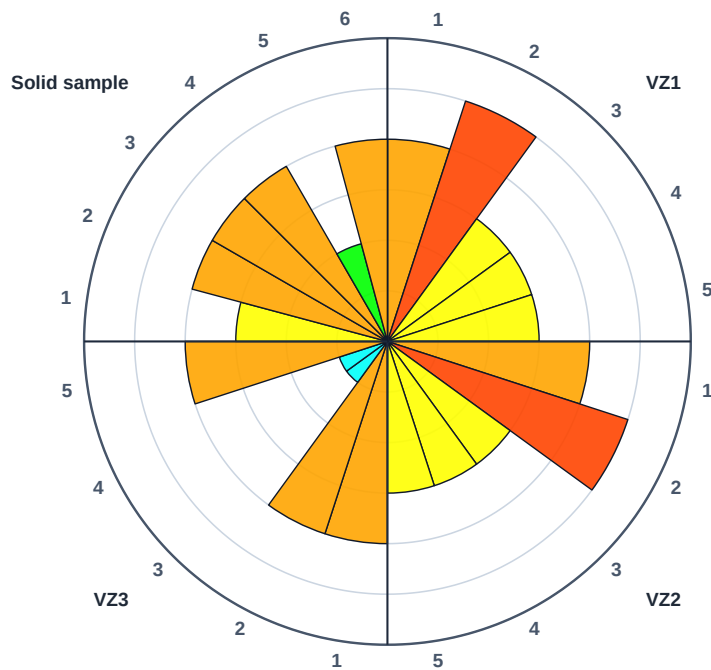


Ecotoxicology Analysis

Before Remediation

Locality: Ferrara, Italy, ER-site
Bioremediation method: Before Bioremediation
Sample type: water, soil
Collection date: 2023-04-04 – 2023-07-07



ORGANISMS

- 1 *Algae*
- 2 *Daphnids*
- 3 *A. fischeri 15*
- 4 *A. fischeri 30*
- 5 *Lettuce aquatic*
- 6 *Lettuce terestric*

CATEGORIES

- A Non-toxic
- B Low toxicity
- C Medium toxicity
- D High toxicity
- E Very high toxicity
- F Extreme toxicity

Category Distribution (% of organism readings)

A: 10%

B: 5%

C: 33%

D: 43%

E: 9%

Resulting category: **E** Very high toxicity

Test Organisms by Type

Consumers:	<i>Daphnids</i>
Producers:	<i>Algae, Lettuce aquatic, Lettuce terestric</i>
Destruent:	<i>A. fischeri 15, A. fischeri 30</i>

Most sensitive organism: Daphnids

Critical ecotoxicological response recommended

Samples fall into category E. At 10% sample concentration inhibition is 51–100%, or EC50 is 1–10%. A severe toxic effect is present.

- It is recommended to implement immediate measures and conduct intensive monitoring.

Ecotoxicity Assessment Criteria

CATEGORY	DESCRIPTION	CRITERIA (ACTIVE RULES)
A	Non-toxic	Undiluted sample: inhibition / stimulation -19.99% – 19.99%
B	Low toxicity	Undiluted sample: stimulation 20% – 50%, or Undiluted sample: inhibition 20% – 50%
C	Medium toxicity	Undiluted sample: stimulation 51% – 90%, or Undiluted sample: inhibition 51% – 90%
D	High toxicity	At 10% sample concentration: inhibition / stimulation -50.99% – 50.99%, or EC50 10% – 50%
E	Very high toxicity	At 10% sample concentration: inhibition 51% – 100%, or EC50 1% – 10%
F	Extreme toxicity	At 1% sample concentration: inhibition 10.01% – 100%, or EC50 0% – 0.99%

Notes: A sample's category is the worst (most toxic) grade reached by any single test organism. Determination of EC50 takes precedence over the inhibition value. In a luminescence bacterial test, an undiluted sample corresponds to a sample concentration of 500 mL/L.

