

The European Commission's science and knowledge service

Joint Research Centre

Chemical mixture occurrence and natural microbial community in the Tiber River (Italy)

Robert Loos, Valentina Ferrero, Maria Ludovica Sacca, Martina Di Lenola, Simona Tavazzi, Paola Grenni, Nicoletta Ademollo, Luisa Patrolecco, Anna Barra Caracciolo, Teresa Lettieri

*Directorate D - Sustainable Resources
Unit D.2 Water and Marine Resources*

ICCE Conference
Oslo, 18-22 June, 2017



Introduction

- Freshwater quality assessment: Regulated by [Water Framework Directive \(WFD\)](#).
- Chemical and ecological water quality status is based on measurements of [chemical pollutants](#) in water and biota together with other indicators such as temperature, nutrients, and species compositions (phytoplankton, microalgae, benthos and fish) and hydromorphological conditions.
- In the current strategy a link between chemical and ecological status is missing. No [microbiological indicators](#) are foreseen for integrating the different anthropogenic pressures, including mixtures of chemicals, nutrients and temperature changes, to provide a holistic view of the freshwater ecosystem water quality.

Marie Curie project: Industry-Academia (IAPP) Collaboration: MicroCoKit

- Identification of river microbial community based indicators for monitoring and evaluating important multiple stressors like chemical pollutants, nutrients, or physico-chemical parameters.
- Five monitoring surveys were conducted along the Tiber River (Italy) from October 2013 to March 2015 in order to investigate four selected sites reflecting a contamination gradient from the source to the mouth of the river.

