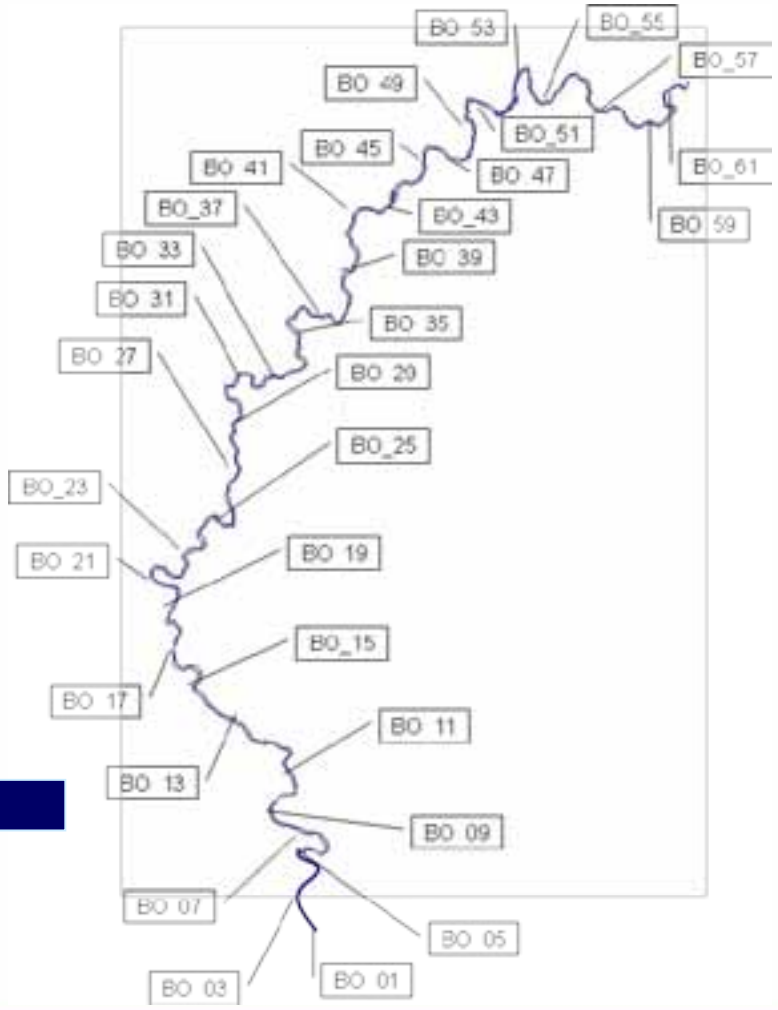
Integration of data from different field applications

