XVII International Estuarine Biogeochemistry Symposium

Book of Abstracts

Portugal

17th to 20th May 2026

https://iebs2026.events.chemistry.pt/

Institutional support

Sociedade Portuguesa de Química

ISTID

UAlg
UNIVERSIDADE DO ALGARVE

DEQ
DEPARTAMENTO DE ENGENHARIA QUÍMICA
TÉCNICO LISBOA

CQE
Química Estrutural

CiMA
Centre for Marine and Environmental Research

IMS

ARNET
AQUATIC RESEARCH NETwork

fct Fundação para a Ciência e a Tecnologia

Edited by the Organising committee

Scientific Committee

Antonio Cobelo-Garcia
Spanish National Research Council (CSIC), SPAIN

Jörg Schäfer
Université de Bordeaux, FRANCE

Dario Omanović
Ruđer Bošković Institute, CROATIA

Duc Huy Dang
Trent University, CANADA

Vanessa Hatje
Universidade Federal da Bahia, BRAZIL
International Atomic Energy Agency, MONACO

Nicolas Layglon
Centre National de la Recherche Scientifique, FRANCE

Andrea Koschinsky
Constructor University, GERMANY

Robert Mason
University of Connecticut, UNITED STATES OF AMERICA

Michael Shields
Texas A&M University, UNITED STATES OF AMERICA

Alexandra Cravo
Centro de Investigação Marinha e Ambiental, Aquatic Research Network, University of Algarve, PORTUGAL

Carlos E. Monteiro
Centro de Química Estrutural, Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (IST-ID), Instituto Superior Técnico, University of Lisbon, PORTUGAL

Local Organising Committee

Carlos E. Monteiro
Centro de Química Estrutural, Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (IST-ID), Instituto Superior Técnico, University of Lisbon

Leonardo Mendes
Sociedade Portuguesa de Química

Alexandra Cravo
Centro de Investigação Marinha e Ambiental, Aquatic Research Network, University of Algarve

Ricardo Bettencourt da Silva
Centro de Química Estrutural, Faculty of Sciences, University of Lisbon

Margarida M. Correia dos Santos
Centro de Química Estrutural, Instituto Superior Técnico, University of Lisbon

Isabel Marrucho
Centro de Química Estrutural, Instituto Superior Técnico, University of Lisbon

Amália Soares
Centro de Química Estrutural, Instituto Superior Técnico, University of Lisbon

Maria Jeremias
Centro de Química Estrutural, Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (IST-ID), Instituto Superior Técnico, University of Lisbon

Camila Tomé
NOVA School of Science and Technology, NOVA University Lisbon

Pietro Civa
Instituto Superior Técnico, University of Lisbon

Conference Programme

Day 0 - Sunday, 17 May 2026

17:30 - 19:30
Welcoming drink at IST Garden, next to the Conference Venue (entrance in IST North gate)

Day 1 - Monday, 18 May 2026

08:30
Registration / Poster installation (Venue)

09:45
Opening session

10:00 KN1
Hermann W. Bange, GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany
Estuarine and coastal biogeochemistry of nitrogen, carbon and sulphur

10:30 OC1
Isotopic tracers of spatio-temporal reactivity of inorganic carbon across the land–sea transition zone (SW Spain)
Eva Capilla Garcia, Ana Sierra Padilla, Jairo Sanchez Rodriguez, Bea Vallejo, Mari Carmen Fernandez Puga, Jesus Forja Pajares, Tedoroa Ortega Diaz

10:45 OC2
CO_2 and CH_4 variability in saltmarshes and mangroves ecosystems along Eastern Australia
Ana Sierra Padilla, Mona A. Andskog, Joanne M. Oakes

11:00 OC3
Sources, drivers and impact of coastal acidification in Ria de Vigo (Rias Baixas, NW Iberian Upwelling System)
Cristina Sobrino, Castro-Olivares., A., Mar Clerencia, Paulo Alcaraz-Rocha, Sara Gómez-Roldán

11:15 **Coffee Break / Posters**

11:45 **OC4**

Development of an unmanned surface vehicle (USV) for monitoring the marine surface microlayer (SML)

Nikolaos Katsikatsos, Aikaterini Sakellari, Theodora Paramana, Georgios Katsouras, Sotirios Karavoltsos

12:00 **OC5**

Sampling the Sea Surface Microlayer: A Comparative Study of Rotating Drum and Glass Plate Methods for Contaminant Characterization

Ana-Marija Cindrić, Veronique Lenoble, Saša Marcinek, Clara Dignan, Benjamin Oursel, Manon Lagarde, Romain Bordenave, Laura Morel, Coraline Mattei, Noah Marko Mesić, Dario Omanović

12:15 **OC6**

Occurrence and distribution of pollutantants in the marine surface microlayer of na intensely industrialized coastal area in the Eastern Mediterranean

Nikolaos Katsikatsos, Aikaterini Sakellari, Dario Omanović, Theodora Paramana, Konstantinos Koukoulakis, Georgios Gkotsis, Sevasti Panagiota Kotsaki, Nikolaos Thomaidis, Evangelos Bakeas, Sotirios Karavoltsos

12:30 **Lunch break**

14:00 **KN2**

Marta Martins, NOVA FCT, Portugal

Aquatic Pollution – From Chemicals to Microplastics: Impacts on Biota and Human Health

14:30 **OC7**

Microplastics in the Portuguese coast

Carla Palma, Matilde São Pedro, Sofia Quendera, José Miguel Almeida, Vanessa Morgado, Ricardo Silva

14:45 **OC8**

The Role of Plastisphere Surface Chemistry in Marine Trace Metal Transport

Romain Bordenave, Tanguy Parinaud, Lolita Bernardi, Ana-Marija Cindrić, Jean-François Briand, Veronique Lenoble, Annick Ortalo-Magné

15:00 **Poster flash talks**

16:00 **Coffee Break / Posters**

16:30 OC9

Optical properties of Organic Matter in tropical estuaries under anthropogenic influence

Fiamma Abreu, Eliete Zanardi Lamardo

16:45 OC10

Irbesartan as a Marker of Pharmaceutical Contamination in Marine Sediments

Mário Mil-Homens, Sara Leston

17:00 OC11

Do Wildfires Trigger Reproductive Toxin Release in Estuaries?

Hannah S. Fitzhugh, Marcos D. Mateus

17:15 - 17:30 Closing for the day and visit to the Terrace - South Tower

Day 2 - Tuesday, 19 May 2026

08:55	Meeting at IST chairs just aside the conference building, (IST West entrance)
09:00	Leave to Sintra by bus
10:00	Team building activity – Visit Sintra
12:30	Lunch
14:30	Leave Sintra by bus to the Alcântara recreational dock
15:30	Boat trip in the Tagus estuary on board the Tall Ship
17:30	Returning to IST by bus
20:00	Conference dinner with typical Portuguese 'petiscos', drinks and Fado, at the Associação de Fado Casto

Day 3 - Wednesday, 20 May 2026

09:30 KN3

Huy Duc Hang, Trent University, Canada

Critical minerals: a central role in the green transition, but also a fragmented understanding of their biogeochemistry in transitional environments

10:00 OC12

Current understanding of copper redox speciation in estuarine waters: The example of Krka River estuary

Dora Crmarić, Saša Marcinek, Ana-Marija Cindrić, Dario Omanović, Elvira Bura-Nakić

10:15 OC13

In situ monitoring of the diurnal cycling of bioavailable mercury(II) in a stratified estuary

M.-L. Tercier-Waeber, L. Maloriol, D. Omanović, A.-M. Cindrić, A. Rodrigues, L.-E. Heimburger-Boavida

10:30 OC14

Reactive dissolved nickel distribution in the Northwest Brazilian Continental Shelf: high versus low river discharge periods and the specific role of mangrove forests

Cristian H. Krause, Nico Fröhberg, Leandro M. de Carvalho, Alexandre B. Schneider, Andrea Koschinsky

10:45 OC15

Biogeochemical processes and fluxes of trace metals from the Amazon-Pará river system and the mangrove belt into the Atlantic: high and low discharge conditions compared

Andrea Koschinsky, Adrian Hollister, Caitlyn Kelly, Alexandre B. Schneider, Nico Fröhberg, Cristian H. Krause, Leandro M. de Carvalho

11:00 Coffee Break / Posters

11:30 OC16

Implications of REE speciation in soil–plant seagrass meadows

Ingrid CM Sena, Lais A Souza, Vanessa Hatje

11:45 OC17

Geochemical Behavior and Fractionation of Rare Earth Elements Along the Stratified Krka River Estuary

Saša Marcinek, Justin Auther, Ana-Marija Cindrić, Dario Omanović

12:00 OC18

Anthropogenic gadolinium: an emerging contaminant or an environmental monitoring tool?

Patrícia Gaspar, Pedro Brito

12:15 OC19

Tracing Gadolinium Anomalies in the Vigo Ria (NW IBERIAN PENINSULA): Experimental Insights from Gadolinium-Based Contrast Agents (GBCAs)

Clara Mendoza Segura, Antonio Cobelo García

12:30 OC20

Contrasting redox pathways of platinum mediated by natural organic matter and microorganisms

Justine Le Doaré, Marc Benedetti, Aurore Gorlas, François Guyot, Alexandre Gelabert, Gautier Landrot, Rémi Marsac, Charlotte Catrouillet

12:45 OC21

Preliminary study on tellurium redox speciation in pristine and industrially impacted estuaries

Lucija Knezevic, Andrea Koschinsky

13:00 Lunch break

14:30 KN4

Pedro Morais, University of Texas Marine Science Institute, USA

Biological Invasions and Estuarine Biogeochemistry

15:00 OC22

Spatial and Temporal Dynamics of the Phytoplankton Community in the Sado Estuary

Joana P. Cruz, Joshua Alexander Heumüller, Beatriz Biguino, Filipa Afonso, Carlos Borges, Carla Palma, Ana Cristina Brito

15:15 OC23

Tracking Changes in Portuguese Estuaries: the CoastNet Perspective

Rui Cereja, Joana P. C. Cruz, Luciane Favareto, Carlos Alexandre, Helena Adão, Bernardo Quintella, Paula Chainho, Susana França, José L. Costa, Ana C. Brito

15:30 OC24

From Data to Protection: High-Resolution Monitoring Supporting Bivalve Aquaculture in Ria Formosa

Alexandra Cravo, Erwan Garel, José Jacob, Ernestina Rodrigues, Marta Rodrigues

15:45 OC25

Seasonal hydrographic structure and nutrient dynamics in the Zrmanja River Estuary

Neven Cukrov, Dora Crmarić, Tomislav Bulat, Marin Lovrić, Ante Šiljeg

16:00 OC26

Evidence for intense benthic-pelagic coupling in the Galician rías

J. Severino P. Ibánhez, Esther Barber-Lluch, Carolina Gil-Lozano, Pablo Álvarez Chaver, Christian Martín Moreira, Silvia Torres López, Nicolás Villacieros-Robineau

16:15 Coffee Break / Posters

16:45 OC27

Biogeochemical Interactions and Dynamics in Metal-Contaminated Estuarine Sediments

M. Dolores Basallote, Eva Pakostova, Carmen Neculita, Saša Marcinek, Julián Blasco, Carlos R. Cánovas

17:00 OC28

Long-term variation in trace metals concentrations in the sediments of Sado estuary (Portugal) (1986-2020)

José Miguel Almeida, Carla Palma, Pedro M. Félix, Ana C. Brito

17:15 OC29

High-resolution spatial distributions of toxic metals within intertidal mudbanks of a contaminated estuary (Aulne, Bay of Brest)

Loïc Madec, Matthieu Waeles, Jérôme Goslin, Nicolas Briant

17:30 Closing session (Venue)

Posters / Flash talks

P01 Greenhouse gases variability and emissions in different coastal systems of SW Iberian Peninsula - Ana Sierra Padilla

P02 Isotopic composition of dissolved inorganic carbon in coastal sediment porewater: a methodological approach - Ana Sierra Padilla

P03 Characterization of dissolved organic matter in the La Paz coastal lagoon, BCS, Mexico - Elvia Sánchez-Pérez

P04 Tidal effects on water quality and phytoplankton communities in the Sado Estuary - Rui Cereja

P05 Ecological status assessment based on dissolved nutrients and phytoplankton in the Sado Estuary (2018–2023) - Joana Cruz

P06 Seasonal–tidal forcing of hydrographic and oxygen dynamics in a tropical estuary – Bons Sinais (Mozambique) - Alexandra Cravo

P07 Antifouling booster biocides in sediments of tropical estuaries in Pernambuco, Brazil - Fiamma Abreu

P08 Assessment of plastic pollution in Namibe Bay, Angola - Bernardo Malongo José

P09 Identification and characterisation of microplastics in environmental matrices (water, biota and beach sediment) of Namibe Bay, Angola - Bernardo Malongo José

P10 Removal of per- and polyfluoroalkyl substances (PFAS) by biochar derived from marine plastic litter - Antonio Cobelo-García

P11 Effects of co-exposure to microplastics and mercury on the estuarine amphipod Gammarus locusta - Marta Martins

P12 Mercury contamination in surface sediments of the southwestern Portuguese continental shelf: implications for good environmental status - Mário Mil-Homens

P13 Metal distribution and contamination from abandoned W–Sn mining in sediments of the Ria de Muros (NW Iberian Peninsula) - Ricardo Prego

P14 Behaviour and distribution of redox-sensitive elements (V, U, Mo) in sediments of the Krka River Estuary (Croatia) - Nuša Cukrov

P15 Recording the Anthropocene: trace metal fingerprints in the Tagus prodelta - Mário Mil-Homens

P16 Fluvial and wastewater fluxes of dissolved and particulate silicon to the Ria de Vigo (NW Iberian Peninsula) - Ricardo Prego

P17 Rare earth elements patterns as tracers of geochemical processes in subterranean estuaries (Pontevedra Ria, NW Iberian Peninsula) - Lucie Rieunau

P18 Rare earth elements as a tool to identify bivalve production areas - Miguel Caetano

P19 Rare earth element accumulation in polychaetes across different feeding strategies - Ingrid Sena

P20 Cisplatin in ecotoxicological research: analytical challenges in aquatic systems – Carlos Monteiro

P21 A revised guide to quantify platinum-group elements in the environment – Maria Jeremias

Keynote Speakers

Prof. Dr. Hermann W. Bange

Marine Biogeochemistry Res. Div.

GEOMAR Helmholtz Centre for Ocean Research Kiel

Kiel, Germany

Hermann W. Bange is a chemical oceanographer at the GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany. Since 2001, he is heading the working group ‘Biogeochemistry of Trace Gases’ at GEOMAR. His research interests include trace gas cycling and emissions as well as the biogeochemistry of the nitrogen, sulfur, and carbon cycles in the open and coastal oceans. His group is operating world-wide and takes part in campaigns to all major ocean basins. Moreover, he is the coordinator of the Boknis Eck coastal time series station which is located in Eckernförde Bay (SW Baltic Sea).

KN1

ESTUARINE AND COASTAL BIOGEOCHEMISTRY OF NITROGEN, CARBON AND SULPHUR

Hermann W. Bange[1]

[1] Marine Biogeochemistry, GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany
hbange@geomar.de

Abstract: Estuarine systems and coastal regions play important roles in the global biogeochemical cycles of nitrogen, carbon and sulphur. These regions are especially affected by ongoing environmental and climate changes such as warming, eutrophication, deoxygenation, acidification and pollution which, in turn, will alter coastal biogeochemical cycles and ecosystems. The associated cycling of climate-relevant trace gases such as nitrous oxide (N_2O), methane (CH_4), and dimethyl sulphide (DMS) is also affected by ongoing environmental and climate changes. Here I will present case studies of biogeochemical cycling of nitrogen, carbon and sulphur from various estuaries and coastal regions (such the Baltic Sea). Moreover, I will illustrate their important roles as hotspots of trace gas cycling in changing coastal oceans. In order to assess the consequences of short- and long-term trends in coastal biogeochemical cycles for human well-being, the need to establish and maintain coordinated and sustained global monitoring networks is obvious.

Keywords: Coastal regions, Trace gases, Nitrogen cycle, Carbon cycle, Sulphur cycle

Prof. Dr. Marta Martins

NOVA University of Lisbon, School of Science and Technology (FCT NOVA)

MARE – Marine and Environmental Sciences

Monte da Caparica, Portugal

Marta Martins (MM) holds a PhD in Environmental Sciences and is currently an Associate Professor at the Faculty of Science and Technology of NOVA University Lisbon (NOVA FCT), where she teaches in the areas of Marine Ecology, Ecotoxicology, Aquatic Pollution, and Environmental Risk Assessment at both undergraduate and master's levels in Environmental Engineering. She is also a lecturer in the Master's Program in Marine Living Resources: Science, Technology, and Society, which she coordinated until August 2025 and member of the Scientific Committee of the Doctoral Program in Environment and Sustainability at NOVA FCT. She is certified by FELASA with the Laboratorial Animal Science level C for directing animal experiments and has a course on Applied In Vitro Toxicology by ESTIV and ASCCT.

Marta Martins is coordinator of the research group MARlab – Marine Research and Environmental Risk Lab, part of the Marine and Environmental Sciences Centre (MARE). She leads the research line on Ecotoxicology and Environmental Risk Assessment, dedicated to studying the ecotoxicological effects of interactions between emerging pollutants (ranging from chemicals to nano- and microplastics) and to developing or reformulating monitoring and risk assessment strategies for Environmental and Human Health protection.

She has published extensively in these fields, has participated in and coordinated several national and international projects, and has supervised young scientists, postdoctoral researchers, and PhD and master's students. She is also member of the SETAC Association and SETAC Education Committee, from 2019.

AQUATIC POLLUTION – FROM CHEMICALS TO MICROPLASTICS: IMPACTS ON BIOTA AND HUMAN HEALTH

Marta Martins[1]

[1] NOVA University of Lisbon, School of Science and Technology (FCT NOVA), MARE – Marine and Environmental Sciences
marta.martins@fct.unl.pt

Abstract: The seminar entitled *"Aquatic Pollution – From Chemicals to Microplastics: Impacts on Biota and Human Health"* will examine the contamination of aquatic environments, such as estuaries and coastal areas, by chemical pollutants and microplastics. It will address the sources, environmental fate, and persistence of these contaminants, with emphasis on organic compounds such as persistent organic pollutants (POPs) and their interactions with microplastics.

The seminar will explore the impacts on aquatic biota, including uptake, bioaccumulation, and trophic transfer, as well as potential risks to human health. Finally, it will consider mitigation strategies, including policy measures and societal actions aimed at reducing pollution and promoting sustainable management of aquatic ecosystems.

Keywords: Ecotoxicology, Risk assessment, Organic pollutants, Plastic pollution

Prof. Dr. Huy Dang

School of the Environment, Trent University

Co-Director, International Institute for Environmental Studies

Peterborough, Canada

Dr. D. Huy Dang is an Associate Professor of Environmental Chemistry at Trent University and serves as co-director of the International Institute for Environmental Studies. His research focuses on understanding the biogeochemical complexities of integrated ecosystems by investigating elemental cycles from both natural and human sources.

CRITICAL MINERALS: A CENTRAL ROLE IN THE GREEN TRANSITION, BUT ALSO A FRAGMENTED UNDERSTANDING OF THEIR BIOGEOCHEMISTRY IN TRANSITIONAL ENVIRONMENTS

Huy Dang[1]

[1] School of the Environment, Trent University
huydang@trentu.ca

Abstract: The global green transition is crucial for tackling the climate crisis, in which critical minerals play an important role, especially in sectors like renewable energy and electric vehicles. However, the biogeochemistry of these natural resources is not well understood, particularly at environmental interfaces between systems, such as from small reactive surfaces to large-scale continent-ocean transitions, as well as between disciplines of chemistry, geology, and biology. This lack of understanding results in an incomplete perspective on their environmental fate and impacts, hampers the development of environmental guidelines and regulations, and creates significant challenges in understanding their role in ecosystems.

Drawing on our research in Canada, France, and Vietnam, this talk examines key challenges in studying the biogeochemistry of critical minerals and highlights examples of biogeochemical processes affecting rare earth elements and platinum group elements in rivers, estuaries, mangroves, and contaminated bays.

Keywords: Technology-critical elements, Biogeochemical processes, Ecosystem contamination

Dr. Pedro Morais

University of Texas Marine Science Institute

Austin, USA

Pedro Morais, Ph.D., works for the University of Texas Marine Science Institute as an Estuarine Ecologist and has over 25 years of experience studying diverse taxa in all types of aquatic ecosystems in temperate regions. He holds degrees from the University of Algarve, Portugal (Marine Biology and Fisheries, 2000; Ph.D. in Ecology, 2008), and conducted postdoctoral research in Portugal, Czechia, and the United States at the University of California, Berkeley. His research has mostly focused on identifying how river flow modulates estuarine functioning and connectivity. He also investigates the mechanisms underpinning fish life history plasticity and the impact of biological invasions on the functioning of estuarine ecosystems. Dr. Morais has a vast editorial experience and contributes to instill the love for science and biodiversity in younger generations, by serving as the Biodiversity Specialty Chief Editor for Frontiers for Young Minds. His contributions to science mentoring and outreach earned him the 2024 Outstanding Educator Award from the Coastal and Estuarine Research Federation. He has published over 70 research articles and book chapters, edited several special issues, and published the book An Introduction to Fish Migration. Dr. Morais also sits on the board of the California Estuarine Research Society and the Coastal and Estuarine Research Federation, and associate editor of Estuaries and Coasts.

KN4

BIOLOGICAL INVASIONS AND ESTUARINE BIOGEOCHEMISTRY

Pedro Morais[1]

[1] University of Texas Marine Science Institute
pedro.morais@austin.utexas.edu

Abstract: Biological invasions are reshaping estuarine ecosystems worldwide, with consequences that extend far beyond changes in biodiversity. After clarifying the distinction between non-indigenous and invasive species, the talk highlights the traits that promote invasion success, including broad environmental tolerance, rapid reproduction, propagule pressure, and ecosystem engineering. This presentation examines how aquatic and riparian invaders transform estuarine biogeochemical processes by altering carbon storage, nutrient cycling, oxygen dynamics, sediment stability, and benthic-pelagic coupling. Overall, the talk presents biogeochemistry as a unifying framework for understanding the impacts of biological invasions in estuarine environments.

Keywords: Invasive Species, Biodiversity, Ecosystem Functioning, Ecology

Oral Communications

OC01

ISOTOPIC TRACERS OF SPATIO-TEMPORAL REACTIVITY OF INORGANIC CARBON ACROSS THE LAND–SEA TRANSITION ZONE (SW SPAIN)

E. Capilla*[1], A. Sierra[1], J. Sánchez-Rodríguez[1], B. Vallejo[1], M.C. Fernandez-Puga[2], J. Forja[1], and T. Ortega[1]

[1] Department of Chemistry-Physics, Marine Research Institute (INMAR), University of Cádiz, Cádiz, SPAIN.
eva.capilla@uca.es
[2] Department of Earth Sciences, Marine Research Institute (INMAR), University of Cádiz, Cádiz, SPAIN.

Abstract:. The analysis of the stable carbon isotopic composition of dissolved inorganic carbon (δ^{13}C-DIC), provides valuable insights into the sources and removal pathways of DIC, which represent the main carbon pool in natural waters. Thereby enhancing our understanding of the biogeochemical processes that regulate carbon dynamics in aquatic ecosystems. This study was conducted in several coastal systems of the southwestern of the Iberian Peninsula across different seasons (summer and winter). Taking Guadalete estuary as an example, DIC concentration increased from 2500 µmol kg^{-1} in the most marine zone to 5100 µmol kg^{-1} in the inner region of the systems. Measurements of δ^{13}C-DIC were conducted using a water-gas equilibration system coupled to an Isotope Ratio Mass Spectrometer (IRMS). A significant δ^{13}C-DIC decrease along the salinity gradient has been found in the studied systems. Values were close to 0 ‰ at the mouth and ranged between -2.9 -10.8 ‰ in the inner zone depending on the system. The observed seasonal variations were less significant than the longitudinal variations. Mixing model was applied to assess the relative contributions of primary production, organic matter degradation, CO_2 outgassing, and $CaCO_3$ dissolution to the variability of δ^{13}C-DIC values. The results emphasize the need for precise δ^{13}C-DIC characterization to better understand carbon cycling in estuarine environments and demonstrate the value of this parameter for future studies.

Keywords: DIC, Carbon isotope, Coastal waters, SW Iberian Peninsula.

