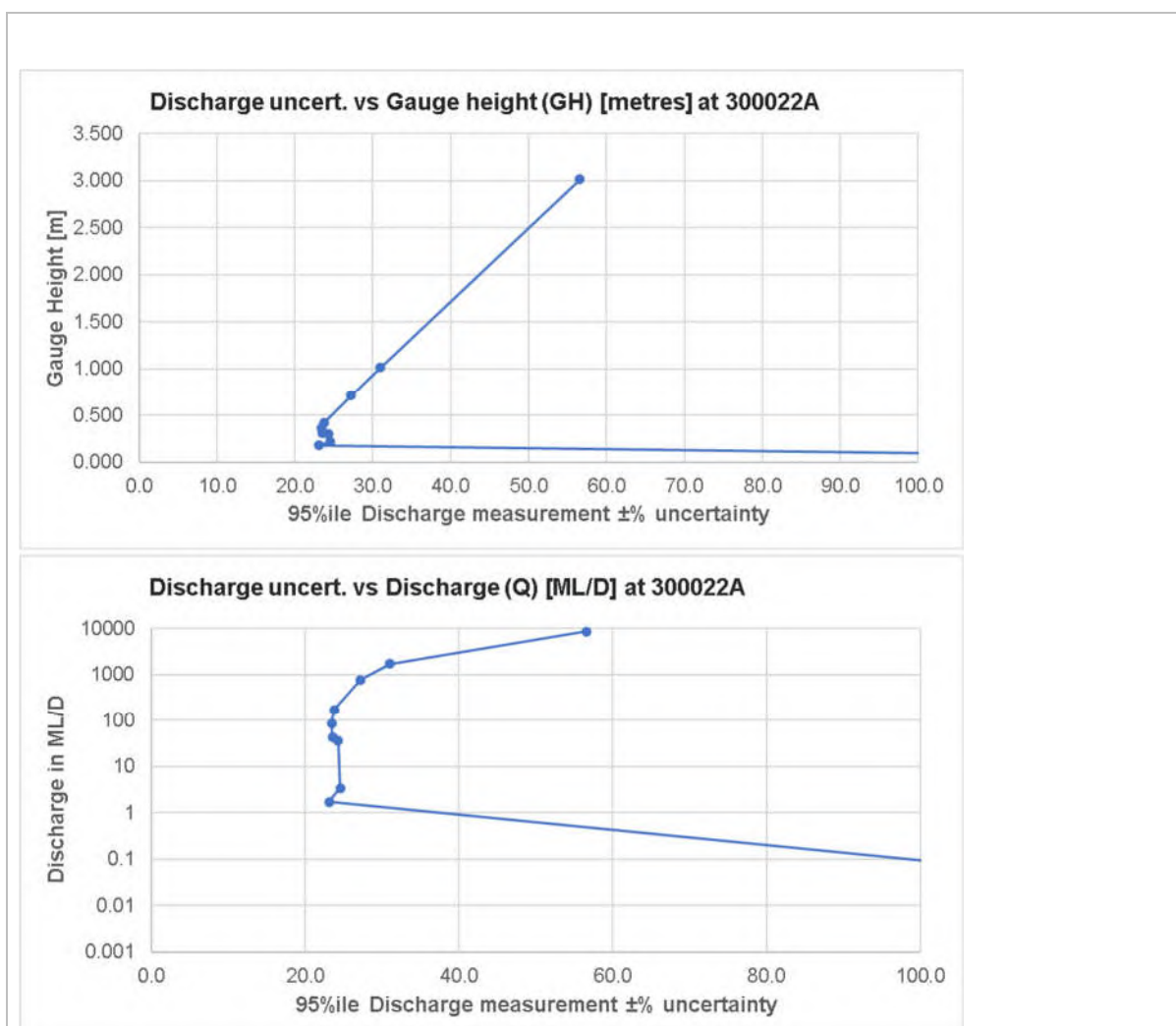
Assessment Sites			Summary - Pre-Mining data						Summary - Post-Mining data					
Watercourse	Hydstra No.	Gauge Name	Start Date	End Date	No. of Records	% available	% suspect	% infilled	Start Date	End Date	No. of Records	% available	% suspect	% infilled
Donalds Castle Creek	300023	DCU	2/11/2007	8/02/2013	1926	100.0%	0.0%	0.0%	9/02/2013	18/09/2023	3874	99.1%	17.5%	0.1%
DC13	300067	DC13S1	27/06/2012	8/02/2013	227	100.0%	0.0%	0.0%	9/02/2013	12/09/2023	3868	92.1%	10.4%	2.0%
Donalds Castle Creek	300068	DCS2	27/06/2012	9/07/2013	378	100.0%	0.0%	0.0%	10/07/2013	12/09/2023	3717	98.4%	8.1%	1.6%
Wongawilli Creek	300022	WWL	2/11/2007	8/02/2010	830	96.4%	3.8%	3.6%	9/02/2010	18/09/2023	4970	98.2%	3.3%	0.0%
Wongawilli Creek	300022A	WWLA							23/08/2018	18/09/2023	1853	96.0%	14.2%	0.7%
WC21	300069	WC21S1	20/06/2012	4/10/2013	472	99.8%	0.2%	0.2%	5/10/2013	12/09/2023	3630	96.7%	16.4%	0.0%
WC15	300071	WC15S1	20/06/2012	27/01/2017	1683	91.2%	15.9%	9.0%	28/01/2017	12/09/2023	2419	95.4%	22.4%	0.0%
WC12	300092	WC12S1	5/04/2019	17/10/2020	562	100.0%	5.0%	0.0%	18/10/2020	12/09/2023	1060	98.5%	8.3%	0.0%
LA4	300070	LA4S1	24/09/2012	31/03/2015	919	100.0%	0.0%	0.0%	1/04/2015	18/09/2023	3093	78.8%	27.0%	0.2%
LA3	300091	LA3S1	3/02/2019	27/04/2019	84	100.0%	2.4%	0.0%	28/04/2019	18/09/2023	1605	99.9%	5.4%	0.1%
LA2	300090	LA2S1	4/02/2019	29/02/2020	391	100.0%	14.6%	0.0%	1/03/2020	18/09/2023	1297	100.0%	1.93%	0.0%
ND1	300093	NDS1	3/03/2019	17/04/2021	777	100.0%	8.8%	0.0%	18/04/2021	18/09/2023	884	100.0%	6.56%	0.0%
SC10	300018	SC10S1	28/10/2007	16/09/2011	1420	96.9%	3.2%	0.0%	17/09/2011	14/09/2023	4381	98.9%	4.6%	0.8%
SC10C	300019	SC10CS1	2/11/2007	16/09/2011	1415	95.1%	5.1%	4.9%	17/09/2011	14/09/2023	4381	96.9%	21.6%	0.3%
Sandy Ck	WaterNSW	2122205	1/05/2011		0				1/05/2011	14/09/2023	3863	87.3%	#N/A	5.9%
LC5	300094	LC5S1	4/04/2019	29/04/2023	1487	100.0%	4.9%	0.0%						
WC20		WC20S1	9/12/2021	9/05/2023	517	100.0%	0.0%	0.0%	10/05/2023	13/09/2023	127	100.0%	0.00%	0.0%
WC24		WC24S1	18/06/2021	20/05/2023	702	100.0%	13.8%	0.0%	21/05/2023	13/09/2023	116	100.0%	0.00%	0.0%
WC26		WC26S1	30/10/2021	11/09/2023	682	99.9%	0.2%	0.0%						

E:\DENDROBIUM\Tech\SurfaceWater\SWFlowData_Compiled_Wshed_v4_202310.xlsx

“Suspect” data based on raw data assigned ALS quality codes >145.

C5) Flow gauge uncertainty (assessed by Enviromon)

Gauge 300022A – WWL_A



The use of an artificial control (halfpipe) leads to generally lower uncertainty than for the natural control sites (e.g. DCS2, WC21 or WWL). High flow uncertainty related to flow above the structure and few high flow gaugings. High flow gaugings, possibly via alternative methods, are recommended.

Comments from Enviromon:

1) There are 13 rating table points, but only 2 of which are within the half pipe depth, to explain and define its low flow rating, which is insufficient to cover this range of most interest;

For example, after CTF level of 0.012m, there are 0.022m (10mm above CTF), then 0.024m (12mm above CTF), then 0.178m (54mm above the top of the half pipe, and spread across the wide bund).

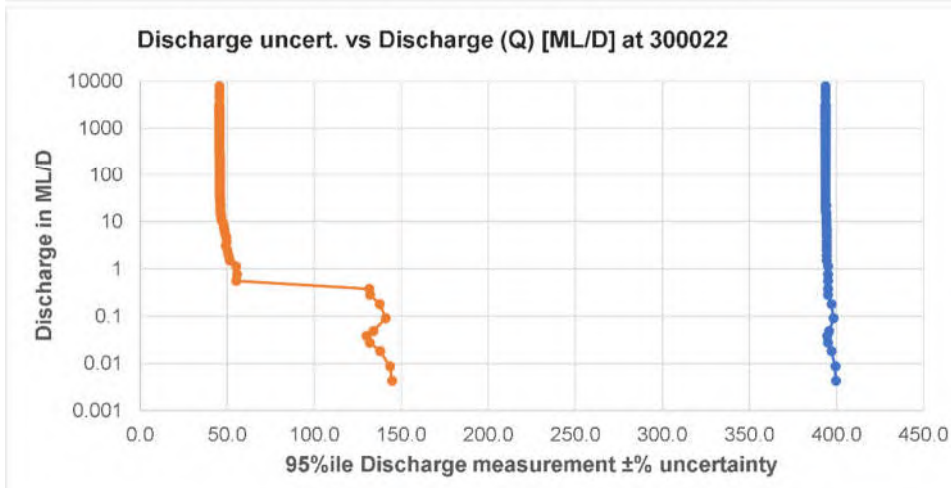
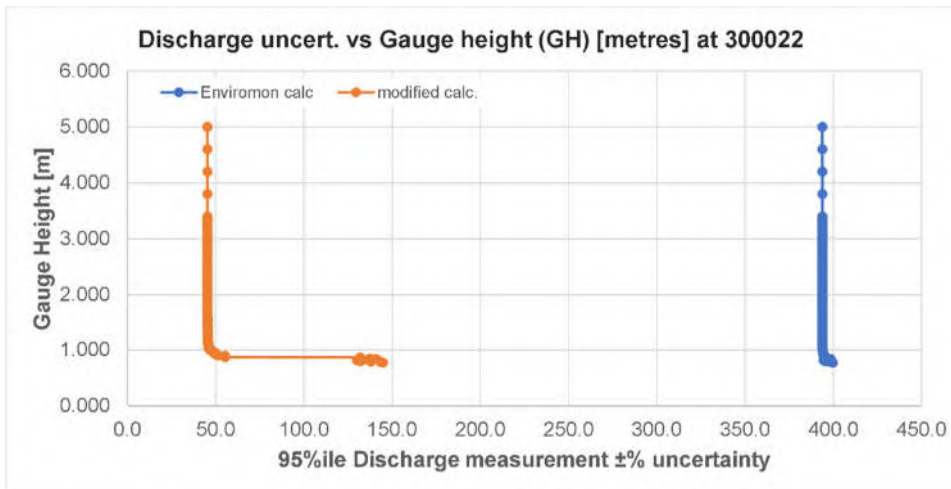
2) ALS could be asked to consider using the generic 225mm half pipe rating done by Enviromon for South32, which does have far more rating points;

3) Most of the low flow gaugings have been done with a pygmy meter held in the centre line of the half pipe. Although practical, this method is unconventional.

ALS could be asked to prove this method against, say, an experimental half pipe setup in their office, versus a V-notch measured flow to the half pipe.

4) In very low flows (e.g. at gauge height 0.022m), discharge uncertainty is dominated by the effects of level measurement uncertainty, whereas for depths above the half pipe, uncertainty is dominated by the uncertainty attributable to the scatter of field gaugings about the rating.

Gauge 300022 – WWL

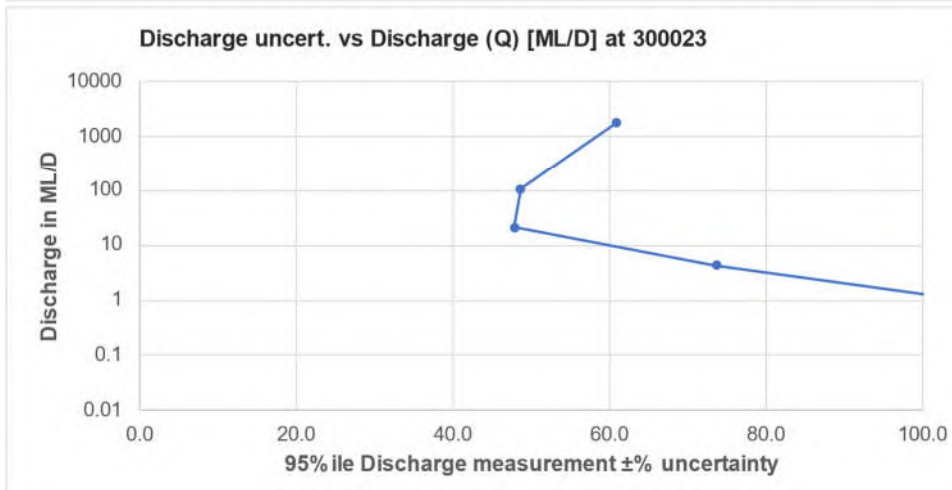
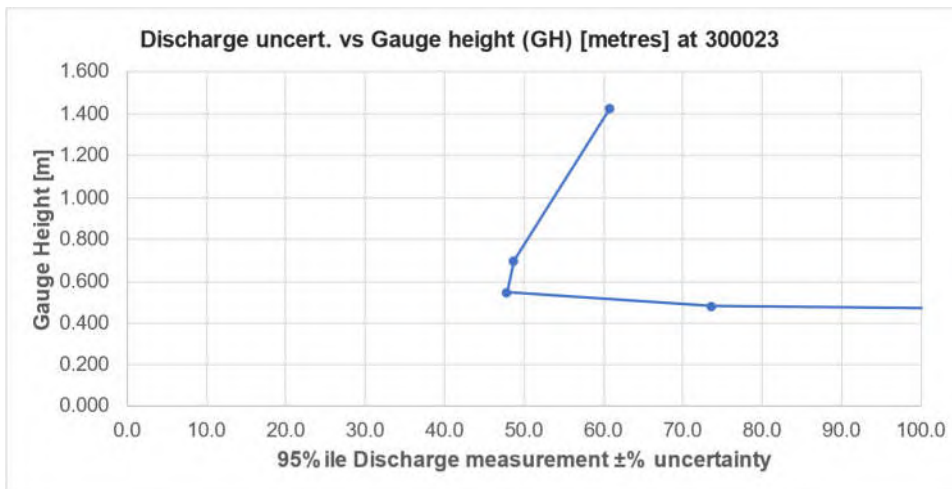


Enviromon developed the blue uncertainty curve, and a modified version of that has been calculated by Watershed HydroGeo (orange series). The high uncertainty at low flow relates to underflow at the (permeable) control. High flow gaugings, possibly via alternative methods, are recommended.

Comments from Enviromon:

- 1) There are 263 rating table change points- which is really excessive for such a site;
It is expected that 10 to 20 would be sufficient, like for site DCU (300023).
- 2) Note the comment in sheet 1 concerning the mismatch between precise CTF level and rounded off CTF level (0.700 vs 0.7085) which needs confirmation/correction.
- 3) Out of the 32 gaugings taken only 18 were suitable for uncertainty analysis, as the other 14 were either no flow or flow so low that a valid gauging could not be taken, OR LEAKAGE PAST THE CONTROL WAS OBSERVED
- 4) Level uncertainty used is the generic +/-8.2mm for a Diver sensor, as there were no comparative field difference readings to analyse
- 5) The very high uncertainty due to gauging deviations is mostly due to "leakage" effects- for example the three gaugings taken on 24/10/2019 which each showed more than 600% deviation mismatch. Using these to quantify low-flow uncertainty alone (and not moderate/high flow uncertainty) is the basis for the orange chart series.

Gauge 300023 – DCU



Comments from Enviromon:

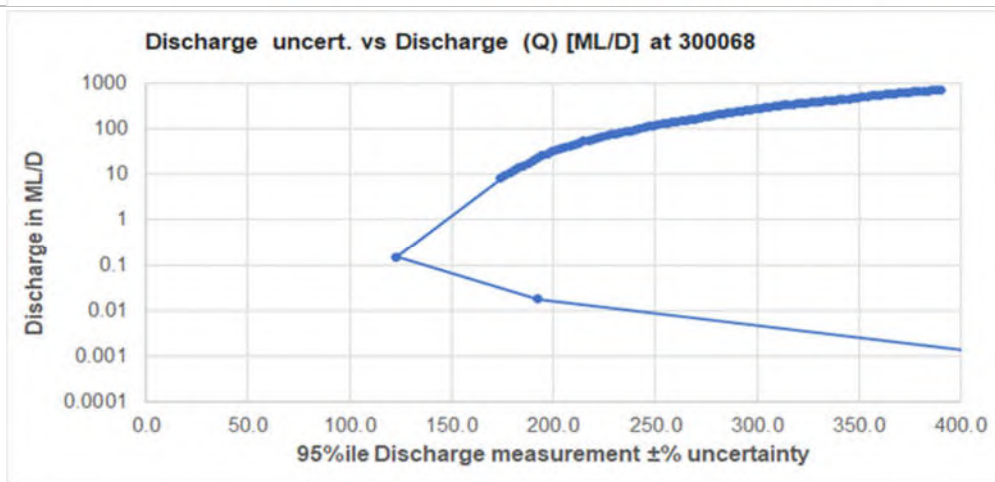
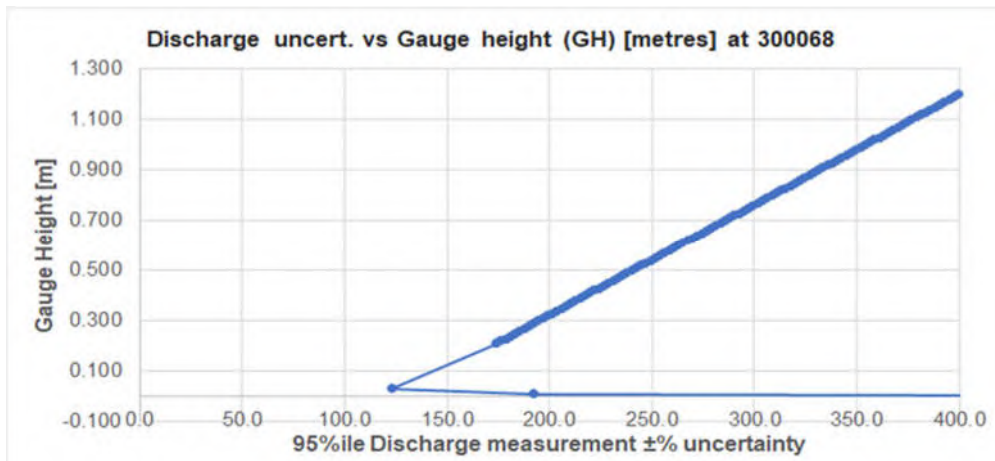
1) Out of the 29 gauging records, only 9 were valid for this analysis, due to 20 being either zero flow or so low that no valid measurement could be taken

2) Gauging 28 on 4/3/21 had the highest deviation- South 32 noted leakage:- Serviced by S32. Pygmy av. = 0.05844 MLD and comment of 'approx. 10% leakage'

Could this be a general issue with this site?

3) Level uncertainty used is the generic +/-8.2mm for a Diver sensor, as there were no comparative field difference readings to analyse

Gauge 300098 – DCS2



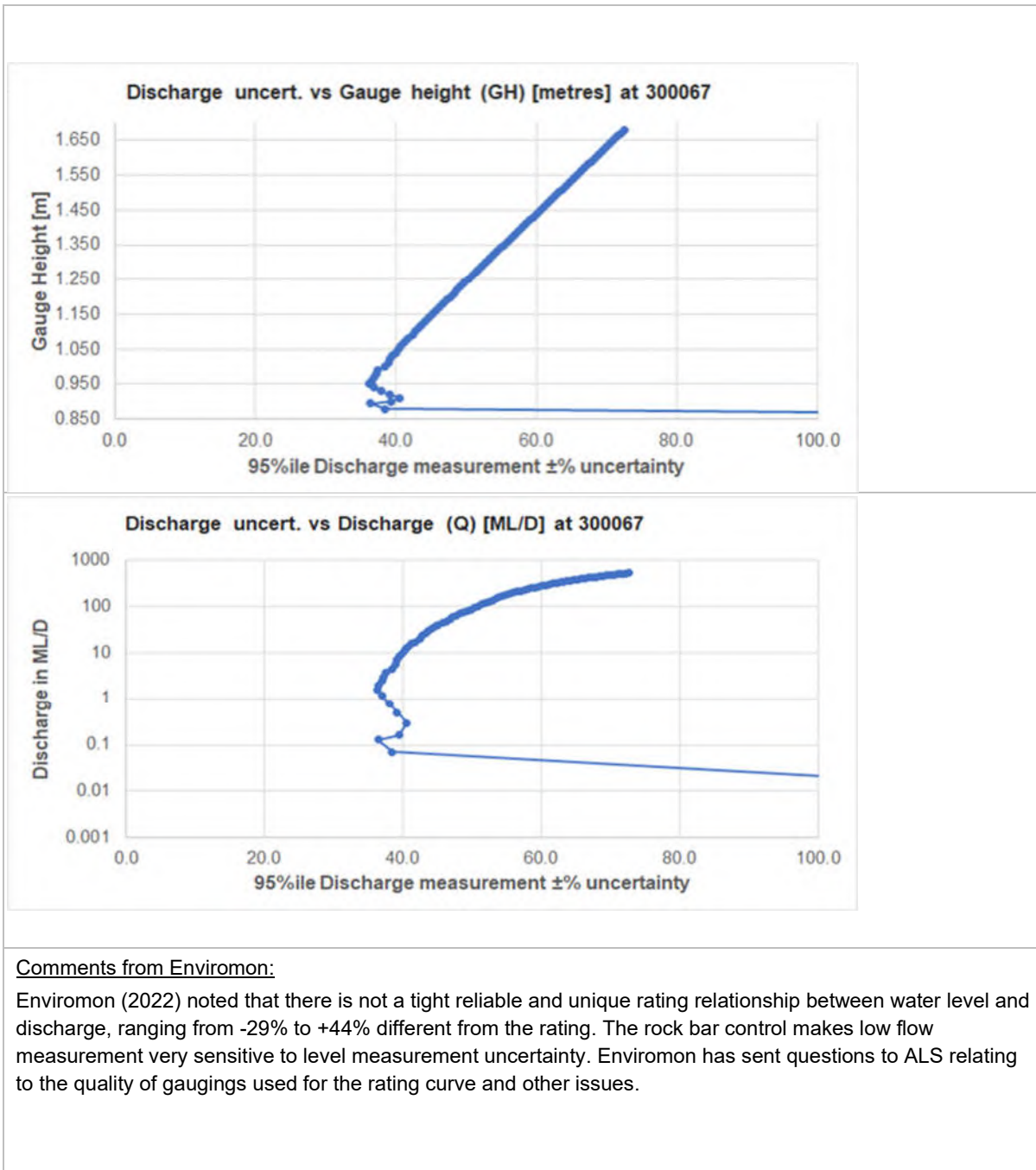
Enviromon (2022) noted that there is not a tight reliable and unique rating relationship between water level and discharge, ranging from -36% to +175% different from the rating. Based on this analysis, Enviromon has sent questions to ALS relating to the quality of gaugings used to develop the rating curve and the rock bar control.

High flow gaugings, possibly via alternative methods, are required to improve high flow.

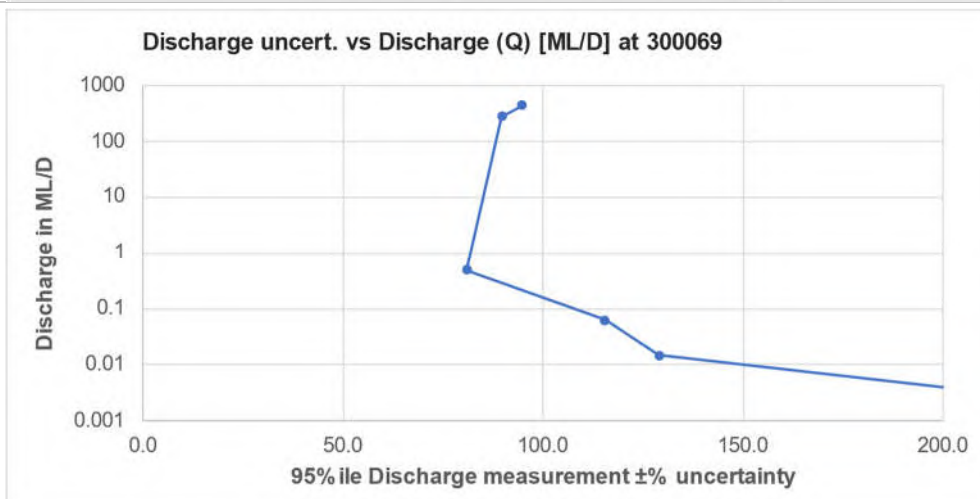
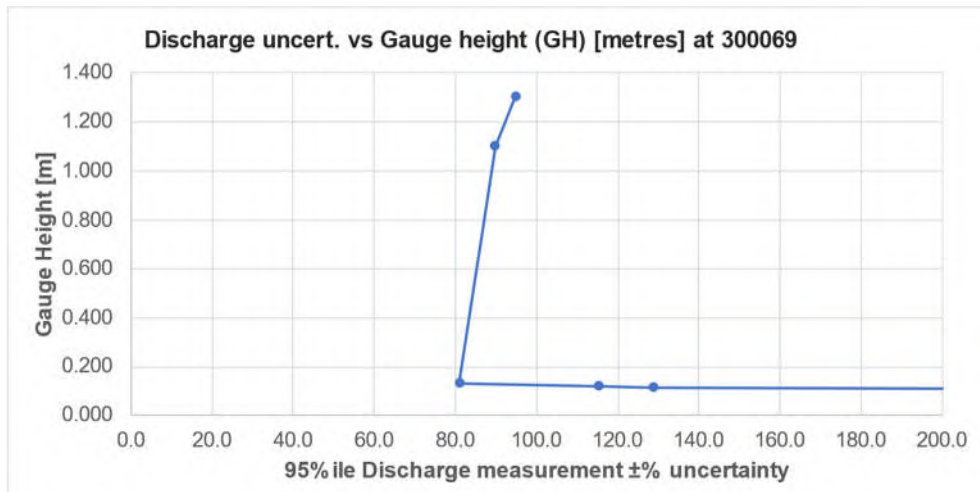
Comments from Enviromon:

This site is affected by intermittent leakage past the control, which causes gauging deviations of greater than 100% in at least 2 of the 7 valid gaugings, and hence very high “scatter of gaugings” rating uncertainty. If this leakage, which could be related to mining subsidence and fracturing, cannot be located and sealed, then relocation should be considered (or grouting beneath the control?).

