Bioessays with the European amphipod *Gammarus fossarum* to assess freshwater sediments toxicity

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Introduction: Freshwater sediments act as sinks for pollutants like metals, PAHs, PCBs, PPCPs[1], per- and polyfluoroalkyl substances[2] which can affect benthic organisms and complicate sediment management. *Gammarus fossarum*, a European freshwater amphipod, is widely used in France to assess water quality[3], [4]. And so, *G. fossarum* is a promising model for sediment toxicity assessments and could help making decisions for the management of contaminated sediments[5]. This study evaluates the toxicity of sediments by measuring feeding rate and reproduction in exposed organisms and complementing these with physico-chemical analyses. From these data, threshold values and bioassay guidelines are proposed to improve sediment quality assessments.

Methods: Sediment stations were selected using French water agency data, categorising them as reference (uncontaminated), contaminated, or random. Bioassays were based on standardised protocols, with feeding rate and reproduction tested on 140 and 84 sediment samples, respectively. Control tests used artificial sediment, and statistical analysis was performed in R Studio.

Results and discussion: Preliminary findings show granulometry and organic carbon contents have minimal impact on endpoints, allowing threshold proposals. Artificial control sediments performed worse than uncontaminated sediments, raising questions about their suitability. Feeding rate (Fig. 1) was more sensitive than reproduction but both endpoints are complementary for assessing sediment toxicity.

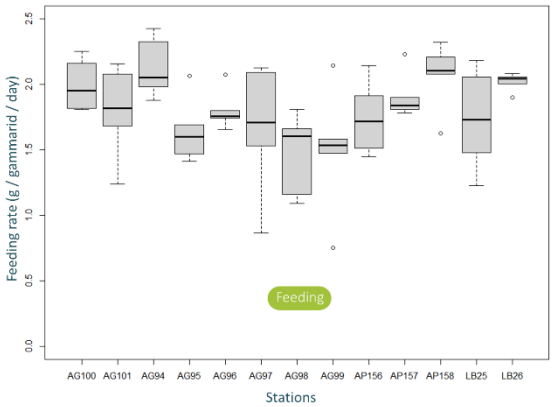

Fig. 1: *Feeding rate (g of MUG/gammarid/day, n = 5 replicates x 15 gammarids per condition) measured in G. fossarum males exposed to 13 environmental sediments.*

Conclusion: *Gammarus fossarum* can be used for sediment toxicity assessment, allowing sediment discrimination based on biological endpoints. These bioassays could help defining what is a healthy sediment.

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Ammonium in marine sediments: from a confounding factor in ecotoxicological assessments to a contaminant?

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Introduction: The ecotoxicological approach is an essential component of the environmental quality evaluation of marine sediments, also in relation to the presence of new emerging contaminants. Particularly bioassay batteries are a predictive tool and a reliable indicator of the biological effects of mixtures of substances contained in the sediments, not predictable by chemical analysis alone. For these reasons, in recent years, bioassays have been introduced in a multidisciplinary Weight of Evidence (WOE) approach to evaluate the environmental quality of marine sediments. The use of the WOE integration, which quantitatively combines and weights different kinds of raw data (i.e. sediment chemistry and biological responses like ecotoxicological bioassays) also called Lines of Evidence (LOEs), allows to better discriminate the environmental impact due to the presence of contaminants [1]. The importance of the application of WOE models is particularly evident in complex environmental scenarios where seemingly conflicting results are provided by various LOEs [2].
In this context, the use of embryonic stages is fundamental to evaluate sublethal effects, but embryo bioassays are also sensitive to the presence of ammonium and other confounding factors, which can cause adverse effects in addition to those attributed to contaminant mixtures. The overestimate of toxicity due to confounding factor has practical implications, as it affects management options related to the sediment quality classes determined by the WOE approach.
The aim of this study is to define a tiered framework for assessing the environmental quality of marine sediments using the WOE model, minimizing the influence of ammonium as a confounding factor in bioassays, while considering its relevant chemical concentration in those cases where it can be regarded as a contaminant.

Methods: The WOE approach has been included in a quantitative user-friendly model (SediqualSoft ®, free software), that has been validated in several case studies [1, 2]. In SediqualSoft® different LOEs are elaborated independently, using specific criteria for each data, weighting the typology of chemical pollutants and the toxicological relevance of the measured endpoints. Synthetic and quantitative hazard indices are calculated for each LOE, before their overall inclusion in the WOE assessment: the calculated risk level is assigned with a value between class 1 and 5 which classifies the risk from absent to serious [3]. This tool was modified and integrated after the procedure reported in ISPRA guideline n. 16/2021 [4] related to the preparation of elutriate. In particular specific toxicity thresholds of ammonium were assigned to each bioassay, considering the results of embryotoxicity tests on elutriate of marine sediments prepared using a sediment/water ratio of 1:10. When ammonium exceed acceptability limits of bioassays, the tool assigns a lower weight to ecotoxicological battery, introducing a chemical reference level for ammonium.

Results and discussion: Preliminary results of the application of this approach showed a more accurate estimate of toxicity when the ammonium is considered a confounding factor. In these cases, the toxicity was overestimated using a classical criterion, Moreover, in some cases, ammonium masks the effects of some traditional contaminants, more persistent in the environment and with higher weight in chemical evaluation. For these reasons this new approach could be a promising tool to be adopted in future guidelines for the management of marine sediments

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Assessment of Rare Earth Elements (REEs) Toxicity in Sediment Environments Using Caenorhabditis elegans

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Conference theme number(s): 1

Introduction: Rare Earth Elements (REEs) are increasingly recognized as emerging environmental contaminants due to their critical roles in renewable energy, electronics, and defense technologies. Their extensive use and subsequent release into aquatic systems have raised concerns about their accumulation in sediments and associated ecological risks. Sediments serve as dynamic reservoirs that influence the mobility, speciation, and bioavailability of REEs through complex microenvironmental interactions. Despite their ecological significance, the effects of sediment physicochemical conditions on REE bioavailability and their toxicological implications for benthic organisms remain insufficiently understood.

Background:
REEs have a complex chemistry and low solubility in natural waters, where they readily form complexes and precipitates. While also dissolved hydroxides are assumed to cause toxicity to some extent, as with other metals it is the free ions that are expected to be available and toxic [1]. Revel, Medjoubi [2], however, showed that presumably precipitated La and Gd both accumulated in the gut of daphnids, and had calculated killing rates of 0.28 mg/L/d (Gd) and 0.07 mg/L/d (La). This leads to the hypothesis that oral uptake of REE-precipitates by invertebrates may contribute to REE toxicity. As precipitates eventually end up and accumulate in sediments, their toxicity in the presence of rare earth elements should be investigated. This study will be among the first sediment contact tests with rare earth elements [3] and therewith provide insights on the effects to this previously neglected compartment.

