FRENCH AND NORWEGIAN SEDIMENT QUALITY GUIDELINES COMPARISON - CASE STUDY IN THE NE ADRIATIC SEA, CROATIA

Jadranka Pelikan, Maja Maurić Maljković, Kristina Pikelj, Dijana Pavičić-Hamer, Bojan Hamer

Jadranka Pelikan

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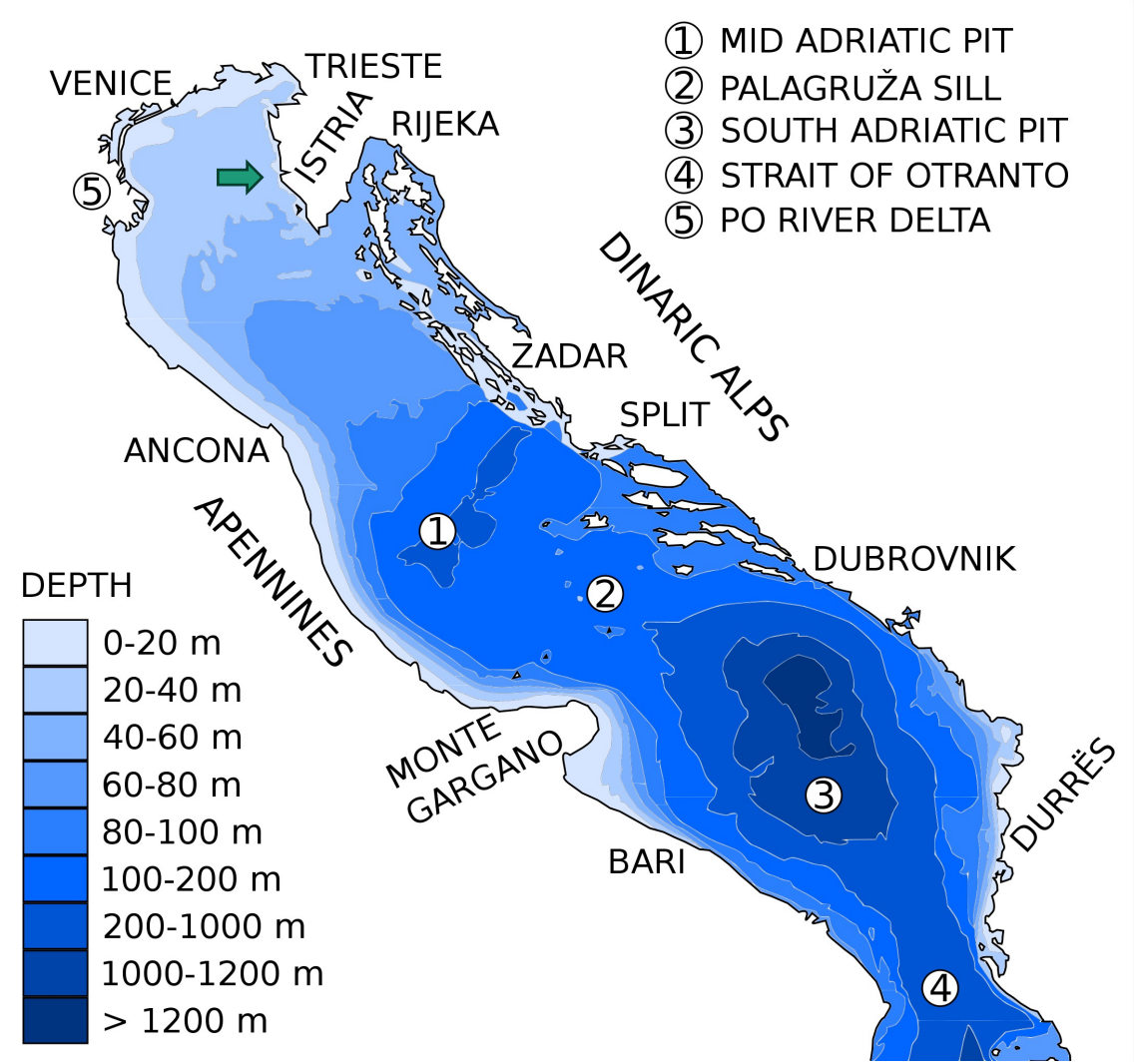
Introduction
The NE Adriatic Sea, Rovinj, Croatia