Acknowledgments: E. Capilla was financed by the Spanish Ministry of Education with a FPI fellowship and A. Sierra by Junta de Andalucia/CUII and FSE+ under contract DG_POST_2024_00087. This work was supported by research projects FEDER-UCA-2024-A1-45 and PID2023-150230NB-C21, and by stable isotope marine laboratory of Instituto Universitario de Investigaciones Marinas (INMAR) (EQC2021-007548-P).

OC02

CO_2 AND CH_4 VARIABILITY IN SALTMARSHES AND MANGROVES ECOSYSTEMS ALONG EASTERN AUSTRALIA

A. Sierra-Padilla[*1,2], M. A. Andskog[2], and J. M. Oakes[2]

[1] Department of Chemistry-Physics, Marine Research Institute (INMAR), University of Cádiz, Cádiz, SPAIN.
ana.sierra@uca.es
[2] Faculty of Science and Engineering, Southern Cross University, Lismore (NSW), AUSTRALIA.
mona.andskog@scu.edu.au, Joanne.Oakes@scu.edu.au

Abstract: Saltmarshes and mangroves are highly productive coastal ecosystems that provide valuable ecosystem services such as high rates of carbon sequestration and nitrogen removal. However, their global coverage is in decline, mainly due to deforestation and changes in land use. Despite their capacity for C storage and N removal, these habitats have been documented as a source of CO_2, CH_4 and N_2O to the atmosphere (e.g. Murray et al., 2018; Rosentreter et al., 2018). In 2023, saltmarsh and mangrove sites on the east coast of Australia (NSW) were studied during daytime and nighttime periods. Samples were collected along longitudinal transects that covered saltmarshes, mangroves and transitional zones between the two habitats. pCO_2, CH_4 and their stable isotopes ($\delta_{13}C$-CO_2 and $\delta_{13}CCH_4$) were analysed with a Cavity-Ring-Down-Spectroscopy (CRDS) analyser (Picarro, G2201-i) using soil respiration chambers installed in the ground at each of the three zones. Moreover, sediment samples were also collected to measure $\delta_{13}C$, $\delta_{15}N$, %C, %N, chlorophyll a, organic matter content, porosity and grain size. $\delta_{13}C$ and $\delta_{15}N$ were measure using an elemental analyser (Flash EA, Thermo Fisher) coupled to an IRMS (Delta V plus, Thermo Fisher). The three habitats exhibited distinct mean values of $\delta_{13}C$ and $\delta_{15}N$, respectively: -19.6 ± 0.9 and 3.4 ± 1.5 ‰ in saltmarsh; -24.3 ± 2.4 and 2.7 ± 1.3 ‰ in mangrove; and -20.9 ± 1.5 and 3.9 ± 0.8 ‰ in transitional zone. Overall, pCO_2 ($\delta_{13}C$-CO_2) ranged between 418 – 1490 ppm (-19 to -10‰), while CH_4 ($\delta_{13}C$-CH_4) between 1.9 – 2.2 ppm (-58 to -39‰). The results show slight differences between habitats and throughout the diel cycle, with CH_4 exhibiting the greatest variations during the day, while CO_2 does at night. The transition zone is influenced by mangroves and saltmarshes, emphasising the significance of investigating these coastal habitats in the current context of climate change.

Keywords: Carbon dioxide, Methane, Carbon stable isotopes, Saltmarshes, Mangroves

Acknowledgments: A. Sierra was financed under contract Margarita Salas by the Spanish Ministry of universities and European Union-NextGenerationEU and by Junta de Andalucia/CUII and FSE+ under contract DG_POST_2024_00087. This research was supported by the Australian Research Council Discovery Project DP200100546.

References:

Murray, R., Erler, D., Rosentreter, J., Maher, D., & Eyre, B. (2018). A seasonal source and sink of nitrous oxide in mangroves: Insights from concentration, isotope, and isotopomer measurements. Geochimica et Cosmochimica Acta, 238, 169–192. https://doi.org/10.1016/j.gca.2018.07.003

Rosentreter, J. A., Maher, D. T., Erler, D. v., Murray, R., & Eyre, B. D. (2018). Factors controlling seasonal CO_2 and CH_4 emissions in three tropical mangrove-dominated estuaries in Australia. Estuarine, Coastal and Shelf Science, 215, 69–82. https://doi.org/10.1016/j.ecss.2018.10.003

OC03

SOURCES, DRIVERS AND IMPACT OF COASTAL ACIDIFICATION IN RÍA DE VIGO (RÍAS BAIXAS, NW IBERIAN UPWELLING SYSTEM)

C. Sobrino*[1], A. Castro-Olivares[1,2], M. Clerencia[1], P. Alcaraz-Rocha[1,3], and S. Gómez-Roldán[1]

[1] University of Vigo, Vigo, SPAIN
sobrinoc@uvigo.es, mar.clerencia.izquierdo@uvigo.gal, sara.gomez.roldan@alumnado.uvigo.gal
[2] Centre for Environmental and Marine Studies (CESAM), University of Aveiro, Aveiro, PORTUGAL
adrian.castro@uvigo.gal
[3] Spanish Institute of Oceanography, A Coruña, SPAIN
lalcaraz@uvigo.gal

Abstract: The Rías Baixas are four coastal embayments in the western coast of Galicia (NW Spain) that harbor large fishing and shellfish activities and support the highest mussel production in Europe. Wind-driven upwelling that is common along the eastern boundary of the North Atlantic (10ºN-40ºN, Iberian Upwelling System) determines the response of the microbial plankton community and is responsible for the pelagic net autotrophic behavior of this ecosystem throughout the year. Nowadays, Rías Baixas are sensitive to the anthropogenic pressure generated by industry, aquaculture, tourism and wastewater treatment plants. Climate change factors such as upwelling intensity, precipitation and the increase in atmospheric CO_2 can also affect coastal acidification. Hydrographic profiles and samples for the determination of pH, dissolved inorganic carbon (DIC) and pCO_2, as well as samples for the assessment of the phytoplankton abundance, community structure and metabolism, were collected throughout a longitudinal transect early morning during low tide in Ría de Vigo, the southest and more populated embayment, from October 2019 to February 2020 and during April 2023- April 2024. Results showed that CO_2 concentration decreased from the inner shallow coastal stations to the deeper stations at the mouth (maximum of ~5400 ppmv in January 2020) and was regulated by wind-driven circulation as well as the intrusion of freshwater. In contrast, pH showed an opposite pattern to pCO_2 and revealed acid values at the inner stations, which aligned with values below the aragonite saturation state during extreme rainfall events. Freshwater intrusion was consistent with decreases in salinity and DIC but also phytoplankton biomass and photosynthetic efficiency, leading to massive bivalve mortality in Ría de Vigo. The results explain that both, upwelling intensity and precipitation arise as important drivers of coastal acidification in Rías Baixas, being the freshwater discharge the most impacting stressor for the socioeconomic activities in the area.

Keywords: Ría de Vigo, Coastal acidification, pH, CO_2, Freshwater discharge, Phytoplankton

DEVELOPMENT OF AN UNMANNED SURFACE VEHICLE (USV) FOR MONITORING THE MARINE SURFACE MICROLAYER (SML)

Nikolaos Katsikatsos[1], Aikaterini Sakellari[1], Theodora Paramana[1], Georgios Katsouras[2], and Sotirios Karavoltsos*[1]

[1] Laboratory of Environmental Chemistry, Department of Chemistry, National and Kapodistrian University of Athens, Athens, GREECE.
skarav@chem.uoa.gr, *esakel@chem.uoa.gr, nikkatsi@chem.uoa.gr, tparaman@geol.uoa.gr*
[2] Athens Water and Sewerage Company S.A (E.Y.D.A.P.), Athens, GREECE.
gekats@eydap.gr

Abstract: The sea surface microlayer (SML) constitutes a biogeochemical interface, critical for air-sea exchange processes. However, potential dilution from subsurface water layers, susceptibility to contamination, laboring and time-consuming procedures make its sampling challenging. To overcome such limitations, a research unmanned surface vehicle (USV) was designed, developed and operationally validated herewith. The USV of catamaran-type is equipped with a sampling system, consisting of rotating glass discs for SML sampling and a peristaltic pump for subsurface water (SSW) collection. Difficulties characterizing marine monitoring within coastal environments either, constrained, shallow or hard to access by larger research vessels, are eliminated by this design, also permitting high-resolution spatial mapping. The USV operational performance was evaluated through field validation sampling campaigns and the efficiency of the system was assessed in terms of established manual sampling techniques, specifically the Harvey and Burzell glass plate and the Garrett mesh screen. The results obtained highlight the effectiveness of autonomous platforms in achieving reliable, low-contamination SML sampling, emphasizing their suitability for broader use in marine biogeochemical research demanding high resolution and minimally disturbed interface measurements.

Keywords: Sea surface microlayer, Unmanned surface vehicle, Sampling, Water quality

Acknowledgments: This project is carried out within the framework of the National Recovery and Resilience Plan Greece 2.0, funded by the European Union-Next Generation EU (Implementation body: H.F.R.I.).

References

Katsikatsos, N., Sakellari, A., Paramana, T., Katsouras, G., Koukoulakis, K., Bakeas, E., Mavromatis, N., Xenakis, T., Ntourntoureka, A., Karavoltsos, S. (2026). InterSeA: An Unmanned Surface Vehicle (USV) for Monitoring the Marine Surface Microlayer (SML) in Coastal Areas. Journal of Marine Science and Engineering, 14(2), 233.

Shinki, M., Wendeberg, M., Vagle, S., Cullen, J.T., Hore, D.K. (2012). Characterization of Adsorbed Microlayer Thickness on an Oceanic Glass Plate Sampler. Limnology and Oceanography: Methods, 10, 728–735.

SAMPLING THE SEA SURFACE MICROLAYER: A COMPARATIVE STUDY OF ROTATING DRUM AND GLASS PLATE METHODS FOR CONTAMINANT CHARACTERIZATION

Ana-Marija Cindrić*[1], Veronique Lenoble[2], Saša Marcinek[1], Clara Dignan[2], Benjamin Oursel[3], Manon Lagarde[2], Romain Bordenave[2], Laura Morel[3], Coraline Mattei[3], Noah Marko Mesić1[1,4], and Dario Omanović[1]

1Ruđer Bošković Institute, Center for marine and environmental research, Zagreb, Croatia.
ana-marija.cindric@irb.hr; veronique.lenoble-garnier@univ-tln.fr
2Université de Toulon, Aix Marseille Univ., CNRS, IRD, MIO, Toulon, France
3Aix Marseille Univ., Université de Toulon, CNRS, IRD, MIO, Marseille, France
4Faculty of Electrical Engineering and Computing, Zagreb, Croatia

Abstract: The sea surface microlayer (SML), a thin interfacial layer at the ocean-atmosphere boundary, is characterized by unique physicochemical properties, making it a critical zone with potentially elevated concentrations of various contaminants (e.g., trace elements, organic matter, and microplastics (MPs). Environmental factors such as waves, wind, and solar radiation, together with microbial processes and photodegradation, influence their intraday distribution and dynamics, which remain largely unexplored.

This study aimed to quantify various contaminants (trace elements - including rare earth elements (REEs), microplastics, and organic matter) in the SML and the underlying water layer (UWL) over 24-hour cycles in the Krka River estuary (Šibenik, Croatia), a semi-enclosed Adriatic area characterized by limited water circulation and localized anthropogenic pressure. Results obtained using two SML sampling methods, a rotating drum sampler and a glass plate, were compared in order to evaluate the preferential sampling approach for specific or multiple contaminant groups.

Samples were collected at 3-hour intervals using both devices. For each sampling method, at least 0.8 L of sample was collected. While up to 15 minutes were sufficient to collect 1 L of SML using the rotating drum, sampling with the glass plate was considerably slower and more physically demanding, requiring at least 45 minutes per liter. Subsurface water was collected at approximately 0.3 m depth. Samples were filtered through 0.45 μm cellulose nitrate membranes (Sartorius), preserved when necessary, and stored appropriately until analysis. High-resolution microscopy was used to identify and classify particles based on their shape, size, and colour, while polymer type determination is planned for subsequent analysis. Trace elements were determined either by stripping voltammetry or by a preconcentration technique (NOBIAS Chelate PA-1 resin) followed by ICP-MS analysis. Dissolved organic carbon (DOC) was measured using the high-temperature catalytic oxidation method (Shimadzu TOC-L), whereas the optical properties of dissolved organic matter were characterized by spectrophotometry and fluorometry.

The results revealed distinct accumulation patterns and contaminant-specific enrichments in the SML, which varied depending on both the sampling method applied and the type of contaminant analysed.

Keywords: Sea surface microlayer, Microplastics, Trace elements, Rotating drum, Glass plate

OC06

OCCURRENCE AND DISTRIBUTION OF POLLUTANTS IN THE MARINE SURFACE MICROLAYER OF AN INTENSELY INDUSTRIALIZED COASTAL AREA IN THE EASTERN MEDITERRANEAN

Nikolaos Katsikatsos*[1], Aikaterini Sakellari[1], Dario Omanović[2], Theodora Paramana[1], Konstantinos Koukoulakis[1], Georgios Gkotsis[1], Sevasti Panagiota Kotsaki[1], Nikolaos Thomaidis[1], Evangelos Bakeas[1], and Sotirios Karavoltsos[1]

[1] Department of Chemistry, National and Kapodistrian University of Athens, Athens, GREECE.
nikkatsi@chem.uoa.gr, esakel@chem.uoa.gr, tparaman@geol.uoa.gr, kkoukoulakis@chem.uoa.gr, geogkotsis@chem.uoa.gr, skotsak@chem.uoa.gr, ntho@chem.uoa.gr, bakeas@chem.uoa.gr, skarav@chem.uoa.gr
[2] Department for Marine and Environmental Research, Ruđer Bošković Institute, Zagreb, CROATIA.
omanovic@irb.hr

Abstract: The occurrence and distribution of priority pollutants (PPs) and emerging contaminants (ECs) are investigated in the marine surface microlayer (SML) of Elefsis Bay, Greece, an area continuously impacted by industrial discharges, wastewater treatment plant (WWTP) effluents and maritime traffic. Six coastal sampling sites were selected near significant hotspots, representing different microenvironments and degrees of anthropogenic pressure. Paired SML and subsurface water (SSW) samples were collected from each site with the use of an unmanned surface vehicle (USV). Analytes investigated include trace metals (Cd, Co, Cr, Cu, Mn, Ni, Pb and Zn), copper complexing capacity (L_{Cu}), sixteen US EPA priority controlled polycyclic aromatic hydrocarbons (PAHs) and various organic micropollutants through a wide-scope target screening of more than 2500 semi-polar to polar LC-amenable ECs, by applying a LC-TIMS-HRMS. The results obtained reflect a long-term chemical load of the study area. Higher PAHs levels detected only in SML demonstrate an oil leakage in part of the coastal zone. Over 100 organic analytes were determined, including pharmaceuticals, plant protection products, per- and polyfluoroalkyl substances (PFASs). Detected substances were prioritized according to their persistent, bioaccumulative and toxic properties, as well as EU legislation values (where applicable).

Keywords: Marine Surface Microlayer, Coastal Monitoring, Priority Pollutants, Emerging Contaminants

Acknowledgments: This project is carried out within the framework of the National Recovery and Resilience Plan Greece 2.0, funded by the European Union-Next Generation EU (Implementation body: H.F.R.I.).

References:

Wurl, O., Obbard, J.P. (2004). A Review of Pollutants in the Sea-Surface Microlayer (SML): A Unique Habitat for Marine Organisms. Marine Pollution Bulletin, 48, 1016–1030.

OC07

MICROPLASTICS IN THE PORTUGUESE COAST

Carla Palma*[1], Matilde São Pedro[1], Sofia Quendera[2], José Miguel Almeida[1], Vanessa Morgado[3], and Ricardo Silva[4]

[1] Instituto Hidrográfico, Lisboa, Portugal.
Matilde.SaoPedro@hidrografico.pt,*vaz.almeida@hidrografico.pt, carla.palma@hidrografico.pt*
[2] Célula de Inovação e Experimentação Operacional de Sistemas Não Tripulados-CEOV, Base Naval de Lisboa, Portugal
Sofia.isabel.quendera@marinha.pt
[3] Laboratório Nacional de Energia e Geologia, Lisboa, Portugal
vmmorgado@fc.ul.pt
[4] Faculdade de Ciências da Universidade de Lisboa, Portugal
rjsilva@ciencias.ulisboa.pt

Abstract: Microplastics—plastic particles smaller than 5 mm—have emerged as ubiquitous pollutants in marine and coastal environments worldwide. Among the diverse types of microplastics, polyethylene (PE) and polypropylene (PP) are the most prevalent in surface waters and sediments due to their extensive production, widespread use in packaging, and low density, which favours their transport and accumulation across distinct environmental compartments, such as along shorelines. Understanding the sources, distribution, and impacts of these microplastics is crucial for designing effective mitigation strategies and protecting coastal and marine ecosystems. The Moniaqua project aims to environmentally characterise sensitive areas through the collection of sediment and water samples for the analysis of physicochemical parameters and microplastics. This work presents the results of three sampling campaigns conducted in 2023, 2024, and 2025, during which approximately 140 water samples were collected between Cabo Espichel and Vila Nova de Milfontes, Sines and Vila Real de Santo António, and along the West Coast between Sesimbra and Vila Nova de Milfontes. Water samples were analysed using filtration, optical microscopy, and micro-Fourier transform infrared spectroscopy (micro-FTIR). Overall, microplastics concentrations were generally low (range for 90% of the samples is [0.40;2.80] $MP.m^{-3}$) across the surveyed areas, with PET and PP identified as the dominant polymer types.

Keywords: Microplastics, Polymers, Moniaqua, Portuguese coast, Validation method

References:

Godinho, C., Teodosio, M. A., et al. (2020). Microplastics contamination along the coastal waters of NW Portugal. Case Studies in Chemical and Environmental Engineering, 2, 100056.

Chouchene, K., Prata, J. C., da Costa, J., Duarte, A. C., Rocha-Santos, T., & Ksibi, M. (2021). Microplastics on Barra beach sediments in Aveiro, Portugal. Marine Pollution Bulletin, 167, 112264.

Antunes, J., Frias, J., & Sobral, P. (2018). Microplastics on the Portuguese coast. Marine Pollution Bulletin, 131 (Pt A), 294-302.

Morgado, V., Gomes, L., da Silva, R. J. B., & Palma, C. (2022). Microplastics contamination in sediments from Portuguese inland waters: Physical-chemical characterisation and distribution. *Science of the Total Environment*, *832*, 155053.

OC08

THE ROLE OF PLASTISPHERE SURFACE CHEMISTRY IN MARINE TRACE METAL TRANSPORT

R. Bordenave[1*], T. Parinaud[1], L. Bernardi[1], A.-M. Cindrić[2], J.-F. Briand[3], V. Lenoble[1], and A. Ortalo-Magné[3*]

[1] Université de Toulon, Aix Marseille Univ., CNRS, IRD, MIO, Toulon, France
romain.bordenave@mio.osupytheas.fr ; annick.ortalo-magne@univ-tln.fr
[2] Ruđer Bošković Institute, Center for marine and environmental research, Zagreb, Croatia.
[3] Université de Toulon, MAPIEM, Toulon, France

Abstract: In the marine environment, it is estimated that between 15 and 51 billion plastic particles are present on the surface water [1]. In this ecosystem, plastic material provides a potential surface for the development of a biofilm, commonly named "plastisphere", composed of microorganisms and a self-produced matrix of extracellular polymeric substances (EPS). Thus, this plastisphere presents functional chemical groups associated with various biochemical compounds (such as carbohydrates, proteins, nucleic acids, lipids) promoting biosorption and transport of contaminants in marine ecosystems.

In our study, ATR-FTIR spectroscopy coupled with chemometrics tools were used to characterize the surface of the plastisphere subjected /or not to metal stress over time in order to determine the chemical functions, thus the EPS, potentially involved in metal biosorption. For this purpose, plastics (polyethylene) were immersed in the Mediterranean Sea (Toulon Bay, France) during 4 weeks in order to allow the growth of a natural biofilm. Once retrieved, the pieces were separated in 3 conditions: the plastisphere was kept as such (reference; condition t0) or submitted to a metal stress (with Cu, or Pb or As) during 1h (condition t1) or 24h (condition t24). For all conditions, the biosorbed metal quantity was estimated using ICP-MS after digestion of the plastisphere. In parallel, pieces from each condition were immersed in cleaned filtered seawater (0.2 µm) during 1h or 24h to measure the amount of metal that could be desorbed.

The results of spectral analyses highlighted different chemical functional groups derived from polysaccharides, proteins and nucleic acids which could be involved in the biosorption of Cu, Pb and As by the plastisphere. A reorganization of the matrix surface was observed after metal pressure treatment during 1h and 24h. Regardless of conditions (t0, t1, t24), the plastisphere clearly showed a potential for metal desorption. Therefore, plastispheres have chemical functions involved in the dynamics of metal bioad-/biode-sorption, as highlighted in this study. Thus, plastispheres could play a key role in binding metals present in contaminated water and then transporting them to less contaminated water. This reinforces the necessity to increase vigilance related to potential health risks.

Keywords: Plastisphere, Trace metals, Desorption, ATR-FTIR spectroscopy

Reference:

Van Sebille, E. et al. (2015). A global inventory of small floating plastic debris. Environmental Research Letters, 10 (12), 124006.

OC09

OPTICAL PROPERTIES OF ORGANIC MATTER IN TROPICAL ESTUARIES UNDER ANTHROPOGENIC INFLUENCE

Fiamma E.L. Abreu[1] and Eliete Zanardi-Lamardo[1]

[1] Oceanography Department, Federal University of Pernambuco (UFPE), Recife, Brazil
fiamma.abreu@ufpe.br, eliete.zanardi@ufpe.br

Abstract: Organic matter (OM) is composed of complex carbon-based structures. Their composition, molecular complexity, and sources may result in variations of OM quality. Tropical estuaries are highly productive systems and important sinks for atmospheric CO_2, but DOM data in these environments remain limited. This study aimed to evaluate the spatial and temporal variability of fluorescent dissolved organic matter (FDOM) components commonly used as proxies for environmental health and carbon budgets. Sub-surface water samples were collected in Formoso River Estuary, a tropical system, located in northeastern Brazil during two wet seasons (2022 and 2023) and one dry season (2023). Samples were filtered through pre-combusted GF/F glass fiber filters. Fluorescence intensity of FDOM was measured using a spectrofluorometer (Hitachi F-7100) with excitation–emission matrix (EEM) scans ranging from 220 to 500 nm and extracted using the staRdom package in RStudio® software. In the dry season, high fluorescence intensity was observed in the upper estuary and was associated with urban influence. Conversely, in the wet season the highest fluorescence occurred in the middle estuary, suggesting surface that runoff is the main contributor of organic matter. The seasonal changes in OM quality were evident, with predominance of Peak A (humic, allochthonous) in the wet season. In the dry season, Peak M (humic-like, recently formed) overlapped with Peak A, particularly in the upper estuary, suggesting enhanced autochthonous production. Additionally, Peak T (indicative of untreated sewage) increased, on average, approximately 50% during the dry season compared to both wet seasons at sites influenced by urban area and sewage treatment plants. These findings indicate that OM quality varies seasonally in tropical estuaries under anthropogenic pressure. Estuarine hydrodynamics also play a key role in driving DOM processes. Continuous efforts to better understand organic matter dynamics in tropical estuaries are essential to improve carbon budget estimates under climate change scenarios.

Keywords: Fluorescent Dissolved Organic Matter, Proxy, Sewage, Excitation-emission matrix

Acknowledgments: The present study was supported by FACEPE (APQ-0267-1.08/21) and CNPq (No 409498/2021–1, 313891/2023-0, 446012/2024-6 and 152413/2024-3).

References:

Coble, P. G. (1996). *Marine chemistry*, *51*(4), 325-346.

Wölfelschneider, M., Dittmar, T., Hatje, V., & Seidel, M. (2025). *Bulletin of Marine Science*. 101(3):1191–1219.

