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Supplementary material

Conceptual Mini-catchment Typologies for Testing Dominant Controls of Nutrient Dynamics in Three Nordic Countries

Fatemeh Hashemi [1,*], Ina Pohle [2], Johannes W.M. Pullens [3], Henrik Tornbjerg [1], Katarina Kyllmar [4], Hannu Marttila [5], Ahti Lepistö [6], Bjørn Kløve [5], Martyn Futter [4] and Brian Kronvang [1]

[1] Department of Bioscience, Aarhus University, Vejlsøvej 25, 8600 Silkeborg, Denmark
[2] Environmental and Biochemical Sciences, The James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH, Scotland, United Kingdom
[3] Department of Agroecology, Aarhus University, Blichers Allé 20, 8830 Tjele, Denmark
[4] Department of Soil and Environment, Swedish University of Agricultural Sciences, P.O. Box 7014, 750 07 Uppsala, Sweden
[5]Water, Energy and Environmental Engineering Research Unit, 4300, 90014 University of Oulu, Finland
[6]Finnish Environment Institute, Latokartanonkaari 11, 00790 Helsinki, Finland
* Correspondence:Corresponding author, e-mail: fh@bios.au.dk

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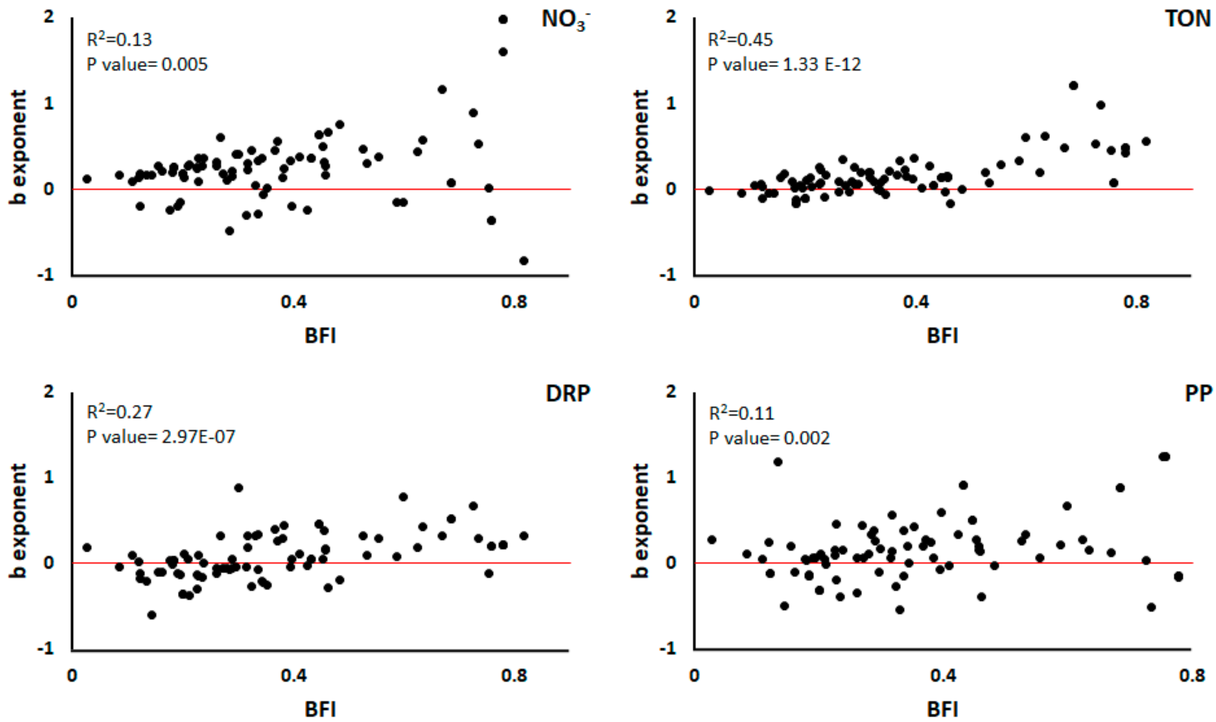

Figure 1. Correlation between base flow index (BFI) as an indicator of hydrological regime and b exponent representing the slope of the log-transformed C-Q relationship for nitrate (NO_3^-), total organic N (TON), dissolved reactive P (DRP) and particulate P (PP). The R-squared value, denoted by R^2, shows the proportion of variation in the b exponent (dependent variable) that can be attributed to the BFI (independent variable). The P-value is the probability to check whether the correlation is statistically significant (**P**<0.05).