In 2010 plans for the harbour deepening

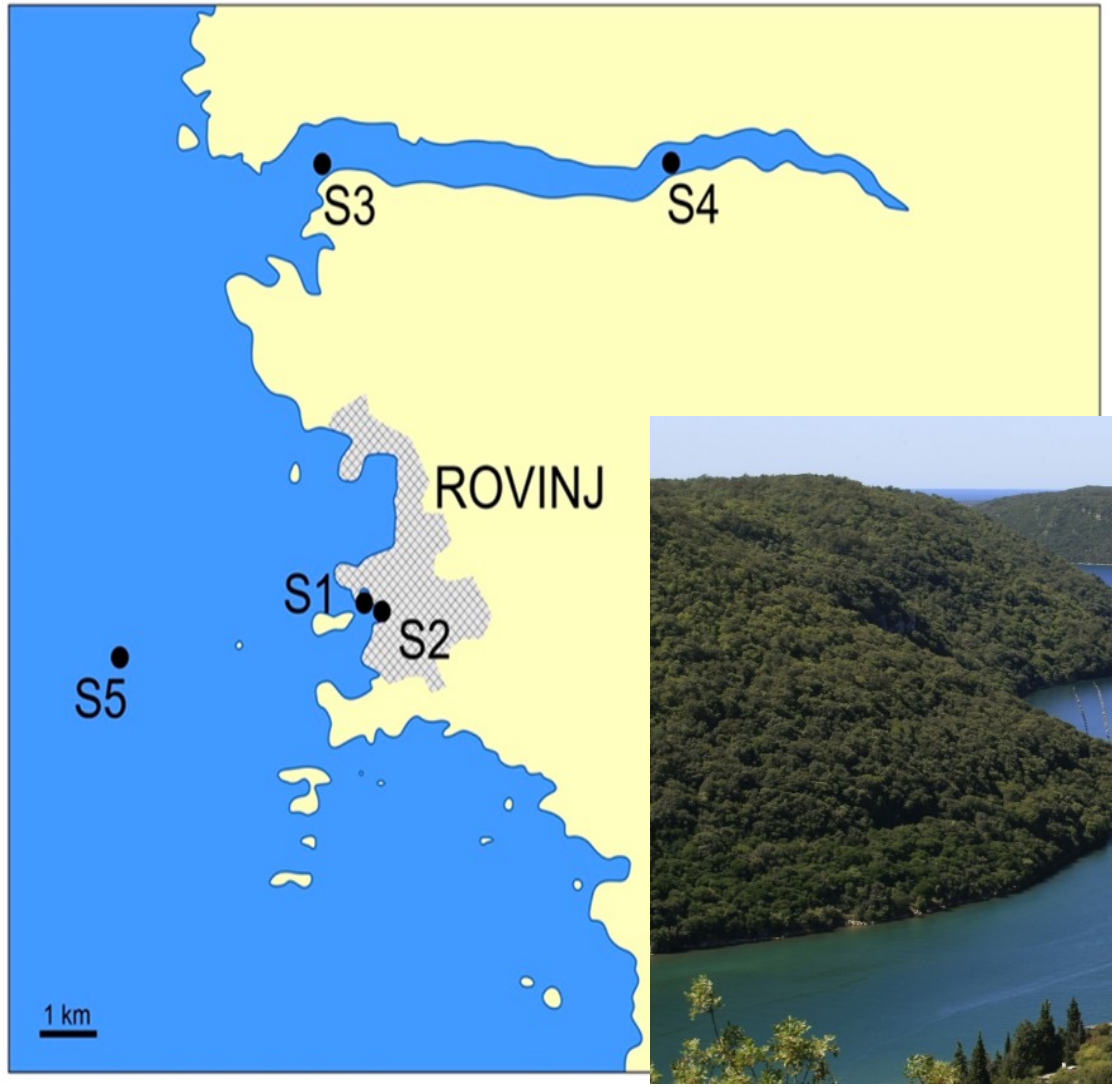
12,000 Inhabitants

>700,000 tourist visits

10 % – 12 % nautical tourists

NE Adriatic Sea – Rovinj area (2011)

- Van Veen grab (6m - 30 m)
- Sediment sampling 3 - 5 cm upper layer



Sediment Quality Guidelines in the national legislation (Croatia) (Action programme for the Management of the Marine Environment and Coastal Area Strategy - Monitoring and Observation System for the Permanent Assessment of the State of the Adriatic Sea (2021 - 2026)

Based on range of observed and predicted effects of chemical compunds concentrations on biota assessed.

D8.C1 concentrations in sediments

- Metals (As, Cd, Cu, Cr, Hg, Ni, Pb, Zn)
- PAHs (Polycyclic aromatic hydrocarbons) (fluoren, fenantren (Phe), antracen (Ant), fluoranten (Flt), piren (Pyr), benzo(a)antracen, krizen, benzo(b)fluoranten, benzo(k)fluoranten, benzo(a)piren, dibenzo(a,h)antracen, benzo(g,h,i)perilen, Indeno(1,2,3-c,d)piren))
- PCBs

- **D8.C2** sediment impact on biota
  - (*Mytilus galloprovincialis* i *Vibrio fischeri*)

Threshold criteria comparison for marine sediments

- French SQG (N1, N2) (JORF No. 184, 10-08-2000)
- Norwegian criteria (Bakke et al., 2010)

Results - French thresholds for dredged sediments

