Appendix A: Supplementary Material

to

Mapping of contamination problem areas in Europe's seas using a multi-metric indicator-based assessment tool

by

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The supplementary online material consists of the following:

Annex 1: Threshold values
Annex 2: Detailed maps per region
Annex 3: Box plots of average values of indicators

ANNEX 1: Threshold values

The threshold values used in this study are solely based on existing and agreed threshold values, sometimes referred to as assessment criteria. An overview can be found in the table below:

	Substance Group	Substance Name	Unit	Threshold	Ref
Substances in water					
Water	Alkylphenols	Octylphenols ((4-(1,1,3,3-tetramethyl- butyl)-phenol))	µg/l	0.01	1
	Alkylphenols	Pentachloro- phenol	µg/l	0.4	1
	Monocyclic aromatic hydrocarbons (MAHs)	Benzene	µg/l	8	1
	Metals	Arsenic (As)	µg/l	3.5	3
	Metals	Cadmium	µg/l	0.2	1
	Metals	Chromium (Cr)	µg/l	25	3
	Metals	Copper (Cu)	µg/l	0.02	3
	Metals	Lead	µg/l	1.3	1
	Metals	Nickel	µg/l	8.6	1
	Metals	Zinc (Zn)	µg/l	1	3
	Organochlorines	1,2-Dichloroethane	µg/l	10	1
	Organochlorines	Alachlor	µg/l	0.3	1
	Organochlorines	Carbon-tetrachloride	µg/l	12	1
	Organochlorines	Dichloromethane	µg/l	20	1
	Organochlorines	Pentachloro- benzene	µg/l	0.0007	1
	Organochlorines	Tetrachloro-ethylene	µg/l	10	1
	Organochlorines	Trichloro-ethylene	µg/l	10	1
	Organochlorines	Trichloro-methane (chloroform)	µg/l	2.5	1
	Organochlorines	Trifluralin	µg/l	0.03	1
	Organotins	Tributyltin compounds (Tributyltin- cation)	µg/l	0.0002	1
	Other organohalogens	Atrazine	µg/l	0.6	1
	Other organohalogens	Bifenox	µg/l	0.0012	1
	Other organohalogens	C10-13 Chloroalkanes	µg/l	0.4	1
	Other organohalogens	Chlorfenvinphos	µg/l	0.1	1
	Other organohalogens	Chlorpyrifos (Chlorpyrifos-ethyl)	µg/l	0.03	1
	Other organohalogens	Cyclodiene pesticides: Aldrin, Dieldrin, Endrin, Isodrin	µg/l	0.005	1
	Other organohalogens	DDT total	µg/l	0.025	1
	Other organohalogens	Diuron	µg/l	0.2	1
	Other organohalogens	Endosulfan	µg/l	0.0005	1
	Other organohalogens	Heptachlor and heptachlor epoxide	µg/l	0.00000001	1
	Other organohalogens	Hexachloro- cyclohexane	µg/l	0.002	1
	Other organohalogens	Isoproturon	µg/l	0.3	1
	Other organohalogens	Nonylphenols (4-Nonylphenol)	µg/l	0.3	1
	Other organohalogens	para-para-DDT	µg/l	0.01	1
	Other organohalogens	Perfluorooctane sulfonic acid and its derivatives (PFOS)	µg/l	0.00013	1
	Other organohalogens	Simazine	µg/l	1	1
	PCBs	PCB-101	µg/l	0.00002	2
	PCBs	PCB-118	µg/l	0.000026	2
	PCBs	PCB-138	µg/l	0.00002	2
	PCBs	PCB-153	µg/l	0.001	2
	PCBs	PCB-180	µg/l	0.0002	2
	Phthalates	Di(2-ethylhexyl)-phthalate (DEHP)	µg/l	1.3	1
	Polycyclic aromatic hydrocarbons (PAHs)	Anthracene	µg/l	0.1	1
	Polycyclic aromatic hydrocarbons (PAHs)	Benzo(a)pyrene	µg/l	0.00017	1
	Polycyclic aromatic hydrocarbons (PAHs)	Fluoranthene	µg/l	0.0063	1
	Polycyclic aromatic hydrocarbons (PAHs)	Naphthalene	µg/l	2	1
	Polycyclic aromatic hydrocarbons (PAHs)	Phenanthrene	µg/l	1.3	4
	Polycyclic aromatic hydrocarbons (PAHs)	Pyrene	µg/l	0.023	4

	Substance Group	Substance Name	Unit	Threshold	Ref
Substances in sediment					
Sediment	Metals	Cadmium	µg/kg$_{DW, 5\% Al}$	1200	6
	Metals	Chrome	µg/kg$_{DW, 5\% Al}$	81000	6
	Metals	Copper	µg/kg$_{DW, 5\% Al}$	34000	6
	Metals	Lead	µg/kg$_{DW, 5\% Al}$	47000	6
	Metals	Mercury	µg/kg$_{DW, 5\% Al}$	150	6
	Metals	Zinc	µg/kg$_{DW, 5\% Al}$	150000	6
	Organochlorines	Hexachlorobenzene	µg/kg$_{DW, 2.5\% Corg}$	20	6
	Organotins	TBTIN	µg/kg$_{DW, 5\% Corg}$	1.6	7
	Other organohalogens	DDE (p,p')	µg/kg$_{DW, 2.5\% Corg}$	2.2	6
	Other organohalogens	Dieldrin	µg/kg$_{DW, 2.5\% Corg}$	2	6
	PCBs	PCB-101	µg/kg$_{DW, 2.5\% Corg}$	3	5
	PCBs	PCB-118	µg/kg$_{DW, 2.5\% Corg}$	0.6	5
	PCBs	PCB-138	µg/kg$_{DW, 2.5\% Corg}$	7.9	5
	PCBs	PCB-153	µg/kg$_{DW, 2.5\% Corg}$	40	5
	PCBs	PCB-180	µg/kg$_{DW, 2.5\% Corg}$	12	5
	PCBs	PCB-28	µg/kg$_{DW, 2.5\% Corg}$	1.7	5
	PCBs	PCB-52	µg/kg$_{DW, 2.5\% Corg}$	2.7	5
	Polycyclic aromatic hydrocarbons (PAHs)	Anthracene	µg/kg$_{DW, 2.5\% Corg}$	85	6
	Polycyclic aromatic hydrocarbons (PAHs)	Benz[a]anthracene	µg/kg$_{DW, 2.5\% Corg}$	261	6
	Polycyclic aromatic hydrocarbons (PAHs)	Benzo[a]pyrene	µg/kg$_{DW, 2.5\% Corg}$	430	6
	Polycyclic aromatic hydrocarbons (PAHs)	Benzo[ghi]perylene	µg/kg$_{DW, 2.5\% Corg}$	85	6
	Polycyclic aromatic hydrocarbons (PAHs)	Chrysene (Triphenylene)	µg/kg$_{DW, 2.5\% Corg}$	384	6
	Polycyclic aromatic hydrocarbons (PAHs)	Dibenzothiophene	µg/kg$_{DW, 2.5\% Corg}$	190	6
	Polycyclic aromatic hydrocarbons (PAHs)	Fluoranthene	µg/kg$_{DW, 2.5\% Corg}$	600	6
	Polycyclic aromatic hydrocarbons (PAHs)	gamma-HCH	µg/kg$_{DW, 2.5\% Corg}$	3	6
	Polycyclic aromatic hydrocarbons (PAHs)	Indeno[1,2,3-cd]pyrene	µg/kg$_{DW, 2.5\% Corg}$	240	6
	Polycyclic aromatic hydrocarbons (PAHs)	Naphthalene	µg/kg$_{DW, 2.5\% Corg}$	160	6
	Polycyclic aromatic hydrocarbons (PAHs)	Phenanthrene	µg/kg$_{DW, 2.5\% Corg}$	240	6
	Polycyclic aromatic hydrocarbons (PAHs)	Pyrene	µg/kg$_{DW, 2.5\% Corg}$	665	6
Substances in biota					
Biota	Dioxins	WHOTEQ	µg/kg$_{WW}$	0.0065	10
	Metals	Cadmium (in fish)	µg/kg$_{WW}$	26	9
	Metals	Cadmium (in Mytilus)	µg/kg$_{DW}$	960	9
	Metals	Cadmium (in oysters)	µg/kg$_{DW}$	3000	9
	Metals	Lead (in fish)	µg/kg$_{WW}$	26	9
	Metals	Lead (in shellfish)	µg/kg$_{DW}$	1300	9
	Metals	Mercury	µg/kg$_{WW}$	20	11
	Organobromines	BDE Sum of 28, 47, 99, 100, 153, 154	µg/kg$_{WW}$	0.0085	12
	Organochlorines	Hexachlorobenzene (in fish)	µg/kg$_{WW}$	0.09	9
	Organochlorines	Hexachlorobenzene (in shellfish)	µg/kg$_{DW}$	0.63	9
	Organochlorines	Hexachloro-butadiene	µg/kg$_{WW}$	55	11
	Other organohalogens	DDE (p,p') (in fish)	µg/kg$_{WW}$	0.1	9
	Other organohalogens	DDE (p,p') (in shellfish)	µg/kg$_{DW}$	0.63	9
	Other organohalogens	Heptachlor and heptachlor epoxide	µg/kg$_{WW}$	0.0067	11
	Other organohalogens	Perfluorooctane sulfonic acid and its derivatives (PFOS)	µg/kg$_{WW}$	9.1	11
	PCBs	PCB-101	µg/kg$_{DW}$	121	8
	PCBs	PCB-118	µg/kg$_{DW}$	25	8
	PCBs	PCB-138	µg/kg$_{DW}$	317	8
	PCBs	PCB-153	µg/kg$_{DW}$	1585	8

	Substance Group	Substance Name	Unit	Threshold	Ref
	PCBs	PCB-180	µg/kg$_{DW}$	469	8
	PCBs	PCB-28	µg/kg$_{DW}$	67	8
	PCBs	PCB-52	µg/kg$_{DW}$	108	8
	Polycyclic aromatic hydrocarbons (PAHs)	alpha-HCH (in shellfish)	µg/kg$_{DW}$	0.64	9
	Polycyclic aromatic hydrocarbons (PAHs)	Anthracene (in shellfish)	µg/kg$_{DW}$	290	5
	Polycyclic aromatic hydrocarbons (PAHs)	Benzo(a)pyrene (in shellfish)	µg/kg$_{WW}$	5	11
	Polycyclic aromatic hydrocarbons (PAHs)	Fluoranthene (in shellfish)	µg/kg$_{WW}$	30	11
	Polycyclic aromatic hydrocarbons (PAHs)	gamma-HCH (in fish)	µg/kg$_{LW}$	11	5
	Polycyclic aromatic hydrocarbons (PAHs)	gamma-HCH (in shellfish)	µg/kg$_{DW}$	1.45	5
	Polycyclic aromatic hydrocarbons (PAHs)	Naphthalene (in shellfish)	µg/kg$_{DW}$	340	5
	Polycyclic aromatic hydrocarbons (PAHs)	Phenanthrene (in shellfish)	µg/kg$_{DW}$	1700	5
	Polycyclic aromatic hydrocarbons (PAHs)	Pyrene (in shellfish)	µg/kg$_{DW}$	100	5
Biological effects					
Biological effects	Biological effects	Lysosomal membrane stability (LMS)	mins	10	13
	Biological effects	VDSI in Littorina littorea, Buccinum undatum, Nassarius reticulatus	VDSI	0.3	14
	Biological effects	VDSI in Neptunea antiqua, Nucella lapillus	VDSI	2	14
	Biological effects	VDSI in Peringia ulvae	VDSI	0.1	14

References	Threshold type / reference
1	2013/39/EU AA-EQS Marine
2	Proposed EAC, OSPAR SIME 2008
3	OSPAR 2004 Lower EAC
4	Firm EAC (OSPAR SIME 2008)
5	OSPAR EAC (CEMP 2008/2009)
6	OSPAR ERL (CEMP 2008/2009)
7	QS HELCOM 2016. Draft core indicator report on TBT and imposex
8	OSPAR EAC (2017)
9	OSPAR BAC (CEMP 2008/2009)
10	1259/2011/EU EQS Biota
11	2013/39/EU EQS Biota
12	2013/39/EU MAC-EQS Marine
13	ICES, 2012
14	OSPAR EcoQO

ANNEX 2: Detailed maps per region

No Bioeffects classifications were made in the regions covered by the maps of the Eastern Mediterranean Sea or Black Sea

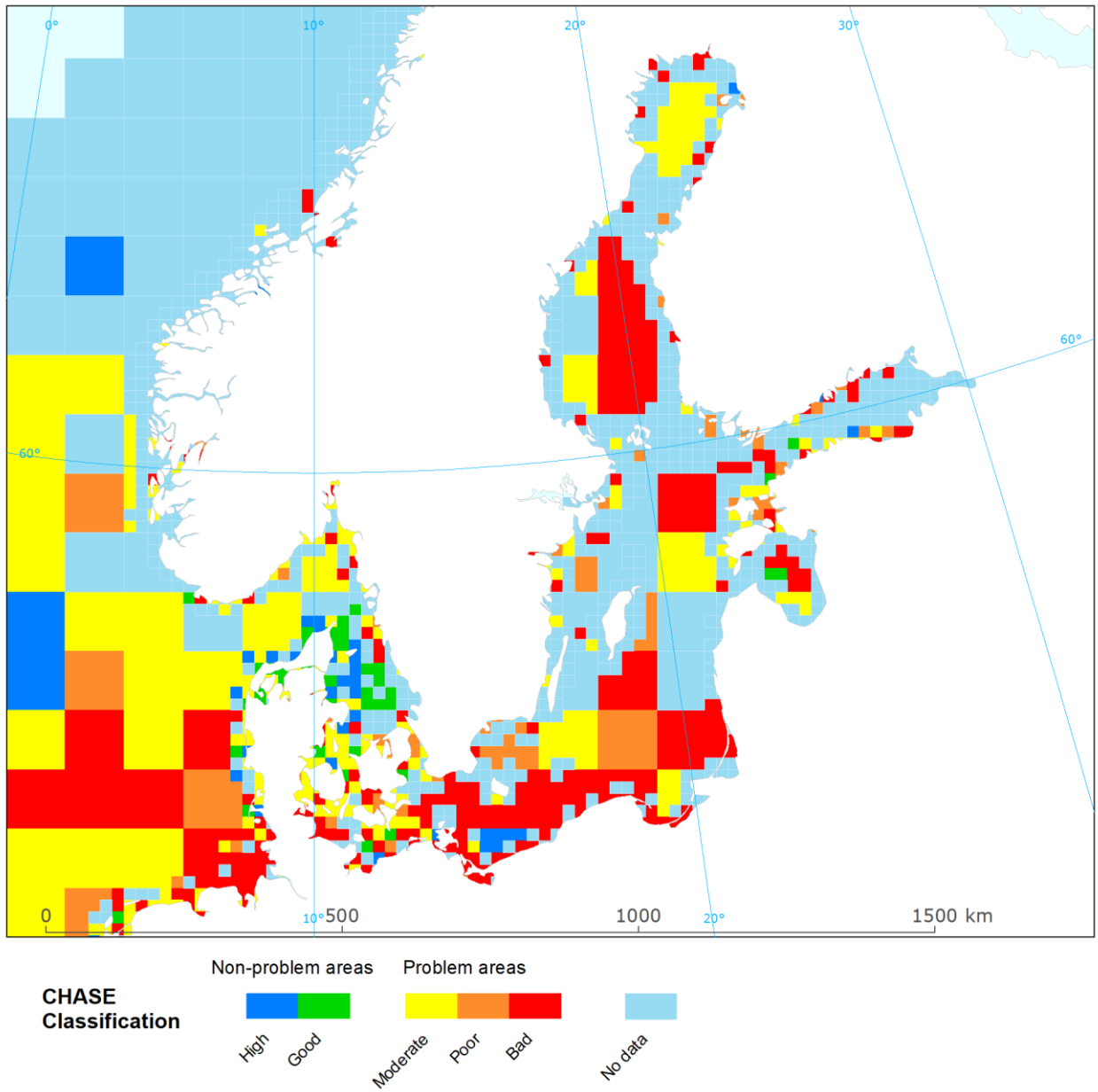

Figure A.1 Integrated CHASE classifications in the Baltic Sea.