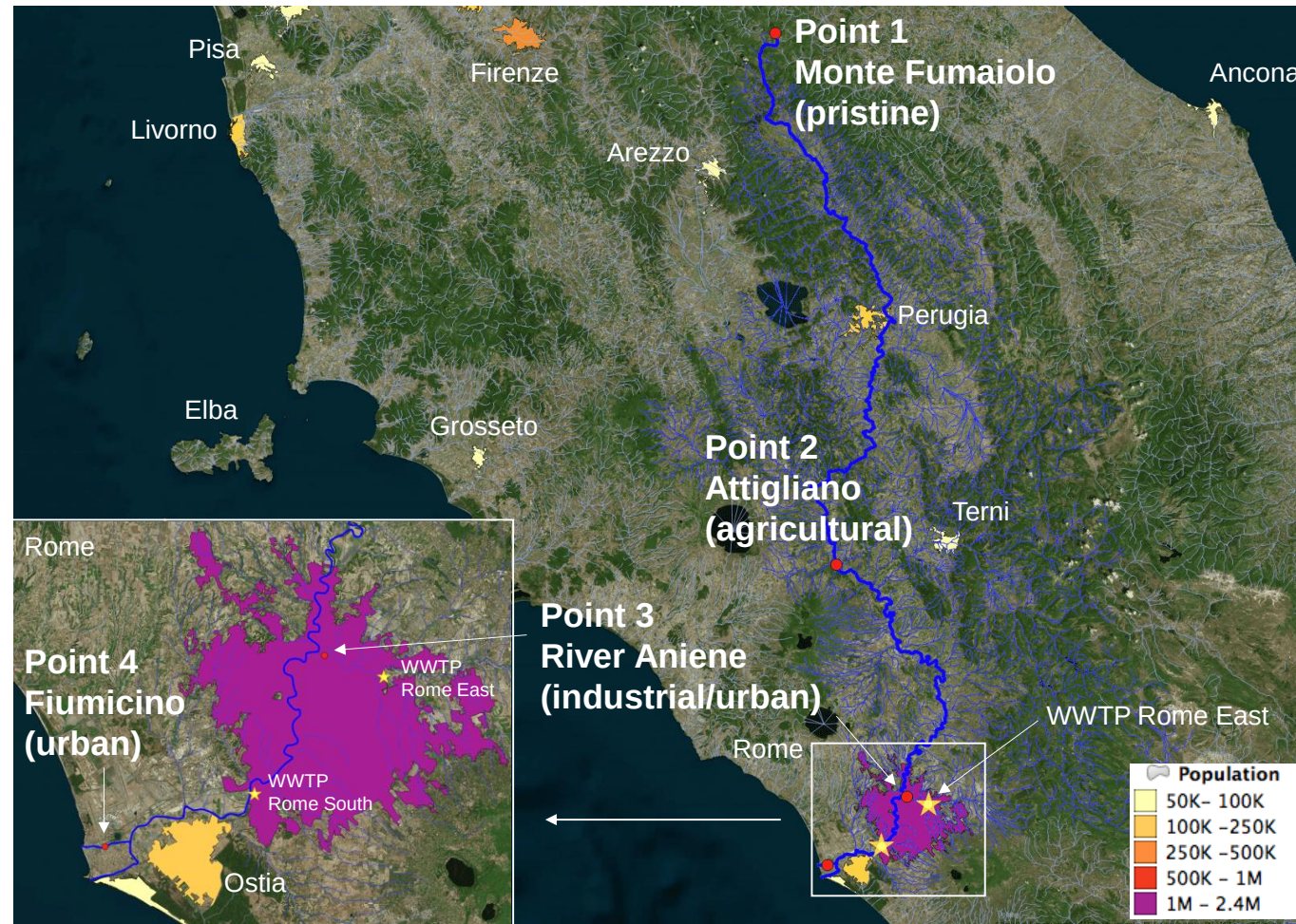
Parameters

Physico-chemical parameters	PAHs	Polar organic contaminants	Microbiological parameters	Ions	Metals
T (°C)	Naphtalene	Benztotriazoles	Cell viability	NO ₂ ⁻	Ba
pH	Acenaphtene	1H-Benzotriazole	Bacterial abundance	NO ₃ ⁻	Sb
Redox potential (mV)	Fluorene	Methylbenztotriazoles	Bacteria	Cl ⁻	As
Conductivity (µS/cm)	Phenanthrene	Pharmaceuticals	Archaea	SO ₄ ²⁻	Cd
Dissolved oxygen saturation (%)	Anthracene	Carbamazepine (CBZ)	α-Proteobacteria	F ⁻	Cr
Dissolved oxygen (mg/l)	Fluoranthene	CBZ metabolite	β-Proteobacteria	Ca ²⁺	Cu
	Pyrene	Diclofenac	γ-Proteobacteria	Mg ²⁺	Pb
	Benzo(a)anthracene	Sulfamethoxazole	δ-Proteobacteria	Na ⁺	Hg
	Chrysene	Pesticides	ε-Proteobacteria	K ⁺	Ni
	Benzo(b)fluoranthene	2,4-D	Planctomycetes	B ⁺	Se
	Benzo(k)fluoranthene	DEET	Bacteroidetes	DOC	V
	Benzo(a)pyrene	Cybutryne (Irgarol)			Fe
	Dibenz(ah)anthracene	MCPA			Zn
	Benzo(g,h,i)perylene	Metolachlor			Mn
	Indeno(1,2,3cd)pyrene	Terbutryn			Al
		Terbutylazine			Li
		Perfluorinated compounds			Cs
		PFBS			U
		PFHxA			Co
		PFHpA			Sr
		PFOA			
		PFNA			
		PFOS			

- Physico-chemical parameters (dissolved oxygen, dissolved organic carbon (DOC), conductivity, temperature)
- Inorganic ions
- Metals
- Organic pollutants
- Natural microbial community composition

Four selected sites corresponding to pristine, agricultural, industrial and urban area.