OC10

IRBESARTAN AS A MARKER OF PHARMACEUTICAL CONTAMINATION IN MARINE SEDIMENTS

M. Mil-Homens*[1,2] and S. Leston[3,4]

[1] Divisão de Oceanografia e Ambiente Marinho, Instituto Português do Mar e da Atmosfera, I.P., Lisboa, PORTUGAL.
mario.milhomens@ipma.pt
[2] CIIMAR/CIMAR-LA, Centro Interdisciplinar de Investigação Marinha e Ambiental, Universidade do Porto, Matosinhos, PORTUGAL.
[3] CFE - Centre for Functional Ecology, TERRA Associate Laboratory, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, PORTUGAL.
[4] REQUIMTE/LAQV – Faculdade de Farmácia, Universidade de Coimbra, 3000-456 Coimbra, PORTUGAL

Abstract: Contaminants of emerging concern (CECs), including pharmaceuticals, are continuously introduced into aquatic ecosystems through wastewater discharges, sewage sludge application, hospital effluents, and aquaculture runoff. A substantial fraction of administered pharmaceuticals is excreted in unmetabolized or biologically active forms, reinforcing the need for environmental monitoring. Among antihypertensive drugs, irbesartan, an angiotensin II receptor blocker widely prescribed for cardiovascular diseases, has raised concern due to its persistence and potential ecological effects.

This study provides the first assessment of the occurrence, spatial distribution, and temporal trends of pharmaceuticals— with particular emphasis on irbesartan — in marine sediments from the Portuguese continental shelf adjacent to the Tagus estuary. A sensitive and selective analytical method based on ultra-high-performance liquid chromatography coupled with time-of-flight mass spectrometry (UHPLC-ToF-MS) was developed and validated in accordance with Commission Implementing Regulation (EU) 2021/808. The method enables the detection and quantification of pharmaceuticals from eight therapeutic classes, including antihypertensives such as irbesartan.

The validated method was applied to 51 marine sediment samples (9 surface and 42 down-core samples) collected from the continental shelf near the Tagus estuary. Results reveal a clear decrease in pharmaceutical concentrations with increasing distance from the estuary, indicating that the Tagus estuary acts as a primary source of pharmaceutical contamination to the adjacent shelf. Irbesartan was detected in both surface and deeper sediment layers, suggesting sustained inputs over time.

Preliminary findings indicate that increasing pharmaceutical consumption in densely populated regions, combined with incomplete removal during wastewater treatment, contributes to the accumulation of these compounds in marine sediments. Given their potential ecotoxicological effects and persistence, the presence of irbesartan and other pharmaceuticals highlights the importance of incorporating emerging contaminants into long-term coastal monitoring and environmental risk assessment frameworks.

Keywords: Contaminants of emerging concern, Irbesartan, Marine sediments, Portuguese shelf

Acknowledgments: The authors would like to thank for financial support: FEAMP through the CSS project (MAR-01.04.02-FEAMP-0013). The TAGUSGAS project (PTDC/CTA-GEO/31885/2017) and the CSS project financed the 2021 sampling campaign. The MINEPLAT project (ALT20-03-0145-FEDER-000013) supported part of the 2021 sampling campaign and the 2019 sampling campaign, respectively. The authors also acknowledge the Fundação para a Ciˆencia e a Tecnologia (FCT) for CIIMAR Strategic Funding UIDB/04423/2020 and UIDP/04423/2020 and for CCMAR Strategic Funding UIDB/04326/ 2020, UIDP/04326/2020 and LA/P/0101/2020.

OC11

DO WILDFIRES TRIGGER REPRODUCTIVE TOXIN RELEASE IN ESTUARIES?

Hannah S. Fitzhugh*[1] and Marcos D. Mateus[1]

[1] MARETEC/LARSyS, Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal
hannah.fitzhugh@tecnico.ulisboa.pt, marcos.mateus@tecnico.ulisboa.pt

Abstract: By the end of the 21st century, fire-prone conditions are expected to increase by 29%. Synthetic endocrine disrupting chemicals (EDCs) are micropollutants pervading every environmental compartment, with some known to persist in estuaries. Fire releases soluble forms of nutrients, modifies soil organic matter, and can increase erosion rates and surface runoff. Wildfires have the potential to transport and concentrate EDCs from terrestrial environments into estuaries via post-fire runoff, as estuaries receive fluvial waters and sediments from non-point sources within the watershed. Although research is underway to monitor EDCs in water, the effect of wildfire on EDC concentrations in estuaries remains largely unexplored.

We systematically evaluated knowledge on wildfire-related mobilization of synthetic EDCs, examined EDC bioaccumulation in the geosphere and estuaries, helping to illustrate the logical relationship between wildfire disruption and the biogeochemical cycling of EDCs in estuaries. A scoping review of 6 key chemical groups identified 164 records, with 11 meeting inclusion criteria. The available studies spanned several EDC chemical groups and focused largely on air and soil matrices, with some involving biota. No studies were found that examined EDC transport in aquatic environments. Following these findings, we performed a survey to identify evidence of EDC uptake in trees, targeting five common EDC groups, and screened 277 records. We compiled an illustrative EDC contamination profile by tree part and summarized data demonstrating EDC bioaccumulation across continents, in multiple tree species, in both contaminated and background environments, and in several tree compartments.

In response to this evidence, we introduce a conceptual model of wildfire disturbance as a mechanism releasing sequestered EDCs from biomass into estuarine systems. We provide a targeted post-wildfire EDC monitoring panel to support early detection and timely management actions and outline key research priorities to advance understanding of EDC behavior in post-fire estuarine environments.

Keywords: Wildfire, Estuary, Endocrine disruption, Biogeochemical, Bioaccumulation, Mobilization

References:

Metcalfe, C.D., Bayen, S., Desrosiers, M., Muñoz, G., Sauvé, S., Yargeau, V., 2022. An introduction to the sources, fate, occurrence and effects of endocrine disrupting chemicals released into the environment. Environ. Res. 207, 112658.

Paul, M.J., LeDuc, S.D., Lassiter, M.G., Moorhead, L.C., Noyes, P.D., Leibowitz, S.G., 2022. Wildfire Induces Changes in Receiving Waters: A Review With Considerations for Water Quality Management. Water Resour. Res. 58, e2021WR030699.

Senande-Rivera, M., Insua-Costa, D., Miguez-Macho, G., 2022. Spatial and temporal expansion of global wildland fire activity in response to climate change. Nat. Commun. 13, 1208.

OC12

CURRENT UNDERSTANDING OF COPPER REDOX SPECIATION IN ESTUARINE WATERS: THE EXAMPLE OF THE KRKA RIVER ESTUARY

Dora Crmarić*[1], Saša Marcinek[1], Ana-Marija Cindrić, Dario Omanović[1], and Elvira Bura-Nakić[1]

[1] Department for Marine and Environmental Research, Ruđer Bošković Institute, Zagreb, CROATIA.
dcrmaric@irb.hr

Abstract: Copper (Cu) bioavailability and toxicity are governed by its speciation[1]. In most marine and estuarine systems, over 99% of dissolved Cu is complexed by organic ligands, commonly classified as strong (L_1) or weak (L_2) according to their binding affinity[2]. However, despite reports of substantial Cu(I) fractions[3], Cu redox speciation remains largely overlooked.

This study examined Cu redox speciation in the stratified Krka River Estuary at two sites during campaigns in 2023–2024. Cu(I) and Cu(II) were separated using a modified solid-phase extraction method with bathocuproine disulphonate and ethylenediaminetetraacetic acid as selective ligands, and quantified by DPASV. Organic Cu speciation was determined using CLE-AdCSV with salicylaldoxime[4]. Dissolved organic matter was characterised through dissolved organic carbon (DOC) measurements, UV/Vis absorbance, and fluorescence excitation–emission matrices[4]. Additional laboratory light/dark experiments were conducted to evaluate the role of solar irradiation in Cu redox cycling.

Cu(I) accounted for 40–83% of total dissolved Cu, with maxima occurring in surface waters or at the halocline. Summer halocline maxima coincided with enhanced biological activity (high biological activity index (BIX) and chlorophyll *a* (Chl *a*)). A correlation between %Cu(I) and DOC was observed in summer but not in spring. Spring surface maxima in %Cu(I) showed no relationship with Chl *a* or BIX, suggesting photochemical reduction of Cu(II) complexes as an important Cu(I) source. The importance of photochemical reactions in Cu redox speciation is supported by diurnal observations showing early-morning minima and daytime increases in %Cu(I), as well as laboratory light/dark experiments.

Keywords: Copper(I), Redox speciation, Estuary

Acknowledgments: This research is supported by the Croatian Science Foundation project: "Understanding copper speciation and redox transformations in seawater" (IPCH-2020-10-4965).

References:

1. Semeniuk, D.M., Cullen, J.T., Johnson, W.K., Gagnon, K., Ruth, T.J. and Maldonado, M.T. (2009). Plankton copper requirements and uptake in the subarctic northeast Pacific Ocean. *Deep-Sea Research Part I: Oceanographic Research Papers*, 56(7), 1130–1142.
2. Ruacho, A., Richon, C., Whitby, H. and Bundy, R.M. (2022). Copper-binding ligands in the global ocean. *Communications Earth & Environment*, 3, 263.
3. Buerge-Weirich, D. and Sulzberger, B. (2004). Photochemical formation of Cu(I) in natural waters: Reduction of Cu(II)–DOM complexes. *Environmental Science & Technology*, 38(6), 1843–1848.
4. Marcinek, S., Santinelli, C., Cindrić, A.-M., Evangelista, V., Gonnelli, M., Layglon, N., Mounier, S., Lenoble, V. and Omanović, D. (2020). Organic copper speciation and dissolved organic matter characterisation in the Krka River estuary. *Marine Chemistry*, 225, 103842.

OC13

IN SITU MONITORING OF THE DIURNAL CYCLING OF BIOAVAILABLE MERCURY(II) IN A STRATIFIED ESTUARY

M.-L. Tercier-Waeber*[1], L. Maloriol[1], D. Omanović[2], A.-M. Cindrić[2], A. Rodrigues[3], and L.-E. Heimburger-Boavida[3]

[1] University of Geneva, Department of Inorganic and Analytical Chemistry, Geneva, Switzerland.
Marie-Louise.Tercier@unige.ch, Laura.Maloriol@unige.ch
[2] Department for Marine and Environmental Research, Ruđer Bošković Institute, Zagreb, Croatia
Omanovic@irb.hr, Ana-Marija.Cindric@irb.hr
[3] MIO - Institut méditerranéen d'océanologie, Marseille, France
Andreia.Rodrigues@mio.osupytheas.fr, Lars-Eric.heimburger@mio.osupythea

Abstract: Mercury is one of the primary contaminants of global concern because of its bioaccumulation and biomagnification along the trophic chain. All dissolved Hg chemical forms in aquatic systems are intricately linked together through the divalent pool, Hg(II), by various chemical reactions and microbiological transformations. Analytical devices enabling *in situ*, reagent-free pre-concentration and quantification of Hg(II), and especially its dynamic (potentially bioavailable) fraction $Hg(II)_{dyn}$, is therefore of prime interest.
This is demonstrated here by high-resolution monitoring of the temporal and spatial (at depth) concentrations of $Hg(II)_{dyn}$ in the Krka Estuary (Croatia) using an on-chip antifouling gel-integrated microstructured-gold sensor array incorporated in a submersible multi-channel sensing probe (TracMetal). The Krka Estuary is characterized by its permanent salinity stratification including: an upper fresh/brackish water layer (FWL), a middle freshwater-seawater interface layer (FSI), and a bottom seawater layer (SWL). The $Hg(II)_{dyn}$ concentrations were recorded in these three layers at hourly interval. Bio-physicochemical parameters were recorded using a submersible multiparameter probe and filtered samples collected for complementary measurements of total dissolved mercury concentrations (Hg_{tot}). The original results of this study are presented. The data revealed clear diurnal cycles of $Hg(II)_{dyn}$ in the FWL and SWL. $Hg(II)_{dyn}$ concentration variation > 300% and > 100% (i.e ratio C_{max}-C_{min}/C_{min}) were recorded in the FWL and SWL, respectively. Decreasing concentrations during night and increasing concentrations up to the afternoon, with a shift of few hours in the SWL, suggest that the observed diel cycles might be due photochemically driven processes. Significant temporal variation in $Hg(II)_{dyn}$ (> 100%) were also observed in the FSI, albeit with more complex (diurnal) trends. These more complex trends suggest diurnal variations of $Hg(II)_{dyn}$ at the halocline controlled by the balance between two distinct, competitive processes as it will be discussed.

Keywords: Hg(II) diurnal cycling, Metal bioavailability-oriented sensing tools, *In situ* monitoring,

References:

Tercier-Waeber, M.-L., Confalonieri, F., Abdou, M., Dutruch, L., Fighera, M., Bakker, E., Schäfer, J. (2021). Advanced multichannel submersible probe for autonomous high-resolution in situ monitoring of the cycling of the potentially bioavailable fraction of a range of trace metals. Chemosphere, 282, 131014.

OC14

REACTIVE DISSOLVED NICKEL DISTRIBUTION IN THE NORTHWEST BRAZILIAN CONTINENTAL SHELF: HIGH VERSUS LOW RIVER DISCHARGE PERIODS AND THE SPECIFIC ROLE OF MANGROVE FORESTS

Cristian H. Krause[1], Nico Fröhberg*[2], Leandro M. de Carvalho[1], Alexandre B. Schneider[3], and Andrea Koschinsky[2]

[1] Departamento de Química, Universidade Federal de Santa Maria, C.P. 5051, 97105-970, Santa Maria, RS, Brazil.
crizzkrause@gmail.com, lemacarvalho@gmail.com
[2] Department of Physics and Earth Sciences, School of Science, Constructor University, Campus Ring 1, 28759 Bremen, Germany.
nfroehberg@constructor.university, akoschinsky@constructor.university
[2] Instituto de Química, Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves 9500, C.P. 15003, 91501-970, Porto Alegre, RS, Brazil.
schneider.alexandre@ufrgs.br

Abstract: The Amazon and Pará rivers estuaries and associated plume on the Northwestern Brazilian Continental Shelf constitute a complex and dynamic system, yet few studies have addressed the interannual variability of processes controlling trace metal transport within it. This work compares the transport of reactive dissolved Ni (dNi) in the Amazon and Pará River estuaries, the mixing plume, and surrounding shelf regions under high- and low-discharge conditions. This study uses data from RV Meteor cruise M206 (GEOTRACES Process Study GAPr21) during the low-discharge period, compared with cruise M147 (GAPr11) during high-discharge. Additionally, surface and porewater samples from mangrove forests in northern Brazil were analyzed. Reactive dNi was quantified by adsorptive cathodic stripping voltammetry (AdCSV) onboard, immediately after filtration (<0.2 μm) and acidification. Surface waters along the estuary showed similar reactive dNi levels during both periods (0.7–9.2 and 0.5–12.6 nmol L^{-1}, respectively), despite differing salinity gradients due to reduced freshwater influx. Concentrations decreased along the estuary with non-conservative distribution, indicating that reactive dNi is influenced by combined input and removal mechanisms. Depth profiles from both periods showed partial surface depletion and regeneration at depth, likely driven by water masses and biogeochemical processes, consistent with its nutrient-like behavior. No significant concentration differences were observed along the mangrove belt (1.3–3.7 and 1.4–4.3 nmol L^{-1} during high- and low-discharge, respectively), suggesting that reactive dNi in groundwater discharge from Amazonian mangroves is not strongly affected by seasonal conditions. Enrichment in mangrove porewaters (65.0–119.5 nmol L^{-1}) represents a local signature, with concentrations decreasing toward the coast due to seawater dilution.

Keywords: Nickel, Amazon, Pará, Mangroves, Trace Elements, Chemical Speciation, Electrochemistry

Acknowledgments: The German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) is acknowledged for funding RV Meteor cruise M206 (reference number of the cruise proposal: GPF 20-1_057). We also acknowledge The Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and the German Academic Exchange Service (Deutscher Akademischer Austauschdienst, DAAD) for funding the mangrove sampling campaign as part of the PROBRAL-Project number 57705545 "Biogeochemical interactions in the Amazon region".

References:

de Carvalho, L. M., Hollister, A. P., Trindade, C., Gledhill, M., & Koschinsky, A. (2021). Distribution and size fractionation of nickel and cobalt species along the Amazon estuary and mixing plume. *Marine Chemistry*, *236*, 104019. https://doi.org/10.1016/j.marchem.2021.104019

Koschinsky, A., Frank, M., Dittmar, T., Gledhill, M., de Rezende, C., Lodeiro, P., Seidel, M., Knoke, M., Paul, S. A. L., Zitoun, R., Heinrich, L., Fronzek, J., Münch, J., Scholten, J., Border, E. C., Schneider, A., de Carvalho, L. M., Leist, L., Mutzberg, A., ...Rohleder, C. (2018). Interactions of trace metals, DOM, and particles in the Amazon estuary and associated plume as key processes for trace metal and DOM fluxes into the Atlantic, Cruise No. M147, April 19 - May 21, 2018, Las Palmas (Gran Canaria) - Belém (Brazil). In METEOR-Berichte (Vol. M147, pp. 1-63). Gutachterpanel Forschungsschiffe. https://doi.org/10.2312/cr_m147Pedrozo-Acuña, A. 2005.

Koschinsky, A., Frank, M., de Carvalho, L., Firus, A., Freitas de Souza, M., Fröhberg, N., Haude, S., Hollister, A., Kaiser, D., Kalfouni, R., Kelly, C., Krause, C., Maguire, T. C., Moje, A., Lacerda, D., Lilie, E., Lima Reis Delatorre, A., Rezende, C., Sander, N., ...Zindorf, M. (2025). Interactions of trace metals, DOM, and particles in the Amazon estuary and plume as key processes for trace metal and DOM fluxes into the Atlantic during the low-discharge period, Cruise No. M206, 01.12.2024 - 30.12.2024, Fortaleza (Brazil) - Belém (Brazil). In *METEOR-Berichte* (Vol. M206, pp. 1-64). Begutachtungspanel Forschungsschiffe. https://doi.org/10.48433/cr_m206

Krause, C. H., Fröhberg, N., de Carvalho, L. M., Schneider, A. B., & Koschinsky, A. (n.d.). Reactive dissolved nickel distribution in the Northwest Brazilian Continental Shelf: High versus low river discharge periods and the specific role of mangrove forests *[Manuscript submitted for publication]*.

OC15

BIOGEOCHEMICAL PROCESSES AND FLUXES OF TRACE METALS FROM THE AMAZON-PARÁ RIVER SYSTEM AND THE MANGROVE BELT INTO THE ATLANTIC: HIGH AND LOW DISCHARGE CONDITIONS COMPARED

Andrea Koschinsky*[1], Adrian Hollister[1], Caitlyn Kelly[1], Alexandre B. Schneider[2], Nico Fröhberg[1], Cristian H. Krause[1,3], and Leandro M. de Carvalho[3]

[1] Department of Physics and Earth Sciences, School of Science, Constructor University, Bremen, Germany.
akoschinsky@constructor.university, ahollister@constructor.university, caitlyn.erin.kelly@uni-oldenburg.de (present address), nfroehberg@constructor.university
[2] Instituto de Química, Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves 9500, C.P. 15003, 91501-970, Porto Alegre, RS, Brazil.
schneider.alexandre@ufrgs.br
[3] Departamento de Química, Universidade Federal de Santa Maria, C.P. 5051, 97105-970, Santa Maria, RS, Brazil.
crizzkrause@gmail.com, lemacarvalho@gmail.com

Abstract: The Amazon River system delivers about half of the total freshwater input to the tropical Atlantic Ocean. Its major influence on coastal and open-ocean bioproductivity, combined with rapid changes driven by climate change and human activities, calls for comprehensive studies of estuarine processes. In particular, understanding the dispersal and variability of trace metals across space and time is essential. River discharge varies strongly between wet and dry seasons, leading to seasonal shifts in trace element input. In estuarine waters, geochemical processes such as biological uptake, (de)sorption, coagulation, precipitation, and dissolution significantly modify these trace metal fluxes. During two GEOTRACES process study cruises (M147, GApr11, high discharge; M206, GApr21, low discharge) we collected water samples from the Amazon and Pará estuaries and the northwestward-flowing river plume as well as the mangrove belt south of the Pará outflow. The pronounced difference in water fluxes between the two seasons caused considerable differences in trace metal concentrations and distributions across the estuarine and shelf region for most trace metals. As an example for a non-conservative, particle-reactive element, dissolved titanium varied greatly among the different river sources (Schneider et al., 2022), with considerably lower concentrations during the low discharge period. Porewaters and surface waters from mangrove environments showed to be a considerable source of Ti into the coastal Atlantic. Copper, as an example for a nutrient-type element, showed less conservative behavior during the dry season compared to the wet season (Hollister et al., 2021). In both seasons, an excess of strong Cu-binding organic ligands was present, and free Cu never reached toxic concentrations. The mangrove belt represents an important additional source of Cu.
In summary, distinct trace metal signatures from the different sources combine to form a shelf flux transported northeastward by the North Brazil Current, which varies greatly between seasons.

Keywords: Amazon, Pará, Mangroves, River Plume, Trace Elements, Seasonal fluxes

Acknowledgments: The cruises M147 and M206 were funded by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and the sampling campaign in the mangrove forests of northern Brazil was funded by the DAAD (Deutscher Akademischer Austauschdienst) and CAPES (Brazil) through the PROBRAL program.

References:

Hollister, A. P., Whitby, H., Seidel, M., Lodeiro, P., Gledhill, M., & Koschinsky, A. (2021). Dissolved concentrations and organic speciation of copper in the Amazone estuary and mixing plume. *Marine Chemistry, 234, 104005.* https://doi.org/10.1016/j.marchem.2021.104005

Koschinsky, A., Frank, M., Dittmar, T., Gledhill, M., de Rezende, C., Lodeiro, P., Seidel, M., Knoke, M., Paul, S. A. L., Zitoun, R., Heinrich, L., Fronzek, J., Münch, J., Scholten, J., Border, E. C., Schneider, A., de Carvalho, L. M., Leist, L., Mutzberg, A., ...Rohleder, C. (2018). Interactions of trace metals, DOM, and particles in the Amazon estuary and associated plume as key processes for trace metal and DOM fluxes into the Atlantic, Cruise No. M147, April 19 - May 21, 2018, Las Palmas (Gran Canaria) - Belém (Brazil). In METEOR-Berichte (Vol. M147, pp. 1-63). Gutachterpanel Forschungsschiffe. https://doi.org/10.2312/cr_m147Pedrozo-Acuña, A. 2005.

Koschinsky, A., Frank, M., de Carvalho, L., Firus, A., Freitas de Souza, M., Fröhberg, N., Haude, S., Hollister, A., Kaiser, D., Kalfouni, R., Kelly, C., Krause, C., Maguire, T. C., Moje, A., Lacerda, D., Lilie, E., Lima Reis Delatorre, A., Rezende, C., Sander, N., ...Zindorf, M. (2025). Interactions of trace metals, DOM, and particles in the Amazon estuary and plume as key processes for trace metal and DOM fluxes into the Atlantic during the low-discharge period, Cruise No. M206, 01.12.2024 - 30.12.2024, Fortaleza (Brazil) - Belém (Brazil). In *METEOR-Berichte* (Vol. M206, pp. 1-64). Begutachtungspanel Forschungsschiffe. https://doi.org/10.48433/cr_m206

Schneider, A.B., Koschinsky, A., Krause, C.H., Gledhill, M., and de Carvalho, L. (2022). Dynamic behavior of dissolved and soluble titanium along the salinity gradients in the Pará and Amazon estuarine system and associated plume. *Marine Chemistry, 238,* https://doi.org/10.1016/j.marchem.2021.104067

OC16

IMPLICATIONS OF REE SPECIATION IN SOIL-PLANT SEAGRASS MEADOWS

Ingrid CM Sena[1], Lais A Souza[2], and Vanessa Hatje[1,3*]

[1] Centro Interdisciplinar de Energia e Ambiente, Universidade Federal da Bahia, Salvador, BRAZIL.
ingrid.mota@ufba.br
[2]Departamento de Química Fundamental, Universidade Federal de Pernambuco, Recife, BRAZIL.
Lais.asouza@ufpe.br
[3]IAEA Marine Environment Laboratories, Department of Nuclear Sciences and Applications, International. Atomic Agency, Monaco, PRINCIPALITY OF MONACO.
**v.hatje@iaea.org*

Abstract: Rare earth elements (REEs) have attracted increasing attention due to their expanding use, potential ecological risks, and limited understanding of their biogeochemical behaviour in coastal ecosystems. Significant knowledge gaps remain regarding their speciation, mobility, and bioavailability in soil-plant systems, including seagrass meadows. Because total metal concentrations provide limited insight into environmental behaviour, selective sequential extraction is a valuable tool to determine how REEs partition among different geochemical fractions (exchangeable, carbonate-bound, oxidizable/organic matter, reducible Fe-Mn oxyhydroxides, and residual), each with distinct implications for mobility and biological uptake.