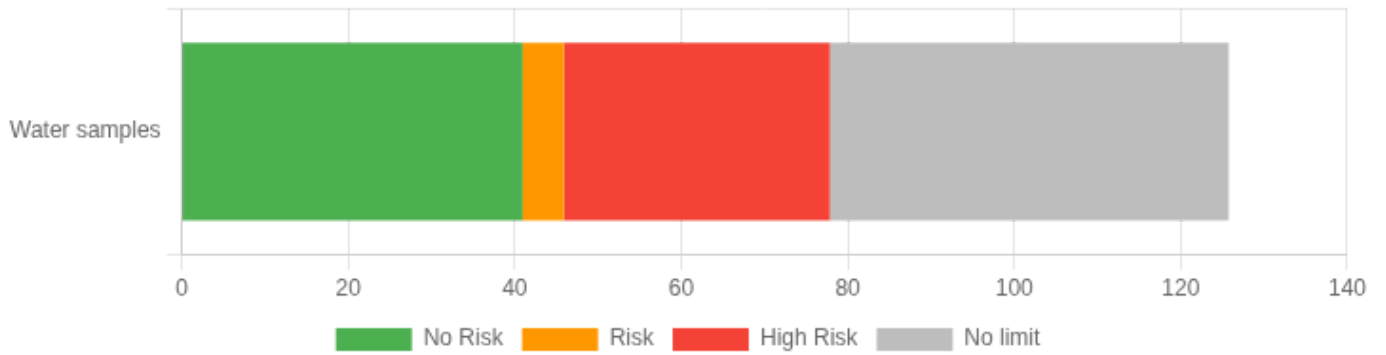
Chemical Risk Assessment

Before Remediation

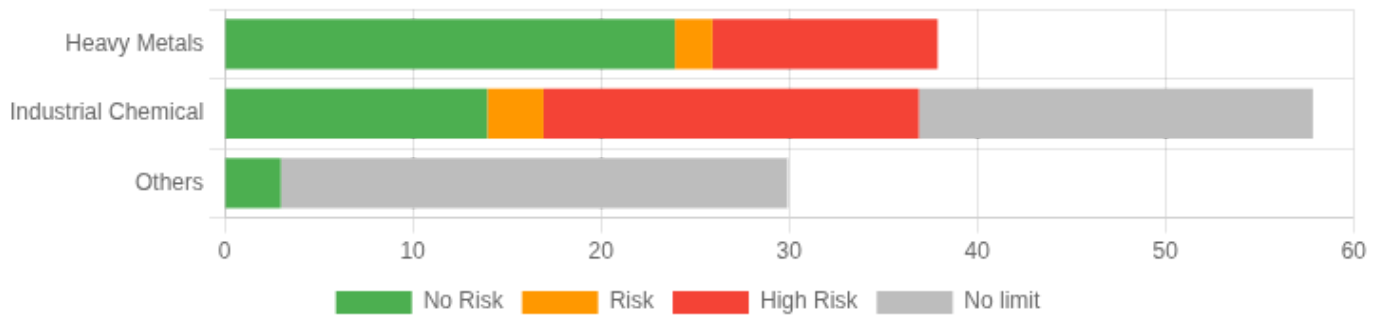
Locality: Ferrara, Italy, ER-site
Bioremediation method: Before Bioremediation
Sample type: water, soil
Collection date: 2023-04-04 – 2023-07-07

- No Risk — at/below limit
- Risk — over limit (up to 50%)
- High Risk — more than 50% over limit
- No limit — not defined