Geographic map of the sampling sites along the Tiber River



Human population:
4.7 million people

Annual mean flow:
260 m³/s

Sampling sites



Point 1: Monte Fumaiolo



Point 2: Attigliano

Sampling sites

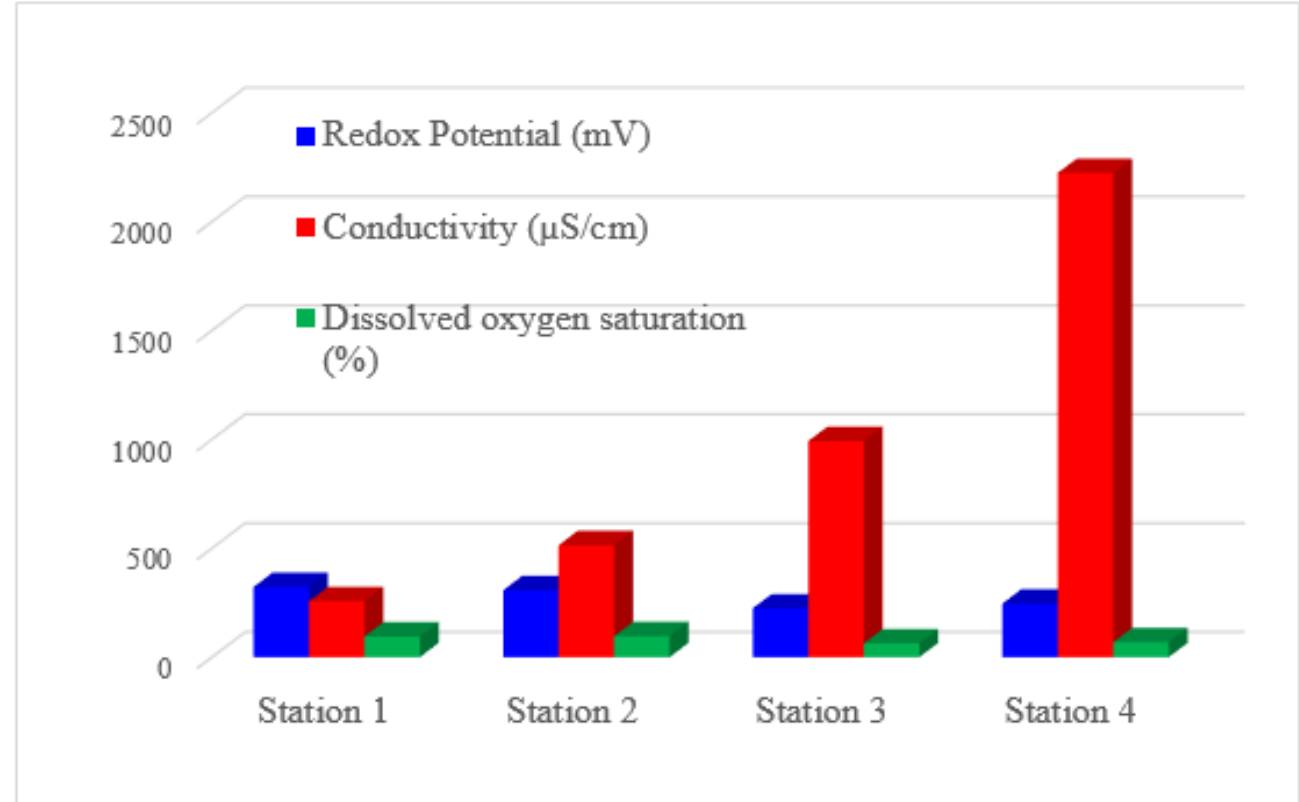
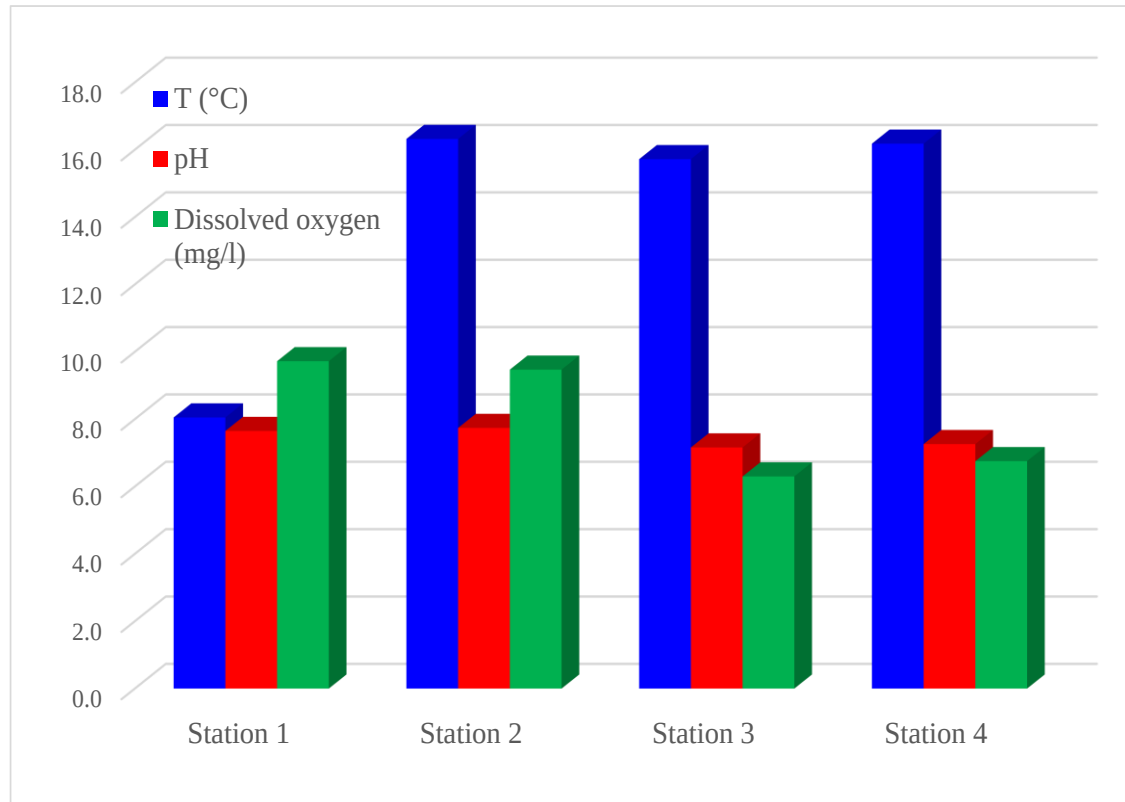


