Supplementary Materials

1. New Danish lakes

Tabel S1. Summer means TP-concentration, the lake area, catchment area, and land use of the included new lakes. (a), designates lakes containing brackish water, (b)

Name		Established		Sampled	Lake area	Catchment	Urban	Agriculture	Forest	Nature	TP summer mean
		year		year	ha	ha	%	%	%	%	mg /l
Alsønderup Engsø		1987		2017	49	9789	14	37	33	5	0.311
Årslev Engsø		2006		2014	117	26482	9	70	8	5	0.084
Birkesø		2017		2018	128	761	0	16	2	81	2.497
Bjerre Engsø		2010		2015	20	219	0	34	58	4	0.044
Bølling Sø		2004		2018	344	2643	5	55	27	9	0.095
Botofte skovmose		2009		2017	31	521	5	68	20	3	0.304
Brokholm Sø		1999		2016	82	1809	3	86	2	7	0.283
Bundsø		2015		2018	141	1101	4	87	3	2	0.193
Egå Engsø		2006		2019	112	5435	17	59	6	3	0.101
Ejsbøl Sø		2000		2015	17	466	4	83	3	5	0.109
Ellebæksø		2016		2018	4	506	4	68	20	3	0.060
Filsø		2013		2018	889	10471	4	68	12	13	0.083
Føns Vang		2006		2012	103	557	4	87	2	2	0.218
Fuglsang Sø[b]		2005		2018	29	24	22	12	0	61	0.024
Gødstrup Engsø		2003		2014	43	1082	3	64	21	8	0.134
Gravlev Sø		1990		2017	17	432	5	82	3	7	0.088
Gyldensteen Engsø		2014		2017	139	112	1	62	27	4	0.143
Halkær sø		2006		2011	89	6669	7	69	5	13	0.278
Hals sø		2000		2013	40	729	9	73	2	4	0.098
Hestholm Sø		2003		2015	213	12725	6	77	6	6	0.101

Hindemade		1994		2018	41	6248	5	71	13	5	0.081
Højby Sø		1990		2015	38	281	11	76	1	3	0.292
Holløse Bredning		1999		2015	50	1976	21	63	6	3	0.380
Hovvig[a]		1979		2015	45	164	5	14	30	48	3.240
Hundeskov Sø[b]		2003		2019	11	94	1	17	0	81	0.026
Jordbroå engsø		2016		2017	105	15383	3	65	16	10	0.322
Juelstrup Sø		2009		2016	53	206	7	79	6	5	0.234
Kærnsø		1999		2016	30	70	0	45	0	52	0.064
Kalø Grå Sø[a]		1997		2016	8	517	3	84	5	3	1.820
Knabberup Sø		2009		2013	11	21004	5	64	16	10	0.135
Kongens Kær		2009		2017	23	90	51	0	29	7	0.136
Legind Sø		1991		2016	18	566	9	60	7	11	0.073
Lillelund Engsø		2015		2018	5	149	42	21	0	1	0.048
Lønborggård Sø		1997		2015	53	770	7	78	4	5	0.354
Louns Sø		1996		2017	46	244	7	59	10	24	0.542
Maltrup Sø[a]		2006		2017	13	31	14	66	1	9	1.498
Marbæk Sø - Midt		1979		2007	4	267	1	41	36	17	0.051
Marbæk Sø - Øst		1981		2007	2	260	0	51	28	14	0.048
Marbæk Sø - Vest		1980		2013	13	65	1	5	37	51	0.180
Mjels Sø[a]		2005		2018	49	1491	5	85	3	2	0.273
Munkesø		1930		2015	21	1601	2	72	14	9	0.109
Nakkebølle Inddæmning		2003		2015	80	2016	5	73	13	4	0.147
Nordredyb		2001		2016	26	736	2	73	1	21	0.083
Nordsø Davinde[b]		1995		2019	3	18	7	40	5	48	0.016
Nørreballe Nor		2006		2017	55	697	5	86	3	3	0.227
Nørrekær		1994		2017	29	592	1	8	30	52	0.322
Øde Hastrup[b]		2018		2019	9	15	5	10	0	85	0.011

