UNESCO-IWRA ONLINE CONFERENCE

17-19 JANUARY 2023

3RD IN THE IWRA ONLINE CONFERENCE SERIES

GLOBAQUA

Emerging Pollutants: Protecting Water Quality for the Health of People and the Environment

Fate, Risks and Remediation of Emerging Contaminants, Antibiotic Resistance Genes and Microplastics in Surface Waters and Groundwaters at Global Scale: Challenges and Solutions

Dr. Damià Barceló

IDAEA-CSIC,Barcelona, Spain and

ICRA, Girona, Spain

unesco

Programme hydrologique intergouvernemental

IWRA International Water Resources Association

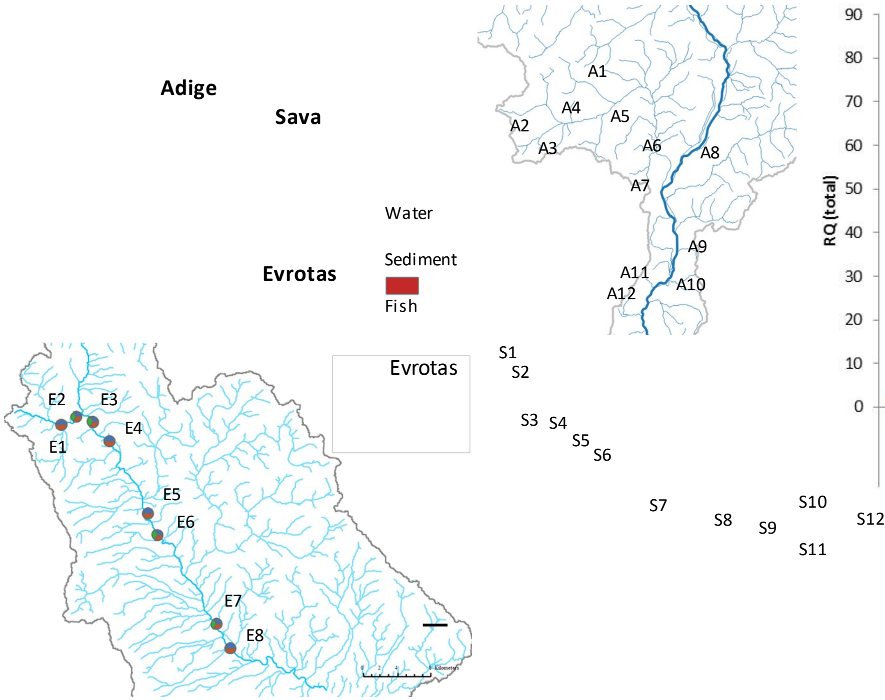
idaea CSIC ICRA

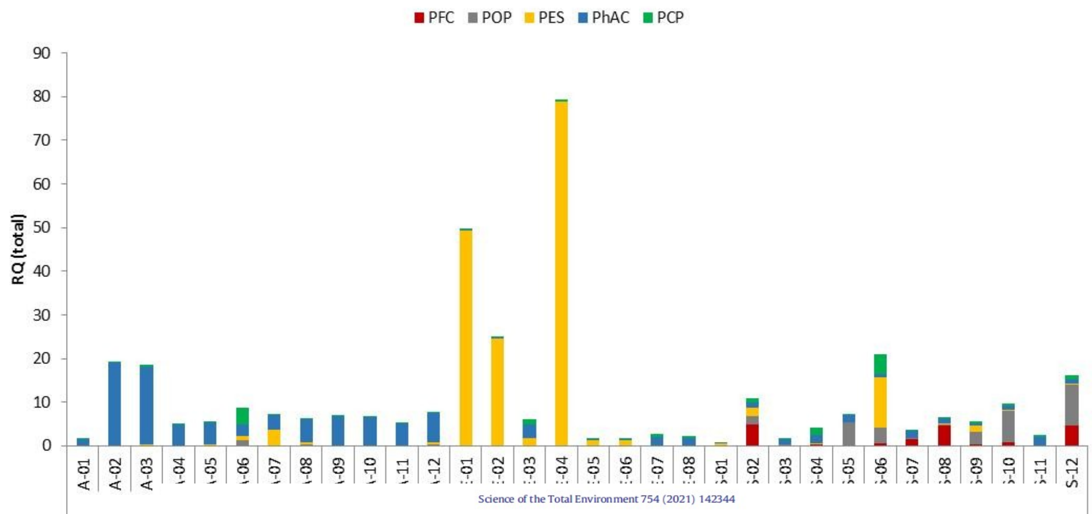
GLOBAQUA

OUTLINE

- **Emerging Contaminants at Global scale , Surface and Groundwaters and New Threats** :
    - Chemicals: Pharmaceutical, Pesticides, Personal Care Products.PFAs, DBPs ,….
    - Antibiotic Resistance Genes (+ virus , Covid-19?)
    - Microplastics (MPs)-before and after Covid-19
- **Remediation: Water treatment** options (+covid-19 related)
- **Challenges and solutions**

- EVROTAS, AGIGE, SAVA) and sampling sites.
- **Emerging Contaminants (PESTICIDES, POPs,PPCPs..**





Science of the Total Environment 754 (2021) 142344

Contents lists available at ScienceDirect

Science of the Total Environment

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

Priority and emerging organic microcontaminants in three Mediterranean river basins: Occurrence, spatial distribution, and identification of river basin specific pollutants

Marianne Köck-Schulmeyer [a], Antoni Ginebreda [a,*], Mira Petrovic [b,c], Monica Giulivo [a], Òscar Aznar-Alemany [a], Ethel Eljarrat [a], Jennifer Valle-Sistac [a], Daniel Molins-Delgado [a], M. Silvia Diaz-Cruz [a], Luis Simón Monllor-Alcaraz [a], Nuria Guillem-Argiles [a], Elena Martínez [a], López de Alda Miren [a], Marta Llorca [a], Marinella Farré [a], Juan Manuel Peña [a], Ladislav Mandaric [b], Sandra Pérez [a], Bruno Majone [d], Alberto Bellin [d], Eleni Kalogianni [e], Nikolaos Th. Skoulikidis [e], Radmila Milačič [f], Damià Barceló [a,b]

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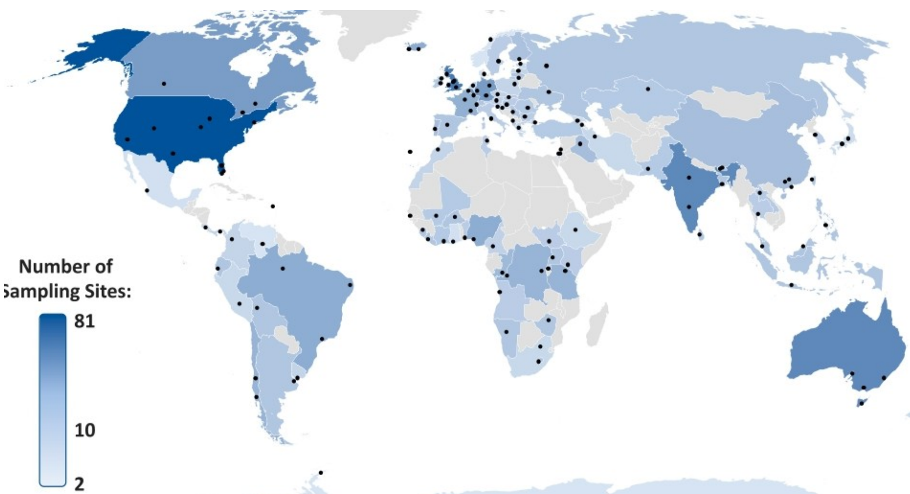
Global study of Pharmaceuticals in rivers, PNAS 2022