We applied a sequential extraction procedure to seagrass soils from meadows located near coral reefs, mangroves, and sandy beaches to assess REE fractionation patterns and evaluate how environmental setting influences their potential plant availability. Across all sites, most REEs were predominantly associated with the residual fraction (51–82% of total), indicating a largely lithogenic and relatively recalcitrant pool. The carbonate fraction represented the second most important sink (15–47%), followed by the organic matter fraction (1–16%), whereas the Fe-Mn oxyhydroxide (1–7%) and easily soluble/ion-exchangeable fractions (<1%) were minor. Organic matter and Fe-Mn oxyhydroxide fractions were generally enriched in light and medium REEs relative to heavy REEs, while the residual fraction showed a slight relative enrichment in heavy REEs, suggesting greater lability of light and middle REEs. Soils near sandy beaches exhibited a particularly high association of REEs with carbonates, especially for MREE, and the lowest proportion in the residual fraction. This carbonate association likely enhances REE lability and transfer to plants, consistent with higher REE bioaccumulation observed in seagrasses from these environments. Additionally, the greater proportion of REEs in the oxidizable phase compared to the reducible fraction suggests that organic matter exerts a stronger control on REE mobilization than Fe-Mn oxyhydroxides. Our findings demonstrate that REE speciation governs their bioavailability and accumulation in seagrass ecosystems, highlighting the importance of considering geochemical partitioning in environmental risk assessments.

Keywords: Rare earth elements, Bioavailability, Fractionation, Soils

Acknowledgments: This work was supported by CNPq (407297/2018-9) and FAPESB (APP0012/2023). The authors were sponsored by CAPES (I.M.S) and CNPq (V.H., 302477/2022-5). The IAEA is grateful for the support provided to its Marine Environment Laboratories by the Government of the Principality of Monaco.

OC17

GEOCHEMICAL BEHAVIOR AND FRACTIONATION OF RARE EARTH ELEMENTS ALONG THE STRATIFIED KRKA RIVER ESTUARY

Saša Marcinek*[1], Justin Auther[2], Ana-Marija Cindrić[1], and Dario Omanović[1]

[1]Ruđer Bošković Institute, Center for marine and environmental research, Zagreb, Croatia.
smarcin@irb.hr
[2]Université de Toulon – UFR Sciences et Techniques, Toulon, France

Abstract: Rare earth elements (REEs) are increasingly introduced into aquatic environments due to their growing use in modern technologies, drawing attention as emerging contaminants[1]. However, their behaviour in marine systems is still poorly understood. We investigated REE geochemical behaviour in the stratified Krka River estuary, analysing their concentrations in surface brackish and bottom seawater layers. Additional size fractionation was assessed using filtration (0.2 μm cutoff) and ultrafiltration (3 kDa cutoff) along vertical salinity profiles. Employing a preconcentration on NOBIAS Chelate-PA 1 resin and ICP-MS analysis, REE concentrations as low as 10 pg/L were detected. REE patterns were interpreted alongside other trace elements and dissolved organic matter (DOM). Shale-normalized REE patterns revealed depletion of light REEs relative to heavy REEs in estuarine waters (HREE/LREE~3.5), whereas riverine end-member exhibited the opposite trend (HREE/LREE=0.6). The dominance of LREE in the river reflects the signature of Croatian karstic freshwaters[2], influenced by *terra rossa* soil cover of the drainage area. A positive Gd anomaly was observed at the estuary head, only slightly exceeding the threshold distinguishing natural from anthropogenic sources. While a significant fraction of REEs, Fe, and other trace metals was removed from the surface layer at the estuary head via coagulation of riverine colloids, Gd persisted, highlighting its stability along the freshwater–seawater mixing zone. Further increases in REEs along the salinity gradient, especially HREEs, correlated strongly with organic matter (CDOM, FDOM, DOC) in the surface layer but not in the bottom layer, suggesting control specifically by biogenic DOM consistent with the results of recent mesocosm study[3]. In the bottom layer, REEs generally increased from river to seawater end-member, except for a mid-estuarine anomaly where the HREE/LREE ratio decreased and concentrations of Fe, Mn, Pb, and Zn increased, indicating groundwater influence. Overall, our study documents the variability of REE distributions in estuarine systems, reflecting influences of freshwater inputs, hydrodynamics and, potentially, organic matter, and provides a baseline for future studies of REE behaviour in stratified coastal systems.

Keywords: Rare earth elements, Dissolved organic matter; Salinity gradient

References:

[1] Gonzalez J. B., Wang, M. H., *et al*., Rare earth elements as emerging contaminants in marine ecosystems: Bioaccumulation and ecological implications. J. Environ. Manage., 394 (2025) 127465.

[2] Fiket, Ž., Rožmarić, M., *et al*., Levels of major and trace elements, including rare earth elements, and ^{238}U in Croatian tap waters. Environ. Science Pollut. Res., 22 (2015) 6789-6799.

[3] Sutorius M.; Mori, C. *et al*., Rare earth element behaviour in seawater under the influence of organic matter cycling during a phytoplankton spring bloom. Front. Mar. Sci., 9 (2022) 89572.

OC18

ANTHROPOGENIC GADOLINIUM: AN EMERGING CONTAMINANT OR AN ENVIRONMENTAL MONITORING TOOL?

Patrícia Gaspar[1] and Pedro Brito*[2, 3]

[1] Escola Superior de Tecnologia de Setúbal, Instituto Politécnico de Setúbal (EST/IPS), Setúbal, PORTUGAL.
202200627@estudantes.ips.pt
[2] Departamento do Mar e Recursos Marinhos, Divisão de Oceanografia e Ambiente Marinho, Instituto Português do Mar e Atmosfera, I.P. (IPMA), Lisboa, PORTUGAL.
pbrito@ipma.pt
[3] Centro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR), Matosinhos, PORTUGAL.

Abstract: Anthropogenic gadolinium (AGd), primarily released through gadolinium-based contrast agents used in medical imaging (Brünjes and Hofmann, 2020; Lerat-Hardy et al., 2019), has emerged as a distinctive tracer of urban wastewater inputs to aquatic systems (Brünjes et al., 2016; Ebrahimi and Barbieri, 2019). While its occurrence and behaviour have been widely documented internationally, national-scale understanding in Portugal remains limited (Pereto et al., 2023). This study provides a first nationwide assessment of AGd in Portuguese surface transitional waters, evaluating its spatial distribution, sources, and role within riverine and estuarine biogeochemical frameworks.

Surface water samples were collected across five major hydrographic basins representing contrasting lithology, hydrology, degrees of urbanisation, and wastewater influence. Rare earth element (REE) concentrations were determined using seaFAST-ICP-MS and normalised to shale reference values to distinguish natural geochemical backgrounds from anthropogenic inputs through the identification of positive Gd anomalies. Spatial trends in AGd were examined in relation to catchment characteristics, downstream mixing processes, and transport behaviour along freshwater–estuarine continua.

Anthropogenic Gd exhibited pronounced spatial variability, with the highest enrichments consistently observed downstream of densely populated and urbanised areas, whereas upstream and low-impact sites displayed coherent, background-normalised REE patterns. Gadolinium showed predominantly conservative behaviour relative to neighbouring REEs, indicating limited reactivity during transport and persistence across fluvial–estuarine gradients. This behaviour contrasts with that of redox-sensitive and particle-reactive metals, underscoring AGd's robustness as a tracer of wastewater influence. Overall, the study highlights the value of AGd for integrating wastewater-derived signals into estuarine biogeochemical assessments. However, increasing Gd loads also raise concerns regarding long-term accumulation, interactions with organic ligands, and potential ecological effects. Anthropogenic Gd thus represents both a powerful biogeochemical tracer and an emerging contaminant warranting continued investigation in human-impacted aquatic environments.

Keywords: Anthropogenic gadolinium, Estuarine waters, Wastewater tracer, Emergent contaminant

References:

Brünjes, R., Bichler, A., Hoehn, P., Lange, F.T., Brauch, H.-J., Hofmann, T., 2016. Anthropogenic gadolinium as a transient tracer for investigating river bank filtration. Sci. Total Environ. 571, 1432–1440. https://doi.org/10.1016/j.scitotenv.2016.06.105

Brünjes, R., Hofmann, T., 2020. Anthropogenic gadolinium in freshwater and drinking water systems. Water Res. 182, 115966. https://doi.org/10.1016/j.watres.2020.115966

Ebrahimi, P., Barbieri, M., 2019. Gadolinium as an Emerging Microcontaminant in Water Resources: Threats and

Opportunities. Geosciences 9, 93. https://doi.org/10.3390/geosciences9020093

Lerat-Hardy, A., Coynel, A., Dutruch, L., Pereto, C., Bossy, C., Gil-Diaz, T., Capdeville, M.-J., Blanc, G., Schäfer, J., 2019. Rare Earth Element fluxes over 15 years into a major European Estuary (Garonne-Gironde, SW France): Hospital effluents as a source of increasing gadolinium anomalies. Sci. Total Environ. 656, 409–420. https://doi.org/10.1016/j.scitotenv.2018.11.343

Pereto, C., Lerat-Hardy, A., Baudrimont, M., Coynel, A., 2023. European fluxes of medical gadolinium to the ocean: A model based on healthcare databases. Environ. Int. 173, 107868. https://doi.org/10.1016/j.envint.2023.107868

OC19

TRACING GADOLINIUM ANOMALIES IN THE VIGO RIA (NW IBERIAN PENINSULA): EXPERIMENTAL INSIGHTS FROM GADOLINIUM-BASED CONTRAST AGENTS (GBCAs)

Mendoza-Segura, C.*[1] and Cobelo-García, A.[1]

[1] Grupo de Biogeoquímica Marina, Instituto de Investigaciones Marinas (IIM-CSIC), Vigo, SPAIN.
cmendoza@iim.csic.es, acobelo@iim.csic.es

Abstract: Since its first recording by Bau and Dulski (1996), several studies have detected the presence of Gd anomalies in river water, groundwater, seawater and tap water across all continents (i.e. Barrat et al., 2026; Kim et al., 2025;; reviewed in Moreira et al., 2025). These findings are primarily associated with anthropogenic sources caused by the use of gadolinium-based contrast agents (GBCAs), highly stable Gd(III) organic complexes mainly employed in magnetic resonance imaging (MRI). In this study, we analysed the presence of these anomalies in the Vigo Ria, situated in a densely populated and industrialised area in the north-west of the Iberian Peninsula. Furthermore, an experiment was conducted to quantify the complexation potential of some of the main GBCAs currently in use, including Gadovist© (gadobutrol), Dotarem© (gadoteric acid) and Magnevist© (Gd-DTPA). Water samples were collected and filtrated on-site (Sartobran® capsule 0.2 μm) with a peristaltic pump and acidified with HCl. For the estimation of total metals concentration, 15 mL aliquots of the samples were subjected to a UV irradiation treatment. The preconcentration of the samples was achieved by employing Bond Elut PPL SPE cartridges while the determination of Gd concentration and the other rare earth elements was performed by means of ICP-MS, and Gd anomalies were detected in both estuarine and river waters of the Vigo Ria. In turn, the recovery of GBCAs in PPL SPE cartridges was approximately 26% (Dotarem) and 42% (Gadovist) as opposed to the low retention rate of less than 0.1% yield observed for Magnevist. This contrasts with previous studies, in which a yield of up to 70% was recorded for the latter compound with resins containing ethylhexylphosphates (e.g. Hennebrüder et al., 2004). These findings point to the need to optimise the methodology and type of resins used to effectively quantify each of these GBCAs, whose persistence in the environment poses a threat to biota. As such, further studies should focus on the improvement and implementation of degradation techniques in wastewater treatment plants for these compounds to reduce the risk of their bioaccumulation and possible effects.

Keywords: Gadolinium anomaly, Gadolinium-based contrast agents, GBCAs, estuarine water, River water, Styrene-divinylbenzene (SDVB) polymer

Acknowledgments: This study was conducted under the project TEC-RISK (Ref. PID2019-111261GB-I00) and supported by a pre-doctoral grant FPU21/01226 to C. Mendoza-Segura both funded by the Spanish Ministry of Science, Innovation and Universities.

References:

Barrat, J.-A., Bayon, G., Tripier, R., Rouget, M.-L., Germain, Y., and Ben Salem, D. (2026). Rare earth element abundances and gadolinium contamination in tap water worldwide. Chemosphere, 394, 144812. https://doi.org/10.1016/j.chemosphere.2025.144812

Bau, M., and Dulski, P. (1996). Anthropogenic origin of positive gadolinium anomalies in river waters. Earth and Planetary Science Letters, 143(1–4), 245–255. https://doi.org/10.1016/0012-821X(96)00127-6

European Medicines Agency: EMA/411650/2017 - Gadolinium Article-31 referral—Assessment report. https://www.ema.europa.eu/en/medicines/human/referrals/gadolinium-containing-contrast-agents

Hennebrüder, K., Wennrich, R., Mattusch, J., Stärk, H.-J., & Engewald, W. (2004). Determination of gadolinium in river water by SPE preconcentration and ICP-MS. Talanta, 63(2), 309–316. https://doi.org/10.1016/j.talanta.2003.10.053

Kim, J., Lim, I., Kim, J., Sim, H., Seo, H., and Kim, T. (2025). Contrasting Seasonal Behaviors of Dissolved Rare Earth Elements and Anthropogenic Gadolinium in the Estuary Dam System. Estuaries and Coasts, 48(3), 71. https://doi.org/10.1007/s12237-025-01504-5

Moreira, I., Pereira, E., Soares, A. M. V. M., and Freitas, R. (2025). Gadolinium: A review on concentrations and impacts in marine and coastal systems. Environmental Pollution, 381, 126453. https://doi.org/10.1016/j.envpol.2025.126453

CONTRASTING REDOX PATHWAYS OF PLATINUM MEDIATED BY NATURAL ORGANIC MATTER AND MICROORGANISMS

J. Le Doaré[1], M.F. Benedetti[1], A. Gorlas[2], F. Guyot[3], A. Gelabert[4], G. Landrot[5], R. Marsac[1], and C. Catrouillet*[1]

[1] IPGP, Paris, FRANCE
ledoare@ipgp.fr, benedetti@ipgp.fr, marsac@ipgp.fr, catrouillet@ipgp.fr
[2] I2BC, Gif-Sur-Yvette, FRANCE
aurore.gorlas@i2bc.paris-saclay.fr
[3] MNHN, Paris, FRANCE
francois.guyot@mnhn.fr
[4] CEREGE, Aix-En-Provence FRANCE
gelabert@cerege.fr
[5] Synchrotron-SOLEIL Saint-Aubin, FRANCE
gautier.landrot@synchrotron-soleil.fr

Abstract: Platinum (Pt) is a technology-critical element that is increasingly being detected in rivers and coastal waters, reflecting its dispersion across the terrestrial-marine continuum[1, 2]. Estuarine environments are dynamic systems characterized a by strong redox gradient, variable oxygen availability, salinity-driven ligand exchange, and a high organic matter content. These conditions can significantly alter metal speciation. Dissolved organic matter has been shown to interact with trace metals and modify their speciation in river-estuary-coast systems, as demonstrated for As and Cd[3]. Despite its growing environmental presence, the processes controlling Pt speciation and transformation in aquatic systems remain poorly understood. In this study, we investigated the temporal evolution of Pt(IV) in the presence of two environmentally relevant organic compartments: natural organic matter (NOM) and a model microorganism (*Escherichia coli*), using X-ray absorption spectroscopy. In an NOM-rich system, Pt(IV) progressively reduced to Pt(II) over 59 days with no detectable formation of Pt(0). This suggests stabilization in the divalent state. In contrast, microbial systems induce much faster reduction (within 24 hours), leading to the formation of Pt(0) nanoparticles, indicating stronger redox power. This comparative approach reveals that (i) Pt reduction and (ii) distinct kinetic transformation pathways depend on the organic matrix. In redox-stratified estuarine systems with variable oxygen levels and salinity-driven ligand exchange, these contrasting reduction pathways may strongly influence the mobility, bioavailability, and toxicity of Pt in the environment.

Keywords: Emerging contaminant, Speciation, X-ray absorption spectroscopy, Biogeochemistry.

References:

[1]Chastanet, M., Debret, M., Gardes, T., Schäfer, J., Abdou, M., Lestel, L., Morereau, A., Mourier, B., Grosbois, C., Eyrolle, F., Coynel, A. (2024). Contrasting platinum trajectories in three major French rivers using dated sediment cores (1910–2021): From geochemical baseline to emerging source signals. Elsevier Science of The Total Environment, 931.

[2]Cobelo-García, A., López-Sánchez, D.E., Almécija, C., Santos-Echeandía, J.S. (2013). Behavior of platinum during estuarine mixing (Pontevedra Ria, NW Iberian Peninsula). Elsevier Marine chemistry, 150, 11-18.

[3]Pan, F., Wang, B., Zhang, Y., Zhang, X., Cai, Y., Liu, H., Guo, Z., Wang, X. (2022). Bioavailability, (im)mobilization kinetics, and spatiotemporal patterns of arsenic and cadmium in surficial sediments of a river–estuary–coast system. Journal of Hydrology. 612, A.

OC21

PRELIMINARY STUDY ON TELLURIUM REDOX SPECIATION IN PRISTINE AND INDUSTRIALLY IMPACTED ESTUARIES

Lucija Knezevic*[1] and Andrea Koschinsky[1]

[1] School of Science Physics & Earth Sciences, Constructor University, Bremen, Germany
lknezevic@constructor.university, akoschinsky@constructor.university

Abstract: As the global economy shift its focus towards sustainable energy sources, the demand for tellurium (Te), a technologically critical element, is rapidly growing. Despite its importance, the environmental implication of extensive Te usage to support current technological needs remain poorly understood (Missen *et al.* 2020). Current understanding of Te geochemical behaviour in different environmental compartments is limited and often contradictory leading to many unresolved questions. This is mainly due to two main factors: I) its rapid exploitation for modern technologies has outpaced systematic studies on its geochemistry and II) ultra-trace concentrations of Te in natural environments make its analytical determination difficult, even with advanced techniques (Filella *et al.* 2014).
In this study we adapted and implemented differential pulse cathodic stripping voltammetry for Te redox speciation in natural estuarine waters first developed by Biver *et al.* 2015 (Biver *et al.* 2015). This method now enables direct determination of Te(IV) species, as electroactive species, with a detection limit of 1 ng/L. Determination of total Te is enabled by previous reduction of Te(VI) to the electroactive form Te(IV). We present preliminary results demonstrating the performance of the optimised analytical method enabling Te redox speciation in both pristine and industrially impacted estuaries, such as Amazon and Weser rivers, respectively. Obtained data include the first Te redox speciation data from the Amazon estuary as a part of larger project on Te cycling and transport in estuarine systems. Our work will expand the limited data available on the natural Te cycle in rivers and estuaries and provide insight into the extent to which the increasing industrial use of Te is already leaving a visible signature in the environment. This information can serve as a basis for assessing potential Te ecotoxicological effects.

Keywords: Tellurium, Redox speciation, Voltammetry, Estuarine waters

Acknowledgments: This research is part of the project "TeTRANS" funded by Alexander von Humboldt foundation.

References:

Missen, O.P., Ram, R., Mills, S.J., Etschmann, B., Reith, F., Shuster, J., Smith, D.J., and Brugger, J.(2020). Love is in the Earth: A review of tellurium (bio)geochemistry in surface environments. Earth-Science Rev., 204, 103150.

Filella, M., Reimann, C., Biver, M., Rodushkin, I., and Rodushkina, K. (2014). Tellurium in the environment. Current knowledge and identification of gaps. Environmental Chemistry, 16 (4), 215-228.

Biver, M., Quentel, F., and Filella, M. (2015). Direct determination of tellurium and its redox speciation at the low nanogram level in natural Waters by catalytic cathodic stripping voltammetry. Talanta, 144, 1007-1013.

OC22

SPATIAL AND TEMPORAL DYNAMICS OF THE PHYTOPLANKTON COMMUNITY IN THE SADO ESTUARY

Joana P. C. Cruz*[1], Joshua Heumüller[1], Beatriz Biguino[1], Filipa Afonso[2], Carlos Borges[3], Carla Palma[3], and Ana C. Brito[1,4]

[1] MARE – Centro de Ciências do Mar e do Ambiente, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal.
jpcruz@ciencias.ulisboa.pt, *jaheumuller@ciencias.ulisboa.pt, bibiguino@ciencias.ulisboa.pt*
[2] Marine Institute, Galway, Ireland.
filipa.afonso@marine.ie
[3] Instituto Hidrográfico, Rua das Trinas 49, 1249-093, Lisboa, Portugal.
carlos.borges@hidrografico.pt, carla.palma@hidrografico.pt
[4] DBio – Departamento de Biologia, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal.
acbrito@ ciencias.ulisboa.pt

Abstract: Estuaries are highly dynamic transitional ecosystems, characterized by the interaction between fresh and marine waters, generating strong environmental gradients shaping their biological communities (Cereja et al.,2022; Xia et al.,2024). Phytoplankton plays a fundamental role in primary production, nutrient cycling, and supporting food chains. Being an important indicator of environmental change (Biguino et al., 2024; Kim et al.,2023; Santos et al.,2022). The distribution of phytoplankton in transitional environments is generally influenced by physicochemical factors, such as salinity, temperature, turbidity, and nutrient availability, which vary seasonally and along the river-sea continuum (Nascimento et al.,2021). Therefore, understanding spatial and temporal patterns of phytoplankton is essential for assessing the effects of climate variability and anthropogenic pressures on estuarine ecosystems (Brito et al.,2022; Lima et al.,2023). The objectives of this study were to evaluate the spatiotemporal variation of the phytoplankton community in the Sado Estuary and to understand how physicochemical factors influence its dynamics. Surface water samples were collected between 2018 and 2023 to analyse the local phytoplankton communities. Sampling was carried out at seven sampling stations along the estuarine gradient, from upstream areas to the mouth, including the two main channels (Alcácer and Marateca). Phytoplankton composition was determined using High-Performance Liquid Chromatography - CHEMTAX, allowing the identification and quantification of the main taxonomic groups based on their pigment signatures (chemotaxonomy). Preliminary results showed well-defined spatial and seasonal patterns in the community structure. The salinity gradient exerted a more marked influence than interannual variability. Diatoms (Bacillariophyceae) were the overall dominant group, while small flagellates had a strong contribution to seasonal variability. The phytoplankton community was mostly influenced by temperature, salinity, and suspended particulate matter. This study provides an updated assessment of phytoplankton dynamics in the Sado Estuary and highlights the key environmental drivers behind its dynamics, offering a baseline for long-term monitoring and for scenario analysis.

Keywords: Transitional Waters, Environmental Monitoring, Temperate Estuary, Chemotaxonomy, HPLC-CHEMTAX

Acknowledgments: Joana P. C. Cruz was supported by the doctoral Grant UI/BD/151399/2021 funded by the Fundação para a Ciência e Tecnologia (FCT). Project AQUASADO - Promoting Sustainable Aquaculture in the Sado Estuary (MAR-02.01.91-FEAMP-0051), funded by the Operational Program Mar2020. This research also received further support from Fundação para a Ciência e a Tecnologia (FCT), through the strategic project (UID/MAR/04292/2025) granted to MARE and LA/P/0069/2020 attributed to ARNET. This work benefited from the Infrastructure CoastNet (http://geoportal2.coastnet.pt), funded by FCT and the European Regional Development Fund (FEDER), through LISBOA2020 and ALENTEJO2020 regional operational programmes, in the framework of the National Roadmap of Research Infrastructures of strategic relevance (PINFRA/22128/2016).

