

Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)

ERAMMP Report-65TA1: The development of a hazard map to inform an environmental AMR monitoring programme in Welsh rivers – Abundance and exposure data

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UK Centre for Ecology and Hydrology

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Approved by	James Stakes (Welsh Government) Bridget Emmett (UKCEH)

Abbreviations Used in this Report

AMR	Antimicrobial resistance
CSO	Combined sewer overflow
OPCAT	Operational Catchment
WWTP	Waste Water Treatment Plant

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2 AMR EXPOSURE

To create the AMR exposure hazard maps, these attribute-specific hazard scores were summed to provide an overall unadjusted hazard score for each catchment. This hazard score was then adjusted by further ranking into percentiles (e.g., for the AMR abundance map, unadjusted summed hazard scores above 27 would become a final adjusted hazard score of 5 (highest hazard rank), to be used in the final map). The table shows all the raw data and calculations used to calculate these hazard scores.

For full details see Stanton, I.C., Tipper, H.J. & Singer, A.C. (2022). Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP). ERAMMP Report-65 The development of a hazard map to inform an environmental AMR monitoring programme in Welsh rivers. (Contract C210/2016/2017)(UK Centre for Ecology & Hydrology Projects 06297 & 06810)

NOTES:

OPCAT: Data from Water Framework Directive Operational Catchments Cycle 2 data layer.

Bathing water (designated): Designated bathing water sites data from "Bathing Water Quality at Designated Beaches." Data register ID: 7.

Bathing water (wild swim): Wild swimming sites from "Wild swimming" dataset created for this project which can be found in AdditionalFile_Datasets.xlsx. Data register ID: 54.

