

Supplementary material

Table S1. Description of environmental variables and its source

	Description	Acronym	Scale	Type	Units	Source
Climatic	Mean temperature during summer	TMESU	catchment	Climate	°C	E-OBS v20e database for temperature (Cornes et al., 2018)
	Mean maximum temperature	MN_tx	catchment	Climate	°C	
	Mean minimum temperature	MN_tn	catchment	Climate	°C	
	Mean average temperature	MN_tg	catchment	Climate	°C	
	Mean annual precipitation	MN_rr	catchment	Climate	mm	SPREAD dataset Serrano-Notivoli et al., 2017
Geological	Mean percentage of igneous rocks	MN_IG	catchment	Geology	%	SOILGRIDS and S-WORLD map/ National soil type map
	Mean percentage of limestone rocks	MN_LM	catchment	Geology	%	
	Mean percentage of sedimentary rocks	MN_SD	catchment	Geology	%	
	Mean percentage of schists rocks	MN_SQ	catchment	Geology	%	
Topographical	The drainage area of the watershed located above each channel segment.	AREA_SQKM	reach	Topography	km ²	European MDT ASTER GDEM V2 (90 m)/ National DEM (5 m)
	Average elevation of the pixels of the reach	ELEV_M	reach	Topography	m/10	European MDT ASTER GDEM V2 (90 m)/ National DEM (5 m)
	Distance from basin outlet	OUT_DIST	reach	Topography	m	
	NetMap classifies streams according to stream order using the Strahler method (1957).	STRM_ORDER	reach	Topography	Classes, 1 – 7+	Netmap
Hydro-morphological	Mean flow during summer in each reach	FLOW	reach	Hydrology	m/s	National gauge stations network/Local river monitoring system. Netmap and SPHY model
	Number of high flow events per year using an upper threshold of 3 time median flow over all years.Events/year	FRE3	reach	Hydrology	Number	Netmap and SPHY model
	Bankfull channel width predicted by statistical regressions	WIDTH_m	reach	Topography	m	Netmap
	Mean Generic Erosion Potential	MN_gepdelm	catchment	Topography	%	Netmap
	Buffer Generic Erosion Potential	BF_gepdelm	reach	Topography	%	Netmap
LULC	Mean broadleaf forest area	MN_bif	catchment	Land use	%	European-National LULC map (CORINE)/Regional LULC map/Regional habitat map/Local occurrence data
	Buffer broadleaf forest	BF_bif	reach	Land use	%	
	Mean agricultural area	MN_agr	catchment	Land use	%	
	Buffer agricultural	BF_agr	reach	Land use	%	
	Mean urban use area	MN_uhd	catchment	Land use	%	
	Buffer urban use	BF_uhd	reach	Land use	%	
	Mean sylviculture area	MN_syl	catchment	Land use	%	
	Buffer sylviculture area	BF_syl	reach	Land use	%	