References:

Biguino, B., Antunes, C., Dias, J. M., Haigh, I. D., Cruz, J. P. C., Borges, C., Palma, C., Pereira, H., Picado, A., Ferreira, A., *and* Brito, A. C. (2024). Long-term trends (1986–2019) in the physicochemical properties of the Sado Estuary (Portugal) driven primarily by changes in river flow and influenced by marine upwelling. Marine Pollution Bulletin, 207. https://doi.org/10.1016/j.marpolbul.2024.116806

Brito, A. C., Pereira, H., Picado, A., Cruz, J. P. C., Cereja, R., Biguino, B., Chainho, P., Nascimento, Â., Carvalho, F., Cabral, S., Santos, C., Palma, C., Borges, C., *and* Dias, J. M. (2022). How will increased oyster aquaculture in the Sado Estuary (Portugal) threaten ecosystem sustainability? Science of the Total Environment. https://doi.org/https://doi.org/10.1016/j.scitotenv.2022.158898

Cereja, R., Chainho, P., Brotas, V., Cruz, J. P. C., Sent, G., Rodrigues, M., Carvalho, F., Cabral, S., *and* Brito, A. C. (2022). Spatial Variability of Physicochemical Parameters and Phytoplankton at the Tagus Estuary (Portugal). Sustainability (Switzerland), 14(20). https://doi.org/10.3390/su142013324

Kim, D., Sung, J. W., Kim, T. H., Cho, H. M., Kim, J., and Park, H. J. (2023). Comparative seasonality of phytoplankton community in two contrasting temperate estuaries on the western coast of Korea. Frontiers in Marine Science, 10. https://doi.org/10.3389/fmars.2023.1257904

Lima, M. J., Barbosa, A. B., Correia, C., Matos, A., and Cravo, A. (2023). Patterns and Predictors of Phytoplankton Assemblage Structure in a Coastal Lagoon: Species-Specific Analysis Needed to Disentangle Anthropogenic Pressures from Ocean Processes. Water (Switzerland), 15(24). https://doi.org/10.3390/w15244238

Nascimento, Â., Biguino, B., Borges, C., Cereja, R., Cruz, J. P. C., Sousa, F., Dias, J., Brotas, V., Palma, C., *and* Brito, A. C. (2021). Tidal variability of water quality parameters in a mesotidal estuary (Sado Estuary, Portugal). Scientific Reports, 11(1). https://doi.org/10.1038/s41598-021-02603-6

Santos, M., Amorim, A., Brotas, V., Cruz, J. P. C., Palma, C., Borges, C., Favareto, L. R., Veloso, V., Dâmaso-Rodrigues, M. L., Chainho, P., Félix, P. M., *and* Brito, A. C. (2022). Spatio-temporal dynamics of phytoplankton community in a well-mixed temperate estuary (Sado Estuary, Portugal). Scientific Reports, 12(1). https://doi.org/10.1038/s41598-022-20792-6

Xia, J., Hu, H., Gao, X., Kan, J., Gao, Y., and Li, J. (2024). Phytoplankton Diversity, Spatial Patterns, and Photosynthetic Characteristics Under Environmental Gradients and Anthropogenic Influence in the Pearl River Estuary. Biology, 13(7). https://doi.org/10.3390/biology13070550

OC23

TRACKING CHANGES IN PORTUGUESE ESTUARIES: THE COASTNET PERSPECTIVE

Rui Cereja*[1], Joana P. C. Cruz[1], Luciane Favareto[1], Carlos Alexandre[2], Helena Adão[2], Bernardo R. Quintella[1,3], Paula Chainho[1], Susana França[1] José Lino Costa[1,3], and Ana C. Brito[1,3]

[1] MARE – Marine and Environmental Sciences Centre/ ARNET — Rede de Investigação Aquática, Faculty of Sciences of the University of 1749-016 Lisbon, Portugal
rfcereja@fc.ul.pt, jpcruz@fc.ul.pt, lrfavareto@fc.ul.pt*, pmchainho@ciencias.ulisboa.pt, sofranca@ciencias.ulisboa.pt*
[2] MARE – Marine and Environmental Sciences Centre/ ARNET — Rede de Investigação Aquática, Laboratório de Ciências do Mar (CIEMAR) Universidade de Évora, Av. Vasco da Gama, Apartado 190, 7521-903 Sines, Portugal
cmea@uevora.pt; hadao@uevora.pt
[3] DBio – Departamento de Biologia, Faculdade de Ciências da Universidade de Lisboa, Lisbon, Portugal, 1749-016 Lisboa, Portugal
bsquintella@ciencias.ulisboa.pt, jlcosta@ciencias.ulisboa.pt, acbrito@fc.ul.pt

Abstract: Understanding long-term estuarine dynamics is essential to support ecosystem-based management. CoastNet is a Portuguese research infrastructure that provides continuous high-frequency monitoring of the Mondego, Tagus, and Mira estuaries, operating three multi-sensor platforms along each estuarine gradient. Since 2019, the infrastructure generates harmonized and openly accessible datasets with valuable information for research and management through the CoastNet Geoportal. In this study, variations in chlorophyll *a*, pH, dissolved oxygen, salinity, and temperature were analysed for the 2019–2025 period to assess spatial and interannual patterns across the three estuaries. Spatially, preliminary results reveal higher chlorophyll *a* concentrations, elevated pH, and greater seasonal temperature amplitude at the upstream station of the Tagus Estuary. The Mondego and Mira estuaries exhibited comparable spatial patterns; however, higher pH values were observed at downstream stations, consistent with expected estuarine gradients. Interannual variability revealed increasing trends in chlorophyll *a* and temperature in the Tagus and Mira estuaries over the six-year period, while dissolved oxygen and salinity tended to decrease at upstream stations. In contrast, the Mondego Estuary did not display marked interannual trends during the analysed period. All estuaries exhibited pronounced seasonal variability in temperature and salinity, as expected for temperate estuarine systems. Chlorophyll *a* concentrations reached their highest values between May and October, with multiple peaks occurring during this period.

Keywords: Infrastructure, Chlorophyll *a*, Interannual variation, Seasonal variations

Acknowledgments: This work benefited from CoastNet Research Infrastructure (http://coastnet.pt, PINFRA/22128/2016, MAR-016.9.1-FEAMPA-00010 and LISBOA2030-FEDER-01319200), which is included in the National Roadmap of Research Infrastructures of strategic relevance. This work was also funded by the UID/04292/2025, attributed to MARE and LA/P/0069/2020 attributed to ARNET. CoastNet has also benefited from CONNECT and CONNECT+, as well as DANUBIUS Implementation Phase Project HORIZON-INFRA-2021-DEV-02-101079778.

OC24

FROM DATA TO PROTECTION: HIGH-RESOLUTION MONITORING SUPPORTING BIVALVE AQUACULTURE IN RIA FORMOSA

A. Cravo*[1], E. Garel[1], J. Jacob[1], E. Macieira[1], and M. Rodrigues[2]

[1] CIMA, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, PORTUGAL
acravo@ualg.pt, egarel@ualg.pt, jjacob@ual.pt, eirodrigues@ualg.pt
[2] Laboratório Nacional de Engenharia Civil, I.P. Avenida do Brasil, 101, 1700-066 Lisboa, PORTUGAL
mfrodrigues@lnec.pt

Abstract: Sustained water quality assessment in coastal environments is fundamental to ensure ecological integrity and socio-economic resilience, particularly in systems that support aquaculture and fisheries. Continuous monitoring allows the identification of alterations associated with natural dynamics or human pressures, enabling proactive management responses. In highly dynamic coastal lagoons, long-term and high-frequency measurements are especially valuable, as they resolve short-lived events, tidal fluctuations, and seasonal signals, while strengthening the performance of forecasting and management models. Under the CONNECT^{+} project, an oceanographic buoy was installed in June 2025 in the Ria Formosa coastal lagoon (southern Portugal), in proximity to bivalve production areas. The buoy carries an NKE multiparametric probe (WIMO model) that records temperature, salinity, pH, and dissolved oxygen (DO) at 15-minute intervals, with data transmitted every six hours in near real time. Monthly maintenance and calibration operations are conducted to guarantee data reliability and equipment security. These parameters are essential for shellfish farming, which is highly sensitive to water quality fluctuations, and thus contribute to safeguarding coastal ecosystems and promoting the regional blue economy. During the first six months of operation (June 2025–January 2026), the system captured variability at multiple temporal scales, including diel cycles, spring–neap oscillations, upwelling episodes, extreme events, and seasonal transitions. Most variables exhibited clear tidal modulation (semi-diurnal and fortnightly), whereas DO and pH showed stronger control by biological activity, particularly photosynthesis and respiration, reflected in pronounced daily cycles. Dissolved oxygen displayed the widest range (4–12 mg L^{-1}; 60–180% saturation), accompanied by pH values between 8.0 and 8.5, underscoring the influence of metabolic processes in this shallow lagoon sector. Importantly, oxygen concentrations consistently remained above the regulatory threshold for shellfish waters (60% saturation). These results provide essential support for aquaculture management, water quality protection, and the continuous validation of the operational model within CONNECT^{+}, with open access through the WebSIG platform.

Keywords: Ria Formosa lagoon, Monitor program, Water quality, High frequency observation

Acknowledgments: The authors acknowledge funding support through P/S 10PS00137 – MERCATOR OCEAN:24263L01-COP-INNO USER-9000. The authors also thank AdA, APA, IPMA, Cooperativa Formosa institutions as well as Olhão Port Authority.

SEASONAL HYDROGRAPHIC STRUCTURE AND NUTRIENT DYNAMICS IN THE ZRMANJA RIVER ESTUARY

N. Cukrov*[1], D. Crmarić[1], T. Bulat[1],M. Lovrić[1], and A. Šiljeg[2]

[1] Division for Marine and Environmental Research, Ruđer Bošković Institute, Zagreb, CROATIA
ncukrov@irb.hr, dcrmaric@irb.hr, tbulat@irb.hr, marinl@irb.hr
[2]*GAL, University of Zadar, Zadar, CROATIA*
asiljeg@unizd.hr

Abstract: Seasonal hydrographic structure and nutrient status were assessed in the Zrmanja river estuary to support baseline characterization and future long-term monitoring of this karst-influenced transitional environment. Water-column profiles were collected at 20 stations (Z1–Z20) in September 2025 and December 2025 using an in situ multiparameter probe measuring temperature, salinity, acidity, turbidity, dissolved oxygen (concentration and saturation) and chlorophyll a. Dissolved nutrients were analysed at five representative stations (Z1, Z2, Z3, Z12 and Z16), including ammonium, phosphate, nitrite, nitrate and silicate.

September captured late-summer conditions characterized by warm waters and predominantly marine salinities, with moderate vertical stratification; dissolved oxygen was generally near saturation and chlorophyll a was low, indicating limited phytoplankton biomass. Under these conditions, nutrient concentrations showed relatively elevated ammonium at several locations, whereas nitrate and silicate were comparatively lower, consistent with enhanced internal recycling and/or biological uptake during the warm season. In contrast, December measurements showed a cold-season regime with markedly lower temperatures, a much broader salinity range, and a strongly two-layered water column reflecting increased freshwater influence overlying a saline bottom layer; dissolved oxygen concentrations were higher, consistent with lower temperature and seasonal ventilation. Coincident with this hydrographic shift, nitrate and silicate increased substantially and phosphate was slightly higher, indicating intensified riverine and catchment-derived inputs during the wetter season and reduced biological demand.

Overall, the combined profiling and nutrient data demonstrate that seasonal changes in freshwater influence and stratification have a primary control on oxygen regime and nutrient availability in the Zrmanja river estuary. The results provide a quantitative reference for detecting future changes, evaluating eutrophication risk, and informing management measures aimed at maintaining water quality and ecosystem functioning.

Keywords: Zrmanja river estuary, Nutrients, Karst

OC26

EVIDENCE FOR INTENSE BENTHIC-PELAGIC COUPLING IN THE GALICIAN RÍAS

J. Severino P. Ibánhez*[1], Esther Barber-Lluch[1], Carolina Gil-Lozano[1], Pablo Álvarez Chaver[2], Christian Martín Moreira[2], Silvia Torres López[2], and Nicolás Villacieros-Robineau[1]

[1] Organic Geochemistry Lab, Oceanography department, Marine Research Institute (IIM-CSIC), Vigo, Spain
jseverino@iim.csic.es, ebarber@iim.csic.es, cgil@iim.csic.es, nvrobineau@iim.csic.es
[2] Unidad de Tecnologías Marinas Centro Tecnológico del Mar-Fundación CETMAR, Vigo, Spain
palvarez@cetmar.org, cmartin@cetmar.org, storres@cetmar.org

Abstract: The Galician Rías Baixas (NW Iberian Peninsula) are the most productive coastal ecosystem of Europe regarding protein extraction for human consumption. This productivity largely relies on seasonal upwelling of nutrient-rich subsurface waters accounting for 58% of the allochthonous nutrient budget of the Ría de Vigo (Fernández et al., 2016). Nevertheless, significant uncertainties remain regarding the ultimate origin of the upwelled nutrient content. Indirect estimates suggest shelf sediment mineralization may drive 50–80% of local primary production (e.g. Álvarez-salgado et al., 1997), implying a critical reliance on a recycling loop with deep implications for ecosystem management.

An autonomous system for radon determination in surface water coupled with high-resolution oceanographic data from an autonomous CTD and DO tethered sliding profiler (Villacieros-Robineau et al., 2024; 2025) were deployed from August 2024 to January 2025 at Marina Davila harbour (Ría de Vigo). The location is representative of prevailing ría´s oceanographic conditions and receives low continental groundwater discharge (Ibánhez et al., 2021). Recorded data captured a succession of upwelling and downwelling events responding rapidly to changes in offshore wind direction and intensity. During downwelling conditions, the entire water column was well oxygenated, while during upwelling oxygen significantly dropped (down to 50% saturation). Radon activities showed high temporal variability but responded neither to tidal modulation nor precipitation. Contrary to expectations if Radon was sourced from land, the lowest activities are associated with downwelling conditions (<50 Bq m^{-3}). Conversely, clear and systematic radon enrichment was observed during upwelling pulses, reaching 400 Bq m^{-3}. These findings evidence significant interaction between upwelled waters and shelf sediments, where mineralized, radon-enriched porewater is released into the water column. This mechanism explains the observed oxygen depletion and implies that a substantial proportion of the nutrients fueling ria productivity originates from the recycling of organic matter in the adjacent shelf.

Keywords: Submarine groundwater discharge, Upwelling ecosystem, Continental shelf, Permeable sediments

Acknowledgments: This work was supported by projects ENVIROSUB (PID2023-153274NB-I00), funded by MCIN/AEI/10.13039/501100011033, SANDINO (ref. 20243MAX002), funded by the RYC-MAX2023 call of CSIC (Spain), INTEGROUNDS (TED2021-130020B-C21), funded by MCIN/AEI/10.13039/501100011033 and the European Union "NextGenerationEU"/PRTR, and UNDERGROUND (ACAM, 2022020014- CA25842) and PROCOAST (ACAM 2022020014 - CA25789), part of the Galicia Marine Science programme which belongs to the Complementary Science Plans for Marine Science of Ministerio de Ciencia, Innovación y Universidades included in the Recovery, Transformation and Resilience Plan (PRTR-C17.I1), funded through Xunta de Galicia with NextGenerationEU and the European Maritime Fisheries and Aquaculture Funds.

References:

Álvarez-salgado, X. A., C. G. Castro, F. F. Pérez, & F. Fraga. 1997. Nutrient mineralization patterns in shelf waters of the Western Iberian upwelling. Cont. Shelf Res. 17: 1247–1270. doi:10.1016/S0278-4343(97)00014-9

Fernández, E., X. A. Álvarez-Salgado, R. Beiras, A. Ovejero, & G. Méndez. 2016. Coexistence of urban uses and shellfish production in an upwelling-driven, highly productive marine environment: The case of the Ría de Vigo (Galicia, Spain). Reg. Stud. Mar. Sci. 8: 362–370. doi:10.1016/j.rsma.2016.04.002

Ibánhez, J. S. P., X. A. Álvarez-Salgado, M. Nieto-Cid, & C. Rocha. 2021. Fresh and saline submarine groundwater discharge in a large coastal inlet affected by seasonal upwelling. Limnol. Oceanogr. 66: 2141–2158. doi:10.1002/lno.11733

Villacieros-Robineau, N., M. E., Garci, & A. Tubío. 2024. Proxecto ProCoast – Primeira adaptación e optimización de perfiladores oceanográficos costeiros. DIGITAL.CSIC. doi:10.20350/digitalCSIC/16749

Villacieros-Robineau, N., P. C. Pardo, L. Millán Fernández, M. Nieto-Cid, J. S. P. Ibánhez, V. Vieitez dos Santos, E. Barber-Lluch, P. Álvarez Chaver, C. Simoes, C. Martín, I. Fraga, S. Torres López, C. G. Castro, & X. A. Álvarez-Salgado. 2025. ProCoast-PCMG Profiler CTD and DO Raw (L0) datasets 2025 in Marina Davila (Ría de Vigo). doi:10.20350/digitalCSIC/17865

OC27

BIOGEOCHEMICAL INTERACTIONS AND DYNAMICS IN METAL−CONTAMINATED ESTUARINE SEDIMENTS

M. Dolores Basallote*[1], Eva Pakostova[2], Carmen Neculita[3], Saša Marcinek[1,4], Julián Blasco[1], and Carlos R. Cánovas[5]

[1] Instituto de Ciencias Marinas de Andalucía, Departamento de Ecología y Gestión Costera, E-11510, Puerto Real, Cádiz, Spain.
mdolores.basallote@csic, julian.blasco@csic.es
[2] School of Natural Sciences, Laurentian University, Sudbury P3E 2C6, ON, Canada
epakostova@laurentian.ca
[3] Research Institute on Mines and Environment (RIME), University of Quebec in Abitibi-Temiscamingue (UQAT), Canada
carmenMihaela.Neculita@uqat.ca
[4] Ruđer Bošković Institute, Zagreb, Croatia
smarcin@irb.hr
[5] Department of Earth Sciences & Research Center on Natural Resources, Health and the Environment, University of Huelva, E-21071, Huelva, Spain
carlos.ruiz@dgeo.uhu.es

Abstract: Microorganisms exert a profound influence on the biogeochemical cycling of metals in environments impacted by Acid Mine Drainage (AMD) (Abramov et al., 2022; Wang et al., 2026). This study investigates the microbial community dynamics across varying contamination levels in the Huelva estuary (SW Spain), a system shaped by millennial-scale mining in the Iberian Pyrite Belt (SW Spain). This estuary provides a unique natural laboratory where metal-laden river inputs interact with seawater, resulting in highly enriched estuarine sediments. To study how metal(loid)s , pH and salinity-driven gradients dictate microbial communities, surface sediments (0–15 cm) were collected across three differently affected sites. Shotgun metagenome sequencing was applied alongside sediment physical-chemical characterization, including pH (3.9 – 8), redox potential (-164 to ±361 mV), electrical conductivity (5 – 19 mS cm^{-1}), mineralogy and particle size distribution. Sediments were characterized as silty loams dominated by quartz, phyllosilicates, and high concentrations of S (up to 36 g kg^{-1}) and metal(loid)s (e.g., Fe reaching 140 g kg^{-1}; As 3 g kg^{-1}; Cu 2 g kg^{-1}). No significant differences were detected in α- or β-diversity between contaminated (C) and uncontaminated (U) samples. The most abundant genus was the marine bacteria *Pseudoalteromonas* (means accounting for 6.7 and 14.8% of total reads in C and U respectively). Sulfur- and/or iron-oxidizers (e.g., *Sulfurovum*) reached 4.4% in C, and sulfate reducers (e.g., *Desulfosarcina*) 2.8%. Importantly, the sediments under marine influence hosted marine Fe(II)-oxidizers (e.g., *Marinobacter*, *Marinomonas),* which are typically absent in acidic environments. In this context, the biogeochemical characterization of contaminated sediments is essential for evaluating contaminant mobilization potential, which can be influenced by changing environmental factors such as rising temperatures or sea level (Kerl et al., 2023). Understanding these interactions is key to predicting sediment stability and supports the integration of microbial ecology into geochemical models for AMD-impacted systems.

Keywords: Iberian Pyrite Belt, DNA metabarcoding, Acid Mine Drainage (AMD), Metal(oid)s, Estuarine sediments

Acknowledgments: M. D. Basallote thanks the Spanish State Research Agency (AEI) for the RYC2022-035326-I grant funded by MICIU/AEI/10.13039/501100011033 and FSE+. This work was supported by the Spanish Ministry of Science, Innovation and Universities under the research project DYNAMICO (PID2023-151504OB-I00) funded by

MICIU/AEI/10.13039/501100011033.

References:

Abramov, S. M., D. Straub, J. Tejada, L. Grimm, F. Schädler, A. Bulaev, H. Thorwarth, R. Amils, A. Kappler & S. Kleindienst (2022). Biogeochemical Niches of Fe-Cycling Communities Influencing Heavy Metal Transport along the Rio Tinto, Spain. Applied and Environmental Microbiology, 88, e02290-21.

Wang, H., X. Li, J. Wang, H. Jin, L. Zhou, H. Yan & Q. Zheng (2026) Uncovering Fe/S-Metabolizing Microorganisms Response to Sharp Geochemical Gradients in a River Affected by Acid Mine Drainage. Bulletin of Environmental Contamination and Toxicology, 116, 43

Kerl, C. F., M. D. Basallote, M. Käberich, E. Oldani, N. P. Cerón Espejo, A. E. Colina Blanco, C. R. Cánovas, J. M. Nieto & B. Planer-Friedrich (2023) Consequences of sea level rise for high metal(loid) loads in the Ría of Huelva estuary sediments. Science of The Total Environment, 873, 162354

OC28

LONG-TERM VARIATION IN TRACE METALS CONCENTRATIONS IN THE SEDIMENTS OF SADO ESTUARY (PORTUGAL) (1986-2020)

José Miguel Almeida*[1], Carla Palma[1], Pedro M. Félix[2], and Ana C. Brito[3,4]

[1] Instituto Hidrográfico, Rua das Trinas 49, 1249-093 Lisboa, Portugal.
vaz.almeida@hidrografico.pt, carla.palma@hidrografico.pt
[2] MARE—Marine and Environmental Sciences Centre/ARNET—Aquatic Research NETwork, School of Technology of Setubal, Polytechnic Institute of Setubal, Campus Estefanilha, 2910-761 Setubal, Portugal.
pmfelix@ciencias.ulisboa.pt
[3] MARE—Marine and Environmental Sciences Centre/ARNET—Aquatic Research NETwork, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal.
acbrito@ciencias.ulisboa.pt
[4] Departamento de Biologia, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Abstract: Estuaries have been preferential sites for human settlement due to favourable conditions such as weather stability, food and fresh water supply. As a result, pollution issues have been present in these waterbodies, such as trace metals that deposit in the sediments. For a long-term evaluation of trace metals in the sediments of the Sado estuary (Portugal), concentrations measured in samples collected between 2018 and 2020 for the AQUASADO project were compared with an historical dataset from Instituto Hidrográfico, covering the period between 1986 and 2010. The samples were analysed by Atomic Absorption Spectroscopy and a Direct Mercury Analyser. Overall, trace metal concentrations tended to stabilise during the last years of the historical dataset, a pattern that was also observed in the more recent period. However, in 2019 there was an increase in concentrations of the semimetal arsenic, copper, lead and zinc, as well as in the percentages of finer sediments, particularly in the station closest to the industrial area. The 2019 sampling period coincided with dredging activities in the estuary, which may justify the higher values registered. In 2020 trace metal concentrations returned to levels similar to those observed in 2018 and in the last years of the historic dataset. Strong correlations between organic content, granulometry and trace metal concentrations were observed at stations less exposed to tides and near the industrial area, while pollution indexes demonstrated that these areas showed the highest levels of enrichment and contamination, while the stations close to the estuary's' mouth exhibited comparatively lower levels. This study allowed an analysis of trace metals in the Sado estuary covering a period in which environmental legislation and monitoring programmes were implemented to maintain or improve the estuary's health, as well as dredging activities important for the navigability of the estuary.

Keywords: Environmental quality, Monitoring, Historical data, Pollution.

Acknowledgments: This work was developed within the framework of AQUASADO Project (MAR – 02.01.01-FEAMP-0051) – Promoting sustainable aquaculture in the Sado estuary. It also received support from CoastNet Infrastructure (PINFRA/22128/2016). This work was also supported by national funds through FCT - Fundação para a Ciência e a Tecnologia, I.P., within the scope of the projects UID/04292/2025 and UID/PRR/04292/2025 awarded to MARE and through project LA/P/0069/2020 (doi:10.54499/LA/P/0069/2020) granted to the Associate Laboratory ARNET. A.C. Brito was partially funded by the Scientific Stimulus Program (CEECIND/00095/2017).