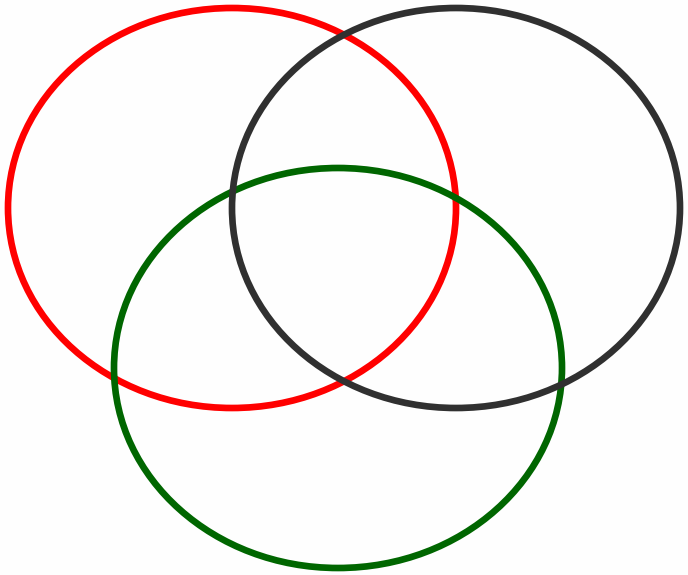
Alessandro Dagnino

Università degli studi del Piemonte Orientale

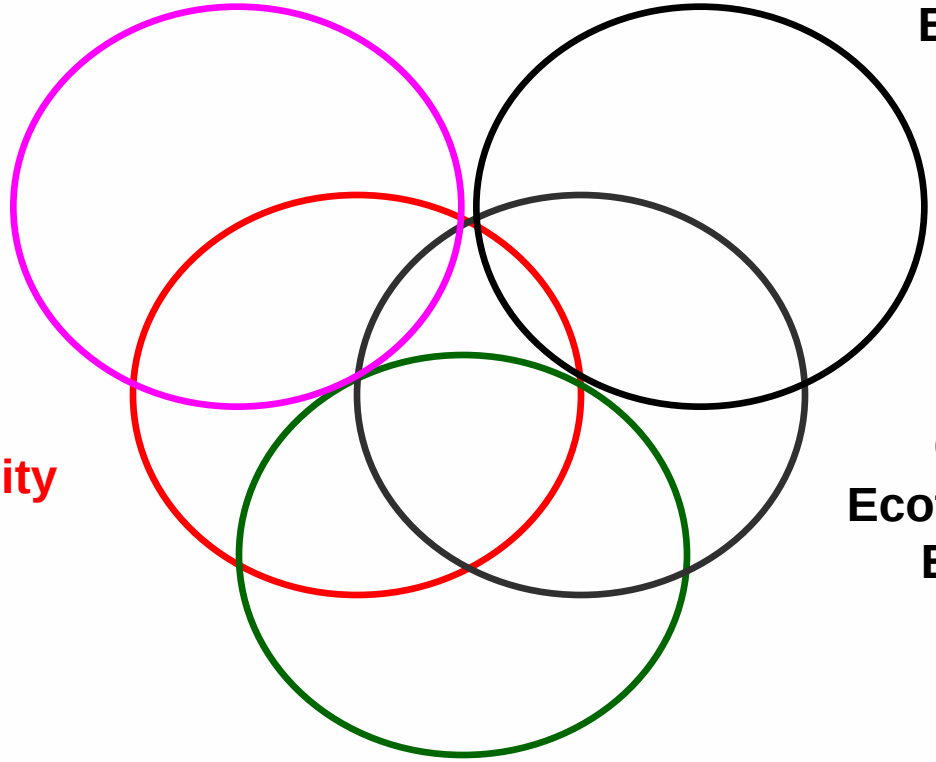
An case of study: the Bormida river



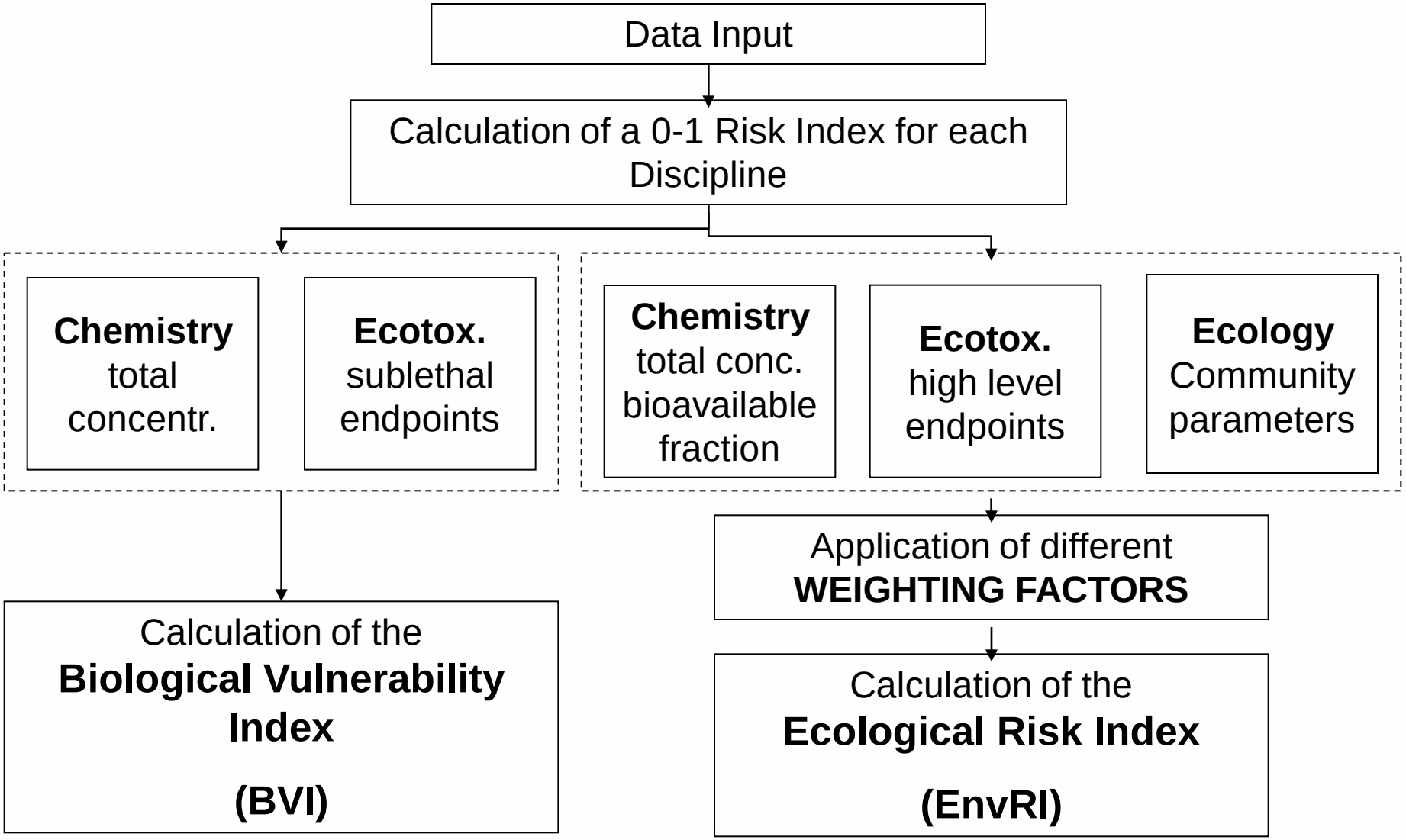
The Triad approach



The Triad approach



Integration procedure



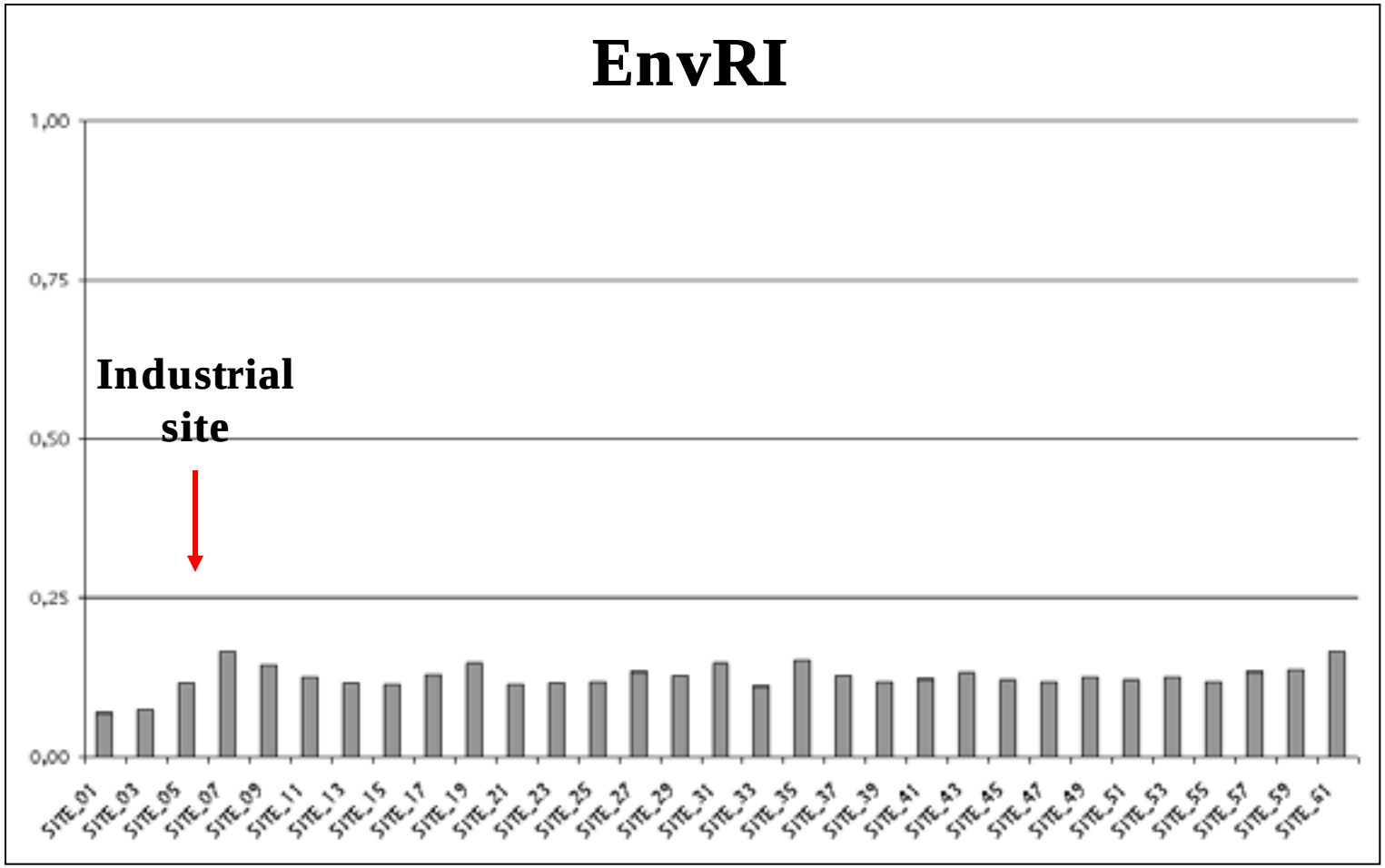
Weighting factors

Triad disciplines	LoEs	W.F.
Chemistry	Concentration levels	**1.0**
	Bioavailability	**1.5**
Ecotoxicology	Sublethal endpoints	**1.0**
	High level endpoints	**1.5**
Ecology	Community functions and structure	**2.0**

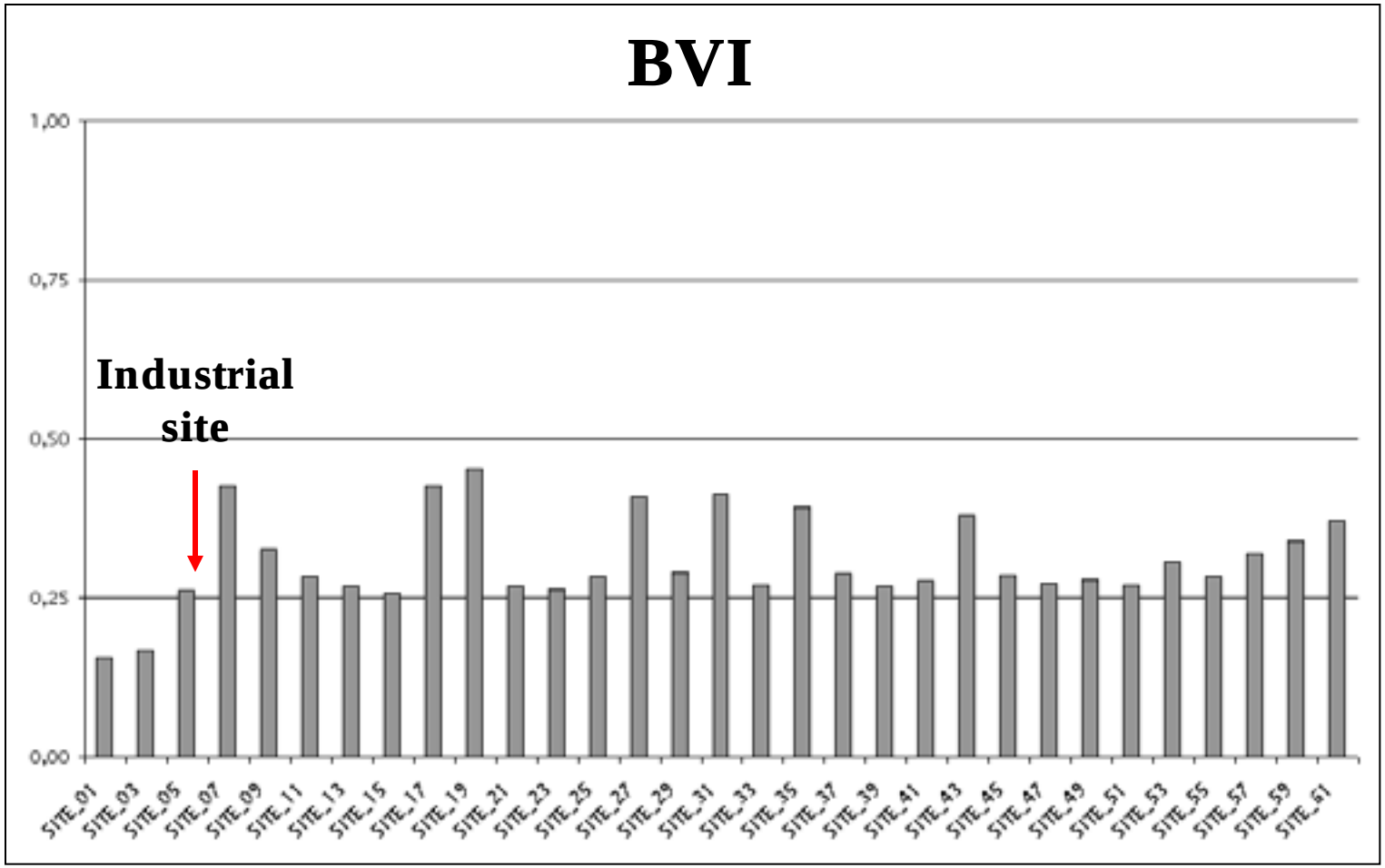
Data set

Chemistry	Bioavailability	N.D.
	Total concentration	Heavy metals, xenobiotics and other compounds in sediments.
Ecotoxicology	High level endpoints	Bioassays (arthropods, nematode, vegetals, protozoa and bacteria) on sediments and interstitial water
	Sublethal endpoints	Biomarkers on protozoa and vegetals Genotoxicity biomarkers on sediments and interstitial water
Ecology	Community structure and functions	Macroinvertebrate community structure (EBI index)