Point 3: Aniene River

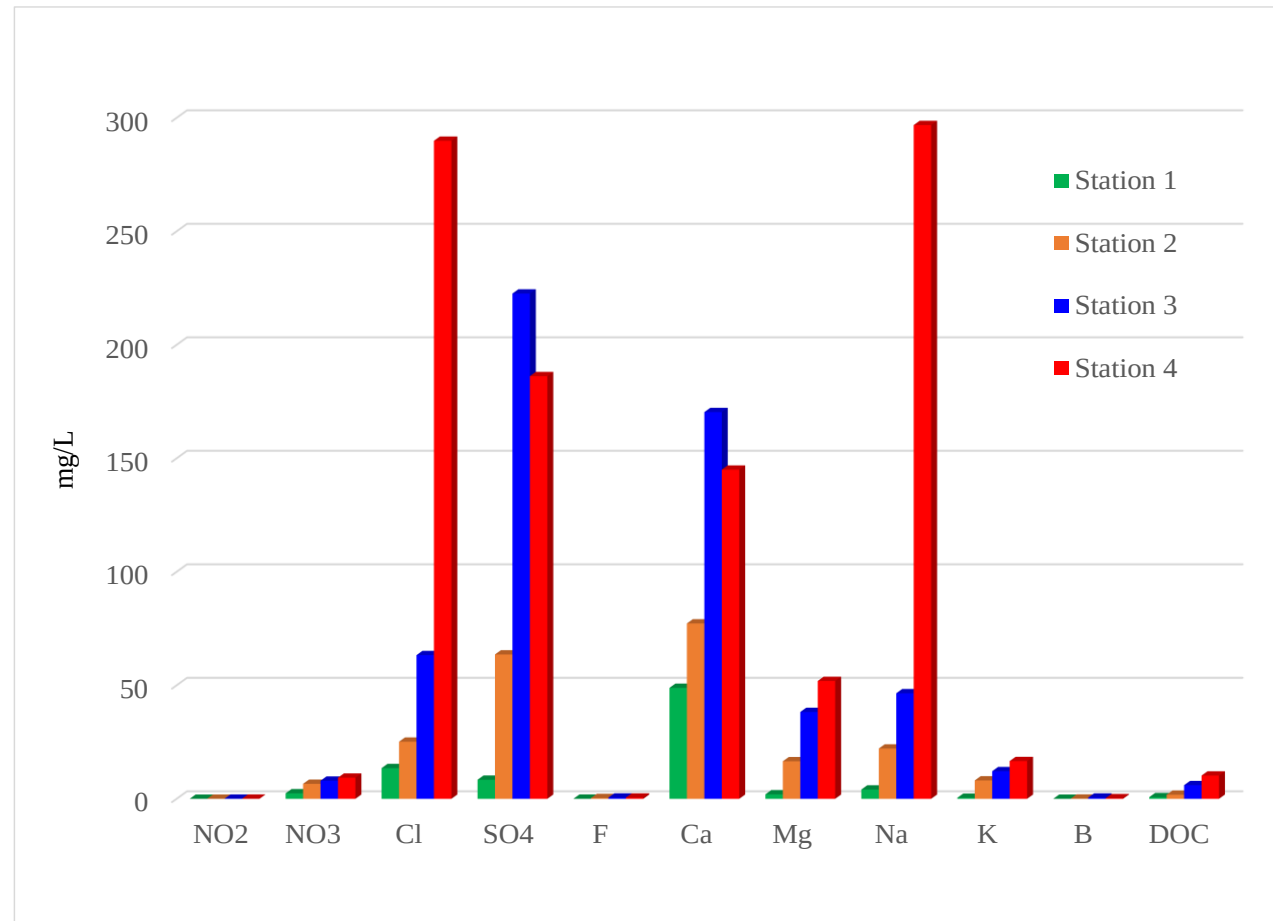


Point 4: Fiumicino

Physico-chemical parameters



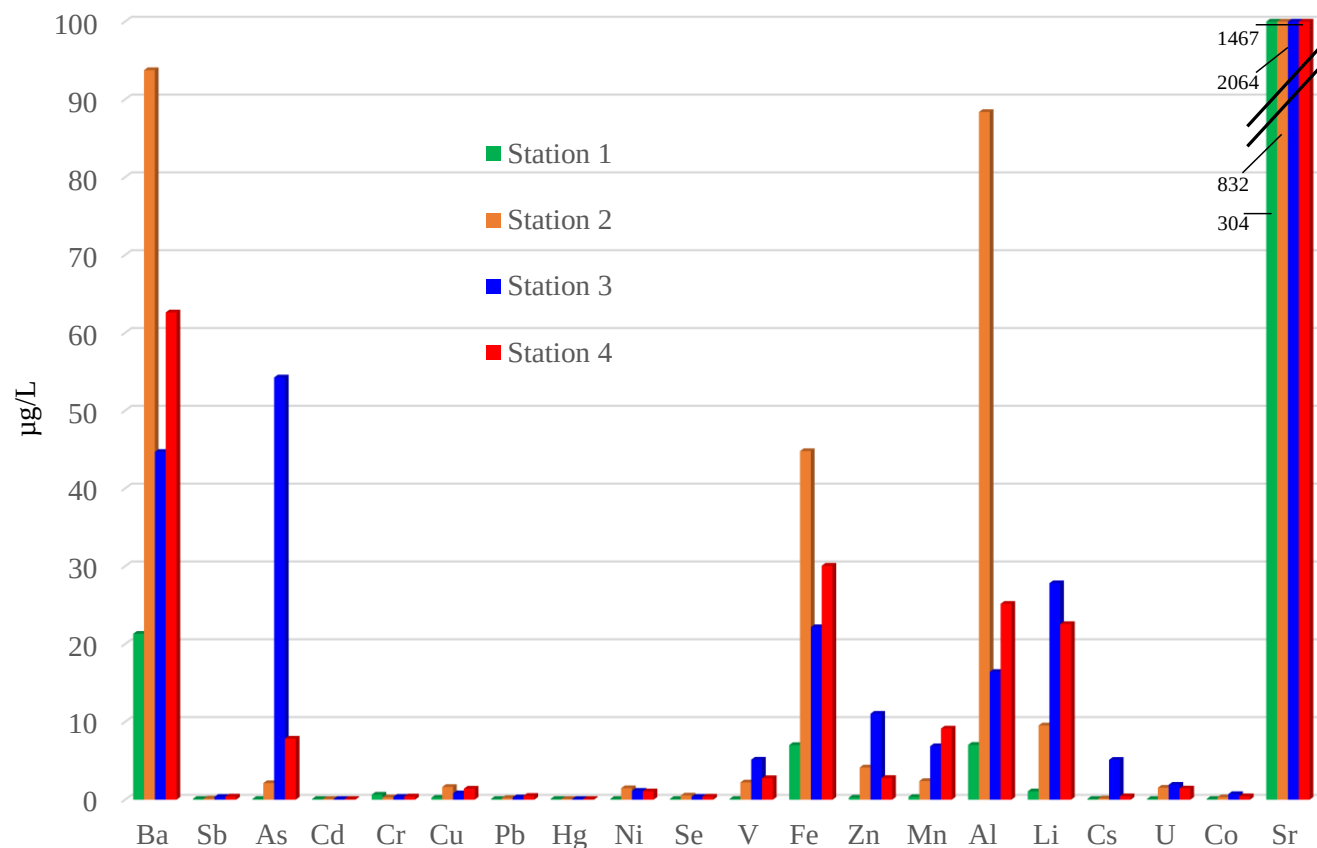
Inorganic ions and DOC



Analyses by ion chromatography with electrochemical conductivity detection

Nitrate: 2 to 12 mg/l

Metals