OC29

HIGH-RESOLUTION SPATIAL DISTRIBUTIONS OF TOXIC METALS WITHIN INTERTIDAL MUD BANKS OF A CONTAMINATED ESTUARY (AULNE, BAY OF BREST)

Loïc MADEC*[1], Jérôme GOSLIN[1], Nicolas BRIANT[2], and Matthieu WAELES[3]

[1] Geo-Ocean, Ifremer, Univ Brest, CNRS, UMR6538, F-29280, Plouzane, France.
loic.madec@ifremer.fr, jerome.goslin@ifremer.fr
[2] Ifremer, CCEM Contamination Chimique des Ecosystèmes Marins, F-44000, Nantes, France.
nicolas.briant@ifremer.fr
[3] Univ Brest, IRD, CNRS, Ifremer, LEMAR, IUEM, F-29280 Plouzané, France.
matthieu.waeles@univ-brest.fr

Abstract: The measurement of metals in sediments is generally based on two approaches: a global approach, based on surface sampling to assess the spatial contamination in a given area, and a discrete approach, using sedimentary cores to reconstruct depositional chronology. However, these methods are limited as they do not consider the variety of hydro-sedimentary processes and sediment characteristics that can occur from the top to the bottom of mud banks.
This study proposes an original approach involving the analysis of transects on two mud banks located upstream and downstream of a macrotidal estuary (the Aulne in the Bay of Brest). This estuary is known to be contaminated with Pb, Zn, Cd, Ag and Cu, primarily due to mining activities in the 18th and 19th centuries (Briant et al. 2026; Goslin et al. 2026). Each transect included at least six two-metre-deep cores, arranged perpendicular to the river flow.
The profiles revealed a highly polluted layer generally located at a depth of ~1 m in of the mud banks, near the salt marsh with enrichment factors (EF) up to 70, 35, 230, 30 and 5 for Pb, Zn, Cd, Ag and Cu, respectively. However, notable differences in distribution were found within each bank. Compared to the top of the bank, deeper, thicker and attenuated maxima were found slightly further down with some elements exhibiting homogeneous distributions at the bottom of the bank. These results highlight the importance of hydro-sedimentary processes in the spatial distribution of metals as well as the need for rigorous sampling site selection.

Keywords: Metals, Contamination, Mud banks, Sediment dynamic

Acknowledgments: This study was funded by the Loire-Bretagne water agency as part of the RELEASE project (2026-2028).

References:

Briant, N., Waeles, M., Goslin, J., Madec, L., Bruzac, S., Bastien, T., Sireau, T., F. Araújo, D., Ponzevera, E., & Grouhel Pellouin, A. (2026). Distribution of trace elements and Pb contamination in the sediment of Bay of Brest under the influence of the Aulne River (Brittany, France). Marine Pollution Bulletin. (submitted)

Goslin, J., Briant, N., Schmidt, S., Madec, L., Girardot, M., & Waeles, M. (2026). Legacy heavy metal pollution from ancient silver-lead mines : Chronicles from the Aulne estuary sedimentary banks (Brittany, France). Marine Pollution Bulletin. (submitted)

Poster Communications

P01

GREENHOUSE GASES VARIABILITY AND EMISSIONS IN DIFFERENT COASTAL SYSTEMS OF SW IBERIAN PENINSULA

A. Sierra-Padilla*[1], E. Capilla[1], J. Sanchez-Rodriguez[1], M.C. Fernandez-Puga[2], R. Ponce[1], E. García-Luque[1], J. Forja[1], and T. Ortega[1]

[1] Department of Chemistry-Physics, Marine Research Institute (INMAR), University of Cádiz, Cádiz, SPAIN.
ana.sierra@uca.es
[2] Department of Earth Sciences, Marine Research Institute (INMAR), University of Cádiz, Cádiz, SPAIN.

Abstract: Coastal zones are highly affected by human activities and represent sources of greenhouse gases (GHG) – CO2, CH4 and N2O - to the atmosphere. These areas are characterized by high productivity and by receiving significant amounts of organic matter and nutrients. This study was carried out in the Bay of Cadiz Natural Park. The bay is affected by anthropogenic pressure such as fish farms or wastewater treatment plants (WWTP) in the most internal zones, and is connected to the Atlantic Ocean by Cadiz Bay. The main objective is to determinate the influence of anthropogenic activity and to assess the role of this area as a source or sink of GHG to the atmosphere. To this end, longitudinal samplings along the salinity gradient were carried out at three different ecosystems of the Bay of Cadiz Natural Park (the Guadalete estuary-GT, the Rio San Pedro creek-RSP, and the Sancti Petri channel-CSP) while in the internal and external zone of the bay, several stations were established to cover the heterogeneity of the zone. In this study, GHG were measured in surface water during summer 2025 and winter 2026. pCO2 was calculated from pH and Total Alkalinity (TA), measured by potentiometric titration (Metrohm 905), and the dissolved concentration of CH4 and N2O was determined using a headspace technique in a gas chromatograph (BrukerR GC-450). GHG show seasonal and temporal variability. The highest concentrations (pCO2: 2000 μatm, CH4: 950 nM, N2O: 180 nM) were found in the innermost zone of GT, RSP and CSP, in the vicinity of the pollution sources, as a consequence of an intensification of the organic matter degradation processes. The mean water-atmosphere fluxes were positive indicating that the study area acts as a source of GHG to the atmosphere.

Keywords: Greenhouse gases, Coastal zones, Water-atmosphere fluxes

Acknowledgments: A. Sierra was funded by Junta de Andalucia/CUII and FSE+ under contract DG_POST_2024_00087. E. Capilla-Garcia was financed by the Spanish Ministry of Education with a FPI fellowship. This work was supported by research projects FEDERUCA-2024-A1-45 and PID2023-150230NB-C21.

P02

ISOTOPIC COMPOSITION OF DISSOLVED INORGANIC CARBON IN COASTAL SEDIMENT POREWATER: A METHODOLOGICAL APPROACH

J. Sanchez-Rodriguez[1], A. Sierra[2], E. Capilla[2], T. Ortega[2], and J. Forja[2]

[1]Instituto Universitario de Investigación Marina (INMAR), Campus de Puerto Real, Universidad de Cádiz, Puerto Real, España.
[2]Departamento de Química-Física, Instituto Universitario de Investigación Marina (INMAR), Campus de Puerto Real, Universidad de Cádiz, Puerto Real, España.
jairo.sanchez@uca.es, ana.sierra@uca.es, eva.capilla@ uca.es, teodora.ortega@uca.es, jesus.forja@uca.es

Abstract: Coastal and estuarine systems generally act as intense sources of CO_2 to the atmosphere. The isotopic composition of dissolved inorganic carbon (δ^{13}C-DIC) is a powerful tracer for understanding carbon cycling in these environments, as it integrates information on DIC sources and the processes regulating its dynamics.
This study presents δ^{13}C-DIC measurements in sediment porewaters from the Bay of Cádiz (SW Iberian Peninsula), including the outer and inner bay, the Guadalete River estuary, the San Pedro River and Caño Sancti Petri. For isotopic analysis, a specific analytical methodology was developed and applied for δ^{13}C-DIC determination in sediment porewater. Briefly,1 mL of porewater was introduced into a 12 mL airtight vial previously flushed with He (100 mL min^{-1} for 10 min). Subsequently, 50 µL of 2 M phosphoric acid were added to ensure pH < 2 and complete conversion of DIC to CO_2. After 24 h equilibration, δ^{13}C-DIC was measured using a liquid–gas equilibration system (Thermo, GasBench Plus) coupled to an isotope ratio mass spectrometer (Thermo, Delta Q). The system was calibrated daily with IAEA603 and NBS18 carbonate standards. External accuracy, assessed against these reference materials, showed a relative error lower than 0.05%. DIC concentrations in porewater were determined by potentiometric titration of 2 mL aliquots (Metrohm, 905), with a precision of 5 µM.
The vertical distribution of δ^{13}C-DIC shows more negative values in surface sediments, reflecting the influence of aerobic oxidation and sulphate reduction of organic matter. A marked enrichment in ^{13}C is observed in deeper layers, likely associated with methanogenesis, which preferentially removes ^{12}C and leads to progressive ^{13}C enrichment of the residual DIC pool.

Keywords: Stable Isotopes, Dissolved Inorganic Carbon, Coastal Sediments Porewater

Acknowledgments: This work was carried out in the marine stable isotopes laboratory of the Marine Research Institute (INMAR) of University of Cádiz (EQC2021-007548-P). E. Capilla-García was financed by the Spanish Ministry of Education with a FPI fellowship (XX) and A. Sierra by Junta de Andalucia/CUII and FSE+ under contract DG_POST_2024_00087. This work was supported by research projects FEDER-UCA-2024-A1-45 and PID2023-150230NB-C21.

P03

CHARACTERIZATION OF DISSOLVED ORGANIC MATTER IN THE LA PAZ COASTAL LAGOON, BCS, MÉXICO.

E.D. Sánchez-Pérez*[1], E. Ortega- Retuerta[2], A. Paulmier[3], B. Marie[2], P. Catalá[2], S. López-López[4], and A.R. Rosales-Villa[4]

[1] Instituto Politécnico Nacional - Centro Interdisciplinario de Ciencias Marinas-Secretaría de Ciencia, Humanidades, Tecnología e Innovación, Avenida IPN, s/n, Colonia Playa Palo de Santa Rita, C.P. 23096, La Paz, Baja California Sur, México.
esanchezp@secihti.mx
[2] Laboratoire d'Océanographie Microbienne, UMR 7621 - Observatoire Océanologique de Banyuls-sur-Mer, C.P. 66650, Banyuls-sur-Mer, France.
eva.ortega-retuerta@obs-banyuls.fr, barbara.marie@obs-banyuls.fr, philippe.catala@obs-banyuls.fr
[3]Institut de Recherche pour le Développement-LEGOS, 14 avenue Edouard Belin, C.P. 31401, Toulouse, France.
aurelienlegos@gmail.com
[4]Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, Avenida IPN, s/n Colonia Playa Palo de Santa Rita, C.P. 23096, La Paz, Baja California Sur, México.
silopez@ipn.mx, arosalev@ipn.mx

Abstract: Dissolved Organic Matter (DOM) is the base substrate of the trophic chain in marine and coastal ecosystems, and its dynamics are influenced by different physicochemical and biological processes that modify its bioreactivity. In this study, DOM was characterized for the first time in the La Paz coastal lagoon using optical properties (Fluorescent, DOM-F, and Chromophoric, DOM-C), which allow us to identify its origin, transformation, and seasonal variations. For this purpose, three samplings were conducted on a network of stations inside and outside the lagoon, where DOM was characterized along with other environmental variables (temperature, salinity, oxygen, nutrients) and biological (phytoplankton and bacteria). The outside stations showed warmer, less saline waters influenced by water from the Gulf of California. Whereas, inside the lagoon, the water was more saline and less oxygenated due to high evaporation and low renewal. Inside the lagoon, DOM-C and humic-type DOM-F dominated, especially in summer, associated with high salinity values and low productivity, indicating the presence of potentially recalcitrant material as a result of internal processes of evaporation and remineralization, while protein-like DOM was related to chlorophyll, indicating a probable microbial origin. This research represents the first study that incorporates such variables in this region and underscores the importance of integrating DOM into coastal dynamics studies, providing a basis to understand the biogeochemical processes that govern semi-enclosed coastal systems.

Keywords: Dissolved Organic Matter; Fluorescent, Chromophoric; Environmental parameters; Coastal lagoon.

References:

Cauwet, G. (1994). HTCO method for dissolved organic carbon analysis in seawater: influence of catalyst on blank estimation. Marine Chemical. 47, 55-64.

Nieto-Cid, M., Álvarez-Salgado, X.A., Pérez, F.F. (2006). Microbial and photochemical reactivity of fluorescent dissolved organic matter in a coastal upwelling system. Limnology Oceanography. 51,1391-1400.

Lavín, M.F., Castro, E., Beier, E., Cabrera, C., Godínez, V.M., Amador-Buenrostro, A. (2014). Surface circulation in the Gulf of California in summer from surface drifters and satellite images (2004–2006). Geophysical Research. 119, 4278–4290.

Sánchez-Pérez, E.D., Pujo-Pay, M., Ortega-Retuerta, E., Conan, P., Peters, F., Marrasé, C. (2020). Mismatched dynamics of dissolved organic carbon and chromophoric dissolved organic matter in the coastal NW Mediterranean Sea. Science of the Total Environment, 746.

P04

TIDAL EFFECTS ON WATER QUALITY AND PHYTOPLANKTON COMMUNITIES IN THE SADO ESTUARY

Rui Cereja[1], Joana P. C. Cruz[1], Ângela Nascimento[1,2], Beatriz Biguino[1], Carlos Borges[2], Fátima Sousa[1,3], Joaquim Dias[1,3], Vanda Brotas[1,4], Carla Palma[2], and Ana C. Brito[1,4]

[1] MARE – Marine and Environmental Sciences Centre, Faculty of Sciences, University of Lisbon, 1749-016, Lisbon, Portugal
rfcereja@fc.ul.pt, jpcruz@fc.ul.pt; bibiguino@ciencias.ulisboa.pt
[2] Instituto Hidrográfico, Rua das Trinas 49, 1249-093, Lisbon, Portugal
carlos.borges@hidrografico.pt; carla.palma@hidrografico.pt
[3] Departamento de Ciências da Terra e Energia (DCTE), Faculty of Sciences, University of Lisbon, 1749-016, Lisbon, Portugal
fsousa@ciencias.ulisboa.pt; jdias@ciencias.ulisboa.pt
[4]Departamento de Biologia (DBio), Faculty of Sciences, University of Lisbon, 1749-016, Lisbon, Portugal
vbrotas@fc.ul.pt; *acbrito@fc.ul.pt*

Abstract: Tidal variability strongly influences estuarine environmental conditions and represents a key driver of estuarine ecology. Estuarine phytoplankton is one of the main contributors to estuarine productivity and an important bioindicator of water quality. However, the effects of tidal variability on estuarine phytoplankton communities are often difficult to analyse due to the interaction with other effects as seasonality and atmospheric variables (e.g. temperature and radiation). The primary aim of this study was to assess how water-quality parameters and the phytoplankton community in the Sado Estuary respond to fortnightly and semidiurnal tidal variability. Temperature, salinity, pH, phytoplankton pigments, dissolved nutrients, suspended particulate matter, and dissolved oxygen were measured at each station. Sampling campaigns were conducted for around 10 hours each day (sampling the low-high and high-low tide transitions), in 8 and 15 of May 2018, 8 and 16 of November 2018, and 18 and 26 of June 2019, during both neap and spring tides, with measurements collected in intervals of 1.5 to 2 hours at four locations along the estuary. Nutrients and temperature presented their lowest values during high tide. Spring exhibited the highest chlorophyll *a* concentrations which responded to the tidal cycle with lower chlorophyll *a* concentrations during the flood tide. Regarding community composition, Bacillariophyceae were in general the dominant group at all sampling stations in all of the analysed tidal cycles; however, their relative contribution varied with tide, with higher Bacillariophyceae percentages during low and flood tides. The fortnightly cycle exerted its strongest influence at the inner sampling station, where riverine input increased markedly during spring ebb and low tides, accompanied by enhanced turbidity.

Keywords: Mesotidal estuary, Fortnight cycle, Semidiurnal cycle, Community composition, Seasonal variations.

Acknowledgments: Project AQUASADO - Promoting Sustainable Aquaculture in the Sado Estuary (MAR-02.01.91-FEAMP-0051), funded by the Operational Program Mar2020. This research also received further support from Fundação para a Ciência e a Tecnologia (FCT), through the strategic project (UID/MAR/04292/2025) granted to MARE and LA/P/0069/2020 attributed to ARNET. This work benefited from the Infrastructure CoastNet, funded by FCT and the European Regional Development Fund (FEDER), through LISBOA2020 and ALENTEJO2020 regional operational programmes, in the framework of the National Roadmap of Research Infrastructures of strategic relevance (PINFRA/22128/2016). Joana P.C. Cruz acknowledges the PhD scholarship UI/BD/151399/2021 awarded by FCT.

P05

ECOLOGICAL STATUS ASSESSMENT BASED ON DISSOLVED NUTRIENTS AND PHYTOPLANKTON IN THE SADO ESTUARY (2018−2023)

Joana P. C. Cruz[1], Joshua Heumüller[1], Beatriz Biguino[1], Filipa Afonso[2], Rui Cereja[1], Carlos Borges[3], Carla Palma[3], and Ana C. Brito[1,4]

[1] MARE – Centro de Ciências do Mar e do Ambiente, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal.
jpcruz@ciencias.ulisboa.pt, *jaheumuller@ciencias.ulisboa.pt, bibiguino@ciencias.ulisboa.pt, rfcereja@ciencias.ulisboa.pt*
[2] Marine Institute, Galway, Ireland.
filipa.afonso@marine.ie
[3] Instituto Hidrográfico, Rua das Trinas 49, 1249-093, Lisbon, Portugal.
carlos.borges@hidrografico.pt, carla.palma@hidrografico.pt
[4] DBio – Departamento de Biologia, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal.
acbrito@ciencias.ulisboa.pt

Abstract: Within the Water Framework Directive, estuaries are classified as "transitional waters", and the assessment of their ecological status depends on several biological elements and supporting physicochemical features. Among these, dissolved inorganic nutrients, particularly nitrogen and phosphorus, and chlorophyll-a (proxy of phytoplankton biomass). Phytoplankton being widely recognized as a sensitive indicator of the ecosystems' response to variations in nutrient loads (Brito et al., 2020; Longphuirt et al., 2019; Martinez-Haro et al., 2022; Mischke et al., 2011; Reyjol et al., 2014), and used to set classes for ecological status in Portuguese transitional waters (Brito et al., 2012; Cereja et al., 2022a; Cereja et al., 2022b; Cereja et al., 2021). The Sado Estuary constitutes a highly dynamic transitional system, strongly influenced by salinity gradients, tidal regimes, and anthropogenic pressures, which influence nutrient availability and primary productivity (Bald et al., 2005; Brito et al., 2020; Santos et al., 2022). This study aimed to evaluate the ecological status of the Sado estuary, considering seven sampling points distributed along the estuarine gradient. This research includes four years of monitoring data, between monthly sampling 2018 and 2022 and bimonthly sampling in 2023, allowing the analysis of intra- and interannual patterns as well as, the evaluation of the trophic conditions of the system. Results highlighted a strong seasonal pattern in the variation of nutrients and chlorophyll-a. Interannual variation was also relevant. Overall, this study unravelled an excellent ecological quality for this period, suggesting that the system maintains a high resilience capacity. These results reinforce the importance of continuous and integrated monitoring programs, which are fundamental for the early detection of environmental changes, understanding long-term trends, and supporting sustainable management strategies, particularly in a context of increasing human pressure and global environmental changes.

Keywords: Transitional waters, Water Framework Directive, Environmental Monitoring, Temperate Estuary

Acknowledgments: Joana P. C. Cruz was supported by the doctoral Grant UI/BD/151399/2021 funded by the Fundação para a Ciência e Tecnologia (FCT). Project AQUASADO - Promoting Sustainable Aquaculture in the Sado Estuary (MAR-02.01.91-FEAMP-0051), funded by the Operational Program Mar2020. This research also received further support from Fundação para a Ciência e a Tecnologia (FCT), through the strategic project (UID/MAR/04292/2025) granted to MARE and LA/P/0069/2020 attributed to ARNET. This work benefited from the Infrastructure

CoastNet (http://geoportal2.coastnet.pt), funded by FCT and the European Regional Development Fund (FEDER), through LISBOA2020 and ALENTEJO2020 regional operational programmes, in the framework of the National Roadmap of Research Infrastructures of strategic relevance (PINFRA/22128/2016).

References:

Bald, J., Borja, A., Muxika, I., Franco, J., and Valencia, V. (2005). Assessing reference conditions and physico-chemical status according to the European Water Framework Directive: A case-study from the Basque Country (Northern Spain). Marine Pollution Bulletin, 50(12), 1508–1522. https://doi.org/10.1016/j.marpolbul.2005.06.019

Brito, A. C., Brotas, V., Caetano, M., Coutinho, T. P., Bordalo, A. A., Icely, J., Neto, J. M., Serôdio, J., and Moita, T. (2012). Defining phytoplankton class boundaries in Portuguese transitional waters: An evaluation of the ecological quality status according to the Water Framework Directive. Ecological Indicators, 19, 5–14. https://doi.org/10.1016/j.ecolind.2011.07.025

Brito, A. C., Garrido-Amador, P., Gameiro, C., Nogueira, M., Moita, M. T., and Cabrita, M. T. (2020). Integrating in situ and ocean color data to evaluate ecological quality under the water framework directive. Water (Switzerland), 12(12), 1–24. https://doi.org/10.3390/w12123443

Cereja, R., Brotas, V., Cruz, J. P. C., Rodrigues, M., and Brito, A. C. (2021). Tidal and Physicochemical Effects on Phytoplankton Community Variability at Tagus Estuary (Portugal). Frontiers in Marine Science, 8. https://doi.org/10.3389/fmars.2021.675699

Cereja, R., Brotas, V., Nunes, S., Rodrigues, M., Cruz, J. P. C., and Brito, A. C. (2022a). Tidal influence on water quality indicators in a temperate mesotidal estuary (Tagus Estuary, Portugal). Ecological Indicators, 136. https://doi.org/10.1016/j.ecolind.2022.108715

Cereja, R., Chainho, P., Brotas, V., Cruz, J. P. C., Sent, G., Rodrigues, M., Carvalho, F., Cabral, S., and Brito, A. C. (2022b). Spatial Variability of Physicochemical Parameters and Phytoplankton at the Tagus Estuary (Portugal). Sustainability (Switzerland), 14(20). https://doi.org/10.3390/su142013324

Longphuirt, S. N., McDermott, G., O'Boyle, S., Wilkes, R., and Stengel, D. B. (2019). Decoupling abundance and biomass of phytoplankton communities under different environmental controls: A new multi-metric index. Frontiers in Marine Science, 6(JUN). https://doi.org/10.3389/fmars.2019.00312

Martinez-Haro, M., Acevedo, P., Pais-Costa, A. J., Neto, J. M., Vieira, L. R., Ospina-Alvarez, N., Taggart, M. A., Guilhermino, L., Ribeiro, R., and Marques, J. C. (2022). Ecotoxicological tools in support of the aims of the European Water Framework Directive: A step towards a more holistic ecosystem-based approach. Ecological Indicators, 145. https://doi.org/10.1016/j.ecolind.2022.109645

Mischke, U., Venohr, M., and Behrendt, H. (2011). Using Phytoplankton to Assess the Trophic Status of German Rivers. International Review of Hydrobiology, 96(5), 578–598. https://doi.org/10.1002/iroh.201111304

Reyjol, Y., Argillier, C., Bonne, W., Borja, A., Buijse, A. D., Cardoso, A. C., Daufresne, M., Kernan, M., Ferreira, M. T., Poikane, S., Prat, N., Solheim, A. L., Stroffek, S., Usseglio-Polatera, P., Villeneuve, B., and van de Bund, W. (2014). Assessing the ecological status in the context of the European Water Framework Directive: Where do we go now? In Science of the Total Environment (Vols. 497–498, pp. 332–344). Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2014.07.119

Santos, M., Amorim, A., Brotas, V., Cruz, J. P. C., Palma, C., Borges, C., Favareto, L. R., Veloso, V., Dâmaso-Rodrigues, M. L., Chainho, P., Félix, P. M., and Brito, A. C. (2022). Spatio-temporal dynamics of phytoplankton community in a well-mixed temperate estuary (Sado Estuary, Portugal). Scientific Reports, 12(1). https://doi.org/10.1038/s41598-022-20792-6

P06

SEASONAL–TIDAL FORCING OF HYDROGRAPHIC AND OXYGEN DYNAMICS IN A TROPICAL ESTUARY - BONS SINAIS (MOZAMBIQUE)

Inocência Paulo[1,2,3*], Alexandra Cravo[1], Vânia Baptista[2], and Fialho Nehama[3]

[1] Centro de Investigação Marinha e Ambiental (CIMA/ARNET LA), FCT, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, PORTUGAL. *inocenciaantoniopaulo@gmail.com, acravo@ualg.pt*
[2] Centro de Ciências do Mar (CCMAR/ CIMAR LA), FCT, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, PORTUGAL
vcbaptista@ualg.pt
[3] Escola Superior de Ciências Marinhas e Costeiras (ESCMC), Universidade Eduardo Mondlane, Quelimane 2400, MOZAMBIQUE
fialho.nehama@gmail.com

Abstract: The Bons Sinais Estuary (central Mozambique) is a shallow (~10 m), meso- to macro-tidal tropical system bordered by mangroves and discharging into the Indian Ocean at the Sofala Bank. It supports diverse and socio-economically important fisheries resources while providing essential ecosystem services, although it is subject to varying anthropogenic pressures along its length. The estuary experiences semi-diurnal tides reaching ~4 m during spring tides and pronounced seasonal variability in freshwater discharge. Circulation is predominantly tidal-driven and classified as mixed to partially mixed, with stratification occurring mainly during neap tides and periods of increased river inflow. The regional climate is humid subtropical, with a hot rainy season (November–April) and a cooler dry season (May–October). Annual rainfall ranges from 1140 to 1400 mm, approximately 80% of which falls during the rainy season, with peak river discharge (500–840 $m^3 s^{-1}$) between January and April. This study assesses how seasonal and tidal variability regulate longitudinal gradients of salinity, temperature, and dissolved oxygen (DO) during the transition season (September 2025) and the rainy season (February 2026). Longitudinal hydrographic profiles were obtained along the 30 km estuarine axis using a SeaGuard RCM SW (model 4430; Aanderaa Data Instruments), equipped with temperature, conductivity and dissolved oxygen sensors. Measurements were taken at surface and bottom under contrasting tidal conditions (spring and neap) and phases (flood and ebb). In September, reduced river discharge enhanced marine intrusion (S=18–34), temperatures ranged from 24–27 °C, and DO from 3–7.5 mg L^{-1}, generally increasing seaward under strong tidal mixing. In February, increased freshwater input reduced upstream salinity (~5), temperatures rose to 28–31 °C, and DO vary between 2.6 and 9.5 mg L^{-1}, with the extreme values at the middle estuary. These data showed that tidal hydrodynamics, seasonal and anthropic forcing strongly structure estuarine water quality.