Results
Environmental Risk Index



Results
Biological Vulnerability Index

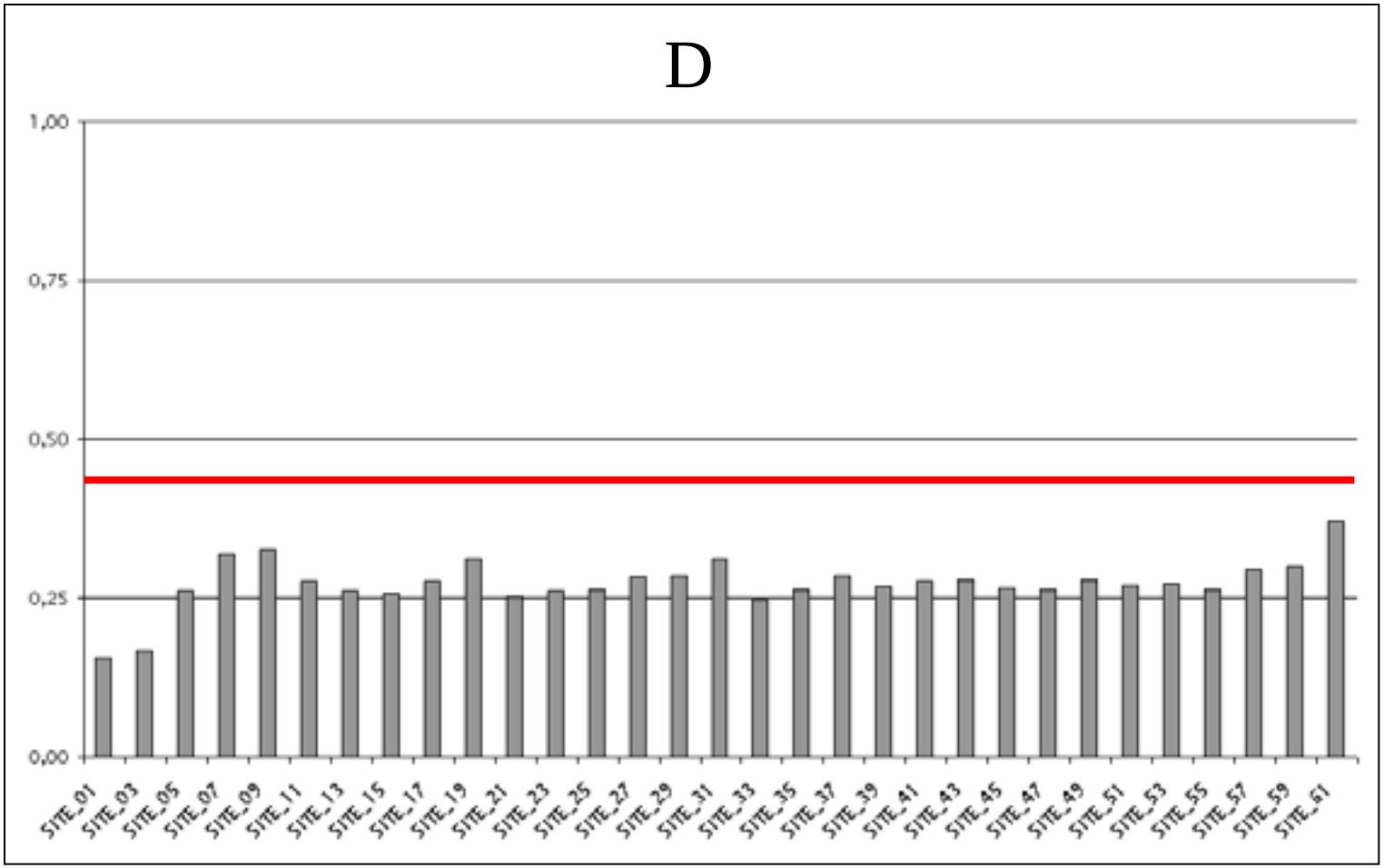


How to interpret the results

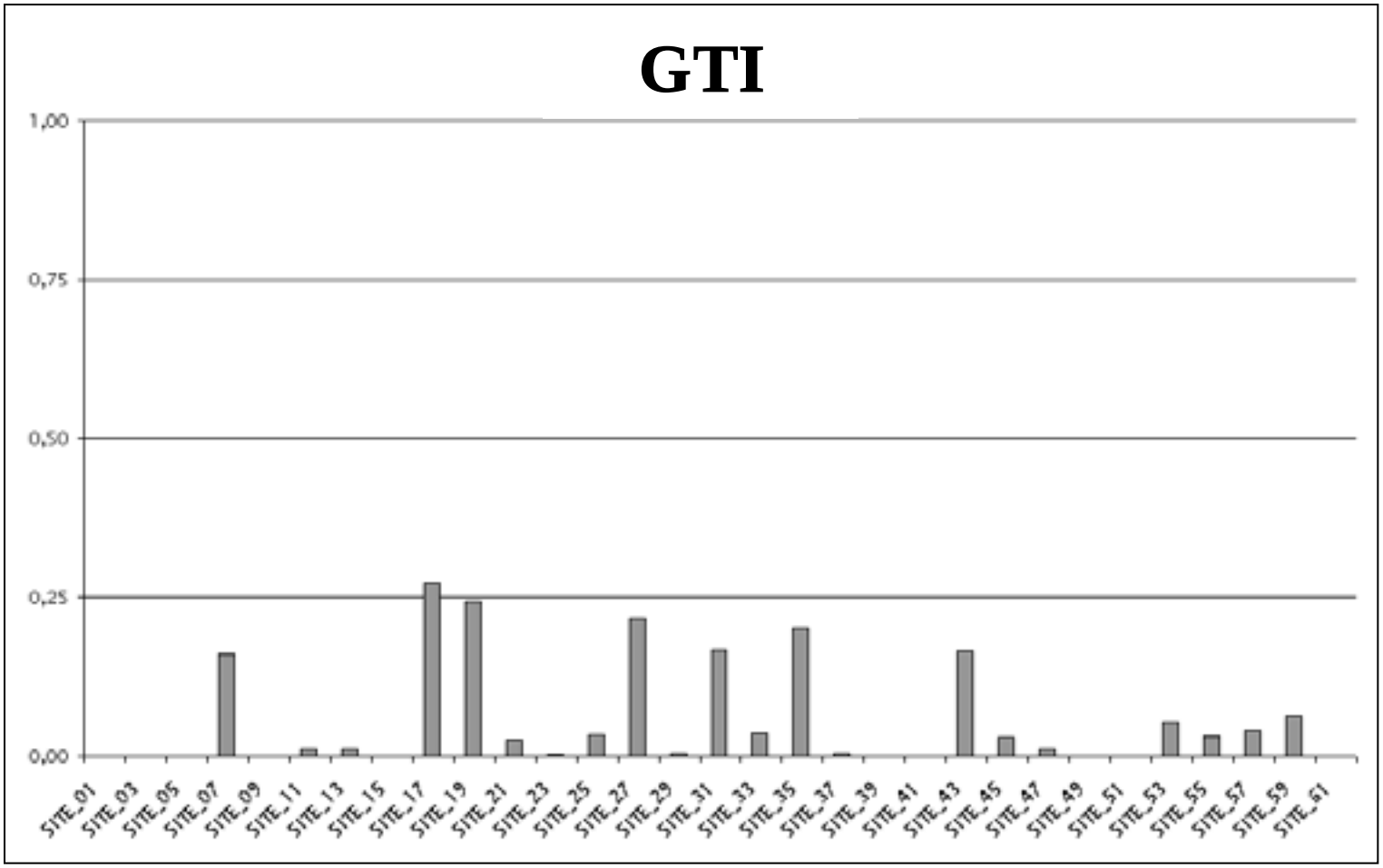
Deviation (D)	EnvRI	Destinazione d'uso	
		Acceptable	Not acceptable
D < 0.4	0.00 < EnvRI < 0.25	N, A, R, I	
	0.25 < EnvRI < 0.50	A, R, I	N, A (with targets of concern)
	0.50 < EnvRI < 0.75	I, (R)	N, A, R (with "green" functions)
	0.75 < EnvRI < 1.00	I	N, A, R, I (with "green" functions)
D > 0.4 additional studies reccomended	0.00 < EnvRI < 0.25	A, R, I	N, A (with targets of concern)
	0.25 < EnvRI < 0.50	I, (R)	N, A, R (with "green" functions)
	0.50 < EnvRI < 1.00	I	N, A, R, I (with "green" functions)

(Da Jensen & Mesman, 2006)

Results
Deviation



Results
Genotoxicity index



Conclusion

- Bormida riverbed show a residual contamination in some areas downstream from the “ACNA di Cengio” industrial site
- However, contaminants are not able to pose a risk of biodiversity decline (EnvRI < 0.25)
- Sublethal pollutant-induced impairments are detectable in organisms exposed to some samples (BVI > 0.25)

Application of the ERA to 2 high polluted Italian lotic systems

- A 2-tiers Triad approach to assess risk related to 2 Italian lotic systems characterized by high pollution level

- **Tier 1 – Screening**

- **Tier 2 – Detailed analysis**

Ecotoxicological and ecological analyses Freshwater

Ecotoxicological tests

- Test with protozoa (*Dictyostelium discoideum*)
  survival rate, replication rate, lysosomal membrane stability
- Test with seeds (*Pisum sativum*)
  germination rate, root growth, DNA damage
- Test with algae (*Pseudokirchneriella supcapitata*)
  growth rate
- Test with bacteria (*Vibrio fischeri*, test Microtox®)
  bioluminescence

Ecological parameters

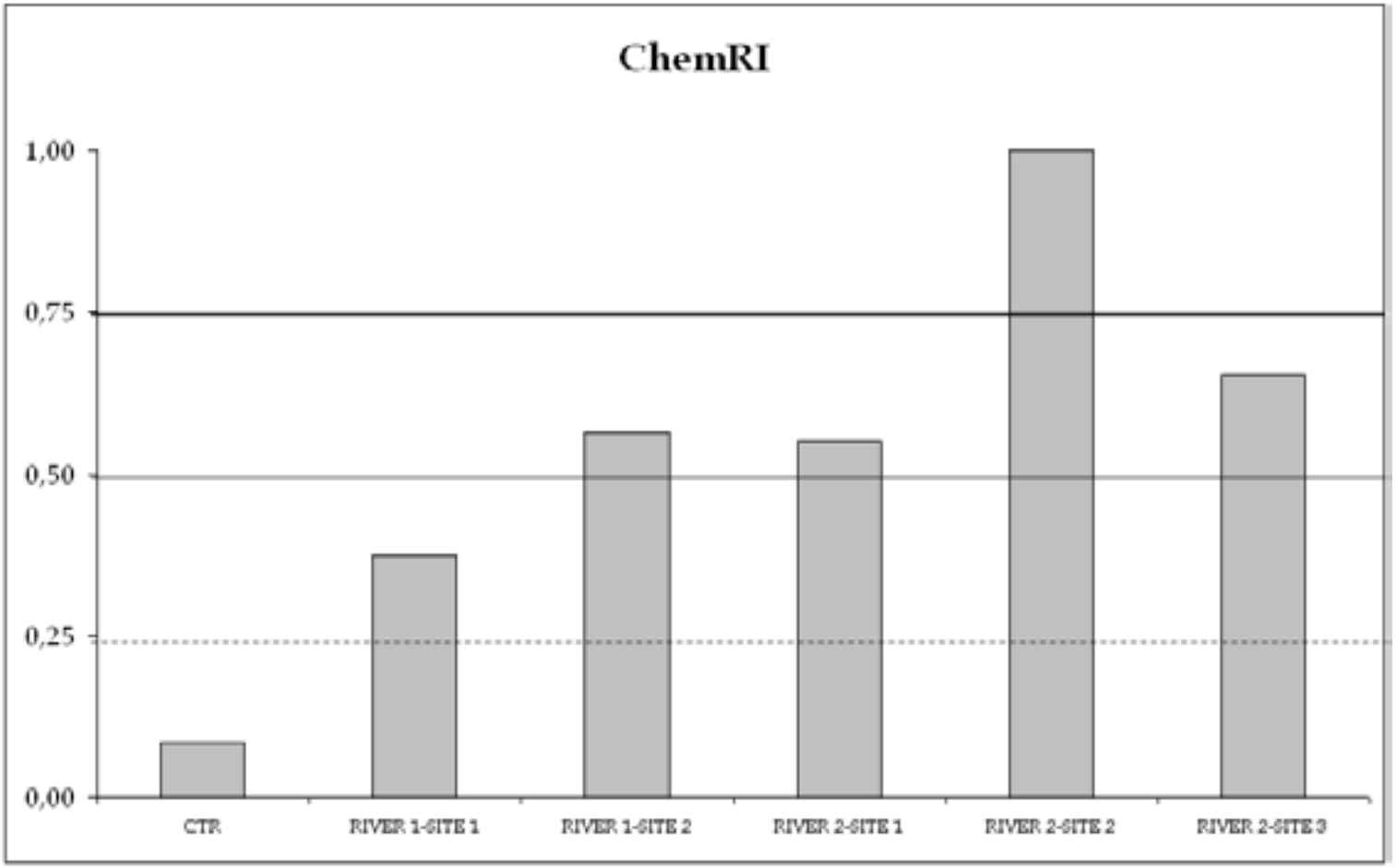
- Benthic macroinvertebrate community structure (EBI)

Ecotoxicological and ecological analyses
Sediment – Interstitial water

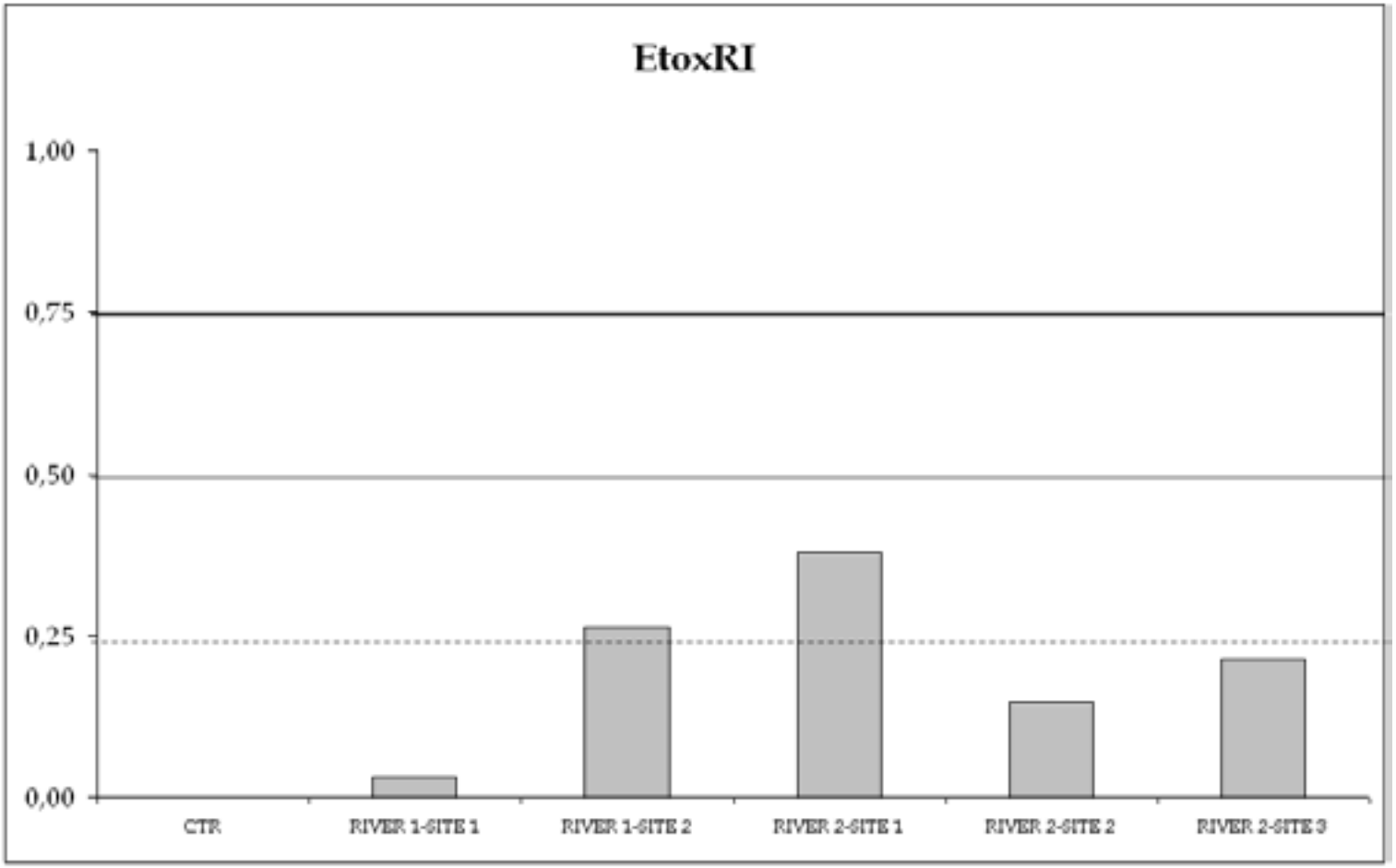
Ecotoxicological tests

- Test with protozoa (*Dictyostelium discoideum*)
  survival rate, replication rate, lysosomal membrane stability
- Test with seeds (*Pisum sativum*)
  germination rate, root growth, DNA damage
- Test with nematodes (*Caenorhabditis elegans*)
  survival rate