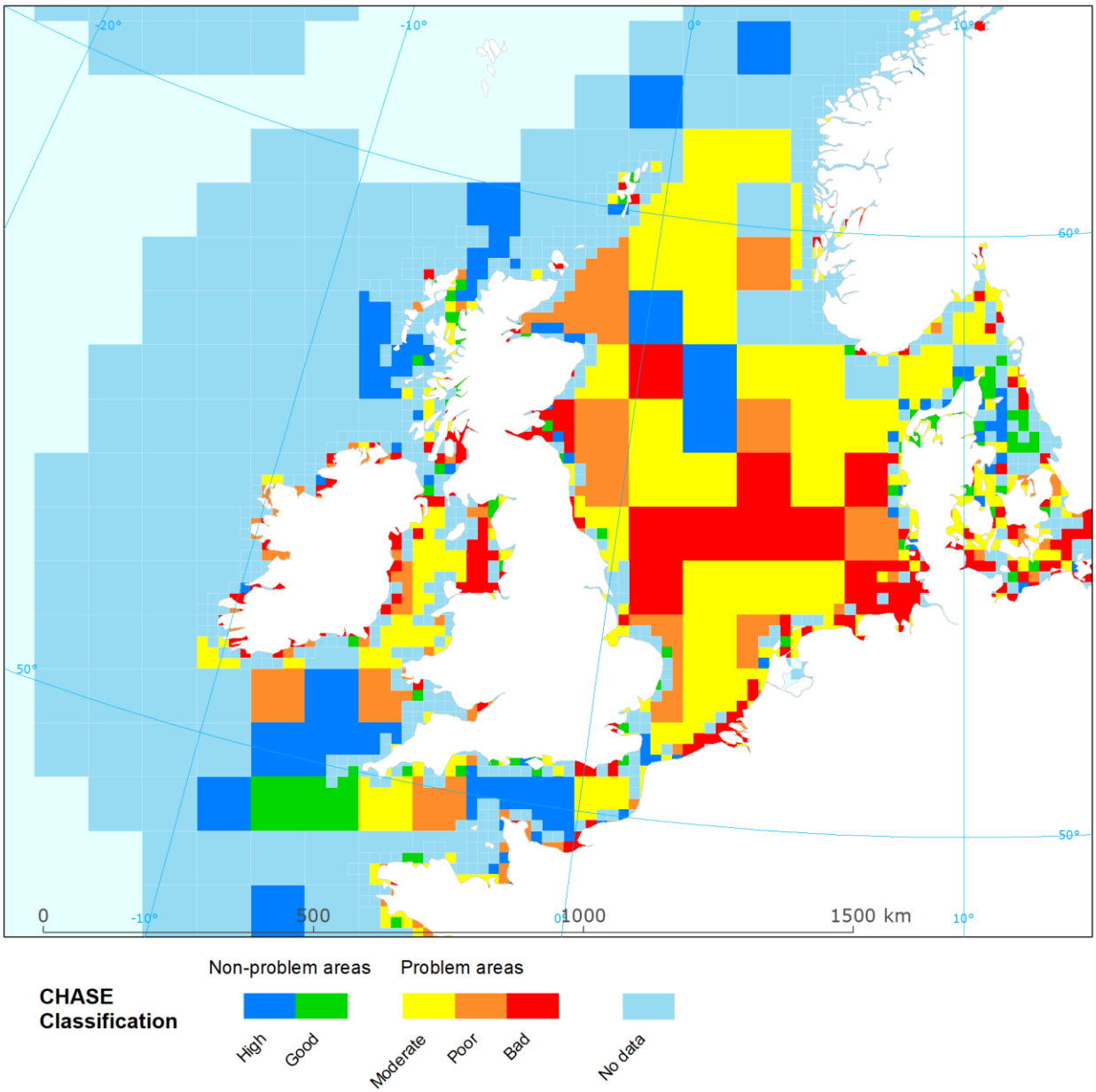

Figure A.2 Integrated CHASE classifications in the North Sea and Celtic Sea.

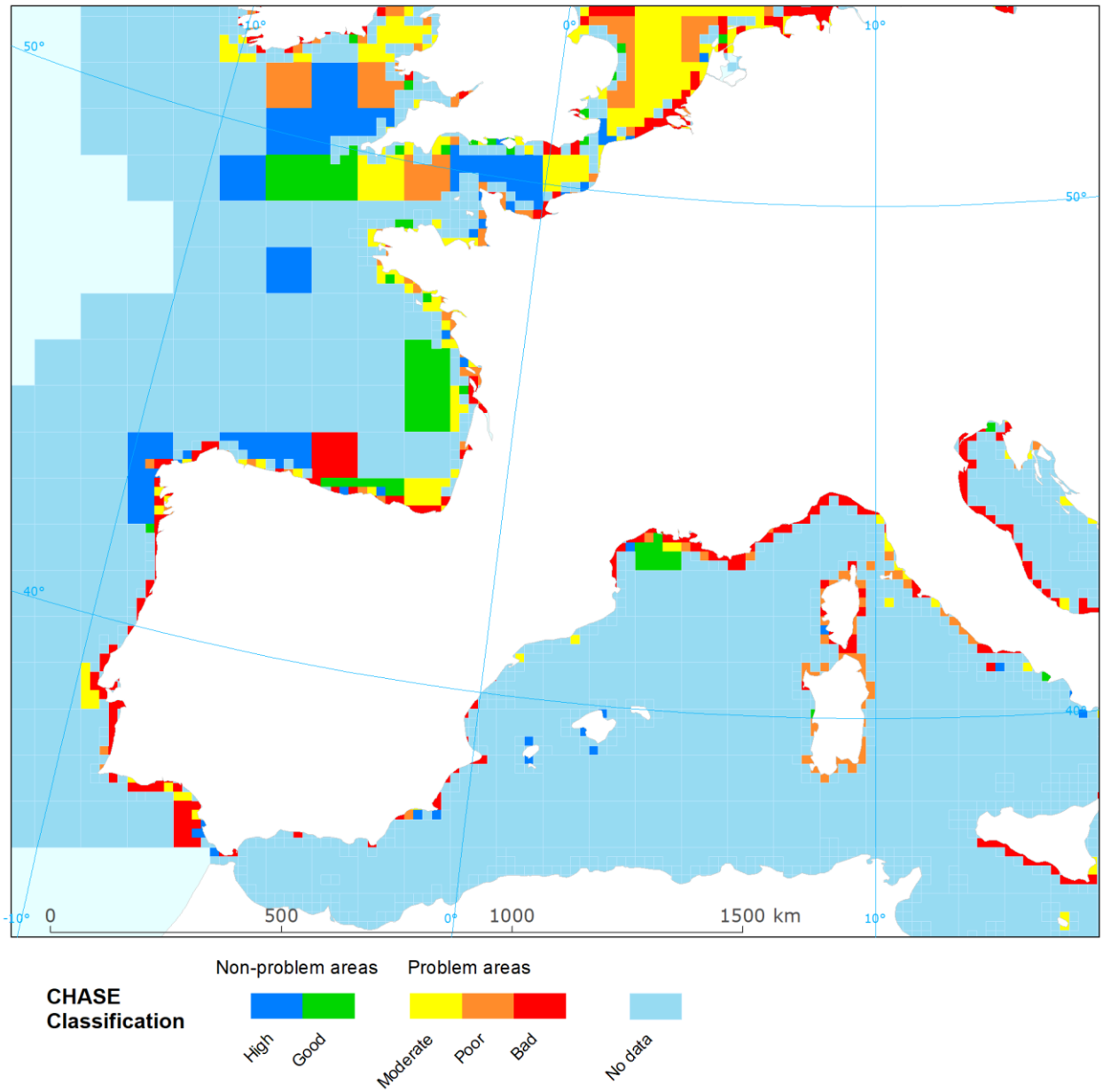

Figure A.3 Integrated CHASE classifications in the Western Mediterranean Sea.

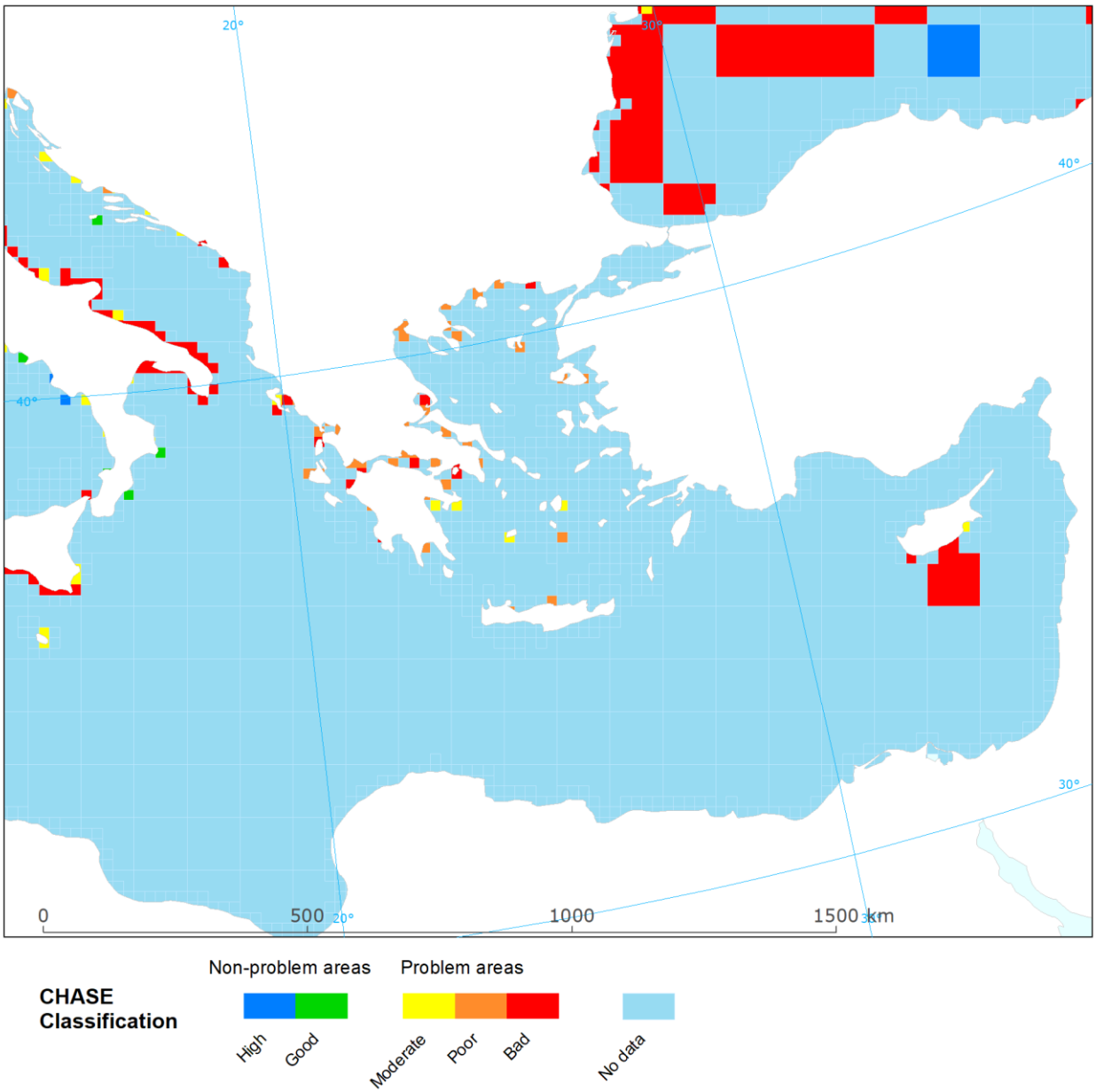

Figure A.4 Integrated CHASE classifications in the Eastern Mediterranean Sea.