A.Boxall et al, University of York, UK

Pharmaceutical pollution of the world's rivers

John L. Wilkinson[a,1], Alistair B. A. Boxall[a], Dana W. Kolpin[b], Kenneth M. Y. Leung[c], Racliffe W. S. Lai[c], Cristóbal Galbán-Malagón[d], Aiko D. Adell[e], Julie Mondon[f], Marc Metian[g], Robert A. Marchant[a], Alejandra Bouzas-Monroy[a], Aida Cuni-Sanchez[a], Anja Coors[h], Pedro Carriquiriborde[i], Macarena Rojo[i],



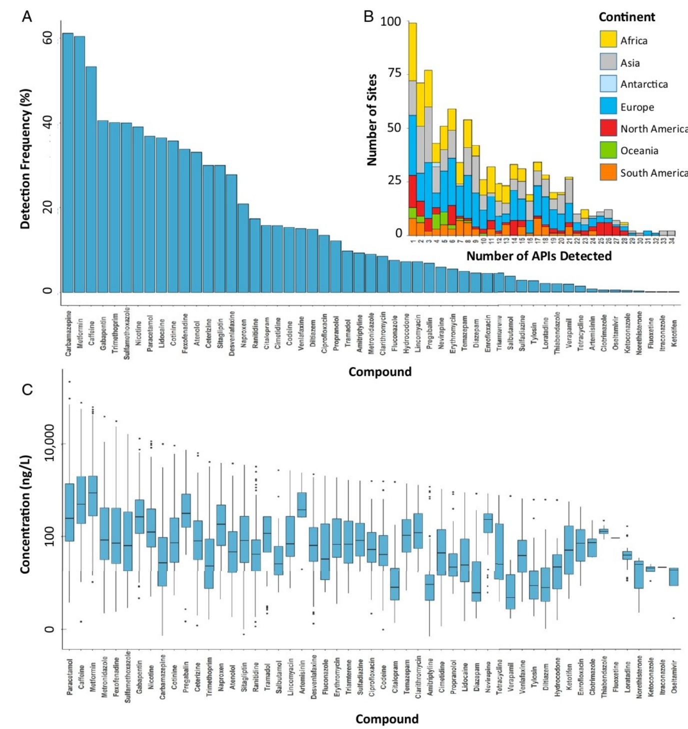


Fig. 3. (A) Detection frequencies (Dataset S5) and (B) number of APIs detected at sampling sites in the global monitoring study (Dataset S4), excluding sites without the detection of any API, and (C) box-and-whisker plots of concentrations (ng/L) of individual APIs (Dataset S4), indicating the mean, minimum, maximum, and upper and lower quartile concentrations for each API globally.

GLOBAQUA

Prioritization of Micropollutants at global scale

Pedro Alvarez et al, ES&T ,2022

Science & Technology
pubs.acs.org/est Critical Review

Which Micropollutants in Water Environments Deserve More Attention Globally?

Yun Yang, Xiangru Zhang,* Jingyi Jiang, Jiarui Han, Wanxin Li, Xiaoyan Li, Kenneth Mei Yee Leung, Shane A. Snyder, and Pedro J.J. Alvarez

Cite This: *Environ. Sci. Technol.* 2022, 56, 13–29 Read Online

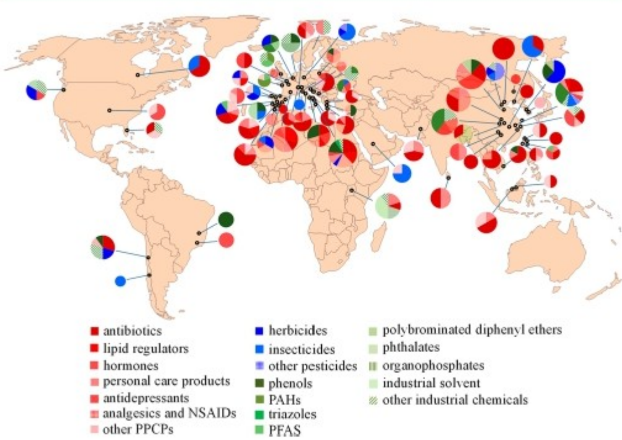
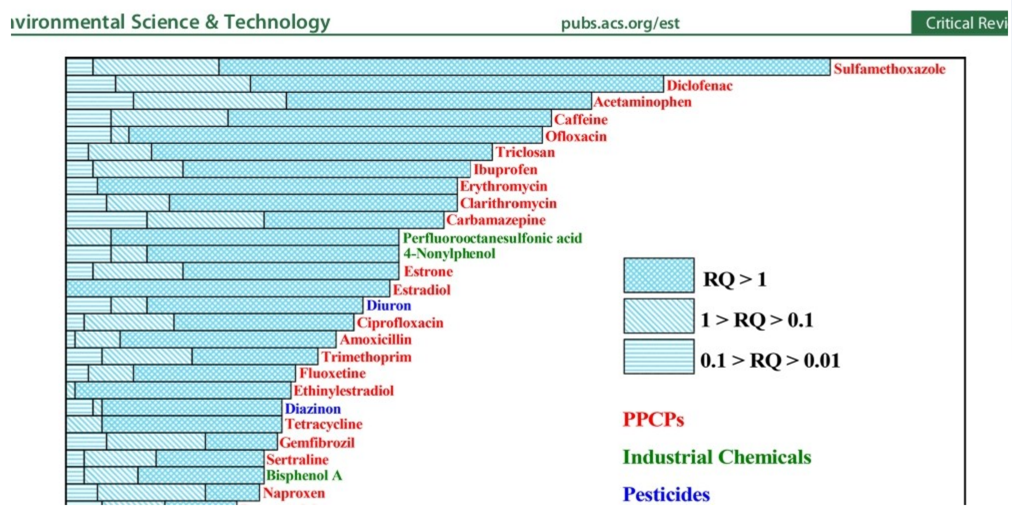


Figure 2. Micropollutant subgroups with highest priority levels (RQ > 1) in different areas identified in the case studies using the RQ method in the past decade. PPCPs, pesticides, and industrial chemicals were



Environmental Science & Technology
pubs.acs.org/est
Critica

Municipal Solid Waste Landfills: An Underestimated Source of Pharmaceutical and Personal Care Products in the Water Environment