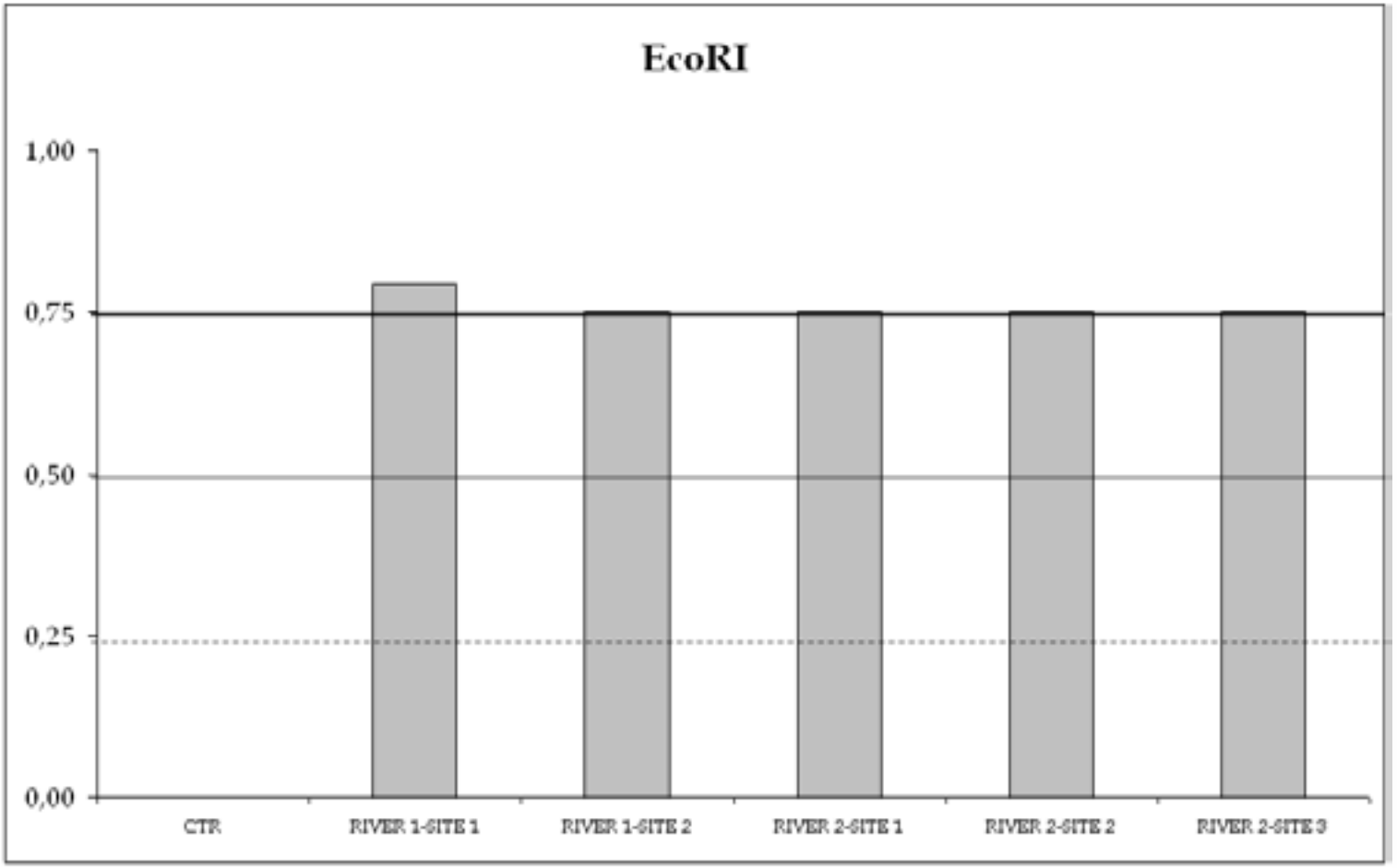
Results - ChemRI



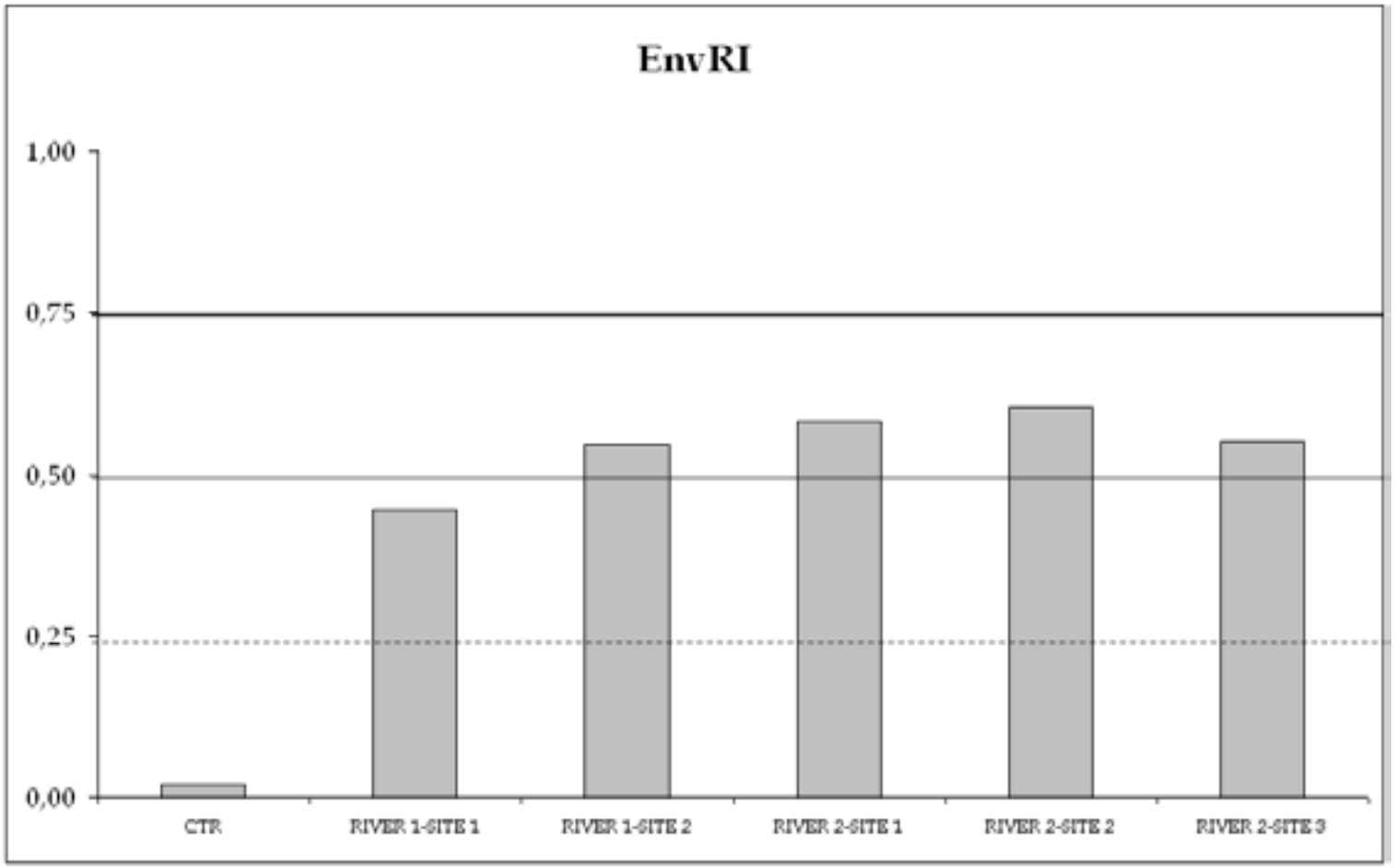
Results - EtoxRI



Results - EcoRI



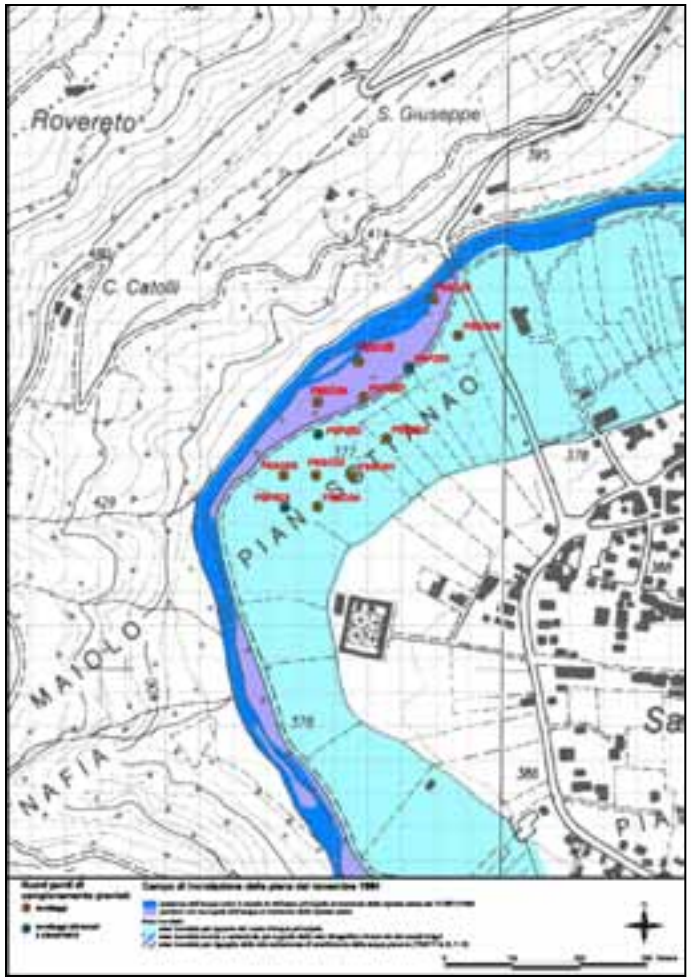
Results - EnvRI

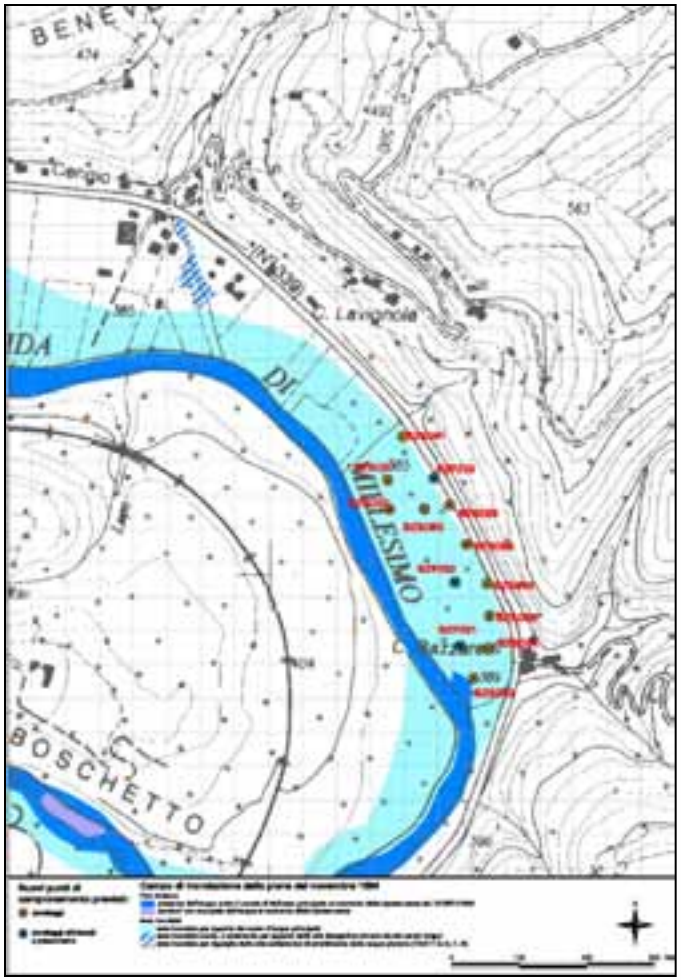


Conclusions

- The high polluted rivers studied here show high level of risk (EnvRI > 0.50)
- In these extreme cases the BVI index is not useful to address sublethal impairments in model organisms
- Risk at population/community level requires intervention aimed to reduce pollutants input and to remove contaminants from the lotic systems