Gauge 300067 – DC13S1



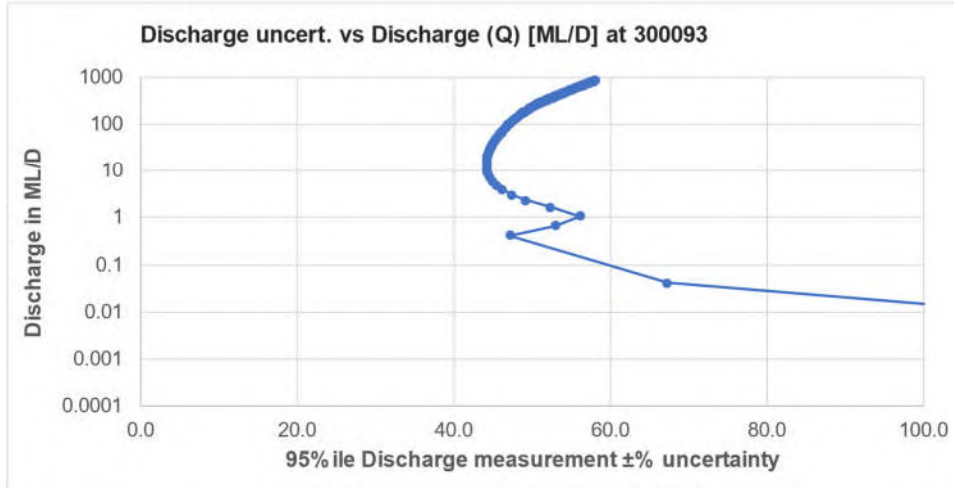
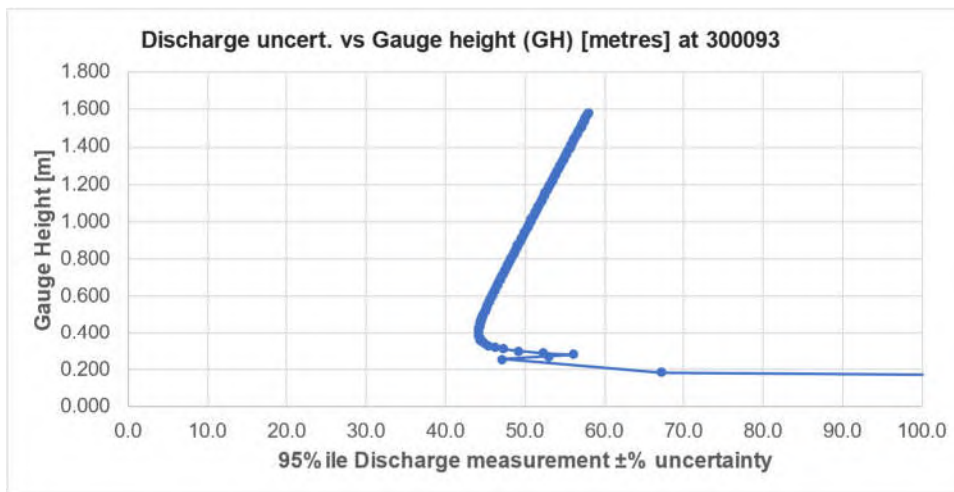
Gauge 300069 – WC21S1



Comments from Enviromon:

- 1) There is not a tight reliable and unique rating relationship between water level and discharge, ranging from -76% to +121% different from the rating. Intermittent leakage under the control is suspected as the main cause of this scatter of gaugings (which could be mining-related?).
- 2) Based on this analysis, Enviromon has sent questions to ALS relating to the quality of gaugings used to develop the rating curve and the rock bar control. If the location of the low flow leakage cannot be found then site relocation should be considered (or grouting beneath the control?).
- 3) High flow gaugings are required to improve high flow rating.

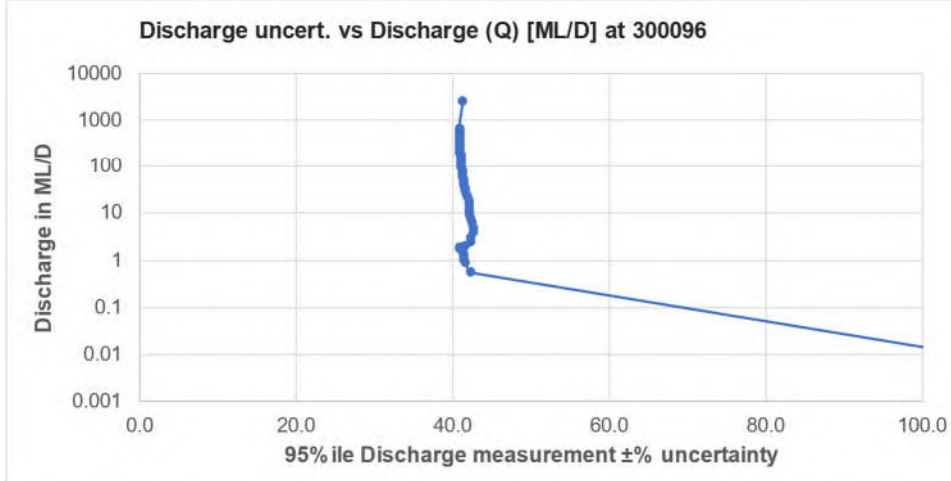
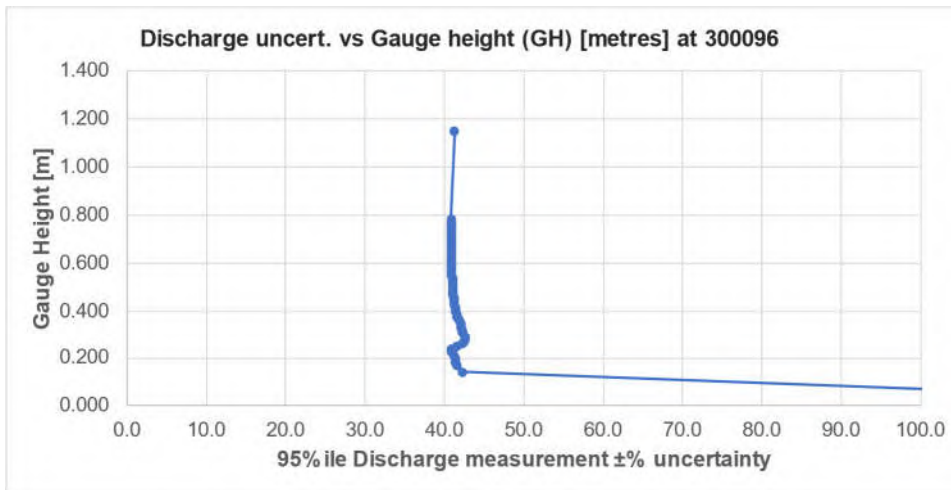
Gauge 300022A – ND1



Comments from Enviromon:

- 4) There are 139 rating table change points- which seems excessive for such a site;
- 5) The last 2 gaugings are done with pygmy meter in half pipe, and show similar rating differences (e.g. circa 30%) as volumetrics
- 6) On sheet 5 "Gauge height uncertainty"- the calculated (from field differences) uncertainty of 0.007238 is greater than the generic Orpheus value of 0.0066, then raise this as an issue with ALS
- 7) The sudden zig-zag in uncertainty at 0.255m is because this is when flow starts to break out of the half pipe and spread wide across the bund, with rapid increase in discharge for small increase in level. This slowly recovers as level rises further and discharge does not increase so much per mm of level rise.

Gauge 300096 – CR36

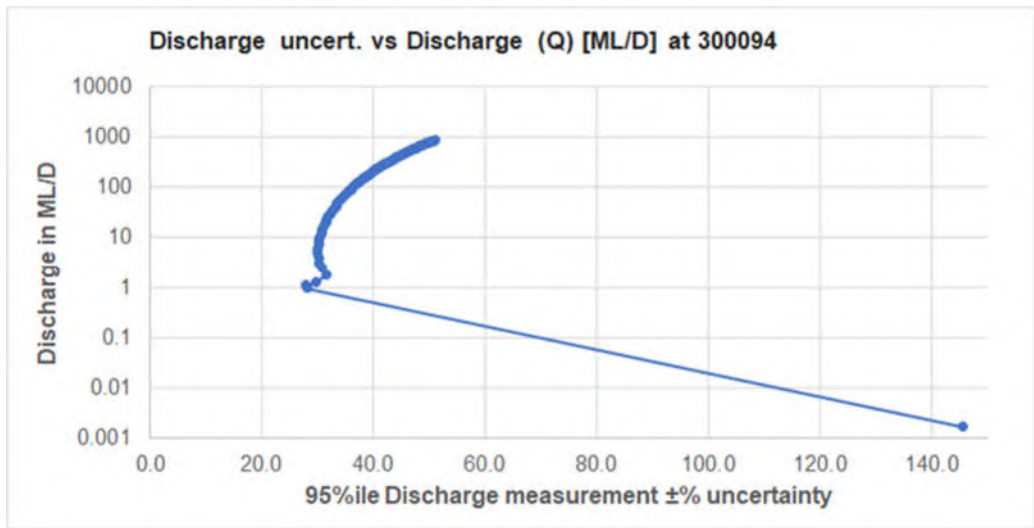
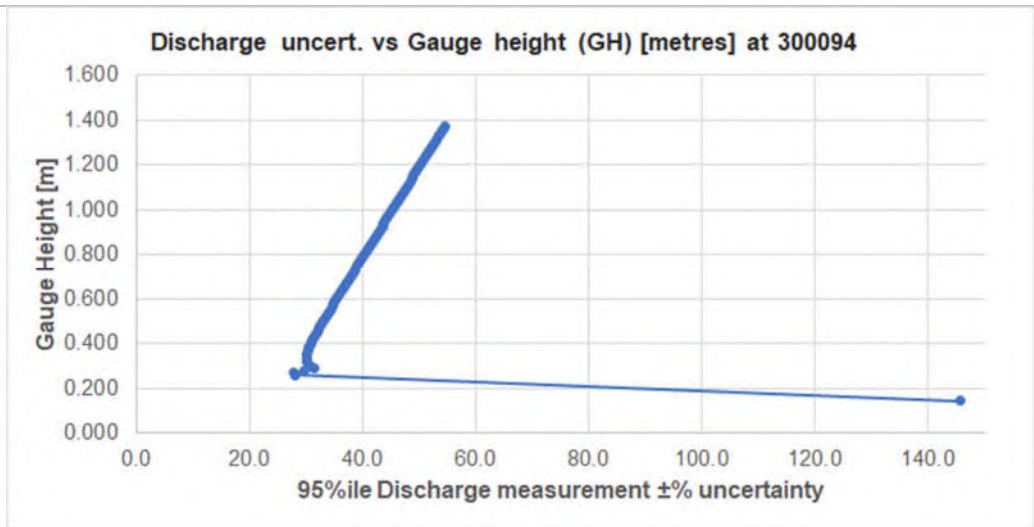


The use of an artificial control (halfpipe) leads to generally lower uncertainty than for the natural control sites (e.g. DCS2, WC21).

Comments from Enviromon:

- 8) There are 68 rating table change points- which seems excessive for such a site;
- 9) Most of the gaugings are at very small flowrates and depths, making the uncertainty of individual gaugings (and hence the rating curve plotted through them) to also be higher;
- 10) Note the existence of the one high gauging at 0.91m, quite a rarity- this stops the extra uncertainty of rating curve extension for most of the range of interest.
- 11) The % deviation varies of similar magnitude whether gauging is volumetric or pygmy meter in half pipe

Gauge 300094 – LC5S1

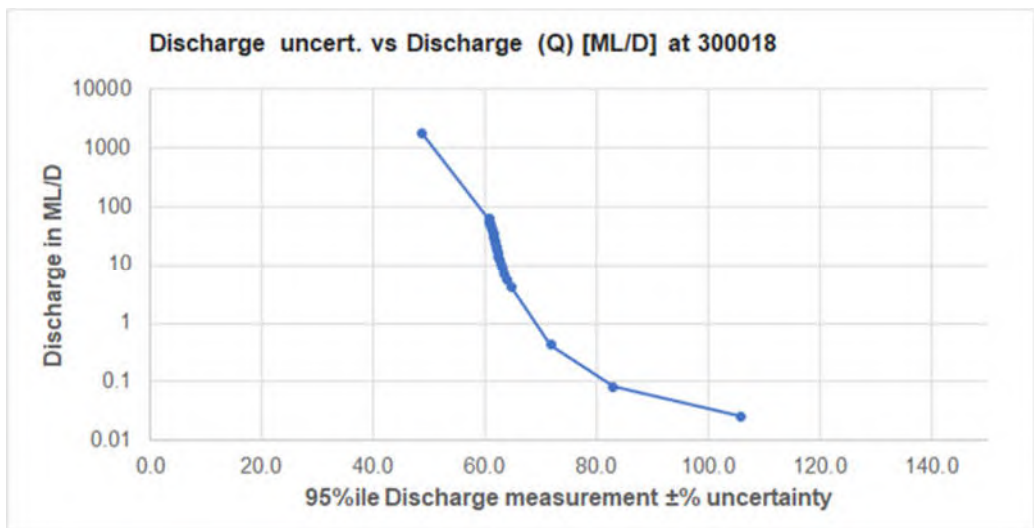
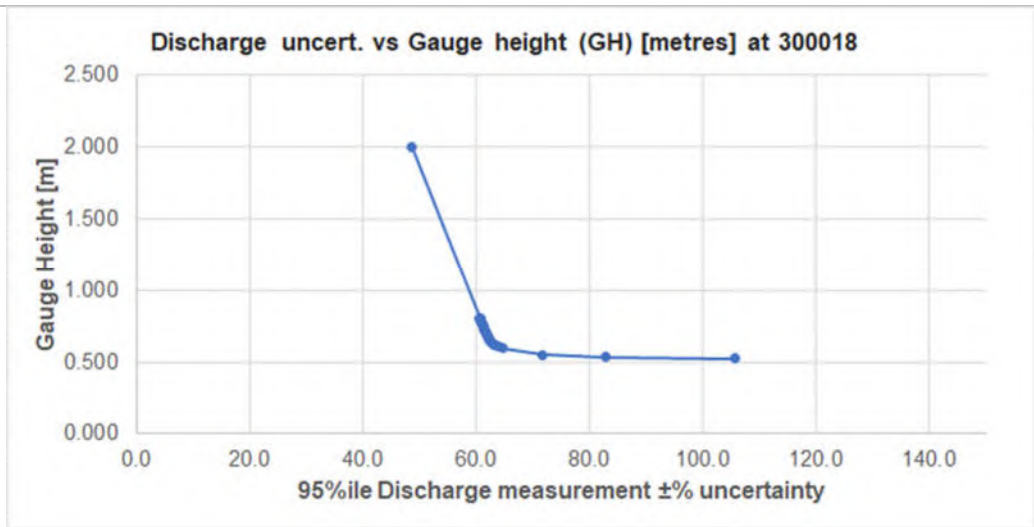


The use of an artificial control (halfpipe) leads to generally lower uncertainty than for the natural control sites (e.g SC10S1 and SC10CS1).

Comments from Enviromon:

- 12) There are 126 rating table change points- which seems excessive for such a site;
- 13) The portion of the rating table covering the half pipe depth range is only 2 points. Although noting that only one gauging has been captured in this range, more points could be added if a generic 225mm half pipe rating were to be developed and used- as suggested in the review document (provided separately to ALS);
- 14) 21 of 32 gaugings exceeded $\pm 10\%$ differences from the rating- why so many with such large differences?;

Gauge 300018 – SC10S1

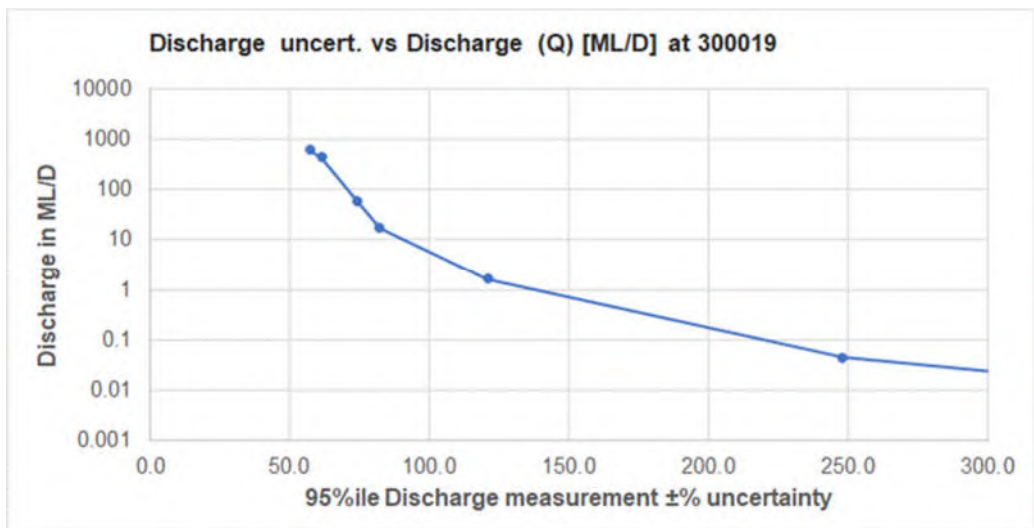
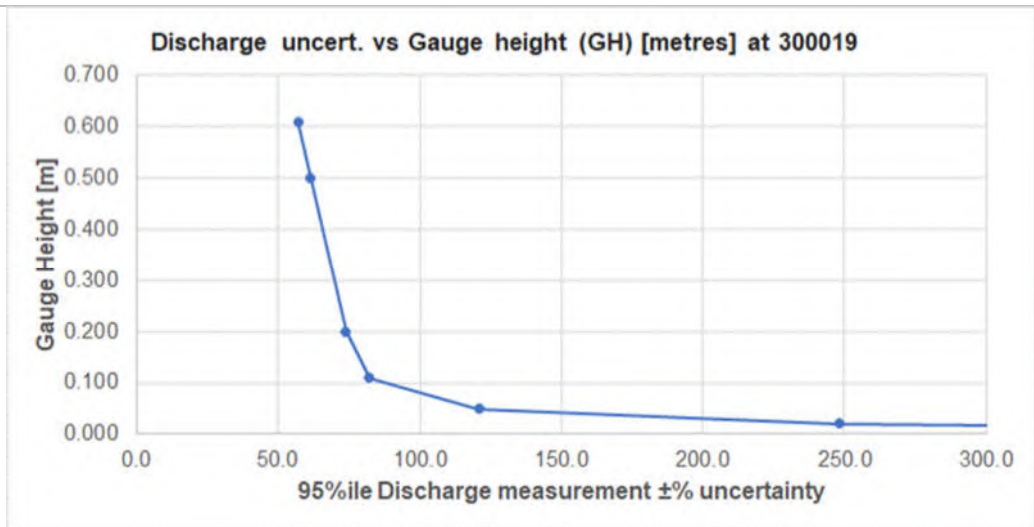


The reliance on natural control at this site leads to higher uncertainty than for the artificial/flume sites.

Comments from Enviromon:

- 1) 23 of 32 gaugings exceeded $\pm 10\%$ differences from the rating—ALS to address why there are so many with significant differences;

Gauge 300019 – SC10CS1

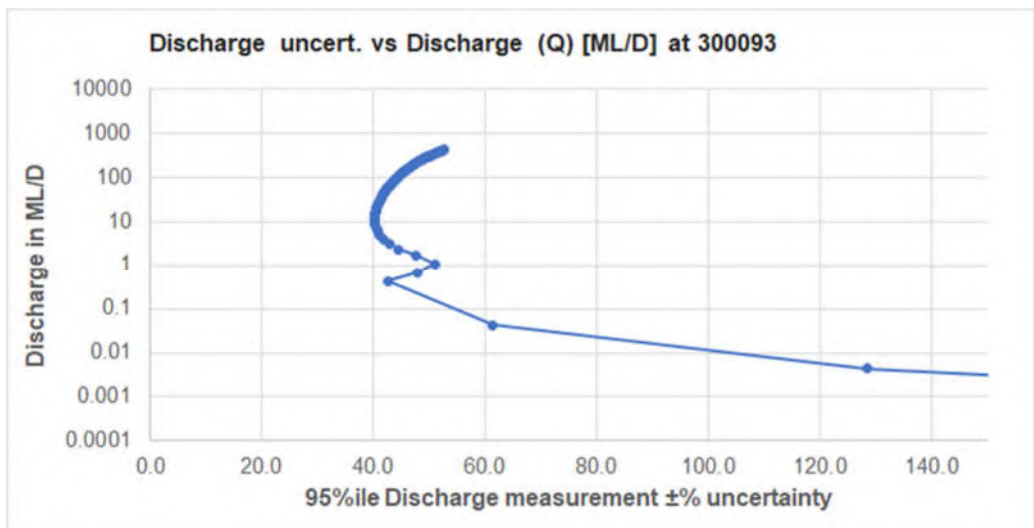
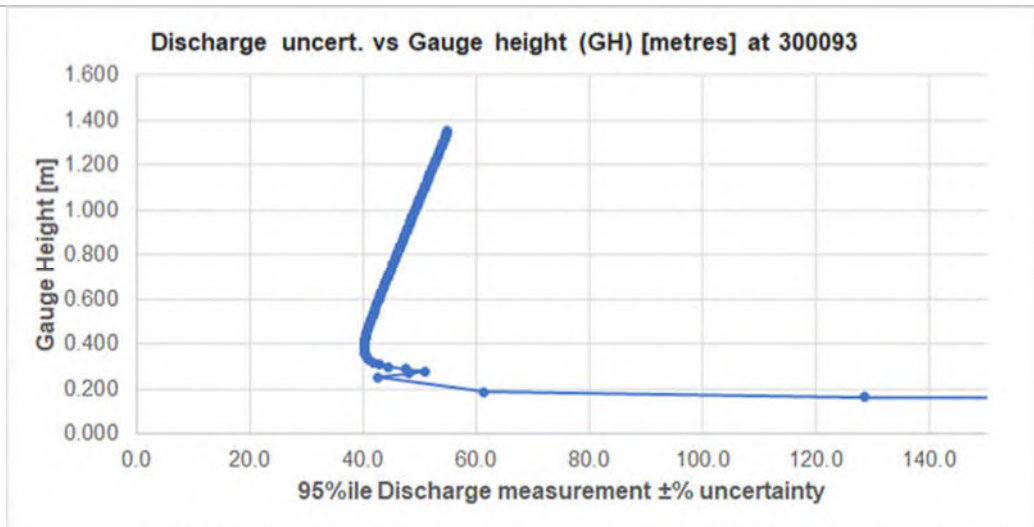


The reliance on natural control at this site leads to higher uncertainty than for the artificial/flume sites.

Comments from Enviromon:

- 1) 22 of the 24 gaugings have deviations greater than 10%, and 19 greater than 20%- ALS to address why there are so many with significant differences;
- 2) 18 of the 24 gaugings are in the depth range from CTF to 0.05 m, but the rating only has 3 points covering this range- ALS to address why only 3 points used. Is it related to the fact that many of the gaugings show large deviations (see point 1, above)?
- 3) Level measurement uncertainty is high at this site, mainly due to two particular field check differences (26mm on 10/2/21, and 23mm on 23/11/22). The hypotheses are that the sensor could be becoming faulty, or are these large differences due to inaccuracy in field measurements. ALS to consider.

Gauge 300093 – ND1S1 (NDT1S1)

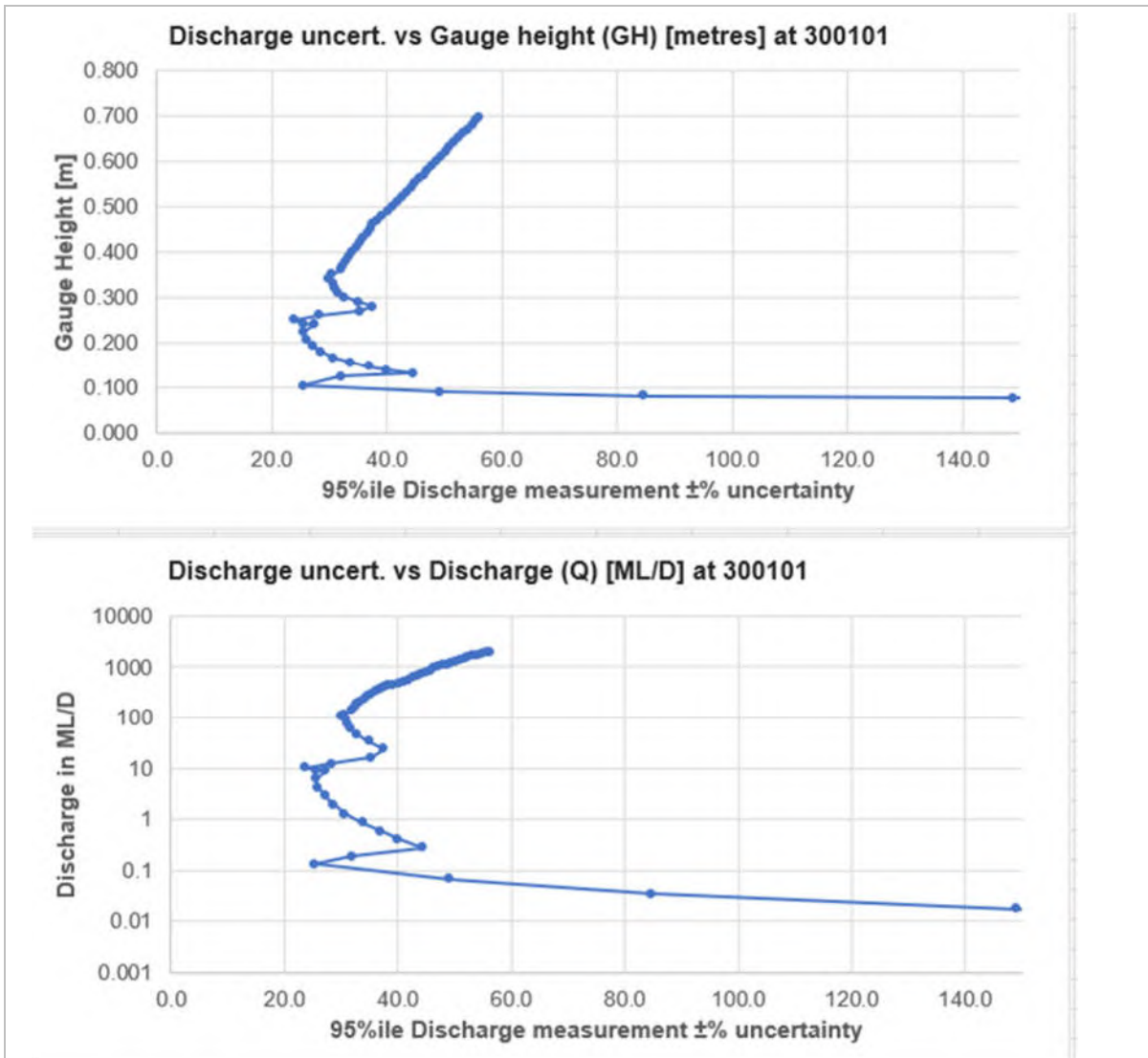


The use of an artificial control (halfpipe) leads to generally lower uncertainty than for the natural control sites (e.g. SC10S1 and SC10CS1).

