water

Supplementary Materials: Article

Modelling the Effects of Changes in Forest Cover and Climate on Hydrology of Headwater Catchments in South-Central Chile

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Table S1. Additional supporting information of the climate scenarios.

Table S1. Summary of hydroclimatic scenarios with selected increments of precipitation and potential evapotranspiration used on modelling exercises (± for reference standard deviation is also shown).

	Hydrological year		No increment	−20%	−10%	+10%	+20%
Precipitation (mm/yr)	2008–2009	1420	1136	1278	1563	1705	
	2009–2010	1421	1137	1279	1564	1706	
	2010−2011	867	693	780	954	1040	
	2011−2012	1140	912	1026	1254	1368	
	2012−2013	1085	869	978	1195	1303	
	2013−2014	955	763	859	1049	1145	
	2014−2015	1255	1004	1129	1380	1506	
Mean temperature (°C)	2008−2009	14.5	-	-	-	-	
	2009−2010	13.5	-	-	-	-	
	2010−2011	13.8	-	-	-	-	
	2011−2012	14.2	-	-	-	-	
	2012−2013	14.4	-	-	-	-	
	2013−2014	13.6	-	-	-	-	
	2014−2015	11.5	-	-	-	-	
Potential evapotranspiration (mm/yr)	2008−2009	1065	852	958	1171	1278	
	2009−2010	966	773	870	1063	1159	
	2010−2011	1015	812	913	1116	1216	
	2011−2012	1070	855	962	1176	1283	
	2012−2013	1134	906	1019	1246	1359	
	2013−2014	1234	988	1112	1359	1483	
	2014−2015	1081	865	973	1189	1297	

10 **Table S2. Additional supporting information of the data grouping.**

11 **Table S2.** Modelling results for each of the studied catchments together with forest management and
12 physiographic information.

	Group 1	Group 2		Group 3			Group 4	
	N2	N3	N4	N5	N7	N8	N9	N11
Dominant tree species	*Pinus radiata*	*Eucalyptus spp.*						
Catchment area (ha)	14	7.1	7.6	14	17	55	98	414
Catchment slope (m/m)	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.4
Plantation (% of catchment area)	93	75	87	77	87	83	56	66
Biomass volume (m^3/ha)	295	302	321	152	179	151	171	164
Plantation density (tree/ha)	315	369	342	1160	1174	567	1320	1246

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14 **Table S3. Additional supporting information of the annual runoff and annual runoff coefficient**

15 **Table S3.** Characterization of catchments hydrology.

	Hydrological year	N2	N3	N4	N5	N7	N8	N9	N11
Runoff (mm/yr)	2008−2009	609	555	504	206	172	323	194	743
	2009−2010	350	423	357	675	151	282	574	518
	2010−2011	248	422	488	390	139	251	468	384
	2011−2012	213	366	380	229	144	211	297	213
	2012−2013	161	267	178	166	147	185	279	160
	2013−2014	113	182	118	105	132	203	360	136
	2014−2015	211	307	245	191	296	349	496	285
	Mean	272	360	324	423	169	258	381	349
Runoff coefficient	2008−2009	0.4	0.3	0.3	0.8	0.1	0.2	0.1	0.5
	2009−2010	0.2	0.3	0.2	0.4	0.1	0.2	0.4	0.3
	2010−2011	0.2	0.6	0.6	0.4	0.1	0.2	0.5	0.4
	2011−2012	0.1	0.3	0.3	0.2	0.1	0.1	0.2	0.1
	2012−2013	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1
	2013−2014	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.1
	2014−2015	0.1	0.2	0.2	0.1	0.2	0.2	0.4	0.2
	Mean	0.2	0.3	0.2	0.3	0.1	0.2	0.3	0.2
Daily maximum runoff (mm/d)	2008−2009	21	34	19	40	6	7	2	34
	2009−2010	8	31	22	14	3	3	8	10
	2010−2011	27	23	31	28	8	11	30	27
	2011−2012	13	35	16	4	3	3	13	7
	2012−2013	13	16	14	6	3	8	4	7
	2013−2014	6	6	13	3	3	7	4	3
	2014−2015	8	18	11	8	12	11	9	9
	Mean	14	23	18	15	5	7	10	14
Daily minimum runoff (mm/d)	2008−2009	0.1	0.1	0.02	0.2	0.09	0.09	0.4	0.1
	2009−2010	0.1	0.2	0.07	0.5	0.1	0.2	0.5	0.5
	2010−2011	0.07	0.4	0.1	0.3	0.1	0.2	0.4	0.2
	2011−2012	0.1	0.3	0.04	0.2	0.1	0.1	0.3	0.08
	2012−2013	0.04	0.2	0.02	0.09	0.1	0.1	0.4	0.06
	2013−2014	0.00	0.1	0.02	0.03	0.04	0.1	0.4	0.02
	2014−2015	0.02	0.00	0.02	0.1	0.1	0.1	0.4	0.1
	Mean	0.07	0.2	0.05	0.2	0.1	0.1	0.4	0.1