Table S2. Spatial data sources per country

		France	Northern Ireland	Portugal	Spain
Boundary and context	Physiography (river network, basins, etc)	Data is in IGNF:LAMB93 - RGF93 Lambert 93	Data is in EPSG:4326 - WGS84, and EPSG:29900 - TM65 / Irish National Grid	Data is in EPSG:3763 - ETRS89 / Portugal TM06 and in EPSG:4326 - WGS 84	Data is in EPSG:25830 - ETRS89 / UTM zone 30N
Topography	National DEM (5 m)	Data is in with IGNF:LAMB93 - RGF93 Lambert 93	Data is in EPSG:29900 - TM65 / Irish National Grid and in EPSG: 29903 -- TM75 / Irish Grid	Data is in EPSG:3763 - ETRS89 / Portugal TM06. There is also a DEM with 10 m resolution, in ESRI:102164 --	Data is in EPSG:25830 - ETRS89 / UTM zone 30N
Geology/Lithology	National to regional maps	Regional data of the catchment. Data in IGNF:LAMB93 - RGF93 Lambert 93	Data is in EPSG:29902 - TM65 / Irish Grid	Only regional data. Data is in EPSG:3763 - ETRS89 / Portugal TM06	Only regional data of the CS. Data is in EPSG:25830 - ETRS89 / UTM zone 30N
Edaphology (soil properties information)	National soil type map	Regional info, not national. Data in IGNF:LAMB93 - RGF93 Lambert 93	Regional data, of the catchment, this is in EPSG:29900 - TM65 / Irish National Grid.	Regional data, of the catchment. Data is in EPSG:3763 - ETRS89 / Portugal TM06	Data is in EPSG:25830 - ETRS89 / UTM zone 30N
Remote Sensing data	Satellite imagery: Sentinel 2, Landsat time series	Data from 2016/2017. Data is in EPSG:32630 - WGS 84 / UTM zone 30N	Landsat data is in EPSG:32630 - WGS 84 / UTM zone 30N. Sentinel data is in EPSG:32629 - WGS 84 / UTM zone 29N	Data is in EPSG:32629 -- WGS84 / UTM zone 29N	Data is in EPSG:32630 - WGS 84 / UTM zone 30N
	LiDAR data				Data is in EPSG:25830 - ETRS89 / UTM zone 30N
	SAR data		Bathymetry data, derived from satellite. Data is in EPSG:32630 - WGS 84 / UTM zone 30N		
	Aerial photographs	Data from 1947. Data is in IGNF:LAMB93 - RGF93 Lambert 93	Data in EPSG:29900 - TM65 / Irish National Grid.		Aerial data in .ECW
Land use, land cover and vegetation	European-National LULC map (CORINE)	Data is in IGNF:LAMB93 - RGF93 Lambert 93.	Data is in EPSG:3035 - ETRS89-extended / LAEA Europe and in EPSG:29900 - TM65 / Irish National Grid	2018 CLC is in EPSG:3035 - ETRS89-extended / LAEA Europe	
	Regional LULC map	Data is in IGNF:LAMB93 - RGF93 Lambert 93		Data is in EPSG:3763 - ETRS89 / Portugal TM06	Data is in EPSG:25830 - ETRS89 / UTM zone 30N
Hydrology	National gauge stations network		Data is in EPSG:29900 - TM65 / Irish National Grid		
	Local river monitoring system	Data is in IGNF:LAMB93 - RGF93 Lambert 93		Data is in ESRI:102164 - Lisboa_Hayford_Gauss_GeoE	Data is in EPSG:25830 - ETRS89 / UTM zone 30N and EPSG:4258 - ETRS89

Table S3. Average values of environmental variables per catchment. See Table S1 for environmental variable codes.

VARIABLE	Carlingford-Lough	Couesnon	Ason	Miera	Pas	Paiva
AREA_SQKM	47.75	171.66	140.82	109.99	101.70	193.67
ELEV_M	18.11	39.17	139.25	154.54	206.56	395.96
OUT_DIST	26.99	41.36	17.81	20.64	32.83	53.38
STRM_ORDER	3.23	4.14	5.16	4.93	4.95	3.94
WIDTH_m	8.92	10.25	13.10	13.32	12.94	16.24
FLOW_	0.63	0.54	1.84	0.80	0.47	1.25
FRE3	4.38	4.89	7.05	7.73	5.81	4.17
TMESU	11.38	16.39	13.12	13.67	12.75	17.19
MN_blf	0.02	0.14	0.11	0.08	0.13	0.21
BF_blf	0.02	0.23	0.34	0.29	0.14	0.47
MN_agr	0.02	0.41	0.01	0.02	0.01	0.14
BF_agr	0.04	0.10	0.01	0.03	0.01	0.17
MN_uhd	0.03	0.08	0.01	0.02	0.01	0.03
BF_uhd	0.23	0.09	0.06	0.11	0.06	0.02
MN_gepdelm	0.01	0.00	0.15	0.18	0.15	0.02
BF_gepdelm	0.00	0.00	0.09	0.08	0.11	0.05
MN_IG	0.50	0.00	0.00	0.00	0.02	0.70
MN_LM	0.00	0.00	0.33	0.39	0.15	0.00
MN_SD	0.50	0.00	0.59	0.46	0.29	0.30
MN_SQ	0.00	0.00	0.67	0.15	0.41	0.00
MN_syl	0.05	0.04	0.12	0.05	0.04	0.27
BF_syl	0.00	0.02	0.03	0.03	0.08	0.22
MN_tx	8.46	15.19	15.92	16.18	15.63	18.87
MN_tn	3.70	7.55	5.27	5.76	4.93	7.48
MN_tg	6.06	11.34	8.23	8.92	7.73	13.05
MN_rr	998.75	696.69	1522.60	1713.87	1557.84	1352.64

Table S4. ANOVA and Tukey post-hoc tests for the comparison of rarefied richness between catchments. Only the results of the groups that yield significant results (Prokaryotes and algae) are shown. N.s. Not significant.