Comments from Enviromon:

- 1) There are 139 rating table change points- which seems excessive for such a site;
- 2) 18 of the 24 gaugings are within the half pipe depth range. The portion of the rating table covering the half pipe depth range is only 5 points. As much of the flow is in this range at the site, more rating points could be added to give more sensitivity. More points could be added if a generic 150mm half pipe rating were to be developed and used- as suggested in the review document;
- 3) 15 of 24 gaugings exceeded $\pm 10\%$ differences from the rating- ALS to address why there are so many with significant differences.

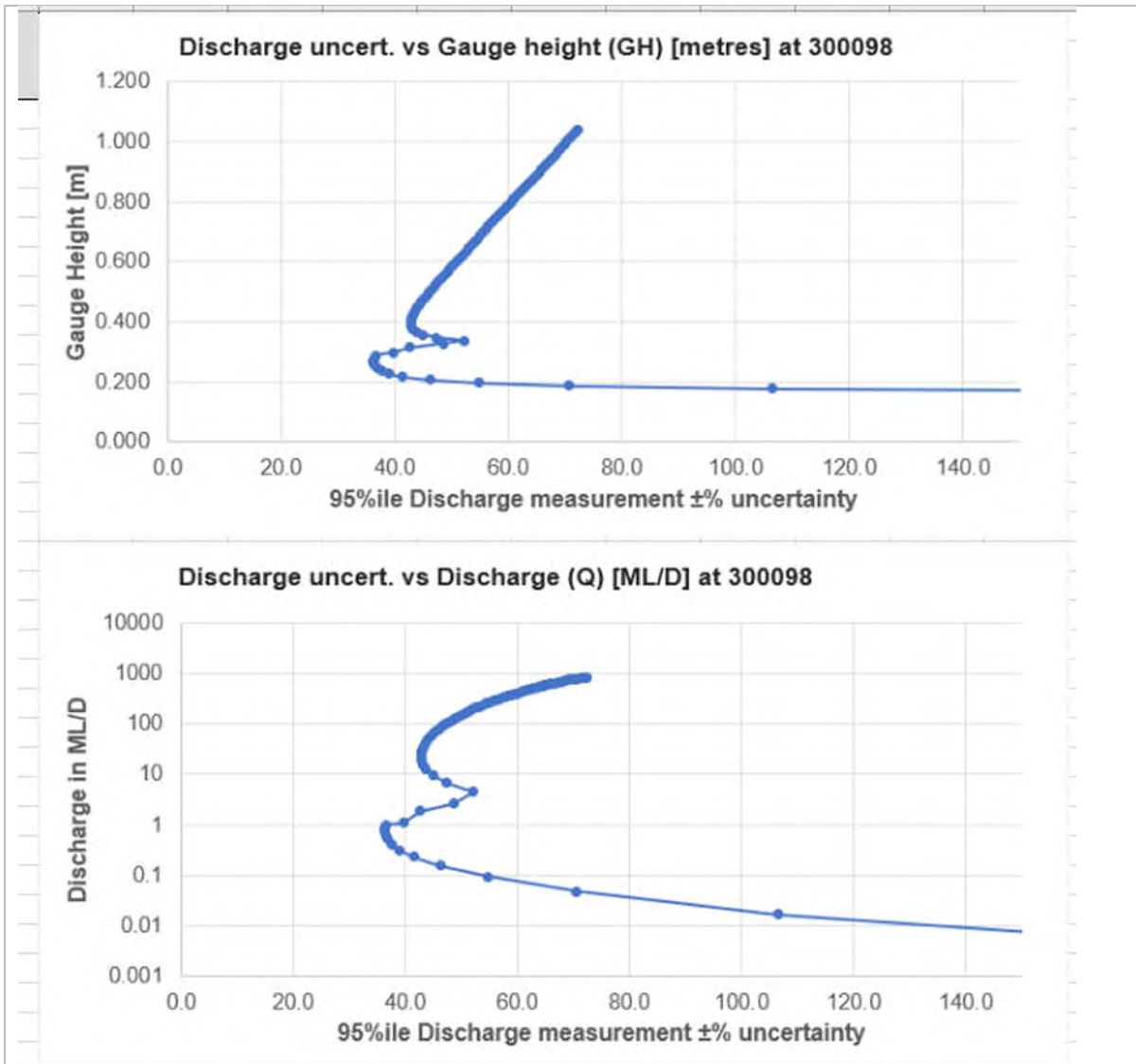
Gauge 300101 – LC6S1



Note that the two lowest flow gaugings were treated as outliers and excluded from the analysis as they had very large differences from the rating curve for the site:- Both these gaugings were taken with a pygmy current meter, which would have been partially above the water level at the point of gauging- making flow measurement accuracy questionable.

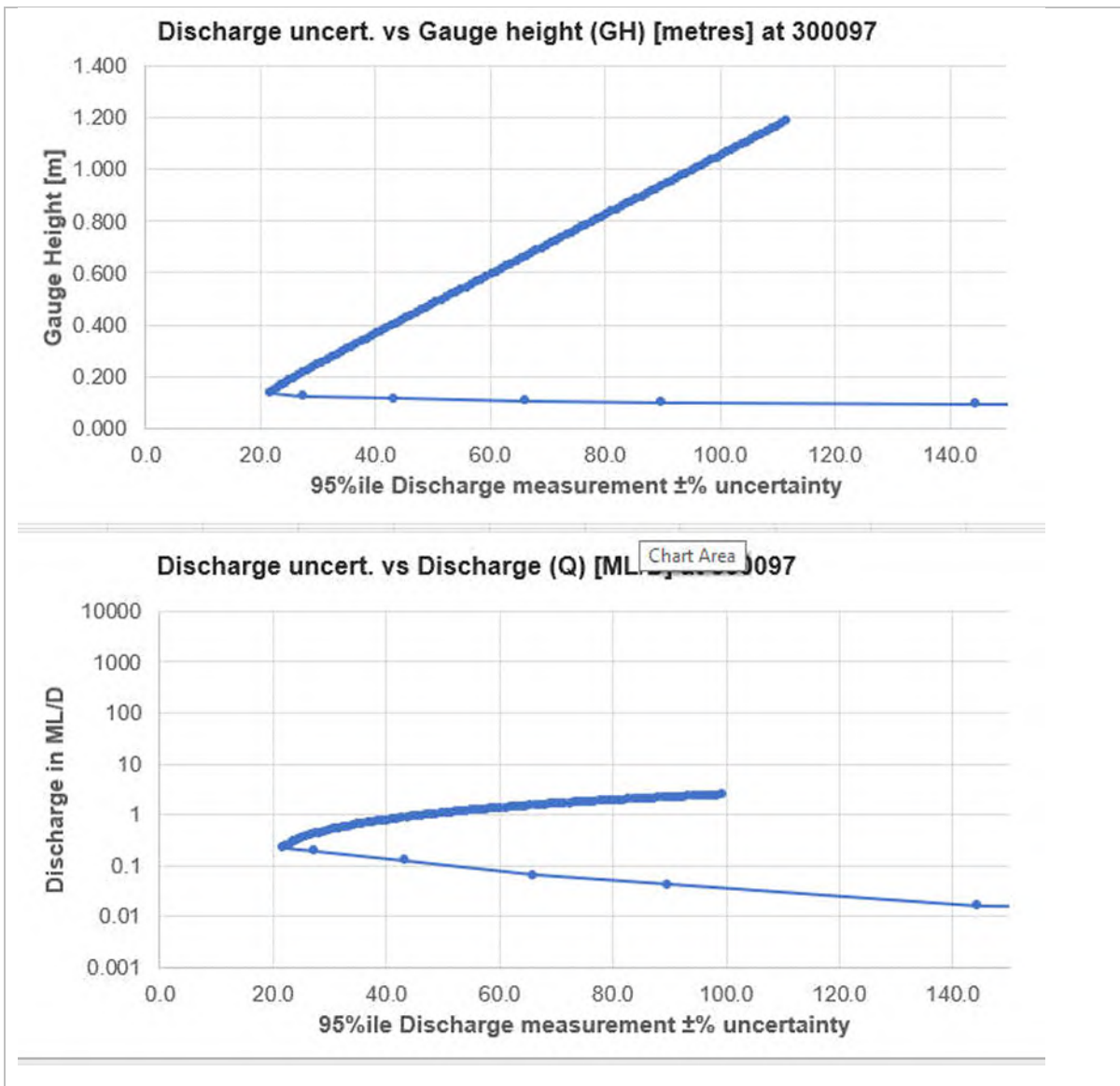
Also note that the 95%ile level measurement uncertainty used for the Orpheus was $\pm 0.0066\text{m}$, which was based on field observations at site WWL_A Orpheus sensor. However if the manufacturer's tech data Technical specifications had been used this 95%ile level measurement uncertainty reduces to 0.0023m . Using ± 0.0023 would reduce discharge measurement uncertainties by 5%.

Gauge 300098 – WC20S1



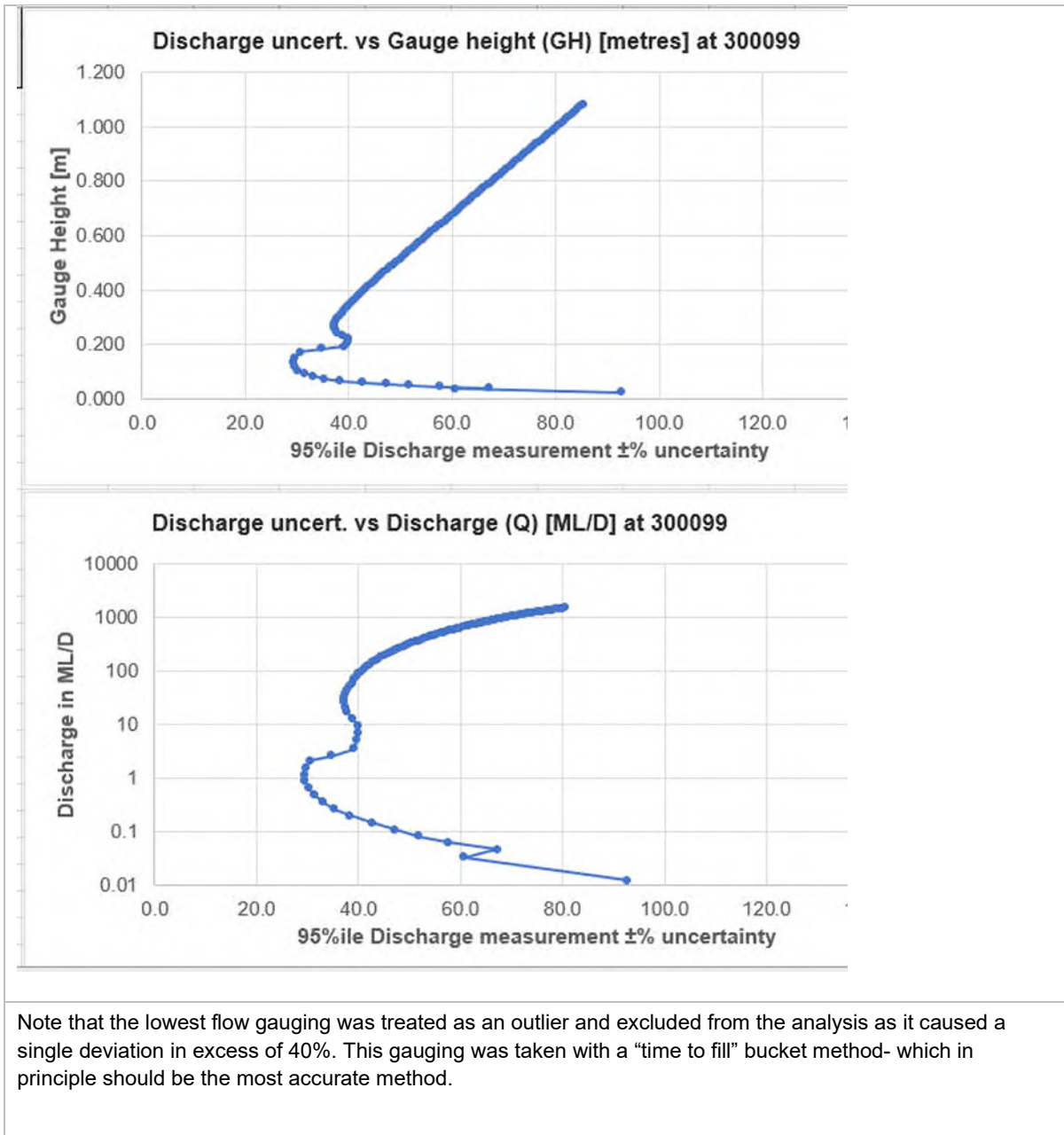
Note that the lowest flow gauging was treated as an outlier and excluded from the analysis as it caused a single deviation in excess of 4000%! This gauging (like most others) was taken with a pygmy current meter, but for this gauging the depth of flow into the half pipe was only 3mm, making the pygmy metter blades protrude above the water level at the point of gauging- making flow measurement accuracy unreliable .

Gauge 300097 – WC24S1



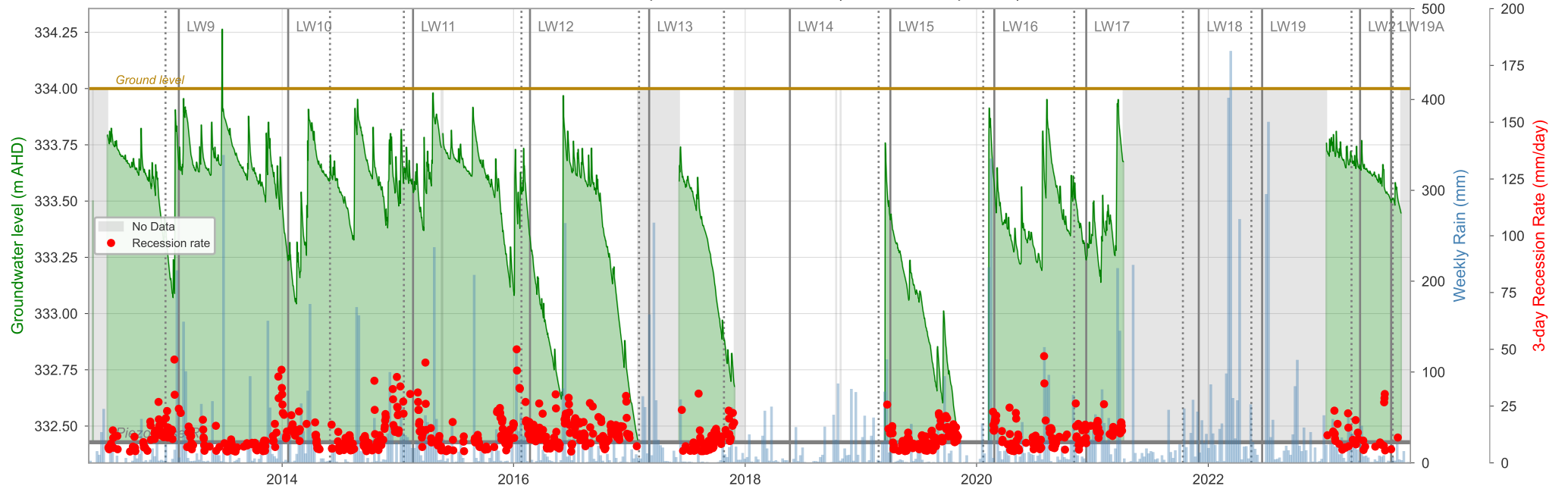
Note that the two lowest flow gaugings (each only 1mm above the lip of the 225mm half pipe) were treated as outliers and excluded from the analysis as they had very large differences from the rating curve for the site:- One these gaugings was taken with a pygmy current meter (which would have been partially above the water level at the point of gauging- making flow measurement accuracy questionable), and the other using the bucket-fill time method.

Gauge 300099 – WC26S1

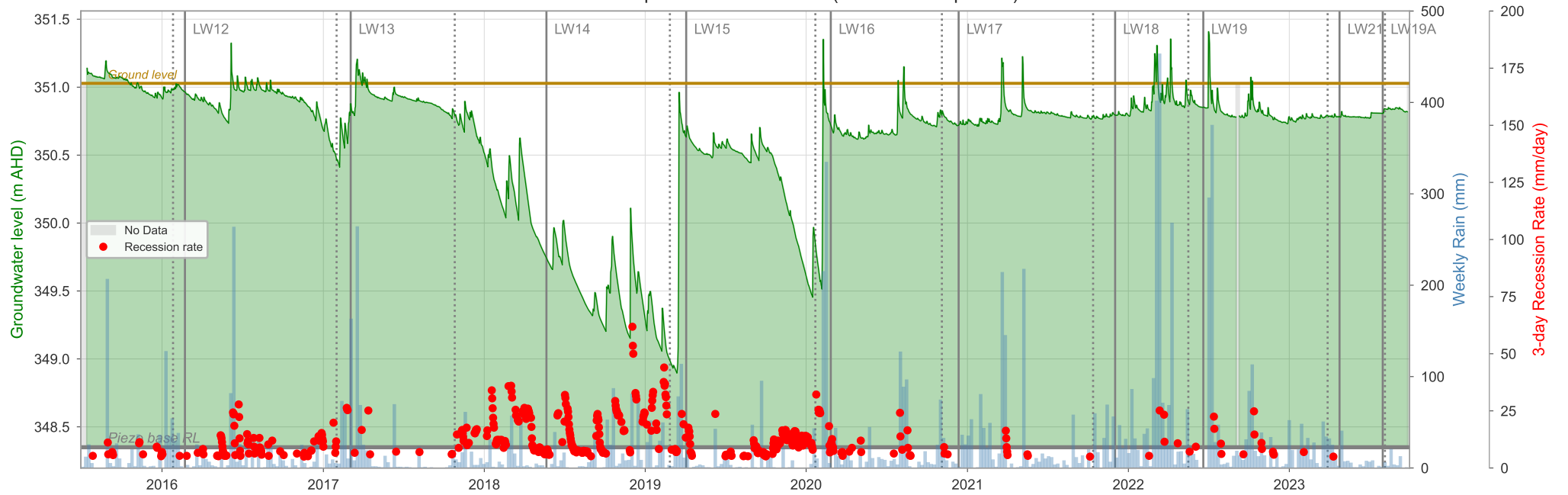


Appendix D: Shallow groundwater hydrographs

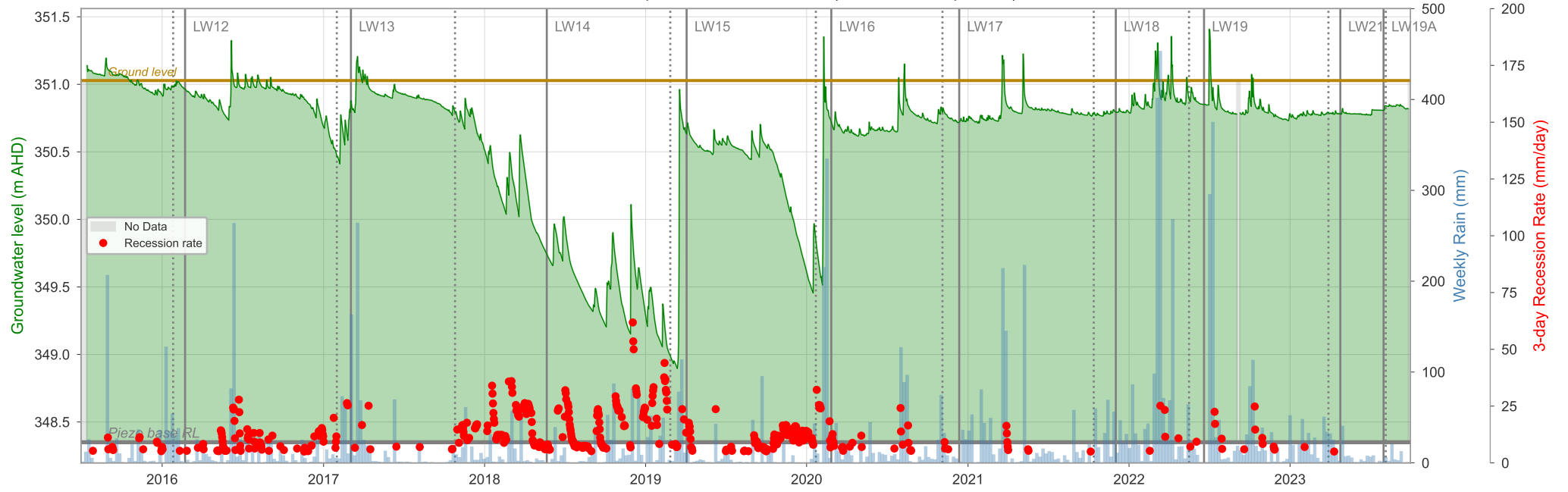
Dendrobium Swamp 02: Piezometer 01 (Within swamp EEC)



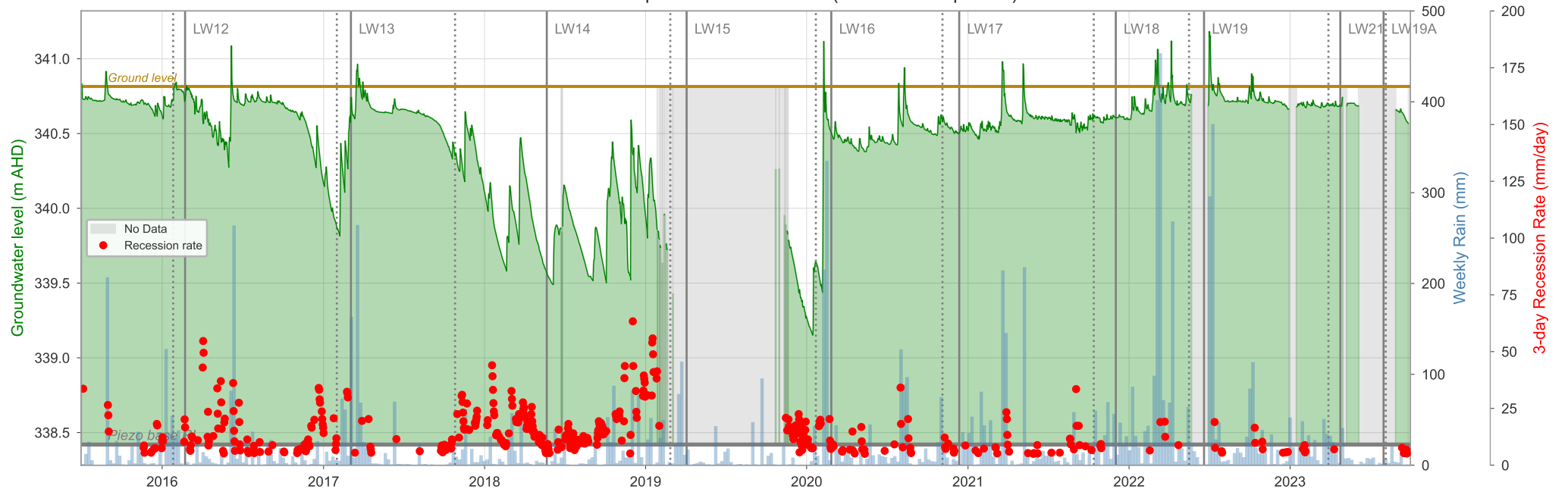
Dendrobium Swamp 07: Piezometer 05 (Within swamp EEC)



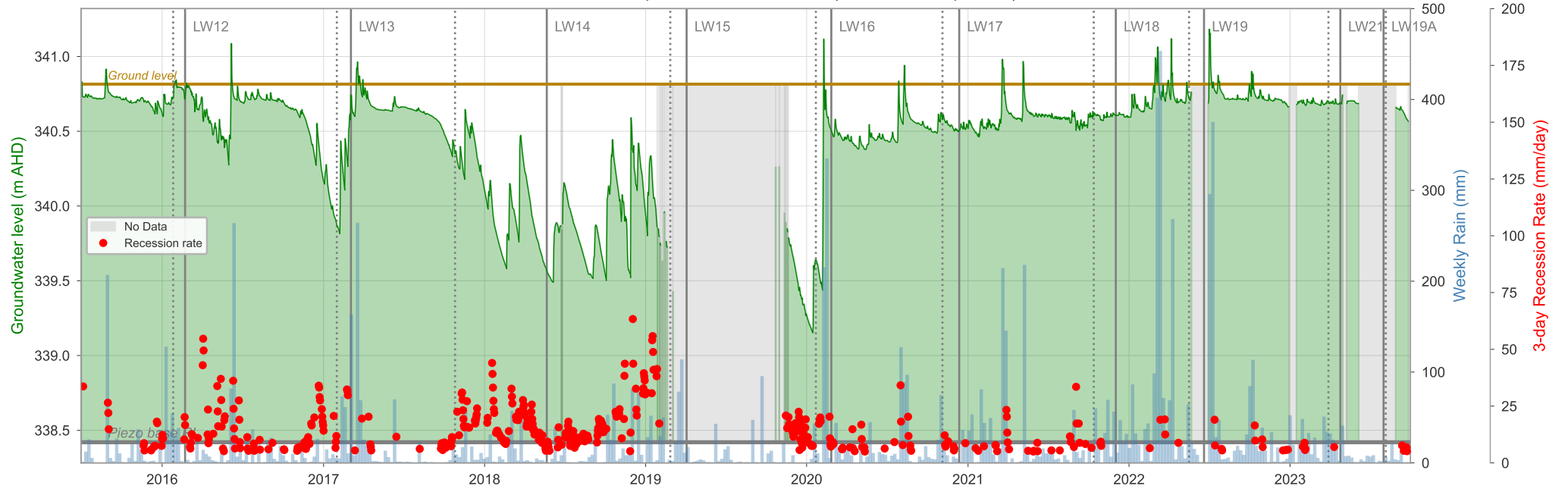
Dendrobium Swamp 07: Piezometer 05 (Within swamp EEC)