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Table S4. Additional supporting information of the observed (Q_o) and simulated (Q_s) runoff yield under land use scenarios (% of change) for the two calibration procedures

Table S4. Observed (Q_o) and simulated (Q_s) runoff yield under land use scenarios (% of change) for the two calibration procedures.

			Whole-time series calibration						Dry season calibration					
			Current cover	Partial harvest	Native forest	(Qo ~ Qs current cover)	(Qo ~ Qs partial harvest)	(Qo ~ Qs native forest)	Current cover	Partial harvest	Native forest	(Qo ~ Qs Current cover)	(Qo ~ Qs partial harvest)	(Qo ~ Qs native forest)
	Runoff Yield	Qo (mm)	Qs (mm)	Qs (mm)	Qs (mm)	(%)	(%)	(%)	Qs (mm)	Qs (mm)	Qs (mm)	(%)	(%)	(%)
N2	Total	1904	1438	1812	1449	−24	−5	−24	1896	3201	1933	0	+68	+2
	2008−2009	608	363	455	365	−40	−25	−40	543	708	551	−11	+17	−9
	2009−2010	349	266	324	269	−24	−7	−23	380	567	386	+9	+63	+11
	2010−2011	248	109	128	109	−56	−48	−56	108	260	110	−56	+5	−56
	2011−2012	212	155	192	157	−27	−9	−26	200	399	207	−5	+89	−2
	2012−2013	163	171	232	173	+5	+43	+6	185	399	190	+13	+145	+17
	2013−2014	114	141	181	143	+24	+59	+26	132	315	135	+16	+177	+18
	2014−2015	212	232	299	233	+10	+41	+10	348	553	354	+64	+161	+67
	Standard D.	165	88	110	88				158	158	160			
	Mean	272	205	259	207				271	457	276			
N3	Total	2753	2983	3018	2997	+8	+10	+9	4064	4934	4098	+48	+79	+49
	2008−2009	607	670	674	672	+10	+11	+11	868	985	871	+43	+62	+44
	2009−2010	461	533	538	535	+16	+17	+16	740	856	745	+61	+86	+62
	2010−2011	460	233	238	236	−49	−48	−49	420	518	424	−9	+13	−8
	2011−2012	401	341	349	344	−15	−13	−14	485	611	490	+21	+52	+22
	2012−2013	290	393	398	395	+35	+37	+36	492	640	499	+69	+120	+72
	2013−2014	200	321	328	324	+60	+64	+62	415	542	421	107	+171	+110
	2014−2015	334	492	493	493	+47	+47	+47	644	782	648	++93	+134	+94
	Standard D.	133	148	147	148				174	174	173			