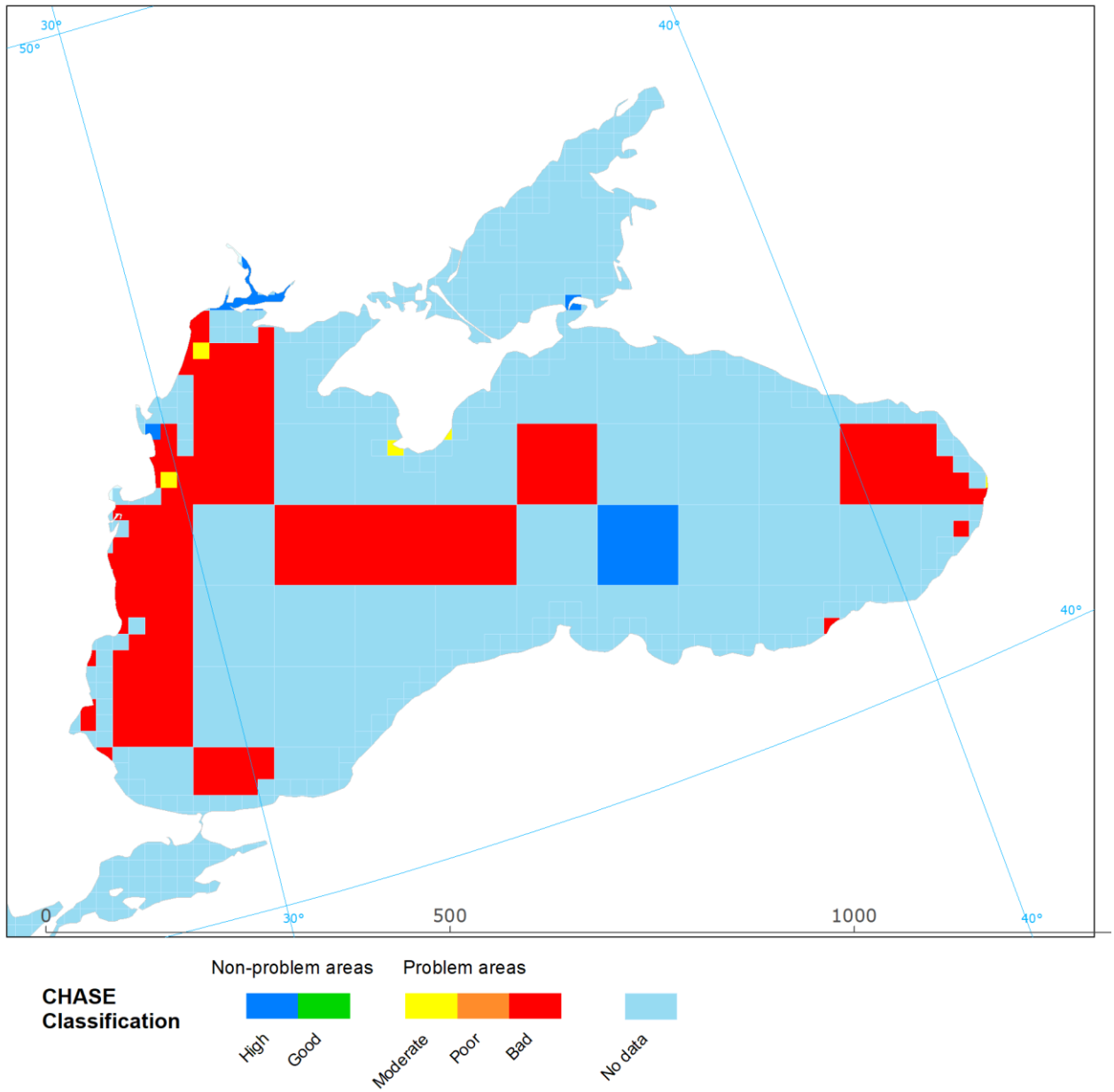

Figure A.5 Integrated CHASE classifications in the Black Sea.

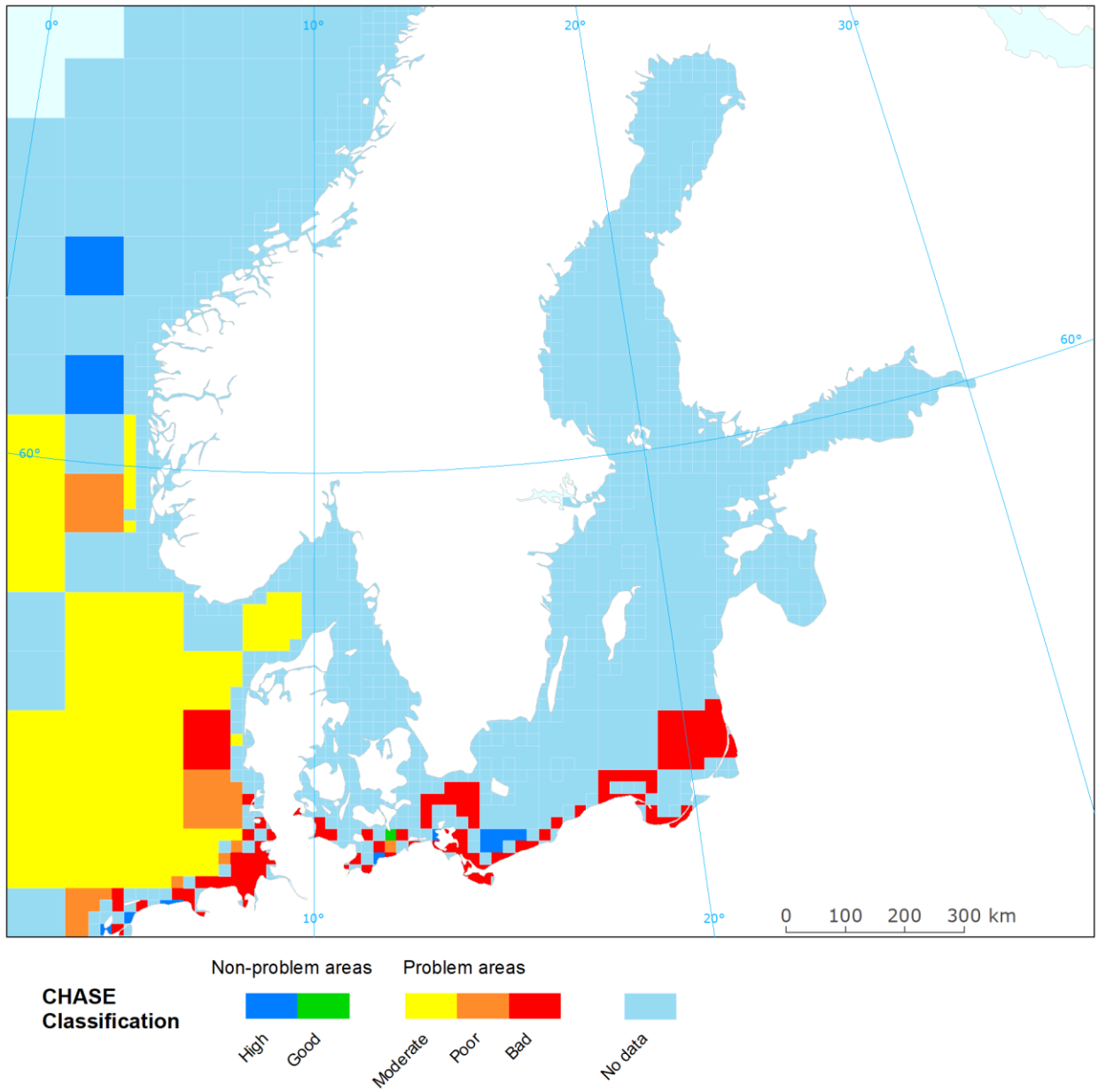

Figure A.6 CHASE classifications for Water in the Baltic Sea.

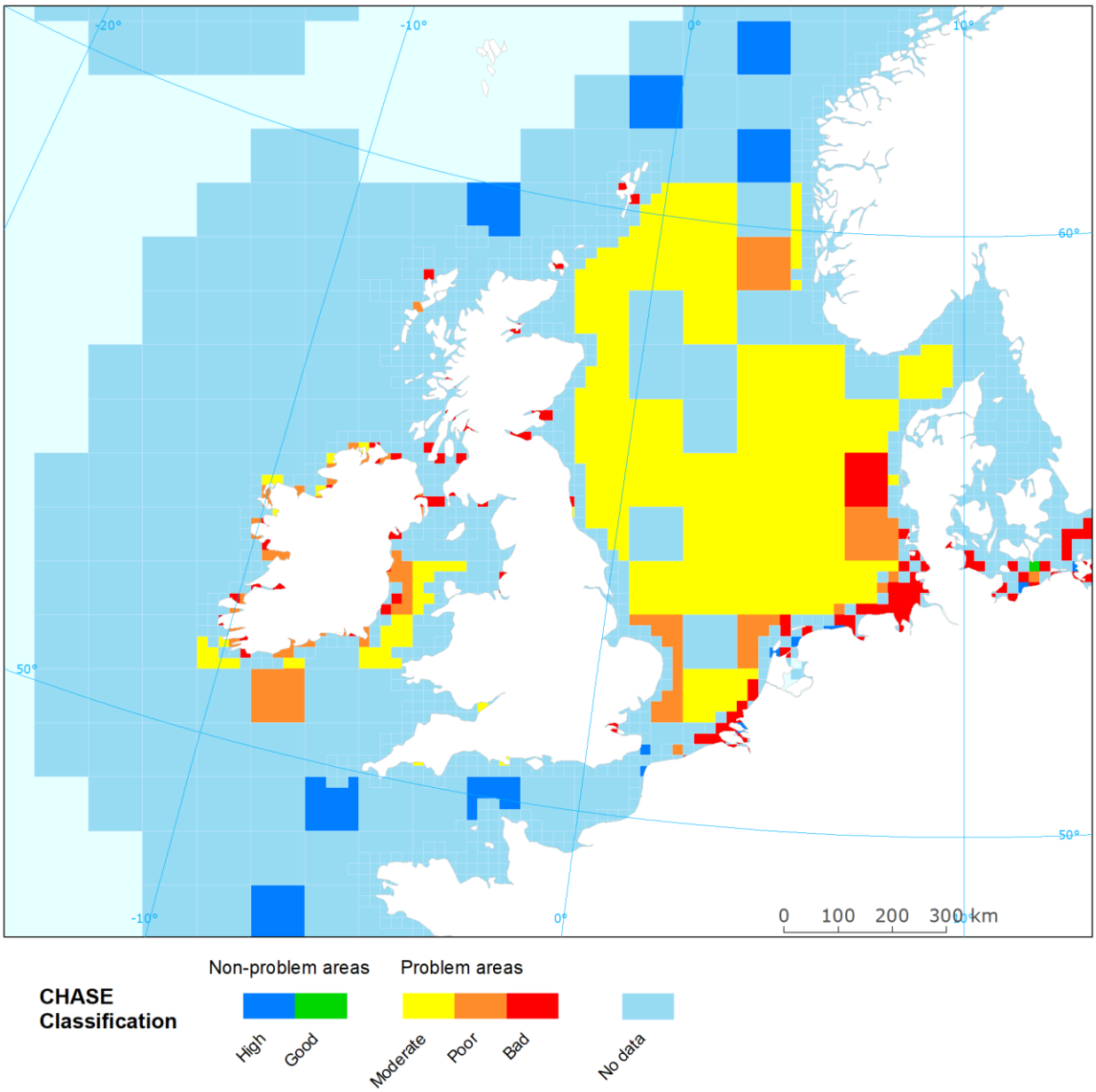

Figure A.7 CHASE classifications for Water in the North Sea and Celtic Sea.

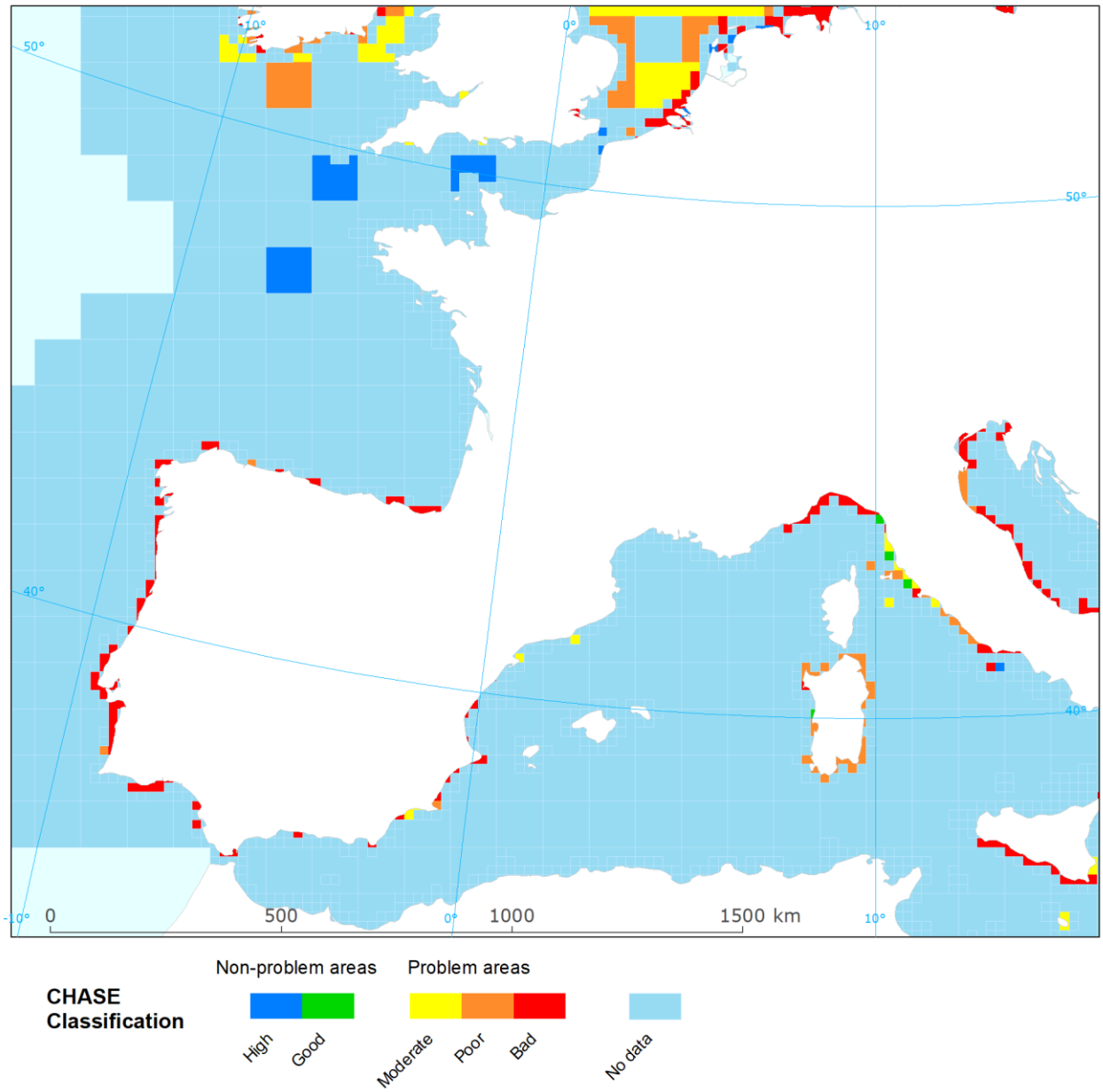

Figure A.8 CHASE classifications for Water in the Western Mediterranean Sea.