Methods: This study is going to employ an integrative approach to investigate the effects of sediment microenvironmental factors, such as pH and organic matter, on the bioavailability and toxicity of REEs (specifically of the light element lanthanum (La) and heavy element gadolinium (Gd)) towards the nematode *Caenorhabditis elegans*. Experiments will be carried out using spiked artificial sediments and modifying the concentrations of organic matter and pH. Diffusive gradients in thin films (DGT) passive sampling will be used to quantify the activity of free REE ions. Ecotoxicological endpoints of concern will comprise growth, reproduction and fertility. Bioaccumulation will be determined by total x-ray fluorescence spectrometry. ROS generation will be visualized microscopically.

Outlook: These findings will elucidate the critical interplay between sediment composition, REE speciation, and bioavailability, and will offer new insights into the ecological risks posed by REEs in sediment environments.

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Preliminary ecotoxicological analysis to optimize sediment quality characterization of the Ravenna Port, Italy.

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Zero pollution

Introduction: In Italy, the Ministerial Decree 173/2016 regulates the management of dredged marine sediments. This decree outlines the procedures for assessing sediment quality and authorizing dredging management options in marine and coastal environment (e.g. nourishment, disposal at sea or storage in confined disposal facility). Assessing sediment quality is complex. In line with this decree, it involves physical, chemical, and ecotoxicological analyses. The presence of pollutants, such as heavy metals, and the sediment's composition (e.g., clay content) can influence toxicity to marine organisms. The unique characteristics of Italian sediments make assessment even more challenging. The geographical variability of sediments, with different mineralogical and organic compositions, requires a tailored approach for each site. In this context, preliminary studies are essential to optimize ecotoxicological analyses. This ensures a more accurate assessment and prevents misclassification of sediments, with direct implications to the different management options.

Methods: The ecotoxicological tests and the physical analyses were conducted on representative samples from different depths (0-50 cm and 50-100 cm) to represent the natural variations within the study area, under UNI CEI EN ISO/IEC 17025:2018 accreditation. Species for ecotoxicological test were selected according to the guidelines of D.M. 173/2016. Two test species were employed for each of the three assay types specified in the D.M. 173/16 (Type I - Sediment; Type II - Elutriate; Type III – Elutriate- larval development) following EPA and/or UNI EN ISO methods.

Results: This preliminary study allowed to select the species that provide the most objective representation of the sediment quality at the Port of Ravenna, leading to more accurate environmental risk classifications. The principal findings are that each species suggested in D.M. 173/16 may not always be suitable for all environments, and natural factors (clay content, metals, ammonia levels) can influence test results and generate false positives (i.e. *P. lividus*). The addition of a fourth species to the test battery (i.e. *A. fischeri* in the liquid phase) is recommended in some cases, e.g. in estuarine harbours. The addition of a more realistic picture of ecotoxicological risks beyond the fourth species does not significantly change the overall hazard assessment (**Figure 1**).

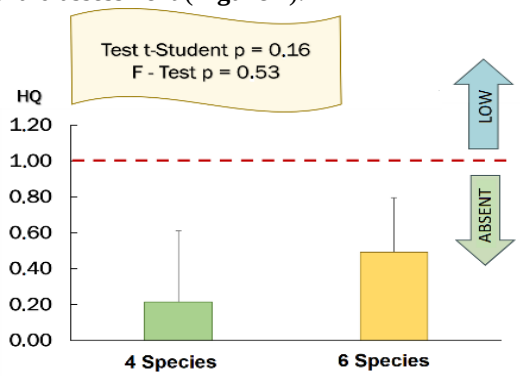

Fig. 1*: Comparative t-Student test for the number of species tested.*

Discussion: A representative classification of sediment quality is crucial for determining sediment management and reuse options. A preliminary assessment is instrumental to defining the analyses methodology that best suits the specificity of the site.

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Potantial Ecological Risk Assesments in the Gediz Delta derived by ^{210}Pb and ^{137}Cs sediment dating

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Conference theme number(s): 1 and 2

Introduction: Gediz Delta is under the pressure of urbanization of the Izmir metropolis. In the last 10 years, with the expansion of housing and industrial zone in Sasalı and Seyrek, the density of buildings and population has increased. The leading factors that pose a threat to environmental ecology and health are the industrial wastes carried by the Gediz River and the pollution caused by agricultural chemicals. These threats significantly affect not only the basin but the entire delta.

Methods: Activity concentrations were measured by using two gamma spectrometers, one of them was planar HPGe detector with low energy and the other was p-type coaxial HPGe detector with medium and high energy. The gamma activity of ^{210}Pb with 46.5 keV energy in sediment samples was measured with a gamma spectrometer system containing a low energy (3-300 keV) planar HPGe detector with a crystal diameter of 36 mm, a crystal length of 13 mm, an active volume of 13 cm^3 and a vertical detector output. P-type coaxial detector has a horizontal output. The HPGe gamma spectrometer system consists of a 184 cc HPGe detector (detector efficiency: 25%, FWHM: 1.83 keV for 1.33 MeV gamma energy of ^{60}Co and peak/compton ratio: 57:1), Ortec Model-671 spectroscopy amplifier and Canberra PC based MCA (8K) Wilkinson ADC and is shielded with 100 mm lead [1]. In sediment samples ^{226}Ra; ^{214}Bi's 609, 1120 and 1764 keV, ^{137}Cs; 661.66 keV gamma energies are used to analyze. Gamma spectra of the samples are taken for 1-2 days and background spectra are recorded regularly [1].
Two models utilized for determining sedimentation rates in ^{210}Pb dating are CRS, and CIC. The CRS model is better suited for scenarios where the profile distribution of unsupported ^{210}Pb concentrations shows a non-monotonic decrease and specific geological conditions [2]. If there is the monotonic decline with depth, and in sediment cores that obtained from same area, total cumulative residual unsupported ^{210}Pb concentrations more or less vary proportionally the mean sediment accumulation rate, CIC model will give the reliable chronology [3].

Fig. 1: Sampling points of the study area.

Results: The sediment accumulation rates calculated in the Homa, Homa-1A core taken from the study area, vary between 0.02 and 3.20 cm y^{-1}. According to the CIC model, it was understood that the layer sixteen centimeters below the surface was formed in 1986 within the error limits. The dating was confirmed by observing the 1986 peak (Chernobyl) at the same depth in the ^{137}Cs vertical distribution graph obtained in this core.

Discussion: Up to now, redox potentials, porosities and organic matter ratios were obtained in the sediment cores (HM-1, HM-2, Homa-1A, Homa-3A and Homa-7A). Persistent organic pollutants (organochlorine pesticides and 16 PAH compounds) and heavy metals analyses in the sediment cores are still ongoing

Acknowledgements: This study was supported by Scientific and Technological Counsil of Türkiye (TUBITAK) under Grant Number 123Y091 authors thank TUBITAK for their support.