	Mean	393	426	431	428				581	705	585			
N4	Total	2351	1851	2548	1900	−21	+8	−19	3064	4597	3102	+30	+96	+32
	2008−2009	511	448	580	455	−12	+13	−11	745	933	748	46	+82	+46
	2009−2010	361	332	458	340	−8	+27	−6	598	805	601	+66	+123	+66
	2010−2011	548	147	196	151	−73	−64	−72	264	452	274	−52	−18	−50
	2011−2012	385	224	302	234	−42	−22	−39	362	592	368	−6	54	−4
	2012−2013	180	202	318	212	+12	+77	+17	328	582	333	82	+223	+84
	2013−2014	118	189	262	194	+61	+123	+65	251	479	258	+114	+308	+119
	2014−2015	247	308	432	314	+25	+75	+27	515	753	519	+109	+205	+111
	Standard D.	163	104	132	105				187	178	185			
	Mean	336	264	364	271				438	657	443			
N5	Total	3096	3102	3986	2213	0	+29	−29	2104	2779	2104	−32	−10	−32
	2008−2009	1260	772	885	675	−39	−30	−46	523	630	523	−59	−50	−59
	2009−2010	704	582	722	445	−17	+2	−37	417	516	417	−41	−27	−41
	2010−2011	408	218	317	102	−46	−22	−75	175	248	175	−57	−39	−57
	2011−2012	240	374	520	244	+56	+117	+2	231	327	231	−4	+37	−4
	2012−2013	174	342	469	200	+97	+170	+15	231	326	231	+33	+88	+33
	2013−2014	110	247	362	120	+124	+228	+9	171	262	171	+55	+138	+55
	2014−2015	200	567	711	426	+184	+256	+113	355	468	355	+78	+134	+78
	Standard D.	413	203	209	208				134	144	134			
	Mean	442	443	569	316				301	397	301			
N7	Total	1414	984	984	984	−30	−30	−30	2770	3764	2815	+96	+166	+99
	2008−2009	206	133	133	133	−35	−35	−35	374	450	378	+82	+119	+84
	2009−2010	182	206	206	206	+14	+14	+14	594	730	600	+227	+302	+230
	2010−2011	167	67	67	67	−60	−60	−60	264	390	270	+58	+134	+62
	2011−2012	173	96	96	96	−45	−45	−45	344	510	353	+99	+195	+104
	2012−2013	176	174	173	174	−1	−1	−1	372	552	380	+112	+214	+116
	2013−2014	157	113	113	113	−28	−28	−28	296	446	303	+88	+183	+92

	2014−2015	354	196	196	196	−45	−45	−45	525	685	533	+48	+93	+50
	Standard D.	69	53	53	53				121	128	120			
	Mean	202	141	141	141				396	538	402			
N8	Total	5771	6845	6462	6847	+19	+12	+19	11870	14546	11908	+106	+152	+106
	2008−2009	1037	1584	1586	1586	+53	+53	+53	2784	3058	2789	+168	+195	+169
	2009−2010	594	947	1159	947	+59	+95	+59	1385	2572	1390	+133	+333	+134
	2010−2011	652	670	521	671	+3	−20	3	1074	1261	1081	+65	+93	+66
	2011−2012	1121	1052	619	1052	−6	−45	−6	2080	1835	2085	+86	+64	+86
	2012−2013	594	875	860	875	+47	+45	+47	1391	1840	1396	+134	+210	+135
	2013−2014	652	668	668	668	+2	+2	+3	1078	1480	1084	+65	+127	+66
	2014−2015	1120	1049	1048	1048	−6	−6	−6	2077	2500	2082	+85	+123	+86
	Standard D.	254	311	373	311				637	648	637			
	Mean	824	978	923	978				1696	2078	1701			
N9	Total	2601	2564	2715	2646	−1	4	2	3449	3917	3476	+33	+51	+34
	2008−2009	190	62	65	64	−67	−66	−66	83	89	83	−56	−53	−56
	2009−2010	559	520	545	534	−7	−3	−5	723	785	727	29	+40	+30
	2010−2011	456	298	314	308	−35	−31	−32	397	461	401	−13	+1	−12
	2011−2012	289	374	400	389	29	38	35	530	618	535	+83	+113	+85
	2012−2013	272	427	455	443	57	67	63	533	619	538	+96	+128	+98
	2013−2014	351	347	373	360	−1	6	3	431	514	436	+23	+46	+24
	2014−2015	483	536	562	548	11	16	13	751	832	755	+55	+72	+56
	Standard D.	132	160	168	164				225	247	226			
	Mean	372	366	388	378				493	560	497			
N11	Total	2435	2213	3664	2005	−9	+50	−18	2247	3143	1971	−8	+29	−19
	2008−2009	745	741	799	563	−1	+7	−24	693	706	683	−7	−5	−8
	2009−2010	520	577	640	394	+11	+23	−24	411	572	358	−21	+10	−31
	2010−2011	386	317	352	160	−18	−9	−59	127	238	96	−67	−38	−75
	2011−2012	214	182	458	221	−15	+114	+3	247	405	201	+15	+89	−6

2012−2013	161	147	456	202	−9	+183	+25	218	367	171	+35	+128	+6
2013−2014	137	85	366	145	−38	+167	+6	156	289	120	+14	+111	−13
2014−2015	272	164	593	321	−40	+118	+18	396	566	343	+45	+108	+26
Standard D.	221	249	162	151				197	170	204			
Mean	348	316	523	286				321	449	282			

Table S5. Additional supporting information of the duration of observed and simulated daily runoff (Q_o and Q_s) and runoff variability (RSD) under land use scenarios: current cover. partial harvest and native forest.

