



Inquinanti emergenti: presenza nelle acque lombarde e loro gestione in una prospettiva di sostenibilità dell'ambiente

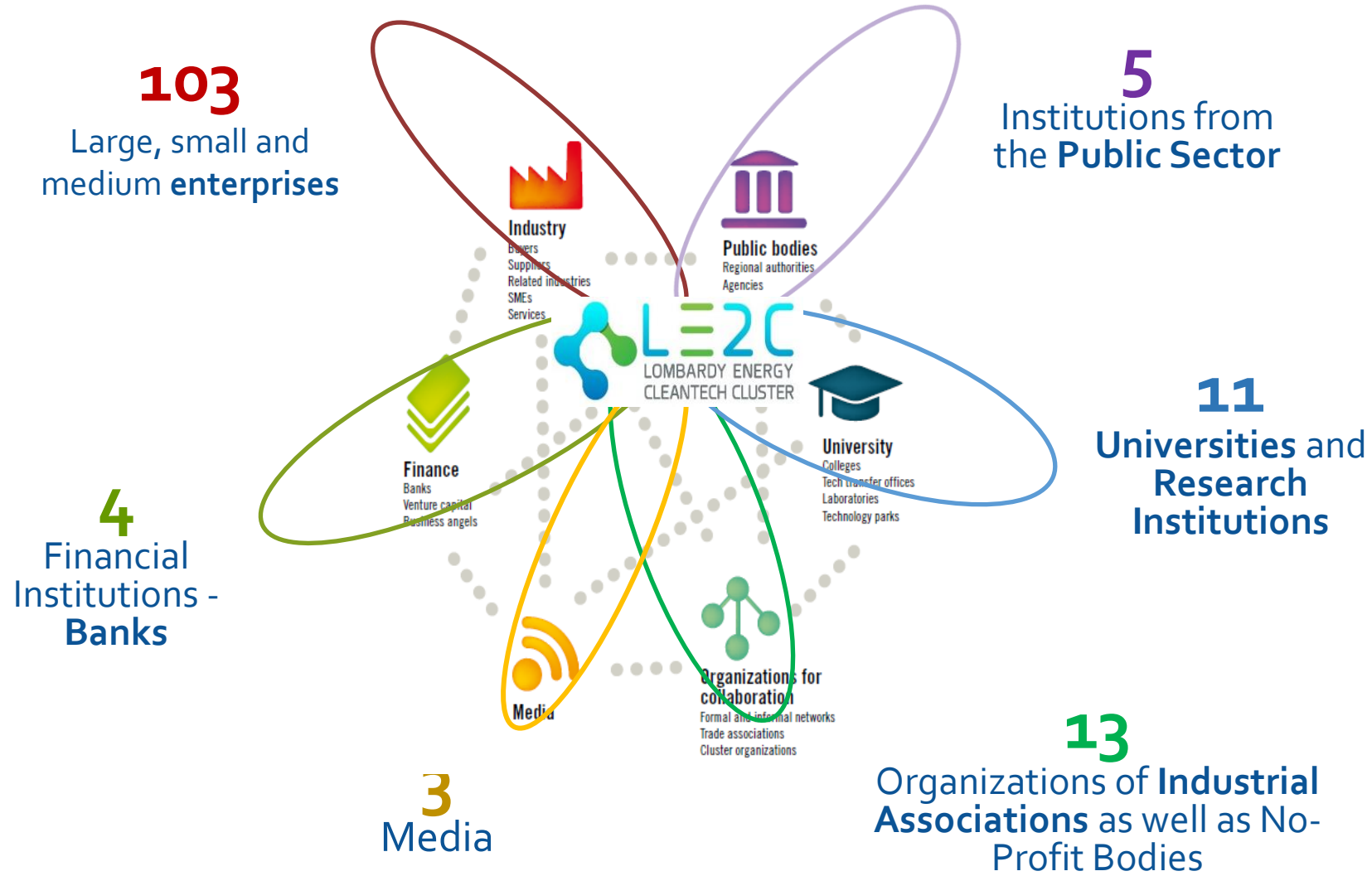
Emerging pollutants: presence in Lombard waters and their management in a perspective of environmental sustainability

Giovanni Bergna, Referente Industria per l'Area di Competenza Water Energy Nexus di LE2C / Lariana Depur SpA

Gianni Tartari, Referente di Ricerca per l'Area di Competenza Water Energy Nexus di LE2C / CNR-IRSA

LOMBARDY ENERGY CLEANTECH CLUSTER

MULTI HELIX SYSTEM



WG – EMPs Report



Last October 2020 the Lombardy Energy Cleantech Cluster presented the volume "Emerging Pollutants" which represents the result of the Emerging Micro-Pollutants Working Group (GdL-MIE) on the presence of chemical pollutants in Lombardy surface and underground aquatic compartments, in wastewater and in drinking water.

Knowledge of the state of contamination from emerging pollutants will allow for a more ambitious management of the problem and the efficiency of the removal will be an incentive for the reuse of water resources and nutrients.

WG – EMPs

First step: 2018-2020

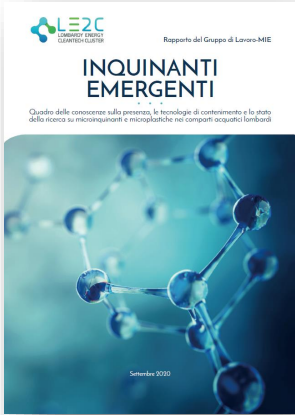
Ending in October

Second step: 2021-2023

Starting in July

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Emerging contaminants cycling



Contents lists available at ScienceDirect
Environment International

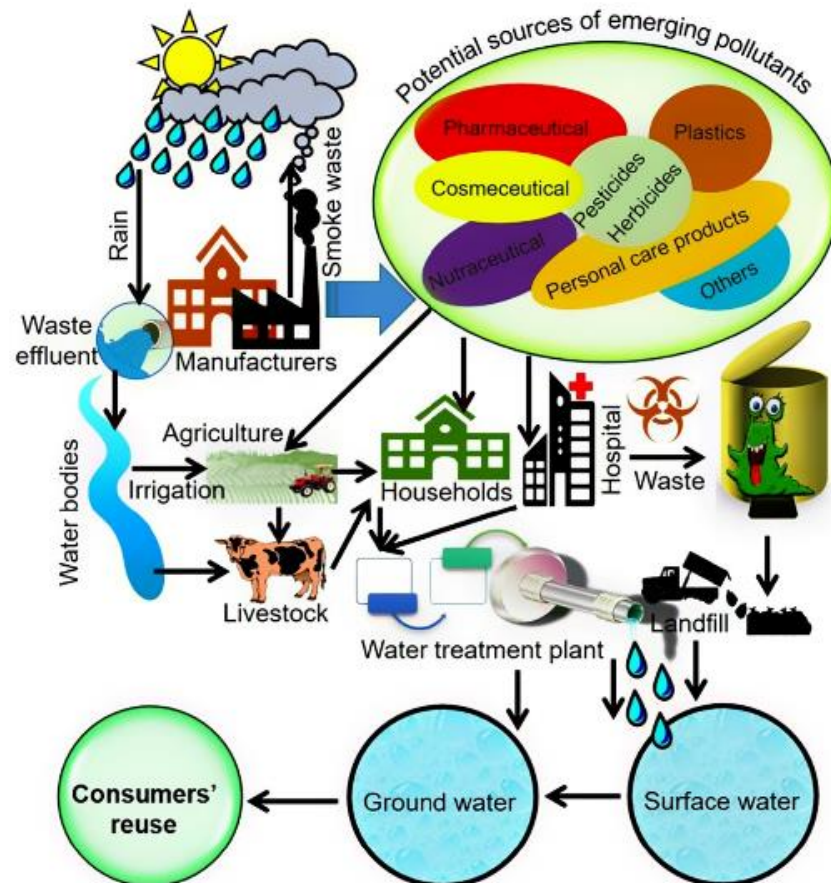
journal homepage: www.elsevier.com/locate/envint

Review article

<https://doi.org/10.1016/j.envint.2018.11.038>

Environmentally-related contaminants of high concern: Potential sources and analytical modalities for detection, quantification, and treatment

Tahir Rasheed^a, Muhammad Bilal^{b,*}, Faran Nabeel^a, Muhammad Adeel^a, Hafiz M.N. Iqbal^{c,*}