Application of the Triad & Duade approach to estimate the risk due to flooding from a polluted river





Field activities

Selection of 21 sampling sites

Soil sampling for chemical and ecotoxicological analyses

- Cores in unsatured soil (a sample for each meter)
- More than 100 chemicals quantified in soils

Ecological investigations

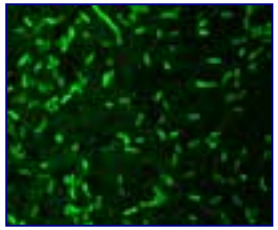
Ecological tools

Microarthropods soil community structure (QBS index)

Feeding activities (Bait-lamina test)

Soil respiration rate

Ecotoxicological parameters
High level endpoints
(i.e. survival & reproduction)



Vibrio fischeri
Bioluminescence

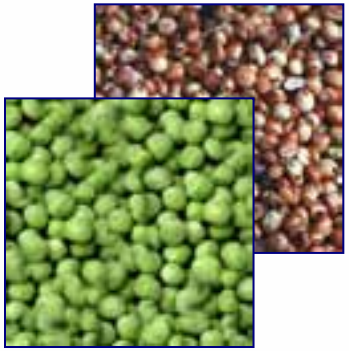
Caenorhabditis elegans
Survival rate

Eisenia andrei
Survival rate

Daphnia magna
Motility rate

Dictyostelium discoideum
Cell survival, replication rate

Pseudokirchneriella subcapitata
Algal growth



Pisum sativum
Sorghum bicolor
Germination rate

Folsomia candida
Reproduction rate

Ecotoxicological parameters
Sublethal endpoints
(i.e. biomarkers)

Dictyostelium discoideum
Endocytosis rate
Lysosomal membrane stability
DNA damage

Pisum sativum
Root growth
Mitotic anomalies
Micronuclei frequency

Eisenia andrei
Lysosomal membrane stability
CaATPase activity
DNA damage
Micronuclei frequency

How to deal with these Triad data-set? Utilizing a Decision Support System

Chemical data

Ecotoxicological data

Ecological data

Expert Decision Support System

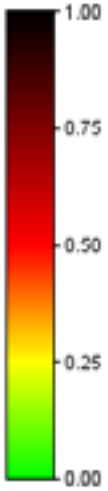
EnvRI

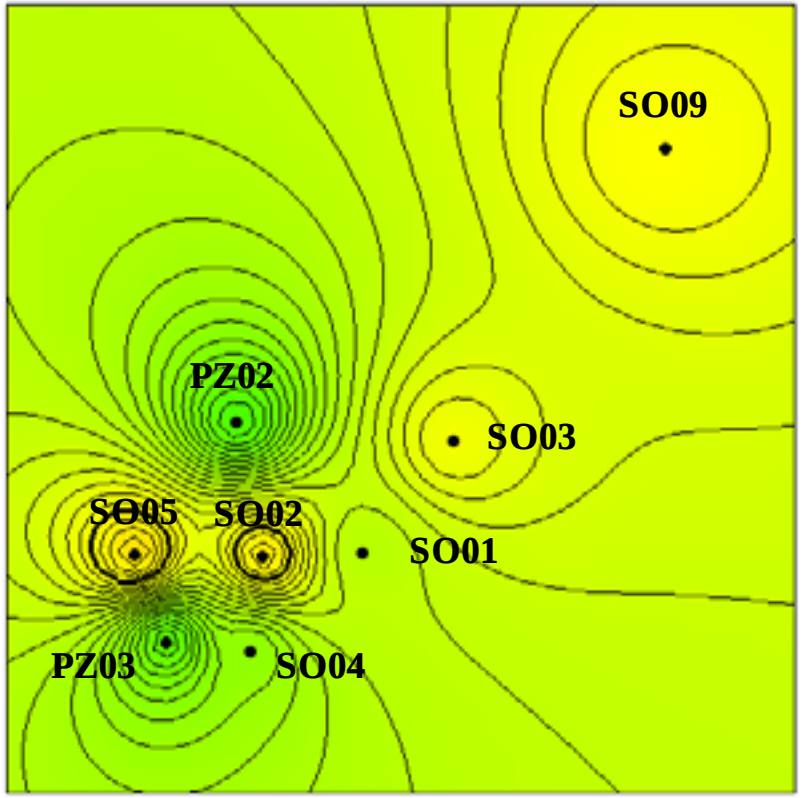
Environmental risk index

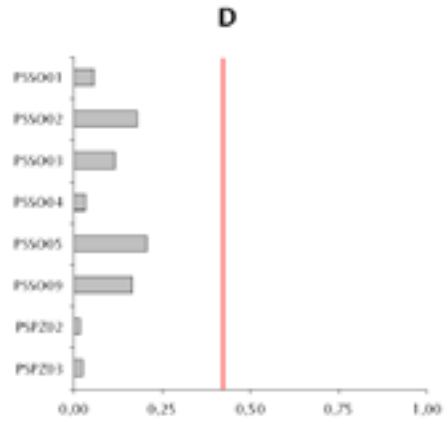
BVI

Biological Vulnerability index

Area di Pian Sottano, Saliceto
Environmental risk index (EnvRI)

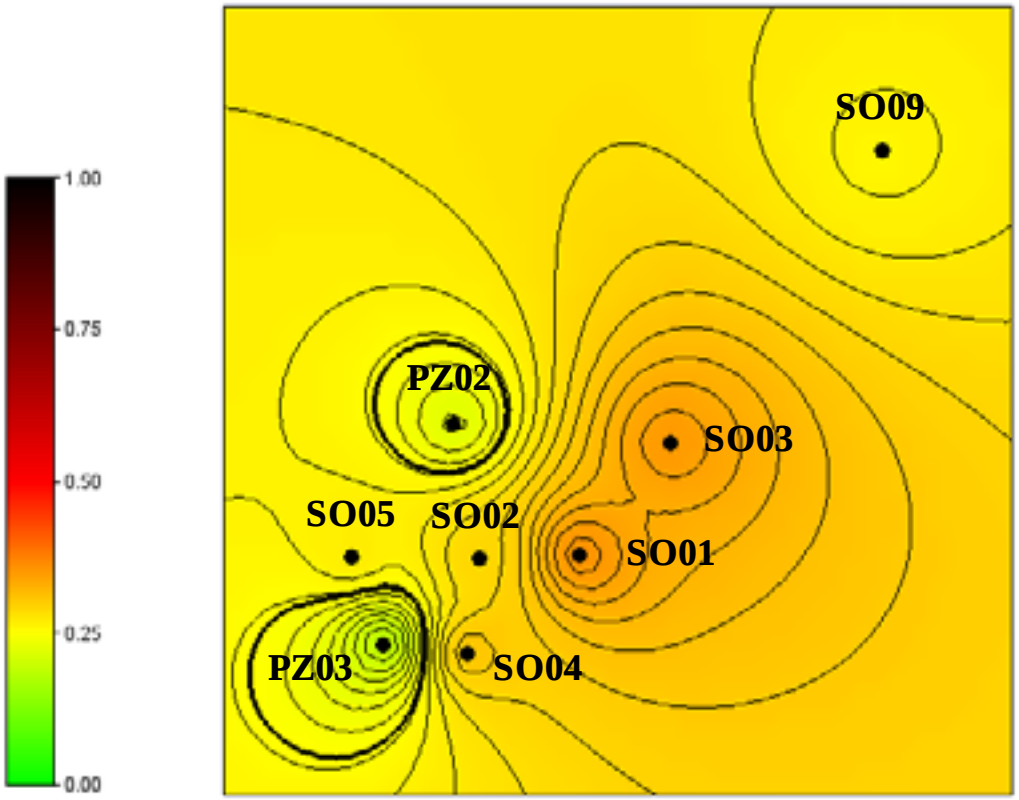






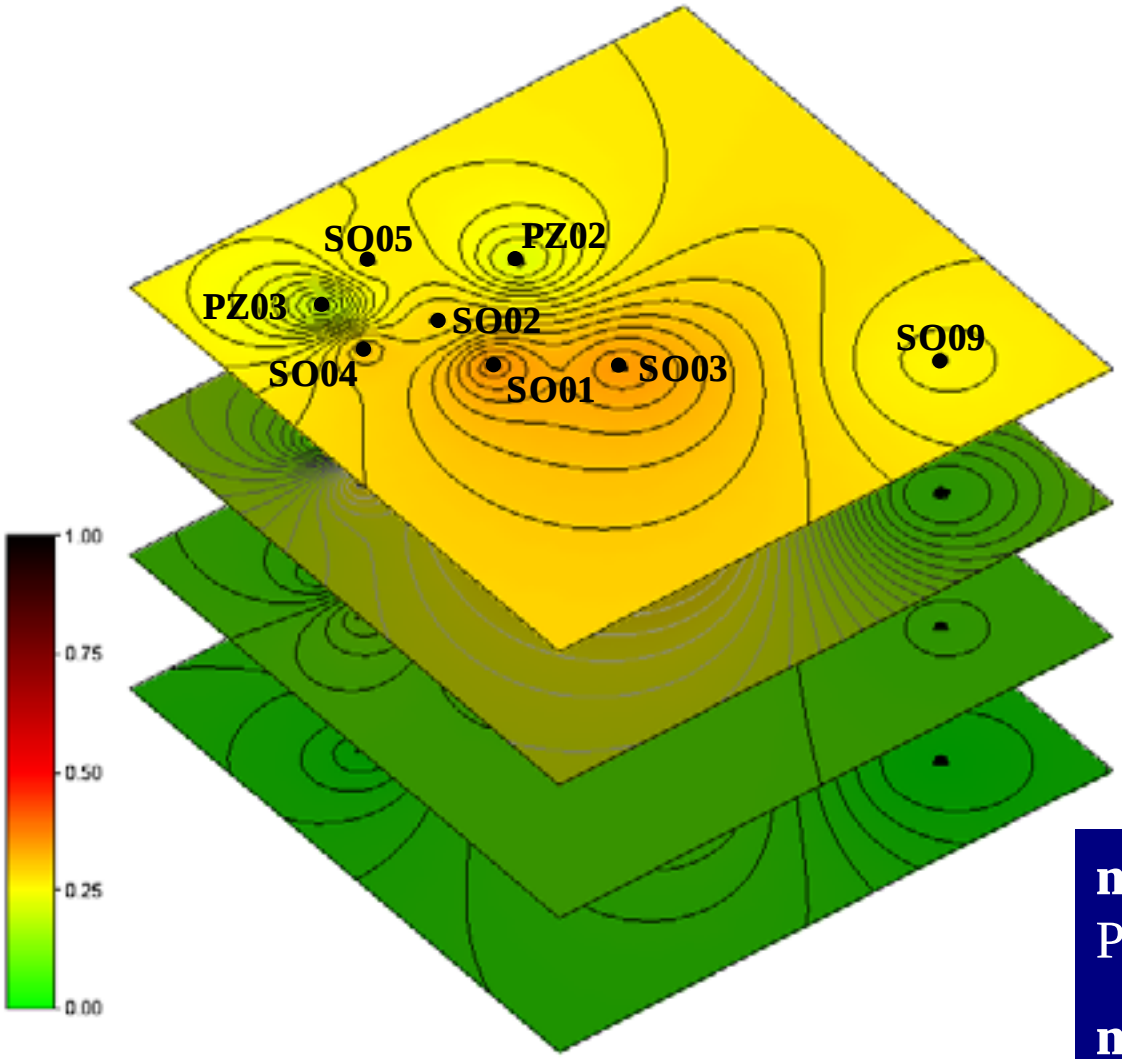
max PSSO05	**0.29**
min PSPZ03	**0.08**

Pian Sottano, Saliceto
Biological vulnerability index (BVI)