Table 1. Catchments used in this study, number of monitored nutrients data and average of concentration [mg/l] for nitrate (NO_3^-), total organic N (TON), dissolved reactive P (DRP) and particulate P (PP).

	Country	Station	Number of Nutrient Observations per Year per Station		Average Concentration (2010–2017) [mg/l]			
			N	**P**	**NO_3^-**	**TON**	**DRP**	**PP**
1	Denmark	Odderbæk	130	129	3.874	4.505	0.051	0.041
2	Denmark	Refskær bæk	130	121	1.063	0.521	0.057	0.026
3	Denmark	Lyby- grønning grøft	96	114	6.624	0.446	0.077	0.056
4	Denmark	Hvam bæk	81	89	13.671	0.895	0.085	0.032
5	Denmark	Lånum bæk	75	75	4.138	0.321	0.032	0.046
6	Denmark	Knud Å	79	79	4.035	0.657	0.042	0.069

7	Denmark	Nimdrup bæk	75	75	6.215	0.370	0.040	0.036
8	Denmark	Skærbæk	88	86	0.762	0.285	0.003	0.008
9	Denmark	Mausing møllebæk	91	93	2.242	0.505	0.025	0.077
10	Denmark	Hylte bæk	73	73	1.510	0.674	0.015	0.034
11	Denmark	Horndrup bæk	276	265	2.400	0.373	0.036	0.038
12	Denmark	Javngyde bæk	97	102	4.126	0.430	0.030	0.057
13	Denmark	Haurbæk	94	94	1.285	0.463	0.022	0.082
14	Denmark	Skjellegrøften	93	93	2.809	0.626	0.032	0.043
15	Denmark	Rustrup skovbæk	89	88	0.037	0.320	0.017	0.022
16	Denmark	Ellebæk	66	66	2.171	0.736	0.054	0.042
17	Denmark	Hestbæk	89	88	0.037	0.320	0.017	0.022
18	Denmark	Sunds møllebæk	76	76	1.599	0.567	0.016	0.070
19	Denmark	Ulstrup Å	88	89	0.037	0.320	0.017	0.022
20	Denmark	Feldbæk	66	66	2.171	0.736	0.054	0.042
21	Denmark	Ejstrup bæk	107	97	1.109	0.354	0.015	0.028
22	Denmark	Langslade rende	75	73	0.035	0.540	0.032	0.051
23	Denmark	Engelsholm bæk	66	66	2.171	0.736	0.054	0.042
24	Denmark	Engelsholm sø, tilløb	64	75	4.138	0.321	0.032	0.046
25	Denmark	Smørpøt bæk	71	73	4.659	0.538	0.019	0.049
26	Denmark	Stenderup bæk	73	73	4.186	0.487	0.018	0.044
27	Denmark	Gamst møllebæk	75	75	3.687	0.360	0.041	0.047
28	Denmark	Søgård sø, tilløb	55	60	5.782	0.545	0.022	0.053
29	Denmark	Solkær Å	107	107	1.479	0.558	0.019	0.051
30	Denmark	Kær mølle Å	103	103	1.400	0.500	0.010	0.050
31	Denmark	Blå Å (Lille Å)	104	106	3.234	0.583	0.030	0.053
32	Denmark	Rejsby Å	91	91	2.393	0.778	0.028	0.107
33	Denmark	Fiskbæk	104	104	2.881	0.859	0.073	0.088