Ødis Sø		2002		2012	25	208	12	74	6	1	0.296
Oldenor		2014		2014	36	201	1	94	1	2	0.542
Ølundgårds inddæmning		1998		2017	13	103	2	89	4	2	0.313
Østerhestholm Sø		1997		2011	13	18	0	23	0	77	0.043
Østerø Sø[a]		1945		2013	27	30	3	5	13	50	0.680
Ravnegård Sø[b]		2015		2019	3	9	8	22	4	66	0.016
Rejsby Klæggrav		2007		2016	18	197	5	90	0	0	0.398
Rettrupkær Sø		2004		2011	28	1298	3	89	2	2	0.164
Ringe Sø		2004		2012	14	311	35	41	2	3	0.248
Rødding Sø		2004		2013	21	319	13	74	2	4	0.230
Rønnebæk Sø		2018		2018	8	270	5	76	6	4	0.093
Rugård Søndersø		1988		2014	8	613	2	58	27	9	1.396
Saltvandssøen[a]		1981		2011	235	838	0	3	0	69	0.322
Sem Sø		1997		2012	7	352	2	69	23	4	0.404
Skænken Sø		1999		2008	32	34	0	5	0	95	0.066
Skenkel Sø		2010		2015	63	959	22	57	3	5	0.584
Slagelse Nysø		2004		2016	14	427	4	1	37	4	0.056
Slivsø		2004		2014	171	4786	4	77	11	4	0.103
Sneum Digesø		1992		2014	24	32	0	77	0	18	0.280
Solbjerg Engsø		1993		2017	33	4318	19	23	34	7	0.392
Solkær Enge[a]		2004		2012	60	3654	6	81	5	4	0.226
Spøttrup Sø		1994		2016	52	1949	5	82	3	6	0.139
Stenskovsø midt		2015		2018	0	1	0	100	0	0	0.434
Stenskovsø øst		2015		2018	2	93	3	93	1	2	0.086
Stenskovsø vest		2015		2018	2	93	3	93	1	2	0.093
Strødam Engsø		1996		2017	17	2636	27	20	23	7	0.261
Sundby Sø		2008		2016	47	2437	6	84	2	3	0.054

Sundet		2000		2013	29	60	0	80	3	12	0.196
Syberg Sø		2017		2018	29	306	25	51	1	5	0.069
Tange Sø		1921		1980	541	168323	6	62	17	9	0.189
Tarm Vestereng		2003		2016	71	76	0	12	0	86	0.057
Thissingvig		2008		2017	74	2882	5	84	4	3	0.192
Tim Enge		2007		2013	84	9870	3	68	14	12	0.055
Tofte Sø		1973		2016	74	186	0	0	1	98	1.798
Tønder Nørresø		2009		2015	54	89926	4	78	7	6	0.071
Tryggelev Nor Vest[a]		2004		2009	29	945	5	76	3	14	0.580
Tulstrup 1[b]		2013		2019	3	27	4	38	0	55	0.018
Tulstrup 3[b]		2005		2019	3	9	0	34	0	66	0.017
Udkæret		2000		2016	6	613	2	20	70	2	0.487
Valdemar Slotssø		2003		2015	16	102	20	46	20	5	0.814
Vilsted Sø		2006		2017	450	8868	4	73	9	9	0.149
Vitsø Nor		2009		2015	49	63	0	58	1	37	0.198
Wedellsborg Hoved[a]		2001		2017	10	208	4	54	23	10	0.436

2. Regressions between runoff and TP-transport of different soil types (Blicher-Mathiesen et al. 2018):

Tabel S2. TP is in kg P ha^{-1} year^{-1} and runoff is in mm.

Loamy soils		
%	regressions	R^2
80	TP = 0.0011 * runoff - 0.0265	0.81
86	TP = 0.0017 * runoff - 0.0039	0.78
70	TP = 0.0014 * runoff - 0.0933	0.51
76	TP = 0.0012 * runoff + 0.0774	0.51
Sandy soils		
72	TP = 0.0013 * runoff - 0.0261	0.36
67	TP = 0.0007 *runoff + 0.0682	0.33