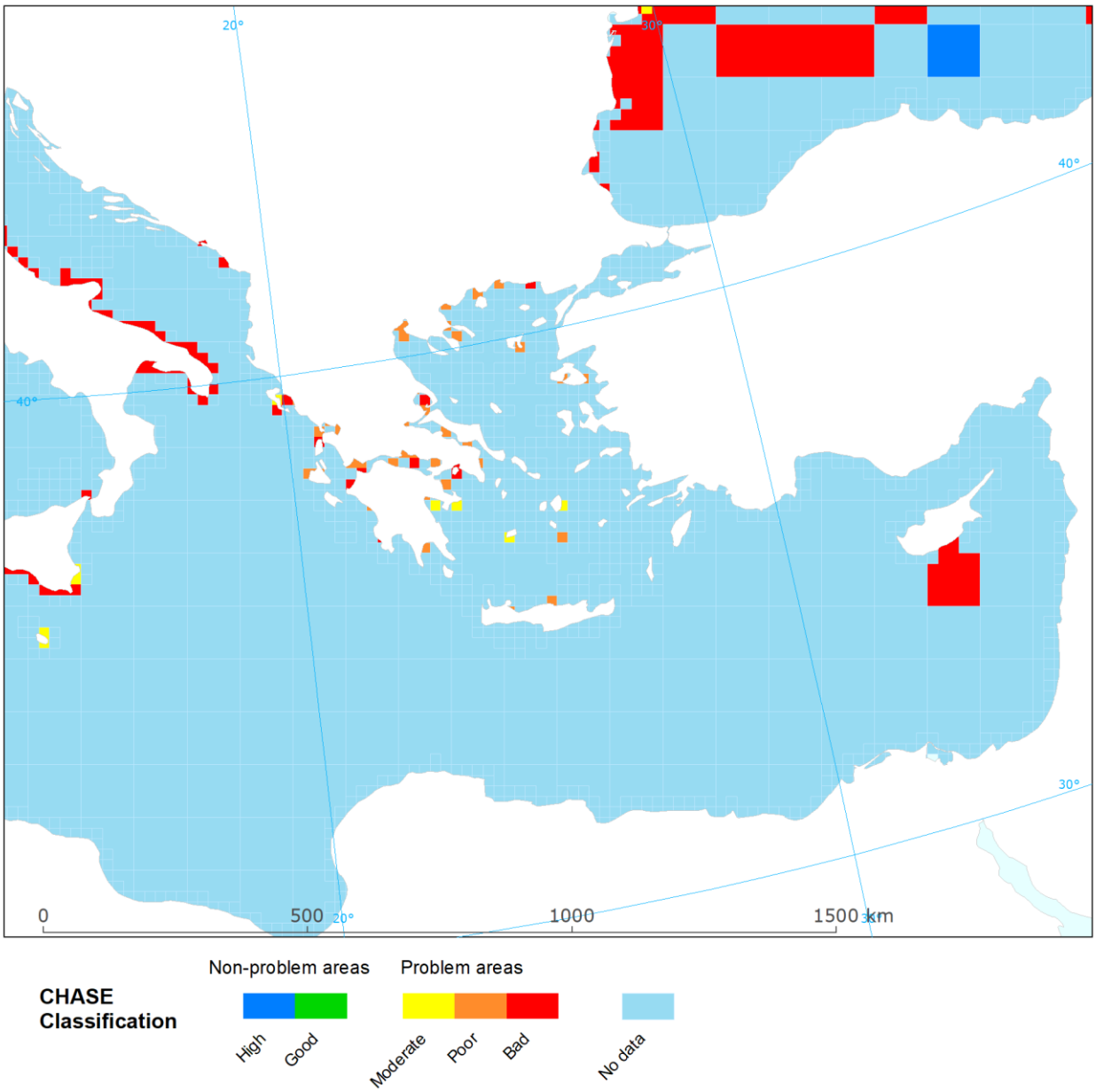

Figure A.9 CHASE classifications for Water in the Eastern Mediterranean Sea.

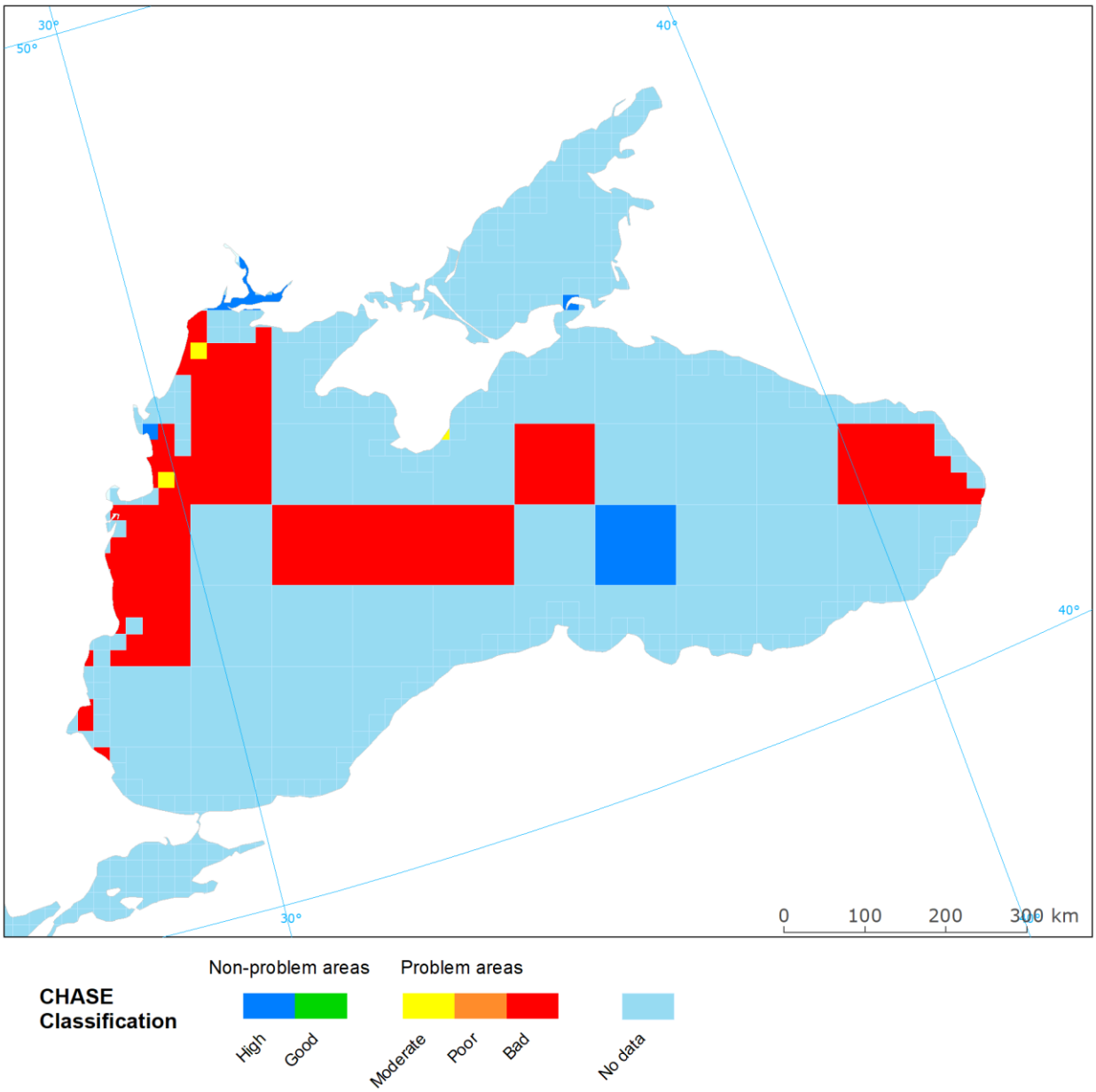

Figure A.10 CHASE classifications for Water in the Black Sea.

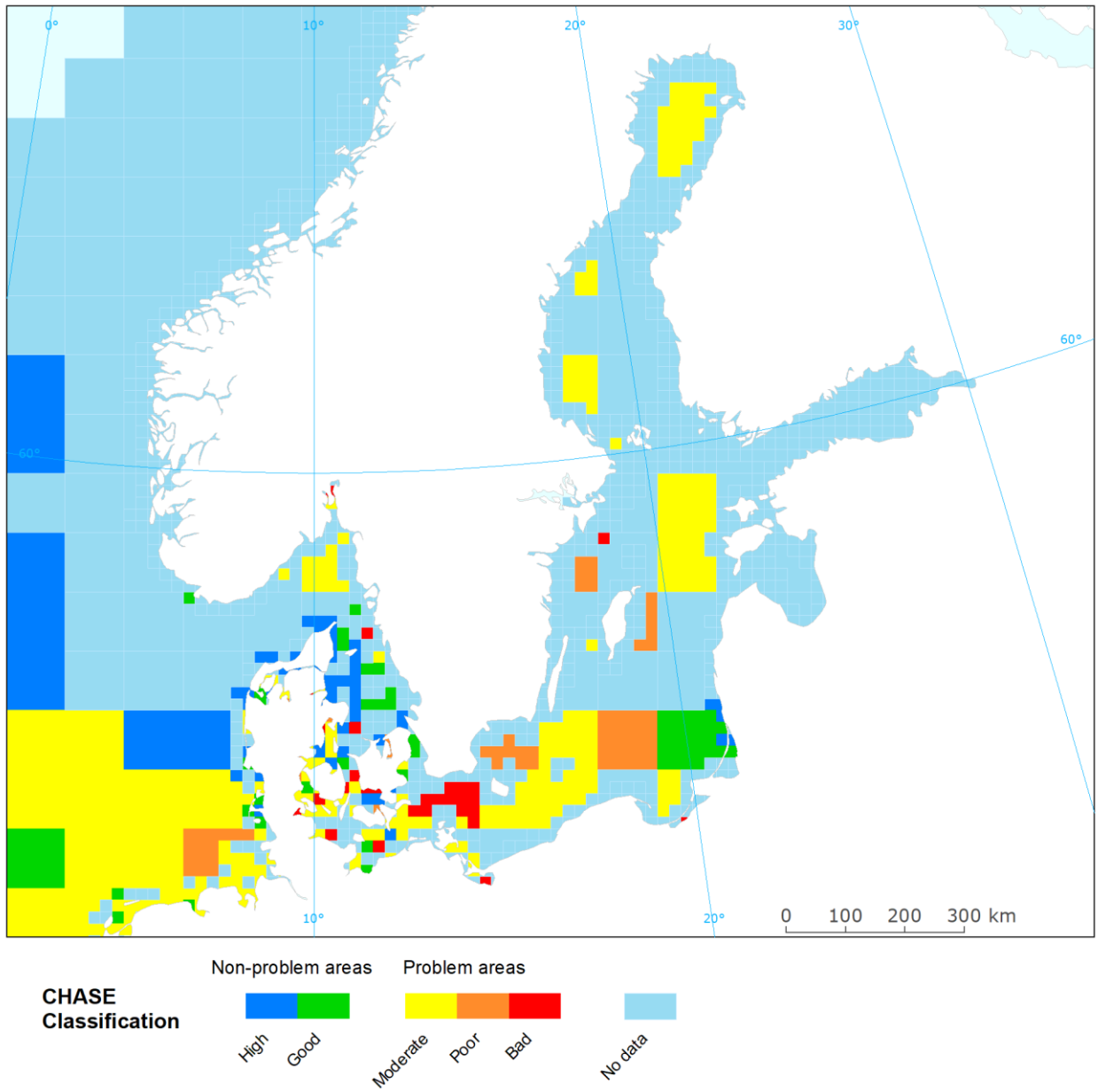

Figure A.11 CHASE classifications for Sediment in the Baltic Sea.

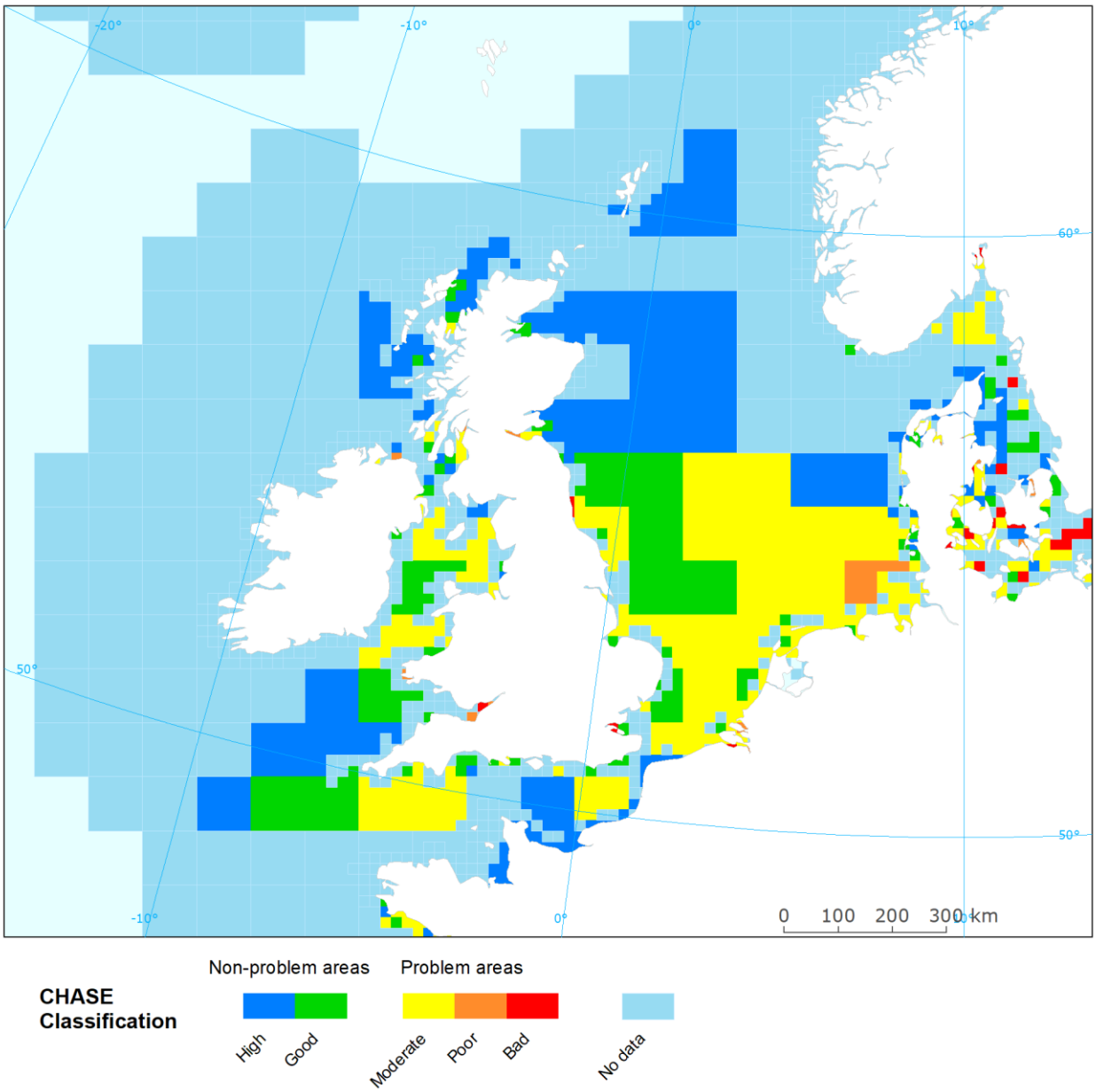

Figure A.12 CHASE classifications for Sediment in the North Sea and Celtic Sea.