Keywords: Bons Sinais Estuary; Salinity; Dissolved oxygen; Tidal dynamics; Seasonal variability.

Acknowledgments: This work was funded by FCT PhD grant, ref. PRT/BD/154662/2022

P07

ANTIFOULING BOOSTER BIOCIDES IN SEDIMENTS OF TROPICAL ESTUARIES IN PERNAMBUCO, BRAZIL

Bruna Santana de Morais*[1], Fiamma Eugênia Lemos Abreu[2], and Eliete Zanardi-Lamardo[2]

[1] Post Graduate Program in Oceanography, Department of Oceanography, Federal University of Pernambuco (UFPE), Recife, Brazil.
bruna.smorais@ufpe.br
[2] Department of Oceanography, Federal University of Pernambuco (UFPE), Recife, Brazil.
fiamma.abreu@ufpe.br, *eliete.zanardi@ufpe.br*

Abstract: Antifouling biocides are organic compounds widely used in marine paints to prevent biofouling on submerged structures. These contaminants are typically associated with areas of vessel maintenance and repair, such as marinas and shipyards. Co-biocides (or booster biocides) are added to broaden the antifouling spectrum against copper-resistant species. Irgarol, DCOIT, dichlofluanid, and chlorothalonil are among the most applied compounds. Despite their extensive use, there is currently no specific legislation or monitoring programs addressing these contaminants in Brazil, limiting the understanding of their environmental occurrence and ecological risks. This study assessed sediment contamination by antifouling booster biocides in two tropical estuarine systems in northeastern Brazil: the Rio Formoso Estuarine System and the Mamucabas and Ilhetas Estuarine System. Surface sediments were collected at eight sampling sites during rainy and dry seasons. The analytical method, based on ultrasound-assisted extraction, solid-phase extraction cleanup, and gas chromatography–mass spectrometry (GC–MS), was optimized for sediment matrices. The Risk Quotient (RQ) was calculated as RQ = MEC/PNEC following international guidelines. All compounds showed good linearity (1–500 ng g^{-1}; $r^2 > 0.999$), precision (<20%), and acceptable accuracy (40–120%). During the rainy season, chlorothalonil was detected at a single site (5.2 ng g^{-1}). Irgarol, DCOIT, and dichlofluanid ranged from 1.8–107 ng g^{-1}, 14.8–26.8 ng g^{-1}, and 6.7–38.3 ng g^{-1}, respectively. In the dry season, concentrations ranged from 2.1–22.1 ng g^{-1} (Irgarol), 6.7–9.3 ng g^{-1} (DCOIT), and 3–31 ng g^{-1} (dichlofluanid). The highest concentrations were observed near marinas and areas of intense vessel traffic and aquaculture activities. Risk assessment indicated high ecological risk (RQ ≥ 1) for Irgarol and DCOIT, moderate risk for dichlofluanid, and low risk for chlorothalonil (RQ ≤ 0.1). These findings provide baseline data on antifouling biocides in Brazilian estuaries and support future monitoring and regulatory actions.

Keywords: Environmental risk assessment, Irgarol, DCOIT, Dichlofluanid, Chlorothalonil

Acknowledgments: The authors acknowledge PELD-TAMS (446012/2024-6), CNPq (409498/2021–1), and CAPES for the scholarship provided.

References:

Almeida, E., Diamantino, T.C., De Sousa, O. Progress in Organic Coatings 59, 2–20. 2007
ECHA, 2017. Guidance on the Biocidal Products Regulation. European Chemicals Agency, Helsinki, Finland, pp. 105.

P08

ASSESSMENT OF PLASTIC POLLUTION IN NAMIBE BAY, ANGOLA

Bernardo Malongo José[1,2,3*], Lia Vasconcelos[1,2], and Marta Susana Gouveia Martins[1,2*]

[1] Department of Environmental Sciences and Engineering, NOVA School of Science and Technology, NOVA University Lisbon, Caparica, PORTUGAL.
[2] Marine and Environmental Sciences Centre, Aquatic Research Network Associate Laboratory, NOVA School of Science and Technology, NOVA University Lisbon, Caparica, PORTUGAL.
bernardojose1987@hotmail.com, ltv@fct.unl.pt, marta.martins@fct.unl.pt
[3] UNINBE, University of Namibe, Angola

Abstract: The challenges of improving and maintaining the environmental quality of marine and coastal ecosystems in Angola in the face of plastic pollution are growing and are a major concern. This study was carried out in Namibe Bay, Angola, with the aim of assessing its environmental quality based on the identification and characterisation of plastic pollution. It took place in two different seasons, summer and winter 2024. A multi-criteria decision analysis methodology was used, combined with the guidelines of the European Union's Marine Strategy Framework Directive and the methodology in the Marine Debris Monitoring and Assessment Guide. A total of 3,955 plastic items were identified. The environmental quality of the bay was characterised as very poor. It was based on the results of the Clean Coast Index obtained from the two beaches in the bay that were classified as extremely dirty in both seasons, as well as the results of the stakeholder surveys. At Miragens beach in summer, the CCI was 83.5 and winter was 36.9. At Miragens beach in summer, the average amount of plastic per square metre was 4.18 ± 1.44. In winter, an average of 1.85 ± 0.38 plastic/m² was obtained. At Amor beach, the CCI in summer was 96.3 and in winter it was 47. In summer, the average number of plastic items per square metre was 4.81 ± 1.08. In winter, the average number of plastic items per square metre was 2.35 ± 0.60. The most common being pieces of styrofoam (29%), plastic bags including bits (28%), drink packaging (14%) and tangled fishing line (10%). Considering the possible sources of origin, maritime activity 38%, tourism and seaside activities 34% and commercial activity 28%. The lack of resources and infrastructure for enhancement and low levels of marine literacy were identified as the main reasons for this.

Keywords: Plastic pollution; Clean Coast Index; Environmental quality; Integrated waste management system.

Acknowledgments: The authors acknowledge FCT funding to MARE through projects UIDB/04292/2025, UID/PRR/4292/2025, and LA/P/0069/2020 (https://doi.org/10.54499/LA/P/0069/2020) granted to the Associate Laboratory ARNET - Aquatic Research Network.

IDENTIFICATION AND CHARACTERISATION OF MICROPLASTICS IN ENVIRONMENTAL MATRICES, WATER, BIOTA AND BEACH SEDIMENT OF NAMIBE BAY, ANGOLA

Bernardo Malongo José[1,2,3*] and Marta Susana Gouveia Martins[1,2*]

[1] Department of Environmental Sciences and Engineering, NOVA School of Science and Technology, NOVA University Lisbon, Caparica, PORTUGAL.
[2] Marine and Environmental Sciences Centre, Aquatic Research Network Associate Laboratory, NOVA School of Science and Technology, NOVA University Lisbon, Caparica, PORTUGAL.
bernardojose1987@hotmail.com, marta.martins@fct.unl.pt
[3] UNINBE, University of Namibe, Angola

Abstract: Knowledge of the environmental status of marine and coastal ecosystems in Angola in relation to microplastic pollution, given its negative effects on fishery resources and human health, is urgently needed due to the lack of studies of this kind and because it is a global socio-environmental concern. The present study, carried out in Namibe Bay, aimed to identify and characterize the presence of microplastics in environmental matrices, seawater, beach sediment, and biota (Trachurus Trachurus ssp, Sargus Diplodus Capensis, and Mussel). Sample collection and analysis were carried out in the summer and winter of 2024. The characterization of the polymers was done using Fourier Transform Infrared Spectroscopy. A total of 4,947 MPs were identified in the analyzed matrices, with a higher concentration in winter. In biota samples, the average MPs/g GIT in summer was 0.88 ± 0.44, while in winter it was 1.40 ± 0.94. In sediment samples from Amor beach in summer, the average MPs/kg sed was 1,254.67 ± 507.31, and in winter it was 1,450.67 ± 1,613.69. At Miragens Beach, the average MPs/kg sed in summer was 558.67 ± 443.78, and in winter it was 529.33 ± 177.30. In surface water in summer, an average of MPs/m^3 of 0.010 ± 0.019 was obtained, and in winter, 0.014 ± 0.010. Meanwhile, in deep water in summer, the average MPs/m^3 was 0.0016 ± 0.0019, and in winter, an average of 0.0012 ± 0.0013 MPs/m^3 was obtained. The polymers most present in both seasons were cellulose, polyester, and polyethylene high-density. Fibers and fragments were the most common types, and blue, black, and white were the most representative colors in both seasons.

Keywords: Microplastic pollution, Marine and coastal ecosystems, Namibe bay, Seawater, Beach sediment and biota.

Acknowledgments: The authors acknowledge FCT funding to MARE through projects UIDB/04292/2025, UID/PRR/4292/2025, and LA/P/0069/2020 (https://doi.org/10.54499/LA/P/0069/2020) granted to the Associate Laboratory ARNET - Aquatic Research Network.

P10

REMOVAL OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) BY BIOCHAR DERIVED FROM MARINE PLASTIC LITTER

Antonio Cobelo-García[1,*], Xandre Costas[2], Estefanía Pereira[2], and Cristina Román[2]

[1] Biogeochemistry Group, Instituto de Investigacións Mariñas, Consejo Superior de Investigaciones Científicas (IIM-CSIC), 36208 Vigo. Spain
acobelo@iim.csic.es
[2] ITG. Fonte das Abelleiras s/n (Citexvi), 36310 Vigo. Spain

Abstract: Water pollution constitutes one of the main environmental and technological challenges facing modern society. Although wastewater treatment plants and conventional treatment systems have achieved notable progress, many contaminants remain difficult to remove completely. In addition, the high energy and economic costs of some technologies limit their application, especially in small facilities or in regions with limited resources. In this context, the search for alternative materials that combine technical effectiveness, low cost, and environmental sustainability has become increasingly relevant. In this context, the development of effective, sustainable, and economically viable solutions is essential. Char, a carbonaceous material obtained from carbon-rich residues through thermochemical processes, has emerged in recent years as a promising alternative for the removal of contaminants from water (e.g. Liu et al. 2021).
The recovery of plastic waste present in marine litter for its valorisation into products that, like char, contribute to the ecological balance of the marine environment, all within the framework of circular alternatives. To this end, this study aims to valorise marine litter in order to obtain a product that can be used for the removal of contaminants from water. Plastic marine litter samples were collected from the coasts of Galicia and the Canary Islands and subjected to a gasification process at 850 °C to produce biochar. The adsorption capacity of the resulting biochar toward PFAS and other organic contaminants was subsequently evaluated in different types of water. The results showed effective removal of most of the tested contaminants, demonstrating the potential of converting plastic marine litter into a sustainable material for the remediation of PFAS pollution and other contaminant compounds commonly present in the environment.

Keywords: PFAS, Biochar, Marine litter, Removal

Acknowledgments: This research was funded by the project POLYBRIS (https://www.polybrispleamar.com). This project is developed in collaboration with the *Fundación Biodiversidad* of the *Ministerio de Transición Ecológica y el Reto Demográfico*, within the framework of the *Programa Pleamar*, and is co-funded by the European Union through FEMPA (*Fondo Europeo Marítimo, de Pesca y Acuicultura*).

References:

Liu, N., Wu, C., Lyu, G., Li, M. (2021). Efficient adsorptive removal of short-chain perfluoroalkyl acids using reed straw-derived biochar. Science of the Total Environment, 798, 149191

P11

EFFECTS OF CO-EXPOSURE TO MICROPLASTICS AND MERCURY ON THE ESTUARINE AMPHIPOD *GAMMARUS LOCUSTA*

Inês L. Pereira[1,2], Miguel Cavaca[1], Vasco Branco[3], Neusa Figueiredo[1], and Marta Martins*[1,2]

[1] Marine and Environmental Sciences Centre (MARE), Aquatic Research Network Associate Laboratory (ARNET), NOVA School of Science and Technology (NOVA FCT), Caparica, PORTUGAL.
[2] Department of Environmental Sciences and Engineering, NOVA FCT, Caparica, PORTUGAL.
il.pereira@campus.fct.unl.pt, marta.martins@fct.unl.pt
[3] Research Institute for Medicines (iMed.ULisboa), Faculty of Pharmacy from the University of Lisbon, Lisbon, PORTUGAL.

Abstract: Microplastics (MPs) and mercury (Hg) are ubiquitous environmental pollutants known to pose risks to aquatic wildlife and public health. In highly contaminated environments such as estuaries, interactions between MPs and Hg are inevitable, however, their impacts on benthic ecosystems remain underexplored. The sediment-dwelling amphipod *Gammarus locusta* plays a significant role in benthic food webs, reflecting ecosystem integrity. Due to its sensitivity to environmental stressors, this species is a reliable indicator of pollutant ecotoxicity. To further investigate the toxic effects of MPs-Hg interactions in estuarine organisms, *G. locusta* were exposed to 4 treatments using environmentally relevant exposure routes: C – Control, MP – Waterborne polystyrene MPs at 1000 MP L^{-1}, Hg – Hg^{2+} and methylmercury at 40 and 0.2 ug g^{-1}, respectively, in the sediments and MPHg – A mixture of MPs and Hg forms, at the same concentrations and routes. After 14 days, total Hg assessment showed that amphipods bioaccumulated Hg, with lower (but not statistically significant) bioaccumulation in MPHg compared to Hg group. Survival, reproduction and the neurotoxicity biomarker acetylcholinesterase were not affected by the treatments. Regarding oxidative stress responses, the catalase enzyme, responsible for hydrogen peroxide dismutation, had increased activity in Hg and MPHg groups, with MPs slightly mitigating Hg's toxic effects. Whereas glutathione *S*-transferase, a xenobiotic detoxification enzyme, increased only in organisms exposed to the mixture in comparison to C. These findings suggest that while MPs don't seem to influence Hg's bioavailability, they might alter its bioaccessibility and toxicokinetic behaviour. This study highlights the importance of mimicking environmentally relevant exposure routes for *in vivo* experiments and demonstrates that contaminants mixtures might cause pathway-dependent effects.

Keywords: Contaminant mixtures, Oxidative stress, Bioaccumulation, Bioavailability, Bioaccessibility

Acknowledgments: This research is supported by national funds provided by FCT (Foundation for Science and Technology) within the framework of the UID/4292/2025 and UID/PRR/4292/2025 granted to MARE and the project LA/P/0069/2020 (https://doi.org/10.54499/LA/P/0069/2020) granted to ARNET and the PhD scholarship attributed to Inês Pereira (2024.02615.BD).

P12

MERCURY CONTAMINATION IN SURFACE SEDIMENTS OF THE SOUTHWESTERN PORTUGUESE CONTINENTAL SHELF: IMPLICATIONS FOR GOOD ENVIRONMENTAL STATUS

M. Mil-Homens*[1,2]

[1] Divisão de Oceanografia e Ambiente Marinho, Instituto Português do Mar e da Atmosfera, I.P., PORTUGAL.
mario.milhomens@ipma.pt
[2] CIIMAR/CIMAR-LA, Centro Interdisciplinar de Investigação Marinha e Ambiental, Universidade do Porto, Matosinhos, PORTUGAL.

Abstract: Marine sediments are key reservoirs and vectors of contaminants derived from terrestrial sources through coastal erosion, river discharge, and atmospheric deposition. As integrative environmental archives, they record contaminant sources, depositional hotspots, and dispersion pathways. However, post-depositional physical and geochemical processes may remobilize sediment-bound contaminants, enhancing their bioavailability and potential for bioaccumulation in marine organisms. This study assesses mercury (Hg) contamination in surface sediments of the southwestern Portuguese continental shelf, focusing on subregions BT1.2 (Cape Roca–Sines) and BT1.3 (Sines–Cape São Vicente). In the 2012 assessment under the Marine Strategy Framework Directive (MSFD), BT1.2 failed to achieve Good Environmental Status (GES), whereas BT1.3 complied with GES criteria. Seventy-three surface sediment samples were collected in 2019 and 2021. Total Hg concentrations ranged from 0.003 to 0.745 mg kg^{-1}. Elevated Hg/Al ratios were identified in the Tagus prodelta depocenter, likely reflecting anthropogenic Hg inputs from the Tagus estuary and subsequent transport to the adjacent shelf via estuarine outflow. High Hg/Al ratios were also detected near a disposal site for contaminated dredged material originating from navigation channels and shipyard facilities in the Sado estuary. Approximately 85% of samples from both subregions exceeded the MSFD reference value ($(Hg/Al)_{ref} = 0.01 \times 10^{-4}$). Based on this criterion, neither BT1.2 nor BT1.3 currently meets GES requirements. Enrichment factor (EF) calculations indicate that 52% of samples exhibit EF > 1.5, suggesting moderate anthropogenic enrichment. These results demonstrate the persistent influence of estuarine and human-derived Hg inputs across the southwestern Portuguese continental shelf and highlight the need for continued monitoring and refinement of environmental status assessments under the MSFD framework.

Keywords: Mercury, Marine sediments, MSFD, Portuguese Margin

Acknowledgments: The authors would like to thank for financial support: FEAMP through the CSS project (MAR-01.04.02-FEAMP-0013). The TAGUSGAS project (PTDC/CTA-GEO/31885/2017) and the CSS project financed the 2021 sampling campaign. The MINEPLAT project (ALT20-03-0145-FEDER-000013) supported part of the 2021 sampling campaign and the2019 sampling campaign, respectively. The authors also acknowledge the Fundação para a Ciˆencia e a Tecnologia (FCT) for CIIMAR Strategic Funding UIDB/04423/2020 and UIDP/04423/2020 and for CCMAR Strategic Funding UIDB/04326/ 2020, UIDP/04326/2020 and LA/P/0101/2020.

P13

METAL DISTRIBUTION AND CONTAMINATION FROM ABANDONED W-Sn MINING IN SEDIMENTS OF THE RIA OF MUROS (NW IBERIAN PENINSULA)

Ricardo Prego*[1], Carmen G. Castro[1], Antonio Cobelo-García[1], and Miguel Angel Álvarez-Vázquez[2]

[1] Instituto de Investigaciones Marinas (IIM-CSIC), Vigo, SPAIN.
prego@iim.csic.es, cgcastro@iim.csic.es, acobelo@iim.csic.es
[2] Área de Geografía Física, Grupo GEAAT, Campus de Ourense (UVigo), Ourense, SPAIN.
mianalva@uvigo.gal

Abstract: The Ria of Muros is the northernmost of the four Western Galician Rias, located in the northwest corner of Spain. At its inner margin lies the Noia Complex, which contains cassiterite, wolframite, pyrite, chalcopyrite, and arsenopyrite (IGME, 1982). Within this complex is the San Fins mine, where copper, tin, and wolfram were extracted during several periods of operation until its closure in the 1980s.

During the 20th century, knowledge of metal contents in this ria was very limited (Prego and Cobelo-García, 2003). Later studies detected localized copper contamination in surface sediment (García et al., 2013), while two sediment cores showed temporally increasing levels of Cu, Pb and Zn (Andrade et al., 2014). Furthermore, high phytotoxic levels of Cu and Zn were recorded in the abandoned mine environment (Álvarez et al., 2003).

Given that the EU is currently promoting the extractions of strategic raw materials, such as W and Sn, the San Fins mine could potentially be reopened. Therefore, it is necessary to assess the influence of local geochemistry and anthropogenic activity on the Ria of Muros. To this end, the contents of Al, Cd, Co, Cr, Cu, Fe, Ni, Pb, Sn, W, and Zn were analysed (by AAS and ICP-MS) in 37 surface sediment stations sampled in 1999 and resampled in 2025. In addition, a 350 cm sediment core was collected to determine the background metal levels.

Contents of W and Sn increased from the late 19th century onward, as did those of other metals. Surface sediment contents of W, Sn and Cu are higher in the inner ria (up to 77, 103 and 221 $mg \cdot kg^{-1}$, respectively), where the Traba Stream flows and within whose basin the mine is located. Regarding other metals, and based on local background levels, contamination by Pb and Zn is particularly noteworthy in the Noia inlet (inner ria).

Keywords: Inorganic, Contamination, Sediment, Mine, Estuary

Acknowledgments: We thank to the captain and crew of R/V Mytilus and to Susana Calvo, Paloma Herbello and Cristina Panete for their collaboration in the sediment sampling and procesing. This study was funded by Spanish-MICIN under the NEMUNO project, (ref. PID2021-122238OB-I00) and by the 'Consolidation and Structuring of Competitive Research Group' program of the Xunta de Galicia (grant number IN607A2025-05).

References:

Álvarez, E., Fernández-Marcos M.L., Vaamonde, C. and Fernández-Sanjurjo, M.J. (2003). Heavy metals in the dump of an abandoned mine in Galicia (NW Spain) and in the spontaneously occurring vegetation. The Science of the Total Environment, 313, 185-97.

Andrade, A., Rubio, B., Rey, D., Álvarez-Iglesias, P., Bernabeu, A.M. and Fedi, M. (2014). Enviromental changes at inner sector of Ría de Muros (NW Spain) during Middle to Late Holocene. Estuarine, Coastal and Shelf Science, 136, 91-101.

García, A., Bernérdez, P. and Prego, R. (2013). Copper in the Galician ria sediments: natural levels and harbour contamination. Scientia Marina, 77, 91-99.

IGME (1982). Mapa Minero-Metalogénico de Galicia. Scala 1:400000. IGME, Madrid, España.

Prego, R. and Cobelo-García, A. (2003). Twentieth century overview of heavy metals in the Galician Rias (NW Iberian Peninsula). Enviromental Pollution, 121, 425-452.

P14

BEHAVIOUR AND DISTRIBUTION OF REDOX-SENSITIVE ELEMENTS (V, U, Mo) IN SEDIMENTS OF THE KRKA RIVER ESTUARY (CROATIA)

Cukrov Nuša*[1], Dario Omanović[1], and Neven Cukrov[1]

[1] Division for Marine and Environmental Research, Ruđer Bošković Institute, Zagreb, CROATIA.
cukrov@irb.hr, omanovic@irb.hr, ncukrov@irb.hr

Abstract: The spatial distribution and geochemistry of redox-sensitive elements (RSE) were investigated in the Krka River estuary, a highly stratified karst estuary on the eastern Adriatic coast. Although the area is largely pristine, anthropogenic pollution has been detected in the lower estuary (Šibenik Bay) (Cukrov et al., 2024). To determine the spatial distribution of selected RSE (U, V, Mo), 40 surface (0–5 cm) sediment samples were collected along the estuary. To study the vertical distribution and geochemical behaviour of U, V, and Mo, five sediment cores were collected from different parts of the estuary for comprehensive porewater and solid-fraction analysis. Additionally, a DGT (diffusive gradients in thin films) probe was deployed to provide further insight into the behaviour of V, U, and Mo at the sediment–water interface. Elemental concentrations in all sample types were determined by HR ICP-MS. In the surface sediments, concentrations of U, V, and Mo ranged from 1.671–25.023 mg kg^{-1}, 19.728–108.454 mg kg^{-1}, and 0.701–7.033 mg kg^{-1}, respectively. Low enrichment factors (mean EF = 1.1) and significant correlations with terrigenous elements indicate that V is primarily of lithogenic origin. In contrast, the elevated EF of U and Mo (maximum EF 17.1 for U and 15.3 for Mo) imply anthropogenic input of these elements in the Šibenik Bay. Interestingly, pronounced peaks of dissolved Mo, U, and V were detected in the anoxic zone at almost all studied sites. This atypical behaviour has already been observed in marine and estuarine sediments (Dang et al., 2018, Jokinen et al., 2020, Duan et al., 2023) and suggests that complex remobilisation processes and the formation of stable soluble complexes (e.g., with DOM) play a key role in controlling RSE mobility in the Krka estuary.

