

Macrophyte- and macrozoobenthic-based assessment in rivers: specificity of response to physico-chemical stressors

Emilia Varadinova^{1,2}, Gana Gecheva^{3*}, Violeta Tyufekchieva², Tanya Milkova⁴

Supplementary Materials

Table S1: Study sites with indicated geographic coordinates, altitude, river type, and ecological quality ratio (EQR) sorted by type (natural and HMWB) of water body; MPH—macrophytes; MZB—macrozoobenthos. Legend for river type: R1—alpine rivers; R3—mountainous rivers; R4/5—semi-mountainous rivers; R7—large Danube tributaries; R8—medium and small Danube rivers; R9—Dobrudzha degrading rivers; R10—large Black Sea rivers; R11—small and medium Black Sea rivers; R12—large lowland rivers; R13—small and medium lowland rivers; R15—karst springs; R16—Black Sea river estuaries. The EQR color scale represents the ecological status/potential as follows: blue—high, green—good, yellow—moderate, orange—poor.

No	River site	Latitude (N)	Longitude (E)	Altitude (m a.s.l.)	River Type	Natural/ HMWB	EQR- MPH	EQR- MZB
1	Stryama River, Manole Village	42.287848	24.912821	190	R13	Natural	Poor	High
2	Bunovitsa River, before Topolnitsa River	42.61505	24.010267	481	R5	Natural	Poor	High
3	Kamchiya River, Grozdyovo Village	43.033455	27.554753	21	R10	Natural	Moderate	High
4	Kamchiya River, Venelin Village	43.036131	27.675437	15	R10	Natural	Moderate	High
5	Karaagach River, Fazanovo Village	42.19488	27.74791	7	R11	Natural	Moderate	High
6	Tundzha River, Srem Village, before bridge	42.062633	26.47655	89	R12	Natural	Moderate	High
7	Karst spring of Maarata River, Krushuna Village	43.14765	25.020051	144	R15	Natural	Moderate	High
8	Lisovo Dere River, near Kiten Town	42.158786	27.864125	5	R16	Natural	Moderate	High
9	Butamyata River, liman	42.053667	27.98565	1	R16	Natural	Moderate	High

10	Rusokastrenska River, Trastikovo Village	42.42503	27.25981	10	R11	Natural	Poor	Good
11	Devnenska River, mouth	43.179109	27.626486	4	R15	Natural	Poor	Good
12	Tundzha River, Yagoda Village, old bridge	42.32745	25.33805	307	R5	Natural	Poor	Good
13	Chairluk River, Cherkovna Village	43.60609	26.63787	268	R9	Natural	Poor	Good
14	Asenovska River, Sliven Town	42.687583	26.283617	290	R3	HMWB	Poor	High
15	Struma River, before Belishka River	41.63314	23.19722	129	R5	HMWB	Poor	High
16	Provadiyska River, upstream Provadiya Town	43.20507	27.43465	42	R11	HMWB	Poor	Good
17	Lesnovska River, before inflow into Iskar River	42.46819	23.22279	492	R4	HMWB	Poor	Good
18	Kamchia River, Shalamanovo Village	43.176949	26.992634	71	R4	HMWB	Poor	Good
19	Struma River, Topolnitsa Village	41.415	23.31859	75	R5	HMWB	Poor	Good
20	Potoka River, before Saedinenie Town	42.297901	24.524951	248	R13	Natural	High	Good
21	Maritsa River, Dolna Banya Village	42.315418	23.73362	733	R3	Natural	High	Good
22	Stryama River, Slatina Village	42.690594	24.568402	518	R5	Natural	High	Good
23	Retidge River, above WHPS	41.72808	23.55775	1622	R1	Natural	Good	High
24	Blagoevgradska Bistritsa River, after Bodrost hut	42.03098	23.27414	896	R1	Natural	Good	High
25	Vlachinska River, before Sinanitsa River	41.73778	23.2297	479	R1	Natural	Good	High
26	Veleka River, Brodilovo Village	43.081503	27.860311	56	R10	Natural	Good	High
27	Sredetska River, Valchanovo Village, bridge	42.31228	27.04267	45	R11	Natural	Good	High