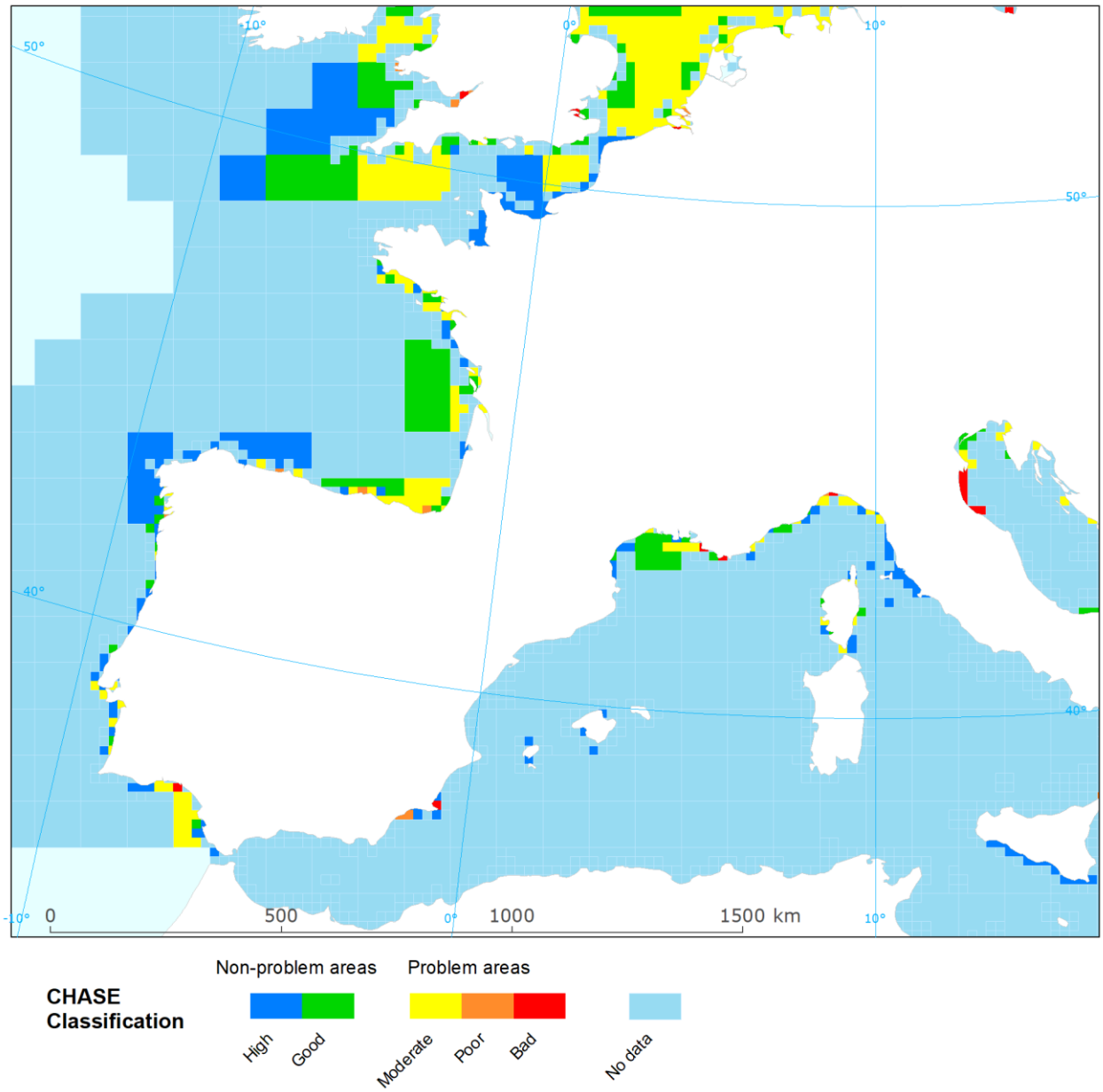

Figure A.13 CHASE classifications for Sediment in the Western Mediterranean Sea.

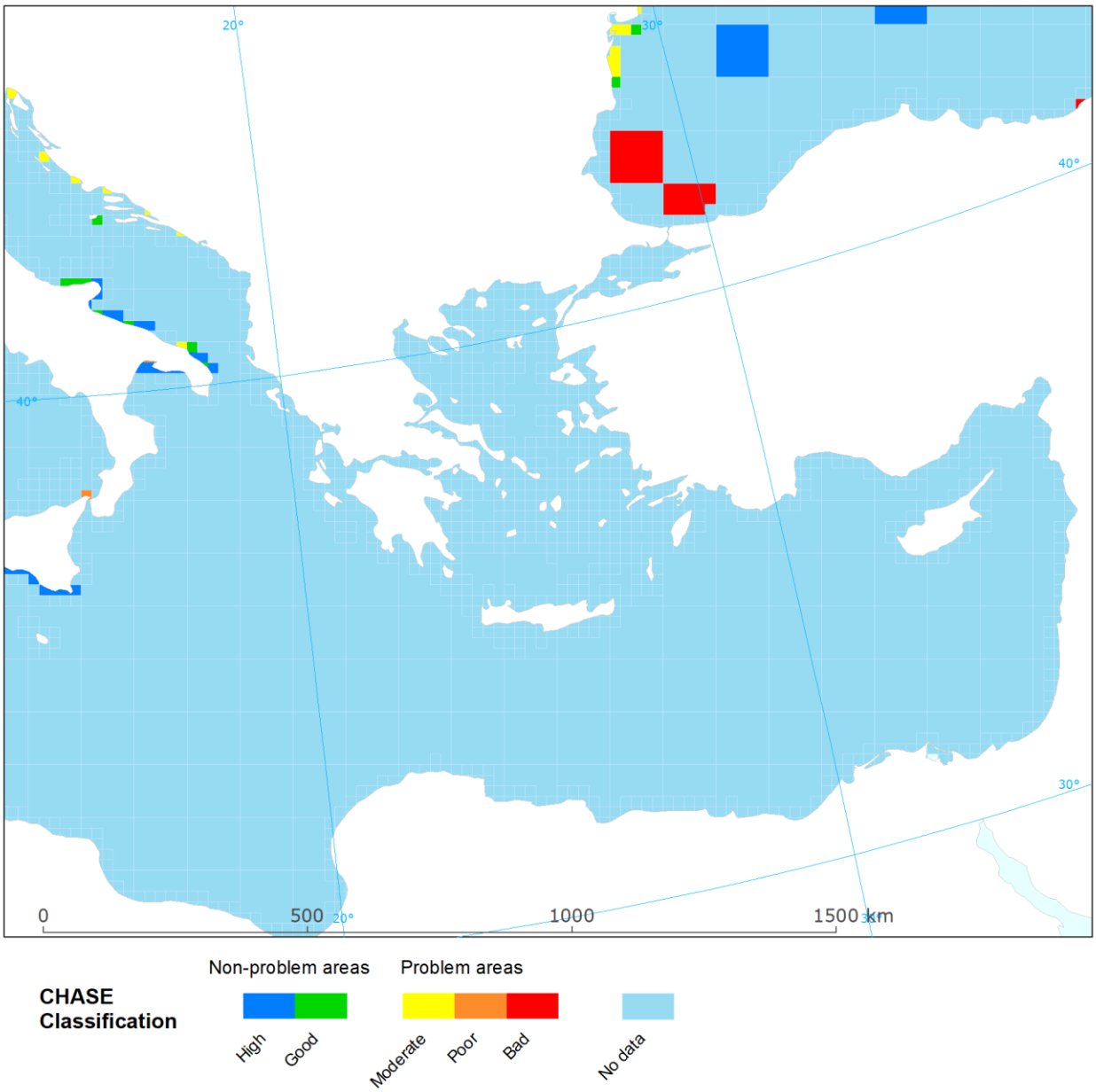

Figure A.14 CHASE classifications for Sediment in the Eastern Mediterranean Sea.

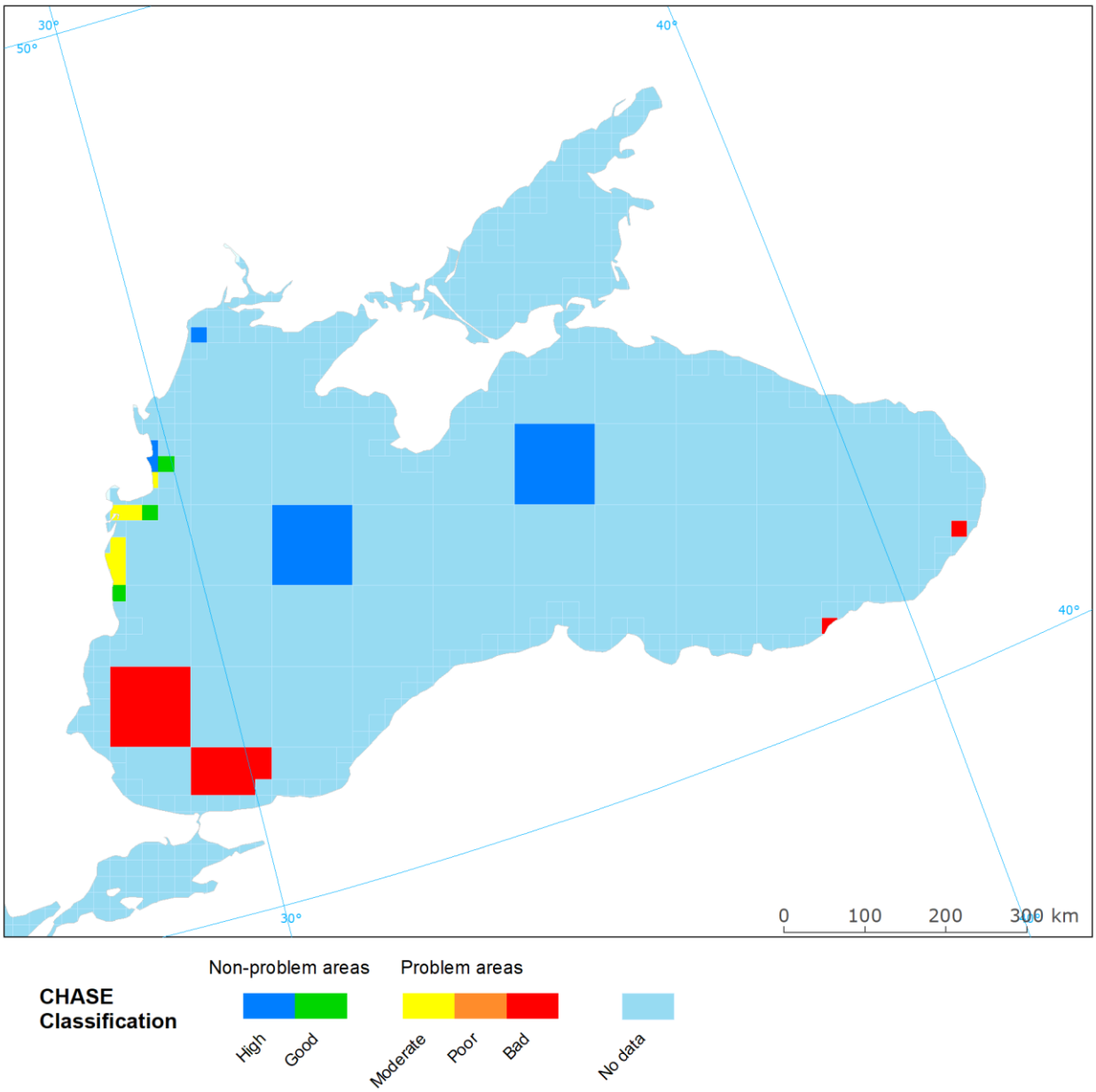

Figure A.15 CHASE classifications for Sediment in the Black Sea.

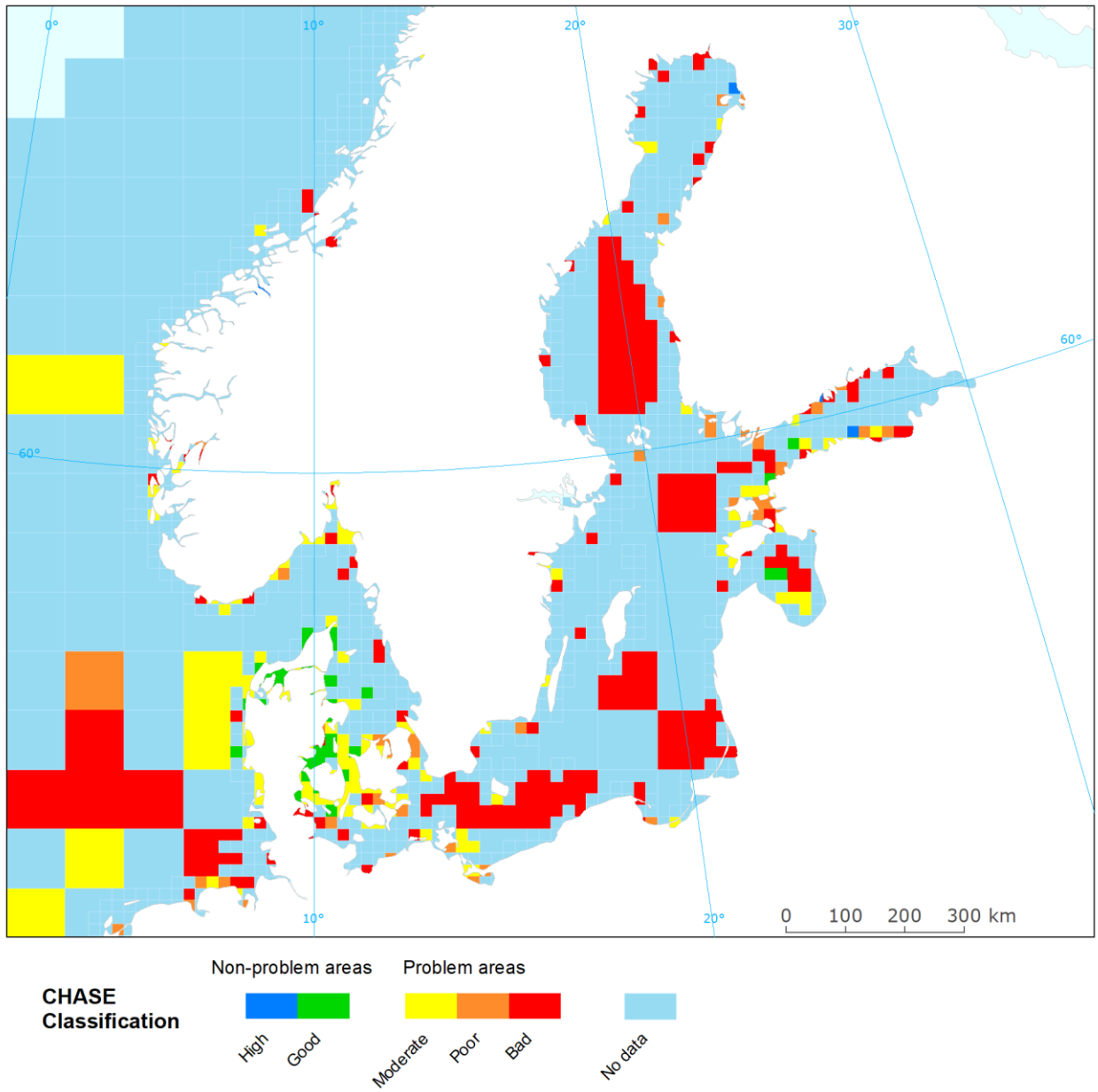

Figure A.16 CHASE classifications for Biota in the Baltic Sea.