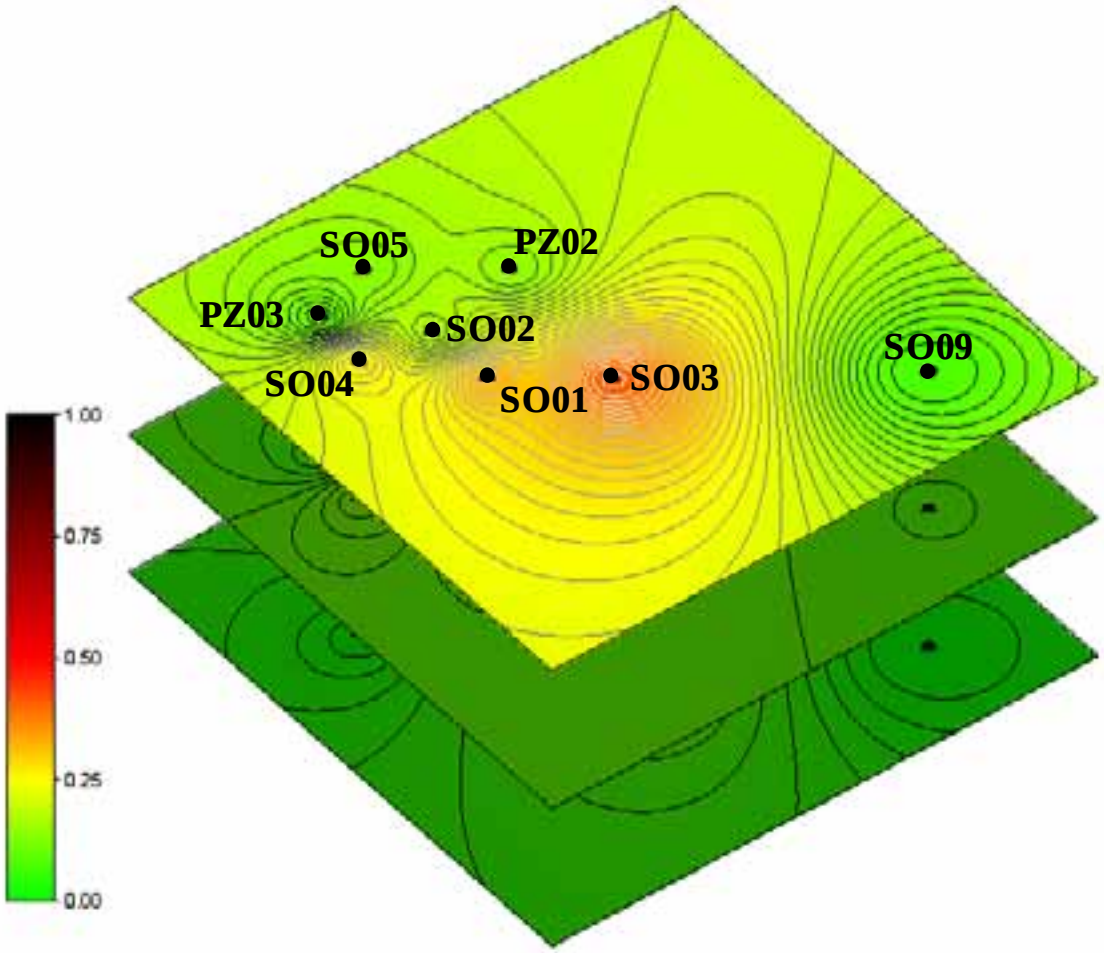
max PSSO01	**0.36**
min PSPZ03	**0.18**

Pian Sottano, Saliceto BVI



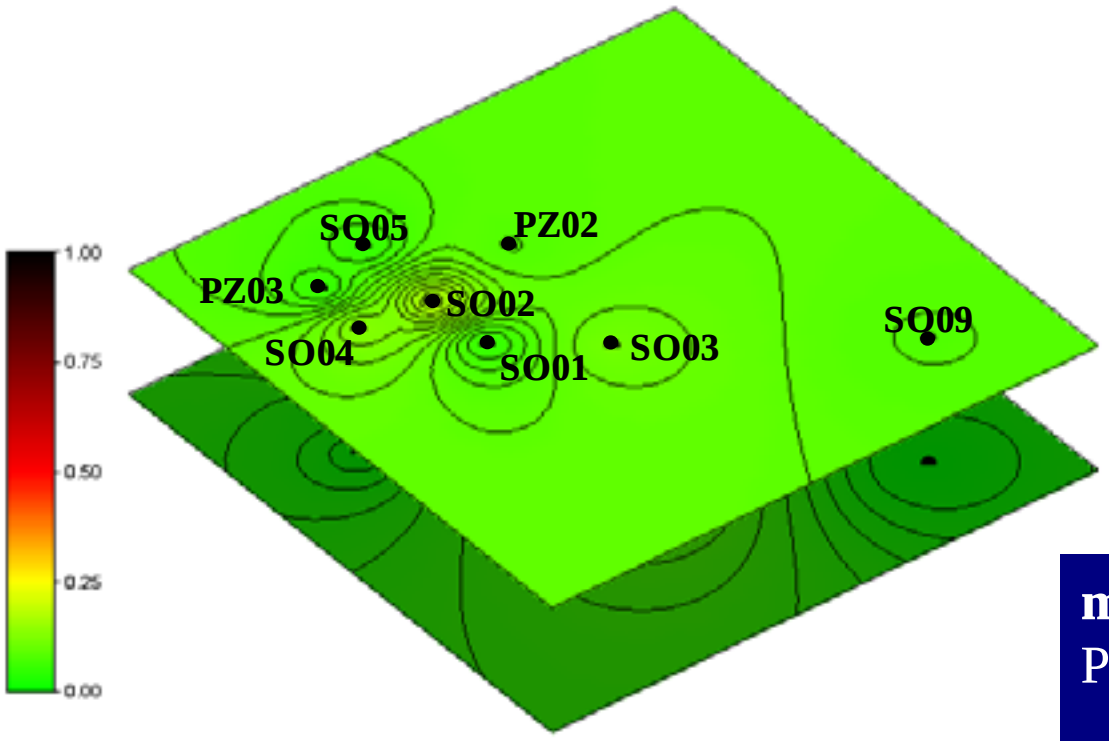
max	**0.36**
PSSO01	
min	**0.18**
PSPZ03	

Pian Sottano, Saliceto
BVI



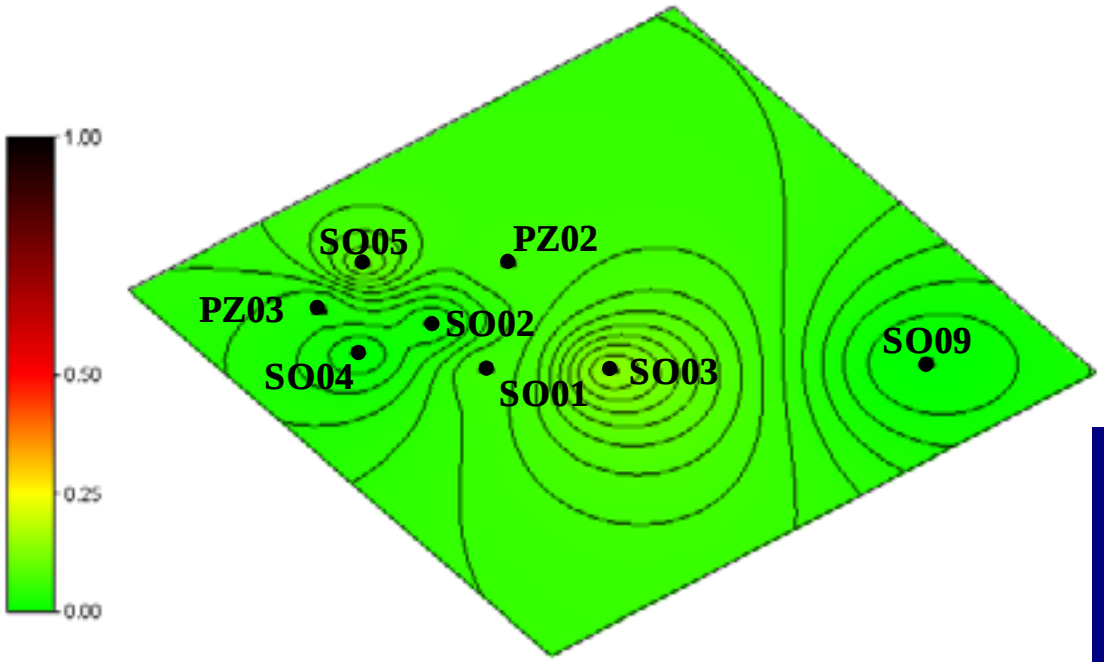
max	**0.41**
PSSO03	
min	**0.07**
PSSO09	

Pian Sottano, Saliceto
BVI



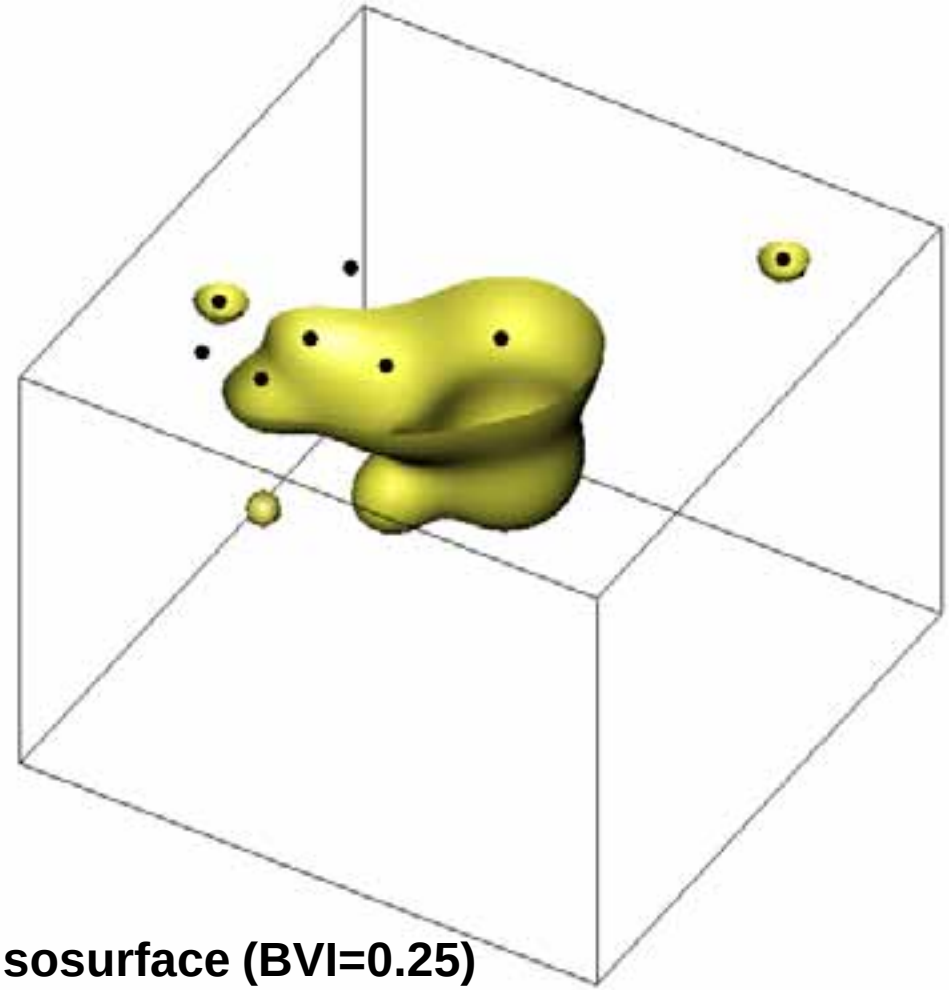
max	**0.17**
PSSO02	
min	**0.05**
PSPZ03	