Xia Yu, Qian Sui,* Shuguang Lyu, Wentao Zhao, Jianguo Liu, Zhenxiao Cai, Gang Yu, and Damia Barcelo

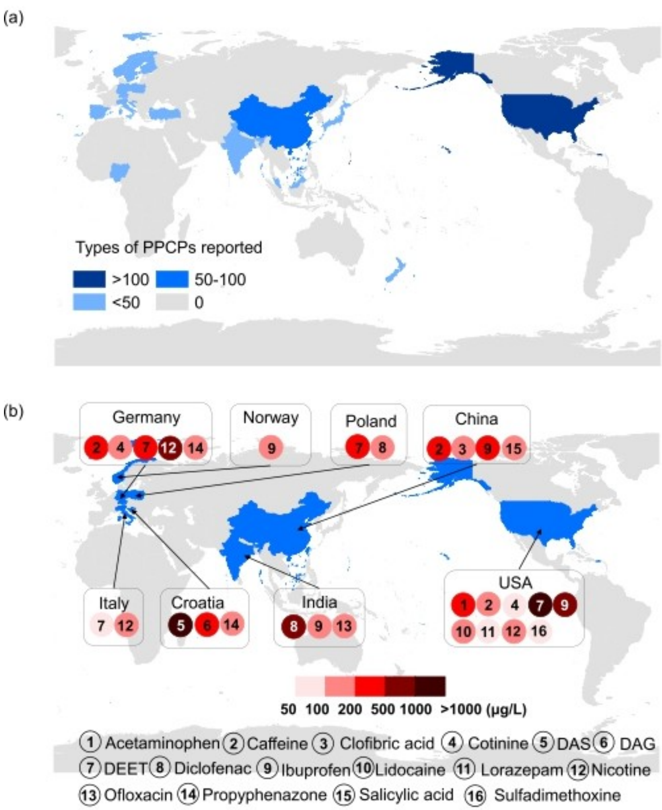


Figure 2. Types of PPCPs reported (a) and maximum concentration of highly contaminating PPCPs (>50 μg/L) (b) in landfill leachates

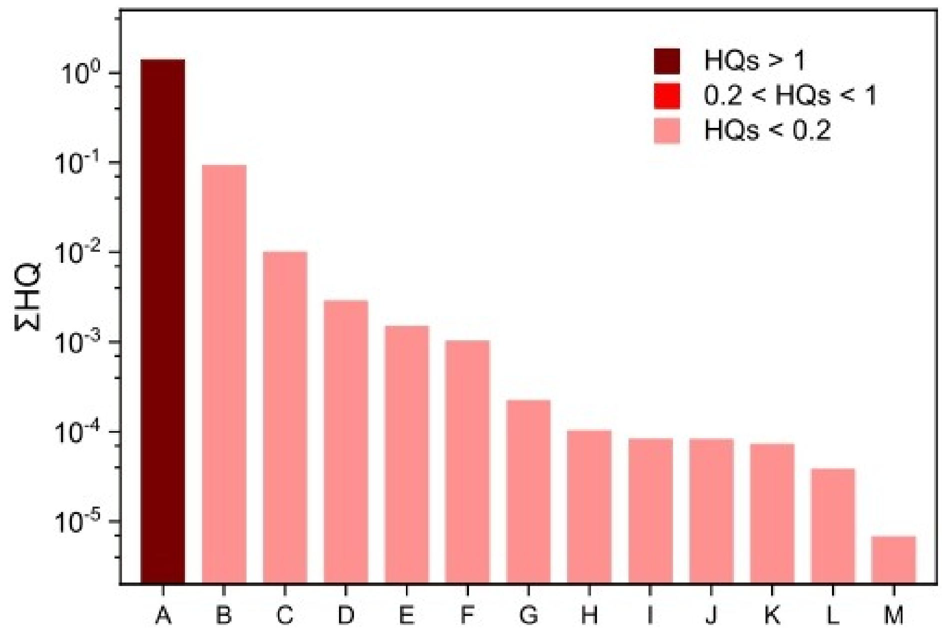


Figure 7. Human risk assessment of PPCPs detected in groundwater adjacent to the landfills (A to M represent different study areas, as shown in Table S7; A: in India;[27] B: in Denmark;[29] C: in Germany;[105] D: in Poland;[106] E: in Germany;[94] F: in China;[68] G: in the U.S.A.;[28] H: in Spain;[107] I: in China;[49] J: in Poland;[108] K: in the U.S.A.;[26] L: in the U.S.A.;[89] M: in China[93]).

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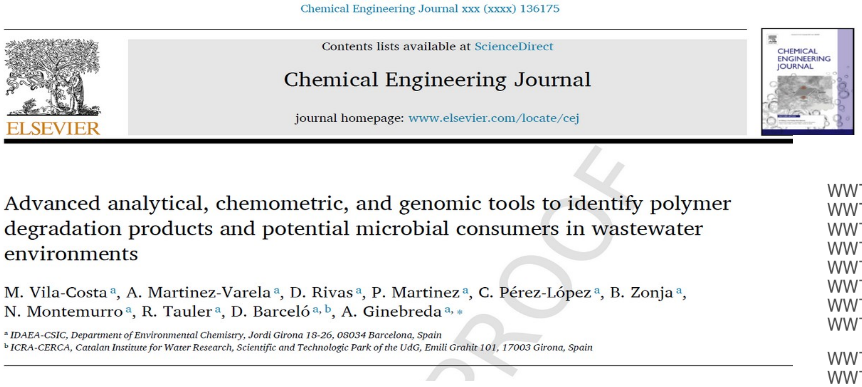
WWTP as a pathway for aquatic contamination
Genomic tools + HRMS+ Chemometrics