OPCAT Information		Bathing waters						Exposure map	
Area km ² f	wild swim	wild swim/area	hazard	designated	designated/area	hazard	Unadjusted	Adjusted hazard	
OPCAT									
Aeron	164.2252162	0	0	1	0	0	2	1	
Afan	118.9742901	0	0	1	0	0	2	1	
Alaw Goch	169.7018278	0	0	1	0	0	2	1	
Alwen	201.0048	0	0	1	0	0	2	1	
Alyn	246.949	0	0	1	0	0	2	1	
Arrow, Lugg and Frome	910.4094	0	0	1	0	0	2	1	
Arth and Wyre	127.4896663	0	0	1	0	0	2	1	
Arthro	117.9437373	1	0.008478619	5	0	0	6	4	
Braint Cadnant Lleinog	154.0281195	0	0	1	0	0	2	1	
Cefni	144.405705	0	0	1	0	0	2	1	
Ceiriog	158.3538	0	0	1	0	0	2	1	
Clun River	271.2708	0	0	1	0	0	2	1	
Clwyd Lower	310.6663497	0	0	1	2	0.006437775	5	4	
Clwyd Upper	205.4602	0	0	1	0	0	2	1	
Clywedog - Dee	103.1803	0	0	1	0	0	2	1	
Coastal streams - Cardigan to Aberaeron	123.3722685	0	0	1	5	0.040527746	5	4	
Coastal streams - Druidston to Fishguard Bay	184.6697752	0	0	1	6	0.032490428	5	4	
Coastal streams - North Gower	72.9193983	0	0	1	0	0	2	1	
Coastal streams - South Gower	106.7634829	0	0	1	0	0	2	1	
Coastal streams and Nevern - Fishguard Bay to Cardigan	262.6448416	0	0	1	1	0.003807423	5	4	
Coastal streams of North Milford Haven - Llangwm Pill to St Anne's Head	130.186509	0	0	1	5	0.038406437	5	4	
Coastal streams of South Pembro and South Milford Haven - Pendine to Landshipping	330.6524705	0	0	1	4	0.012097294	5	4	
Conwy Lower	256.3603602	2	0.007801518	5	0	0	6	4	
Conwy Upper	304.7495	0	0	1	0	0	2	1	
Crigyll Caradog	148.7942116	1	0.006720692	5	0	0	6	4	
Cynon	133.5327625	0	0	1	0	0	2	1	
Dee Estuary	324.4807357	0	0	1	0	0	2	1	
Dee Lower Chester Weir to Ceiriog	286.3929	0	0	1	0	0	2	1	
Dee Middle Ceiriog to Alwen	219.6349	1	0.00455301	5	0	0	6	4	
Dee Upper above Alwen	438.5555	1	0.002280213	4	0	0	5	4	
Dulas Ganol	116.9009722	0	0	1	1	0.008554249	5	4	
Dwyrfor	153.1059473	1	0.006531425	5	1	0.006531425	5	10	
Dwyrfor	198.0384135	1	0.005049525	5	0	0	6	4	
Dyfi Lower	372.3417334	1	0.002685705	5	1	0.002685705	5	10	
Dyfi Upper	315.6874	0	0	1	0	0	2	1	
Dysynni	164.8237656	1	0.006067086	5	0	0	6	4	
East Reens	93.29181131	0	0	1	0	0	2	1	
Eastern Cleddau	207.2289	0	0	1	0	0	2	1	
Ebbw Sirhowy	224.4206934	0	0	1	0	0	2	1	
Elwy	251.5605	0	0	1	0	0	2	1	
Ely	167.4569127	0	0	1	0	0	2	1	
Erch	184.1936932	0	0	1	1	0.005429068	5	4	
Gele	53.82939084	0	0	1	0	0	2	1	
Glaslyn	152.9047526	3	0.019620057	5	0	0	6	4	
Gwendraeth Fach and Fawr	211.9970166	0	0	1	0	0	2	1	