28	Silistar River, upstream delta	42.02268	27.9994	10	R11	Natural	Good	High
29	Tundzha River, Samuilovo Village	42.583833	26.322233	153	R12	Natural	Good	High
30	Matnitsa River, before Perelik Village	41.49506	23.86401	486	R13	Natural	Good	High
31	Mochura River	41.62	23.45251	1653	R13	Natural	Good	High
32	Iztok River, before Mesta River	41.89277	23.54382	759	R15	Natural	Good	High
33	Petrovska River, before river mouth	41.40653	23.43201	174	R15	Natural	Good	High
34	Veleka River, bridge to the road E87	42.060853	27.966979	4	R16	Natural	Good	High
35	Chepelarska River, after Bachkovo Village	41.963868	24.864603	375	R3	Natural	Good	High
36	Bezbozhka River, before river mouth	41.81934	23.62031	705	R3	Natural	Good	High
37	Mesta River, Gospodintsi Village	41.6543	23.73337	548	R5	Natural	Good	High
38	Maritsa River, Plovdiv Town	42.153263	23.745178	193	R12	Natural	Good	Moderate
39	Senkyovitsa River, Golyama Voda Village	43.56678	26.83259	305	R9	Natural	Good	Moderate
40	Ovcharitsa River, Prohorovo Village	42.3536	26.207933	175	R13	Natural	Good	Moderate
41	Kamchiya River, Poda	43.021014	27.820399	30	R10	Natural	Moderate	Good
42	Maritsa River, Parvomai Village	42.116009	24.212368	158	R12	Natural	Moderate	Good
43	Stryama River, Banya Village	42.5203	24.8476	300	R5	Natural	Moderate	Good
44	Fandakliyska River, near Shkorpilovtsi Resort	42.957343	27.896283	1	R16	Natural	Moderate	Poor
45	Stryama River, Razheno Konare Village	42.33452	24.803253	230	R13	Natural	Poor	Moderate
46	Dobrichka River, bridge between Rosenovo and	43.644784	27.76255	183	R9	Natural	Poor	Moderate

	Kozloduytsi Village							
47	Bebresh River, Scravena Village	42.57185	23.4586	301	R4	HMWB	High	Good
48	Arkata River, before Struma River	42.48029	22.91527	625	R13	HMWB	Good	High
49	Aheloi River, mouth	42.634128	27.640458	3	R16	HMWB	Good	High
50	Yadenitsa River, after Yundola Resort	42.101138	23.889909	1190	R3	HMWB	Good	High
51	Aitoska River, downstream Kameno Village	42.56893	27.3094	10	R11	HMWB	Good	Moderate
52	Maritsa River, Ognyanovo Village, after Luda Yana River	42.14411	24.412279	220	R12	HMWB	Good	Moderate
53	Shavarna River, before inflow of Osam River	43.20432	25.0717	66	R8	HMWB	Good	Moderate
54	Cherni Lom River, before inflow in Banski Lom River	43.32377	25.57649	90	R8	HMWB	Good	Moderate
55	Sredetska River, Sredets Town, Avramov bridge	42.3672	27.23407	7	R11	HMWB	Moderate	Good
56	Maritsa River, Stamboliyski Town, the bridge	42.151781	24.553512	200	R12	HMWB	Moderate	Good
57	Maritsa River, Govedare Village	43.143761	24.418989	220	R12	HMWB	Moderate	Good
58	Kamchiya River, before Veliki Preslav Town	43.153979	227.82765037	92	R4	HMWB	Moderate	Good
59	Vit River, after Gulyantsi Village	43.38027	24.4186	29	R7	HMWB	Moderate	Good
60	Vit River, after Dolna Mitropoliya Town	43.29601	24.33865	49	R7	HMWB	Moderate	Good
61	Yantra River, Draganovo Village	43.12369	2544390	43	R7	HMWB	Moderate	Good
62	Suha River, Novo Botevo Village	43.47901	27.71176	207	R9	HMWB	Moderate	Good
63	Provadiyska River, downstream Provadia	43.12592	27.47614	18	R11	HMWB	Moderate	Poor

Town								
64	Aidere River, Stoilovo Village	43.033247	27.512782	319	R15	Natural	High	High
65	Maritsa River, Raduil Village	42.281648	23.685428	911	R3	Natural	High	High
66	Ropotamo River, Veselie Village	42.3108	27.62393	25	R11	Natural	Good	Good
67	Dvoinitsa River, before Popovich Village	42.8465	27.74782	27	R11	Natural	Good	Good
68	Tundzha River, Elhovo Town	42.170433	26.55885	102	R12	Natural	Good	Good
69	Ropotamo River, Velyov Vir	42.22957	27.708078	13	R16	Natural	Good	Good
70	Razhdavitsa River, Dobrinishte Town	41.82771	23.55849	837	R5	Natural	Good	Good
71	Provadiyska River, Sindel Village	43.11702	27.59857	7	R11	Natural	Moderate	Moderate
72	Zlatna Panega Rivers, spring	43.5304	24.9381	181	R15	Natural	Moderate	Moderate
73	Ropotamo River, bridge to the road E87	42.302385	27.727823	10	R16	Natural	Moderate	Moderate
74	Karaagach River, mouth	42.225089	27.7771	5	R16	Natural	Moderate	Moderate
75	Tsaratsar River, downstream confluence of Voyka River	43.71585	26.76286	191	R9	Natural	Moderate	Moderate
76	Tsaratsar River, Ludogortsi Village	43.64223	26.78365	259	R9	Natural	Moderate	Moderate
77	Kamchiya River, Avren Village	43.050038	27.596853	404	R10	HMWB	Good	Good
78	Izvorska River, upstream delta between Dimchevo and Tvarditsa Village	42.38941	27.43721	26	R11	HMWB	Good	Good
79	Maritsa River, Pazardzik Town	42.185517	24.31011	205	R12	HMWB	Good	Good
80	Kamchiya River, after Ticha Reservoir	43.093610226	7.9536085	185	R4	HMWB	Good	Good