Chemical Engineering Journal xxx (xxxx) 136175

Contents lists available at ScienceDirect

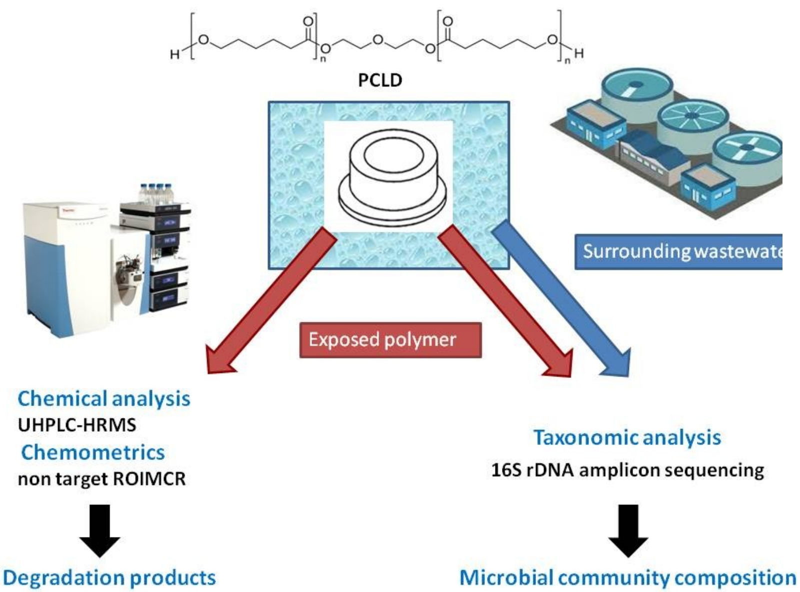
Chemical Engineering Journal

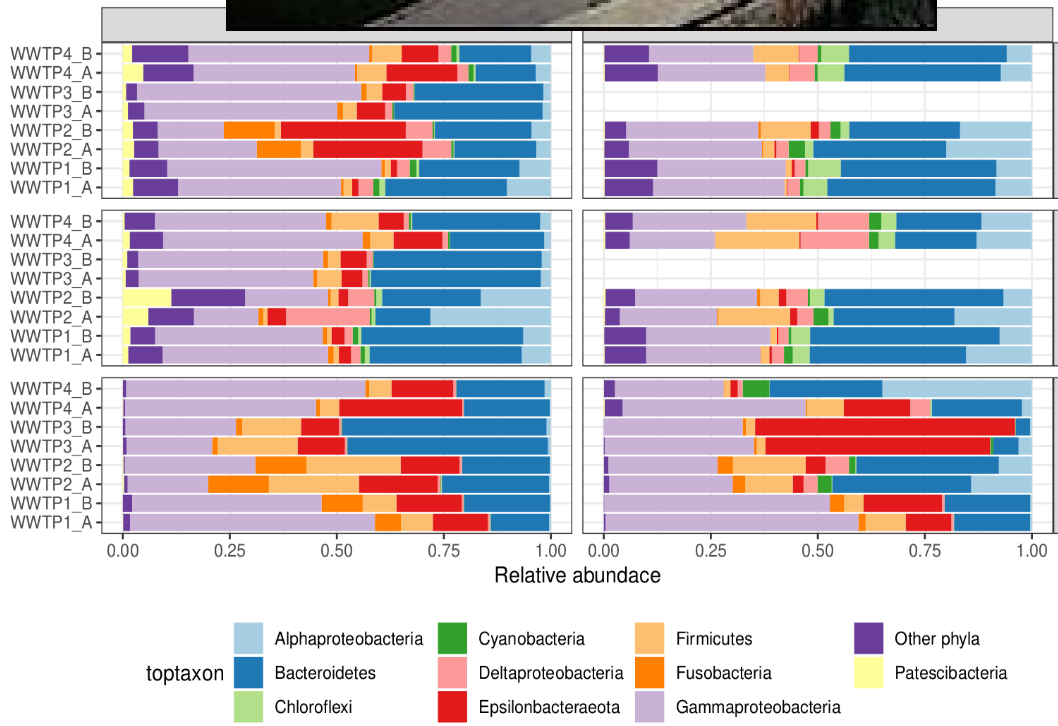
journal homepage: www.elsevier.com/locate/cej

Advanced analytical, chemometric, and genomic tools to identify polymer degradation products and potential microbial consumers in wastewater environments

M. Vila-Costa [a], A. Martinez-Varela [a], D. Rivas [a], P. Martinez [a], C. Pérez-López [a], B. Zonja [a], N. Montemurro [a], R. Tauler [a], D. Barceló [a,b], A. Ginebreda [a,*]

[a] IDAEA-CSIC, Department of Environmental Chemistry, Jordi Girona 18-26, 08034 Barcelona, Spain
[b] ICRA-CERCA, Catalan Institute for Water Research, Scientific and Technologic Park of the UdG, Emili Grahit 101, 17003 Girona, Spain





METAGENOMIC TOOLS APPLIED TO WWTPs (+ LC/HRMS + CHEMOMETRICS)

- PCLD-(Polymer-passive sampler) microbial communities responsible of the degradation
- Microbial communities identified in each step of (WWTPs), different conditions, inlet, secondary treatment, denitrification (INput, AERobic, and ANAerobic tanks).

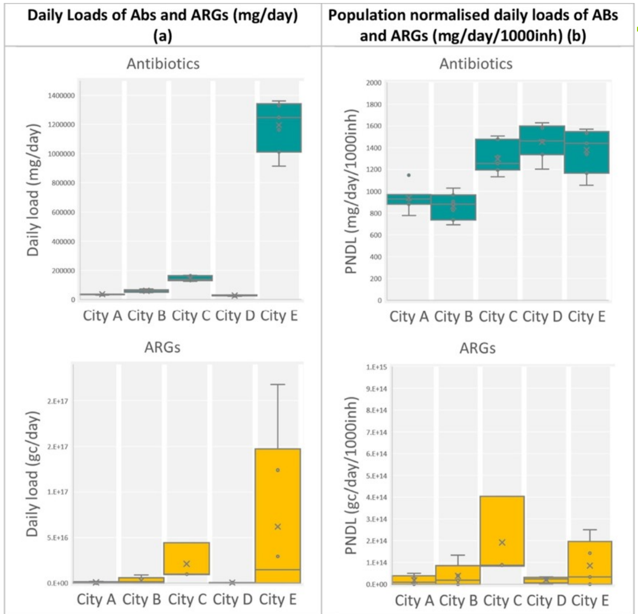
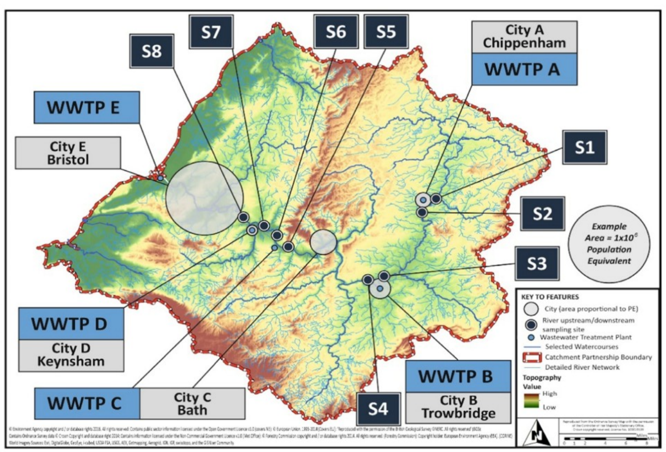


Fig. 7. ABs and ARGs: (a) daily loads and (b) population normalised daily loads (chloramphenicol was excluded in total AB calculatic



ELSEVIER

Journal of Hazardous Materials

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

Research Paper

Human population as a key driver of biochemical burden in an inter-city system: Implications for One Health concept

Barbara Kasprzyk-Hordern [a,*], Kathryn Proctor [a], Kishore Jagadeesan [a], Felicity Edler [a], Richard Standerwick [b], Ruth Barden [a,b]