34	Denmark	Pulverbæk	102	105	3.855	0.533	0.065	0.076
35	Denmark	Bolbro bæk	232	229	0.494	0.592	0.013	0.049
36	Denmark	Bjerndrup mølle Å	129	129	4.484	0.528	0.064	0.066
37	Denmark	Arreskov sø, Tilløb	61	89	13.671	0.895	0.085	0.032
38	Denmark	Lindved Å	101	101	1.964	0.543	0.028	0.042
39	Denmark	Geels Å	98	98	2.341	0.646	0.046	0.055
40	Denmark	Holstenhuus afløb	89	88	0.037	0.320	0.017	0.022
41	Denmark	Lillebæk	103	103	2.881	0.862	0.073	0.089
42	Denmark	Vejstrup Å	101	101	2.684	0.641	0.070	0.054
43	Denmark	Følstrup bæk	94	94	0.289	0.761	0.020	0.026
44	Denmark	Lyngby Å	131	131	3.691	0.983	0.039	0.072
45	Denmark	Æbelholt Å	132	130	2.135	0.766	0.031	0.084
46	Denmark	Mademose Å	95	101	4.923	0.590	0.046	0.055
47	Denmark	Ll. Vejle Å	107	112	3.003	0.486	0.037	0.080
48	Denmark	Fladmose Å	104	104	2.881	0.859	0.073	0.088
49	Denmark	Hulebæk, Hulbækhus	110	112	4.315	0.715	0.071	0.050
50	Denmark	Hulebæk,N..Broskov	104	106	3.207	0.668	0.055	0.086
51	Denmark	Tranegård lille Å	276	265	2.400	0.373	0.036	0.038
52	Denmark	Højvads rende	241	239	3.214	1.021	0.043	0.047
53	Denmark	Marrebæksrende	92	97	5.797	0.784	0.254	0.066
54	Denmark	Nældevas Å	101	101	3.786	0.817	0.093	0.040
55	Denmark	Bagge Å	96	101	4.810	0.477	0.108	0.041
56	Denmark	Øle Å	79	79	0.352	0.672	0.004	0.014
57	Sweden	Aneboda	178	178	0.205	0.636	0.006	0.017
58	Sweden	E23	199	199	5.323	0.564	0.030	0.047
59	Sweden	E24	197	197	1.912	0.606	0.106	0.143
60	Sweden	Gammtratten	177	177	0.006	0.208	0.003	0.013

61	Sweden	H29	185	185	3.980	0.681	0.026	0.055
62	Sweden	K31	182	182	2.156	0.491	0.018	0.064
63	Sweden	K32	190	190	18.333	2.432	0.205	0.254
64	Sweden	Kindla	179	178	0.205	0.636	0.006	0.017
65	Sweden	M39	196	196	5.530	0.601	0.052	0.054
66	Sweden	O14	209	209	2.249	0.712	0.051	0.109
67	Sweden	O17	194	194	1.278	0.601	0.012	0.035
68	Sweden	S13	189	189	1.314	0.806	0.038	0.092
69	Sweden	X2	143	143	0.697	1.577	0.077	0.077
70	Finland	Hovi	57	52	3.593	4.760	0.053	0.219
71	Finland	Huhtisuonoja	131	131	0.128	0.690	0.005	0.019
72	Finland	Haapajyrä	136	134	4.537	2.541	0.005	0.087
73	Finland	Kelopuro	160	162	0.263	0.271	0.001	0.006
74	Finland	Kesselinpuro	148	154	0.785	0.722	0.010	0.026
75	Finland	Kotioja	98	83	0.091	0.484	0.027	0.012
76	Finland	Latosuonoja	104	104	1.081	0.880	0.009	0.031
77	Finland	Liuhapuro	147	147	0.010	0.560	0.005	0.017
78	Finland	Lompolojänganoja	141	82	0.005	0.166	0.002	0.007
79	Finland	Löytäneenoja	77	79	3.276	1.144	0.048	0.129
80	Finland	Laanioja	139	121	0.021	0.086	0.001	0.003
81	Finland	Myllypuro	200	192	0.024	0.457	0.006	0.017
82	Finland	Porkkavaara	103	103	0.013	0.216	0.001	0.004
83	Finland	Ruunapuro	59	132	0.677	0.774	0.019	0.056
84	Finland	Savijoki	157	158	1.438	0.850	0.023	0.144
85	Finland	Teeressuonoja	116	112	0.641	0.524	0.002	0.015
86	Finland	Vähä-Askanjoki	136	123	0.009	0.233	0.002	0.009
87	Finland	Ylijoki	98	83	0.066	0.535	0.008	0.022

Table 2. Catchments characteristics used in this study including area [km²], land use [% of agriculture and nature] in total between 0% and 100% for each category, climatic characteristics for standard reference period 1971-2000 (average yearly precipitation [mm] and temperature [°C]) and reclassified soil classes for this study.