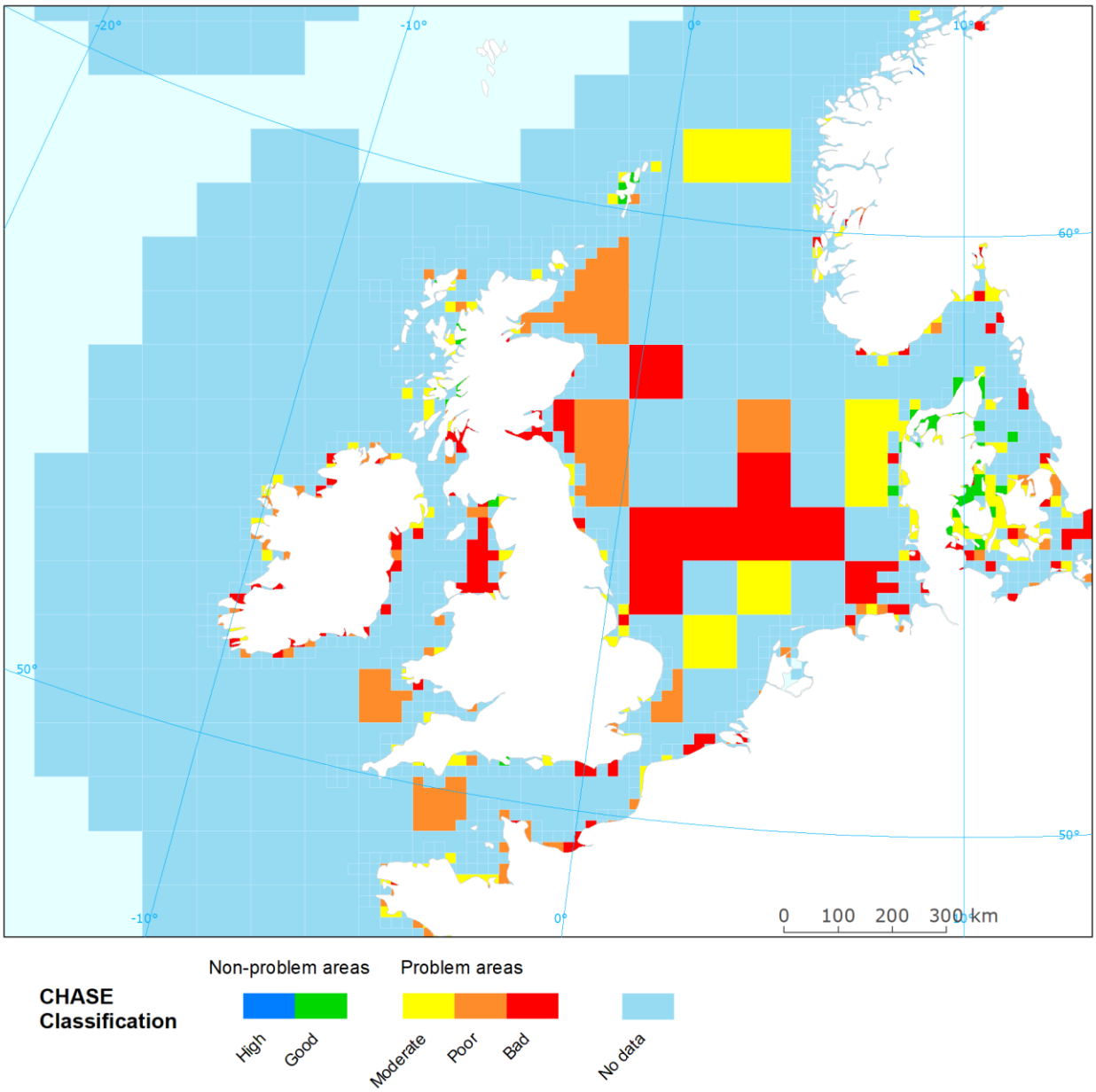

Figure A.17 CHASE classifications for Biota in the North Sea and Celtic Sea.

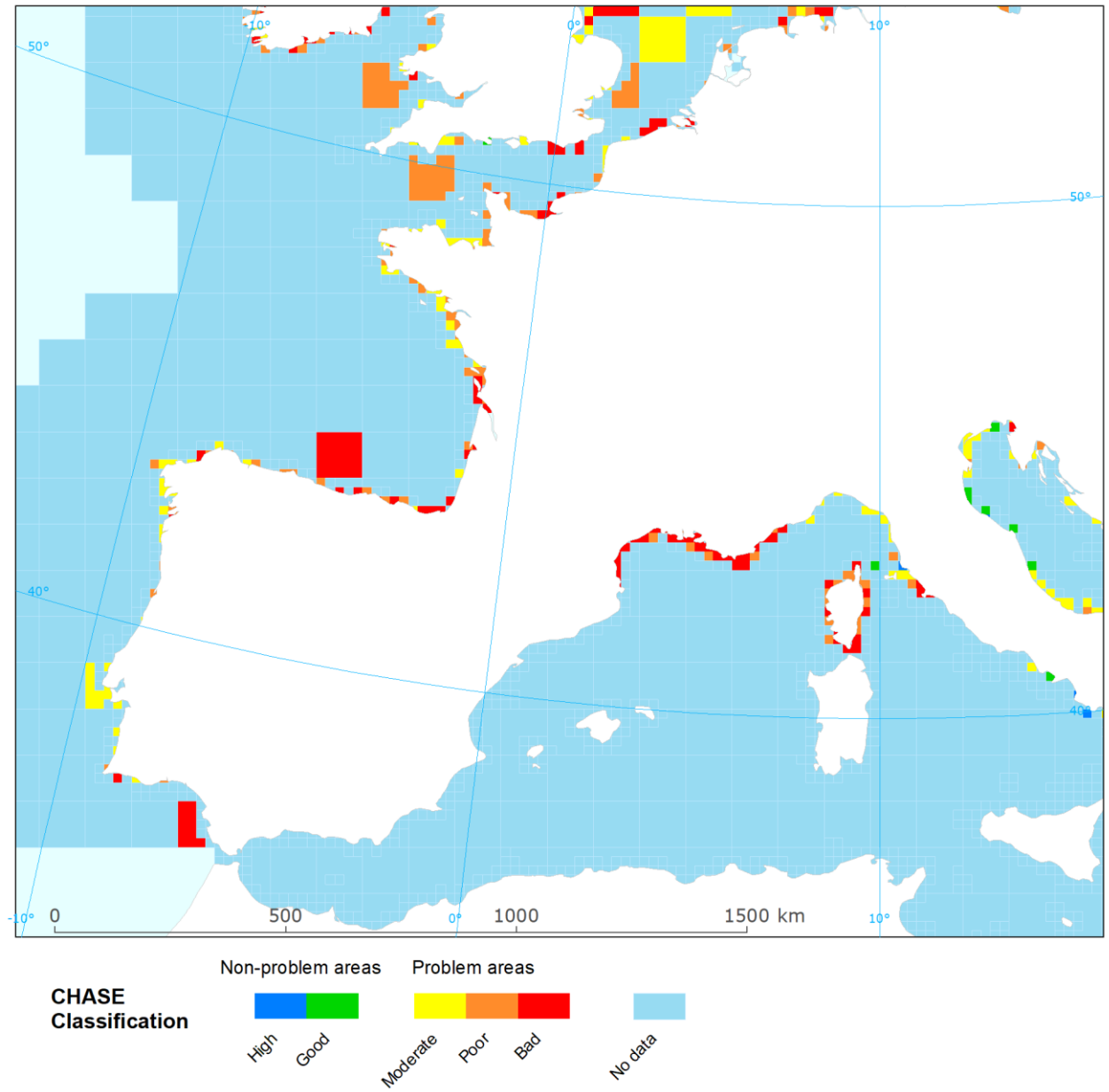

Figure A.18 CHASE classifications for Biota in the Western Mediterranean Sea.

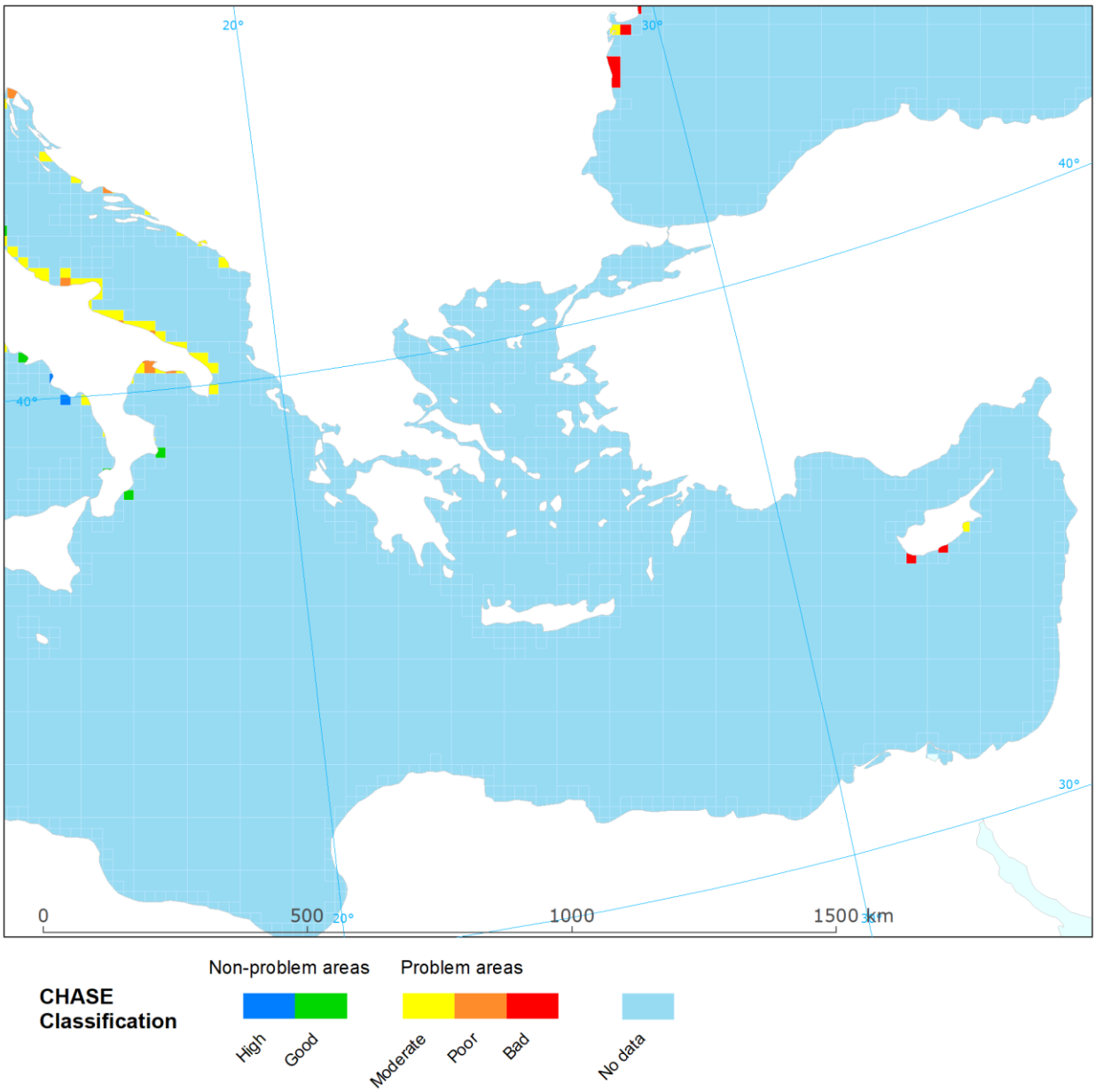

Figure A.19 CHASE classifications for Biota in the Eastern Mediterranean Sea.