Table S5. Duration of observed and simulated daily runoff (Q_o and Q_s) and runoff variability (RSD) under land use scenarios: current cover. partial harvest and native forest.

					***Whole-time* series calibration**						***Dry season* calibration**					
					Current cover		**Partial harvest**		**Native forest**		**Current cover**		**Partial harvest**		**Native forest**	
Catchment group		**Percentile**	**Q_o (mm)**	**RSD[1]**	**Q_s (mm)**	**RSD[1]**	**Q_s (mm)**	**RSD[1]**	**Q_s (mm)**	**RSD[1]**	**Q_s (mm)**	**RSD[1]**	**Q_s (mm)**	**RSD[1]**	**Q_s (mm)**	**RSD[1]**
1	**N2**	Q_5	2.83		2.71		3.14		2.71		2.09		2.90		1.35	
	n=2540	Q_{16}	1.11		1.29		1.48		1.29		0.86		1.17		0.80	
		Q_{50}	0.30	12.2	0.00	0.0	0.12	37.5	0.00	0.0	0.30	9.0	0.61	5.7	0.30	6.4
		Q_{84}	0.12		0.00		0.00		0.00		0.12		0.30		0.12	
		Q_{95}	0.06		0.00		0.00		0.00		0.06		0.24		0.06	
	N3	Q_5	3.16		5.71		5.84		5.71		5.84		6.57		5.96	
	n=2541	Q_{16}	1.21		1.33		1.33		1.33		2.55		3.16		2.67	
		Q_{50}	0.60	6.2	0.12	56	0.12	57.0	0.12	56.0	0.85	8.4	1.09	7.4	0.85	8.7
		Q_{84}	0.36		0.12		0.12		0.12		0.60		0.85		0.60	
2		Q_{95}	0.24		0.12		0.12		0.12		0.60		0.73		0.60	
	N4	Q_5	3.29		4.43		5.91		4.77		5.22		7.27		5.22	
	n=2540	Q_{16}	1.25	9.7	0.45	0.0	1.02	0.0	0.45	0.0	0.90	9.8	1.70	9.7	0.90	9.8
		Q_{50}	0.45		0.00		0.00		0.00		0.56		0.79		0.56	
		Q_{84}	0.11		0.00		0.00		0.00		0.34		0.68		0.34	

		Q_{95}	0.00		0.00		0.00		0.00		0.22		0.56		0.22	
	N5	Q_5	4.69		3.57		4.32		2.59		1.72		2.22		1.72	
	n=2540	Q_{16}	1.72		2.03		2.65		1.60		1.29		1.72		1.29	
		Q_{50}	0.61	9.8	0.74	7.1	1.04	6.1	0.43	9.0	0.67	3.7	0.86	3.7	0.67	3.7
		Q_{84}	0.24		0.24		0.30		0.18		0.30		0.43		0.30	
		Q_{95}	0.12		0.12		0.24		0.12		0.18		0.30		0.18	
3	**N7**	Q_5	1.32		1.27		1.27		1.27		3.76		5.08		3.76	
	n=2540	Q_{16}	0.66		0.66		0.66		0.66		0.45		0.96		0.50	
		Q_{50}	0.30	5.6	0.10	19.0	0.10	19.0	0.10	19.0	0.30	12.2	0.40	13.1	0.30	12.3
		Q_{84}	0.15		0.00		0.00		0.00		0.25		0.35		0.25	
		Q_{95}	0.10		0.00		0.00		0.00		0.25		0.35		0.25	
	N8	Q_5	2.05		1.74		1.74		1.75		6.95		8.35		6.97	
	n=2540	Q_{16}	1.11		1.27		1.24		1.27		1.49		2.18		1.50	
		Q_{50}	0.42	6.5	0.64	3.9	0.59	4.1	0.64	3.9	0.50	15.8	0.64	15.3	0.50	15.9
		Q_{84}	0.21		0.29		0.31		0.29		0.28		0.39		0.28	
		Q_{95}	0.15		0.23		0.21		0.23		0.21		0.31		0.21	
	N9	Q_5	2.41		3.39		3.63		3.50		5.02		5.56		5.02	
	n=2540	Q_{16}	1.54		1.27		1.36		1.32		1.33		1.52		1.34	
4		Q_{50}	0.83	3.5	0.70	5.5	0.74	5.7	0.72	5.6	0.76	7.2	0.89	6.9	0.77	7.2
		Q_{84}	0.54		0.44		0.47		0.46		0.45		0.55		0.45	
		Q_{95}	0.44		0.31		0.33		0.32		0.34		0.41		0.35	
	N11	Q_5	2.95		1.89		4.58		2.35		2.76		3.36		2.61	
	n=2540	Q_{16}	1.45		1.37		1.79		1.01		1.78		2.27		1.51	
		Q_{50}	0.60	6.7	0.53	5.3	0.93	5.6	0.51	5.5	0.44	10.0	0.81	6.5	0.38	10.5
		Q_{84}	0.17		0.25		0.64		0.29		0.06		0.18		0.07	
		Q_{95}	0.09		0.18		0.52		0.21		0.02		0.09		0.03	