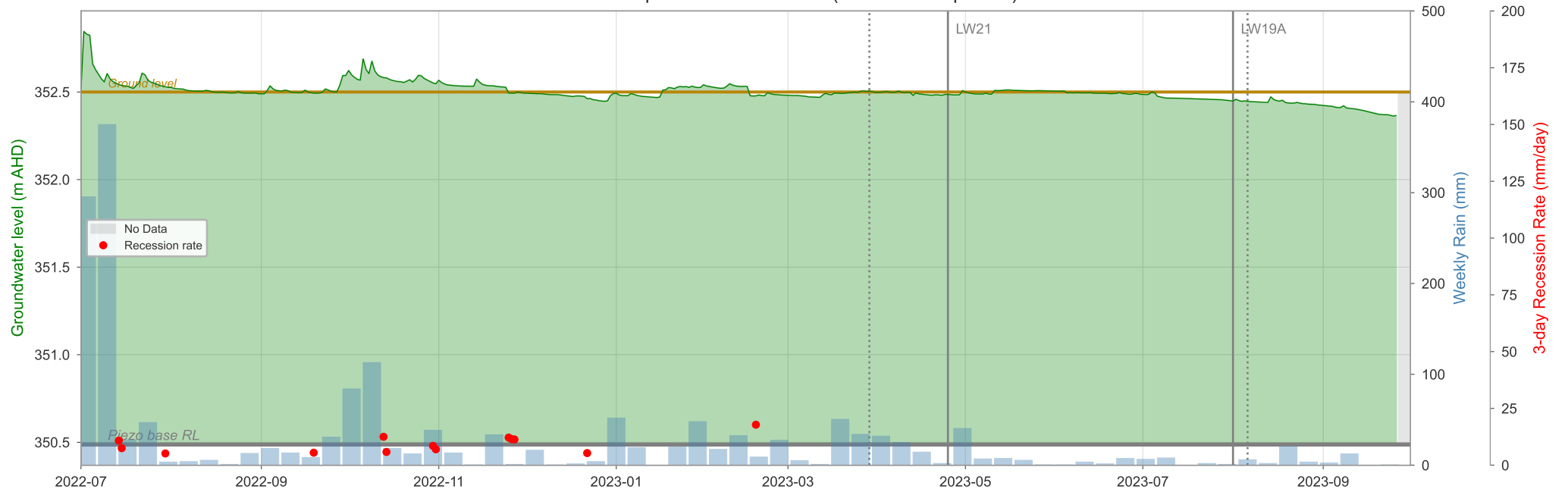
Dendrobium Swamp 07: Piezometer 06 (Within swamp EEC)



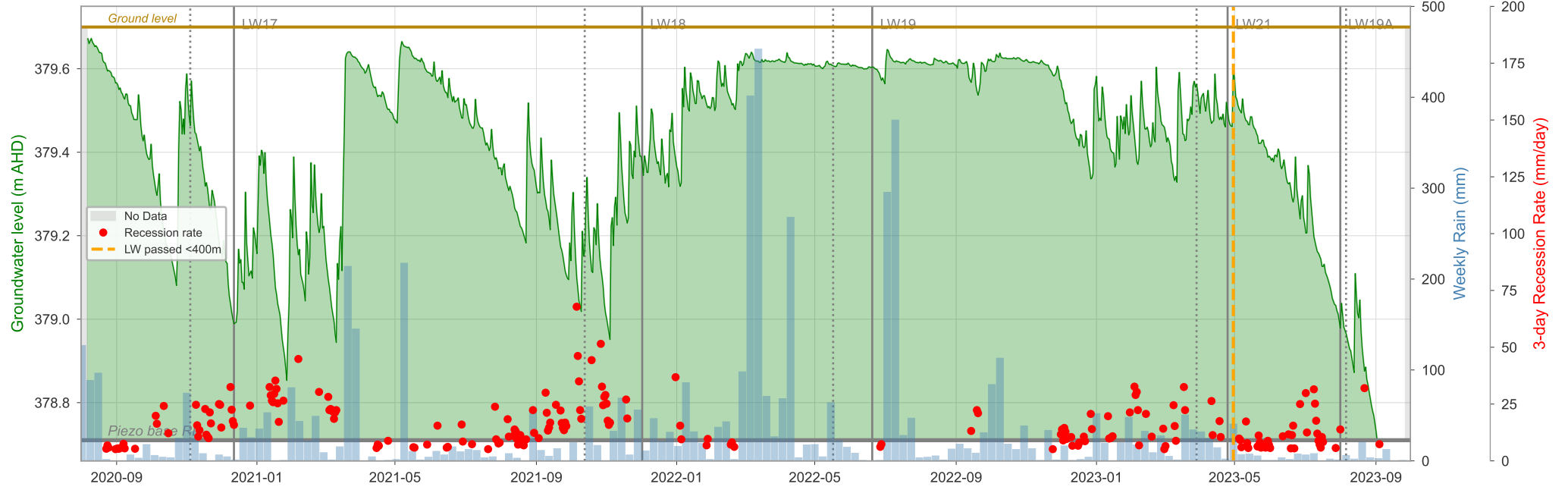
Dendrobium Swamp 07: Piezometer 06 (Within swamp EEC)



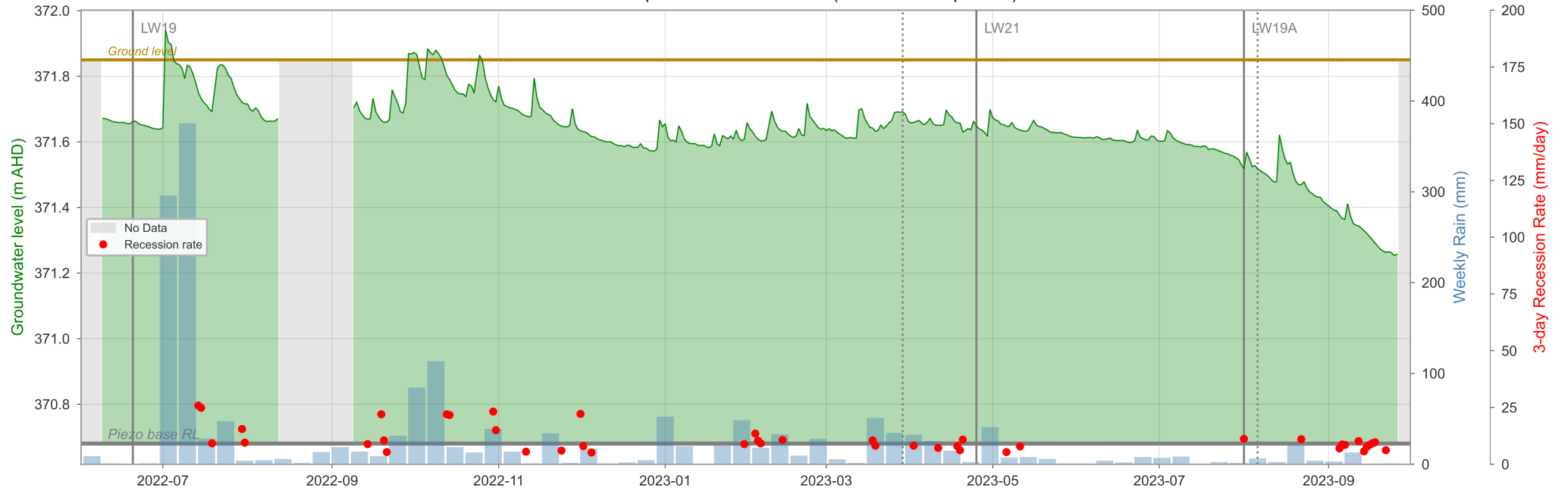
Dendrobium Swamp 07: Piezometer 07 (Within swamp EEC)



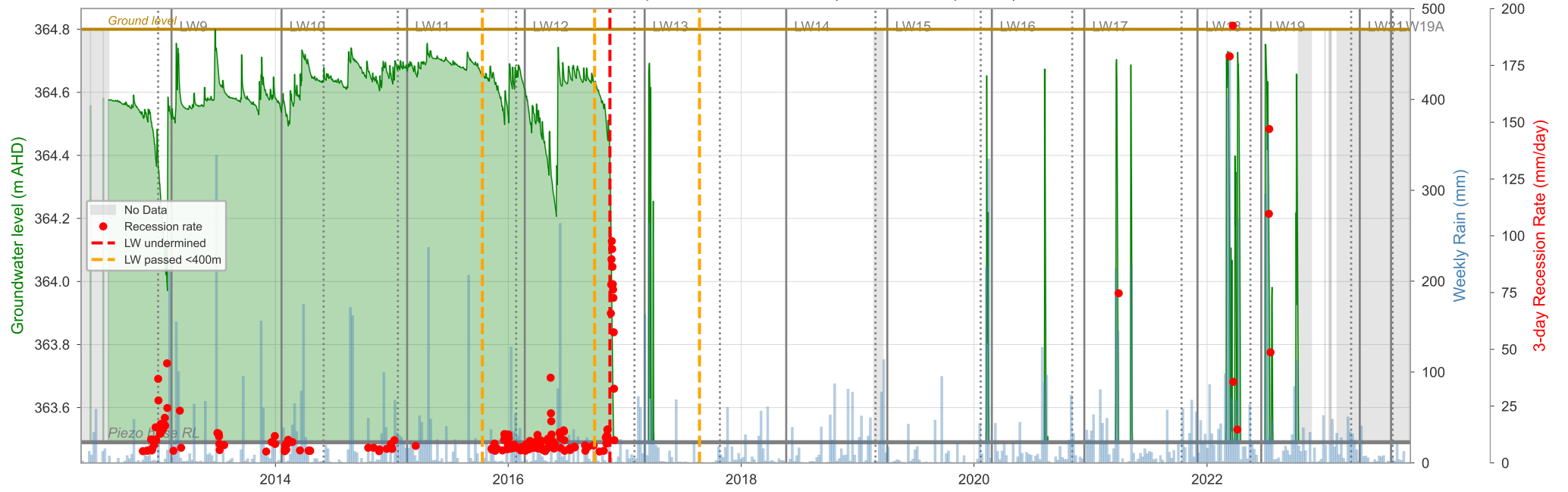
Dendrobium Swamp 09: Piezometer 01 (Within swamp EEC)



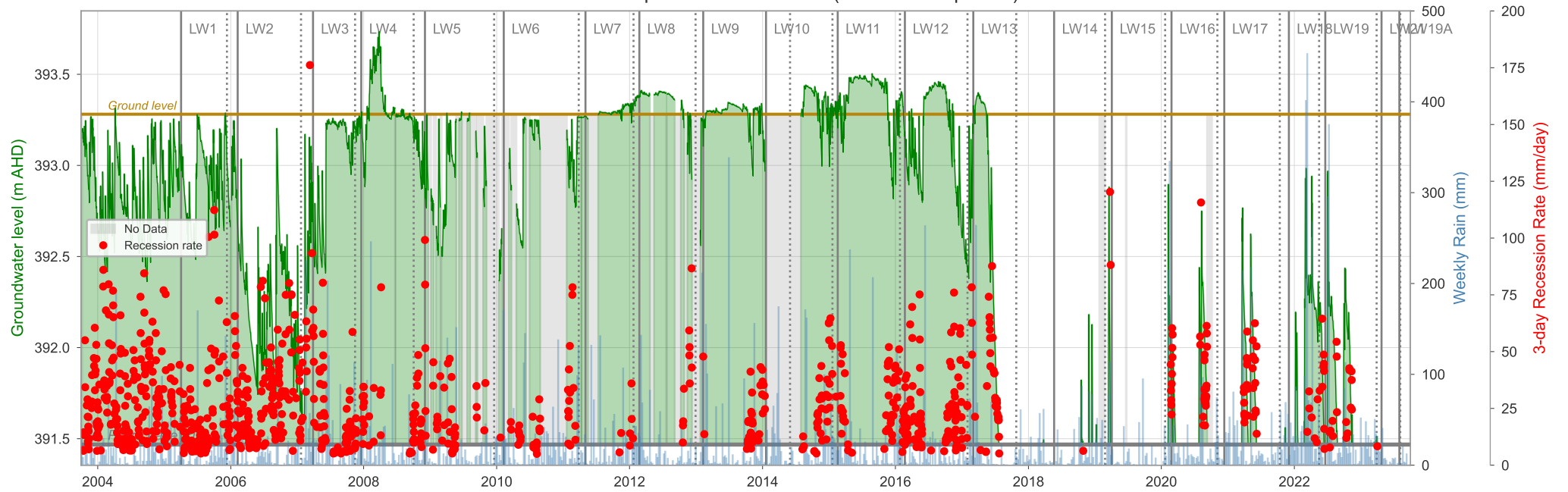
Dendrobium Swamp 09: Piezometer 02 (Within swamp EEC)



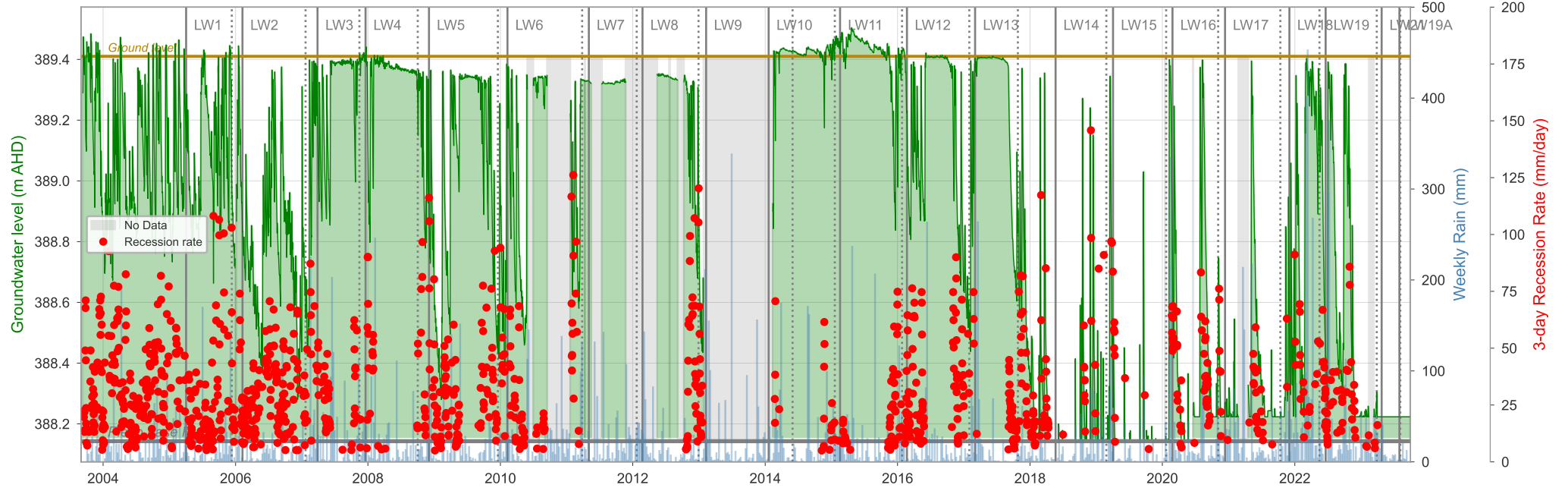
Dendrobium Swamp 10: Piezometer 01 (Within swamp EEC)



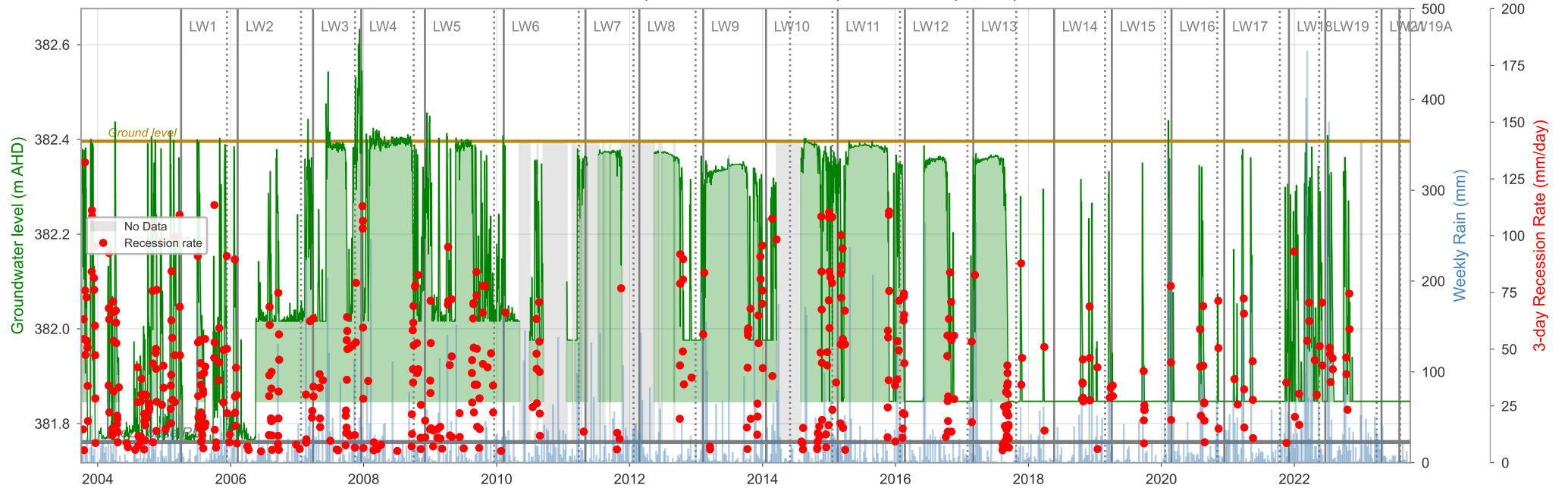
Dendrobium Swamp 11: Piezometer H1 (Within swamp EEC)



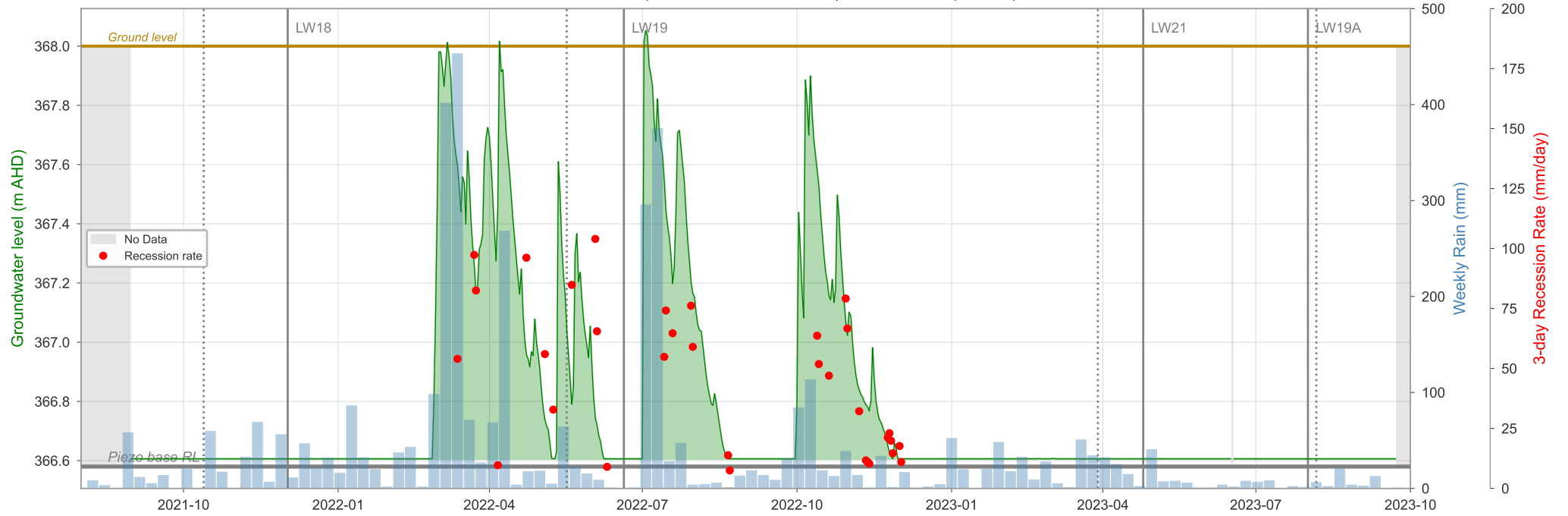
Dendrobium Swamp 11: Piezometer H2 (Within swamp EEC)



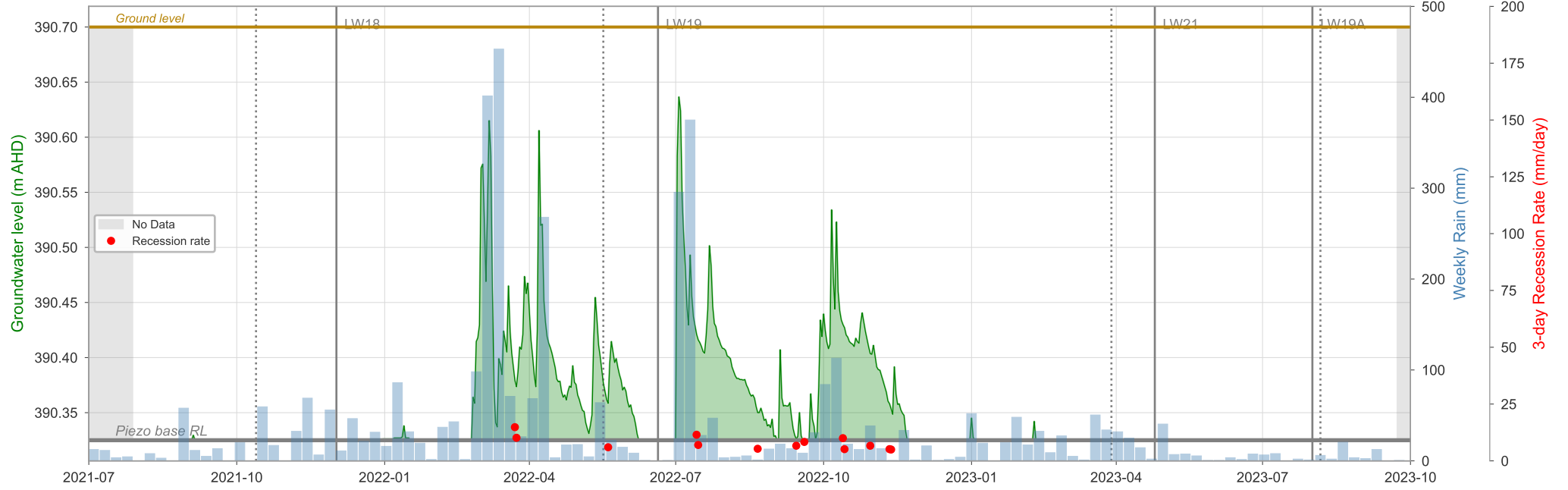
Dendrobium Swamp 11: Piezometer H3 (Within swamp EEC)



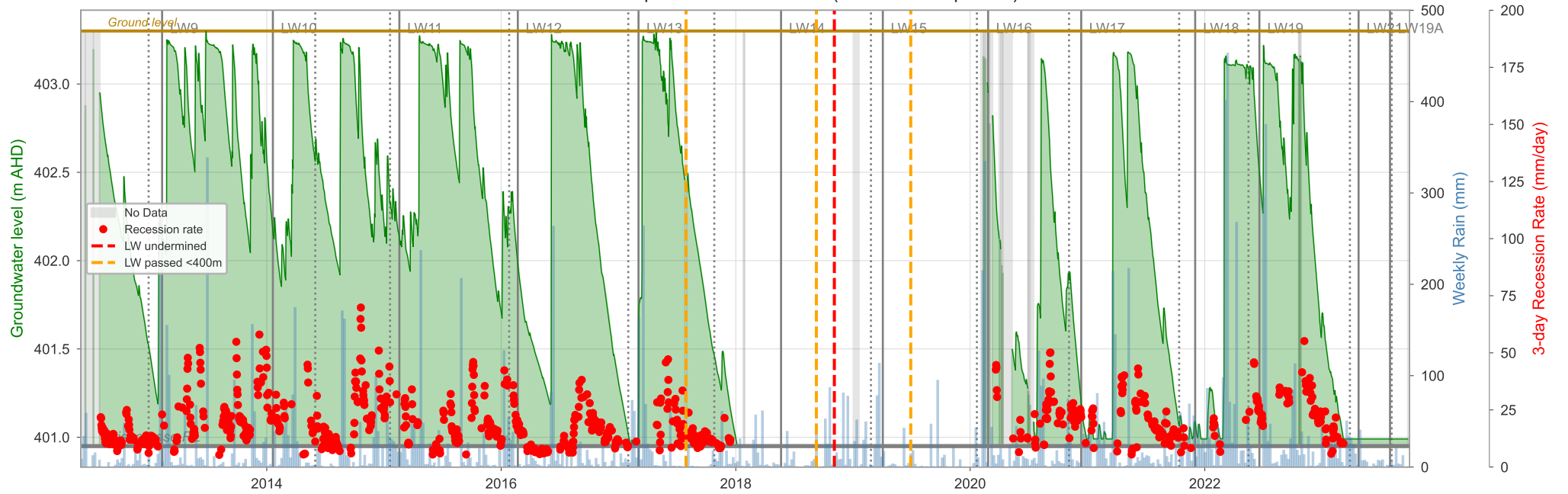
Dendrobium Swamp 12: Piezometer 01 (Within swamp EEC)



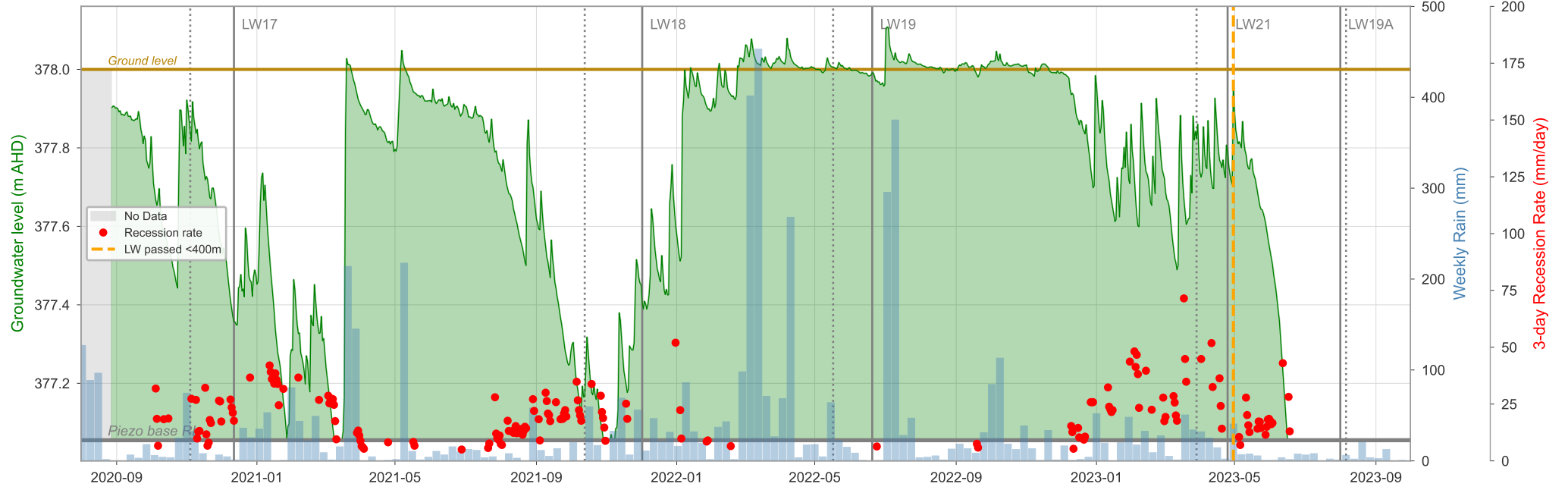
Dendrobium Swamp 12: Piezometer 03 (Outside swamp EEC)