3. Regression between CA : LA and t_W

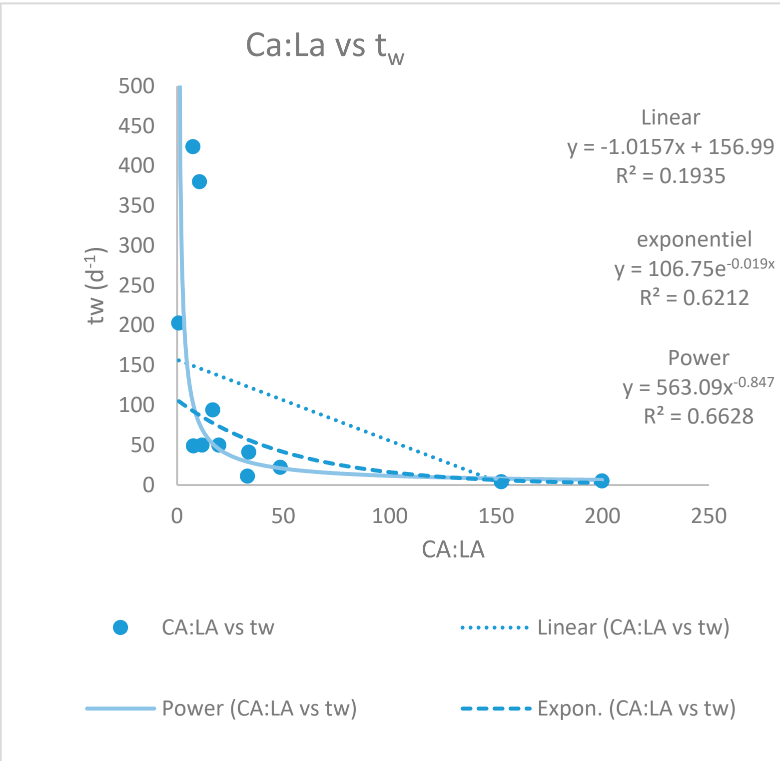

Figure S1. Regression between CA : LA and tw

4. Regression between $TP_{Internal}$, DIP-flux, and proportion of loamy soil in the catchment.

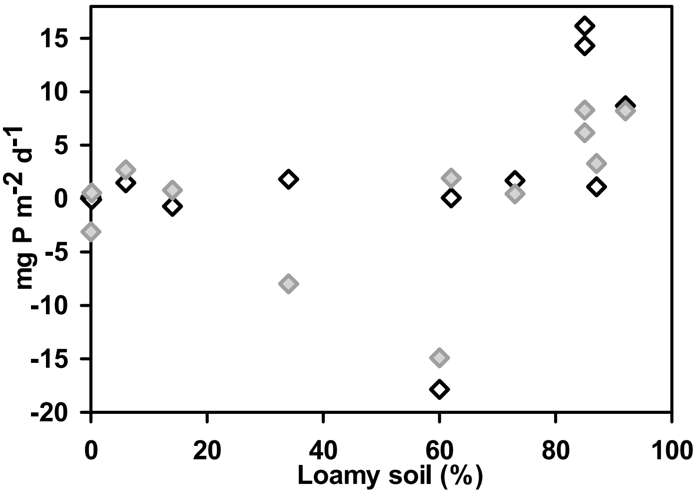

Figure S2. $TP_{Internal}$ (grey) and DIP-flux (white) as a function of the percentile proportion of loamy soil in the catchment of the 12 selected lakes.

5. Regressions between TP_{Summer} and catchment characteristics

Table S3. Regressions are tested with linear and exponential, and power regressions and the regression with the highest R^2-value is stated.

Regressions		n	Type	equations	R^2
TP_{Summer} vs CA:LA	All lakes	90	linear	$y = -0.0002x + 0.3676$	0.008
TP_{Summer} vs CA:LA	All lakes (-out)	88	linear	$y = -0.0011x + 0.4001$	0.011
TP_{Summer} vs CA:LA	Other lakes	88	power	$y = 0.2263x^{-0.077}$	0.015
TP_{Summer} vs CA:LA	12 selected lakes	12	linear	$y = 0.0005x + 0.118$	0.115
TP_{Summer} vs CA:LA	Brackish	10	linear	$y = -0.0061x + 1.127$	0.024
TP_{Summer} vs CA:LA	Gravel-pit lake	7	linear	$y = 0.0005x + 0.0161$	0.084
TP_{Summer} vs Age	Other lakes	61	linear	$y = 0.0014x + 0.2653$	0.002
TP_{Summer} vs Age	12 selected lakes	12	linear	$y = 0.0037x + 0.1035$	0.157
TP_{Summer} vs Age	Brackish	10	linear	$y = 0.0103x + 0.7644$	0.042
TP_{Summer} vs Age	Gravel-pit lake	7	linear	$y = 0.0003x + 0.015$	0.203
TP_{Summer} vs agriculture %	All lakes	90	linear	$y = -0.0031x + 0.5282$	0.028
TP_{Summer} vs agriculture %	12 selected lakes	12	linear	$y = 0.002x - 0.0045$	0.233
TP_{Summer} vs impermeable %	All lakes	90	Exponential	$y = 0.1594e^{0.0117x}$	0.007
TP_{Summer} vs impermeable %	Other lakes	61	Exponential	$y = 0.1658e^{0.0107x}$	0.011
TP_{Summer} vs impermeable %	12 selected lakes	12	Exponential	$y = 0.154e^{-0.024x}$	0.257
TP_{Summer} vs nature %	All lakes	90	Linear	$y = 0.0032x + 0.2846$	0.027