[1] Runoff Standard Deviation relative to the median daily runoff. adapted from the index developed by Folk and Ward (1957) and further by Batalla et al., 2004

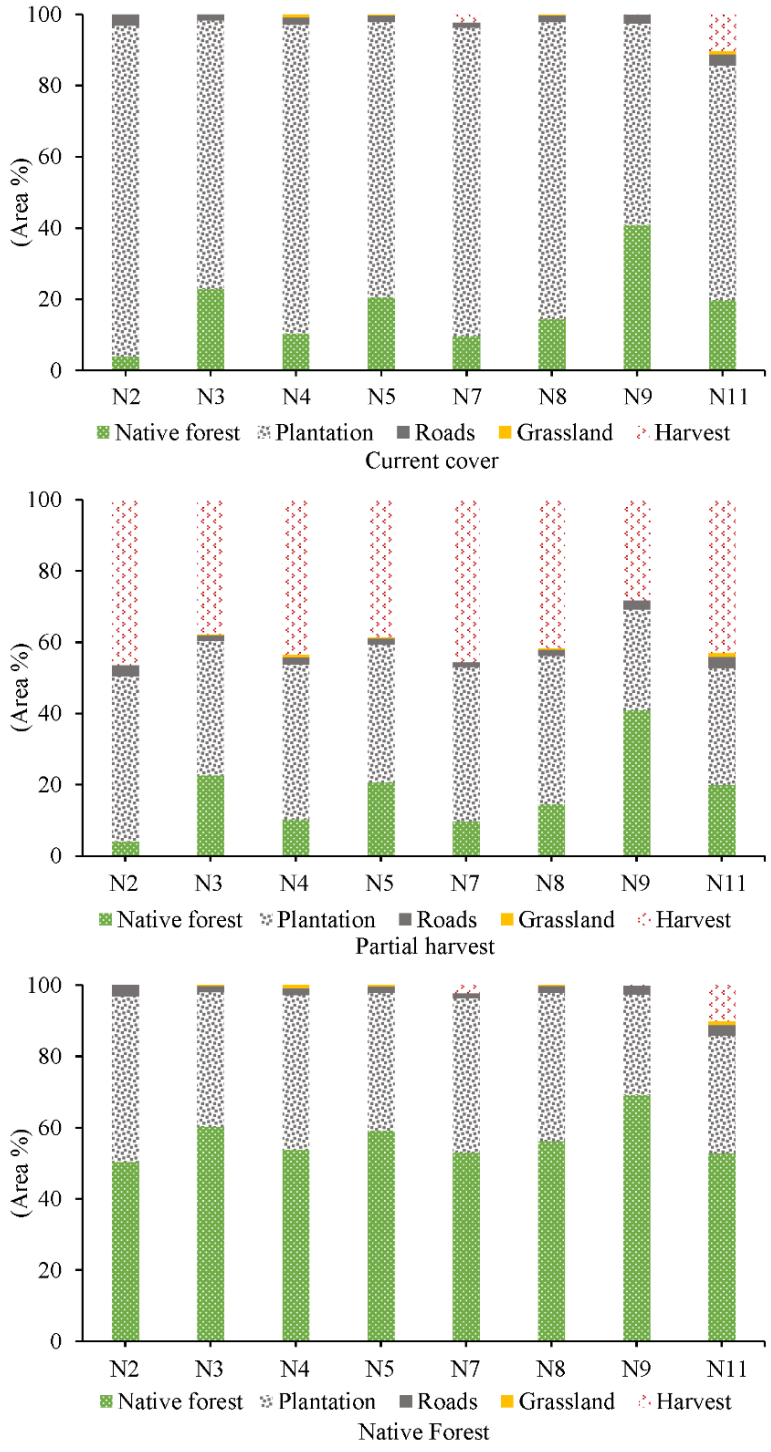