Abs , ARGs Bath/Bristol, JHM 2022
Population size drives BCI burden

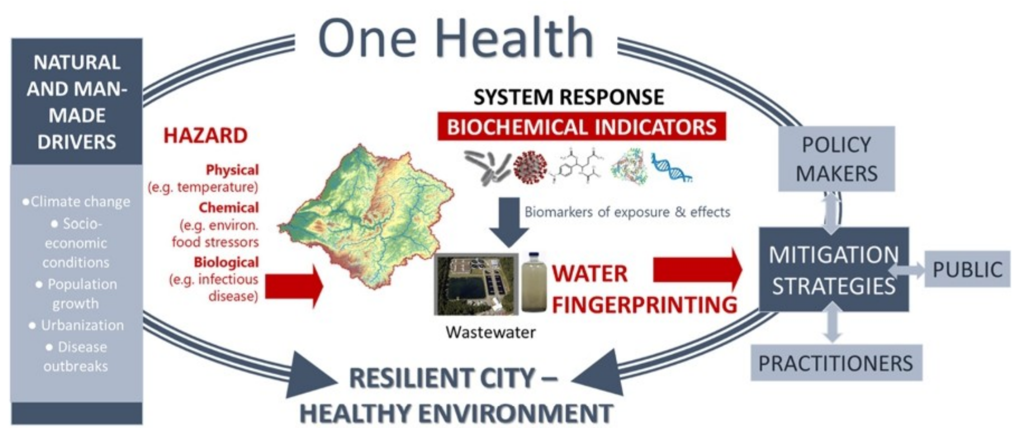
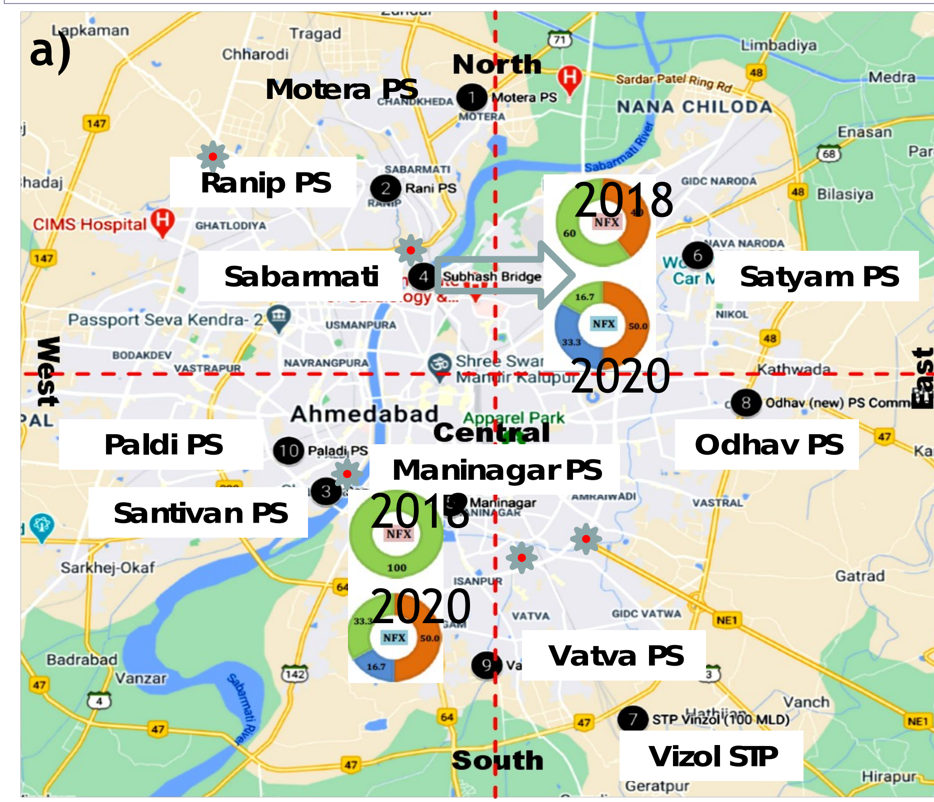


Fig. 1. Water Fingerprinting and One Health.

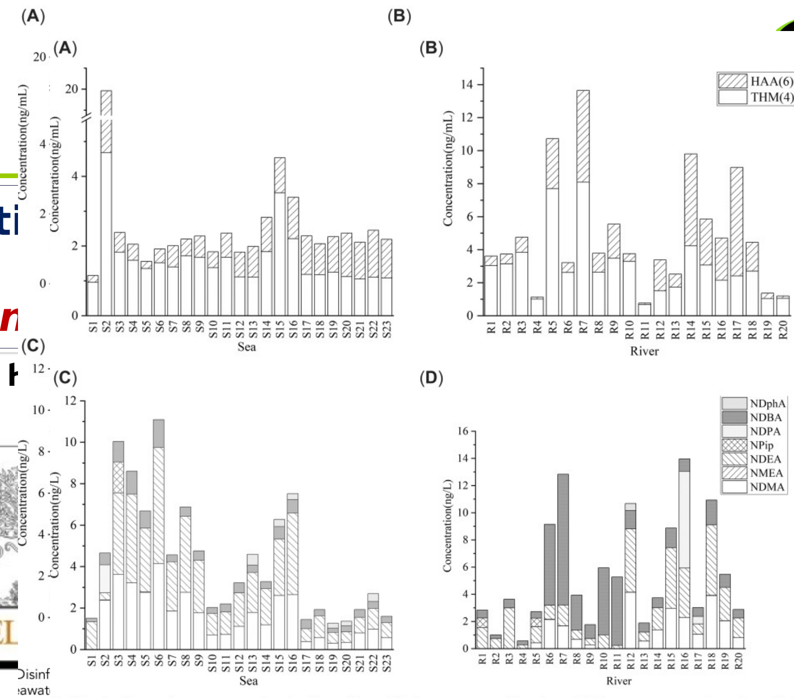
WBE can definitely help in city zonati... emic preparedness powered by early warning !!

What about effects of population density an...



Location from which samples tested for a...

Location from which samples tested for...



...Disinfection byproduct concentrations in Hong Kong. (A) Seawater sampling sites. (B) River water sampling sites. (C) Nit... ...awater sampling sites. (D) Nitrosaines (NAMs) in river water sampling sites. HAA = haloacetic acid; THM = trihalomethane.