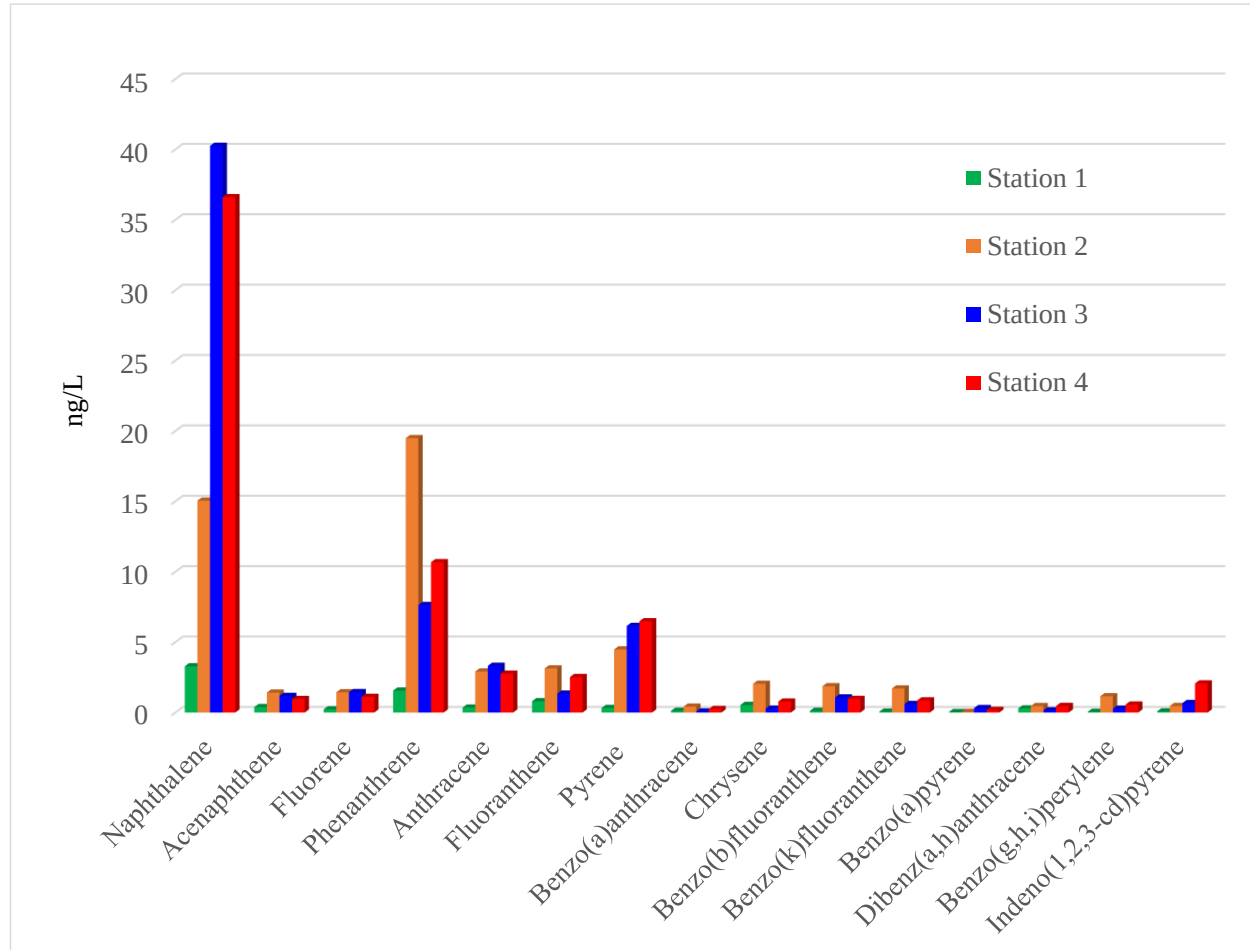


Analyses by ICP-MS

Strontium (Sr) concentrations:
304 µg/l at point 1 to
2064 µg/l at point 3.

Arsenic at point 3:
Average 54 µg/l (EQS 10 µg/l).

Polycyclic aromatic hydrocarbons (PAHs)



20 June 2017

Total PAHs in the dissolved water:

- 8 ng/l at station 1