Figure S1. Additional supporting information of the three land cover scenarios.

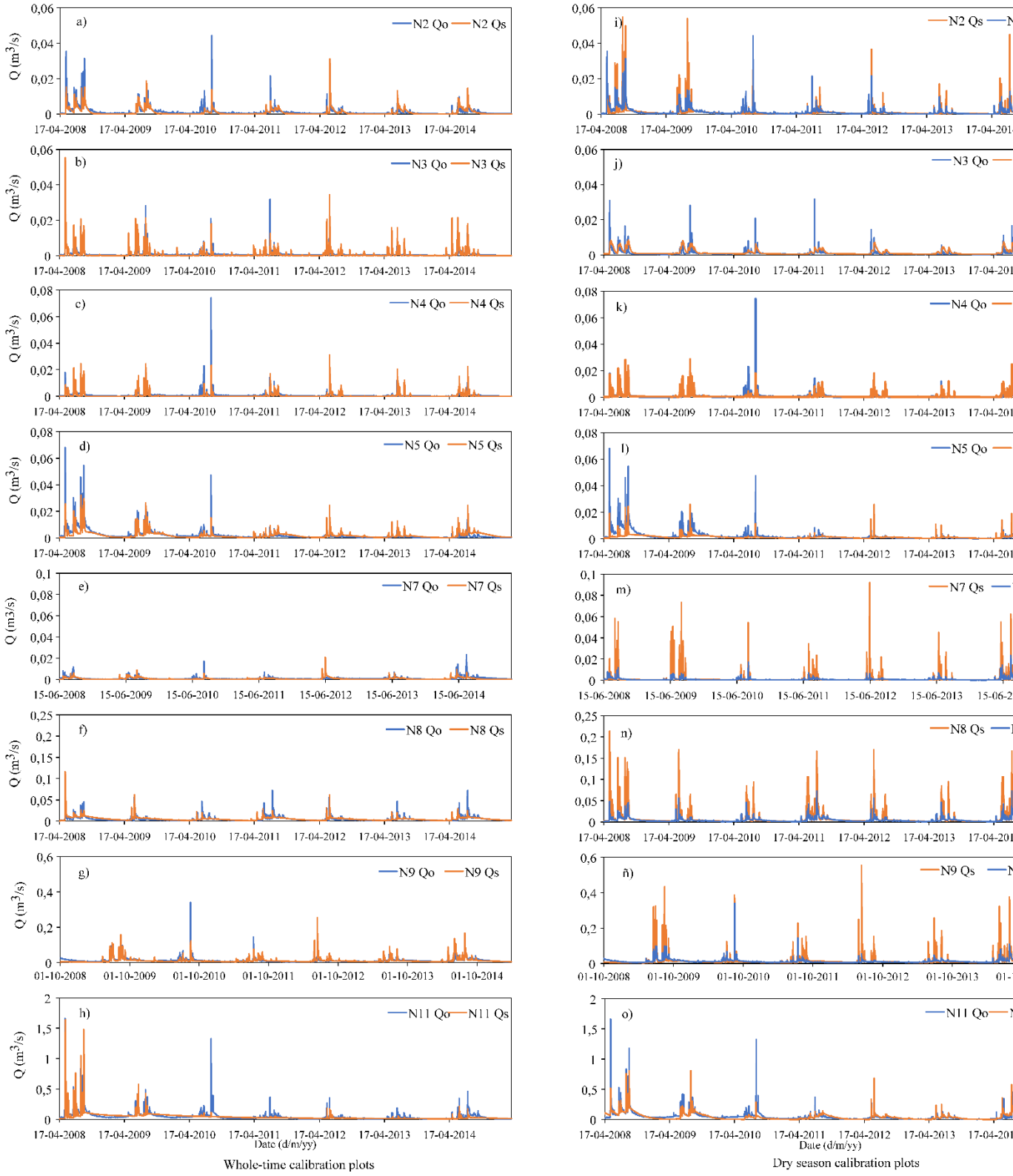

Figure S2. Additional supporting information of the Figure 3 (all catchments).