Parameters (units) (mg/kg d.w.)	Sampling sites					N1 Legal level	N2 Legal level
	S1 Harbour	S2 Shipyard	S3 Lim out	S4 Lim middle	S5 Open Sea		
As	9.223	23.440	8.126	13.850	3.985	25	50
Cd	0.265	0.092	0.083	0.091	0.073	1.2	2.4
Cu	69.95	30.59	13.77	18.45	4.77	45	90
Ni	7.93	14.15	28.59	41.16	8.49	37	74
Pb	24.38	6.95	1.83	1.35	3.69	100	200
Zn	115.60	50.66	71.75	88.00	31.87	276	552
Hg	0.838	0.266	0.129	0.138	0.038	0.4	0.8
Cr	22.49	26.31	76.11	98.14	22.39	90	180
ΣPAHs	10609	9867	4555	2.8	103	1500	15000
ΣPCBs	0.278	0.170	0.058	0.021	<0.010	0.5	1.0

Results for S1 Norwegian criteria for sediment (Bakke et al. 2010)

	Results	I (Background)	II (Good)	III Moderate	IV (Bad)	V (Very bad)
(mg/kg d.w.)	S1 Harbour	Background levels	No toxic effects	Toxic effects following chronic exposure	Toxic effects following short term exposure	Severe acute toxic effects
As	9.223	<20	20-52	52-76	76-580	>580
Cd	0.265	<0.25	0.25-2.6	2.6-15	15-140	>140
Cr	22.49	<70	70-560	560-5,900	5,900-59,000	>59,000
Cu	69.95	<35	35-51	51-55	55-220	>220
Hg	0.838	<0.15	0.15-0.63	0.63-0.86	0.86-2	>1.6
Ni	7.932	<30	30-46	46-120	120-840	>840
Pb	24.380	<30	30-83	83-100	100-720	>720
Zn	115.60	150	150-360	360-590	590-4,500	>4,500
Total PAHs	10609	<300	300-2,000	2,000-6,000	6,000-20,000	>20,000
Total PCB		<5	5-17	17-190	190-1,900	>1.900