ID*	Catchment Area [km²]	Land Use		Climatic Characteristics		Soil Class for This Study**
		Agriculture [%]	**Nature [%]**	**Average Yearly Precipitation [mm]**	**Average Daily Temperature [°C]**	
1	11.43	80	9	663	7.92	1
2	1.69	11	83	627	8.00	1
3	11.29	85	2	696	8.10	2
4	15.15	79	8	696	8.10	1
5	17.12	85	5	743	8.06	3
6	32.2	74	14	684	8.00	2
7	31.02	60	22	684	8.00	2
8	4.59	22	71	743	8.06	3
9	27.53	72	14	684	8.00	1
10	2.28	68	26	684	8.00	2
11	5.47	69	22	684	8.00	2
12	10.58	81	7	684	8.00	2
13	3.13	65	23	743	8.06	1
14	10.61	83	7	684	8.00	2
15	0.46	1	92	684	8.00	1
16	19.01	69	9	753	8.33	3
17	5.38	2	94	728	8.64	2
18	48.47	79	9	743	8.06	2
19	0.62	0	88	639	7.99	1
20	0.58	86	7	639	7.99	2
21	15.2	33	61	728	7.92	1

22	15.7	0	95	745	7.92	3
23	5.98	71	13	748	8.09	1
24	0.6	78	5	748	8.09	1
25	6.57	74	18	778	8.48	1
26	9.67	81	8	778	8.48	1
27	9.55	84	4	802	8.17	1
28	3.32	89	2	802	8.17	2
29	29.47	77	9	682	8.32	2
30	4.92	76	17	682	8.32	1
31	43.47	84	6	778	8.48	2
32	19.78	86	6	784	8.49	2
33	13.54	76	13	784	8.49	3
34	7.52	83	8	784	8.49	2
35	32.47	81	8	802	8.17	2
36	3.01	80	8	625	8.37	2
37	64.73	71	20	625	8.37	2
38	26.68	54	12	557	8.55	2
39	0.38	62	16	625	8.37	2
40	4.36	19	75	557	8.55	2
41	39.97	87	3	557	8.55	1
42	6.13	64	21	556	8.84	1
43	19.38	6	79	556	8.84	1
44	11.85	66	17	556	8.84	2
45	5.41	58	20	556	8.84	1
46	23.58	83	7	556	8.84	2
47	13.97	46	10	492	8.71	2
48	15.05	87	4	492	8.71	2

49	7.79	72	14	507	8.73	2
50	18.48	74	11	516	8.74	2
51	9.85	68	20	528	8.79	2
52	24.56	64	27	528	8.79	2
53	39.82	90	2	528	8.79	2
54	42.59	74	17	528	8.79	2
55	42.59	79	9	552	7.98	1
56	8.44	15	78	552	7.98	1
57	0.189	0	100	749	5.85	4
58	7.56	54	0	537	6.42	2
59	6.26	67	0	568	6.90	2
60	0.45	0	100	618	1.43	4
61	7.02	73	0	500	7.41	5
62	7.69	25	0	666	7.20	2
63	8.6	66	0	666	7.20	5
64	0.204	0	100	731	5.69	2
65	6.8	82	0	712	7.53	2
66	10.13	72	0	828	6.64	4
67	9.67	56	0	763	6.34	2
68	35.22	39	0	725	5.69	4
69	8.06	35	0	623	4.87	4
70	0.12	100	0	660	4.70	2
71	4.94	0	100	605	3.57	2
72	6.09	57	43	559	3.31	2
73	0.74	0	100	636	1.78	2
74	21.7	1	99	603	2.43	2
75	18	1	99	574	0.26	6

76	5.32	17	83	605	3.57	2
77	1.7	0	100	606	1.53	2
78	5.14	0	100	513	-2.16	6
79	6.24	63	37	583	4.34	2
80	13.6	0	100	527	-1.74	2
81	9.86	1	99	588	0.86	6
82	0.72	0	100	619	1.40	2
83	5.39	20	80	610	2.48	6
84	15.21	39	61	620	4.53	2
85	69	0	100	660	4.70	4
86	15.62	0	100	501	-0.42	2
87	56	3	97	574	0.26	2

* ID numbers as explained in Table S1.