TP_{Summer} vs nature %	All lakes (-out, -brackish)	77	Exponential	$y = 0.183e^{-0.022x}$	0.307
TP_{Summer} vs nature %	12 selected lakes	12	Linear	y = -0.0048x + 0.1652	0.037
TP_{Summer} vs forest %	All lakes (- selected lakes)	78	Exponential	$y = 0.1564e^{0.009x}$	0.010
TP_{Summer} vs forest %	12 selected lakes	12	power	$y = 0.0822x^{0.2021}$	0.398

6. Regressions between measured and modeled TP_{Annual} and catchment parameters

Table S4. Regressions are tested with linear and exponential, and power regressions and the regression with the highest R^2-value is stated.

		type	equation	R^2-values
$TP_{ModAnnual}$ vs Age	measured	Power	$y = 0.073x^{0.133}$	0.060
	Natural average	Linear	y = 0.0012x + 0.1008	0.023
	Runoff dependent	Linear	y = 0.0015x + 0.0991	0.028
	Crop distribution	Linear	y = -0.0072x + 0.5641	0.018
	Model 1)	Linear	y = 0.0057x + 0.1512	0.184
	Model 2)	Linear	y = 0.0019x + 0.0801	0.097
	DNC	Power	$y = 0.1175x^{-0.114}$	0.078
$TP_{ModAnnual}$ vs TP_{Annual} measured	measured	Linear	Y = x	1
	Natural average	Linear	y = 0.5764x + 0.0403	0.597
	Runoff dependent	Linear	y = 0.7744x + 0.0198	0.785
	Crop distribution	Linear	y = 4.1707x + 0.0094	0.634
	Model 1)	Linear	y = 0.5761x + 0.1342	0.204
	Model 2)	Linear	y = 0.2647x + 0.063	0.213
	DNC	Linear	y = 0.1259x + 0.089	0.108
$TP_{ModAnnual}$ vs T_W	measured	Exponential	$y = 0.0808e^{0.001x}$	0.046
	Natural average	Exponential	$y = 0.0701e^{0.0016x}$	0.071
	Runoff dependent	Exponential	$y = 0.0673e^{0.0019x}$	0.088
	Crop distribution	Exponential	$y = 0.212e^{0.0028x}$	0.107
	Model 1)	Exponential	$y = 0.1416e^{0.0005x}$	0.005
	Model 2)	Exponential	$y = 0.0704e^{0.0007x}$	0.012
	DNC	Linear	y = -2E-05x + 0.108	0.006
$TP_{ModAnnual}$ vs loamy soil %	measured	Exponential	$y = 0.0559e^{0.0104x}$	0.307
	Natural average	Exponential	$y = 0.0372e^{0.0164x}$	0.442
	Runoff dependent	Exponential	$y = 0.0351e^{0.0172x}$	0.474
	Crop distribution	Exponential	$y = 0.0951e^{0.0222x}$	0.437
	Model 1)	Exponential	$y = 0.1036e^{0.0073x}$	0.072
	Model 2)	Linear	y = 0.0009x + 0.0528	0.339
	DNC	Linear	y = 0.0004x + 0.0837	0.186