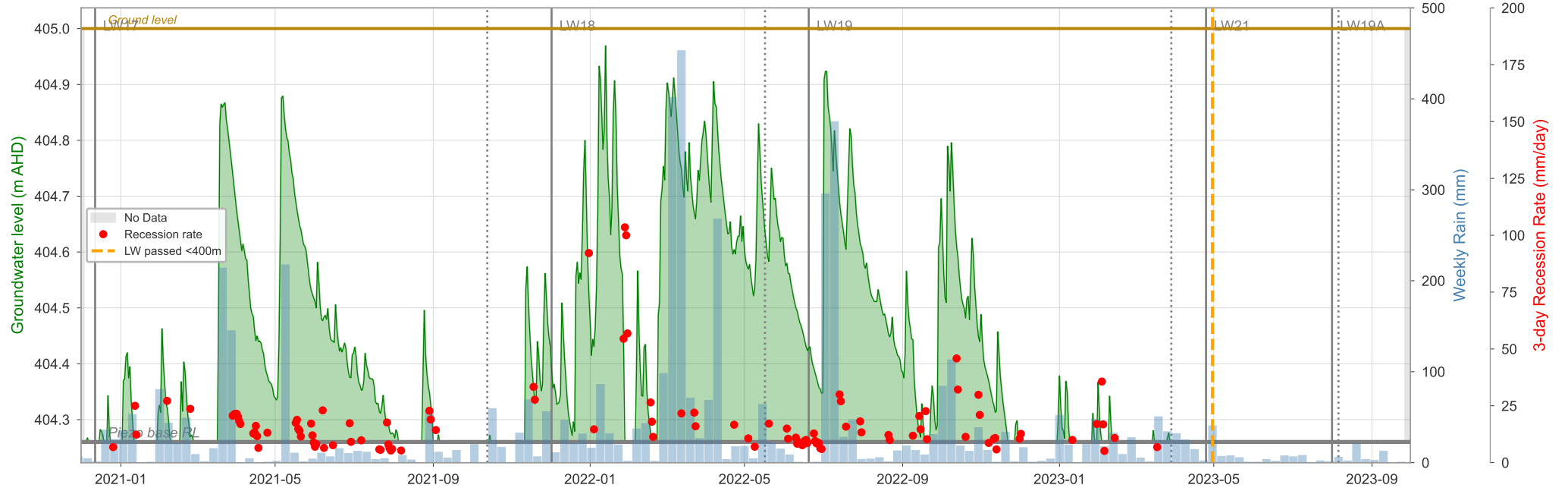
Dendrobium Swamp 13: Piezometer 01 (Within swamp EEC)



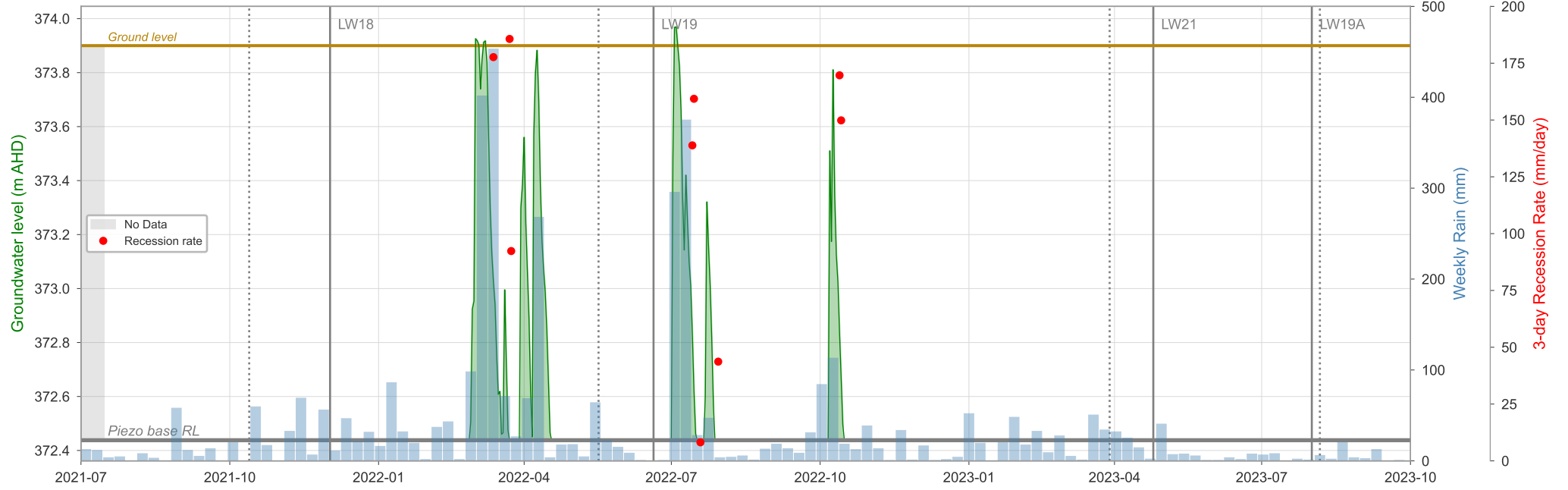
Dendrobium Swamp 144: Piezometer 01 (Within swamp EEC)



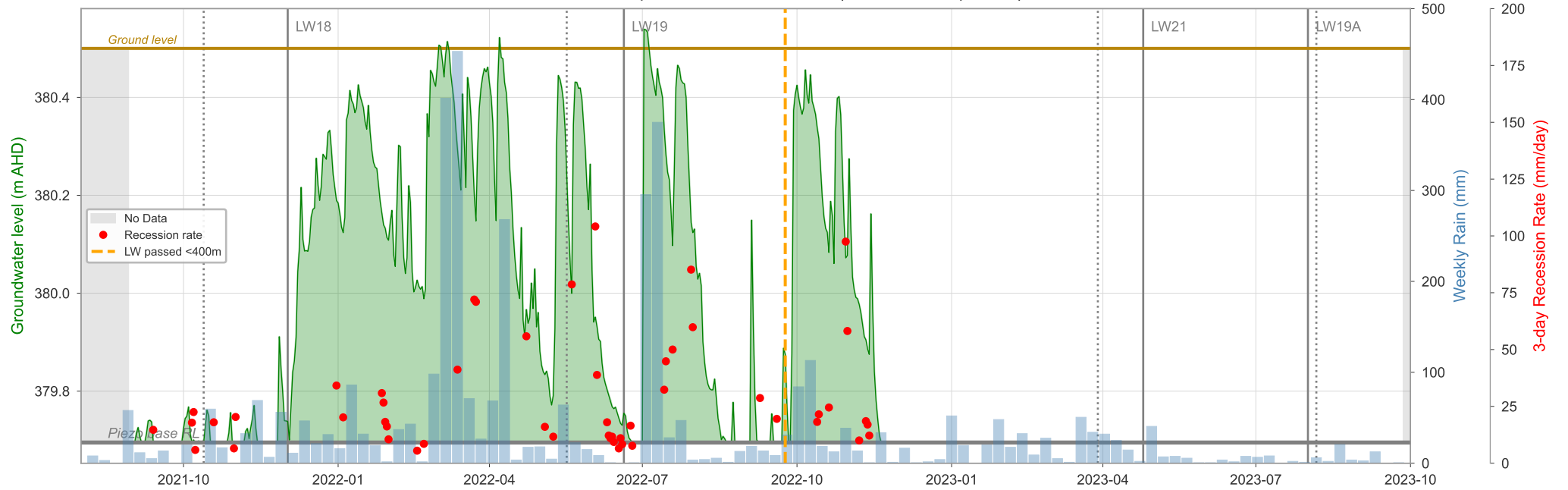
Dendrobium Swamp 145: Piezometer 01 (Within swamp EEC)



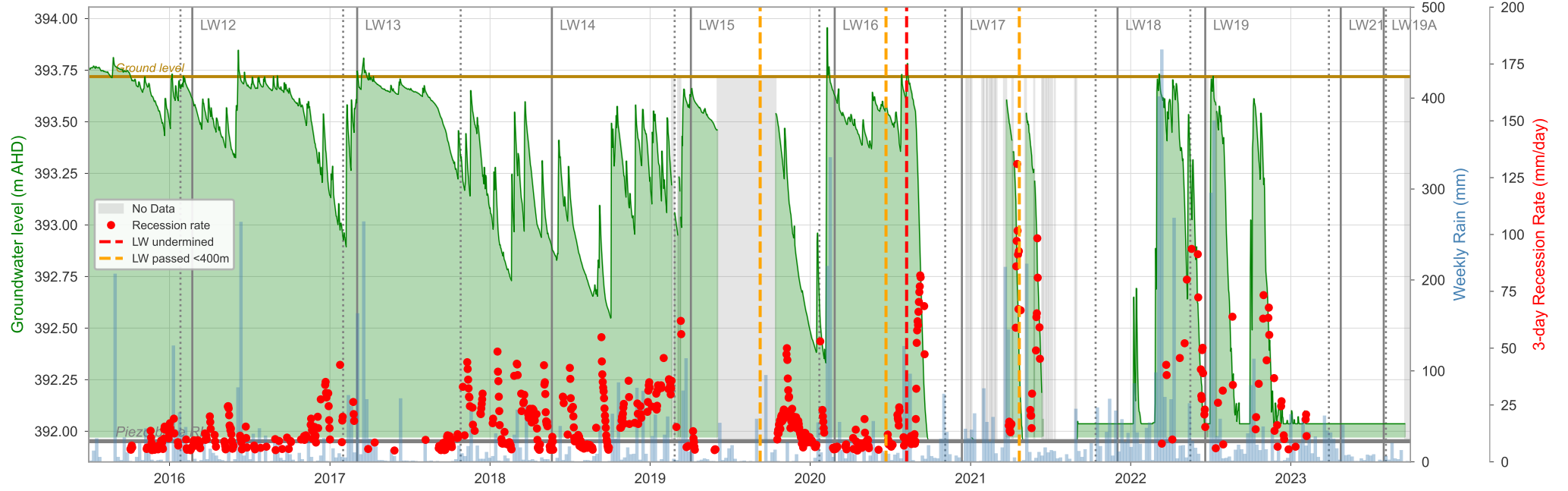
Dendrobium Swamp 146: Piezometer 01 (Within swamp EEC)



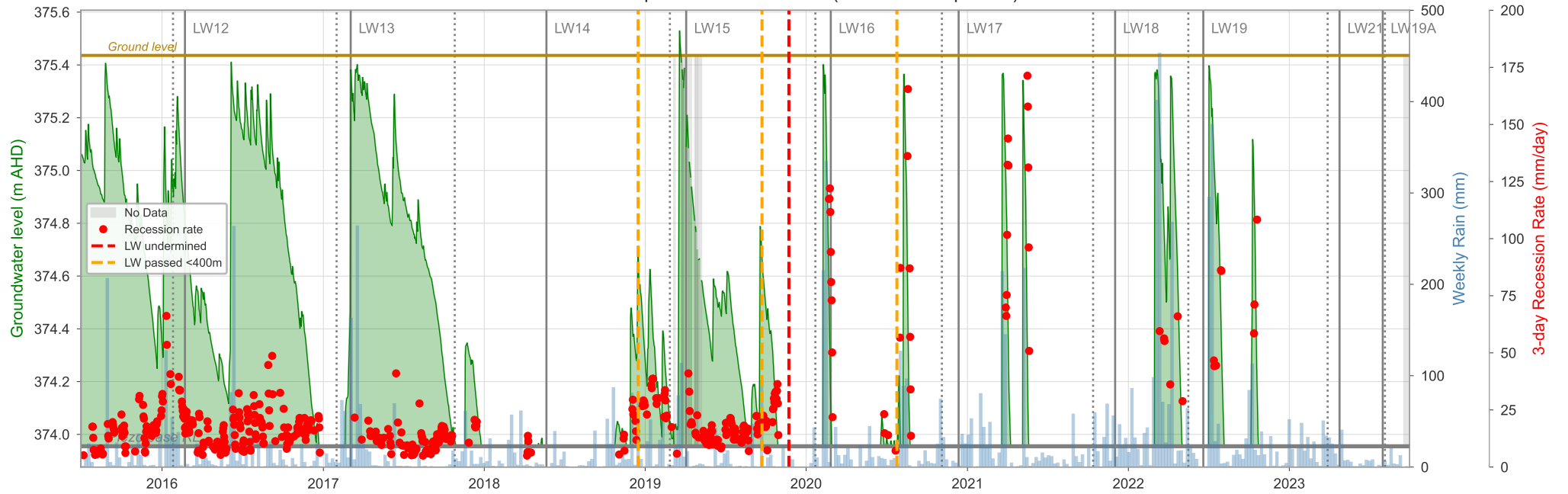
Dendrobium Swamp 148: Piezometer 01 (Within swamp EEC)



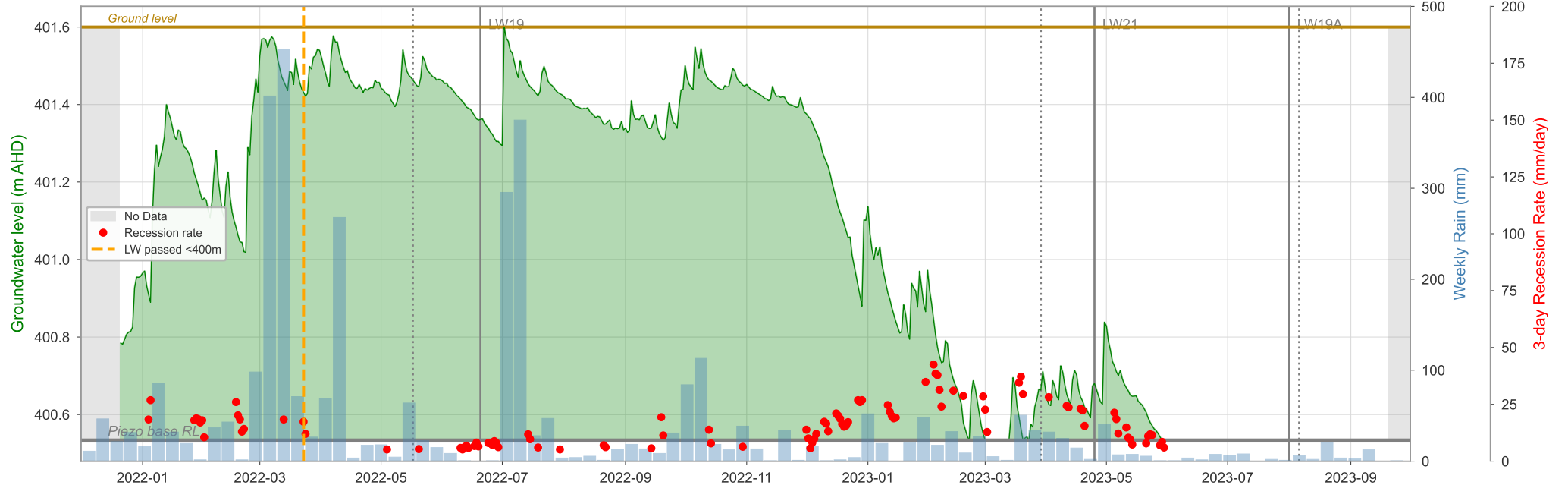
Dendrobium Swamp 14: Piezometer 01 (Within swamp EEC)



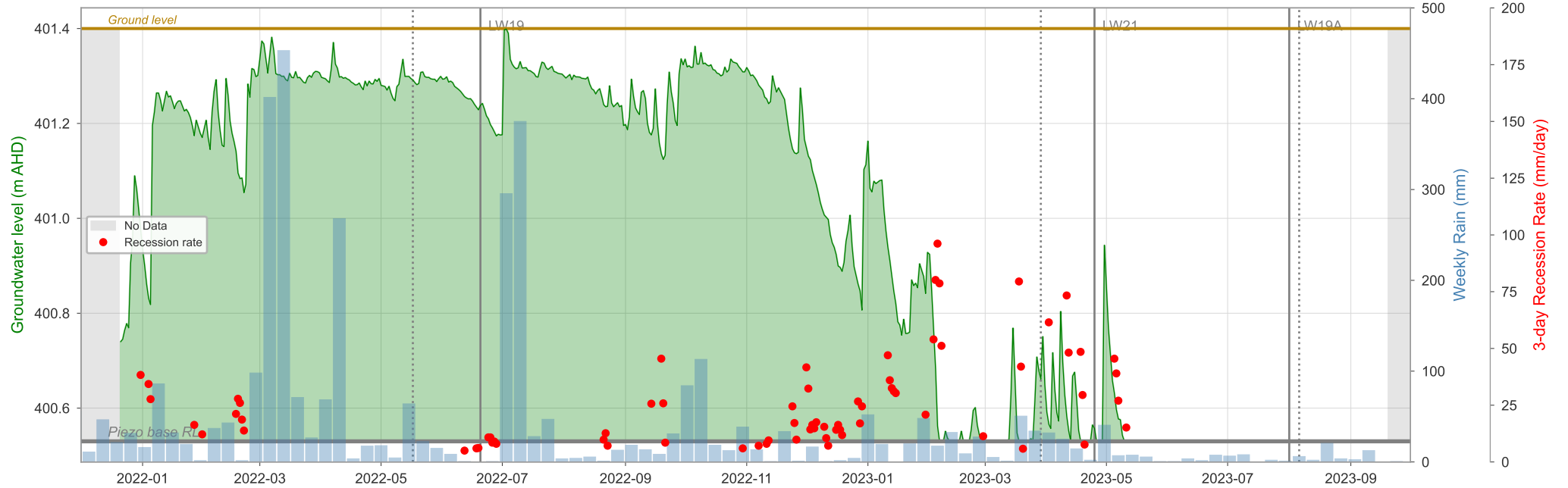
Dendrobium Swamp 14: Piezometer 02 (Within swamp EEC)



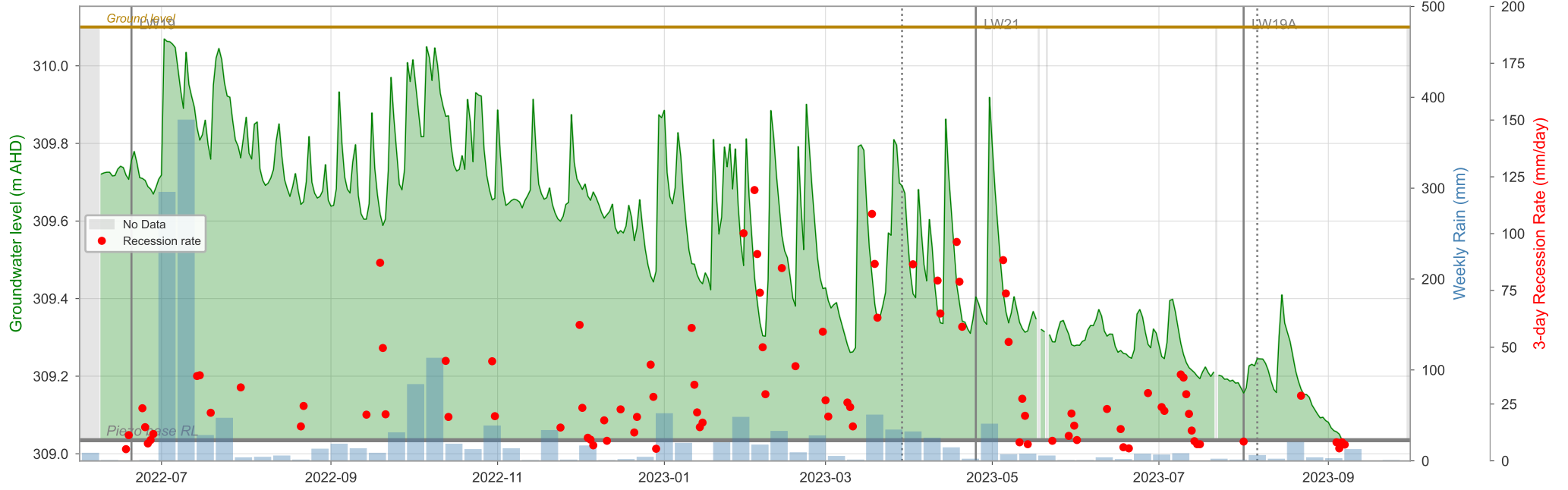
Dendrobium Swamp 150: Piezometer 01 (Within swamp EEC)



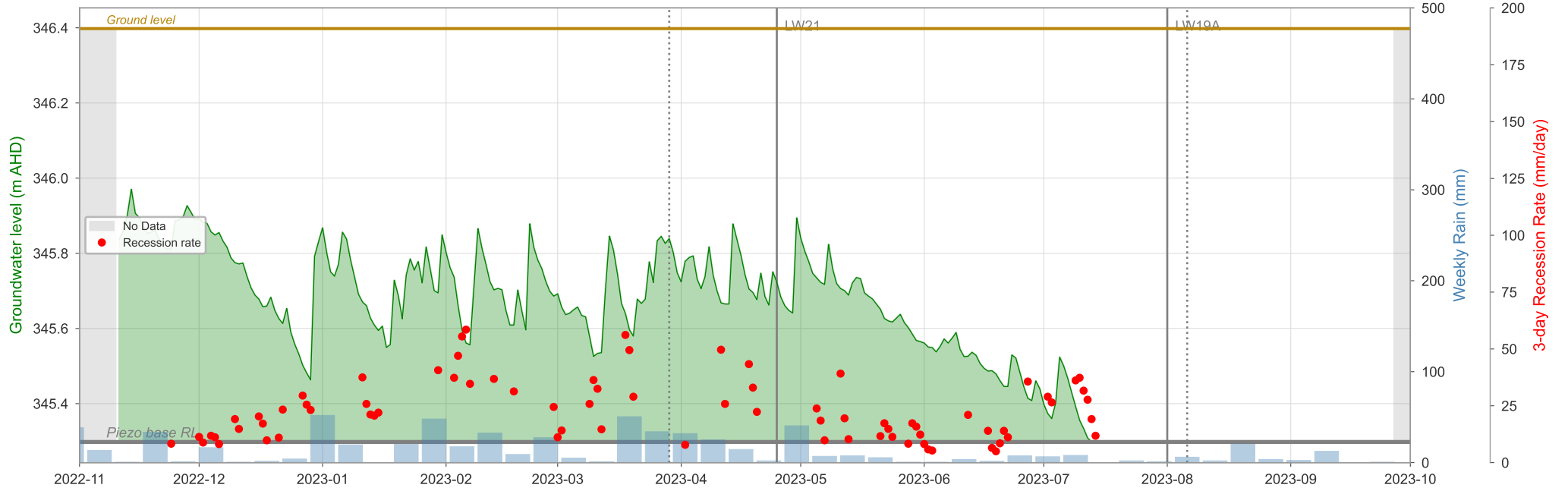
Dendrobium Swamp 151: Piezometer 01 (Within swamp EEC)



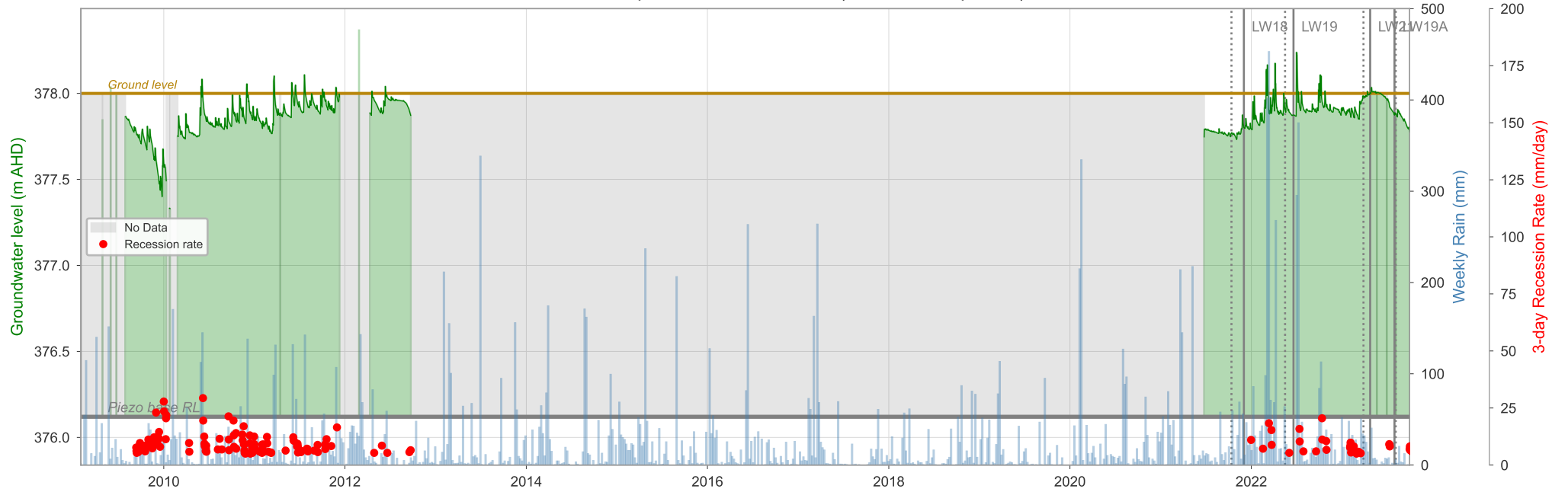
Dendrobium Swamp 153: Piezometer 01 (Within swamp EEC)