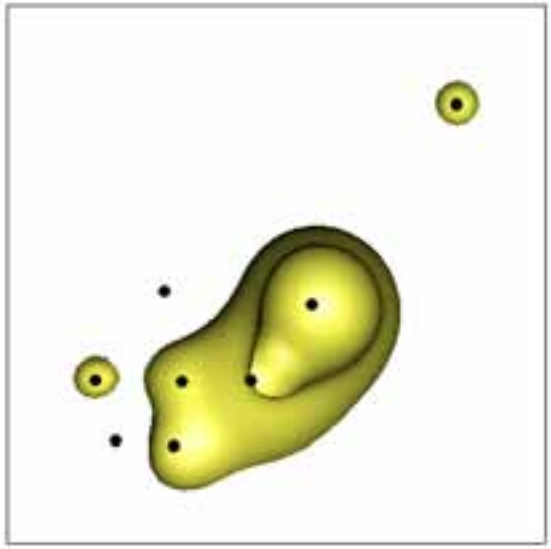
Pian Sottano, Saliceto
BVI

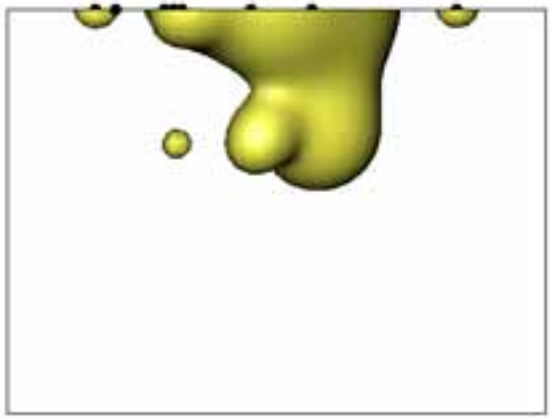


max	**0.13**
PSSO03	
min	**0.00**
PSSO09	

Pian Sottano, Saliceto BVI



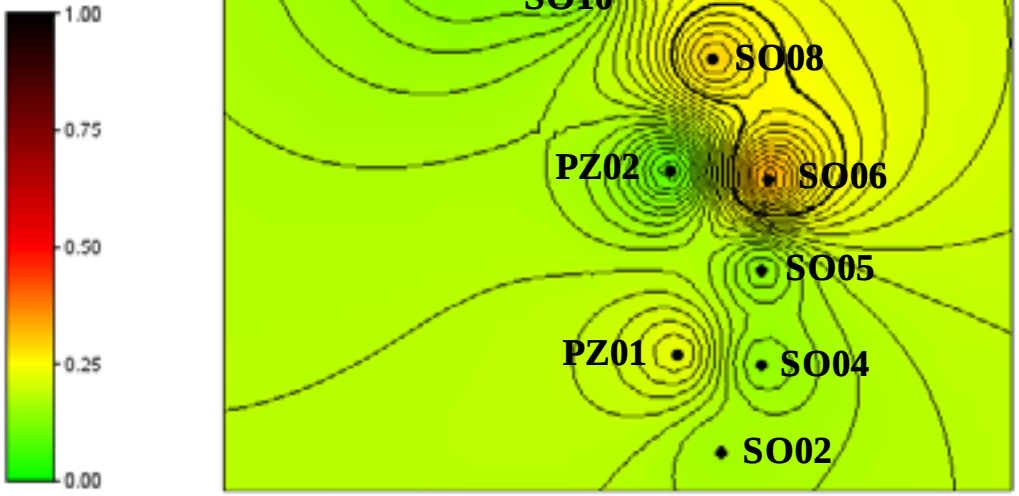


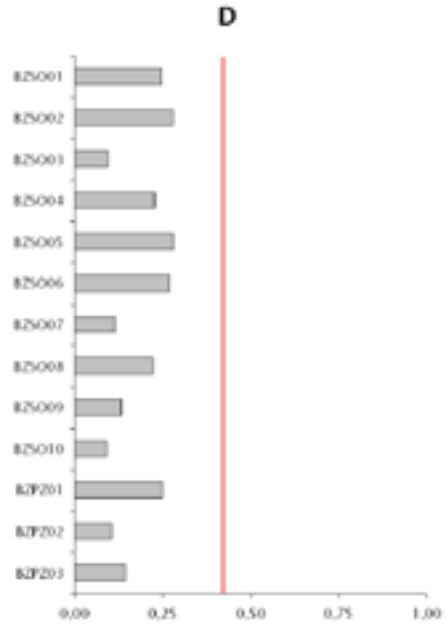


Isosurface (BVI=0.25)

- BVI overcomes hazard threshold in the first 2 meters

Case Bazzaretti, Saliceto (CN)
Environmental risk index (EnvRI)

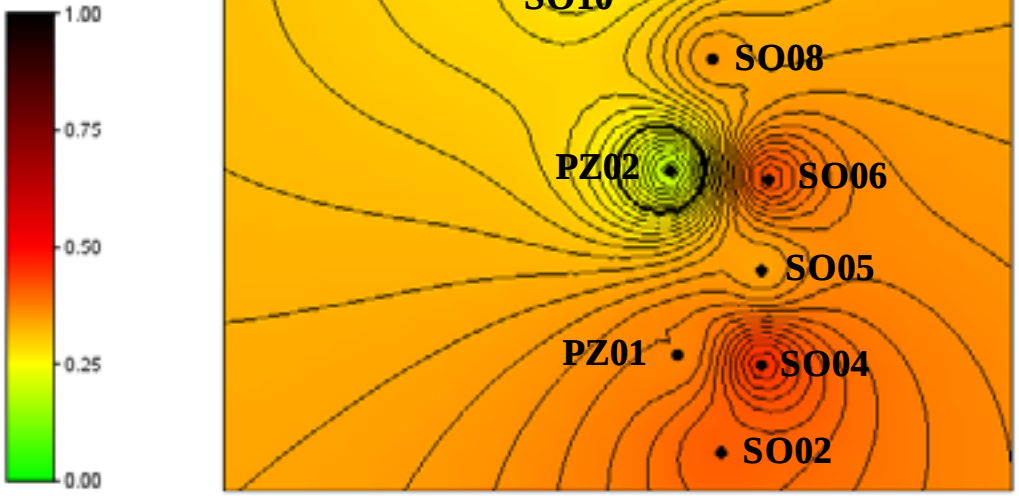




max **0.35**
BZSO06

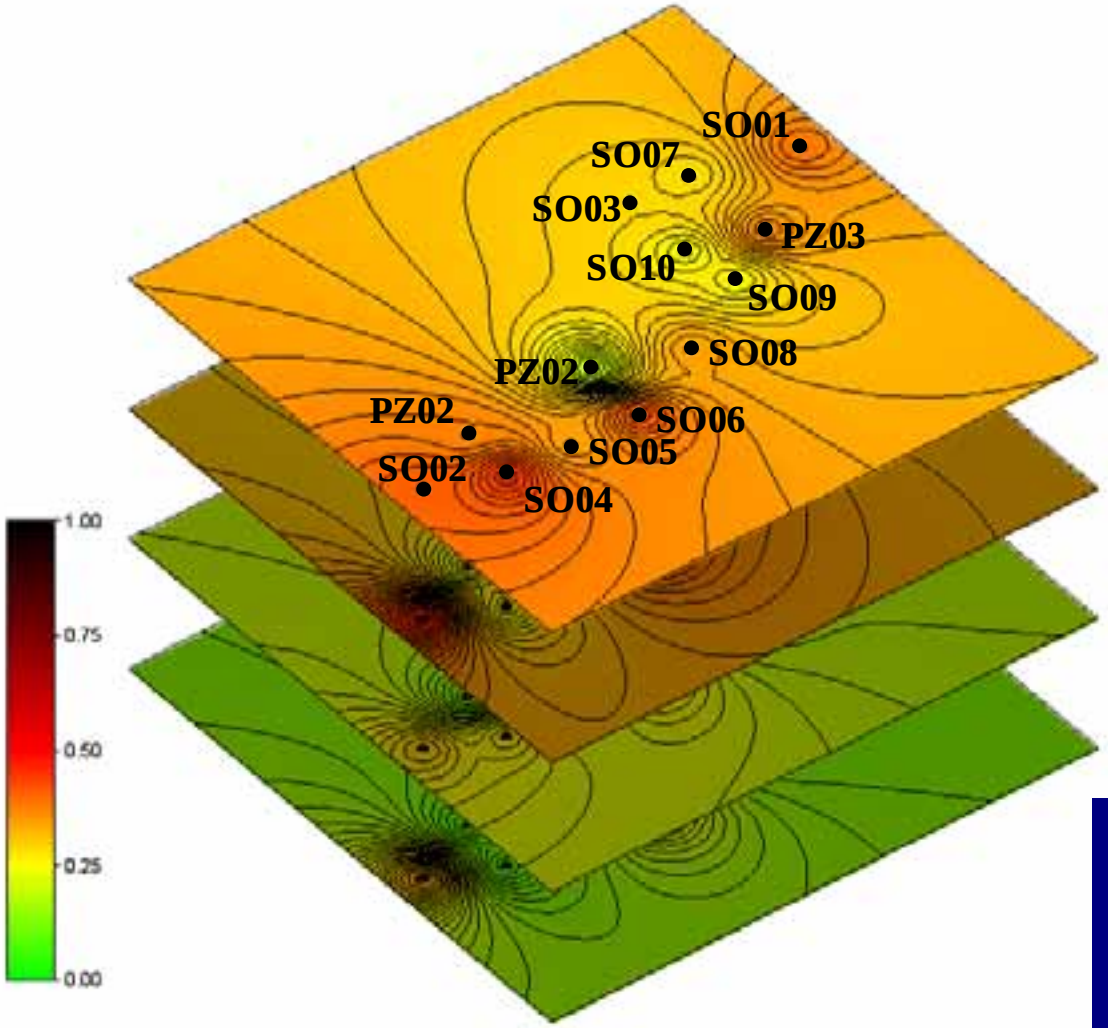
min **0.08**
PSPZ02

Case Bazzaretti, Saliceto (CN)
Biological vulnerability index (BVI)