	Prokaryotes	Algae
	Pr(>F)	Pr(>F)
ANOVA overall significance	0.0019	0.003
Tukey post-hoc	p adjusted	p adjusted
Paiva-Ason	n.s.	0.002
Paiva-Miera	0.002	0.05
Paiva-Pas	0.02	0.01
Couesnon-Paiva	n.s.	0.03

Table S5. Results of the pairwise –adonis test on differences between RMC communities for all catchment comparisons per taxonomic group (Prokaryotes, fungi, protist and algae). F-test statistics and adjusted p values are shown. P-adjusted values for not significant results are left blank.

Site comparison	Prokaryotes		Fungi		Protist		Algae	
	F-Model	p-adjusted	F-Model	p-adjusted	F-Model	p-adjusted	F-Model	p-adjusted
Asón - Carlingford	3.39		3.48	0.015	3.28	0.015	5.30	0.015
Asón - Couesnon	9.62	0.015	10.56	0.015	4.31	0.015	11.75	0.015
Asón - Miera	2.53		1.42		1.02		1.46	
Asón - Paiva	12.7	0.015	13.89	0.015	8.32	0.015	13.66	0.015
Asón - Pas	3.95		2.86	0.03	1.33	0.03	2.05	
Carlingford - Couesnon	6.14	0.015	5.32	0.015	3.29	0.015	4.91	0.015
Carlingford - Miera	2.74		2.75	0.03	2.86	0.03	3.88	0.03
Carlingford - Paiva	9.86	0.015	7.63	0.015	2.95	0.015	7.36	0.015
Carlingford - Pas	2.38		3.04		2.34		3.35	0.045
Couesnon - Miera	8.52	0.015	8.52	0.015	3.65	0.015	8.72	0.015
Couesnon - Paiva	12.46	0.015	8.67	0.015	5.16	0.015	10.55	0.015
Couesnon - Pas	9.95	0.015	8.02	0.015	4.29	0.015	10.48	0.015
Miera - Paiva	12.52	0.015	10.33	0.015	7.47	0.015	11.59	0.015
Miera - Pas	1.96		1.38		1.05		1.93	
Paiva - Pas	12.83	0.015	9.04	0.015	6.51	0.015	10.50	0.015

Table S6. Variation partitioning results for RMC richness showing adjusted variation, percentage of explained variation, percentage explained from total variation and degrees of freedom for each fraction and combined fractions. Clim-geo: climatic and geological variables; Topo: Topographical variables; LULC: Land use and land cover variables.

Prokaryotes

Fraction	Variation(adj)	% of Explained	% of All	DF
Clim-geo	0.23	57.63	23.405	5
Topo	0.12	30.22	12.272	2
LULC	0.04	8.84	3.589	2
Clim-geo + Topo	-0.04	--	-3.793	--
Topo + LULC	0.01	1.48	0.603	--
Clim-geo + LULC	0.01	1.29	0.523	--
Shared by all	0.00	0.55	0.222	--
Total Explained	0.37	100.00	36.82	9.00

Fungi

Fraction	Variation(adj)	% of Explained	% of All	DF
Clim-geo	0.07381	31.20	7.381	4
Topo	0.01716	7.25	1.716	1
LULC	0.13847	58.53	13.847	4
Clim-geo + Topo	-0.0004	--	-0.04	--
Topo + LULC	0.00713	3.01	0.713	--
Clim-geo + LULC	-0.05461	--	-5.461	--
Shared by all	-0.0067	--	-0.67	--
Total Explained	0.17486	100.00	17.486	9

Protist

Fraction	Variation(adj)	% of Explained	% of All	DF
Clim-geo	0.0755	37.16	7.55	3
Topo	--	0.00	--	--
LULC	0.12768	62.84	12.768	3
Clim-geo + Topo	--	0.00	--	--
Topo + LULC	--	0.00	--	--
Clim-geo + LULC	-0.0315	--	-3.15	6
Shared by all	--	0.00	--	--
Total Explained	0.17168	100.00	17.168	12

Algae

Fraction	Variation(adj)	% of Explained	% of All	DF
Clim-geo	0.12641	46.28	12.641	1
Topo	--	0.00	--	--
LULC	0.14674	53.72	14.674	4
Clim-geo + Topo	--	0.00	--	--
Topo + LULC	--	0.00	--	--
Clim-geo + LULC	-0.05327	--	-5.327	--
Shared by all	--	0.00	--	--
Total Explained	0.21988	100.00	21.988	5

Table S7. Variation partitioning results for RMC composition based on RDA analysis showing adjusted variation, percentage of explained variation, percentage explained from total variation, degrees of freedom and mean squares for each fraction and combined fractions. Clim-geo: climatic and geological variables; Topo: Topographical variables; LULC: Land use and land cover variables.