Keywords: Sediment, Redox-sensitive elements, Krka River estuary, Porewater, Sediment-water interface

References:

Cukrov, N., Cindrić, A.-M., Omanović, D. and Cukrov, N. (2024). Spatial distribution, ecological risk assessment, and source identification of metals in sediments of the Krka River Estuary (Croatia). Sustainability, 16, 1800.

Dang, D. H., Evans, R. D., Wang, W., Omanović, D., El Houssainy, A., Lenoble, V., Mullot, J.-U., Mounier, S., Garnier, C. (2018). Uranium isotope geochemistry in modern coastal sediments: Insights from Toulon Bay, France. Chemical Geology, 481, 133-145.

Duan, L., Song, J., Li, X. and Yuan, H. (2023). Dynamic mobilization of redox sensitive elements Mo, U and V in seasonal hypoxic sediments off the Changjiang Estuary. Continental Shelf Research, 252, 104902.

Jokinen, S. A., Jilbert, T., Tiihonen-Filppula, R. and Koho, K. (2020). Terrestrial organic matter input drives sedimentary trace metal sequestration in a human-impacted boreal estuary. Science of the Total Environment, 717, 137047.

P15

RECORDING THE ANTHROPOCENE: TRACE METAL FINGERPRINTS IN THE TAGUS PRODELTA

M. Mil-Homens*[1,2], V. Magalhães[3,4], P. Brito[1,2], and M. Caetano[1,2]

[1] Divisão de Oceanografia e Ambiente Marinho, Instituto Português do Mar e da Atmosfera, I.P., Lisboa, PORTUGAL.
mario.milhomens@ipma.pt
[2] CIIMAR/CIMAR-LA, Centro Interdisciplinar de Investigação Marinha e Ambiental, Universidade do Porto, Matosinhos, PORTUGAL.
[3] Divisão de Geologia e Georrecursos Marinhos, Instituto Português do Mar e da Atmosfera, I.P., Lisboa, PORTUGAL.
[4] IDL, Instituto Dom Luiz (LA), PORTUGAL

Abstract: A 3.5 m sediment core was collected from the Tagus prodelta to investigate the temporal variability of trace elements in this sector adjacent to the Tagus estuary. The Tagus estuary (≈320 km²) is one of the largest in Europe and drains a densely populated and highly industrialized region, including chlor-alkali plants, pyrite roasting facilities, smelters, and shipyards, serving approximately 2.9 million inhabitants in the Lisbon metropolitan area.
In a first analytical phase, the split core surface was scanned using an Avaatech X-ray fluorescence (XRF) core scanner, enabling high-resolution, non-destructive bulk geochemical profiling. The XRF record revealed progressive enrichment of Pb, Zn, and Cu toward the surface that was not accompanied by an increase in Al counts (used as a proxy for grain-size variability), suggesting that metal enrichment is not controlled by sediment texture but rather by enhanced anthropogenic inputs. Guided by the XRF results, the core was subsampled at variable depth resolutions. Mercury concentrations were determined by atomic absorption spectrometry (LECO AMA-254). Preliminary results indicate that Hg down-core profiles mirror the enrichment trends observed for Pb, Cu, and Zn. These trends are interpreted as reflecting the onset and intensification of industrial activity in the Tagus estuary from the second half of the 19th century onward, with continued impacts throughout the 20th century.
These findings highlight the prodelta as a sensitive archive of historical anthropogenic contamination and provide new insights into the long-term evolution of trace element inputs to the Tagus coastal system.

Keywords: Trace metals, Marine sediments, Anthropocene, Portuguese shelf

Acknowledgments: The authors would like to thank for financial support: FEAMP through the CSS project (MAR-01.04.02-FEAMP-0013). The TAGUSGAS project (PTDC/CTA-GEO/31885/2017) and the CSS project financed the 2021 sampling campaign. The MINEPLAT project (ALT20-03-0145-FEDER-000013) supported part of the 2021 sampling campaign and the2019 sampling campaign, respectively. The authors also acknowledge the Fundação para a Ciência e a Tecnologia (FCT) for CIIMAR Strategic Funding UIDB/04423/2020 and UIDP/04423/2020 and for CCMAR Strategic Funding UIDB/04326/ 2020, UIDP/04326/2020 and LA/P/0101/2020.
We acknowledge the EMSO-PT project European Multidisciplinary Sea floor and water column Observatory, Portugal (POCI-01-0145-FEDER-022157) for the XRF analysis.

P16

FLUVIAL AND WASTEWATER FLUXES OF DISSOLVED AND PARTICULATE SILICON TO THE RIA OF VIGO (NW IBERIAN PENINSULA)

Ricardo Prego*[1], Patricia Bernárdez[2], and María López-Acosta[1]

[1] Instituto de Investigaciones Marinas (IIM-CSIC). Vigo, SPAIN.
prego@iim.csic.es; lopezacosta@iim.csic.es
[2] Instituto Español de Oceanografía (IEO-CSIC). Vigo, SPAIN.
patricia.bernardez@ieo.csic.es

Abstract: In the north-western coast of Spain, the biogeochemical cycle of silicon is mainly conditioned by spring-summer upwelling events (Prego and Bao, 1997), whereby the fluvial silicon discharges river-ria were considered unimportant and roughly estimated (Prego et al., 1995). This study is undertaken to assess, in particular, the inputs of silicon to a ria coastal system (Goudie, 2018) and, in general, to enrich the information (DeMaster, 2019) about the land-sea contributions of this chemical element.

The Galician Rias are incised valleys where the estuarine zone can move according to climatic changes. The second largest ria is that of Vigo that receives continental supplies from the Oitavén river, five streams (Alvedosa, Lagares, Fraga, Maior and Ullo) and six urban WWTPs (Vigo, Teis, Arcade, Redondela, Cangas and Moaña).

Water was monthly sampled in 2004, filtered the same sampling day (0.45 μm Pall hydrophilic polypropylene) in a cleaned lab and dissolved silicate analysed following the auto-analytical methodology. Filters were weighed, microwave digested (USEPA 3052 guideline) and silicon determined by ETAAS.

In rivers, the annual average concentration of dissolved silicate (DSi) ranged 92-179 μM, while 143-194 μM in WWTPs. These concentrations are similar to the world river average (158 μM; Tréguer and De-La-Rocha, 2013). Fluvial particulate silicon (PSi) was 14-163 μM and WWTP 19-187 μM. The main DSi flux to the ria corresponded to the quasi-pristine Oitavén River with 1120 $t \cdot yr^{-1}$, while the major PSi flux is due to the contaminated Lagares Stream with 890 $t \cdot yr^{-1}$. Overall Si-load to the ria was 3590 $t \cdot yr^{-1}$ (32% PSi), where WWTP discharges were only 11% of total. The land-ria transport of DSi, normalized with respect to the ria fluvial basin area, is 5.1 $t \cdot km^{-2} \cdot yr^{-1}$, which is the order of the mean land-ocean yield (3.3 $t \cdot km^{-2} \cdot yr^{-1}$; Dürr et al., 2011) but PSi discharge (2.5 $t \cdot km^{-2} \cdot yr^{-1}$) is 30-times lower.

Keywords: Silicon, River, Sewage, Discharge, Estuary

Acknowledgments: We thank to the companies 'Pridesa', 'Aqualia', 'Espina y Delfín' and 'Fergó Galicia' for providing sewage flow and to Dr. Alvarez Eijo (USC) for the Oitavén gauging station calibration and river flow quantification. This study was funded by Spanish-CICYT under the METRIA project, (ref. REN2003-04106-C03) and by the 'Consolidation and Structuring of Competitive Research Group' program of the Xunta de Galicia (grant number IN607A2025-05).

References:

DeMaster, D.J. (2019). The global silica budget: sources and sinks. Encyclopedia of Ocean Sciences (3Ed.), 473-483.

Dürr, H.H., Meybeck, M., Hartmann, J., Laruelle, G.G. and Roubeix, V. (2011). Global spatial distribution of natural riverine silica inputs to the coastal zone. Biogeosciences, 8, 597-620.

Goudie, A. (2018). Rias: Global distribution and causes. Earth-Science Reviews, 177, 425-435.

Prego, R. Bao, R. and Howland, R. (1995). The biogeochemical cycling of dissolved silicate in a Galician Ria. Ophelia, 42: 301-318.

Prego, R. and Bao, R. 1997. Upwelling influence on the Galician coast: silicate in shelf water and underlying surface sediments. Continental Shelf Research, 17, 307-318.

Tréguer, P.J. and De La Rocha, C.L. (2013). The World Ocean Silica Cycle. Annual Review of Marine Science, 5, 477-501.

P17

RARE EARTH ELEMENTS PATTERNS AS TRACERS OF GEOCHEMICAL PROCESSES IN SUBTERRANEAN ESTUARIES (PONTEVEDRA RIA, NW IBERIAN PENINSULA)

Lucie Rieunau*[1,2], Mónica Calvo[1], José Guitián[1,3], Vanesa Vieitez[3], María José Pazó[3], Carolina Gil-Lozano[3], Laura Millán[3], Esther Barber-Lluch[3], Nicolás Villacieros-Robineau[3], Rita González-Villanueva[3], J. Severino P. Ibánhez[3], and Antonio Cobelo-García[1]

[1] Biogeochemistry Group, Instituto de Investigacións Mariñas, Consejo Superior de Investigaciones Científicas (IIM-CSIC), Vigo, Spain
lucie-rieunau@etud.univ-tln.fr; acobelo@iim.csic.es
[2] Faculty of Science and Technology, University of Toulon, La Garde, France.
[3] Organic Geochemistry Lab, Instituto de Investigacións Mariñas, Consejo Superior de Investigaciones Científicas (IIM-CSIC), Vigo, Spain.

Abstract: Rare earth elements (REEs) are a group of 15 metals, ranging from lanthanum (La) to lutetium (Lu). Due to their characteristics, the patterns of REEs have been extensively used as tracers in oceanic processes including particle removal, redox changes, and the origin of particles or water masses. Recent studies have shown that submarine groundwater discharge (SGD) may contribute, depending on the characteristics of the area, with comparable or even greater amounts of REEs than those from regional rivers or sedimentary diffusive fluxes (Johannesson et al. 2017; Paffrath et al. 2020). To this end, the processes controlling the behaviour – and therefore the fluxes – of REEs in subterranean estuaries (STE) need to be further explored.
An integrated study of continental groundwater discharge was conducted in a large coastal inlet surrounded by a crystalline drainage basin (Pontevedra Ria, NW Iberian Peninsula) during February, May and September 2025. Samples were collected at local subterranean estuaries at 13 sites; also, samples were also taken in 6 wells and in the major freshwater input (Lérez river) and in surface and deep water of the Pontevedra Ria for a characterization of the end-members.
Concentrations of total REEs (ΣREEs) were higher in the wells and rivers compared to STE and ría waters. Normalized patterns of REEs were distinctive for each well and river and were in agreement in the three sampling campaigns – although higher total concentrations were determined in the wet period – indicating that their distribution is controlled by the lithological setting. Rare earth element patterns at the STE did not follow a continuum with respect to the end-members (groundwater and ria waters); instead, the decrease in REEs concentrations at the STE and the appearance of a sharp positive anomaly of the particle-unreactive anthropogenic Gd suggests that STE – contrary to previous observations – may act as a sink of dissolved REEs in coastal areas.

Keywords: Rare earth elements, Subterranean estuary, Geochemical processes, Gadolinium anomaly

Acknowledgments: This research was funded by the project ENVIROSUB (Ref. PID2023-153274NB-I00; Spanish Ministry of Science, Innovation, and Universities).

References:

Paffrath, R., Pahnke, K., Behrens, M.K., Reckhardt, A., Ehlert, C., Schnetger, B., Brumsack, B.J. (2020). Rare earth element behavior in a sandy subterranean estuary of the Southern North Sea. Frontiers in Marine Science, 7, 424. 10.3389/fmars.2020.00424

Johannesson, K.H, Palmore, C.D., Fackrell, J., Prouty, N.G, Swarzenski, P.W., Chevis, D.A., Telfeyan, K., White, C.D., Burdige, D.J. (2017). Rare earth element behavior during groundwater-seawater mixing along the Kona Coast of Hawaii. Geochimica et Cosmochimica Acta, 198, 229-258.

P18

RARE EARTH ELEMENTS AS A TOOL TO IDENTIFY BIVALVES PRODUCTION AREAS

Miguel Caetano*[1,2], Sónia Ferreira[1], Pedro Brito[1,2], Rui Silva[1], Rute Granja[1], and Joana Raimundo[1,2]

[1] IPMA – Portuguese Institute for Sea and Atmosphere, Av. Alfredo Magalhães Ramalho, 6, 1495-165 Algés, Portugal.
[2] CIIMAR – Interdisciplinary Centre of Marine and Environmental Research, Avenida General Norton de Matos S/N, 4450-208 Matosinhos, Portugal.
mcaetano@ipma.pt, jraimundo@ipma.pt

Abstract: Over the past few decades, the unique properties of rare earth elements (REE) have made them essential tools for understanding key oceanic, terrestrial and biological processes. These elements have become an important raw material in industry, playing a vital role in modern electronics, industrial and medical products, and innovative environmental technologies. Their exponential use, and consequently their release into the environment through effluents and waste, means that they are now regarded as emerging contaminants. The clam *Ruditapes decussatus* was sampled in different production areas (PA) of 8 estuarine systems (Lima-1 PA, Ria Aveiro-3 PA, Mondego-1 PA, Óbidos-1 PA, Alvor-2 PA, Ria Formosa-9 PA). The clam *Spisula solida*, characteristic from coastal waters, was sampled in 6 PA from the Portuguese coast covering all the coastal line (L2, L3, L6, L7C, L8, L9). Production areas are defined at national level by the Portuguese Bivalve Monitoring Program (SNMB). A total of 848 bivalves specimens were collected. Each sample results from a pool of 5 individuals. The number of samples per estuary varies with its dimension. The concentration of La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu was determined by ICPMS. The sum of the REEs varied by location, with the highest values found in the Mondego estuary reaching 3448 ng/g, and the lowest in bivalves from the Óbidos coastal lagoon at 867 ng/g. The accumulation of REEs in bivalves results from a mixture of sources, including food (phytoplankton and microphytobentos), inorganic suspended matter and water (overlying water and pore water). Profiles normalised for European shale showed different patterns according to terrestrial input and local geological features. Bivalves from the Lima estuary and the Ria de Aveiro presented a similar pattern, with higher LREE and MREE than HREE, and a clear negative Eu anomaly. Clams from the Mondego Estuary exhibited a distinct pattern, featuring increased MREE coupled with elevated La values, though no evident Eu anomalies were observed. Samples from the southern estuaries and coastal lagoons exhibited similar profiles that were almost flat, with a slight increase in MREE. Therefore, despite the multiple REE sources, it was possible to identify an REE/ES pattern that may be linked to the estuarine system of origin, and consequently to the areas in which they were produced.

Keywords: Rare Earth Elements, Bivalves, Origin identification

Acknowledgments: This work was supported by Fundação para a Ciência e Tecnologia (FTC), through the project EMINENT (2022.08285.PTDC).

P19

RARE EARTH ELEMENT ACCUMULATION IN POLYCHAETES ACROSS DIFFERENT FEEDING STRATEGIES

Ingrid CM Sena[1], Lais A Souza[2], Wagner F Magalhaes[3], Sabine Azemard[4], and V Hatje[1,4]

[1] Centro Interdisciplinar de Energia e Ambiente, Universidade Federal da Bahia, Salvador, BRAZIL.
ingrid.mota@ufba.br
[2]Departamento de Química Fundamental, Universidade Federal de Pernambuco, Recife, BRAZIL.
Lais.asouza@ufpe.br
[3] Instituto de Biologia, Universidade Federal da Bahia, Salvador, BRAZIL
magalhaeswf@gmail.com
[4] IAEA Marine Environment Laboratories, Department of Nuclear Sciences and Applications, International. Atomic Agency, Monaco, PRINCIPALITY OF MONACO.
S.Azemard@iaea.org, v.hatje@iaea.org

Abstract Feeding habits play a fundamental role in controlling the bioaccumulation and trophic transfer of contaminants in aquatic ecosystems. Different feeding strategies determine the type, quantity, and form of contaminants that organisms are exposed to, influencing uptake pathways and accumulation patterns. In this study, 7 polychaete species representing different feeding habits were collected from an intertidal flat in northeast Brazil to assess how feeding strategy influences the accumulation and cycling of REEs. REEs analysis was conducted in surface sediments (~10 cm) and suspended particulate matter (SPM), as well as in tissues of polychaetes. The deposit-feeder *Sipunculus nudus* (muscle, viscera, and fecal pellets), *Notomastus sp* (whole body) and *Terebellidae* (whole body and tubes), the suspension-feeders *Chaetopterus sp.* and *Branchiomma patriota* (whole body and tubes) and the carnivores *Marphysa sp* and *Lumbrineris* sp (whole body) were analyzed. The ∑REEs concentrations in sediments ranged from 5.81 to 6.73 mg kg^{-1} and exhibit seawater-like REEs normalized patterns, while the SPM (1.47 – 1.49 mg kg^{-1}) displays a flat REEs profile. The deposit-feeding organisms exhibit higher levels of ∑REEs (0.900 - 23.5 mg kg^{-1}) than suspension-feeders (3.71 - 4.70 mg kg^{-1}) and carnivores (2.20 - 4.52 mg kg^{-1}). In *Sipunculus nudus*, the viscera showed a flat normalized pattern, whereas muscle was enriched in light REEs relative to heavy REEs. Comparison between organisms and their produced materials showed that in *S. nudus*, fecal pellets had a REE pattern comparable to the viscera. In contrast, tubes produced by Terebellidae, *Chaetopterus* sp., and *Branchiomma patriota* showed patterns more similar among the tubes than their respective tube-building organisms. This study demonstrates that feeding strategy is an important factor controlling REEs uptake. The REEs signatures found in the tubes indicate that environmental conditions play a more relevant role than the organisms themselves.

Keywords: Bioaccumulation, Traits, REE

Acknowledgments: This work was supported by CNPq (407297/2018-9) and FAPESB (APP0012/2023). The authors were sponsored by CAPES (I.C.M.S, 88881.126027/2025-01) and CNPq (V.H., 302477/2022-5). The IAEA is grateful for the support provided to its Marine Environment Laboratories by the Government of the Principality of Monaco.

References:

Pastorino, P., Brizio, P., Abete, M.C., Bertoli, M., Oss Noser, A.G., Piazza, G., Prearo, M., Elia, A.C., Pizzul, E., Squadrone, S. (2020). Macrobenthic invertebrates as tracers of rare earth elements in freshwater watercourses. Science of the Total Environment 698. https://doi.org/10.1016/j.scitotenv.2019.134282

P20

CISPLATIN IN ECOTOXICOLOGICAL RESEARCH: ANALYTICAL CHALLENGES IN AQUATIC SYSTEMS

Marta P. Loureiro[1], Margarida M. Correia dos Santos[1], Camila Tomé[2], Marta Martins[2,3], and Carlos E. Monteiro*[1]

[1] Centro de Química Estrutural, Institute of Molecular Sciences, Instituto Superior Técnico, Universidade de Lisboa, Lisboa, PORTUGAL.
marta.pinto.loureiro@tecnico.ulisboa.pt, mcsantos@tecnico.ulisboa.pt, *carlos.e.monteiro@tecnico.ulisboa.pt*
[2] Department of Environmental Sciences and Engineering, NOVA School of Science and Technology, NOVA University Lisbon, Caparica, PORTUGAL.
cf.tome@campus.fct.unl.pt, marta.martins@fct.unl.pt
[3] Marine and Environmental Sciences Centre, Aquatic Research Network Associate Laboratory, NOVA School of Science and Technology, NOVA University Lisbon, Caparica, PORTUGAL.

Abstract: Cisplatin (cis−Pt) is present in the environment due to its source emission in oncological treatments. Unmetabolized cis−Pt is excreted and may reach aquatic ecosystems, posing risks to biota. In this study, we evaluated the bioavailability, bioaccumulation, and toxicity of cis−Pt through the application of stripping voltammetry, a robust analytical technique for Pt determination, combined with ecotoxicological assays to investigate effects in saline and freshwater organisms, *Artemia salina* and *Daphnia magna*, respectively. The substitution of chloride ligands by formazone favoured the formation of Pt−complexes, which adsorb and react on the Hg electrode surface. Quantification of cis−Pt was done in both water and biota, reporting for the first time its bioaccumulation. Additionally, the role of dissolved organic matter (DOM) in waters was investigated, mimicking patterns in the environment that affect metal bioavailability and toxicity. Bioaccumulation of Pt was relatively higher than that of cis−Pt, likely owing to differences in chemical structure and detoxification mechanisms. However, cis−Pt was more toxic than Pt.
These findings highlight the need of considering natural environmental conditions in the ecotoxicological assessment. The integration of ecotoxicological assays with a sensitive quantification of cis−Pt proved to be an effective framework for evaluating the risks of contaminants of emerging environmental concern.

Keywords: Cisplatin, Voltammetry, Bioaccumulation, Ecotoxicology, Aquatic environment

Acknowledgments: C.E. Monteiro acknowledges FCT contract 2023.09489.CEECIND; The authors acknowledge FCT funding to CQE through projects UID/00100/2025 and UID/PRR/00100/2025; to IMS through LA/P/0056/2020; to MARE through projects UID/04292/2025 and UID/PRR/04292/2025; and to ARNET through LA/P/0069/2020. The authors acknowledge the collaboration of Aquário Vasco da Gama.

P21

A REVISED GUIDE TO QUANTIFY PLATINUM-GROUP ELEMENTS IN THE ENVIRONMENT

Maria Jeremias*[1], Carlos E. Monteiro*[1], Antonio Cobelo-García*[2], and Jörg Schäfer*[3]

[1] Centro de Química Estrutural, Institute of Molecular Sciences, Instituto Superior Técnico - Universidade de Lisboa, Portugal.
maria.j.sardinheiro@tecnico.ulisboa.pt, carlos.e.monteiro@tecnico.ulisboa.pt
[2] Bioxeoquímica Mariña, Instituto de Investigacións Mariñas IIM-CSIC, Spain.
acobelo@iim.csic.es
[3] Université de Bordeaux, France
jorg.schafer@u-bordeaux.fr

Abstract: Platinum-group elements (PGEs), including platinum (Pt), palladium (Pd), rhodium (Rh), iridium (Ir), osmium (Os), and ruthenium (Ru), are part of the technology-critical elements that are increasingly used nowadays. Due to their various applications, which leads to a larger demand and extraction despite their extremely low concentrations in the earth's crust, PGE emissions to the environment have increased, raising concern. Although PGEs have been investigated in the past decades, there is still a gap on information regarding their cycling, fate and effects.
In this work, we compiled and systematically reviewed various methodologies for the collection and preservation of environmental samples derived from different matrices (e.g., air, water, sediment, and biota). Moreover, the current analytical techniques for determining PGEs (e.g., ICP-MS, voltammetry) were critically assessed from the literature. There are analytical limitations often resulting from low PGE concentrations in complex matrices associated with severe interferences that still need to be further explored. This work outlines a framework to reduce inter-study discrepancies, facilitating a robust comparative analysis of PGEs in different environmental matrices, enabling a better understanding of PGE biogeochemical cycles.

Keywords: Platinum Group Elements, Sampling, Analytical Methods

Acknowledgments: The Portuguese Science Foundation (Fundação para a Ciência e a Tecnologia, FCT) is acknowledged for funding MJ PhD grant (2025.03477.BDANA), CM contract under the Individual Call to Scientific Employment Stimulus - 6th Edition (2023.09489.CEECIND), Centro de Química Estrutural through projects UID/00100/2025 (https://doi.org/10.54499/UID/00100/2025), UID/PRR/00100/2025 (https://doi.org/10.54499/UID/PRR/00100/2025), and the Associate Laboratory Institute of Molecular Sciences through project LA/P/0056/2020 (https://doi.org/10.54499/LA/P/0056/2020). The authors also acknowledge the EU COST Action TD1407–NOTICE (https://www.costnotice.net/)

XVII International Estuarine Biogeochemistry Symposium

Centro de Congressos, IST
17th to 20th May 2026
https://iebs2026.events.chemistry.pt/

Sociedade Portuguesa de Química

DEQ DEPARTAMENTO DE ENGENHARIA QUÍMICA TÉCNICO LISBOA

ISTID

CQE Química Estrutural

IMS

UAlg UNIVERSIDADE DO ALGARVE

ARNET AQUATIC RESEARCH NETwork

CiMA Centre for Marine and Environmental Research

fct Fundação para a Ciência e a Tecnologia