Gwyrfai Seiont	193.0338051	2	0.01036088	5	1	0.00518044	5	10	
Irfon	290.369	2	0.006887788	5	0	0	6	4	
Ithon	360.4932	0	0	1	0	0	2	1	
Kenfig	58.40802632	0	0	1	0	0	2	1	
Llŷgwy - Ynys Mon	60.20809318	0	0	1	0	0	2	1	
Llwyd	105.9175282	0	0	1	0	0	2	1	
Llynfi	70.79067877	1	0.014126154	5	0	0	6	4	
Loughor	394.9511588	0	0	1	0	0	2	1	
Lugg	156.8968	0	0	1	0	0	2	1	
Mawddach	177.3439578	1	0.00563876	5	0	0	6	4	
Mawddach Estuary North	41.48523757	0	0	1	0	0	2	1	
Mawddach Estuary South	41.54076701	1	0.024072738	5	0	0	6	4	
Monnow	434.5936	1	0.002301	5	0	0	6	4	
Morda and Severn North Shropshire	285.4767	0	0	1	0	0	2	1	
Neath	325.8707115	3	0.009206105	5	0	0	6	4	
Ogmore	332.1782695	0	0	1	0	0	2	1	
Ogwen Ddu	190.1028979	0	0	1	0	0	2	1	
Perry Roden and Tern North Shropshire	959.8362043	0	0	1	0	0	2	1	
Rea Brook	190.4376	0	0	1	0	0	2	1	
Reens West	47.10410257	0	0	1	0	0	2	1	
Rheidol and Clarach	245.4568421	1	0.004074036	5	0	0	6	4	
Rhondda	112.1292091	0	0	1	0	0	2	1	
Rhymney	225.3619847	0	0	1	0	0	2	1	
Severn Up Trannon Clywedog	314.2603128	0	0	1	0	0	2	1	
Severn Up Twrch and Banwy	210.7762	0	0	1	0	0	2	1	
Severn Upper and Cain River	129.6089	0	0	1	0	0	2	1	
Severn Upper and Rhiw River	101.5101	0	0	1	0	0	2	1	
Severn Upper and Tanat River	270.0896	0	0	1	0	0	2	1	
Severn Upper and Vrynwy River	190.0518	0	0	1	0	0	2	1	
Severn Upper Montfort East	161.6958	0	0	1	0	0	2	1	
Severn Upper Montfort North	170.618	0	0	1	0	0	2	1	
Severn Upper Montfort South	299.07	0	0	1	0	0	2	1	
Soch	177.8930504	0	0	1	0	0	2	1	
Taf	497.6439347	0	0	1	0	0	2	1	
Taff d s Cynon	87.92976587	0	0	1	0	0	2	1	
Taff u s Cynon	195.2709106	0	0	1	0	0	2	1	
Tawe	280.5256852	0	0	1	0	0	2	1	
Teifi	1010.306029	0	0	1	0	0	2	1	
Teme Upper	919.4275	0	0	1	0	0	2	1	
Thaw and Cadoxton	209.1224215	0	0	1	0	0	2	1	
Trothy	144.7985	0	0	1	0	0	2	1	
Tywi	1365.864549	3	0.002196411	4	0	0	5	4	
Usk Brecon to Abergavenny	372.1786785	2	0.005373763	5	0	0	6	4	
Usk Lower Abergavenny	428.0068581	1	0.002336411	5	0	0	6	4	
Usk Upper Brecon	474.1214	1	0.002109164	4	0	0	5	4	
Western Cleddau	341.6854701	0	0	1	0	0	2	1	
Wnion	115.9268	0	0	1	0	0	2	1	
Worthenbury	147.5541	0	0	1	0	0	2	1	
Wye	890.1336467	2	0.002246854	4	0	0	5	4	
Wye H and W - Ithon to Hay	489.8316	1	0.002041518	4	0	0	5	4	
Wye H and W d s Lugg	64.3179825	0	0	1	0	0	2	1	
Wye H and W u s Ithon	439.6387872	0	0	1	0	0	2	1	
Wygryr	36.76180443	0	0	1	0	0	2	1	
Ystwith	197.2796898	1	0.005068946	5	0	0	6	4	