81	Lefedzha River, Bryagovitsa Village, before Inflow in Yantra River	43.11461	25.53043	131	R7	HMWB	Good	Good
82	Suha River, downstream Odrintsi Reservoir	43.53071	27.70287	179	R9	HMWB	Moderate	Moderate
83	Beli Lom River, after Razgrad Town	43.3292	26.28713	270	R7	HMWB	Bad	Bad

Table S2: List of macrophyte species (nomenclature after Hill et al. [35] for mosses and Euro + Med PlantBase [36] for vascular plants) and their codes.

Non Vascular plants	Code
Mosses	
<i>Platyhypnidium riparioides</i> (Hedw.) Dixon	PLA.RIP
Vascular plants	
Pteridophytes	
<i>Equisetum</i> sp.	EQU.SPX
Hydrophytes	
<i>Ceratophyllum demersum</i>	CER.DEM
<i>Ceratophyllum submersum</i>	CER.SUB
<i>Elodea canadensis</i>	ELO.CAN
<i>Lemna minor</i>	LEM.MIN
<i>Lemna gibba</i>	LEM.GIB
<i>Lemna polyrhiza</i>	LEM.POL
<i>Myriophyllum spicatum</i>	MIR.SPI
<i>Najas marina</i>	NAJ.MAR
<i>Potamogeton berchtoldii</i>	POT.BER
<i>Potamogeton crispus</i>	POT.CRI
<i>Potamogeton pectinatus</i>	POT.PEC
<i>Potamogeton pusillus</i>	POT.PUS
<i>Potamogeton nodosus</i>	POT.NOD
<i>Ranunculus</i> sp.	RAN.SPX
<i>Spirodela polyrhiza</i>	SPR.POL
<i>Vallisneria spiralis</i>	VAL.SPI
Hygrophytes	
<i>Bidens tripartite</i>	BID.TRI
<i>Bidens frondosus</i>	BID.FRO
<i>Cyperus longus</i>	CYP.LON
<i>Myosoton aquaticum</i>	MYS.AQU
<i>Paspalum paspalodes</i>	PAS.PAS
<i>Petasites hybridus</i>	PET.HYB
<i>Polygonum lapathifolium</i>	POL.LAP
<i>Polygonum mite</i>	POL.MIT
<i>Polygonum</i> sp.	POL.SPX

<i>Ranunculus repens</i>	RAN.REP
<i>Ranunculus sceleratus</i>	RAN.SCE
<i>Scirpus maritimus</i>	SCI.MAR

Helophytes

<i>Alisma lanceolatum</i>	ALI.LAN
<i>Alisma plantago-aquatica</i>	ALI.PLA
<i>Berula erecta</i>	BER.ERE
<i>Butomus umbellatus</i>	BUT.UMB
<i>Cyperus fuscus</i>	CYP.FUS
<i>Cyperus glomeratus</i>	CYP.GLO
<i>Echinochloa crus-galli</i>	ECH.GRU
<i>Glyceria fluitans</i>	GLY.FLU
<i>Iris pseudacorus</i>	IRI.PSE
<i>Lycopus europaeus</i>	LYC.EUR
<i>Lythrum salicaria</i>	LYT.SAL
<i>Mentha aquatica</i>	MEN.AQU
<i>Mentha longifolia</i>	MEN.LON
<i>Nasturtium officinale</i>	NAS.OFF
<i>Polygonum hydropiper</i>	POL.HYD
<i>Phragmites australis</i>	PHR.AUS
<i>Rorippa amphibian</i>	ROR.AMP
<i>Sagittaria latifolia</i>	SAG.LAT
<i>Sparganium erectum</i>	SPA.ERE
<i>Scirpus lacustris</i>	SCI.LAC
<i>Typha angustifolia</i>	TYP.ANG
<i>Typha latifolia</i>	TYP.LAT
<i>Typha laxmannii</i>	TYP.LAX
<i>Veronica anagallis-aquatica</i>	VER.ANA
<i>Veronica beccabunga</i>	VER.BEC
<i>Juncus effuses</i>	JUN.EFF
<i>Juncus maritimus</i>	JUN.MAR