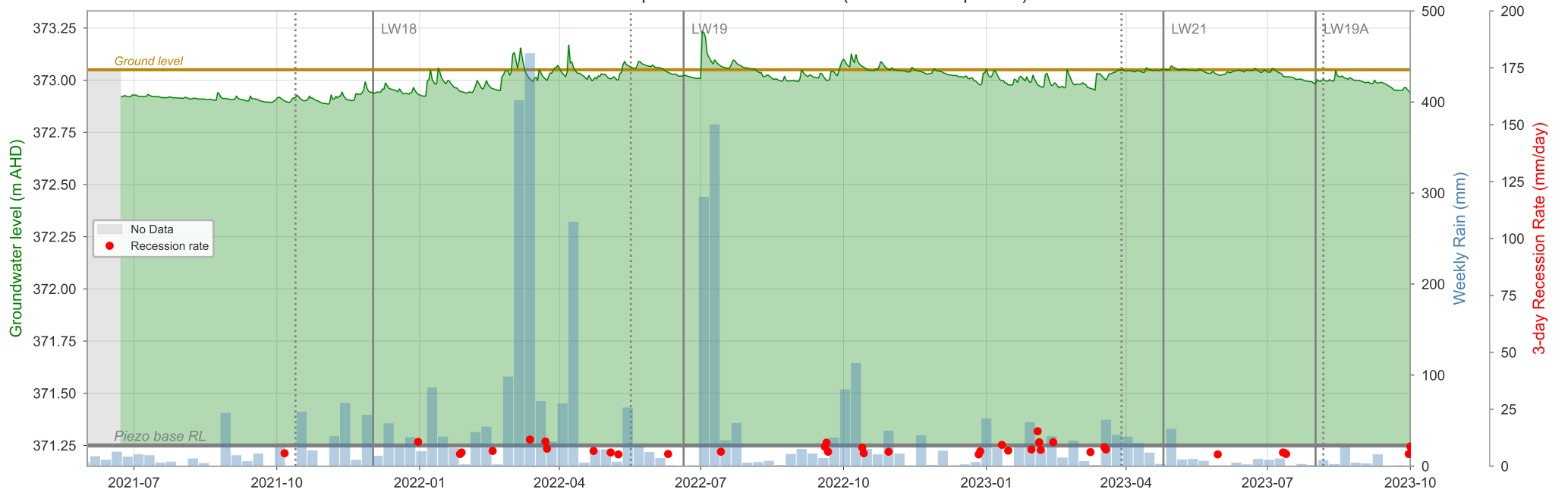
Dendrobium Swamp 154: Piezometer 01 (Within swamp EEC)



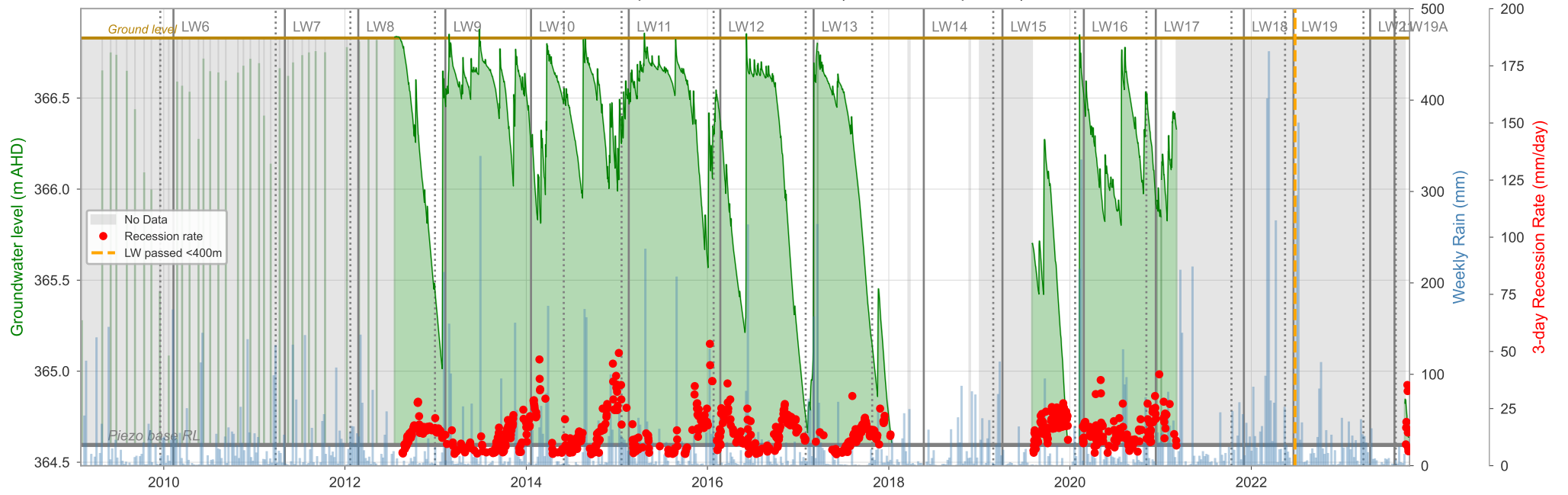
Dendrobium Swamp 15A: Piezometer 03 (Within swamp EEC)



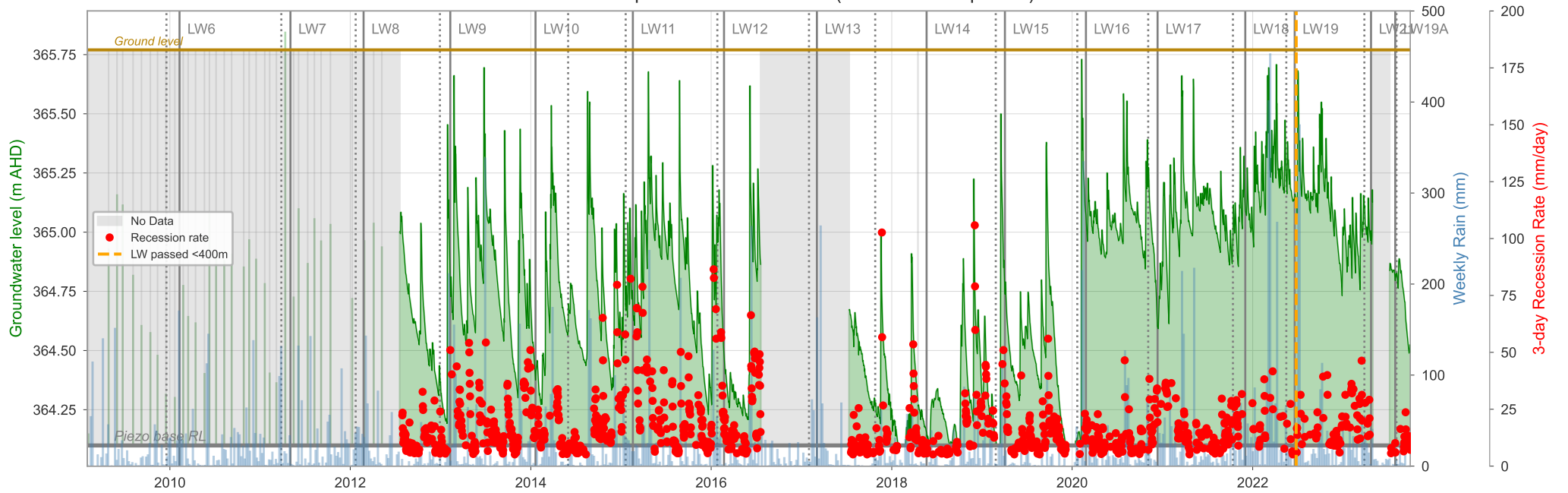
Dendrobium Swamp 15A: Piezometer 04 (Within swamp EEC)



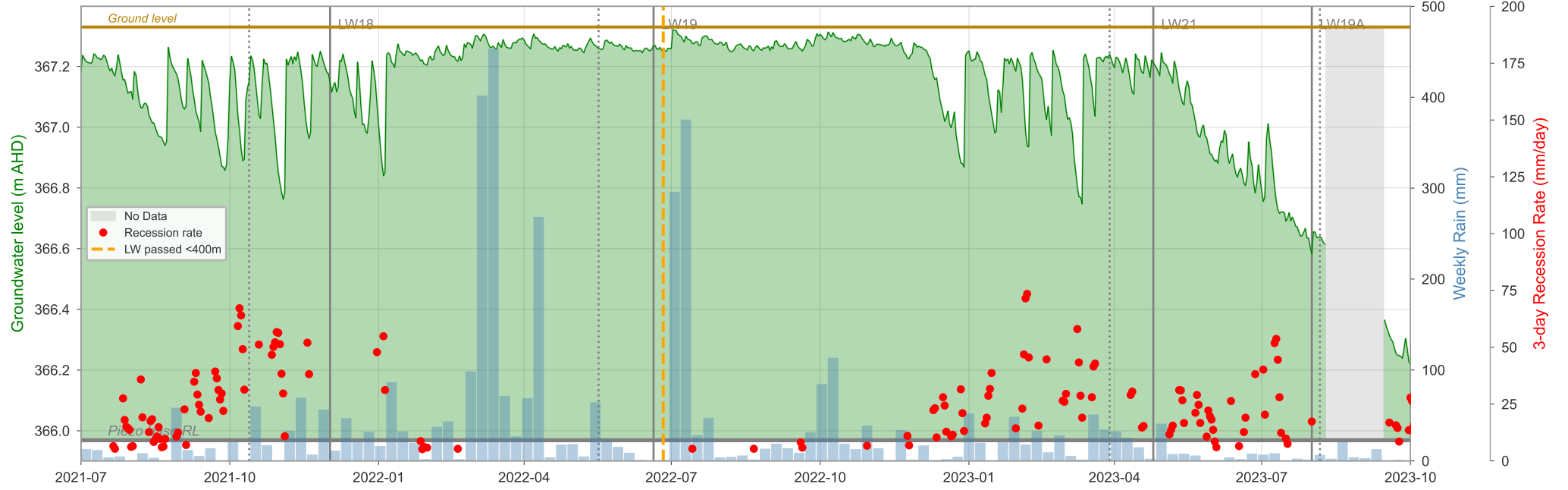
Dendrobium Swamp 15A: Piezometer 06 (Within swamp EEC)



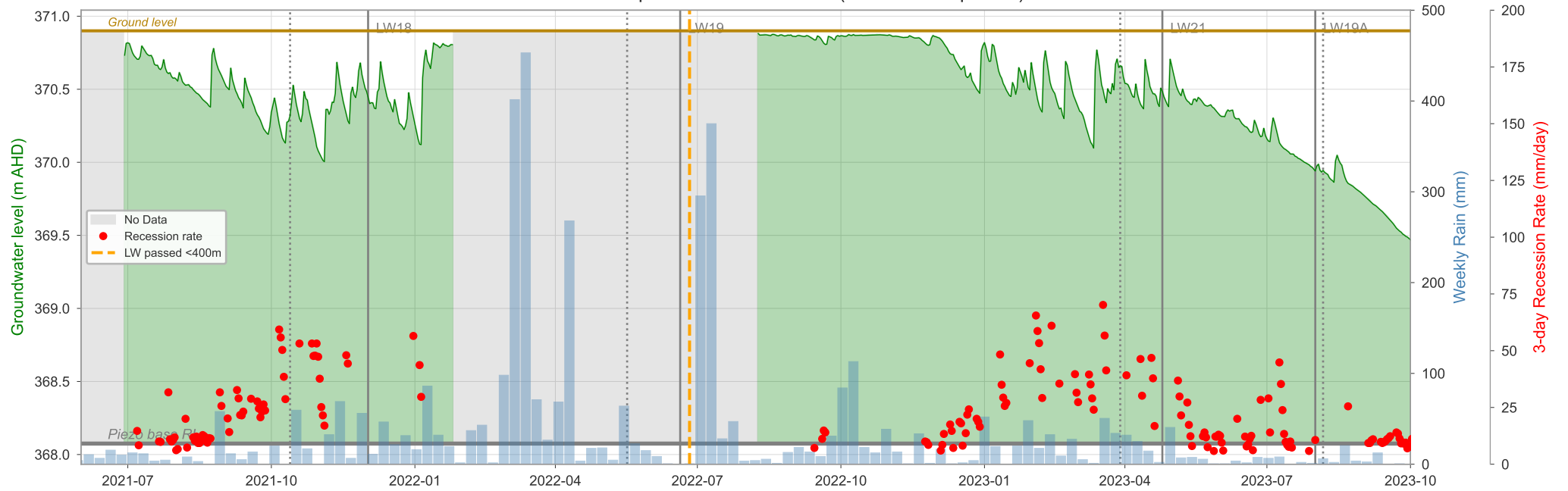
Dendrobium Swamp 15A: Piezometer 07 (Outside swamp EEC)



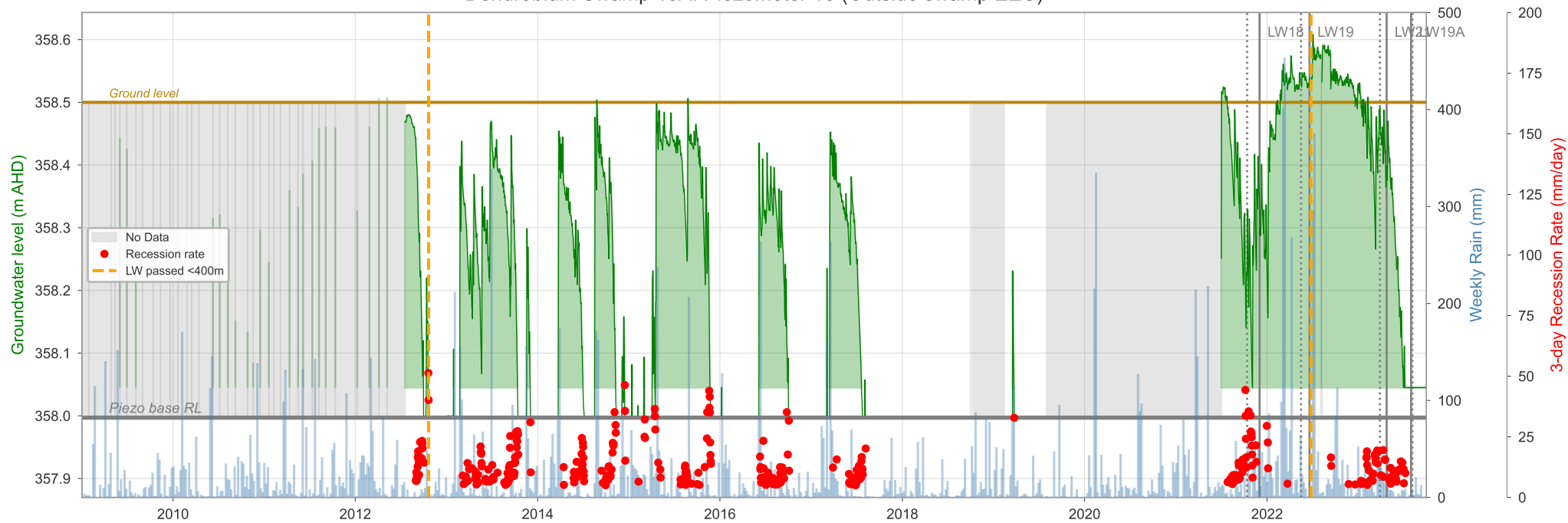
Dendrobium Swamp 15A: Piezometer 12 (Outside swamp EEC)



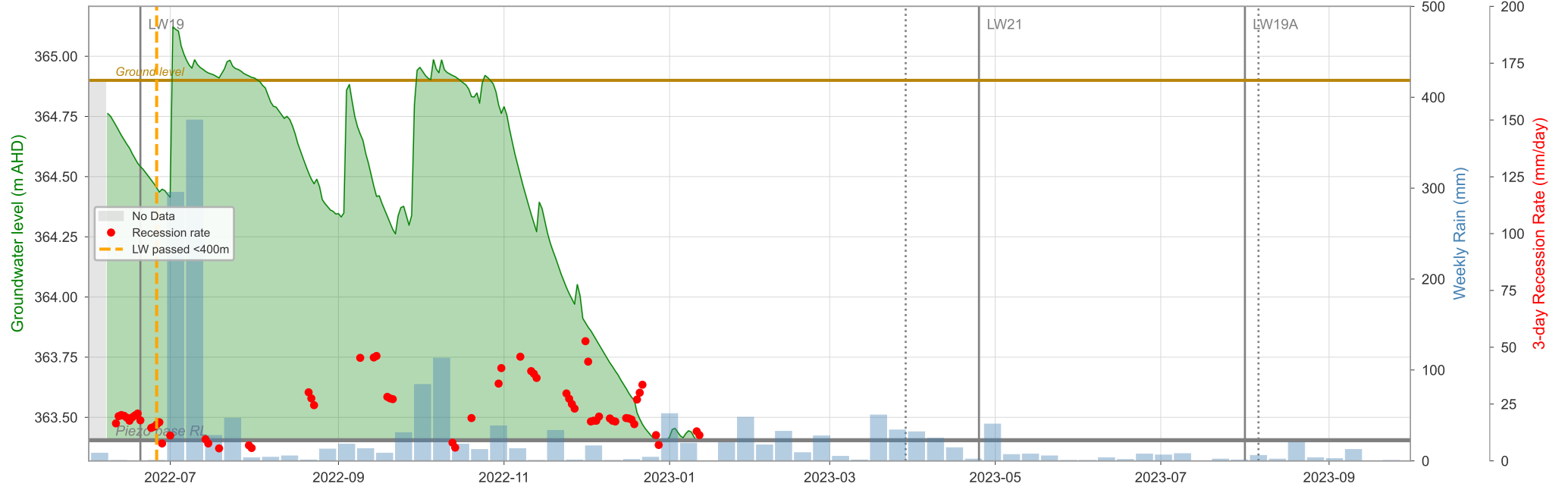
Dendrobium Swamp 15A: Piezometer 15 (Within swamp EEC)



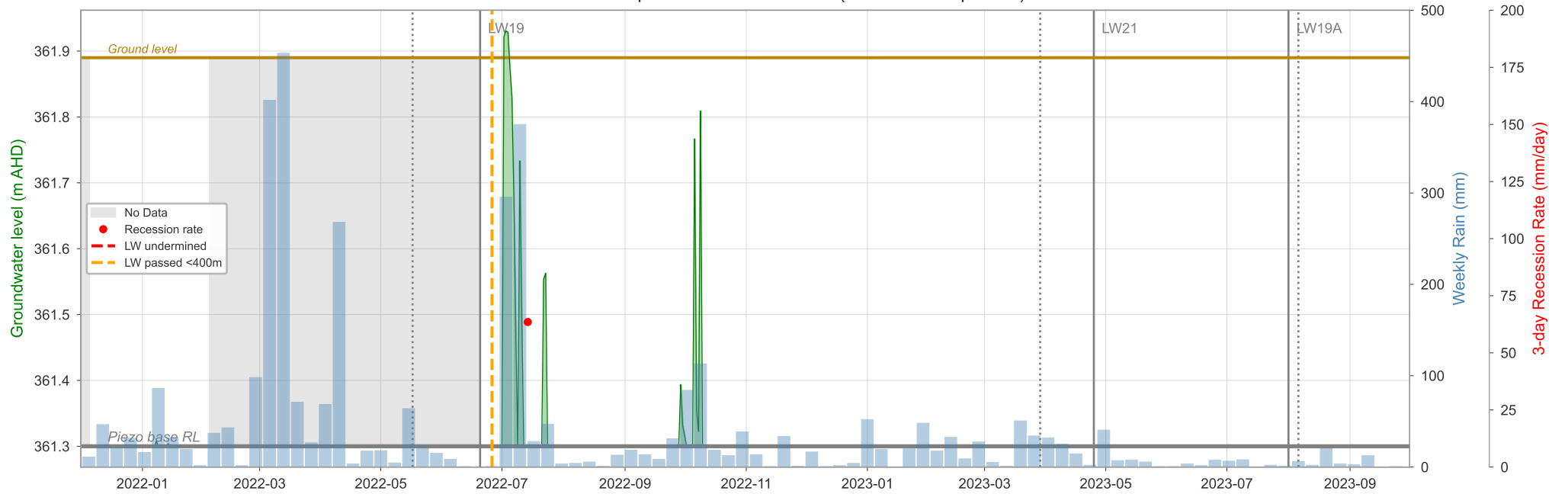
Dendrobium Swamp 15A: Piezometer 18 (Outside swamp EEC)



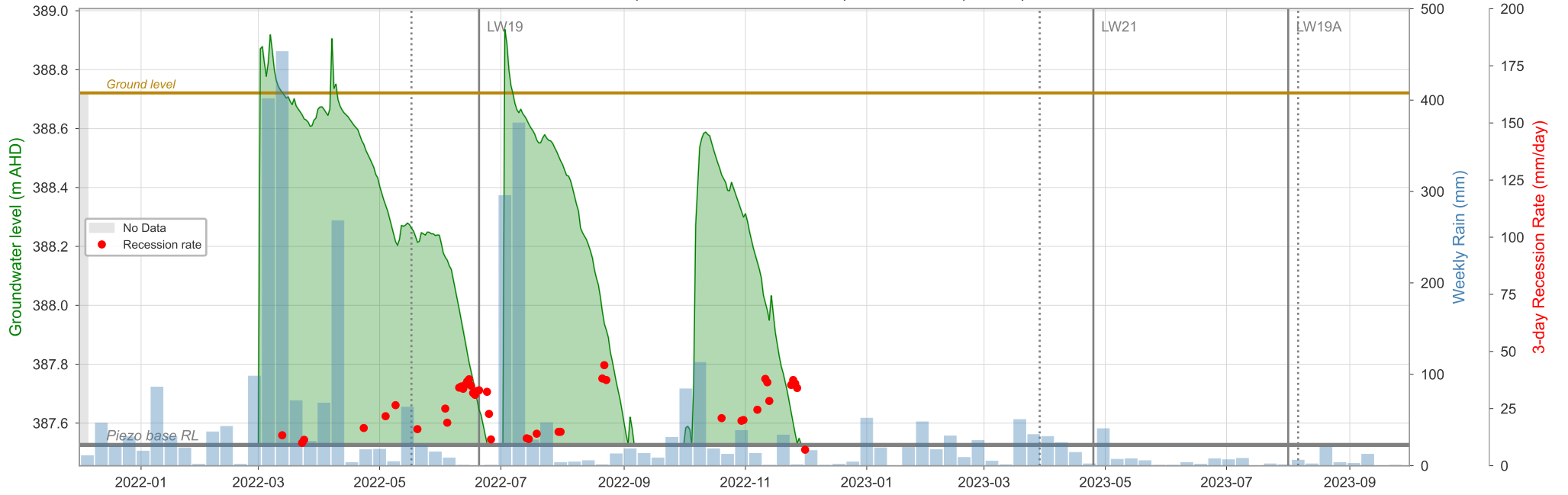
Dendrobium Swamp 15A: Piezometer 19 (Within swamp EEC)



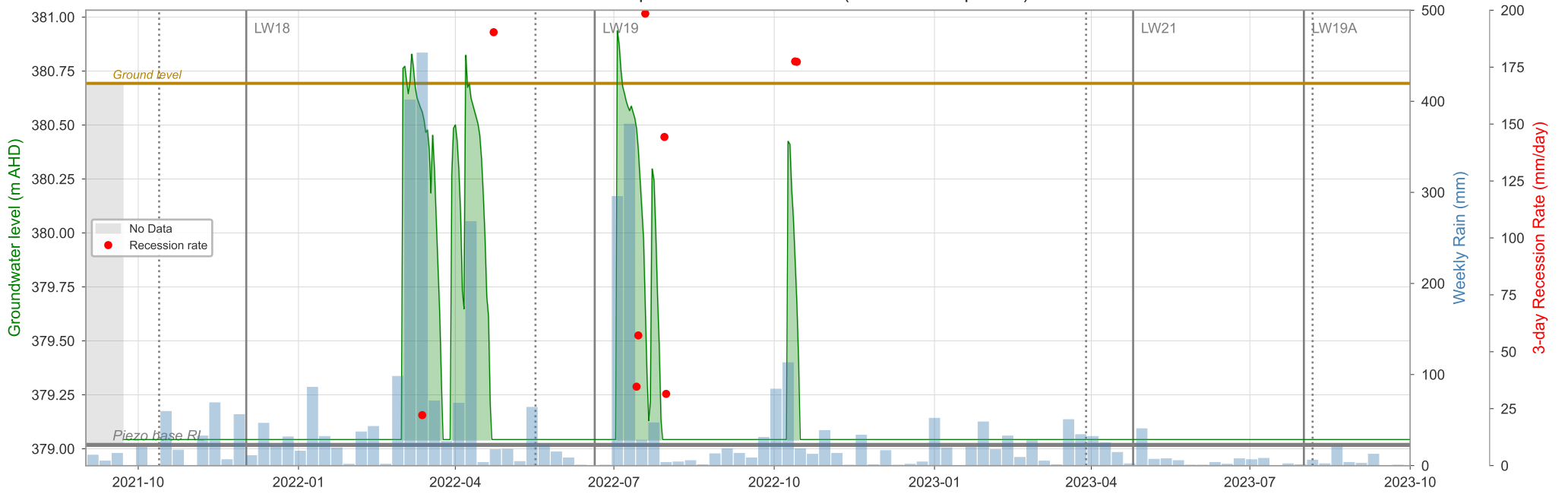
Dendrobium Swamp 15B: Piezometer 39 (Within swamp EEC)



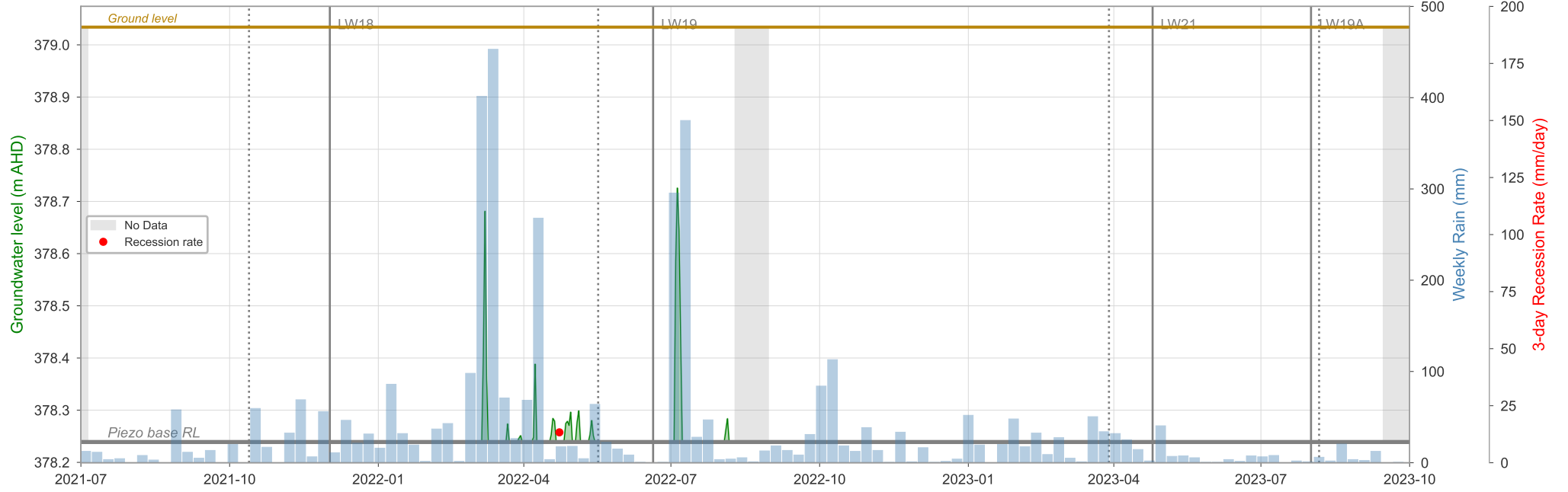
Dendrobium Swamp 15B: Piezometer H1 (Within swamp EEC)