Trends in
Ecology & Evolution

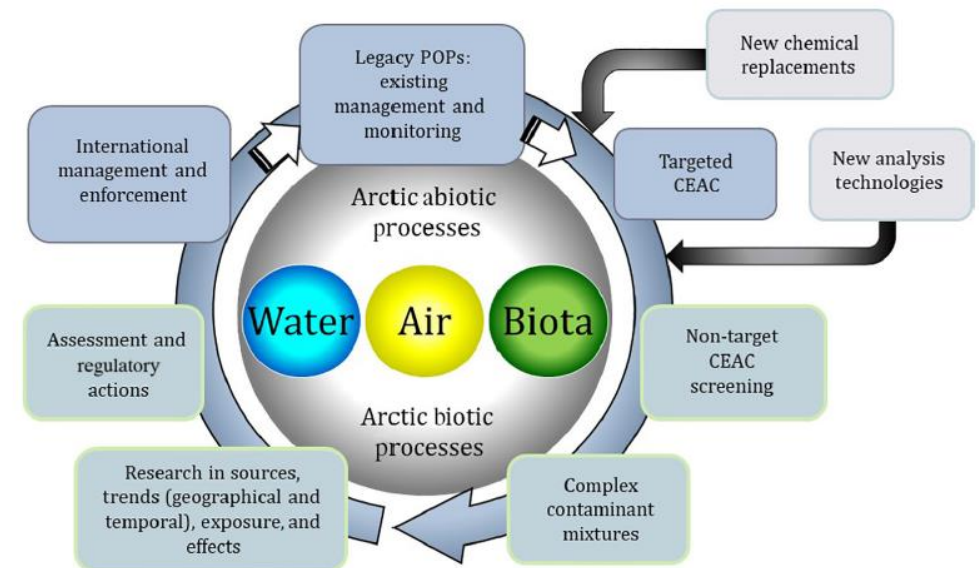


Opinion

Emerging contaminants and biological effects in Arctic wildlife

Christian Sonne^{a,1,2,*}, Rune Dietz¹, Bjørn Munro Jenssen^{1,3,4}, Su Shiung Lam^{5,2} and Robert J. Letcher⁶

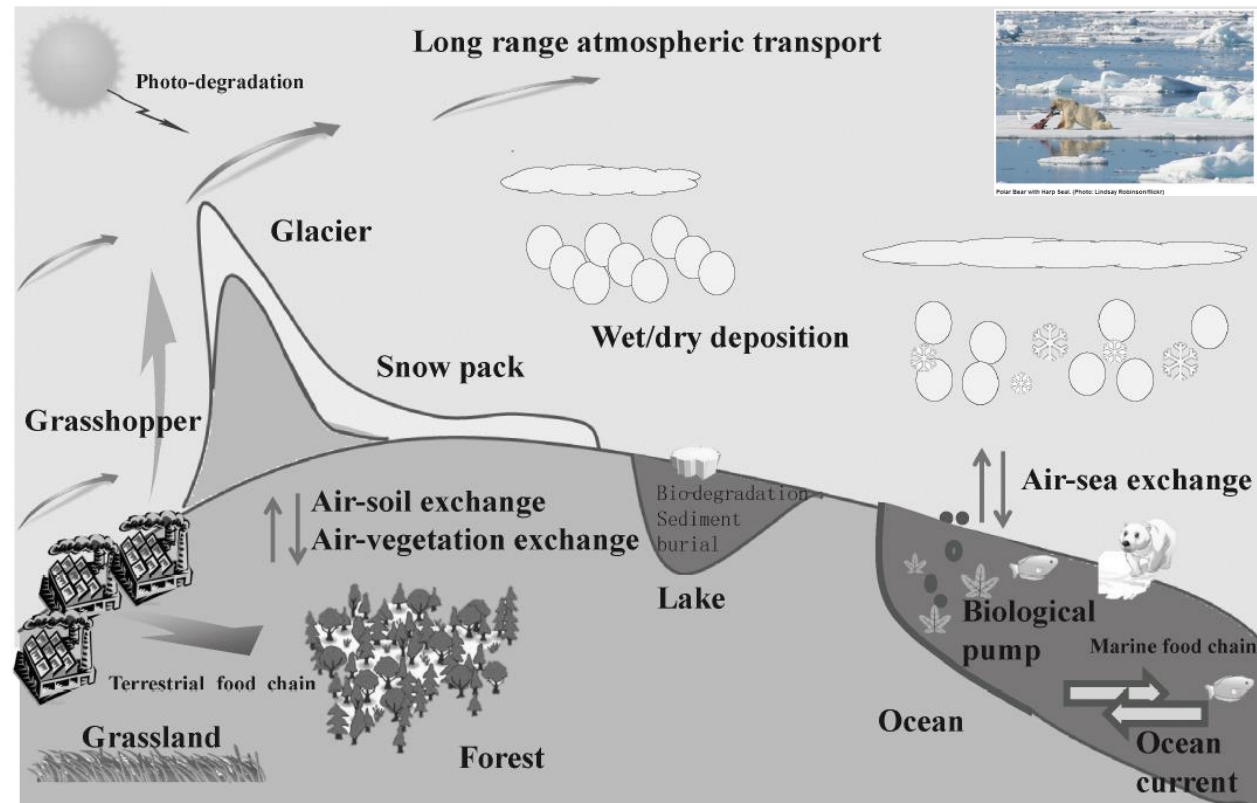
Trends in Ecology & Evolution, May 2021, Vol. 36, No. 5



Trends in Ecology & Evolution

Figure 3. A Suggested Holistic and Integrated Management Strategy to Address Chemicals of Emerging Arctic Concern (CEACs) and Cumulative Effects in the Arctic. Abbreviation: POPs, persistent organic pollutants.

Global warming and emerging contaminants cycling

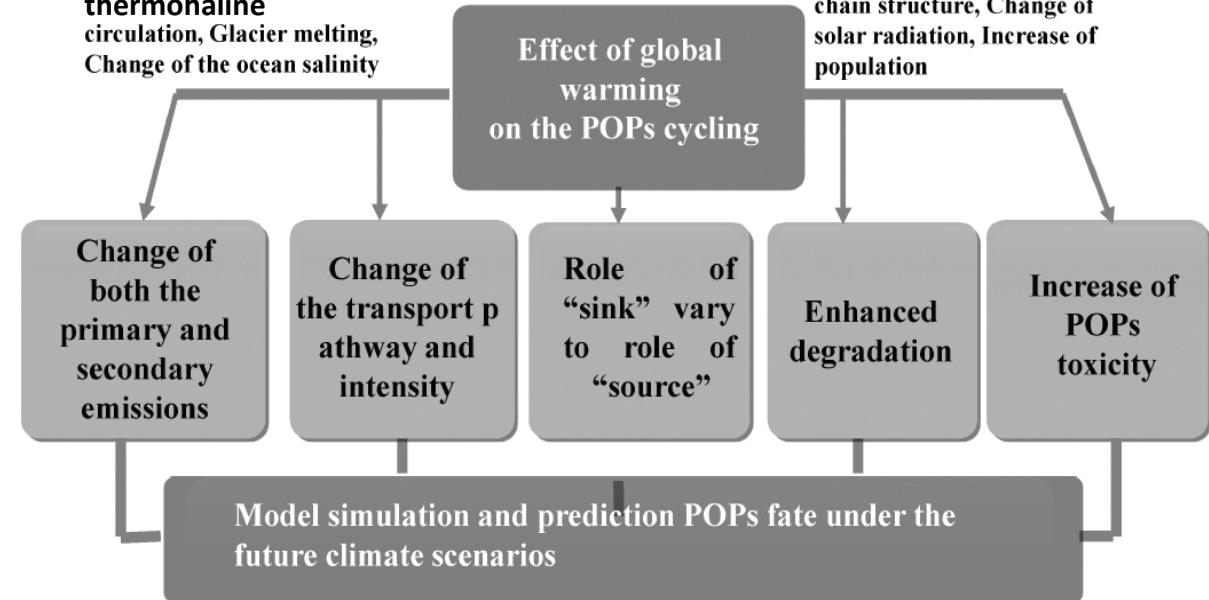


Direct impacts

Temperature increase,
Variation of air circulation, Change
of deposition pattern, Waning of the
thermohaline
circulation, Glacier melting,
Change of the ocean salinity

Indirect impacts

Terrestrial vegetation change, Vari-
ation of ocean
productivity, Change of food
chain structure, Change of
solar radiation, Increase of
population