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Title: Reconstruction of historical events by studying radionuclides and chemical concentrations in a sediment core at North Cretan deep basin, Greece

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Abstract

Deep ocean basins are considered adequate laboratories for the study of the cycle of basic physicochemical quantities and tracers. They play a decisive role in better understanding environmental processes and ecosystem functioning. Sediments are also adequate marine matrices for studying the evolution of any quantity of interest, such as the relevant pollutants discharged or to reconstruct past events due to natural hazards. A 31cm sediment core was collected from the northern Crete basin, at a depth of 1500m, using the box corer method, in order to determine the sedimentation rate, measure the levels of 137Cs radioactivity due to the Chernobyl accident and investigate possible radiotracers. The radionuclide activity concentrations were measured in the laboratory using gamma spectroscopy and a high purity germanium (HPGe) detector at the Institute of Oceanography of the Hellenic Centre for Marine Research (HCMR). The sedimentation rate was calculated using radiodating models using both the ^{210}Pb and ^{137}Cs methods. The signals of the nuclear tests as well as from the Chernobyl accident were not resolved for validating the ^{210}Pb model. The time marker of the Kolumbo volcano eruption that took place in 1650 A.D. it was also used to optimize the geochronology results.

Environmental characterization for sediment management: the case of the Port of Civitavecchia (Rome, Italy)

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Conference theme number: THEME 1 - poster presentation

Introduction:
The North Central Tyrrhenian Sea Port Authority, in order to guarantee the safety of navigation and commercial operations taking place in the Port of Civitavecchia (Rome, Italy) planned a maintenance dredging in the commercial docks and in the ship's turning circle. This in order to be able to restore the original bathymetry foreseen by the current harbor master plan: -15m above sea level in the turning circle and -13.50m above sea level in the remaining watersheeds.
In Italy, the management options for dredged sediments are obtained through a multiple line-of-evidence approach, according to the Ministry Decree (M.D.) 173/2016. It is known that the combination of chemical and biological analyses represents an added value for monitoring and management purposes [2].
This work summarizes the results of environmental characterization studies carried out in the port of Civitavecchia. It should be noted that the marine area outside the port of Civitavecchia is characterized by the presence of protected habitats (Habitats Directive) such as *Posidonia oceanica* meadows and coralligenous reefs [3].
The aim of this work is to assess the environmental quality and to suggest the proper management options minimizing the adverse effects on marine ecosystems.

Methods: Sediment samples were collected according to the strategy defined by M.D. 173/2016, providing a total of 78 samples. For each sample, grain size, chemical and ecotoxicological analysis were carried out. Data were elaborated using Sediqualsoft 109.0® software to identify the overall quality classes for management.

Results: Most sediment samples showed an overall quality classified as B and C, with only a few samples classified as A. For class A and B it is possible to manage sediment directly in the marine environment and for C to dispose them into a confined disposal facility (CDF) without isolation, i.e. any exchanges with the marine environment do not generate adverse effects.
Only 8 samples showed a worse quality D, suitable for disposal in a waterproofed CDF and, to a limited extent, class E for sediments that have to be safely removed from the marine environment.
The main responsible parameter for classification is provided by aliphatic hydrocarbons C>12, characterized by a lower toxicity than PAHs

Discussion: The characterization of the sediments to be dredged highlighted the presence of a number of samples that cannot be disposed in a CDF without isolation and handled with particular care.
In order to better discriminate the quality of materials classified in class E and guide their management, the Severe Effect Level (LEG) was calculated. The LEG is defined as "the concentration of the contaminant at which serious ecotoxicological effects are expected (i.e. higher than the average ecotoxicological risk) with a probability of 95%". The samples classified as class E, showing chemical concentrations of C>12 aliphatic hydrocarbons lower than the calculated LEG, can be managed according to the options provided for class D sediments, such as disposal in waterproofed CDF.
The application of the LEG allowed to simplify the management of dredging sediments promoting their reuse in line with the principles of circular economy, ensuring the protection of the marine environment.
Moreover, the resulting quality classification of sediments was fundamental to establish proper mitigation measures (to prevent or reduce the spreading of contaminated resuspended sediment) and monitoring plans, paying attention on nearby protected habitats and species.

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Metals and phosphorus in riverine sediments from catchments under distinct environmental pressures: potential availability assessment

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Conference theme number(s): …..

Introduction: Metal accumulation and transport within sediments has been investigated over the past decades, but still represents a concern and a challenge regarding the development of River Basin Management Plans (RBMPs), under the implementation of the Water Framework Directive (WFD). In catchments where the agricultural, urban and industrial pressures interact, phosphorus coexists with metals in sediments, in which can be retained by the same geochemical components. The resulting interactions between P and metals at the sediment-water interface may lead to secondary pollution, due to the release of metals from sediments.
The Northern region of Portugal shows contrasting land uses, and land management practices infer differences in the factors that contribute to non-point source pollution. Recent studies support concerns related to soil losses and land use conflict, high levels of P, metals and organic contaminants in the regional fluvial systems. This study aims to recognize the pattern of distribution and the potential availability of metals and P in streambed sediments from two catchments, Vilariça and Vizela, with distinct geomorphology (and connectivity), land use and environmental pressures, located in the mentioned region.

Methods: The sediment samples were collected in September, at the end of the Dry Period (DP) and in May, at the end of the Wet Period (WP); the 63µm fraction was studied for As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn and V. To assess the contents and potential mobility of metals and P, aqua regia digestion, a modified Tessier method, water extractable P, anion exchange membrane extractable P, and the Chang and Jackson P fractionation methods were used.

Results and Discussion: The metals that showed the highest levels (above TEL and PEL reference values), in both catchments, were As, Cd, Cu, Pb and Zn. Of these, Cd, Cu and Pb occur in percentages ranging from 45 to 90% in the most unstable fractions (most labile fractions - #1, bound to Mn oxides - #2, bound to Fe amorphous compounds – #3). In the Vizela catchment the contents of Zn were also high in these fractions. The metal(oid) showed no affinity with fraction #4 (forms bound to organic matter). This distribution indicates the contribution of anthropogenic activity and a high potential for mobility and risk to river waters. The higher contents Cr, Fe, V and Ni presented in the residual fraction, express a significant contribution from a lithological source.
Between DP and WP, there was an increase in Pt in most of the samples, more pronounced in some sampling stations. Higher P-MTA contents were registered in the WP sampling period at most of the sampling stations in Vilariça and a few stations in Vizela. Yet, it was also observed a decrease in the Pi/Po ratio, revealing significant increases in Po between DP and WP. The distribution of P among the most active fractions shows that the Vilariça sediments are dominated by Ca-P, Fe-P and CBD-P. Between sampling periods, the high increases in P associated with Fe in the WP stand out, implying a susceptibility to P losses. In the sediment samples from Vizela, the distribution of the most active forms of P differs from that recorded in Vilariça, registering higher amounts of Al-P and lower amounts of CBD-P. When the variation between DP and WP is considered, there is some redistribution of P between the studied fractions.
The results of this study revealed a large variation in available metals and P from sediments of both catchments, and some samples reached levels that may present an environmental risk to the watercourses.