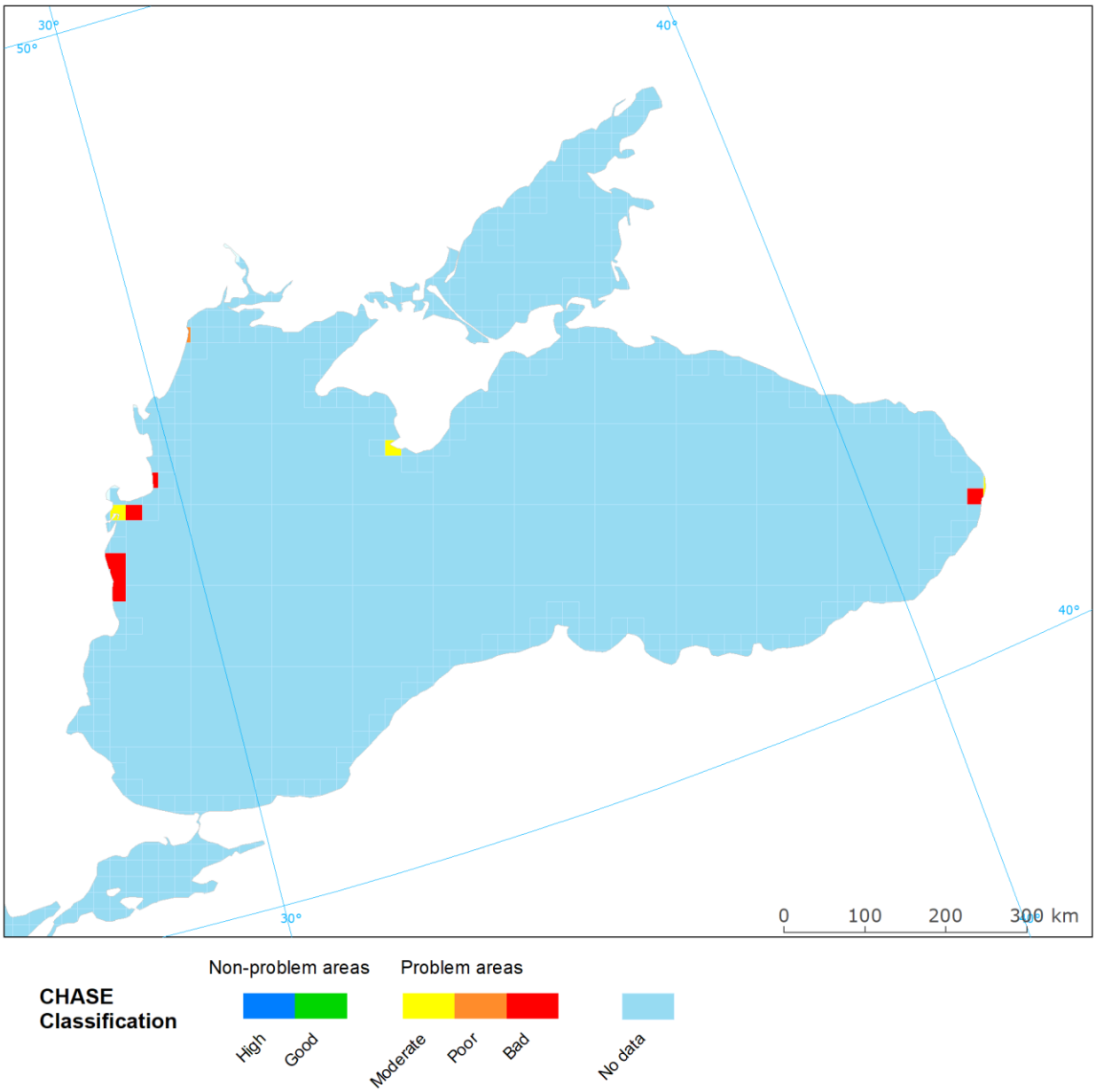

Figure A.20 CHASE classifications for Biota in the Black Sea.

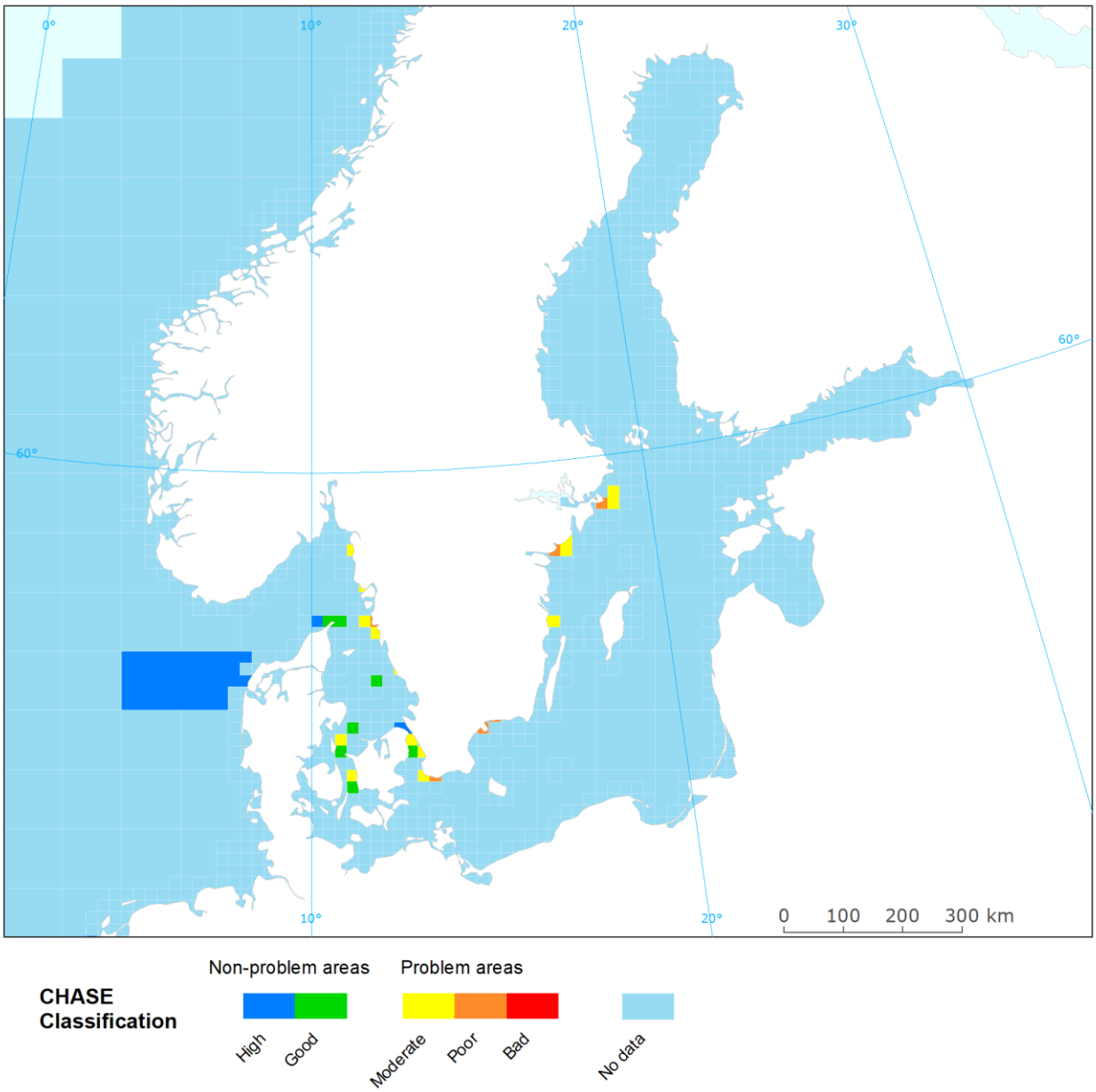

Figure A.21 CHASE classifications for Bioeffects in the Baltic Sea.

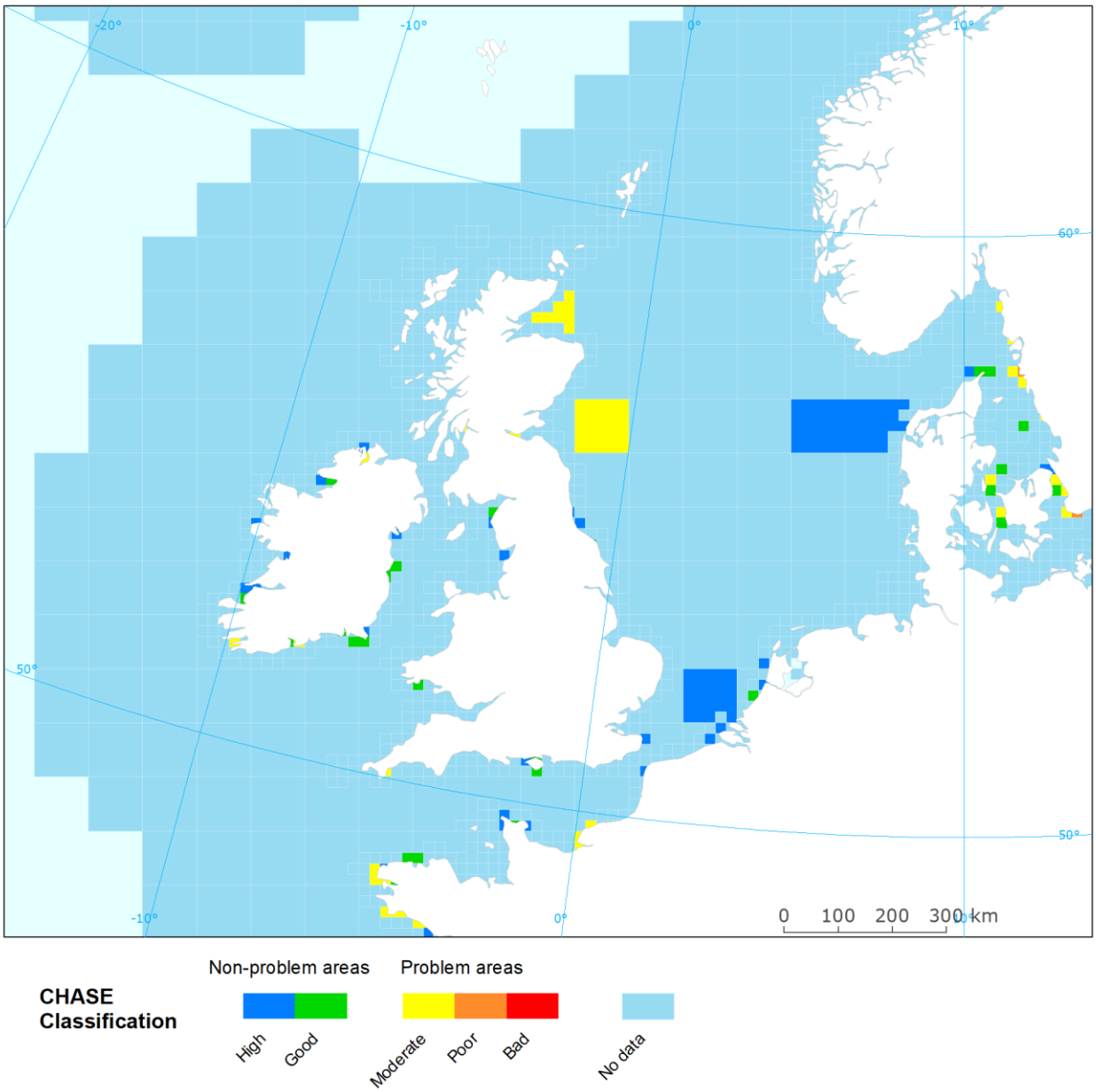

Figure A.22 CHASE classifications for Bioeffects in the North Sea and Celtic Sea.

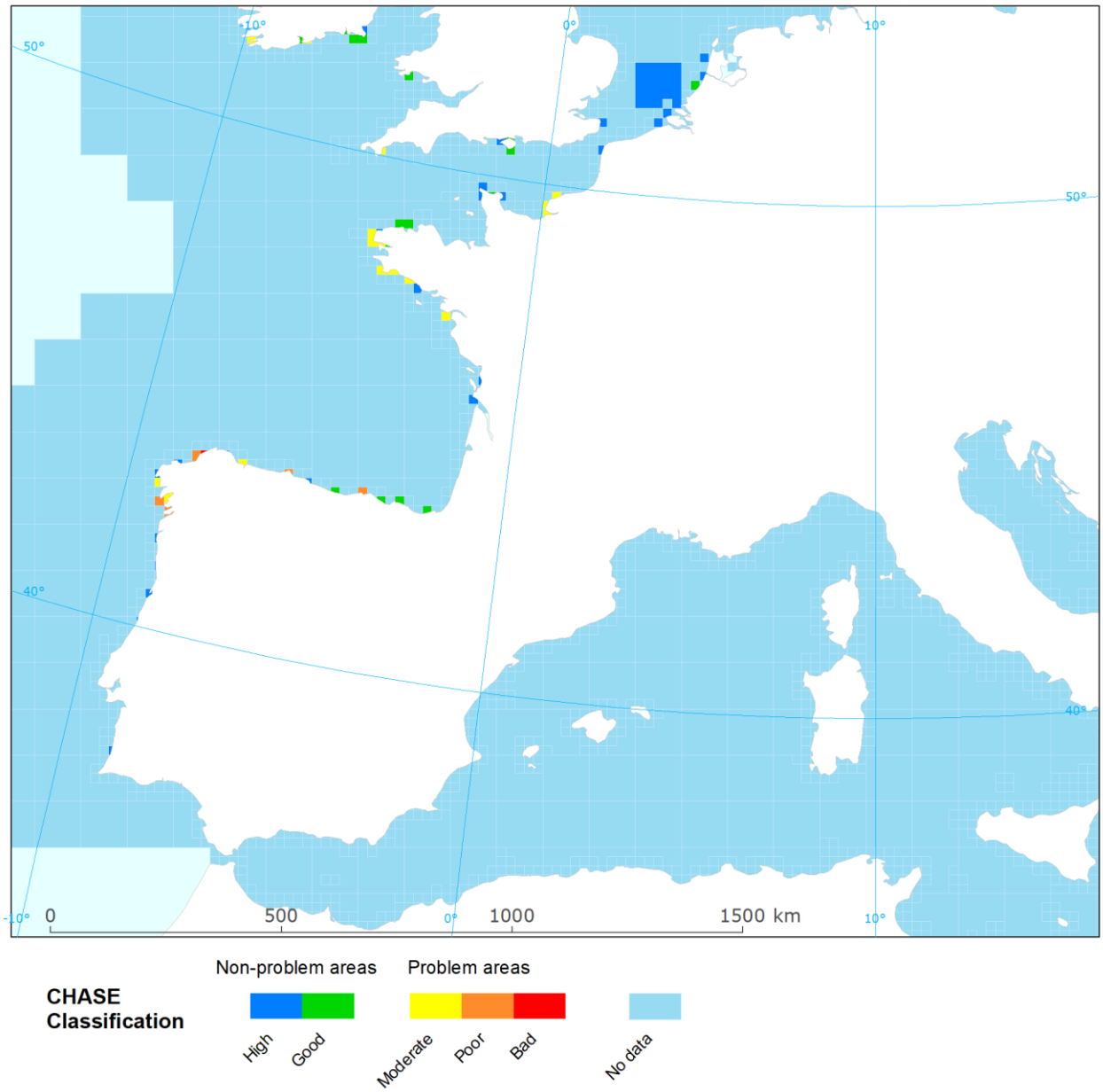

Figure A.23 CHASE classifications for Bioeffects in the Western Mediterranean Sea.