- 56 ng/l at station 2
- 65 ng/l at station 3
- 67 ng/l at station 4

Only slight **EQS exceedances:**

Benzo(a)anthracene (EQS: 0.23 ng/l):

Station 2: 0.36 ng/l; 0.48 ng/l;

Station 4: 0.37 ng/l;

Chrysene (EQS 1.2 ng/l):

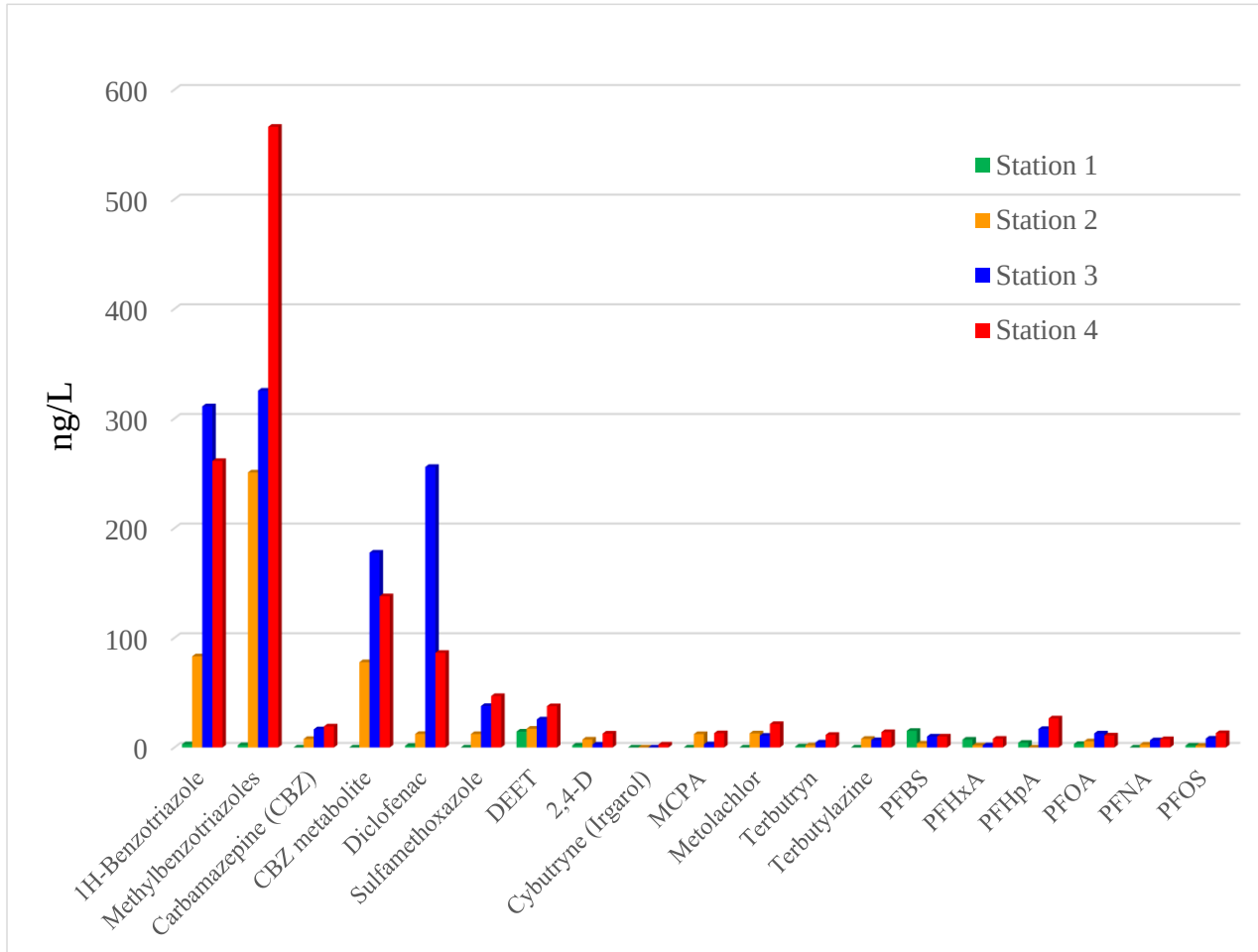
Station 2: 2.0 ng/l;