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Mercury contamination: from sediments to the terrestrial ecosystem. The case study of the Toce River (Northern Italy)

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Conference theme number(s): 1. Zero pollution

Introduction: Mercury is still considered a contaminant of concern in freshwater ecosystems, due to accumulation in sediments and biomagnification in trophic chains. About 50% of European surface water bodies fail to achieve the good chemical status because of mercury concentrations in water and/or biota [1]. Mercury bioavailability was assessed in the Toce River (Northern Italy), were residual contamination deriving from the activity of a chlor-alkaly plant is present in sediments. The aim was to assess the transfer of mercury from sediments to higher trophic levels, both in the aquatic (up to predator fish) and in the terrestrial ecosystem (insectivorous birds) and potential risks.

Methods: Total mercury (THg) and methylmercury (MeHg) were analyzed in sediments of the Toce River, in native benthic invertebrates belonging to different taxonomic/functional groups and in different benthofagous fish species (*Salmo trutta*, *Telestes muticellus*, *Squalius squalus*). To assess the transfer to terrestrial trophic chains, THg was analysed in adult macroinvertebrate insects and in different body tissues (feathers, blood, eggs) of the resident insectivorous passerine great tit (*Parus major*).

Results: THg in sediments showed values up to 100 µg kg^{-1} d.w., slightly declining in time, while MeHg represented <1% of THg. Among benthic invertebrates, collectors, shredders and predators exhibited higher concentrations (up to 253 µg kg^{-1} d.w. for THg and 88 µg kg^{-1} d.w. for MeHg) than grazers, confirming that exposure is mainly due to the ingestion of contaminated food resources (sediments or preys) [2]. Fish showed values up to one order of magnitude higher than preys, and almost 100% of mercury was in the organic form (MeHg). THg concentrations in adult insects were close to those in aquatic stages, proving active mercury transfer to terrestrial food chains. Here, analysis of body tissues of resident great tits showed the presence of mercury in feathers and blood of adult females (THg up to 2 mg kg^{-1} d.w. and 0.28 mg kg^{-1} w.w., respectively) and its transfer to their offspring (THg up to 0.04 mg kg^{-1} w.w. in eggs), as proved by significant correlations between Hg levels in eggs and maternal blood (r=0.91) or feathers (r=0.76, p<0.05).

Discussion: Active cycling of mercury stored in sediments has been observed in the Toce River, with values in benthic invertebrates – organisms at the basal levels of the aquatic trophic chain - and in fish exceeding the European Environmental Quality Standard for biota (EQS_{biota}=20 µg kg^{-1} w.w. THg in fish) (Fig. 1). This threshold is aimed to protect top predators from risk of secondary poisoning. Based on these data, the chemical quality of the Toce River stretch should be classified as "not good". However, as in other mercury-contaminated ecosystem, further research is needed to determine the extent to which Hg exposure may cause significant impacts on wildlife.

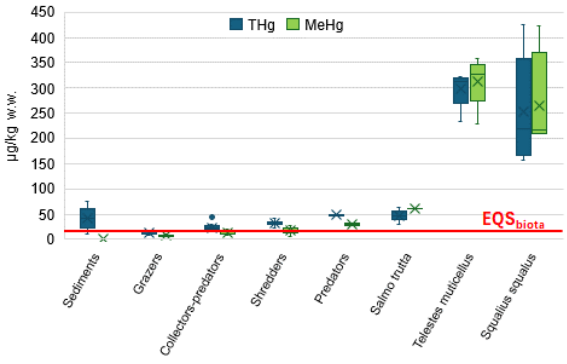

Fig. 1: THg and MeHg concentrations in sediments, benthic invertebrates (functional feeding groups) and fish collected in the Toce River, in comparison to the EQS for Hg in biota.

References: [1] EEA (2024) *https://www.eea.europa.eu/en/analysis/publications/europes-state-of-water-2024*; [2] Marziali et al. (2021) *Toxics* **9**:197.

The NRRP Return Project: Environmental integrated monitoring plan for both traditional and emerging contaminants

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Conference theme number: 1 – Zero pollution

Introduction: The Italian NRRP (National Recovery and Resilience Plan) RETURN (multi-Risk sciEnce for resilienT commUnities undeR a changiNg climate) Project aims to improve understanding of environmental, natural and anthropogenic risks within the context of climate change. RETURN includes the proposal of a new integrated monitoring plan for traditional (metals and hydrocarbons) and emerging contaminants (asbestos fibers, organic microcontaminants, drugs, etc.) in seawater and sediments and their ecotoxicological effect in port sea environment. The first application of the monitoring plan was carried out in the Port of Genoa (Italy) for the first time between 15 December 2023 and 8 January 2024.

Methods: The monitoring plan included measures of physical-chemical parameters of the water column and dynamics by fixed and mobile instruments; sampling of sediments and water by Van Veen grab and Niskin bottle; sampling of traditional and emerging contaminants by passive samplers (DGT, POCIS and SPMD)[1]. Moreover, ecotoxicological evaluation of water and sediments was performed by tests on *Dunaliella tertiolecta* and *Artemia salina*. Sediments were sampled throughout the port basin, while two sites (Site 1 and Site 2) with different characteristics in terms of marine dynamics, port activities, stream inputs and vessel traffic were chosen for contaminant determination.

Results: Results made it possible to both characterize the port basin from a geological point of view and determine the distribution of major elements and trace elements. Significant differences between the two monitoring sites were found, including, for example, different sea dynamics (Site 2>Site 1), and metal concentrations in seawater (Fe in Site 1>Site 2), sediments (Site 1>>Site 2), and DGT (Site 1>Site2). Caffeine, cocaine and some drugs such as naproxen (an anti-inflammatory) were detected at both sites, while other compounds such as sucralose and benzophenone-3, which is a UV filter found in creams, were only detected at the eastern site (Site 2), the one closer the city of Genoa. Notable differences in toxicity levels between seawater and sediment elutriates were highlighted, but no differences between monitoring sites.

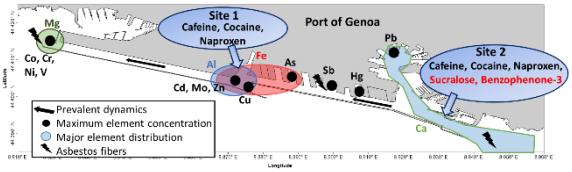

Fig. 1: Scheme of the results obtained in the Port of Genoa with the first application of the RETURN integrated monitoring plan.

Discussion: The proposed plan proved to be valid for the characterization of the port basin and the further sampling and measurement campaigns will allow us to refine the chosen methodology and better understand the results obtained.

Acknowledgements: The Authors would like to thank the Port System Authority of the Port of Genoa for having granted the use of the port areas as pilot site for their research activities. The present study was funded by the Italian NRRP (National Recovery and Resilience Plan) RETURN project (CUP D33C22001290002).

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Organic ultraviolet filters (OUVFs) in sediments of freshwater bathing areas in Southern Poland: Current sink and future risk?