percentile	count
0	2
0.2	2
0.4	2
0.6	2
0.8	6
1	10

3 AMR ABUNDANCE - THE HAZARD MAP WORKBOOK.XLSX

To create the AMR abundance maps, these attribute-specific hazard scores were summed to provide an overall unadjusted hazard score for each catchment. This hazard score was then adjusted by further ranking into percentiles (e.g., for the AMR abundance map, unadjusted summed hazard scores above 27 would become a final adjusted hazard score of 5 (highest hazard rank), to be used in the final map). The table shows all the raw data and calculations used to calculate these hazard scores.

For full details see Stanton, I.C., Tipper, H.J. & Singer, A.C. (2022). Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP). ERAMMP Report-65 The development of a hazard map to inform an environmental AMR monitoring programme in Welsh rivers. (Contract C210/2016/2017)(UK Centre for Ecology & Hydrology Projects 06297 & 06810)

Notes:

OPCAT: Data from Water Framework Directive Operational Catchments Cycle 2 data layer.

CSO spill count: Spill count data from "Event Duration Monitoring - Storm Overflows - 2021 (England and Wales)." Data register ID: 17.

CSO spill duration: Spill duration data from "Event Duration Monitoring - Storm Overflows - 2021 (England and Wales)." Data register ID: 17.

Hospital beds: Number of hospital bed data from "Hospitals in Wales." Data register ID: 20. Dataset created for this project. More detail can be found in AdditionalFile_Datasets.xlsx

Manure/Slurry/Excreta: Data from "Estimates of manure volumes by livestock type and land use for England and Wales." Data register ID: 16.

WWTP private: Private consented discharge data from "Consented discharges to controlled waters with conditions." Data register ID: 11.

WWTP company: WWTP locations ranked by total populations equivalents. Data provided by Dŵr Cymru (Welsh Water) and Hafren Dyfrdwy (Severn Trent). Data register ID: Dŵr Cymru - 53 and Hafren Dyfrdwy - 18.

Arable land cover: Arable land cover data from "Land Cover 2020." Data register ID: 24.

Aquaculture/shellfish: Aquaculture and shellfish consented discharge data from "Consented discharges to controlled waters with conditions." Data register ID: 11.