Risk distribution by sample type



Water samples



No risk 33%

Risk 4%

High risk 25%

No limit 38%

CLASS	NUMBER	OVER LIMIT	SUM CONCENTRATION
Heavy Metals	38	14	81954.171 µg/L
Industrial Chemical	58	23	398618.3667 µg/L
Others	30	0	1448.22 mg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
VZ2	arsenic	Heavy Metals	31.7	µg/L
VZ2	iron	Heavy Metals	24800	µg/L
VZ2	manganese	Heavy Metals	1720	µg/L
VZ2	1,1,2-trichloroethane	Industrial Chemical	5	µg/L
VZ2	1,1-dichloroethylene	Industrial Chemical	71	µg/L
VZ2	benzene	Industrial Chemical	3000	µg/L
VZ2	ethylbenzene	Industrial Chemical	1000	µg/L
VZ2	toluene	Industrial Chemical	3780	µg/L
VZ2	vinyl chloride	Industrial Chemical	20200	µg/L
VZ3	arsenic	Heavy Metals	19	µg/L
VZ3	arsenic	Heavy Metals	19	µg/L
VZ3	cobalt	Heavy Metals	156	µg/L
VZ3	cobalt	Heavy Metals	156	µg/L
VZ3	iron	Heavy Metals	25400	µg/L
VZ3	iron	Heavy Metals	25400	µg/L
VZ3	manganese	Heavy Metals	1710	µg/L
VZ3	manganese	Heavy Metals	1710	µg/L
VZ3	1,1,2-trichloroethane	Industrial Chemical	19.3	µg/L
VZ3	1,1,2-trichloroethane	Industrial Chemical	19.3	µg/L
VZ3	1,1-dichloroethylene	Industrial Chemical	311	µg/L
VZ3	1,1-dichloroethylene	Industrial Chemical	311	µg/L
VZ3	benzene	Industrial Chemical	3380	µg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
VZ3	benzene	Industrial Chemical	3380	µg/L
VZ3	ethylbenzene	Industrial Chemical	1750	µg/L
VZ3	ethylbenzene	Industrial Chemical	1750	µg/L
VZ3	toluene	Industrial Chemical	4950	µg/L
VZ3	toluene	Industrial Chemical	4950	µg/L
VZ3	vinyl chloride	Industrial Chemical	50800	µg/L
VZ3	vinyl chloride	Industrial Chemical	50800	µg/L
water sample	manganese	Heavy Metals	388	µg/L
water sample	benzene	Industrial Chemical	29	µg/L
water sample	toluene	Industrial Chemical	37	µg/L
VZ2	cobalt	Heavy Metals	66	µg/L
VZ3	1,2-dichloroethylene	Industrial Chemical	73	µg/L
VZ3	1,2-dichloroethylene	Industrial Chemical	73	µg/L
water sample	iron	Heavy Metals	205	µg/L
water sample	n-Hexane	Industrial Chemical	388	µg/L
VZ2	Aluminium	Heavy Metals	21.7	µg/L
VZ2	Chromium (total)	Heavy Metals	1.15	µg/L
VZ2	chromium VI	Heavy Metals	1.06	µg/L
VZ2	copper	Heavy Metals	0.921	µg/L
VZ2	nickel	Heavy Metals	17.5	µg/L
VZ2	1,1-dichloroethane	Industrial Chemical	9.11	µg/L
VZ2	1,2-dichloroethylene	Industrial Chemical	27.8	µg/L
VZ2	1,2-Dichloroethylene	Industrial Chemical	18.4	µg/L
VZ2	1,2-Dichloroethylene	Industrial Chemical	9.39	µg/L
VZ2	Nitrites	Others	0.13	mg/L
VZ3	Aluminium	Heavy Metals	15.9	µg/L
VZ3	Aluminium	Heavy Metals	15.9	µg/L
VZ3	Chromium (total)	Heavy Metals	1.18	µg/L
VZ3	Chromium (total)	Heavy Metals	1.18	µg/L
VZ3	chromium VI	Heavy Metals	0.732	µg/L
VZ3	chromium VI	Heavy Metals	0.732	µg/L
VZ3	copper	Heavy Metals	0.44	µg/L
VZ3	copper	Heavy Metals	0.44	µg/L
VZ3	mercury	Heavy Metals	0.05	µg/L
VZ3	mercury	Heavy Metals	0.05	µg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
VZ3	nickel	Heavy Metals	15.3	µg/L
VZ3	nickel	Heavy Metals	15.3	µg/L
VZ3	1,1-dichloroethane	Industrial Chemical	4.72	µg/L
VZ3	1,1-dichloroethane	Industrial Chemical	4.72	µg/L
VZ3	1,2-Dichloroethylene	Industrial Chemical	52	µg/L
VZ3	1,2-Dichloroethylene	Industrial Chemical	21.3	µg/L
VZ3	1,2-Dichloroethylene	Industrial Chemical	52	µg/L
VZ3	1,2-Dichloroethylene	Industrial Chemical	21.3	µg/L
VZ3	Nitrites	Others	0.08	mg/L
VZ3	Nitrites	Others	0.08	mg/L
water sample	Aluminium	Heavy Metals	30.4	µg/L
water sample	arsenic	Heavy Metals	2.83	µg/L
water sample	Chromium (total)	Heavy Metals	3.04	µg/L
water sample	chromium VI	Heavy Metals	0.576	µg/L
water sample	cobalt	Heavy Metals	12.6	µg/L
water sample	copper	Heavy Metals	3.79	µg/L
water sample	nickel	Heavy Metals	10.7	µg/L
water sample	1,2-dichloroethane	Industrial Chemical	0.122	µg/L
water sample	ethylbenzene	Industrial Chemical	32	µg/L
water sample	pyrene	Industrial Chemical	0.0207	µg/L
water sample	vinyl chloride	Industrial Chemical	0.121	µg/L
VZ2	naphthalene	Industrial Chemical	425	µg/L
VZ2	sum organohalogen	Industrial Chemical	20300	µg/L
VZ2	Tetrachloroethylene	Industrial Chemical	2.97	µg/L
VZ2	total hydrocarbons as hexane	Industrial Chemical	34300	µg/L
VZ2	Trichloroethylene	Industrial Chemical	2.55	µg/L
VZ2	Xylene	Industrial Chemical	3180	µg/L
VZ2	ammonia nitrogen	Others	23.9	mg/L
VZ2	chlorides	Others	448	mg/L
VZ2	organic nitrogen	Others	9.1	mg/L
VZ2	potassium	Others	2.23	mg/L
VZ2	sulphates	Others	23.3	mg/L
VZ2	TOC	Others	154	mg/L
VZ2	total inorganic nitrogen	Others	18.6	mg/L
VZ3	naphthalene	Industrial Chemical	327	µg/L