French vs. Norwegian criteria for sediment (Bakke et al. 2010)

Contaminants	French	French	I (Background)	II (Good)	III Moderate	IV (Bad)	V (Very bad)
(mg/kg d.w.)	N1	N2	Background levels	No toxic effects	Toxic effects following chronic exposure	Toxic effects following short term exposure	Severe acute toxic effects
As	25	50	<20	20-52	52-76	76-580	>580
Cd	1.2	2.4	<0.25	0.25-2.6	2.6-15	15-140	>140
Cr	90	180	<70	70-560	560-5,900	5,900-59,000	>59,000
Cu	45	90	<35	35-51	51-55	55-220	>220
Hg	0.4	0.8	<0.15	0.15-0.63	0.63-0.86	0.86-2	>1.6
Ni	37	74	<30	30-46	46-120	120-840	>840
Pb	100	200	<30	30-83	83-100	100-720	>720
Zn	276	552	150	150-360	360-590	590-4,500	>4,500
Total PAHs	1500	15000	<300	300-2,000	2,000-6,000	6,000-20,000	>20,000
Total PCB	0.5	1.0	<5	5-17	17-190	190-1,900	>1.900

Ecological risk assessment and probability of toxic effect QPEC - risk quotient and QPECm average risk quotient - Results

- The ∑QN1 and QPECm risk quotients were used as appropriate indicators of potential ecological effects on the aquatic environment.
- ∑QN1 represents the sum of all individual ratios between the contaminant concentration and the French N1 legal level (PEC value).
- The general sediment risk quotient QPECm represents the averaged ∑QN1 value for a given sediment divided by the number of all pollutants studied.
- QPECm = (Σ n i=1 (Ci/PECi))/n

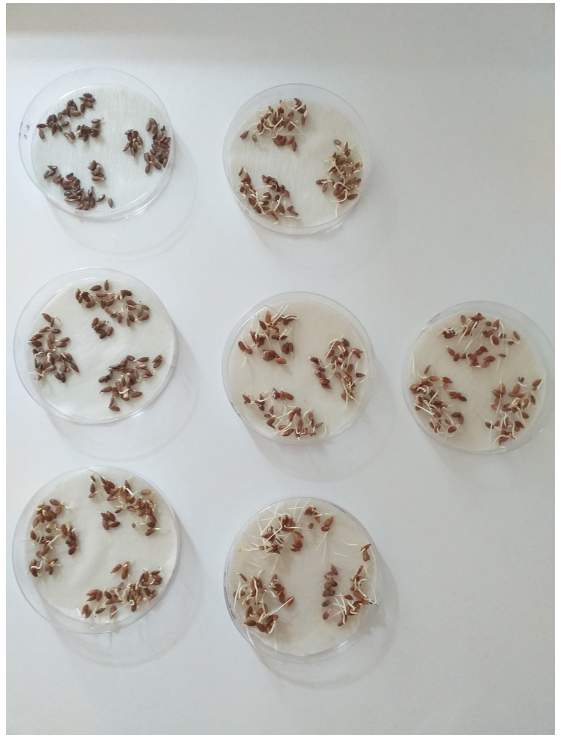
	S1 Harbour	**S2** Marina	**S3** Lim Bay Out	**S4** Lim Bay Middle	**S5** Open Sea
ΣQ_{N1}	**12.99**	**10.20**	**6.07**	**3.98**	**1.12**
Q_{PECm}	**1.30**	**1.02**	**0.61**	**0.40**	**0.11**