OPCAT information				CSO spill count				Hospital beds				Manure/Slurry/Excreta				WWTP private				WWTP company				Arable landcover				Aquaculture/shellfish				Abundance map							
OPCAT	Area km2_f	count	count/area	hazard	duration	duration/area	hazard	beds	beds/area	hazard	manure	manure/area	hazard	slurry	slurry/area	hazard	excreta	excreta/area	hazard	hazard (average of MSE)	WWTP count	count/area	hazard	Total PE	totalPE/area	hazard	arable	arable/area	hazard	Aqua and shell	aqua and shell/area	hazard	Unadjusted	Adjusted hazard					
Aeron	164.2251262	194	1.18130458	2	1752.75	10.67284331	2	0	0	1	46669406.3	282961.4561	4	56545632.21	344317.5995	4	151616315.7	923221.8975	5	4.733333333	15	0.001337983	3	3499.887765	21.31151261	2	1.393723941	0.008486662	2	0	0	1	17.33333333	2					
Afan	118.9742901	1021	8.581686005	5	6122.5	51.46067911	4	0	0	1	6326651.77	53479.16069	1	4129153.021	34709.16069	1	32359765	27196.5617	1	0.008405177	1	0	0	1	0.009337983	3	0.004005177	1	0	0	1	0.001132203	0.005993631	2	0	1	20.33333333	2	
Alaw Goch	169.7018278	373	2.197972791	2	3300	19.44587188	2	0	0	1	52883844.41	311628.019	5	41901446.44	246912.1694	4	145896291.1	859721.3892	4	4.333333333	20	0.117853769	4	6217.018642	36.63495393	3	2.775524968	0.016353504	3	0	0	1	20.33333333	2					
Alwen	201.0048	85	0.422058723	1	443.75	2.207658273	1	0	0	1	39359522.65	195813.8445	3	27234229.95	135490.4457	3	205306128.1	102005.88	5	3.666666667	9	0.044775051	1	664	3.3034037	0.008412631	0.00041854	1	3	0.014925017	5	14.66666667	1	0	1	20.33333333	2		
Alyn	246.949	1240	5.021279697	4	6080	24.62046819	3	40	0.161976764	4	86535024.64	349679.5882	5	90882783.96	368022.4822	5	177794192.4	719963.2004	3	3.333333333	52	0.210569794	5	64272.20524	260.2650962	5	7.223852737	0.029252407	4	0	0	1	30.33333333	5					
Arrow, Lugg and Frome	910.4094	1208	1.33949579	2	7610.5	8.35942599	2	0	0	1	31900485.79	350397.1506	5	19511623.96	21431.073	4	659156957	724022.5738	4	133	0.146088123	4	31079.73206	34.13819405	4	1.146088123	0.026167576	5	0	0	1	22	3	0.4	20.333333	3			
Arth and Wyre	127.4896663	424	3.325759745	3	5094.75	39.96206241	4	0	0	1	31197357.32	247404.9885	4	40244521.32	329787.6805	4	96382655.37	756003.6882	4	4	0.070593957	2	1993.745952	15.63849063	2	4.589113821	0.035959667	4	0	0	1	21	2	0.8	27	0	1	30.33333333	5
Arthro	117.9437373	442	3.743219542	3	3743.25	31.73579019	3	0	0	1	7453412.004	63194.63986	1	3945179.625	33449.67452	1	44587283.7	378038.5862	4	1	18	0.15261514	4	6849.050998	58.07049322	4	6.084261941	0.005123307	2	0	0	1	19	3	0.2	26.6667	4		
Braint Cadnant Lleinio	154.0281195	1483	9.628112095	5	14280.75	92.71521362	5	0	0	1	36232141.79	235230.6963	3	2583263.58	16720.1778	3	84621136.84	549387.5862	2	2	19	0.1233541	4	10669.12321	69.26373703	4	0.897640631	0.005827771	2	0	0	1	24.66666667	4					
Cefni	144.405705	459	3.178544782	3	3527.5	24.42770527	2	0	0	1	4475401.491	309918.6173	4	36024090.51	250710.9433	4	113676529	78720.4792	4	10	0.069249342	2	19413.47016	133.4007208	4	2.985470383	0.06074186	3	0	0	1	20	2	0	0	1	20.33333333	4	
Ceirng	158.3538	214	1.351404261	2	974.75	6.155520108	1	0	0	1	44358967.92	280125.6927	4	53502028.65	37863.876	4	150674808.8	951507.3764	5	4	0.050519785	1	1427.458497	9.013426125	2	2.598143931	0.016407209	3	0	0	1	15.33333333	1	0	1	15.33333333	3		
Clun River	271.2708	169	0.622993701	1	1271.348331	4.68639075	1	0	0	1	6153372.41	232805.6407	3	58651490.67	142883.0489	3	219171133.8	23805.4265	4	12	0.044236239	1	4569	16.84298208	2	19.38609286	0.017463987	4	0	0	1	14.33333333	1	0	1	14.33333333	3		
Clywd Lower	310.666497	887	2.855153128	3	5154	16.59014568	2	40	0.12875496	4	94897934.9	305465.7673	4	109418956.8	352207.3019	4	280274052.1	902170.6162	4	55	0.177038807	5	33441.48622	107.6443788	4	12.7424222	0.041016422	2	0	0	1	27	4	0	1	15.33333333	4		
Clywd Upper	205.4602	371	1.805702516	2	4365.75	21.24864086	2	0	0	1	55137317.3	268360.0878	4	58119796.29	28276.1789	4	193597317.7	942261.8963	5	4	11	0.05353835	1	1658	8.069689409	1	3.768587793	0.018342179	3	0	0	1	15.33333333	1	0	1	15.33333333	4	
Clywedog - Dee	103.1803	884	8.567526941	5	4827	46.78218613	4	800	7.53418046	5	46944881.14	454979.1108	5	57058240.71	552995.4915	5	78384036.91	759680.2579	4	4	0.096917226	3	123077.191	1192.836142	5	6.368432186	0.061721396	4	0	0	1	31.66666667	5	0	1	31.66666667	5		