SCIENCE CHINA
Earth Sciences

• REVIEW •

October 2016 Vol.59 No.10: 1899–1911
doi: 10.1007/s11430-016-5073-0

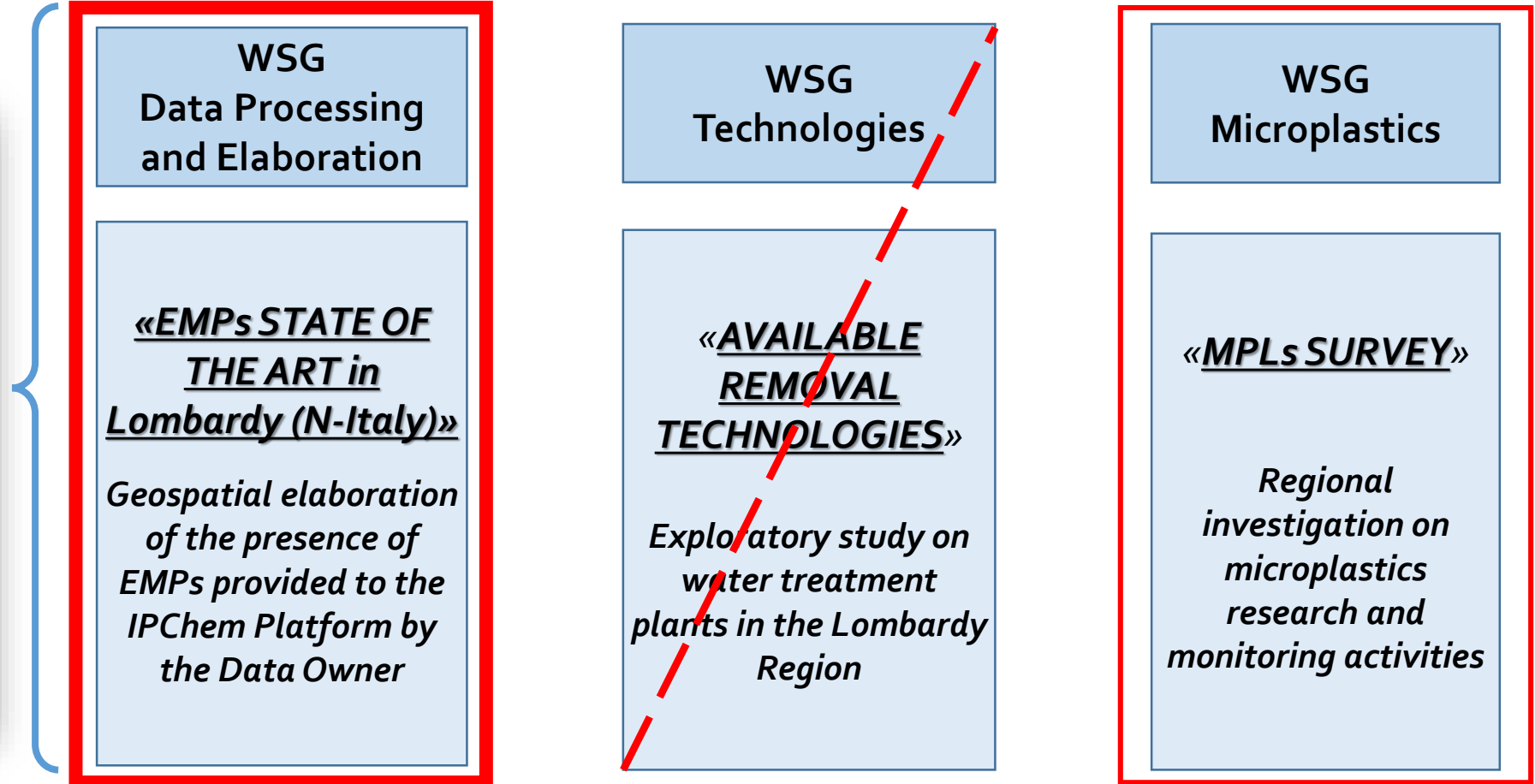
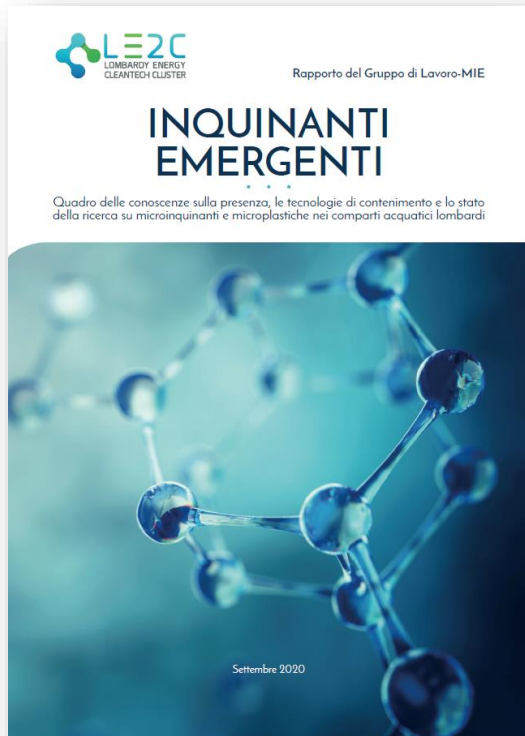
Climate change and global cycling of persistent organic pollutants: A critical review

WANG XiaoPing^{1,2*}, SUN DianChao^{1,3} & YAO TanDong^{1,2}

Working Group on Emerging Micropollutants

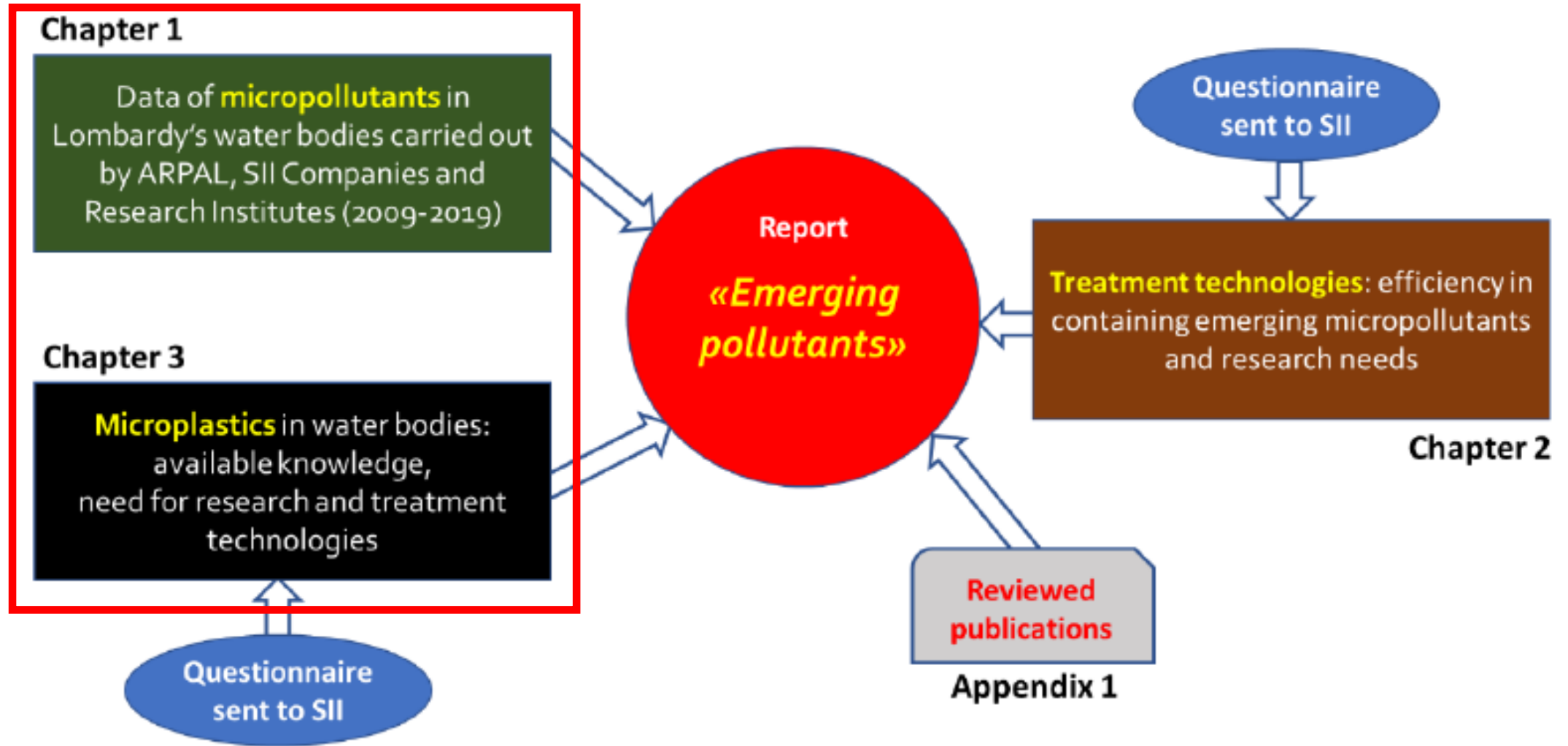
The WG-EMPs activities have been organized in

3 main Working Subgroups (WSGs)



☐ Aspects considered in this contribution

Structure of the report



Emerging issues in water analysis

Reviews by Susan D. Richardson, with the collaboration of Thomas A. Ternes and Susana Y. Kimura

Selected issues in biannual "Review contents" of Analytical Chemistry	Water analysis		Water analysis: Emerging contaminants and current issues								
	1999	2001	2003	2005	2007	2009	2011	2014	2016	2018	2020
Nutrients	●										
Inorganic Pollutants		●									
Surfactants		●									
Disinfectants, Disinfection (drinking waters)		●	●	●	●	●	●	●	●	●	●
Pesticides		●									
Pesticides Degradation/Transformation products				●	●	●	●	●			
Endocrine Disrupting Chemicals (EDCs) and Pharmaceuticals		●									
Pharmaceuticals, Hormones, and Endocrine Disrupting Compounds			●	●	●	●					
Pharmaceuticals and Hormones							●	●	●	●	●
Perfluorinated Compounds				●	●	●	●	●	●	●	●
Brominated Flame Retardants				●	●	●	●				
Brominated and Emerging Flame Retardants								●	●	●	●
Musks						●	●	●			
Sunscreens				●	●	●	●	●	●	●	●
Algal Toxins		●	●	●	●	●	●	●	●	●	●

Data collected by Working Group (1)