Prokaryotes

Fraction	Variation(adj)	% of Explained	% of All	DF	Mean Square
Clim-geo	0.085686	24.6	8.6	5	0.023
Topo	0.054965	15.8	5.5	3	0.023
LULC	0.02941	8.4	2.9	4	0.013
Clim-geo + Topo	0.05304	15.2	5.3	--	--
Topo + LULC	0.0097434	2.8	1	--	--
Clim-geo + LULC	0.062378	17.9	6.2	--	--
Shared by all	0.05346	15.3	5.3	--	--
Total Explained	0.34868	100	34.9	12	0.036

Fungi

Fraction	Variation(adj)	% of Explained	% of All	DF	Mean Square
Clim-geo	0.055675	22.7	5.6	6	0.016
Topo	0.041739	17.1	4.2	4	0.017
LULC	0.0091882	3.8	0.9	5	0.009
Clim-geo + Topo	0.03265	13.3	3.3	--	--
Topo + LULC	-0.0019585	-0.8	-0.2	--	--
Clim-geo + LULC	0.043157	17.6	4.3	--	--
Shared by all	0.064319	26.3	6.4	--	--
Total Explained	0.24477	100	24.5	15	0.024

Protist

Fraction	Variation(adj)	% of Explained	% of All	DF	Mean Square
Clim-geo	0.063181	34.8	6.3	5	0.02
Topo	0.025702	14.2	2.6	4	0.014
LULC	0.0045809	2.5	0.5	5	0.009
Clim-geo + Topo	0.0048136	2.7	0.5	--	--
Topo + LULC	0.0061564	3.4	0.6	--	--
Clim-geo + LULC	0.040642	22.4	4.1	--	--
Shared by all	0.036265	20	3.6	--	--
Total Explained	0.18134	100	18.1	14	0.021

Algae

Fraction	Variation(adj)	% of Explained	% of All	DF	Mean Square
Clim-geo	0.10006	35.4	10	5	0.026
Topo	0.035848	12.7	3.6	3	0.018
LULC	0.02379	8.4	2.4	5	0.012
Clim-geo + Topo	0.0050555	1.8	0.5	--	3
Topo + LULC	0.0067241	2.4	0.7	--	5
Clim-geo + LULC	0.07055	24.9	7.1	--	4
Shared by all	0.040859	14.4	4.1	--	6
Total Explained	0.28288	100	28.3	13	0.029

Table S8. Percentage of explained variation, contribution and statistics of each fraction separately and por taxonomical group based on RDA analysis. See Table S1 for environmental variable codes.

Climatic-geological					Prokaryotes					Land use				
Overall Explains 25.46%					Overall Explains 17.2%					Overall Explains 15.5%				
Name	Explains %	Contribution	pseudo-F	P	Name	Explains %	Contribution	pseudo-F	P	Name	Explains %	Contribution	pseudo-F	P
MN_tg	10.6	33.5	11.2	0.002	AREA_SQKM	7.9	35.3	8.2	0.002	MN_agr	11	43.7	11.7	0.002
MN_rr	7.4	23.6	8.5	0.002	ELEV_M	6.4	28.5	7	0.002	MN_blf	3.2	12.6	3.5	0.004
MN_LM	6.8	21.4	8.3	0.002	STRM_ORDE	5.4	24.2	6.3	0.002	MN_uhd	3	11.8	3.2	0.002
MN_IG	2.5	8.1	3.2	0.004						MN_syl	1.9	7.6	2.2	0.018
MN_SD	2	6.5	2.6	0.006										
Fungi														
Overall Explains 19.58%					Overall Explains 13.67%					Overall Explains 11.47%				
Name	Explains %	Contribution	pseudo-F	P	Name	Explains %	Contribution	pseudo-F	P	Name	Explains %	Contribution	pseudo-F	P
MN_tg	9.3	36.7	9.9	0.002	STRM_ORDE	5.9	34.2	6.3	0.002	MN_agr	7.8	39.2	8.2	0.002
MN_rr	4.4	17.5	4.9	0.002	ELEV_M	4.6	26.5	5.1	0.002	BF_gepdelm	2.5	12.3	2.6	0.004
MN_IG	3.8	15	4.4	0.002	AREA_SQKM	4.2	24.7	4.3	0.002	BF_syl	2	10.1	2.2	0.004
MN_LM	3.1	12.1	3.6	0.002	OUT_DIST	2.5	14.7	2.9	0.002	MN_uhd	1.8	9.2	2	0.016
MN_SD	2.5	9.9	3	0.002						MN_blf	1.8	9.2	2	0.022
MN_SQ	1.4	5.6	1.7	0.036										
Protist														
Overall Explains 14.49%					Overall Explains 7.29%					Overall Explains 8.76%				
Name	Explains %	Contribution	pseudo-F	P	Name	Explains %	Contribution	pseudo-F	P	Name	Explains %	Contribution	pseudo-F	P
MN_LM	6.7	32.2	6.9	0.002	AREA_SQKM	3.6	32.9	3.8	0.002	MN_agr	5	28.8	5.2	0.002
MN_rr	5.2	24.9	5.6	0.002	OUT_DIST	3.3	29.8	3.3	0.004	BF_uhd	2.4	13.4	2.5	0.004
MN_IG	2.5	12	2.7	0.002	STRM_ORDE	2.4	21.3	2.4	0.008	BF_agr	2.3	12.8	2.3	0.004
MN_SD	2.4	11.6	2.7	0.002	ELEV_M	1.8	16	1.9	0.024	BF_gepdelm	2.2	12.4	2.3	0.004
MN_tg	2.2	10.6	2.5	0.002						BF_syl	1.6	9.1	1.7	0.046
Algae														
Overall Explains 21.65%					Overall Explains 8.85%					Overall Explains 14.19%				
Name	Explains %	Contribution	pseudo-F	P	Name	Explains %	Contribution	pseudo-F	P	Name	Explains %	Contribution	pseudo-F	P
MN_LM	9.3	33.8	10	0.002	ELEV_M	5	29.5	5.1	0.002	MN_agr	9.4	41.2	10.1	0.002
MN_rr	6.4	23.1	7.3	0.002	OUT_DIST	3.8	22.6	4	0.002	BF_gepdelm	3.2	14.2	3.6	0.002
MN_tg	5.8	21.1	7.1	0.002	AREA_SQKM	2.9	17	3.1	0.002	MN_uhd	2.6	11.5	2.9	0.002
MN_IG	2.6	9.5	3.3	0.002						MN_syl	1.8	7.7	2	0.008
MN_SD	1.4	5.2	1.8	0.034						MN_blf	1.5	6.7	1.7	0.048