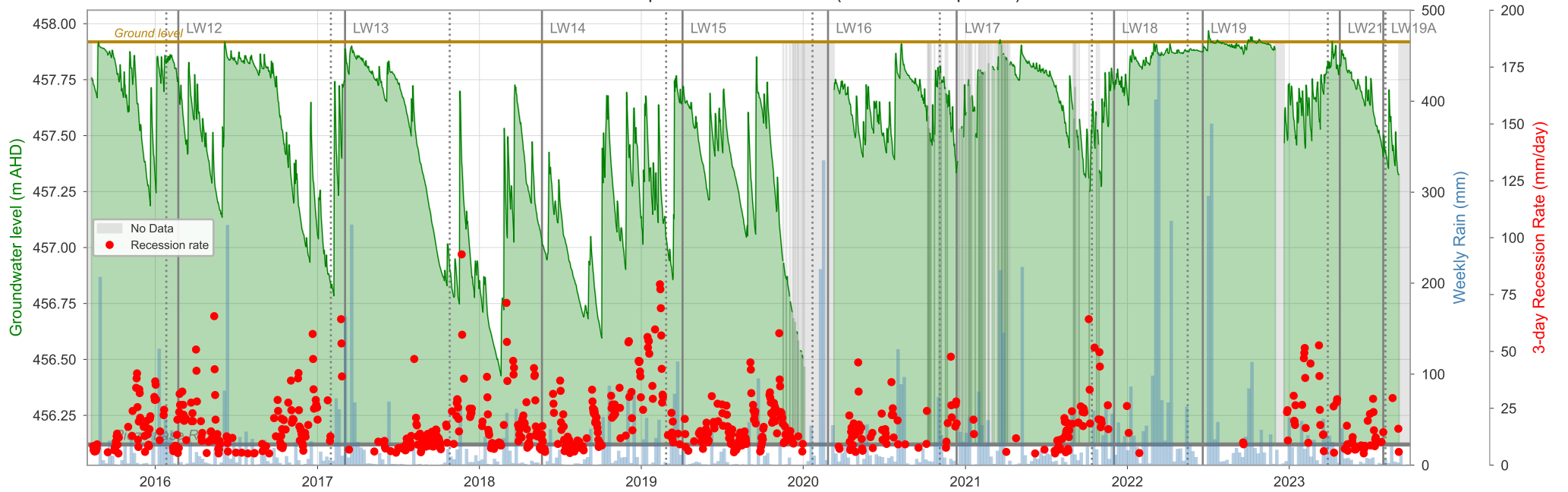
Dendrobium Swamp 15B: Piezometer H2 (Within swamp EEC)



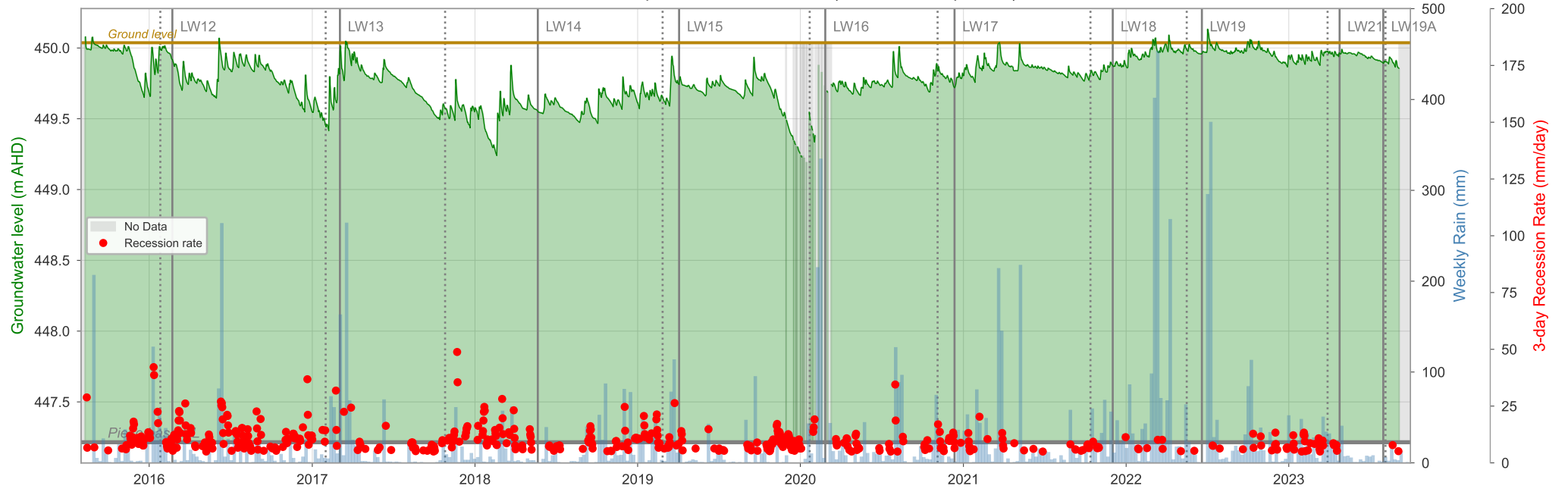
Dendrobium Swamp 15B: Piezometer H3 (Within swamp EEC)



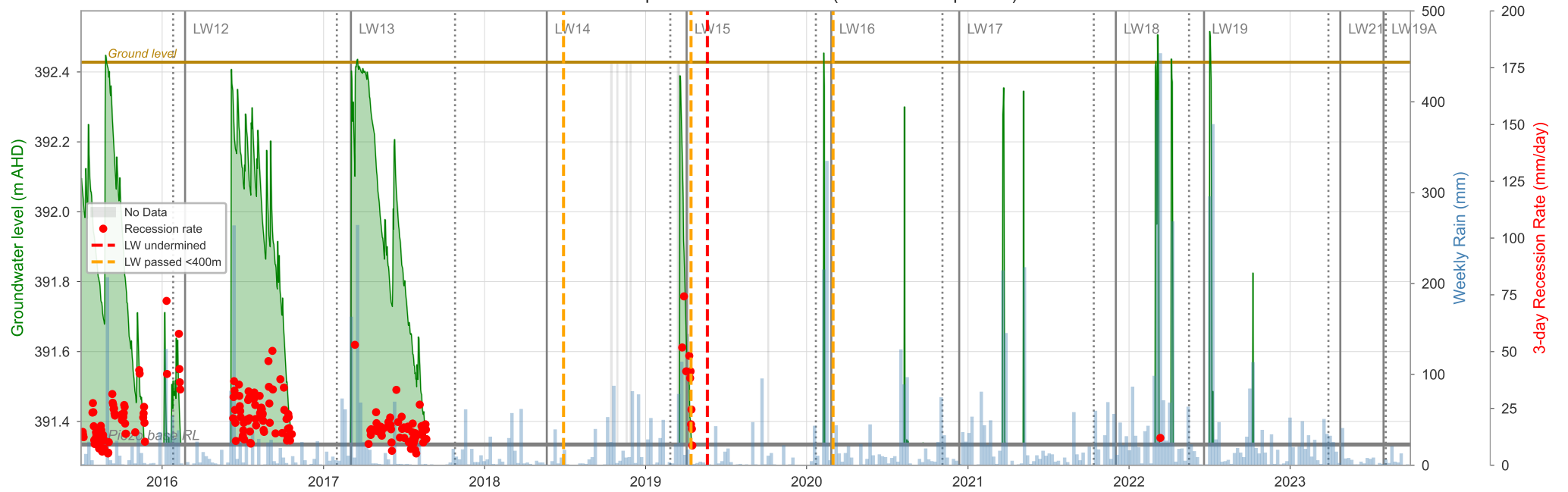
Dendrobium Swamp 22: Piezometer 01 (Within swamp EEC)



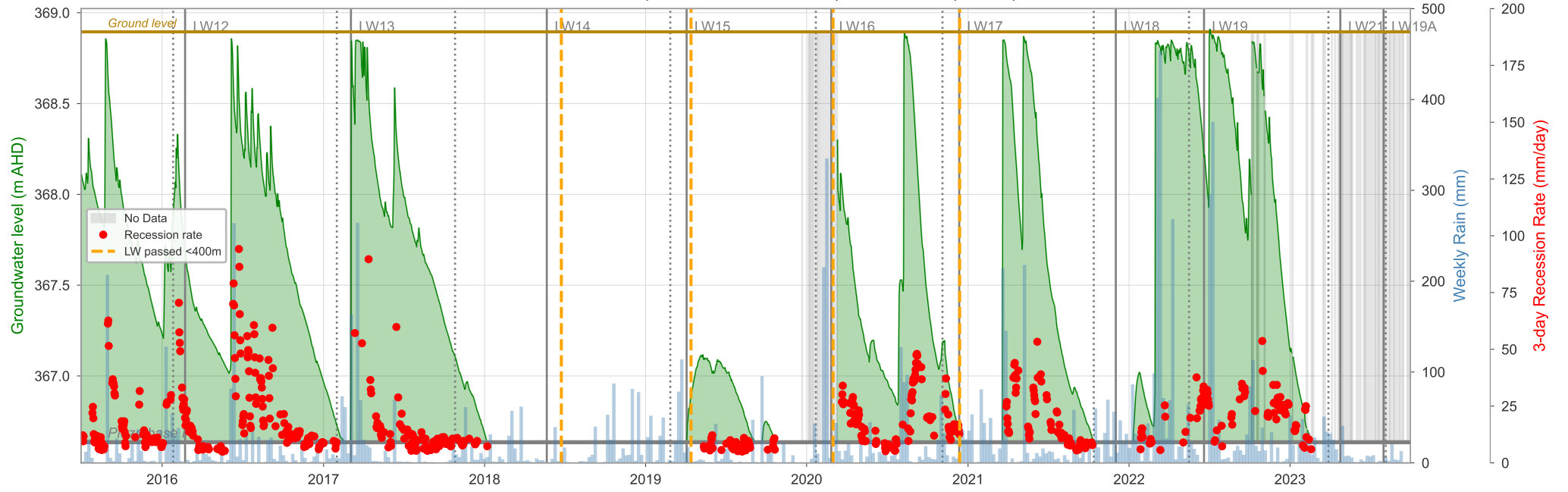
Dendrobium Swamp 22: Piezometer 02 (Within swamp EEC)



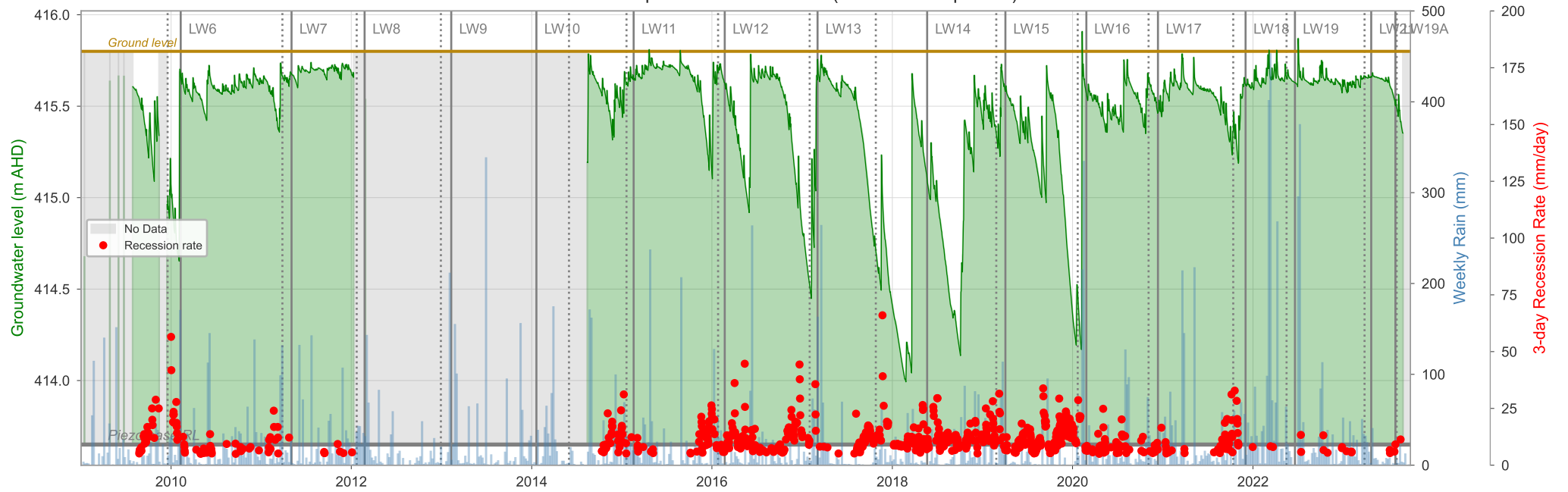
Dendrobium Swamp 23: Piezometer 01 (Within swamp EEC)



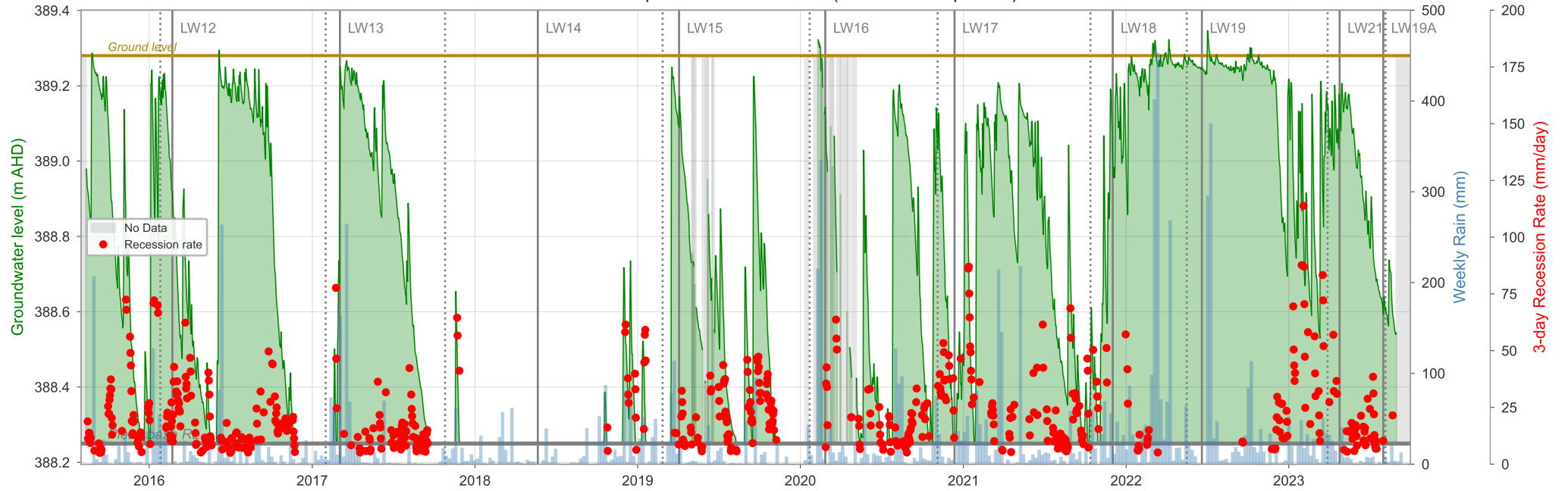
Dendrobium Swamp 23: Piezometer 02 (Within swamp EEC)



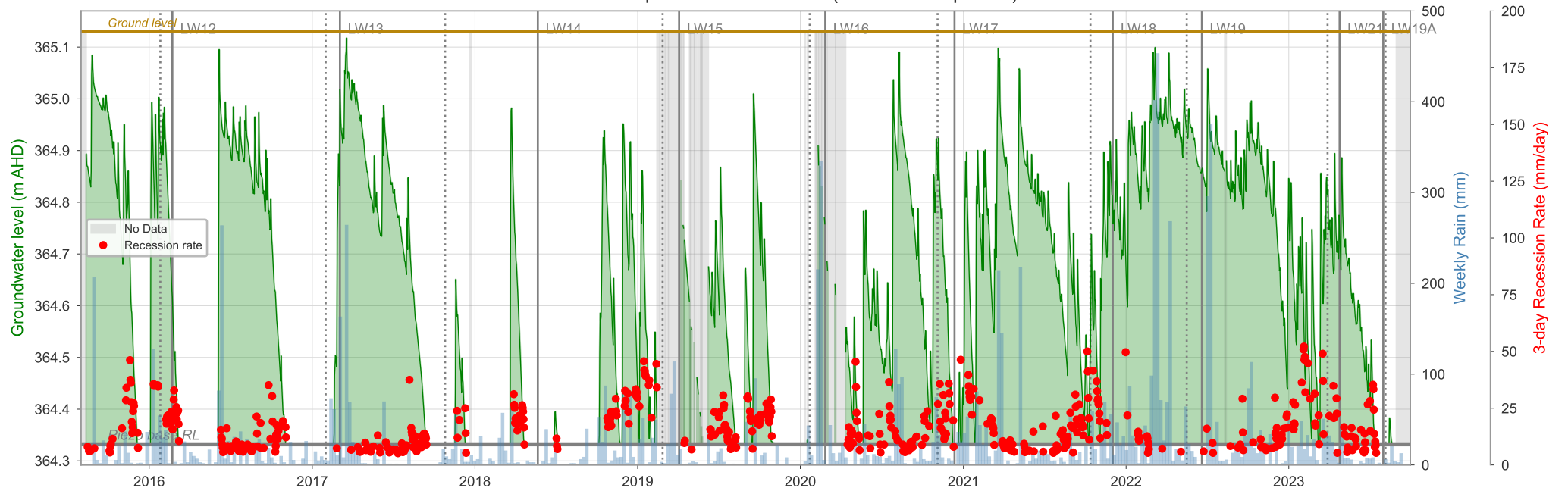
Dendrobium Swamp 25: Piezometer 01 (Within swamp EEC)



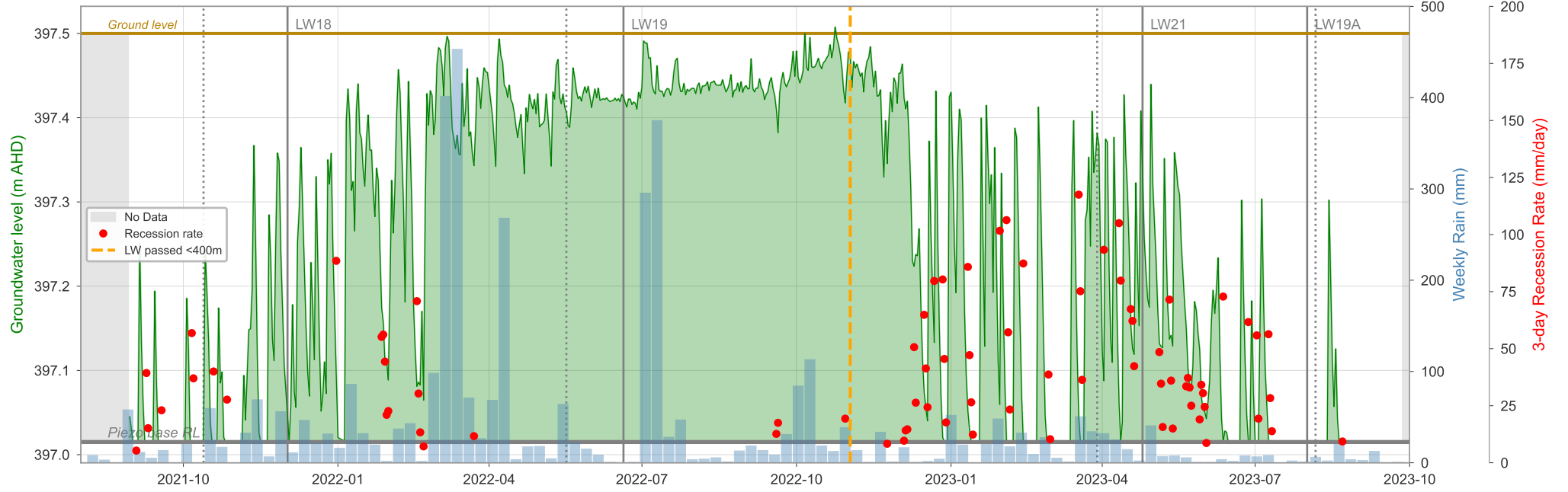
Dendrobium Swamp 33: Piezometer 01 (Within swamp EEC)



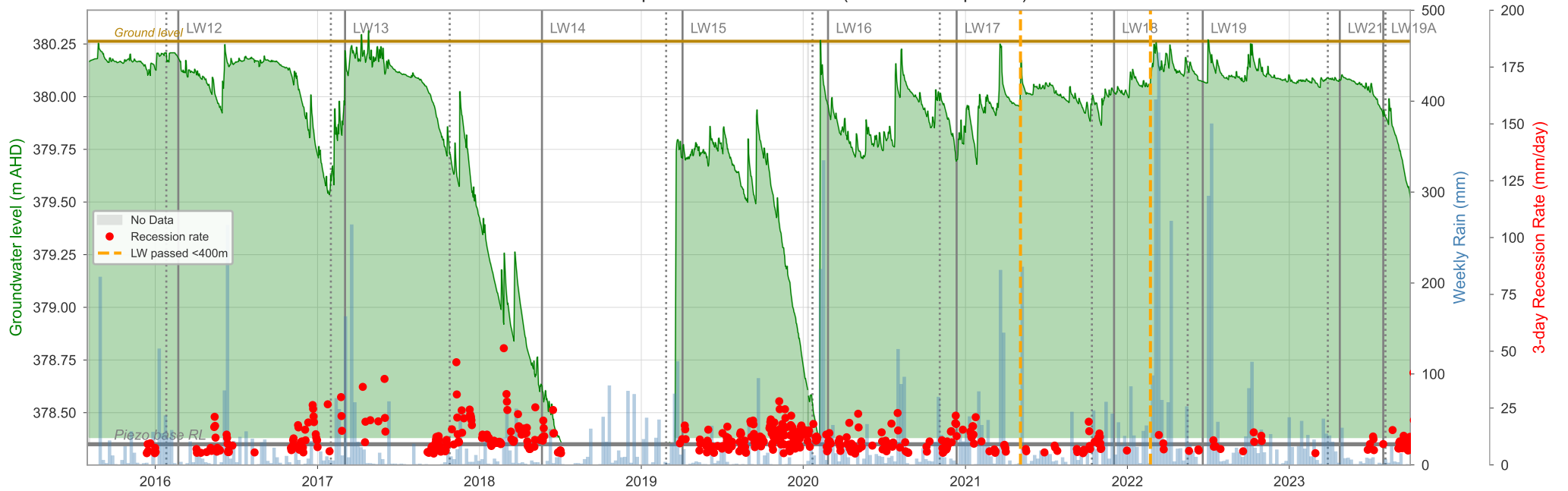
Dendrobium Swamp 33: Piezometer 03 (Within swamp EEC)



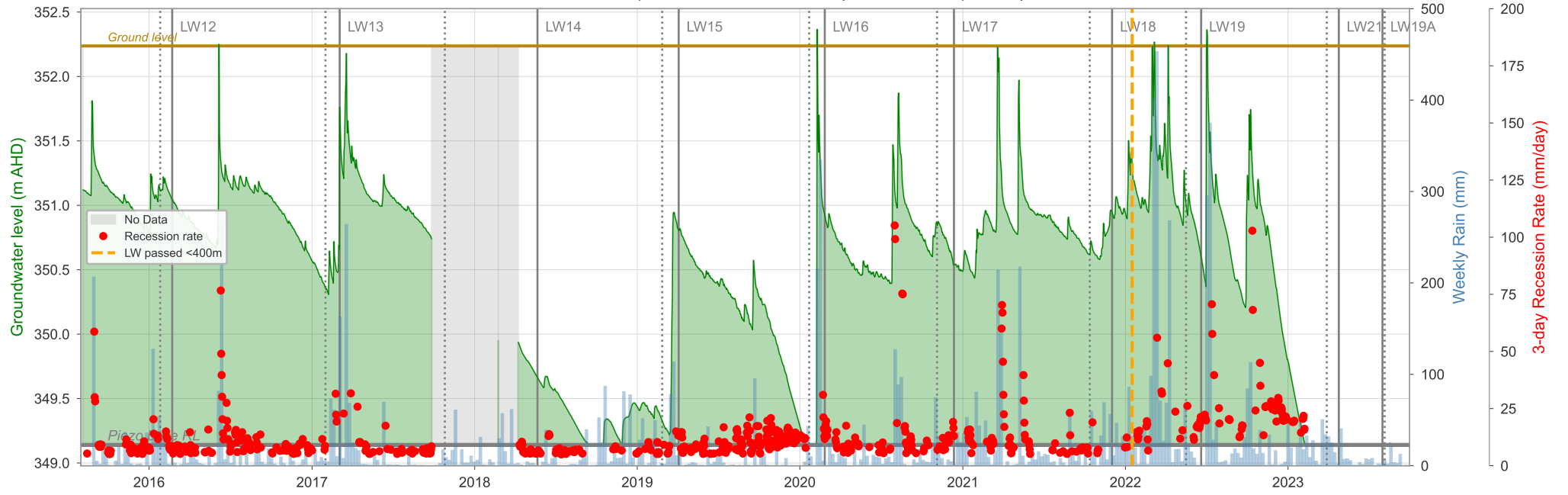
Dendrobium Swamp 34: Piezometer 01 (Within swamp EEC)



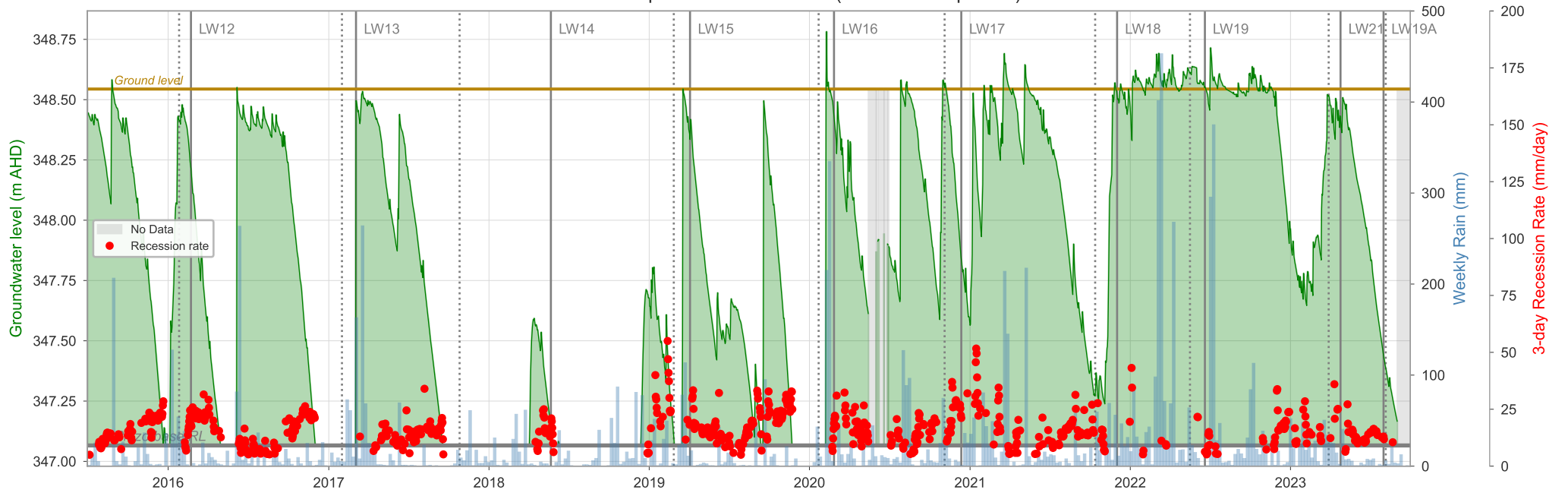
Dendrobium Swamp 35A: Piezometer 01 (Within swamp EEC)