WSG
**Data Processing
and Elaboration**

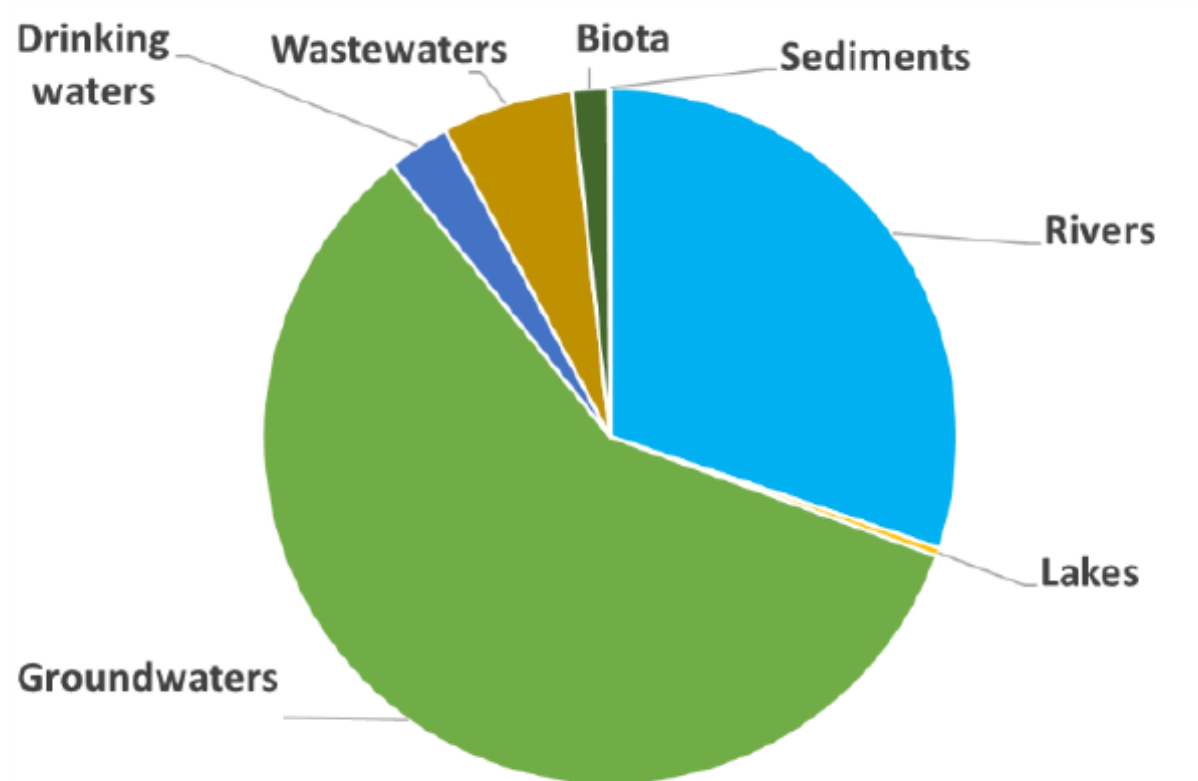
**«EMP STATE OF
THE ART in
Lombardy (N-Italy)»**

*Geospatial elaboration
of the presence of
EMPs provided to the
IPChem Platform by
the Data Owner*

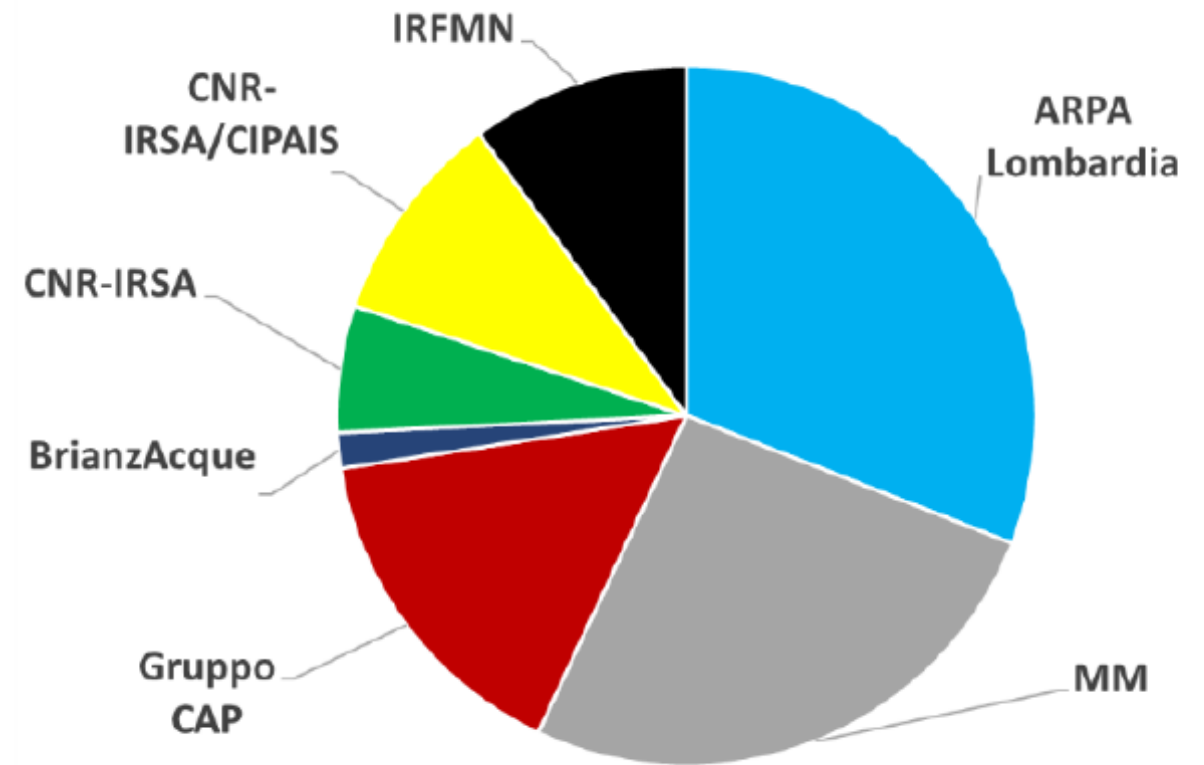
- More than **500 variables** including macro descriptors, nutrients, pollutants, physical and chemical-physical measures for a total of about **3,000,000** measures for river waters, **2,650,000** measures for groundwater and about **640,000** measures for lake waters, mostly reported to the period 2009-2019.
- With regard to **350 emerging pollutants**, almost **one million of measurements** were provided ($9.77 \cdot 10^5$) of which **32.9%** for **rivers** and **63.1%** for **groundwater**, while the remaining **4.0%** concerns data from **lakes, drinking** and **waste water, sediments** and some **biological components**.

Data collected by Working Group (2)