ANNEX 3: Boxplots

The following figures show the variation average values for indicator parameters calculated in each assessment unit:

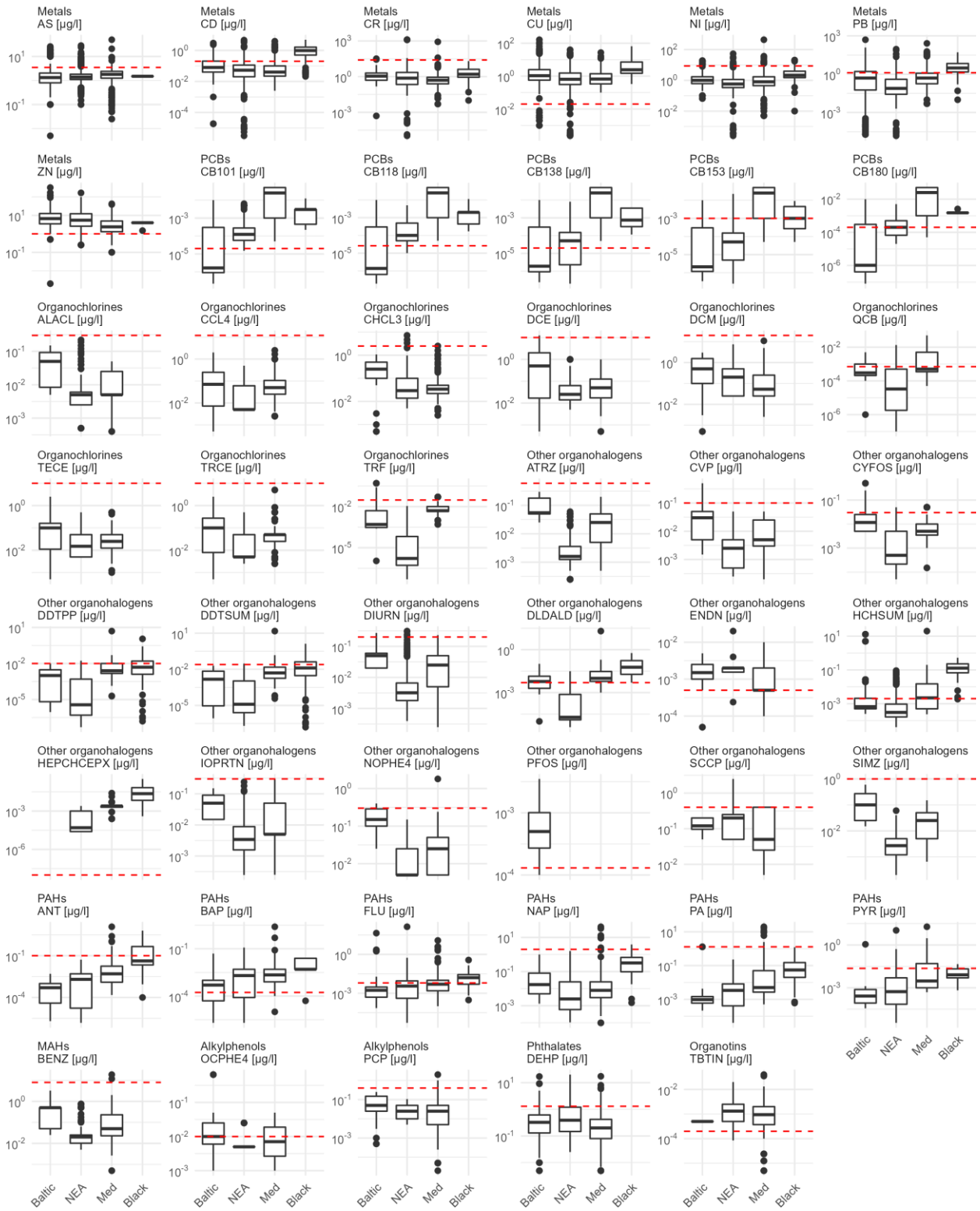

Figure A.24 Water Category - variation in average concentrations in assessment units, threshold values indicated by red dotted lines. See key to substance abbreviations in table below.

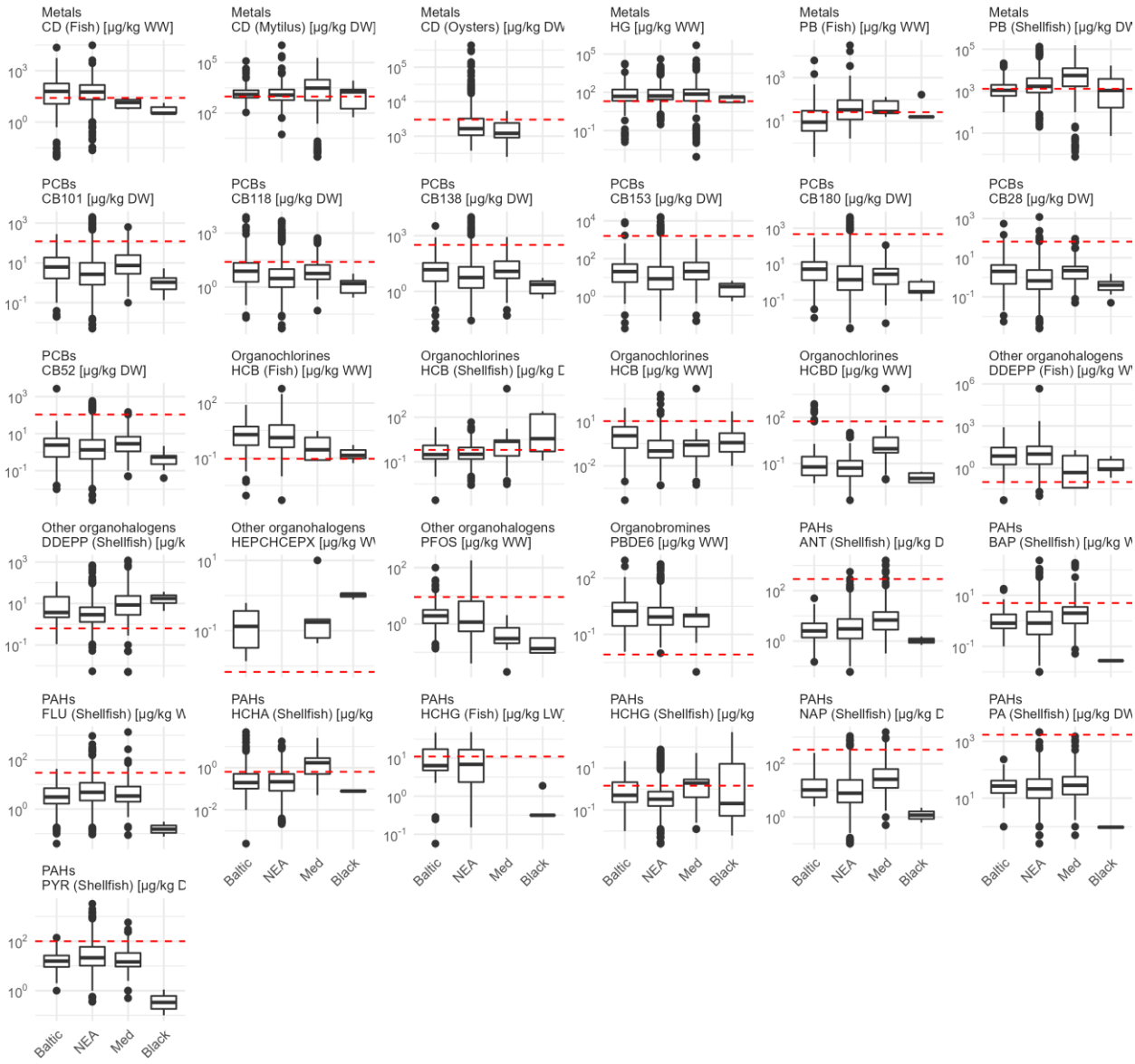

Figure A.25 Biota Category - variation in average concentrations in assessment units, threshold values indicated by red dotted lines. See key to substance abbreviations in table below.

For some substances in biota, different threshold values were applied depending on the species or type of organism, for example, Cadmium (CD) in fish, mussels or oysters. In this case, there is a separate boxplot for each set of observations and corresponding threshold value.

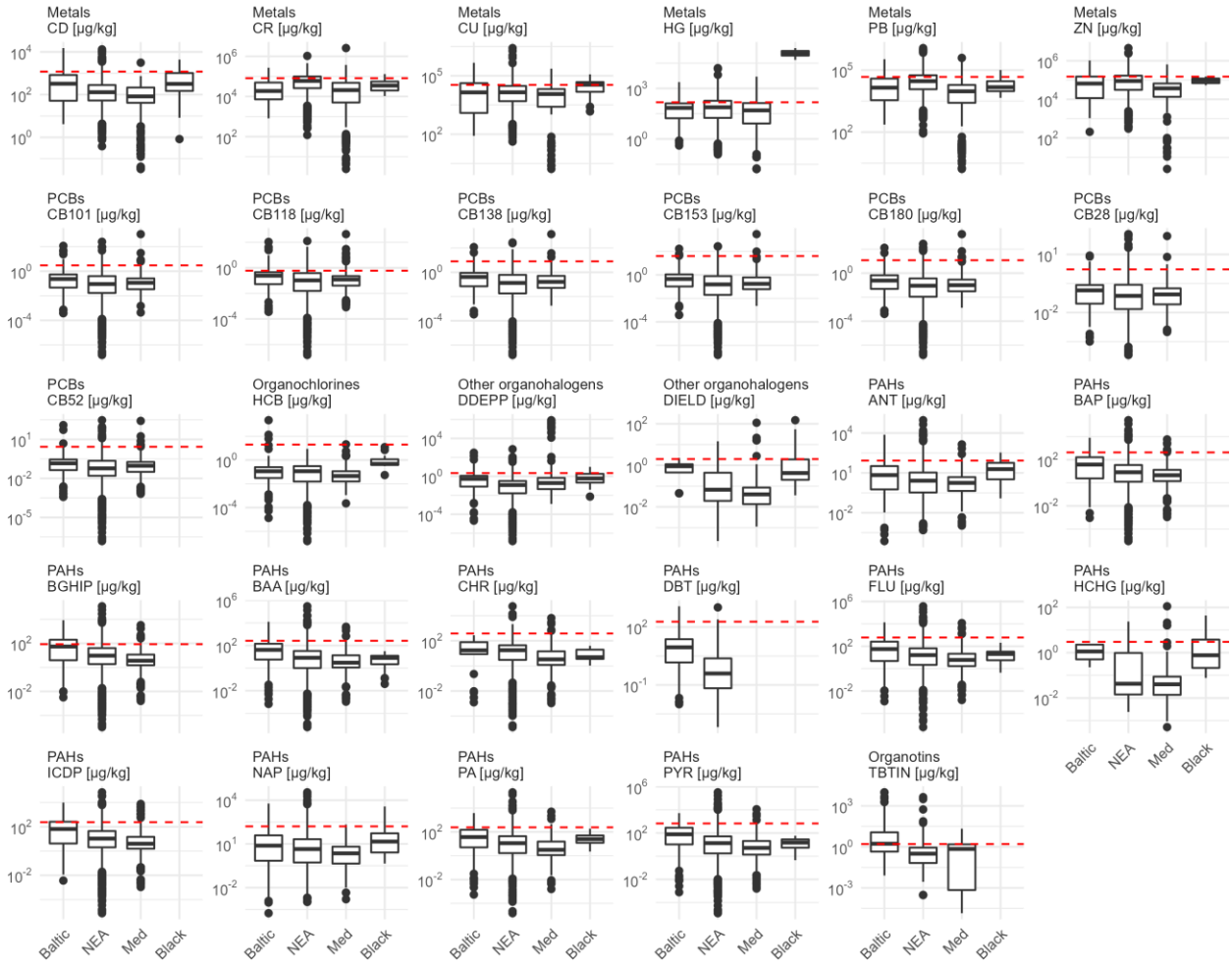

Figure A.26 Sediment Category - variation in average concentrations in assessment units, threshold values indicated by a red dotted line. See key to substance abbreviations in table below.

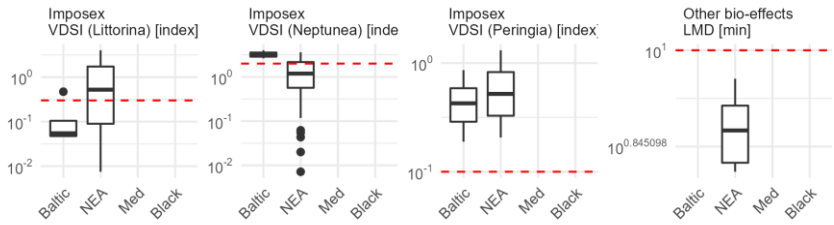

Figure A.27 Bio-effects Category - variation in average values in assessment units, threshold values indicated by red dotted lines

Species key:

Littorina: *Littorina littorea, Buccinum undatum, Nassarius reticulatus*
Neptunea: *Neptunea antiqua, Nucella lapillus*
Peringia: *Peringia ulvae*

Key to substance names in boxplots:

Parameter	Description
ALACL	Alachlor
ANT	Anthracene
AS	Arsenic
ATRZ	Atrazine
BAP	Benzo[a]pyrene
BENZ	Benzene
BGHIP	Benzo[ghi]perylene
BAA	Benzo[a]anthracene
CB101	2,2',4,5,5'-pentachlorobiphenyl (CB101)
CB118	2,3',4,4',5-pentachlorobiphenyl (CB118)
CB138	2,2',3,4,4',5'-hexachlorobiphenyl (CB138)
CB153	2,2',4,4',5,5'-hexachlorobiphenyl (CB153)
CB180	2,2',3,4,4',5,5'-heptachlorobiphenyl (CB180)
CB28	2,4,4'-trichlorobiphenyl (CB28)
CB52	2,2',5,5'-tetrachlorobiphenyl (CB52)
CCL4	Carbon tetrachloride
CD	Cadmium
CHCL3	Chloroform
CHR	Chrysene
CR	Chromium
CU	Copper
CVP	Chlorfenvinphos
CYFOS	Chlorpyrifos
DBT	Dibenzothiophene
DCE	1,2-dichloroethane
DCM	Dichloromethane
DDEPP	DDE (p,p')
DDTPP	DDT (p,p')
DDTSUM	Sum DDE, DDT, DDD
DEHP	Phthalic acid, bis(2-ethylhexyl) ester
DIELD	Dieldrin
DIURN	Diuron

Parameter	Description
DLDALD	Aldrin, dieldrin, endrin, isodrin SUM
ENDN	Endosulphan
FLU	Fluoranthene
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
HCHA	Alpha-HCH (alpha-hexachlorocyclohexane)
HCHG	Gamma-HCH (gamma-hexachlorocyclohexane)
HCHSUM	Hexachlorocyclohexane
HEPCHCEPX	Heptachlor+heptachlor epoxide
HG	Mercury
ICDP	Indeno[1,2,3-cd]pyrene
IOPRTN	Isoproturon
LMD	Lysosomal membrane stability (LMS)
NAP	Naphthalene
NI	Nickel
NOPHE4	4-Nonylphenol
OCPHE4	4-Octylphenol
PA	Phenanthrene
PB	Lead
PBDE6	Sum 6 BDEs
PCP	Pentachlorophenol
PFOS	Perfluorooctanyl sulphonic acid
PYR	Pyrene
QCB	Pentachlorobenzene
SCCP	Short chain chlorinated parrafin
SIMZ	Simazine
TBTIN	Tributyltin (TBT)
TECE	Tetrachloroethylene
TRCE	Trichloroethylene
TRF	Trifluralin
VDSI	Vas Deferens Sequence Index (VDSI)
ZN	Zinc