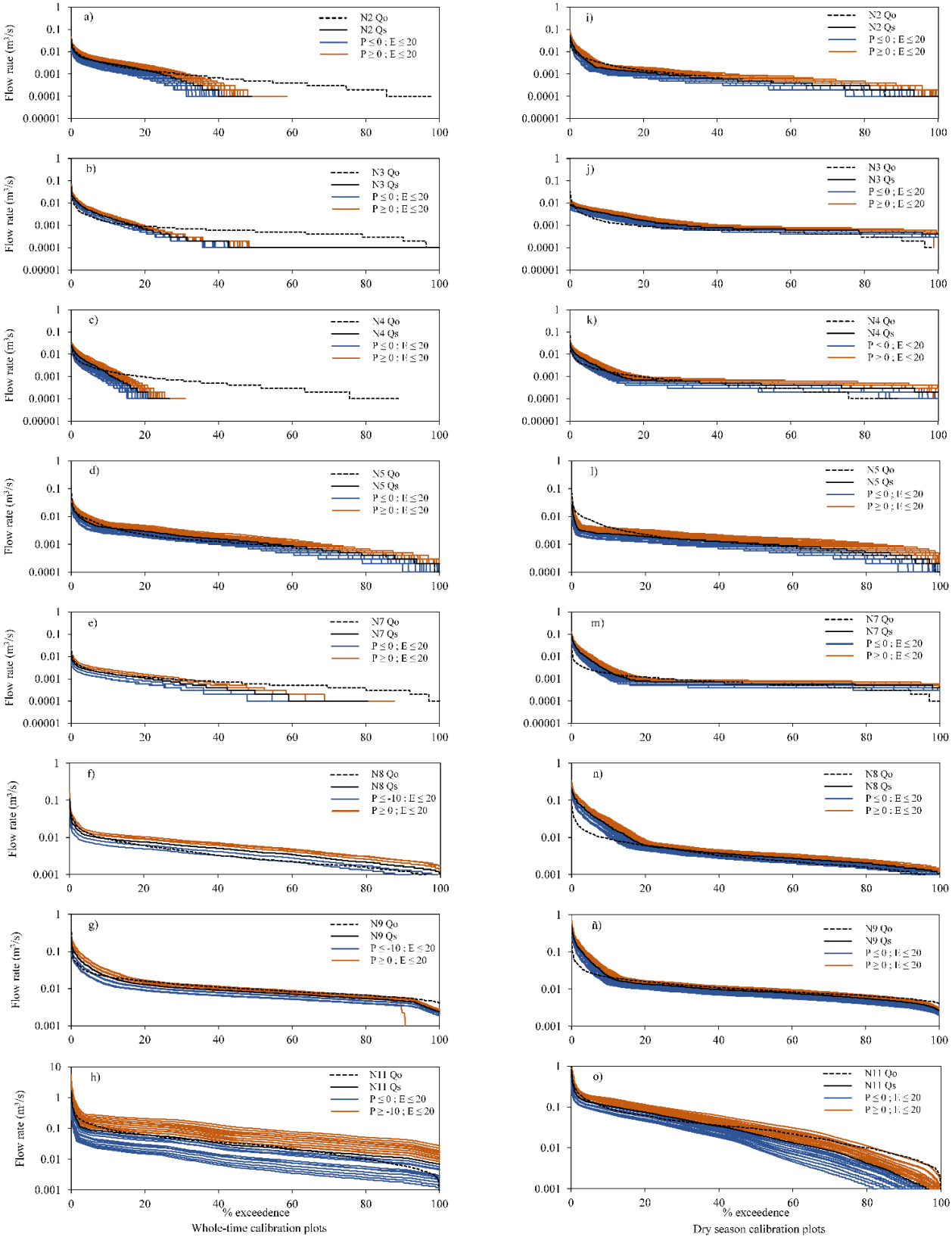

Figure S3. Additional supporting information of the Figure 4 (all catchments).