Period: 2009-2019



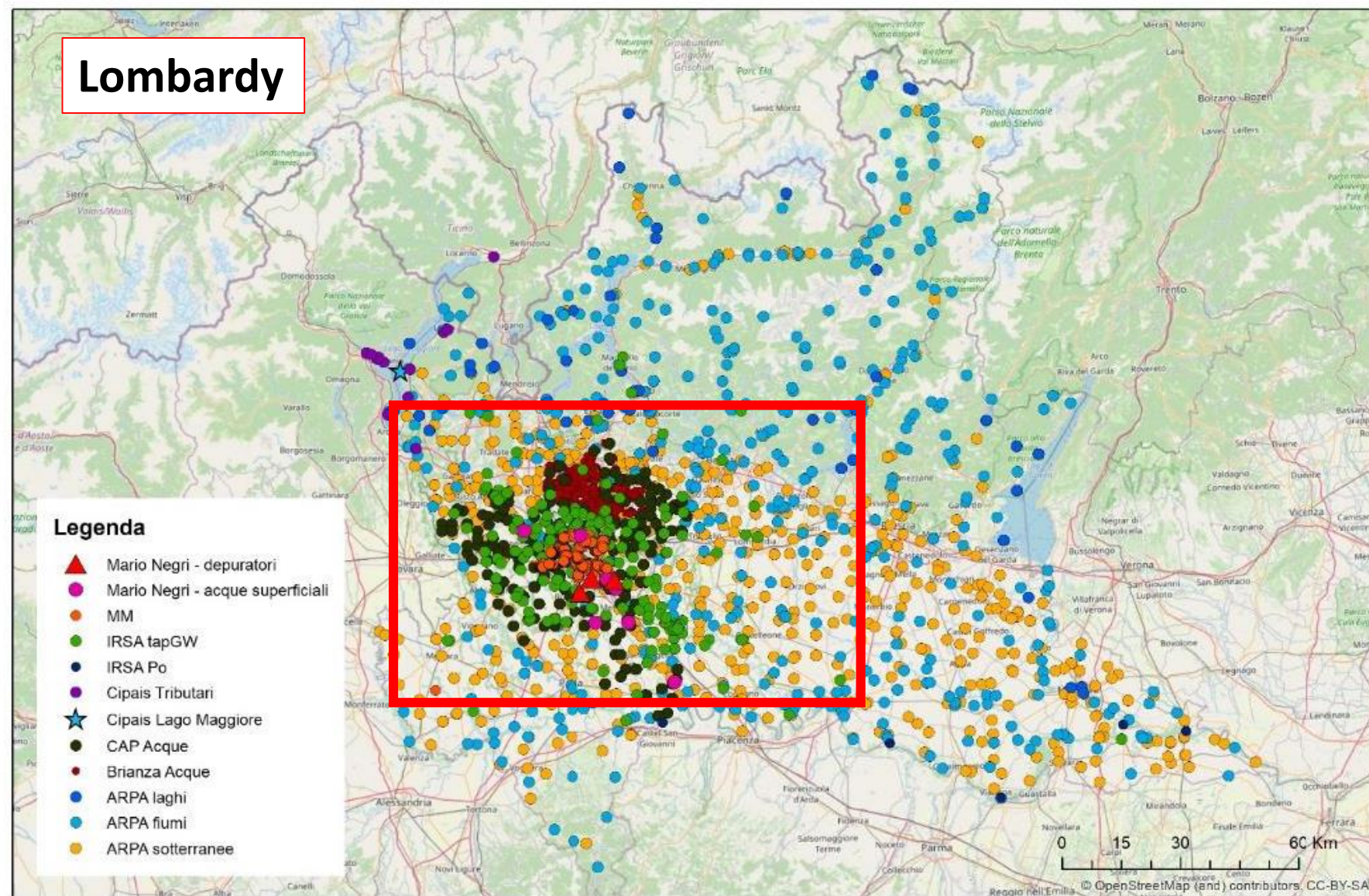
Data owners

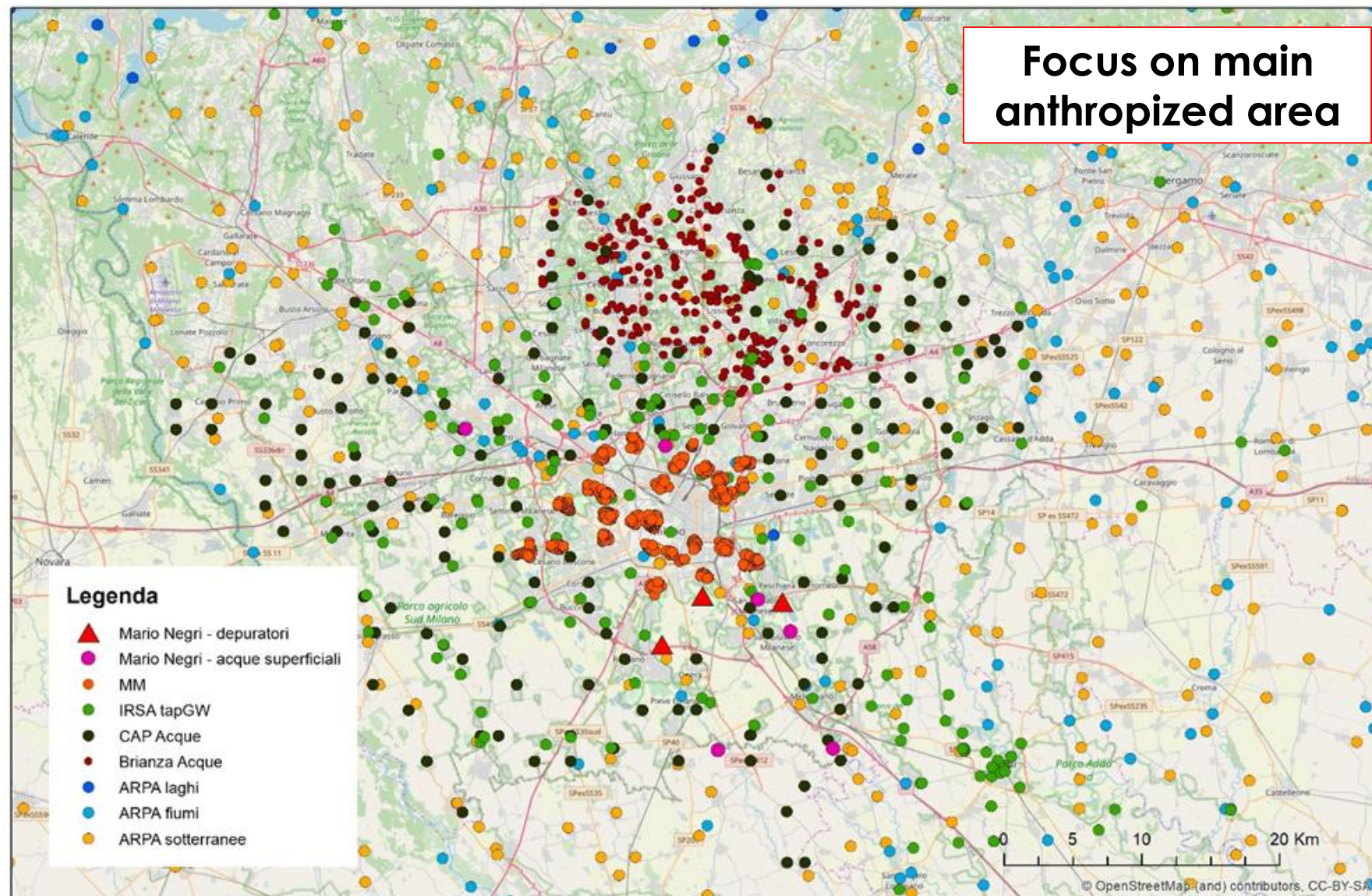
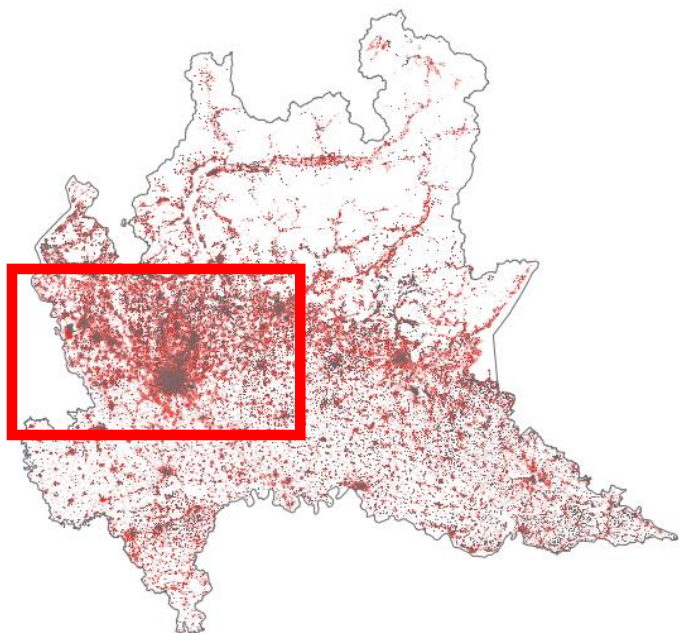


Spatial distribution of data provided by Data Owners:

- groundwaters,
- rivers,
- lakes,
- wastewaters, drinking waters, sediments,
- biota.

ARPA Lombardia
BriancAcque
Gruppo CAP
Istituto di Ricerca Sulle Acque
Istituto di Ricerche Farmacologiche Mario Negri
MM S.p.A.





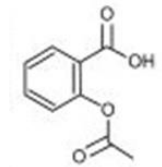
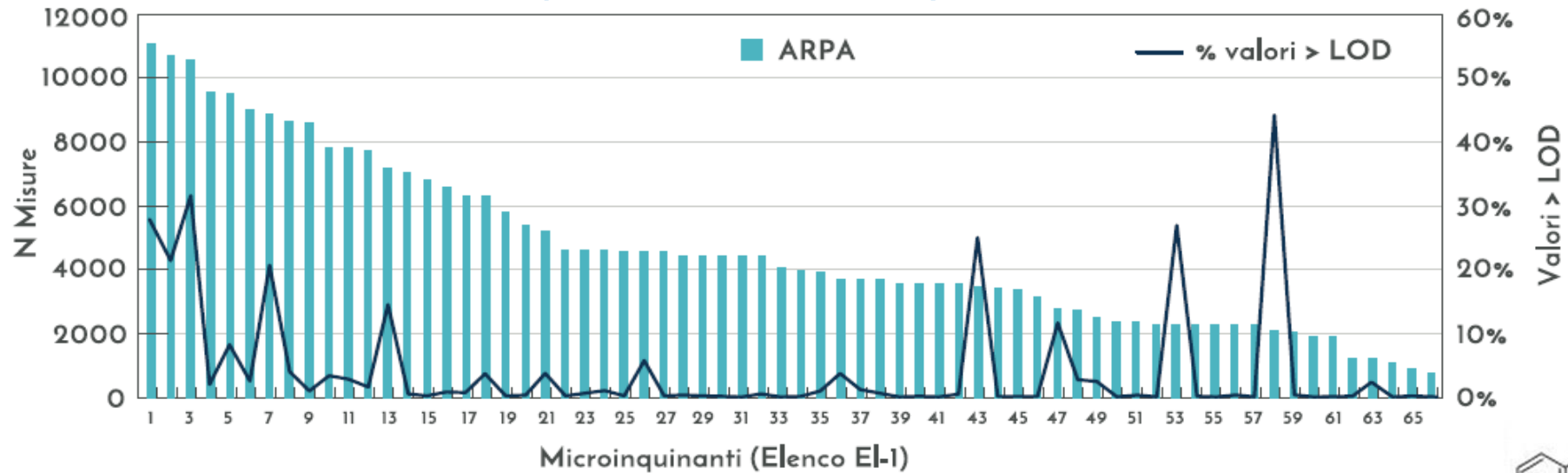
Parameters selection

The selection of the parameters was made using the **NORMAN network** (<https://www.norman-network.net/>), an international network of laboratories and research bodies that deal with monitoring and which periodically updates the list of emerging pollutants and associates, where available, a value of **lowest PNEC** (Predicted no-effect concentration). PNEC values are intended to be conservative and predict the concentration at which a chemical will likely have no toxic effect.