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Conference theme number(s): Theme 1 (Zero Pollution)

Introduction: Organic ultraviolet filters (OUVFs) are essential components in sunscreens and personal care products [1], designed to protect the skin by absorbing UV rays [2]. Despite their protective benefits, the environmental impact of OUVFs cannot be overlooked, as these compounds are directly released into ecosystems through recreational activities, wastewater treatment plant effluents, and illegal dumping [3]. As emerging contaminants, OUVFs pose a significant threat to the environment due to their high concentrations, frequent detection, chemical stability, resistance to biodegradation, persistence, potential toxicity, and endocrine-disrupting properties [4]. To our knowledge, no studies have yet examined OUVF concentrations in freshwater sediments in Poland. Therefore, this study aimed to determine the concentrations of the most used OUVFs in the sediments of recreational freshwater reservoirs in Southern Poland.

Methods: Sediment samples were collected in April and July 2024 from the popular freshwater reservoirs in Southern Poland, namely Kryspinów, Chechło, and Balaton, as well as from the Dobczyce reservoir that as the primary drinking water source for the Krakow's inhabitants was selected as the reference site. The determination of OUVFs followed the modified procedure described in [5]; briefly, 20 g sample of air-dried sediment was subjected to ultrasonic-assisted extraction using 20 mL of methanol (MeOH) for 30 minutes. Following extraction, the sample was centrifuged at 5000 rpm, and the supernatant was decanted. The extract was then evaporated to dryness using a CentriVap vacuum concentrator and reconstituted in 0.25 mL of MeOH. Organic UV filters were determined using an ultra high performance liquid chromatography (UHPLC) system (Vanqiush Flex Thermo Scientific), coupled to a triple quadrupole mass spectrometer (TSQ Altis Plus, Thermo Scientific).
Environmental risk associated with the analyzed OUVF concentrations in sediment samples were assessed using the risk quotient (RQ) methodology originally designed by the US Environmental Protection Agency [6]. RQ values were calculated as the ratio of measured environmental concentrations (MECs) to predicted no-effect concentrations (PNECs) for each investigated OUVFs. The mean concentrations of UV filters detected in each reservoir were used as MECs. The worst-case scenario was also considered, with maximum measured concentrations used as MECs. PNEC values were obtained directly from the ECHA Chemical Database [7] or, when unavailable, from relevant scientific literature.

Results: The concentrations of seven investigated OUVFs, namely benzophenone-3 (BP-3, oxybenzone), octocrylene (OC), 4-methylbenzylidene camphor (4-MBC), ethylhexyl methoxycinnamate (EHMC, octinoxate), butyl methoxydibenzoylmethane (BMDBM, avobenzone), homosalate (HMS), and isoamyl p-methoxycinnamate (IAMC) will be presented. Additionally, changes in the concentration of investigated OUVFs between spring (before the swimming season) and summer (during the peak of the swimming season) will be discussed. Finally, the estimated environmental risk as RQ values calculated for mean OUVF concentrations as well as for the worst-case scenario, represented by the maximum OUVF concentrations will be considered.

Discussion: As the first study investigating OUVFs concentrations in inland freshwater sediments in Poland, the findings of this research fill a critical knowledge gap and offer valuable insights. These results will also support the development of future pollution control strategies and enhance sediment quality monitoring efforts.

Funding: Research project was supported by program „Excellence initiative – research university" for the AGH University of Krakow.

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Historical analysis of micro plastics and heavy metals from the sediment records in İzmir Bay

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Conference theme number(s): I ve II

Introduction: The province of Izmir is an important settlement area where the concept of urbanization has been experienced throughout history for more than 3000 years. Today, the metropolitan city of Izmir is the third largest city in Turkey in terms of urbanization with a population of approximately 5 million and the second busiest port of Turkey. The Gulf of Izmir is heavily affected by both natural micro-oceanographic and anthropogenic effects caused by intensive industrial-commercial activities, maritime traffic/shipyard activities and population density [1]. Therefore, the aim of the presented study is to examine the historical analysis of micro-plastics and heavy metals in the sediment records of İzmir Bay by ^{210}Pb and ^{137}Cs dating .

Methods: This study deals with the sediment cores from Izmir Bay /Aegean Sea within the scope of the ongoing project" Potential Ecological Risk Assessments in the Izmir Bay-Gediz Delta". One-day sampling expedition was conducted on 26th August 2024, onboard of R/V Marmara.

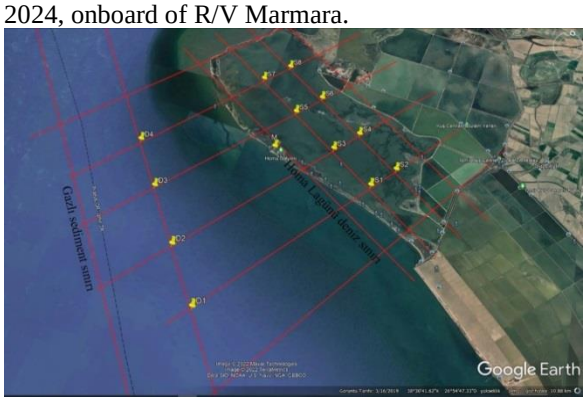

Fig.1: The sampling stations in the Izmir Bay-Gediz Delta

The sampling has been performed using Box-Corer sampler. The sampling stations (Fig.1) were selected based on recent preliminary information as shown in Fig.2. Four sediment cores from the inner Bay were sliced at 1-cm intervals for further analyses. In this study, the quantitative determination of the ^{210}Pb and ^{137}Cs was carried out by HPGe gamma spectrometry. Heavy metal analyses are carried out by Wavelength Dispersive XRF Spektrometers. Micro-plastic analyses are performed using well-known defined methods [2].

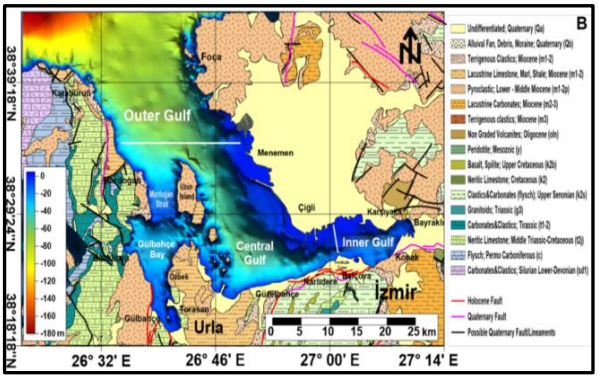

Fig.2 Bathymetric map of the Izmir By[1].

Results: It was derived from ^{210}Pb dating that the sedimentation rates of the region were in the range of 1,71- 3,54 cm.yr^{-1}. There is not a significant discrepancy between CRS and CIC Models [3-4] and give the almost same results. Furthermore, the validity of the proposed methodology is confirmed by ^{137}Cs chronology. After all analysis of heavy metals and micro plastics are completed, pollution history of the studied marine region will be evaluated within the established chronology.

Discussion: Sediments are a fundamental, complementary and dynamic part of the aquatic environment and serve as an archive for understanding the environmental processes and fates of pollutants in the aquatic systems.

Acknowledgements: This Project (Contract No: 123Y091) is financially supported by the TUBITAK (The Scientific Technological Research Council of Turkey).

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MEASUREMENT OF MICROPLASTICS IN SAND SAMPLES TAKEN FROM AZERBAIJAN COASTS OF THE CASPIAN SEA.