** Reclassified soil classes for this study in Table S2.

Table 3. FAO soil type's descriptors for study sites and clustered soil classes based on the percentages of sand, till, moraine, sediment, gravel and organic soil.

	FAO descriptors
1	Moraine sand
2	Glacial till
3	Outwash sand, dunes
4	Moraine, postglacial sediment
5	Moraine, glacial till, esker, postglacial sediment
6	Peat

Table 4. Results of C-Q types (T1-T9) of mini-catchments in this study nitrate (NO_3^-), total organic N (TON), dissolved reactive P (DRP) and particulate P (PP) considering export regime (enrichment (E), constant (C) and dilution (D)) and hysteresis patterns (clockwise (CL), anticlockwise (A) and no hysteresis (N)).

ID*	Export regime				Hysteresis pattern				C-Q relationships classes			
	NO_3^-	TON	DRP	PP	NO_3^-	TON	DRP	PP	NO_3^-	TON	DRP	PP
1	E	E	D	C	CL	CL	N	N	T1	T1	T8	T5
2	C	C	D	C	N	CL	N	CL	T5	T4	T8	T4
3	E	C	C	C	CL	N	N	CL	T1	T5	T5	T4
4	D	C	C	C	A	N	CL	CL	T9	T5	T4	T4
5	C	C	C	C	N	CL	CL	CL	T5	T4	T4	T4
6	E	C	C	C	CL	N	N	N	T1	T5	T5	T5
7	C	C	C	E	A	CL	N	N	T6	T4	T5	T2
8	C	C	C	C	A	N	CL	N	T6	T5	T4	T5
9	E	C	E	E	CL	CL	CL	N	T1	T4	T1	T2
10	E	C	C	C	N	N	CL	N	T2	T5	T4	T5
11	E	C	D	C	CL	N	CL	N	T1	T5	T7	T5
12	E	C	C	C	CL	N	CL	CL	T1	T5	T4	T4
13	E	C	C	C	CL	CL	N	CL	T1	T4	T5	T4
14	E	C	E	C	CL	N	N	CL	T1	T5	T2	T4
15	E	C	C	C	N	CL	CL	N	T2	T4	T4	T5
16	C	D	D	D	N	N	N	N	T5	T8	T8	T8
17	C	C	C	C	N	CL	CL	N	T5	T4	T4	T5
18	E	E	E	C	CL	N	N	CL	T1	T2	T2	T4
19	E	C	C	C	N	CL	CL	N	T2	T4	T4	T5
20	C	D	D	D	N	N	N	N	T5	T8	T8	T8
21	E	C	C	C	N	N	N	N	T2	T5	T5	T5
22	C	E	C	C	CL	N	A	A	T4	T2	T6	T6
23	C	D	D	D	N	N	N	N	T5	T8	T8	T8
24	C	C	C	C	N	CL	CL	CL	T5	T4	T4	T4
25	C	C	C	C	A	N	CL	N	T6	T5	T4	T5
26	E	E	C	C	N	N	N	N	T2	T2	T5	T5
27	C	C	C	C	CL	N	N	N	T4	T5	T5	T5
28	E	C	C	C	N	N	CL	CL	T2	T5	T4	T4
29	E	C	C	E	CL	N	CL	CL	T1	T5	T4	T1
30	E	C	C	E	CL	N	CL	CL	T1	T5	T4	T1
31	E	C	D	C	N	N	N	N	T2	T5	T8	T5
32	E	E	C	E	CL	CL	CL	N	T1	T1	T4	T2
33	E	D	C	D	N	N	N	CL	T2	T8	T5	T7
34	E	C	D	C	CL	N	CL	N	T1	T5	T7	T5
35	C	C	C	C	CL	CL	CL	N	T4	T4	T4	T5
36	E	E	C	C	N	N	CL	CL	T2	T2	T4	T4
37	D	C	C	C	A	N	CL	CL	T9	T5	T4	T4
38	E	C	D	C	CL	N	CL	N	T1	T5	T7	T5
39	E	C	D	C	CL	N	N	N	T1	T5	T8	T5
40	E	C	C	C	N	CL	CL	N	T2	T4	T4	T5
41	E	D	C	C	N	N	N	N	T2	T8	T5	T5
42	E	E	D	C	CL	N	N	N	T1	T2	T8	T5
43	C	C	D	D	CL	N	N	CL	T4	T5	T8	T7
44	E	C	C	C	N	N	CL	CL	T2	T5	T4	T4