SAMPLE	COMPOUND / ELEMENT	CLASS	MEASURED	UNIT
VZ3	naphthalene	Industrial Chemical	327	µg/L
VZ3	sum organohalogen	Industrial Chemical	51100	µg/L
VZ3	sum organohalogen	Industrial Chemical	51100	µg/L
VZ3	Tetrachloroethylene	Industrial Chemical	1.66	µg/L
VZ3	Tetrachloroethylene	Industrial Chemical	1.66	µg/L
VZ3	total hydrocarbons as hexane	Industrial Chemical	39200	µg/L
VZ3	total hydrocarbons as hexane	Industrial Chemical	39200	µg/L
VZ3	Trichloroethylene	Industrial Chemical	2.99	µg/L
VZ3	Trichloroethylene	Industrial Chemical	2.99	µg/L
VZ3	Xylene	Industrial Chemical	3880	µg/L
VZ3	Xylene	Industrial Chemical	3880	µg/L
VZ3	ammonia nitrogen	Others	16.7	mg/L
VZ3	ammonia nitrogen	Others	16.7	mg/L
VZ3	chlorides	Others	200	mg/L
VZ3	chlorides	Others	200	mg/L
VZ3	organic nitrogen	Others	3.46	mg/L
VZ3	organic nitrogen	Others	3.46	mg/L
VZ3	potassium	Others	1.55	mg/L
VZ3	potassium	Others	1.55	mg/L
VZ3	sulphates	Others	0.9	mg/L
VZ3	sulphates	Others	0.9	mg/L
VZ3	TOC	Others	119	mg/L
VZ3	TOC	Others	119	mg/L
VZ3	total inorganic nitrogen	Others	13	mg/L
VZ3	total inorganic nitrogen	Others	13	mg/L
water sample	naphthalene	Industrial Chemical	3.7	µg/L
water sample	sum organohalogen	Industrial Chemical	0.243	µg/L
water sample	Xylene	Industrial Chemical	51	µg/L
water sample	ammonia nitrogen	Others	0.89	mg/L
water sample	chlorides	Others	20	mg/L
water sample	potassium	Others	2.3	mg/L
water sample	sulphates	Others	27	mg/L
water sample	TOC	Others	8.7	mg/L
water sample	total inorganic nitrogen	Others	0.69	mg/L

Chemical Assessment Criteria

Chemical data exceed the limit values

Exceedances of limit values indicate the presence of chemical risk. The remediation is insufficient or ineffective for the substances concerned. It is recommended to identify the source of contamination, reassess the remediation strategy, and propose additional measures. Exceedances are considered relevant above 0.5 µg/L for water samples and 0.5 mg/kg for soil samples.

Supportive Methods

Before Remediation

Locality: Ferrara, Italy, ER-site

Bioremediation method: Before Bioremediation

Per-sample evaluation

Sample	Type	Diversity — Shannon (H')	Diversity — Simpson (1-D)	Nitrification	Respiration	Conformity
VZ1	Water	— expected: Low	— expected: Low	8.3% Within $\pm 20\%$ Conforming		Conforming
VZ2	Water	— expected: Low	— expected: Low	58.1% Exceeds $\pm 20\%$ — significant effect on the nitrifying community Nonconforming		Nonconforming
VZ3	Water	— expected: Low	— expected: Low	56.4% Exceeds $\pm 20\%$ — significant effect on the nitrifying community Nonconforming		Nonconforming

Diversity (Shannon / Simpson): read as a trend across the before / during / after phases (rising = recovery), compared with the expected level per phase. **Respiration:** QR \leq 0.5 acceptable; above that the AHB count is checked (\geq 1000 CFU/g = not suitable, below = not suitable without microbial augmentation). **Nitrification:** inhibition / stimulation within $\pm 20\%$.