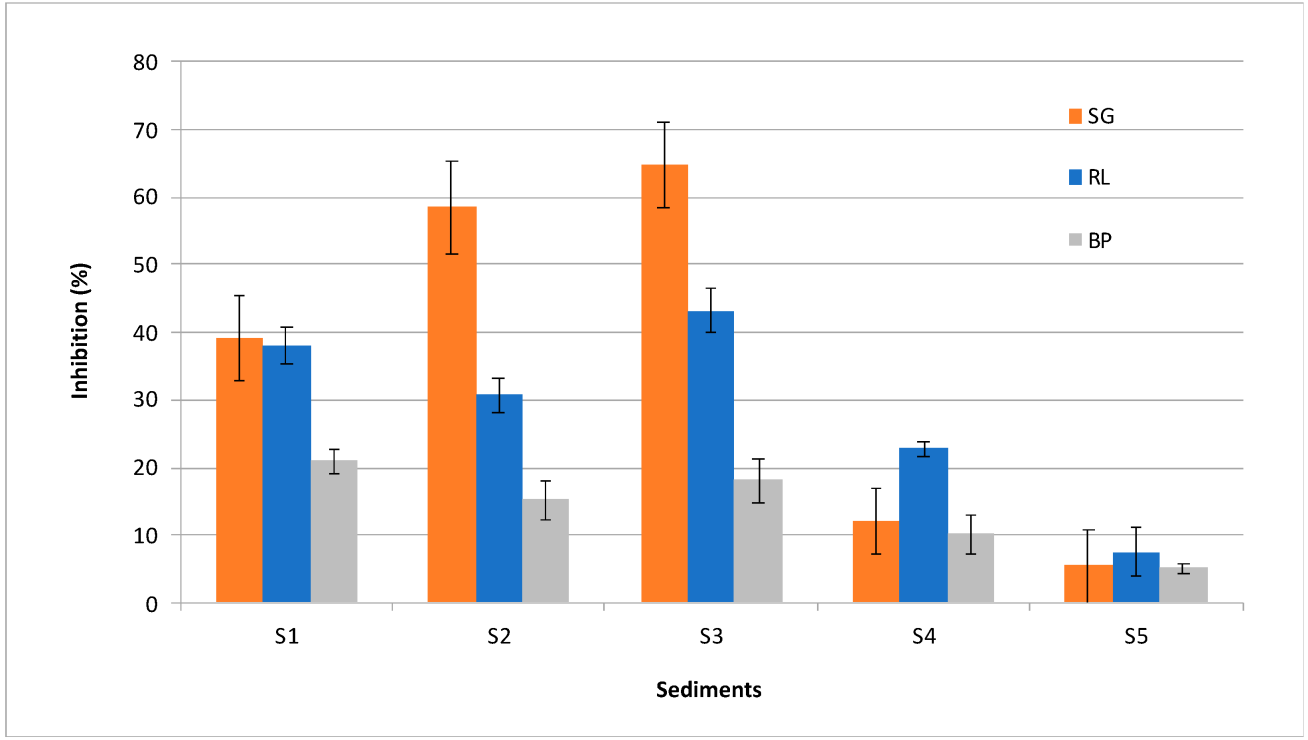
Phytotoxicity index (%)

- Phytotoxic effect on germination delay:

56.5 % to 84.2 % compared to the S5 control site (GI = 100 %)

- Phytotoxic index (PI): 15.8 % – 43.5 %





Conclusion

Almost all measured values are below the French N1 threshold level with QPEC values < 1.00, indicating no ecological risk and good environmental quality of the coastal area of Rovinj and Lim Bay. Only S1 shows increase in ecological risk as QPEC value 1.30 due to measured Hg concentration 0.838 mg/kg (harmful) d.w. and Cu 69.95 mg/kg d.w.

The Norweigian criteria recognised several concentrations potentially adverse for biota in sediments collected at the S1 with Cu (69.95 mg/kg s.t.), Hg (0.838 mg/kg s.t.) – moderate impact.

Although the French regulation has lower thresholds than the Norwegian criteria, therefore stricter for contaminated sediments intended for further use, the later is more suitable for differentiation of less polluted marine sediments.