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Conference theme number(s): 1. Zero Pollution

Introduction: Plastics are synthetic organic polymers, which are derived from the polymerisation of monomers extracted from oil or gas [1]. Since the mass production of plastics began in the 1940s, microplastic contamination of the marine environment has been a growing problem. Microplastics are both abundant and widespread within the marine environment, found in their highest concentrations along coastlines and within mid-ocean gyres [2]. Due to their small size, microplastics are widespread pollutants that can permeate various environments, posing risks to both ecosystems and human health. Microplastics have emerged as a significant environmental problem worldwide, particularly affecting unique ecosystems such as the Caspian Sea. The Caspian Sea is the largest lake on Earth both in terms of area and volume. It has a surface area of 371,000 square kilometers (143,000 sq mi). Its volume is 78,200 cubic kilometers (18,800 cubic miles). The Caspian Sea has 40-44% of the world's total lake waters. The Caspian Sea is an endorheic water body. It borders with Russia, Azerbaijan, Iran, Turkmenistan and Kazakhstan. Although research on microplastics is increasing globally, research focused on the Caspian region is still limited, especially regarding their potential effects on human health. This gap in research indicates the need for targeted research in this area. Research works on the study of microplastics in the Caspian region were mostly carried out in Iran, located on the southern shores of the Caspian Sea. In this study, sand samples taken from the Azerbaijani shores of the Caspian Sea were analyzed to determine contamination with microplastics.

Methods: The microplastics were analyzed using the IAEA's NUTEC protocol in samples taken from the Azerbaijani coast of the Caspian Sea. In the study, sand samples were collected from two distinct coastal areas of Caspian Sea in Azerbaijan, Novkhani and Shikhov (Figure N:1), with particular attention given to the surrounding environmental conditions and weather during the sampling process. Analisis process of samples include Drying, Fractionating, Density Separation, Filtration, Microscopic analysis of samples and Calculation of microplastic particles.

Results: A certain amount of microplastics were detected in the samples taken from both areas - Novkhani and Shikhov.

Fig. 1: Sampling stations along the coastline of the Caspian Sea in Azerbaijan (Absheron peninsula)

In particular, 94 MP/kg microplastics were found in the 4 mm-1.6 mm fraction in the Novkhani area, and 117 MP/kg in the same fraction in the Shikhov area. After calculations for each fraction, the total number of microplastics found in the Shikhov and Novkhani samples was divided by the weight of the dry sample, and approximately how many microplastics were present per 1 kg of sand was calculated .The discovery of a large amount of microplastics (150–290 particles/kg) in the coastal areas of Novkhani and Shikhov confirms that plastic pollution is widespread in the region.

Discussion: These results provide an estimate of the microplastic concentration in sand samples collected in the Novkhani and Shikhov coasts of the Caspian Sea, which help to understand the distribution of microplastics in different size fractions. Based on these results, it is possible to say that plastic pollution exists.This indicates that microplastics are present in significant quantities on the coasts.

The amounts of microplastics in different fractions demonstrate that microplastics vary in size and quantity across sites, and that overall plastic pollution is a problem in both sites. Based on this, the presence of plastic pollution on these shores of the Caspian Sea is confirmed.

Acknowledgements. This work was funded by the Institute of Radiation Problems, Ministry of Science and Education of the Republic of Azerbaijan.

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Microplastic pollution in a special protection area for migratory birds

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Conference theme number(s): 1

Introduction: Plastic pollution in Special Protection Areas (SPAs) for migratory birds and in Sites of Community Importance (SIC) is a growing environmental concern. These areas, often designated to safeguard migratory bird species, are increasingly threatened by plastic waste. This study presents the first assessment of microplastics (MPs) pollution in beach sediments along the coast of the Strait of Messina (Central Mediterranean Sea) to evaluate the ecological risk.

Methods: Microlitter samples were collected from two sandy beaches, Montorsoli and Pylon beach, with a different anthropogenic impact. Microparticles were identified using Raman spectroscopy and Fourier Transform Infrared Attenuated Total Reflection Spectroscopy (FTIR-ATR). To evaluate the risk, the Polymer Hazard Index (PHI) and Polymer Load Index (PLI) were calculated.

Results: A total of 80 beach sediment samples were collected, with an average of 52.1 MPs/kg. At Montorsoli beach, 321 MPs were detected (80.2 MPs/kg), while Pylon beach had 96 MPs (28 MPs/kg). The dominant polymer at Montorsoli beach was PMMA (91%), followed by PE (2%) and PTFE (1%), with natural fibers, including cotton, accounting for 3% of the findings. In contrast, at Pylon Beach, the most common microparticles were cotton (49%) and cellulose-based fibers (35%), followed by PP (9%), PE (5%), and PET (2%). Based on PHI values, the overall risk of MP pollution at Montorsoli beach was categorized as hazard level V, whereas Pylon beach (PHI = 84) was categorized as hazard level III. Montorsoli beach was characterized by a PLI > 20 (Risk Level Category III), while Pylon beach was characterized by a PLI > 10 (Risk Level Category II).

Discussion: The Strait of Messina is one of the most important European migration flyways, supporting raptors, storks, and many other bird species. This study provides the first data on the MPs contamination of the beaches along the Strait of Messina. Despite not being a popular tourist destination, Montorsoli Beach was the most polluted, primarily by PMMA pellets. In contrast, Pylon Beach which is, a highly touristic area, was relatively clean. This baseline assessment provides critical insights into the current state of microplastic pollution and serves as a valuable foundation for effective management and conservation efforts.

Funding

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eDNA metabarcoding for the assessment of benthic macroinvertebrate biodiversity in Mediterranean coastal lagoons

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Conference theme number(s): 1

Introduction: Benthic invertebrates are invertebrate animals inhabiting the sediments of water bodies. They have a role as suspension feeders by capturing organic particulate from the water column and introducing it to the bottom. Benthic macroinvertebrates also act in the sediment to accelerate the decomposition processes of organic matter. They are suitable as ecological indicators of transitional water ecosystems for their critical role in the food web as well as being sensitive to the pollution conditions of the ecosystems due to their relatively sedentary life, long life cycles, and space use behaviour.. Moreover, the biodiversity reduction of benthic macroinvertebrates can impact the ecosystem functioning as demonstrated for different freshwater ecosystems. The application of molecular methods, such as environmental DNA (eDNA) metabarcoding, is improving the analysis of benthic macroinvertebrate biodiversity (1,2). eDNA metabarcoding refers to the analysis of DNA molecules present in an environmental sample, such as water or sediment, through PCR amplification of specific gene markers, high-throughput sequencing of amplicons, and taxonomic classification of DNA sequences comparing them with DNA barcodes deposited in the reference databases.

Methods:

The study area is a coastal lagoon included within the NATURA 2000 Site “Aquatina di Frigole” (IT50003) located in southeastern Italy. During the spring of 2021, three replicates of 1 L of surface water were collected in seven sampling sites and DNA was extracted. A region of COI gene marker was amplified and the amplicons were sequenced by NGS. The sequences were clusterized in OTU and taxonomically assigned to benthic invertebrates.