Station 4: 1.6 ng/l;

Indeno(1,2,3-cd)pyrene (EQS 2.0 ng/l):

Station 4: 2.8 ng/l.

Polar organic compounds



Pesticides: low concentrations;

Benzotriazoles: up to 852 ng/l;

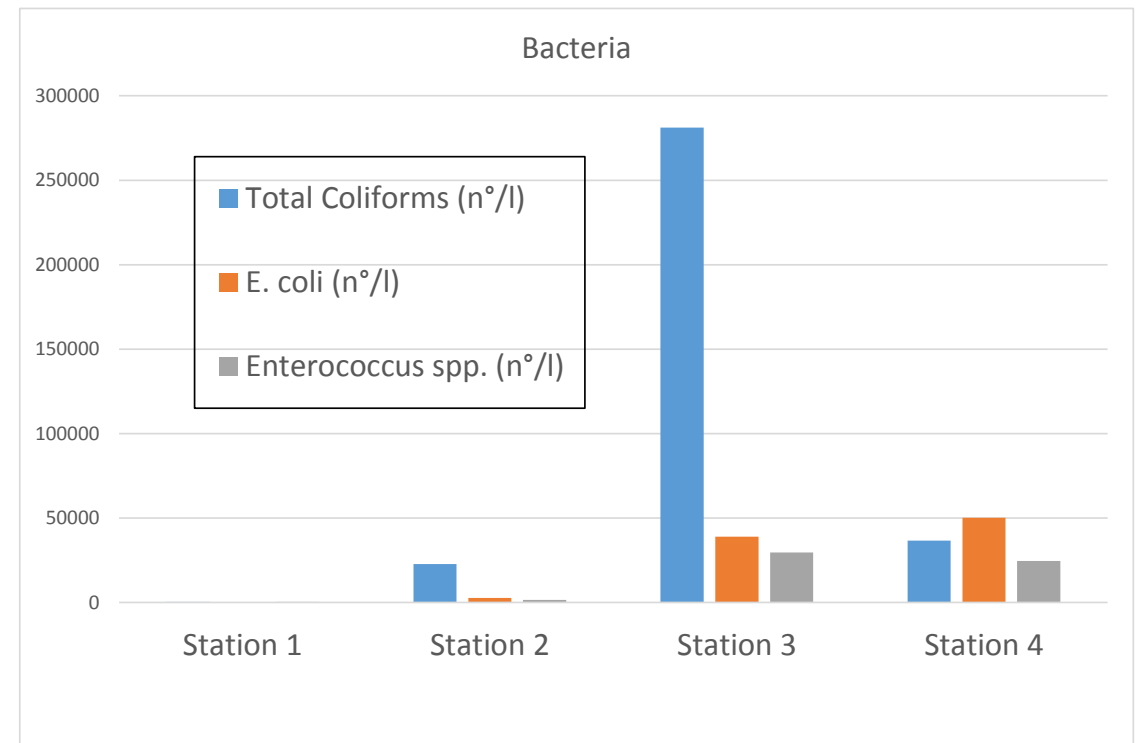
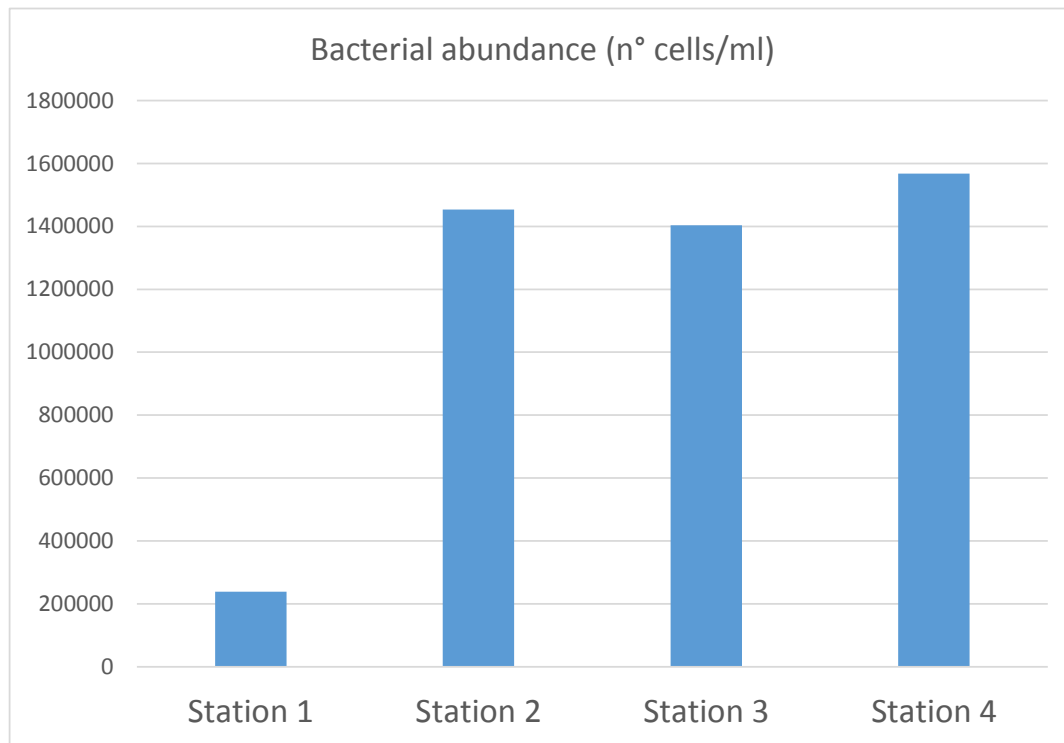
Dihydroxy carbamazepine metabolite: up to 236 ng/l;