...2021) 126125

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Antidrug resistance in the Indian ambient waters of Ahme... COVID-19 pandemic

Manish Kumar [a,*], Kiran Dhangar [a], Alok Kumar Thakur [a], Bhagwana Ra... Tushara Chaminda [c], Pradeep Sharma [d], Abhay Kumar [e], Nirav Raval [f], V... Jörg Rinklebe [g,h], Keisuke Kuroda [i], Christian Sonne [j], Damia Barcelo [k,l]

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[d] Department of Environmental Science, Graphic Era Deemed to be University, Dehradun, Uttarakhand, India
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[h] Department of Environment, Energy and Geoinformatics, University of Sejong, Seoul, Republic of Korea
[i] Department of Environmental and Civil Engineering, Toyama Prefectural University, Imizu 939-9308, Japan
[j] Aarhus University, Department of Bioscience, Arctic Research Centre (ARC), Frederiksborgvej 399, PO Box 358, DK-4000 R...
[k] Institute of Environmental Assessment and Water Research, IDAEA-CSIC, C/ Jordi Girona 18-26, 08034 Barcelona, Spain
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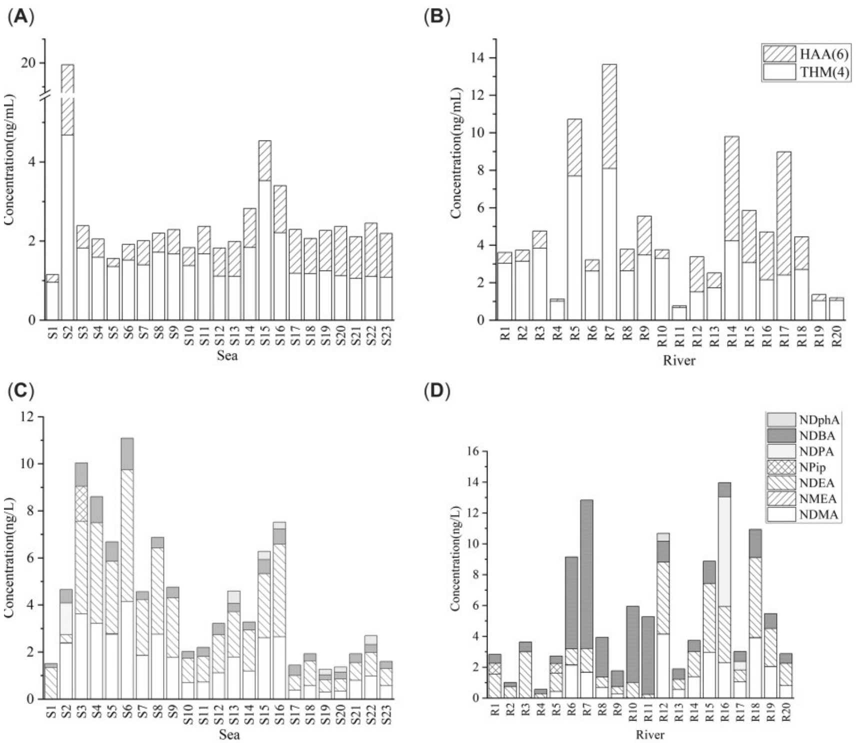

Disinfection byproduct concentrations in Hong Kong. (A) Seawater sampling sites. (B) River water sampling sites. (C) Nit
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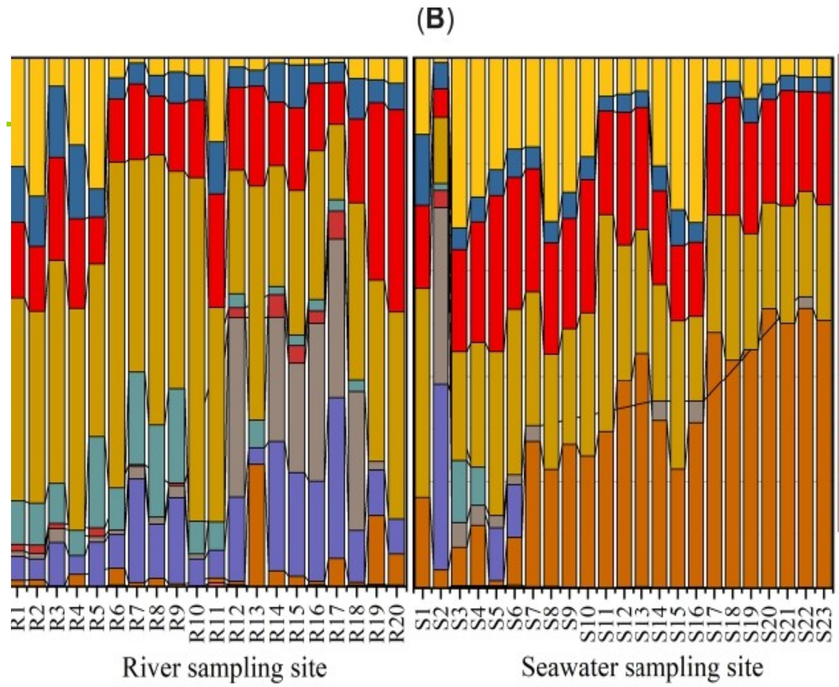

tributions to total concentrations of disinfection byproducts in Hong Kong. (A) River
form; DBCM = chlorodibromomethane; DCBM = bromodichloromethane; BF = brom
CAA = dichloroacetic acid; BCAA = monobromomonchloracetic acid; DBAA = dibromo
phenylamine; NDMA = N-nitrosodimethylamine; NDPA = di-n-propylnitrosamine; N
= nitrosodibutylamine; NMEA = mitroso-methyl ethylamine; NPip = nitroso-pipe

GLOBAQUA

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Received: 3 February 2022 | Revised: 6 May 2022 | Accepted: 24 July 2022

Hazard/Risk Assessment

Pilot Study of Pollution Characteristics and Ecological Risk of Disinfection Byproducts in Natural Waters in Hong Kong

Jing Liu,[a,b] Li-Xin Hu,[b] Wen-Jing Deng,[a,*] Guang-Guo Ying,[b,*] Huachang Hong,[c] Eric P. K. Tsang,[a] and Damià Barceló[d,e]