The **environmental risk assessment** was conducted on the basis of:

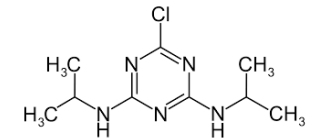
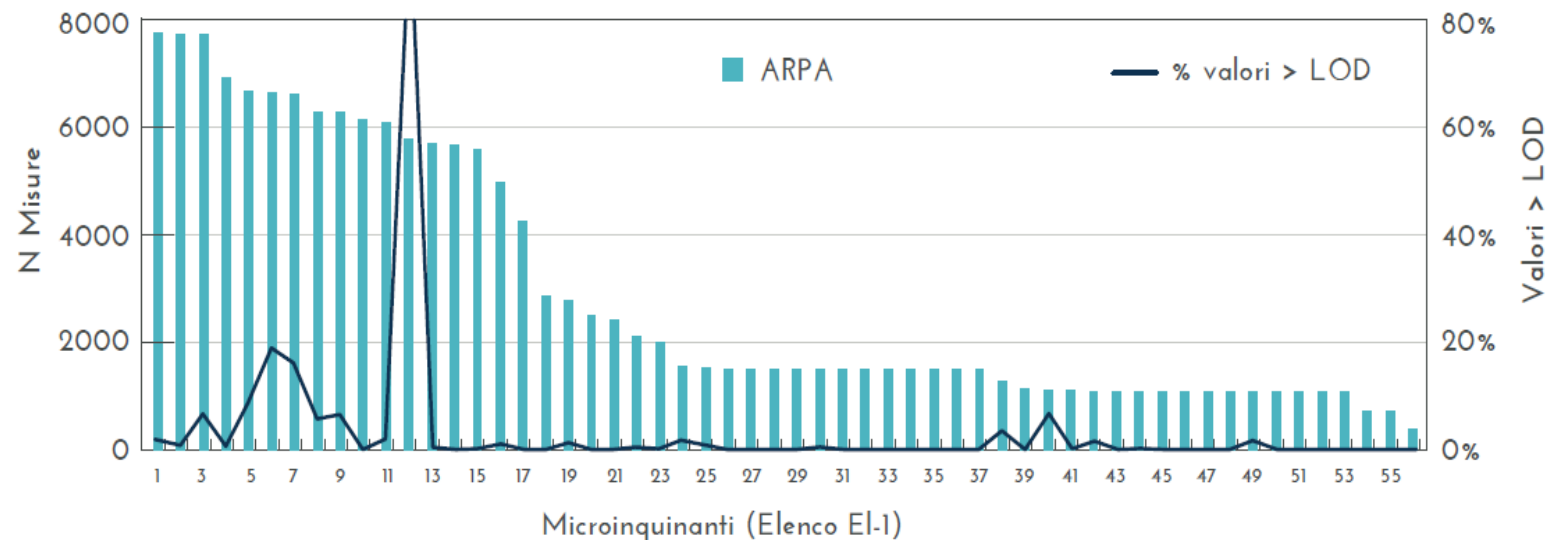
- the inclusion of the pollutant in the NORMAN collection;
- frequency of at least 10 concentration values higher than the LOD (Limit Of Detection)

Rivers

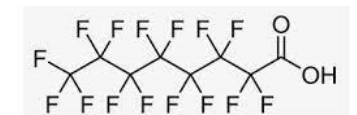


phthalic acid

Groundwaters

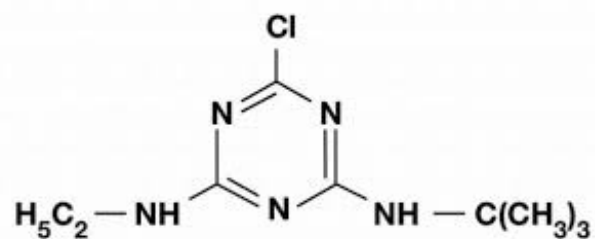


Propazine

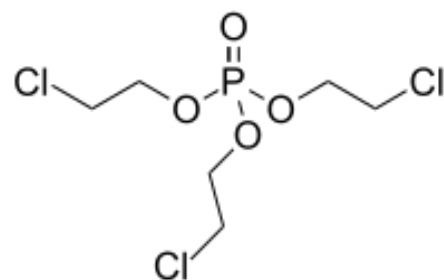


Perfluorooctanoic acid acid (PFOA)

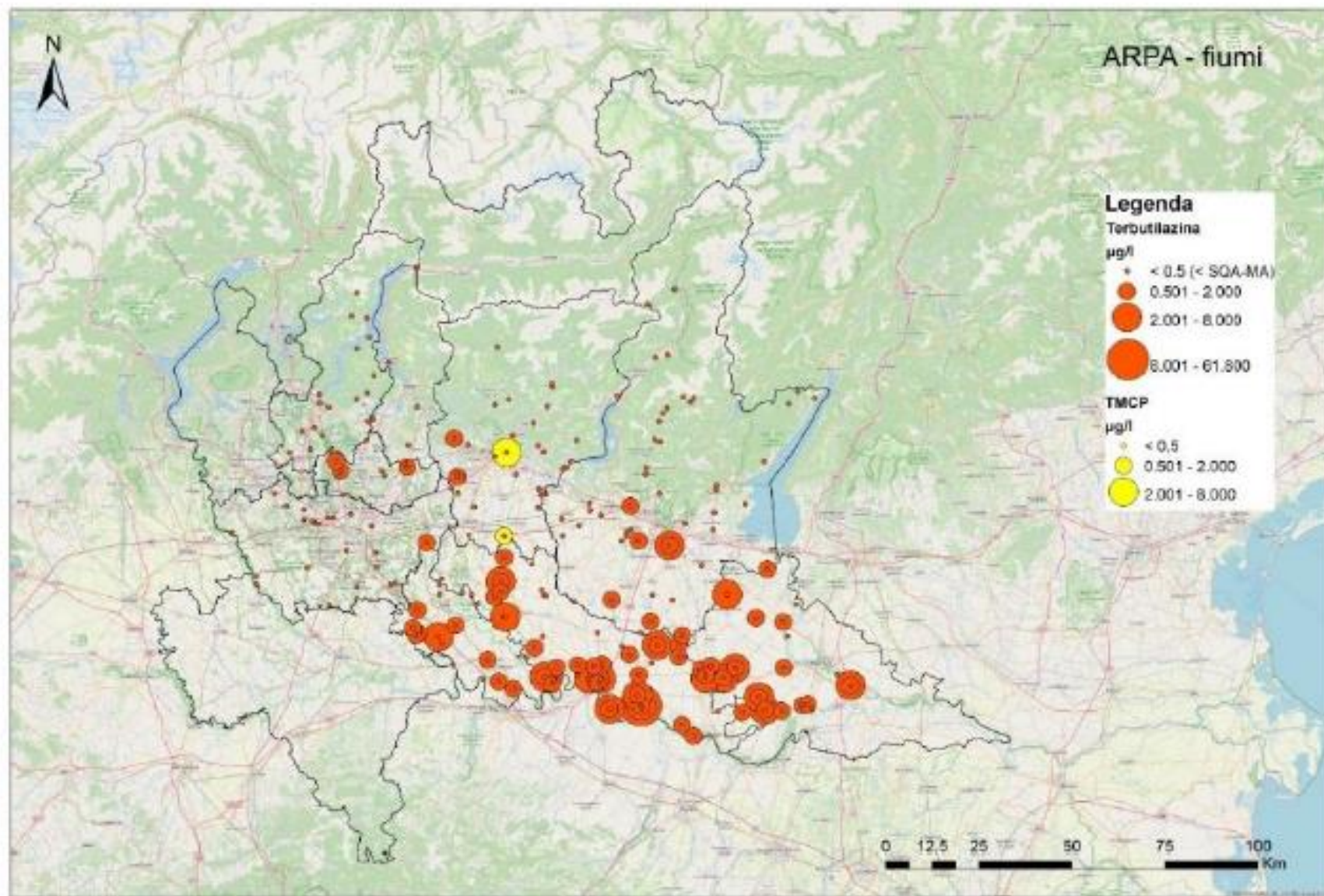
Spatial distribution of two of the main EMPs detected in river waters



terbutylazine



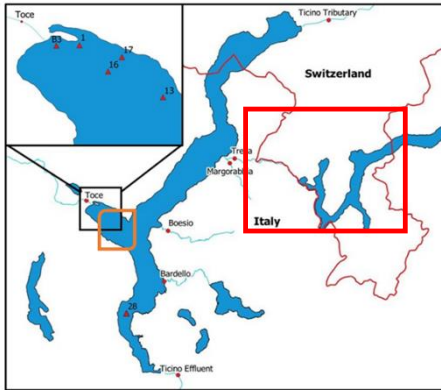
tris (2-chloroethyl) phosphate (TCEP)



Different distribution in lake waters

In lakes Maggiore and Lugano different levels of concentration of flame retardants (PBDEs) are observed in fish fauna. The contamination of Lugano is still being studied by CIP AIS.