Diclofenac: max. 849 ng/l;

The **EQS** were exceeded for

perfluorooctansulfonate (PFOS) (EQS: 0.65 ng/l), **diclofenac** (EQS: 100 ng/l), and **cybutryne** (EQS: 2.5 ng/l).

Microbiological indicators



Conclusions

- Conductivity increase and dissolved oxygen decrease; Increasing trend of the main anions and cations and of the DOC.
- Metals: arsenic, and strontium; arsenic exceeded the legal limit of 10 µg/l in the Aniene River (average 54 µg/l).
- PAHs concentrations were generally low; only slight EQS exceedances for benzo(a)anthracene, chrysene, and indeno(1,2,3-cd)pyrene.
- Low pesticide concentrations. High concentrations for benzotriazoles (up to 852 ng/l), di-OH-carbamazepine (up to 236 ng/l), and diclofenac (max. 849 ng/l).
- Increasing bacterial abundance from the source to the mouth of the river.

Acknowledgements

Sampling: Joaquin Pinto Grande (JRC) and Gunther Umlauf (JRC).

Tiber map: Maria Gabriella Villani (ENEA).

MicroCoKit project was funded under FP7 (PEOPLE) Industry - Academia Partnerships and Pathways - Marie Curie Actions (FP7-PEOPLE-2012-IAPP), Project MicroCokit n. 324518.

Tiber River in Rome







PAHs in the Tiber River

Patrolecco et al. (2010) reported much higher PAHs concentrations for benzo(b)fluoranthene (average: 8.9 ng/l), benzo(k)fluoranthene (6.4 ng/l), benzo(a)pyrene (9.0 ng/l), benzo(g,h,i)perylene (2.9 ng/l), and indeno(1,2,3-cd)pyrene (9.7 ng/l).

Also Montuori et al. (2016) reported higher PAHs levels in the Tiber River (at Fiumicino). Total PAHs concentrations in the dissolved water phase in Fiumicino were 607 ng/L (70 ng/L for the 5-ring PAHs (benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and dibenzo(a,h)-anthracene), and 35 ng/L for the 6-ring PAHs (benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene)).

Montuori, P., Aurino, S., Garzonio, F., Sarnacchiaro, P., Nardone, A., Triassi, M. 2016. Distribution, sources and ecological risk assessment of polycyclic aromatic hydrocarbons in water and sediments from Tiber River and estuary, Italy. [Science of the Total Environment](#) 566–567, 1254–1267.

Patrolecco, L., Ademollo, N., Capri, S., Pagnotta, R., Polesello, S. Occurrence of priority hazardous PAHs in water, suspended particulate matter, sediment and common eels (*Anguilla anguilla*) in the urban stretch of the River Tiber (Italy). [Chemosphere](#) 81 (2010) 1386–1392.