Coastal streams - Cardigan to Aberaeron	123.3722685	435	3.525913928	3	4941.5	40.05357167	4	0	0	1	34963673.23	283399.7757	4	49092695.51	397923.2618	5	86117200.28	698027.209	3	33	0.267483126	5	6881.056591	55.77474316	4	6.416303048	0.05200766	4	0	0	1	26	4	0	1	26.66666667	4		
Coastal streams - Druidston to Fishguard Bay	184.6697752	912	4.938545027	4	12115.25	65.60494258	4	0	0	1	54647169.33	295918.3182	4	83262700.4	450873.4594	5	107342882.6	581269.3629	2	3	0.162452139	4	5062.689863	27.41482561	3	33.89950561	0.18356824	5	0	0	1	26.66666667	4	0	1	26.66666667	4		
Coastal streams - North Gower	72.9193983	400	5.485508785	4	3683.5	50.51467903	4	0	0	1	6703765.424	91933.91033	1	47432030.3	65048.81298	1	19672564.21	196785.059	1	8	0.109710176	3	2339.495238	32.0833046	3	3.610245363	0.049510082	4	0	0	1	21	3	0	1	21.33333333	4		
Coastal streams - South Gower	106.7634829	530	4.964244194	4	2383.25	22.3277075	2	368	3.44687144	5	10218435.13	95710.95714	1	743370.466	69628.39977	2	2328711.27	218077.4797	1	1	1.333333333	15	0.140497477	4	7030.520644	65.85136092	4	5.37200579	0.050316884	4	0	0	1	25.33333333	4				
Coastal streams and Nevern - Fishguard Bay to Cardigan	262.6448416	1016	3.868341727	3	14931	56.84863221	4	0	0	1	92027212.74	350386.5227	5	134050965.3	510388.723	5	222730158.3	848027.9184	4	4	0.091378151	3	9550.602977	36.36318505	3	8.635892338	0.032880495	4	0	0	1	23.66666667	4	0	1	23.66666667	4		
Coastal streams of North Milford Haven - Llangwn Pll to St Anne's Head	130.186509	1299	9.977992422	5	10324	79.30161183	5	0	0	1	72797978.5	209683.6202	3	33298072.53	255772.0673	4	51969260.69	399190.8309	1	9	0.069131587	2	22053.34601	169.3980903	5	29.41302651	0.225929912	5	0	0	1	26.66666667	4	0	1	26.66666667	4		
Coastal streams of South Pennine and South Milford Haven - Pendine to Landshipping	330.6524705	1950	5.897430608	4	22349.25	67.59135949	5	35	0.105851319	4	88068126.57	266346.495	4	128030374	387205.2547	5	164691565.6	498080.5537	2	69	0.208678314	5	42056.18815	127.1915135	4	31.42107898	0.095027504	5	0	0	1	31.66666667	5	0	1	31.66666667	5		
Conwy Lower	256.3604602	1002	3.908560587	3	8580.25	33.469488	3	0	0	1	38657977.28	150795.4555	2	3517021.31	137190.7666	3	210331493.3	82052.2693	4	3	29	0.11322013	3	6208.825638	24.21913291	3	1.396943596	0.00544914	2	1	0	0.003900759	5	23	0	1	23.33333333	3	
Conwy Upper	304.7495	824	2.703860056	3	13568.25	44.5263252	4	0	0	1	29566534.06	97019.13885	2	19349337.08	63492.58664	1	198242832.2	65010.7511	3	17	0.05783521	2	2152.236427	7.062313234	1	0.012750114	4.18386e-05	1	0	0	1	14	1	0	1	14.33333333	3		
Crigyll Carrog	148.7942116	915	6.149437654	4	9297.5	62.8562965	4	33	0.221782821	4	3928889.61	26349.7508	4	3308285.25	228388.0872	4	98188721.87	659896.113	3	3	0.3120634138	5	21577.27727	145.0142249	5	1.998020603	0.01342808	3	0	0	1	29.66666667	2	0	1	29.66666667	5		
Cynon	133.5327652	2579	19.31361226	5	15340.25	113.820467	5	0	0	1	602704.92	45097.72973	1	312054.948	23904.65746	1	36831647.9	275824.8029	1	1	15	0.112331983	3	0	0	0	1	1.228034226	0.000949605	5	0	0	1	18	2	0	1	18.33333333	5
Dee Estuary	324.4807357	3100	9.553725873	5	20895.29	64.39608797	4	106	0.326675788	4	86158429.35	265527.1018	4	129683106.5	399663.4999	5	163706009.6	504516.8838	2	64	0.197238212	5	285477.4549	879.7978538	5	33.96851266	0.104685772	5	1	0	0.003081847	5	36.66666667	5	36.66666667	5			
Dee Lower Chester Weir to Ceirng	286.3299	1259	4.396058701	4	8514.33	29.72958488	3	0	0	1	160459047.8	560275.928	5	243296065.3	846281.6825	5	230324838.9	804239.347	4	4	0.666666667	91	0.317745307	5	13102.10478	45.7487067	3	49.12273844	0.171521294	5	0	0	1	26.66666667	4	0	1	26.66666667	4
Dee Middle Ceirng to Alwen	219.6349	691	3.146130237	3	5144.5	23.42296238	2	31	0.141143325	4	14974873.26	191112.0376	3	3935625.13	179189.3052	3	179940028.7	1012881874	3	17	0.077401178	2	12822.33595	58.38022988	4	2.829309081	0.012881874	3	0	0	1	22.33333333	3	0	1	22.33333333	4		
Dee Upper above Alwen	438.5555	545	1.247216114	2	5047.25	11.50880561	2	0	0	1	47025183.92	107227.4408	2	27803145.62	63396.79572	2	300656659.1	685561.2554	3	25	0.057005328																		

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