Results: High throughput sequencing of the COI amplicons and OTUs annotation highlighted the specific benthic macroinvertebrates communities composition throughout the Aquatina Lagoon (Fig.1). Overall, 49% of the OTUs belong to the Mollusca phylum, 16% to the Annelida phylum, 13% to the Gastrotricha phylum, 8% to the Chordata phylum, 7% to the Arthropoda phylum, 3% to the Cnidaria phylum, 2% to the Porifera phylum, and the remaining 2% to the Echinodermata and Nemertea phyla. The analysis also demonstrated that benthic macroinvertebrate communities structure is correlated to the temperature and salinity gradient of the lagoon.

Discussion: This research demonstrated the validity of eDNA metabarcoding as an efficient tool for the assessment of benthic macroinvertebrate biodiversity in coastal lagoons. The results suggest that peculiar features of this ecosystem, such as shallow waters and limited currents, facilitate the assessment of benthic macroinvertebrate communities through environmental DNA analysis from surface water samples, opening for more rapid and accurate monitoring programs for these animals inhabiting the sediments.

Acknowledgement: This research was supported by the PRO-COAST project funded by EU HORIZON-CL6-2022- BIODIV-01 to Maurizio Pinna; post-doc grant of F. Zangaro was supported by the National Biodiversity Future Center (NBFC) project CN_00000033 funded under the National Recovery and Resilience Plan (NRRP, Mission 4 Component 2 Investment 1.4) of Italian Ministry of University and Research (MUR) funded by the European Union—NextGenerationEU.

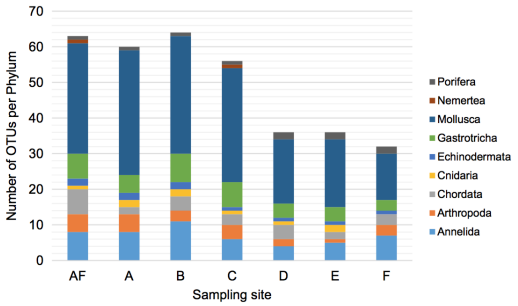

Figure 1. Benthic macroinvertebrates biodiversity among sampling lagoon sites

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The new breakwater of the Port of Genoa (Italy): a complex marine environmental monitoring strategy

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Conference theme number: 1 - Zero pollution

Introduction: Thanks to the realization of the new breakwater and the modernisation of the inner port areas, the Port of Genoa (Italy) is a candidate to become a centre of gravity for large ships and a great logistics hub for trade in Southern Europe, to keep pace with Northern European ports and the rapid growth of North African, Middle East and Black Sea ports [1]. The new infrastructure will allow ultra-large container vessels (over 400 m long and 60 m wide) and bigger cruise ships (over 300 m long) to enter safety the Port of Genoa.
To ensure the sustainable use of marine waters and resources, the European Union has developed a strict system of environmental regulations, including the Marine Strategy Framework Directive (MSFD 2008/56/EC), which defines the general framework of environmental objectives to be applied in all European marine regions [2][3].

Methods: Under the indications and requests of the Italian Ministry and other government and control agencies, the monitoring plan of the construction of the new breakwater has involved a large group of researchers of UNIGE, each involved for their own specific skills in marine environmental monitoring.
All 11 descriptors of MSFD were taken into consideration, and UNIGE was responsible for characterizing Descriptors 1, 2, 3, 4, 5, 6, 7, 9 and 10 "in and around" the works area, and follow their evolution during the works as requested. Given that, the project in question foresees the dredging of the seabed of the port basin and of the inlet channel to the east of the Port, the spillage of the dredged material into the modular caissons of the new breakwater, the preparation of the embankment with gravel spillage and the consolidation of the foundation soils by creating gravel columns, i.e. all activities that may create turbidity along the water column, it was decided to add to the MSFD descriptors also the monitoring of turbidity and water mass dynamics.

Results: Figure 1 is a summary of the monitoring activities planned for each individual MSFD descriptor and for water turbidity and dynamics.

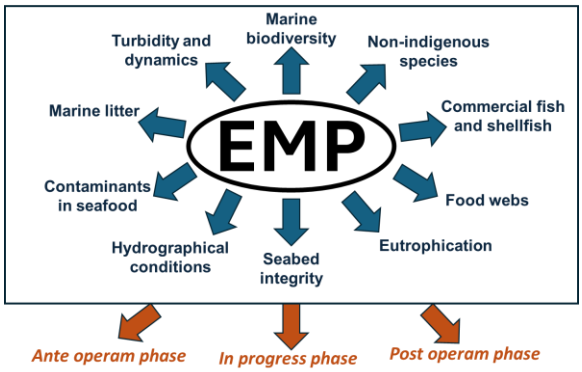

Fig. 1: Scheme of the Environmental Monitoring Plan (EMP) subjects (blue) and phases (orange).

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Rock-glacier springs as key water sources for the future: is trace element contamination a risk?

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Conference theme number(s): 1. Zero pollution

Introduction: Rock glaciers - landforms indicating the past/current presence of ice-rich permafrost - are considered key water storage for the future, since the melting of ground ice is generally slower than the melting of surface glacier ice and because of their role as shallow groundwater reservoirs [1]. Moreover, rock glaciers can be important refugia for cold-adapted species. However, rock-glacier sediment transfer and ice melting can impact surface waters located downstream, since enhanced weathering in rock glaciers may favour the release of trace elements into the outflowing water [2,3]. Our aim was to analyze trace element concentrations in sediments and water of different rock-glacier springs in the Eastern Alps (North Italy) and to evaluate potential (eco)toxicological risks for native aquatic communities and for human health.

Methods: Sediments and water were collected in summer 2024 in springs (Trentino-Alto Adige, North Italy, 1800-2800 m a.s.l.) originating from rock glaciers (n=7) with different degree of activity (from intact to relict ones) vs. non-rock glacier springs (n=6). Trace elements were analyzed by ICP-OES and ICP-MS. Benthic macroinvertebrates were collected with kick-nets and identified to the finest taxonomic level.

Results: The results revealed that sediments of rock-glacier springs located in paragneiss-dominated catchments are characterized by high concentrations of some trace elements, e.g., Ni (Fig. 1) and Cr, exceeding Probable Effects Concentrations [4]. These values mirror concentrations in water, proving potential concern also for human consumption. To evaluate potential ecotoxicological effects on benthic invertebrates, the study will involve analysis of community structure, and of bioaccumulation and incidence of morphological deformities in larvae of Diptera Chironomidae.

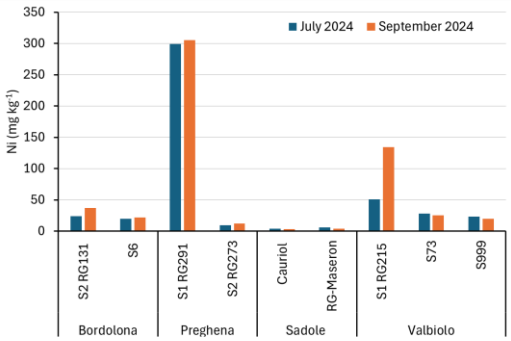

Fig. 1: Concentrations of nickel in sediments of springs originating from rock-glaciers ("RG" in spring code) vs. non-RG, in different areas.