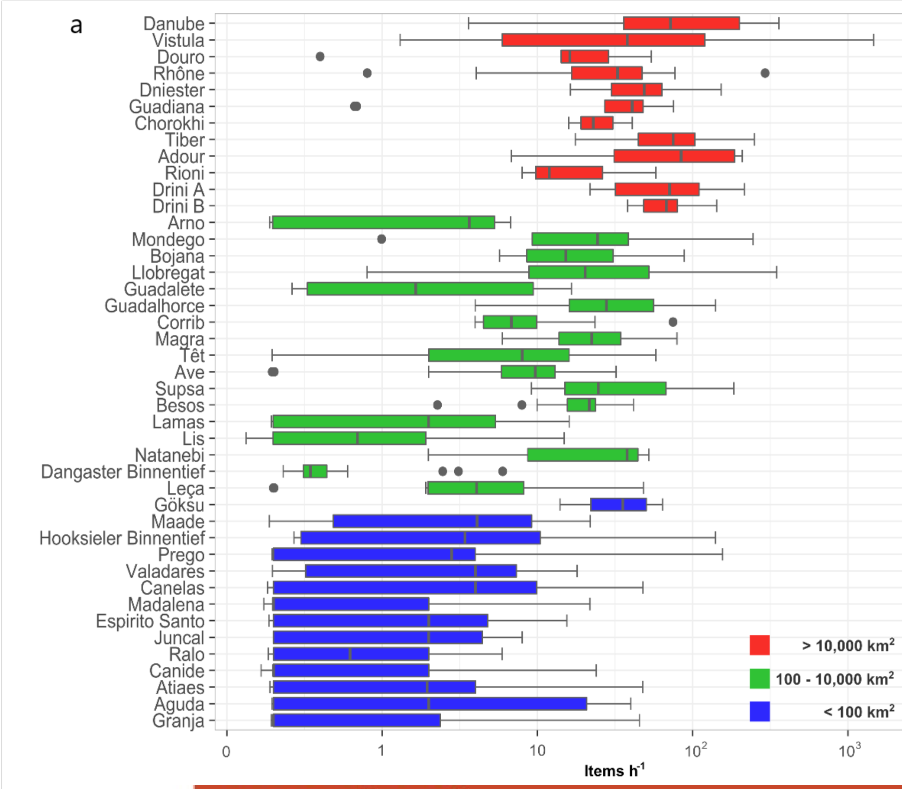
2023

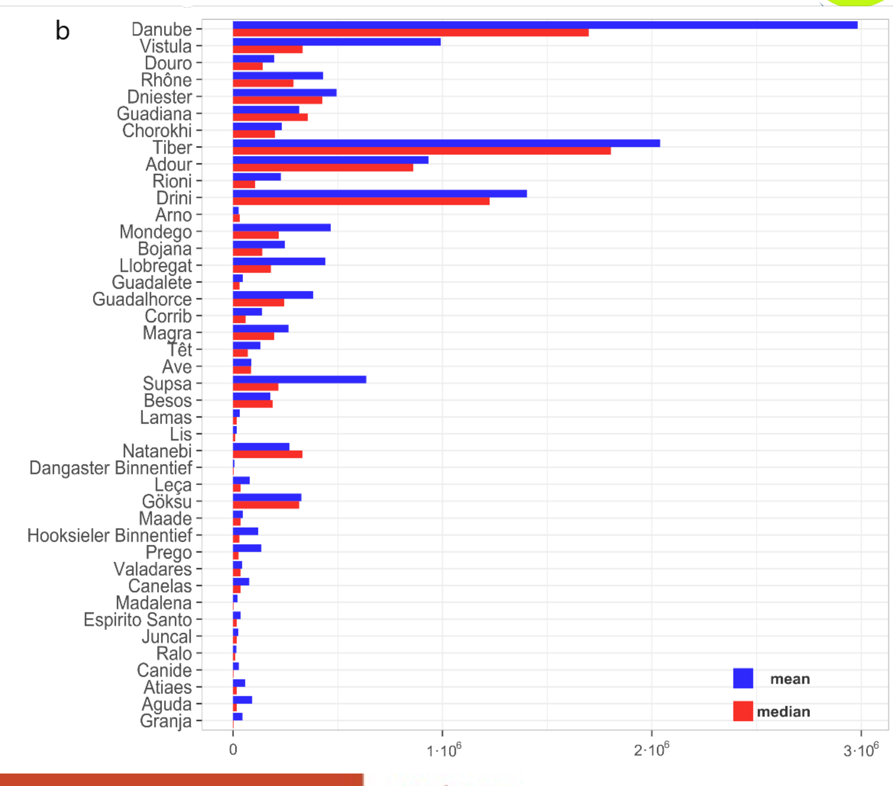
MPs-general

- Macro-Plastics(>2.5 cm),Meso-P (2.5cm-5mm), Micro-P (micro-5mm) Nano-P (1-100 nm)
- Plastikos(Greek)- shaped in various systems
- WWTPs, 1.4 x 10^{15} MPs/year, untreated 3.8x10^{16} MPs/year to water
- 1 cloth=1.900 fibers(washing) 700.000 fibers each complete washing
- 2.4-4.0 million Tonnes/year of land-based plastic waste hit the oceans,
- River litter plastic input into the ocean,
  - 1000 rivers account 80% GLOBAL plastic into ocean
  - GLOBAL input .0.8-2.7 millions Tonnes/year
  - EUROPEAN input, 1.656 -4.997 Tonnes/year (RIMMEL)
- 2050 Macro- and Micro-Plastics will exceed the amount of fish-oceans are connected
- 5.25 trillion plastic particles(0.3-4.7 mm)floating in the ocean
- First paper published plastic in ocean, Carpenter/Smith, *Science*,1972

Floating macro-litter flux (items h^{-1})

Annual floating macro-litter loading (items y^{-1})





ARTICLES
https://doi.org/10.1038/s41893-021-00722-6
nature sustainability

Check for updat

Floating macrolitter leaked from Europe into the ocean

Daniel González-Fernández[1]✉, Andrés Cózar[1], Georg Hanke[2], Josué Viejo[1], Carmen Morales-Caselles[1], Rigers Bakiu[3], Damià Barceló[4,5], Filipa Bessa[6], Antoine Bruge[7], María Cabrera[8], Javier Castro-Jiménez[9,26], Mel Constant[10], Roberto Crosti[11], Yuri Galletti[12],

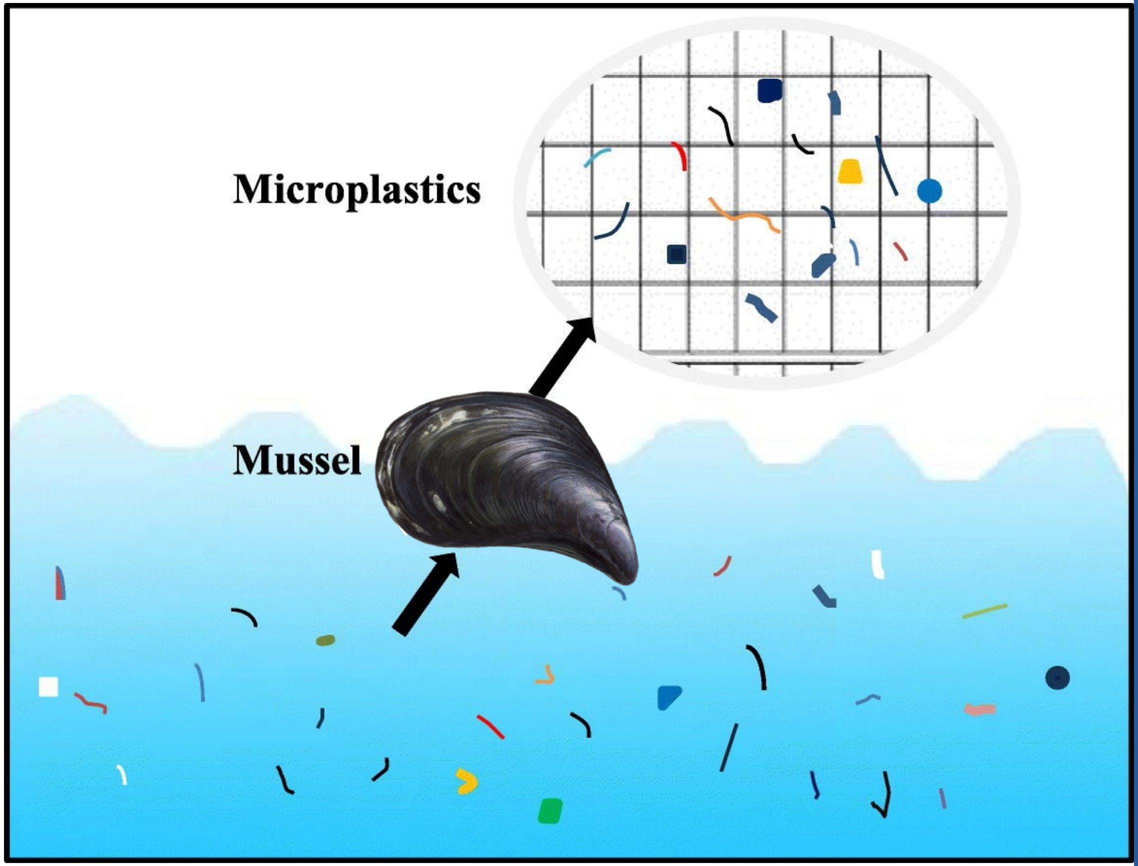
2023

MYTILUS GALLOPROVINCIALIS AS BIOINDICATORS OF MICROPLASTIC POLLUTION

For marine environments, bivalves as *Mytilus galloprovincialis* have been found to be the most suitable organisms for biomonitoring, becoming good bioindicators for their natural habitat (Li et al., 2019).