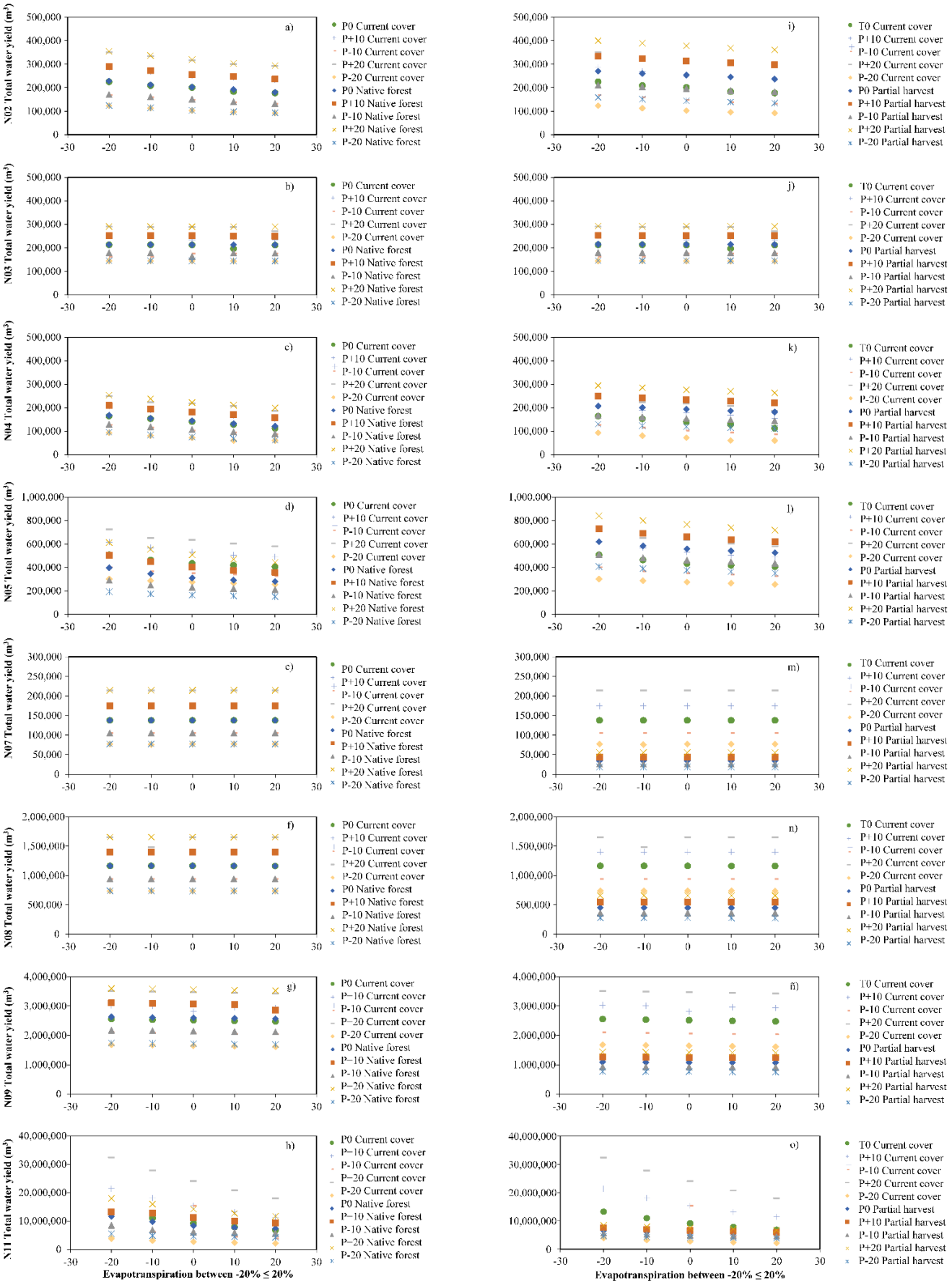

Figure S4. Additional supporting information of the Figure 5 (all catchments).