Table S9. Richness models coefficients and derived statistics for each taxonomical group.

Prokaryote model Coefficients				
	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	13125.16	1251.6	10.487	< 2e-16 ***
AREA_SQKM	-864.27	245.57	-3.519	0.000691 ***
FRE3	337	131.43	2.564	0.012058 *
MN_uhd	-15744.02	8465.87	-1.86	0.066307 .
MN_IG	-2205.68	611.27	-3.608	0.000514 ***
MN_SD	-7014.69	1930.88	-3.633	0.000473 ***
MN_SQ	-1396.75	603.84	-2.313	0.023075 *
MN_syl	8656.07	4500.84	1.923	0.057724 .
MN_tg	-147.63	86.86	-1.7	0.092763 .
ELEV_M	393.86	270.92	1.454	0.149596

Fungi model Coefficients				
	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	793.02	86.24	9.195	1.79e-14 ***
AREA_SQKM	59.92	35.62	1.682	0.09609 .
MN_blf	1087.29	697.74	1.558	0.1228
BF_blf	367.29	233.98	1.57	0.1201
BF_agr	228.29	148.64	1.536	0.12821
BF_gepdelm	2994.23	948.4	3.157	0.00219 **
MN_IG	-115.47	81.69	-1.413	0.1611
MN_LM	-159.06	99.54	-1.598	0.11366
MN_SD	606.77	265.53	2.285	0.02473 *
MN_SQ	-225.42	88.22	-2.555	0.01235 *

Protist model Coefficients				
	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	7.84E+02	7.47E+01	10.487	< 2e-16 ***
BF_blf	4.25E+02	1.72E+02	2.464	0.015633 *
MN_uhd	-1.79E+03	1.00E+03	-1.79	0.076766 .
BF_gepdelm	2.72E+03	7.88E+02	3.454	0.000844 ***
MN_SQ	-1.92E+02	6.43E+01	-2.984	0.003667 **
MN_SD	4.13E+02	2.17E+02	1.906	0.059848 .
MN_rr	-7.85E-02	5.71E-02	-1.375	0.17266

Algae model Coefficients				
	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	1061.33	52.83	20.089	< 2e-16 ***
BF_blf	568.53	269.14	2.112	0.037393 *
MN_uhd	-2223.81	1410.9	-1.576	0.118458
BF_gepdelm	2057.5	1148.78	1.791	0.076612 .
MN_SQ	-397.47	99.66	-3.988	0.000134 ***
MN_syl	1698.63	582.88	2.914	0.004488 **