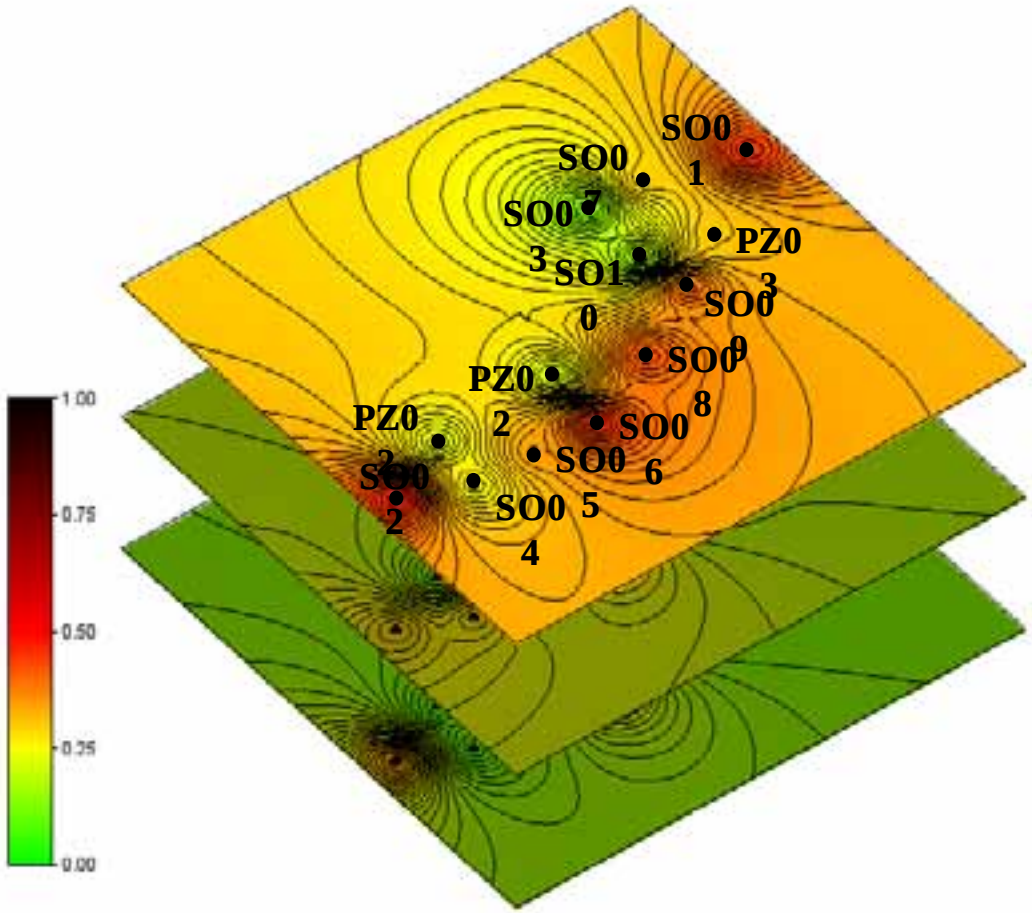
max BZSO04	**0.46**
min BZPZ02	**0.17**

Case Bazzaretti, Saliceto BVI



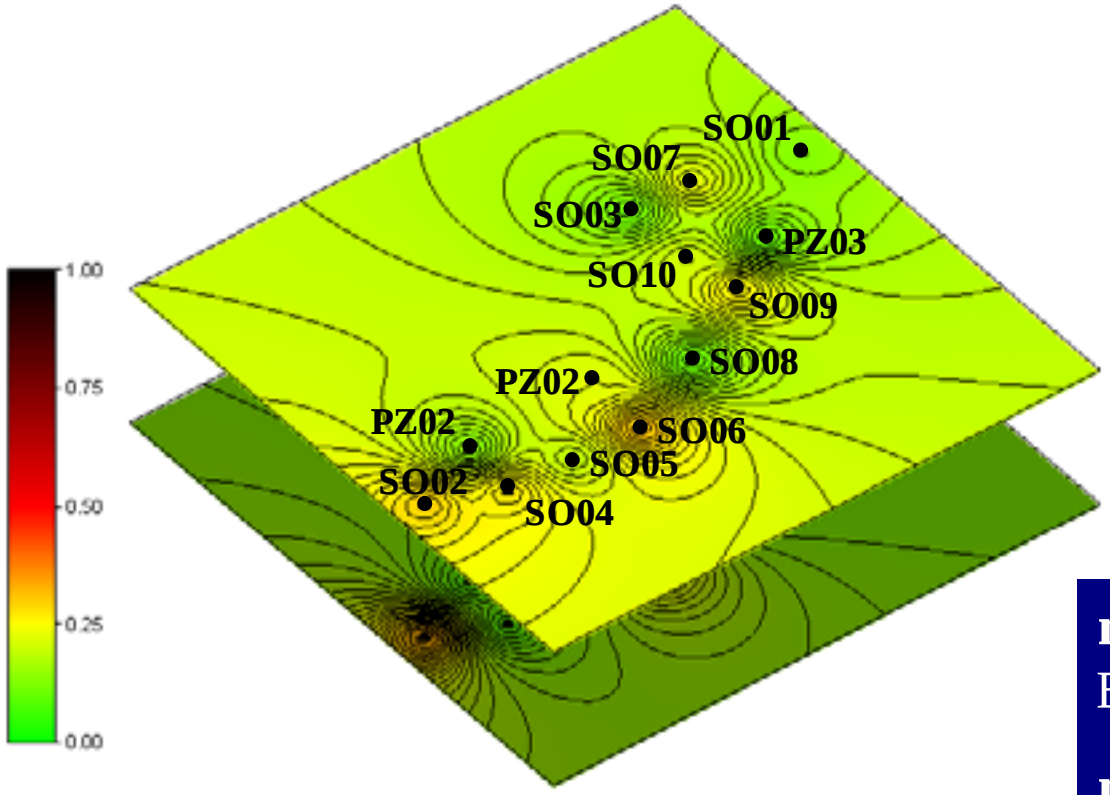
max BZSO04	**0.46**
min BZPZ02	**0.17**

Case Bazzaretti, Saliceto BVI



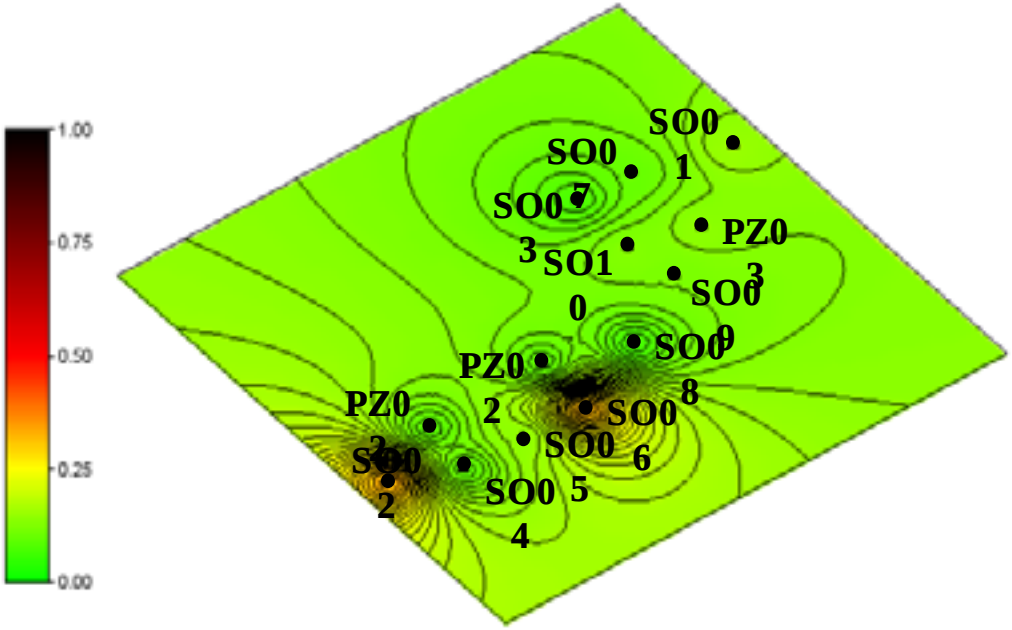
max BZSO02	**0.49**
min BZSO03	**0.11**

Case Bazzaretti, Saliceto BVI



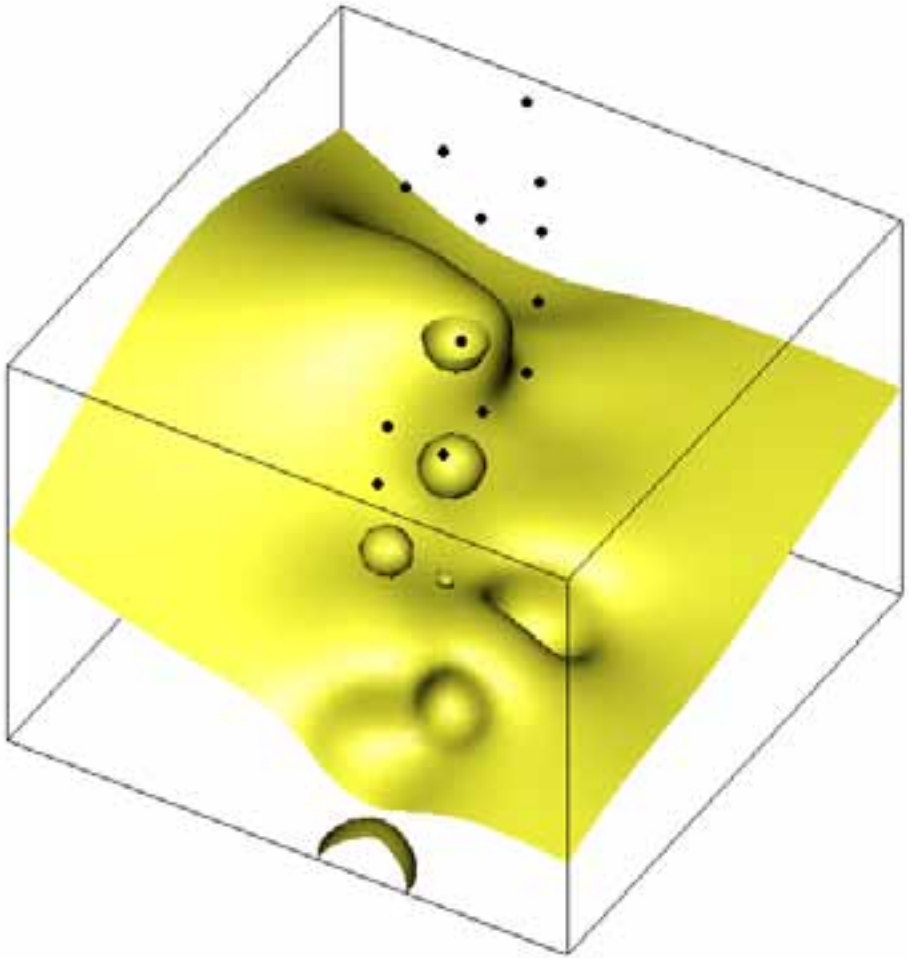
max	**0.33**
BZSO06	
min	**0.09**
BZPZ03	

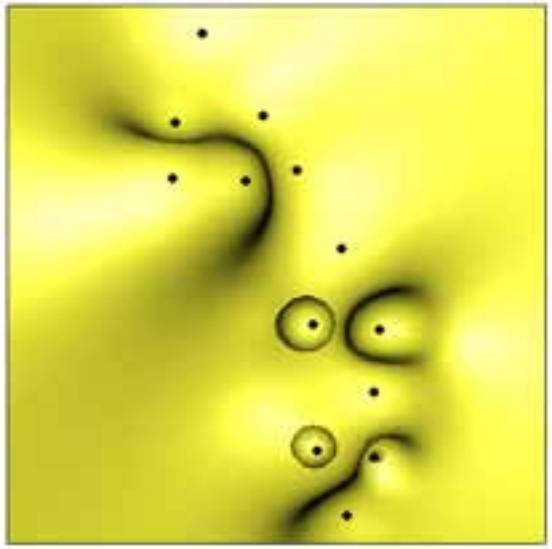
Case Bazzaretti, Saliceto BVI

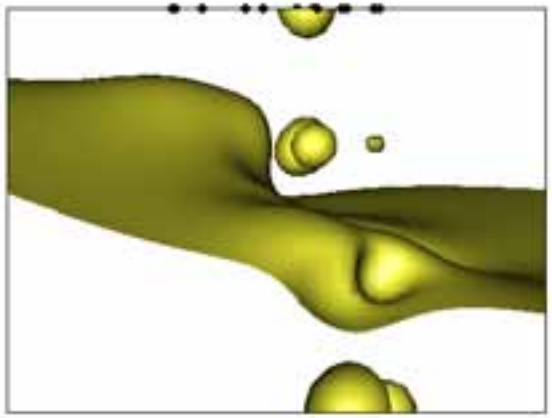


max	**0.35**
BZSO02	
min	**0.06**
BZSO08	

Case Bazzaretti, Saliceto BVI







Isosurface (BVI=0.25)

- BVI overcomes hazard threshold in the first 4 meters

Conclusions

- Triad data are useful to investigate risk of biodiversity decline
- However ecological studies are applicable only in the first layer of soil
- The application of a “Duade” approach encompassing chemistry and ecotoxicology could describe the vertical pattern of risk driving effective remediation activities