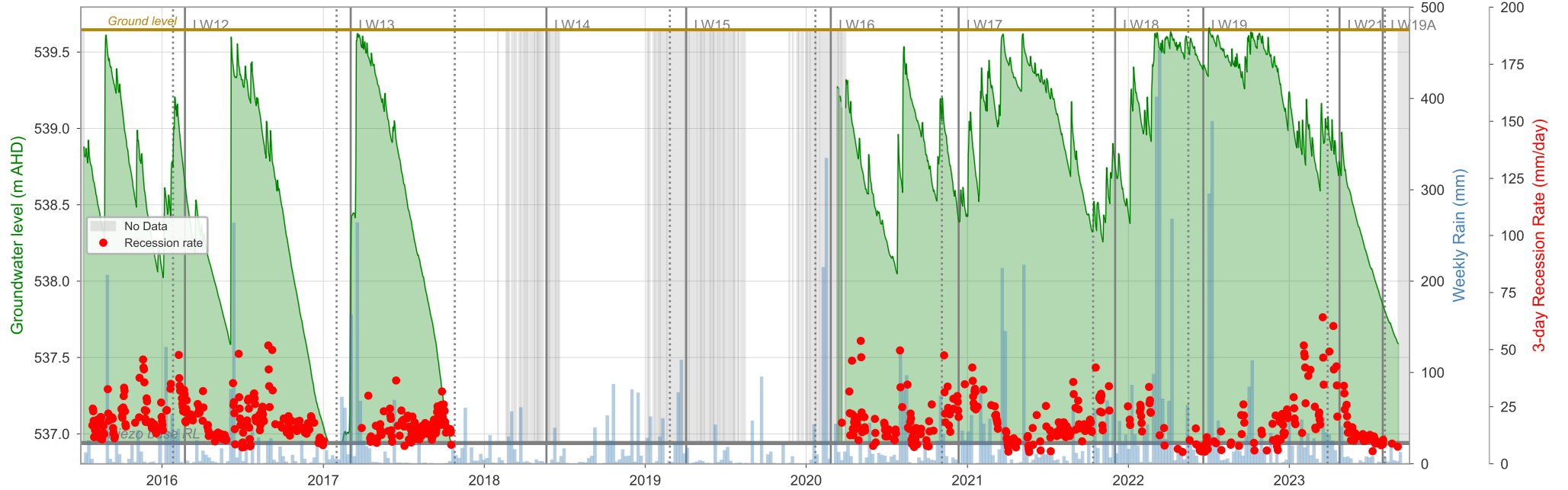
Dendrobium Swamp 35B: Piezometer 01 (Within swamp EEC)



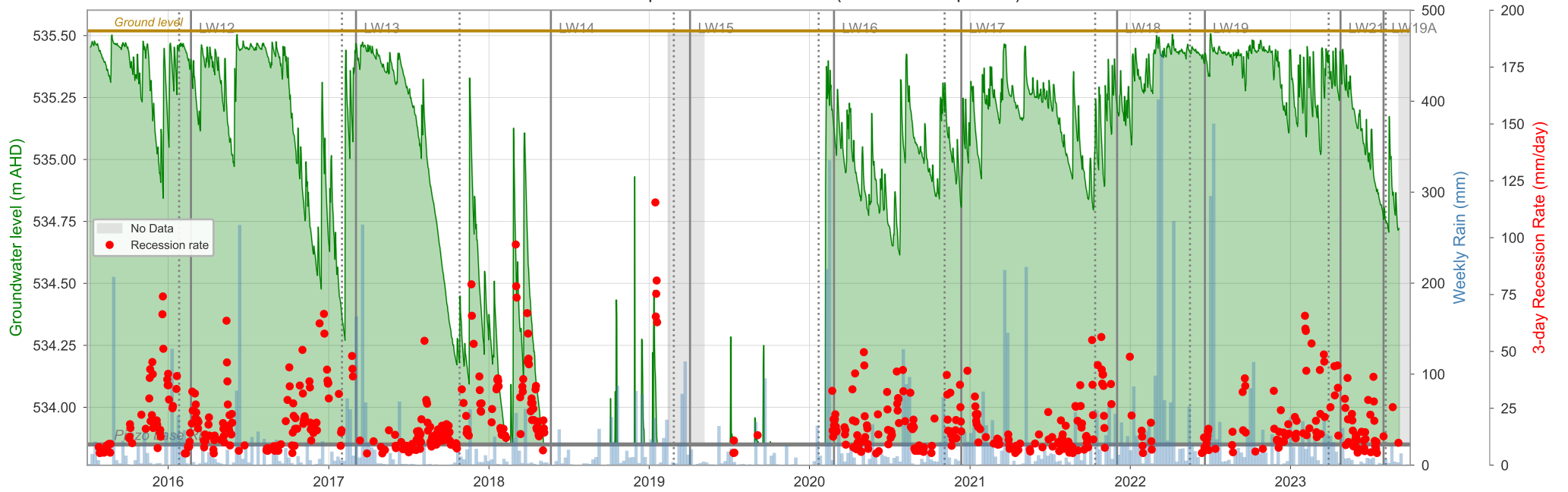
Dendrobium Swamp 84: Piezometer 01 (Within swamp EEC)



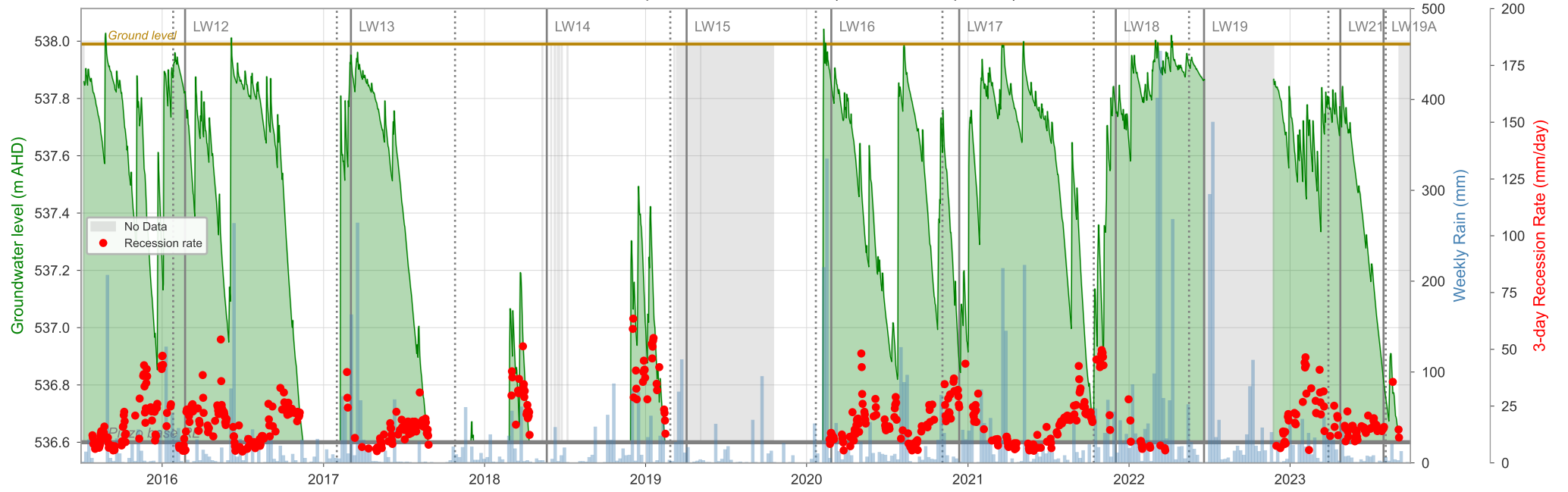
Dendrobium Swamp 87: Piezometer 01 (Within swamp EEC)



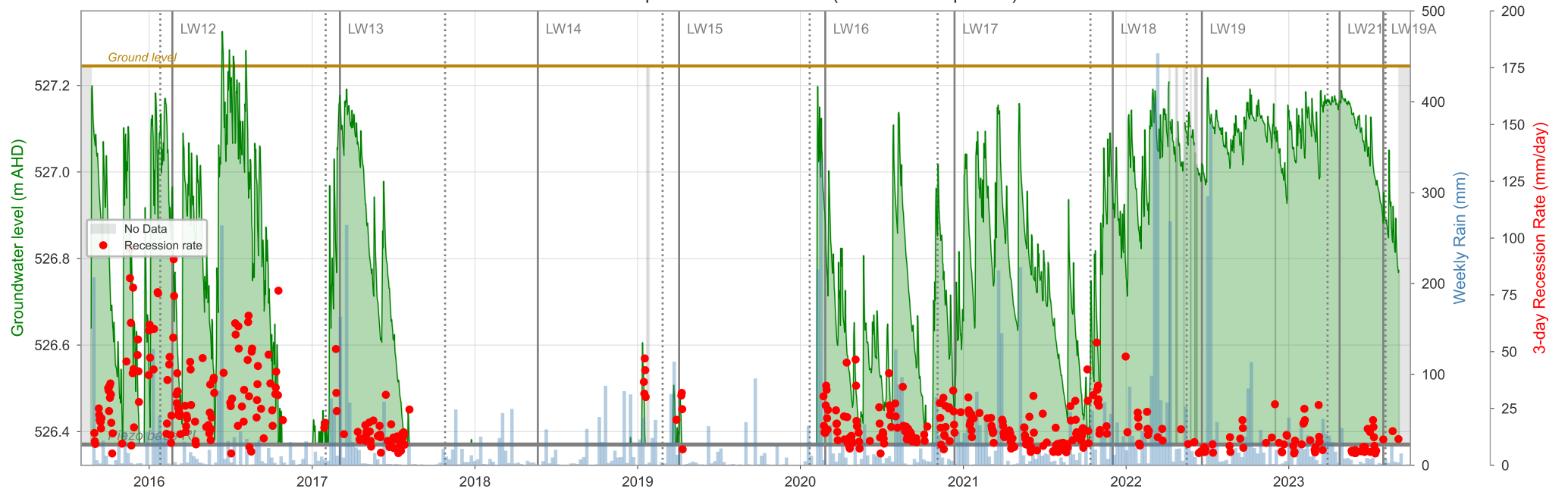
Dendrobium Swamp 87: Piezometer 02 (Within swamp EEC)



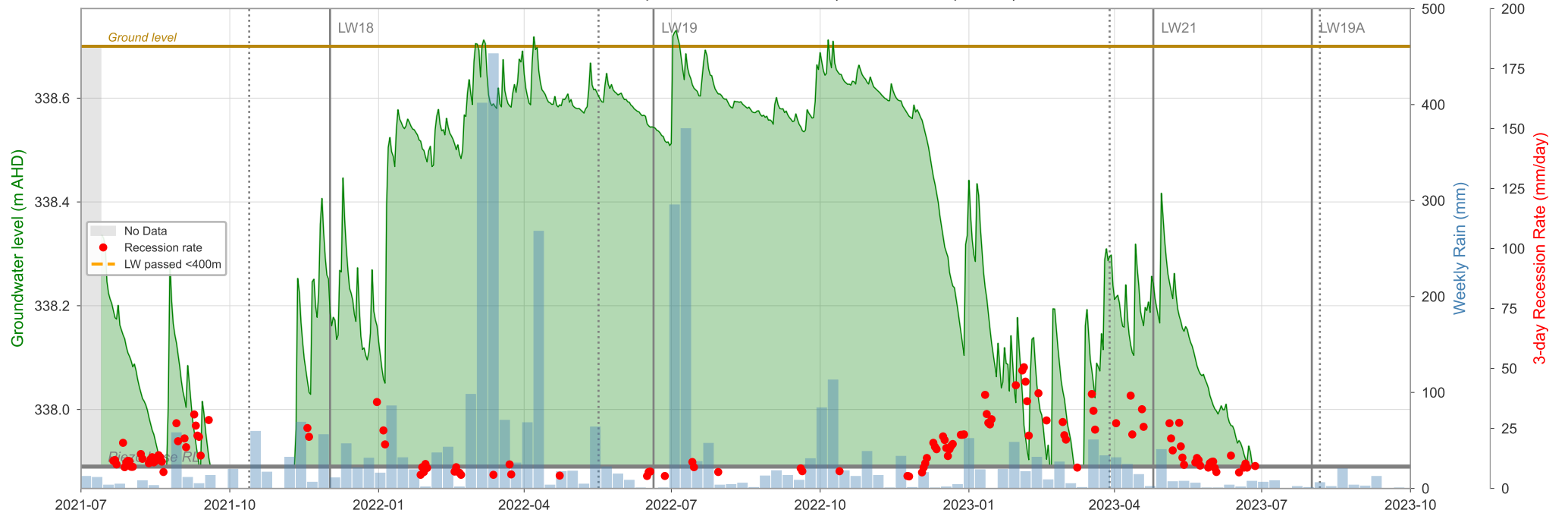
Dendrobium Swamp 88: Piezometer 01 (Within swamp EEC)



Dendrobium Swamp 88: Piezometer 02 (Within swamp EEC)

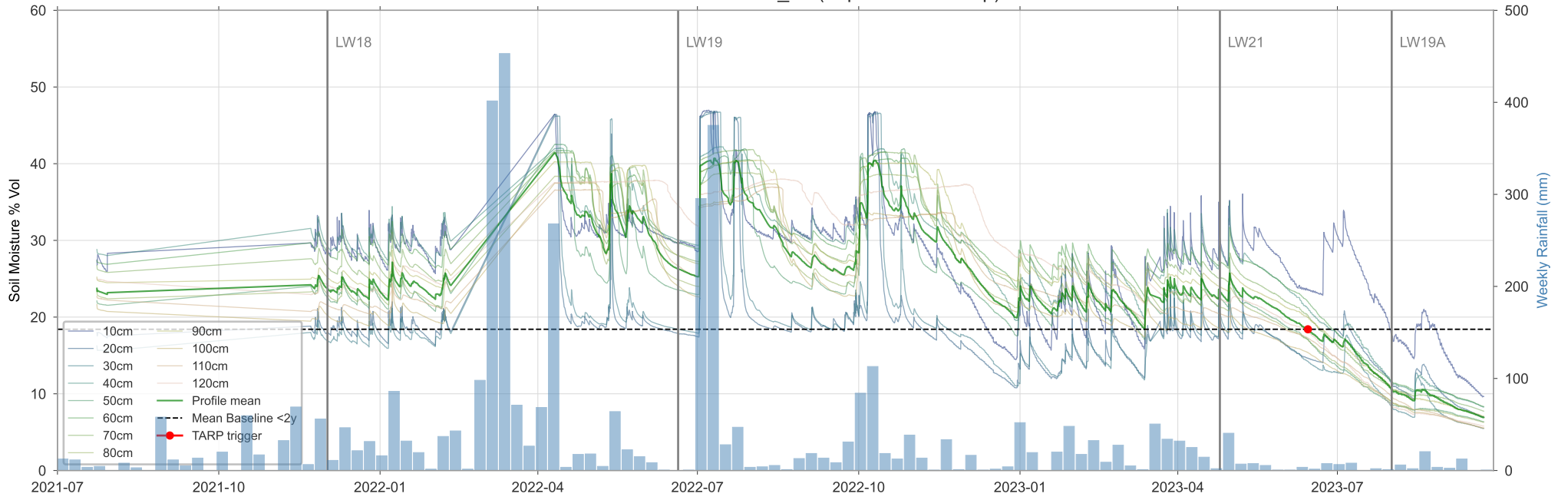


Dendrobium Swamp 95: Piezometer 01 (Within swamp EEC)

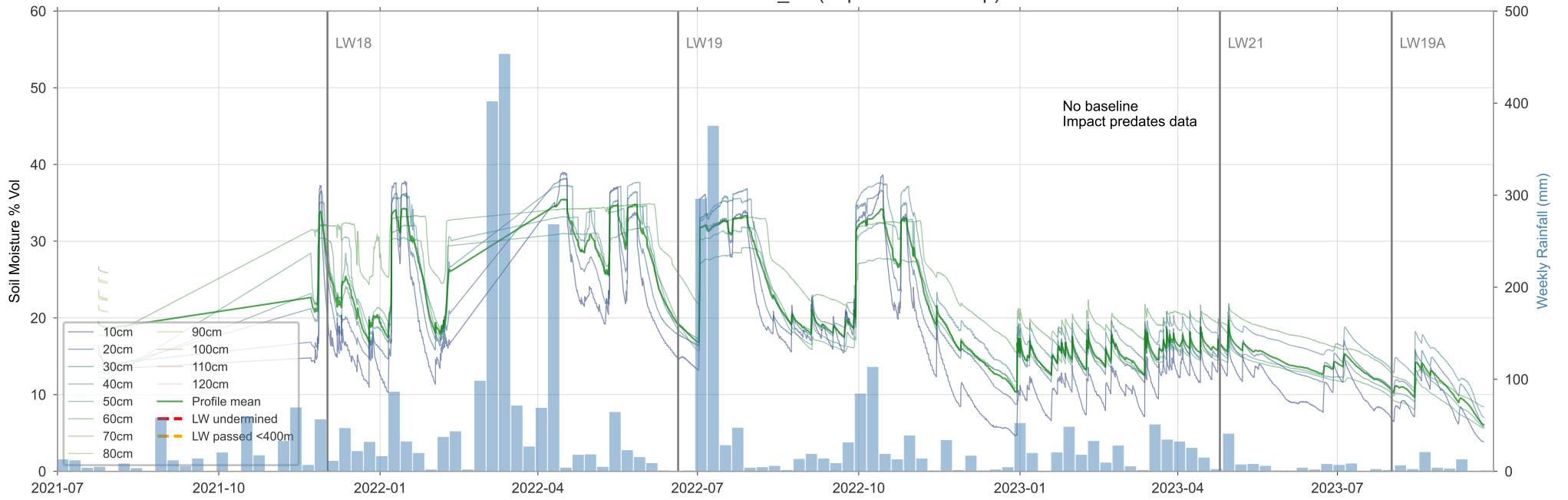


Appendix E: Soil moisture hydrographs

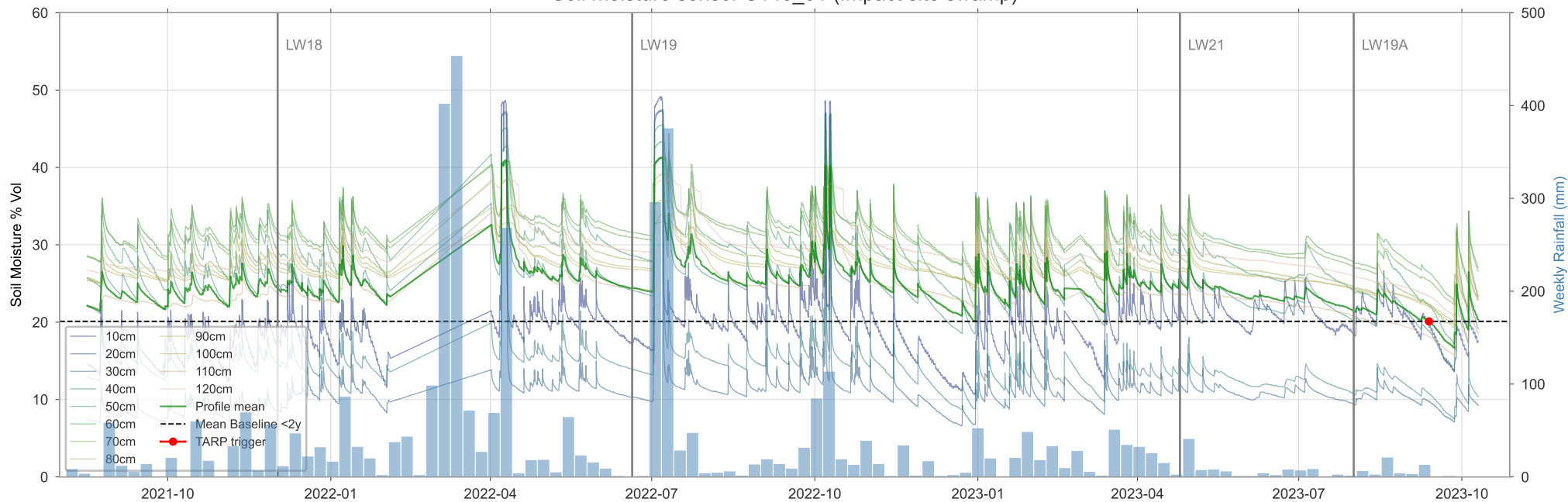
Soil moisture sensor S12_01 (Impact site swamp)



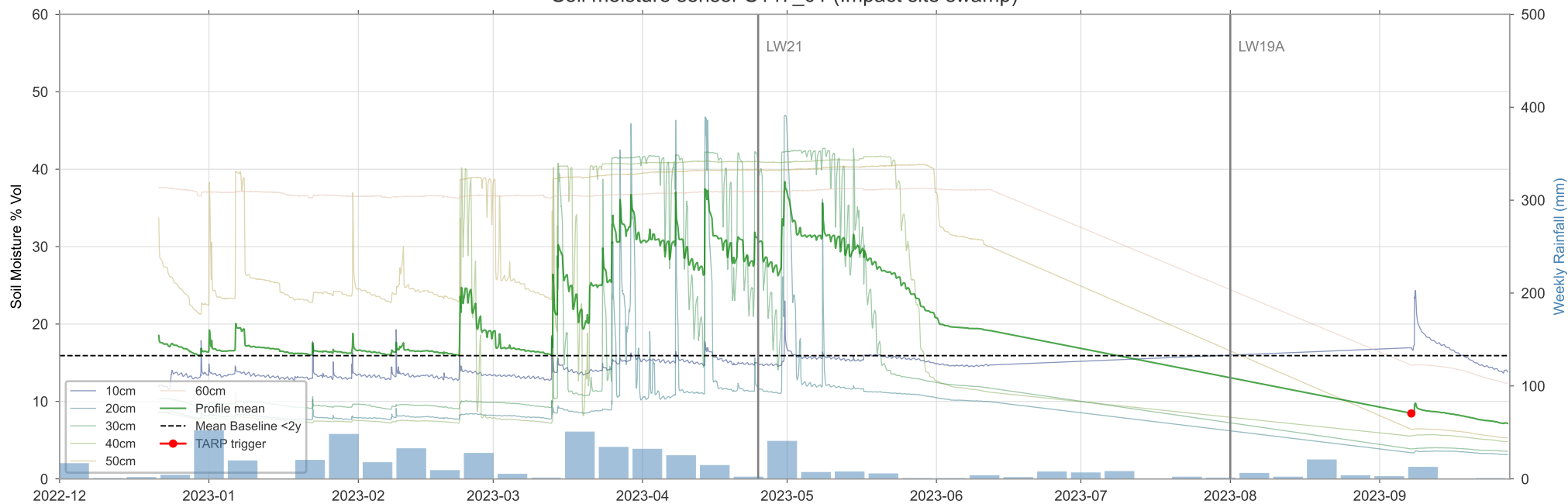
Soil moisture sensor S12_04 (Impact site swamp)



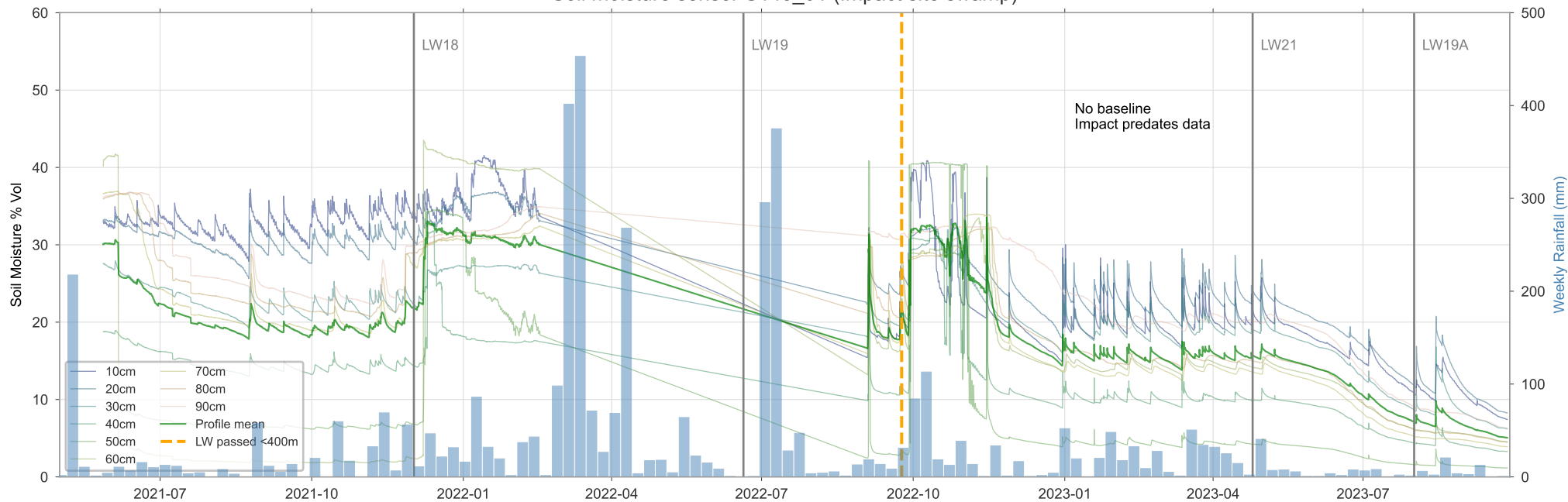
Soil moisture sensor S146_01 (Impact site swamp)



Soil moisture sensor S147_01 (Impact site swamp)



Soil moisture sensor S148_01 (Impact site swamp)



Soil moisture sensor S15a_03 (Impact site swamp)