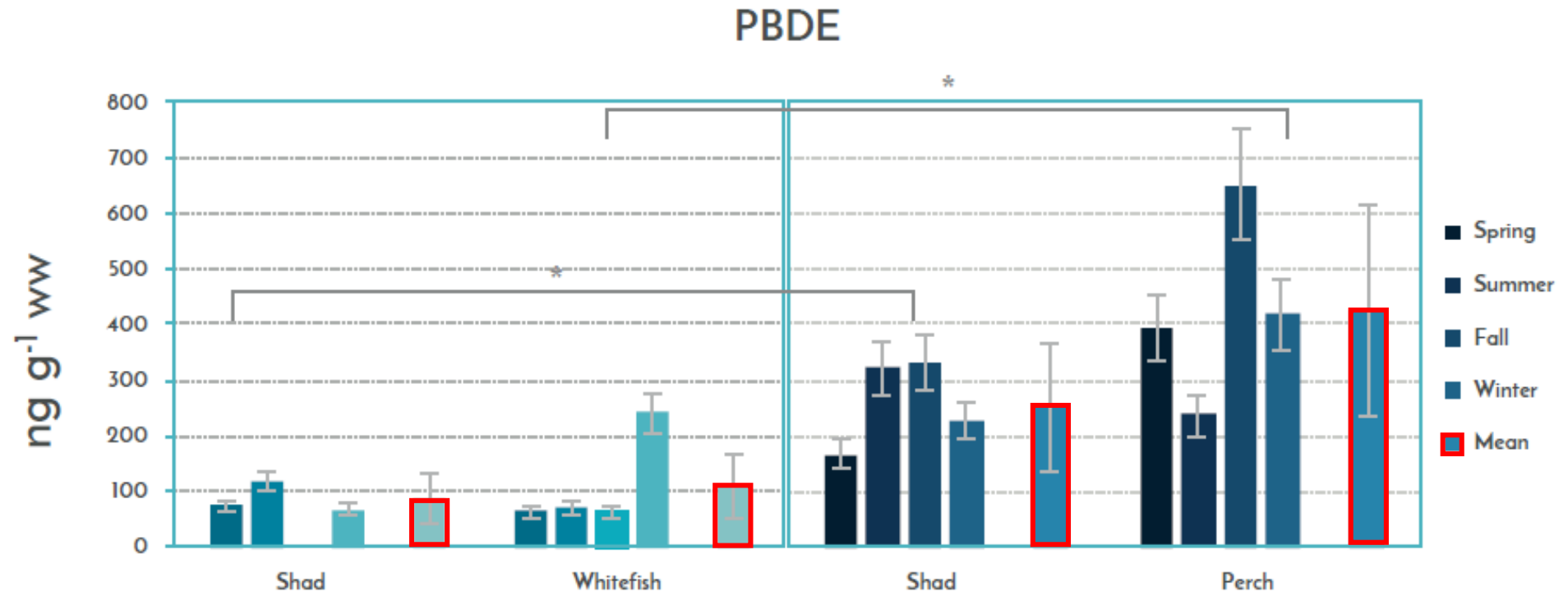
Lake Maggiore



Lake Lugano



CNR-IRSA elaboration on data provided by the International Commission for Italian-Swiss waters (CIP AIS)



Maggiore

*: $p < 0.05$

Lugano



Example of the Environmental Risk Assessment quantification

Quantification of the environmental risk was calculated as the ratio between the maximum concentration detected in the measurements and two threshold values:

- the threshold value defined by Legislative Decree 152/2006, where available,
- the ecotoxicological reference value assessed through the Lowest PNEC (Risk Quotient, RQ).

EMPs	Type / uses	Legal limit (LL)	Lowest PNEC	Total determinations	Max concentration	Risk Quotient (RQ)		Exceedance RQ			
						MEC/ LL **	MEC/ PNEC ***	N> Legal limit	N> PNEC	Probability	
										Legal limit (%)	PNEC (%)
Dieldrin	Organochlorine insecticide	0.03	NA	6324	478	15934	NA	4	0	0.1	0.0
Benzo (g,h,i) perilene	Polycyclic aromatic hydrocarbon	0.01	0.01	8569	84	8400	10244	14	14	0.2	0.2
Simazina	Herbicide	0.10	1.0	21342	221	2210	221	41	17	0.2	0.1
Atrazina-desetil	Herbicide	0.10	0.60	22973	211	2105	351	442	146	1.9	0.6
Atrazina	Herbicide	0.10	0.60	21374	147	1473	245	548	146	2.6	0.7
Prometrina	Herbicide	0.10	0.02	15773	14	140	824	18	207	0.1	1.3
Bromacil	Herbicide	0.10	11.2	20754	65	653	5.8	196	3	0.9	0.0
TCEP*	Flame retardant	0.10	4.0	16847	49	488	12	443	4	2.6	0.0
Terbutilazina desetil	Herbicide	0.10	0.25	22758	45	446	178	239	158	1.1	0.7
Triclorometano	Alkyl halide	0.15	2.5	15524	65	433	26	1443	174	9.3	1.1
Terbutilazina	Herbicide	0.10	0.06	21405	25	250	416	157	190	0.7	0.9
Σ organoalogenati	Organohalogenates	10	NA	6545	3993	399	NA	5334	0	81	0.0
Propazina	Herbicide	0.10	0.18	16223	18	178	99	61	38	0.4	0.2

Median
Exceedance RQ§

LL = 0.9 %

PNEC = 0.2 %

§relative to these EMPs

* (tris-2cloroetil-fosfato) ** Max measured concentration (MEC)/ Legal limit (LL) *** Max measured concentration (MEC)/PNEC NA Non available

General considerations on water quality assessment of EMPs (1)

1) Availability of a **large amount of data** on EMPs

2) **Exceedance risk thresholds assessment:**

- the substances with the highest risk index in **groundwater** were found to be the **organo-halogen compounds** for which exceeding the legal limit is very frequent, while for **all other substances the exceedance** of the legal limit is **less than 1%** of the measures available and 0.5% compared to the PNEC;
- in the case of **river waters**, compliance with the legal limit is guaranteed for almost all compounds with the exception of **glyphosate** which has the highest percentage of exceedances (around 18%), while PNEC exceedances occur only in the case of some drugs;
- in the case of **lake waters**, exceeding the legal limit are even **more rare**

General considerations on water quality assessment of EMPs (2)

- 3) The datasets provided by the Research Institutes (CNR-IRSA and Mario Negri Institute of Pharmacological Research) provided interesting insights :
- in lakes Maggiore and Lugano there are decreasing trends were found for the contamination by organochlorines (DDx and PCBs), while the levels of flame retardants (PBDEs) were found different in the two lakes;
 - the analyzes of PFAS in the lake biota (zooplankton / ichthyofauna) show a certain variability between the lakes;
 - differences are evident in the contamination profiles of the different PFAS congeners in treatment plants with different dimensional classes;
 - recurrent associations between drugs are observed in the quality profiles of wastewater entering in the treatment plants;
 - drugs show weekly and perhaps even seasonal variability in the inflow of treatment plants.

“New” emerging contaminants: Microplastics:

Why a focus on microplastics (MPs)?

- are emerging contaminants, as they are present in all compartments (water, sediment, biota) and therefore ubiquitous substances;
- are the subject of growing concerns and interest from politics and the population;
- MPs could have harmful effects on the environment and ecosystems;
- It is necessary to promote scientific research and global cooperation.

Objectives

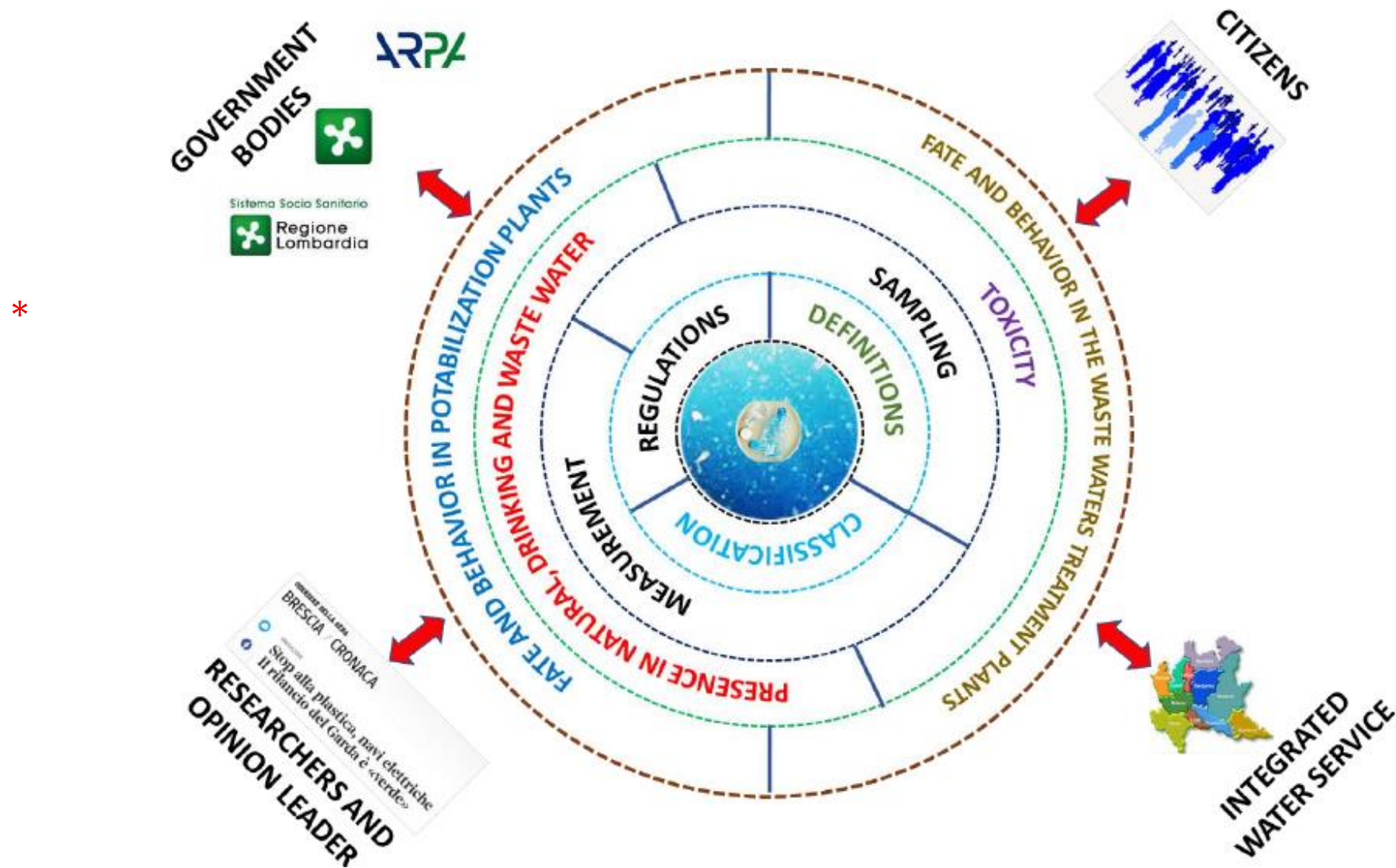
- Definition, classification and regulatory needs.
- Sampling and measurement methods.
- Sources, presence and behavior in the environment (waters and sediments).
- Aspects related to ecotoxicity, human toxicity and food safety.
- Behavior in purification and drinking water plants (water and sludge).
- Preliminary assessments on control technologies for water and sludge.
- Conclusions and recommendations.