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References: [1] Carturan et al. (2024) *The Cryosphere* **18**:5713-5733 [2] Colombo et al. (2020) *Catena* **194**:104700; [3] Brighenti et al. (2024) *STOTEN* **953**:175706; [4] MacDonald et al. (2000) *Arch. Environ. Contam. Toxicol.* **39**:20-31.

Gammarus fossarum as European amphipod species for substance toxicity assessment using spiked sediment

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Conference theme number(s): 1

Introduction: As part of the evaluation of the chemicals' toxicity via the sedimentary phase in non-vertebrate aquatic species, an OECD test guideline on freshwater amphipods is currently under validation through interlaboratory assay ("Sediment-Water Amphipod Toxicity Test Using Spiked Sediment", Project 2.68). The protocol assesses toxicity of persistent chemicals in sediment and comprises both sub-chronic and chronic toxicity tests that measure the effect of exposure to spiked sediment on juveniles' growth and adults' reproduction, respectively [1-2]. The test guideline proposal focuses on the North-American amphipod *Hyalella azteca* but also includes the possibility to use alternative amphipod species. Here, we aim at highlighting the interest for including the European freshwater amphipod *Gammarus fossarum* as second model species. As a proof study of feasibility, we focused on the sub-chronic toxicity test: an experiment was conducted with *G. fossarum* to assess juvenile's growth in control conditions (i.e. without contaminated sediment).

Methods: Pairs of sexually-mature gammarids were isolated and maintained during 24h in the laboratory in two aquaria at 16°C until juveniles were spawned. Adults were then removed to allow the neonate gammarids to grow without risk of cannibalism. After 7 days (day 7), ten pools of thirty 7-day-old juveniles were sampled from the aquaria, sacrificed in ethanol and dried in an oven (24h, 80°C) to measure mean individual body mass. The remaining juveniles were introduced in new aquaria for 14 days. At day 21, ten pools of thirty 21-day old juveniles were sampled from the aquaria, sacrificed in ethanol and dried to measure mean individual body mass (Fig. 1).

Results: Our analyses showed that juvenile gammarids grew significantly during the 14-day experiment (t-test: t_9 = -8.45, P < 0.001; Fig. 1). Juveniles body mass doubled between day 7 (mean ± SE: 0.03 ± 0.001 mg) and day 21 (0.06 ± 0.003 mg).

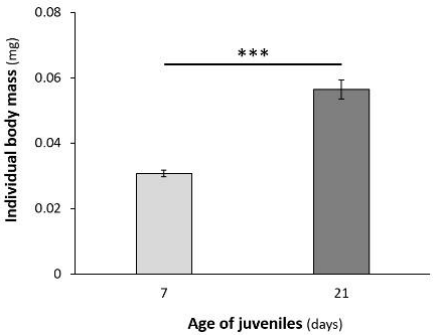

Fig. 1: Mean (± SE) growth of 7-day old juvenile gammarids during the 14-day sub-chronic toxicity test in control conditions (i.e. without contaminated sediment).

Discussion: By determining growth of 7-day old gammarids after 14 days, we demonstrated that validity criteria of the sub-chronic toxicity test was fulfilled (i.e. significant growth in control conditions). These results look promising regarding the Sediment-Water Amphipod Toxicity Test protocol applicability to *Gammarus fossarum*, a European amphipod species. To support these results, an interlaboratory assay is planned in early 2025 with several European countries to determine during sub-chronic toxicity test the effect of two molecules (bifenthrin and pyrene) spiked in sediment.

Acknowledgements: We thank M. Claitte, C. Arcanjo, S. George, A. Racher and D. Galaman for their technical assistance.

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Exploration of sediment research by water authority HHNK within its Water Framework Directive Impulse Program

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Conference theme number(s): 1

Introduction: The current goals of the Water Framework Directive (WFD) for water quality are not going to be met for all waterbodies in the Netherlands in 2027. Dutch water authorities, like Hoogheemraadschap Hollands Noorderkwartier (HHNK), play an important role in the acceleration of the improvement of water quality, both ecological and chemical. This is why HHNK launched its own WFD Impulse Program (WFD-IP), which contains supplementary measures in order to speed up the implementation of the WFD goals. The ambition of HHNK is that all the waterbodies within its management area will be clean and healthy according to the WFD standards by 2027 [1]. However, this is a very though challenge and might not be entirely achievable. HHNK conducted in 2023 a WFD review which revealed that 27 chemical substances do not meet the water quality standards in one or more WFD water bodies[2]. HHNK conducted a monitoring program all substances not meeting the WFD standard. Based on the outcome of the monitoring an action plan was determined by HHNK. One approach was to perform research and monitoring of WFD specific substances, problem substances and (upcoming) substances of concern in relation to the sediment quality. In preparation for dredging work, HHNK already carries out standard water bottom surveys[2]. HHNK will now also take the additional chemical substances into account in this process. This will give HHNK a better understanding of sediment as a source and possible impact of dredging on the chemical water quality. The goal is to use data from monitoring of the WFD-IP and link it and coordinate it to the dredging work. By determining the role of dredging and the local sediment quality on the water quality, dredging can be assessed as part of other possible actions that can be taken by HHNK for improvement of the overall water quality.

Methods: HHNK performs several experiments in relation to the WFD-IP sediment research. Here we focus on an experiment that is being performed with the assistance of Deltares; Monitoring WFD specific substances, problem substances, and substances of concern in sediments at five locations along the motorway N9 (Fig. 1) . Duplo samples will be taken according to guidelines at undisturbed silt rich points. They will be taken either from shore, a bridge, or by boat. A 500 gr. (mixture of 3 monsters) sediment sample will be taken with a piston sampler from the top layer (up to 30 cm). The samples will be stored in the dark around 4 degrees. An additional third sample will be taken for a leaching test (liquid to solid ratio of 10 L kg^{-1}, NEN-EN 12457-2 [3]). Abiotic factors like the weather, pH, temperature, oxygen, and suspended matter will be measured. Samples will be prepared and analyzed by the inhouse laboratory of HHNK, Stichting Waterproef.

Fig. 1: *Indication of sampling locations in the province North-Holland. Modified from A. Wijdeveld.*

Outlook: We would like to further elaborate on this study and present preliminary results in the poster. Some questions we would like to focus on are: 1) What are the possibilities of subsequent delivery from the sediment for various WFD specific substances?, 2) How does this impact these substances reaching our WFD goals?, 3) What are the possible follow-up actions for HHNK that can be implemented in the WFD-IP in relation to sediment contaminated with problematic WFD substances?, and 4) How can we as HHNK improve sediment research within the WFD-IP in a cost-effective way? We will also discuss challenges and lessons learned, and hope to gain insight from experts in the field.

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