$TP_{ModAnnual}$ vs sandy soil %	measured	Exponential	$y = 0.1491e^{-0.01x}$	0.225
	Natural average	Exponential	$y = 0.1927e^{-0.019x}$	0.427
	Runoff dependent	Exponential	$y = 0.1999e^{-0.02x}$	0.468
	Crop distribution	Exponential	$y = 0.8765e^{-0.025x}$	0.412
	Model 1)	Exponential	$y = 0.2147e^{-0.008x}$	0.066
	Model 2)	Exponential	$y = 0.1525e^{-0.016x}$	0.316
	DNC	Exponential	$y = 0.133e^{-0.007x}$	0.198
$TP_{ModAnnual}$ vs agriculture %	measured	Exponential	$y = 0.0719e^{0.0043x}$	0.019
	Natural average	Exponential	$y = 0.0453e^{0.0116x}$	0.070
	Runoff dependent	Exponential	$y = 0.04e^{0.0137x}$	0.094
	Crop distribution	Exponential	$y = 0.0399e^{0.0372x}$	0.384
	Model 1)	Exponential	$y = 0.0442e^{0.0229x}$	0.219
	Model 2)	Exponential	$y = 0.0367e^{0.0137x}$	0.101
	DNC	Exponential	$y = 0.0734e^{0.0052x}$	0.044
$TP_{ModAnnual}$ vs impermeable %	measured	Exponential	$y = 0.1122e^{-0.012x}$	0.089
	Natural average	Linear	$y = 0.0003x + 0.1071$	0.004
	Runoff dependent	Exponential	$y = 0.0862e^{-0.002x}$	0.002
	Crop distribution	Exponential	$y = 0.4523e^{-0.024x}$	0.106
	Model 1)	Linear	$y = -0.0022x + 0.2473$	0.088
	Model 2)	Linear	$y = 3E-05x + 0.0982$	0.000
	DNC	Exponential	$y = 0.0917e^{0.0029x}$	0.009
$TP_{ModAnnual}$ vs forest %	measured	Exponential	$y = 0.0596e^{0.026x}$	0.230
	Natural average	Exponential	$y = 0.1135e^{-0.019x}$	0.068
	Runoff dependent	Exponential	$y = 0.1031e^{-0.014x}$	0.035
	Crop distribution	Exponential	$y = 0.4487e^{-0.028x}$	0.080
	Model 1)	Exponential	$y = 0.2009e^{-0.019x}$	0.054
	Model 2)	Exponential	$y = 0.1156e^{-0.027x}$	0.140
	DNC	Exponential	$y = 0.1259e^{-0.017x}$	0.164
$TP_{ModAnnual}$ vs nature %	measured	Exponential	$y = 0.1251e^{-0.041x}$	0.069
	Natural average	Exponential	$y = 0.1644e^{-0.088x}$	0.176
	Runoff dependent	Exponential	$y = 0.1826e^{-0.103x}$	0.237
	Crop distribution	Linear	$y = -0.0342x + 0.7565$	0.086
	Model 1)	Linear	$y = 0.0044x + 0.1719$	0.024
	Model 2)	Exponential	$y = 0.1114e^{-0.05x}$	0.060
	DNC	Exponential	$y = 0.1264e^{-0.035x}$	0.088
$TP_{ModAnnual}$ vs slope	measured	Exponential	$y = 0.0784e^{0.025x}$	0.050
	Natural average	Linear	$y = -0.0007x + 0.1166$	0.003

	Runoff dependent	Linear	y = -0.0009x + 0.119	0.004
	Crop distribution	Linear	y = -0.0075x + 0.5365	0.008
	Model 1)	Linear	y = -0.0084x + 0.253	0.155
	Model 2)	Linear	y = -0.0015x + 0.1074	0.024
	DNC	Exponential	$y = 0.0945e^{0.0043x}$	0.003
$TP_{ModAnnual}$ vs Annual precipitation	measured	Exponential	$y = 1.6819e^{-0.003x}$	0.341
	Natural average	Linear	y = -0.0005x + 0.4996	0.475
	Runoff dependent	Exponential	$y = 4.752e^{-0.005x}$	0.347
	Crop distribution	Exponential	$y = 41.957e^{-0.006x}$	0.290
	Model 1)	Linear	y = -0.0001x + 0.311	0.013
	Model 2)	Linear	y = -0.0003x + 0.3457	0.322
	DNC	Linear	y = -0.0001x + 0.2273	0.183
$TP_{ModAnnual}$ vs lake area	measured	Linear	y = -1E-04x + 0.1353	0.071
	Natural average	Linear	y = -0.0001x + 0.1389	0.242
	Runoff dependent	Exponential	$y = 0.1103e^{-0.002x}$	0.192
	Crop distribution	Linear	y = -0.0005x + 0.5954	0.078
	Model 1)	Linear	y = 0.0001x + 0.1802	0.085
	Model 2)	Linear	y = -0.0001x + 0.1175	0.205
	DNC	Linear	y = -3E-05x + 0.1121	0.053