- *M. galloprovincialis* has a high ecological and commercial relevance in the Mediterranean Sea, where MPs contamination is also of particular concern (Lusher, 2015).

- *M. galloprovincialis* has been proposed by the International Council for the Exploration of the Sea to monitor MP pollution in the marine environment (Bråte et al., 2018).



Advanced treatments for Contaminants of Emerging Concern (CEC), ARG , Microplastics and SARS-CoV-2

GLOBAQUA

- **Membrane technologies** :Membrane bioreactors (MBR),Micro Filtration Nanofiltration/ultrafiltration, Reverse osmosis, RO

- **Eco-friendly- technologies: Algal-based (*Arthrospira maxima*,*Chorella vulgaris*)-Reduction of GHG by Phytocapture**

- **Advanced Oxidation Processes (AOP)**Peroxymonosulfate(PMS)/Fe/UV-C)
- Clay mineral photocatalysis and Nanobiocatalysis

- **ARG removal** :Full scale tertiary WWT by UV-C AOP,Constructed Wetlands
- MOF-Metal Organic Framweworks- a new approach NERC funding?

- **Microplastics** removal: Membrane, Photocatalytic and Microbial Technologies. Applications to **Landfill Leachate**

- **SARS-CoV-2** removal: CAS, Root Zone Treatment, MBR, Disinfection,AOP

idæa CSIC Consejo Superior de Investigaciones Científicas ICRA Institut Català de Recerca de l'Aigua

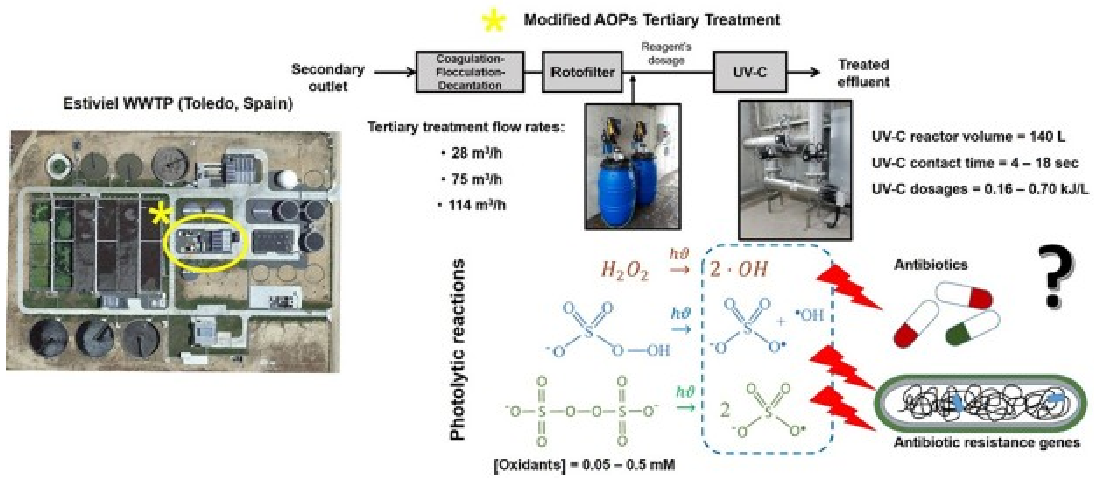
Contents lists available at ScienceDirect

Science of the Total Environment

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

Assessment of full-scale tertiary wastewater treatment by UV-C based-AOPs: Removal or persistence of antibiotics and antibiotic resistance genes?

Jorge Rodríguez-Chueca [a,b], Saulo Varella della Giustina [c], Jaqueline Rocha [d], Telma Fernandes [d], Cristina Pablos [a], Ángel Encinas [e], Damià Barceló [c,f], Sara Rodríguez-Mozaz [c], Célia M. Manaia [d], Javier Marugán [a,*]



- Wastewater treatment by Advanced Oxidation Processes studied at full-scale
- Removal of antibiotic residues and antibiotic resistance genes assessed
- Oxidants photolysis proved more efficient than UV-C alone for antibiotics removal
- Sulfate radical based processes did not improve the ARGs removal reached by UV-C
- Competition between DNA and oxidants for absorption of UV photons is hypothesized

Challenges and Solutions

COVID-19 effects into the environment: Increased amounts of Plastic waste, Antibiotic and other Pharmaceuticals, ARGs and Disinfection Byproducts- THMs

SUP is the largest proportion of plastics, around 40% of 380 Milion Tonnes in 2018 (in 2040 close to 700 million Tons, 340 Milions Tons of SUP).

COVID-19 worse days:129 billion Disposable Masks/Month (Global)= 4 Billions/Day

HYGINE THEATRE: SU Plastic Face Masks, gloves,tiny bottles of sanitizer/ antiseptic, meter high plastic dividers restaurants, Looks Like fight against Pandemic

10-37 g of plastic each PCR diagnostic test, until August 2020, 15,000 Tons of Plastic Waste

Microplastics can be removed by Membrane Technologies as well as by Photocatalytic and Microbial Technologies ,i.e, bacterial-directed-strains and fungal-mediated

Rethinking and re-designing new plastic materials-Biodegradable and Sustainably produced from Non Petrochemical Sources-requires URGENT RESEARCH INPUT

New polymers based on polyactic acid (PLA) and poycaprolone (PCL). Polymer blends maybe more compostable. Today ONLY 2% of the total plastic manufactured is biodegradable TODAY

Constructed Wetlands (CW) with Vertical Subsurface Flow removed ARG varying from 9-11% up to 47-97% depending on the ARG

Microalgae biorreactor combined with **biodigester technology** can be used ofr treatment of swine wastewater, **emnerging contaminants removal,bioplastics, phytocapture CO2**

Pollution prevention: dimmish the use of chemicals, low-dose pharmaceuticals, increasing use of Bio-Plastics, more legislation with monitoring and reconnaissance studies

Chemical cocktails ,nanomaterials (MPs), ARG and pathogens in surface and groundwater and wastewaters, need more treatment