45	E	E	C	C	N	N	CL	N	T2	T2	T4	T5
46	E	C	C	C	CL	N	CL	N	T1	T5	T4	T5
47	E	C	D	E	CL	N	CL	CL	T1	T5	T7	T1
48	E	D	C	D	N	N	N	CL	T2	T8	T5	T7
49	E	C	D	C	CL	N	CL	CL	T1	T5	T7	T4
50	E	C	C	D	CL	CL	CL	A	T1	T4	T4	T9
51	E	C	D	C	CL	N	CL	N	T1	T5	T7	T5
52	E	E	D	C	CL	A	CL	N	T1	T3	T7	T5
53	E	C	D	D	N	N	N	N	T2	T5	T8	T8
54	E	C	D	C	N	N	N	N	T2	T5	T8	T5
55	E	C	C	D	CL	CL	N	CL	T1	T4	T5	T7
56	C	C	C	C	CL	N	N	N	T4	T5	T5	T5
57	E	D	D	D	CL	N	N	N	T1	T8	T8	T8
58	E	C	C	C	CL	N	N	A	T1	T5	T5	T6
59	E	C	C	C	CL	CL	N	A	T1	T4	T5	T4
60	D	C	C	C	N	N	N	N	T8	T5	T5	T5
61	E	E	C	E	CL	N	CL	N	T1	T2	T4	T2
62	E	E	C	C	N	N	CL	N	T2	T2	T4	T5
63	E	C	C	C	N	N	N	CL	T2	T5	T5	T4
64	E	D	D	D	N	N	N	N	T2	T8	T8	T8
65	E	E	D	C	CL	CL	N	CL	T1	T1	T8	T4
66	E	D	C	C	N	N	N	CL	T2	T8	T5	T4
67	C	C	C	C	N	N	CL	CL	T5	T5	T4	T4
68	E	D	D	D	N	N	CL	CL	T2	T8	T7	T7
69	D	D	D	C	CL	CL	CL	CL	T7	T7	T7	T4
70	E	C	C	E	N	A	CL	CL	T2	T6	T4	T1
71	E	E	E	C	CL	CL	N	CL	T1	T1	T2	T4
72	E	D	D	D	N	N	CL	CL	T2	T8	T7	T7
73	D	D	D	D	A	A	N	CL	T9	T9	T8	T7
74	E	E	C	D	CL	CL	N	CL	T1	T1	T5	T7
75	D	E	C	C	A	N	CL	N	T9	T2	T4	T5
76	E	E	E	C	CL	CL	CL	CL	T1	T1	T1	T4
77	C	C	D	D	N	N	A	CL	T5	T5	T9	T7
78	C	C	C	C	N	CL	N	CL	T5	T4	T5	T4
79	E	C	D	D	A	CL	N	N	T3	T4	T8	T8
80	D	E	C	C	N	CL	N	CL	T8	T1	T5	T4
81	D	E	D	C	N	N	N	CL	T8	T2	T8	T4
82	D	E	C	C	N	N	N	CL	T8	T2	T5	T4
83	C	C	C	C	CL	CL	CL	CL	T4	T4	T4	T4
84	E	C	C	C	N	CL	CL	CL	T2	T4	T4	T4
85	D	E	C	E	A	CL	N	CL	T9	T1	T5	T1
86	D	E	D	C	N	CL	A	CL	T8	T1	T9	T4
87	C	E	C	E	N	N	N	CL	T5	T2	T5	T1

* ID numbers as explained in Table S1.

Table S5. Results on the percentage of explained variances by seven principal components (PC1-PC7) defined via PCA analysis for nitrate (NO_3^-), total organic N (TON), dissolved reactive P (DRP) and particulate P (PP).

	Explained variances (%)						
Nutrient form	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**
NO_3-	45.2	15.8	9.3	9.1	8.8	7.5	4.3
TON	41.9	16.7	9.7	9.6	8.6	7.8	5.7
DRP	41	16	9.8	9.7	8.9	8.1	6.5
PP	40.8	17.3	9.8	9.2	8.7	7.9	6.3