WSG
Microplastics

«**MPLs SURVEY**»

*Regional
investigation on
microplastics
research and
monitoring activities*

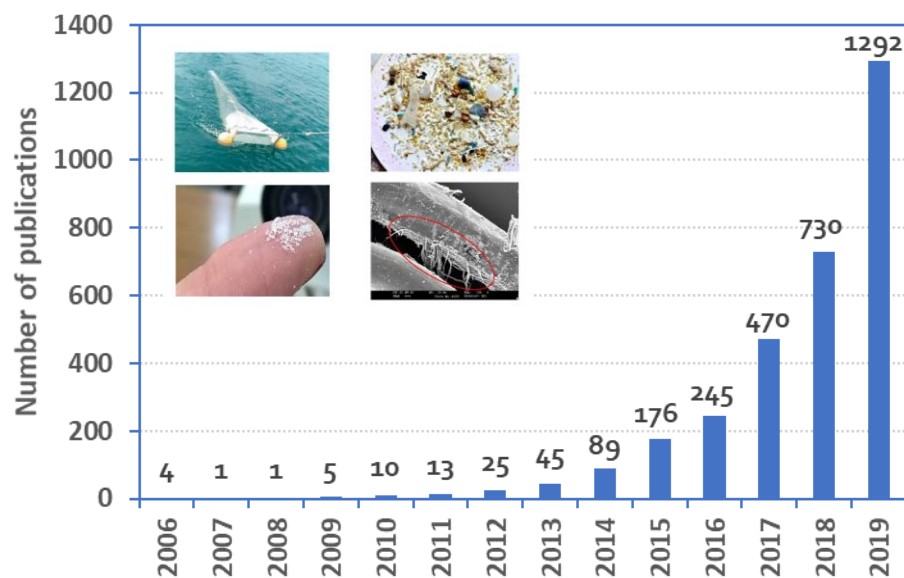
Microplastics in the aquatic compartment are on the attention of many stakeholders



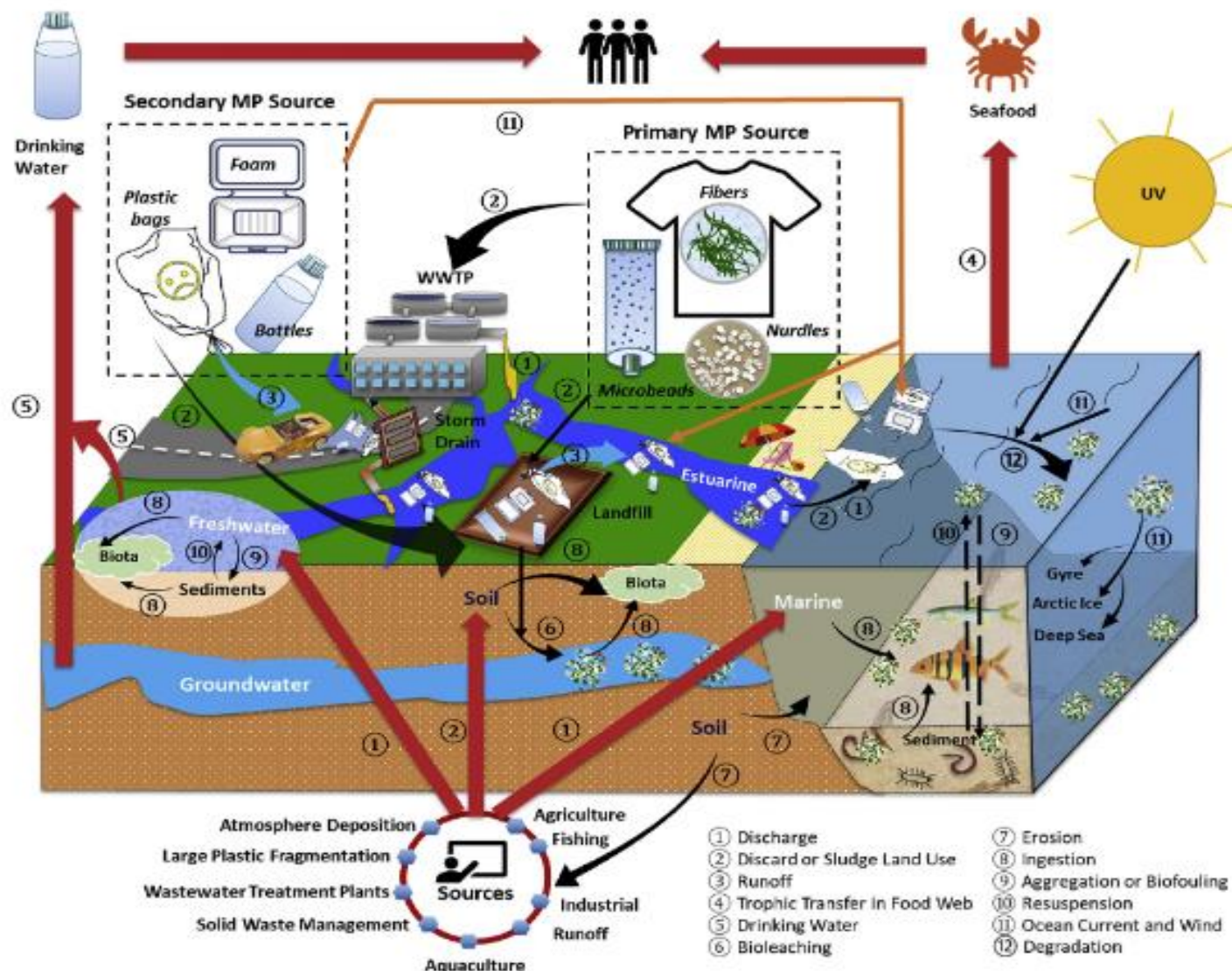
Sources, transport and fate of MPs in the environment

Plastic production in the world
(2018): $359 \cdot 10^6$ t/y

(PlasticsEurope, 2019)



MPs: $1 \mu\text{m} - 5\text{mm}$



Presence of MPs in the environment

Aquatic compartment	Italy/Europe	World
Rivers (MPs/m ³)	1- 300	$< 1 - 1,6 \cdot 10^6$
Lakes (MPs/km ²)	$(< 1 - 5,5) \cdot 10^4$	$(2 - 19) \cdot 10^4$
Oceans (MPs/km ²)	$(< 1 - 25)$ Until $1,3 \cdot 10^5$ in Mediterranean sea	$1,7 \cdot 10^6$ <i>Japanese sea</i>
Sediments (MP/kg _{ss})	185 - 2.175	178 - 980

Still **few data**, difficult to compare and with differences of orders of magnitude:

- precise **location**;
- sampling and analysis mode (**size ranges...**);
- **units of measurement** (volumes / surfaces / weights);
- population density and socio / economic aspects;
- etc.

General recommendations on MPs

The Working Group (GdL-MIE) recommends to support and promote interdisciplinary researches aimed at:

- the **development of sampling and analysis methods** to provide complete data (shape, size, composition, number and weight);
- the planning of **measurement campaigns** to quantify the presence and typology of MPs in water bodies and in different water compartments;
- the **assessment of environmental risk, exposure and effects on human health and ecosystems**;
- the assessment of **removal efficiency** in existing wastewater and drinking water treatment plants;
- the **dissemination of correct scientific information to the different stakeholders** to understand the impact of possible mitigation measures and to support the social perception of the issue.



The volume and the executive summary can be downloaded for free at these links:

<https://bit.ly/3lz1ak6>

<https://bit.ly/3qkHHHC>

Thank you

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[LE2C - Lombardy Energy Cleantech Cluster](#)
www.energycluster.it